AUDIO

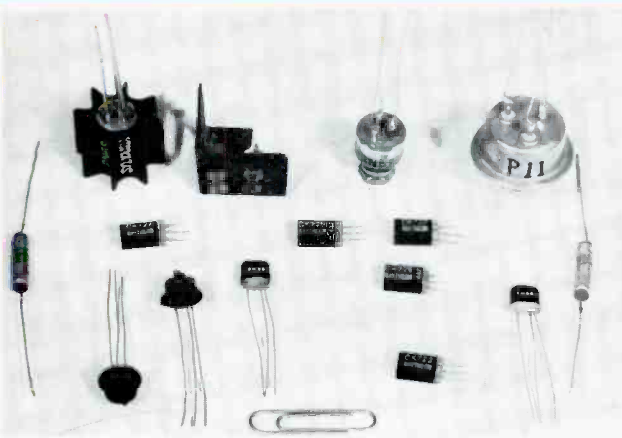
FEBRUARY, 1956

50¢

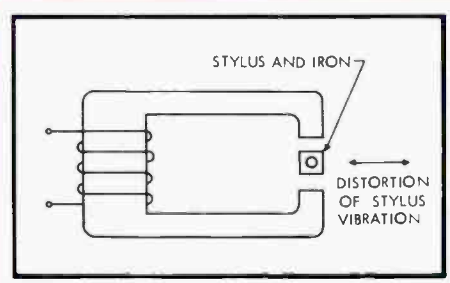
ENGINEERING MUSIC SOUND REPRODUCTION

including 12-page TAPE EQUIPMENT section

ANC



Keeping abreast of audio developments demands a working knowledge of transistors, how they work, how they are used, and what performance we can expect from them. Start learning about this new marvel on page 17.



To use any piece of equipment intelligently, one must understand it thoroughly. Yet while everyone knows how to play the phonograph, not everyone knows why it functions as it does. This chapter of SOUND clarifies the operation of phono components. See page 10.

TRANSISTOR TIPS AND TECHNIQUES
A NEW TURNTABLE DESIGN
PICKUPS, TONE ARMS, and NEEDLES
SPECIFICATIONS OF HOME TAPE RECORDERS

NEW HERMETIC POWER COMPONENTS

HIGHEST RELIABILITY FOR MILITARY AND INDUSTRIAL USE

Listed below are just a few of the 50 new **stock items** in the United hermetic power series. These MIL-T-27 power components add to the 200 other hermetic stock items of filter, audio, and magnetic amplifier types. Through the use of proven new materials and design concepts, an unparalleled degree of life and reliability has been attained, considerably exceeding MIL-T-27 requirements. Test proved ratings are provided, not only for military applications but for **industrial, broadcast, and test equipment service (55°C. ambient).**

For complete listing of these new items, write for Catalogue #56.

MIL-T-27 RATINGS IN REGULAR TYPE — **INDUSTRIAL RATINGS IN BOLD TYPE**

TYPICAL POWER TRANSFORMERS, PRI: 115V., 50-60 cycles.

Type No.	Hv Sec. C.T.	Approx* DC volts	DC MA	Fil. Wdg.	**Approx* DC volts**	**MA DC**	**Fil. Wdg.**	MIL Case
H-81	500 550	L 180 C 265 L 200 C 300	65 55 60 50	6.3VCT-3A 5V-2A	**L 170 C 240 L 190 C 280**	**75 65 70 60**	**6.3VCT-3A 5V-2A**	HA
H-84	700 750	L 255 C 400 L 275 C 420	170 110 160 105	6.3V-5A 6.3V-1A 5V-3A	**L 240 C 360 L 260 C 380**	**210 150 200 140**	**6.3V-6A 6.3V-1.5A 5V-4A**	KA
H-87	730 800	L 245 C 390 L 275 C 440	320 210 300 200	6.3V-6A 6.3V-2A 5V-4A	**L 210 C 350 L 245 C 400**	**420 310 400 300**	**6.3V-6A 6.3V-2A 5V-4A**	NB
H-93	1000 1200	L 370 L 465	280 250	6.3V-8A 6.3V-4A 5V-6A	**L 340 L 455**	**340 300**	**6.3V-10A 6.3V-5A 5V-6A**	OA

*After appropriate H series choke. L ratings are choke input filter. C ratings are condenser input.

United "H" series power transformers are available in types suited to every electronic application. Proven ratings are listed for both high voltage outputs . . . condenser and choke input filter circuits . . . military and **industrial** applications.

United "H" series filter reactors are extremely flexible in design and rating. Listings show actual inductance at four different values of DC. Bold type listings are **industrial** application maximums.

A FEW TYPICAL LISTINGS OF FILTER REACTORS.

Type No.	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	**Ind. Hys.**	**@ MA DC**	Res. Ohms	Max. DCV* Ch. Input	Test V. RMS	MIL Case
H-71	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	11	200	10	230	8.5	250	**6.5**	**300**	90	700	2500	KB
H-77	10	300	9	350	**8**	**390**	**6.5**	**435**	60	2000	5500	MB
H-79	7	800	6.5	900	6	1000	**5.5**	**1250**	20	3000	9000	9x7x8

*Based on maximum ripple voltage across choke in choke input filter circuit, in terms of DC output voltage.

