November 1956

Volume 1 Number 13

audiocraft

THE HOW-TO-DO-IT MAGAZINE OF HOME SOUND REPRODUCTION

Philip C. Geraci is the only contributor to this issue whose name is here for the first time. He is a photographer and an instructor in photography for the University of Maryland, which made it convenient for him to take and process the pictures that illustrate his article so well. This is also, he says, an ideal situation for an amateur recordist, because of the opportunities to tape excellent musical performances by a great many bands, orchestras, and choral groups. He is assembling material for a collection of Maryland music that will be released as a disc.

Mr. Geraci has a wife, two boys, two cats, and a goldfish recently widowed by one of the cats. The rumor that his wife and children live upstairs while he lives in the basement with his hi-fi equipment, coming up occasionally for meals and to mow the lawn, is probably unfounded in truth. It *is* a fact that, although his photographs have been published frequently, this is his first article — a feature article, at that.

We've another new department this month: Book Reviews. This column will be prepared regularly by Richard D. Keller, an engineer who spends his daylight hours working on semiconductor products for General Electric, Syracuse, N. Y. A good part of his spare time is occupied by high-fidelity experiments with transistors, and in listening to the results thereof. Mr. Keller wrote an article on distortion and its effects for our March 1956 issue.

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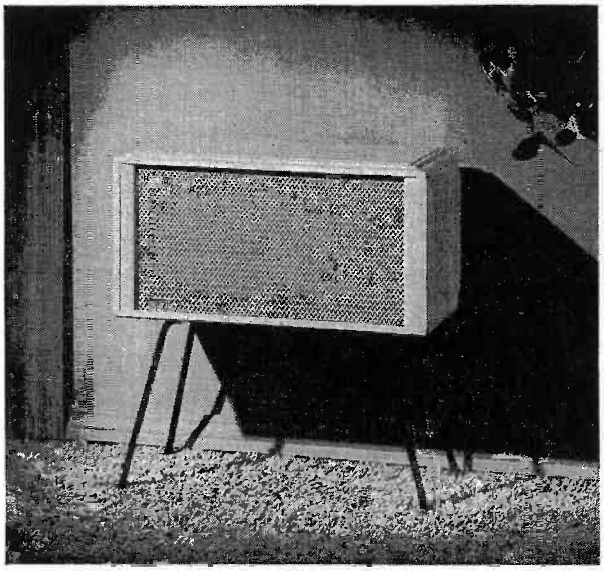
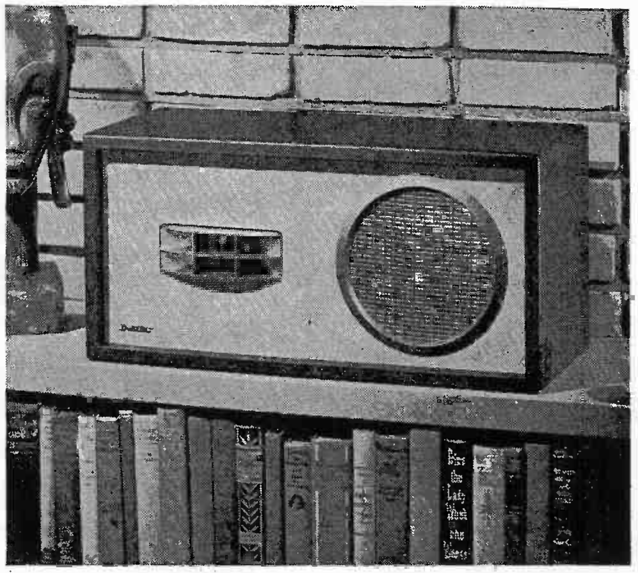
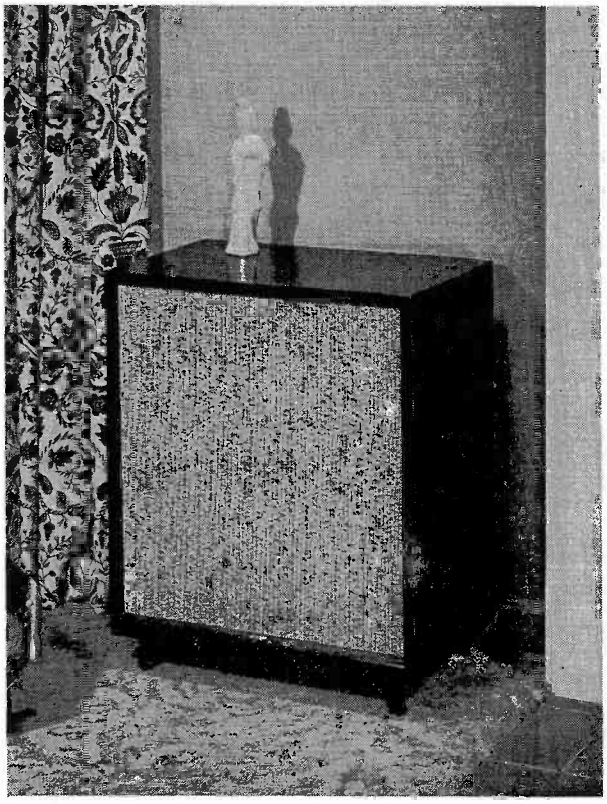


DU-300



DU-201

Biggest HI-FI PERFORMANCE ... IN *Small* PACKAGES



CN82—CN-83

Jensen Duette and Contemporary models are the greatest values in hi-fi loudspeaker history! Nowhere will you find so much performance at such a low cost . . . nowhere can you get such fine reproduction in so little space.

These authentic hi-fi reproducers are full 2-way and 3-way systems with special heavy-duty 8" woofer in specially designed enclosures for best bass response. High frequencies are reproduced by a Hypex* horn loaded compression driver tweeter (plus Hypex horn loaded compression driver supertweeter in the CN-83 system).

You'll need to listen to fully appreciate the outstandingly smooth, clean, finely balanced hi-fi sound. We think you'll be pleased with the trim styling and fine finishes. Ask your dealer about Jensen Duette and Contemporary now.

*TM Reg.

Duette Speaker Systems

DU-201	Duette 2-way system. Pigskin grained Burgandy Fabrikoid finished Cabinet. Sizes 11" H.; 23¼" W.; 10" D. Net Price	$62.50
DU-300	Duette "Treasure Chest" 2-way system. Choice of genuine Blonde Oak or Mahogany veneers. Size 11" H.; 23¼" W.; 10" D. Net Price	$76.50
	Wrought iron leg set	4.25

Contemporary Speaker Systems

CN-82	Contemporary 2-way system. Selected Mahogany. Net Price	$88.75
	Blonde Oak. Net Price	89.75
CN-83	Contemporary 3-way system Selected Mahogany. Net Price	$128.75
	Blonde Oak. Net Price	129.75

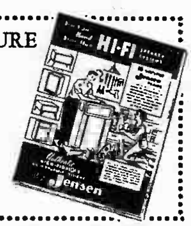
Contemporary dimensions are: 24¼" H.; 19" W.; 12⅜" D.

Write for Catalog 165-A

YOU CAN BUILD YOUR OWN ENCLOSURE

If you want the fun of building your own hi-fi speaker system of your own selection, this Jensen Manual simplifies it for you. Complete instructions for free-standing or built-in systems with simplified drawings, parts lists, circuit and wiring diagrams.

Send 50¢ today for Jensen Manual 1060



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The Grounded Ear

by Joseph Marshall

Acoustic Resistance Unit

The bass reflex is probably the most popular enclosure for loudspeakers, especially with those who like to build their own equipment. It is relatively simple to build; it is, or can be, reasonably small; and properly designed, built, and tuned, it is capable of excellent performance. Now Goodmans Industries Ltd. of England, manufacturer of the excellent Axiom line of speakers, has introduced a gadget which will probably make the bass-reflex enclosure even more popular by simplifying its design and construction, and by promising even better performance. This is the Acoustic Resistance Unit.

The principle of its operation is not new. Acoustic resistance has been used by knowledgeable audiophiles for some time. The bass-reflex enclosure, of course, is a resonator that is tuned to a certain frequency complementary to the free-air resonance frequency of the speaker. If it is too sharply resonant, it will give boomy, unnatural reproduction of bass. Introducing acoustic resistance into the system spreads out the frequency range of resonance and reduces the amplitude; that is, it reduces the *Q* of the enclosure resonance, or damps it. There are several ways of introducing an acoustic resistance, but one of the simplest is the "resistive port" method. In this method the reflex port of the enclosure is covered with layers of dense fabric until a satisfying effect is achieved.

The Acoustic Resistance Unit (ARU) is a prefabricated resistive port. Instead of layers of cloth, it has layers of wire screening on which flocking has been applied to produce a resistive effect similar to that of cloth. It is a handsome device in a fine unfinished wood frame, with a metal grille, which fits into a rough opening in a suitable cabinet and is screwed in from within.

Those who have had experience with bass-reflex enclosures will appreciate that no single unit could possibly suit all enclosures and speakers. At present there are four models of the ARU. Three are designed to work with various combinations of the fine Axiom 80 speaker. A fourth has more universal application; it is said to be usable with many 12-inch speakers besides the Goodmans speakers recommended. Each of these units requires an enclosure of a certain volume, although there is a 10% tolerance in the volume — just enough to make construction noncritical. The ARU's for the Axiom 80 speakers require cabinets from 5,900 cu. in. for a single speaker to 11,700 cu. in. for a set of four speakers. The 172ARU, which is applicable to many 12-inch speakers, requires an enclosure of 7,800 cu. in. The ARU can be placed in any convenient position in the enclosure; a cutout opening of about 10 by 10 in. is needed for the 172ARU. Goodmans says that the ARU's will load the cone down to zero frequency and provide an extension of range (with suitable speakers) down to 20 cps. Additional damping is recommended in the form of padding of the interior surfaces and the addition of a pair of felt curtains hanging within the enclosure back of the cone. This combination is said to result in the complete absence of cabinet resonances above 20 cps and to reduce distortion resulting from excessive cone displacement.

The principle is sound, certainly, and the model I tried with the Axiom 80 speakers produced fine audible results. I have no personal experience or reports on the use of ARU's with other speakers, but I am inclined to think that the addition of an ARU to an already constructed system would provide an improvement only by coincidence. Effects of the acoustic resistance will vary with both the volume of the enclosure and the characteristics of the speaker used; unless the volume and speaker characteristics happened to be close to those required for the ARU, the match and tuning would not be proper for the combination. So the ARU provides no cure-all for bass-reflex problems. Assuming, however, that you want to use one of the recommended speakers and either have or can build an enclosure of the recommended volume, the ARU can provide an almost foolproof way of achieving a good speaker system. Even the most unskilled should be able to build an enclosure of the specified volume; the size and form are not important factors and the relative positions of speaker and ARU are noncritical; no tuning is necessary. Even an absolute amateur could build himself an inexpensive enclosure and be pretty sure of results comparable or even superior to those obtained from very good factory produced combinations.

At the moment Goodmans is distributing (through Rockbar, Inc.)

Here, kitty kitty kitty kitty kitty. . . !

ARU's suitable for use with their own speakers and the model which can be used with some 12-inch speakers. But the idea is worthy of much wider application, and I should not be surprised to see the line extended.

Destaticized Records

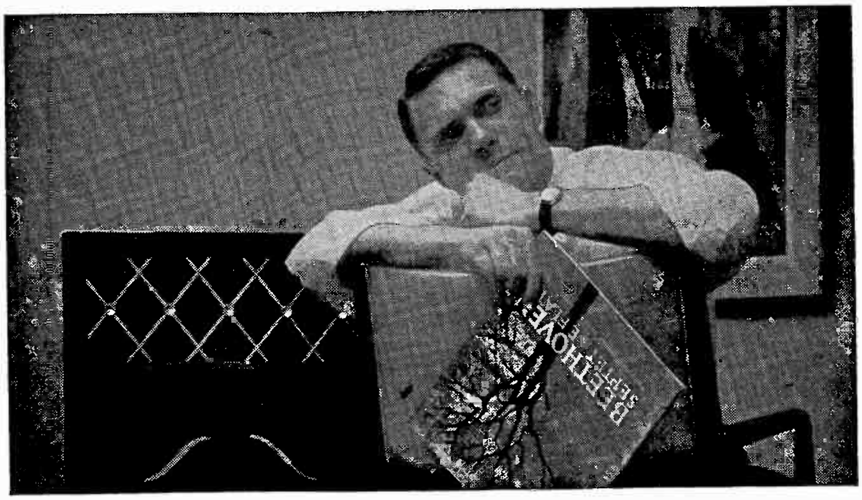
The most recent releases from MGM records have come with a sticker reading: "DUST PROOF. This MGM record is specially treated and protected by a process eliminating the attraction of dust by static electricity. . . ." This is a long-overdue development — one which, I trust, will soon be so widely copied by other labels that in a few months we can take it for granted that any record we buy has been so treated. Now that there are several ways of destaticizing records, it seems to me that the manufacturer has a pretty clear obligation to deliver to his customer a recording as free of static susceptibility as the art permits. Though I know little of the business of manufacturing records, it seems likely to me that manufacturers can do this more conveniently and more effectively than the customer himself; certainly, the customer would be pleased to have the job done before the record comes to him.

As for the MGM discs, the destaticizing is quite effective. I experienced far less trouble with dust and lint on the first playing of the new MGM's than with other labels. I don't suppose the treatment can be permanent, but this is certainly a step in the right direction; I hope MGM is rewarded for its pioneering with wider sales.

New Cartridge

Some months ago in this column we had a discussion about pickup movements. It began when I commented on the theoretical advantages of the moving-iron design used by Angel. Then I reported some correspondence with Sherman Fairchild, in which he pointed out that a moving-coil pickup (like the Fairchild) is not necessarily handicapped by having to move a coil as well as a stylus bar. The newest model of the Fairchild, the 225A, is evidence that Mr. Fairchild was not speaking merely in academic terms; the 225A is a considerable improvement on a fine cartridge. Previous models were nicely flat to 15,000 cps but had a small peak at 17,000 or so, followed by a fairly sharp cutoff. The peak in the 225A has been moved to above 20,000 cps, and response is now beautifully flat all the way up to that frequency and beyond. Low-end response is also very good indeed, being flat on my system down to 15 cps. The sound is especially clean and sweet on the high end, the transient response is excellent, and my ears

Continued on page 44



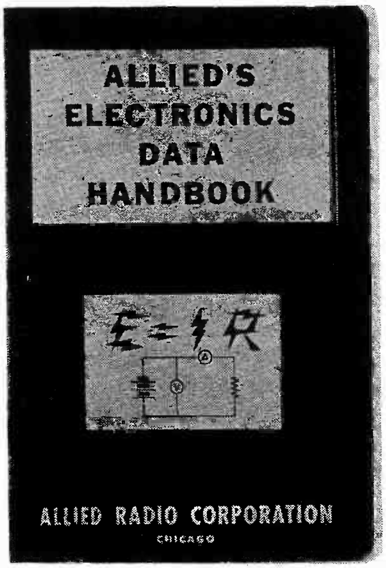
Audionews

ELECTRONICS DATA HANDBOOK

Allied Radio Corporation has announced the release of a 64-page *Electronics Data Handbook* that consists of a carefully selected collection of the most-often needed formulas and data used in radio and industrial electronics.

Formulas include those needed for basic circuit analysis, transmission-line calculations, determination of vacuum-tube characteristics, resonance calculations, and meter calculations.

Included are up-to-date RETMA and Military specifications for resistors and



New electronics data handbook.

capacitors, coil winding data, wire gauge data, metric relationships, tables for directly interchangeable radio and TV picture tubes, interchangeable batteries, pilot lamps, decimal equivalents of fractions, logarithms, and trigonometric functions. A three-page explanation of the use of logarithms precedes the logarithm tables. Additional data cover attenuator networks, minimum loss pads and mixers, decibels *vs.* voltage, current and power ratios, and complete details on using the RETMA 70-volt system of speaker hookup.

This information was compiled and prepared by Allied's technical staff. The booklet was prepared by the Publications Division of Allied Radio, under the direction of Eugene Carrington, and was edited by Nelson M. Cooke, Lt. Cdr., United States Navy (Ret.), author of *Mathematics for Electricians and Radiomen* and formerly with the Naval Research Laboratory.

The book is available from Allied Radio Corporation and is priced at 35¢ postpaid. Allied's stock number is 37 K 398.

CABINART/JENSEN KITS

An arrangement has recently been announced whereby the Cabinart Division of the G & H Wood Products Company will manufacture and sell a special line of Jensen-designed cabinet kits intended for use with Jensen high-fidelity loudspeaker kits.

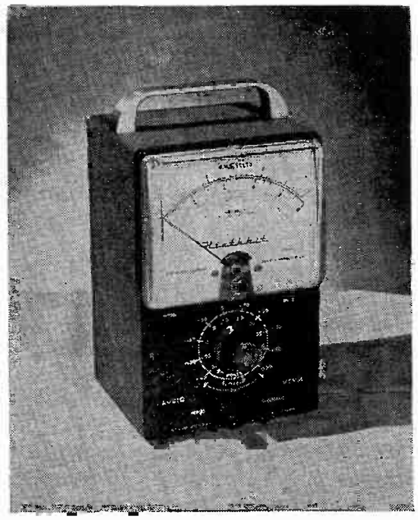
Seven basic cabinet kits are offered to accommodate Jensen speaker kits. They range from the diminutive Duette to the large Imperial. A choice of highboy corner or lowboy noncorner styles is available for systems using 12- and 15-inch woofers.

All needed parts are furnished with the cabinet kit series, including hardware. In addition, all wood panels are cut to size and shaped, and all necessary cutouts for speaker units and controls are provided.

All cabinet types are furnished in basic kits, constituting the plain plywood functional enclosure; or prefinished dress kits which include prefinished and rubbed mahogany or blonde korina top panels, bottom moldings, and a base or legs, plus wraparound grille cloth.

AUDIO VACUUM-TUBE VOLTMETER KIT

The new Heathkit *Model AV-3* AC vacuum-tube voltmeter is designed especially for audio measurements and low-level AC measurements in power-supply filters, etc. The unit employs a cascode amplifier circuit with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. The input impedance of the circuit is 1 megohm at 1,000 cps. Response of the AV-3 is said to be essentially flat from 10 cps to 200 Kc, and the meter is reported to be usable for tests even beyond these frequency limits. Increased damping in the meter circuit stabilizes the meter for low-frequency tests. Nylon insulating bushings at the input terminals reduce leakage and permit the use of the 5-way Heath binding post.



Redesigned Heath VTVM kit.

The wide voltage range covered by the AV-3 makes it valuable not only in high fidelity and service work, but also in experimental laboratories. AC (RMS) voltage ranges are 0 to .01, .03, 1, 3, 10, 30, 100, and 300 volts. Decibel ranges cover —52 db to +52 db. This unit employs an entirely new circuit as compared to the previous model. 1% precision multiplier resistors are used for maximum accuracy.

Additional information about the Model AV-3 AC vacuum-tube voltmeter will be furnished on request.

For more information about any of the products mentioned in Audionews, we suggest that you make use of the Product Information Cards bound in at the back of the magazine. Simply fill out the card, giving the name of the product in which you're interested, the manufacturer's name, and the page reference. Be sure to put down your name and address too. Send the cards to us and we'll send them along to the manufacturers. Use this service; save postage and the trouble of making individual inquiries to a number of different addresses.

NEWCOMB AMPLIFIER/TUNER

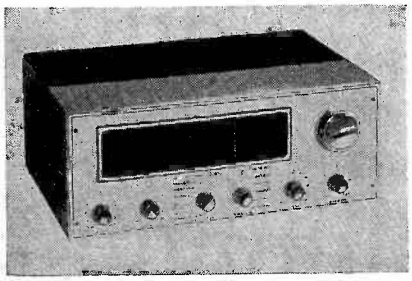
A new combination tuner/amplifier/preamp with controls has been added to the Compact line of Newcomb Audio Products Company. The new unit, known as the *Royal 712 Compact*, is 5⅜ in. high, 14⅜ in. wide, and 10 in. deep.

The amplifier section of the unit is

rated at 12 watts, with response said to be within 1 db from 20 to 20,000 cps. Total harmonic distortion, according to the manufacturer, is below 1% at 12 watts. Output impedances are 8 and 16 ohms.

Inputs are provided for magnetic pickups, crystal pickups, tape, and an auxiliary input. An input-impedance selector matches input requirements of magnetic pickups. A special multiple-output jack simplifies adaptation to the reception of stereophonic or binaural broadcasts using the new FM multiplex system. A tape-output jack permits the recording of programs while listening. Magnetic-pickup input is said to be able to produce full rated power with as little as .005 volt input.

The radio dial of the Royal 712 Compact is edge-lighted, and includes a finely calibrated 0 to 100 reference scale in addition to the regular FM and AM scale. The FM sensitivity is claimed to be better than 5 μv for 30 db of quieting.



Newcomb combined amplifier-tuner.

The Newcomb Royal 712 includes seven panel controls as follows: bass tone, range −24 to +16 db; treble control, range −27 to +14 db; function selector for FM, FM no AFC, AM, phono, phono with rumble filter, auxiliary input, and tape input; record-response control with six positions; level control; full-range loudness control; and tuning control.

Latest Anechoic Test Room

A NEW anechoic chamber for research and testing in all phases of acoustics has been completed by Stromberg-Carlson, a division of General Dynamics Corporation.

This new facility, designed both to exclude all exterior sounds and to eliminate internal acoustic reflections, is adjacent to the engineering building of the company's Special Products Division, at 1700 University Avenue, Rochester, New York. Design and construction of the chamber was under the direction of the company's Electro-acoustics Research Group, headed by Frank H. Slaymaker.

Since the chamber stands less than 50 ft. from the main line of the New York Central Railroad, and is only a slightly greater distance from a heavily traveled city street, it was necessary to construct a "room within a room" in order to exclude exterior noise. The outer shell of this structure is of high-density concrete blocks. Inside this, separated by several inches of air space, is another room, the walls of which are fabricated of panels of a high-density cement and asbestos composition. This entire internal structure, 25 by 25 by 27 ft., is completely suspended on special vibration-absorbing felt hangers.

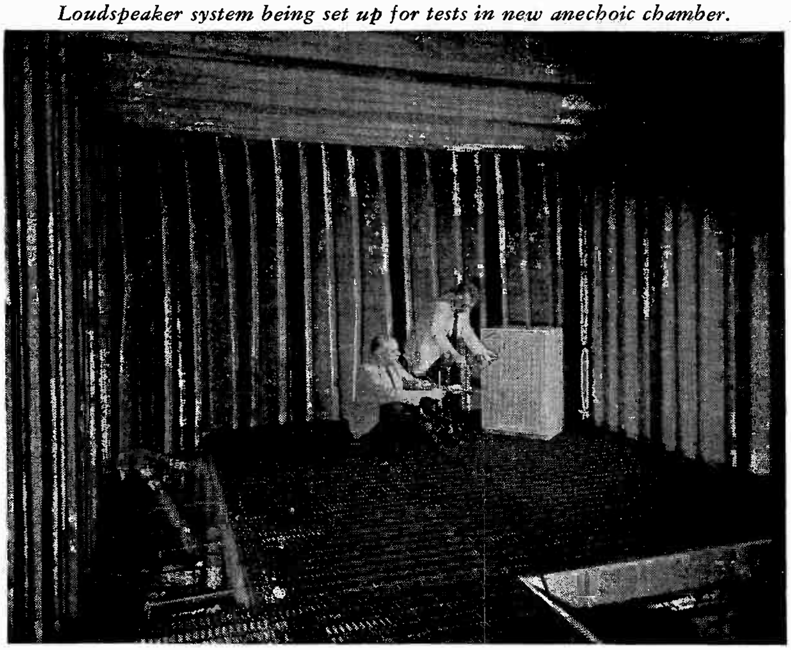
To absorb internal sounds and prevent echoes within the room, the chamber is lined on all sides, including floor and ceiling, with thick glass-fiber batts, hung edgewise to the wall in alternate widths of 1, 2 and 4 ft. Thus this acoustical insulation, when viewed in profile, presents a saw-tooth appearance, with a minimum thickness of 1 ft. of the glass-fiber insulation, and a maximum thickness of 4 ft. A fabric core in the glass-fiber material supports the insulating material from the ceiling.

For most acoustical measurements an open steel grid will serve as a floor. However, in some cases in which even this might cause echoes that would interfere with the tests, the grid can be removed, and the equipment suspended from the ceiling.

The single opening into the chamber is fitted with special double doors of the same type used for jet-engine test cells. They are 6 in. thick, and filled with a cork sound-absorbing material.

In addition to serving Stromberg-Carlson's acoustical research and testing requirements, the new anechoic chamber also will be made available to other industries for sound measurements.

Loudspeaker system being set up for tests in new anechoic chamber.



