HI-FI/TAPE RECORDER ISSUE

MAR. 50c

Radio-Electronics

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A GERNSBACK PUBLICATION

HUGO GERNSBACK, Editor-in-chief

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 re-alignment when you replace tubes.

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2ER5	4EH7	6ES8	6EJ7	6BL8	15CW5
3GK5	4EJ7	6ER5	6HG8	6BQ5	16AQ3
3EH7	4ES8	6FY5	7HG8	12AX7	27GB5

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IN CANADA: PHILIPS ELECTRON DEVICES, LTD., TORONTO 17.

Radio-Electronics

MARCH 1964 VOL. XXXV NO. 3

Over 55 Years of Electronic Publishing

EDITORIAL

AUDIO-HIGH FIDELITY-STEREO

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TEST INSTRUMENTS

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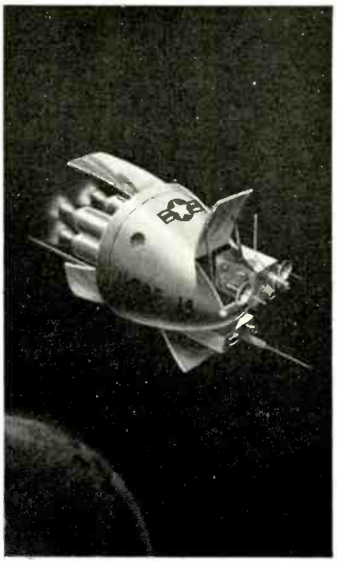

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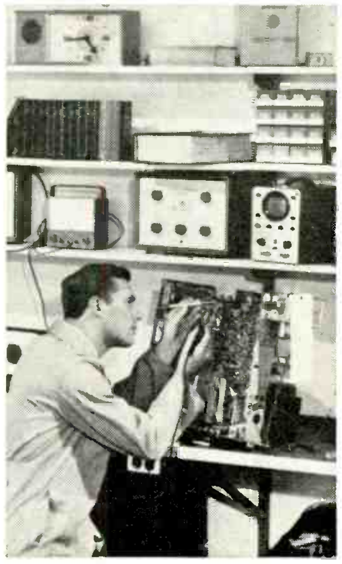

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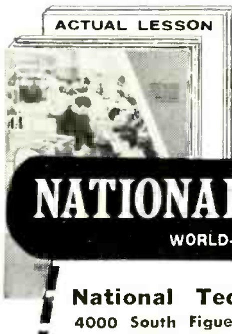

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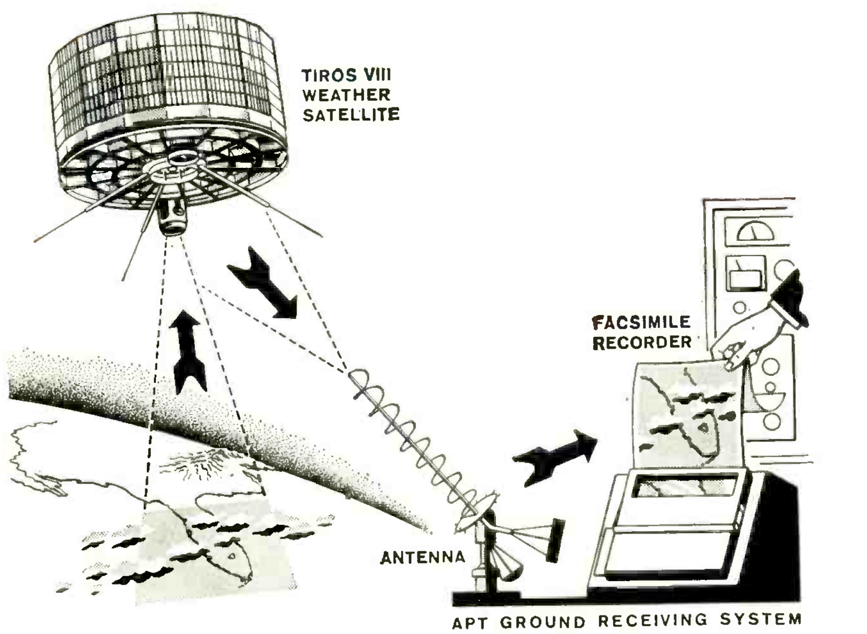
NEWS BRIEFS

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.



How Tiros VIII works. Viewing an area approximately 1,000 miles on a side, it snaps a picture on a special vidicon tube which retains the image on the screen for 208 seconds while it is being read out and transmitted to APT facsimile receivers. The facsimile picture is 8 inches on a side.

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 RADIO-ELECTRONICS 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 ¼-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

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their sales of built-in music intercom systems are to builders who install them. Generally, such installations are limited to higher-priced houses.

WWV Increases Propagation Notices

WWV 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.

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"

New training simulators, analogous to those used in training aviators, now make it possible for submarine navigators to go through every experience they would meet at sea, and even to rerun an actual 60-day patrol in a half day, with the help of "time compression."

Two of the trainers, designed and built by the Sperry Gyroscope Co., are in use at submarine bases in New London, Conn., and Charleston, S.C. Most of the equipment is the full-scale operating copy of the units aboard every Polaris submarine.

The voyages can be stopped, repeated or sped along 200 times faster than real time. An instructor at the computer console watches displays which tell him the "actual" position of the make-believe boat, while a printer types out a running log showing where the student navigators think they are, for after-class evaluations.

CALENDAR OF EVENTS

Los Angeles High-Fidelity Music Show, Mar. 10–15; Ambassador Hotel, Los Angeles, Calif.

International High-Fidelity Show, Mar. 12–19; Paris France.

Intercollegiate Broadcasting System (IBS) 25th Annual National Convention, Mar. 21; Ferris Booth Hall, Columbia University, New York, N. Y.

IEEE International Convention, Mar. 23–26; Coliseum and New York Hilton Hotel, New York, N.Y.

International Conference on Nonlinear Magnetics, April 6–8; Shoreham Hotel, Washington, D.C.

95th Technical Conference, Society of Motion Picture & Television Engineers (SPMTE), April 12–17; Ambassador Hotel, Los Angeles, Calif.

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. The flight was 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

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.

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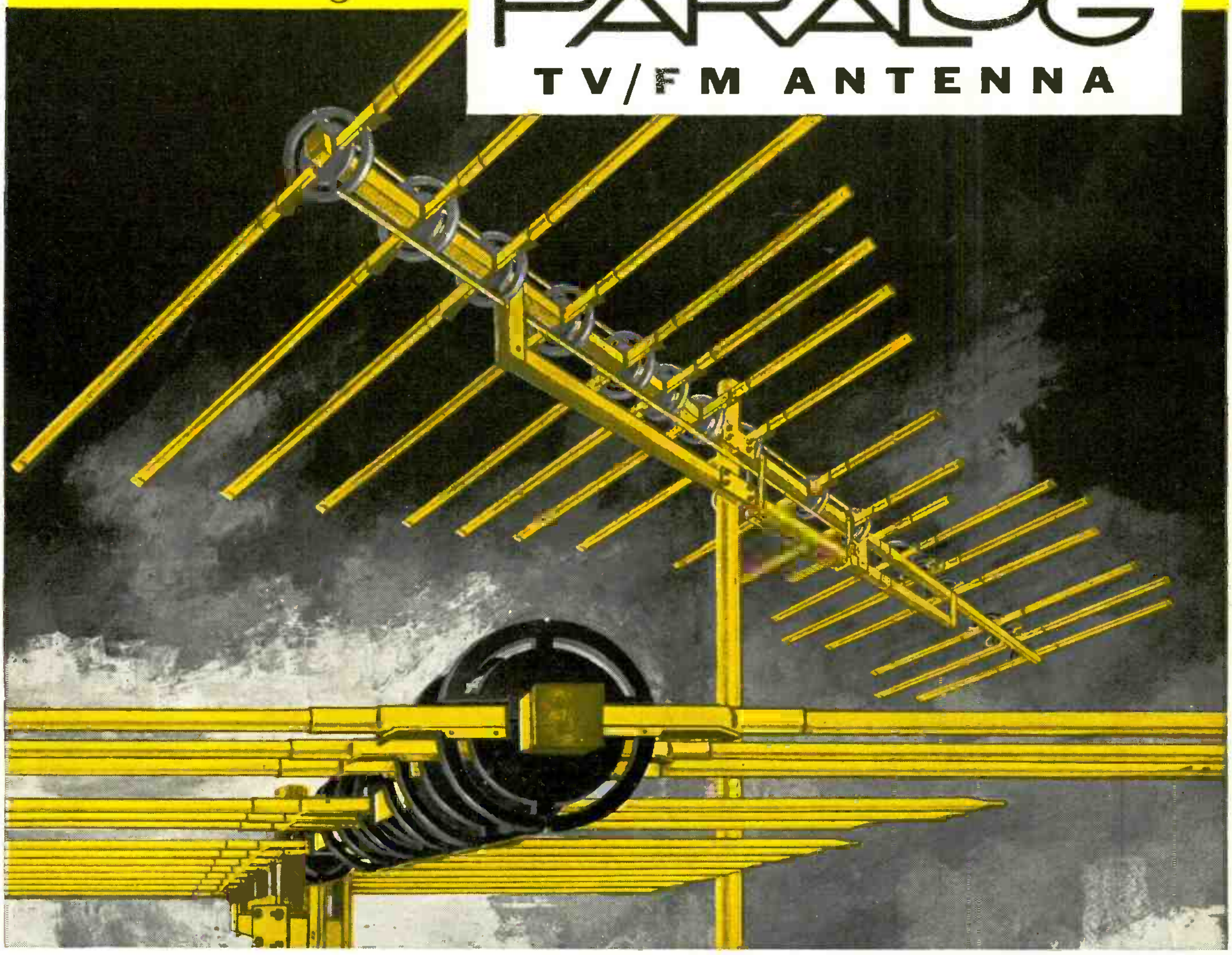

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fused silica (the purest glass known), made by Corning Glass Works at Bradford, Pa., was ground and finished by Perkin-Elmer Corp., Norwalk, Conn., who also constructed the telescope system. Fused silica was chosen because of its near-zero thermal 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

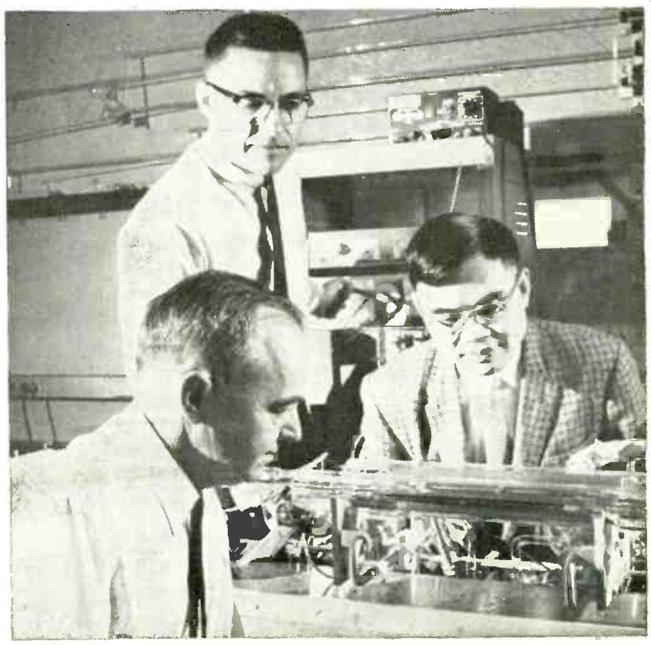
The 1963 National Medal of Science has been awarded to John R. Pierce, executive director of the Bell Telephone Laboratories, Murray Hill, N.J., and to four other scientists.

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



Bell Labs scientists D. MacNair, H. L. Hodges (standing) and P. K. Tien at work on their invention, the triode laser.

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"I HAD A PROMOTION BEFORE I FINISHED the Communications Course," reports Ronald L. Ritter, 113 Helms Dr., Eatontown, 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.

SPARE TIME EARNINGS OF $3,800 in one year reported by Emerson A. Breda, 1620 Larkin Ave., San Jose 29, California. He has a Radio-TV Servicing shop as completely equipped as you would want for a full-time business. Says Mr. Breda, "The training I received from NRI is the backbone of my progress."

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., RFD 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."

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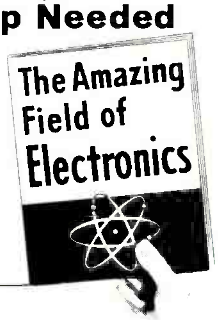

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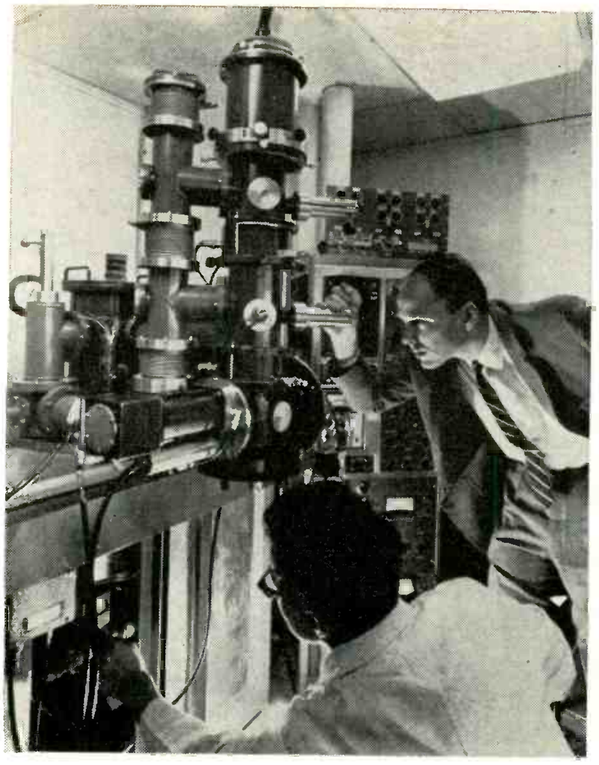

The first successful scanning electron microscope in the United States, being used to study surfaces of tiny microelectronic devices.

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 ¼ 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. END

Correspondence

Polarity Changed

Dear Editor:

A note on "Transistors and Your Ohmmeter" (RADIO-ELECTRONICS, November 1963, page 80): The polarity listing for the Triplett 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

New Institute Certifies Engineering Technicians

Dear Editor:

Some of your readers may be interested in a relatively new organization called the Institute for the Certification of Engineering Technicians (ICET). The purpose of this organization is to help raise the standards of engineering technicians, and to examine and certify those technicians found qualified. Application is voluntary.

Many of the electronic technician readers of RADIO-ELECTRONICS are probably qualified for certification. Those interested in furthering their careers should apply. Certification will raise the status of a technician and could help bring about raises, promotions or a more responsible position. A future benefit of certification will be greater recognition for that group of individuals classified as engineering technicians.

Interested technicians should write the Institute for the Certification of Engineering Technicians, 2029 K Street, N.W., Washington 6, D.C., for further information and an application.

LOUIS E. FRENZEL, JR.

Houston, Tex.

Jack Still Has Friends

Dear Editor:

I had a good chuckle over the "Full of Holes?" letter and Jack Darr's answer in the January RADIO-ELECTRONICS. When I read the letter I figured that Johnston worked in a machine shop, but if he can't grind a drill freehand, he's no machinist. He doesn't seem to know his mechanical punches, either.

The same kind of incident happened last spring when a mechanics magazine editor called a generator an alternator. The editor was right by the electronics dictionary, and the complainant by the regular 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.

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; the tower might be illuminated by bright multiple spotlight beams from below on cloudy nights. This might at least show up the cables. Another possible experiment would be to use a spotlight or series of spotlights on a cloud away from the tower to attract the birds away from the danger points. Perhaps fluorescent cables could be used.

I should explain that the big casualties occur when the skies are overcast and the stars are not shining. Apparently the birds—losing the stars that guide them—are attracted by the TV beacons high in the sky. They swarm around the tower like moths around a flame. As

What are you aiming at?

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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.

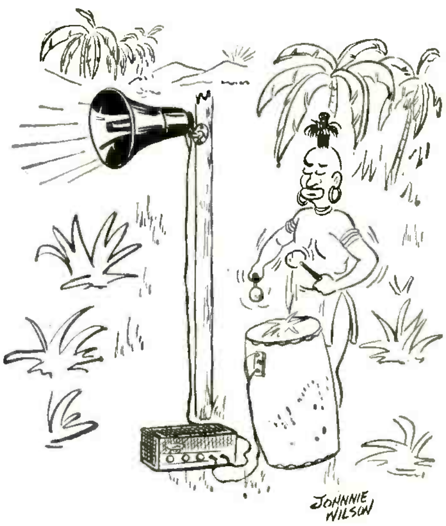
The amazing results reported by the author have been confirmed in numerous CATV and microwave systems, and we have even run G-Line through tunnels for vehicle-to-fixed-station communication.

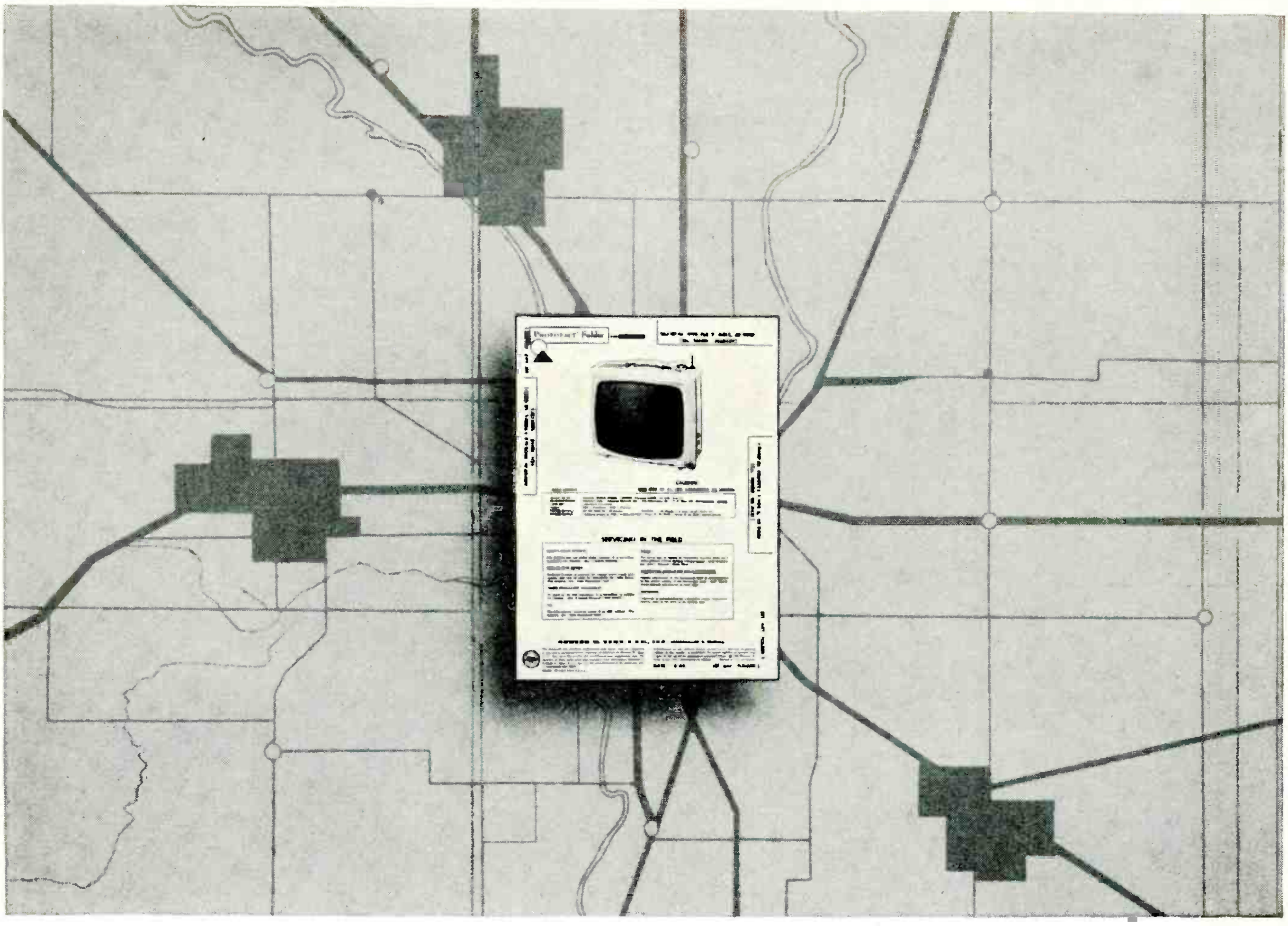
For those who want to become familiar with surface conduction principles, our company has put on the market an inexpensive G-Line kit for uhf TV. It can eliminate boosters in some fringe-area installations.

A. PHILLIPS

Surface Conduction, Inc.
New York, N. Y.

END





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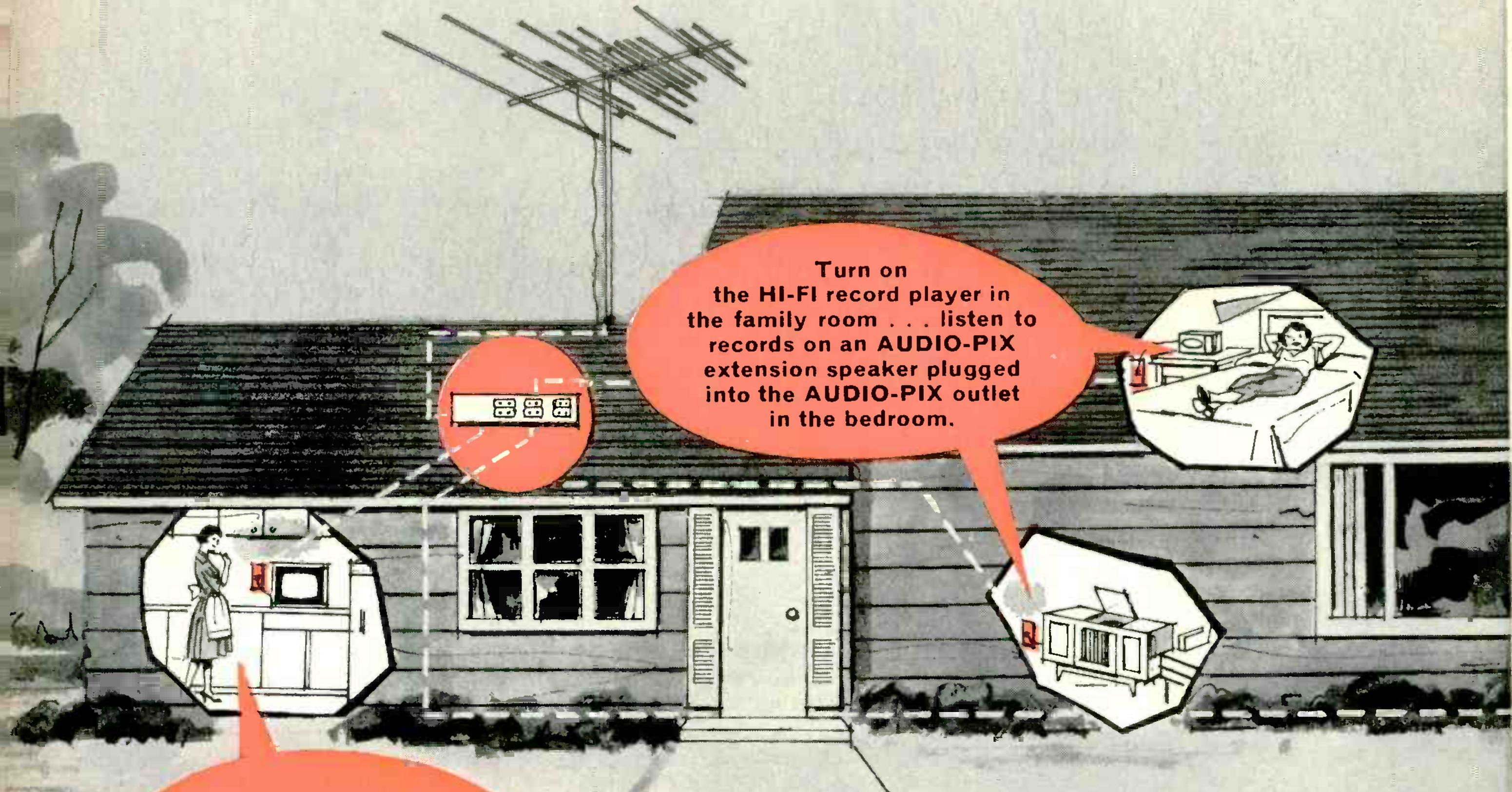
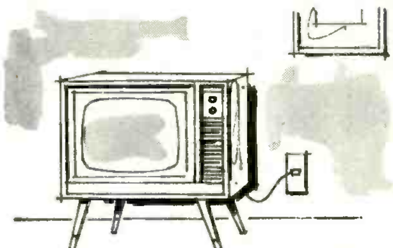
NEW IDEA

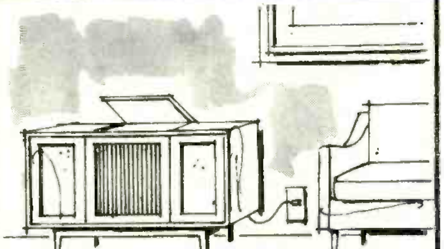
Winegard Introduces An Amazing New Home TV and Music Outlet System



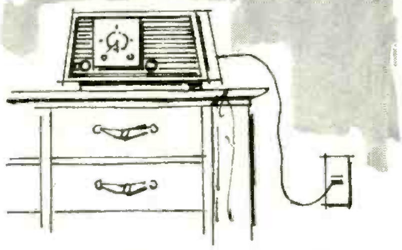
All this electronic entertainment can go on simultaneously over a single wire without interference! That's the amazing new AUDIO-PIX system by Winegard.



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.

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.

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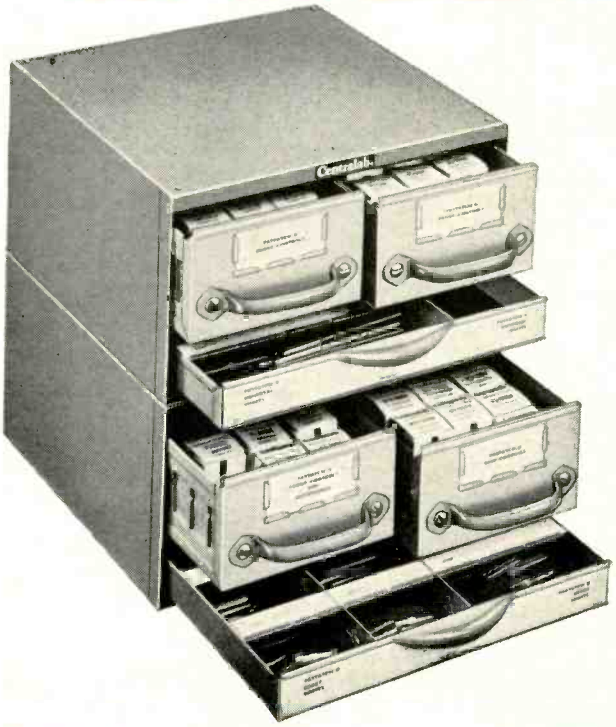

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EXACT REPLACEMENT SHAFTS

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- 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.

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THE FRK-200 KIT CONTAINS:

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30 Exact Rear Shafts (6 sizes)
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5 Push-Pull Line Switches
5 Twist-Tab Adapter Plates
2 3-Drawer Equipto Cabinets
27 Assorted Front Controls
9 Assorted Rear Controls
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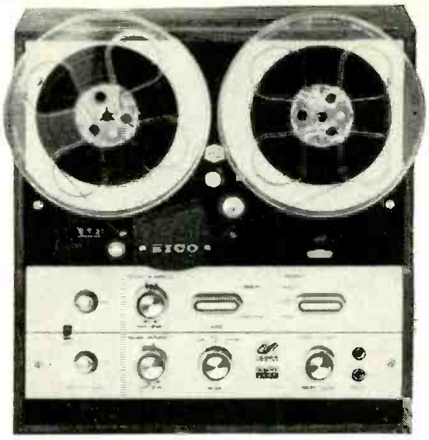
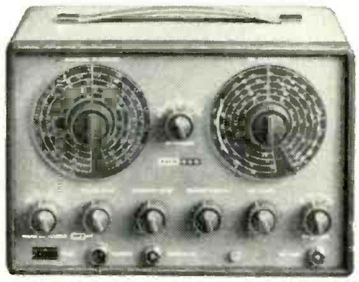


New Tape Deck

Eico Classic 2400 stereo/mono 4-track tape deck. Kit $199.95; wired $269.95 (Incl. oil finish walnut base)

New 3" Portable Scope

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

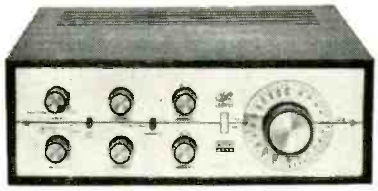


New COLOR AND B & W /FM Sweep Generator

Eico 369 TV/FM Sweep generator, with built-in post injection marker adder. Kit $89.95; wired $139.95

New CB Transceiver

Eico 777 dual conversion 6 crystal-controlled channels, 5-watts. Kit $119.95; wired $189.95

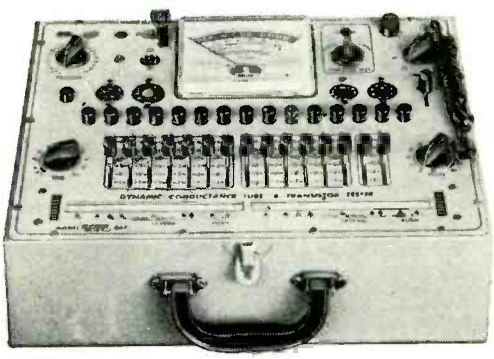


New Stereo Rcvrs.

Eico Classic 2536 36-watt FM-MX Stereo Receiver. Kit $154.95; wired $209.95 (Incl. F.E.T.)

New Stereo Tuner Eico Classic 2200 FM-MX Stereo Tuner. Kit $92.50; wired $119.95 (Incl. F.E.T.)

New Stereo Amplifiers Eico Classic 2036 36-watt. Kit $79.95; wired $109.95. Eico Classic 2050—50-watt stereo. Kit $92.50; wired $129.95. Eico Classic 2080 80-watt stereo. Kit $112.50; wired $159.95.



New Tube Testers

Eico 667 Dynamic Conductance Tube & Transistor Tester. Kit $79.95; wired $129.95.
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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 worth-while, 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)

BUILD YOURSELF A FLUTTER METER

Measures tape, disc or film-sound flutter directly

By LT. (jg) JOHN WAGNER, USN (ret)

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.

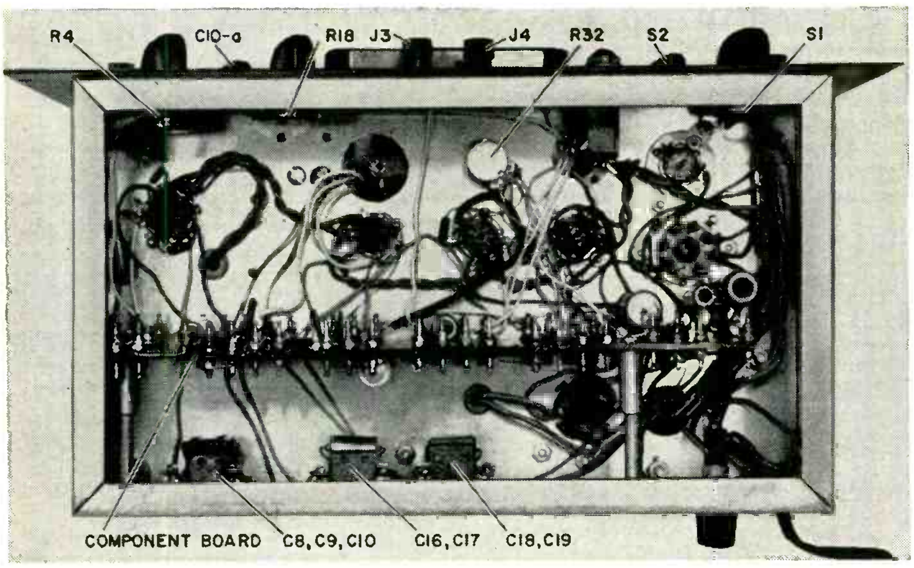
Fig. 1 is the schematic of the meter. V1 is a 3-kc transitron negative-resistance oscillator, designed for maximum stability. As measured on a frequency counter, the oscillator drifted 1½ cycles in 1 hour after a 20-minute warmup. Drift and short-term instability would cause false readings, and must 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.