TYPICAL FILAMENT TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

Type No.	Sec. Volts	Amps. (MIL)	**Amps. (Ind)**	Test volts RMS	MIL Case
H-121	2.5	10	**12**	10000	JB
H-124	5	3	**3**	2000	FB
H-127	5	20	**30**	21000	NA
H-131	6.3CT	2	**2.5**	2500	FB
H-132	6.3CT 6.3CT	6 6	**7 7**	2500	JA
H-136	14, 12, 11CT	10	**14**	2500	LA

United "H" series filament transformers have multi-tapped primaries, good regulation, and are rated for **industrial** as well as military service.

United "H" series plate transformers incorporate dual high voltage ratings and tapped primaries to provide versatile units for a wide range of military and **industrial** electronic applications. Large units have terminals opposite mounting for typical transmitter use.

TYPICAL PLATE TRANSFORMERS, PRI: 105/115 210 220V., 50-60 cycles.

No. Type	Sec. V. C.T.	Approx.* DC volts	MA DC	Choke No.	**MA DC**	**Choke No.**	Case
H-110	1050 1200	380 465	275 250	H-75 H-75	**385 350**	**H-77 H-77**	MB
H-113	2500 3000	1050 1275	280 250	H-77 H-76	**340 300**	**H-77 H-76**	5¼ x 6 x 7
H-115	3500 4400	1500 1900	265 225	H-77 H-77	**350 300**	**H-77 H-77**	8¾ x 6½ x 8
H-117	5000 6000	2125 2550	900 800	H-79 H-79	**1100 1000**	**H-79 H-79**	13½ x 11 x 14½

*After filter choke. All ratings are for choke input filter.

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CABLES: "ARLAB"

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Sounding Board

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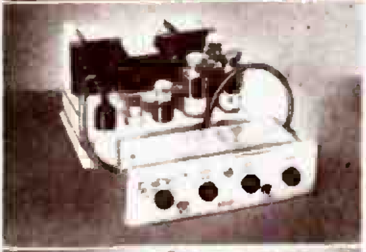
World's finest record changer. Fully automatic, precision-engineered and trouble free.

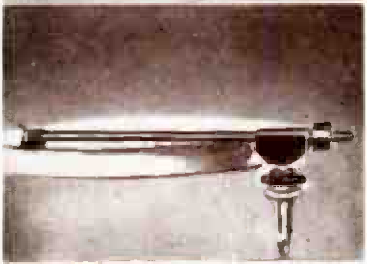
■ **GARRARD**
Model "T" Crest
3-speed manual player, with automatic start and stop. Compact; efficient; incorporates basic features of RC-80.

■ **GARRARD**
Model 301
World's finest professional 3-speed transcription turntable for home use. All speeds variable.



■ **LEAK**
T/L 10
Amplifier with "Point One" Remote Control Preamp. Amazingly low 0.1% harmonic distortion.

■ **LEAK**
T/L 12
Britain's finest amplifier, with unique "Vari-Slope" Preamp. Unsurpassed at any price.



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The original KT66, Britain's famous power-amplifying tetrode . . . and the original Z729 low-hum input tube.

(see other side, please)

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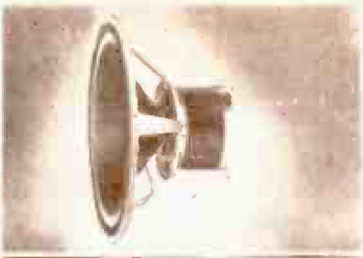

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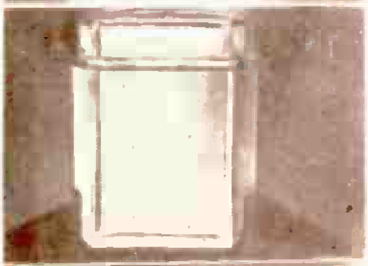

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AUDIO

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CONTENTS

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AUDIO PATENTS

RICHARD H. DORF*

One common element in all volume-expander and volume-compressor circuits as well as remote volume controls is the control stage itself. This is almost invariably a voltage amplifier whose output is controlled by d.c. applied to some electrode—usually the grid. The idea of controlling output by applying a voltage to a tube element is simple and excellent on the surface, but in practice it gives rise to distortion at any but full level, since there is an optimum set of electrode voltages for an amplifier of particular design and departure from these voltages causes nonlinear operation, unless the signal voltage is so small as to remain on the linear portion of the characteristic despite moderate bias changes. Even so, not a great deal of control range is available without reaching the distortion point.

Eric Davies, the inventor of a new control stage, recognizes these points, especially as regards video amplifiers where changes in waveform may have even more serious results than in audio systems. His control stage is useful, however, at audio, and with the premium placed by us all on linearity in present day audio systems, the invention would, it seems, be useful for remote volume controls as well as for expanders and compressors. It is covered by Patent No. 2,721,909, assigned to British Marconi.

The principle on which the invention depends is the application of negative feedback from the screen of a pentode to the control grid, so that as the operating point changes the feedback maintains the output's linearity, both as to frequency (speaking in simple audio terms) and waveform (as applied to video).

Figure 1 is the schematic diagram. The tube type was not specified and the values shown are for video operation. Load resistances are, of course, very low for video amplifiers where frequencies in the megacycle range are being dealt with; for audio use it should be simple to substitute the normal high values with a concomittant increase in gain.

The input signal is applied through a 10,000-ohm resistor and a blocking capacitor to the control grid. The grid leak is connected to a source of negative bias, 10 volts in the inventor's case. It may be feasible to use either contact bias or a well bypassed resistor for audio, where low low frequencies are not so important as in video.