PRINTED-CIRCUIT KIT

Photocircuits Corporation has developed a complete kit for accurate and simplified production of engineering or prototype models of printed-circuit parts. A completely etched electrical circuit ready for assembly can be made in about 30 min., according to the manufacturer. A newly developed drawing pen is used to draw the pattern, obviating the use of paints, tape, photosensitive coatings, or negatives.

The kit is composed of the drawing pen and etchant resist ink, 4 bottles of etching powder, a drawing guide, 10 copper laminated Bakelite sheets (5 with copper laminate on two sides), 10 most popular tube sockets, and detailed instructions for use.

Kit of materials for etched-circuit parts.

At least a dozen circuits, it is said, may be produced with the materials in the kit. Information about the printed-circuit kit is available on request.

Fine High-Fidelity is for you too . . .

You *can* enjoy savings *without* sacrificing quality—if you "build-it-yourself" and eliminate labor charges; and if you buy direct from the manufacturer and eliminate extra profit.

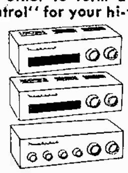
MODEL BC-1

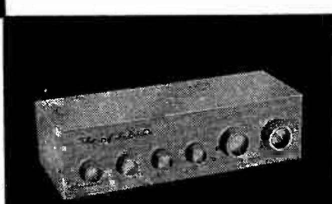
Here's what you get:

High-fidelity amplifiers, tuners, and speakers that you *assemble yourself,* from the step-by-step instructions furnished. You get, top-quality parts at lower cost through Heath mass purchasing power. You get the equivalent of systems costing approximately twice the Heathkit price.

MATCHING CABINETS

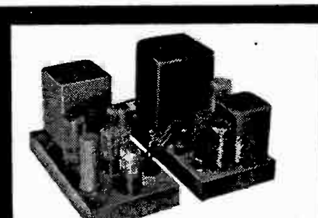
The Heathkit AM tuner, FM tuner, and preamplifier kits may be stacked one on the other to form a compact "master control" for your hi-fi system.





MODEL WA-P2

MODEL W-5M

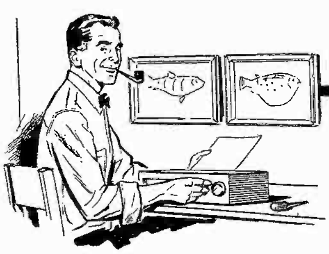


MODEL W-3M

MODEL FM-3A

HERE'S WHY A Heathkit® IS FUN TO BUILD:

Instructions are *complete,* and our amazing step-by-step method, tied-in with large pictorial illustrations, guide the beginner through each stage of assembly. If you can follow directions you can succeed, and can build high-fidelity equipment you will be proud to show off to your family and friends.



Here's the proof:

Thousands of Heathkits have been built at home by people just like yourself, and you should treat yourself to this same experience by dealing with the world's largest manufacturer of top-quality electronic kits for home and industry.

Heathkit Model FM-3A High Fidelity FM Tuner Kit
Features A.G.C., and stabilized, temperature-compensated oscillator. Ten uv sensitivity for 20 DB of quieting. Covers standard FM band from 88 to 108 mc. Ratio detector for efficient hi-fi performance. Power supply built in. Illuminated slide rule dial. Pre-aligned coils and front end tuning unit.
$26.95* (With Cabinet) Shpg. Wt. 7 Lbs.

Heathkit Model BC-1 Broadband AM Tuner Kit
Special AM tuner circuit features broad band width, high sensitivity and good selectivity. Employs special detector for minimum signal distortion. Covers 550 to 1600 kc. RF and IF coils pre-aligned. Power supply is built in.
$26.95* (With Cabinet) Shpg. Wt. 8 Lbs.

Heathkit Model WA-P2 High Fidelity Preamplifier Kit
Provides 5 inputs, each with individual level controls. Tone controls provide 18 DB boost and 12 DB cut at 50 CPS and 15 DB boost and 20 DB cut at 15,000 CPS. Features four-position turnover and roll-off controls. Derives operating power from the main amplifier, requiring only 6.3 VAC at 1 a. and 300 VDC at 10 ma.
$21.75* (With Cabinet) Shpg. Wt. 7 Lbs.

Heathkit Model W-5M Advanced-Design High Fidelity Amplifier Kit
This 25-watt unit is our finest high-fidelity amplifier. Employs KT-66 output tubes and a Peerless output transformer. Frequency response ± 1 DB from 5 to 160,000 CPS at one watt. Harmonic distortion less than 1% at 25 watts, and IM distortion less than 1% at 20 watts. Hum and noise are 99 DB below 25 watts. Output impedance is 4, 8 or 16 ohms. Must be heard to be fully appreciated.
$59.75 Shpg. Wt. 31 Lbs. Express Only

MODEL W-5: Consists of Model W-5M above *plus* Model WA-P2 preamplifier. $81.50* Shpg. Wt. 38 Lbs. Express only

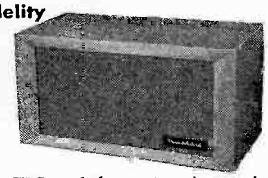
Heathkit Model W-3M Dual-Chassis High Fidelity Amplifier Kit
This 20-watt Williamson Type amplifier employs the famous Acrosound Model TO-300 "ultra linear" output transformer and uses 5881 output tubes. Two-chassis construction provides additional flexibility in mounting. Frequency response is ± 1 DB from 6 CPS to 150 kc at 1 watt. Harmonic distortion only 1% at 21 watts, and IM distortion only 1.3% at 20 watts. Output impedance is 4, 8 or 16 ohms. Hum and noise are 88 DB below 20 watts.
$49.75 Shpg. Wt. 29 Lbs. Express only

MODEL W-3: Consists of Model W-3M above *plus* Model WA-P2 preamplifier. $71.50* Shpg. Wt. 37 Lbs. Express only

HEATHKIT SPEAKER SYSTEM KITS

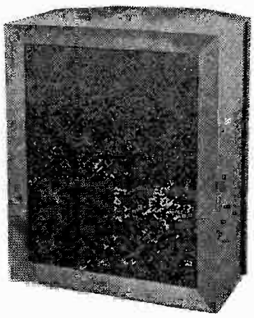
These speaker systems are a very vocal demonstration of what can be done with high-quality speakers in enclosures that are designed especially to receive them. Notice, too, that these two enclosures are designed to work together, as your high-fidelity system expands.

Heathkit Model SS-1 High Fidelity Speaker System Kit

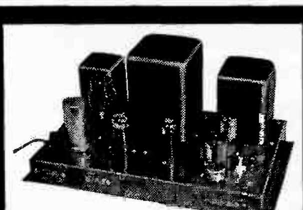


Employing two Jensen speakers, the Model SS-1 covers 50 to 12,000 CPS within ± 5 DB. It can fulfill your present needs, and still provide for future expansion through use of the SS-1B. Cross-over frequency is 1600 CPS and the system is rated at 25 watts. Impedance is 16 ohms. Cabinet is a ducted-port bass-reflex type, and is most attractively styled. Kit includes all components, pre-cut and pre-drilled, for assembly.
$39.95 Shpg. Wt. 30 Lbs.

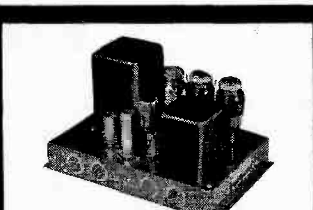
Heathkit Model SS-1B Range Extending Speaker System Kit



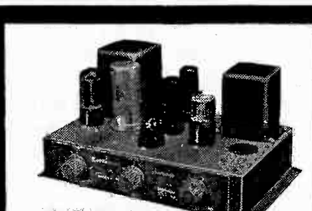
This range extending unit uses a 15″ woofer and a super-tweeter to cover 35 to 600 CPS and 4000 to 16,000 CPS. Used with the Model SS-1, it completes the audio spectrum for combined coverage of 35 to 16,000 CPS within ± 5 DB. Made of top-quality furniture-grade plywood. All parts are pre-cut and pre-drilled, ready for assembly and the finish of your choice. Components for cross-over circuit included with kit. Power rating is 35 watts, impedance is 16 ohms.
$99.95 Shpg. Wt. 80 Lbs.



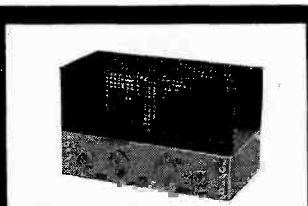
MODEL W-4AM



MODEL A-9B



MODEL A-7D



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TIPS FOR THE WOODCRAFTER

by George Bowe

IN the months past we have discussed at some length the use of both hand and power tools in the home workshop. Once the operation of a tool is mastered, the craftsman should learn how to sharpen that tool. Quality and accuracy of woodwork depend upon the keenness of the tool's cutting edge, and sharp tools are safer to use than dull ones. Yet, as obvious as these facts may appear, many a man continues to use unbelievably dull tools.

Caring for most hand tools requires, principally, a common oilstone with a rough surface on one side and a fine

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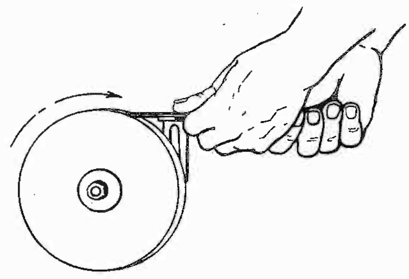

Fig. 1. Grinding a chisel or plane iron.

surface on the other; a flat file and a slim-tapered triangular file; and a small grinding wheel, either hand-operated or power-driven. Now let's trace the steps necessary to put a razor-sharp edge on the tools most used.

Sharpening Chisels, Plane Irons, etc.: When chisels, plane irons, and spokeshave blades have been damaged or the bevels shortened by numerous whettings on an oilstone, it is necessary to restore the bevel by using a grinding wheel. The angle of bevel should be 25° to 30° and can be gauged by making the length of the bevel twice the thickness of the tool blade. Place the tool on the rest with the bevel lightly touching the face of the wheel, which is revolving toward the tool as illustrated in Fig. 1. It is important that the bevel be ground flat or slightly concave. Move the tool from side to side across the stone and dip the blade in water frequently to prevent burning the edge. If the metal turns blue-black in color, the temper of the steel is lost and the softened edge is easily dulled and damaged. When you've finished grinding the bevel, check it for squareness. The edge should be approximately at right angles to the sides of the tool. To assist the amateur in grinding chisels and plane irons, there are several devices on the market which hold the tool at the correct angle throughout the operation to insure a straight, even bevel.

The second part of the sharpening process is whetting or honing, and this requires an oilstone with a mixture of machine oil and kerosene as a lubricant on its surface. Do not use water, or small particles of the steel will become embedded in the pores of the stone. Occasional whetting can keep a fine edge on the tools for a long time between grinding.

Place the bevel almost flat on the oilstone with the back edge of the bevel very slightly raised, and with a steady hand move the tool back and forth over the entire surface of the stone in a rotary motion. Using the complete face of the oilstone will wear it down evenly to maintain the flatness necessary for perfect whetting. When the bevel edge has been honed, reverse the tool and place the back side perfectly flat on the oilstone. A few strokes back and forth should remove the wire or feather edge which formed during the grinding. Finish the whetting by drawing the tool several times across a piece of smooth leather that has been glued to a piece of wood. If leather is

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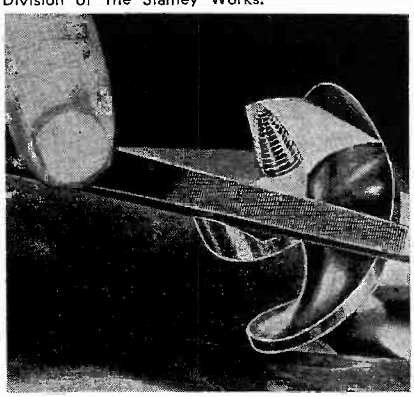

Fig. 2. Sharpening inside of augur bit.

not available, a piece of hardwood may be used for stropping.

To test the sharpness of the tool pass the thumbnail lightly over the edge of the blade. If the edge is sharp, it will grip the nail; if not it will slide over it. Another method is to inspect the cutting edge for reflection of light; a dull edge reflects light, a sharp edge does not.

Auger Bits: Use a small, flat, auger-bit file and sharpen the inside of the

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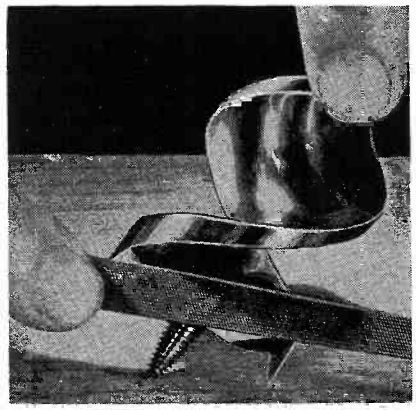

Fig. 3. How to file augur-bit lip edge.

spurs — *never* the outside, or the diameter of the bit will be reduced. Hold the bit firmly on a bench with the point upward and move the file in an arc following the inside shape of the spur, as in Fig. 2. To file the cutting edge of the lips, hold the bit point down and sharpen on the side toward the shank (Fig. 3). Remove any burr by lightly stroking the outside with an oilstone.

Twist Drills: The safest method of sharpening twist drills is to use a special precision grinder attachment which assures straight cutting edges equal in length.

Hand Saw: Although filing a saw is a task not too many perform, it's good to know the routine of the process to give your saw the "once over lightly" between sharpenings by a professional. Skill, experience, and patience are requisites in saw filing. The first attempt should be made on an old saw, using a new one as a model for comparison. Three principal operations are necessary in saw sharpening:

1) Jointing, or making the teeth uniform in height, is accomplished by running a flat file over the points of the teeth until every tooth is touched by the file. As you progress, you'll notice that some teeth have been flattened on the top while others have barely touched the file. Continue the

filing until all flattened points can be seen clearly. Best results are obtained when the file is attached to a holder made especially for this purpose.

2) Setting, or bending the teeth outward, makes the saw kerf wide enough to prevent the saw from binding in the wood. Setting is accomplished best by using a special tool called a "saw set" (Fig. 4). Starting next to the handle of the saw, place the saw set on the first tooth bent away from you. Then, after setting that tooth, skip one and set the next tooth bent away from you. When you reach the point of the blade, reverse the saw and repeat the process.

3) Filing, or shaping the teeth, is done with a 6- or 7-inch slim-tapered triangular file, with the saw held in a special saw clamp or an improvised version made from C-clamps and two strips of hardwood. Begin at the point of the saw by placing the file in the gullet next to the first tooth that is bent away from you. For a crosscut saw swing the file to an angle of about 65° to the handle and make the first stroke. Lift the file at the end of the stroke. Each alternate tooth is filed until the handle of the saw is reached. Then turn the saw around and, beginning at the point, start filing the remaining teeth. The procedure in jointing and setting a ripsaw is the same as with a crosscut saw. The only difference in filing is the angle of the stroke — with the ripsaw the file should be held at right angles to the blade. Fig. 5 shows side and top views of crosscut and ripsaw teeth correctly ground. As a final operation for both crosscut and ripsaws dress the sides of the teeth very lightly with an oilstone. Two or three light strokes of the stone on each side of the blade usually are sufficient.

Screw Driver: This is one tool that, strictly speaking, should never be "sharpened" since it works best with a blunt edge. But, since we're on the subject of grinding and filing, I think we would be remiss not to include one of the most abused of instruments; it

Continued on page 13

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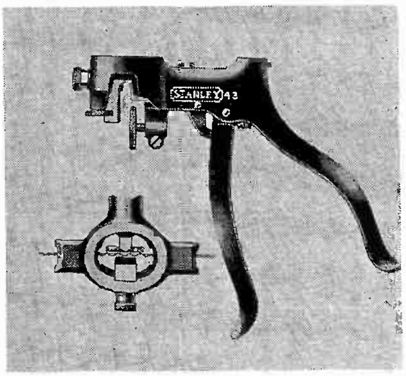

Fig. 4. Tool for setting hand-saw teeth.

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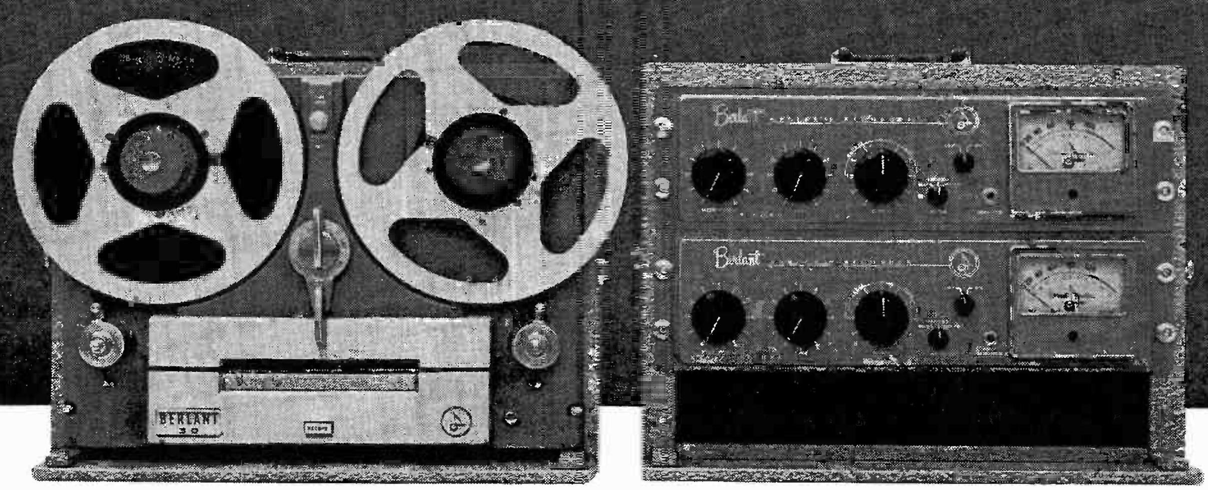

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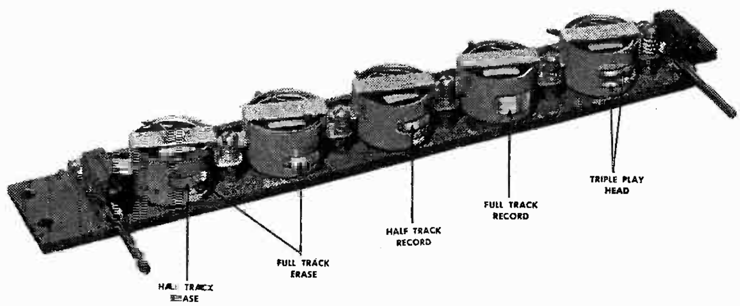

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WOODCRAFTER

Continued from page 11

serves in various capacities from prying lids to chiseling stonework. Yet, when we need it for such a simple job as driving a screw, we become exasperated when it fails to deliver. Let's not blame the tool — in fact, let's not blame any-

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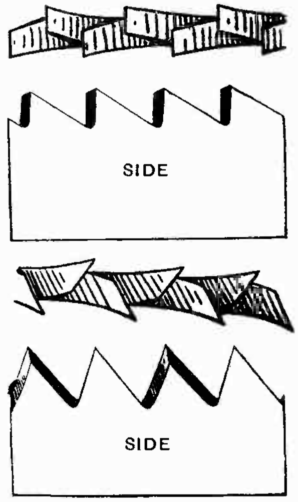


Fig. 5. Ripsaw (top) and crosscut saw (bottom) teeth as they should appear.

thing or anybody. Let's just determine to put a good tip on the poor old implement and use it only for what it was intended.

Damaged or bent screw-driver tips should be ground to the proper shape and size on a grinding wheel. The tip should be straight across and at right angles to the shaft of the screw driver. Be careful not to put a point on the tip. Retain its original thickness and the faces, near the tip, should be almost parallel (Fig. 6). Bear lightly on the

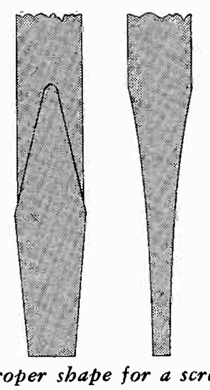


Fig. 6. Proper shape for a screw driver.

wheel during the grinding and dip the tip of the screw driver into water frequently.

File and Rasp: No grinding action is necessary for the amateur craftsman to sharpen these tools — cleaning does the trick. When wood particles are solidly wedged between the teeth, try a fire bath to restore their usefulness.

Continued on page 42

TAPE NEWS & VIEWS

by J. Gordon Holt

Microphone Maintenance

In these days when our whole national economy is built upon a product's easy replaceability (up to a year to pay, if need be), we tend to take it for granted that today's purchase will be tomorrow's refuse. We gladly trade in the burned-out shell that was the hottest car on the road two years ago. We pay $15,000 for a clapboard house with a questionable foundation because we figure it will last until we can afford to move to another neighborhood. And so it goes.

Just what all this has to do with microphones may not be immediately clear, but both microphones and loudspeakers have something that the above-mentioned items do not. Not even the most idealistic amplifier manufacturer would dare to guarantee his products for five years, *including tubes*, because electron tubes somehow seem to have about the same life expectancy as light bulbs. They wear out — and it doesn't take long for them to wear out, either. The nice thing about a good microphone or loudspeaker, though, is that its manufacturer would probably be quite safe in guaranteeing it for five years, since it has no components in it that will wear out.

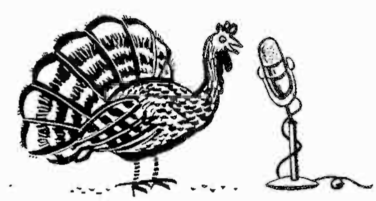
Like any sweeping statement, that one needs some qualification. Loudspeakers will last almost indefinitely, as long as they are not subjected to extremes of climate or are not battered with overload signals. A woofer will, in fact, improve with age as its constant edge flexing loosens the suspension and increases the compliance. A new woofer's cone-resonance frequency will usually be found to drop significantly within the first six months of use, and the drop will taper off from that time on. I don't know of anyone who has kept really close tabs on what happens to a woofer over a period of twenty years, but several reports have indicated that the resonance will continue to drop until the cone rots or dries up and falls out.

A microphone exhibits even less tendency to change than does a loudspeaker, but, once again, this is subject to limitations that might be imposed by climatic extremes. Crystal microphones, for instance, are likely to be the shortest-lived. A temperature above a certain limit or a few hours of storage in too high a humidity will ruin one permanently. Hermetic sealing of the element will help to stave off nemesis, but never indefinitely.

Ceramic types are far better in this respect, being quite insensitive to any climatic conditions that would not kill off all forms of life. But few ceramic microphones are of sufficiently high quality to deserve a place in the perfectionist's gadget bag.

Dynamics and ribbon units are indisputably the most rugged and long-lived of any of the quality microphones. They require care to keep them in peak condition, of course. Condenser microphones, on the other hand, may well provide the ultimate quality attainable at the present state of the audio art, but since they incorporate one or more tubes and must be used with an external power supply, they must be classed with amplifiers in their degree of reliability. More about condenser mikes later.

It can be categorically stated that the three worst enemies of quality microphones are dirt, concussion, and corrosion, and the degree to which a microphone can be protected from these things is likely to determine how long it will last and in what condition it will be until its ultimate demise. This may sound like a contradiction of what was said before about long life, but remember that a microphone will usually not deteriorate at all in normal use; it is only under abuse that it will suffer.



Dynamic and ribbon microphones contain powerful magnets which can do an effective job of sorting out the ferrous constituents in air-borne dust and collecting them around the edges of the moving element, where they will scrape noisily each time the diaphragm or ribbon moves. Many mike manufacturers take infinite pains to install filters and screens between the diaphragm and the outer environment, but these will stop only the larger metal particles from getting through. Finer dust filters would stop even more from getting in, but they would also stop the high frequencies in sound, so these protective measures can never be totally effective. The safest way of keeping dust out of a microphone is to store it in a case or in a small plastic bag, keeping a dust bag over it at all times when it is left inactive on its stand.

The risk of concussion to a microphone is likely to be even greater. Many seemingly inoffensive acts can have much the same effect on a mike as a long drop onto a marble floor. All of us have at some time seen a person using a PA system blowing into the microphone to see whether or not it was turned on. This will certainly serve its purpose as a continuity tester, but it is instant death for certain types of mikes, particularly ribbon velocity units. The corrugations in an extremely thin microphone ribbon are there to allow it to bend easily and in a linear manner — but the aluminum used for these ribbons will stretch only so far. Any ribbon movement as violent as that imparted by a closely delivered blast of air will stretch the ribbon beyond its limit, either breaking it and wrapping it around the magnet assembly or pulling out all the corrugations, leaving it hanging limply like a shred of chintz. It is easy to see how this could interfere with the mike's normal operation.

