Check Tape Recorder Performance
Build a Humless Preamp
Which Tape Is Best?
Improved Recording
See page 4
are you replacing top quality tubes with identical top quality tubes?

Now you can carry the identical tubes that you find designed into most of the quality TV sets you service. Chances are, you were not aware that these TV sets were designed around special Frame Grid tubes originated by Amperex and that even more tube types originated by Amperex are being designed into the sets you'll be handling in the future. Amperex frame grid tubes provide 55% higher gain-bandwidth, increase TV set reliability by simplifying circuits and speed up your servicing because their extraordinary uniformity virtually eliminates need for realignment when you replace tubes.

Tubes introduced by Amperex, currently used by major TV set makers include:

<table>
<thead>
<tr>
<th>Frame Grid</th>
<th>Others</th>
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For optimum satisfaction for your customers and a better profit operation for yourself, make room in your caddy now for these matchless-quality tubes. Next time you visit your distributor, look for the green-and-yellow boxes and enjoy confidence in your work such as you never have before. Amperex Electronic Corporation, Hicksville, L. I., New York.
COLUMBIA STEREO TAPE CLUB NOW OFFERS YOU

ANY 4 of these exciting pre-recorded 4-track STEREO TAPES

for only $5.98

Value up to $39.80 at regular Club prices

FREE-if you join now

REVOLUTIONARY SELF-THREADING TAKE-UP REEL

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

IF YOU ARE ONE OF THE FORTUNATE PEOPLE who own 4-track stereo tape playback equipment, you know the thrill of the near-perfect fidelity, the unsurpassed sound of tape. Now you have an exceptional opportunity to build an outstanding collection of superb stereo tapes at great savings through the most generous offer ever made by the Columbia Stereo Tape Club.

By joining now, you may have ANY FOUR of the magnificently recorded 4-track stereo tapes described here—sold regularly by the Club for up to $39.80—for only $5.98!

TO RECEIVE YOUR 4 PRE-RECORDED STEREO TAPE FOR ONLY $5.98—simply fill in and mail the coupon today! Be sure to indicate which Club Division best suits your musical taste: Classical or Popular.

HOW THE CLUB OPERATES: Each month the Club's staff of music experts chooses outstanding selections for both Divisions. These selections are described in the Club Magazine, which you receive free each month.

You may accept the monthly selection for your Division—or take any of the wide variety of tapes offered in the Magazine. These selections are described in the Club Magazine, which you receive free each month.

Your only membership obligation is to purchase 5 tapes from the more than 150 to be offered in the coming 12 months. Therefore, if you have no further obligation to buy any additional tapes...and you may discontinue your membership at any time.

FREE TAPES GIVEN REGULARLY. If you wish to continue as a member after purchasing five tapes, you will receive—FREE—a 4-track stereo tape of your choice for every two additional tapes you buy.

The tapes you want are mailed and billed to you at the regular Club price of $7.95 (occasional Original Cast recordings somewhat higher), plus a small mailing and handling charge. You may continue your membership for up to $39.80—the regular Club price plus a small mailing and handling charge.

SEND NO MONEY—Just mail the coupon today to receive your four pre-recorded 4-track stereo tapes—ALL FOUR for only $5.98!

IMPORTANT NOTE: All tapes offered by the Club must be played on 4-track stereo tape playback equipment. If your tape recorder does not play 4-track stereo tapes, you may be able to convert it simply and economically. See your local service dealer for complete details.

COLUMBIA STEREO TAPE CLUB

Torre Haute, Ind.

SEND NO MONEY—mail coupon to receive 4 tapes for $5.98

COLUMBIA STEREO TAPE CLUB, Dept. 428-8

Torre Haute, Indiana

I accept your special offer and have written...in the boxes at the right the numbers of the 4 tapes I would like to receive for $5.98, plus a small mailing and handling charge. I also receive my self-threading reel—FREE! I agree to receive the following numbers of the Club Magazine—

CLASSICAL or POPULAR

I understand that I may select tapes from either Division. I agree to purchase five selections from the more than 150 to be offered in the coming 12 months and to be billed at regular Club prices on a small mailing and handling charge. Thereafter, if I decide to continue my membership, I am to receive 4 new pre-recorded tapes at regular Club prices for the next 12 months, less a small mailing and handling charge. I agree to accept 4 pre-recorded tapes for the next 12 months.

SEND ME THESE 4 TAPES

Tape Numbers:

FAVORITE FOR GIFT-GIVING: THE RAINBOW STRAIN. The New Christy Minstrels. Hanalei. Columbia STEREO APE Club now offers you 9 more selections, plus 13 more; if you join the Club now and agree to purchase as few as 5 selections from the more than 150 to be offered in the American Salute Album.

Send this coupon to:

COLUMBIA STEREO TAPE CLUB

1281 Columbia Records Distribution Corp., 1964

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START NOW. A whole new world of opportunity awaits the man with Electronic Home-Training from National Technical Schools—a recognized leader in technical training for 58 years.
New Weather Satellite
Broadcasts Local Reports

Tiros VIII, latest of America's weather satellites, carries a special automatic transmitting system that sends pictures to earth via relatively simple ground stations.

The first seven satellites sent rather complex pictures on command for reception by special ground stations. Tiros, called "everyman's weather satellite," broadcasts its signals so that individual localities will be able to obtain direct readout pictures of what the weather activity over a local region looks like from 400 miles in space.

The pictures are recorded by facsimile rather than on film. The quality is not as good as that of film pictures but will provide as much information as local meteorologists will need. The new system, called APT, for Automatic Picture Transmission, is already transmitting to more than 50 ground stations throughout the world.

Intercom Works Under Water

An underwater communications system recently announced by Bendix uses an electronic transmitter attached to a diver's air tank, a mouth mask that allows him to move his lips freely, and a throat microphone. A transducer at one end of the cylindrical transmitter sends audio signals directly into the water, where they can be heard by other divers without any equipment.

British TV Recorder Demonstrated Here

Telcan, the low-price British TV tape recorder, announced in RADIOTELEONICS October 1963, page 6, was demonstrated in New York City by Cinerama, Inc. Cinerama is the majority stockholder in a company formed to distribute Telcan in the United States.

Demonstrated in a basement room of the Cinerama theater in New York City, off-the-air taping gave a hardly acceptable picture. Another demonstration was a live pickup with a Telcan TV camera, the subject being photographed and the tape played back immediately. In the words of one observer the picture "would have been considered good 10 years ago." Representatives of Telcan and Cinerama guessed that it might be possible to sell the recording unit for less than $200, and possibly a home type electronic camera for about the same price.

Regular 1/4-inch audio tape was used with half-track recording, 20 minutes on each side. Tape speed is 120 inches per second.

Relay I Won't Quit

NASA's Communications Satellite, RELAY I, launched from Cape Canaveral on Dec. 13, 1962 kept working and merrily answering questions from earthmen after Dec. 31, 1963, which was supposed to be its last working day. It was equipped with a self-destructive timing device to switch off its power about a year after launching. Engineers believe that it failed to go off because of the extreme cold.

Richard P. Dunphy, RCA project manager for RELAY, explained that "the reason for the planned silencing of the satellite was that the more advanced RELAY is scheduled for launch shortly and, since RELAY I will have completed its mission, it was deemed good sense to silence it so that its signal would not be added to the already limited radio-frequency spectrum." He said that an electrolytic material was placed inside RELAY which was supposed to eat away a connection between the main power lead and the solar panels at a predetermined rate. But unexpected coldness around the device has slowed down the erosion.

Built-In Music Systems Becoming Popular?

Manufacturers of home music systems at the National Association of Home Builders Show in Chicago estimated that between 5% to 8% of new homes built in 1963 were equipped with intercom music systems. This figure may rise to 8% to 10% yearly.

Manufacturers say that most of
Men 17-55
JOB OPPORTUNITIES!
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MONEY!

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Yours as a trained
Electronics
TECHNICIAN

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

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☐ Television and Radio ☐ Computers
☐ Microwaves ☐ Broadcasting
☐ Radar ☐ Industrial Electronics
☐ Automation Electronics ☐ Electronic Control

Name ___________________________ Age ___________________________
Address ___________________________ City __________ Zone ____________
Apt ___________________________ State ___________________________

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

Canadian residents: Write DeVry Tech of Canada, Ltd.
970 Lawrence Avenue West, Toronto 12, Ontario

MARCH, 1964
NOW! CASTLE OFFERS YOU THE BIGGEST BARGAIN IN TV TUNER OVERHAULING!

THE BIGGEST BARGAIN IN NOW! CASTLE OFFERS YOU Seven Hours...all others within 24 Hours.

for TV TUNER OVERHAULING!

CASTLE defective unit only sent in. VHF tuners must be dismantled and the piece construction. Separate UHF and *UV combination tuner must be of one (or rebuilt.) $12.95 exchange. (Replacements are new and complaint. 90 Day Warranty. Completions and shipped within 12 hours. They range from 1 for impossible to 9 for excellent. These notices are revised at midnight, 7 am, noon and 6 pm.

New Training Device Takes Students “Undersea”

W indicates ionospheric disturbance in progress or expected; U, conditions unstable but communications possible with high power; N, no warning. The numbers apply to expected conditions during the following 12 hours. They range from 1 for impossible to 9 for excellent. These notices are revised at midnight, 7 am, noon and 6 pm.

In a decade of experience overhauling TV Tuners of ALL MAKES, Castle has developed new handling and overhauling techniques which give you...

Fast Service

A recent study at our Chicago Plant revealed that of all tuners accepted for overhauling, over 30% were completed and shipped within...

Seven Hours...all others within 24 Hours.

Simply send us your defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. 90 Day Warranty.

One Low Price includes All UHF, VHF and UV Combination Tuners

9.95

in telegraphic code, consist of a letter (N, W or U) followed by a number from 1 to 9. They indicate propagation conditions over the North Atlantic.

W indicates ionospheric disturbance in progress or expected; U, conditions unstable but communications possible with high power; N, no warning. The numbers apply to expected conditions during the following 12 hours. They range from 1 for impossible to 9 for excellent. These notices are revised at midnight, 7 am, noon and 6 pm.

New Training Device Takes Students “Undersea”

WIV is now broadcasting propagation notices every five minutes following the code time announcement and just preceding the voice time announcement. Formerly, propagation notices were broadcast 19½ and 49½ minutes after the hour. These notices, in telegraphic code, consist of a letter (N, W or U) followed by a number from 1 to 9. They indicate propagation conditions over the North Atlantic.

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Seven Hours...all others within 24 Hours.

Simply send us your defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. 90 Day Warranty.

Exact Replacements are available for tuners unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

*UV combination tuner must be of one piece construction. Separate UHF and VHF tuners must be dismantled and the defective unit only sent in.

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*UV combination tuner must be of one piece construction. Separate UHF and VHF tuners must be dismantled and the defective unit only sent in.

Students aboard the simulated submarine find and track the North Star in a planetarium built above the telescope. The scope operator is helped by an electronic computer that automatically swings the scope to the designated star, then locks on the tiny spot of light.

15-Mile-High Telescope Gathers New Data

A 36-inch fused silica mirror, lifted to 80,000 feet by a balloon and controlled by scientists on the ground with two on-board television cameras, was used to gather infrared data on Jupiter, the moon, several cool red giant stars and other targets.

from Palestine, Tex., starting at 4 pm Nov. 26, and landing at 9:32 am near Newport, Miss. The telescope was in good condition when recovered.

A 450-pound mirror blank of
THE SAME ENGINEERING, SAME PLANT THAT PRODUCES AMERICA'S GREATEST SATELLITE-TRACKING AND TELEMETRY STATIONS, HAS CREATED the revolutionary new PARALOG TV/FM ANTENNA

...Unparalleled performance because it has ALL 5:
- HIGHEST GAIN
- SHARPEST DIRECTIVITY
- EXTREMELY LOW VSWR
- BEST FRONT-TO-BACK RATIO
- RUGGED CONSTRUCTION

HERE IT IS—the space-age TV/FM antenna from the only manufacturer with actual experience in making space-probing antennas!

All new, the PARALOG is the first home antenna that really comes through with log-periodic design plus a unique parasitic-element system for maximum all-channel gain and pinpoint directivity. Exclusive Cycolac insulating mounts assure constant impedance, eliminate troublesome cross-feed design. Extremely rugged construction.

There are fourteen PARALOG antenna models, listing from $19.95, including four electronic PARALOGs with Super Powermate preamplifier, and three special FM stereo models. See your Jerrold-TACO distributor now, or write Jerrold Electronics, Philadelphia 32, Pa.
fused silica (the purest glass known), made by Corning Glass Works at Bradford, Pa., was ground and finished by Perkin-Elmer Corp., Norwalk, Conn., who also constructed the telescope system. Fused silica was chosen because of its near-zero thermal expansion factor. Large and sudden temperature changes do not change the shape of the glass.

The telescope control system includes 40 command and 64 telemetry channels. The project is being conducted by Princeton University with financial aid from several Government bureaus.

**Laser Triode Invented**

A new type of gas laser that can be modulated by varying the voltage on the grid in the tube, has been reported by Bell Telephone Laboratories. Excited by a beam of electrons of nearly identical energies emitted from a hot oxide cathode, the triode laser oscillates without the usual glow discharge of ordinary gas lasers.

Inside the triode laser tube are a cathode, grid and anode in the form of ribbons parallel to each other and extending about 8 inches along the horizontal axis of the laser. The electrons from the cathode are controlled by the grid to have an energy spread of only a fraction of a volt.

(In ordinary discharge lasers the energy spread is tens of volts, much of which is wasted because only a narrow band of energies is used in the excitation process. Thus, in the triode laser, the efficiency of excitation per electron is increased a hundredfold.)

By varying the grid voltage which controls the electron flow in the laser tube, the light beam can be switched and amplitude modulated. At high electron energies and gas pressures, strong absorption of light instead of laser oscillation has been observed.

**Dr. John Pierce Among Scientists Honored At White House**

The 1963 National Medal of Science has been awarded to John R. Pierce, executive director of the Bell Telephone Laboratories, Murray Hill, N.J., and to four other scientists.

The others honored at the White House presentations were Dr. Vannevar Bush, engineer, scientist and administrator; Luis W. Alvarez, associate director of the Lawrence Radiation Laboratory, Livermore, Calif.; Dr. Cornelius V. van Niel of the Hopkins Marine Station of Stanford University, Palo Alto, Calif., and Norbert Wiener, professor emeritus of the Massachusetts Institute of Technology, Boston.

**Parisian “Radio City” Receives Mixed Reviews**

A 21-story radio headquarters, called “La Maison de la Radio” (The House of Radio), was inaugurated recently by President de Gaulle. Critics, pointing out that the center is designed for radio rather than TV, wondered why the Government spent $40 million in the 1960’s on a project that seemed more appropriate for the 1930’s, when the US and Britain built their radio headquarters. M. Robert Bordaz, director-general of the State Radio & Television Service, expressed a desire for a TV center some time in the future, but said there were many unsolved problems.

“La Maison de la Radio” includes 50 studios, from a 1,000-seat
Perhaps you're working in Electronics now but feel the need for an FCC License or more math ... perhaps you're a hobbyist trying to decide between a career in Automation and one in Communications ... perhaps you're a beginner who left school early, but you're thinking about the career possibilities of building a spare-time or full-time business of your own servicing radio and television sets. Worker, hobbyist or beginner, whatever your desire, there is training for you among the nine specialized courses NRI offers. Read the descriptions of NRI training on the other side of this page, about successes of NRI graduates, about NRI training equipment included at no extra cost. Then, cut out and mail postage-free form for FREE NRI CATALOG.

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"I HAD A PROMOTION BEFORE I FINISHED the Communications Course," reports Ronald L. Ritter, 1133 Holmes Dr., Gettysburg, N. J., "as well as the satisfaction I could handle a job of responsibility." He works for the U. S. Army Electronic Laboratories, Ft. Monmouth. He received one of the highest grades in Army proficiency tests.

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., RTD 2, Cayuga, N. Y., says of his position with the G. E. Advanced Electronics Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."

HAS SERVICE BUSINESS OF HIS OWN. Don House, 3012 2nd Place, Lubbock, Texas, went into his own full-time business six months after finishing the NRI Radio-TV Servicing course. "It makes my family of six a good living," he states. "We repair any TV or Radio. I would not take anything for my training with NRI. I think it is the finest."

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., 1916 Fern St., New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer and holds FCC Radio-Telephone License. He says, "I can recommend NRI very highly."

Special Equipment Included

The NRI “train-by-doing” method, using special training equipment, is the time-proved way to assure advancement or turn your hobby into a new and profitable career in the fast-growing fields of TV-Radio, Electronics-Automation.

Most NRI courses include special equipment at no extra cost. You build circuits and work experiments. Theory you study comes to life in an interesting, easy-to-grasp manner.

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LEARN to service black-and-white and color TV sets, AM-FM radios, stereo hi-fi, PA systems, etc. A profitable, interesting field for part-time or full-time business of your own.

2. INDUSTRIAL-MILITARY ELECTRONICS
LEARN Principles, Practices, Maintenance of Electronic equipment used today in business, industry, defense. Covers Electronic controls and measurement, computers, servos, telemetry, multiplexing, many other subjects.

3. COMPLETE COMMUNICATIONS
A comprehensive training program for men seeking careers operating and maintaining transmitting equipment in Radio-TV Broadcasting or mobile, marine, aviation communications. Prepares you for FCC License.

4. FCC LICENSE
Prepares you quickly for First Class License exams. Every communications station must have one or more FCC-licensed operators. Also valuable for Service Technicians. You train at home.

5. BASIC ELECTRONICS
An abbreviated, 26-lesson course covering Automation-Electronics, Radio-Television language, components and principles. Ideal for salesmen, hobbyists and others who find it valuable to be familiar with the fundamentals of this fast-growing industry.

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8. MARINE COMMUNICATIONS
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9. MOBILE COMMUNICATIONS
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Washington 16, D.C.

Please send me your Electronics, Radio-TV catalog with complete information on 9 ways to train at home. (No cost or obligation. No salesman will call)

Name

(Please Print)

Age

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City Zone State

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The first successful scanning electron microscope in the United States, being used to study surfaces of tiny microelectronic devices.

concert hall to announcing booths, grouped in a vast circle, a quarter-mile in circumference and 10 stories high. An inner circle houses technical facilities and a rectangular tower for record collections and archives.

Sound Soothes Bees
Scientists at the University of Wisconsin have discovered that a sound wave of the right frequency is as effective in quieting bees as is the smoke commonly used by beekeepers. A 960-cycle note beamed into the hive would cause the bees to stop flying, apparently becoming calm and listless.

Researchers found that the bees pick up the sound through the vibrations of the object on which they were perched, rather than through the air. They found that the bees' forelegs are necessary either to receive the sound vibrations directly or to transmit them to sensitive organs.

New Electron Microscope Uses Scanning Techniques
Combining the principles of the electron microscope and the TV receiver, a new instrument, designed by Westinghouse Research Laboratories, displays detailed pictures of areas only about 15 millionths of a square inch on a 5-inch screen. It also gives equally detailed pictures of the electric fields of the surface scanned. Thus one can see the actual voltage distribution across a resistor or transistor in operation.

As in the regular electron microscope, the electrons comprising the beam are accelerated to high speed by an applied voltage and focused with magnetic coils on to the sample. Then magnetic coils like those on a TV yoke guide the beam across and down the surface in the scanning operation.

The electrons striking the surface cause the sample to emit low-voltage secondary electrons in quantities determined by the surface structure and charge. These electrons are collected, amplified and fed as an electrical control signal to a special TV picture tube, where a visible image of the surface is displayed.

The scanning time for a specimen can be varied from 1/4 to 4,000 seconds. The number of lines can be varied from 250 to 1,000, the 1,000-line setting giving about four times the picture detail of a regular television picture.

Brief Briefs
Philco Corp., pioneer of car radio manufacturing, announced it will re-enter the auto radio field when it begins preliminary production of a newly developed model at its Lansdale, Pa., division, in late spring of 1964.

The dynamic modulation range of gallium arsenide lasers has been increased by a technique similar to that used in push-pull electronic amplifiers. Using two diodes with the output radiation collimated on the same optical path and the input modulation signals 90° apart, scientists of ITT Federal Laboratories, Nutley, N. J., balanced the second-harmonic sidebands in the modulated light output.

FULL FIDELITY HI-FI SPEAKERS
Slim-line styling! Ceramic magnets! Superb reproduction over the full audio spectrum! Complete choice: coaxials, extended range, tweeters, woofers! The new Quam hi-fi line is as modern as tomorrow—and it's designed to offer the serviceman a top-quality product at a list price that's lower than others' "audiophile net." (Quam never advertises net prices—to protect your mark-up!)

Use Quam Hi-Fi Speakers in new systems, as extension speakers in existing systems, and as replacement improvements in stereo consoles. They'll open your way to exciting new sales!

Write for your free copy of the new Quam Hi-Fi Catalog HF-64.

END
**Polarity Changed**

**Dear Editor:**

A note on “Transistors and Your Ohmmeter” (Radio-Electronics, November 1963, page 80): The polarity listing for the Triplet 630 is correct up to approximately serial No. 186,000, after which the red lead is positive and the black one negative.

W. Laubengayer
Collins Radio Co.
Cedar Rapids, Iowa

**TV Towers: Menace to Birds?**

**Dear Editor:**

May I write to you about a problem which has nothing to do with television, but is created by modern improvements in TV? I refer to the destruction of birds due to the new super-high TV towers, which are so greatly increasing the service areas of many stations.