The screen acts as an output electrode, having a 1,000-ohm resistor as its load, grounded for a.c. by a 100-μf capacitor. When the screen load resistor is increased in value for audio use the large capacitor can, of course, be made smaller. Between the bypassed end of the screen load and the B-supply, the 22,000-ohm resistor limits screen current, and thus dissipation, to a safe value.

From the "hot" end of the screen load there is a path (blocking capacitor and 10,000-ohm resistor) back to the grid end of the input resistor. This places negative feedback on the grid, the value being determined by the voltage divider involving the two 10,000-ohm resistors, with the assumption that the impedance of the source is so comparatively small as to be essentially zero, as it would for a usual preceding video voltage amplifier. For audio, the screen output voltage would be higher, also the source impedance, but normal procedure for apportioning feedback components would suffice to obtain the best feedback ratio. The plate load is 330 ohms, and output is taken from the plate. This resistance would also be much higher in audio work.

The stage is controlled by a variable source of negative voltage applied to the suppressor grid. With the potentiometer arm at ground, the suppressor is at cathode potential, tube operation is normal, and output voltage is maximum. As the suppressor goes negative, the plate current decreases, and the output goes down. At the same time, there is increased feedback from the screen, which actually tends to improve frequency response as the suppressor is biased.

Dotted capacitor connections show the plate-to-ground and screen-to-ground capacitances of the tube and circuitry. If the time constants due to the plate load resistor and the plate-to-ground capacitance is the same as that of the screen load resistor and the screen-to-ground capacitance, the frequency response at the stage output is the same as though the same feedback percentage were being obtained from the plate in the more usual manner. The inventor states that substantially linear response is obtained at the output for levels between 5 and 100 per cent of full output, a range of 20 to 1 or about 26 db. Since linearity tolerance for video broadcast equipment is probably greater than for home audio, an addition to the range of 6 db or more might be expected without harm, especially since a small amount of distortion may be less important at very low volume levels.

Claims—Long and Short

A friend who is a very competent patent attorney recently complained in the course of our conversation about a certain inventor who gives him a hard time on

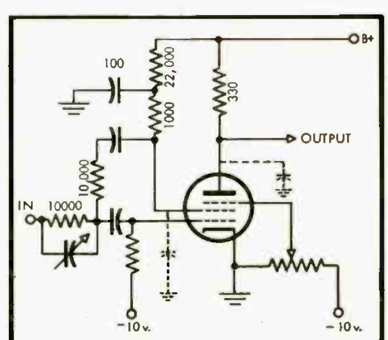

Fig. 1.

Electronics Consultant, 255 W. 84th St., New York 24, N. Y.

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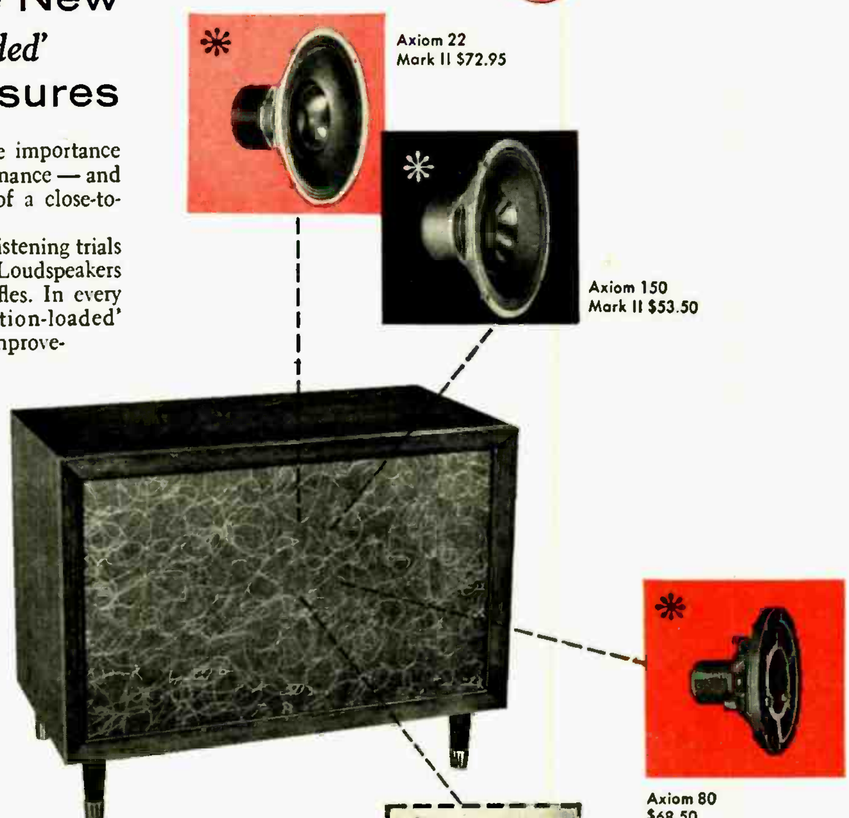
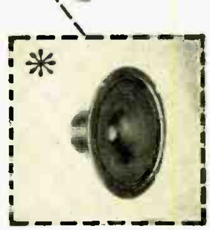
Actual comparison tests and listening trials were conducted with Goodmans Loudspeakers mounted in different types of baffles. In every instance, the new Axiom 'friction-loaded' enclosures produced a marked improvement in sound quality. It appears that this design brings out the full inherent performance of the loudspeaker.