Other types of microphone are less likely to suffer serious damage from being blown into, although here again the degree of risk depends largely upon the construction of the individual mike. Some dynamic types and most crystals and ceramics are very rugged in this respect, but whether or not a particular mike in question is blast-sensitive is, unfortunately, not likely to be determined until it has proved itself otherwise. It doesn't pay to experiment with a valuable mike to see how rugged it is; the safest course is simply to avoid blowing into it, regardless of how tough you suspect it to be. Many microphones are equipped with blast filters, and it is easy to assume that this renders them blast-insensitive. A blast filter, though, is primarily to reduce the effects of wind noise when the mike is used outdoors,

Continued on page 40

Book Reviews

by Richard D. Keller

Transistors — Theory and Practice

Rufus P. Turner; pub. by Gernsback Library, New York, No. 51; 143 pages; $2.00; paper bound; 4th printing.

For engineers, technicians, and experimenters who are taking their first faltering steps toward one of the most fascinating new frontiers of science, this introductory nonmathematical book is a fine trail blazer.

Beginning with an introductory section on semiconductor theory, it proceeds to transistor fabrication techniques and a discussion of the major transistor characteristics, and emphasizes the current-controlled low-impedance nature of transistors as contrasted to the high-impedance voltage control inherent in vacuum tubes.

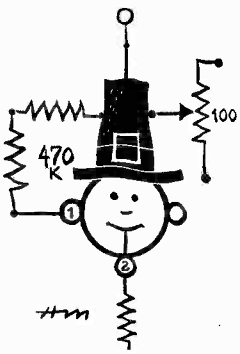
A chapter on equivalent circuits points out the lack of isolation between transistor input and output circuits, and the next several chapters treat in general terms transistor amplifiers (both RF and audio); simple oscillators; the theory of duality, (intriguing, but not sufficiently developed to a point of practical usage); and trigger and switching principles. The last subject, of course, is becoming increasingly important in today's world of electronic computers and control systems, and the basic principles of negative-resistance operation are nicely presented by Mr. Turner.

Chapter 8, however, is probably of greatest immediate concern to the practical-minded hobbyist, for it contains complete information on innumerable small experimental circuits, with component specifications and values. Simple audio amplifiers, hearing aids, oscillators, signal injectors, multivibrators, field-strength meters, DC meters, and regenerative broadcast receivers are included.

The book concludes with chapters on transistor testing and commercial specifications, most of which are, however, now outdated.

Much of the material is concerned with point-contact transistors which are now pretty well out of the picture. And such rapid strides have been made in the state of the art that the frequency and power limitations given for the familiar junction transistors have been far surpassed in the relatively short span since publication of this book. Also, concepts such as the importance of I_{co}, cutoff current, and C_{ob}, collector capacitance, have been completely neglected.

Still, it is a highly recommended introduction to the new world of solid-state electronics. It should be pointed out, too, that it is written by a registered professional engineer who is a noted and much-published authority in this field.



Electrical Interference

A. P. Hale, Grad. I.E.E.; pub. by New York Philosophical Library, Inc., New York; 122 pages; $4.50.

Interference is a problem that concerns nearly all of us when the radio begins crackling (generally AM, of course); the TV picture starts tearing, rippling, and distorting; or when clicks or buzzing sounds are heard in our high-fidelity systems.

Interference can come from natural causes such as atmospheric disturbances, or from man-made noises propagated by machinery and equipment of all kinds. It is with the latter type that this interesting volume deals.

In fact, it starts out listing a chart breakdown of the 140,000 complaints of interference with reception received by England's General Post Office in 1954! Most of these were traceable to electrical machinery, although some 10% of the troubles were caused by insufficient aerial or ground installations at the receiving site.

In exploring the subject this book takes the practical point of view, starting with the basic causes of interference — switching noises, gas discharges and corona effects, RF heating and medical generators, and harmonics from intentionally produced nonsinusoidal wave forms (such as television saw-tooth sweep circuits). Series motors, fluorescent and neon lamps, and buzzing-type thermostats are given as the most common trouble makers. The effects of interference on reception are then explained and illustrated with an exceptionally interesting series of TV raster photographs showing the effects of such things as drill motors, diathermy apparatus, and corona discharges, on the picture image.

Improvement of aerial systems is next taken up to eliminate that 10% portion of the complaints, and then the measurement and location of interference is discussed, with a listing of British regulations on the matter.

The bulk of the book then deals with filters, and, in a clear and non-mathematical manner, explains the action of the basic components — capacitors and inductors — and gives practical applications with effective circuits and values for use with practically every noisy trouble-making situation. A handy guide, this, for the repairman, technician, and noise-haunted individual as well.

Ribbons of Sound

Karl A. Barleben; pub. by U. S. Camera Publishing Co., New York; 126 pages; $2.50; paper bound.

The basic philosophy that the kind or make of tape recorder you have doesn't matter as much as how you handle and operate it — a diplomatic, if hard-to-defend position — serves as the introduction to this nicely printed slick-paper volume.

A good bit of information is given about the five major tape manufacturers and their various brands, and about microphone and recording techniques.

The book contains quite a lot of reprinted material. There is a press account of Major Orr's pioneering work on magnetic tapes upon returning from Germany after World War II, Howard Souther's towering "Temples of Tone" article, Ronald Anderson's *Tape Recording* Magazine article on "How Your Recorder Works", and a Shure Brothers paper on "Let's Professionalize Our Microphone Technique". Mr. Barleben covers rather fluently the wide field of tape-recorder application, with a plentiful supply of pictures to punctuate his remarks.

Readers' Forum

Gentlemen:

AUDIOCRAFT has been more than welcome to me since its first issue, and I have thoroughly enjoyed each copy I have received; however, I am more than a little burned up after reading R. D. Darrell's scathing, vitriolic "Sound Fanciers' Guide" [AUDIOCRAFT, August 1956, p. 29] in condemnation of theater organs and organists and, in particular, George Wright. Thank heavens I, for one, do not intend to be "guided" by the uncalled for propaganda appearing under his by-line.

In extremely bad taste is Darrell's use of such terms as *vulgarity*, *horrid fascination*, *racket*, and *jauntiness* in stressing his opinion of George Wright's music. I think Mr. Wright does a remarkable service on his *Encores* record, not only to hi-fi enthusiasts, but to real music fans. And since when does the magnificent theater organ become the whipping boy of instruments, except to Darrell's fancy?

I strongly suspect that Mr. Wright (like Liberace) is laughing all the way to the bank, and, for each new record he makes, part of that dough in his moneybag will be mine. *Vive*!

Walter L. Draughon
Fort Myers, Fla.

I believe any reviewer ought to be able to take it as well as dish it out, and I just regret that more readers don't get stirred up enough to let fly with their own opinions — pro or con. My head is bloody, but unbowed, and if I can't congratulate Mr. Draughon on his tastes, I certainly can on his vigor of expression. That, at least, is one quality for which we both share an admiration!

I plead guilty to the charge of bad taste in my choice of adjectives, but I also plead justification by extreme provocation. Mr. Wright, like Liberace, may laugh his head off on the way to the bank, but I have my laugh in print; and, among the brickbats that come my way, there are occasional roses to prove that at least some readers share my, rather than your, point of view.

I shall keep my copies of the George Wright records and cherish them, with these letters, as battle-campaign mementos, and as a quick test for my friends (surprisingly enough, I do have some), to determine, by their reactions, whether the quality of their musical tastes makes

Continued on page 42

EDITORIAL

A high-fidelity sound system has often been compared to a chain, with the pickup, preamplifier, amplifier and speaker system identified as links in that chain. The usual observation is that the chain can be no stronger than its weakest link — inferring, of course, that the component of poorest quality establishes the over-all system quality.

This is all right as far as it goes, provided we interpret it as meaning only that the quality cannot *exceed* the capabilities of the poorest component. There are exceptions even to this rule; a preamplifier with versatile controls, for instance, may be able to compensate slightly for the inadequacies of a speaker system. But if we understand "quality" to mean freedom from distortion products, then the rule is almost invariably true. It is in the conclusions we draw from the rule that we are likely to err.

Specifically, it is easy to assume that the quality of the system components, so long as they are equal to or better than the "weakest link", can have no effect whatever on the sound quality. Therefore, it is foolish to have any one component much better than the others; one should stick to, or work toward, a "balanced" system. Fine reasoning. But it simply isn't valid, because the resultant quality of a sound system is determined by every single component in it, weak or not. You can prove this easily by setting up a minimum-quality or medium-quality matched system. Substitute a top-notch pickup, preamplifier, amplifier, or speaker for the corresponding component in the matched system, and you'll notice an improvement with every substitution. Obviously, *every* link in this chain does its bit to restrict the over-all quality. The better any link is, the smaller is its toll on quality, and the better the system as a whole will sound.

There are at least two possible reasons for this seeming paradox. First, we may be measuring total distortion in an unrealistic way; in a way that may not correlate with the subjective judgment of quality. It is well known that the *order* of harmonic distortion, for instance, affects the degree of its offensiveness to the ear. Fifth harmonic distortion is more disagreeable than an equivalent amount of third harmonic. Therefore, a weighting factor should be used in calculations of total harmonic distortion. Some recommend a weighting factor directly proportional to the order of the harmonic; others believe that it should be proportional to the square of the order. Usually no weighting factor at all is used in harmonic distortion specifications for audio equipment. An unweighted 0.5% THD could easily be a realistically weighted 2%, which is certainly audible.

In the standard method of IM measurement, a weighting is obtained automatically that is directly proportional to the order of distortion. But the distortion components are invariably expressed as an RMS sum, and there is strong evidence that this, too, is unrealistic. A far better correlation between IM distortion percentage and subjective listening tests would almost certainly be obtained if the distortion products were added arithmetically — that is, if they were measured by a peak-reading voltmeter rather than one responsive to average rectified values. As IM is measured now, the particularly nasty higher-order products are not appropriately represented in the total distortion figure. Further, the total distortion of an amplifier and a preamp-control unit in series may actually be *less* than the distortion produced by one of them, when measured in the conventional way. Distortion cancellation? Perhaps there is some cancellation of lower-order products, but listening tests will affirm that the audible effects of distortion have been increased, not decreased.

It is possible also that the performance aspects we usually consider to be secondary may be of equal or greater importance than nonlinearity or frequency range. Dynamic range, transient response, stability, and performance outside the normal operating range are all known to affect the subjective judgment of quality, but are not easily specified and interpreted. In any or all of these respects the so-called matched system may not be matched at all. Aside from distortion, replacing the turntable with a better one should result in less noise, less flutter and wow, and more accurate pitch, regardless of the other system components; a better pickup and arm should produce smoother sound, extended range, less record surface noise, and possibly lower hum level; a better preamp-control should give less hiss and hum, extended bass, better balance, and greater control flexibility; a better amplifier should result in tighter bass and sweeter highs, and possibly greater dynamic range; a better speaker system may improve the sound in a dozen ways.

Don't be dissuaded from making improvements one by one in your sound system because you've heard that any one by itself won't make an audible difference. It will. — R.A.

by Philip S. Geraci

REBUILD *your Recorder*

NO doubt about it, high fidelity is expensive. My constant battle with the budget for a more eloquent preamp or speaker system is now of more vital moment than household deliberations over the merits of buying a new living room rug or new slip covers.

But if the cost of high-fidelity sound seems prohibitive, pity the poor victim who has succumbed to the recording bug. Not only must he have the familiar appurtenances to high fidelity, but he must own a high-fidelity tape recorder, a high-fidelity microphone or two, a high-fidelity mixer, high-fidelity headphones, mikes stands and booms of immaterial fidelity, and plenty of good-quality tape. If he plans to do much editing or dubbing, he needs *two* high-fidelity tape recorders.

Let's assume that you already own a speaker system and amplifier. You have the basic rig for amplifying and hearing sound. But you can produce only silence (or noise) until you attach a sound source. A changer and cartridge may cost $50; a tuner may cost about the same amount; a turntable, arm, and cartridge can run more or less, depending upon the models you buy. For that amount you can have a record player or tuner that produces quite acceptable, distortion-free sound.

What happens when you hook in a $50 tape recorder? To begin with, you can't find one. Bear in mind that I'm speaking of a tape recorder, not just a tape player. The man interested in a recorder is faced with a real dilemma if his financial resources do not match his interest in quality.

This does not imply that the less expensive tape recorders are not excellent units for their intended purposes. They are designed for the individual who wants a tape recorder that will record and play back immediately, usually through its own speaker; that is handy to operate, portable, and attractively styled; and that will not cost very much.

But the manufacture of recorders in this price range must involve compromises in quality. Such machines cannot be individually tested and readjusted to precise tolerances because this requires extensive individual attention, and labor is perhaps the most expensive commodity in the American economy.

This two-sentence economics lesson is designed merely to emphasize that you cannot expect $600 worth of sound quality from a recorder tagged at $200 or less. When you part with money for a machine advertised as "professional", you expect it to meet its specifications. Chances are that it will, because it has been tested at the factory. This testing is one of the reasons it costs $600. But it is not the only one.

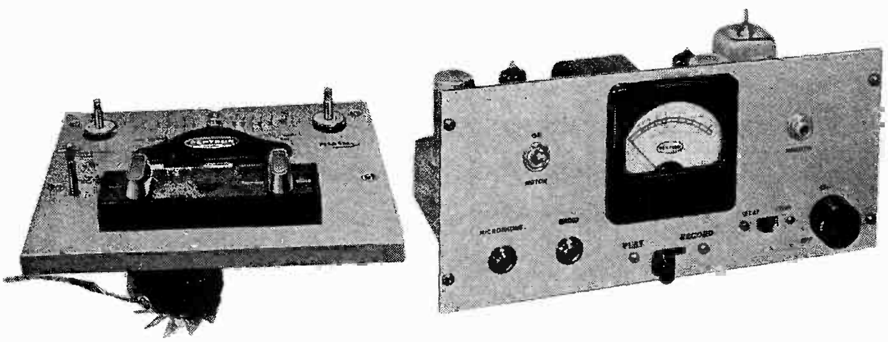


Fig. 1. Pentron 9T3M tape transport and HFP-1 preamplifier, before rebuilding.

In judging a tape recorder, the most significant specifications concern flutter and wow, signal-to-noise ratio, distortion, and frequency response. Recording speeds, though not strictly a specification, are of interest because the faster speeds indicate a wider frequency response.

In the more expensive tape recorders, flutter and wow will be below 0.3%, and perhaps as low as 0.1%; signal-to-noise ratio will be at least 50 db, and maybe 55 db; frequency response will be within 2 db from 50 to 10,000 cps, and within 4 db to 15,000 cps. Distortion will be 3% total harmonic at maximum record level for 400 cps.

Most so-called "home-type" recorders will not meet these specifications, although many of them will come close in one respect or another. This should not cause a great deal of dismay to the average user, however; such recorders are not generally used for making master recordings to be pressed. But since the human ear tends to become satisfied with recurring sound of the same quality, an audiophile cannot tolerate anything that falls short of the sound available from modern records. He is therefore chagrined if a tape recorder, for which he has spent $200 or so, doesn't measure up to this standard. And he will be interested to know that there is a lot he can do to improve tape-recorder performance himself — even a "home-type", nonprofessional machine can be made acceptable to the supercritical listener.

I own a Pentron PMD-1, which is the package unit consisting of the HFP-1 preamp and the 9T3M transport mechanism, in a portable case. This assembly, shown in Figs. 1 and 2, cost me $134.

The machine performed satisfactorily for this price. It recorded and played back through my hi-fi system, erased cleanly, had a hiss level which was not too objectionable for average music, and was very light and easy to carry. I used it constantly for two years.

My primary objections to the Pentron were a sharp drop below 100 cps; a drive system with a large amount of flutter and wow; a signal-to-noise ratio which was not as great as I wanted;

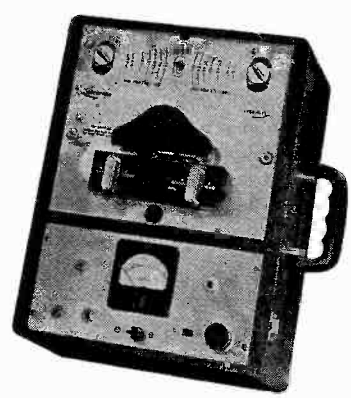


Fig. 2. The portable PMD-1 assembly.

and a high end which began to rise at 3,000 cps, hit a high of 6 db at 6,000 cps, and then dropped rapidly to minus 8 db at 12,000 cps. This was at 7½ ips. But the tape transport mechanism was fundamentally sound. When I decided to modify, my intention was only to help it to do its job a little better, and not to make drastic design changes. I am confident that many of the adjustments I made are applicable, if in modified degree, to nearly any portable recorder.

Transport Mechanism

The power behind tape transport is the motor. In nonprofessional recorders,

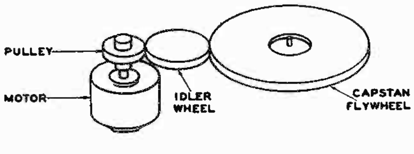


Fig. 3. A typical tape-drive system.

the motor is generally a four-pole induction type, with a loaded speed of about 1,700 rpm. In order to move the tape past the heads the motor must drive a capstan, either directly or through a rubber idler wheel, as diagrammed in Fig. 3. It is the capstan which contacts and moves the tape. Concurrently, the motor must power the takeup spindle and apply a slight drag to the supply spindle. This is achieved in the Pentron through belts. More expensive recorders use separate motors for each reel, and operate them electrically rather than mechanically.

To begin, I removed the transport mechanism from the case and balanced it on blocks of wood to watch the movement of each component in operation. This is a requisite in any modification. If your machine is of a different manufacture, you should spend quite a bit of time just watching the wheels go around.

Alterations to a transport mechanism are all aimed at a single purpose — the reduction of flutter and wow. Ideally, the tape should pass the heads at an even speed with no fluctuations. This is impossible, so we aim for as little fluctuation as possible.

If the capstan rotates constantly, the tape will move past the heads constantly, assuming the proper pressure is applied by the pressure roller and that the drag exerted by the pressure pads and the supply reel is not too great. The most significant alteration made to the Pentron served to insure constant rotation of the capstan.

With the machine balanced on blocks, I fashioned a short loop of tape on which I recorded a 1,000-cps tone. All moving wheels were marked with a red pencil. By playing back the taped signal I was able to hear irregularity in pitch, which I compared with the motion of the pencil-marked components.

The pressure roller was the chief offender. I increased its tension by snipping off pieces of the spring connected to it, but this increased wow by unduly loading the motor. Decreasing tension caused the tape to slip, and magnified the effect of supply reel and pressure-pad drag. What I needed was a more powerful motor which would hold its speed under increased pressure-roller tension.

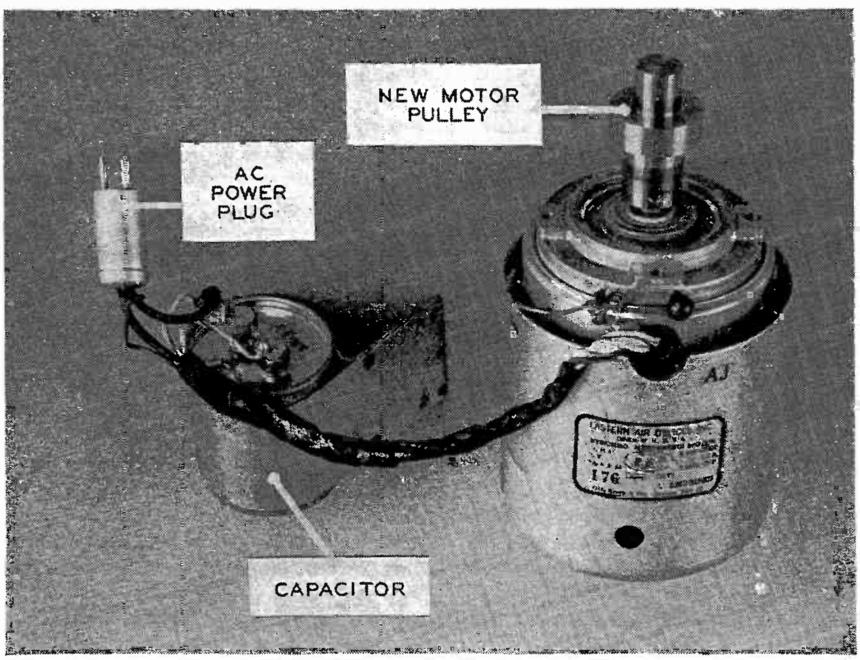
The problem of the motor was thus brought to the fore. Fortunately, a new motor would also rid my recorder of other mechanical defects. When operated at 3¾ ips the Pentron exhibited a great amount of flutter. I tried five different motors of the same manufacture, and, although the amount of flutter varied, it was never completely inaudible even at 7½ ips.

Flutter appeared to be caused by two things. First, loose bearings in the motor allowed the motor shaft to bounce around as it revolved. Second, an improperly balanced rotor created instability similar to that of an automobile with wheels which are out of balance.

Just to be certain that worn idlers were not causing my difficulty, I measured the amount of flutter with three different idlers, one of which had never been in a recorder before. The measurement, in each case, was the same.

I decided to buy a new motor. But what type? I wanted a precision motor, but soon learned that a precision induction motor is as expensive as a pre-

Fig. 4. Hysteresis-synchronous replacement motor with new drive pulley attached.



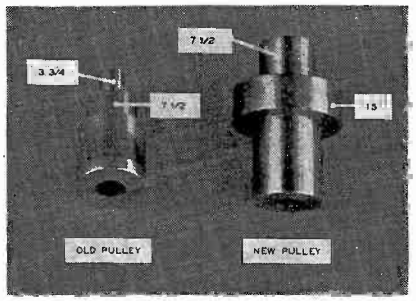


Fig. 5. The old and new motor pulleys.

cision synchronous motor. Perhaps the greatest single improvement I made to the Pentron mechanism involved replacing the existing motor with a hysteresis-synchronous motor of greater horsepower. This is shown in Fig. 4.

The speed of an induction motor is subject to change from a variety of conditions. Free speed differs from speed under load. As the load varies, the speed changes. If the voltage feeding the motor is changed, the speed of the motor changes. A recording made in one locality with a line voltage of 117 volts, on a recorder with an induction motor, will play back at a lower pitch in another locality where the voltage is only 110.

A synchronous motor eliminates these difficulties. Its speed is constant, regardless of the load and irrespective of voltage variations. Speed is governed by the cyclage of the power feeding it, generally 60 cps. As to load, it will either run at full speed, or stop. There are no in-betweens. For sound recording this is the ideal combination.

Fortunately, the 1/50-hp motor I bought fit nicely in the Pentron case. It was necessary to drill new mounting holes, but that was a simple task, since the mounting plate for the old motor furnished plenty of room.

Since the synchronous motor generally operates at 1,800 rpm (mine did), it was necessary to use a smaller motor pulley to transmit the same rotational speed to the capstan. I needed a new motor pulley anyway, so I decided to go whole hog and make the machine operate at 15 as well as 7½ ips.

The speed of the recorder is deter-

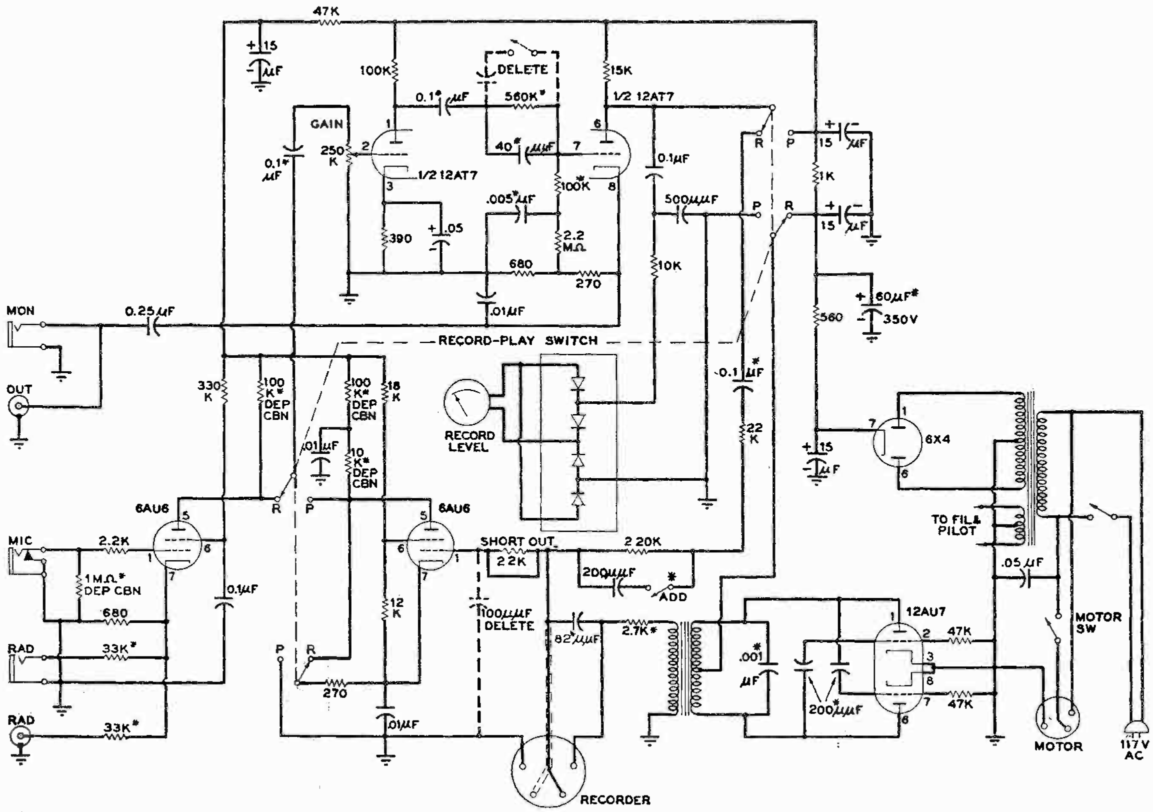


Fig. 6. Schematic diagram showing all electrical modifications, with parts added or changed in value marked by asterisks.

mined by the speed of the motor, the size of the capstan flywheel where it engages the idler wheel, and its size where it contacts the tape. Since I made no changes to the capstan itself, I had to consider only the increased speed of the motor and the consequent reduction in the size of the motor pulley, for 7½-ips operation.