Most of the components are wired on a terminal board, which makes wiring and servicing easier.

Selector switch S2 has four positions. The first allows the oscillator to be nulled to the discriminator. The second permits checking to see whether there is enough signal to saturate the limiters. The third and fourth are "read" positions, 0.5% and 0.25% flutter, respectively. The AUX OUTPUT is for a scope or mechanical recorder.

Use silver mica capacitors for all tank circuits. NOTE: Do not wire in C9, C10-a, C16, C17, C18, R9 or R21 until the instrument is ready for calibration. Be sure to plan to wire these parts in an easily accessible spot; they will have to be changed several times during calibration. C10-a may be mounted but not wired.

Winding T2

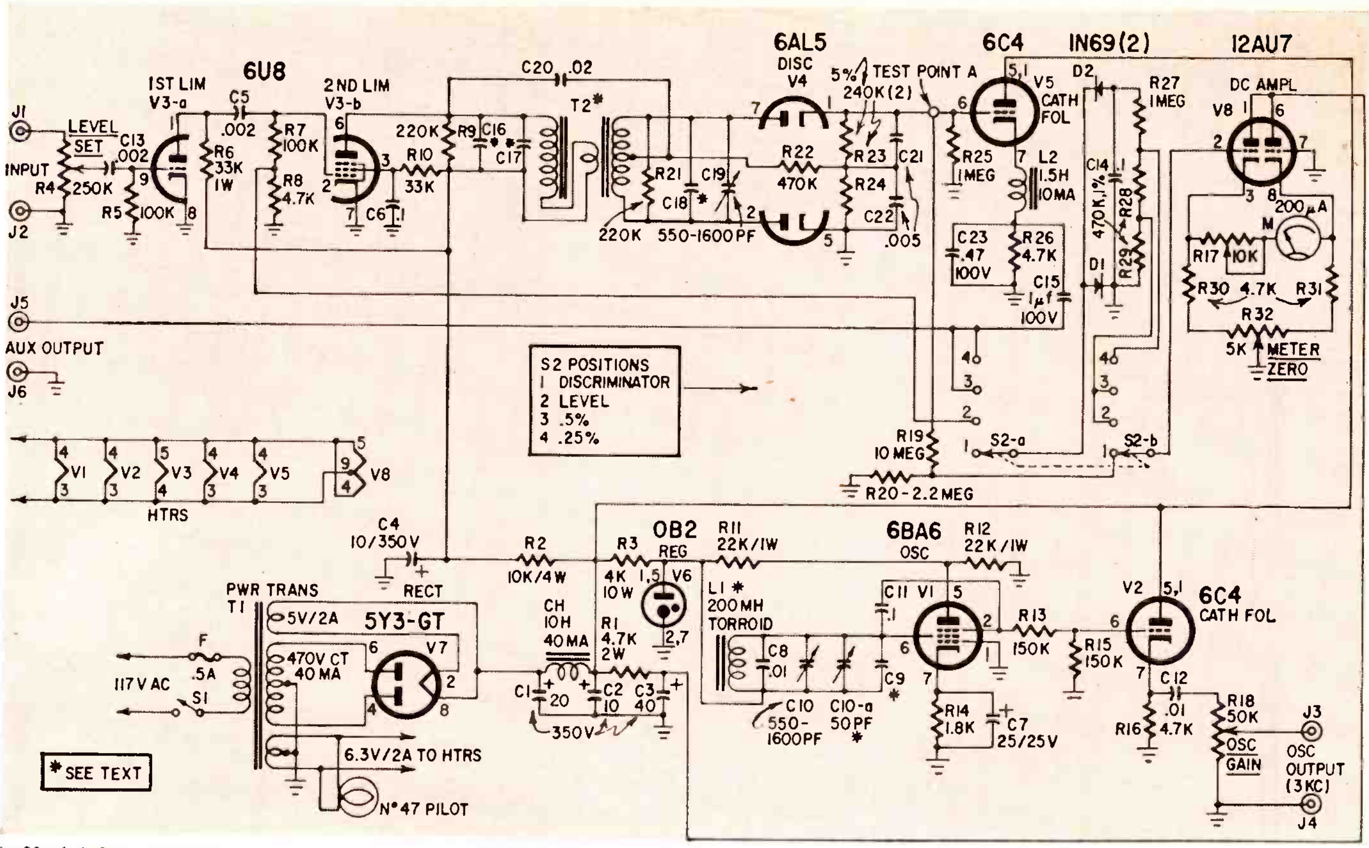
Discriminator transformer T2 uses two Arnold A-254168-2 toroidal cores, wound as shown in Fig. 3. Be sure to use exactly the number of turns and size of wire specified, and place the windings exactly as shown.

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).



C1—20 µf, 350 v, electrolytic
C2, C4—10 µf, 350 v, electrolytic
C3—40 µf, 350 v, electrolytic
(4-section electrolytic, 10–10–20–40 µf, 350 v)
C5, C13—.002 µf, ceramic
C6, C11, C14—0.1 µf, 200 v
C7—25 µf, 25 v, electrolytic
C8—.01 µf, silver mica
C9, C16, C17, C18—see text
C10, C19—trimmer, 550–1,600 pf
(Elmenco 309 or equivalent)
C10-a—50 pf, variable (see text)
C12—.01 µf, ceramic
C15—1 µf, 100 v
C20—.02 µf, disc ceramic
C21, C22—.005 µf, disc ceramic
C23—0.47 µf, 100 v
CH—filter choke, 10 h, 40 ma
D1, D2—1N69
F—fuse, ½ a
J1, J2, J3, J4, J5, J6—5-way binding posts
L1—200-mh toroid inductor (Triad EK-200 or equivalent —order direct from Triad, 4055 Redwood Avenue, Venice, Calif., or your local Triad distributor)
L2—1.5 h, 10 ma choke (Thordarson 26C40 or equivalent)
M—0–200-µa dc meter
R1—4,700 ohms, 2 w
R2—10,000 ohms, 4 w
R3—4,000 ohms, 10 w
R4—pot, 250,000 ohms
R5, R7—100,000 ohms
R6—33,000 ohms, 1 w
R8, R16, R26, R30, R31—4,700 ohms
R9, R21—220,000 ohms
R10—33,000 ohms
R11, R12—22,000 ohms, 1 w
R13, R15—150,000 ohms
R14—1,800 ohms
R17—pot, 10,000 ohms
R18—pot, 50,000 ohms
R19—10 megohms
R20—2.2 megohms
R22—470,000 ohms
R23, R24—240,000 ohms, 5%
R25, R27—1 megohm
R28, R29—470,000 ohms, 1%
R32—pot, 5,000 ohms
All resistors ½ watt, 10% except as noted
S1—spst rotary or toggle switch
S2—2-pole 4-position rotary wafer switch
(Mallory 3229J or similar)
T1—power transformer: 470 vct, 40 ma; 5 v, 2 a; 6.3 v, 2 a (Stancor PC-8401 or equivalent)
T2—see text
V1—6BA6
V2, V5—6C4
V3—6U8
V4—6AL5
V6—0B2
V7—5Y3-GT
V8—12AU7
Toroidal cores for T2—type A-254168-2, available from Arnold Engineering Co., PO Box G, Marengo, Ill., at $1.30 each (2 required)
No. 47 pilot light and fixture; chassis, cabinet to suit; No. 30 heavy Formvar magnet wire; sockets; miscellaneous hardware

Fig. 1—Complete circuit of the flutter meter.

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 vtvm—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 µf will be required).

When the 3-kc 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-kc signal to the vertical input and watch for Lissajous patterns at

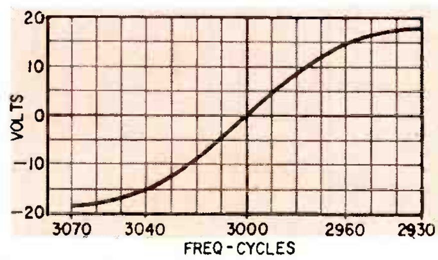


Fig. 2—Characteristic curve of discriminator in this flutter meter. Your curve should look as much like this as possible.

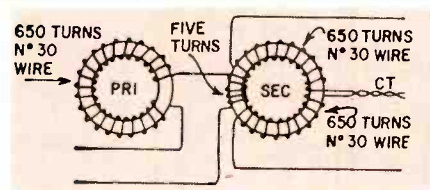
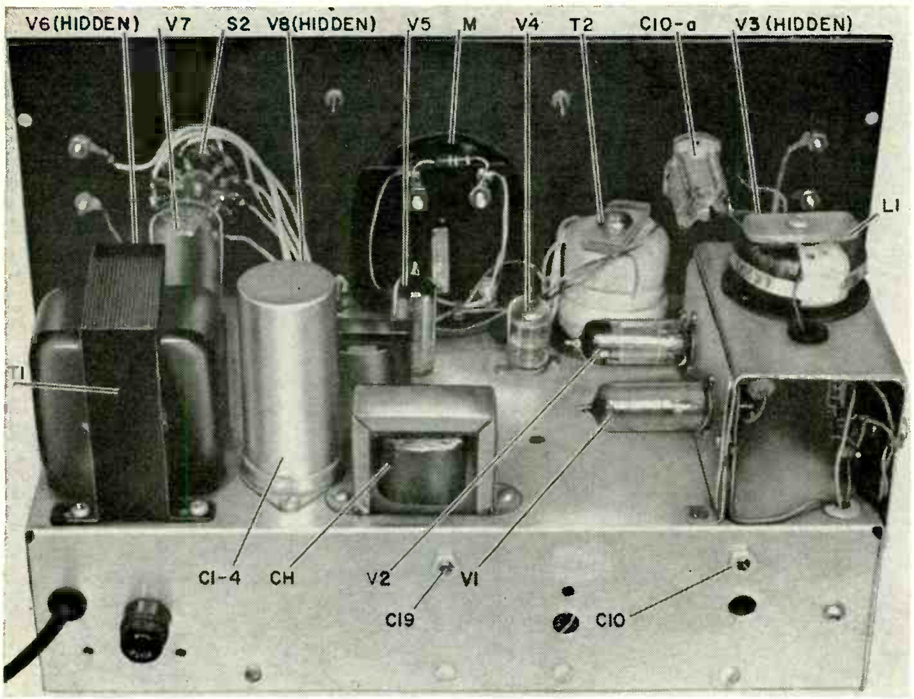


Fig. 3—Winding details of T2, discriminator transformer. It must be wound exactly as shown.



Rear view shows placement of major components. Layout has proved trouble-free.

2,980, 3,000 and 3,020 cycles. If you cannot get fixed patterns at those frequencies, you will have to change the value of C9.

Discriminator precalibration

The flutter meter power should be off for these next steps. Disconnect C20 from the center tap of T2. Insert about 500,000 ohms isolating resistance in series with the generator output lead, and set the generator to exactly 3 kc. Connect both the audio generator and the vtvm (set to an ac range) across T2's primary and add enough capacitance to tune it to resonance (C17) as indicated by a peak in meter reading. The value will be around .03 μf.

Repeat the procedure for the secondary. This added capacitance makes up C18 and should be selected so that C19 remains near its mid-position at 3 kc.

Wire in R9 and R21, and reconnect C20 and the center tap of T2.

The final discriminator tuning consists of adjusting T2 so that discriminator output is zero at exactly 3 kc, and varies linearly above and below 3 kc as shown in Fig. 2. Set the audio signal generator to exactly 3 kc. Zero-center your vtvm and connect it between point A in Fig. 1 and ground. Feed the audio generator output to the flutter meter input (J1–J2). Turn the LEVEL SET control to maximum and the 3-kc OSC GAIN control to minimum. Adjust the signal generator output to about 2 volts.

Tune C19 for a null—zero-center reading on the (external) vtvm. When you tune the audio generator above and below 3 kc, the vtvm pointer must swing exactly the same amount positive and negative. On my unit, the limits were 17 volts positive and negative. Adjust this by changing C16 as necessary.

Representative capacitance values are .0359 μf for C16—made up of a .03, a .002 and a .0039 in parallel—and .0082 plus the variable for C18—.005, .0022 and .001 μf in parallel (obtainable as a stock item in some types of capacitors).

Final calibration

Reconnect the flutter-meter vtvm circuit and allow the unit 30 minutes to warm up. Recalibrate the 3-kc oscillator to exactly 3 kc by using the 60-cycle line frequency as descrbed earlier.

Set the signal generator to 20 cycles exactly, using Lissajous figures, and feed it to the horizontal input of the scope.

Turn the selector switch (S2) to LEVEL, the OSC GAIN control full clockwise (maximum) and the LEVEL SET control full counterclockwise (minimum). Connect the oscillator output to the instrument input, and connect a vtvm (ac range) from the junction of R7 and R8 to ground. Turn the LEVEL SET control clockwise until you read 0.4 volt on the ac vtvm. Mark this point on the panel and leave the control set at that position. This level assures full limiting.

Disconnect the external vtvm and leave everything else connected just as it is. Now connect the output of the internal 3-kc oscillator to the scope vertical input. Set the vtvm to dc and zero-center, and connect it to point A and ground. Adjust the discriminator (C19) for zero volts.

You should be able to get three Lissajous displays by tuning C10, at 2,980, 3,000 and 3,020 cycles. Record the voltage readings obtained at 2,980 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 × 3,000). In terms of voltage, this is 0.45 × 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 tape machine. 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%. END

By HANS FANTEL

Kodak

White-gloved worker inspects a reel of tape by transmitted light before packaging. Light shows up irregularities or foreign matter in winding.

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 ½ 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).

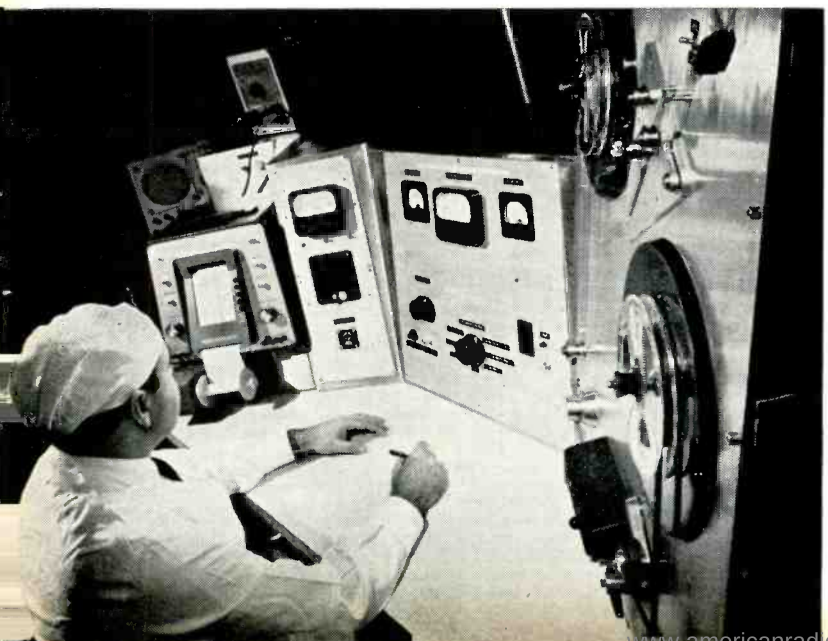
Recently, 3-M introduced a triple-play tape (No. 290-36) which winds 3,600 feet on a 7-inch reel and permits 90 minutes of uninterrupted recording at 7½ ips. Presumably this tape is an outgrowth of 3-M's development work in tape cartridges. Slower recording speeds add time, but reduce frequency range and signal-to-noise ratio. At 3¾ ips, playing time is double the 7½-ips figure, and at 1⅞ 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

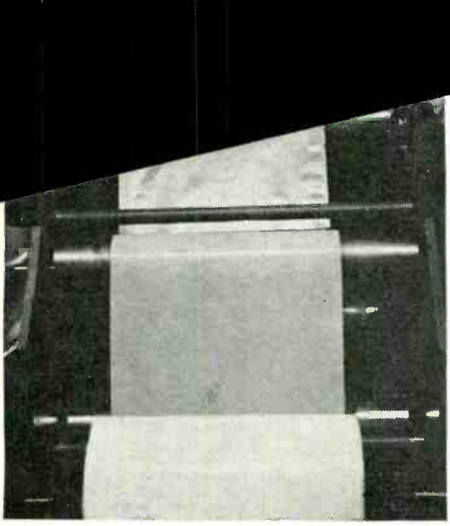
Two principal types of material are used for the basic tape stock to which the oxide is applied: acetate and polyester—the latter commonly called Mylar, a trade name of Dupont, which pioneered its use. Both acetate and Mylar have staunch partisans, and their relative merits are always good for an argument. 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 clean, 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.



Checking samples is a major part of quality control. Here, a Kodak engineer checks frequency response, distortion, noise, saturation and uniformity. Note surgical attire to help keep room (and tape) dust-free.

Kodak



BASF

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 would 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.

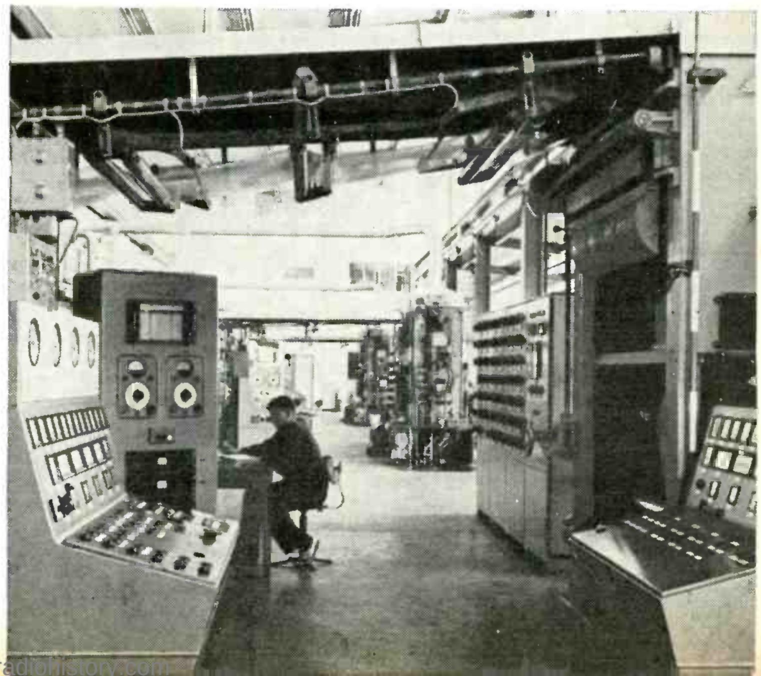
Tape testing

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?

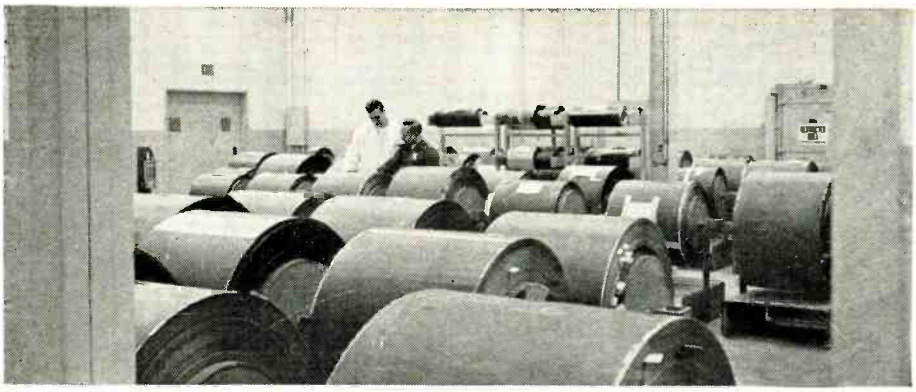
The answers to these questions are clues to other quality factors: dimensional constancy and lubrication. Uniform tape width is especially important in four-track operation. If uneven width causes the tape to weave up and down, the four tracks won't stay properly aligned with the head, resulting in cross-talk, 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-

Full automation assures close tolerance in the German BASF tape plant.



BASF



3M Co.

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 undistinguishable 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.

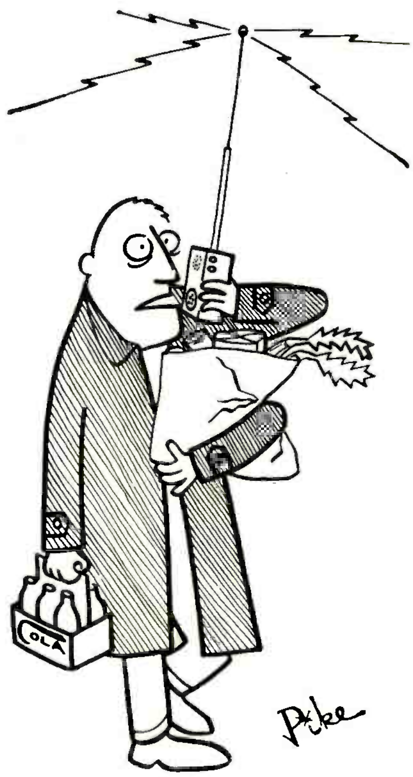
For one thing, unlike audio tape, video tape has vertical particle orientation in the oxide layer. This reduces signal-to-noise ratio when used in audio recorders. Also, since TV tape is 2 inches wide, it must be slit to ¼-inch width before being sold for audio use. Often the reject processors are quite 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 ±.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



Quiet, Please...!

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

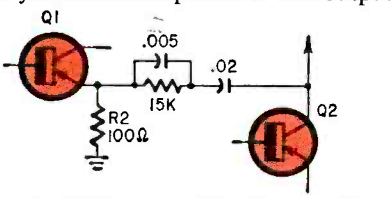
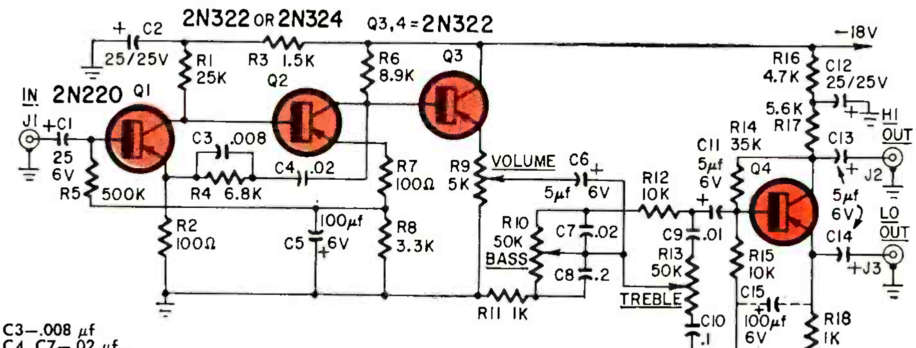


Fig. 2—RIAA equalization values. Values given in Fig.1 and parts list are for author's preferred equalization, not RIAA. See text for details.



R1—25,000 ohms*
R2, R7—100 ohms*
R3—1,500 ohms
R4—6,800 ohms
R5—500,000 ohms* (see text)
R6—8,900 ohms*
R8—3,300 ohms
R9—pot, 5,000 ohms
R10, R13—pot, 50,000 ohms
R11—1,000 ohms
R12—10,000 ohms
R14—35,000 ohms*
R15—10,000 ohms*
R16—4,700 ohms
R17—5,600 ohms*
R18—1,000 ohms*
*Resistors marked * are 1% metal film or deposited-carbon types (low noise).*
C1—25 µf, 6 volts, electrolytic
C2, C12—25 µf, 25 volts, electrolytic
C3—.008 µf
C4, C7—.02 µf
C6, C11, C13, C14—5 µf, 6 volts, electrolytic
C8—0.2 µf
C9—.01 µf
C10—0.1 µf
J1, J2, J3—phono jacks
Q1—2N220 (see text)
Q2—2N322 or 2N324
Q3, Q4—2N322
Two 9-volt transistor batteries
Dpdt transfer switch (optional)
Miscellaneous hardware

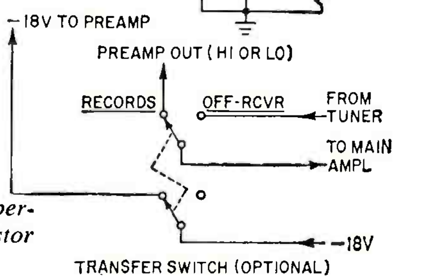


Fig. 1—Preamp circuit. The author reports performance improves with a 100,000-ohm resistor connected from C7–C8 junction to ground.

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.

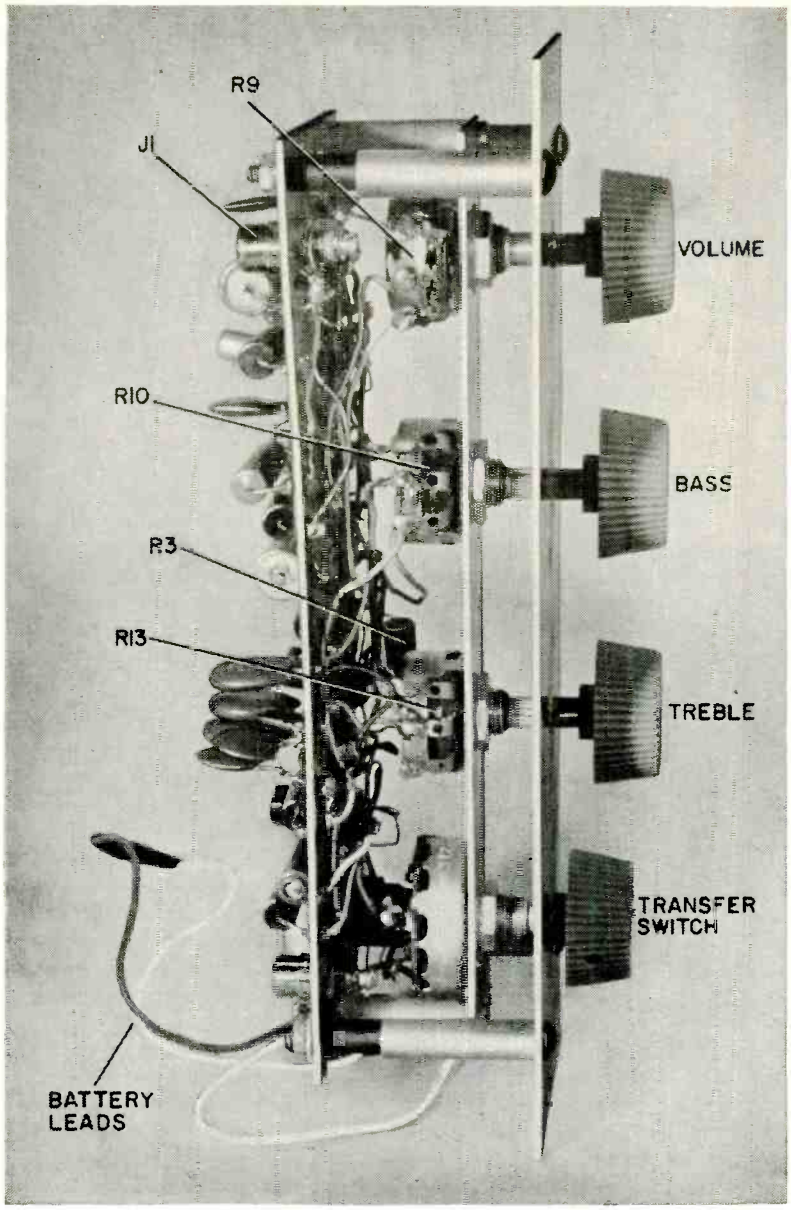
The mounting board measures 2½ x 7 inches, and was laid out and drilled in a pattern that followed the schematic. We used transistor sockets, but the transistors could just as well be soldered to the eyelets if the leads are left long. If, after mounting a few components, you find you need an extra eyelet, 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 vtvm) 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.

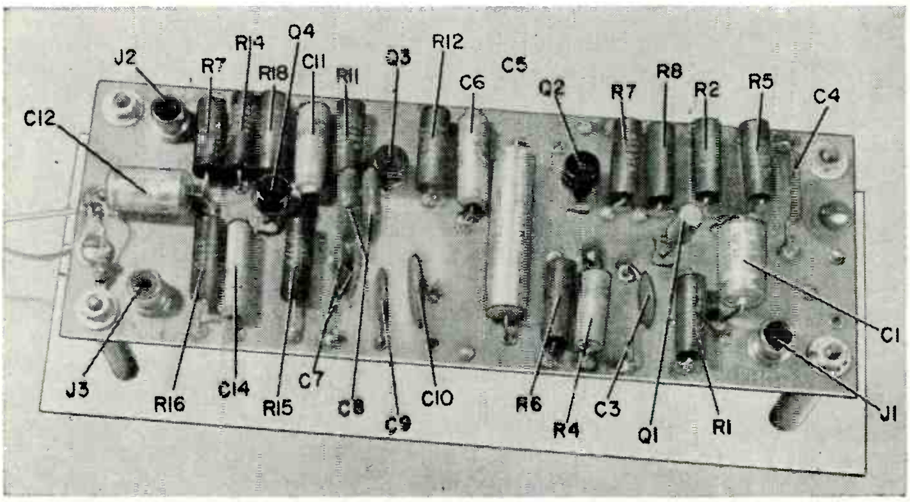
Output voltage at LO OUT is 0.25 rms using a G-E VR-II cartridge and a Columbia ZRD431-1A Standard Characteristic Recording. Output at HI OUT under the same conditions should be greater than 1 volt and can be increased by increasing R14.

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. END



Bottom view of preamp.



Preamp's "chassis"—phenolic board with eyelets swaged into it.

By ALBERT B. GRUNDY, JR.*

BETTER STEREO REPRODUCTION WITH 15° STYLUS

Cover Story

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

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 stereophiles, 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; up 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

> **Our Cover**
>
> A recording lathe at the International Recording Co. in New York City, is being operated by Claude Rie. The equipment uses a stylus at the 15° angle, and the efficiency of the recording head is increased by removing heat from the coils with helium taken from the tank at the left (hoses may be seen on the cutting head). By cooling the coils as originally suggested by George Neumann of Germany, larger currents can be carried, and therefore more power applied to the cutter.

*International Electroacoustics, Inc.

Fig. 1—How cutting and playback styli differ.

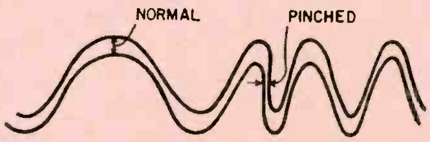


Fig. 2—Pinch effect will distort high frequencies.

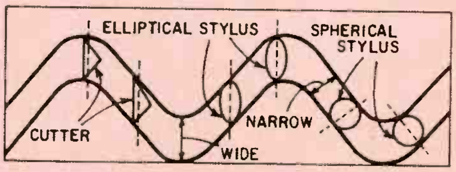


Fig. 3—Elliptical stylus reduces pinch effect.

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

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°.*

The Ortofon DSS601, an example of a modern stereo cutting head.