Friction loading is an entirely original principle. It was developed by a famous British physicist while working on an acoustical project for Goodmans Industries. At present, there are four enclosure designs available:





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MODEL 280
— for use with two Axiom 80 loudspeakers operating as a wide range single system.

MODEL 480
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claim writing. It seems that this inventor is never satisfied with short claims but gets a big kick out of seeing claims that take hundreds of words and detail every aspect of the invention and its embodiments. The reason for the complaining tone was, of course, that a short claim is almost always far better than a long one. We decided that apparently a great many inventors don't know that important point, so a little expatiation is indulged in here.

A patent is good only for what it covers—what it can prevent others from copying; and what it covers is explicitly defined in the claims. Claims can be broad, narrow, or anything in between, but the inventor's and attorney's object is to push through claims that are as broad as possible. In brief and in nonlegal terms, a broad claim is usually one that covers a principle more than anything else, so that anyone else wishing to achieve the same result with the same principle cannot avoid infringement by changing a detail.

The classic illustration is the wheel. Let us assume that nobody has ever before thought of this gadget and the inventor is writing his claims. He was interested in primitive wagons actually, and the wheel he made and used was a round slice of wood with a hole in the middle. So he might claim:

> A circular body having a central axis and adapted to be mounted on an axle, and means on said circular body for engaging said axle to rotatably mount said circular body for rotation about said central axis.

Now, this was the wheel as he actually made it and it worked very nicely.

Our inventor's wheel did have to have a central axis, because if the hole were not at center, the wagon would have given a very bumpy ride indeed. However, after the patent came through, other inventors saw it and began getting ideas. One of them came up with the circular cam, which is just like the wheel except that the hole is not at the center. Since our claim calls for a "central" axis and the cam hole is off center, the cam inventor can get his own patent and needn't pay royalties to the wheel man.

Evidently the wheel claim isn't as broad as we thought. But it would have been better if the word "central" had been omitted. While the word described in greater detail what actually had been done, it need not have been in the claim since a claim is not a description of the invention but simply a statement of what is to be covered. The wheel inventor still would have covered the wheel he actually made, but in addition he would have covered wheels with holes elsewhere than in the center and the cam would have been out of luck!

Go one step further. Suppose a third man comes along and invents a cam whose shape is not circular. Both the first and second inventors claimed circular bodies; since the last invention is not circular, both previous claims are circumvented. Yet, neither of the first two inventors needed to specify circularity to cover their inventions, even though their own models were circular.

In the light of this bitter experience, let us now turn time backward and rewrite the original wheel claim in what is probably its broadest form:

> An annular body having an axis and adapted to be mounted on an axle, and means on said annular body for engaging said axle to rotatably mount said annular body for rotation about said axis.

(Continued on page 62)

Perfection!

MIRACORD XA-100

with PUSHBUTTON CONTROL
and the "MAGIC WAND" SPINDLE

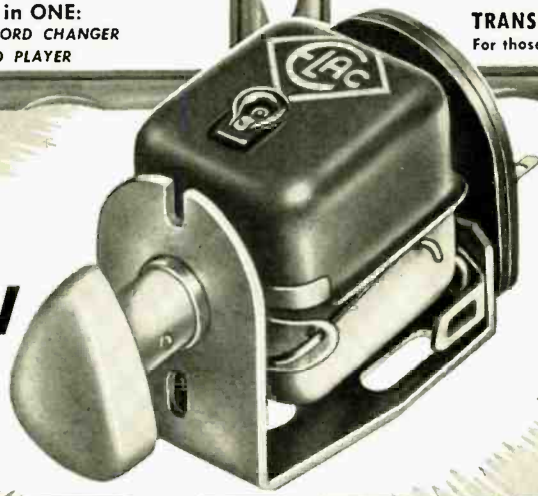
2 Precision Instruments in ONE:
(1) *PUSHBUTTON AUTOMATIC RECORD CHANGER*
(2) *PUSHBUTTON MANUAL RECORD PLAYER*

Perfection!

MIRAPHON XM-110A

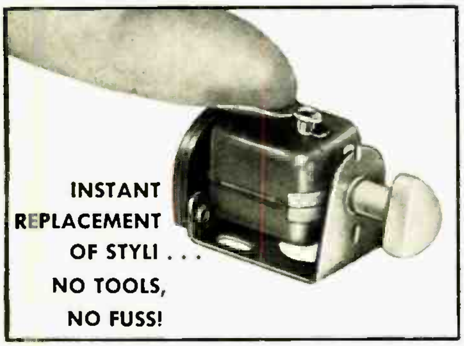
Manual Record Player

TRANSCRIPTION-QUALITY PERFORMANCE
For those who want professional quality at low cost!



..and now the new

MIRATWIN
Cartridge



A NEW ADVANCE IN CARTRIDGE DESIGN AND PERFORMANCE THAT BRINGS OUT THE BEST IN ANY HI-FI SYSTEM!

Never a cartridge more sensitive than the New MIRATWIN . . . never a cartridge easier to use! The craftsmanship that painstakingly produced the world-renowned Miracord XA-100 and Miraphon XM-110A has developed *the* cartridge that faithfully and minutely imparts all the rich, full tones of today's recordings!