Purely for the joy of experimenting, I did it the hard way. If you don't like to work with mathematics you can do the same, and arrive at the same result. Or you can use a formula.

I experimented with the 7½-ips speed in a process which went like this: I removed the motor and pulley, laid it on the bench, and turned it on. Using a flat file, I carefully ground the pulley. At several steps in the process I placed the pulley on the new motor, installed it in the recorder, and played back the loop of tape containing the 1,000-cps tone recorded earlier. This I compared with the original tone record. When the two were identical in pitch I drew up a diagram for a new pulley, took it and the old pulley to a machine shop, and let the shop foreman measure the diameter. Exactly doubling this diameter gave the size for the 15-ips speed. The machine shop made the new pulley for me in about two hours. Fig. 5 shows the old and new pulleys for comparison.

As I say, this is the hard way, but it works. If you prefer the easy route, a simple ratio will give you the answer. You must know the exact diameter of the old pulley (Do), and the speeds of both the old motor under load (So), and the new motor (Sn). It is then a simple matter to determine the ratio of the old pulley diameter to motor speed and calculate the new diameter (Dn) according to the formula $Dn = Do\ (So/Sn)$. This will give you the diameter for 7½ ips. Double your answer for the 15-ips speed.

Part of the high-frequency pre-emphasis must be removed from the record circuit when operating at 15 ips.

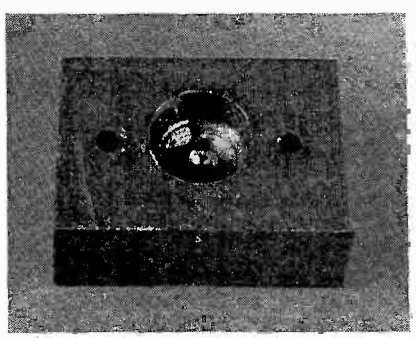


Fig. 7. A new lower bearing for capstan shaft improved the flutter performance.

In the Pentron, a simple treble-boost circuit involving a resistor shunted by a capacitor is in circuit just before the point at which audio is fed to the head. Lifting this capacitor at one end and attaching it to the "compensate" switch, which formerly provided extra treble boost at 3¾ ips, let me switch the capacitor out of the circuit when operating at 15 ips. This change is indicated on the revised schematic diagram, Fig. 6. Response was remarkably flat, and extended to beyond 20 Kc.

One additional mechanical alteration was necessary before flutter and wow were reduced to the point I considered satisfactory. The capstan was secured with a bronze bearing at either end. The upper bearing was satisfactory, since the pressure roller eliminated play. But the lower bearing served mainly to keep the capstan vertical, with the weight of the capstan resting on a flat metal washer. The area of contact was large, and dirt collecting under the washer impeded movement of the capstan. Such an arrangement is never as satisfactory as ball-point suspension.

I tried using a bearing assembly similar to that found in ball-bearing motors, but the problem resolved from flat-area friction to multiple-ball friction, still not as desirable as single-ball contact.

Finally I secured a small piece of metal, almost square, drilled two holes through it and the capstan mounting plate, and bolted them together, with the metal located directly beneath the lower capstan bearing. Carefully marking the exact center of the bearing, I removed the metal and drilled a hole approximately ½ in. deep. The lower end of the capstan was filed to produce a slightly rounded edge. In reassembling the capstan, I dropped a ball bearing into the well produced by the bit, as shown in Fig. 7. The weight of the capstan was thus lifted from the metal washers and taken up entirely by the ball. This reduced friction by several hundred percent.

Now I could safely increase tension on the pressure roller, by snipping off a small bit of spring and bending a new hook. Tension on both the supply and takeup spindles was carefully adjusted to maintain the tape taut, without unnecessary pull in either direction. Fig. 8 shows the new motor installed, and the capstan well in operation.

I experimented with belt drive to replace the idler wheel, and found that the machine ran much more quietly. I abandoned the idea, however, since I preferred the two-speed arrangement obtainable only with a two-diameter motor pulley and idler.

An alternative which may interest you would be to have two separate pulleys made, one for each speed, and install the pulley desired before each recording session. Unfortunately, this is inconvenient. Perhaps the most sensible solution would be to give up the 15-ips speed altogether since, for all but the most exacting work, response at 7½ ips is satisfactory.

As to the noise, which is not the noise transmitted to the tape but mechanical noise in the studio while the machine is running, the recorder with idler drive is quiet enough that a microphone may be within 6 ft. of it and pick up absolutely nothing, with the gain on the mike set for an announcer.

If you decide on belt drive, be sure that the pulley you have made has two raised lips on the ends (Fig. 9) to keep the belt from slipping off. The flat capstan is slippery, but if the belt is held in position on the motor pulley it will stay in position on the capstan flywheel. Also be certain that you use a slightly rubberized, seamless flat belt. They are rather hard to come by, but your local rubber-products dealer can have one made for you. Be certain you know the exact size first, however.

Tests of the modified Pentron proved the success of my experiments. Flutter and wow were reduced to the point at which they were completely inaudible. A later test with a flutter bridge indicated less than 0.2% — a most respectable figure.

Electronic Modifications

I was so pleased with the results of the mechanical alterations that I decided immediately to improve the electronic response as well.

This brought up the question of heads. I had, of course, the possibility of retaining the original heads and attempting to improve response with them. But I had heard so much about Dynamu heads that I decided to install them rather than experiment with the Pentron units. My results are based entirely on the use of Dynamu heads. It may be that you will want to apply my experiments to your original head equipment and, in the interests of economy, by all means do so. But I can offer no figures regarding response of the Pentron heads, other than the listed catalogue specs of 50 to 12 Kc at 7½ ips.

Dynamus are sold as direct replacement units for a wide variety of tape recorders. They come in pairs (record head and erase head) with easy-to-follow, extensively illustrated directions.

My first move was to install the heads precisely as recommended. This involved removing the Pentron heads, positioning the Dynamu heads on a new bracket (supplied with the heads),

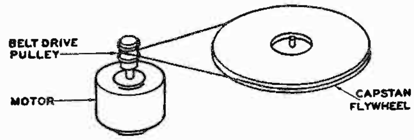


Fig. 9. An alternative capstan drive.

and soldering four leads. The gap covers the lower half of the tape, and care must be taken that it does not extend above the tape center, or it will pick up some of the information contained on the other half of the tape. By the same token, the erase head should be positioned so that it covers *all* the lower half of the tape, but not so high that it erases part of the upper track as well. It's tricky, but with care, failure is virtually impossible.

I followed the electronic instructions step by step. They prescribed removal of several resistors and capacitors, replacement of some of them with different values, and repositioning a wire or two. The entire operation took about one evening, and I was able to hear the results of my handiwork before bedtime. The sound was literally breathtaking.

Low-noise resistors in both preamp tubes increased the signal-to-noise ratio tremendously; lowering a few resistor values boosted the signal to the tape, lessening tube noise in record, and from the tape, resulting in greater output. The decrease in distortion was immediately evident. This, coupled with the reduction in flutter and wow, realized from earlier mechanical modifications, gave me a machine with highly respectable qualifications. My additional expenditure for motor, heads, and associated parts had been only about $80.

I might have rested on my laurels at this point but, like most tinkerers, I decided to explore a little further. Response of the converted Pentron was within 4 db from 60 to 20,000 cps at 7½ ips. The deviation involved a 3-db boost at 8 to 10 Kc and a drop below 100 cps to a low of 4 db at 60 cps. The high-frequency peak was caused by the equalization which, in order to extend response to 20 Kc, required a boost in the middle. The low-frequency drop-off was intended by the head manufacturer to minimize hum.

I decided to reduce high-frequency boost to the point at which the response was flat to 10 Kc, with a slow rolloff beyond, 12 Kc being down 2 db. This I did by lowering the value of the

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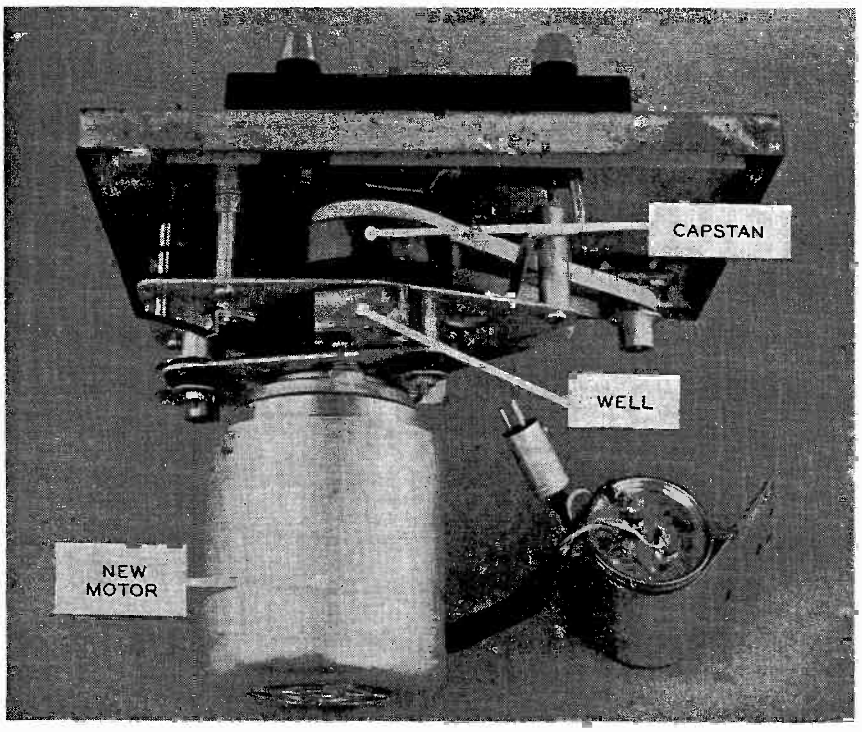
Fig. 8. Synchronous motor and new capstan shaft bearing fit nicely in place.



TRANSISTORS *in Audio Circuits*

by PAUL PENFIELD, JR.

II. Miscellaneous Transistor Types

JUNCTION transistors, although at present the most common, are not the only type of useful semiconductor device. Many other types of transistors exist, as well as useful two-terminal semiconductor components such as diodes, thermistors, and photocells. Furthermore, present types of junction transistors are not the only possible types, and germanium is not the only semiconductor practical for use in transistors.

We found in the first article of this series that an intrinsic semiconductor (i-type) is a conductor only by virtue of thermally caused and light-caused carriers present in the crystal. These

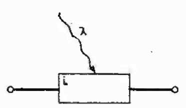


Fig. 1. An i-type photocell. The waved line and the symbol λ represent light.

properties in themselves yield useful i-type devices — for example, a small thermometer, or a midget photocell. Semiconductor materials are used to make temperature-sensitive resistors known as *thermistors,* whose resistance decreases with high temperature. The details of such a device do not concern us immediately, but it is easy to see how they work.

In addition, i-type can be used as a photocell, if it is mounted as in Fig. 1, with a window in the case. Commercial *photoresistors* similar to this are available, but for reasons a bit too complex to go into here, n-type germanium is used instead.

So far this month we've seen useful devices result from just one type of

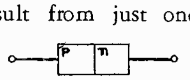


Fig. 2. A p-n junction diode rectifier.

germanium. Combinations of p, n, and i-types produce others.

The simple p-n junction diode shown in Fig. 2 is capable of acting as a rectifier, as we saw last month. If the p-end is connected to the negative terminal of a battery, and the n-end to the positive, the current carriers are drawn away from the junction, and little current flows. But hook up the battery the other way, and the current carriers are pushed by the battery toward the junction, near which they recombine, and a large current flows. The volt-ampere characteristics for a typical germanium junction diode (Fig. 3) show this "one-way" action.

The same unit in Fig. 2 can be used as a photocell. Such a device — a junction diode with a window to let light fall on the junction — is called a *photodiode* (see Fig. 4). Several models are available commercially. The principle of operation is very simple — merely bias the junction in reverse, and whatever current does flow is caused either by temperature effects or by light. For

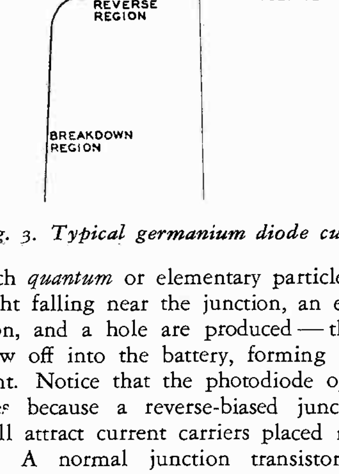


Fig. 3. Typical germanium diode curve.

each *quantum* or elementary particle of light falling near the junction, an electron, and a hole are produced — these flow off into the battery, forming current. Notice that the photodiode operates because a reverse-biased junction will attract current carriers placed near it. A normal junction transistor is merely a device that puts current carriers near a reverse-biased junction by electrical means. The emitter, as in Fig. 5, injects them into the base where they encounter the reverse-biased col-

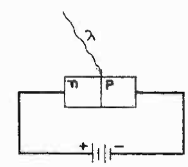


Fig. 4. Photo-diode is reverse-biased.

lector junction. Thus the operations of a photodiode and a transistor are quite similar, except for the method used to introduce the carriers into the junction. Because of the similarities, the photodiode used to be called a phototransistor. Now, however, the name phototransistor is reserved for the unit shown in Fig. 6. This looks just like a transistor, even to the point of having one junction biased forward, and one in reverse. But the base lead is not brought out, and a window is provided in the case for light to fall on the right-hand reverse-biased junction.

Suppose light does fall there. In that case, holes and electrons are formed

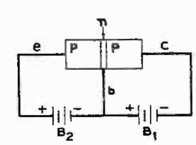


Fig. 5. A junction transistor circuit.

at this junction. The electrons are pushed toward the right-hand terminal, and the holes start off toward the left. But they find themselves in what looks like an n-p-n junction transistor. They remain momentarily in the base, and fifty times as many electrons are attracted from the emitter. For every quantum of light hitting the phototransistor, one hole goes off toward the base. Fifty electrons then enter from the emitter to neutralize the charge set up by the one hole. Forty-nine of them pass right through into the collector (right-hand region), and one recombines with the hole in the base. This, of course, is merely hook multiplication, which we discussed last month.

A phototransistor, then, is (using our case of $\beta + 1 = 50$) fifty times

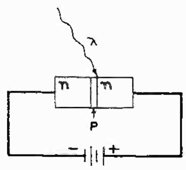


Fig. 6. n-p-n phototransistor circuit.

more sensitive than a photodiode. It is merely a photodiode with a built-in hook multiplier.

Just as the transistor is analogous to the photodiode, so there is a four-element device analogous to the phototransistor. Instead of getting current carriers from the incident light, it gets them from a fourth element.

Fig. 7 tells the story about this *hook transistor*. The right-hand three elements look just like an n-p-n phototransistor, even to the point of having the middle junction biased in reverse, and the right-hand one biased forward. Now, however, the left-hand n-region is made very thin. The middle junction (which is normally biased in reverse) then receives its current carriers from the emitter (p-type) at the left, instead of from incident light.

In this way current gains greater than one are readily achieved.

Alternatively, the device may be thought of as a normal p-n-p junction transistor (the left-hand three elements) except that the collector is made differently. From this standpoint it's quite easy to see how, in the grounded base configuration, a current

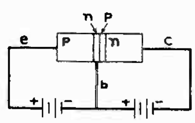


Fig. 7. The p-n-p-n hook transistor.

gain greater than one results. It merely takes place in the hook multiplier in the collector lead.

The hook transistor is not yet available commercially, although there is at least one experimental model about. It is expected to find a permanent niche for itself in the field of electronics because of the ease of building the device, and its desirable characteristics.

Point-Contact Transistors

The original transistor, back in 1948, was not the junction transistor which is so common now. It was an entirely different type, known as the *point-contact transistor*.

It is natural that the first transistors should have been point-contact models, since the properties of p-n junctions were not well known. On the other hand, point-contact diodes had been common since the Second World War.

The operation of the point-contact transistor, which has a current gain greater than one in the ground-base configuration, was for a long time unexplained. Several plausible explanations arose, but the one which has remained until today explains the point-contact transistor as being quite similar to the hook transistor just described.

Two metal points, the emitter and the collector, are pressed onto a base of n-type germanium, and surges of current passed through them. This process, known as electroforming, creates small p-type areas close to and right around each point contact. Furthermore, the collector point is electroformed in such a way that not only a p-type area, but also an n-area is formed, as shown in Fig. 8. Notice the similarity between this diagram and Fig. 7, showing the hook transistor.

This hook collector explanation shows how the point-contact transistor can have a current gain larger than one. At first it may be thought that this is an advantage and that point-contact

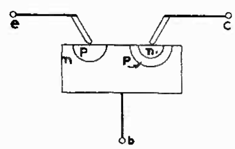


Fig. 8. Electroformed point-contact unit.

transistors should be more widely used. Unfortunately, they have several disadvantages. First, the power-handling capabilities are small. Second, distortion is quite high. Third, the noise level is very high. Fourth, in certain circuits the point-contact transistor is unstable. And fifth, it is virtually impossible to control the electroforming process sufficiently well to mass-produce predictable transistors.

However, for some applications these disadvantages are not important, and other factors are helpful. For example, the point contacts can be put very close together, with resulting good high-frequency response. The instability that was listed as a disadvantage in the preceding paragraph can be used to produce extremely simple and reliable oscillators and computer elements.

Because of their peculiarities, point-contact transistors are here to stay. But at present, for audio work, junction transistors are the only ones worth considering. For that reason, whenever the word *transistor* is used by itself in this series from now on, a junction transistor will be meant.

Miscellaneous Transistors

A few other types of devices use semiconductors, and have three leads, and for these reasons (more than anything else) are called transistors. Some are commercially available now, but most are still in the pipe-dream stage. Only a few of the more promising types will be mentioned here, although in future years more and more specialized transistor types will be available.

Surface-barrier transistors (see Fig. 9) are useful at high frequencies — not because of anything inherent about their method of operation, but merely

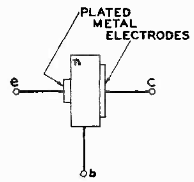


Fig. 9. The surface-barrier transistor.

because construction techniques are available for making very small and thin bases on the units.

At the surface of a semiconductor are a number of unsatisfied bonds — wherever the bond should be formed with an atom which is not present, because the edge of the lattice is at hand. These extra electrons form a type of structure that can trap further electrons, and hold them right at the surface. The trapped electrons are not free to move, but their charge repels other electrons away from the surface.

If the material is n-type, the surface charge caused by the trapped electrons repels the normally present electrons toward the center, Fig. 9, just as if this region were merely between two p-type regions. And indeed this similarity is more than passing: remember that p-germanium has embedded in it small fixed centers of negative charge (the acceptors). The acceptors near the junction form the *barrier layer* at the junction in a normal junction transistor; here such a layer is a *surface barrier*.

To make contact with the surface, electrodes (the emitter and the collector) are plated onto the germanium base. The finished transistor resembles

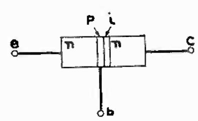


Fig. 10. An intrinsic-region transistor.

a p-n-p junction transistor electrically, except that manufacturing techniques enable the surface-barrier base to be very thin, so that high-frequency operation is possible.

Another approach to the high-frequency problem is the structure shown in Fig. 10. The intrinsic region between the collector and the base decreases the collector-to-base capacitance. This results in better high-frequency response.

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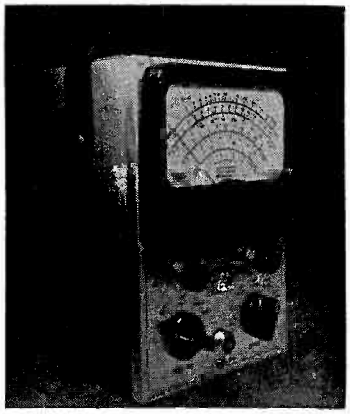


PHOTOS BY SYER

An AUDIOCRAFT *kit report*

The EICO VTVM Kit

ALMOST daily the selection of high-fidelity equipment kits grows to be more impressive. It is now possible for the enterprising kit builder to construct the greater part of a hi-fi system himself. Kits range in complexity from simple to elaborate, but the advantages they offer are similar. To anyone interested in what's happening behind the front panel of his amplifier, preamp, or tuner, a kit offers a good opportunity to find out. Circuits can be traced as they're being wired; parts, having once been identified and put in place, become somewhat more familiar objects than they might otherwise be. If something goes wrong with equipment you've built yourself, there's more likelihood of your being able to locate the trouble and remedy it without outside assistance than would be the case with a piece of similar ready-made equipment. Somehow the bewildering array of neat wiring and innumerable parts is not so mystifying when you've put them there yourself; and if you get stuck you can always refer to the instruction book.

If assembling kits holds any appeal for you, you'll probably be putting

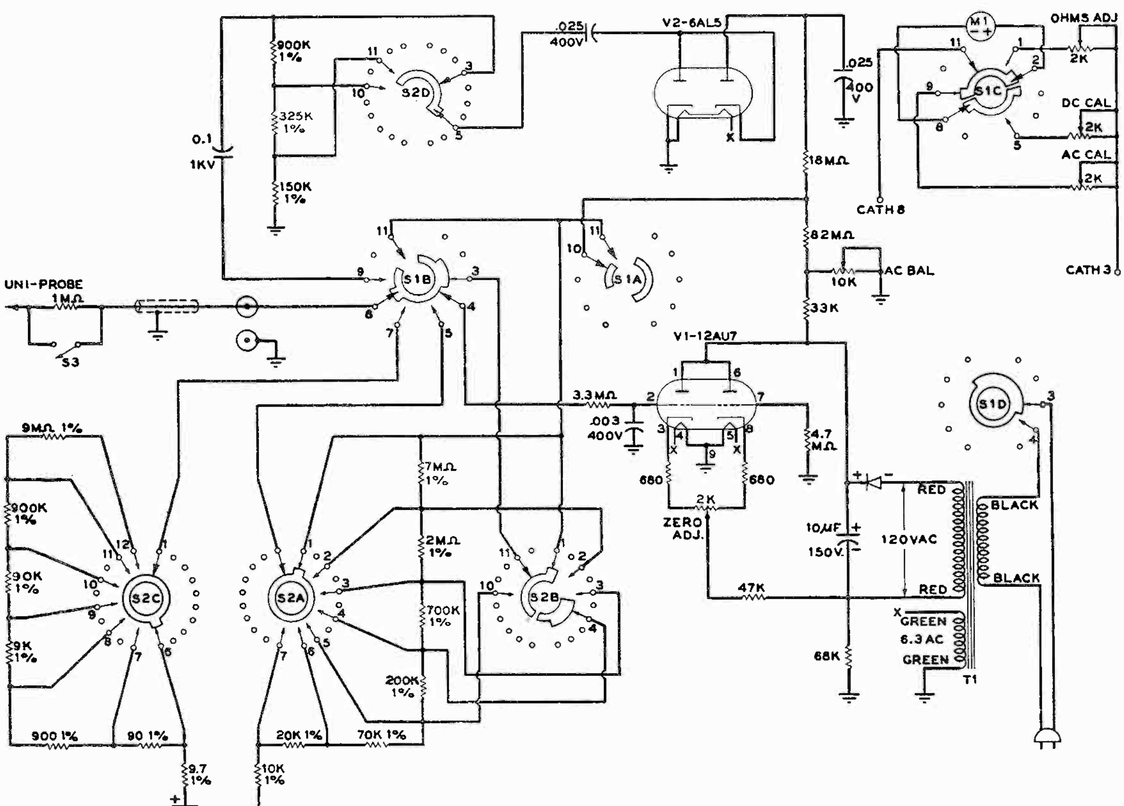
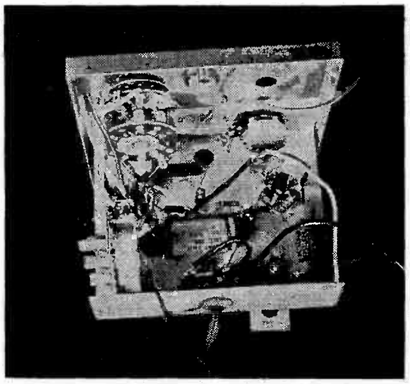


Fig. 1. A complete schematic diagram of the EICO model 232K VTVM kit.

several of them together; some of them, unfortunately, may not work right off the bat. The difficulty may be because of an error in wiring, or perhaps a faulty component. Whatever the trouble, test equipment, which comes in kits too, will help reveal it quickly. Test-instrument kits have been on the market for a number of years, and a variety of excellent instruments is available in this form. All the benefits of kit building apply as well to building test equipment from kits. It is possible, if your interest warrants it, to construct a complete laboratory of test instruments to help service and maintain your hi-fi system. But whether you intend eventually to have a complete test setup, or to invest only in the most necessary and basic test instruments, the vacuum-tube voltmeter* should make an early appearance on your test shelf. The kit we assembled was the Eico Model 232, manufactured by the Electronic Instrument Company. This kit retails for $29.95; the factory-assembled unit can be purchased for $49.95. Fig. 1 is the schematic diagram of the Eico VTVM.