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

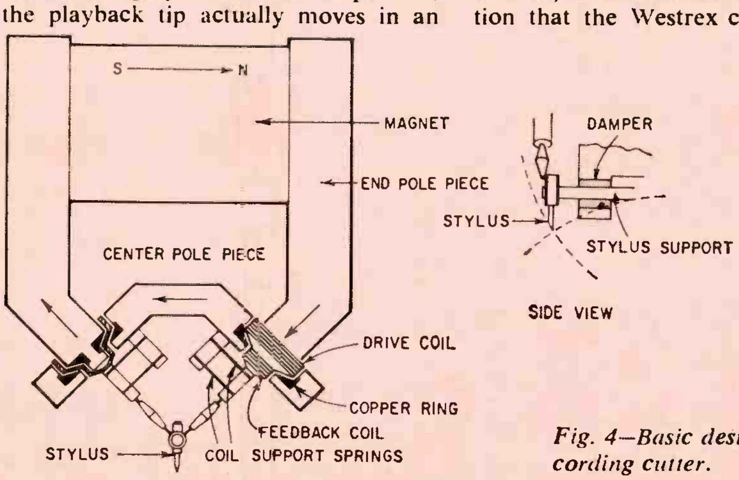


Fig. 4—Basic design of stereo recording cutter.

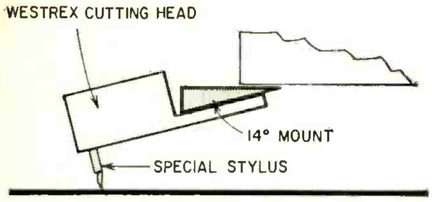


Fig. 5—Cutter modified for a 15° angle. Original cutter has approximate 1° tilt, hence the 14° mount.

level of vertical modulation. In trick recordings with exaggerated separation and so-called "ping-pong effects," 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° in the recording being cut. It is, of course, necessary to use a special stylus in the cutter. This special stylus, introduced by CBS Laboratories, has its cutting face tilted this same 15° from the vertical (Fig. 5). 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.

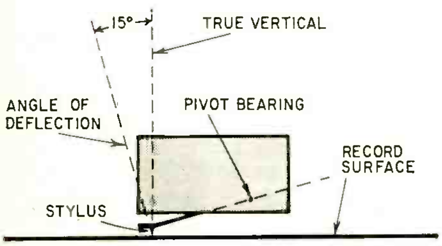


Fig. 6—What is meant by the 15° effective tracking angle.

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. END

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 15/16 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.

Tape Time Table

Feet	Tape Speed—Inches Per Second				
↓	15/16	1 7/8	3 3/4	7 1/2	15
150	32	16	8	4	2
225	48	24	12	6	3
300	64	32	16	8	4
600	128	64	32	16	8
900	192	96	48	24	12
1,200	256	128	64	32	16
1,500	320	160	80	40	20
1,800	384	192	96	48	24
2,000	426	213	106	53	27
2,400	512	256	128	64	32
3,000	640	320	160	80	40
3,600	768	384	192	96	48

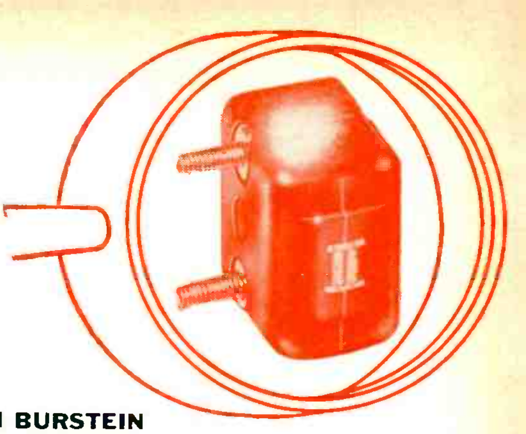
Time in minutes, calculated to nearest whole minute, 1 direction, 1 track only.
For total mono time on 4-track recorders, multiply time by 4.
For total mono time on 2-track recorders, multiply time by 2.
For total stereo time on 4-track recorders, multiply time by 2.
For total stereo time on 2-track recorders, use given figures.

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 erasure 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 vtvm virtually flat from 20 to 100,000 cycles and with a full-scale range to 30 mv; audio generator operating from 20 to 100,000 cycles, with less than 0.5% distortion; a harmonic-distortion meter; a scope flat from 20 to at least 500,000 cycles; test tapes (playback-response, azimuth-alignment and "operating-level" tones); an audio system (amplifier and speaker); a stroboscopic device 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.

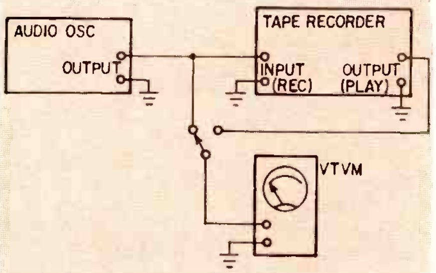


Fig. 1—Setup for checking overall record-playback response. Vtvm at oscillator output monitors level (which must be kept constant); at output of recorder, it reads playback output level. Ratio of the two in db is response variation.

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

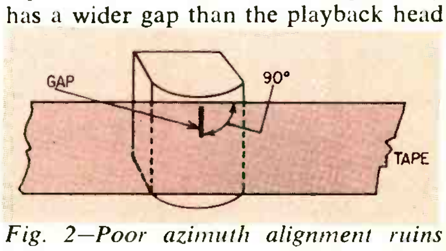


Fig. 2—Poor azimuth alignment ruins high-frequency response. Playback head gap must be perpendicular to direction of tape movement.

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

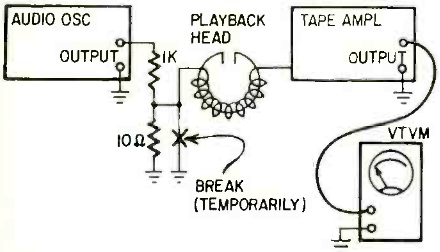


Fig. 3 — Measuring playback equalization. R1 and R2 divide down signal 100:1, provide low source impedance. Note that signal is injected in series with head. Audio oscillator output must be constant for all frequencies.

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 like that in Fig. 5 is often employed. Fig. 5 is the curve suggested by the Magnetic Recording Industry Association (MRIA) as a standard, though not yet officially adopted.

If the machine under test does not claim to follow the NAB or other widely accepted playback curve, consult the service manual to find out what that curve should look like.

The technique of Fig. 6 is employed to measure record equalization. First, it is imperative to remove the oscillator tube (or transistor). Feed signals into the high-level input jack of the record amplifier, and measure across a small resistor inserted between ground and the record head's ground lead. A 100-ohm resistor is usually best, but if your vtvm is not sensitive enough to read the signal voltages across this resistor, try 1,000 ohms.

The important thing is that at the lowest audio frequency measured, the resistance should not exceed one-tenth the impedance of the record head in combination with its circuitry (driving tube or transistor, load resistor, constant-current resistor, etc.).

To avoid overloading the record head or associated circuitry at high frequencies, keep input signals about 20 db below maximum recording level as shown by the record-level indicator.

Consult the service manual of the machine under test to find out what the record equalization curve should look 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

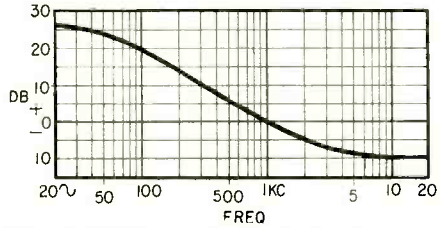


Fig. 4—NAB standard playback curve for 15 ips (used widely at 7.5 ips also).

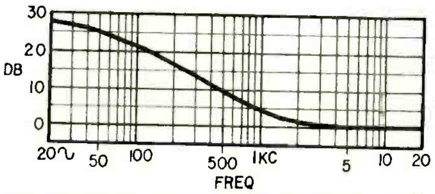


Fig. 5—MRIA-suggested playback equalization for 3.75 ips.

record equalization shall be tailored so that, in conjunction with the standard playback curve, the machine shall yield overall flat response.

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.

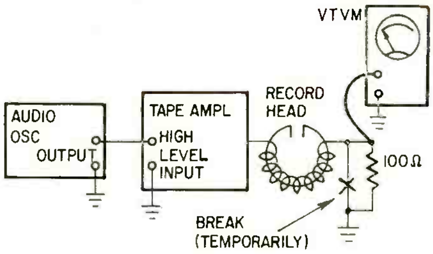


Fig. 6—Measuring record equalization. Reading audio voltage drop across 100-ohm resistor in series with head includes head characteristics in overall curve. Same technique is used for measuring bias current.

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 ½ 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

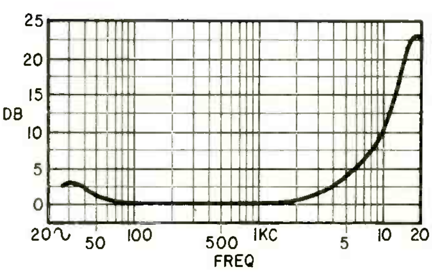


Fig. 7—Typical 7.5-ips record equalization used in high-quality home machine.

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 fires. If not, 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 understates 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.

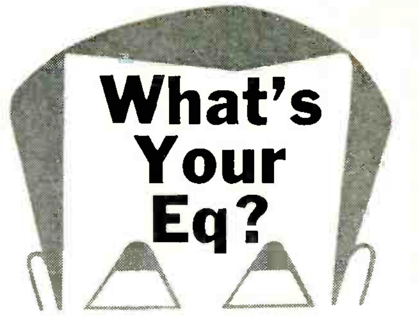
To measure signal–noise ratio, record a signal of 400 cycles on virgin or bulk-erased tape at the recording level that produces 3% harmonic distortion in playback. Measure the playback signal with a vtvm. Rewind the tape and put it through the recording process again, but this time with no signal input 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 31321-01. 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 vtvm. 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.

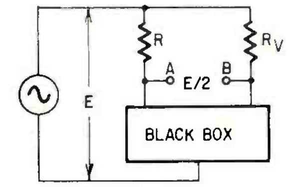
An accurate instrument for measuring wow and flutter is very expensive and therefore seldom found in a service shop. However, the ear is good for detecting even slight departures from perfection. Record and play (or, in the case of a tape player, just play) a 3,000-cycle tone. Listen for wow, which shows 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. END



This month's answers on page 76.

Always Half

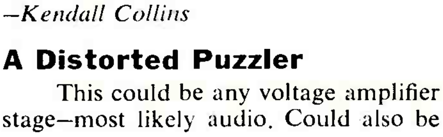
An ac generator is connected to a network consisting of two resistors, R and R_v, and the black box shown in the diagram. It is found that the voltage be-



tween A or B is independent of the value of R_v. Whether R_v is shorted or open, the voltage across AB is E/2 where E is the voltage of the generator. It is also independent of the frequency. Why?
—Qutaiba Bassim El-Dhuwaib

What Voltage?

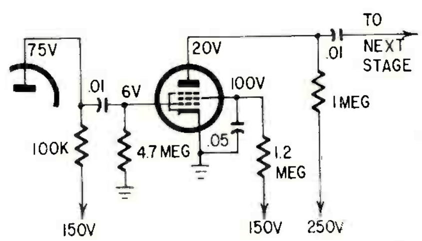
Three voltmeters are connected as shown. V1 is an electrostatic type, calibrated to read peak voltage values. It indicates that the output from the recti-



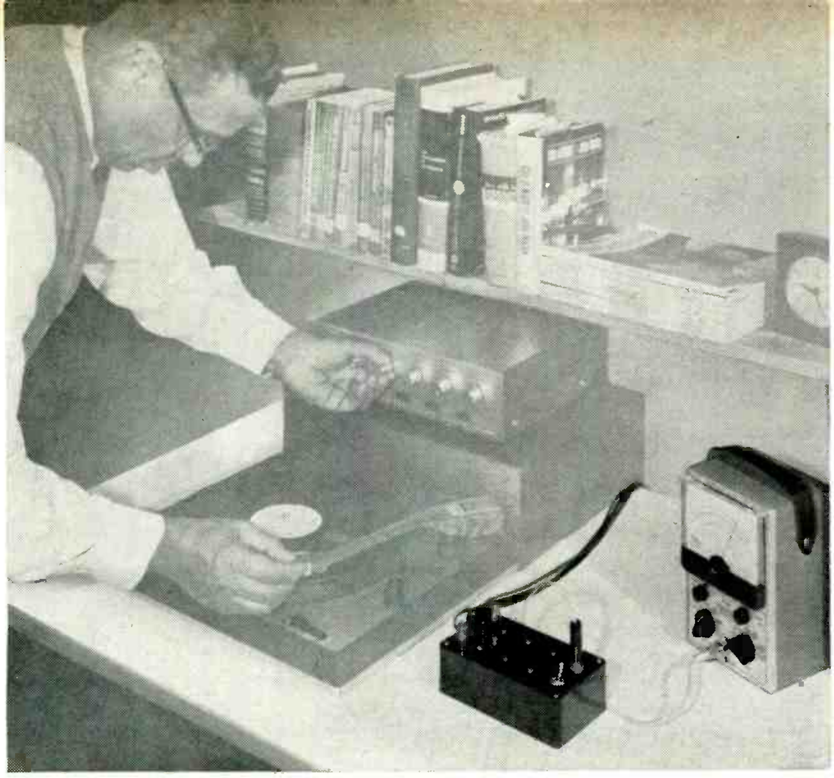
fier is 1,000 peak volts. V2 is a dc voltmeter of the d'Arsonval type. V3 is an ac voltmeter of the electrodynamometer or iron-vane type. What will be the voltage indicated by voltmeters V2 and V3?
—Kendall Collins

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 END



RADIO-ELECTRONICS' *Technical Editor tries out the Black Box.*

BLACK BOX–

A STEREO ANALYZER

With this device and a vtvm, you can check phasing and balance of your stereo system.

By **BOB WHITE**

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*.

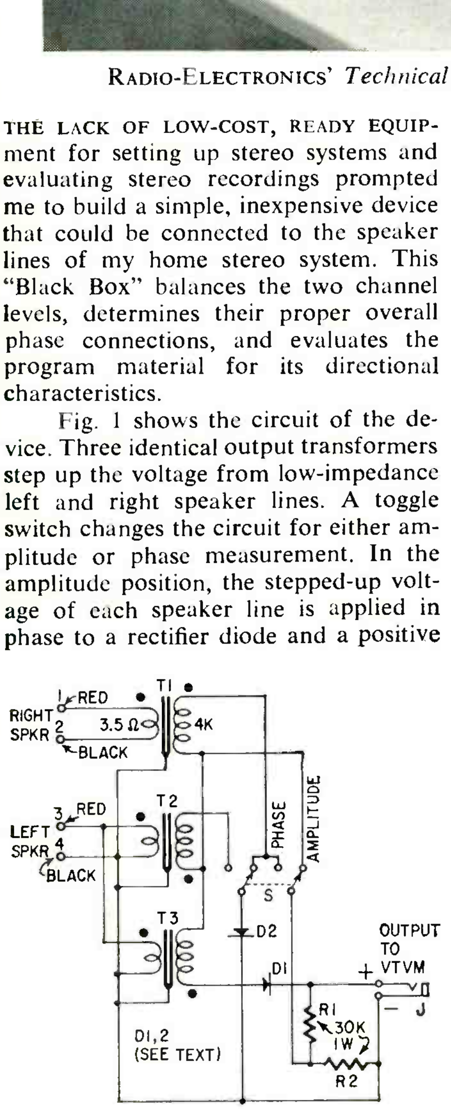


Fig. 1—Circuit of the Black Box.

R1, R2—30,000 ohms, 1 watt
D1, D2—1N459, or 1N649 (see text)
J—phone jack
S—toggle switch, dpdt
T1, T2, T3—output transformer; primary, 4,000 ohms; secondary 3.5 ohms; 3 watts
Binding posts (4)
Plastic case and panel, 6¼ x 3¾ x 2 inches
Miscellaneous hardware

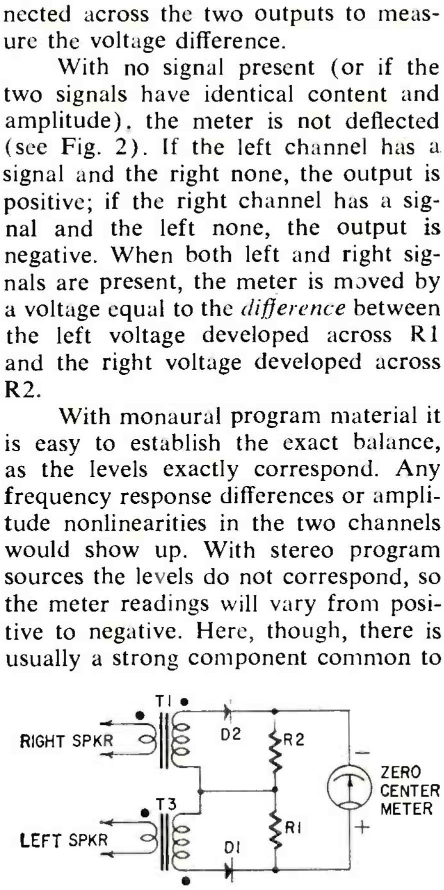


Fig. 2—Simplified diagram of amplitude sensing circuit. Dots at T1 and T3 indicate phasing of transformers; positive-going wave at dotted end of primary produces positive-going wave at dotted end of secondary. See text for explanation.

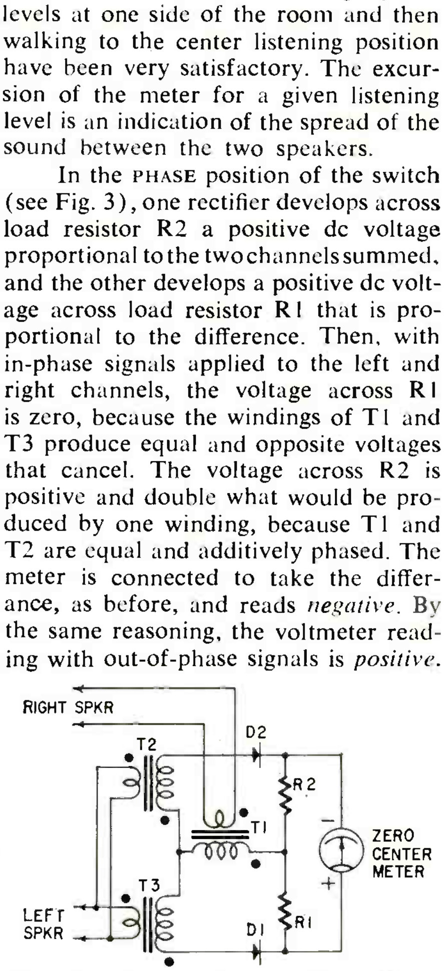
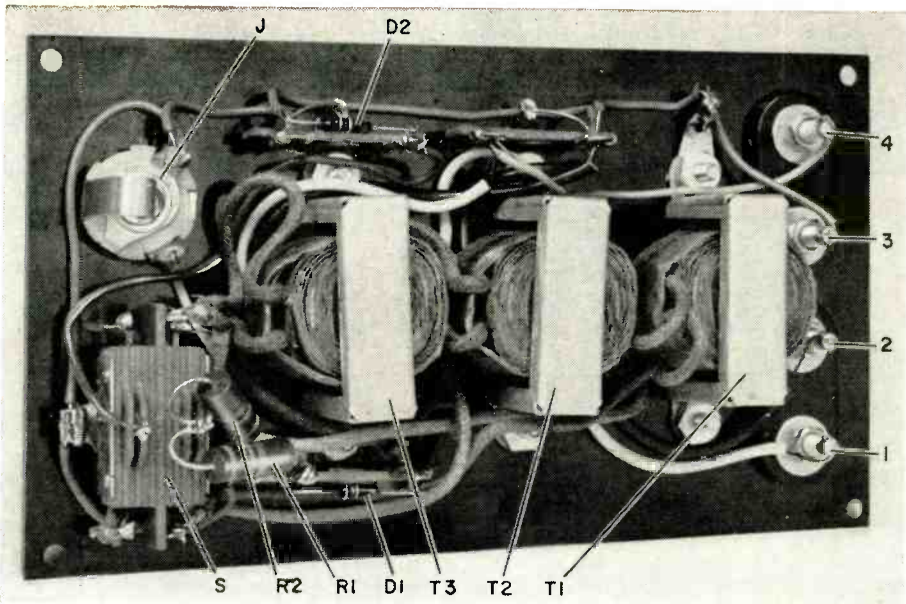


Fig. 3—Phase-sensing portion of analyzer. Dots at transformers indicate phasing, as in Fig. 2. Text describes operation.



All components are mounted and wired on panel of bakelite case.

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 readings, and those that produced confused stereo sounds were strong in both polarity readings. Programs that were predominantly out of phase could be improved by reversing one set of speaker leads.

Surface noise on stereo recordings is out of phase with program content. This is because most of the surface noise is in the vertical component of the needle movement. It illustrates that a stereo cartridge used to play monophonic records with the channels tied together cancels the vertical groove noise.

Details of the Black Box

In the circuit shown, three identical output transformers were used across 4-ohm speaker lines. For other impedance lines, connect the Black Box to the 4-ohm taps of the audio power amplifiers while the speakers are connected to their required impedance taps. Or use three identical transformers of the desired impedance level. The actual impedances are not critical except that the speaker lines should be roughly matched to the transformers. The stepup connection causes a high voltage to be developed across the high-impedance windings and the rectifiers.

The amplifier output (each channel) must not exceed 10 watts sine-wave power, or an instantaneous peak power of 14 watts with the transformer impedances specified and 1N649 rectifiers. So keep the volume down! At 14 watts, a peak voltage of 600 is developed across the two windings and rectifiers. (For sinusoidal power levels of 1 watt or less, 1N459 diodes with a 200-volt peak inverse rating can be used.) If the specified transformers were connected to 8-ohm speaker lines, the maximum operating power level would be just half—5 watts rms and 7 watts peak.

In the plastic box shown in the photos, a good ground connection was made between the three transformer frames, the toggle switch frame and one speaker line terminal, as shown in the schematic. This prevents accidental shock from the various exposed metal parts. The voltmeter indicator was set to a +7.5 – 0 – —7.5-volt range. This varies with normal listening levels.

Make sure that the speakers are properly phased with respect to the Black Box. One simple method is to disconnect the speakers from the system, and then momentarily touch a flashlight cell across the speaker voice-coil terminals. Both left and right speaker cones must move in the same direction when the positive battery terminal is touched to the speaker terminal which is to be connected to the red terminal on the Black Box.

[Some amplifiers have the 4-ohm output taps common to chassis and to each other, instead of the "ground" or "common" terminals. This allows simple two-terminal connection of a sum (left-plus-right) center-channel speaker. In such amplifiers, grounding the "common" taps as well would short half of each output transformer secondary. For that reason, the primary of T1 in Fig. 1 is left "floating".—*Editor*] END

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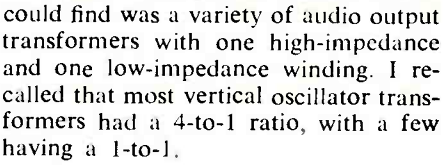
Ingenious Replacement

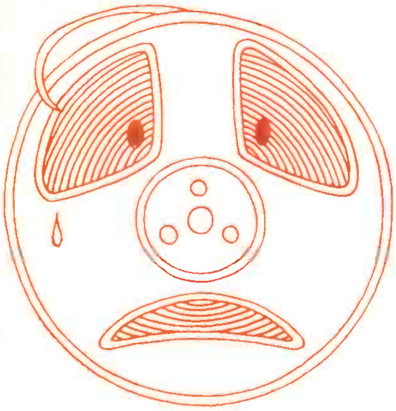
SOME TIME AGO, A TECHNICIAN FRIEND of mine was faced with repairing an "off-brand" TV set, and needed a vertical blocking oscillator transformer. He enlisted my help and we started ransacking the shop, looking for any kind of transformer with two high-impedance windings on suitable laminations. All we could find was a variety of audio output transformers with one high-impedance and one low-impedance winding. I recalled that most vertical oscillator transformers had a 4-to-1 ratio, with a few having a 1-to-1.



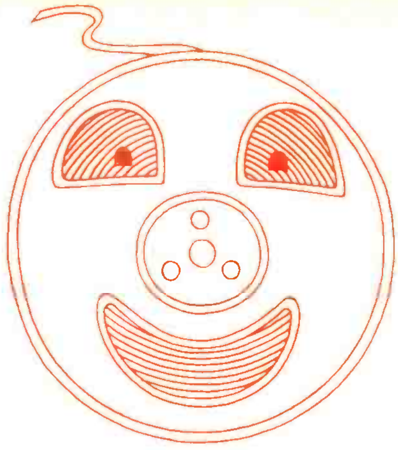
Then I wondered how two of his old audio transformers, hooked back to back, would work. We tried it, connecting them as shown in the schematic. It worked fine!

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. Velásquez*



Tape Recorder Problems



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, wirewound or deposited-metal film types, are expensive ($2 or $3 each). Even an expensive resistor can develop noise after a while. Deposited-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

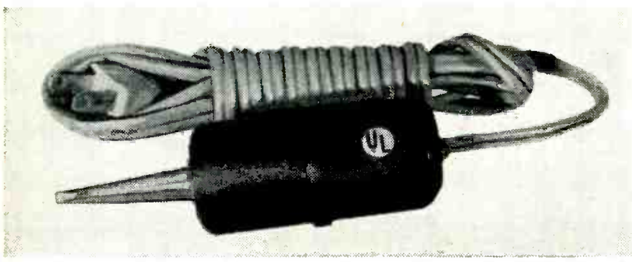


Fig. 1—A head demagnetizer, like this, is an absolute must for quiet recordings.

Robins Industries Corp.

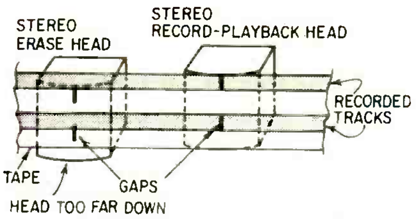


Fig. 2—A misaligned erase head can result in incomplete erasure of previously recorded material if it "wipes clean" only part of each track.

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).

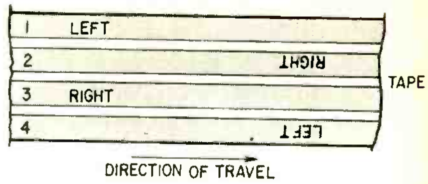


Fig. 4—Vertical misalignment of record-playback head can cause crosstalk between tracks 2 and 3.

Fig. 3—Bulk erasers are the most convenient way of erasing whole reels of tape. If unit is properly used, erased tape is as clean as new.

Lafayette Radio

tape guides and other metal parts of the machine contacted by the tape. (Turn off the machine when demagnetizing.)

In recording, the main cause of noise is distortion in the bias oscillator waveform. Bias is supplied to the record head (along with the audio signal) to minimize tape distortion and maximize the amount of signal recorded. Make a rough check for bias distortion: with no input signal and with the recording gain control at minimum, put several feet of blank (virgin or bulk-erased) tape through the recording process. Play it back and compare its noise level with that of the following "unrecorded" tape. There will always be *some* rise in noise level but, if this rise is strong, it suggests poor oscillator waveform (should be a perfect sine wave). Try replacing the oscillator tube. If that doesn't help, the service technician should take over.

Incomplete erasure belongs in the noise category. The cause may simply be that you are recording at an excessive level, which the erase head isn't designed to cope with. If that isn't the case, the trouble may be a defective erase head, insufficient erase current, too-high oscillator frequency or misalignment of the erase head with respect to the record head so that their gaps don't span the same portion of the tape (Fig. 2). All these are ordinarily problems for the technician.

Tapes that have been recorded at excessive level are best erased with a bulk eraser (Fig. 3). Unfortunately, this means erasing *all* tracks on the tape.

Crosstalk is another form of noise. 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 moist 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

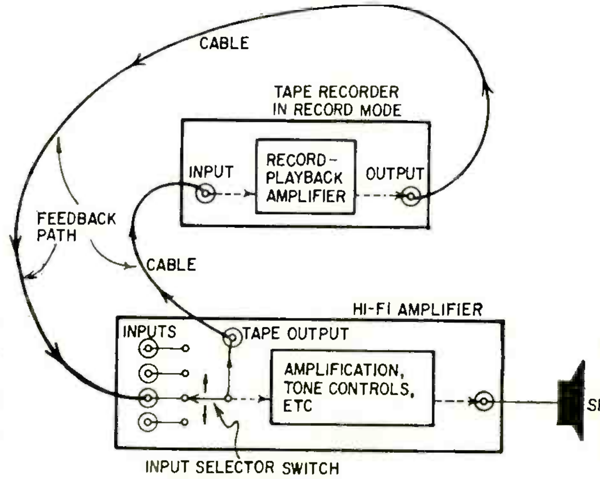


Fig. 5 – Earsplitting feedback howl occurs in some installations because of switching arrangement shown here.

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 when 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 wavering 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

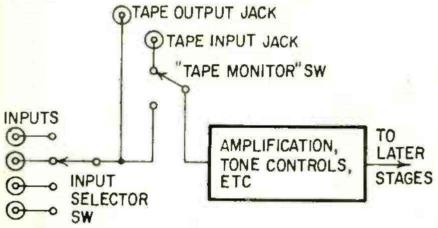


Fig. 6—"Tape Monitor" switch prevents feedback shown in Fig. 5.

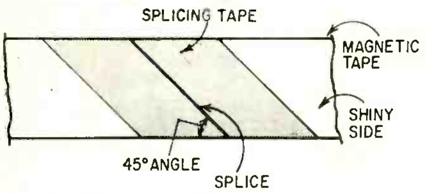


Fig. 7—Correct splice, cut and taped at 45° angle, is practically noiseless and very strong.

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. END

improvising an FM tuner

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

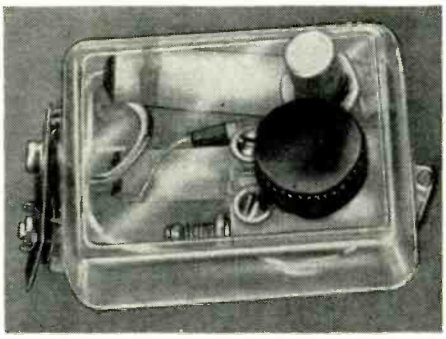
By OLIVER E. WILSON

WHEN THE FIRST FM BROADCAST STATION opened in this area (on 95.9 mc) many would-be listeners wondered how they could pick up a sample broadcast before deciding whether to invest in equipment to take advantage of this source of good music.

Manufacturers and dealers were ready for the new market, but for the experimenter there was an opportunity to create or build something.

My first step was to pull the coarse- and fine-tuning knobs from the front of the TV set. With a flashlight, I explored the opening for access to the tuner adjustment slugs. Setting the tuner to unused Channel 6 brought the head of that slug into view and, with a long alignment screwdriver, about two turns got some sound output. Tuning with the fine-tuning knob was critical. The sound seemed to drift in and out and lacked fidelity.

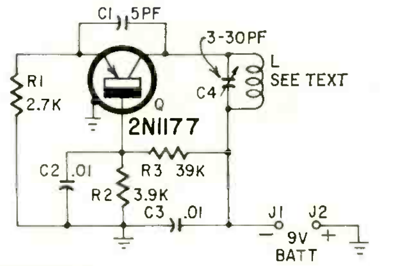
After a little reflection, it dawned on me that the TV set with standard intercarrier circuitry requires two carriers (normally picture and sound)—to produce the 4.5-mc sound i.f. carrier.



Tiny box tucks away inside TV, or almost anywhere.

I tuned my grid-dip meter between 90 and 100 mc, holding it several feet from the TV set. Careful tuning cleared the sound, and reception was excellent. The grid-dip meter, with an occasional correction for oscillator drift, helped make a quite satisfactory FM tuner.