The MIRATWIN is a variable reluctance magnetic cartridge, for both LP and standard recordings, of extremely high quality, manufactured under precise quality control conditions. It consists of two completely independent and non-reacting movements, mounted back to back in a turnover mount. Since both styli, 1 mil. for LP, 3 mil. for 78 rpm, have no mechanical connection, the stylus in use is unaffected by the other. The result is a small, compact unit, which together with a stylus pressure of only 5 to 8 grams, guarantees a minimum of record wear!

THESE OUTSTANDING MIRATWIN FEATURES GUARANTEE COMPLETE MUSICAL SATISFACTION:

★ **RESPONSE:** Under average home conditions, the MIRATWIN delivers an amazing response of within 2 db, from 30 to over 17,500 cycles at 33⅓ rpm, and within 4 db, to 22,500 cycles at 78 rpm. Equally outstanding is the freedom from resonant peaks throughout the entire range — a characteristic maintained even when the Cartridge works into unusually high output capacitances. These features, combined with superb internal damping, produce unsurpassed transient response!

★ **OUTPUT:** The Cartridge at 1,000 cycles per second is 45mv for 33⅓ rpm and 55mv for 78 rpm at a recorded velocity of 10 cm/sec. . . . the MIRATWIN yields a great improvement in signal-to-noise ratio.

★ **DISTORTION:** One of the lowest ever achieved in wide-range cartridges!

★ **HUM:** High output actually produces a 6 to 10db improvement in hum ratio of associated amplifiers!

★ **MAGNETIC PULL:** Will not attract even the smallest iron filings! The difference in needle pressure with magnetic or non-magnetic turntables is virtually unmeasurable.

★ **TRACKING:** Perfect tracking of very high amplitude peaks at all speeds. The position of the stylus is such that tracking angle remains optimum when the MIRATWIN replaces other cartridges. Slotted holes permit stylus adjustment.

★ **NEEDLE CHATTER:** Completely negligible... probably the lowest ever achieved! Also, the freedom from peaks and the smooth response, along with the extremely wide range, results in an unprecedented low scratch level, even from old recordings.

★ **MOUNTING:** Unusually simple... the Cartridge is removable from the mount without tools, making mounting screws instantly accessible.

★ **STURDINESS:** Design and construction gives high immunity aganist damage and shock.

★ **PLUS** . . THE EASIEST STYLUS REPLACEMENT YOU'VE EVER SEEN.. Good reasons why an independent testing laboratory stated that the New MIRATWIN "EXCEEDS ITS OWN SPECIFICATIONS"!

MIRATWIN Cartridge,
with Diamond Stylus for LP,
Sapphire Stylus for Standard **$45.00**

With Two Sapphire Styli **$22.50**

The New MIRATWIN Cartridge is now available at high fidelity dealers everywhere. Once you've heard it in use, we know you'll agree there's never been a cartridge like the MIRATWIN!

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NEW LITERATURE

• **University Loudspeakers, Inc.,** 80 S. Kensico Ave., White Plains, N. Y., announces availability of a new edition of "The Ultimate in Sound," a 28-page booklet for the consumer interested in high-fidelity speakers, speaker systems and speaker enclosures. Handsomely printed in multi-color, it is intended as a ready reference for the hi-fi enthusiast. In addition to covering a great deal of general theory, the booklet describes the various exclusive features embodied in University products. A copy of the 1956 edition of "The Ultimate in Sound" may be obtained without charge by writing to the attention of Desk LA2 at the address shown above. **F-1**

• **Technical Apparatus Builders,** 109 Liberty St., New York 6, N. Y., lists complete specifications, ratings and prices for Tabtron d.c. power supplies, selenium rectifiers, chokes and transformers in recently-published Catalog PR156. Included are power supplies built to JAN specifications for a wide variety of electronic equipment. Copy will be mailed on request. **F-2**

• **Radio Recorders,** Hollywood, Calif., has prepared a 12-page outline of recording studio practices, procedures and costs, designed to serve as a guide for advertising agencies, industrial firms, educational organizations and recording artists. A useful feature of the booklet is a section devoted to the various ways of processing masters in relation to the number of pressings required, and the contemplated further use of the master at a future date. Also included is a glossary of technical recording terms. The booklet is available without cost on letterhead request. **F-3**

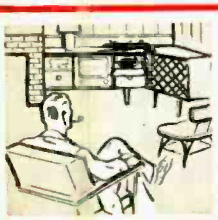
• **Audak Company,** 500 Fifth Ave., New York 36, N. Y., is now distributing the 1956 edition of "Electronic Phono Facts," an interesting 22-page book of authoritative information on pickups, styli, pickup arms, turntables, "hidden pull," stylus wear tests, brushes, static removers, pre-emphasis and de-emphasis, record care, etc. Written by Maximilian Weil, pioneer in electro-acoustics and high fidelity, "Electronic Phono Facts" is of distinct value to serious record collectors. A copy will be mailed free on request. **F-4**

• **The International Nickel Company, Inc.,** 67 Wall St., New York 5, N. Y., through its Development and Research Division, has just issued a new, fully illustrated booklet titled "Design of Nickel Magnetostriction Transducers." Written by Boyd A. Wise of the Battelle Memorial Institute, the 38-page publication summarizes all practical experiments to guide the engineer toward a workable design in exploring new fields in the sonic and ultrasonic regions. The booklet is available without charge and may be obtained by writing to the Readers Service Section at the address shown above. **F-5**

• **Precision Apparatus Company, Inc.,** 70-31 84th St., Glendale 27, N. Y., in its new Catalog No. 23 illustrates and describes in detail the entire line of Precision test instruments for laboratory, production and service applications. All users of test equipment should have a copy of the booklet in their files. Copy will be mailed without charge on request. **F-6**

• **Stockman Electronics Research Company,** 543 Lexington St., Waltham 54, Mass., in a 4-page issue of Serco Monographs covers the use of the time-saving "potentiometer" method of conducting calculations pertaining to steady-state and transient conditions as opposed to the "equation system." Highly technical in nature, this paper will be of interest only to the most advanced engineer. Requests for copies must be accompanied by a remittance of twenty cents. **L-19**

What a wonderful way to begin your 'Dream' system



Sooner or later you will begin to plan your 'dream' high fidelity system. It will have none of the weaknesses of your present one—and you will carefully avoid repeating the same mistakes.