The full-wave, high-frequency rectifier circuit of the Model 232 measures the peak-to-peak voltage value of complex and sine-wave forms, even when DC is present. AC peak-to-peak measurements are made over seven ranges: 0 to 4 volts on a special LOW-AC scale, and 0 to 14, 42, 140, 420, 1,400, and 4,200 volts. The meter also indicates, on a separate scale, the RMS voltage of sine waves, in ranges of 0 to 1.5 volts on the special LOW-AC scale, and 0 to 5, 15, 50, 150, 500, and 1,500 volts. The AC voltmeter responds to frequencies from 30 cps to 3 Mc, for a source of 100 ohms or less. With an accessory RF probe (not supplied with the kit), the meter can be used for measurement of RF voltages with frequencies up to 250 Mc. The DC voltmeter measures voltages from 0 to 1,500 volts in steps of 0



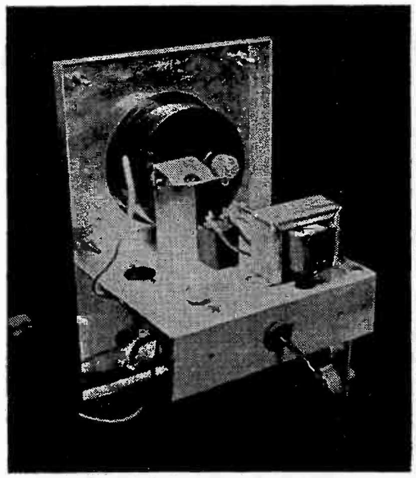


Fig. 3. Lower view of the prewired main chassis, left, and the top view, right.

to 1.5, 5, 15, 50, 150, 500, and 1,500 volts. With an accessory high-voltage probe (not supplied with the kit), the DC voltage range can be extended to 30,000 volts. Resistance measurements from 0 to 1,000 MΩ are made on the meter's seven resistance ranges: R × 1, R × 10, R × 1,000, R × 10K, R × 100K, and R × 1MΩ. Ten ohms appear at the center of the scale on the R × 1 range.

The Eico Model 232 has several convenient features that deserve to be mentioned here. On the face of the meter there is a zero-center indicator that can be used to set the meter's pointer at center scale when making bias measurements and aligning FM discriminators. Once the meter has been correctly calibrated (directions for doing this are given in the instruction manual), changing the position of the range or function switches does not affect the zero adjustment. It is not necessary to remove the meter from the cabinet to calibrate it; the calibration controls are accessible through the cabinet. Only two test leads are required for normal operations with the instrument, and both are supplied. One is the ground connection; an alligator clip is supplied for the working end. All measurements are made with the other single probe, which has a rotating tip that snaps into either of two marked positions: DC, for DC voltage measurements, or AC-OHMS, for AC voltage and resistance measurements. This is called a Uni-Probe by the manufacturer.

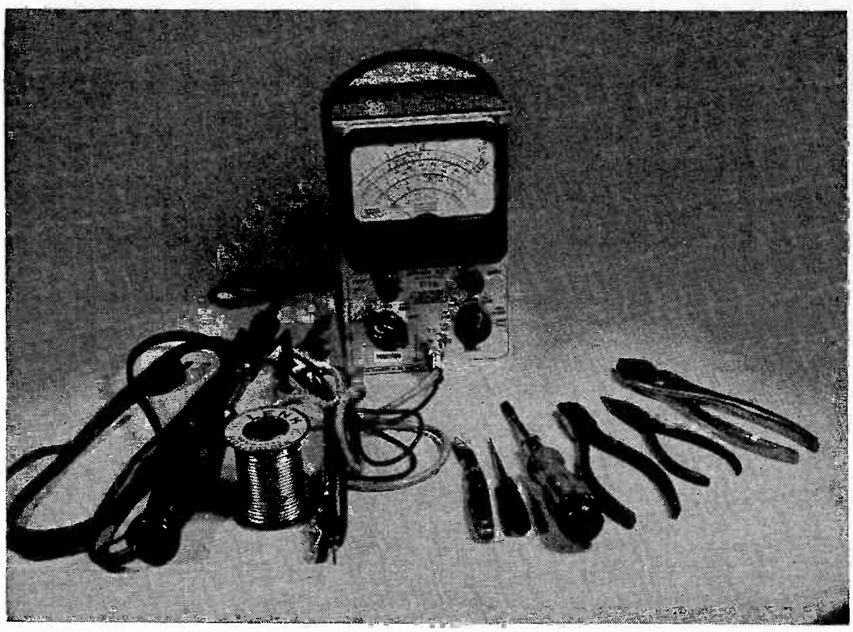
Construction Notes

No great degree of experience in electronic construction is requisite to putting this kit together. The step-by-step instructions and the accompanying pictorial diagrams are quite clear. If you haven't had any practice at all with a soldering iron, it would be useful to make a few trial connections before starting on the kit; otherwise little demand is made on the engineering background of the builder. Tool requirements are not extensive either. Fig. 2 shows the completed meter with the tools that were used to put it together. With the possible exception of the soldering iron, they are all tools that would usually be found in any well-run household. The only construction material not furnished with the kit is the solder, so be sure to have on hand a supply of good-quality rosin-core solder.

There is a parts list for the meter in the construction manual that comes with the kit. As they are unpacked, the parts should be checked off against this list. If a few of the pieces defy identification, put them aside and check

*See Mullings, E. B., "Using Test Instruments," AUDIOCRAFT, Dec. 1955, p. 33; Jan. 1956, p. 26; Feb. 1956, p. 30.

Fig. 2. The finished 232K kit, with all the tools necessary to put it together.



off the ones you're sure of first. The puzzlers left over at the end can be identified by referring to the pictorial diagrams in the construction manual.

After all of the identification work has been taken care of, and the parts have been put in a place where they will be easy to get at when they're wanted, spend a few minutes looking through the instructions to get an overall idea of what you are about to do. It's not necessary to know exactly how the VTVM works, or what is the function of each resistor, but it *is* helpful to have an idea of what sort of work has to be done in the different stages of construction and what the different assemblies are going to look like. Once you begin the work of construction, go *slowly*. Read each step carefully and be sure you understand it completely before making any connections. It is far simpler to avoid making errors than to have to go back and try to find and correct them when the completed instrument doesn't work.

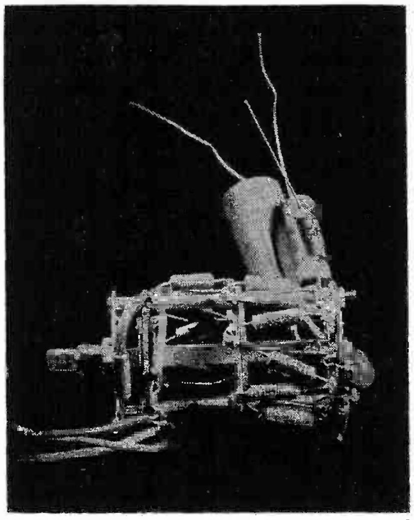


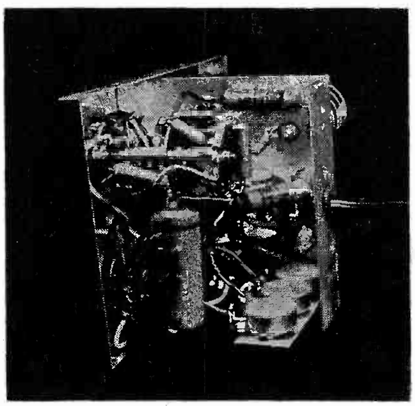
Fig. 4. Range switch is also prewired.

The first part of the assembly is purely mechanical. The transformer, potentiometers, brackets, clips, and the like are mounted on the chassis. It took us just 3 hours from the time the kit was opened until these parts were mounted. This includes time spent checking all the parts and riffling through the instruction manual, taking it very easy in accordance with our own good advice. There is no soldering to be done until after the completion of this assembly procedure.

Once the larger parts have been assembled mechanically, the chassis is wired and resistors and capacitors set in place. Soldering is done during this part of the work, although not all connections are soldered now. At some points additional connections are to be made later, and these are left unsoldered for the present. Directions are given in the construction manual about when joints are to be soldered. Fig. 3 shows the prewired chassis mounted on the meter's front panel. Wiring the chassis took 3½ hours.

The range switch, shown in Fig. 4, is also wired before it is finally set in position on the front panel. Identification of the lugs on this switch, as well as those on the function switch to be wired later, is difficult. The safest way is to study the pictorial diagram carefully and match the lugs on the switch with those in the picture. Don't make any of the connections to the switch until you're certain that you have identified the lugs correctly. The time taken to wire the range switch was 1 hour and 55 minutes.

The remainder of the work on the meter proper consists of mounting the parts on the front panel and making the final internal connections. It took 1 hour and 50 minutes to do this part of the work. The completed instrument, *sans* cabinet, is shown in Fig. 5. Wiring the test probe, connector, and ground cable, checking over the work on the meter, and putting the finishing touches on the cabinet are all that remain to be done after this. Assembling the test probe took 30 minutes, and that was the most time-consuming of these jobs. Total assembly time for the kit, from the time the box was opened to the time the finished instrument was plugged into the line and tried out, was 11 hours and 55 minutes. As was pointed out earlier, the work was done slowly and carefully; it was also done in a number of short working periods of from two to three hours at a stretch.



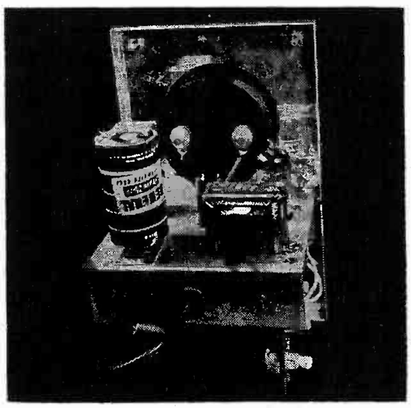


Fig. 5. Two views of the internal wiring and chassis assembly entirely finished.

The moment of justification for the time and care spent on its construction came when the meter, just finished, was tried — and worked!

AUDIOCRAFT Test Results

Performance specifications given by the manufacturer, in addition to those mentioned previously, follow:

DC Voltmeter section: input resistance, 11 MΩ on all ranges; accuracy, ±3% of full-scale reading or better.

AC Voltmeter section: input impedance, 1 MΩ shunted by 60 μμfd; accuracy, ±5% of full-scale reading or better.

Tubes: 6AL5 as full-wave peak-to-peak rectifier; 12AU7 in balanced meter bridge circuit.

Power Supply: transformer-operated selenium rectifier, and 1.5-volt flashlight cell.

These specifications are typical of high-quality multi-purpose VTVM's, so the Eico Model 232 should be expected to perform the essential functions as well as any. Moreover, its capabilities are equivalent to those of prewired instruments selling for about three times the price of this kit. It has two competitors in kit VTVM's, though. Its specs and appearance differ from them basically in two ways: the others have decibel meter scales, and the Eico unit does not; the others utilize separate test leads for AC and DC functions, while the Eico 232 has the single-lead Uni-Probe.

The missing decibel scale is replaced in the 232 with a special scale for the lowest AC volts range. Diode rectifiers that are used in all VTVM's for AC measurements are notoriously nonlinear on the lowest range, so that a separate meter scale is necessary for greatest accuracy on this range. If this scale is furnished, there is no room for a db scale. Now, in audio equipment it is very often necessary to measure AC voltages on the order of 1 volt or less. If you want maximum accuracy you must have either this scale or (preferably) a single-purpose AC VTVM, which will have scales down to 10 mv or so. Such an instrument will not measure DC volts or ohms. Therefore, if the buyer must get along with one multi-purpose instrument, it seems to us that he would be better off with one having a separate LOW-AC volts scale — in spite of the admitted utility of a decibel scale for response measurements.

The Uni-Probe, with its rotating tip

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Bulk-Tape Eraser and Recording-Head Demagnetizer

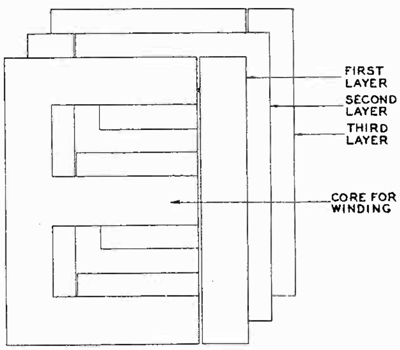
A magnetized recording head will adversely affect the frequency response of your tape recorder. A demagnetizer costs about $7. For $20 you can buy a bulk eraser that will wipe your tape clean for re-recording without the time-consuming, head-wearing process of running the tape past the erase head of your recorder. A bulk eraser also eliminates the irritating residual signal where incompatible recorders result in only partial erasure of exchanged tapes. Here's how you can kill both birds with one do-it-yourself stone.

If the "junk box" doesn't contain a large power transformer, your local repair shop should have a discarded one you can purchase cheaply. The larger the better; one from an old high-power amplifier will fill the bill nicely. It doesn't matter what else is wrong with it as long as the 117-volt primary winding is all right. The black leads are normally the leads to the primary winding. If you are uncertain, or if the lead coloring isn't standard, a good preliminary check is to determine the leads to each winding by a continuity test with an ohmmeter. Some windings may be center-tapped, in which case continuity will show on three leads.

After you have separated the leads by windings, it is a fairly safe guess that the pair showing the highest resistance will be the secondary high-voltage winding. The pair with the next highest resistance is probably to the primary or 117-volt winding — the one you're looking for. The resistance here will be in the order of a few ohms. It was 11 ohms in the transformer I used. The other leads will probably show even less resistance and will be the filament secondaries.

In order to double check your identification of the windings the following procedure is suggested before applying the full 117-volt current. Connect the leads from the winding with the highest resistance, which you have tentatively identified as the high-voltage secondary, to a voltmeter set for AC. Connect the leads from the winding with the next highest resistance, tentatively identified as the primary, across the output of a step-down filament transformer. If you don't have one, use the filament output of the transformer of your amplifier or AC radio. This voltage will probably be in the order of 6.3 or 12.6 volts. If you get a voltage reading on the voltmeter of from 3 to 7 times the input voltage, you have identified the windings correctly.

Remove the outer metal shell surrounding the transformer. Inside you will find a metal rectangle with a bar through the center, around which the coils are wound. On closer examination you will see that this metal frame and core is laminated and consists of many layers of thin sheets of iron. Each layer consists of two pieces or sheets, one shaped like the letter *E* and one like the letter *I*. These are fitted together as shown in the illustration, with the positions of the *E* sheet and the *I* sheet reversed in alternate layers to make a continuous frame and core for the windings.



E-type power transformer laminations.

The next step requires patience and care. Using a thin-bladed knife, start at one side and separate the first sheet from the rest and remove it from the winding, being careful not to injure the windings. Proceed with each successive layer until all sheets have been removed, placing the *E* pieces in one pile and the *I* pieces in another. Put the *I* pieces back in the junk box — you never can tell what you might want them for. Reassemble the *E* pieces, all pointing in the same direction, and reinsert them in the windings. If the pitch with which the transformer is impregnated is so thick and hard that you can't get started pulling the sheets out, dump the whole thing in some boiling water to soften the pitch. Be sure the unit is thoroughly dried before you put any juice through it.

With the iron core reinserted, proceed to snip all leads except those to the primary winding. Cover the ends of each cut lead with insulating tape and bend the lead to lie flat against the winding. Wrap the entire winding and the laminated metal *E* with rubber tape. The tape will stretch enough on the corners to fit smoothly. This will protect the windings and serve to hold the laminations in place. It is best to leave the three faces of the laminated frame and core exposed; covering them with tape will not interfere with the magnetic lines of force, but leaving them exposed will help in dissipating the heat generated when the unit is in use.

Connect an ordinary electric power cord of convenient length — 3 or 4 ft. — to the two leads of the primary winding, soldering and taping the junctions. Put a line plug on the other end of the cord and the unit is ready for use.

To erase a reel of tape in 15 or 20 seconds, place the transformer on a flat surface with the exposed faces up, and plug into any AC 117-volt outlet. Grasp the reel of tape firmly in both hands and, starting about 2 ft. above the transformer, bring it down slowly with a circular motion to the transformer and then withdraw it slowly, also with a circular motion. Turn the reel over and repeat the process. Trial and error will determine the amount of exposure required for complete erasure by the individual transformer.

Hold on to the reel firmly, because the transformer's pull on the iron oxide coating of the tape will surprise you. The circular motion in advancing and withdrawing the tape should describe a pattern which will expose all of the reel to the magnetic field which will probably be

Continued on page 44

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BASIC ELECTRONICS

by Roy F. Allison

XII: Capacitance in AC circuits

THE behavior of inductors in AC circuits was discussed in the preceding chapter. Now let us turn our attention to capacitors, and how they react to AC sine waves. Fig. 1 shows a capacitor connected directly across an AC voltage source. Terminal A is alternately positive and negative with respect

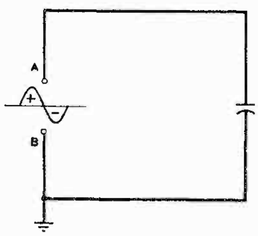


Fig. 1. AC circuit with pure capacitance.

to terminal B. Let it be assumed that the voltage source has been connected for some time.

Because the capacitor is subjected to a voltage that changes in value constantly (except for an instant at the top and bottom of the wave form) and in direction periodically, it will charge first in one direction and then in the other. Electrons, constituting the charge flow, are drained from one capacitor plate and forced into the other plate; then, as directed by the changing source voltage, they are shifted back through the source to the other side of the capacitor. This continuously shifting charge flow produces an alternating current in the circuit as a whole. Although not a single electron may actually go *through* the capacitor from one plate to the other, it is convenient to think of an AC current as being passed by the capacitor — as, in effect, it is. And because the applied voltage wave form is that of a single-frequency sine wave, the current wave form is sinusoidal also.

A sine wave of source voltage is drawn again in Fig. 2, with numbers at the important points on the wave form. It should be kept in mind that this is also the voltage across the capacitor, because the capacitor is connected directly to the source. Accordingly *it represents the state of charge of the capacitor*. At the maximum positive point, 2, the capacitor is charged to its maximum value in the positive direction; that is, the top plate is maximally deficient in free electrons, and the bottom plate has a maximum excess of free electrons. Further, since the voltage at instant *2* is not changing in value, the charge on the capacitor is momentarily not changing in magnitude; therefore, the rate of charge flow (current) must be zero at that instant. Now, as the voltage begins to decrease in value, the charge on the capacitor must decrease. It can do this only by means of electrons flowing out of the bottom plate, through the source, and back to the top plate. This negative direction of charge flow is opposite to the direction of the applied voltage, which is still positive although decreasing in value. During the time from *2* to *3* of the applied voltage, then, current increases in the negative direction. At point *3*, where the voltage is changing fastest, the current reaches its maximum negative value. At this point the charge on the capacitor is zero (because the source voltage, which is identical to the capacitor charge, is zero).

As the voltage continues into the negative part of its swing, current continues in the negative direction. But, with the *rate of change of voltage* decreasing from point *3* to *4*, the *rate of charge flow* (current) also decreases. At point *4* again the voltage ceases changing at all for an instant; thus, the current at that point is zero. The capacitor is now fully charged in the negative direction: there is a maximum number of free electrons on the upper plate and a minimum on the

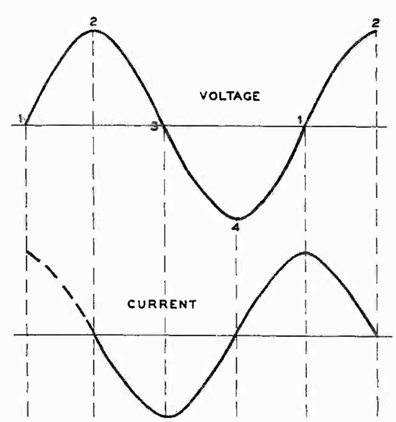


Fig. 2. Voltage and current in capacitor.

lower plate. When the voltage begins to decrease from its maximum negative value, the capacitor charge must also decrease to correspond with it. This is possible only if charge begins to flow in the opposite (i.e., positive) direction, producing a positive current. From voltage points *4* to *1*, therefore, current rises from zero to its maximum positive value. At point *1*, the voltage and the charge on the capacitor are again zero. The current is maximum at point *4* because the rate of voltage change, and accordingly the rate of charge flow, is maximum. From point *1* to point *2* the capacitor charges in the positive direction; current continues positive, but it decreases in value because the rate of voltage change (hence the rate of charge flow) decreases. At point *2* the voltage ceases changing for a moment, the current is again zero, and the capacitor is

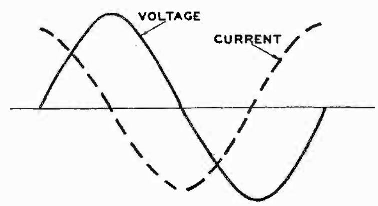


Fig. 3. E and I wave forms combined.

once more fully charged in the positive direction. The cycle then repeats.

If the two wave forms are superimposed, Fig. 3, it will be seen that (as with an inductor) the current is 90° out of phase with the voltage. In this case, however, the current is leading — not lagging. These facts account for a great many similarities and differences in capacitors and inductors, as will be seen.

It has been shown that the capacitor charges to the peak value of the source voltage, and then discharges, twice during each cycle. In chapter VII[1] the formula relating charge in coulombs (Q), potential in volts (E), and capacitance in farads (C) was given as $E = Q/C$. This is easily rearranged as $Q = CE$. Since the current in the circuit of Fig. 1 is actually the rate of charge flow for the capacitor, and the amplitude of the charge flow is the product of C and E, then clearly the current is directly proportional to both C and E. With larger capacitors, more current will flow in the circuit; with higher voltages, more current will flow also. We know, too, that current is the *time rate* of charge flow. During each cycle the same

[1] AUDIOCRAFT, I (May, 1956); pp. 36-38.

amount of charge flows, no matter how long the cycle takes, since the capacitor is fully charged and discharged twice during each cycle. If more cycles occur each second, more total charge will flow during each second. Thus the current is directly proportional to the *frequency* of the applied AC voltage; the higher the frequency, the greater the current. All these variables are taken into account in the formula for current in a capacitor:

$$I = 2\pi EfC,$$

where I is current in amperes, π is the numerical constant pi (approximately 3.14), E is the AC voltage across the capacitor in volts, f is the AC frequency in cps, and C is capacitance in farads. If E is RMS or effective value, I will be the effective value of current, and if E is peak voltage, I will be peak current.