North American birds migrate in spring and fall. Most species migrate at night, feeding during the day. It is now generally believed that they travel by celestial navigation. They use the stars to steer by.

Early TV towers did not cause any particular hazard. Only when the thousand-foot structures, with their many supporting cables, started to go up, did collision casualties begin to become numerous. Since 1957, I estimate the victims at one single tower in this area to be over 250,000, usually small migrants. Occasionally geese and ducks have been reported, but this is rather rare.

It has been a study of mine to collect and identify birds that have hit the tower. Similar studies have been made and are being made by ornithologists all over the country. Some suggestions for remedies have been made. It was proposed that racks be placed around the tower, as has been done by lighthouses; remedial have been made. It was proposed that racks be placed around the tower to attract the birds away from it. Multiple spotlight beams from below on cloudy nights. This might at least show the other one.

My belief here is, when a fellow talks so technical and won’t realize what the other one means, then it’s just talk. Jack answered him well.

Peter Legon
Malden, Mass.
What are you aiming at?

What are your career objectives? Big pay? Job security? Greater prestige? Interesting work? Sure. All of these. But, these are rewards for hitting the bull’s eye. Can you see the real target? Before you can hit it, you must see it clearly. And, your efforts might ricochet if “fired” from the wrong training program. Get “on target” with Grantham. Get your first class F.C.C. license on the first shot, and then continue with higher-level electronics training if you wish. Aim in the right direction by mailing the coupon for full details.

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RCA WR-51A FM STEREO SIGNAL SIMULATOR

RCA WR-50A RF SIGNAL GENERATOR

Generates continuous wave or amplitude-modulated rf signals of sinusoidal waveform from 85 Kc to 40 Mc. Particularly useful for aligning and signal tracing in AM and FM radio receivers and Citizens' Band transceivers—and for aligning if amplifiers, and for signal tracing in TV receivers.

- Wide frequency range—continuous coverage 85 Kc to 40 Mc in 6 overlapping ranges
- Built-in crystal-calibrating oscillator circuit with front panel crystal socket
- Permanently attached, shielded output cables prevent errors, minimize time loss and inconvenience. Built-in DC blocking capacitors
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- Eight sine-wave frequencies: 400 cps, 1 Kc, 5 Kc, 19 Kc, 28 Kc, 38 Kc, 48 Kc, 67 Kc—available separately or for modulating FM signals.
- 100 Mc carrier signal tuneable ± 0.8 Mc to permit selection of a quiet point in the FM band
- 19 Kc subcarrier signal crystal-controlled within ± 2 cps
- 100 Mc sweep signal adjustable from 0-750 Kc at 60 cps sweep rate
- Choice of three composite stereo output signals: left stereo, right stereo, and special phase test

ALSO features crystal-controlled markers for receiver rf and if alignment. Zero-center meter for checking the balance of stereo amplifier output. Portable and compact: weighs only 14 pounds.

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See them at your Authorized RCA Test Equipment Distributor

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N. J.

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they circle it, many hit cables and fall to the ground.

If any of your readers have had similar experiences and know of any way to remedy or alleviate the situation, I—and many others—would greatly appreciate hearing from them.

CHARLES A. KEMPER, M.D.
Chippewa Falls, Wis.

Notes on the G-Line (From the People Who Make It)

Dear Editor:

We enjoyed Mr. Patrick's fine article (February 1964, page 46) on how he constructed a private TV line with a home-grown version of our proprietary G-Line. The challenge presented by installing 3,400 feet of line over rough terrain proves the tenacity and ingenuity of the author, and incidentally confirms the message we have been preaching: that there is absolutely nothing equal to G-Line for low-loss, low-cost transmission of vhf, uhf and microwave energy.

Of course, we feel that Mr. Patrick could have saved considerable time, effort and even money if he had first contacted us. We could have supplied him with our standard launchers and cable for any frequency.

The amazing results reported by the author have been confirmed in numerous CATV and microwave systems, and we have even run G-Line through tunnels for vehicle-to-fixed-station communication.

For those who want to become familiar with surface conduction principles, our company has put on the market an inexpensive G-Line kit for uhf TV. It can eliminate boosters in some fringe-area installations.

A. PHILLIPS
Surface Conduction, Inc.
New York, N. Y.
These are the very words a lot of technicians use to describe PHOTOFACT. A typical letter (unsolicited) reads like this:

"My PHOTOFACTS mean as much to my business as a road map does to a traveler. I would be lost without them."

Getting "lost" is no way to make a profit in electronics service work. PHOTOFACT users have a perfect road map to the trouble source—with no costly backtracking or detours. On almost any job, PHOTOFACT means all the difference between making a profit or not.

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SEE YOUR SAMS DISTRIBUTOR FOR FULL DETAILS, OR MAIL COUPON .

MARCH, 1964
Winegard Introduces An Amazing New Home TV and Music Outlet System

Plug TV set into any AUDIO-PIX outlet. Run one or more sets simultaneously from a single antenna.

Run a HI-FI (record player, FM or AM, or tape recorder) and feed the sound into the system to be picked up at any AUDIO-PIX outlet.

Plug an FM receiver into the AUDIO-PIX. The AUDIO-PIX serves as an FM antenna signal source, and at the same time automatically feeds the FM sound back into the system to the extension speakers.

All this electronic entertainment can go on simultaneously over a single wire without interference! That's the amazing new AUDIO-PIX system by Winegard.

Watch TV in the kitchen (plug the TV set into an AUDIO-PIX outlet and receive TV antenna signals.)

Turn on the HI-FI record player in the family room... listen to records on an AUDIO-PIX extension speaker plugged into the AUDIO-PIX outlet in the bedroom.
AUDIO-PIX delivers TV, FM or HI-FI
Anywhere Inside or Outside the House Over a Single Wire

Audio-Pix comes beautifully packaged in a Winegard selling display carton with built-in carrying handle.

Watch TV on the patio (the portable TV set is plugged into an AUDIO-PIX outlet and is receiving TV signals from the same antenna.)

Audio-Pix is two systems wrapped into one simple, inexpensive installation. It is both a TV-FM system (distributes TV-FM antenna signals) and a HI-FI music system at a price any home owner can afford. No new home is truly modern without AUDIO-PIX.

The AUDIO-PIX is a revolutionary new electronic entertainment convenience for the home which—

(1)... feeds TV (Ch. 2-83) and FM antenna signals to each AUDIO-PIX outlet.

(2)... feeds sound from a HI-FI (record player, FM and tape recorder) to the same AUDIO-PIX outlets.

The complete Winegard AUDIO-PIX system comes in a kit which contains a special AUDIO-PIX 6-outlet coupler*, 4 AUDIO-PIX outlets and plugs (any number of additional outlets may be added if desired), special AUDIO-PIX HI-FI extension speaker, a special AUDIO-PIX attachment for FM or HI-FI system, and 100 ft. of lead-in wire. Model APK-360, list price $49.95.

Start selling AUDIO-PIX to your customers now. Write for spec sheets or ask your distributor.

*Pat. Pend.
The commanding presence of Sony sound

Now enter the world of the professional. With the Sony Stereocorder 600, a superbly engineered instrument with 3-head design, you are master of the most exacting stereophonic tape recording techniques.

Professional in every detail, from its modular circuitry to its 3-head design, this superb 4-track stereophonic and monophonic recording and playback unit provides such versatile features as:

- Vertical and horizontal operating positions
- Sound on Sound tape and source monitor switch
- Full 7" reel capacity
- Microphone and line mixing
- Magnetic phono and FM stereo inputs
- 2 V.U. meters
- Hysteresis-synchronous drive motors
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- Automatic shut off
- Pause control and digital tape counter— all indispensable to the discriminating recording enthusiast. Less than $450, complete with carrying case and two Sony F-87 cardioid dynamic microphones.

Multiplex Ready!

Sony tape recorders, the most complete line of quality recording equipment in the world, start at less than $79.50. For literature or name of nearest dealer, write Superscope, Inc., Dept. T, Sun Valley, Calif. In New York, visit the Sony Salon, 585 Fifth Avenue.
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FASTATCH II®
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REPLACEMENT
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Makes Control Replacement A SNAP!

- Centralab's new FRK-200 kit gives you the most convenient, most versatile, and simplest system for control replacement.
- Since it includes 13 sizes of exact replacement shafts, shaft cutting is eliminated on all the popular dual concentric controls and on almost 60% of all dual controls.
- The Fastatch II® Control System is a snap to use. Single and dual concentrics snap together without tools! Shafts plug in and are permanently locked. Assembled units can't loosen—shafts can't pull out.

JUST CHECK THESE EXCLUSIVE FEATURES:
1. Just one control system for dual concentric or single controls.
2. Universal terminals.
3. Plug-in, permanently locking shafts.
4. Rotary or push-pull (snap-on) line switches attach to both front and rear controls.

The FRK-200 kit is contained in two stacking Equipto steel cabinets with plenty of extra space for expansion. All your control needs, including push-pull, are at your fingertips.

THE FRK-200 KIT CONTAINS:
- 35 Exact Front Shafts (7 sizes)
- 30 Exact Rear Shafts (6 sizes)
- 5 Universal Push-Pull Shafts (1 size)
- 5 Push-Pull Line Switches
- 5 Twist-Tab Adapter Plates
- 2 3-Drawer Equipto Cabinets
- 27 Assorted Front Controls
- 9 Assorted Rear Controls
- 40 Assorted Universal Shafts for Single and Dual Concentrics
- 5 SPST on/off Switches
- 2 DPST on/off Switches
- 1 DP on/off Switch
- Complete with current cross-reference guides.

Dealer Net $72.50
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Build your own
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Eico Classic 2400 stereo/mono 4-track tape deck. Kit $199.95; wired $269.95 (incl. oil finish walnut base)

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Eico 430 General Purpose 3" Scope. Kit $65.95; wired $99.95

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Eico Classic 2536 36-watt FM-MX Stereo Receiver. Kit $154.95; wired $209.95 (Incl. F.E.T.)
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Eico 667 Dynamic Conductance Tube & Transistor Tester. Kit $79.95; wired $129.95.
Eico 628 Tube Tester. Kit $44.95; wired $59.95

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MULTIPLEX VIDEO

...Multiple All-Channel Receiver Will Simplify Reception...

Ever since the late 1940’s, television receivers have remained practically static. Needed improvements have not been developed, with perhaps one exception: color.

Such improvements as the long-heralded three-dimensional TV, i.e., viewing TV in perspective; flat “picture-on-the-wall” TV; pocket and wristwatch TV—these and many others are still in the future.

Still another badly needed improvement is one to overcome a situation constantly spoken of with irritation by millions of TV viewers: the single-channel annoyance.

In many families there is constant bickering as to which channel to monopolize: Father wants a good prizefight or some other sport; mother wants a drama; the children, comic stuff. No one is satisfied. This often results in several television receivers per family, scattered through a number of rooms, which may not be the best solution of the problem.

Is it possible today or in the near future to have a SIMULTANEOUS ALL-CHANNEL single TV receiver? Yes, this can be done right now, if we are willing to pay the increased price over the present-day TV receiver.

Multiplex or multi-channel TV receivers are not only urgently desired by many home viewers, but by all broadcasting offices, TV writers, critics, reporters, TV actors and their staffs, advertisers and their agencies—in fact everybody in the television industry (numbering hundreds of thousands).

One important reason for a more sophisticated TV receiver is a very fundamental one for millions of viewers: they want to know what other programs are on the air at the same time!

Today one must go through the time-consuming chore of consulting the newspaper or TV program magazines daily to find out what’s on the air. These programs are often inaccurate because they are printed far ahead and seldom contain late corrections, news of program switches, substitutions, etc. This gives rise to the impatient Channel-Switch-Bug. Every fifteen minutes or less, he goes on a channel-switching spree for fear of missing a program that he might never see otherwise.

This and other shortcomings are a sad commentary on our much-vaunted technological age. Yet there is a remedy which we recommend to the TV set industry.

In the United States today there are thousands of localities that have anywhere from two to seven television channels. New York has seven, Chicago five, Los Angeles seven. The average for the country is four.

It is quite feasible at this time to enlarge the width of present-day TV receivers by some 8 inches. The old TV screen remains unaltered, as does the large video tube and many of the various components.

Then on each side of the main screen we add four 3-inch new video tubes in two vertical rows (see illustration). Each of these tubes gives a separate 3-inch picture, one picture for each channel. Each of these auxiliary video tubes is permanently tuned to one channel. Every channel has its own video and audio. But the audio of these auxiliary video tubes can be heard only if you plug in a headset. Thus as many listeners as there are channels can listen and view simultaneously; this also means extra headsets.

If the TV set is used by only one person, no headsets are required. Yet he will see all channels simultaneously, but hear only one.

Would it not be confusing to see such a multiplicity of channels together? No—not any more than seeing a three-ring circus. A viewer will normally concentrate on the large picture. Once in a while he will flick his eyes to the right or left over the other channels. Then if he wishes to switch to another channel on which he sees something worthwhile, he proceeds thus:

He will hold in his hand a small portable channel selector. These are already in use today. They operate a remote, motorized channel switching assembly. Let us say he is watching channel 4 on the large screen and wants to switch to channel 13. He merely presses button 13. Instantly channel 13 flashes on the main screen, while at the same moment the auxiliary small screen 13 on the right goes dark.

From the above it becomes clear that when the viewer was watching channel 4 on the large screen, the small standby screen 4 was dark. This means that the auxiliary video tubes have no connection with the large “master” video tube. Thus no auxiliary video tube can be “on” while the “master” video tube is on the same channel.

(Continued on page 60)
MOST WELL MADE RECORD PLAYERS AND tape recorders meet wow and flutter specs when new, but what about them when they're a year or two old? If you want your high-fidelity system to sound "like new," or if you do any audio service work, you'll want to build this practical flutter meter.

No special skill is needed to build or calibrate this instrument - just some patience. It can be done with ordinary service type test equipment: a scope, an audio oscillator and a vtvm with a zero-center scale (most have one). The only noncommercial component is a toroidal transformer, which you must wind yourself. It isn't hard.

This instrument was checked against a commercial model, and the results were identical.

Fig. 1 is the schematic of the meter. V1 is a 3-kc transitron negative-resistance oscillator, designed for maximum stability. As measured on a frequency counter, the oscillator drifted 1 1/2 cycles in 1 hour after a 20-minute warmup. Drift and short-term instability would cause false readings, and must be eliminated.

V2 is a cathode follower, intended to isolate the oscillator from the load and offer a low-impedance output. This output, via R18 and J3-J4, is fed to the device to be tested.

The "playback" signal, containing some unknown amount of flutter, is fed to J1-J2. V3 is a two-stage amplitude limiter, which prevents amplitude variations from affecting readings. About 0.4 volt rms produces full limiting with R4 set at maximum.

V4, together with T2, make up a frequency-discriminator circuit much like the one used in many FM tuners. Here the "carrier" frequency is 3 kc instead of 10.7 mc. The usable bandwidth of this discriminator is about 50 cycles—25 to either side of 3 kc (Fig. 2). The flutter signal, which is just frequency modulation of the 3-kc "carrier," appears at point A and at the grid of V5. A low-pass filter, L2 and C23, removes the 3-kc signal and leaves only the flutter. D1 and D2 rectify that flutter information, which is then read as a dc voltage on the meter.

V7 is the rectifier, and V6 holds the voltage constant to improve stability.

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WINDING T2

Discriminator transformer T2 uses two Arnold A-254168-2 toroidal cores, wound as shown in Fig. 3. Be sure to use exactly the number of turns and size of wire specified, and place the windings exactly as shown.

The primary is 650 turns of No. 30 heavy Formvar magnet wire, with 5 turns around the secondary core for coupling. The secondary is two such windings (1,300 turns), placed as shown in Fig. 3, with the center tap made from the two adjacent winding ends.

Unless you have access to a toroidal coil winder, the easiest way to wind T2 is to make a shuttle from a 9-inch length of ¼-inch dowel with a slot cut in each end. Wind 85 turns of the wire around the shuttle, lengthwise, and dip each end into a bottle of service cement to keep the wire in place while winding.

Now wind the toroids by passing the shuttle through the center, once for each turn. The 85 turns on the shuttle will be enough for one 650-turn toroid winding.

When the windings are finished, wrap each completely wound core with plastic tape. Mount them one on top of the other with a ¼-inch insulating spacer between them. A strip of plastic or fiber can serve as a clamp with a long screw to fasten the completed transformer to the chassis (see photo).
Calibration

This is not difficult, but does take patience. Time spent here will reward you with an accurate instrument.

The flutter meter is calibrated with 60-cycle ac line voltage and Lissajous figures. You will need a scope, an audio oscillator and a separate vtm—the one in the flutter meter is not used except where specified.

The capacitor values used for calibration in this unit are given as starting points only. Each unit will use slightly different values. In the steps that follow, you may connect capacitors temporarily with clip leads until you determine the exact value.

Before you begin, zero the meter electrically by adjusting R32. Then disconnect one side of the meter to protect it during calibration.

Oscillator precalibration

C9 is made up of paralleled capacitors chosen so that the 3-kc oscillator frequency may be varied from 2,980 to 3,020 cycles by tuning C10.

Allow at least 20 minutes for the instrument and test equipment to warm up. Use 60-cycle line sweep on the scope. Feed an audio oscillator to the scope's vertical input terminals and adjust it to exactly 600 cycles (10-to-1 Lissajous pattern). Now switch the scope to external horizontal sweep and substitute the 600-cycle signal for the 60-cycle. Feed the 3-kc oscillator to the vertical input.

Adjust C10 to approximate mid-position, and add enough capacitance to resonate the 3-kc oscillator at 3 kc while still maintaining C10 at mid-position (about .014 uf will be required).

When the 3-kyc oscillator is tuned to exactly 3 kc, tune the audio oscillator to exactly 3 kc by using a 1-to-1 Lissajous figure. Mark this point carefully on the oscillator dial—you'll need it later.

Now check to see if you can tune C10 through the required frequency range. Using a 1-to-3 Lissajous with 60-cycle line sweep, set the audio generator to exactly 20 cycles. Remove the 60-cycle sweep and substitute the 20-cycle.

Feed the 3-kyc signal to the vertical input and watch for Lissajous patterns at

Fig. 1—Complete circuit of the flutter meter.

Fig. 2—Characteristic curve of discriminator in this flutter meter. Your curve should look as much like this as possible.

Fig. 3—Winding details of T2, discriminator transformer. It must be wound exactly as shown.
and 3,020. Check again to be sure the oscillator is set at 3,000 cycles.

Use the voltage readings to calibrate the meter. Suppose you read 9 volts at each of the above extremes. This is 18 volts change for 40 cycles change, or 0.45 volt per cycle per second. A 0.5% flutter is a deviation of 15 cycles from 3,000 (i.e., .005 X 3,000). In terms of voltage, this is 0.45 X 15, or 6.75 volts peak—4.77 volts rms. If now the full-scale reading of the flutter meter is adjusted for 4.77 volts, it would indicate a flutter of 0.5%.

Disconnect all leads and switch to the 0.5% range. Connect an ac vtvm across the output of the signal generator and adjust the generator to about 100 cycles. Feed the output of the generator to point A (Fig. 1) and adjust R17 until you get a full-scale deflection on the flutter-meter vtvm that agrees with the voltage calculated earlier (in the example, 4.77 volts, 0.5% flutter). Disconnect all test leads.

Switch S2 to the LEVEL position and connect the internal 3-kc oscillator output to the instument's input. Turn the OSC GAIN control full clockwise and the LEVEL SET control to the position you marked earlier. Note the meter reading. This will be the voltage required to drive the instrument during actual tests. It might be wise to mark this voltage on the panel for easy reference.

Now wire discriminator zero-set capacitor C10-a across C10, and set C10-a to mid-position. Feed the 3-kc output to the input and set the LEVEL SET control for the correct amount of input signal. Switch S2 to the discriminator (DISC) position and adjust C10 for zero reading on the flutter-bridge vtvm; C10-a is now the oscillator control.

Using the meter

If a tape recorder you want to check for flutter has separate record and playback heads, feed the 3-kc signal to the recording input of the test equipment. The playback output goes to the flutter-meter input. Set the LEVEL SET control for the correct input signal, switch the selector (S2) to the 0.5% range, and read percent flutter directly off the meter. Switch to the 0.25% scale if you can't read the percentage accurately.

In other cases, record the 3-kc signal on a piece of tape and play it back, reading flutter as before. Do the recording on the machine you want to test, to prevent speed differences from confusing the measurement. Flutter measured this way will be about twice as great as the figure obtained with simultaneous record/playback.

On most professional equipment, you can expect 0.1% to 0.15% with random excursions to 0.2% or 0.25%. Good home instruments will read about twice that, and cheap machines, between 0.5% and 1.2%.
NEVER BEFORE HAS THERE BEEN SUCH a bewildering variety of tape types. Some tape recordists almost long for the days—not long gone—when one kind of tape was all you could buy. Yet each of today’s tape categories is designed for specific applications. The problem is choosing the proper tape.

The first consideration is uninterrupted playing time. Nothing is sadder than the face of a tapester recording a once-in-a-lifetime event only to see his reel run out in the middle of it. The playing time of a reel of tape is determined by the tape thickness (more specifically, the thickness of the backing material to which the magnetic coating is applied). Standard thickness is 1.5 mils, and a standard 7-inch reel (1,200 feet) of such tape plays 1½ hour at the standard speed of 7½ ips before it has to be flipped. To cram more uninterrupted playing time on a reel, tape thickness must be reduced. A 1-mil backing extends the playing time of a 7-inch reel to 45 minutes. Such tapes are known as extra-play tapes (1,800 feet). Further slimming to 0.5 mil produces double-play tape with a 1-hour run per reel at standard speed (2,400 feet).