A more permanent system was built in a small plastic box. The circuit, a transistor oscillator, is given in Fig. 1. The parts layout is not too critical, except that leads to the coil and capacitor combination must be short. The coil was



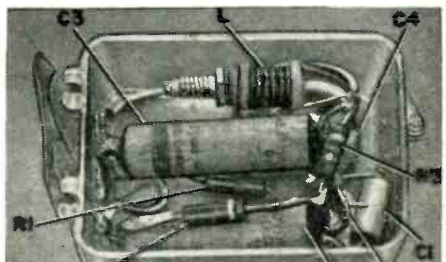
R1—2,700 ohms
R2—3,900 ohms
R3—39,000 ohms
All resistors ½ watt, 10%
C1—5 pf ceramic
C2, C3—.01 µf paper or ceramic
C4—3-30-pf trimmer
J1, J2—Snap terminals from discarded 9-volt transistor battery
L—5 t. No. 14 enamel closewound on ¼-in. slug-tuned form
Q—2N1177 (RCA)
Batt—9-volt transistor battery (Eveready 246, or equivalent)
Plastic box
Miscellaneous hardware

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.

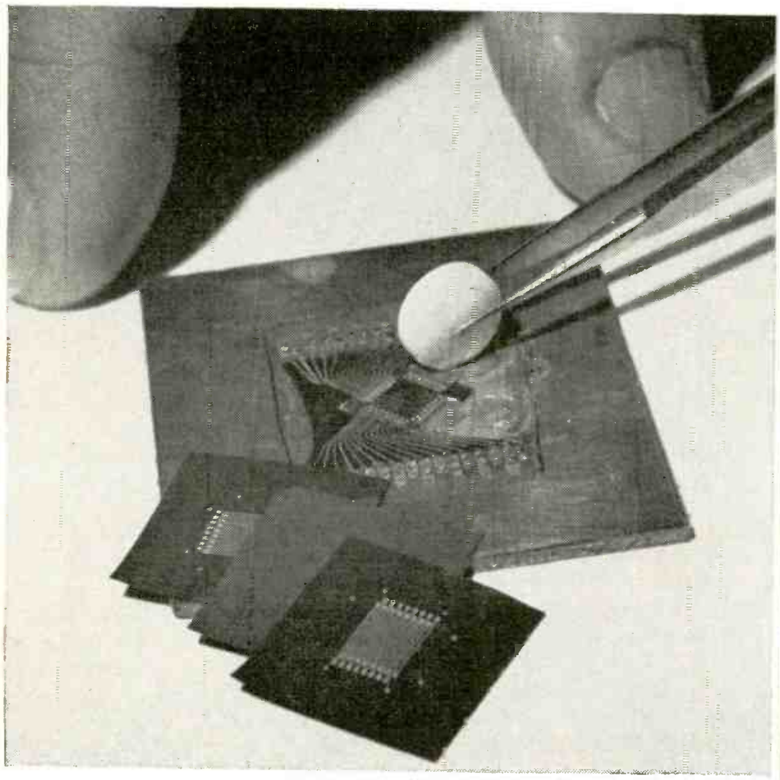
If the coil dimensions given are followed, the unit should work without using a grid-dip meter to check it out, but if one is available it can be very convenient. Use a socket for the transistor to guard against possible heat damage during construction. END



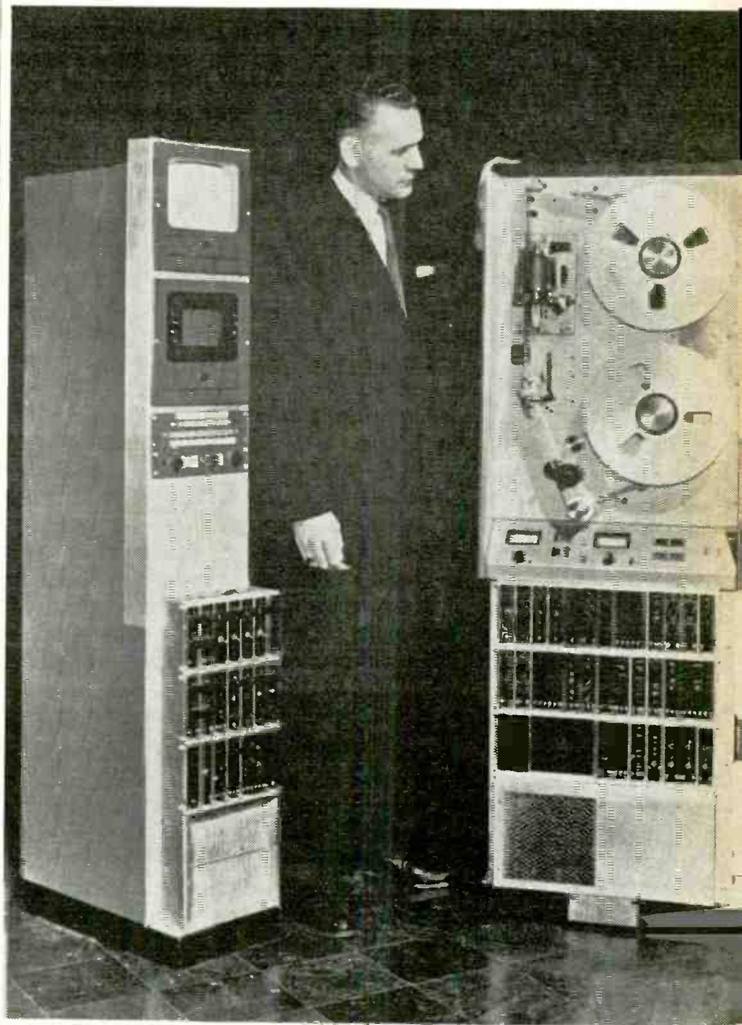
Completed oscillator shows snap terminals from old battery. 9-volt battery simply snaps onto the terminals. No switch needed.

What's New

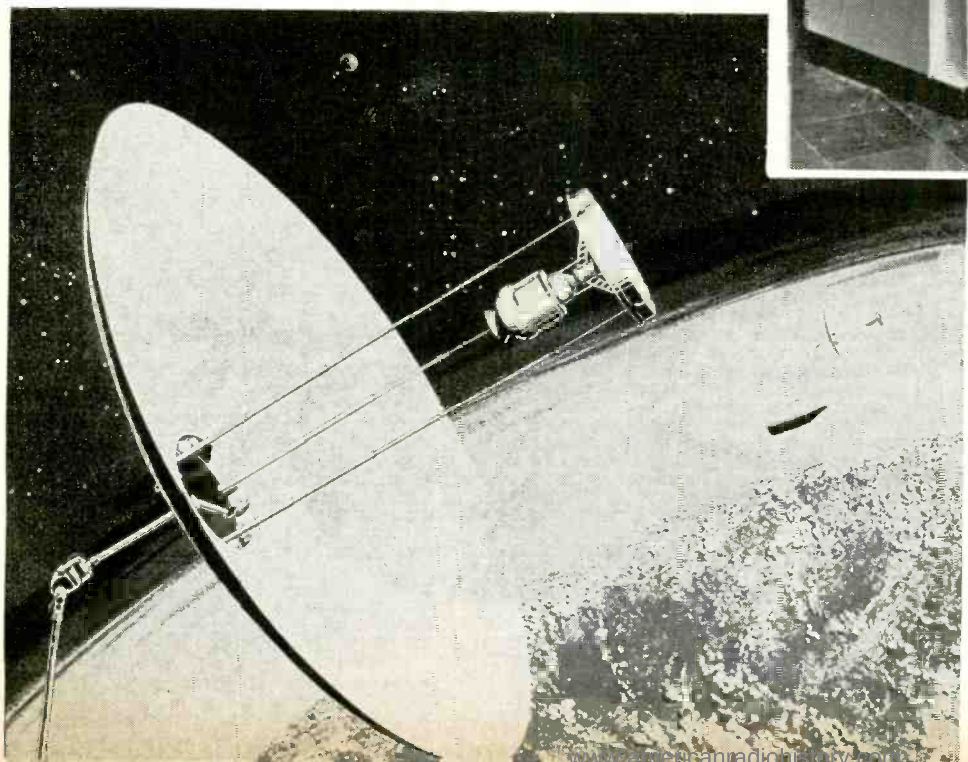
NEW COMPUTER MEMORY in which thin ferrite sheets are stacked, laminated and cured in a new process "borrowed by RCA from the plywood industry." Unfinished sheets are in the foreground; the complete memory, compared for size with an aspirin tablet, is in the rear.



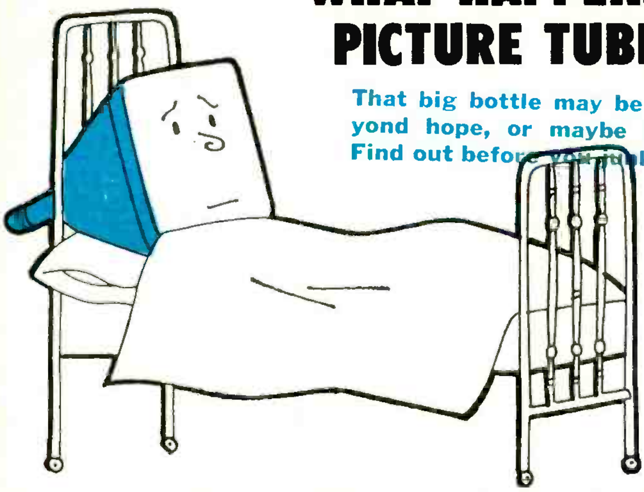
MOTHER HEART MACHINE, sleep-inducer for babies patterned after the device invented by Dr. Lee Salk, now marketed by a Japanese company. The battery-operated unit produces sounds resembling a mother's heartbeat, tranquilizing the infant.



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 junk it!

By JACK DARR
SERVICE EDITOR

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 it 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,

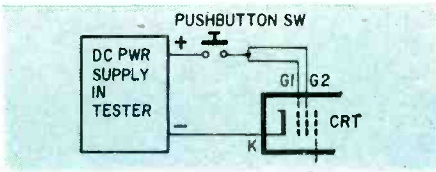


Fig. 2—Basic "rejuvenator" circuit. Pushbutton applies dc to "plate" (G1 and G2) of "diode", causing burst of current that pulls fresher cathode material to surface.

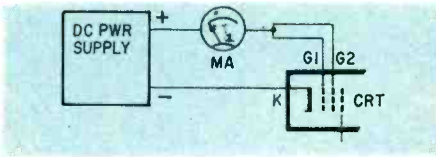


Fig. 3—CRT connected as diode for emission testing. Meter reads total current.

Fig. 1—The picture looks like this when the tube gets weak. But video trouble can also cause this kind of thing.

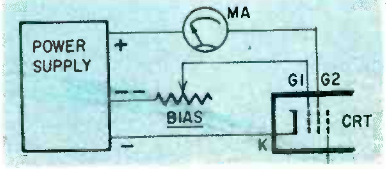


Fig. 4 — Triode connection for testing. Grid bias can be varied to find out where tube cuts off.

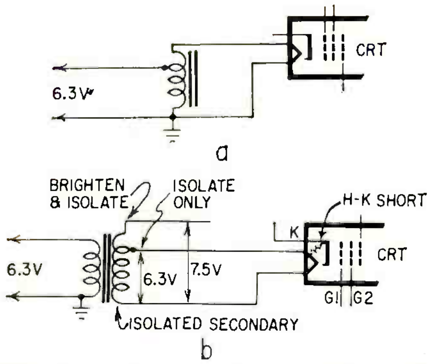


Fig. 5-a — Autotransformer brightener raises heater voltage, does not isolate circuit. In 5-b, a two-winding brightener, which can isolate heater from cathode circuit in case of internal short.

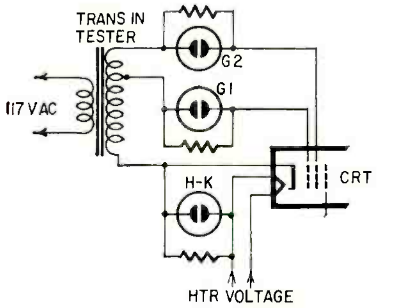


Fig. 6—Basic short-test circuit of CRT checker. Good element lights one side of neon lamp, shorted one lights both, and open element, neither side.

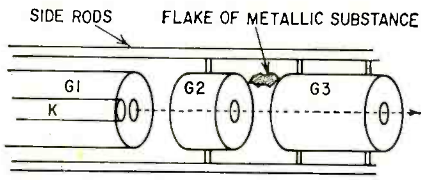


Fig. 7—Shorts between elements (except heater-to-cathode) usually result from flake of conductive material lodged between them.

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 to them that all it does is raise the heater voltage just a little—which is, of course, true.)

A brightener is a wee transformer; the primary goes to the original heater source, and the secondary has a stepup ratio to raise the voltage to about 15% above normal. Be sure to get the right type. Now, "if the base fits, the brightener fits." For early tubes, there are two types: "series" and "parallel," for heater strings of those types. The primary inductance of the transformer matches the characteristics of each type. Using a parallel brightener in a series circuit, for instance, actually *lowers* the CRT heater voltage!

There are two types. The cheapest is an autotransformer (Fig. 5-a). This raises the voltage, but there is no isolation.

If the tube has a heater–cathode short, you'll see a clean raster, and the brightness control will have no effect at all. The cathode will be grounded, removing the bias, so that the tube can't be cut off. To cure this, install a transformer type brightener (Fig. 5-b). This isolates the cathode short, by lifting the heater above ground. Never try to "blow" heater–cathode shorts; you're more likely to damage the heater and ruin the tube forever. The transformer brightener makes a complete cure at a very small cost.

Shorts testing

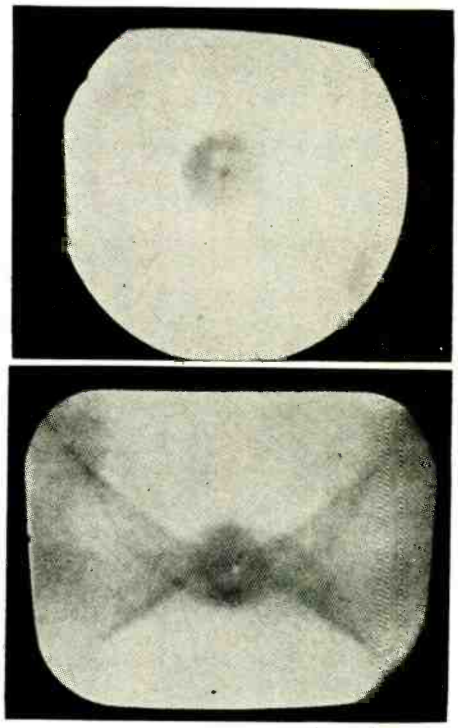
CRT testers have an ingenious circuit for testing shorts, which also gives an indication of continuity in each element. Fig. 6 shows the basic circuit. An ac voltage is applied to each element through small neon lamps, each shunted by a resistor. Each element of the tube becomes a "plate." If the element is connected, it will rectify the ac. So, one half of the neon lamp lights, showing that this element has continuity. If there is a short between any two elements, both will have ac on them, since they'll not rectify any longer! Then both halves of the corresponding neons light, showing which two elements are shorted.

This kind of short is usually due to flakes of conducting material lodged in the gun (Fig. 7). Place the set screen-down on a pad of some kind and jar the neck of the tube with the handle of a screwdriver—GENTLY!! In some cases, this will dislodge the flake, and it'll fall into the bell of the tube.

If this won't work, try applying dc between these two elements. (Never between heater and cathode!) You can connect to the dc power supply of another TV set or, easier, charge up an electrolytic capacitor of about 20–50 μf and discharge it between the two elements. One CRT tester uses this method to apply the rejuvenation voltage. A large capacitor is charged, then discharged by the pushbutton. This prevents excess rejuvenation.

Ion burns

One thing is incurable: an ion burn. Mostly found in the older tubes, it's caused by the ion-trap magnet (beam bender) being set wrong, allowing some of the heavier ions to go through and strike the phosphor screen. Because of their far greater mass, continued ion bombardment knocks off enough of the phosphor to cause a dim spot. In the round tubes, this looked like Fig. 8-a, a round spot in the center of the screen. In rectangular types, you usually see "the spider," a round spot with four fuzzy arms, as in Fig. 8-b.



General Electric

Fig. 8-a — Approximately round spot caused by ion-burn in round CRT. Fig. 8-b shows "spider" burn in rectangular tube.

If this shows up, there's nothing to do but replace the tube—this can't be cured. In some cheap "rebuilts," the gun is replaced (?) and the original phosphor used. If the tube was ion-burned, it'll *still* be ion-burned! The rebuilt tubes from the better factories replace the phosphor screen, using nothing but the glass bulb of the old tube. Aluminized phosphors will not have this trouble; the aluminum backing prevents the ions from reaching the phosphor.

Gassy CRT's

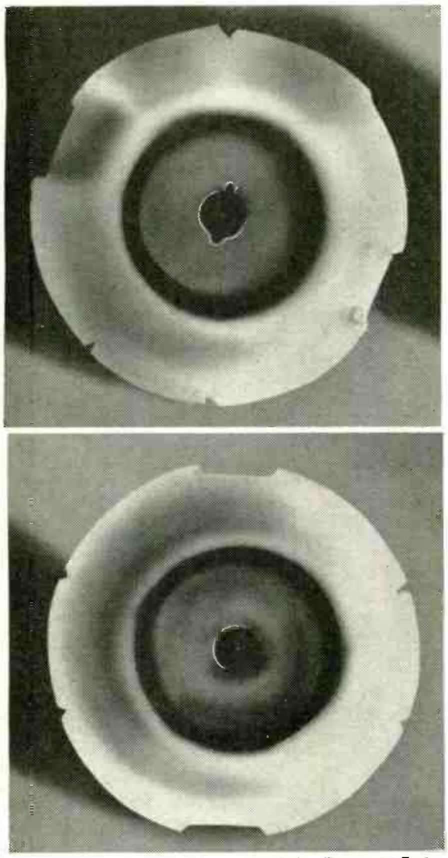
Once in a while, you'll find CRT's with gas, air leakage, etc. In some of these, you'll be able to see the electron beam as it goes through the gun, as a thin blue "pencil" of light! If the gas concentration is bad enough, you'll get an effect similar to that in Fig. 1—defocusing and loss of grid control.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



Allen B. DuMont Labs.

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 piece of fine bare wire, well tinned, inside the pin, while heating the pin and feeding fresh solder to the tip, is a good trick. Don't let it go more than ½ 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!* END

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 precision test instruments. A scope, audio vtvm 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.

DIRECTORY

Audio Devices, 444 Madison Ave., New York, N. Y.
Audio Fidelity Inc., 770 11th Ave., New York, N. Y.
Audiotex Mfg. Co., Div. G-C/Textron Inc., 400 S. Wyman St., Rockford, Ill.
CBS Labs., Professional Products Dept., 227 High Ridge Rd., Stamford, Conn.
Command Records, Div. Grand Award Record Co., 1501 Broadway, New York, N. Y.
Hi-Fi Stereo Review, Ziff-Davis Publishing Co., 1 Park Ave., New York, N. Y.
Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, N. Y.
Nortronics Co. Inc., 8101 10th Ave. No., Minneapolis, Minn.
RCA Victor Custom Record Sales, 155 E. 24th St., New York 10, N. Y.
Vanguard Recording Society, 154 W. 14th St., New York, N. Y.
Westminster Recording Co., Inc., 1501 Broadway, New York, N. Y.
Westrex Co., 1136 Los Palmos Ave., Hollywood, Calif.

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.

Ampex Reproduce Alignment Tapes

These tapes are recorded for specific operating speeds. The tone designated for alignment has a wavelength of ½ 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 31321-01 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, 10, 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 record 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.

Audio Alignment Tape

This 4-in. reel of Mylar tape, produced by Audio Devices, Inc., is used to align record and play heads at 15 and 7.5 ips. It consists of 30 seconds each of 2- and 10-kc tones, 60 seconds of 15 kc and then 30 seconds of 10 and 2 kc when played at 15 ips. (All frequencies are halved and times doubled when played at 7.5 ips.) All tones are separated by 5-second intervals.

This tape is recorded symmetrically so it can be run in either direction and rewinding is not necessary. (Alignment tapes should never be subjected to high-speed rewind. This can cause stretching, which may produce inaccuracies. The added stress on the tape also increases the likelihood of print-through.)

Connect a scope or vtvm to the recorder's output terminals, play the 2-kc band. Set the recorder's volume control for normal listening level and adjust the output indicator's sensitivity control for a convenient reference level. Adjust the recording azimuth for maximum output at 10 kc and then at 15 kc.

If the machine has a separate recording head, record a high-frequency signal on blank tape and then play it back through the already aligned reproducing head. Adjust the recording head azimuth for maximum output from the machine.

Audiotex 30-206 and 30-208

The 30-206 (Standard Tolerance for Home Equipment) and 30-208 (Precision Tape for Professional Use) tapes open with a 60-second, 7,500-cycle band for head alignment. The next is a 1-kc reference tone to set level. Next, we have an ascending series of 10 tones from 30 to 10,000 cycles for checking overall frequency response. The next band is a continuous sweep of 10,000 to 30 cycles to indicate any serious peaks or dips in the overall response of the system and to pinpoint any resonant peaks in the speaker system or listening area.

The next band is 100 cycles and 7,000 cycles mixed 4 to 1 for intermodulation tests. Any buzz or fuzz indicates severe IM distortion caused by weak amplifier tubes, dirty heads or other troubles. An IM distortion meter is recommended for accurate measurements.

A 20-second, 3-kc tone, recorded at −6-db level, is used as a test for wow and flutter. These defects in reproduction are generally caused by a defective motor, idlers, slippery or worn capstan or pulleys, and must be corrected.

A band of metronome clicks is used to balance the volume of the two channels so the sound appears to come from midway between the two speakers. The tape concludes with a few sustained piano chords as a final check for wow, flutter and overall distortion.

Nortronics AT-100

This is the only tape supplied without a detailed instruction sheet or booklet. Instructions are on the tape. The first band is a 30-second, 7,500-cycle tone for head alignment. This is followed by a 400-cycle tone to get reference level. A 1-kc band follows. The recorder's tone controls are adjusted so the output meter reads the same as at 400 cycles. Bands of 4,000, 1,000, 400, 100 and 40 cycles are supplied for response checks.

RCA Victor 12-5-61T Tape Recording

This is a 7.5-ips standard test tape. It is a two-track recording for testing half-track mono and two-track stereo machines. It has four parts: (1) A 1,000-cycle tone at normal recording level followed by the same tone 20 db lower as the reference level. (2) A 12,000-cycle tone for playback and alignment. (3) A rapid logarithmic sweep from 15,000 to 30 cycles with 17 announced spot frequencies for checking response and detecting dips and peaks in the overall response. (4) Frequency response run of spot frequencies from 15,000 to 30 cycles with voice announcements at 1-kc intervals from 15,000 to 1,000 cycles and at 700, 400, 300, 200, 100, 70, 50 and 30 cycles.

TEST RECORDS

Audio Fidelity FCS 50,000

This is a stereo test record with nine test bands on Side A and five orchestral demonstration selections on the other. The bands on Side A are: (1) Metronome for channel balance. (2) 1-kc tone on both channels as a reference level for subsequent tone tests. (3) 25 seconds of silence for checking for hum, turntable rumble and stylus wear. A worn stylus gives these grooves a grayish, dusty look. (4) Eleven spot frequencies between 1 and 15 kc recorded in phase in both channels at a constant velocity of 5 cm/sec. This band should be played back *flat* to give the correct impression of overall system response above 1 kc. (5) Nine frequencies between 1,000 and 30 cycles recorded with RIAA equalization and should be played back on an RIAA curve to check the low-end response of the system. (6) A 15 to 70-cycle sweep frequency to test for resonances in the pickup, arm and speaker system. (7) White-noise bursts to check speaker phasing. (8) 440-cycle Musician's A. (9 & 10) Mixed 800 and 3,000 cycles for checking channel separation, correct tracking force and cartridge alignment.

Audiotex 30-200

Side A for monophonic tests and Side B for stereo. Bands 1 and 6 of Side A are 8-kc tones which should reproduce with equal volume and clarity. Lower volume or fuzziness on the inner band indicates a worn stylus or defective or dirty cartridge. Band 2 is the RIAA frequency response test. Tones at 11 spot frequencies between 15,000 and 30 cycles are compared to the 1-kc reference level. Band 3 consists of 100 and 7,000 cycles for IM tests. Severe IM distortion can be detected by ear but an IM meter is recommended for this test. The rumble test (band 4) consists of a very low-level (40 db down) 1-kc signal. Rumble signal should not be higher than the level of the 1-kc tone on a high-quality turntable. Band 5 is a slow sweep from 50 to 10 cycles recorded at 100% modulation to test tracking. Arm resonances at some frequencies in this range will cause the stylus to skip or jump out of the groove.

On the stereo test side, Bands 1 and 3 are for pickup alignment and channel separation tests. They consist of a 1-kc tone recorded on one channel and nothing on the other. With a good, correctly aligned pickup, the outputs of the two channels should have a voltage ratio of about 10 to 1 (20 db). Bands 2 and 4 check RIAA response (up to 10 kc) of the right and left channels, respectively, and crosstalk in the unmodulated channel. The stereo balance test on Band 5 is the familiar metronome. Band 6 is the rumble test with a 1-kc signal on both channels.

CBS Labs test records

The **STR 100** (Stereophonic Frequency Test Record) was prepared specifically as an engineering tool of particular interest to the advanced audiophile and audio service technician. Several bands are provided for studying the effects of stylus force, mass, radius and wear on high-frequency response. Other bands are used to measure compliance and other factors important to the engineer. Several sweep-frequency bands have keying tones for synchronizing automatic recorders and oscillographs.

STR 111 (Square Wave, Tracking and Intermodulation Tests) is a precise engineering tool featuring square-wave modulation for rapid tests of high-frequency stylus-tip mass, damping and tracking of phonograph cartridges. Low-frequency compliance and tracking are tested by a series of 300-cycle bands of progressively increasing amplitude. IM distortion is tested in graduated 200- and 400-cycle bands.

STR 100 (Wide-Range Pickup Test—10 to 50,000 Cycles) is prepared for the audio scientist and pickup designer. It tests pickup response from 10 to 50,000 cycles; checks standard level, rumble; surface noise.

STR 130 (RIAA System Response Test) is a professional test record with various types of sweep-frequency and spot-frequency bands to facilitate response tests of phonograph reproducing systems.

Command CSC-100

This is a stereo test record consisting of nine test bands on one side and four musical selections on the other. The first three test bands are 1,000-cycle tones for channel balance, channel identification and reference level. The fourth band has 12 spot frequencies between 30 and 10,000 cycles for RIAA response tests. The remaining bands are for checking phasing, acoustic balance of the speakers and turntable rumble.

PR-14

This test record, made by Components Corp. for Lafayette Radio Electronics, has one side for stereo tests and one for monophonic tests using either a LP or stereo stylus. The stereo-test side has bands for channel identification, the familiar metronome balance test, speaker phasing using 100 cycles both in and out of phase and channel separation measurements. A band of sound effects is used to demonstrate fidelity and stereo spread.

Side B, for monophonic tests, has bands 1 and 7 to test stylus wear. Band 2 is a constant-velocity glide-tone band covering from 35,000 to 1,000 cycles with a "beep" at 5-kc intervals. This should be played back flat without equalization. On Band 3, spot frequencies are checked against a 1-kc reference level for RIAA equalization. Pickup tracking is tested on a glide band covering from 100 to 5 cycles with spaced grooves at 80, 60, 40, 30, 20, 15, 10 and 5 cycles. Bands 4 and 6 provide rigid tests for hum and rumble.

RCA test records

The **RCA 12-5-71,** a 12-inch, 78-rpm banded stereo test record covering from 20,000 to 1,000 cycles in 1-kc steps. Side 1 contains modulation only on the left channel and Side 2 is modulated only on the right. Channel separation is better than 30 db at all frequencies. Particularly useful in checking pickup response and separation between 1 and 20 kc.

The **RCA 12-5-73,** is a 12-in., 33⅓-rpm disc with bands at 30, 50, 70, 100, 200, 300, 400, 700 and 1,000 cycles in the right channel on one side and the same frequencies in the left channel on the other side. For checking system response, crosstalk and low-frequency resonances.

The **RCA 12-5-77 (RL1476)** is a 10-in., 33-⅓-rpm test record with the same material on both sides. It is used to adjust stereo phonograph systems for balance, level and phase. Band 1 is 1,000 cycles of about 3 minutes duration on the left channel. Band 2 is the same signal on the right channel. Band 3 is a 1-kc tone recorded laterally at 5.5 cm/sec peak velocity. It should produce equal in-phase signals from both channels. Band 4 is the same signal recorded vertically. It should indicate equal out-of-phase signals from both channels.

Vanguard VSD-100

This Stereolab Test Record provides nine separate tests for aligning, calibrating and balancing stereo phonographs. The first two tests consists of 14 spot frequencies recorded with RIAA equalization on the left channel and then on the right. The next test is for balance with a 1-kc, 0-db tone on the left and the right channel. The fifth test band consists of a 1-kc tone recorded first laterally and then vertically for checking pickup output. This test can be used to check cartridge and preamplifier phasing by paralleling the outputs and measuring the resulting signal with a vtvm. It should be very high on the lateral (in-phase) cut and very low on the vertical cut.

Next, the speakers are checked for acoustic balance so that the repetitive staccato sound appears to originate midway between them. The seventh test uses a 150-cycle tone to check speaker phasing. Speakers are placed face-to-face and just far enough apart for sound to escape. Three bursts of 150-cycle signal will be heard. If the first and third are lower than the second, the speakers are in phase. If the middle burst is lower, the speakers are out of phase and the leads to one should be reversed.

A 3-kc band is used for the flutter test. The next test is a 400-cycle signal recorded at plus 8, 6, 4 and 2 db and 0 level for checking distortion caused by excessive level and excessive tracking error. This is folowed by an unmodulated groove for checking signal-to-noise ratio. The disc concludes with two musical excerpts. The second side is a duplicate of the first and should be used only as a reference to check the first side for possible wear or damage.

Westminster SRX

This stereo test record begins with a 1-kc test and reference tone. Bands 2 and 3 are 100-cycle tones to check overall phasing. Band 2 should be louder. Improper phasing can be caused by incorrect connections to the cartridge or speaker. Bands 4, 5 and 6 are for checking RIAA response of left, right and both channels, respectively.

Band 7 is a unique test to check frequency response by ear. It has test tones recorded at levels to complement the Fletcher-Munson hearing curve so that all should be reproduced at approximately the same level.

Wow and flutter are tested with a 3-kc signal on Band 8. Band 9 is the musical equivalent of Band 7 with the test tones ranging from 29.1 cycles from a contrabassoon to 4,184 cycles from a piccolo. The tones are recorded at levels that will play back at approximately equal volume levels.

The second side of this disc uses musical instruments as sound sources to indicate frequencies, provide transients, to illustrate dynamic range and to check stereo separation and tracking.

Westrex Stereodisk 1-A

This 45°–45° frequency test record covers most of the tests provided by the RCA 12-5-71 and 12-5-73. It is recorded in two frequency bands at constant velocity. Band 1 covers from 1 to 15 kc in 1-kc steps. When played at 78.26 rpm, stylus displacement from left and right channels has a peak constant velocity of 5.0 cm/sec ±1 db. Band 2 has spot frequencies at 1 kc, 700, 400, 200, 100, 50 and 30 cycles. When played at 33⅓ rpm, peak stylus velocity is 0.43 cm/sec ±0.5 db. Since it is recorded at constant velocity, it can be used to measure overall response of the reproducing system directly. When played without RIAA equalization, the response will be flat except for variations in the gain of the reproducing system.

Hi-Fi Stereo Review Model 211

This record is unique in that it uses warble tones instead of spot frequencies and sweeps for most tests. A warble tone that sweeps continuously from 80 to 160 cycles is used for speaker phasing. Frequency response runs on the right and left channels consist of 18 warble tones sweeping between 14,700 and 20,000 cycles on the high end and 20 to 40 cycles on the low end. Each test warble is identified by voice announcement and is preceded by a 920–1,300-cycle test warble for comparison.