For a given voltage the current is obviously limited in value by the capacitor, just as it would be by a resistor. This current-limiting effect is called *capacitive reactance*, and it is comparable to inductive reactance. Its symbol is X_C; it is also expressed in ohms. To find X_C in ohms, we set down the standard formula for current, replacing R with X_C:

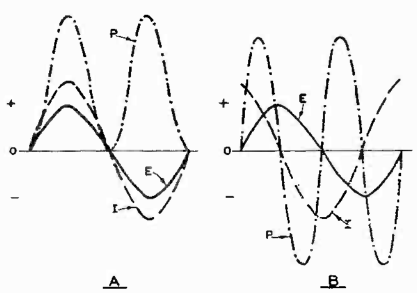


Fig. 4. AC power in R and C.

$$I = \frac{E}{X_C}.$$

From the preceding formula, I is also equal to $2\pi EfC$. Setting the two right-hand terms equal to each other,

$$\frac{E}{X_C} = 2\pi EfC;$$

$$\frac{1}{X_C} = 2\pi fC;$$

$$X_C = \frac{1}{2\pi fC}.$$

Capacitive reactance is, then, *inversely* proportional to frequency and *inversely* proportional to capacitance. This should be compared to the inductive reactance formula:

$$X_L = 2\pi fL.$$

This shows that inductive reactance is *directly* proportional to both frequency and inductance. As frequency increases, X_L increases but X_C decreases; as L increases, X_L increases; but as C increases, X_C decreases.

As with a pure inductance, a pure capacitance does not consume energy, and for the same reason: the 90° phase relationship between current and voltage. This is illustrated in Fig. 4. Instantaneous power values are obtained by multiplying the instantaneous values of current and voltage. Fig. 4A shows this done for a resistance, and Fig. 4B for a capacitance. Note that since current and voltage in a resistance are always either positive or negative together, their product — the instantaneous power curve — is always positive. But during half of each cycle in the capacitance, current is opposite in polarity to voltage; therefore, in these parts of the cycle, the instantaneous power curve is negative. In the positive sections of the power curve the source delivers energy to the capacitance, which is stored in the electrostatic field. In the negative sections of the power curve this energy is returned to the source. The net power consumption is zero.

When a resistance and a capacitance are in series across an AC source, they are handled in about the same way as a series combination of resistance and inductance. The different phase relationship in the capacitance must, of course, be taken into account. An appropriate circuit is shown in Fig. 5.

In this circuit, the same current is common to all elements: R, C, and the source. It is common also to the combination of R and X_C — Z — that the source "sees" as the resultant load. The voltage across R, E_R, is in phase with this current, while the voltage across C, E_C, lags the current by 90°. Thus the voltage across C lags the voltage across R by 90°. What is the sum of these voltages, E_S, and its phase angle with respect to the current and the two component voltages? We can find out by plotting the two voltages in proper phase and amplitude relationship, and adding their instantaneous amplitude values graphically. This is done[2] for equal values of E_R and E_C in Fig. 6. It will be seen that E_S is sinusoidal also and, although larger than either E_R or E_C, is *not* as large as their numerical sum. The reason is obvious: The peak values of the two constituent voltages do not occur at the same time. As a matter of fact, for equal values of E_R and E_C, E_S is almost exactly 1.414 times either of them. It is apparent as well that the source voltage lags the voltage across R by 45°,

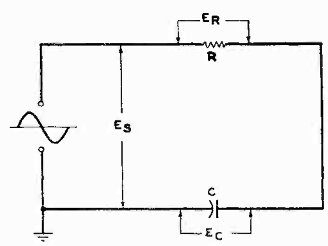


Fig. 5. Combined R and C in AC circuit.

and leads the voltage across C by 45°. Since the current is in phase with the voltage across R, then the source voltage also lags the circuit current by 45°.

We can draw some further conclusions with the aid of Fig. 6. Since the same value of current is common to R, X_C, and their resultant impedance Z, then the magnitudes of R, X_C, and Z must be proportional to the voltage drops across them. E_R and E_C in our example are equal; therefore, R must be equal to X_C. Z is the resultant impedance across

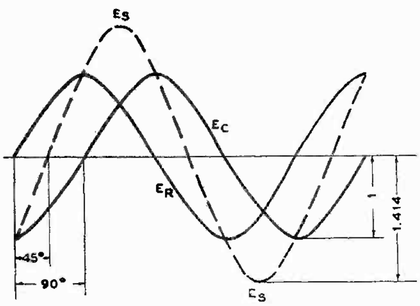


Fig. 6. Voltages across R, C, and source.

which the source voltage E_S is developed. E_S is 1.414 times either E_R or E_C, so Z must be 1.414 times either R or X_C.

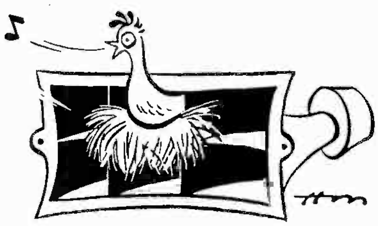
This is information for a specific case only (although a most important case). More general information can be obtained from a vector construction, as explained in the preceding chapter. Fig. 7 contains three vector diagrams of the same circuit: in Fig. 7A the diagram is for the case when R is equal to X_C; in Fig. 7B, X_C is substantially larger than R; and in Fig. 7C, R is substantially larger than X_C. In each case E_R is drawn at an angle of zero degrees (directly to the right) since it is in phase with the current. Because the voltage across C lags the current by 90°, E_C and X_C are drawn at an angle of −90°, which is the same as 270° — directly downward from the origin.

We can see by completing the parallelogram, a process discussed in Chapter XI, that the resultant voltage or impedance is always larger than either of the two constituent vectors and always less than their numerical sum. Measurement of the vector lengths would reveal again that the resultant of two equal vectors at right angles is 1.414 times either; conversely, either is 0.707 times the resultant. If an AC voltage of 10 volts were impressed across a resistor and a capacitor in series, and the frequency were such that X_C equaled R in magnitude, there would be 7.07 volts across each. The diagram would tell us also that E_R led the source voltage (E_S) by 45°, that E_C lagged the source voltage by 45°, and that the source voltage lagged the current by 45°.

In Fig. 7B, with X_C much larger than R, the circuit is primarily capacitive and behaves more like a purely capacitive

Continued on page 40

[2] The corresponding process was described for combining E_R and E_L in the preceding chapter, but was not carried out because of lack of space. The actual construction may make it easier to understand why a vector diagram accomplishes the same thing.



Sound-Fanciers' Guide

by R. D. DARRELL

SINCE the "transit time" between copy drafting and publication is many orders of magnitude greater than that of electron flow between cathode and plate, or even that of sound waves between loudspeakers and listeners' ears, this is being written well before the first of the high-fidelity and audio shows, which will open the fall season not with a whimper (to reverse T. S. Eliot's famous phrase), but with a bang. Yet I know in advance about what that bang will be like, partly because of previous experience with public demonstrations of hi-fi in full cry; still better by my own current, private, preparatory bout with what I think of as the "Audiophile's DDT's" — that is, ultrasensational Display, Demonstration, and Test records.

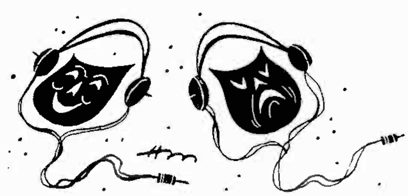
If you were able to attend any of the shows or fairs, your ears probably still ring as you read these words. Indeed, it's not at all unlikely that you're so thoroughly fed up with what is most assertively proclaimed as hi-fi that you now want to listen (if to anything at all) only to flute solos *pianissimo* and with full treble cutoff. But if you couldn't hear the public demonstrations in person, or if your appetite for big, loud, wide-range sound is as insatiable as mine is, you may want to share some of my home decibel-display and work-out sessions. In any case, such a personal audio orgy can be infinitely more fun — and incalculably more instructive — than any mob experience.

Public *vs.* Private DDT's

Now, don't get me wrong! I love the big shows and wouldn't dream of missing any I could possibly get to. They are ideal occasions for meeting old and new audio friends, as well as for looking over all the new and revamped equipment coming on the market. But I, for one, refuse to subscribe to the notion that hearing really is (under certain conditions, at least) believing. Whatever I hear at a big show, or for that matter at any public demonstration, goes in one ear and right out of the other; I make no attempt to *listen*. I simply don't know how to judge what I'm hearing, or to what extent it is affected by the nature of the program materials, the performance, the recording techniques, the various reproducing-system components, the particular control settings, the demonstration-room acoustics, and dozens of other highly significant — but here unfamiliar — variables.

How different everything is at home! Our own sound system, good or bad by any absolute standards, at least is thoroughly familiar, and so is the acoustic environment. We set our controls exactly where we want them and where we know what they do. And if the music itself or its performance is new at first, a few playings quickly make it familiar, whereupon we can begin to evaluate the actual reproduced-sound qualities according to known standards and individual aural tastes.

My complaint about the big show and fair demonstrations is not the usual one that everything is played too loudly (although some things certainly are), but that what should be loud isn't really loud enough, while what should not be loud isn't nearly soft enough. In other words, I'm unhappy about the constricted dynamic range, which under the existing conditions I never can be sure is a fault of the particular reproducing equipment utilized or a result of the



elevation of the masking-noise threshold by the crowd pandemonium. At home, however (especially as blessed with a comparatively low ambient-noise level and no worries about tender-eared neighbors), I can put on the most sensational disc or tape, set the level so that the quiet passages are properly close to the low threshold, and let the loud ones go to the fullest extent of my system's dynamic capabilities. On some occasions the peaks may be too much even for my fair-sized living room, but they've never yet been too much for my ears or nerves — indeed, like Oliver Twist, I'm continually begging for "More!"

These past few weeks I've really gone whole hog in my combined private preview of the big fall shows and review-examination of sensational display materials which either have been hits of past, or promise to be the hits of forthcoming, public demonstrations. In addition to rehearing some of those I've written about in earlier columns (the percussion works of last July and September, the hi-fi *Further Studies* and *Adventures* of July, and the organ recitals of August and September), I've been reveling in a batch of other releases, some of which have been around for a while, but which I never had a chance to know at first hand before; others of which are hot and briskly popping off the griddle. And I've had such a wonderful time with them that I can commend them to every other like-minded audiophile with far more than ordinary enthusiasm.

But one warning is necessary: if you don't have truly wide-range equipment, you're not going to hear records like these at their best. And perhaps another is advisable: if you *have* a sound system which will do them full justice, you may have to go around your house after each session looking for loosened or shattered windowpanes, or even cracked foundations! As for the personal risk of punctured eardrums, overloaded aural nerves, or psychic traumas — well, you'll just have to take your chances. The only reassurance I can give on that score is that *I've* gone through the experience unscathed — I think.

Sounds "Out of This World"

A man after every hi-fi fanatic's heart sends us right off into outer space and back below the terrestrial crust: Emory Cook with *Sounds from the Ionosphere* and *Earthquakes Around the World* (Cook 5012). The former features an uncanny batch of aptly named Swishes, Whistlers, and Swishlers, which include some of the finest ripping and tearing noises since Carl Sandburg tore his shirt and exulted in the lovely razzing sound; plus an incongruously sober and informative discussion of stratospheric signals by Emory and Dr. M. G. Morgan. The latter features seismographic vibrations set up by some five earth tremors, which become terrifyingly audible when speeded up by factors of 375 and 750. But not content with providing some of the severest tests of pickup tracking available on discs, Emory perversely adds one band in which the seismographic "shakes" are stepped up only two or three times in speed — and are guaranteed to shake any pickup yet made right out of the grooves with wholly subsonic perturbations.

Another superstrenuous workout for your pickup and arm (as well as your ears) comes from the equally fanatical and resourceful E. D. Nunn, in the form of a "psychiatrist's special", *Echoes of the Storm* (Audiophile AP 20). Echoes, nothing! These *are* the most room-shaking and heart-shaking thunder crashes and lightning near misses I've ever undergone, as well as some superbly splattering torrential rain. He's outdone even Emory Cook's earlier storm recordings here, but he still has to equal the Old Master's skill with frog croakings: those at the end of this storm aren't in nearly as good voice as Cook's (004) reviewed here last July. The *Crazy Quilt* bands on the other side proffer a wide variety of man-made sounds, of which the rotary-saw rings and screams are guaranteed to penetrate anyone's skull, and the nail hammering provides some authentic thuds. But the water-pail drips and faucet-dribbling sounds are more amusing, and I liked best of all the infectiously rhythmed drumming (one of the best brief percussion-display recordings yet) and the exceptionally bright and sonorous examples of a music box which plays (miraculously) almost in tune.

After these, *Through the Sound Barrier* (McIntosh 105) — which I was hearing for the first time, although it made a highly acclaimed debut at least a year ago — seemed somewhat anticlimactic. Its jet-aircraft thunders, sonic booms, and literally hellish rocket-engine roars are admirably recorded, all right, but the tape originals are poorly edited with too long stretches of control-tower-and-pilot talk and too few highly dramatic moments. The same criticism also applies to the overside miscellaneous subway, alarm clock, machinery, and aircraft-cannon sound demonstrations. Few of these are particularly impressive anyway (the 22-mm guns sound more like pneumatic drills), and throughout this disc I felt myself wishing — as I never did in those mentioned earlier — that the recording had been done in stereo. But maybe the planes, trains, fireworks, etc., in the more realistic movement and "perspective" of Concertapes' stereo *Sound in the Round* (501 and 504) have spoiled me.

More effective, if in a quieter, eerier way, is the Luening-Ussachevsky *Tape Recorder Music* (Phonotapes-Sonore PM 5007; also on the Innovations LP, GB 1), although some of the pieces here also go on a bit longer than their inherent interest warrants. At their best, however, they have some fine throbbing lows and glittering highs, as well as intentional wows and flutters for which (for once) your tape-playback mechanism can't be blamed. I can't say that

Continued on next page

SOUND FANCIER

Continued from preceding page

these works really make the grade as aesthetically significant compositions, although they surely do lay some of the experimental groundwork for more meaningful exploitation of tape-manipulation techniques, but even considered as sheer sound, they considerably enlarge the available repertory of what is fascinating as well as strange to our ears.

But the last word in this domain belongs again to Emory Cook, who has gathered up a zany assortment of leftovers from his sonic adventures in a disc spoof on the whole hi-fi craze, *The Compleat in Fidelytie* (Cook 1044). The recorded sounds are perhaps not so extraordinary in themselves, although the various wind noises are surprisingly thrilling or scary at their best, and the baby's squalling and blue-bottle fly's buzzing are aural realism *in excelsis.* But the full-blast reproduction of old Edison cylinders is astonishing — for what could be, as well as what couldn't be, done in recording in those days; and the aural insight into a Mexican church organ from the mike view of the wind box itself is a matchless revelation of the horrors of distortion beyond the power of any meter to measure. Anyway, this record is a must for every hi-fi collector if only for its jacket annotations — sophomoric humor, perhaps, but superb of its kind.

So Quiet in the Country?

If you felt a pang of envy a moment ago when I boasted about the low ambient-noise level of my present country location, it may be some consolation when I confess that this condition is the occasional ideal one. At times it soars, as 7 sheep, 4 cats, 3 ducks, 1 dog, 1 calf, 1 parrot and x^n katydids — solo or tutti — lift their voices in assorted blatting, mewing, quacking, barking, lowing, screaming, and general yak-yakking. So far, I haven't lacked disc and tape decibels to override their best *fortissimi,* but I'm beginning to fear that I may run out of electroacoustic gain before the animals learn to exploit their full lung power.

But one gets hardened to rural, no less than to urban, noises. By now, I'm even willing to take a kind of busman's holiday by playing records in which the sounds of nature have been selected, isolated, and combined with a considerable degree of artistry. Two of these I've enjoyed lately are the second volume of the Stillwell's bird songs (Ficker 107) and Stokowski's documented version of the Beethoven *Pastorale* Symphony (RCA Victor LM

Continued on page 34

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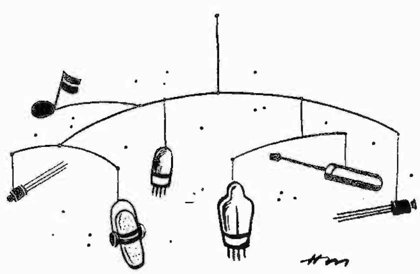
SOUND FANCIER

Continued from page 32

1830). The former, with 140 songs and calls of some 58 species (some in illuminating half-speed repetitions), is a worthy companion to Ficker 101, cited here last July, and the somewhat better-known Cornell series — so useful indeed to bird watchers and *aficionados* that I barely had a chance to play it through once before it was avidly claimed for closer study and reference use by my more ornithologically minded sister. The *Pastorale,* so far as the symphony itself is concerned, is merely a clean but rather heavy recording of an indefensibly mannered, even languishing, reading. The disc's real claim to distinction lies in its added brief dissertation by Stokowski on the stylized "artistic" use of natural sounds, illustrated first by actual brook, storm, and bird recordings; then by isolated Beethovenian musical impressions of these; and finally by an ingenious combination of both real and idealized versions, which, thanks to extremely clever editing, are made to fit together with astonishing effectiveness.

Not the least important value of this half-serious, half-humorous documentary is the clue it gives, by implication at least, to the lack of dramatic *substance* (a quite different thing from the dramatic *impact*) in some of the "raw-sound" recordings discussed earlier. For as much as I and other hi-fi fanatics



relish these, even we find eventually that we are likely to replay them only when we want to impress some new listener with our super-sound systems, or to check the power and distortion characteristics of unfamiliar systems (or our own after any major component changes or repairs have been made). With a very few special exceptions, the most lastingly satisfactory display and demonstration recordings are those in which the brute force of sound "effects" is exploited for aesthetically meaningful ends.

Breaking the "New-Music" Barrier

I might go so far as to concede that even in symphonic compositions, an excessive preoccupation with sheerly sonic values tends to make them more short lived in all-round listener satisfaction than works in which sound as such is subordinated to, or at least tightly integrated in, musical expressiveness. A case in point is the *Tape Recorder Music* above. But an even better one is the Carl Orff trilogy *Trionfi* (Decca DL 9706, 9824, 9826).

When the first piece of this triptych, *Carmina Burana,* appeared in 1953, it scored one of the most striking successes of any modern musical work on records, thanks largely to its electrifying recording of almost barbarically rhythmed, pounding percussion and chanting. But with familiarity quite a bit of this work's intoxicating potency begins to weaken. And although Orff exploits the same formulas with undiminished energy in *Catulli Carmina* (which, moreover, is now recorded with even finer transparency and more dazzling brilliance), it makes hardly as sensational an impact even on first hearing — at least for anyone who knows its predecessor. On the other hand, my present argument proves to be double-edged when we reach the concluding piece, *Trionfo di Afrodite,* for here, except in a few already anticipated driving passages, more or less straight solo and choral singing predominates; yet, while the appeal is primarily musical rather than sonic, it still isn't particularly substantial except perhaps to devotees of contemporary idioms and experimental neobaroque styles.

Perhaps the real point is that while sonic splendors alone can't give permanent validity to a musical work, they can be immensely helpful in persuading listeners to accept — and better understand — idioms and styles which otherwise might seem unacceptably alien to them. Certainly the first two works in the Orff trilogy are rightfully popular (exceptionally so for any contemporary compositions) both as dramatic sound and dramatic music, but I very much doubt that they would have become so popular so fast before the days of wide-range recording. And even if they may never seem quite as exhilarating again as on the first few hearings, or if the final piece may seem somewhat thin from the beginning, the whole set still deserves an honored place in every record library. It should be pulled out for replaying whenever there is an opportunity to spring it on any lucky listener-guest who has yet to experience that incomparable first acquaintance.

Another example of superb sonics, matched this time to less pretentious but, I think, more innately ingratiating music, is Colin McPhee's *Toccata for Orchestra,* a kind of concerto grosso with "gamelan" *ripieno, Tabuh-Tabuhan* (Mercury MG 50103). Some actual

Balinese instruments are used, others are invoked by more familiar percussive orchestral resources, but both are always used for jaunty or lyrical expressive purposes. At first hearing, it surely is the crisply brilliant and extremely powerful recording of fascinating *timbres* which most delights one's ears, but I'm willing to bet that they still will do so on the *n*th hearing, simply because all this kaleidoscopic coloring is applied so fittingly to such delightful musical ideas and textures. The suite from Elliott Carter's ballet, *The Minotaur*, on the other side, is tighter, more somber, and less immediately appealing music, but here too the sheer sonic magnificence of brass screams, thunderous drums, and climactic gong are sure to be powerfully persuasive factors in the work's aesthetic as well as aural acceptance.

Last Word — For How Long?

Of course the power of sound in itself can be a vital aid, not only to new music, but in reanimating overly familiar warhorses, especially when the original intention or hope of the composer was to produce a maximum of sensational impact. The classic current example is the highly touted Dorati version of Tchaikovsky's *1812 Overture*. If the recording world were supervised by race-track stewards, this version would certainly be scratched for undue use of hypodermic stimulation (Mercury MG 50054). I approached it very dubiously indeed, only to be completely overwhelmed — at least as a hi-fi fan. In the first place, Dorati's is a first-rate, nonexaggerated and nonsentimentalized reading. Second, the forces employed, including brass bands as well as real cannon and bells, approximate as closely as possible those Tchaikovsky planned (but never received) for the original outdoor festival performance. Third, and most important, the dubbed-in West Point cannon shots really sound like cannon (and not a bass drum), and the dubbed-in, speeded-up bells provide the most tumultuous jangling imaginable. Moreover, all these have been recorded with an authenticity, power, and incredibly expanded range which surely top anything ever achieved on discs before. If you delight as much as I do in supersonic displays, this record is everything it has been claimed to be, and still more!

Deems Taylor's narration, which follows the overture itself, might be skipped for its verbal story of the elaborate production involved, but it can't be missed by any true audiophile for its absorbing aural illustrations of the cannon shots and carillon peals, both in their original and tape-edited, enhanced forms. The rather violent version of the *Capriccio Italien* overside is less noteworthy, despite its equally brilliant recording. It's the glorious racket at the end of the *1812* that makes this disc a milestone in the evolution of sonic technology.

Just how far and how fast that evolution has progressed is proved by the belated, "documentary", first commercial issue of the *20,000-Cycle Demonstration Pressings* (Cook White Label Series, 001) with which Emory startled the 1949 Audio Fair. I thought then that they sounded terrible, but now I find I was quite wrong in ascribing their top-heaviness to inferior low-frequency reproduction. The lows are actually missing in the recording, and while the excessive highs now sound much sweeter than they did then, not all the brilliance in the world can make an unbalanced spectrum tolerable to my ears. The piano excerpts come off best, but even there the tonal qualities are unpleasantly hard. The schmaltzy organ pieces are atmospheric, all right, but pretty blurry. And the orchestral pieces show up at its worst the spectrum imbalance, as well as the tonal inadequacies of a little orchestra under the late Macklin Marrow, and also those of an overly dry studio. Cook, who has done such infinitely superior things since then, deserves a medal of some kind for his courage in making these old milestones generally available. They are documents for every audiophile's library, for they prove better than any words could possibly do how far we've come from the days when it was *high* fidelity, rather than high *fidelity*.

TRANSISTORS

Continued from page 23

Operation of n-p-n (or p-n-i-p) transistors up to the hundreds of megacycles is expected.

The structure in Fig. 11 is called a field-effect transistor. Soon to be released commercially, this unit has a *gate* which controls current from a *source* to a *drain*. Current flows down the center n-region. The gate is biased so that the p-n junction down the cylinder is in reverse. Near the actual junction, therefore, there will be a space where the bias removes the current carriers. Here no current can flow.

Now the source-to-drain path is constricted anyway, and the removal of a small portion near the junction because of the gate bias makes an appreciable effect on the source-to-drain resistance. This resistance varies as the gate voltage is varied. Since the gate is biased in reverse, little input current is required. And, since an input of moderate voltage at little current controls a large amount of current at moderate-to-high voltages, the power gain is great.

With a high input resistance and moderate output resistance, this device

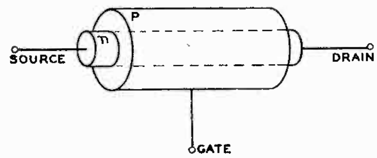


Fig. 11. The field-effect transistor is much like a vacuum tube in operation.

resembles a normal vacuum tube more closely than junction transistors, and many vacuum-tube circuits can be used with field-effect transistors without very much change.

The Tandem transistor, recently released by Marvelco, is merely two transistors in one case, internally connected. Fig. 12 shows the connection. These clever devices have no advantage over two separate junction transistors, except for the fact that the two transistors used are made especially for each other.

In the future, two or three transistors inside one case will be common; perhaps there will even be totally enclosed amplifiers, including resistors and capacitors, inside a small package. Especially, twin transistors (two matched units inside the same case) will be useful.

Transistor Materials

Germanium is not the only semiconductor suitable for use in transistors. It is the most common today because it is just about the simplest to understand, the cheapest, and the easiest to work with. In the future, other semiconductors will be used in making diodes and transistors.

At present, silicon is of some use. Although harder to work with, silicon has some useful properties, especially its low thermal current and small variation with temperature changes. Silicon diodes are now available which make very efficient rectifiers — much more efficient than other types. And silicon high-power transistors are coming into use. Alloys of germanium and silicon which combine the best features of each material may be obtained, also.

In the future, the material most worth watching is silicon. However, several other semiconductors are known. For example, transistor action has been observed in many compounds, such as indium antimonide, aluminum antimonide, and gallium arsenide. When the structure and behavior of these complicated compounds is better known, their properties can be used to advantage.