Recently, 3-M introduced a triple-play tape (No. 290-36) which winds 3,600 feet on a 7-inch reel and permits 90 minutes of uninterrupted recording at 7½ ips. Presumably this tape is an outgrowth of 3-M’s development work in tape cartridges. Slower recording speeds add time, but reduce frequency range and signal-to-noise ratio. At 3¼ ips, playing time is double the 7½-ips figure, and at 1¾ ips it is double again.

Naturally, the thinner the backing, the more delicate the tape. It takes careful handling and a very gentle tape transport mechanism to do back-and-forth editing on 0.5-mil tape without breaking or stretching. That’s why professional users in general prefer the sturdiness of standard 1.5-mil tape, provided they can get sufficient playing time per reel for the job. Likewise, casual tape users with recorders that pull and jerk the tape had best stick with the standard thickness. Owners of battery-powered portable recorders often prefer thinner tape, for many of those small machines do not accept standard-size reels and the thin tape is necessary to extend recording time. Fortunately, battery-powered recorders operate at low tape tension so there is less danger of damaging thin tape.

Acetate vs Mylar

Two principal types of material are used for the basic tape stock to which the oxide is applied: acetate and polyester—the latter commonly called Mylar, a trade name of Dupont, which pioneered its use. Both acetate and Mylar have staunch partisans, and their relative merits are always good for an argument. Mylar is almost twice as strong as acetate of the same thickness. Hence 0.5-mil Mylar and 1-mil acetate are about comparable in strength. But Mylar has a nasty habit of stretching like taffy before it breaks. If that happens, anything recorded on the stretched portion is ruined beyond repair. Acetate breaks cleanly, virtually without stretching, and the damaged tape can be spliced without losing any recorded program.

To overcome this drawback, Mylar makers came up with a special stretch-resistant “tensilized Mylar.” It takes quite a tug to pull it out of shape, but during professional editing—rolling the tape back and forth for precise cuing—even tensilized Mylar might stretch. “I’d rather risk an acetate break I can patch than a Mylar stretch that would ruin an irreplaceable master tape,” says Stewart Hegeman, the audio engineer and former chief engineer of Westminster Records.
Tape is made in wide sheets called "webs". After coating, webs are slit to proper width.

Much has been done recently to improve the tensile strength of acetate. Kodak introduced a special acetate under the trade name Durol that combines the strength of Mylar with the low-stretch characteristics of other acetates.

Some professionals value the ability of Mylar to withstand changes in temperature and humidity that could seriously affect the performance of acetate tapes. Moreover, Mylar is impervious to age whereas acetate becomes brittle and stiff over the years as its plasticizer evaporates. For those who want to keep their recordings for years, the superior storage qualities of Mylar may well be the deciding factor. If in doubt whether a given reel is Mylar or acetate, hold the full reel against a strong light. Acetate is translucent; Mylar opaque.

A third type of tape material widely used in Germany, polyvinyl chloride (PVC), forms the basis of BASF tape (for Badische Aniline & Soda Fabrik AG, the German manufacturer), now being imported in this country. In addition to high strength and low stretch, PVC is extremely pliant and wraps itself closely around the record and playback heads, which contributes significantly to the smoothness of high-frequency response.

Special-purpose tapes

The next step is to pick among the magnetic characteristics of different tape types: all-purpose, high-output, low-print-through and special tapes with extended high-frequency response. Special-purpose are usually more expensive than all-purpose tapes, but certain situations may justify the investment.

For instance, during prolonged storage, a phenomenon known as print-through occurs between adjacent layers of tape on a reel. Loud passages, representing strong magnetic fields, imprint their images on the layers before and after the loud passage itself. Tapes with thin backing are especially susceptible to print-through because of the shorter layer-to-layer distance. Where recorded material is to be preserved for years, low-print-through tape is worth the extra cost. The signal-to-print-through ratio of most all-purpose tapes is usually about 48–49 db. In low-print-through tapes it increases to about 53–54 db. BASF tape, however, claims a ratio as high as 58 db even on the all-purpose tape. Reduced print-through is usually achieved by coating a relatively thick base with a relatively thin layer of a special oxide formulation. Of course, print-through can be lessened on any tape by recording at lower levels so that volume peaks produce a weaker magnetic field.

In recording situations demanding utmost fidelity, so-called high-output tape offers an advantage. For instance, Kodak's new A304 produces double the output of standard tape, yielding 79-db signal-to-noise ratio as compared to standard values in the order of 50 db for all-purpose tapes. Another way to improve signal-to-noise ratios is to use tapes especially designed for a low background noise. For instance, 3-M's recently introduced No. 203 attains a 6-db gain in signal-to-noise ratio over all-purpose tape. Most low-noise varieties require a slightly stronger recording signal (about 2 db higher than standard tape) and some yield best results with a slight increase in bias current (about 15%).

Low-noise tape offers a particular advantage in multiple-mike recording. For instance, the loudness difference between a mike close to the orchestra and one positioned at the rear of the hall to pick up reverberation may be as high as 50 db. Unless the tape signal-to-noise ratio is greater than that, output from the distant mike is buried in the noise.

A number of firms, notably Reeves Soundcraft and Kodak, have lately put on the market tapes with extra fine-grain oxide layers to yield better high-frequency resolution. The improved high-frequency response of such tapes is especially noticeable when played with narrow-gap playback heads. Less treble pre-emphasis is required, and the equalization of the recorder must be adjusted to the requirements of such tape. The lower pre-emphasis reduces background hiss and high-frequency distortion. Professional recorders have provisions for the equalization and bias adjustments required for special-purpose tapes. Unfortunately, such facilities are lacking on many home recorders.

Tape testing

Even the oxide on standard all-purpose tape varies somewhat between brands. A tape recorder with fixed bias and equalization may give better results with some brands than with others. One way to find out which sounds best on your recorder is to splice several lengths from various manufacturers and record the same test program on each. Then play back the composite reel to see if there is any difference between the sections. Watch for treble and bass response, hiss and distortion. (If all brands hiss considerably, chances are that your tape heads need demagnetizing.) Observe also the mechanical characteristics of the tapes. Do they pass over the head without binding or weaving up and down? Do they squeak or whistle as they run through the machine?

The answers to these questions are clues to other quality factors: dimensional constancy and lubrication. Uniform tape width is especially important in four-track operation. If uneven width causes the tape to weave up and down, the four tracks won't stay properly aligned with the head, resulting in crosstalk, poor signal-to-noise ratio, uneven output or even complete signal loss at times. (The track on full-track or half-track tapes is wide enough to be largely insensitive to such physical displacement.)

Tapes are permanently lubricated to increase their pliancy and give them good contact with the head surface. Such lubrication also keeps the tape from rubbing down the heads—an im-
Large rolls of tape await slitting, winding and packaging.

Portant factor with today's narrow-gap designs. If the tape squeals as it runs across the head, it is a sign of improper lubrication. Well lubricated tape also sounds cleaner because it moves across the head more smoothly.

Another important difference between brands lies in the adhesion of the oxide layer to the base. Any tape that sheds excessive amounts of oxide powder will soon clog the head gaps and impair performance. If you must clean your recorder heads after every two or three reels, choose another brand.

Some recording engineers complain about sizable variations in performance of a given tape brand and type from year to year. This is largely a matter of quality control, an expensive item in the overall cost of tape manufacturing. Most manufacturers are reluctant to discuss details, but E. O. Welker, marketing manager for RCA Victor tape, points out that no less than 100 quality checks are performed at the RCA tape plant in Indianapolis between raw-material testing and final inspection. Kodak explains that making photographic film is essentially similar to manufacturing recording tape and that the noted quality of Kodak tape is directly attributable to that company's long experience in the photographic field.

Some firms offer various grades of tape. RCA, for instance, sells tape that does not meet the exacting standards of Red Seal tape as the lower-priced "RCA Vibrant Series." While falling short of the most critical professional standards, these "second-line" tapes still satisfy the demands of most users.

**Bargain tapes**

This brings up the controversial issue of bargain tapes. Since name-brand tapes are priced competitively, there are no "bargains" in that group. But if budget buying is more important to you than assured top results, investigate the house-brand tapes sold by some of the larger electronics supply firms at below-standard prices. House-brand tapes from reputable sources are usually good. Often they are name-brand rejects that failed to meet tight specifications but may be indistinguishable in practical use from the name product. Frequently the only difference lies in greater variability of performance between one reel and another. Unless you do professional editing, splicing together "takes" from different reels, this is no major drawback.

Another source of house-brand tape is reject computer and instrumentation tape with minor faults unlikely to show up in the less critical audio applications. Some instrumentation tape, for instance, may have fallen short of the required 0.5-mc frequency range. Since audio requirements extend only to 15 kc, such tape would still be fine for home use. Computer tape, however, is usually optimized for high frequencies (to accommodate the rapid pulse sequence of computers) and its bass response may be poor.

Cheapest of all is so-called white-box tape, sold in unmarked boxes. With luck, good tape can be found in those nameless boxes. More likely, you'll wind up with reject TV tape, the most prolific source of white-box stock. This has some serious disadvantages.

For one thing, unlike audio tape, video tape has vertical particle orientation in the oxide layer. This reduces signal-to-noise ratio when used in audio recorders. Also, since TV tape is 2 inches wide, it must be slit to ¼-inch width before being sold for audio use. Often the reject processors are quite lax about slitting tolerances, making the tape erratic in width and likely to weave up and down over the recording heads. (Quality tape is usually held to constant width within 0.002 inch.) Finally, TV tape is not designed for flat audio response. It peaks on highs and its relatively thin coating restricts the dynamic range, causing magnetic saturation and distortion at loud passages.

Not all white-box tapes are rejects. Some are specifically made to sell cheaply. Though the rejects are erratic, these tapes are simply consistently inferior, clearly showing the marks of hurried processing (inadequate oxide milling time and slapdash coating) in terms of poor frequency response, high noise level and mechanical difficulties. Perhaps their most troublesome defect is dropout—complete momentary signal failure because of uneven coating.

Some commercial studios use bargain tapes for economy. They usually specialize in making air checks for casual customers who simply don't care about fidelity. But such studios usually run a simultaneous safety recording on standard-brand tape. Should the bargain reel turn out defective, they have the standard tape to fall back on. Otherwise, they re-use it as a safety for the next job.

**General trends**

Except for the bargain-basement trade, the general trend in the tape industry today is toward upgrading of quality. According to C. J. LeBel, vice president of Audio Devices, Inc., the makers of Audiotape, the impetus came from the more stringent quality requirements for computer and instrumentation tape. New production techniques developed to satisfy these demands have spilled over into the production of audio tape. Says LeBel: “Milling procedures, coating temperature, flow rate of the coating material, the rate of ribbon motion—all these affect the performance of the final product. Increasing process automation now enables us to keep tighter tolerances on all these factors than was possible with human control. The net result is greater consistency in frequency response, output and noise level in every type of tape.”

END
Transistor preamp is a simple step to hissless, humless music

By DON V. R. DRENNER

Our amplifier-speaker combination has some sort of a record, for an engineer's, having been in almost daily use for four years without a single revision. We've been happy with the "Copy-Cat" amplifier (Radio-Electronics, September 1957) and the Karlson enclosure—with a WE 728-B speaker—ever since.

The preamp for our VR-II cartridge, however, has long been a problem: HUM. To solve this, we've tried everything in all the books. The only solution has been to turn the thing off!

But the transistor preamp described here does offer absolute hum-free operation and while its behavior is different from the four-tube preamp we've always used, there are no problems you can't solve by using your ears. This preamp proves a point we've shouted about before—that bench testing and laboratory curves mean nothing unless the sound pleases your ears.

This preamp resulted from a few preconceived notions of what a preamp should be. Based on ideas other than our own (owing a great debt to G-E's transistor manual) but including a few tricks tried out with it as the front end of our amplifier, it is a neat package of quietness.

A glance at the photo will show what appears to be a printed-circuit board. Actually this is a 3/32 inch thick phenolic board with small brass eyelets swaged into it as mounting holes for all components except the transistors. The resistors and capacitors are inserted into the eyelets, their leads clipped on the underside, a drop of solder used to anchor them securely. Then, No. 22 wire, mostly bare, is used to join each component by wiring from eyelet to eyelet to form the circuit. The result is a neat-appearing construction job that can be laid out almost exactly like the schematic.

The circuit (Fig. 1) was evolved from several sources, but seems to be basic. This is partly because transistors—like vacuum tubes—can be connected in only a few basic ways, and everybody has to remember about thermal runaway, beta and h-parameters. So the basic preamp, comprising the first two transistors, does what all preamps do: increases the signal level from the pickup and provides frequency compensation. The feedback network from collector to emitter does not follow exactly the recommended values for RIAA compensation, but this, again, is a matter of ears. If you want the real thing, the "true" values shown in Fig. 2 are for you. In our case, despite what the meter said when we ran a frequency check, the increase in the bass turnover frequency sounded better.

The third transistor is an emitter follower. It isolates the input stages from loading effects and provides a low-impedance source for the tone controls.

All this is pretty conventional—as are the bass and treble control circuits—but the whole thing derived from a few trial-and-error gimmicks that made the results a little different. There is pretty terrific gain, even after the tone control circuits, so that the output stage had to be provided with both high- and low-level connections. Which you use will depend upon how much it takes to drive your main amplifier. If the output levels fall a bit short of the 9-volt battery-saturated output of the preamp, you can use a 100,000-ohm resistor in series with the output lead and a 1000-ohm resistor in series with the tone controls.

Fig. 2—RIAA equalization values. Values given in Fig. 1 and parts list are for author's preferred equalization, not RIAA. See text for details.

Fig. 1—Preamp circuit. The author reports performance improves with a 100,000-ohm resistor connected from C7-C8 junction to ground.
is taken from the collector, the dotted-in 100-μf emitter bypass capacitor should be used. We used the emitter for the output, and the 1,000-ohm emitter bias resistor is used alone.

The brass eyelets used as connecting points are made by General Cement and are available from most radio parts stores. They come in various sizes, but the ones we used are 5/32 inch long and .085 inch in diameter. This small size allows three leads or wires to be inserted with ease, and provides a securely soldered connection. Small holes are drilled to provide a snug fit for the eyelet, and they are then swaged, or spread, with center punch and hammer.

The mounting board measures 2 1/2 x 7 inches, and was laid out and drilled in a pattern that followed the schematic. We used transistor sockets, but the transistors could just as well be soldered to the eyelets if the leads are left long. If, after mounting a few components, you find you need an extra eyelet, the brass is soft and easily spread. So extra or additional parts can be mounted without damaging those already mounted.

You will note from the photo that the three controls and the off/on-transfer switch are not mounted directly on the phenolic board, but attached to a small subpanel. The front panel, subpanel and mounting board are held together by metal spacers. Front-panel size (ours is 3 x 8 inches) and spacing are a matter of convenience, really, and anything you have in the junkbox will do. Our completed unit measures 3 x 3 x 8 inches, and fits nicely into a small cutout on the front of our wall-mounted amplifier system. I tried various transistors and the 2N220 worked best. If you have on hand a 2N508 or some of the Workman 99 series, they work fine with only a slight increase in noise level. The base-bias resistor for the input stage, R5, is adjusted for between 0.5-0.6 ma of emitter current. With the values shown, you should have (measured with a vtm) 2.8 volts between collector and emitter of the 2N220, .06 volts between emitter and ground, and 2 volts between collector and base. The output stage should measure 5 volts between collector and emitter with 1 ma emitter current.

Output voltage at Lo OUT is 0.25 rms using a G-E VR-II cartridge and a Columbia ZRD431-1A Standard Characteristic Recording. Output at Hi OUT under the same conditions should be greater than 1 volt and can be increased by increasing R14.

The equalizer network can be adjusted to suit your needs (despite the purists). While the tone controls do give some flexibility, we like a lot of bass at normal listening levels, and the values shown in Fig. 1 please our ears! We measured the bass boost (about 20 db) with the treble control at "flat" and we like it that way when we listen, refusing to be influenced by what we measured.

The power supply is two 9-volt batteries connected in series. Total drain is 5 ma.
BETTER STEREO REPRODUCTION WITH 15° STYLUS

Tracking distortion in the vertical direction and how it can be avoided

Fig. 1—How cutting and playback stylus differ.

Fig. 2—Pinch effect will distort high frequencies.

Fig. 3—Elliptical stylus reduces pinch effect.

A NEW POSSIBLE SOURCE OF DISTORTION in stereo phonograph record reproduction has received considerable attention recently—distortion due to the stylus-groove relationship. Record and equipment manufacturers, as well as stereo-philes, strive to free sound reproduction from distortion entirely. They diligently search out and correct any fault that stands in the way of this goal. The proposed RIAA (Recording Industries Association of America) standard of 15° vertical tracking angle is now the subject of lively controversy. A clear understanding of the mechanics of disc playback will help, not only to comprehend what the manufacturers are doing, but also to determine what you may do to improve sound in your playback equipment.

Forms of distortion

Distortion in disc record playback is caused primarily by tracing and tracking errors. Obviously there could be many sources of distortion in other parts of the complete playback system but these two, due to the physical relationship of the playback stylus to the groove, are the most important.

Tracing distortion occurs because recordings are cut with a chisel-shaped stylus and played back with one that is spherical (Fig. 1). This spherical tip cannot trace precisely the minute undulations cut by the chisel. Two conditions aggravate this misfit: recording at high level, and the slow groove speed at the inside diameters. It is possible for any normal cutter to cut angles, especially at high frequencies, which are actually less than the dimensions of the playback stylus.

Part of this distortion is called pinch effect. This occurs because the cutting stylus, in moving from side to side to cut a groove in the record, actually produces a groove of varying width (Fig. 2). When this groove is played back, the playback stylus is actually forced to move up and down when the groove gets narrower and down when the groove gets wider. Since stereo cartridges have vertical as well as lateral response, this undesirable motion produces second-harmonic distortion in the cartridge output. This is because the groove undergoes this narrowing and widening twice each cycle of recorded sound. A smaller-radius playback stylus helps reduce this distortion. Hence the recent change from the standard 1-mil LP stylus to 0.7 and now 0.5 and even smaller radii.

Inner-groove distortion occurs when frequencies are high and modulation heavy. The angles engraved by the cutter are so sharp that a spherical stylus cannot maintain continuous contact with both sides of the groove. The stylus simply rides along over these high frequency tracks and does not reproduce them. This translation loss (loss due to the pickup stylus not being able to get out of the record what the cutter put into it) is what causes records to sound duller at the inner diameters than they do at the outside. Along with the missing high frequencies there will, of course, be other distortion due to the bumping along of the stylus. Here again a smaller tip helps reduce the trouble.

These extremely small tip radii have two disadvantages: first, the tendency of a small tip to ride down into the bottom of the groove during high-level modulation when the groove is wide and deep; second, the extreme pressures that occur with the low contact area of the small tips. Unless the stylus force is held down to a gram or less, the record material will be destroyed.

Attacks on the problem

Two approaches have been recently advocated by different companies to try to eliminate tracing distortion. Ortofon has attacked the problem directly by introducing an elliptical-shaped playback stylus (Fig. 3). Since the elliptical stylus has essentially the same shape as the cutting stylus, it traces the actual groove path more closely. The ellipse maintains the same tangential contact with the groove walls as the side of the cutting stylus did while cutting the groove. The approximate dimensions of the elliptical tip are 0.7 mil for the major axis and 0.3 mil for the minor.

A more indirect approach is advocated by RCA. Here the signal fed into the cutting head is predistorted. What is actually engraved on the disc—in terms of present-day techniques—is a distorted signal but distorted in exactly the opposite way that tracing error distorts the signal during playback. When the predistortion on the record and the
opposite tracing distortion of the playback are combined, the two cancel and distortion is reduced. This description is, of course, for an ideal system—one that takes into account simultaneously such factors as the complex frequency of the recorded signal and the instantaneous amplitude, velocity and acceleration of the cutting stylus as well as the radius at which the record is being cut. Such a device would be extremely sophisticated and built along the lines of a computer. Present-day devices certainly take some of these factors into account, but are still far from perfection.

Tracking-error distortion is much simpler to understand and correct. It occurs when the playback stylus does not move in the same direction that the cutting stylus did when engraving the record. In cutting laterally (the standard monophonic system), the recording stylus moves in a plane perpendicular to the surface of the record and along a radius of the record. The playback stylus should also move in the same direction in order not to introduce tracking distortion. Stylus motion of virtually all high-quality playback cartridges is identical to that of a cutting stylus, but since most playback arms are pivoted, the playback tip actually moves in an arc across the record rather than in a straight line along a radius. This is the primary source of tracking distortion in lateral records.

If the playback arm were short and straight, the arc would have a radius equal to the arm length and be tangent to a radius of the record at only one point during playback. At this point the playback stylus moves along the same line that the cutting stylus did and the tracking distortion would approach zero. To overcome this fault, the head of most arms is bent at an angle toward the center of the record to give an effective radius much longer than the distance from the arm pivot to the stylus. Therefore the stylus moves across the record along a more nearly straight line and the lateral tracking distortion is considerably reduced.

In stereo records where the cutting stylus moves both laterally and vertically, a similar situation exists. It is generally assumed that the vertical modulation is produced by a direct up and down motion of the cutting stylus. This is not the case. It was learned very early that it would not be easy to build a playback cartridge in which the stylus moved in such a manner.