Cartridge tracking at low frequencies is checked by a 300-cycle note that repeatedly swings to a high volume level and then back down again. Tracking force should be adjusted so this band plays without buzzing. For the high-frequency tracking test, 11,000 and 11,500 cycles are recorded simultaneously in a series of volume sweeps. The 500-cycle difference frequency should be almost inaudible or very short and steady. If it is loud, long and rough, increase stylus pressure.

Additional tracking tests are provided by short musical passages repeated at successively higher levels. Buzzing or shattering highs indicate incorrect stylus pressure.

Separation is checked with warble tones similar to those used in the response runs. END

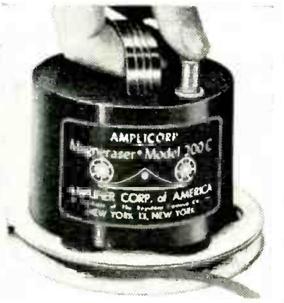
Tape and Disc Accessories

. . . 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 200C features a 750-gauss erasing field with low power consumption. Handles ¼-in and ½-in tape and 16- and 35-mm magnetic sound film on any reel from 5 to 15 in. Lowers 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. 2½ in. high; 4-in. diameter. 3½ lb. Push-button safety switch and 8-ft line cord.—**Amplifier Corp.**

Magneraser Senior. Professional model for audio, computer, telemeter and machine-control tapes to 35 mm. Handles reels up to 10½ in. without shifting. Erases all tapes better than 65 db below standard reference level. Also demagnetizes tools, watches, tape guide posts, capstans, and magnetic sheet metal. Field intensity 800 gauss. Draws 175 watts from 50–60 cycle line. *Model 300A*, 100–130 volts *Model 300B*, 200–240 volts. 3¾ in. high, 7-in. diameter, 10 lb.—**Amplifier Corp.**

Magneraser Junior, model 150A concentrates maximum vertical erasing flux in tape up to 35 mm with a minimum of horizontal leakage flux. Also demagnetizes heads, guides, tools and metal. Field intensity 750 gauss. 110–130 volts, 105 watts. 4⅜ x 4⅜ x 2½ in., 4 lb.—**Amplifier Corp.**

Taperaser (Cat. No. 30-114) combines advantages of powerful professional models with compactness of popular models. Magnetic field concentrated in relatively small area. Movable spindle slides tape reel across the field. Handles tape reels up to 10½ in. and erases to minus 52-db level without low-frequency thumps or "spokes." Has 6-ft line cord and momentary on–off switch.—**Audiotex**

Model ML-120, a professional instrument featuring two separate coils for complete erasure of tapes up to 1 in. on reels up to 10½ in. Reduces tape hiss to level of new virgin tape. Has heavy-duty line cord and switch, pilot light and fuse. 105–125 volts, 60 cycles, 9 amps. 6¼ x 7⅞ x 3½ in. 14 lb.—**Lafayette**

ML-176, similar to ML-120 for tapes up to ¼ in. Reel must be turned over once. Has spindle positions for 3-, 5-, 7- and 10½-in. reels. 105–125 volts, 60 cycles, 5 amps. 7½ x 4¾ x 3½ in. 9 lb.—**Lafayette**

No. 55-03 accommodates any size reel up to 10 in. and completely erases entire reel in seconds. Reduces background level far below that of normal tape recorder erase heads.—**Roberts**

Model ME-99 removes recorded and unwanted signals and reduces background noise 3 to 6 db below normal erase-head level. Demagnetizes tapes up to ½ in. wide on reels up to 10½ in. 110–120 volts, 6 amps, 50–60 cycles. 3¾ x 5¼ x 6¾ in.—**Robins**

Model ME-77, low-cost version of the ME-99. For ¼-in. tapes on reels up to 7 in. Reduces background noise 2 to 4 db below erase-head level. 110–120 volts, 50–60 cycles. 2⅜ x 3¾ x 6¼ in. **Robins**

Tape-Head Demagnetizers

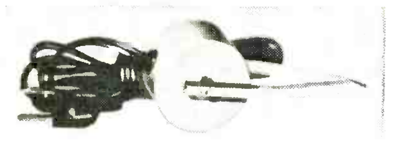
High-level peaks in the recording signal and transients produced by noise on the power line and by stopping and starting the machine tend to magnetize the recording, playback and erase heads in the recorder. This may increase the noise level 5 to 10 db, distort the signal and gradually erase the high 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 ac 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 PK-238*, has removable straight, 45° and 90° pole pieces for quick and easy use 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.

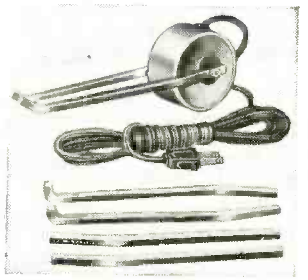
To use the head demagnetizer, plug it into the line or close the switch, straddle the pole pieces across the gap in the recording head and run it up and down several times for a few seconds. Then gradually withdraw the unit from the head before turning it off. Repeat the operation on the play and erase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

Model 820 features flat contoured pole pieces.—**Ampex**

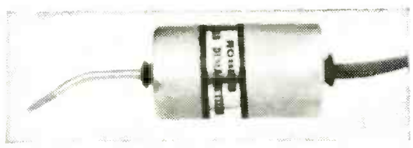


Type 400 head demagnetizer has beveled tips to simplify operation.—**Audio Devices**

Head-Demag (Cat. No. 30-112) has built-in momentary switch.—**Audiotex**



PK-238 shown with three sets of pole pieces. Manufacturer's model *MS-694* (not shown) is similar in appearance to the model 820.—**Lafayette**



HD-3, economy version of the manufacturer's UL

DIRECTORY

- **AR**—Acoustic Research, Inc., 24 Thorndike St., Cambridge 41, Mass.
- **Ampex**—Ampex Corp., 934 Charter St., Redwood City, Calif.
- **Amplifier Corp.**—Amplifier Corp. of America, 398 Broadway, Newk York 13, N. Y.
- **Audio Devices**—Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.
- **Audiotex**—Audiotex Co., Div. of GC-Textron Electronics, 400 W. Wyman St., Rockford, Ill.
- **Elpa**—Elpa Marketing Industries, Inc., New Hyde Park, N. Y.
- **Ferro**—Ferrodynamics Corp., Lodi, N. J.
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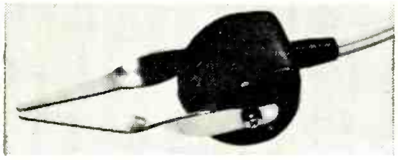
- **Lektrostat**—Dexter Chemical Corp., 819 Edgewater Rd., New York 59, N. Y.
- **Roberts**—Roberts Electronics, Inc., 5978 Bowcroft St., Los Angeles 16, Calif.
- **Robins**—Robins Industries Corp., 15-58 127th St., Flushing 56, N. Y.
- **Walco**—Walco Electronics Co., Junction Routes 3 & 46, Clifton, N. J.
- **3M**—3M Co., 2501 Hudson Rd., St. Paul 19, Minn.

approved *HD-6*. For less-often-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**

Klenzatape kit. Reel of rubber-backed tape with extrasoft brush velvet face and a bottle of fluid to remove dirt and oxide deposits. Harmless to plastic, rubber or metal parts.—**Elpa**

RT-378. Tape impregnated with special cleaner. Can be reused many times. 100 ft. on 5-in. reel.—**Lafayette**

Tape Clean, 5-in. reel of chemically treated cloth tape cleans heads and guides and deposits layer of silicone lubricant to reduce friction.—**Robins**

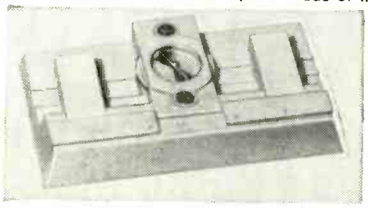
Tape Recorder Head Cleaner (Cat. No. 30-124-1) A balanced formula of safe solvents to remove grease and dirt. For best results, use with *Tape Recorder Head Lubricant (Cat. No. 30-124-2)*, a silicone in a solvent base, to lubricate heads and guides to eliminate tape squeal and reduce wow and flutter. *Tape Cleaning Cloth (Cat. No. 30-026)* works two ways. Applies an antistatic agent to tape to repel dust and dirt and a thin coating of silicone lubricant to reduce abrasive friction.—**Audiotex**

JCT-2 Jockey Cloth for Tapes, HC-2 Head Cleaner, RC-2-22 Head and Guide Lubricant, RC-2-23 Tape and Phone Drive Oil, RC-2-56 Non-Slip for Tape and Phono Drives—**Robins**

Tape Splicers

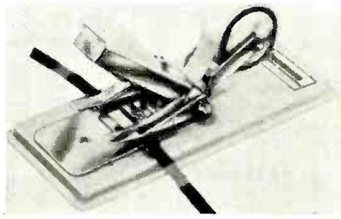
Model 805 splicer designed for precise requirements of splicing 4-track tape. Protects program material on tape. Has splicing tape dispenser and two cutting positions.—**Ampex**

Metro-Splicer splices either standard magnetic recording tape or 8-mm movie film. Features interchangeable channels calibrated in inches and millimeters. Nonmagnetic blade cuts at any angle. Transparent unit shows exactly where cut is made. Splicer made of high-



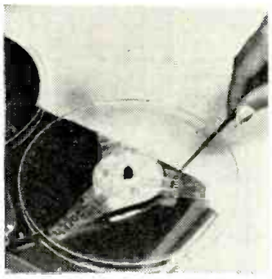
tensile nylon and is entirely nonmagnetic. Comes with replacement cutter unit.—**Elpa**

Standard Stereo 4-Tape Splicer, TS-4S, made of metal and plastic with replaceable cutter cartridge and blades. Has blade centering adjustment and integral



tape dispenser with 100-ft. roll of splicing tape. *TS-4J*, similar to the *TS-4S* without integral tape dispenser. *TS-8D* has features of and is similar in appearance to the *model 805*.—**Robins**

Self-Threading Tape Reel



The clumsy hard-to-thread slots and grooves have been eliminated from the new self-threading tape reel shown. You simply hold the end of the tape against the hub and start the machine. Tape end is automatically anchored by pressure of three tiny spring clips.—**3M**

Tape Care Kits

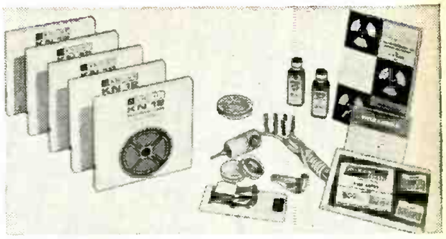
Home Recorder Accessory Kit model 895 includes model 820 head demagnetizer, splicing and leader tapes, 4-oz. can of No. 823 head cleaner, model 805 tape splicer and box of swabs. *Professional Accessory Kit model 894* includes can of No. 823 head cleaner, model 820 head demagnetizer, bottle of lubricating oil and box of swabs.—**Ampex**

Maintenance and Service Kit (Cat. No. 30-099) for language labs and professional users. Contains tape and record labels, splicing and leader tapes, tape strobe, bottle of head cleaner, bottle of head lubricant, roll of Kleen-Tape, head demagnetizer, splicer, hi-fi service tool kit and handy carrying case.—**Audiotex**

TK-7 7-in. tape kit contains two 3-in. reels, two 3¼-in. reels, two 5-in. reels, two 7-in. reels, two reels of 1200-A tape, splicer, splicing tape, two leader tapes, one strobe tape, six tape clips, marking

pencil, book "How to Make Better Tape Recordings" and an attractive carrying case. Kit *TK-3* has three 3-in. reels, two 3¼-in. reels, one 3-in. reel of tape, one 3¼-in. reel of tape, splicer, splicing tape, two leader tapes, strobe tape, six tape clips, marking pencil, recording booklet and carrying case.—**Ferro**

Professional kit (Cat. No. 79 RX 898D) for serious recordists (illus). Consists of five 7-in. reels of 1½-mil Mylar tape, head demagnetizer, tape cleaning cloth, 150 ft. of leader tape, tape splicer, tape threader, 2-oz. bottle of head cleaner, 30 adhesive tape labels, 12 tape clips and 24-page book on splicing and editing tape. *Low-Cost Kit (Cat. No. 79 RX 893D)* contains such recording essentials as three 7-in. reels of 1½-mil Mylar, 150 ft. of leader tape, splicer, threader, head cleaner, labels, clips and book on splicing and editing. *Cat. No. 79 RU 896D*, kit for battery recorders, has three 3-in. reels of ½-mil tape, one empty reel, splicer,



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

Gibson Girl Stereo 4 kits. *AVK-1* for professionals, language labs, visual-aid departments, broadcast and audio studios. Contains manufacturer's MD-99 bulk eraser, HD-6 head demagnetizer, TS-8D splicer, TC-12 tape clips, SL-30 reel labels, JCT-2 tape cleaning cloth, six rolls of ST-500 splicing tape, TT-1 tape threader, TK-5 strobe and light, TK-6 head and guide lubricant and cleaner. TK-4STD is the standard accessory kit containing TS-4J 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**

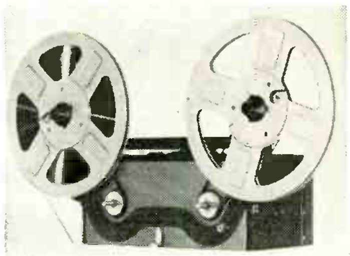
Magnetic-Tape Viewer

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**

Tape-Reel Adapter

No. 54-86 mounts on manufacturer's 997, 990A, 990S and 192 recorders so they handle 10½-in. reels.



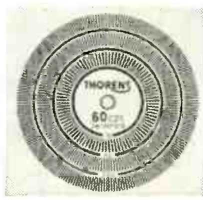
Increases total playing time up to 12 hours per reel. Up to 3 hours of stereo record or playback without changing reels. Makes recorders ideal as background music sources.—**Roberts**

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. Hold up to 125 12-in. LP's, 150 45's or 30 tapes. Several cabinet styles and finishes.—**Kersting**

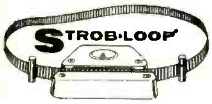
Phono and Tape Strobes

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.



Cardboard types like the **Robins** *SD-4* are most common. Strobes are also available in metal **(Thorens-Elpa,** illus.) and plastic (**Audiotex** *30-230*).

Tape Strobe 30-234 is driven directly by the tape. When viewed under neon or fluorescent light, the strobe disc appears motionless at the indicated speed. Checks 3¾- and 7½-ips speeds.—**Audiotex**



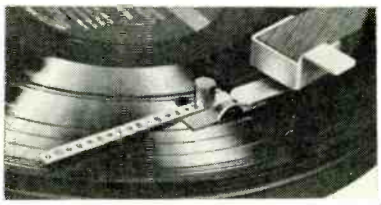
Strob-Loop (Cat. No. RT-380), a continuous loop of 1½-mil Mylar tape checks speed, timing, wow and flutter at 7½ ips. Accurate to .001%. No need to thread on reels. Just drape across heads as shown, operate machine and view tape under neon or fluorescent light.—**Lafayette**

Strobe and Light Kit TK-5 contains neon lamp on 6-ft oc cord and five 24-in. strobe tapes. Splice one strip into continuous loop to test capstan drive. Splice strips into beginning, middle and end of full reel of tape to check machine speed under varying loads. *ESK-5* consists of a strobascopic disc and neon lamp for checking phono turntable or changer speeds.—**Robins**

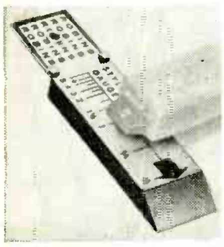
Stylus Pressure Gages

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 calibrated weight on the other.

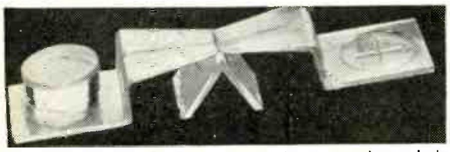
The **Walco** *Microgram* (illus) and **Audiotex** *(Cat. No. 30-222)* have a single weight that is moved to



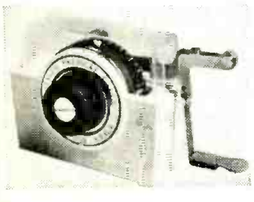
calibrated positions on the beam to measure stylus pressure. These are calibrated from 1 to 10 grams.



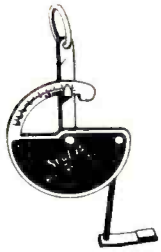
To use the **Robins** SG-2, we move the stylus to calibrated positions along the beam to balance it against a fixed weight on the other end. Measures ½ to 8 grams.



The **AR** *Needle Force Gauge* is an equal-arm balance with weights to ¼ gram.

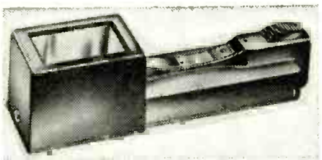


The **Garrard SPG3** features a large legible scale with easy-to-read ½-gram markings. A 5-gram standard weight is supplied to check and set accuracy.



The **Audiotex** *(Cat. No. 30-220)*, **Lafayette** *PK-223* (illus) and **Weathers** *P-675* are similar in appearance and operation. A platform slips under the end of the pickup arm and measures the force needed to lift the arm off the record.

Stylus Microscopes

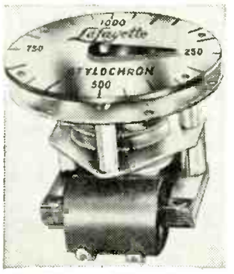


Stylograph PK-634 for inspecting stylus tips for wear, chipping and other damage. Shows large illuminated silhouette of stylus tip on 1 x 1½-in. ground-glass screen. Stylus need not be removed from cartridge or pickup arm. Complete with batteries, on–off switch and bulb. 5¾ x 1⅝ x 1⅝ in. *PK-237* pocket-type inspection scope with 50X magnification. Similar in appearance to Robins MX-1 below.—**Lafayette**

Model MX-1 (bottom) features precision-ground lenses and knurled focusing adjustment for clear mag-

nification. Slot holds stylus assembly steady. Pen-type pocket clip. ½-in. diameter, 3¾ in. long. *MX-40 Hobbyist* is an inexpensive unit. Direct reading with clear plastic lens.—**Robins**

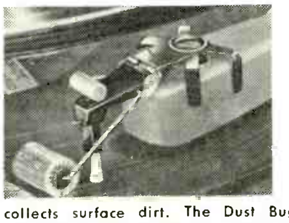
Stylus-Wear Timer



Stylochron 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 2⅜-in. 1,000-hour dial is marked in 50-hour units. Mounts on motor board or any convenient spot. Extends 1⅞ in. below or behind panel. —**Lafayette**

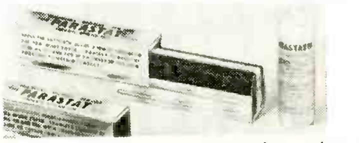
Record Cleaners and Record-Care Kits

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

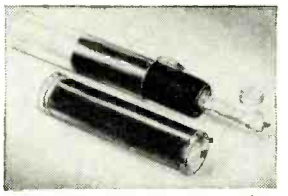


The *Watts Dust Bug* and *Changer Dust Bug* (illus) consist of a tiny nylon brush that dislodges dirt before it reaches the stylus and a plush roller that applies the antistatic cleaner and collects surface dirt. The Dust Bug is on a pivoted arm with positions for 12- and 16-in. records. A suction cup 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.

Parastat MK 11A is a manual adaptation of the Dust Bug. Nylon bristles and detergent reach deep into

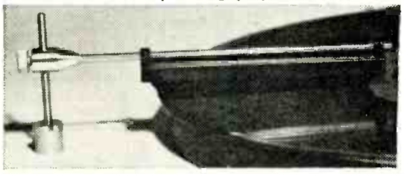


record grooves, removing accumulated dust, grime and residue. Improves reproduction of old records and sustains the hi-fi reproduction of new ones.



Preener, designed especially for new records, has long plush-pile cylinder with electrostatic cleaner in center wick. Removes dust and dirt and applies antistatic compound to record without leaving film.—**Elpa**

Dustat velvet-surface brush on a swivel cleans entire record continuously during playback. Pivot mounts



in suction cup or ¼-in. hole drilled approximately 7 in. from center of turntable.—**Grado**

Lektrostat Record Cleaning Kit consists of a 1¼-oz squeeze bottle of antistatic detergent and an applicator of sheared acetate velvet fibers in a convenient plastic envelope. Cleans records, reduces pops and crackles from static electricity.—**Lektrostat**

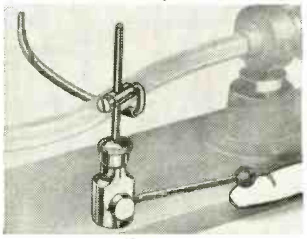
Disk-Whisk Kit (similar in operation to Changer Dust Bug) consists of lightweight nylon brush, mohair cylinder and a bottle of antistatic fluid containing silicone lubricant and detergent. *Rob-O-Stat* is a record-cleaning kit consisting of a velvet and foam applicator mitt, 1½-oz bottle of antistatic detergent and lubricant and a polyfoam pad for removing dust from the mitt.—**Robins**

Phono Accessory and Care Kit (Cat. No. 30-098) consists of a record brush, antistatic detergent and velvet pad applicator, package of 12 plastic record envelopes, pickup arm lift, stylus microscope, stylus pressure gauge, strobe disc and a vial of special phonograph and recorder oil.—**Audiotex**

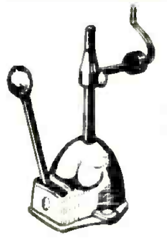
Deluxe Record Care Kit, ESK-3 helps you to bring out the best from your stereo or monophonic phonograph. Consists of stylus gauge, stylus microscope, turntable level, record cleaning cloth, needle brush, record brush and pickup arm lift.—**Robins**

Pickup-Arm Controls

Remote controls for phonograph pickup 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.



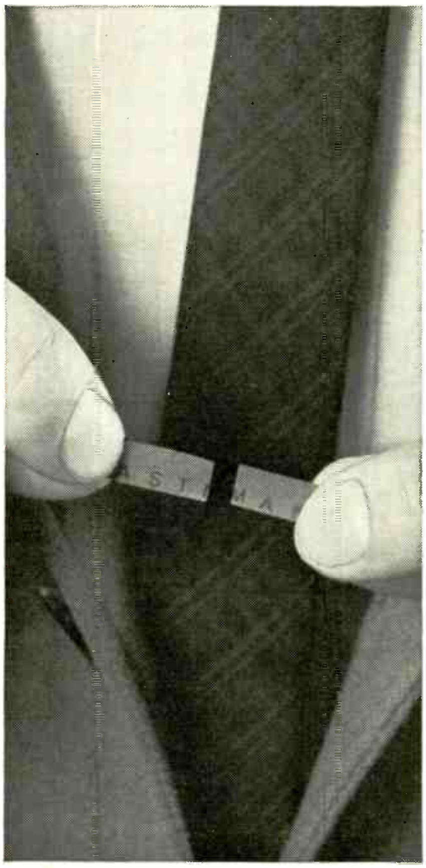
Ortofon Hi-Jack features air-cushioned lowering. Mounts on Thorens TD-124 and TD-121 turntables without drilling.—**Elpa**



MS-785 has adhesive mounting base to keep it in position and is supplied with both wood and metal mounting screws for permanent installations.—**Lafayette**

END

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.

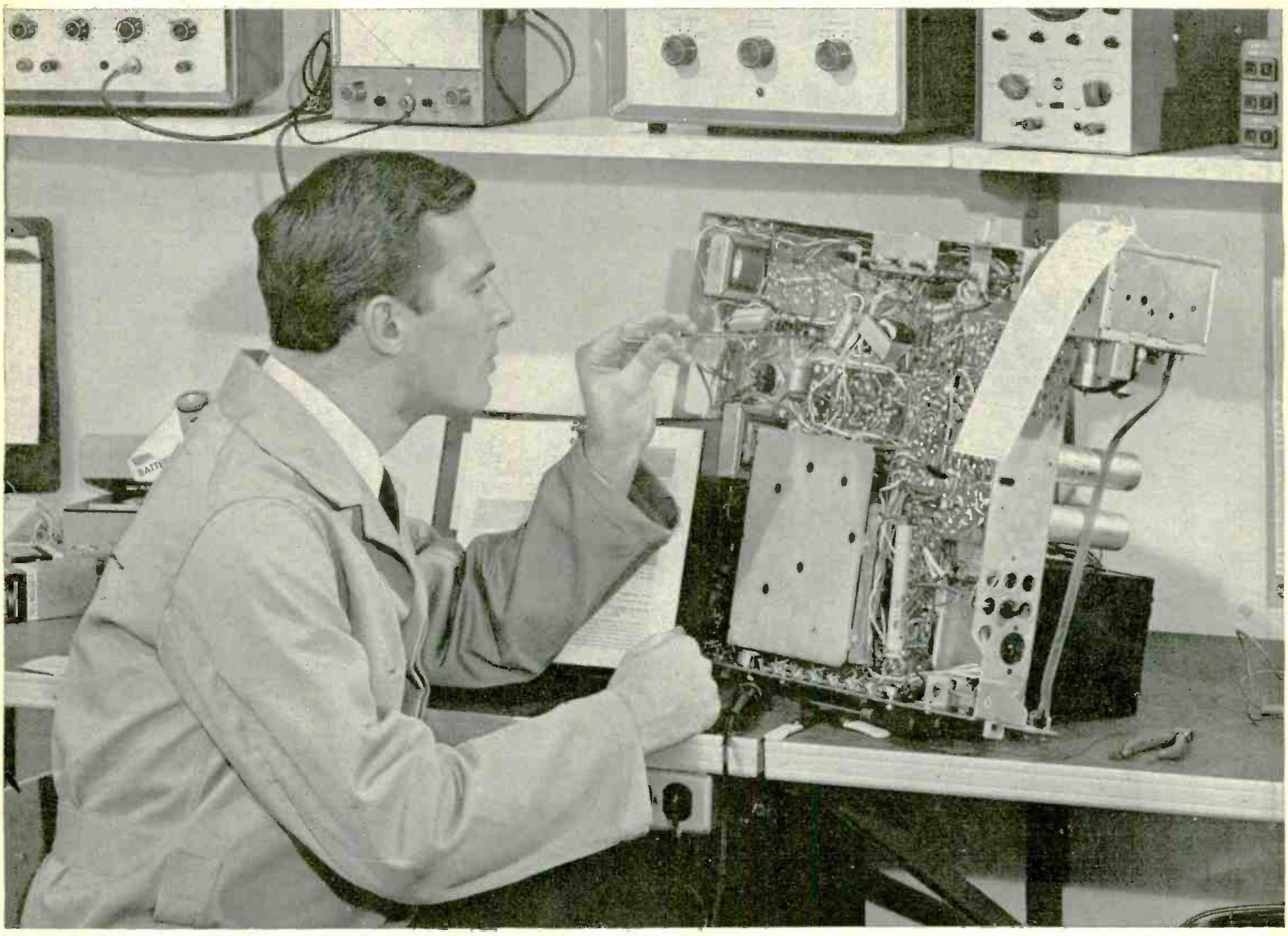
The superb magnetic properties of the new binder make possible the development of two superlative sound-recording tapes.

Ask for the new Eastman tapes at **leading electronic supply houses:** Eastman tape, Type A303 (low-print) or Type A304 (high output with low noise).

Unique Thread-Easy Reel allows fast, easy loading, has indexing scales and splicing jigs on both sides.

EASTMAN KODAK COMPANY, Rochester, N.Y.

Kodak
TRADE MARK



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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 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.

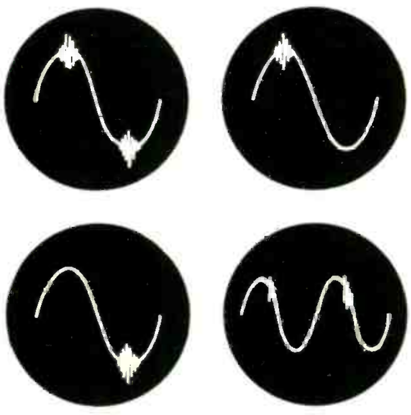


Fig. 1—A few examples of parasitic oscillation kicked off by high-amplitude signal. "Fuzz" may be on either peak or both, or neither.

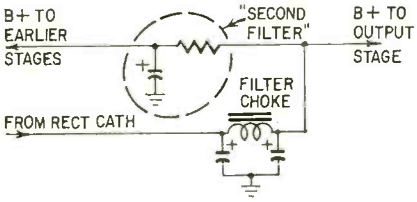


Fig. 2 — "Second filter" or decoupling network can improve stability in high-gain amplifiers. Sometimes, shunting existing electrolytics with a .05-μf paper or ceramic capacitor helps.

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–.001 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.

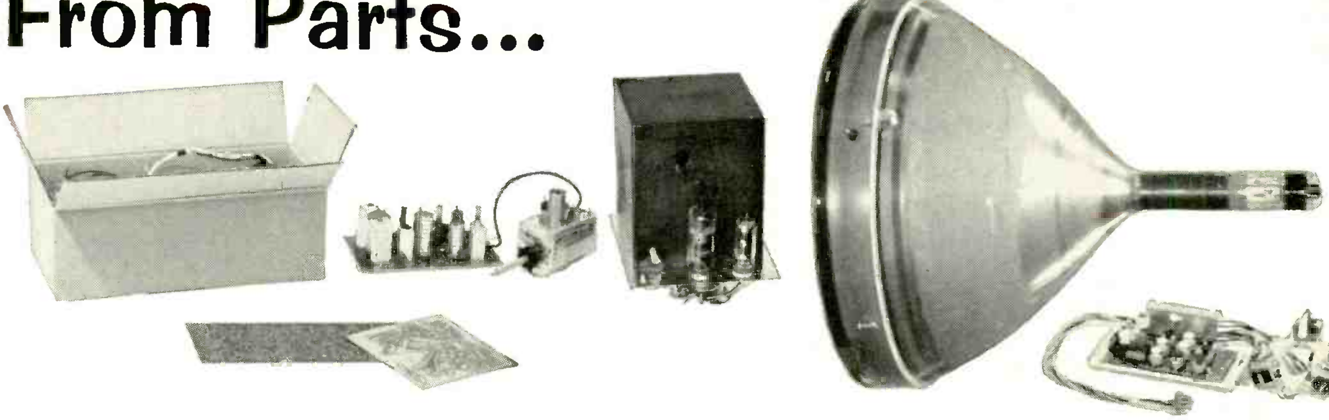
For other methods, see "Test Tape Checks Recorder Speed" and tape strobes listed in the "Tape and Disc Accessories" directory on pages 100 and 49, respectively of this issue.

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.

From Parts...



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Kit GR-53, chassis and tubes, 118 lbs. $349.00
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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.

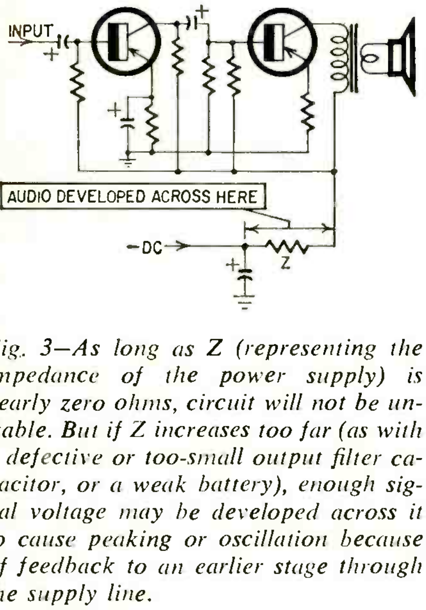

Fig. 3—As long as Z (representing the impedance of the power supply) is nearly zero ohms, circuit will not be unstable. But if Z increases too far (as with a defective or too-small output filter capacitor, or a weak battery), enough signal voltage may be developed across it to cause peaking or oscillation because of feedback to an earlier stage through the supply line.