You will listen, deliberate and appraise—speakers, tuners, amplifiers—over and over again, in an infinite variety of combinations. You will ask hundreds of questions, devour all specifications and digest every bit of available information. There is so much to choose from.

How comforting it will be to know that in selecting your turntable and arm, no such problem exists—that there is only one first choice possible—that one manufacturer is so far ahead of the field, there is hardly a second choice. In fact, with your problem so simplified, you can actually begin today. Let us show you how Rek-O-Kut Turntable and matching Turntable Arm can be the wonderful start of *your* 'dream' system.

REK-O-KUT TURNTABLES

Rondine Deluxe (3-speed, hysteresis)	**$129.95**
Rondine (3-speed, 4-pole)	**79.95**
Rondine Jr. L-34 (33⅓ and 45 rpm)	**49.95**
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Model 120 (for records up to 12")	**$26.95**
Model 160 (for records up to 16")	**29.95**

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LETTERS

Tweeter

SIR:

We have read with considerable interest the December issue of Audio and wish to comment on the statement made in AUDIOCLINIC as to why tweeters are so often used with high-fidelity speaker systems. Mr. Giovanelli stated that "a tweeter is used to raise the level of the high frequencies to that of the middle and low frequencies. This must be done as it is extremely difficult for a single speaker to respond equally well to all the frequencies necessary for good sound reproduction."

Although the statement in itself is basically true, we feel that the very important aspects of greater polar dispersion and thus increase of optimum listening area and vast reduction of intermodulation distortion products are more important than wide frequency response *per se.*

It is our feeling that low intermodulation distortion in a loudspeaker system is a more important consideration than wide frequency response, and to implement this philosophy we tend toward three- and four-way loudspeaker systems.

If good high-frequency response is to be achieved, it must be available throughout the room, and it is for this reason that we manufacture slit-type diffraction horns for high-frequency driver units to be sure that equal energy is purveyed at all high frequencies throughout the listening area.

There is no great trick to making a unit that will reproduce high frequencies. This was done by Bostwick in 1931, and everyone that has built high-frequency units since then has followed in his footsteps. We do believe that low intermodulation distortion and wide polar response are things that have been added by the more modern developments, and feel that we should make this point clear.

CULLEN H. MACPHERSON,
Manager, High Fidelity Products,
Electro-Voice, Inc.,
Buchanan, Michigan.

Sweeter

SIR:

It is very seldom that I do any letter writing unless it is an emergency. Right now there is one, and I hope many more readers of AUDIO feel the same as I do.

I have been enjoying AUDIO now for several years and expect to keep on doing so. The purpose of this letter is to say that I hope it will be possible for Mr. Giovanelli's AUDIOCLINIC to continue to be a part of it. I find this a very interesting and helpful addition to an already fine magazine.

Happy New Year to all who make Audio possible.

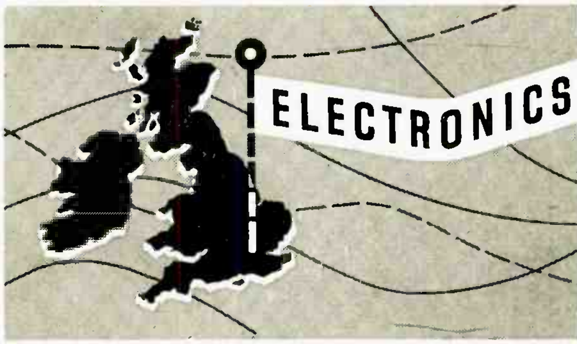
LEO J. SAMPSON,
356 W. 56th St.,
New York 19, N. Y.

(AUDIOCLINIC *will continue.* ED.)

Neater

SIR: In regard to the discussion on padding of loudspeakers to compare quality at the same level, we should like to add our comments.

No loudspeaker of low efficiency can eliminate so-called "hangover." A high-fidelity loudspeaker requires a high flux density adjacent to the voice coil. This can only be obtained with a large amount of magnet material. Without high flux density,



in Britain

EF86

Another Mullard contribution to high fidelity

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage	250V
Screen voltage	140V
Grid voltage	—2V
Plate current	3mA
Screen current	0.6mA
Transconductance	1800 μmhos

Base

Small button noval 9-pin

Supplies available from:—

In the U.S.A. International Electronics Corporation, Dept. A2, 81 Spring Street, N.Y.12, New York, U.S.A.

In Canada Rogers Majestic Electronics Limited, Dept. HF, 11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Mullard

ELECTRONIC TUBES

used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND a voice coil with its attached speaker cone is free to move without the essential damping furnished by a high-intensity field. To eliminate hangover and spurious transient response, manufacturers of quality loudspeakers have been forced to go to a large amount of magnet material to use a high-efficiency material such as Alnico V. No manufacturer is interested in spending more money on the cost of his product unless it is essential to quality performance. The profit motif guides us all in manufacturing policies, and obviously if five or six of the leading manufacturers of loudspeakers in the United States spend this additional money on magnets, it is not done foolishly.