The stylus angle

When the Westrex stereo disc cutting head (Fig. 4) was designed, the stylus motion had a 23° angle leading the vertical. The 10 A stereo playback cartridge that Westrex manufactured in 1958 also included this 23° angle. Westrex recommended to all pickup manufacturers that this angle be included in the cartridge design. In Europe the direct vertical system was attempted and most European cutters are designed with the 0° system. Cartridge manufacturers in America attempted to follow the 23° design but many cartridges vary from close to 0° to almost 40°.

The whole question of vertical tracking angle in stereophonic records has gained much publicity in the past year from work done by B. B. Bauer at CBS Laboratories. In producing test records, he discovered that the assumption that the Westrex cutter was actually cutting vertical modulation at an angle of 23° was incorrect. It had been taken for granted that the modulation on the disc was cut at the same angle as the theoretical stylus motion. Bauer determined that actually the angle of the modulation cut into the record was very close to 0°.

Since the Westrex cutter has been used to cut the vast majority of stereo records available in America, Bauer’s discovery shows that cartridges designed for 23° and higher were actually introducing considerable vertical tracking error when playing back these records. Tracking distortion is the result of this error. Many people feel that today’s stereo records sound quite good as they are and that this tracking-angle error distortion must therefore be small. The distortion is at its maximum when the recorded level is very high and therefore may well be hidden by more overwhelming sources of distortion in other parts of the playback equipment. The distortion is also most apparent at the inner diameters and can easily be heard on organ and choral recordings, which are very susceptible to intermodulation distortion.

Since this tracking-error distortion occurs only during vertical modulation, it may be best to take a look at what causes this modulation. The amount of vertical modulation in the record is determined by the difference signal, that is, how much the sound of the right channel differs from the left channel. As this difference becomes less, the vertical modulation becomes less, and if the difference becomes zero, the vertical modulation is zero and we have a standard monophonic record. In high-quality symphonic stereo recordings where true stereophony is desired, there is very little difference signal and a low

This CBS Labs stylus is designed to cut at the 15° angle.

The Ortofon DSS601, an example of a modern stereo cutting head.
Fig. 5—Cutter modified for a 15° angle. Original cutter has approximate 1° tilt, hence the 14° mount.

level of vertical modulation. In trick recordings with exaggeration of separation and so-called "ping-pong effect," the vertical modulation can be heavy and the tracking distortion quite severe.

In analyzing this difference between cutter angle and the resultant modulation angle, Bauer determined that the cutting stylus and its mounting were not perfectly stiff but would bend elastically and the precise motion of the cutter head was not transferred to the disc intact. This stylus elasticity accounts for about 40% of the discrepancy in the angle. The remaining 60% is caused by elasticity or springback in the lacquer coating of the master recording disc. The cutting stylus actually pushes some of the material of the lacquer as well as cutting it. After the stylus has passed this point in the record, the pushed part of the material springs back to its original position.

Since the 23° cutter produces modulation at approximately 0°, it would seem logical that a 0° standard should be accepted. There are two good reasons against it. Many thousands of magnetic playback cartridges in use today have angles in the range of 20° to 30° and many more ceramic types have vertical tracking angles very close to 15°. The second reason—brought out by Bauer more recently—is that it is actually possible to cut a higher level on the record with an angle greater than 0°.

These two reasons combined have led the RIAA to accept as a recommended standard a vertical tracking angle of 15°. It is therefore necessary to tilt the recording head approximately 15°, to produce modulation with a tilt of 15° from the vertical (Fig. 6). In the case of European cutters it has been determined that even though they were designed for a 0° vertical tracking angle, the resultant modulation in the disc was actually less than zero (a negative angle) and therefore they also must be tilted to produce a 15° modulation slant in the record.

The present situation

Most US recording companies have modified their stereo disc-cutting systems to agree with the RIAA recommended standard of 15°. It is, of course, desirable to have the playback stylus track exactly the same angle as the cutting stylus, but unfortunately there is very little that anyone can do to an existing playback cartridge to change its vertical tracking angle. The cantilever systems which hold the stylus and transfer its motion to the generating elements in the cartridge are extremely delicate and any attempt to bend one of these would more than likely result in total destruction.

Furthermore, it is extremely difficult to determine precisely at what angle any playback cartridge is actually tracking. The simplest method—actually quite complex—requires at the least, an intermodulation distortion meter and a test record that has been cut at varying vertical tracking angles. To measure the angle, it is necessary to play each band of the record, and measure the intermodulation distortion produced at the various angles. The angle of the cut that produces the least amount would be the approximate tracking angle of the playback cartridge. If any change were made by bending the stylus assembly, it would be necessary to repeat this test to determine whether the stylus had been bent the proper amount. If by chance an angle closer to 15° were achieved, it would then be necessary to check all other specifications of the cartridge to be sure that frequency response, channel separation and compliance had not been altered. With modern sophisticated cartridges, it is difficult even for manufacturers with usually unlimited equipment to check these specifications.

Today most cartridge manufacturers have introduced or will soon introduce new models incorporating this change to 15° (Fig. 6). There have been many pro and con arguments, primarily based on whether the improvement is significant. Certainly the reduction of distortion will not show up on all records. Some of them will have sufficient distortion from other sources to overshadow the improvement gained by correcting the tracking angle. Nevertheless, total overall quality of your playback system is the sum of the quality of each individual part. Any improvement, however small, is another step toward achieving the goal of distortion-free sound reproduction.

How Long Will Your Tape Play?

By STEVE P. DOW

The Norelco 401 stereo recorder has introduced to the audiophile the new extra-slow tape speed of 1/6 inches per second. Greentree Electronics, manufacturers of American brand tape, have introduced four new tape footages on 7-inch reels: 1,500, 2,000, 3,000 and 3,600 feet. Hence it's time to bring tape time charts up to date.

Below is a complete table showing playing time in minutes for every speed and reel size in current use on home recorders.

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### Tape Time Table

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<td>1</td>
<td>3/4</td>
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**Tape Speed—Inches Per Second**

- 15/16: 0.94 inches per second
- 3/4: 0.75 inches per second
- 3/4: 0.75 inches per second
- 3/4: 0.75 inches per second
- 3/4: 0.75 inches per second
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- 3/4: 0.75 inches per second

### Tape Recorders Limited In California Classrooms

An addition to the California Education Code provides that "it shall be unlawful for anyone, including a student, to use without the prior consent of the teacher and the principal of the school having been obtained any electronic listening or recording device in any class of any public school of the state."

The law arose out of abuse of tape recording as a means of harassing teachers, but many in the tape industry feel that it will reduce the use of tape recorders for educational purposes for students, a practice which is becoming common in colleges and junior colleges. The red tape required to use a recorder, dealers feel, is likely to discourage the student from attempting to use a recorder in the classroom.
CHECKING OUT TAPE RECORDERs

What you need, what to look for. Frequency response, signal-to-noise, equalization, speed

By HERMAN BURSTEIN

PERFORMANCE CHECKS OF TAPE RECORDERs include the vital factors of frequency response, distortion and signal-to-noise ratio. Equalization, bias current and azimuth alignment intertwine with the question of frequency response. Bias current also bears on distortion. If erase appears inadequate, check oscillator current through the erase head. And check tape motion: accuracy and steadiness of speed (wow and flutter).

For these measurements, you will need at least an ac voltmeter for measuring tape speed; a bulk eraser; a head demagnetizer; materials for cleaning the heads. First clean and demagnetize the heads to avoid treble loss.

Connect an audio generator (Fig. 1), to the high-level input of the tape recorder, record a series of frequencies of equal magnitude covering the audio range, and measure the playback signal at the output jack with a vtvm. Record at least 20 db below maximum permissible level (as shown by the record-level indicators). Else you will saturate the tape at high frequencies and cause an apparent loss of treble. With the tape machine's record volume control well advanced, feed in a 400-cycle tone and adjust the audio generator's gain so that the record-level indicator shows maximum permissible level. Then back down 20 db on the generator's gain control.

This is your recording level.

The minimum number of test frequencies, in the interest of saving time, would be: 30, 50, 100, 250, and 500 cycles; 1, 2.5, 5, 7.5, 10, 12 and 15 kc. It would be desirable to use several additional frequencies above 5,000 cycles, where deviations from flat response are usually greatest.

There is no problem of identifying the test frequencies in playback if the machine under test has separate record and play heads and permits simultaneous recording and playback. If it hasn't, one method of identification is to intersperse announcements by microphone. Another, and perhaps preferable, method is to "mark" several key frequencies—say 100, 1,000 and 10,000 cycles—as mileposts. You can mark a frequency by momentarily increasing its level 10 or 20 db.

If the machine has a tone control, set it to "flat" before you check frequency response. If there is no "flat" position, set it at mid-position. You may want to check response at several settings to find out which gives flattest response, and mark that one for the customer's reference.

Playback response

A check of playback response lets you determine two things: whether defective record—playback response is due to faulty playback (if not, the fault must occur in recording); whether playback response conforms to existing standards. The latter is most important at 7.5 ips because that is the prevailing speed for prerecorded tapes.

To measure playback response, play a standard test tape (Ampex tapes, probably the most widely used, are available for 15, 7.5 and 3.75 ips) and measure the playback signals with a vtvm. Ideally, response should measure flat. This procedure takes into account the tape machine's playback equalization, the frequency characteristics of the playback head in both the bass and treble regions, possible treble loss due to stray capacitance, and all other factors affecting playback response.

A number of top-grade home machines have no internal power amplifier and speaker. You will connect such a machine's output to an external amplifier—speaker as well as to a vtvm.

To avoid treble loss, remember to clean and demagnetize the heads before measuring response. Magnetized heads can spoil an expensive test tape by partially erasing its high frequencies. And be sure to find out which tone-control position provides flattest response.

Azimuth

This is the angle formed by the head gap and the length of the tape. Ideally, it should be exactly 90° (Fig. 2).

If there is treble loss when checking playback response, suspect azimuth alignment of the playback head. Frequency test tapes, such as Ampex, usually contain a prolonged high-frequency tone for checking and adjusting azimuth. While reproducing this tone, tilt the playback head slightly to the left or right to produce maximum output signal as indicated on a vtvm. Watch out for "false peaks", which are smaller than the true peak output at correct azimuth alignment. If the playback head is a stereo one, with two gaps, it is possible that the gaps are not in exactly the same straight line. Hence it will not be possible to obtain peak output on both channels in a given head position. You will have to determine a compromise azimuth alignment which gives equally good results on both channels (though not as good as on either alone).

If the tape recorder has separate record and playback heads, and if it has been necessary to change the azimuth of the playback head, the record head must be adjusted correspondingly. After the playback head has been adjusted, simultaneously record and play a high-frequency tone and adjust the record head for maximum playback signal as indicated on a vtvm. Some machines have separate record and playback heads but do not permit simultaneous recording and playback. In this case, wire the record head to the playback amplifier (disconnecting the playback head) and align its azimuth on the basis of the test tape. Because the record head probably has a wider gap than the playback head.

Fig. 1—Setup for checking overall record-playback response. Vtvm at oscillator output monitors level (which must be kept constant); at output of recorder, it reads playback output level. Ratio of the two in db is response variation.

Fig. 2—Poor azimuth alignment ruins high-frequency response. Playback head gap must be perpendicular to direction of tape movement.
and therefore has difficulty reproducing high frequencies, reduce the frequency of the alignment tone by reducing tape speed.

**Equalization**

If frequency response is unsatisfactory and if azimuth alignment and bias current (discussed later) are OK, check equalization.

To measure playback equalization, feed a series of very small signals of different frequencies and equal amplitude through the playback head and into the playback amplifier (Fig. 3). Measure output with a sensitive vtvm. The signals are inserted between the head's ground lead and ground, taking the head's electrical characteristics into account. To avoid overloading the head or amplifier, keep input signals small enough so that maximum output of the tape preamplifier, at the low end, is not more than about 1 volt. This usually means inputs of 1 to 5 mv.

NAB equalization is used virtually without exception at 15 ips, and also at 7.5 ips by many better-quality home machines. On these machines, the test of Fig. 3 should produce an output curve closely resembling Fig. 4; there may be moderate departures from the standard NAB playback curve to allow for the playback head's characteristics at the bass and treble ends. At 3.75 ips, playback equalization is often employed. Fig. 5 is the curve suggested by the Magnetic Recording Industry Association (MRIA) as a standard for all machines. Consult the service manual of the machine under test to find out what the record equalization characteristic employed is like. This will differ from one tape recorder to the next. Fig. 7 is a typical record equalization characteristic employed at 7.5 ips. It is important to understand that there is no such thing as a standard recording equalization curve. The NAB standard simply specifies that record equalization shall be tailored for 3.75 ips.

Bias and erase current

Bias current is fed to the record head along with audio current to reduce distortion and increase the amount of signal recorded on the tape. Correct bias is critical. Too much attenuates the high frequencies. Too little raises distortion sharply.

The technique of Fig. 6 can be used to measure bias current (with the oscillator tube in place). This presumes that you know the amount of bias current specified by the tape recorder manufacturer. A high-impedance head requires 0.2 to 1 ma; a low-impedance head, 5 to 10 ma. First allow the recorder to warm up about 15 minutes. Then measure voltage across the resistor in series with the record head, and calculate current by Ohm's law.

If the tape recorder permits simultaneous recording and playback, the manufacturer often specifies a simpler technique. A frequency, usually between 500 and 2,000 cycles, is simultaneously recorded and played back at a given tape speed. Bias current is adjusted for maximum playback signal. Sometimes the maker advises that bias be further increased until the playback signal falls 1/2 db below maximum level. This helps prevent slight changes in bias current (due to tube aging, fluctuations in line voltage, etc.) from having appreciable effect on distortion and treble response. When you adjust bias according to this technique, use the same kind of tape that your customer uses, because optimum bias tends to vary somewhat from one kind of tape to another.

To minimize noise produced in recording, the bias waveform should be as nearly a sine wave as possible. Check for gross distortion (about 5% or more) by viewing the bias waveform on a scope connected across the record head.

Bias frequency is also important. Too low a frequency may beat with the harmonics of the upper audio frequencies. Too high a frequency tends to undermine the effectiveness of the erase head (powered by the same oscillator that supplies bias current to the record head). Check bias frequency against the manufacturer's recommendation by connecting the vertical input of a scope to the record head and the horizontal input to an audio generator, set sweep to external, adjust the generator until you get a circle or ellipse on the scope (depending on phase relationships), signifying...
equal frequencies at both inputs. Read the frequency of the audio generator.

If erasure appears inadequate, check against the manufacturer’s recommendation the amount of oscillator current going through the erase head. This usually lies between 10 and 50 ma. The technique is the same as in Fig. 6, except that the series resistor should be closer to 10 ohms than 100 because of the low impedance of the erase head.

**Distortion**

Tape-recorder specifications are almost without exception in terms of harmonic rather than IM distortion (which runs much higher). Using your audio generator, record a 400-cycle signal and measure the harmonic content in playback with a harmonic distortion meter. A low frequency like 400 cycles is used: to provide a substantial number of harmonics before reaching the tape recorder’s upper cutoff frequency; to avoid the treble emphasis that takes place in recording, which would exaggerate the distortion, because peak audio energy generally occurs around 400 cycles, so that a test in this region gives a good notion of the maximum distortion apt to be encountered.

The test of harmonic distortion has two purposes: to provide a reference point for measuring signal-to-noise ratio, as discussed in the next section; to check the calibration of the record-level indicator, as discussed in the next paragraph.

If the indicator is an “eye” tube or neon lamp, the recording level at 400 cycles that produces 3% harmonic distortion should also be the point at which the eye shadow closes or the neon lamp filaments start to turn off, adjust the indicator calibration. (This assumes that you have previously checked that bias current is correct, because the recording level that produces 3% distortion varies with bias.)

If the indicator is a VU meter, the recording level that produces 1% harmonic distortion should read 0 VU. This recording level is about 6 to 8 db below the 3% distortion point. It provides a safety margin to compensate for the inertia of the meter, which underestimates distortion-producing signal peaks. Not all tape recorders with a VU (or similar) meter provide this safety margin. If the machine under test reads 0 VU at the 3% distortion level, advise your customer that for clean recording he should try to keep the pointer from swinging past approximately –6 VU.

**Signal-to-noise ratio**

In good-quality home tape recorders, signal-to-noise ratio usually refers to the recording level that produces 3% harmonic distortion on the tape. “Noise” encompasses noise and hum due to the record and playback amplifiers, tape hiss, distortion of the bias waveform and imperfect erasure.

To measure signal–noise ratio, record a signal of 400 cycles on virgin or bulk-erased tape at the recording level that produces 3% harmonic distortion in playback. Measure the playback signal with a VU meter. Rewind the tape and put it through the recording process again, but this time with no signal input and with the recorder’s volume control fully down. Again measure the playback signal, which now consists of noise. The signal–noise ratio is the relationship, in db, between the first playback signal and the second one.

You can also measure the “playback signal–noise ratio.” This is particularly appropriate for a tape player (which cannot make recordings). The technique may be illustrated with reference to the 7.5 ips speed and Ampex test tape 3132.101. Play the “operating level” tone, a 700-cycle signal recorded at a level that produces 1% harmonic distortion on the tape. Measure the playback signal with a vtm. Now play a reel of bulk-erased or virgin tape, and again measure the playback signal. Calculate the ratio between the first and second measurements in db; then add about 6 db to obtain the signal–noise ratio. The reason for adding 6 db is that the accepted reference level—a recorded tone producing 3% harmonic distortion—is roughly 6 db higher than a recorded tone producing 1% distortion (as on the Ampex test tape).

**Motion**

Speed accuracy can be measured with a tape stroboscope—a wheel held against the moving tape. Bars on the wheel are viewed under a 60-cycle neon or fluorescent light source. The bars appear stationary if speed is exact, move in the same direction as the tape if speed is fast, and in the opposite direction if speed is slow. Seventy-two bars per minute moving past a given point (say a pencil point) correspond to 1% speed error. Another speed-measuring device consists of a loop of tape with stroboscopic bars, which is threaded past the heads and guides in usual fashion. Slack in the loop is taken up by light pressure of a pencil or similar object. The tape loop is run around and around, and the bars are viewed under a 60-cycle light source.

An accurate instrument for measuring wow and flutter is very expensive and therefore seldom found in a service shop. However, the ear is good for detecting even slight departures from perfection. Record and play (or, in the case of a tape player, just play) a 3,000-cycle tone. Listen for wow, which shows up as a quavering or pulsing quality. Listen for flutter, which appears as graininess or coarseness of tone. If possible, compare the performance of the machine under test with a professional or semiprofessional machine.

What’s Your Eq?

**What Voltage?**

Three voltmeters are connected as shown, V1 is an electrostatic type, calibrated to read peak voltage values. It indicates that the output from the rectifier is 1,000 peak volts. V2 is a dc voltmeter of the d’Arsonval type. V3 is an ac voltmeter of the electrodynamometer or iron-vane type. What will be the voltage indicated by voltmeters V2 and V3?

—Kendall Collins

**A Distorted Puzzler**

This could be any voltage amplifier stage—most likely audio. Could also be a triode. Signal is getting through, but with less than usual volume and with considerable distortion. The tube is good, the voltages are as shown. The components? Well, better check ’em. Won’t have to disconnect anything to find any bad ones, though. Just look.

—Jack Darr
THE LACK OF LOW-COST, READY EQUIPMENT for setting up stereo systems and evaluating stereo recordings prompted me to build a simple, inexpensive device that could be connected to the speaker lines of my home stereo system. This "Black Box" balances the two channel levels, determines their proper overall phase connections, and evaluates the program material for its directional characteristics.

Fig. 1 shows the circuit of the device. Three identical output transformers step up the voltage from low-impedance left and right speaker lines. A toggle switch changes the circuit for either amplitude or phase measurement. In the amplitude position, the stepped-up voltage of each speaker line is applied in phase to a rectifier diode and a positive voltage is developed across each of two load resistors. An external high-impedance dc voltmeter, or vtvm, preferably with a zero-center adjustment, is connected across the two outputs to measure the voltage difference.

With no signal present (or if the two signals have identical content and amplitude), the meter is not deflected (see Fig. 2). If the left channel has a signal and the right none, the output is positive; if the right channel has a signal and the left none, the output is negative. When both left and right signals are present, the meter is moved by a voltage equal to the difference between the left voltage developed across R1 and the right voltage developed across R2.

With monaural program material it is easy to establish the exact balance, as the levels exactly correspond. Any frequency response differences or amplitude nonlinearities in the two channels would show up. With stereo program sources the levels do not correspond, so the meter readings will vary from positive to negative. Here, though, there is usually a strong component common to both channels, and by watching the meter excursions from positive to negative, you can rapidly balance the two channels. The results of setting up the levels at one side of the room and then walking to the center listening position have been very satisfactory. The excursion of the meter for a given listening level is an indication of the spread of the sound between the two speakers.

In the PHASE position of the switch (see Fig. 3), one rectifier develops across load resistor R2 a positive dc voltage proportional to the two channels summed, and the other develops a positive dc voltage across load resistor R1 that is proportional to the difference. Then, with in-phase signals applied to the left and right channels, the voltage across R1 is zero, because the windings of T1 and T3 produce equal and opposite voltages that cancel. The voltage across R2 is positive and double what would be produced by one winding, because T1 and T2 are equal and additively phased. The meter is connected to take the difference, as before, and reads negative. By the same reasoning, the voltmeter reading with out-of-phase signals is positive.