Several semiconductors have been used in the past without knowing the theory behind their operation. Notable among these is galena, or lead sulfide, used in early radio days with a catswhisker for detecting purposes. Also, present-day selenium rectifiers operate because selenium is a semiconductor. The various types of photocells used in the past (often called barrier-layer cells) used semiconducting materials. Even today, the most sensitive photodetector known to science is a small cadmium sulfide photocell — and cadmium sulfide is a semiconductor.

New Designs

You may expect eventually to see designs for transistors that are unheard of today. Although the present junction transistor will probably not be replaced, specialized operations will be taken over by specialized types of transistors. Better point-contact transistors

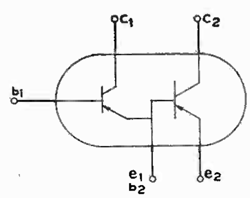


Fig. 12. Tandem (two-unit) transistor.

will be available when manufacturing processes (mainly concerned with the difficulties encountered in electroforming) improve.

And remember that we have only talked about p-n junctions so far. In addition, p-to-i junctions, and n-i junctions have interesting properties, and devices built to take advantage of those properties will be useful in the future. A junction between two p-regions, one stronger (p+) than the other, is a p-p+ junction. Semiconductor devices using p-p+ and n-n+ junctions as well as other types will be used someday.

It should be evident that the transistor field is a very big one, and is rapidly advancing. Nobody today can predict what the transistor of 1965 will be like, but mention can be made of the various types today — either available now, or still in the planning stage. And indications can be pointed out concerning possible new avenues of research for different types of transistors tomorrow.

This installment of the series on audio transistor applications should leave the reader with a better knowledge of transistor action as it occurs in a junction transistor, and some understanding of how semiconductor theory explains the behavior of many different types of semiconductor devices. The reader should have a little perspective as to how the junction transistor fits into the pattern formed by the many different transistor types. In addition, interesting avenues of research which will result in tomorrow's transistor should give the reader some basis on which to understand tomorrow's transistor when it becomes available.

Further Reading

The following books will be referred to by the author's name in the categorical reading suggestions below:

Bevitt, W. D. *Transistors Handbook.* Englewood Cliffs, N.J.: Prentice Hall, 1956.

Coblenz, A., and Owens, H. L. *Transistors: Theory and Applications.* New York: McGraw-Hill, 1955.

Kiver, M. S. *Transistors in Radio and Television.* New York: McGraw-Hill, 1956.

Krugman, L. M. *Fundamentals of Transistors.* New York: Rider, 1954.

Lo, A. W., Endres, R. O., Zawels, J., Waldhauer, F. D., and Cheng, C. C. *Transistor Electronics.* Englewood Cliffs, N.J.,: Prentice Hall, 1955.

Scott, T. R. *Transistors and Other Crystal Valves.* London: Macdonald and Evans (Distr. in U.S. by Essential Books, Inc.), 1955.

Shea, R. F. *Principles of Transistor Circuits.* New York: Wiley, 1953.

Turner, R. P. *Transistors, Theory and Practice.* New York: Gernsback Publications, 1954.

Diodes

Shea, pp. 453-466.

Photodetectors

Bevitt, Chapt. 9.
Coblenz, pp. 87-88, p. 258.
"Miniature Cadmium Sulfide and Lead Sulfide Photocells." *Electrical Manufacturing*, Staff Report (Apr. 1955).
Kiver, pp. 203-211.
Seed, R. G. "Germanium Photosensitive Devices." Clevite Transistor Products pamphlet.

Hook Transistor

Coblenz, pp. 85-87.
Kiver, pp. 222-225.
Krugman, p. 17.
Lo, pp. 75-76.
Shea, pp. 475-476.

Point Contact Transistors

Bevitt, Chapt. 3.
Coblenz, Chapt. 6.
Kiver, pp. 44-50.
Krugman, pp. 8-11.
Lo, pp. 76-79.
Scott, Chapt. 4.

Surface Barrier Transistors

Kiver, pp. 59-61.
"The Surface Barrier Transistor." *Proc. I.R.E.*, XLI (Dec. 1953), p. 1702.
Turner, pp. 22-24.

Intrinsic-Region Transistor

Scott, Chapt. 7.

Field Effect Transistor

Huang, C., Marshall, M., and White, B. H. "Field Effect Transistor Circuit Design." *Electronic Design*, (Jul. 1955), p. 38, (Oct. 1955), p. 42.
Kiver, pp. 233-239.
Scott, Chapt. 7.

Tandem Transistor

Hollmann, H. E. "Applications for Tandem Transistors." *Tele-Tech and Electronic Industries*, (Feb. 1956), p. 58.

Miscellaneous Transistor Types

Berger, A. W., and Rutz, R. F. "A New Transistor with Thyratron-Like Characteristics." International Business Machines Corporation Bulletin No. 101.
Coblenz, Chapt. 15.
Kiver, pp. 226-233.
Lo, pp. 72-75.
Shea, Chapt. 21.

Materials

Coblenz, Chapts. 14 and 15.
Scott, Chapt. 8.

REBUILD

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capacitor which was totally out of the circuit when operating at 15 ips. A 1-db boost was still there at 6,000 cps, but since professional standards call for a maximum deviation of 2 db, this was immaterial. The machine was within 2 db to 12,000 cps.

At 15 ips response flattened out considerably, extending beyond 15 Kc and being only slightly down at 20 Kc. The

Continued on next page

REBUILD

Continued from preceding page

extreme flatness of the 15 ips curve was caused, in a roundabout way, by *removal* of the equalization, since the extremely narrow gap and extra tape speed make realization of high frequencies routine.

My problem would have been simple if low-frequency repair could have been so easily executed. But the hum that the low-frequency cut was intended to minimize was inductive, and elimination required considerably more time and effort.

Later models of the Pentron have been designed with a single ground connection to the chassis, but on my earlier machine thirteen chassis grounds had to be eliminated. After removing all tubes, I drilled out the rivets holding each end of the terminal strips, bent up the tab, and placed a piece of electrical tape under it, sticky side next to the chassis. Then I reconnected all ground lugs with wire.

Using my 10-watt amplifier and volt-ohmmeter as a sort of makeshift VTVM, I adjusted the amplifier and preamp volume to give a sizable hum indication on the meter, with speakers disconnected. I prepared a pair of single conductor wires with alligator clips on each end and, after replacing the tubes and turning on the preamp, alternately connected and disconnected ground at the point which produced the least hum.

This was a time-consuming operation, but it did the trick. Hum which formerly read as high as 1½ was reduced to 1/20 volt. You can readily see what a drastic effect this had on signal-to-noise ratio.

Rather than construct a DC supply for the tube heaters, I lifted the six-volt transformer centertap from ground, and connected the tube heaters in parallel across a 100-ohm potentiometer, with the center leg connected to ground. Careful adjustment of the arm decreased hum to an extremely low value. I must point out, however, that this adjustment, for optimum results, must be checked occasionally, since replacing a tube or reversing the plug polarity will alter the balance and make readjustment necessary.

An alternative is to connect the center arm of the pot to a positive voltage in the neighborhood of 50 volts. I tried this but the procedure requires an additional capacitor and two resistors, and the results were no better than before.

The signal-to-noise ratio at this point was better than 55 db. Hum had been so significantly reduced that I could turn my attention to lowering response of the Pentron to 20 cps or so. This was done by increasing the amount of low-frequency boost and by increasing

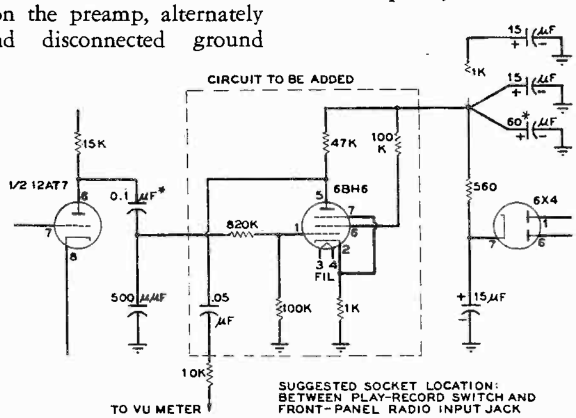


Fig. 10. Circuit that may be used to isolate VU meter from line.

points throughout the chassis, noting the change in hum level on the meter. As the hum approached a minimum, I switched the speakers on occasionally to be sure that the meter was indicating hum and not thermal noise, or a sudden decrease in gain as a cathode ground was inadvertently lifted.

All radio and mike-input and amplifier-output connections were made with noninsulated jacks, using the chassis as a ground return. Although insulated jacks are available from electronic parts distributors, I achieved the same effect by drilling the mounting holes slightly larger and using fiber washers on both sides of the panel. The jacks were then reconnected to ground with wire, the size of the coupling capacitors. Only one resistor had to be changed to provide the necessary bass boost. The diagram in Fig. 6 incorporates circuit changes recommended by Dynamu, as well as those I found necessary. Parts added, moved, or changed in value are marked with an asterisk. Fig. 10 is an optional modification which isolates the VU-meter rectifier from the audio line, thus reducing distortion from nonlinear loading.

Since the Pentron uses standard tube types for all its stages, rather than low-noise types, I found I could lower the hum and noise level by using the well-known expedient of tube selection. The Pentron uses a 6AU6 for both microphone and playback preamplifiers, which simplified the problem. I bought half a dozen of these tubes, and tried them individually in the playback preamp socket. After each had warmed for several minutes, I read the hum level on the meter, ultimately selecting the quietest. This, of course, could mean the difference between a signal-to-noise ratio of 30 db and one of 55 db.

One final problem, which is still not entirely solved, hit me with sudden impact when I was reassembling the recorder in its case. Hum, a monstrous and overpowering amount of it, blared forth. I hurriedly pulled out the preamp, upended it on the bench and removed the bottom plate. With current once again flowing through the tubes, the hum had disappeared. Piece by piece I reassembled it, but not until I started to lower the preamp into the case did the hum come back.

The culprit was the power transformer, whose proximity to the heads when in the case caused a hum condition which the increased bass response of the recorder intensified. I tightened the bolts on the transformer, built a mu-metal cage for it, and placed pieces of mu-metal around the head. This helped a little, but not enough.

Since the hum was noticeable only on playback, I decided to carry the preamp in the case for remote recording, thus gaining the convenience of single-unit equipment. Back in the studio, with plenty of table space, I would merely remove the preamp and let it rest on the table beside the mechanism for playback. Someday, perhaps, I'll remove the power supply and build another case for it.

Now my conversion was complete. I had a recorder which would record and play back, virtually flat, all frequencies between 50 and 10,000 cps, and within 2 db everything from 40 to 12,000 cps, at 7½ ips. Stretch the response to 4 db and the machine will produce 30 to 15,000 cps. At 15 ips, you can forget about the 4 db on the high end.

Flutter and wow were, for all practical purposes, eliminated. The machine is quiet to operate. The signal-to-noise ratio is better than 55 db, and on half-track heads at that. Distortion is extremely low.

And you can do the same. If you own a recorder of different manufacture, your problems will be different only in the mechanical details and in the respective parts used. Fundamentally, the procedure will be the same. Relocating grounds in one machine will do essentially the same thing as relocating grounds in another.

I have attempted to give here only the general rules for all recorders, with specific reference to the Pentron PMD-1. Since everything in electronics is somewhat variable, your conversions may work out somewhat better, or somewhat less successfully than mine.

Before you start, however, bear in mind that major mechanical alterations should not be undertaken until you have a pretty good idea of just what makes your particular brand of tape recorder tick. Spend plenty of time watching the machine operate, out of the case, until you are intimately familiar with how the movement of each and every screw will affect subsequent performance. And, equally important, when you disassemble, don't forget where each screw came from. If necessary, make a diagram as each part is removed. When fiddling with a machine with so many interconnecting parts, care is a prime requisite.

But if you decide to take the plunge, and go about your work methodically, with attention to every detail and with a constant check on progress, your result will be a tape recorder worth, in its quality of reproduction, far more than your expenditure.

More important, perhaps, your recorder will contain a little bit of your own design. And what, when you get right down to it, could be a source of greater satisfaction than that?

Parts List

1/50-hp hysteresis-synchronous motor, Model LH731NCJ, manufactured by Eastern Air Devices, 385 Central Ave., Dover, N. H. — $26.73.

Motor pulley, can be made by any moderately equipped machine shop, total 2 hours labor. — $10.00.

Seamless flat belt (used for belt drive), ⅜ in. by length desired, type S5. Must be manufactured to order, minimum order 6 belts, manufactured by Arthur S. Brown Mfg. Co., Tilton, N. H. — $2.00 per belt, approx.

Dynamu Conversion Kit, Model 8208 for Pentron PMD-1. Other recorders take different models. Kits are made for practically all recorders, and are manufactured by Dynamu Magnetronics Corp., Maico Bldg., 21 North Third St., Minneapolis 1, Minn. — $39.95.

Capstan well, size to fit physical dimensions of recorder. Can be made in any machine shop, or at home with hand tools. — $1 approx.

Ball bearing, small, size not critical. Can be found in furniture caster, if not sold by machinist supply houses. — $0.39 for caster.

BASIC ELECTRONICS

Continued from page 29

circuit. X_C is very nearly equal to Z, and the source voltage is dropped almost entirely across C. R and E_R are small. The voltage across C lags the source voltage by only a small angle, and the source voltage lags the current by almost 90°. The voltage across R, however, leads the source voltage by almost 90°; that is, its phase has been shifted forward by virtually 90°. In Fig. 7C the situation is reversed. With R much larger than X_C, the circuit is primarily resistive. R is close in magnitude to Z, and E_R is nearly as large as the source voltage, while X_C and E_C are relatively small. The circuit current, and the voltage across R, are virtually in phase with the source voltage; they have been shifted in phase only slightly by the capacitor. E_C, of course, lags the source voltage substantially.

It should be realized that a circuit with any given values of R and C can be in any of the conditions portrayed in Fig. 7, depending on the frequency involved. If R is equal to X_C at, say, 1,000 cps, then the relationships pictured in Figs. 6 and 7A apply at 1,000 cps. But Fig. 7B would apply at 200 cps (since X_C would be five times as large), and Fig. 7C would apply at 5,000 cps (since X_C would be only 1/5 as large). If the frequency were kept constant, circuit conditions represented accurately by Fig. 7A could be changed to those in Fig. 7B by decreasing C to 1/5 its former value, and to those in Fig. 7C by multiplying the value of C five times. The diagrams in Fig. 7 are individually proportioned, obviously, for clarity, and the vector lengths in one diagram do not apply to those in another diagram.

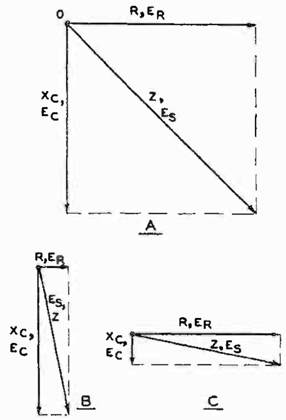


Fig. 7. Vectors in RC circuit. See text.

We found in the last chapter that it wasn't necessary to draw out the vector diagrams in order to find resultant voltages and impedances, because in these simple cases the diagrams are rectangular or square in outline. Thus, as in Fig. 8, a right triangle is formed by the resistive leg, the resultant vector, and construction line A (which is equal in length to the capacitive leg). The resultant vector, being the hypotenuse of this triangle, when squared (multiplied by itself) is equal to the sum of the squares of the two sides. Two useful formulas are thereby obtained:

$$E_S^2 = E_R^2 + E_C^2, \text{ and}$$
$$Z^2 = R^2 + X_C^2.$$

The latter especially is often stated as

$$Z = \sqrt{R^2 + X_C^2}.$$

If it is necessary to find θ, the angle between current and source voltage, it can be found by any of the following formulas (see Fig. 8):

$$\sin\theta = \frac{-X_C}{Z} \qquad \cos\theta = \frac{-R}{Z}$$

$$\tan\theta = \frac{-X_C}{R} \qquad \cot\theta = \frac{-R}{X_C}$$

The latter pair of formulas has an advantage occasionally in that it isn't necessary to calculate the resultant impedance. Corresponding voltage quantities may be used alternatively, of course. The minus signs are employed because the angle is a minus (lagging) one in capacitive circuits.

If these formulas for resultant values and phase angles are compared with those for RL circuits, a close similarity will be found. They are used in the same way also. As an example, suppose R in Fig. 5 is 1,000 ohms and C is 1.5 μfd. The source voltage is 10 volts and its frequency is 60 cps. What is the total impedance in the circuit, the current, the voltages across R and C, and the phase angles?

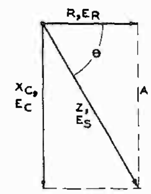


Fig. 8. Diagram for numerical example.

X_C is found from the formula as follows:

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2 \times 3.14 \times 60 \times 1.5 \times 10^{-6}}$$

$$X_C = 1{,}769 \text{ ohms.}$$

Z is then calculated:

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{(1{,}000 \times 1{,}000) + (1{,}769 \times 1{,}769)}$$

$$Z = \sqrt{4{,}129{,}361} = 2{,}032 \text{ ohms.}$$

$$I = E_S/Z = 10/2{,}032 = 4.92 \text{ ma.}$$

$$E_R = IR = .00492 \times 1{,}000 = 4.92 \text{ volts.}$$

$$E_C = IX_C = .00492 \times 1{,}769 = 8.70 \text{ volts.}$$

$$\sin\theta = -X_C/Z = -1{,}769/2{,}032 = -0.87057.$$

$\theta = -60.5°$ approximately. Therefore, the current and the voltage across R lead the source voltage by about 60.5°, and the voltage across C lags the source voltage by about 29.5°. This problem is illustrated by the vector diagram in Fig. 8.

TAPE NEWS

Continued from page 14

and to eliminate pops and booms from close talking.

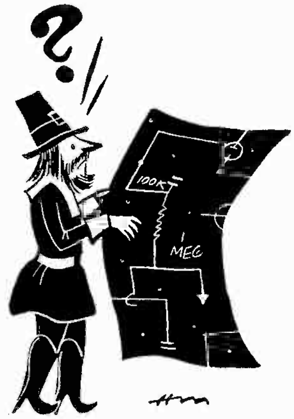
There are a few other sources of potential diaphragm damage that often escape the notice of even the most careful mike coddler. Among these are storing pressure microphones in an automobile luggage compartment, and slamming the lid of one of those small velvet-lined boxes which are often used for the protection of deluxe mikes. Slamming the trunk door or the box lid can create a very high instantaneous air pressure that will almost invariably damage a fragile and unprotected pressure mike's diaphragm. Velocity units are less susceptible to this form of damage, but, for safety's sake, they should be accorded the same protection as pressure units. Needless to say, a microphone wrapped in a plastic bag or in a closed case will be spared much of the impact of such an air shock.

It is hardly necessary to point out that a microphone will not take kindly to being dropped, either. It seems a part of human nature to suppose that anything in a box is *ipso facto* out of harm's way. This is partially true, but simply putting a mike in its protective case does not end the user's responsibility to it. The diaphragm or magnet assembly in the boxed microphone can still be damaged by careless handling or by slamming the box down onto a table top. The box will help take up the shock, but it can't do everything.

There is little that can be said about the matter of corrosion in a microphone, because there is little that can be done about it. A microphone kept in New York City or Los Angeles will fall victim to corrosive air pollution long before one kept in Bloomington, Indiana, or Gallup, New Mexico. Plastic bags, boxes, and protection from rain will abet longevity, but if there is anything in a microphone that will corrode, a foul atmosphere will get to it sooner or later. A seaboard location is about as bad an environment as a mike can have, so one intended for use in a coastal area should be chosen for its advertised resistance to corrosion. Since most mikes use aluminum diaphragms, corrosion usually hits the coil or matching transformer windings first. If these have been "tropicalized", it can prolong their life considerably. Before I begin to give the wrong idea here, I should like to add that the "short" life I refer to as caused by corrosion means that the mike would have a life expectancy of, say, 10 years instead of 15 to 40.

I have purposely left the subject of condenser microphones until last because they are in a class of their own. Generally, their diaphragm systems are very rugged and dependable, and have practically an unlimited life expectancy. But the associated equipment is another matter altogether. Since they use tubes and power supplies, they are immediately in a dependability class with other amplifier components. Since a condenser microphone's system consists of relatively few components, the law of averages would tend to make them more dependable and long-lived than, say, a 12-tube hi-fi system. But because they *are* used with microphones, there is often a tendency to overlook the possibility of trouble in them.

Strangely enough, defects in a condenser microphone system are sometimes reflected in what sounds like a severe high-range response peak rather than out-and-out audible distortion. A gassy translator tube in a condenser mike will, however, usually cause a slight drop in output level, a rough high end, and a disturbing "blooping" sound accompanying very high-level



program passages. The cure is obvious . . . replace the tube, and while you're at it, it's a good idea to check the operating voltages coming from the power supply, to see if they tally with those listed in the mike's service notes. If not, the whole system (including the microphone) should be shipped off to the manufacturer for servicing.

Another form of trouble that is unique to certain condenser mikes, notably the Altec 21-B, is a faint series of regular clicking or popping sounds which bear no relationship to the program material itself. I have not as yet heard a good explanation for this, but it seems to have something to do with moisture getting into the microphone, probably from condensation when the mike is brought from a cold outdoors into a warm room. The best way to prevent its occurrence is to carry the

Continued on next page

TAPE NEWS

Continued from preceding page

microphone (in its case) in a warm place, like an overcoat pocket, until it is ready to be used. Another cure is to place it (in its case) on top of a radiator until it has come up to slightly above body temperature (caution — do not overcook!).

These points may all seem like a lot of concern over the welfare of a microphone, but if a microphone was worth buying, it should be worth taking care of. That is, unless you intended to trade it in on a new model every two years.

VTVM KIT

Continued from page 26

section, is certainly an ingenious device. Its advantages in neatness and avoiding confusion are obvious enough; we wonder, however, if the user may not occasionally forget to turn the probe tip to the position proper for the measurement he is taking. Perhaps we're simply being reactionary here, since we're used to separate leads!

The meter movement is much more highly damped than most; that is, it takes an appreciable period for it to swing up or down scale. This, we believe, is desirable — it positively prevents the needle from banging a stop pin hard if you're using a range too low for the voltage you're measuring. Further, the bridge circuit that is used inherently limits the maximum current through the meter, so it is unlikely to burn out no matter how badly you overload the input circuit (that isn't recommended practice, even so).

When properly calibrated the accuracy of our Model 232 was well within specifications. Then, to check range accuracy and scale calibration, we measured several AC and DC voltages, and a group of resistors, using two appropriate positions of the range switch for each quantity measured. On the 500-volt range the indicated value for a voltage might be, say, 320 volts, while on the 1,500-volt range the reading might be 310 volts. The difference on a percentage basis is a measure of the interrange inconsistency; the lower the percentage difference, the better. Our average difference for several such sets of measurements of AC voltages was 2.70%; for DC voltages, 2.73%; and for resistances, 4.70%. The average for measurements of all types was 3.4%. Then we did the same thing with a far more expensive multi-purpose VTVM we have used for several years. With a grand average range inconsistency of 3.9%, it was beaten easily by the Eico unit.

We noticed that the zero adjustment tended to drift; occasionally, it would drift two scale divisions within a few minutes. This, we have been told, will rectify itself when the meter bridge tube has had time to age.

The general appearance of this instrument makes a favorable impression. It is sturdily constructed and pleasingly styled, and the etched heavy aluminum front panel reflects accurately the over-all quality. The Eico 232 merits the attention of anyone who has finally decided that he needs some test equipment.

WOODCRAFTER

Continued from page 13

1) Either dip or pour alcohol over the file or rasp and ignite it with a match.

2) Wait for the small blue flame to die out completely in about half a minute.

3) Brush the surface with a file card.

4) If all the wood particles are not removed, repeat the process.

Another procedure involves soaking the tool in hot water for an hour. The wood will swell and loosen itself so it can be removed easily with a file card or a steel brush. Be sure to dry the tool immediately to prevent its rusting.

When a file has become clogged with metal, rub the surface with a piece of copper the size and thickness of a penny. Hold the copper at a 45° angle and stroke with the teeth to remove the chips.

So much for sharpening the most frequently used hand tools in the home workshop. Next month we'll concentrate on keeping a keen edge on power tools.

READERS' FORUM

Continued from page 17

them sheep or goats in the domains of aesthetic sensibility. To be sure, my sheep always will be Mr. Draughon's goats and vice versa, for in these domains there are no absolute values and each of us sets his own standards. It's the difference of opinion that makes horse racing — and record reviewing — the fascinating sports they are.

I'm afraid that, as Jimmie Durante used to say, "You go your way, and I'll go the way of all flesh. . . ."