The dual-battery power supply shown in the original circuit was used mainly for that reason, I suspect. Perhaps if you used two separate ac supplies, you'd cure the trouble.

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!

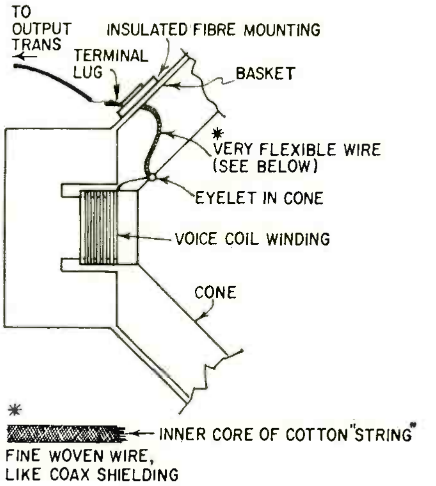

Fig. 4—Detail of woven-wire connection between terminal board and voice coil. Break in electrically conductive outer braid may be invisible, because of support from inner cloth core.

Quick-check: hook an ohmmeter across terminals, and move the flexible leads with a pencil or soldering-aid tool. *Repair:* take the leads from a discarded speaker. *Definite test:* using sharp-pointed test prods, check the voice coil at the two "dots" on the cone. These are the terminals of the voice coil itself, and you can measure from them to the terminals on the basket.

Hot transistors at high frequencies

I have built the transistor amplifier described in the May 1963 issue. However, I've run into some problems. When I test with a sine-wave signal, the output transistors get very hot. They run cool at 1 kc, but heat up if I put a 10–12-kc signal in at the same level! The response drops off quite sharply at this end. What's the matter?—W. B. M., Toronto, Ont.

This is due to a little-known characteristic of most germanium-alloy power transistors. They tend to run away during prolonged high-level, high-frequency tests! The loss (dissipation) in the transistors increases rapidly with frequency, so the junctions heat. In normal use (music, etc.), the high-frequency peaks are short. Also, the impedance of the speaker increases with frequency and tends to hold down the output. If you're testing into a noninductive load, such as a resistor, you won't have this, and the high-frequency dissipation may rise to such a point that you damage the transistors.

Cure: add a bit more feedback at the high end of the range. By increasing the high-frequency inverse feedback, you cut the high-end response and hold down the losses in the power transistors. This can be done in any of several ways, like using a larger capacitor for C19 (.001–.005 μf) across the main feedback resistor. Or try a high-frequency rolloff network at Q4.

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. END

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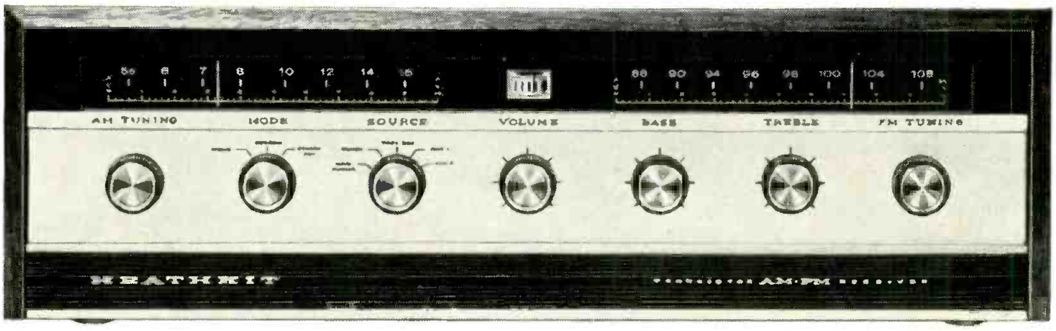

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Many advanced features have been incorporated to make possible the advanced performance of the AR-13. You'll like the way this unit *automatically* switches to stereo, and the stereo indicator light silently verifies that stereo is being received. For all-around versatility there are three stereo inputs (mag. phono and two auxiliary) plus two filtered tape recorder outputs for direct "off-the-air" beat-free recordings. Dual-tandem controls provide the convenience of simultaneous adjustment of volume, bass, and treble of both channels. Balancing of both channels is accomplished by a separate control. The AM tuner features a high-gain RF stage.

Other quality features include an FM local-distance switch to prevent overloading in strong signal areas; a squelch control to eliminate between-station noise; AFC for drift-free reception; heavy die-cast flywheel for accurate, effortless tuning; pin-point tuning meter; and external antenna terminals for long-distance reception. For added convenience the secondary controls are "out-of-the-way" under the hinged lower front panel to prevent accidental system changes. The slide-rule AM and FM dial is fully lighted.

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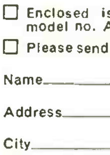
SPECIFICATIONS — Amplifier: Power output per channel (Heath Rating): 20 watts /8 ohm load, 13.5 watts /16 ohm load, 9 watts /4 ohm load. (IHFM Music Power Rating): 33 watts /8 ohm load, 18 watts /16 ohm load, 16 watts /4 ohm load @ 0.7% THD, 1 KC. **Power response:** ± 1 db from 15 cps to 30 KC @ rated output; ± 3 db from 10 cps to 60 KC @ rated output. **Harmonic distortion** (at rated output): Less than 1% @ 20 cps; less than 0.3% @ 1 KC; less than 1% @ 20 KC. **Intermodulation distortion** (at rated output): Less than 1%, 60 & 6,000 cps signal mixed 4:1. **Hum & noise:** Mag. phono, 50 db below rated output; Aux. inputs, 65 db below rated output. **Channel separation:** 40 db @ 20 KC, 60 db @ 1 KC, 40 db @ 20 cps. **Input sensitivity** (for 20 watts output per channel, 8 ohm load): Mag. phono, 6 MV; Aux. 1, .25 v; Aux. 2, .25 v. **Input impedance:** Mag. phono, 35 K ohm; Aux. 1, 100 K ohm; Aux. 2, 100 K ohm. **Outputs:** 4, 8, & 16 ohm and low impedance tape recorder outputs. **Controls:** 5-position Selector; 3-position Mode; Dual Tandem Volume; Bass & Treble Controls; Balance Control; Phase Switch; Input Level Controls (all inputs except Aux. 2); Push-Pull ON/OFF Switch. **FM: Tuning range:** 88 mc to 108 mc. **IF Frequency:** 10.7 mc. **Antenna:** 300 ohm balanced (internal for local reception.) **Quieting sensitivity:** 2½ uv for 20 db of quieting, 3½ uv for 30 db of quieting. **Bandwidth:** 250 KC @ 6 db down (full quieting.) **Image rejection:** 30 db. **IF Rejection:** 70 db. **AM Suppression:** 33 db. **Harmonic distortion:** Less than 1%. **Multiplex: Bandpass:** ± ¼ db, 50 to 53,000 cps. **Channel separation:** 30 db, 50 to 2,000 cps; 25 db @ 10 KC. **19 KC Suppression:** 50 db down, from output @ 1 KC. **38 KC Suppression:** 45 db down, from output @ 1 KC. **SCA Rejection:** 30 db. **AM: Tuning range:** 535 to 1620 KC. **IF Frequency:** 455 kc. **Sensitivity:** 1400 KC, 3.5 uv; 1000 KC, 5 uv; 600 KC, 10 uv—standard IRE dummy antenna. **Bandwidth:** 8 KC @ 6 db down. **Image rejection:** 30 db @ 600 KC. **IF Rejection:** 45 db @ 600 KC. **Harmonic distortion:** Less than 1%. **Overall dimensions:** 17" L x 5⅜" H x 14¾" D.

AR-13 POWER RESPONSE



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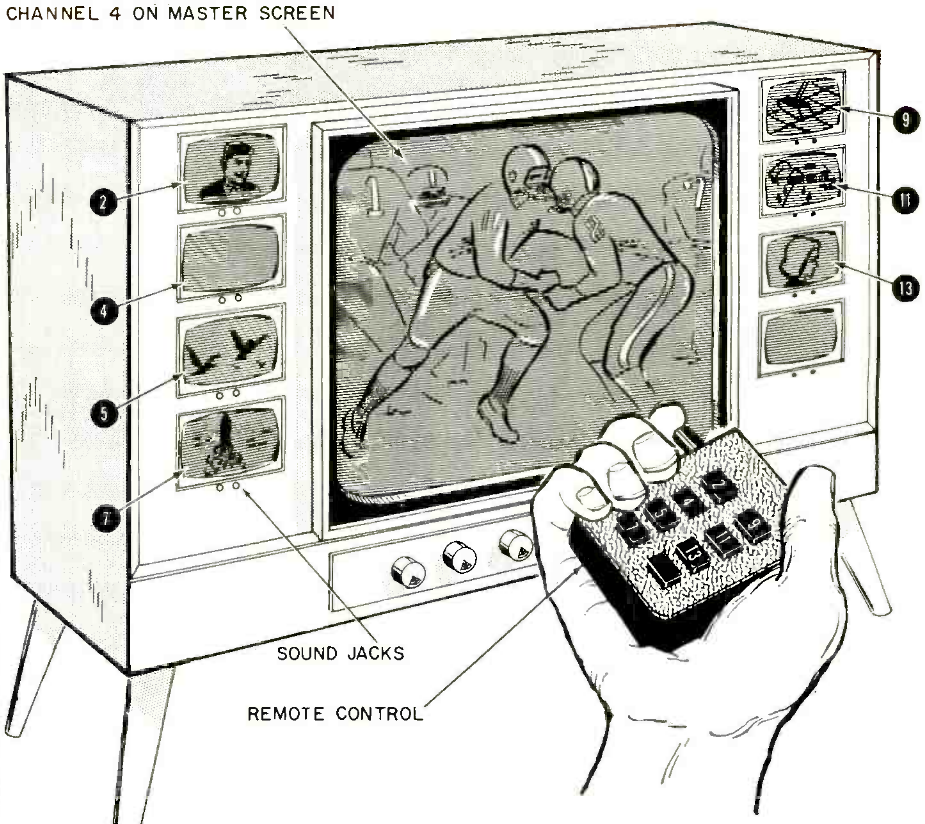


This proposed receiver shows all channels simultaneously, so viewers know every second what programs are on the air. TV receiver shown is for eight-channel reception. New York and Los Angeles each has seven channels. There is one more channel, unlabeled, that can be used in fringe areas. An eight-channel 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 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.*

Stereo Amplifier

(Heathkit All-Transistor AA-22)

a

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 pushbutton 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 uninitiated 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

SPECIFICATIONS

(All specifications are the manufacturer's)

Simultaneous power output (per channel): 20 watts into 8-ohm load; 13 watts into 16-ohm load; 9 watts into 4-ohm load. (IHF music power approx 1.6 times as great at all impedances). All outputs for 0.7% total harmonic distortion at 1 kc.

Power response: ±1 db, 15 cycles to 30 kc at rated output

Harmonic distortion (rated output): less than 1% at 20 cycles; 0.3% at 1 kc; 1% at 20 kc

IM distortion (at rated output, 60 and 6,000 cycles mixed 4:1): less than 1%

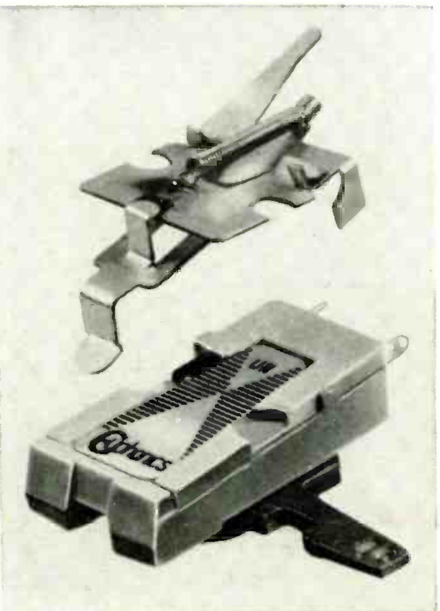
Hum and noise: 50 db below rated output (MAG PHONO input); 65 db on AUX inputs

Separation: 60 db at 1 kc; 40 db at 20 cycles and 20 kc

Dimensions: 15⅝ x 3¾ x 11⅜ in. in walnut cabinet supplied

Heathkit AA-22 stereo amplifier.

Euphonics 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 occurs 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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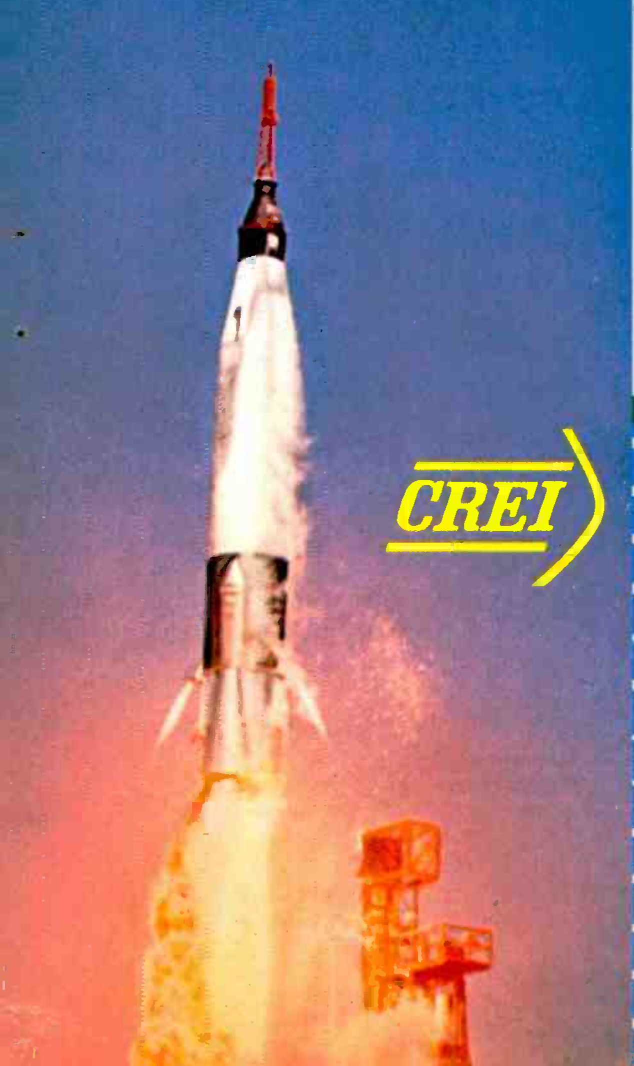

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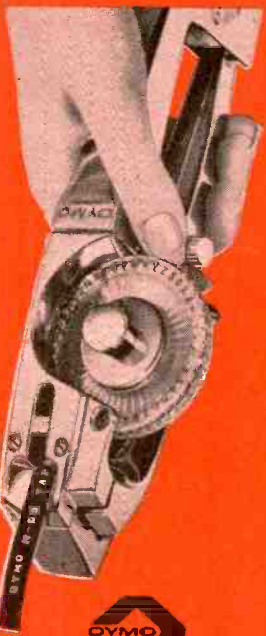

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What's Your Eq?

These are the answers. This month's puzzles are on page 37. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y.—10011.

Always Half

The black box contains a capacitor and a resistor equal to R as in Fig. 1. The voltage $E_{CA} = E_{AD} = E/2$ having zero angle with E; the voltage E_{BC} is 90% out of phase with E_{BD} and the vector sum is equal to E: consider the modified vector diagram (Fig. 2). E_{BC} is always perpendicular to E_{BD}, thus point B will fall on

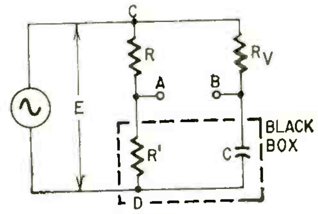


Fig.1

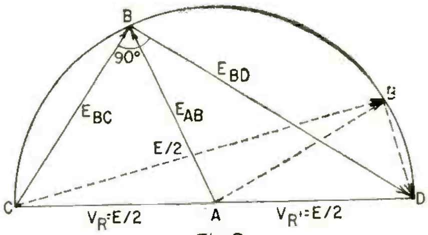


Fig.2

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 amplititude.

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).

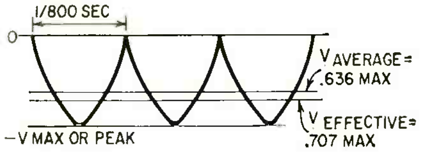
Readers may be assured that the circuit is "bench-tested," that it works, and is indeed so ruggedly based in theory that an unfortunate change of sign in one of the terms of the October explanation did not change the final result.

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 average 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 vom 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 .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 shutoff (stopped the motor when a package got 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)

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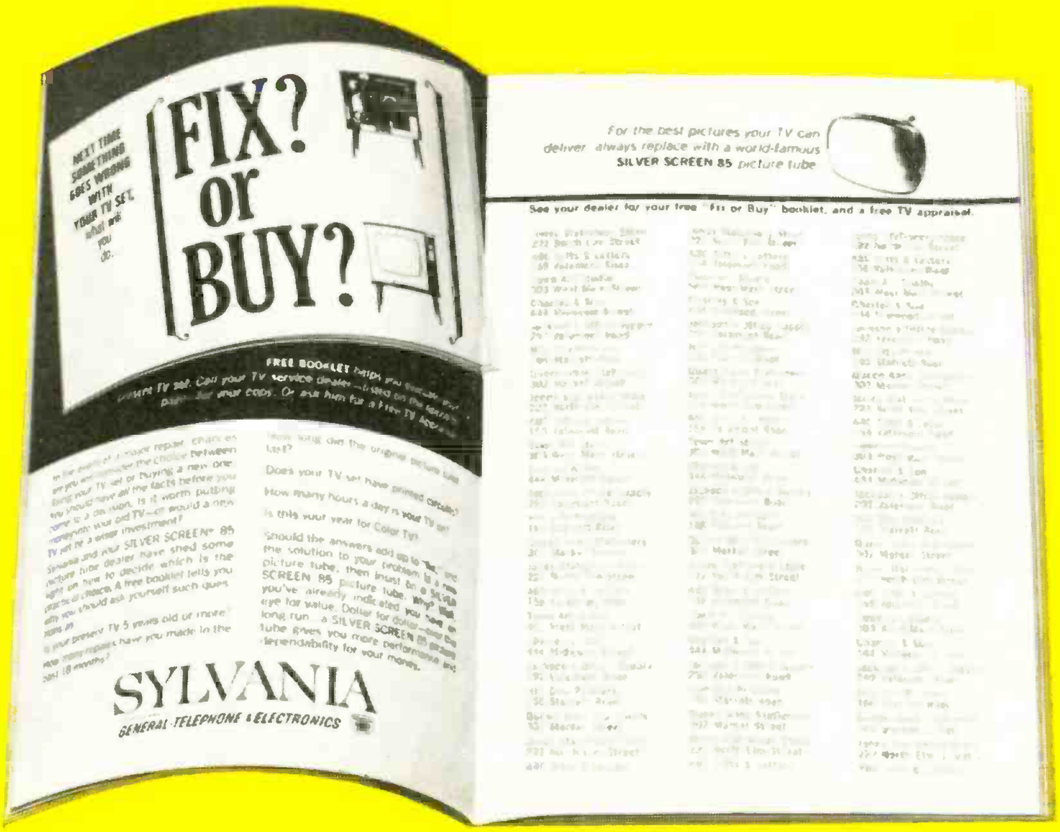

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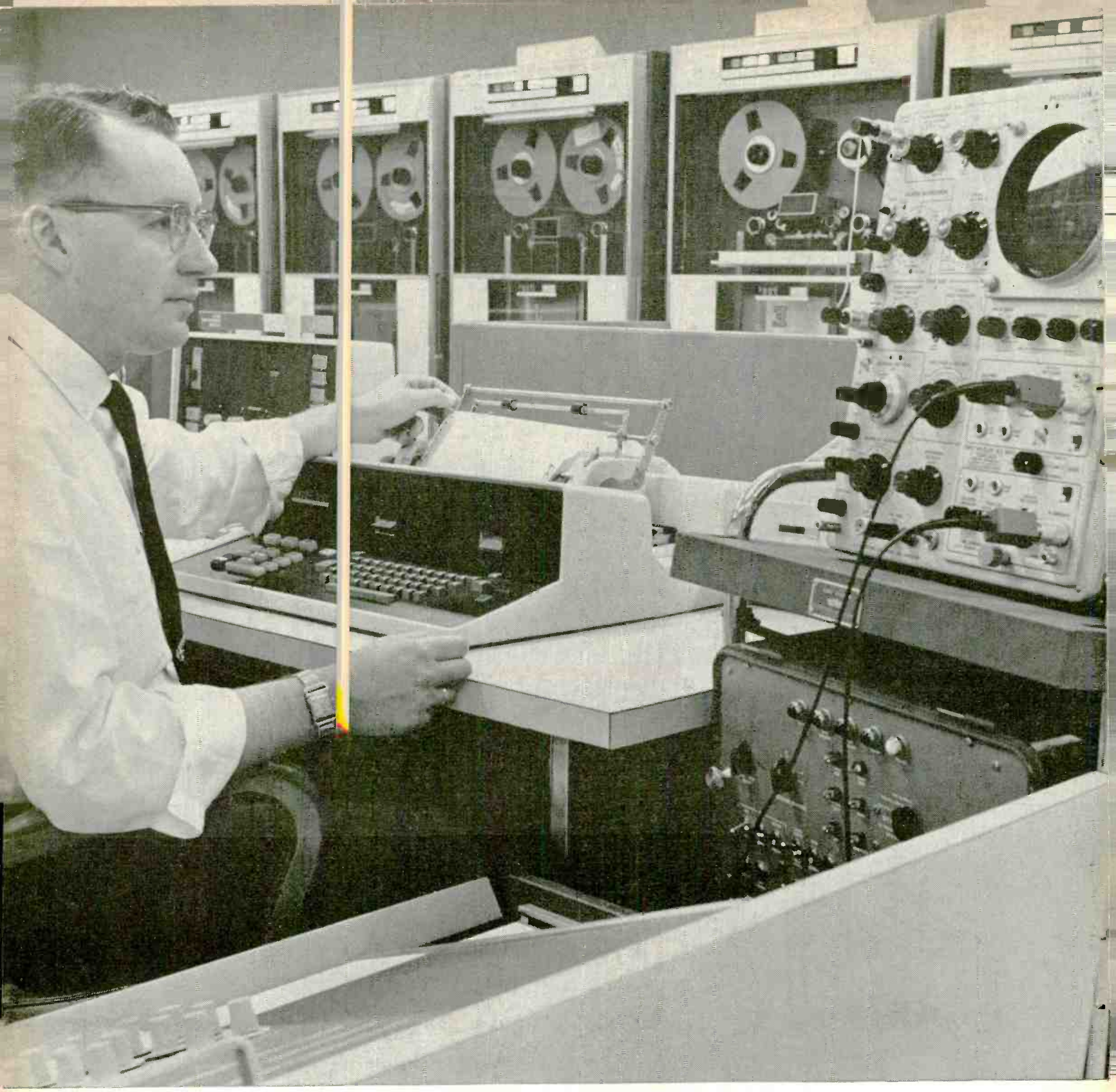

Why Fred got a better job . . .

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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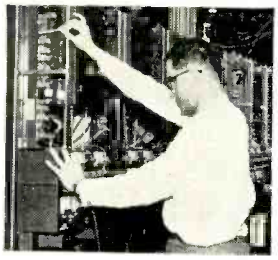

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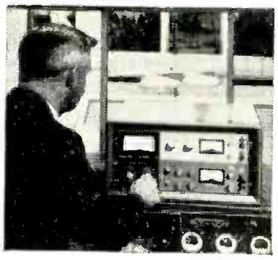

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(Continued from page 70)
gun, I went back and traced it out in more detail. Fig. 1-a shows how it should have been connected; Fig. 1-b shows how it *was* connected. The "contactor coil," part of the motor control, should have been fed from the same phase that fed the power transformer. Instead, it was connected to *another* phase, *and* to the power transformer at the same time! We got a "vector sum voltage" and smoke. Things didn't burn up, because there must have been enough inductance in the circuit to hold the current down. Of course, we could only leave it on for a few seconds.

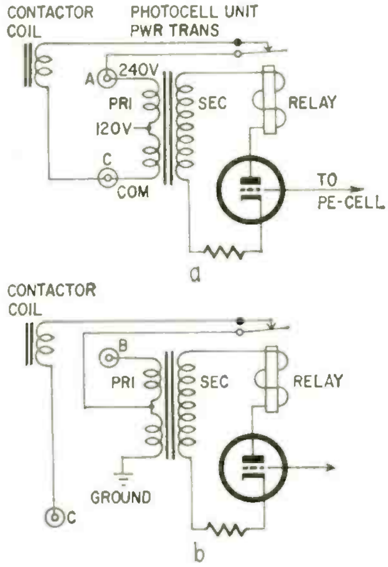


Fig. 1—In correct circuit (a), 240 volts between A and C operates coil and transformer primary. In no-good circuit (b), there are 2 phases (B–C and B–gnd) connected into same circuit. Letters refer to terminals in Fig. 2.

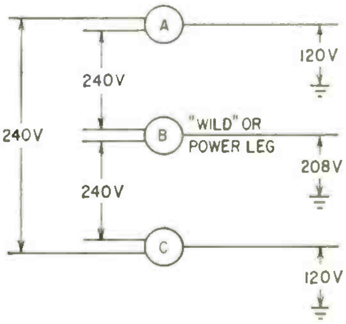


Fig. 2—Actual voltages to be found on 3-phase line.

Fig. 2 shows the true voltages in such a circuit, just as many readers wrote in to remind me. So, if the members of my Fan Club will lay down those baseball bats and let me get the egg off my face, I'll apologize! Too fast a diagnosis on too little evidence.

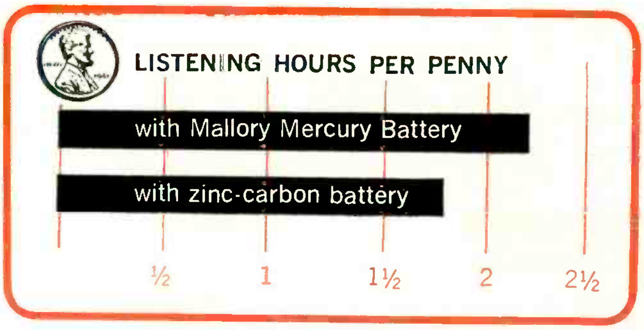
The Young Electrician said *I* was wrong. I said *he* was wrong. In that respect, at least, we were both right.—*Jack Darr*

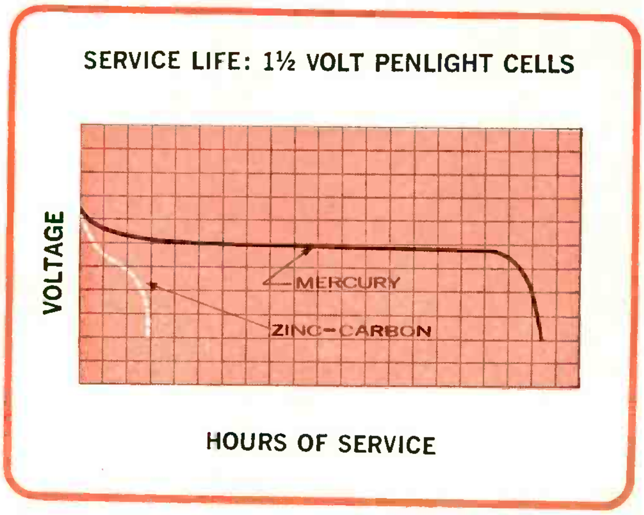
MALLORY P. R. MALLORY & CO. Inc.

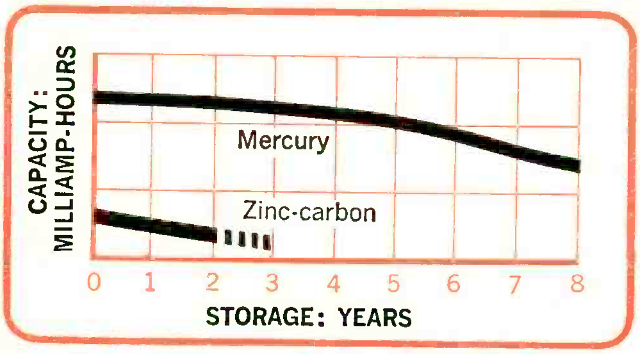
Tips for Technicians

Mallory Distributor Products Company
P.O. Box 1558, Indianapolis 6, Indiana
a division of P. R. Mallory & Co. Inc.

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 75¢ versus 20¢ 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 20¢ 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.

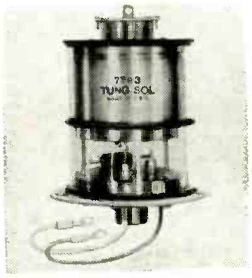
We've used this "Tip" to illustrate the superiority of Mallory Mercury Batteries in transistor radios. But this superiority extends to *thousands* of other applications. So whether you're building test equipment, heart-pacers, or satellites, see your Mallory Distributor. He has a Mallory Mercury Battery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

New Semiconductors and Tubes

You aren't likely to see many of these around your home, but they should find a wealth of industrial applications. The 7793 is called by the manufacturer (Tung-Sol) "an entirely new type of hydrogen-filled, indirectly heated half-wave diode tube possessing greater voltage and current-surge safety factors than . . . semiconductor stacks."

The new tube is claimed to handle higher voltages then comparable xenon tubes, and to work over a wider range of temperatures than comparable mercury-vapor tubes. It has a hydrogen reservoir with external connections, to replenish hydrogen as necessary. The 7793 is intended for use as a high-voltage rectifier, clipper or backswing diode.

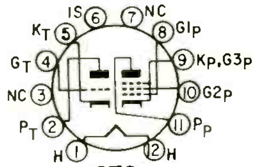


Maximum peak inverse voltage for shunt diode operation is 30 kv, and for rectifier service, 25 kv. Maximum cathode currents for those applications are 1,500 and 16 amperes, respectively.

6T9

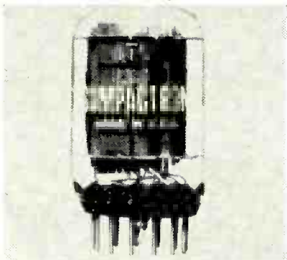
A new triode-pentode compactron for audio applications has been registered by its designer, General Electric, as the 6T9. The pentode section is a power tube, similar to the old 6AQ5, and the triode section is similar to half of a 12AX7.

The power pentode section is rated



6T9

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

LEADING SOURCE
OF POWER FOR TESTING COLOR TV!

Precision's G-36 Color Bar White Dot Generator

The *easiest-operating* generator of its kind!
An essential instrument with only the essentials!
Works quickly, simply . . . gets the job done profitably!
Completely capable of testing and adjusting color phasing, matrixing, linearity and convergence circuits in all color receivers.

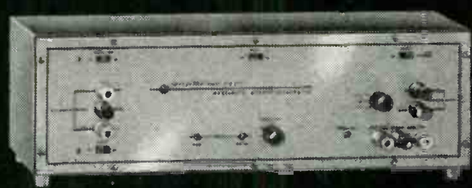
G-36K (Kit): $119.95; G-36W (Factory Wired): $179.95

LEADING SOURCE
OF MULTIPLEX SIGNALS FOR TESTING STEREO!

Precision's E-490 Multiplex Signal Generator

Specifically designed to fill the technician's need for a fast-working, high-quality multiplex signal source at a truly low price! Highly versatile, yet extremely simple to operate. Provides complete testing of multiplex circuitry in FM stereo receivers and multiplex adapters.