By BOB WHITE

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**Fig. 1—Circuit of the Black Box.**

- R1, R2—30,000 ohms, 1 watt
- D1, D2—1N439, or 1N649 (see text)
- J—phone jack
- S—toggle switch, dpdt
- T1, T2, T3—output transformers; primary, 4,000 ohms; secondary, 3.5 ohms; 3 watts
- Binding posts (4)
- Plastic case and panel, 6 1/4 x 3 1/2 x 2 inches
- Miscellaneous hardware

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**Fig. 2—Simplified diagram of amplitude sensing circuit.** Dots at T1 and T3 indicate phasing of transformers; positive-going wave at dotted end of primary produces positive-going wave at dotted end of secondary. See text for explanation.

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**Fig. 3—Phase-sensing portion of analyzer.** Dots at transformers indicate phasing, as in Fig. 2. Text describes operation.
The phase reading does not depend on the amplitudes of the two channel signals. As the level on either channel decreases, the deflection drops, but is always of the correct polarity. If one channel is silent, the output reading is zero. Another interesting case is when the phase difference between the two channels is not exactly zero or 180°. Then the meter readings drop and reach zero at a shift of 90°, which is halfway between in phase (zero degrees) and out of phase (180°).

Proper phasing of the entire stereo system from program source to speaker is extremely important. If the same sound source (mono) is used for both channels, then determining phase is just a matter of watching for correct polarity deflection. With stereo program material, the indication is not all in phase or out of phase, but the in-phase components in general predominate. It's fun to watch the meter with orchestral music and see how its indication corresponds with the instruments being played. With higher-frequency tones, the wavelengths are shorter and the sounds are equally likely to arrive in phase or out. With lower-frequency tones, they will more likely be in phase. In program material of no apparently predominant phase, the bass can be turned up and the treble down to accentuate in-phase readings and establish proper overall phasing from studio to listening room.

It's interesting too to listen to stereo recordings or broadcasts and correlate the meter indications with the judgment of the ear. The recordings that were most pleasant to me were strong on in-phase components in general predominate. It's fun to watch the meter with orchestral music and see how its indication corresponds with the instruments being played. With higher-frequency tones, the wavelengths are shorter and the sounds are equally likely to arrive in phase or out. With lower-frequency tones, they will more likely be in phase. In program material of no apparently predominant phase, the bass can be turned up and the treble down to accentuate in-phase readings and establish proper overall phasing from studio to listening room.

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Then I wondered how two of his old audio transformers, hooked back to back, would work. We tried it, connecting them as shown in the schematic. It worked fine!

We tried three or four other transformers, and all worked. With only one was there a slight hitch; the vertical timing resistor had to be changed to keep the vertical hold control near mid-range. If the circuit won't oscillate, reverse the two leads to any one winding.—M. D. Velázquez

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Part 1—Hum and noises

By HERMAN BURSTEIN

IT SIMPLY ISN'T IN THE NATURE OF A mechanism as complex as a tape recorder to operate indefinitely without trouble, the way some preamps and power amplifiers do. When trouble arrives, it falls into one of two categories:

1. The kind that requires a technician.
2. The kind the owner can cure himself.

Without attempting to draw a sharp line between the two categories, it is still true that a variety of elementary recorder problems can be handled by the user with little technical knowledge or equipment. This doesn't deprecate the technician's role. The simple measures the owner can try are often the technician's first steps in approaching a problem.

At the same time, it is important for the owner to know what he can't do and had best leave for the technician. Unwise tinkering may lead to extra trouble and expense.

This article is concerned largely with electronic rather than mechanical problems, which vary more than electronic troubles from one make to the next. Repairing mechanical faults almost always requires special skill, knowledge and parts.

Hum

Playing a tape or recording from a microphone generates signals of only a few millivolts, so it is little wonder that hum is one of the most formidable problems in a tape recorder. The 60-cycle line frequency is apt to be the principal offender, but its 120- and 180-cycle harmonics may also be intrusive. Hum is usually more of a problem in playback than in recording because of the large bass boost in playback.

When the tubes are heated by ac, a "hummy" tube can easily be responsible for excessive hum. Usually (though not always), it will be in the first stage of the record or playback amplifier. Keep a stock of replacement tubes on hand, so you can check tubes by substitution. Such a stock is not very expensive—the entire tape recorder may use only three or four tube types. It is a good idea to have at least two of the type used in the first stage.

A tube can pick up hum not only from its own heater but also from transformers and motors. Even though a tube is heated by dc, replacement by a tube less susceptible to hum may help.

Watch out for a missing tube shield, or one that is hanging loose and not making contact with ground.

Hum sometimes decreases noticeably when you ground the equipment via a heavy lead to a cold-water pipe or similar object (but never to a gas line).

A violent case of hum may be due to a break or poor contact in the ground lead from the playback head to the tape amplifier. If you are feeding the signal directly from a playback head to an external preamplifier, you may find that hum is due to a poor connection between the cable plug and the preamp's input jack. Try filing or scraping the contacting surfaces. Squeezing the shell of the plug slightly with pliers will help assure a firm ground connection.

Be careful how you route the cable from a playback head to an external preamp. If this path is close to a motor, power transformer or ac line, appreciable hum may result. Remember that even though the cable picks up only a minute amount of hum, this may be large compared to the few millivolts of signal delivered by a tape head. The cable should be as short as possible.

Because of the large bass boost used in playback—as much as 36 db—anything that further, and unnecessarily, boosts the bass is apt to introduce noticeable hum. This might be a bass-boost control in your audio system which is advanced too far for the volume level (the higher the level, the less bass boost is ordinarily required). It might be a misadjusted loudness control (producing substantial volume well below a 12 or 1 o'clock setting).

Other noises

Tubes are a prime cause of noise, as well as of hum. Again, suspicion initially focuses on the tube in the first stage of the playback amplifier (or of the record amplifier). Sometimes, though, a later stage will be responsible. Noise level can often be reduced by trying several tubes (of the same type, of course) in the first stage. Some equipment manufacturers use selected tubes in early stages to minimize noise.

Resistors are a well known source of noise. The least noisy resistors, wire-wound or deposited-metal film types, are expensive ($2 or $3 each). Even an expensive ($2 or $3 each). Even an expensive resistor can develop noise after a while. Depo-sited-carbon resistors have been suggested as low-noise types, but often they are hardly better than molded carbon units. Using a garden-variety resistor of excess wattage rating—for example, a 2-watter where a ½-watter might otherwise do, sometimes cuts noise. Low-noise resistors are called for in the plate load, and in the cathode load if the cathode is unbypassed. The audiophile with kit-building experience might have sufficient know-how to go about replacing resistors suspected of being noisy. Ordinarily, though, this is the technician's domain.

Tape heads become magnetized with use, producing noise in playback and also recording noise on the tape. Heads should be demagnetized after about every 8 hours of use. Head demagnetizers (Fig. 1) cost only a few dollars. They should be applied also to

Fig. 1—A head demagnetizer, like this, is an absolute must for quiet recordings.

Robins Industries Corp.
If a stereo head is positioned too high or too low relative to the tape, crosstalk may occur because the signal intended for one tape track overlaps onto the adjacent one when the reels are reversed. On a quarter-track stereo head, crosstalk may occur on tracks 2 and 3 (Fig. 4). If you are tempted to adjust head height, follow the manufacturer’s instructions and make sure you follow up with azimuth alignment to avoid treble loss (discussed in the next article).

Crosstalk may result from poor isolation between channels in the tape amplifier, or poor electromagnetic isolation between the two sections of a stereo head. With stereo signals, a fair amount of crosstalk is ordinarily tolerable. But with unrelated mono signals, even slight crosstalk can be objectionable. One reason for the high price of a good-quality tape machine is the care taken to minimize crosstalk.

Recording at too high a level or using too thin a tape may cause print-through — transfer of sound (magnetically) from one layer of tape to the adjacent layers. The audible results are often called pre-echo and post-echo. Print-through increases with the length of time a recorded tape has been stored. Special low-print tapes are available, but if you use good quality conventional tape with a 1½- or 1-mil base, and if you stay within permissible recording levels as indicated by the record-level indicator, you will avoid print-through.

Tape squeal is a particularly annoying form of noise, not only as a direct air-transmitted sound, but it can also be recorded on the tape to mar all future playbacks of that recording. Squeal may be due to dry tape, rough pressure pads or excessive pad pressure. High-quality tape contains an efficient lubricant that helps avoid the problem. Moisture can be restored to dry tape by storing it for about a day in a closed container with a moss sponge. Audio stores carry lubricating devices and substances to be applied to the tape, heads, pressure pads and tape guides (but not to the capstan and pressure roller). Cleaning the heads, capstan and pressure roller with alcohol can help.

Under-recording is a source of noise. A low recording level means relative accentuation of tape hiss and tape amplifier noise. A faulty record-level indicator may be responsible for under-recording, and here you will need a technician to check and correct. Or the fault may simply be your own, in setting recording level.

Some recorders, used with an external preamplifier, produce electrical feedback—a violent howl or roar. Most home tape machines use the same head for recording and playback, and therefore only one amplifier for both purposes, with switching. In such machines, the output jack may remain connected to the tape amplifier in the record mode. If the tape machine is in the record mode and the selector switch of the external preamp is accidentally set to tape playback, a situation like Fig. 5 occurs. Any signal entering the machine’s input jack...
is amplified, goes to the machine's output jack, proceeds along the cable to the tape input jack of the preamp, goes to the preamp's selector switch and then its tape output jack, re-enters the tape machine, is further amplified and so forth. The obvious answer is to avoid turning the preamp selector switch to "tape playback" when the tape machine is in the record mode.

A better solution is to make sure you purchase a preamp that it provides for breaking the feedback path. Such a preamp has a special input jack for tape playback, and a special "tape monitor" switch that bypasses the regular selector switch (Fig. 6). Alternatively, you can choose a tape recorder that interrupts the feedback path in the record mode.

A thump, click, pop or waverering sound may result from an improper splice. For a correct splice, cut the tape at a 45° angle and apply the splicing tape (special tape sold for the purpose, not ordinary cellophane tape) at the same angle (Fig. 7). This allows the magnetic and splicing tapes to make gradual contact with the tape heads and pressure pads.

The harmonics of a stereo pilot signal (19,000 cycles) may beat with the high-frequency bias current, putting spurious signals on the tape. For example, the fourth harmonic, 76,000 cycles, might beat with a 70,000-cycle bias frequency, producing an audible 6,000-cycle note. Better stereo tuners and adapters keep the pilot signal and its harmonics negligibly small at their output. Some tape recorders have a special input filter. But if you do run into the problem, buy one of the commercially available filters and install it between the stereo tuner (or adapter) and the tape recorder.

The next article in this series will deal with bass and treble problems, distortion and disappearance of sound.

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**improvising an FM tuner**

Get FM broadcasts on any intercarrier TV with the help of this little oscillator

**By OLIVER E. WILSON**

![Diagram of simple common-base oscillator](image)

Circuit of simple common-base oscillator. Radiation from coil should be sufficient.

wound with 5 turns on an old slug-tuned ¼-inch ceramic coil form (see photo). A larger air-core coil, with one or two more turns, should be equally good.

Mount all parts solidly to make the oscillator stable. The tuning is relatively free from drift and frequent tuning is not required. The unit is unshielded, so hand capacitance makes the initial tuning fairly critical.

If the coil dimensions given are followed, the unit should work without using a grid-dip meter to check it out, but if one is available it can be very convenient. Use a socket for the transistor to guard against possible heat damage during construction.

**Tiny box tucks away inside TV, or almost anywhere.**

Completed oscillator shows snap terminals from old battery. 9-volt battery simply snaps onto the terminals. No switch needed.
NEW COMPUTER MEMORY in which thin ferrite sheets are stacked, laminated and cured in a new process “borrowed by RCA from the plywood industry.” Unfinished sheets are in the foreground; the complete memory, compared for size with an aspirin tablet, is in the rear.

MOTHER HEART MACHINE, sleep-inducer for babies patterned after the device invented by Dr. Lee Salk, now marketed by a Japanese company. The battery-operated unit produces sounds resembling a mother’s heartbeat, tranquilizing the infant.

FIRST VIDEO PLAYBACK-ONLY tape machine has been announced by RCA. It is the unit displayed by John Salani of the RCA Broadcast & Communications Products Div. The equipment behind him makes the playback unit a complete recorder.

SPACE-SHIP POWER PLANT for manned space vehicles would consist of parabolic mirror with collector mounted at focus. Light-looking frame makes it possible to keep power plant oriented on the sun, and is strong enough for use in no-gravity conditions. Design was proposed by Sundstrand Aviation-Denver, a division of Sundstrand Corp.
WHAT HAPPENS TO PICTURE TUBES?

That big bottle may be beyond hope, or maybe not. Find out before you pack it!

TO THE CUSTOMER, THE PICTURE TUBE is the most important part of his TV set. It's the most expensive! So we need to know what's going on in the "big bottle." Sad to relate, some perfectly good picture tubes have been replaced. Also, picture-tube testing can be a powerful "psychological warfare" weapon with the customer. By taking many pains to try to rejuvenate a dead CRT, you can make a good friend out of even the most contrary customer! (Of course, be sure to tell him, "Your picture tube's dead, I'm sorry to say. But I'm going to try to bring it back to life so that you can get some more use out of it." Even if you fail, he'll feel better if you're obviously trying.) Let's take the common troubles first.

Most common, of course, is the "weak" tube—4 to 6 years old, cathode pretty well exhausted. Symptoms: dim raster and poor contrast. However, this can be due to other things: video trouble or low high voltage. So let's be sure. A good CRT tester is essential. Fig. 1 shows the appearance of a weak tube, before rejuvenation. Focus is fair, as you can see in the gray areas, but the highlights "smear out" when the brightness is brought up. Many weak tubes won't show this much contrast. Remedy: rejuvenate it.

Rejuvenation

This is a simple process, really. The cathode of a CRT is a wee dot of active material on the end of a metal cylinder; the heater is inside this. After years of use, all the "goody" is gone from the surface, so we get few electrons and a thin beam. To restore emission, we tie all the other elements together, making a diode plate out of them, and feed a high dc voltage to that "plate." The resulting surge of emission will (we hope) burn off the outer layer of depleted material from the cathode. So, we get more emission. Fig. 2 shows this schematically.

Testing for quality

To find out if this worked, we check the tube. Practically the same circuit. We tie the elements together, put a lower dc voltage on the plate and a milliammeter in series (Fig. 3). (This is the principle used in all emission testers.) Read the cathode current. If it is more than about 300 microamperes, we did it! Some testers make a triode out of the CRT, as in Fig. 4. Positive dc voltage is fed to the "plate" (G2 and G3, if the tube has a G3), and the grid is returned to a variable bias voltage source. Now, we can not only check total emission but measure the grid cutoff voltage, to be sure that the tube is capable of being controlled by the bias as if should be. (Normal cutoff voltage for the average CRT is between −30 and −50.) Incorrect cutoff bias will upset the video level, cause poor contrast, etc.

Drastic measures

If the CRT is old, sometimes this rejuvenation won't "take" the first time. So we resort to more drastic measures. CRT testers now have a heater voltage variable from 1.1 to 12. (Early models had only 6.3 volts ac, but they had provisions for increasing this, as we'll see.) Most CRT testers have three positions for rejuvenation that we might call "normal," "heavy duty" and "last resort!"

In "normal," only the dc voltage is applied. This cures most tubes. In "heavy duty," the heater voltage is increased by about 15% to bring the cathode temperature above normal and "boil" the active material. Then, when the dc is applied, it can "get in" much easier.

The last step should really be called "resuscitation" instead of "rejuvenation" since it is used only on tubes that are to all intents and purposes completely dead. (In none of these cases will we "bring back their lost youth," so "rejuvenation" is a misnomer!) The heater voltage is increased by 20% or more, and...
Fig. 5- a—Autotransformer brightener raises heater voltage, does not isolate circuit. In 5-b, a two-winding brightener, which can isolate heater from cathode circuit in case of internal short.

Fig. 6—Basic short-test circuit of CRT checker. Good element lights one side of neon lamp, shorted one lights both, and open element, neither side.

Fig. 7—Shorts between elements (except heater-to-cathode) usually result from flake of conductive material lodged between them.

and in some testers the dc voltage is raised. You'll usually see fire fly in the neck when you hit the button, on this one!

**Brighteners**

Many tubes, after rejuvenation, will show *good* at first, then slowly die out as the cathode cools. This calls for a brightener. (Never say "booster"; that has a bad connotation. Many customers think a booster gadget raises the high voltage, causing X-ray emission, and all sorts of horrible things! Always explain voltage, causing X-ray emission, and all think a booster gadget raises the high voltage, but the focus is still poor, this could be rounded, it can cause blurring and loss of focus. If all other tests show nothing, but the focus is still poor, this could be.

**Gassy CRT's**

Once in a while, you'll find CRT's with gas, air leakage, etc. In some of these, you'll be able to see the electron beam as it goes through the gun, as a thin blue "pencil" of light! If the gas concentration is bad enough, you'll get an effect similar to that in Fig. 1—defocusing and loss of grid control. Replacement is the only cure. Some CRT testers have gas checks, the same circuits used on other tube testers.

**Grid damage**

If the ion-trap magnet wasn't set right when the tube was installed, the electron beam can hit the side of the tiny hole in the grid or anode disc. This can, in time, chew away some of the metal! See Fig. 9. If the hole is too much enlarged, it can cause blurring and loss of focus. If all other tests show nothing, but the focus is still poor, this could be
the cause. There is no way to be sure, without taking the gun apart! When you install a new CRT, always be sure that the ion-trap magnet is properly set, for maximum brightness. In electrostatic-focus tubes, set it for maximum brightness by sliding it back and forth along the tube neck, then very slightly around the neck, watching the screen, for best focus. Don't use it to remove neck shadows!

Loose bases

The CRT base often came loose in older tubes, from aging of the cement.

Fig. 9—Note the hole and ragged edges in the anode disc at top. Compare it with the undamaged disc, bottom.

Special tube-base repair cement can be found in parts houses, Run a thread of this around the base and let it dry well.

If the leads become loose in the pins, resolder them. Running a short feeding fresh solder to the tip, is a good trick. Don't let it go more than 1/2 inch inside the pin. Clip it off after the solder has cooled.

A pin crimper especially made for this purpose is also very handy. It crushes the base of the pin to make a firm contact to the wire lead. Always carry one in the tube caddy for emergencies.

When all of these tests have been tried, without results, there's only one thing to do: replace the CRT. On this, only one suggestion. Don't drop it!

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**R-E Guide to Test Tapes and Records**

by Robert F. Scott Technical Editor

High-fidelity amplifiers, tape recorders and phonographs must be correctly installed and kept in top-notch condition. The hi-fi listener usually requires optimum reproduction. Tape decks and record players have to be checked and adjusted for minimum flutter and wow; cartridges must track correctly with minimum stylus pressure.

Speakers in stereo and multi-channel systems must be correctly phased, stereo channels should balance and amplifier response and equalization meet minimum standards.

If you are wondering how your equipment meets these and other stringent requirements, why not give it a complete checkout by using test tapes and records. Some deficiencies can be corrected with a few simple adjustments. Others may require precise test instruments. A scope, audio vtm or vu meter is recommended as an output-level indicator. In emergencies, you can connect a flashlight bulb (200–300 ma, 2–6 volts) across the speaker leads as an output indicator.

If you are a service technician, you will find test tapes and records invaluable in installing, troubleshooting and servicing high-fidelity audio equipment. Here is a review of some of the most popular test tapes and records and an outline of what they do and how to use them.

**Test Records**

The gaps in tape recorder reproduce and record heads must be checked for precise alignment at right angles to the tape track. This brings performance from pre-recorded tapes to optimum and makes it possible to interchange tapes between different machines without loss of high-frequency response. Playback response, signal-to-noise ratio, wow, flutter and stereo balance must also be checked.

**Audio Alignment Tape**

This tape is used to align tape, produced by Audio Devices, Inc., etc. to align a tape and play heads at 15 and 7.5 ips. It consists of 30 seconds each of 2- and 10-kc tones, 60 seconds at 15 kc and then 30 seconds of 10 and 2 kc when played at 15 ips. All frequencies are 50 times doubled when played at 7.5 ips. All tones are separated by 5-second intervals. The tone is recorded symphonically so it can be run in either direction and rewinding is not necessary.

Allignment tape should be subjected to high-toward rewind. This can cause stretching, which may cause the tape to become loose in the machine.

**Ampex Reproduce Alignment Tapes**

These tapes are recorded for specific operating speeds. The tone designated for alignment has a wavelength of 5 mil on 7.5- and 3.75-ips tapes and 1 mil on 15-ips tapes. Voice announcements identify each tone frequency and level.

On the 317/1-01 7.5-ips full-track tape reviewed here, a 700-cycle reference tone is recorded 10 db below the normal operating level. This is followed by a 15-kc signal for head alignment and then 10-second bands of tones at 12, 7.5, 5, 2.5 and 1 kc and 500, 250, 100 and 50 cycles.

These tones are recorded 10 db below normal operating level and are used to check playback response. The playback amplifier gain should be adjusted so the vu meter reads 0 db. This setting is used for sound adjustments and making signal-to-noise ratio tests.

We found that the time allowed for head alignment is not long enough. This makes it necessary to rewind and replay the alignment band to insure precise adjustments.

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A band of magnetos clicks to balance the volume of the two channels so the sound output comes from midway between the two speakers. The tape includes a number of musical passages repeated at successively higher levels. Each test warble is identified by ear. The 500-cycle difference frequency should be within a 1 kc to 2 kc range for RIAA equalization. Pickup tracking is tested on a glide band covering from 100 to 5 cycles with spaced grooves of 80, 60, 50, 40, 30, 20, 15, and 10 cycles. Bands 4 and 6 provide tests for hum and rumble.