A fairly simple test for judging loudspeaker quality is "How much does the speaker weigh?"

Efficiency is necessary to quality performance and efficiency requires a mass of magnet to eliminate any and all spurious vibrations.

Robert L. Stephens,
Stephens Manufacturing Corporation,
8538 Warner Drive,
Culver City, California.

COMING EVENTS

February 8–11—Los Angeles High Fidelity Music Show. Alexandria Hotel, Los Angeles. Sponsored by the Institute of High Fidelity Manufacturers and the West Coast Electronics Manufacturers Association.

February 9–11—Southwestern Regional Conference and Electronic Show. Municipal Auditorium, Oklahoma City, Okla. Sponsored by Sixth Region, IRE.

February 16–17—Conference on Transistor Circuits. University of Pennsylvania, Philadelphia, Pa. Sponsored by PGCT of IRE, AIEE, and Univ. of Pa.

February 14—Soundarama High Fidelity Concert. Academy of Music, Philadelphia, Pa.

March 2–4—Washington High Fidelity Music Show of 1956. Shoreham Hotel, Washington, D. C. Produced by WGMS, Washington.

March 19–22—IRE National Convention. Waldorf-Astoria Hotel and Kingsbridge Armory, New York.

April 10–12—Radio Electronic Component Manufacturers Federation Show, Grosvenor House, London, England.

April 13–15—The London Audio Fair 1956. Washington Hotel, Curzon St., London, England.

April 23–24—New England Radio-Electronics Meeting, "Stocktaking of Electronic Progress." Sheraton-Plaza Hotel, Boston, Mass.

April 23–May 6—British Industries Fair. Earls' Court, London, England.

May 21–24—Electronic Parts Distributors Show. Conrad Hilton Hotel, Chicago, Ill.

EDITOR'S REPORT

AUDIO SHOW—LOS ANGELES

This is surely the big season for audio shows, and leading off in point of size is sure to be the Los Angeles High Fidelity Music Show at the Alexandria Hotel in Los Angeles, which opens on the 8th and runs through the 11th of February. The West started a little slow—not following in the footsteps of New York until 1953—but its first exhibit was a huge success, as have been all the others since then. This is the first year of operation under the joint sponsorship of the Institute of High Fidelity Manufacturers and the West Coast Electronic Manufacturers Association, and judging from the success of the IHFM show in Philadelphia in November, everyone is optimistic about the coming affair.

And why not? It is quite generally agreed that the art—or science—got its start in Hollywood where the movie sound engineers borrowed professional techniques and adapted them to sound reproduction in the home as long ago as 1930 (hi-fi isn't as new as some people seem to think). Furthermore, there are many important manufacturers of hi-fi equipment on the West Coast, not all in Los Angeles, necessarily, but still in the West. In addition to audio manufacturers, it must also be noted that there is a very high concentration of electronic research and development centered around Los Angeles. While Chicago has long been considered the center of radio set manufacturing, Los Angeles is coming closer to being the center of hi-fi production—at least, it runs a close second to the New York area now.

So we salute the L.A. show, and look forward to participating in an event which will introduce a few thousand more families to the enjoyment that comes with having a home music system of real quality. Those who have lived with hi-fi for years know well the satisfaction and pleasure that they derive from good music well reproduced.

AUDIO SHOWS—MONTREAL, TORONTO

While the presses are running off this page, the fourth Canadian Audio Show is taking place in Toronto, the third one having just finished in Montreal. Our northern neighbor has somewhat less population than we have—about one tenth—but there is no less interest in good sound in Montreal and Toronto than in our own cities. Over five thousand people came to the show in Montreal, each paying the nominal sum of fifty cents for admission, and in three days and some thirty exhibitors' rooms in which to roam, there was about the same degree of crowding as we have become accustomed to in New York, Chicago, Los Angeles, Philadelphia, Washington, Boston, and even Mexico City. By any standards, the Montreal show was a success; and from what we remember of last year's show in Toronto, it is quite probable that the corridors and rooms of the Prince George Hotel are right now overflowing with people.

AUDIO SHOW—LONDON

It's a little further away, in both distance and time, but the first all-audio show comes to London, along with Spring, in April. Titled "THE LONDON AUDIO FAIR 1956," a three-day show opens at the Washington Hotel on Curzon Street, Mayfair on Friday, April 13. We trust the selection of opening date will have no effect on the success of the show, but we venture to predict that three days won't be long enough for all those who are interested in hi-fi in England to see and hear as much as they want to. We shall be interested in a report of this show, but must necessarily restrain our curiosity for almost three months. We mention this event so early because it might possibly influence anyone who intended to be abroad somewhere near that time—or who has such an abiding interest in audio shows as to make the trip just for that one reason. Actually, one would get a three-for-one advantage, since the Radio Electronic Component Manufacturers Federation has its exhibit the three days preceding the Audio Fair, and just a little over a week afterwards the British Industries Fair opens. Since we once had the pleasure of attending an RECMF exhibit and all that goes with it, and later had the pleasure of browsing through some of the auditoria used by the BIF, we can honestly recommend these as well worth putting on the agenda if the slightest excuse can be found for attending. And if you can't find an excuse, invent one. You won't regret it.