R. D. Darrell

Gentlemen:

I read the article by R. D. Darrell in the August issue with interest. I cannot but agree somewhat when he takes to task the recorded performances of theater organs in which the noisier side of the instrument (drums, traps, bells, etc.) predominates, but how can he reconcile his caustic remarks about George Wright with the following facts: Mr. Wright plays his music, popular though it may be, with expression, rubato, and registration *par excellence.* His rendition of the *Dance of the Sugarplum Fairy* (HIFIrecord R 706) is a thing of remarkable accuracy. The celeste, played on the harp stop, is as "celesty" as any used in symphony work. The clarinet and oboe and pizzicato fiddles are as they should be and there have been no liberties taken with the score, either musically or sonically. In addition to this, Mr. Wright was recently the featured organist at a meeting of the American Guild of Organists whose membership must certainly include many fine organists. Mr. Wright is held in such esteem by the AGO as to have been invited to play on the recently refurbished organ at the Paramount Theater in New York City. I wish I had been there to get the "icy fingers up and down my spine" first hand.

Charles A. Conrad III
Racine, Wis.

In the end, Mr. Wright's "expression, rubato, and registration" remain matters of personal taste, about which, contrary to the old proverb, there always will be disputes; disputes, moreover, which never can be settled. Nevertheless, it can be a lot of fun, and often highly illuminating, to argue our own value standards, re-examine the evidence in the light of someone else's standards, and sometimes change our minds, but more often to reaffirm our original verdict as determined by our personal temperament, musical experience, and heaven knows how many other consciously recognized or unrecognized factors.

I'm sure Mr. Wright (whom I've never met) is a swell guy and highly admired by his organist colleagues, but I have to judge his work by the evidence of my own ears, always as colored by my own prejudices and admirations — and, alas, I don't like it! Very likely mine is a minority report, but that neither makes it more likely wrong, or right.

Anyway, whatever else I may accuse Mr. Wright of, I certainly can't belittle his power of enlisting spirited defenders.

R. D. Darrell

Gentlemen:

I enjoyed your "Sound-Fanciers' Guide" for August all the way through. I got a special kick from the review of George Wright's *Encores.* "Aesthetic vulgarian", "lively if horrid fascination", "glorious racket" ring the (Wurlitzer) bell. What's more, the reader should acquire a very good idea of just what to expect should he weaken and order a copy of *Encores.*

Henry F. Robbins
New York, N. Y.

Gentlemen:

R. D. Darrell's column "Sound Fanciers' Guide" adds a department that I believe your magazine has been overlooking. More power to him. I enjoyed his first column very much.

AUDIOCRAFT has surely done a fine job this first year of publication. It has supplied me with many ideas and has saved me many dollars by helping to solve my audio problems.

V. E. Burgon
Midvale, Utah

Gentlemen:

Recently I read in your magazine [February 1956, p. 15] a suggestion that an amplifier be hooked up to the same connection as a turntable motor. This seems wasteful to me. It is a sure-fire way of ruining all the tubes in the amplifier extra fast. By this method, every time a record ended the amplifier would be shut off and would have to be turned on again at the beginning of the next record.

My suggestion is to install an ad-

Continued on next page

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933
Of Audiocraft, published monthly at Great Barrington, Massachusetts, for October 1, 1956

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Charles Fowler, Egremont, Mass.; Editor, Roy F. Allison, North Egremont, Mass.; Managing Editor, Frank R. Wright, New Marlboro, Mass.; Business Manager, Warren B. Syer, New Marlboro, Mass.

2. The owner is: Audiocom, Inc., Great Barrington, Mass.; R. F. Allison, North Egremont, Mass.; C. G. Burke, Ghent, N. Y.; J. M. Conly, Great Barrington, Mass.; S. Q. Curtiss, Sheffield, Mass.; C. Fowler, Egremont, Mass.; R. H. Hoopes, Jr., Washington, D. C.; R. Lindstrom, North Egremont, Mass.; F. C. Michalove, Englewood, N. J.; W. B. Syer, New Marlboro, Mass.; H. R. Sykes, Pittsfield, Mass.; F. R. Wright, New Marlboro, Mass.

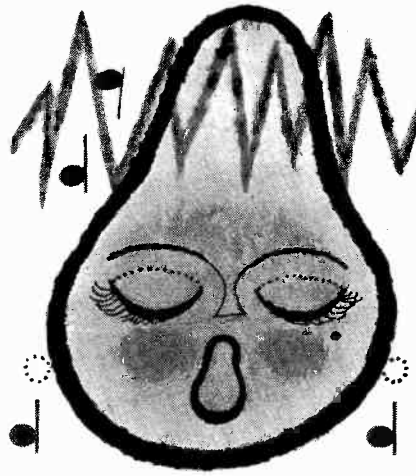
3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none.

4. The two paragraphs next above the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) Charles Fowler

Sworn to and subscribed before me this Twenty-fifth day of September, 1956.
(Seal) Lillian F. Bendross, Notary Public

Commission expires June 24, 1961.



AUDIOCRAFT
Sound Sales Directory

Following is a list of dealers who state that they carry the products specified.

KEY TO PRODUCTS HANDLED
1 Audio system components
2 Speakers and enclosures
3 Records and record accessories
4 Tape recorders
5 Pre-recorded tape
6 Radio hardware
7 Tools, wood
8 Audio parts
9 Microphones
10 Books
11 Test equipment

A series of items numbered consecutively is identified by a hyphen between the first and last numbers. Thus, 1-6 indicates 1 through 6; 8-11 indicates 8, 9, 10, and 11.

CALIFORNIA
Beverly Hills
Minthorne Music of Beverly Hills
230 N. Beverly Dr.
BR. 2-7676; CR. 6-4793 — 1-5, 9
Hollywood
Hollywood Electronics
7460 Melrose Ave.
Webster 3-8208 — 1, 2, 4, 5

CONNECTICUT
West Hartford
Audio Workshop, Inc.
1 South Main St.
Adams 3-5041 — 1-5, 9, 10

DELAWARE
Newark
Delaware Music House
20 Academy St.
Endicott 8-3258 — 1-5, 8, 9

FLORIDA
Miami
High Fidelity Assoc.
3888 Biscayne Blvd.
FR. 1-8401 — 1-5, 8-10

GEORGIA
Atlanta
Baker Fidelity Corp.
1140 Peachtree St., N. E.
TRinity 5-2156 — 1-6, 8, 9

ILLINOIS
Chicago
Allied Radio Corp.
100 N. Western Ave.
HAymarket 1-6800 — 1-11
Evergreen Allied High Fidelity, Inc.
2025 W. 95th St.
BEverly 8-1067 — 1-11
Musicraft
48 East Oak St. — 1-11
Evanston
Allied High Fidelity Stores, Inc.
602 Davis St.
DAvis 8-8822 — 1-11
Oak Park
West Suburban Allied High Fidelity, Inc.
7055 W. North Ave.
EStebrook 9-4281 — 1-11

LOUISIANA
New Orleans
The Music Shop, Inc.
4215 South Claiborne Ave.
TW. 1-5871 — 1-5

MASSACHUSETTS
Boston
The Listening Post, Inc.
161 Newbury St.
COpley 7-7530 — 1, 2, 4, 5, 8-10

MICHIGAN
Detroit
Hi-Fi Studios
8300 Fenkell
Diamond 1-0894 — 1-6, 8-10

MISSOURI
St. Louis
The High Fidelity Showroom
6383 Clayton Rd.
Parkview 1-6500 — 1-5, 9

NEW JERSEY
New Brunswick
Monmouth Music House
215 Bevier Road
University Heights
CHarter 9-5130 — 1, 2, 4, 5, 9

NEW YORK
Albany
Audio-Video Corporation
324 Central Ave.
3-1167 — 1-5, 8-10
Amsterdam
Adirondack Radio Supply
185-191 West Main St.
VI. 2-8350 — 1, 2, 4, 8
Buffalo
Frontier Electronics, Inc.
1507 Main St.
GA. 5727 — 1-5, 8-10
New York City
Arrow Audio Center
65 Cortlandt St.
DIgby 9-4730 — 1, 2, 4-6, 8-11
Grand Central Radio, Inc.
124 East 44th St. at Lexington Ave.
MUrray Hill 2-3869-70 — 1-6, 8-11

PENNSYLVANIA
Bethlehem
Audio Laboratories, Inc.
808 Mohican St.
UNiversity 7-3909 — 1-5, 9
Philadelphia
Almo Radio Co.
913 Arch St.
WAlnut 2-5153 — 1-4, 6-11
Danby Radio Corp.
19 South 21st St.
Rittenhouse 6-5686 — 1-5, 8-10
Radio Electric Ser. Co. of Pa., Inc.
7th & Arch Sts.
LO. 3-5840 — 1-11
Ten Cate Associates
6128 Morton St.
Germantown 8-5448 — 1-5, 8-10

SOUTH CAROLINA
Columbia
Hi-Fi Sound & Records Co.
621-23 Harden St.
6-3538 — 1-6, 8-10

TENNESSEE
Kingsport
Radio Electric Supply Co.
245 East Market St.
CI. 5-1471; 5-2651 — 1, 2, 4, 6, 8-11

TEXAS
San Antonio
Bill Case - Records & Sound
4206 Broadway
TAylor 2-1341 — 1-5, 8-11

VERMONT
Rutland
Fleetwood Sound Studio
285 S. Main St. (Rt. 7)
Prospect 3-2312 — 1-5, 8, 9

WASHINGTON
Seattle
High Fidelity Headquarters
603 Broadway North
CApitol 2266 — 1-4, 8, 10

CANADA
Montreal
Payette Radio Limited
730 St. James West
UNiversity 6-6681 — 1-11

READERS' FORUM

Continued from preceding page

ditional switch to operate a relay in the plate circuit, cutting out the high voltage each time a record ended and putting the high voltage back when another began. This would give the tubes maximum life.

James A. Devlin
Ridgefield, Conn.

Switching off AC power to the amplifier by means of a changer's automatic shutoff switch is recommended only for changers — not manual-play turntables — and then only when several records are to be stacked on the changer for background-music listening. A bypass switch should also be provided so that the amplifier can be controlled normally when it is desired to hear only one or two record sides, or to use a radio tuner or tape machine. The automatic shutoff modification is only to prevent leaving the amplifier on continuously when it is not being used; its purpose is not to turn the amplifier off and on between record sides. — ED.

GROUNDED EAR

Continued from page 5

classify the 225A among the very finest cartridges.

We now have several cartridges capable of covering the entire audio range to 20,000 cps or beyond. It is interesting to note that the principles used include the moving-coil, the variable-reluctance, and the frequency-modulation types. Here is more evidence that there is no single best way of achieving a high-fidelity end, and that it is not so much theoretical principles that determine performance, but the art of applying them.

AUDIO AIDS

Continued from page 27

smaller in cross section than the reel of tape.

To demagnetize the heads of your recorder, plug in the transformer and grasp it firmly while bringing it slowly up to, and slowly away from, the heads. Hang on to it, or it will jump at the heads when it gets close. Heads on most recorders can be demagnetized in place, without disturbing anything. If, however, the heads sit flush with a metal shielding cover, you will have to take whatever steps are necessary to insure that the gap in the head itself is exposed to the alternating magnetic field.

Don't worry about the buzz; the laminations aren't tight, and the buzz is caused by the 60-cps current.

One final, important caution: don't leave the transformer connected to the power line for more than a minute or two at a time. Without any load on the secondary winding there is only one way to use the energy of the current flowing through the primary, and this is to generate heat. The primary winding can easily be burned out unless it is given a chance to cool between periods of operation. The permissable period of operation is more than ample to erase a reel of tape or to demagnetize a head.

Lionel C. Holm
Arlington, Va.

Cleaning Styli

Elder pith can be used effectively and simply to clean and polish the stylus of a phono pickup. This pith, used for supporting delicate plant tissue for section cutting in botanical microtechnique, can be obtained for a few cents from most biological supply houses.

Merely cut the pith into convenient size for handling and soften the end by moistening it in a very mild detergent solution. Press the tip of the stylus into the end of the pith stick and gently rotate the stick. That's all there is to it! Under the microscope the diamond will shine like the jewel that it is.

Pith must not be immersed in detergent solution to a point where it becomes soggy, or the wood fiber will be too soft to remove dirt particles. There may also be some danger of squeezing a little moisture into the cartridge. The pith may be dried and used again and again. When necessary, a thin slice can be trimmed from the end with a razor blade to present an entirely clean surface for even further use.

This method of cleaning the stylus is most helpful with the use of a Disc-Charger, which enables the stylus to pick up grime more readily from the record grooves.

Susan E. Chappell
Winnipeg, Man.

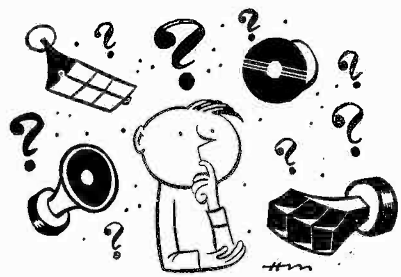
Radioactive Static Eliminator

Most audiophiles are keenly aware of the problems associated with the collection of static electricity on phonograph records. In the past, elimination of this problem was mainly sought by utilizing antistatic sprays, solutions, cloths, etc. More recently the emphasis has been placed on radioactive antistatic agents which have proved to be the most effective devices currently available.

The main point of interest to the audiocrafter is the possibility of making a radioactive static eliminator which, in some respects, can be more effective than, or at least equal to, most currently available commercial products.

This is definitely a project for those who enjoy rummaging about junk yards, attics, war-surplus stores, and places of similar nature, for it is in such places that suitable radioactive materials are most likely to be found. Acceptable material can be found in the radium dials of old clocks, watches, and certain wartime instruments. One of the best available radioactive sources is the luminous face of an old alarm clock (the older the better); some of these clock faces, particularly those manufactured years ago, contain a relatively high percentage of radium salts. On the other hand, many recent luminous substances are either nonradioactive or only mildly radioactive.

If by chance you are a uranium hunter as well as an audiophile and own either a geiger counter or a scintillator, the problem of selecting a suitable radioactive material is simplified. When such equipment is not available, the



best material can generally be selected from luminous samples (clock faces, dials, indicators, etc.) by placing them in total darkness for at least 48 hours. In general, the material that glows most brightly after this period is the most radioactive. An effort should be made, particularly on very old parts, to clean or scrape them so that dirt will not obscure their true luminosity. Radioactivity in doubtful luminous material can be positively checked (in total darkness) with a magnifying lens (stylus microscope); close examination will show scintillations or flashes of light resulting from the collision of atomic particles with the phosphorescent matrix of the material.

After the best material has been selected, its preparation for use is relatively simple. The material should be removed from the part and crushed into a fine powder. In this form it can be mixed with dilute acetate dope or lacquer to form a creamy paste. The paste is applied either directly to the cartridge, both fore and aft of the stylus, or to a piece of tape that can be affixed in the same manner. If sufficient material is available, it may be applied to several spots along the underside of the pickup arm for greater effectiveness.

A test can be made to check the antistatic qualities of your handiwork simply by playing a disc with a high static charge and noting the effect on the

Continued on page 47

Abbreviations

Following is a list of terms commonly used in this magazine, and their abbreviations. The list is arranged in alphabetical order.

alternating current	AC
ampere, amperes	amp, amps
amplitude modulation	AM
audio frequency	AF
automatic frequency control	AFC
automatic gain control	AGC
automatic volume control	AVC
capacitance	C
cathode ray tube	CRT
characteristic impedance	Z_o
current	I
cycles per second	cps
decibel	db
decibels referred to 1 milliwatt	dbm
decibels referred to 1 volt	dbv
decibels referred to 1 watt	dbw
direct current	DC
foot, feet	ft.
frequency	*f*
frequency modulation	FM
henry	h
high frequency	HF
impedance	Z
inch, inches	in.
inches per second	ips
inductance	L
inductance-capacitance	LC
intermediate frequency	IF
intermodulation	IM
kilocycles (thousands of cycles) per second	Kc
kilohms (thousands of ohms)	K
kilovolts (thousands of volts)	KV
kilowatts (thousands of watts)	KW
low frequency	LF
medium frequency	MF
megacycles (millions of cycles) per second	Mc
megohms (millions of ohms)	MΩ
microampere (millionth of an ampere)	μa
microfarad (millionth of a farad)	μfd
microhenry (millionth of a henry)	μh
micromicrofarad	μμfd
microvolt (millionth of a volt)	μv
microwatt (millionth of a watt)	μw
milliampere (thousandth of an ampere)	ma
millihenry (thousandth of a henry)	mh
millivolt (thousandth of a volt)	mv
milliwatt (thousandth of a watt)	mw
ohm	Ω
permanent magnet	PM
potentiometer	pot
radio frequency	RF
resistance	R
resistance-capacitance	RC
resistance-inductance	RL
revolutions per minute	rpm
root-mean-square; effective value	RMS
synchronous, synchronizing	sync
television	TV
ultra high frequency (radio)	UHF
vacuum-tube voltmeter (multipurpose)	VTVM
vacuum-tube voltmeter for AC measurements only	AC VTVM
variable reluctance	VR
very high frequency (radio)	VHF
volt	v
volt-ampere	va
voltage, or potential difference	E
volts, center-tapped	vct
watt	w

PROFESSIONAL DIRECTORY

TRADERS' MARKETPLACE

Here's the place to buy, swap, or sell audio equipment. Rates are only 20¢ a word (including address) and your advertisement will reach 20,000 to 35,000 readers. Remittance must accompany copy and insertion instructions.

AUDIO AIDS

We'll pay $5.00 or more for usable Audio Aids. *See page 27 for details.*

AUDIO AIDS

Continued from page 45

disc's ability to attract small particles after being played. The stylus may tend to pick up more foreign matter and need more frequent cleaning for the first few playings; this is a good indication of neutralization of the disc's attractive force on foreign particles.

The effectiveness of one's homemade antistatic agent is dependent solely upon its degree of radioactivity. This effectiveness is greater with even mildly radioactive substances than that of most commercial products because the radioactive source can be made to cover a relatively wide area very near the surface of the record. The resulting increase in radiation intensity and distribution adds considerably to the antistatic effect. In addition, the weight and volume of the agent are negligible and ordinarily will not necessitate readjustment of the stylus force. In most cases there will be little or no visible evidence of its presence.

Lt. Edward D. Rodgers, Jr.
Seattle, Wash.

Marking Speaker Leads

If you use TV 300-ohm flat lead-in wire for speaker leads and wish to polarize one of the conductors, you can nick out one edge of the insulation about every foot or so. The nicks can be made easily with a knife and they will not be unsightly.

Running your thumbnail along the edge of the flat line at either end of the run will indicate which conductor is being used to what terminal.

Robert A. Sjoberg
Los Angeles, Calif.

Bass Equalization

Many music lovers go to inordinate lengths to achieve better bass response in their speaker systems when all too often they ignore deficiencies in their phono equalization.

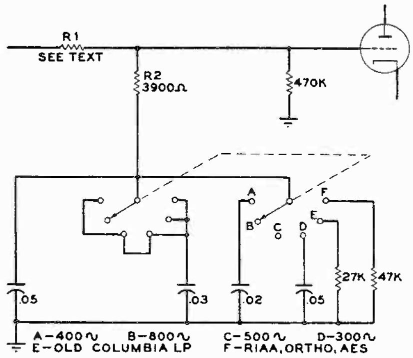
There are many preamps on the market using losser circuits to achieve this equalization, and none of them is perfect. The author has an excellent commercial unit which was modified to give nearly ideal response at negligible cost and with little effort. The unit uses a single-section losser network as in the diagram. The original value of R_1 was 100 K. This gave R_1 and R_2 a ratio of about 25:1. This ratio, however, was not high enough to give the best possible bass equalization.

The unit as purchased yielded a curve which was down by about 2 db at 60 cps. By changing R_1 to 220 K the response was improved to the point where the curve was nearly asymptotic to below 30 cps. It is recommended that those having equalizers with a ratio of less than 50:1 between R_1 and R_2 change R_1 to such a value as to increase the ratio to the desired value.

It is possible with this modification that hum may become a problem, but the writer has encountered none and uses only balanced AC on the filaments.

Talbot M. Wright
Silver Spring, Md.

Two other points should be made. First, this circuit accomplishes bass equalization only; a separate provision for treble rolloff is needed. Second, insertion loss of the equalizer will be doubled by this circuit change, so that over-all preamplifier gain will be halved. The change should be made only if there is gain to spare, and if the normal noise level is very low. — Ed.

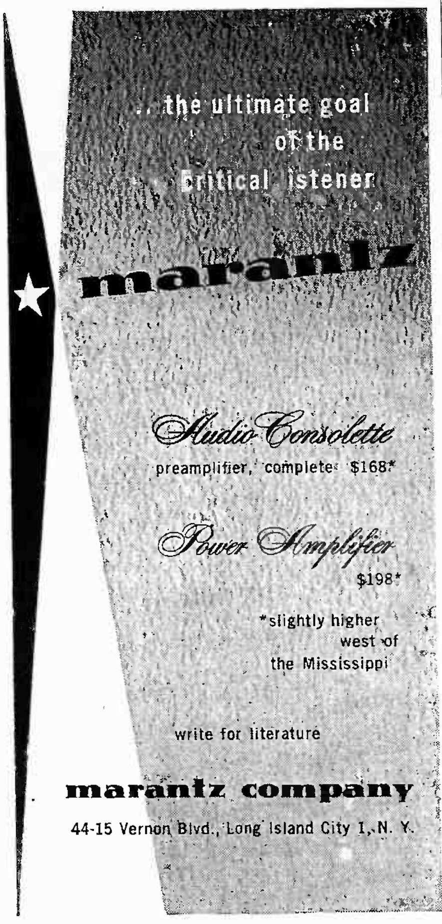


Modified bass equalization circuit.

Inexpensive Stylus-Use Timer

Hi-fiddlers who are as fussy about stylus wear as Colston Nauman (Audio Aids, June) but less funded might like to tinker with a bit of gadgetry that should do the job well at substantially lower cost. Most surplus houses stock the requisite parts, and, predicated on a quick survey of catalogues within easy reach, a $5 bill should cover the project. Materials needed are a 1-rph clock motor costing from $1 to $2; a small Veeder-Root counter with reset, priced at about $1.50; and a "normally closed" microswitch at about 50¢.

The microswitch is mounted in such a way that it is held open by the pickup arm when the arm is not in use. It is wired to control the clock motor which in turn has been hitched to the counter in a suitably ingenious fashion. A small metal chassis box will serve as a convenient means of mounting the latter two items, as well as providing a shield for the motor. Or, since only the switch is concerned with activation, and power can be taken from any convenient outlet, the rest of the mechanism may be placed elsewhere in order to eliminate both noise and hum pickup. (Genuine purists can solve the problem



AUDIO AIDS

Continued from preceding page

by suspending the box in a well-padded closet and grounding it to a 6-foot I-beam buried in moist earth.)

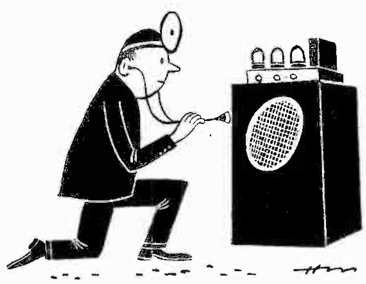
Somewhat greater accuracy is provided in that the device registers only when the pickup is off its rest (and presumably on the record), rather than being geared to the turntable. If, on the other hand, the question is one of "table time", it may be wired to utilize the switch on the turntable. Either way, the mounting box can be isolated.

Parke S. Barnard
New Haven, Conn.

Chassis Drilling

Anyone who has tried to drill a large hole in a thin chassis knows what a job it is to get one that is round. Large drills and thin metal just don't go together. To remedy this situation, drill a smaller hole than you need and ream it to the desired size with a tapered hand reamer. For example, to get a clean ⅜-inch hole, first drill a $^{3}/_{16}$-inch hole; then ream to ⅜ in.

L. E. Johnston
Madison, Wis.



Stylus Shadowgraph

Nothing beats shadowgraph projection for inspecting the condition of stylus tips. Any audiophile who owns or can borrow home movie equipment (preferably 8 mm) can use that equipment for shadowgraphing.

Simply set up the projector and screen as if to show movies, but thread no film into the works. Switch on the projector motor and lamp to fill the screen with light, and then, using tweezers, maneuver into the film aperture the tip of the stylus to be inspected. Adjust the focus until a sharply defined image of the stylus tip appears on the screen. You'll want a head-on view of the stylus tip, since a profile will probably show up perfectly round (and hence apparently safe) while actually hiding dangerous flat spots visible only from front or rear.

Warning! Cover all exposed projector mechanisms with Scotch tape before starting this experiment. Needles are difficult to find once they've fallen inside a greasy gear box.

J. M. Kucera
San Francisco, Calif.

ADVERTISING INDEX