**RCA test records**

The RCA 12-5-6LT Tape Recording Test Record, made by Components Corp. for Lafayette Radio Electronics, has one side for stereo tests and one for monophonic tests. The test record consists of nine sections, each containing a band of sound effects. For example:

1. 1-kc tone for head alignment. This is followed by a 10-kc tone on the second band. The 1-kc tone is a phasing reference level. The second band contains a 1-kc reference level. The third band has 12-kc tones at 100 cycles. The fourth band has 512-kc tone at 5 cycles. The fifth band has 512-kc tone at 5 cycles. The sixth band has 512-kc tone at 5 cycles. The seventh band has 512-kc tone at 5 cycles. The eighth band has 512-kc tone at 5 cycles. The ninth band has 512-kc tone at 5 cycles. The tenth band has 512-kc tone at 5 cycles.

2. 1-kc tone for head alignment. This is followed by a 10-kc tone on the second band. The 1-kc tone is a phasing reference level. The second band contains a 1-kc reference level. The third band has 12-kc tones at 100 cycles. The fourth band has 512-kc tone at 5 cycles. The fifth band has 512-kc tone at 5 cycles. The sixth band has 512-kc tone at 5 cycles. The seventh band has 512-kc tone at 5 cycles. The eighth band has 512-kc tone at 5 cycles. The ninth band has 512-kc tone at 5 cycles.

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9. 1-kc tone for head alignment. This is followed by a 10-kc tone on the second band. The 1-kc tone is a phasing reference level. The second band contains a 1-kc reference level. The third band has 12-kc tones at 100 cycles. The fourth band has 512-kc tone at 5 cycles. The fifth band has 512-kc tone at 5 cycles. The sixth band has 512-kc tone at 5 cycles. The seventh band has 512-kc tone at 5 cycles.

10. 1-kc tone for head alignment. This is followed by a 10-kc tone on the second band. The 1-kc tone is a phasing reference level. The second band contains a 1-kc reference level. The third band has 12-kc tones at 100 cycles. The fourth band has 512-kc tone at 5 cycles. The fifth band has 512-kc tone at 5 cycles. The sixth band has 512-kc tone at 5 cycles. The seventh band has 512-kc tone at 5 cycles.
Tape and Disc Accessories

... a directory

By ROBERT F. SCOTT, TECHNICAL EDITOR

Bulk Tape Erasers

Bulk erasers assure 100% erasure and remove all recorded signals faster and more completely than most recorders. Save wear on heads, pressure pads, guides, clutches and other parts of the recorder.

Magneraser

260C features a 750-gauss erasing field with low power consumption. Handles 3/8 in. and 1/2 in. tape and 16- and 35-mm magnetic sound film on any reel from 5 to 15 in. lower background level 3 to 6 db below that of virgin tape. Also demagnetizes record - playback and erase heads, reducing distortion and background noise. Draws 60 watts from 110-130 volt 50-60 cycle source. 2 1/2 in. high, 4-in. diameter, 3 1/2 lb. Push-button safety switch and 8-ft line cord.—Amplifier Corp.

Tape-Head Demagnetizers

High-level peaks in the recording signal and transients produced by noise on the power line and by stopping and starting the machine tend to magnetize the recording, playback, and erase heads in the recorder. This may increase the noise level 5 to 10 db, distort the signal and gradually erase the high frequencies on any tape played on the recorder. Thus, the heads should be demagnetized every 8 hours or so for optimum recorder performance.

Head demagnetizers consist of an electromagnet with narrow-gap pole pieces shaped to straddle the gap in the heads. The pole pieces are shaped to reach the heads in most recorders without removing the head covers. One demagnetizer, the Lafayette MK-238, has removable straight, 45° and 90° pole pieces for quick and easy operation on any tape head. Some models have momentary on-off switches. Others are turned on by plugging them into the ac line.

Generally, pole pieces are tipped with a soft plastic material to protect the head surfaces.

To use the head demagnetizer, plug it into the line or close the switch, straddle the pole pieces across the gap in the recording head and run it up and down several times for a few seconds. Then gradually withdraw the unit from the head before turning it off. Repeat the operation on the play and erase heads and the tape guides.

... 48
Approved HD-6. For less-offen-used recorders.—Robins

New demagnetizer replaces the model 54-02.—Roberts

Tape and Head Cleaners

Tape-head cleaners consist of chemicals, cloths and reels of special tape to clean and lubricate tape heads and guides as the tape is run through the machine. Kleen-Tape, a 30-ft., 3-in. reel of impregnated cloth tape.—Audiotex

12 clips, 100 ft. of splicing tape, 2-oz. bottle of head cleaner, book on splicing and editing tape.—Knight

Gibson Golf Stereo 4 kits, AVK-1 for professionals, langemana labs, visual-aids departments, broadcast and audio studios. Contains manufacturer's MD-99 bulk waxes, HD-4 head demagnetizer, TS-80 splicer, TC-12 tape clips, SL-30 reel labels, JCT-2 tape cleaning cloth, six rolls of ST-500 splicing tape, TT-1 tape thresher, TK-8 strobe and light, TK-6 head guide lubricant and cleaner. TK-45TD is the standard accessory kit containing TS-42 tape splicer, 100 ft. of splicing tape, threader, tape clips, HC-2 head cleaning fluid, tape cleaning cloth and "Guide Book to Better Tape Splicing and Editing."—Robins

Magnetic-Tape Viewer

The No. 600, designed especially for use with instrumentation tapes, has several audio uses such as to examine and synchronize the audio track on video tape, check head alignment and track placement and to study the pattern of the recorded sound.—3M

NEW DEMAGNETIZER REPLACES THE MODEL 54-02.—ROBERTS

Tape Care Kits

Home Recorder Accessory Kit model 995 includes model 820 head demagnetizer, splicing and leader tapes, 3-oz. can of No. 823 head cleaner, model 805 tape splicer and box of swabs. Professional Accessory Kit model 996 includes can of No. 823 head cleaner, model 820 head demagnetizer, bottle of lubricating oil and box of swabs.—Ampex

Tape Splicers

Model 805 splicer designed for precise requirements of splicing 4-track tape. Protects program material on tape. Has splicing tape dispenser and two cutting positions.—Ampex

Phono and Tape Strobos

The speed of a phonograph turntable or a tape recorder affects the pitch of the music. Simple stroboscopic devices are used to check the speed. Strobe discs for phonographs are available from a number of sources.

Record and Tape Files

Quick-See all-metal slide-mounted record and tape files mount easily in built-in music centers, Hi-Fi cabinets, closets or shelves. Front-view visibility and flip-through convenience. Nine models to fit most storage areas. Hood up to 123 15/16 in. LPs, 150 45's on 30 tapes. Several cabi-
Strob-Loop (Cat. No. RT-380) a continuous loop of 1/5 mil Mylar tape checks speed, timing, wow and flutter. Slot holds stylus assembly steady. PK-224 phonograph timer begins to operate when turntable or changer starts, and stops when the turntable cuts off. 2 1/4 in. 1,000 hour dial is marked in 50-hour units. Mounts on motor board or any convenient spot. Extends 1 1/2 in. below or behind panel.

Stylus Pressure Gages

Stylus pressure must be correct for optimum tracking and sound and for minimum record wear and damage. Stylus gages are essential for measuring the pressure of the stylus on the record. In the most common type, the weight of the stylus on one end of a platform is balanced against a variable weight on the other end. The Walco Microgram (illus) and Audiotex (Cat. No. 30-2221) have a single weight that is moved to calibrated positions on the beam to measure stylus pressure. These are calibrated from 1 to 10 grams.

Stylus Microscopes

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Stylograph PK-224 is for inspecting stylus tips for wear, chipping and other damage. Shows large silhouette of stylus tip on 1 x 1 1/2-in. ground-glass screen. Stylus need not be removed from cartridge or pickup arm. Complete with batteries, on-off switch and bulb. 4 x 1 1/2 x 1 1/2-in. PK-227 pocket-type inspection scope with 50X magnification. Similar in appearance to Robins MX-1 below.

Stylus-Wear Timer

Stylachron PK-224 keeps accurate record of actual time phono stylus is in use. Motor-driven timer begins to operate when turntable or changer starts, and stops when the turntable cuts off. The 2 1/4-in. 1,000-hour dial is marked in 50-hour units. Mounts on motor board or any convenient spot. Extends 1 1/2 in. below or behind panel.

Record Cleaners and Record-Care Kits

Most record cleaners consists of an antistatic detergent and lubricant and a soft pad applicator that removes dust and grime.

The Watts Dust Bug and Changer Dust Bug (illus) consist of a tiny nylon brush that dislodges dirt from the record and a plush roller that applies the antistatic cleaner and collects surface dirt. The Dust Bug is on a pivoted arm with positions for 12- and 15-in. records. A suction cup mounts the arm on turntables and changers without interfering with the turntable or pickup arm operation. The Changer Dust Bug clips directly on the changer arm. Supplied with antistatic cleaner:

Panasonic MK-10A is a manual adaptation of the Dust Bug. Nylon bristles and antistatic compound deep into record grooves, removing accumulated dust, grime and residue. Improves reproduction of old records and sustains the hi-fi reproduction of new ones.

Pickup-Arm Controls

Remote controls for phonograph pick-up arms minimize stylus and record damage caused by accidentally dropping the arm or sliding the stylus across the record. The control gently lowers the arm onto the record and lifts it off at the end of play. Ideal for cueing. Adaptable to most pickup arms and changers with manual features.

Ortofon Hi-Jack features air cushioned levelling. Mounts on Thorens TD-124 and TD-121 turntables without drilling.
New EASTMAN Sound Recording Tapes give you sound recording at its best.

STOP New DUROL Base won't stretch. Special triacetate formulation has exceptional tensile and yield strength. Yet in case of equipment failure the tape breaks clean without stretching. Splices are quickly and easily made; program loss is reduced to an absolute minimum.

LOOK New "lifetime coding" assures highest quality. Permanent legend continuously printed on the back of the new Eastman tapes identifies Eastman Kodak Company as the manufacturer and provides a convenient indexing code.

LISTEN New "R-type" binder greatly improves sound quality. Smooth, tough, oxide layer of supreme uniformity suppresses tape noise and intermodulation distortion. High resistance to abrasion prevents oxide build-up at the recorder head. Great chemical stability results in long tape life.

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- Industrial Electronics
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The Most Trusted Name in Electronics
IF YOU RUN INTO AN AUDIO AMPLIFIER that "just doesn't sound right," whether it's in a radio, TV, hi-fi, stereo, PA or anywhere else, look for ultrasonic oscillation! This can occur in any stage and anywhere else, look for ultrasonic oscillation! This can occur in any stage and really upset things. (Like the bias, for example.) As usual, a scope is the quickest way to be sure. Just hook it across the voice coil, with no signal input, and turn the gain control on the amplifier up and down. If you get a high-frequency waveform, there it is!

A similar complaint shows up when the amplifier is oscillating intermittently. In a lot of cases, it'll be going into the same kind of oscillation, but only on very high signal peaks. This is even harder to find, and almost impossible without the scope. Best check: feed a low-frequency sine wave through the amplifier—up to, say, 150 cycles. Set the scope sweep to hold the signal. Now turn up the gain of the amplifier and watch. (Reduce the scope's vertical gain to keep the pattern on the screen.) If you see things like Fig. 1 starting to show up, here we go again! The amplifier is going into oscillation when the signal gets above a certain level.

The major cause of this is some kind of resonance in the primary of the output transformer, it seems. The output stage causes most of the troubles. In low-priced amplifiers, the output stages are driven hard, and any tendency toward oscillation is "swamped out" by shunting a capacitor across the output transformer primary. Since this is usually a pretty high-frequency oscillation, often as high as 50 or 60 kc, even a small capacitor will have such a low shunting reactance that the stage won't oscillate.

If the capacitor isn't there, you can add it. By using the smallest size that kills the oscillation, you won't affect the frequency response too much. Start with about 100 pf. In cheap amplifiers any slight rolloff won't matter anyhow! In higher quality amplifiers, this kind of trouble will be due to opening up or aging of filter capacitors, usually in the "second filter," as in Fig. 2. The B-plus voltage comes through the "first filter," as in all sets. Then, in the good ones, it is filtered again before it is fed to the plates of the preamplifier and other high-gain stages.

This is generally called a "decoupling network," but for some reason I have always thought of it as a filter: seems to do the same thing, anyhow! If you find such trouble in a home-built amplifier, do the same things to get rid of it. Add a capacitor across the output transformer primary, add more filtering (a "second filter" if you don't have one). In a few cases, you can help things by lowering the voltage on plate or screen (if it's a pentode) of the input or preamp stage. This holds the gain down and prevents feedback of unwanted signals into the B-plus. Shunting an overall-feedback-loop resistor with a small capacitor (50 pf—0.01 μf) often helps too.

Final word: If you find a powerful amplifier that's doing this, don't run it too long. Most especially, don't let it run without a load on the output transformer! If you can't stand the noise, hook a suitable resistor across the secondary to take the place of the speaker. But don't let it sit there and run with this oscillation going on. The voltage peaks reached in the output stage can often flash over the output transformer, and burn it up! This is made much worse if the load is removed: the output tubes are then working into a very high load impedance, so they can build up higher voltage peaks. So, watch it!

Tape recorder frequency tests

I'm working on a pretty high-grade tape recorder. Is there any really accurate way to check tape speed and timing?—R. G. M., Oakland, Calif.

Several ways. Try this one: set the recorder up, and record several minutes of the 440-cycle tone from WWV, plus the "ticks." Now play this back, and feed both the output of the tape recorder and the signal direct from WWV into a scope. By comparing the frequencies, you can get a very good idea of how the speed is holding, etc. Feed the tape output to the horizontal input and the receiver output to the vertical, and make Lissajous patterns. They should be circles, lines or steady ovals.

For other methods, see "Test Tape Checks Recorder Speed" and tape strobos listed in the "Tape and Disc Accessories" directory on pages 100 and 49, respectively of this issue.

Output transformer flashover

I've got a high-power PA system in for repair. Although it was trouble in the input stage to start with, now the output transformer flashes over when I turn the amplifier on with a test signal. Voltages, etc., are OK, and the signal shows no distortion on a scope.—H. P., Brooklyn, N.Y.

You must be running this system with the output transformer secondary open. Are you? If so, the flashover is natural! Running the output transformer secondary open will upset the loading on the output tubes. They will develop a tremendous peak voltage across the much higher load resistance, and usually flash over.

---

Fig. 1—A few examples of parasitic oscillation kicked off by high-amplitude signal. "Fuzz" may be on either peak or both, or neither.
From Parts...

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Heathkit High Fidelity Color TV For As Low As $349

25 hours of relaxing, rewarding fun! That's all! And you've built the new Heathkit High Fidelity 21" Color TV with the finest color circuitry, components, and performance possible today. Goes together quickly, easily. No special skills or knowledge required! So simple anyone can build it! You'll enjoy 21 inches of beautiful, high fidelity picture that reproduces every color naturally, realistically, faithfully... you'll enjoy high fidelity sound that's sharp, crisp, clean... and you'll enjoy features and performance comparable only to units costing 50% more!

Compare these Heathkit features with others: • 27 tube, 8 diode circuit with optional UHF • High definition RCA 70° 21" color tube with anti-glare, bonded-face safety glass Automatic Color Control • Gated Automatic Gain Control for peak performance • 24,000 volt regulated picture power • Hi-Fi sound with outputs for speaker and hi-fi amplifier • Deluxe Nuvistor tuner with “push-to-tune” fine tuning for individual channels • 3-stage high gain video I.F. • Line thermistor for longer tube life and thermal circuit breaker for component protection • Degaussing coil and built-in dot generator for perfect picture adjustments • All critical circuits factory-built and tested • Can be custom mounted or installed in handsome walnut cabinet • One year warranty on picture tube, 90 days on parts.

Save On Maintenance Costs! In addition to the initial savings you realize by building this set yourself, you'll save on expensive repair bills too. The simple-to-follow Heathkit instruction manual contains circuit diagrams and a “Servicing Hints” section so you can easily make adjustments and replacements should it ever become necessary.

Versatile Installation! The chassis, tubes, and front panel of the Heathkit Color TV can be mounted in the handsome GRA-53-1 walnut-finished hardboard cabinet. Or if you prefer, it can be mounted in a wall or custom cabinet, and the sound signals fed to an external amplifier unit. Required custom mounting space dimensions: 24-3/4"D x 22-1/4"H x 28"W. In this case the GRA-53-3 Custom Mounting Kit should be ordered to provide physical support between the chassis and front panel.

Optional UHF! An optional UHF tuner is available for coverage of channels 14 to 82.

Kit GR-53, chassis and tubes, 118 lbs. $349.00
GRA-53-1, walnut cabinet, 70 lbs. $49.00
GRA-53-2, opt. UHF tuner, 3 lbs... $20.00
GRA-53-3, custom mounting kit, 10 lbs. $4.00

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When checking such systems, always be sure that the secondary is loaded. I have an old 75-ohm 100-watt resistor I found in surplus, that I use as a dummy load by connecting it across the 100-volt output line. You can use any resistor of sufficient rating, and a resistance that is close to one of the output impedance taps. For instance, a 3- to 5-ohm resistor on a 4-ohm tap, and so on. Watch out, though: this resistor will get mighty hot!

**Transistor intercom motorboats**

I'm using a transistorized intercom system, similar to the one shown in your June '62 issue. I use a single battery for the power supply. When I try to operate it from an ac power pack, I get motorboating.—W. D., Berwyn, Ill.

This seems to come up regularly in ac-powered transistor equipment. The main cause seems to be too high impedance in the power supply. In this case, only a few ohms is too high! To prevent interaction between stages, which is the major cause of motorboating, your power supply must have a very low impedance (Fig. 3). This, of course, means very large capacitors, and very low-resistance chokes, if used.

**Speaker intermittents**

I've had trouble in several speakers with intermittent voice-coil connections. Once in a while, one of the speakers makes a terrible squawk. Do you have any idea what causes this?—O. P., W., Roaring Spring, Pa.

Yes, sir! We used to find it in a lot of older speakers. Fig. 4 shows the reason. The flexible wire between the terminals on the basket (frame) and the voice coil itself has a stringlike fiber core. The conductor is a copper braid wound on the outside. Continual flexing breaks the tiny strands, but the string holds the thing in place. So, a jar or movement of the cone can cause the open ends of the cone to touch. Because the wire is still in place, the break can open and close very rapidly. As the cone moves in, the contact is made, and when the cone moves out, it breaks. If this happens rapidly enough, you can get an "oscillation" that is actually caused by the speaker circuit opening and closing!

**Unstable audio "front ends"**

I've built audio amplifiers of various types, and I always have a time trying to get the input stages to stop oscillating, being noisy and so on. Isn't there a cure for this?—S. P., Brookhaven, N.Y.

There's the one you thought I'd mention: be more careful in your construction techniques! Watch your lead dress, and shield liberally in all high-gain voltage-amplifier stages.

One way, which I thought was pretty crude when I first found it but which I've seen used with success in other circuits lately, is to use a 12-volt tube instead of a 6-volt. For example, a 12AU6 instead of a 6AU6 (on the 6-volt heater supply). Running the tube at such a low cathode temperature makes it a lot quieter, and there is usually ample gain! Try it.

**Locating Bogen "Challenger" data**

I have a Bogen amplifier for repair, and I can't find a listing on it. I know it must be in there somewhere but I sure can't find it. It's a CHA-75.—P. F., Long Island City, N.Y.

Look for this under "Challenger" in Sams Photofact Index. (This one is in 395-7.) The Challenger line is built by David Bogen, as you saw from the label on the back, but listed under C for Challenger.
Thirteen years ago we introduced the "Williamson Type Amplifier Kit!". It represented a breakthrough in "do-it-yourself" high fidelity. For the first time a truly high fidelity amplifier was made available in kit form at an "easy-to-afford" price. The old WA-1 and its successors including the famous W-5 provided high fidelity listening pleasure to hundreds of thousands of music lovers across the nation. Ever since, Heath's history has been one of major advances in the hi-fi/stereo field. And now today, another first from Heathkit! Heath's newest...a stereo receiver in kit form! Compact in price...stylish in design...fashioned in Heathkit's model no. AR-13. This is the first all-transistor, all-solid-state circuitry, at a price far below similar units...only $195.00!

Now in one compact unit!...two 20-watt power amplifiers, two separate preamplifiers, plus wide-band A.M. F.M. FM stereo...all superbly engineered to give you the clean, fast, reliable "transistor sound" of tomorrow, to-day, by ordering the AR-13 now!

An exciting challenge for the more experienced kit-builder. Takes approximately 35 hours to assemble. The "front-end" and AM-FM F.I.F. strip are already preassembled and prealigned to aid construction.

Compare the new AR-13 Stereo Receiver with similar units. You'll agree that for advanced features, advanced solid-state engineering, advanced styling, and money-saving price, no unit matches the AR-13. Start enjoying the "transistor sound" of tomorrow, to-day, by ordering the AR-13 now!