E-490 (Factory Wired): $249.95



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Precision's Full Line of New Test Equipment

The perfect combination of superior quality at the very lowest possible price!
A full line designed with one objective: to help you accurately handle all testing jobs faster, easier and *more profitably!* Never was there equipment designed with your real needs so much in mind!
And it's available at your local distributor *now!*

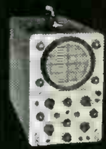
As shown:
Model G-30—Kit: $32.95; Semi-kit: $39.95; Factory Wired: $44.95
Model G-32—Kit: $85.95; Factory Wired: $159.95
Model S-55—Kit: $99.95; Factory Wired: $155.95
Model ES-550B—Factory Wired: $279.95
Model S-51—Kit: $69.95; Factory Wired: $109.95

G-30 RF Signal Generator

G-32, Sweep Generator and Marker Adder

S-55 DC to 5MC Oscilloscope

ES-550B Wide Band 5MC Oscilloscope



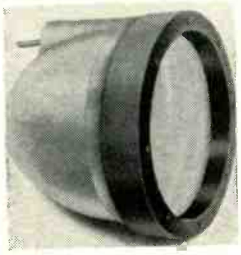
S-51, General Purpose Oscilloscope

Write for new Catalog No. PP631 describing the *full* new Precision line containing *all* the test equipment you need!

PRECISION Apparatus, Inc.
80-00 Cooper Ave., Glendale, N.Y. 11227, 212-TW 4-4290

Export: Morhan Exporting Corp., 458 Broadway, New York, N.Y. 10013
Canada: William Cohen, Ltd., 8900 Park Avenue, Montreal, Canada

within .001 inch after tube processing. Then the ring is drilled and tapped for



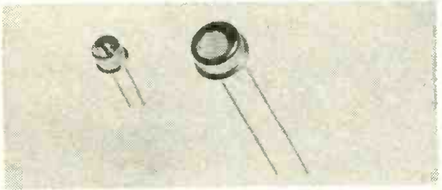
mounting. Inside and outside diameters of the mounting ring are machined concentric to the tube neck.

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 2.300 ohms, and dark resistances to 500 megohms are avail-

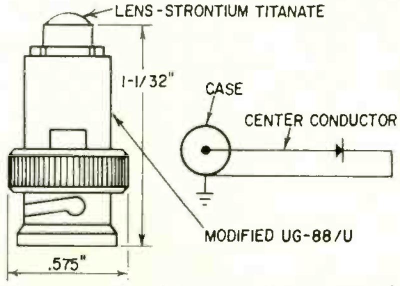


able in the three types. Voltage ratings are from 60 to 250 volts. Dissipation for the CL703C and -703CL (TO-5 cases) is 125 mw; for the CL903C (TO-18 case), 50 mw. All are hermetically sealed.

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 10^9 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 piv's of up to 15,000 volts, and in average dc outputs to 1.75 amps. Voltage transient protection is provided by avalanche di-

odes. The devices, made by Syntron Co., offer advantages over thermionic rectifiers: longer life, less heat, no warmup.

END

This *Weller*®

Heavy Duty Soldering Kit

has a professional
240/325 WATT

Dual Heat Gun

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. Model D-550PK. Weller Electric Corp., Easton, Pa. **$12.95 LIST**

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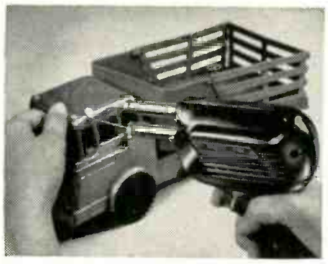
Electrical work

Repairing plastics

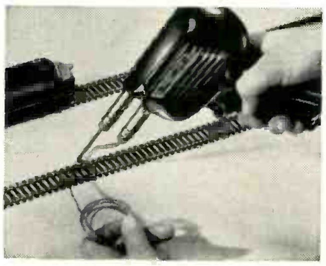


Sealing plastic bags

Appliance repairs

Metal work

Model RR connections



Cutting plastic tile

New Literature
booklets — charts — catalogs

LOUDSPEAKERS, principles and methods of setting them up in a living room, etc. described in 4-page reprint of article, "How to Get the Most From Your Loudspeakers."—**Acoustic Research, Inc.**, 24 Thorndike St., Cambridge, Mass.

TAPE RECORDER DIRECTORY includes 67 manufacturers and more than 200 different machines. 36 pages, illustrations of recorders, specs of units, suggested list prices.—**Audio Devices,** 444 Madison Ave., N.Y. 22. **25¢**

WINDOW POSTER. 17 x 22 in. black-and-white poster entitled, "Are TV Service Dealers Gyps?" concludes they are not. Humorous cartoon at top.—**Sprague Products Co.,** North Adams, Mass.

ENTERTAINMENT PRODUCTS indexed in 23 page, excellently illustrated catalog. Product lines include radio–TV silicon and selenium rectifiers, entertainment diodes and transistors, silicon tube-replacement rectifiers, etc. — **General Instrument Corp.**, 65 Gouverneur St., Newark 4, N. J.

RECORD PLAYBACK COMPONENTS described technically in 8-page illustrated brochure. Points on care and evaluation of disc-record playback systems and recommendations for a basic stereo record library. — **Empire Scientific Corp.,** 845 Stewart Ave., Garden City, N. Y.

25 THINGS TO DO WITH A TAPE RECORDER. 8-page booklet suggests family, business, church recording, for extra income, etc.—**Stanford International,** 569 Laurel St., San Carlos, Calif.

LOW-FREQUENCY INSTRUMENTS described in 31-page booklet. Includes generators, transmission measuring sets, miniature instruments, mountings, theory behind instrument performance (circuit theory, dial accuracy, etc.). Illustrations, specs.—**Waveforms, Inc.,** 333 Sixth Ave., New York, N. Y.

TV/FM ANTENNA PREAMPLIFIERS described in 4-page illustrated spec sheet. 3 models, indoor and outdoor.—**Jerrold Electronics,** Philadelphia 32, Pa.

TAPE RECORDER CATALOG, 16 pages, extensive specs. Describes manufacturer's line of recorders and accessories.—**Superscope, Inc.,** 8150 Vineland Ave., Sun Valley, Calif.

HIGH-CURRENT SILICON RECTIFIER STACKS covered in 16-page illustrated catalog. Specs for single-phase center tap, single-phase bridge, 3-phase bridge and 6-phase star assemblies. Selection chart with output current, output voltage and prv rating of silicon rectifiers used in four types of assemblies.—**Tung-Sol Electric, Inc.,** 1 Summer Ave., Newark 4, N.J.

AUDIO TAPE RECORDERS, ACCESSORIES, discussed in 12-page catalog *No. 1817* for Government procurement agencies. Covers items approved by General Services Administration under Contract No. GS-00S-44680. Illustrations, specs. **Ampex Corp.,** Mail Stop 6-1, 401 Broadway, Redwood City, Calif.

PORTABLE TAPE RECORDER, 3-speed with self-contained ac power supply and batteries, described in spec sheet.—**Freeman Electronics Corp.,** 729 N. Highland Ave., Los Angeles 38, Calif.

CAPACITORS. Mylar and foil, metallized, Mylar, Teflon and foil, described in 24-page booklet, includes graphs, charts, specs. Illustrates temperature characteristics. — **Texas Capacitor Co.,** 4310 Langley Rd. Houston 16, Tex.

PROFESSIONAL REVERBERATION UNIT explained in 8-page illustrated booklet. Discusses problems and origins of reverberation, and construction data. Full specs and details.—**Gotham Audio Corp.,** 2 W. 46 St., New York 36, N. Y.

SILICON RECTIFIERS AND ZENER DIODES described in 3 bulletins. *Bulletin B-113* covers silicon entertainment rectifiers, gives electrical and mechanical specs. *B-107* is silicon rectifier chart listing 500 types. *B-110* is Zener diode reference chart listing about 230 Zener diodes.—**National Transistor,** 500 Broadway, Lawrence, Mass.

16-MM TECHNICOLOR SOUND FILM available to any CB group or club. Runs for about 15 minutes; explains functions and instructions of CB units.—**Sonar Radio Corp.,** Jim Liebman, 73 Wortman Ave., Brooklyn 7, N. Y.

METAL-CASED PAPER CAPACITORS described in 12-page catalog. Complete specs, dimensions, ratings, application information.—**General Electric Co.,** Schenectady 5, N. Y.

PHILADELPHIA WIRELESS TECHNICAL INSTITUTE described in 28-page school catalog. Lists courses, departments, general entrance requirement information, fees.—**Philadelphia Wireless Technical Institute,** 1531-33 Pine St., Philadelphia 2, Pa.

TAPE RECORDERS, their use and care, described in 96-page booklet. Illustrations, photos, troubleshooting chart. Chapters on motors, tape transports, magnetic heads, bias oscillator, and glossary of recording terms. — **Robins Industries Corp.,** 15-58 127th St., Flushing, N. Y. **$1.00**

SOUND-LEVEL METER; OCTAVE FILTER SET detailed in 12-page spec sheet. Includes applications, accessories available, complete specs. Graphs, charts, diags. — **B&K Instruments, Inc.,** 3044 W. 106th St., Cleveland 11, Ohio

SPEAKERS AND ACCESSORIES described in 8-page catalog. High efficiency speakers, radial, sound paging, sound column, etc.—**Atlas Sound,** 1419-51 39th St., Brooklyn, N. Y.

CALIBRATION AND TESTING SERVICES provided to science and industry listed in 103-page booklet. Includes listing of the Bureau's calibration and test fee schedules. Statement of statutory functions, testing policy.—**US Department of Commerce,** National Bureau of Standards, Washington, D.C. **70¢**

ENTERTAINMENT TRANSISTORS which can be used as replacements for most types used in radio and other entertainment products, featured in a *Replacement and Interchangeability Guide.*—**General Instrument Corp.,** 65 Gouverneur St., Newark 4, N. J.

AMENDMENT 2 OF MIL-R-5757D, which supersedes Amendment 1, and which makes important revisions and additions to the basic relay specification, reprinted in 7-page booklet.—**Filtors, Inc.,** East Northport, N. Y.

ELECTRONIC ORGAN KITS described in 20-page booklet. Flexible 7-inch phonograph record demonstrates sound of different models. Specs, illustrations.—**Schober Organ Corp.,** 43 W. 61 St., New York, N. Y. 10023.

1964 GUIDE TO CUSTOM STEREO includes explanation of FM multiplex, hints for selecting amplifiers and tuners. 24-page booklet has photos and suggestions on stereo installation.—**H. H. Scott, Inc.,** Dept. P., 111 Powdermill Rd., Maynard, Mass.

MAGNETIC RECORDING TAPE STORY told in 16-mm color film "Magnetic Memory", available on free loan to clubs and other organizations. 25-minute film describes theory of sound and recordings, manufacturing process.—**3M Co.,** Dept. Z3-580, 2501 Hudson Rd., St. Paul 19, Minn.

PLANS FOR 2 HI-FI CABINET INSTALLATIONS, include space for tuners, amplifiers, record player and record storage space. Large 17 x 22-inch sheets.—**Institute of High Fidelity, Inc.,** 516 Fifth Ave., New York 36, N.Y.

"WHAT'S THIS ALTERNATOR TALK ALL ABOUT?" answered in 8-page cartoon booklet. Explains in layman's language operation of typical automotive electrical system. Applies to boats, trucks, emergency vehicles. — **Leece-Neville Co.,** 1374 E. 51 St., Cleveland, Ohio. END

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead-do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.

UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

23 CRYSTAL CONTROLLED CHANNELS

THE NEW EXECUTIVE 750

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.

Available at your International dealer $229.00

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CRYSTAL MANUFACTURING CO., INC.
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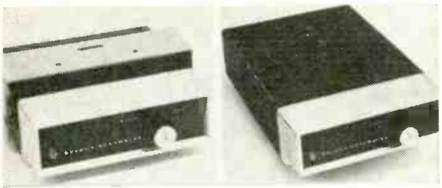
CB ANTENNA, *model GAM CB-11.* Base-loaded mobile antenna for 27-mc CB unit. Whip 38 in. long. Tunable loading coil at base. VSWR

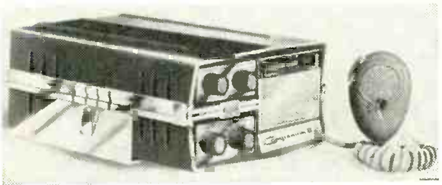
less than 1.2:1 on 23 CB channels when correctly adjusted.—**GAM Electronics, Inc.,** 138 Lincoln St., Manchester, N.Y.

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 Industrial Ave., Palo Alto, Calif.

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



tal socket. Hand-wired circuitry, preset noise limiter, aluminum chassis.—**Pearce-Simpson, Inc.,** 2295 N.W. 14th, Miami, Fla.

6-CHANNEL CB TRANSCEIVER for home and office, *model TWR-4.* Built-in S-meter indicating transmitter and receiver performance. Prewired

with external socket to accommodate selective calling unit. Automatic volume control, adjustable squelch circuit. — **Raytheon Co.,** Lexington 73, Mass.

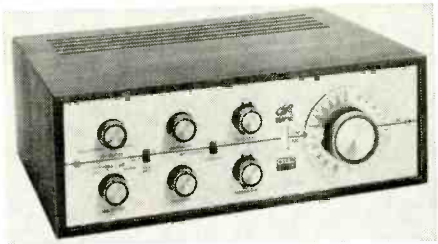
FM MONO 18-WATT RECEIVER, with paging facility, *model 2716.* Tuner: Antenna input 300 ohms balanced; IHF usable sensitivity: 3 μv (30 db quieting); i.f. bandwidth: 280 kc at 6 db points; ratio detector bandwidth: 1 mc peak-to-peak separation. IHF signal-to-noise ratio: 55 db. *Amplifier:* Power: 18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

±1 db 15 cycles—40 kc; sensitivity: 240 mv on phono, tape; 4 mv on mike; noise: 80 db down on phono and tape, 60 db down on mike.—**EICO Electronic Instrument Co., Inc.,** 131-01 39th Ave., Flushing N.Y. 11354.

GENERAL-COVERAGE RECEIVER, *model NC-121.* Continuous coverage 550 kc to 30 mc in 4 bands. Built-in 5-in. PM speaker, separate rf and audio gain controls. SSB/CW agc and product de-

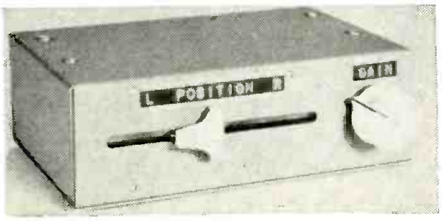
tector, automatic series-gate noise limiter, full-wave transformer-operated power supply. — **National Radio Co., Inc.,** Dept. P, 37 Washington St., Melrose 76, Mass.

FM STEREO RECEIVER, *model 2536.* Tuner: antenna input: 300 ohms balanced; IHF usable sensitivity: 3 μv (30 db quieting), 1.5 μv for 20 db quieting; i.f. bandwidth: 280 kc at 6 db points; IHF signal-to-noise ratio: 55 db; harmonic distortion: 0.6%; channel separation: 30 db. Amplifier: power: 36 watts IHF music; 28 watts continuous;



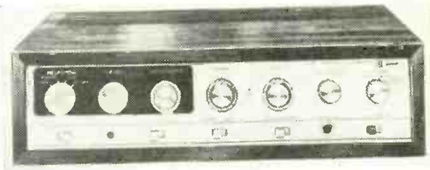
IM distortion (each channel); 2% at 14 watts, 0.7% at 5 watts. 0.2% at 1 watt; harmonic distortion (each channel): 0.6% at 10 watts, 40 cycles–10 kc; frequency response: ±1 db 15 cycles–40 kc; speaker output: 8 and 16 ohms. 5⅝ x 15⅞ x 13⅝ in.—**EICO Electronic Instrument Co., Inc.,** 131-01 39th Ave., Flushing, N.Y. 11354.

STEREO POSITIONER gradually moves stationary sound source from left channel to right channel and back again. Input: low-level 50–600 ohms unbalanced; 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-



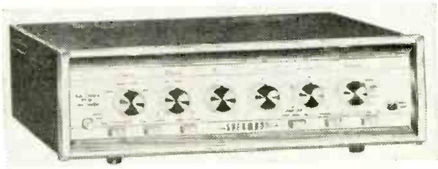
monic; signal-to-noise ratio: better than 60 db. 4 x 6 x 2 in. Self-contained 9-volt battery. Controls: panning, gain.—**UltrAudio,** PO Box 821, Beverly Hills, Calif.

70-WATT TRANSISTOR STEREO HI-FI AMPLIFIER, *Knight-Kit KG-870,* (22 transistors, 4 silicon diodes). Power output: IHF music power: 70 watts; 35 watts per channel. Sine wave. 28 watts per channel. Response: ±1 db, 20–25,000 cycles. Distortion at rated power: IM, less than 1%. Hum: tuner, −80 db; Mag phono, −68 db, tape head,



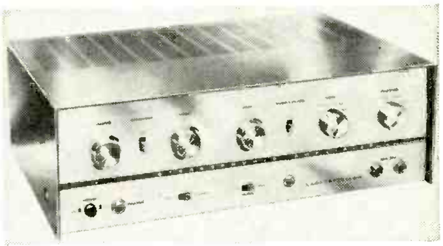
−60 db. Channel separation: exceeds 30 db. Output circuitry thermal stability protects transistors. No capacitors or transformers in output stages. Low current drain. Variable loudness control. Tape-monitor input switch. Rumble and scratch filters. Speaker phasing switch. 2¾ x 13 x 11 in.—**Allied Radio 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 mv; tuner sensitivity: 0.25 volt. Frequency response 20–20,000 cycles ±½ db. Music power: 40 watts each channel; 36 watts continuous at 1½% IM distortion.—**Sherwood Electronic 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



phono 4.5 mv; high level: .5 v. 14¾ x 5⅛ x 11 in.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y.

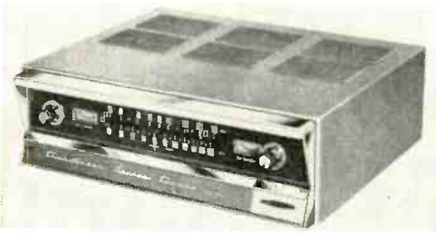
SUBMINIATURE STEREO PICKUP, *model 500AT Micro Fluxvalve.* Less than 5 grams. For automatic turntables utilizing low-mass tone-arm

systems. 15° playback angle.—**Stanton Magnetics, Inc.,** Terminal Drive, Plainview, N.Y.

STEREO TAPE RECORDERS, *F-44 series,* replaces 1200 series. (Model F-4460 portable illus-

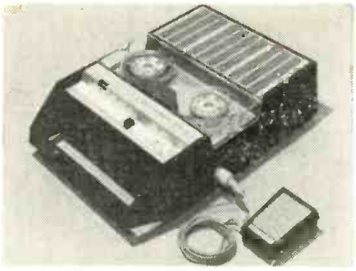
trated.) 4-track stereo/4-track monophonic. Frequency response 50–15,000 cycles ±2 db at 7½ ips; outputs about 1.0 volt rms: signal-to-noise ratio better than 53 db at 7½ ips, 48 db at 3¾ ips. Flutter and wow under 0.15% rms at 7½ ips; under 0.2 at 3¾ ips. Timing accuracy ±1.0%.—**Ampex Corp.**, 934 Charter St., Redwood City, Calif.

ALL-TRANSISTOR TUNER, *model AJ-43*, AM, FM, FM stereo. 25 transistors, 9 diodes. FM section: sensitivity: 2 μv for 30-db quieting; capture ratio: 7.5 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:



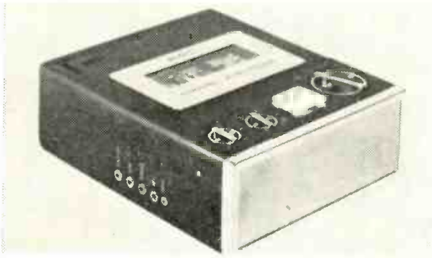
35 db below 30% mod.—**Heath Co.**, Benton Harbor, Mich.

TRANSISTOR TAPE RECORDER, *Butoba MT-7*. 4 x 6-in. speaker. Operates 20 hours on 4 flashlight batteries, also on 6- or 12-v car battery



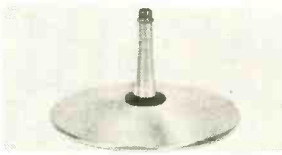
or ac power. Response: 70–12,000 cycles at 3¾ ips; 100–5,000 cycles at 1⅞ ips.—**Stanford International**, 569 Laurel St., San Carlos, Calif.

PORTABLE TAPE RECORDER, *660 Senior*.



7½ x 9 x 3 in. 8½ lb. 3-speed (7½, 3¾, 1⅞), built-in stroboscope for 7½ ips on capstan.—**Freeman Electronics**, 729 N. Highland Ave., Los Angeles 38, Calif.

DESK STAND for mikes any shape, size or weight. Heavy 8 in. diameter base and anodized collar. 4 in. long. Terminates with standard ⅝ in.

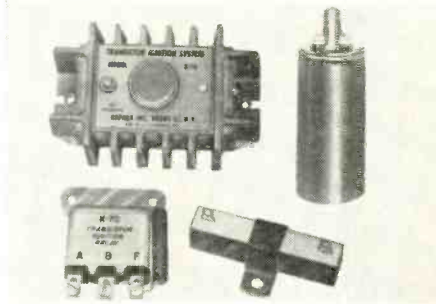


–27 precision thread.—**Atlas Sound,** 1419-51 39th St., Brooklyn, N.Y.

5-SPEAKER SYSTEM, *SK-300WX*. Four

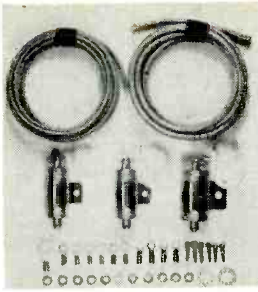
6½-in. low-resonance speakers and one 2½-in. cone type tweeter. Frequency response: 50 to 18,000 cycles. Power handling capacity: 50 watts continuous, 30 watts peak. Impedance: 8 ohms. Size: 17⅝ x 21¾ x 4¼ in. 17 lb.—**Lafayette Radio Electronics Corp.**, 111 Jericho Turnpike, Syosset, N.Y.

TRANSISTORIZED IGNITION SYSTEM, *model K-70*, does not require removal, short-out, or bypass of ignition ballast resistance. Installed without disturbing old ignition ballast resistance



or bypass. Installation involves removing distributor condenser and replacing old ignition coil.—**Kapner, Inc.**, 1924 Washington Ave., Bronx 57, N.Y.

NOISE-SUPPRESSION KIT controls whines associated with worn generator brushes and pop-

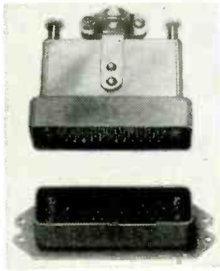


ping caused by making and breaking of voltage regulator contacts.—**Webster Manufacturing,** 317 Roebling Rd., So. San Francisco, Calif.

MINIATURE THERMAL TIME-DELAY RELAY fits 9-pin miniature tube socket. Bi-metal relay in shatterproof metal shell. Contact rating 2

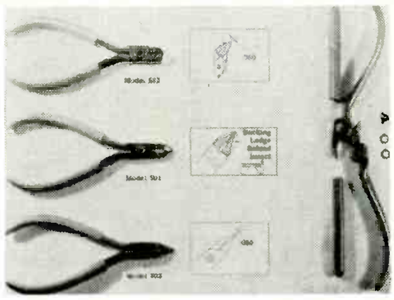
amps resistive at 115 v ac or 28 v dc. Normal time-setting tolerance of ±20%.—**G-V Controls Inc.,** Livingston, N.J.

CONNECTOR, *Series REMI* removable re-



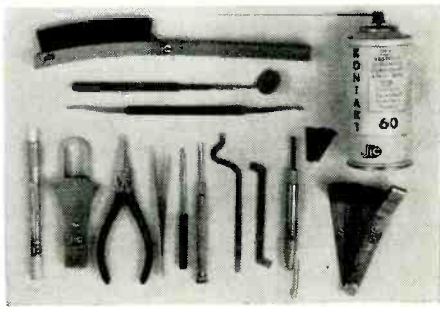
entrancy miniature crimp type, *MI* miniature and *SMI* subminiature types. Available with bath-tub type shells and mounting plates for protection against pin damage and certain environmental conditions. Shells meet latest Mil Spec MS-17775. .040 thick aluminum, sulphuric anodized finish. 7 polarization positions available. — **U.S. Components, Inc.,** 1320 Zerega Ave., Bronx, N.Y.

PRECISION INSERTED TIP WIRE CUTTERS for cutting wire up to .025 in. diam. Repairs by factory include sharpening and realignment; replacement when required. Hard chrome-plated;



assembled with precision screw and shims; cutting edges diamond-honed to optimum.—**ETM Corp.,** 112 S. Magnolia, Monrovia, Calif.

15-PIECE RELAY SERVICING TOOL KIT. All tools made of carbon steel, with heavy chrome plating. Most tools insulated for up to 10,000 volts



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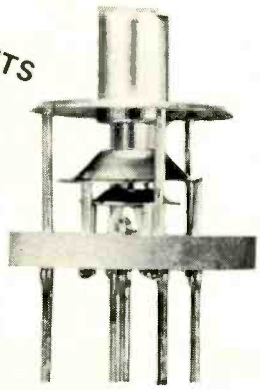

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HITACHI	
6CW4	TRIODE, FOR VHF-AMPLIFIER IN STANDARD TV.
2CW4	SAME AS 6CW4, FOR 450 MA TRANSFORMERLESS TV.
2B-H5	SAME AS 6CW4, FOR 600 MA TRANSFORMERLESS TV.
6DS4	SEMI-REMOTE TRIODE, TV VHF-AMPLIFIER.
2DS4	SAME AS 6DS4, FOR 450 MA TRANSFORMERLESS TV.
2N-H11	SAME AS 6DS4, FOR 600 MA TRANSFORMERLESS TV.
6DV4	TRIODE, FOR UHF-OSCILLATOR IN STANDARD TV.
2DV4	SAME AS 6DV4, FOR 450 MA TRANSFORMERLESS TV.
2N-H12	SAME AS 6DV4, FOR 600 MA TRANSFORMERLESS TV.
6N-H10	LOW NOISE TRIODE, AUDIO PRE-AMPLIFIER.
6N-L7	TRIODE, FOR VERY LOW-B+ APPLICATIONS.
7586	TRIODE, FOR INDUSTRIAL APPLICATIONS.
7587	TETRODE, FOR INDUSTRIAL APPLICATIONS.
8056	TRIODE, FOR LOW-B+ APPLICATIONS.
8058	TOP-PLATE TRIODE, FOR UHF APPLICATIONS.

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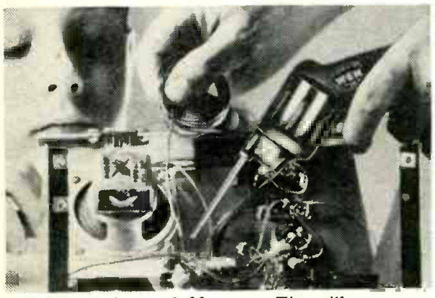
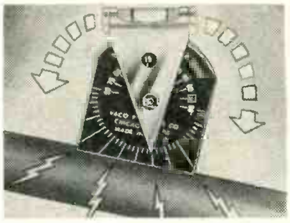
to permit operation on "live" equipment. Spring adjusters, pliers, inspection mirror, gauges, etc.—**Jonard Industries Corp.,** 3733 Riverdale Ave., Bronx 63. N.Y.

SOLDERING PISTOL, *model 75.* Tip heat of 100-watt device from peak surge rating of 50 watts



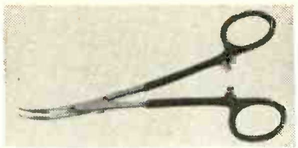
and normal draw of 30 watts. Tip will not overheat. 9 in. long, 4½ in. high, 1 lb.—**Wen Products, Inc.,** 5810 Northwest Highway, Chicago 31, Ill.

MAGNETIC LEVEL, *model ML-7,* usable as



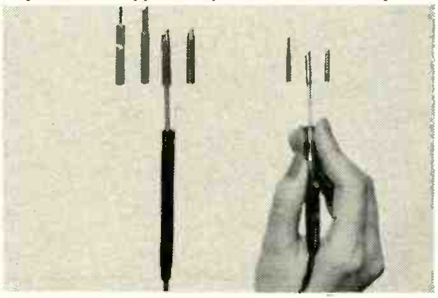
level or plumb. protractor, rule and square. Protractor vial head swivels left and right. allowing reading of any angle up to 90°. Level magnetized on sides and bottom. Placed on any surface to be checked and protractor adjusted until bubble centered. Reading then taken.—**Vaco Products Co.,** 317 E. Ontario St.. Chicago, Ill.

LOCK TYPE HOLDER. 2-position stainless steel snaplock. Insulated handle. Serrated jaws provide heat sink and clamp for soldering transistors, thermistors and diode, etc. Straight or curved.—



Techni-Tool, Inc., 1216 Arch. Phila., Pa.

MINIATURE SOLDERING IRONS. High thermal capacities. In 2 sizes and 5 wattage ranges. Replaceable copper alloy or solid nickel tips de-

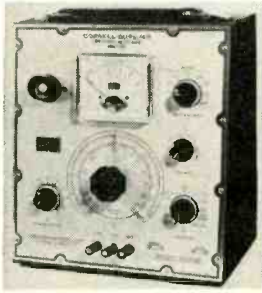


liver maximum heat at production speeds. Sealed element maintains constant temperature within ±2% of indicated heat under normal operating conditions.—**Meadow Corp.,** 2712 W. Montrose, Chicago, Ill.

VOLTAGE REFERENCE, *models 1118 A, B, C* and *D,* cover 10 µv to 1/10 v; accuracy ±0.5%. Self-contained, own power source. Mercury cell and 0.25% resistors used. Cell capacity 14,000 mil-

liampere hours. — **Emcee Electronics, Inc.,** 1202 Arnold Ave., Greater Wilmington Airport, Wilmington, Del.

CAPACITANCE-RESISTANCE ANALYZER, *model BF-71A,* measures all low- and high-voltage capacitor and resistor values. 0–500-volt variable dc supply for measuring leakage cur-



rent at rated capacitor voltage. Measures capacitor values 10 pf to 2,000 µf; resistor values 2.5 ohms to 25 megohms; capacitor leakage current 1 µa to 100 ma, and power factor from 0–50% at 60 cycles. —**Cornell-Dubilier Electronics Div.,** 50 Paris St., Newark 1, N.J.

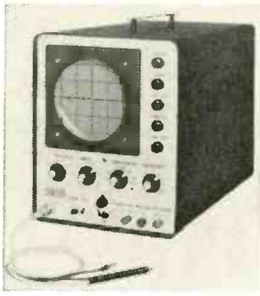
RF ATTENUATOR, *model TG-9050,* covers 82.5 db in 0.5-db steps. Toggle-switch type attenu-

ator incorporating 9 pi-pads. Frequency range dc to 300 mc. Impedance 50 ohms.—**Telonic Industries, Inc.,** 60 N. First Ave., Beech Grove, Ind.

AUDIO SIGNAL GENERATORS, *models H-1, J-1* and *J-2.* Sinusoidal signal over entire af spectrum, 15 to 50,000 cycles. *H-1,* squarewave output. *J-1, J-2* less than 2% distortion at 1-watt output and output impedance of 600 ohms with alternate 5-ohms output. *H-1,* continuously variable square-

wave output of 80 mv to 80 v, peak to peak, and continuously variable sine-wave output voltage of 200 mv to 20 v rms. Distortion less than 1% at 1 kc at level of 20 v. Rise time less than 3 μsec. Frequency response of all signal generators flat ±1 db.—**Houston Instrument Corp.**, 4950 Terminal Ave., Bellaire 101, Tex.

5-INCH SCOPE, *model PS127,* requires no narrow-band facility due to high sensitivity of .017 volt rms for 1-inch deflection on broad band. Z-



axis modulation, direct plate connections on rear. Low frequencies down 3 db at 10 cycles, horizontal sweep range up to 500 kc, positive synclocking.—**Sencore, Inc.**, 426 So. Westgate Dr., Addison, Ill.

PRECISION VOLT-OHM-MILLIAMMETERS, models 120 and 120M, feature silicon varistor to prevent damage to meter-movement even

when subjected to accidental transient overloads of 1,000 times or more.—**Precision Apparatus, Inc.**, 80-00 Cooper Ave., Bldg. #3, Glendale 27, N. Y.

PORTABLE VHF-UHF TRANSLATOR provides service technician and TV showroom with uhf television signals when none available through local telecasting stations. Color info as well as black-and-white. Bias control varies signal strength from 100 μv to 10 mv or higher, depending on

strength of vhf station. Operates on 110–125 volt 50–60 cycles with 30 watts maximum power consumption.—**Standard Kollsman Industries, Inc.**, 2085 N. Hawthorne Ave., Melrose Park, Ill.

All specifications from manufacturers data.

technicians' News

St. Louis TESA Looks at 1964

The December 1963 issue of TESA *News*, official organ of the St. Louis, Mo., TV-Electronic Service Association, contained a capsule prognosis of trends in TV for 1964. Three items singled out are "overwhelming sale of portables", fewer tubes being used and extended warranties.

Fewer tubes are being sold, apparently because of greater reliability and smaller tube complements of recent TV sets. Coupled with the continuing avalanche of new tube types, this makes tube inventory a thing to be watched closely.

Extended warranties "will mean the rapid exchange of parts and careful control, but . . . more service with little or no parts sales." The article concluded by noting that service technicians have too long let parts sales produce the profit. ". . . Service is what we have to sell . . . If we have no parts to sell, will our service and shop charges keep us in business?"

All That Glitters Is Not New

There's been quite a stir recently over rebuilt and regunned picture tubes being sold as new, or at least with advertising and labeling that suggest very strongly to the customer that the tubes are new.

Rebuilt tubes (from reputable factories, large or small) carry a notice to the effect that all materials and parts in them are new except for the envelopes, which have been inspected and tested to the same standards as new envelopes.

But Gene Love, editorial member of *TESA News* (official publication of the Television Electronic Service Association of St. Louis, Mo.), reports inspecting a CRT carton with a notice like this: "This tube is **Completely New** with the exception of the envelope, screen and coating." He writes that "completely new" is emphasized in bold print, and mentions parenthetically that we can soon expect to see notices like "The box surrounding this tube is **Completely New**"!

Love points out that in cases of misrepresentation to the ultimate consumer, the technician is likely to be the fall guy, because it may be very difficult to lay blame on anyone else. The only possible defense, he says, is *never* to use the word *new* in selling a picture tube. In fact, genuinely new tubes are relatively rare among replacements; most are rebuilt. As long as the label says so, there is no fraud involved. Honestly rebuilt tubes can represent quite a bargain, since their performance is equivalent to that of a new tube, at about 40% lower cost.

Gene Love suggests using terms like "first-line," "second-line," "regunned" and "clean". A first-line tube might be, say, a completely new one (even the envelope); a second-liner, a truly rebuilt one (new gun, screen and coating). A regunned tube would be one in which only the electron gun is new, the screen and coatings being the originals. A "clean" tube is, in Mr. Love's words, "just a plain second-hand tube with the dirt washed off."

Two New "Dirty" Words?

Semantic change marches on. Two words frequently encountered in the TV service industry (and elsewhere) are on the road to being officially black-listed: "discounter" and "repairman."

"Discounter" may soon be out for use as part of a firm's name, according to the National Better Business Bureau. The organization is recommending a ban on the term in the new rules being formulated by the Federal Trade Commission.

The NBBB has been campaigning for more consumer protection in pricing and the advertising of prices. It is also asking the FTC to clamp down on slogans used by retailers and others which lead the public to believe that they offer lower prices or "more for your money" than generally available in the marketplace.

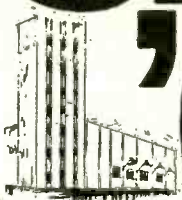
And now the venerable catch-all "repairman" is on its way down and out, if the National Alliance of Television & Electronic Service Associations has its way.

"The word repair has fallen into disrepute. To most people repairing implies makeshift work. For instance, your wife might repair your socks by darning them, not reweaving the break. Thus if 'repairing' has connotations of slipshod 'make-do' activity, how do you think the word 'repairman' rates?"

The article in the NATESA *Scope* goes on to suggest that people who service electronic equipment call themselves "technicians" and refer to their work as "professional technical services." It concludes by saying, "Let's conclusively delegate 'repairman' to its rightful place, one step below 'serviceman,' which in turn is at least one big step below 'technician.' Let us consider 'repair' and 'repairman' as dirty words unfit to be heard in the American home." END

TWO BIG SECTIONS

IEEE SHOW '64



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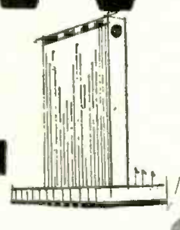

march 23-26
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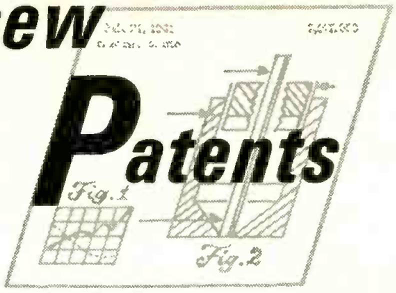
new Patents

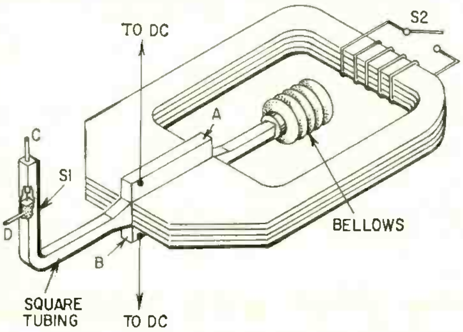


Magnetic Fluid Relay

PATENT No. 2,944,127

William L. Carlson, Jr., Bloomington, Minn. (Assigned to Minneapolis-Honeywell Reg. Co. Minneapolis, Minn.)

This relay switches large currents by remote control. It consists of a magnetic core whose gap is filled by electrodes A and B. These electrodes form part of the wall of the tubing that passes through the magnet gap and are connected to a source of high-current, low-voltage dc (not shown). The tubing contains a conductive fluid and is terminated at a bellows, which acts as a flexible storage tank for the liquid, at one end, and at switch S1 with contacts C and D at the other end.



When any current flows through a conductor in a magnetic field, that conductor tends to move perpendicularly, both to the current and the field. Here the fluid itself is the conductor. Current between A and B flows through the fluid and also generates the magnetic field. As a result, the fluid is forced into S1 and it shorts terminals C and D.

When S2 is closed, it weakens the magnetic field. This permits the fluid to return into the bellows (under the force of gravity).

Light Amplifier for Color

PATENT No. 3,005,108

Radames K. H. Gebel, Dayton, Ohio (Assigned to USA as represented by Secretary of US Air Force)

Certain phosphors glow when they are suspended within a dielectric between electrodes and excited by ac. The color depends upon the particular phosphor and the frequency. For example, zinc sulphide (with copper and lead impurities) glows green at 50 cycles, blue at 500.

Narrow phosphor strips (see the diagram) are placed between upper and lower electrodes. When excited, they glow red (R), green (G) or blue (B), as the case may be. The photoconductor's resistance is high but, when light shines on it, sufficient ac flows to energize the phosphor above it. At the bottom are filter strips which can transmit light of the same color as the corresponding phosphor.

A colored image to be amplified is focused through an optical system onto the filter. Where the

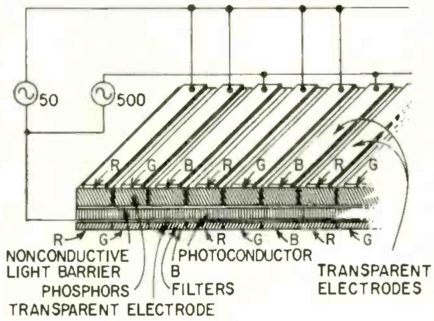


image contains *red*, for example, beneath a *red* filter, this color passes through. Falling on the photoconductor, it lowers its resistance and ac flows to excite the *red* phosphor at that point. If the phosphor strips are narrow, the reproduced color image will have good detail. If there is sufficient 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

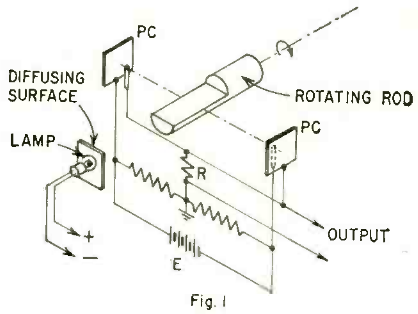


Fig. 1

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.

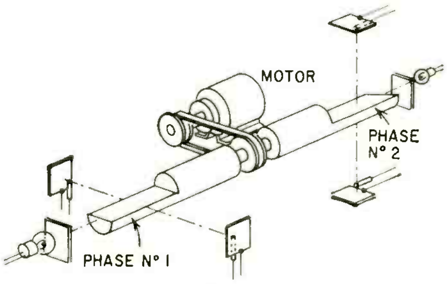


Fig. 2

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.

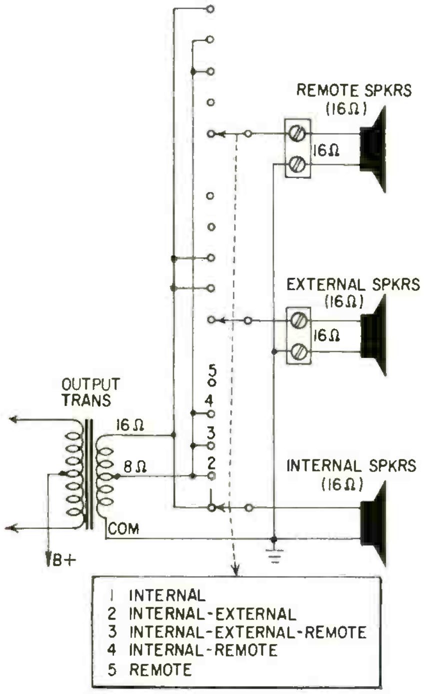
Other possibilities of this device include various waveforms (by using nonplanar surfaces); optical modulation; multi-phase output. Fig. 2 shows a 2-phase generator. The phase angle is determined by the position of the cells. END

"I'll have to have my watch repaired. It's 15 nanoseconds fast again."

noteworthy 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*

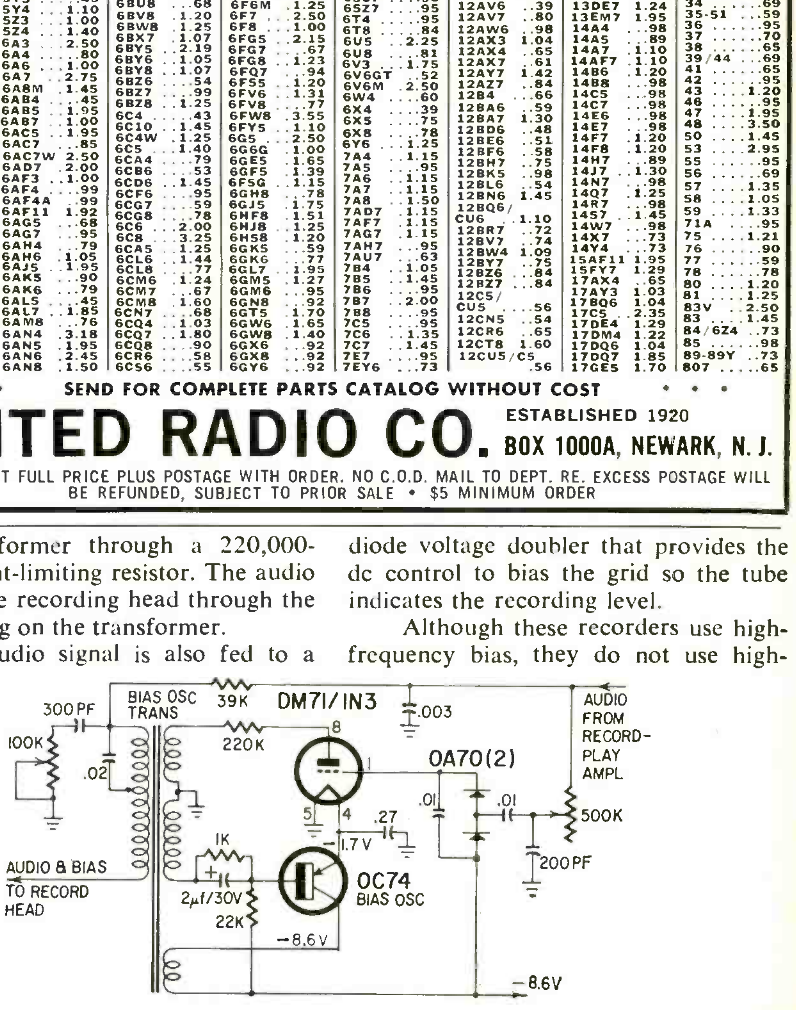
Unusual Recorder Circuit

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.

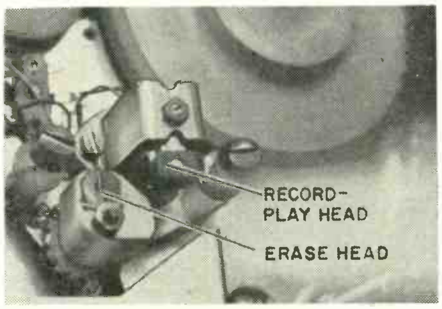
The audio signal is also fed to a diode voltage doubler that provides the dc control to bias the grid so the tube indicates the recording level.

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

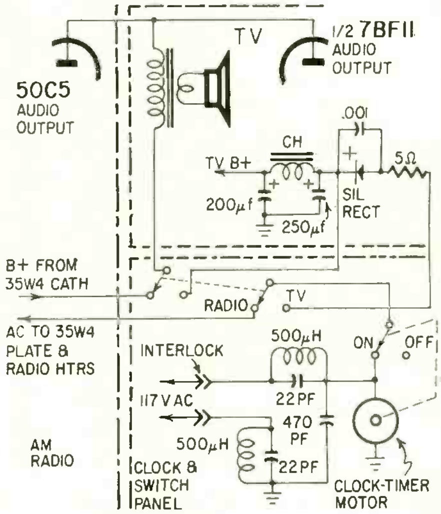


magnet on a pivot as shown in the photo. A chain and gear assembly rotates the magnet so its gap faces the tape when the function selector switch is in the RECORD position. The selector turns the gap away from the tape in the play, reverse and off positions.—*Steve P. Dow*

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-energized 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 audio 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* END

TECHNOTES

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.

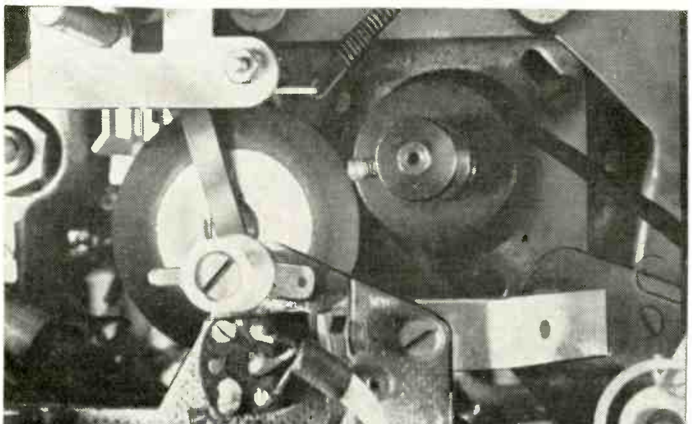
Revere TR-1200 Recorder

If the speed-change lever won't stay in either 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 tears—replace it if it has any.

To remove the idler, slide back the spring retainer (on



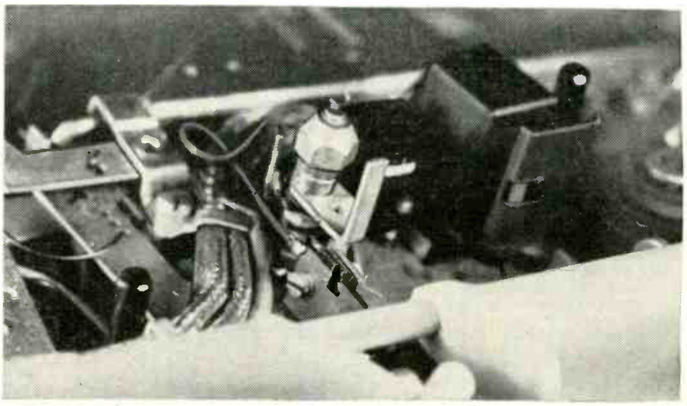
top of idler in photo) while the speed and power switch is in the 7½-OFF position.

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 start end.

To readjust these machines to work with newer reels, thread the tape, wind it (on "fast-forward") to its end, and adjust the contact to touch the tape. Be careful not to change the height of the feed guidepost, for that will alter tracking. Make sure the surface of the contact is smooth and even: it will be touching the tape longer now with standard reels.



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

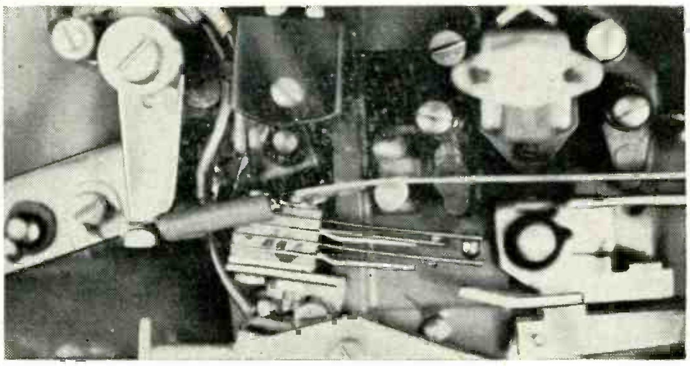
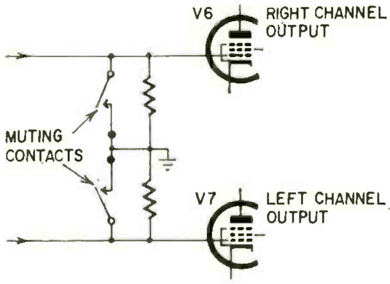


photo. The adjustment arm should be bent so that there is 1/16-inch clearance between the switch contacts. Clean the contacts with wood alcohol; other solvents may melt the plastic spacer bead.

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. END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*	
Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics and the Electrical Experimenter on file for interested readers.

In March, 1914, Electrical Experimenter

A New Wireless Relay, by Henri Mea.

New "Electro" Loading Inductance.

Experimental Electricity Course, by S. Gernsback and H. W. Secor.

Construction of an Improved Loose Coupler, by H. Winfield Secor.

A Pocket Wireless Set.

Wireless Receiving Set Without Aerial or Ground, by H. Gernsback.

A Switch-Board for Wireless Stations, by H. C. Graham.

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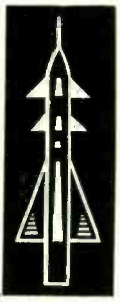
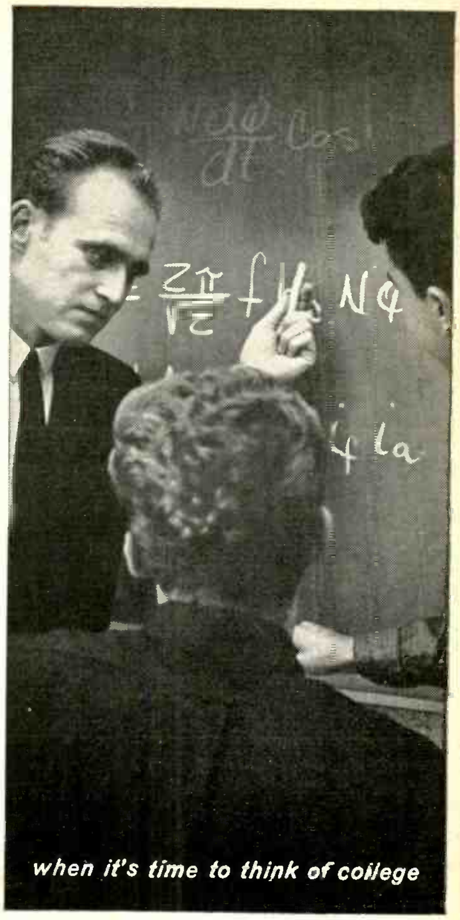
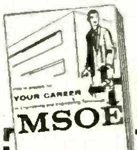






Breaking in a Woofer

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 mellowness 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.

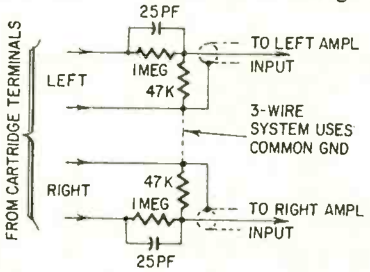
To determine if the machine is running at the right speed (in this case, 7½ ips), set the machine to play back and cue up to the "start" mark. Using a sweep-second-hand clock or stopwatch, start the machine at any convenient point on the clock dial. If you start at "straight up," then (assuming that 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 ¼- or ⅒-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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101 WAYS TO USE YOUR COLOR-TV TEST EQUIPMENT, by Robert G. Middleton. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 8½ x 5½ in., 144 pp. Paper, $2.50.*

Latest of the "101" book series, this one is divided into short, easily grasped sections averaging about a page, and is extremely well illustrated with actual scope photographs.

GETTING STARTED IN ELECTRONICS. *Publications Div., Allied Radio Corp., Chicago 80, Ill. 5½ x 8½ in., 112 pp. Paper, $.50.*

Described as a book "for everyone," this work uses the simplest possible language and clear photographic illustrations or drawings to start the beginner in electronics. Schematics are not introduced until nearly halfway through the book and the first construction project is wiring a doorbell. (Transistor radios come later.)

THEORY OF NETWORKS AND LINES, by James L. Potter and Sylvan J. Fich. *Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in., 436 pp. Cloth, $16.*

Basic theory for advanced engineering students. A well-organized text, with problems and math tables.

DICTIONARY OF ELECTRONICS COMMUNICATIONS TERMS, by Howard W. Sams Engineering Staff. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 157 pp. Paper, $3.95.*

More than 2,500 terms, including nontechnical ones such as "fist" and "rock," are clearly defined. Modern and apparently reasonably complete.

THE MATHEMATICAL THEORY OF COMMUNICATION by Claude E. Shannon and Warren Weaver. *University of Illinois Press, Urbana, Ill. 5½ x 8 in., 117 pp. Paper, $.95.*

This reprint of an original 1949 clothbound edition contains Claude Shannon's original paper, "The Mathematical Theory of Communication" plus a shorter piece, "Recent Contributions to the Mathematical Theory of Communication," written in 1949 by Warren Weaver of the Rockefeller Foundation.

STATIC ELECTROMAGNETIC DEVICES, by William T. Hunt, Jr. and Robert Stein. *Allyn & Bacon, 150 Tremont St., Boston 11, Mass. 9¼ x 6¼ in., 395 pp. Cloth, $10.50.*

A complete engineering treatment, beginning with characteristics of magnetic materials, and going through transformers, reactors and magnetic amplifiers. The book contains many examples and problems.

TRANSISTOR IGNITION SYSTEMS, by Brice Ward. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 128 pp. Paper, $2.50.*

The author, himself a designer and constructor of transistor ignition systems, covers the theory of transistor ignition, describes a number of commercial units and gives some hints on installation and troubleshooting.

A HISTORY OF ELECTRICITY, by Edward Tatnall Canby. *Hawthorn Books, Inc., Englewood Cliffs, N.J. $6\frac{1}{2}$ x $10\frac{1}{2}$ in., 112 pp. Cloth, $5.95.*

This excellent work, beginning with the early static experiments of the Greeks, the magnetic compass of the Chinese and Peregrinus and the early experiments of European scientists, continues to the modern laser. The illustrations are remarkable, largely old woodcuts and line drawings, taken from sources contemporary with the experiments described. They range from illustrations of Otto von Guericke's experiments to photographs of a radio telescope.

MOST-OFTEN-NEEDED 1964 RADIO DIAGRAMS (Vol. R-24), compiled by M. N. Beitman. *Supreme Publications, 1760 Balsam Road, Highland Park, Ill. $8\frac{1}{2}$ x 11 in., 192 pp. Paper, $2.50.*

Compilation of original manufacturers' schematics and service data covering nearly 700 chassis and models of home, auto and portable AM, FM, and FM–AM radios; phonographs and combinations of 33 makes and brands.

SEMICONDUCTOR FUNDAMENTALS, by A. H. Seidman and S. L. Marshall. *John Wiley & Sons, 605 Third Ave., New York 16, N.Y. 6 x 9 in., 278 pp. Cloth, $6.50.*

Transistors and circuits discussed at engineering level, for students familiar with vacuum tubes. Includes tunnel diodes and computer logic.

TV SERVICE PRICING MANUAL, by PF Reporter editorial staff. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. $4\frac{1}{2}$ x $6\frac{1}{2}$ in., 96 pp. Paper, $1.50.*

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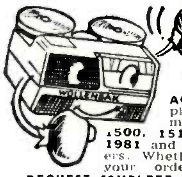

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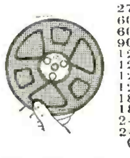

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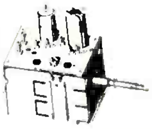

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- ☐ 10 FAMOUS CK722 TRANSISTORS, pnp $1
- ☐ 15 PNP TRANSISTORS, asst types and cases $1
- ☐ 15 NPN TRANSISTORS, asst types and cases $1
- ☐ 5 100mc SB-100 TYPE TRANSISTORS, TO1 case . $1
- ☐ 15 CBS GERMANIUM DIODES, 1N34 equals $1
- ☐ 2—2N341 NPN SILICON TRANSISTORS, 1 watt . $1
- ☐ 3 CBS 20-WATT TRANSTRS, pnp, stud, 2N1320 . $1
- ☐ 3 CBS 20-WATT TRANSTRS, npn, stud, 2N1321 . $1
- ☐ 25 TRANSISTORS, pnp 'n' npn's, TO5 cases $1

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• Ignition • TO3 Case • Switching • PNP **$1.47 EA.**

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*Over 15 mc. **25 amp

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Amps	Volts	Sale	Amps	Volts	Sale	Amps	Volts	Sale
6	200	$.37	12	50	$.49	25	50	$.99
6	400	.59	12	100	.69	25	100	1.29
6	600	.69	12	200	.88	25	200	1.60
6	800	.89	12	300	1.19	25	300	1.75
6	1000	.95	12	400	1.37	25	400	1.95

85 WATT SILICON NPN "MESA" TRANSISTOR 2N424 $1

10¢ FOR OUR "SPRING" BARGAIN CATALOG ON: ☐ Semiconductors ☐ Poly Paks ☐ Parts

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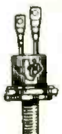

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PRV	5 Amp	10 Amp	25 Amp
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100	1.50	1.95	2.95
150	1.79	2.25	—
200	1.95	2.50	3.45
250	2.25	2.95	—
300	2.69	3.19	3.75
350	2.95	3.50	—
400	—	3.95	4.25

*See ELECTRONICS WORLD magazine, Oct. 1963 for uses 'n' hookups

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24" wide, 10" high, 9" deep; 8" high compliance woofer; 3" hardened tweeter cone; coaxial wound 1" voice coil; silicone treated edge allows for ¾" cone displacement; Alcomax III 1-lb. 5-oz. magnet; 10,000 gauss flux density; 8 ohm impedance; zero external magnetic field; 40-18,000 cps; up to 30 watts power capacity; 1450 cubic inch volume; Fibreglass acoustic dampening; matched for stereo. Solid wood—not a composite.

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ADVERTISING INDEX

FROM THE INVENTORS OF TAPE RECORDING...

NOW HEAR THIS:

EASY MAINTENANCE: Amplifier plate opens on hinge for easy, fast servicing ... one of many special **TELEFUNKEN** features.

EASY PORTABILITY: Weighs only 26½ lbs. including carrying case. Overall dimensions 9" x 11½" x 16".

The Perfect Tape Recorder...is instantly revealed...in Telefunken's Magnetophon 97 de Luxe. With push-button ease, this fully self-contained 4-track stereo record/stereo playback system with 2 loudspeakers shows its Telefunken lineage. *No compromises here: are you sure you're not in the concert-hall?*

Now, hear the secrets of its marvelous sound...Telefunken's patented extra-sensitive brake mechanism assures correct tape tension always, protecting heads and tapes. Pre-amplifier equalization automatically optimizes frequency response (30-18,000 cps at 7½ ips, 30-16,000 at 3¾, 30-9,000 at 1⅞). At 7½ ips wow and flutter are less than 0.15%, and signal-to-noise ratio better than 50 db.

Versatility? The Magnetophon 97 de Luxe takes reels to 7", offers sound-on-sound recording, mixing, and transcription from one track to another. You can edit, monitor and use it as a public address system. There's a built-in tape splicing groove and a digital counter—and a full line of accessories. Hear the "touch of perfection" to believe it.

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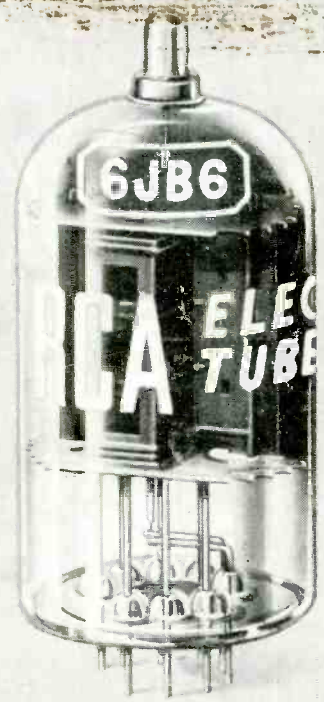
SEE HOW RCA RECEIVING TUBES KEEP GETTING BETTER

1959—N-132 Cathode Base Material

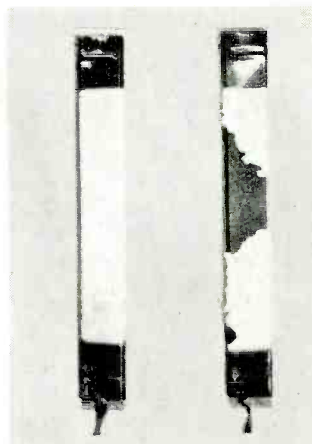
1960—S-311 Plate Material

1961—RCA Dark Heater

...AND 1963



THE BONDED CATHODE



Ends cathode peeling, even after long periods of high-temperature, high-voltage tube operation.

Picture on right is an example of peeling which may occur in non-bonded cathode of a horizontal-deflection-amplifier tube after several hundred hours of operation in a TV receiver.

From RCA research comes another major contribution to electronic performance and reliability: the bonded cathode. Its emissive coating will not peel even after extended service under high-voltage, high-temperature conditions encountered in TV horizontal-deflection-amplifier tubes and damper diodes. Permanent adhesion of the emissive-oxide coating of the RCA bonded cathode improves over-all tube performance and reliability. Here's why:

THE NEW RCA BONDED CATHODE:

- virtually eliminates peeling of emissive oxide coating
- reduces cathode interface-type impedance effects during life
- reduces grid-to-cathode shorts during life
- improves stability of cathode-to-grid spacing
- improves anode-voltage-per-mil-spacing safety factor in damper diodes
- transmits heat more efficiently and uniformly—thereby providing more uniform cathode-current density

The RCA bonded cathode was first applied with outstanding success in beam power tube types 6DQ6-B and 6JB6 and half-wave vacuum rectifier types 6AU4-GTA and 6AY3. This new development is now being incorporated in a growing number of types where service conditions show a need.

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