Kit AR-13...30 lbs. $195.00

SPECIFICATIONS - Amplifier: Power output per channel ( Heath Rating): 30 watts, 8 ohm load; 15 watts, 16 ohm load; 9 watts @ 4 ohm load. (HFM Musical Power Rating): 33 watts (8 ohm load), 16 watts (4 ohm load) @ 0.7%, THD, 1 KC. Power response: -2 db from 15 cps to 30 KC @ rated output; +3 db from 30 cps to 80 KC @ rated output. Harmonic distortion: less than 1% @ 10 watts, less than 3% @ 100 watts, less than 5% @ 1 KC. Intermodulation distortion: less than 0.5% @ 10 watts output. Crosstalk: 65 db @ 100 MHz. Frequency response: +1 db from 15 cps to 100 MHz. Harmonic distortion: less than 1% @ 10 watts output per channel. Channel separation: 30 db @ 1000 Hz. Power response: 40 db @ 1000 Hz. Power consumption: 30 watts at 120 volts. Overall dimensions: 17 L x 9 3/4 W x 14 3/4 H. D.
This proposed receiver shows all channels simultaneously, so viewers know every second what programs are on the air. TV receiver shown is for eight-channel reception. New York and Los Angeles each has seven channels. There is one more channel unlabeled, that can be used in fringe areas. An eight-channel receiver, however, would be exceptional. For most of the US, a four-channel—and much less costly—receiver would probably be standard.

Note that all channels come in simultaneously and all are visible together. Audio, however, can be heard on the speaker only from the master channel. The small 3-inch auxiliary channels can be heard by plugging headsets in the respective jacks.

The auxiliary channels are labeled on both sides. By using the motorized remote control you switch from channel 4 as shown, let us say to 13. Note that auxiliary channel 4 is dark. As you switch to 13, this standby channel 13 goes dark, while the small tube on channel 4 shows a picture.

(Continued from page 23)

In the future, for economy's sake, instead of having eight separate small video auxiliary tubes, we may be able to make two small "flat" video tubes each with four separate elements.

So as not to complicate the future color multiple-channel receiver, as well as raise its cost, the small auxiliary video tubes can be black and white.

Furthermore, the first multiplex TV sets will probably have only four auxiliary video tubes instead of eight.

In various parts of the country it is possible to receive as many as 15 channels with a given set; if one has a directional antenna able to get these channels. Here are some statistics that give the story of TV reception in the U.S.

As of 1961, 56% of the population could receive 4 or more vhf stations. Of the nation's 272 markets, 17 have 4 or more stations, 53 have 3 stations, 69 have 2 stations and 132 have 1 station.

How could a multiple simultaneous-channel TV receiver be constructed? The simplest—and probably most expensive—way to do it would be to set up independent receiver circuitry for each auxiliary viewing tube, with a switch that could transfer any program from a small screen to the big one.

But possible combinations become apparent immediately. For instance, one power supply would be sufficient for all the circuitry. And a single TV tuner contains all tuned circuitry needed for all channels. Under some circumstances, it might be possible to combine other circuitry, using broad-band amplifiers. For instance, it might be possible to use a single i.f. amplifier for several channels, picking out each signal with tuned circuits at the video detector.

True multiplexing offers other opportunities, limited, however, by the tremendous amount of information and the broadness of the band characteristic of television transmissions. Storage systems have been proposed in the past to make it possible to transmit less information and yet receive a good picture. The same principles would work for multiplex television. A slightly higher visual-persistence phosphor on the small auxiliary tubes would, for example, convert them into storage devices that would take advantage of the redundancy of the television scene to produce an acceptable picture with less information supplied, thereby possibly making sampling techniques practical.

—H.G.
TAKE Heathkit's Deluxe Transistor Stereo Amplifier

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Each instrument with its characteristic sound reproduced realistically, faithfully, naturally. This is “transistor sound.” No filtering, no fading, no compromising... just the quick, clean sound that only transistors can reproduce. You enjoy this totally different dimension in stereo listening with the total transistor performance of the Heathkit deluxe 70-watt Stereo Amplifier and matching AM, FM, FM Stereo Tuner.

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Full 70 watts of continuous power, 100 watts music power at ± 1 db from 13 to 25,000 cps. Additional features include 26-transistor, 10-diode circuitry for cool, “hum-free” operation, smooth power delivery, and fast effortless “transient response”; complete freedom from microphonics; front-panel mounted controls with 5-position dual concentric source switch, 5-position mode switch, and dual concentric volume, bass and treble controls; circuit breaker protection of output transistors and AC power; and encapsulated preamplifier circuits in 6 epoxy-covered modules, all factory wired and sealed, ready for easy installation. Check the AJ-43 Tuner...

Enjoy extra convenience. Automatic switching to stereo; automatic stereo indicator light; filtered stereo tape recorder outputs for direct “heat-free” recording; Stereo Phase Control for maximum separation and minimum distortion; Automatic Gain Control for constant volume; 25-transistor, 9-diode circuitry for lower power consumption and cool operation; individual AM & FM tuning meters for pin-point tuning; effortless flywheel tuning; transformer operated power supply; and preassembled FM tuning unit and 4-stage FM I.F. circuit board for fast assembly.

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Buy Now! See Order Blank Page!
Stereo Amplifier
(Heathkit All-Transistor AA-22)

Stereo Cartridge
(Euphonics Ceramics)

The AA-22 LIVES UP TO THE HEATHKIT tradition and fulfills its specs in every detail. Power output varies according to the nominal impedance used. This should be explained: The maximum power of 20 watts per channel is available only into an 8-ohm load; 16 ohms (or any higher impedance) connects to the same pair of terminals as 8 ohms, and thus gets less power because only the same voltage output is available. Four-ohm impedances are connected to different terminals which reduce power by putting a resistor in series so only the same current is available as for the 8-ohm load.

I tested the amplifier with 16-ohm speakers, for which the 13.5 watts available is plenty unless your speakers are very inefficient.

The main panel controls, reading from left to right, are: MODE, SOURCE, VOLUME, BASS, TREBLE and ON-OFF. The MODE switch has three positions: MONOPHONIC (which combines inputs to both channels and thus cuts rumble effects with monophonic discs); STEREO (straight) and REVERSED STEREO (transposing left and right outputs). The SOURCE switch provides 5 choices: magnetic phono, tuner, tape recorder and two auxiliaries for which input sockets are at the back and preset input level controls behind the trim flap in front. VOLUME, BASS and TREBLE controls are all dual, working on both channels simultaneously. The BALANCE control, screwdriver adjusted, is behind the trim flap. My room conditions required no off-center setting and the balance of the dual volume control was good enough at all level settings not to need a manual balance control, as did most equipment tested previously. So relegation of the balance control to a preset adjustment represents an advance not previously possible, compatible with effectiveness.

Each tone control has an adjustment range that makes a clearly audible change in its respective component of the sound to an extent that sounds, musically and esthetically, just right.

The phase switch, which reverses the phase of one channel (right), is also behind the trim flap. This control will be needed less and less as source material in circulation conforms more completely to standard, so this location is appropriate.

After a spate of combining the on-off switch with other controls, such as volume, bass or treble (and even balance), I appreciate the separate push-button type, coupled with the neat indicator lights associated with the mode switch to show when the equipment is on. Pushbutton on-off has two main advantages: the uninstructed does not have to be informed how far to turn the knob when the amplifier comes on and the initiated can switch on and off without losing his control settings.

The sound from the AA-22 is extremely clean. The quality of the source material comes right through, and you are more conscious than usual of program defects or excellence. Recorded distortion that previously might not have been noticed because the amplifier swamped it—becomes readily detectable to the conditioned ear. Absence of distortion in the next record played shows the amplifier is clean. This clarity is particularly noticeable in all forms of transients, which the amplifier handles with apparent precision.

As other transistor amplifiers have acted similarly, I would say that transistor circuits are inherently better for audio amplifiers than tube types. I noted just one negative, but not very important, performance feature: every time the amplifier is switched off, there is a slight plop in the speakers. This seems to be a feature difficult to eradicate from transistor circuits using large amounts of feedback. As it occurs only at switching off, and not during active use, it is a small price to pay for the beautiful way the amplifier handles program material.

The compactness of this transistorized unit still amazes those of us who remember when 20-watt amplifiers were extremely bulky and with difficulty (and unsightliness) dissipated 100 watts or so of heat from big glass "bottles"!

-Norman H. Crowhurst

Euphones Ceramic Stereo Cartridge

The particular model I tested is a two-element turnover piezoelectric stereo pickup in a spring-supported shock-resistant mount. It is intended for low-priced record changers operating at stylus forces in the 5-gram region. However, I found that it tracks cleanly at 3 grams and possibly lower in changers that will cycle with this force. The shock mounting is stiff, compared with that of the Shure Gardamatic series, and retraction almost at forces considerably higher than 5 grams; but the protection apparently is sufficient to prevent chipping the stylus when the point is dropped on a record.

The frequency response is very smooth (Fig. 1), though the low end,
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as in all piezoelectric pickups, varies with the loading. With the specified 3-megohm load, it is down only about 6 db at 30 cycles. With a 1-megohm load, it is down about 10 db. The high-end response follows the RIAA curve nicely — within ±2 db between 250 and 13,000 cycles. The response drops to —5 db at 15,000 and —10 db at 20,000. There are no peaks anywhere in its range. The separation (Fig. 2) is better than 20 db below 3 kc, about 15 db at 5,000, and 10 db at 15,000 cycles.

Working into the 500,000-ohm load of a “spare” channel of a hi-fi amplifier, the cartridge is thin in the bass. But fed into the magnetic input through a pair of Sonotone type 9 equalizers, which I had on hand, and with loudness boost, it delivered excellent sound with commendably low distortion even on the very high levels of many pop records. As with other ceramic pickups, the high end is rather sharp, possibly because the slope at the bottom end tends to accentuate the highs. The performance on 78-rpm records was also very good.

The cartridge is particularly easy to mount and to remove for stylus replacement. The cartridge itself clips into a sheet-metal base attached to the arm with the usual two screws. To replace the stylus, pull the cartridge off the base and pull out the entire stylus assembly. A new one is easily inserted. The job is easily done even in the hard-to-get-at wells of furniture type hi-fi’s, or in arms with limited lift. —Joseph Marshall

---

**Specifications**

(All specifications are the manufacturer’s)

- **Type of cartridge:** stereo; ceramic generating elements
- **Frequency response:** 16 to 25,000 cycles, RIAA curve
- **Output voltage:** 0.5 volt at 1 kc (Westrex 1A record)
- **Separation:** 24 db at 1 kc; 18 db at 4 kc (see curve)
- **Element capacitance:** 450 pf (per channel)
- **Compliance:** 4 X 10^-6 cm/dyne
- **Weight:** 3 grams
- **Mounting centers:** 1/2 and 1/16 inch; conform to EIA recommendations
- **Terminals:** 4 (connectors supplied)

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**test equipment reports**

**Dynamic Conductance Tube & Transistor Tester (Eico 667)**

and

**CR Analyzer (Lafayette TE-46)**

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**Dynamic Conductance Tube & Transistor Tester (Eico 667)**

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**CR Analyzer (Lafayette TE-46)**

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**Leakage tests are supposed to be made before merit (quality) tests. (Excessive leakage, or a short, can ruin a meter in a fraction of a second.) There are four leakage tests, not one. The circuits used — basically ohmmeter types (Fig. 1)—are varied only by the switching.**

**Note that —70 volts is applied to the plate and grids. This prevents tube emission current from affecting the leakage resistance reading.**

**Transistor leakage, too, must be**

(Continued on page 68)
UNIVERSITY OF ILLINOIS
MAYES-CARRELL PATENT ON LOG-


U.S. PATENT DISCLOSES THAT NEW LOG-PERIODIC

(Col. 1, lines 10-12 of Log-Periodic Patent)
Has "Unidirectional radiation patterns that are essentially independent of frequency over wide bandwidths."

(Col. 2, lines 62-66 of Log-Periodic Patent)
"Increases directivity*** permits more effective utilization of antenna since the same structure can be used in several frequency modes to achieve coverage of different frequency bands."

(Col. 4, lines 40-43) "***given by the formula \( \frac{L(n+i)}{L_n} \)

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MODEL LPV11
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MODEL LPV8
UP TO 100 MILE RANGE
$29.95, list

MODEL LPV6
UP TO 75 MILE RANGE
$21.95, list

MODEL LPV4
UP TO 50 MILE RANGE
$14.95, list.
FOR THE RECORD

All claims by a competitor to the multiple V-type and straight inline active dipole array were rejected because of the prior Isbell "Straight dipole Log-periodic" work published in the May 1960 IRE Transactions on Antennas and Propagation; five months before our competitor's application was filed. This covered work done at the University of Illinois Antenna Research Laboratories since 1957.

Shown below are extracts from the official files of the Patent office citing their reasons for rejecting our competitor's claims to multiple V and straight inline dipole array patents. An official copy is available from JFD, on request.

(Note: All underscoring done by JFD.

DO NOT BE MISLED BY LOG-PERIODIC IMITATIONS OR MISLEADING PATENT CLAIMS

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PNP POLARITY REVERSED FOR NPN -

Fig. 2—Voltage for transistor leakage tests is 6 volts. Base circuit is open.

POLARITY REVERSED FOR PNP

Fig. 3—Collector current of forward-biased transistor indicates its relative conductance.

measured before attempting a merit reading. The $I_{sc}$ of the transistor is measured in the EIA-prescribed manner—base open-circuited (Fig. 2). The merit test of the transistor applies a bias to the base connection through a 200,000-ohm resistor (Fig. 3) to measure the $beta$. These simple tests indicate whether the transistor is good or bad. More complex tests are needed to duplicate the factory checks of frequency response, input resistance, collector capacitance and other electrical characteristics used to classify transistors.

The tube merit test circuit (Fig. 4) differs from that of Fig. 3 only by the addition of the meter shunt resistance ($R_s$), the additional elements in the tube envelope and the higher voltages required.

Dual tubes are tested for merit with voltages applied to all electrodes, except for full-wave power rectifiers. These are tested one plate at a time.

Voltage regulator tests use the filament voltage selector circuit connected to the VR tube being tested. Once the starting potential of the VR tube is exceeded, the tube conducts and the meter gives an indication of the current flow until the applied voltage drops below that needed to maintain conduction.

New roller charts will be available periodically and interim supplements will be issued when needed. To insure against the instrument becoming obsolete and to take care of seldom-encountered tube types, instructions for developing your own settings for tubes are included in the manual.—Elmer C. Carlson

High voltage. This method is safer).

The transformer turns-ratio test puts one winding on each side of the bridge (see diagram), and the range switch and the potentiometer (VR) dial are adjusted for a null indication on the eye tube.

Resistance and capacitance values are determined with a more common bridge circuit—a standard component in one leg, the unknown in the other.—Elmer C. Carlson

Lafayette TE-46 CR Analyzer

**SPECIFICATIONS**

(all specifications are the manufacturer’s)

- **Capacitance ranges:** 200 pF—.005 uF, .002–.005 uF, .02–.5 uF, 200–2,000 uF
- **Resistance ranges:** 2–500 ohms, 200–50,000 ohms, 20,000 ohms–5 megohms, 50–200 megohms
- **Transformer turns-ratio ranges:** 1:1–10:1, 10:1–200:1
- **Transformer impedance-ratio ranges:** 1:1–100:1, 100:1–40,000:1
- **Dc leakage test volts:** variable 3–600
- **Leakage current ranges:** 0–1 mA, 0–10 mA
- **Dc insulation test volts:** 600

**Tube complements:** (1)–6X4, (1)–6E5

**Dimensions:** 10½ x 7 x 5½ inches

**Weight:** 11 lb, with test leads

**Partial schematic shows circuit used to measure transformer turns and impedance ratios. Main dial is adjusted until 6E5 “eye” tube opens, indicating null.**

68 RADIO-ELECTRONICS
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DEALER PLATFORM

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15 MODELS
6 TAPE SIZES
15 TAPE COLORS

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MARCH, 1964

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High profit D YMO tape sells fast because it sticks fast. Turnover creates profits for you.

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Wide range of "sell-up" accessory items meet customer needs; sales-proven merchandising programs create store excitement.

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Dramatic company history and product development, plus consistent promotion, have made D YMO tools, tape and kits real demand items!

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DYMO M-55 TAPEWRITER
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Dept. RE-3-55
Always Half

The black box contains a capacitor and a resistor equal to R as in Fig. 1. The voltage \( E_{Ac} = E_{M} = E/2 \) having zero angle with E; the voltage \( E_{Dc} \) is 90° out of phase with \( E_{M} \) and the vector sum is equal to E: consider the modified vector diagram (Fig. 2). \( E_{M} \) is always perpendicular to \( E_{Dc} \), thus point B will fall on the circumference of a circle having a diameter of E or a radius of E/2. Likewise, as point A falls in the center of this circle, the distance between A and B will become E/2. Whatever the resistance, only the phase shift will change.

This circuit is used often as a phase shifter to change phase without changing amplitude.

Note: This puzzle, in slightly different form, was published as "Output Voltage" by Cameron McCulloch in the October 1963 issue and evoked a flood of disbelieving letters as well as criticisms of an attempted abridged mathematical proof (Mr. McCulloch's proof was much longer than the one printed). Readers may be assured that the circuit is "bench-tested," that it works, and is indeed so ruggedly based in theory that an unfortunate change of sign in one of the terms of the October explanation did not change the final result.

What Voltage?

The output from the full-wave rectifier consists of negative half-cycles at the rate of 800 per second. Therefore the output is negative with respect to the center tap on the transformer secondary.

Unless otherwise stated, dc voltmeter readings should be taken as effective values, and ac voltmeter readings should be taken as rms values. Observing polarity, the dc voltmeter (V2) reading is 636 volts, determined by multiplying 0.636 times the peak value of 1,000 volts. The ac voltmeter (V3) reading is 707 volts, determined by multiplying 0.707 times the peak value of 1,000 volts.

If ac voltmeter V3 is a basic d'Arsonval type, calibrated with and using a half-wave rectifier, the indicated voltage will be entirely different. This method is used in some vdm instruments. Again observing polarity, the meter would indicate 1,414 volts, or double the rms value, in the forward position and zero volts with the test leads reversed. The output waveform of the circuit shown in the puzzler, along with the relative voltages, is shown in the diagram. The 0.636 factor applies to the average value of a sine wave and also to the output of an unfiltered full-wave rectifier.

A distorted puzzler

A simple one, and not uncommon. The key is, of course, that 6 volts positive at the grid, which causes a high plate current and a low plate voltage. Pretty obviously, the 0.01-µf input coupling capacitor is leaking badly.

Correction

There were two errors in the solution to the EQ problem "Complex Black Box", on page 70 of the December 1963 issue. The next-to-last sentence should have ended, "we have a coil with an impedance of 100 ohms and a resistance of 12.5 ohms."

Our thanks to Mr. R. T. Schweigert of Merritt Island, Fla., for pointing out the error and also a second possible solution, based on the principle that for every parallel circuit there is a series circuit with the same characteristics. In this case, the series reactance would be about 100 ohms, and the series resistance about 800 ohms.

3-Phase Circuit: Out-of-Phase Head!

In the matter of getting single-phase voltages from a 3-phase supply (Power Supply Puzzler, page 39, October 1963), I was wrong! This was on a conveyor belt, with a photocell-operated switch (stopped the motor when a package came to the end). Everything worked except the photocell unit: it smoked. By isolating the power transformer, feeding it from single-phase supply, I could make it work. This started an argument, so I left in the middle of it.

Later, after the argument had be-(Continued on page 76)
Was your name part of this hard-sell ad in TV Guide?

If you took advantage of the offer, February 8th TV Guide tells every reader in your neighborhood that you are the expert on whether they should repair or replace their TV set. And a helpful free booklet titled "Fix or Buy?" is in your hands for distribution free to your customers. National advertising in TV Guide, the booklet, plus a banner advertising the booklet for your store—a triple-barreled way to hit your very best prospects. Specials like this are available regularly through your participating Sylvania Distributor. They show that he is sincerely concerned with raising your profits and your prestige—and so is Sylvania. You can expect more than the highest-quality tubes when you deal with your Product-Plus Sylvania Distributor.
I laughed when Fred Williams, my old high school buddy and fellow worker, told me he was taking a Cleveland Institute Home Study course in electronics. But when our boss made him Senior Electronic Technician, it made me stop and think. Sure I'm glad Fred got the break... but why him... and not me? What's he got that I don't. There was only one answer... his Cleveland Institute Diploma and his First Class FCC License!

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

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

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This one is

The Blonder-Tongue FMB STEREOBOOSTER is special because it increases signal strength 8 times (18 db gain), while keeping noise down to the bare minimum (noise figure 3.8 db) because it eliminates distortion caused by phase and amplitude variation and by impedance mismatch (low VSWR) because it doesn't overload when there are strong local stations present... and because it does all these things steadily and reliably. But since Blonder-Tongue is the company with the most experience in TV and FM signal amplification, how could you expect any less? A must for multiplex stereo, and for mono in weak signal areas... installed quickly & easily anywhere indoors. Improves reception with an FM antenna, your TV antenna, or a homemade twinlead dipole.

List $2240

Fig. 1—In correct circuit (a), 240 volts between A and C operates coil and transformer primary. In no-good circuit (b), there are 2 phases (B-C and B-gnd) connected into same circuit. Letters refer to terminals in Fig. 2.

Fig. 2—Actual voltages to be found on 3-phase line.
Why Mallory Mercury Batteries work better in transistor radios

There are a lot of good reasons why more and more people are using mercury batteries in their transistor radios. And the reasons boil down to this—they're a better value, and they give better performance.

To get a comparison between mercury batteries and ordinary zinc-carbon batteries, let's look at a typical transistor radio. This radio uses size "AA" penlight batteries and has a current drain of 15 milliamperes. The Mallory Mercury Battery is the ZM9 and the zinc-carbon type would be the NEDA type 815. The ZM9 retails for 75c versus 20c for the 815. Got the picture?

Here's where the fun begins. The ZM9 will operate the radio for 165 hours versus only 35 hours for the zinc-carbon battery. This means that for one penny you'll get 2.2 hours of listening pleasure using the ZM9 versus 1.75 hours for the zinc-carbon battery. In other words, it costs you 0.57 cents per hour to use the zinc-carbon compared to only 0.45 cents for the mercury battery.

We're not through yet. Let's get back to listening pleasure. The mercury battery has essentially a flat discharge curve. This means that it presents a more constant voltage to the transistors. Result: you don't have to keep turning the volume control up while you're listening AND the radio sounds better because there's far less distortion.

Had enough? There's one more important point. Suppose you put the batteries in the radio and use it only slightly. Those 20c zinc-carbon batteries go "dead" in a few months whether you use them or not. But the mercury batteries can be stored 2 to 3 years and still deliver dependable power. Plus the fact that Mallory Mercury Batteries are guaranteed* against leakage in your transistor radio.

We've used this "Tip" to illustrate the superiority of Mallory Mercury Batteries in transistor radios. But this superiority extends to thousands of other applications. So whether you're building test equipment, heart pacers, or satellites, see your Mallory Distributor. He has a Mallory Mercury Battery that will do exactly the job you want done.

*We guarantee to repair the radio and replace the batteries, free of charge, if Mallory Mercury Batteries should ever leak and damage a radio set. Send radio with batteries to Mallory Battery Company, Tarrytown, New York.
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Add visual excitement to hi-fi or stereo system with AUDIO-COLOR... a transistorized unit that can be easily attached to your hi-fi, stereo, tape recorder... even most radios.

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Kit w/walnut finished cabinet..................$32.95
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**6T9**

A new triode-pentode compactron for audio applications has been registered by its designer, General Electric, as the 6T9. The pentode section is a power tube, similar to the old 6AQ5, and the triode section is similar to half of a 12AX7.

The power pentode section is rated at 12 watts plate dissipation, has a transconductance of 6,500 µmhos and a large cathode for easy driving—8 volts peak audio for full 4.2 watts output.

Other ratings:
- Heater volts: 6.3
- Heater amps: 0.925

Pentode section:
- Plate and screen volts (max): 250
- Grid 1 volts (class A): -8
- Plate resistance (approx): 100,000 ohms
- Max. sig. plate current (class A): 39 ma
- Max. sig. screen current (class A): 7 ma
- Load resistance: 5,000 ohms

Triode section:
- Plate volts (max): 250
- Grid 1 volts (class A): -2
- Amplification factor: 95

**Integral-mount CRT's**

A new series of high-definition cathode-ray tubes with rugged integral, machined mounts has been announced by the Electron Tube Division of Litton Industries.

One of the new tubes is shown in the photograph. The mount is machined with reference to the tube faceplate to

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New 24-page 1964 Custom Stereo Guide packed with photos, descriptions, and specifications of all Scott tuners, amplifiers, tuner/amplifiers, speakers, and kits. Also... articles and pictures on decorating your home with stereo, selecting a tuner and amplifier, and how FM multiplex stereo works. Send for your Scott Custom Stereo Guide today.

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Model G-32 - Kit: $85.95; Factory Wired: $159.95
Model S-55 - Kit: $99.95; Factory Wired: $155.95
Model S-55B - Factory Wired: $279.95
Model S-51 - Kit: $89.95; Factory Wired: $109.95

Write for new Catalog No. PP631 describing the full new Precision line containing all the test equipment you need!
within .001 inch after tube processing. Then the ring is drilled and tapped for mounting. Inside and outside diameters of the mounting ring are machined concentric to the tube neck.

Advantages claimed for the new mount include highly accurate mechanical connection between the CRT and its magnetic focus and deflection components, eliminating padding or resilient material. The close tolerances of the machined surfaces permit orienting the tube to an optical system for perpendicularity and concentricity of the faceplate, especially where depth of field is short.

CL703C, -703CL, -903C

These are new cadmium selenide high-speed photoconductive cells designed for use as photoelectric choppers at rates up to 1,000 cycles. Rise and fall times of the cells are 0.4 and 3 msec, respectively. Light resistances as low as 2,000 ohms and dark resistances to 500 megohms are available in the three types. Voltage ratings are from 60 to 250 volts. Dissipation for the CL703C and -703CL (TO-5 cases) is 125 mw; for the CL903C (TO-18 case), 50 mw. All are hermetically sealed.

GaAs infrared diode

This is a piece of semiconductive esoterica from Philco—a gallium arsenide infrared-emitting diode with a strontium titanate lens.

It radiates intensely at a very restricted beam angle—about 30°. Though its efficiency sounds dreadfully low by most standards, it isn’t so bad compared with devices of a similar nature: .06%. It can be modulated by frequencies up to 1 gc (= 1 kmc, or 109 cycles).

The diode is packaged in a UG-88/U type BNC connector for quick mounting and interconnection to other parts of the system. Want one? $190!

Hv silicon rectifiers

These are intended to replace, mechanically as well as electrically, high-voltage mercury-vapor rectifiers like the 872-A, 8008 and 575-A, used extensively in broadcast transmitters and industrial equipment.

The photograph shows one of the silicon devices lying on its side. At right are the base pins, which plug directly into the tube socket without further ado, and at left is the top (plate) cap, which again is connected just as though it sat on top of a tube. The string of silicon diodes is housed in an epoxy-sealed phenolic tube.

The rectifiers are available in pvs of up to 15,000 volts, and in average dc outputs to 1.75 amps. Voltage transient protection is provided by avalanche diodes. The devices, made by Syntron Co., offer advantages over thermionic rectifiers: longer life, less heat, no warmup.
This **Weller**

**Heavy Duty Soldering Kit**

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No other soldering set offers you such versatility. The heavy duty Weller gun is the same professional tool used by technicians. Two trigger positions let you switch instantly to either 240 or 325-watt heat. In this single tool you have a choice of heat to suit the job, and tip temperature high enough to handle the tough ones. Instant heat saves time and current.

Kit includes 3 different tips for soldering, cutting, sealing and smoothing; tip-changing wrench and supply of solder. Everything is in a sturdy plastic carrying case. **$12.95**


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**MARCH, 1964**
Discover new operating performance with International's Executive 750 citizens band transceiver. Turn the illuminated Channel Selector dial . . . transmit and receive on any one of 23 crystal controlled channels.

Set the HI-LO switch in the LO position . . . dial Channel 1 through 12. Set the switch in the HI position . . . dial Channel 13 through 23.

The Remote Console, installed under the auto dash, gives you complete remote operation. It turns the set (in the trunk) on or off, adjusts speaker volume and squelch at the desired threshold.

The Executive 750 is complete with crystals, external 4" speaker with cabinet, mounting rack for Remote Console, trunk mounting rack for set, push-to-talk microphone, DC power cable, plus all necessary connecting cables.

International takes pride in introducing the Executive 750 . . . engineered for mobile operation . . . 23 crystal controlled channels . . . operates on 6 vdc, 12 vdc, or 115 vac.

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CB ANTENNA, model GAM CB-11. Base-loaded mobile antenna for 27-MC CB unit. Whip 38 in. long. Tunable loading coil at base. VSWR less than 1.2:1 or 23 CB channels when correctly adjusted.—GAM Electronics, Inc., 138 Lincoln St., Manchester, N.Y.

RADIO SCRAMBLER. Privacy for 2-way AM and FM radios. Electronically rearranges sound of spoken voice into unintelligible patterns. Gibberish then broadcast. Can be retranslated to original message only by similarly coded instrument. Mobile and base station units.—Delcon Corp., 943 Indiana Ave., Palo Alto, Calif.

CB TWO-WAY RADIO, Chumpan II, all-transistor universal power supply, 5 fixed channels tunable to transmit 23 channels with external crys-

6-CHANNEL CB TRANSCEIVER for home and office, model TWR-4. Built-in 6-meter indicat-
ing transmitter and receiver performance. Prewired with external socket to accommodate selective call-
ing unit. Automatic volume control, adjustable squelch circuit.—Raytheon Co., Lexington 73, Mass.

FM MONO 18-WATT RECEIVER, with paging facility, model 2716. Tuner: Antenna input 300 ohms balanced; IHF usable sensitivity: 3 µV (30 db quieting); i.f. bandwidth: 280 kc at 6 db points; ratio detector bandwidth: 1 mc peak-to-peak separation. IHF signal-to-noise ratio: 55 db. Amplifier: Power: 18 watts IHF music; 14 watts continuous; IM distortion: 2% at 14 watts; frequency response:

IM distortion (each channel): 2% at 14 watts, 0.7% at 5 watts, 0.2% at 1 watt; harmonic distor-
tion (each channel): 0.6% at 10 watts, 40 cycles -10 kc; frequency response: ±1 db 15 cycles -40 kc; speaker output: 8 and 16 ohms. 5% x 15 7/8 x 13 x 11 in.—EICO Electronic Instrument Co., Inc., 131-01 39th Ave., Flushing, N.Y. 11354.

STEREO POSITIONER gradually moves stationery sound source from left channel to right channel and back again. Input: low-level 50-600 ohms balanced; high-level 5,000-15,000 ohms unbalanced. Output: approximately 15,000 ohms each channel, unbalanced; output level: 1 volt; gain: 60 db; distortion: less than 1% total har-
monic; signal-to-noise ratio: better than 60 db. 4 x 6 x 2 in. Self-contained 9-volt battery. Controls: panning, gain.—UltraAudio, PO Box 821, Beverly Hills, Cali.

70-WATT TRANSISTOR STEREO HI-FI AMPLIFIER, Knight-Kir KG-870, (22 transistors, 4-silicon diodes). Power output: IHF music power: 70 watts; 35 watts per channel. Sinewave, 28 watts per channel. Response: 20-20,000 cycles. Distortion at rated power: IM, less than 1%. Hum: tuner, -80 db; Mag phono, -68 db, tape head,

-60 db. Channel separation: exceeds 30 db. Output circuitry thermal stability protects transistors. No capacitors or transformers in output stages. Low current drain, Variable loudness control, Tape-monitor input switch. Rumble and scratch filters. Speaker phasing switch. 2 3/4 x 11 x 13 in.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

80-WATT STEREO AMPLIFIER, model S-5500III, for home music systems with tape decks, phonographs, tuners. Noise and hum: 72 db below rated output. Phono input sensitivity: 1.2 mv. Tape-

HEAD SENSITIVITY: 1.6 db; tuner sensitivity: 0.25 volt. Frequency response 20-20,000 cycles ±1/2 db. Mu-

sic power: 40 watts each channel; 35 watts con-

tinuous at 1% IM distortion.—Sherwood Elec-
tronic Laboratories, Inc., 4300 N. California Ave., Chicago, Ill.

40-WATT STEREO AMPLIFIER, model LA-260. Harmonic distortion: less than 1% at rated output. Frequency response: ± 1 db 40-20,000 cycles. Hum and noise: tuner: 75 db; magnetic phono: 58 db. Sensitivity: for full output: mag-

80-300 MHz STEREO TUNER, model 500-4T Micro Flavacore. Less than 5 grams. For auto-
matic turntables utilizing low-mass tone-arm

PHONO 4.5 mv; high level: 5 x 143 x 5 1/4 x 11 in.—Lafayette Radio Electronics Corp., 111 Jericho Turnp

ike, Syosset, N.Y.

MINIATURE STEREO PICKUP, model 500-4T Micro Flavacore. Less than 5 grams. For auto-
matic turntables utilizing low-mass tone-arm
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ALL-TRANSISTOR TUNER, model AJ-43, AM, FM, FM stereo. 25 transistors, 9 diodes. FM section: sensitivity: 0.5 µv for 30-db quieting; capture ratio: 10 db; harmonic distortion: less than 1%; output voltage: 0.5. FM stereo converter section: separation: 30 db at 10,000 cycles. AM section: sensitivity: 1000 kc, 5 µv for 10 db S/N; harmonic distortion: less than 1%; hum and noise: 35 db below 30% mod.—Heath Co., Benton Harbor, Mich.

TRANSISTOR TAPE RECORDER, Butoba MPT-7, 4 x 6-in. speaker. Operates 20 hours on 4 flashlight batteries, also on 6- or 12-v car battery power. Response: 70-12,000 cycles at 3½ ips; 100-5,000 cycles at 1½ ips.—Stanford International, 569 Laurel St., San Carlos, Calif.

PORTABLE TAPE RECORDER, 660 Series, 6½ x 9 x 3 in. 8½ lb, 3-speed (7½, 3½, w.s), built-in stroboscope for 7½ ips on capstan.—Freeman Electronics, 729 N. Highland Ave., Los Angeles 38, Calif.

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<td>SAME AS 6CW4, FOR 450 MA TRANSFORMERLESS TV.</td>
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image contains red, for example, beneath a red filter, this color passes through. Falling on the photoconductor, it lowers its resistance and ac flows to excite the red phosphor at that point. If the phosphor strips are narrow, the reproduced color image will have good detail. If there is sufficient input power, the output image will be more intense than the original.

Note that the same phosphor can be used for green and blue, color being determined by the frequency.

**Photocell Sine Generator**

**PATENT No. 3,093,785**

Albert K. Edgerton, Sunland, Cal.

This is a simple, efficient and variable source of sine waves. It uses a Lucite rod that rotates between photocells (PC). Part of the rod is flattened as shown (Fig. 1). Diffused light from a lamp source enters the end face of the Lucite semicylinder and is radiated from the flat surface. The curved surface is painted opaque.

The amount of light from the illuminated (flat) surface varies with the sine of the angle of rotation. Therefore each cell delivers one-half of a sine wave. Since the cell outputs appear across R out of phase, the result is a complete sine wave. Frequency depends upon speed of rotation.

Other possibilities of this device include various waveforms (by using nonplanar surfaces); optical modulation; multi-phase output. Fig. 2 shows a 2-phase generator. The phase angle is determined by the position of the cells.

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Circuits

Speaker Switching Circuit

Have you ever wanted to add remote speakers to your radio system and didn't know just how to hook them up? If so, why not try the circuit used by Admiral in some of their stereo consoles. The diagram shows the basic switching circuit of one of the stereo channels. When a single speaker is used, it is connected across the transformer tap equal to its impedance. When two or three speakers are used, they are paralleled across the tap equal to half the impedance of a single speaker.—E. Wilhelm

Unusual Recorder Circuit

The Grundig TK1 and TK1-E battery operated transistor tape recorders use a unique circuit to provide recording bias and plate and filament voltages for the DM71/1N3 recording level indicator. The tube requires 1.4 volts at 25 ma for the filament and 50 to 90 volts on the plate. The bias oscillator circuit is shown in the diagram.

The filament of the DM71 is in series with the transistor emitter and thus supplies a measure of thermal stability for the oscillator. The plate is connected to a high-voltage winding on the oscillator transformer through a 220,000-ohm current-limiting resistor. The audio is fed to the recording head through the bias winding on the transformer.

The audio signal is also fed to a diode voltage doubler that provides the dc control to bias the grid so the tube indicates the recording level. Although these recorders use high-frequency bias, they do not use high-
frequency erasing. This is because of the extra power that would be required from
the oscillator. This would increase the drain on the batteries.

Most recorders use a bar type magnet for erasing. This one uses a circular
magnet on a pivot as shown in the photo. A chain and gear assembly rotates the
magnet so its gap faces the tape when the function selector switch is in the
record position. The selector turns the gap away from the tape in the play,
reverse and off positions.—Steve P. Dow

Radio-TV Speaker Switching

A common speaker system is generally used in radio-TV combinations. In
many cases, the secondaries of the radio and TV output transformers are
connected in series and the speaker voice coil is connected across the two. The
audio circuit not in use is de-emphasized so its output transformer has little or
no effect on the overall operation.

General Electric has come up with a new and unusual gimmick when the
clock radio is added to the SY TV chassis. The basic diagram shows the plates
of the radio and TV output tubes are connected in parallel at the primary of the
common output transformer. The TV-radio switch feeds ac to the power
supply of the selected circuit and B-plus to the primary of the transformer.—
Henry O. Maxwell
All the Technotes in this month’s special Audio Issue were contributed by Steve P. Dow, Vancouver, B.C. All concern tape recorders, domestic and foreign, and all are examples of small, recurrent, off-beat problems that are worth knowing about.

Revere TR-1200 Recorder

If the speed-change lever won’t stay in the 7½-or the 3¾-ips position, the lever detent spring has become detached. Remove the bottom plate and locate the spring, between the motor and the mike compartment. It goes between the cam roller attached to the equalization switch on the speed-change shaft and the screw that holds the digit counter—the one farthest from the motor. Pinch the spring loop on the retaining bolt to keep the same thing from happening again.

Uher SR III Speed Change, On-Off Switch Failure

If the speed change on this machine doesn’t work, the spring retaining the flywheel idler wheel has slipped off. Before you replace the spring, check the idler for flat spots and tear—replace it if it has any.

To remove the idler, slide back the spring retainer (on top of idler in photo) while the speed and power switch is in the 7½-off position.

To protect the idler in this machine, avoid changing speed from high to low without letting the flywheel stop. This takes about 5 seconds.

Large-hub Reels Fool Automatic Stop

Large-hub reels won’t operate the automatic stop on some machines, when the tape is fitted with conductive foil at either end. The stop contact is normally adjusted to touch the tape only when the angle of the tape to the center of the feed spindle indicates the end of a standard (small-hub) reel. This prevents the machine from stopping when it has just been threaded, because of the foil at the end start.

To readjust these machines to work with newer reels,
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The photo shows the angle-selective contact on a Philips EL3515-D. The contact is grounded by the foil on the tape, when the foil passes the grounded guidepost. This discharges a capacitor (the output-stage cathode bypass) through a relay coil, which in turn operates the automatic stop magnet by discharging the output B-plus filter capacitor through the stop-magnet coil.

Grundig TK42 and TK45
In these machines, intermittent recording and playback can be traced to the amplifier muting contacts, shown in the photo. The adjustment arm should be bent so that there is \( \frac{3}{16} \) inch clearance between the switch contacts. Clean the contacts with wood alcohol; other solvents may melt the plastic spacer bead.

Muting on Webcor Recorders
Tape machines that operate on long standby intervals should keep silent when they are not actually in use. Muting switches to short the output of the playback heads, as in the Webcor EP-2008-5, cannot kill noise generated in the preamp stage.

Solve the nuisance by reconnecting the muting switches at the output stage grids, as shown in the diagram. Now the machine will be completely quiet until it is started.

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Breaking in a Woofer

To limber up the cone suspension of a new all-paper-cone woofer and improve its bass response, connect it to a 6.3-volt filament transformer through a 100-ohm rheostat or potentiometer. Set the control for maximum resistance, and plug the transformer into the ac line. Set the pot now until the cone vibrates vigorously but not violently enough to spring anything. You can muffle the hum by putting the whole setup in a large trunk or closet with plenty of clothing or pillows around the speaker.

After a few hours, when you disconnect the speaker and hook up to your hi-fi system, you'll find that this "aging" makes quite a difference in the mellow-ness of the low notes. This method is not good for cloth-surround speakers or other nonpaper types.—John Comstock

Test Tape Checks Recorder Speed

Though this method doesn't show up wow and flutter, it does show whether two recorders are operating at the same speed, which is important whenever tape recorded on one machine is played back on another. It gives a very precise check on long-term speed accuracy.

The machines for which I tried this all ran at 7½ ips—37½ feet per minute. For that speed, mark off 37½-foot intervals on a new reel of tape, using bits of white splicing tape as markers. Put the tape on the machine, set it to record, and start it up.

Pick a convenient fixed spot on the recorder near the supply reel as a reference point. When the first mark passes the point, say "start" into the mike. When the second spot comes up, say "one," and so on until all the marks have been accounted for.

To determine if the machine is running at the right speed (in this case, 7½ ips), set the machine to play back and cue up to the "start" mark. Using a sweep-second-hand clock or stopwatch, start the machine at any convenient point on the clock dial. If you start at "straight up," then (assuming that the...
speed is correct) you should hear your voice saying "one," "two," and so on, each minute at "straight up." If the point on the clock dial at which you hear your voice "drifts" clockwise with each mark, the machine is slow; if it heads counterclockwise, the machine is fast.

Note that this method does not depend on the speed accuracy of the machine you used to make the tape, since you have marked the tape in length, not time, intervals. If you suspect that a particular machine is off speed, about 10 minutes of this tape will tell if so and how much. You can use it for any other speed, too.—J. C. Craver

Substitute Pickup Saves Wear on Expensive One

When Mr. Ardent Audiophile buys an expensive changer and an expensive cartridge to use in it, he's naturally afraid to let the kids use the family hi-fi for a stack of twist discs. An easy solution is to supply him with an inexpensive extra cartridge in a head that fits the particular changer he has.

You can get a pretty good, rugged stereo crystal or ceramic cartridge for about $5. You may have to weight the spare head to get the proper tracking force for the new cartridge—about 5 to 6 grams for most recent types.

Because the signal level from a piezo cartridge is much higher than from the magnetic type your man is using, you will have to attenuate its output and shape its frequency response so it can be fed to the magnetic-phono input on the amplifier without changing connections. The diagram shows a simple network that does that job. If you use 1/4- or 1/2-watt resistors and tiny ceramic capacitors, you can build it right into the pickup shell.

Fixing a customer up with an accessory like this can make the difference between selling him a good component setup and a package "hi-fi."—S. P. Dow

Solder Remover

Do you have trouble opening up the holes in printed-circuit boards after removing components? Hunt up a 6-inch-long piece of nichrome wire (used in toasters, electric irons, etc.). Straighten it out and make a little loop in one end as a handle.

Now you can heat the solder in the hole and poke it clean with the wire. Solder won't stick to nichrome.—K. N. Gray
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