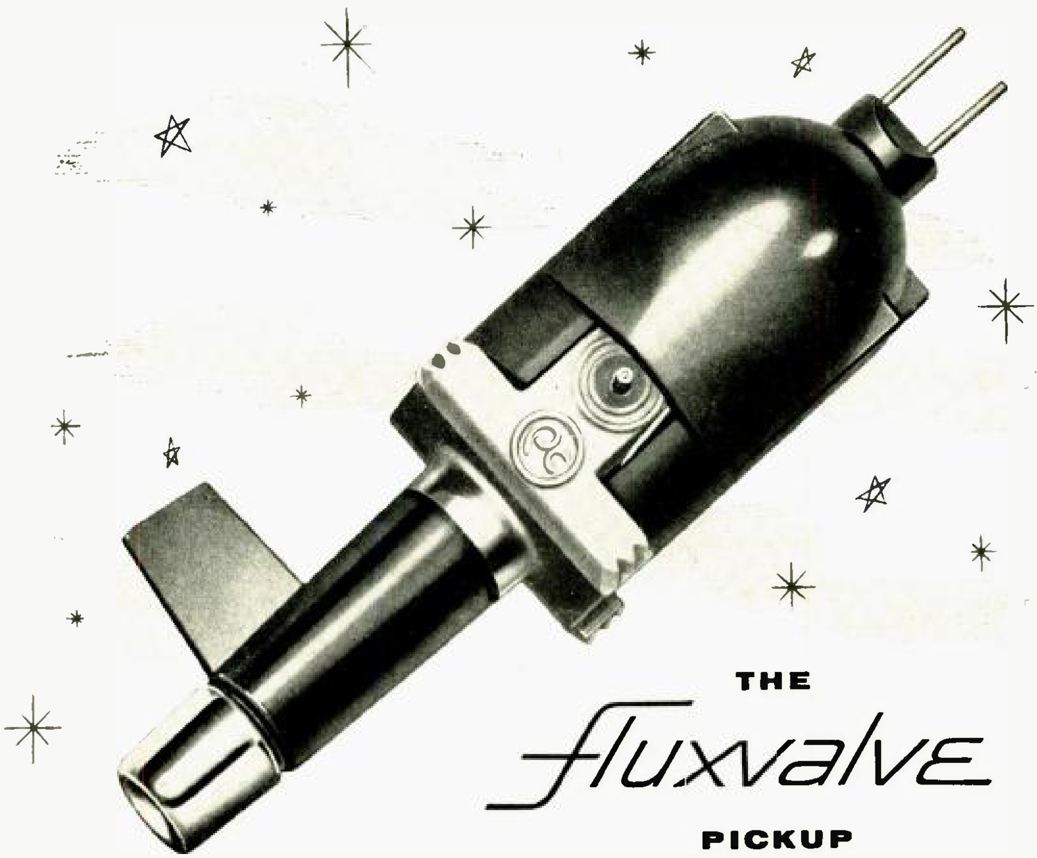
AUDIO SHOW—WASHINGTON

Coming back to home shores again, we mustn't overlook the Washington High Fidelity Music Show of 1956, to be held March 2, 3, and 4 at the Shoreham Hotel in the nation's capital. This show has been held heretofore at the Harrington Hotel, where the studios of WGMS are located, but not enough space was available for all the exhibitors who wanted in, and the larger Shoreham was selected. Washington's Good Music Station—WGMS—organized and sponsored the first show in that city in 1954, and has continued since as the sponsor and producer. Both of the previous shows have been considered successful by the exhibitors—which is, after all, the true criterion—and to all indications this third show will follow the others to success. A fifty-cent admission fee is being charged for this show also, but so far that has not curtailed attendance at other exhibits where the same fee was applicable. Most exhibitors seem to be of the opinion that they get more serious lookers and listeners at a paid show than at a free one.

TOO MANY SHOWS?

An emphatic no to that question—even though it is undeniably expensive for exhibitors. If they must attend six to eight shows each year they have relatively little time left in which to get their normal work done. But we do think that dozens of the smaller cities should have miniature audio shows which could be put together by the local distributors with a minimum of trouble. There are some of these now, but since they do not expect national attendance we don't always hear about them. We doubt if there are enough, though, and trust there will be more of them as the idea catches on.

the first really new pickup in a decade

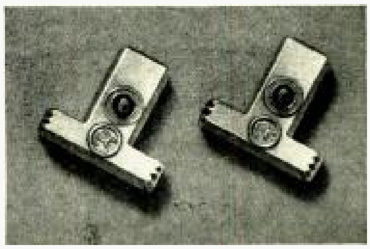


Made by perfectionists—for perfectionists. The FLUXVALVE is literally the cartridge of the future, its unique design meets the demands of all presently envisioned recording developments, including those utilizing less than 1 mil styli.

There is absolutely nothing like it! The FLUXVALVE Turnover Pickup provides the first flat frequency response beyond 20kc! Flat response assures undistorted high frequency reproduction — and new records retain their top "sheen" indefinitely, exhibiting no increase in noise . . . Even a perfect stylus can't prevent a pickup with poor frequency characteristics from permanently damaging your "wide range" recordings.

With this revolutionary new pickup, tracking distortion, record and stylus wear are reduced to new low levels.

The FLUXVALVE will last a lifetime! It is hermetically sealed, virtually impervious to humidity, shock and wear...with no internal moving parts.



The FLUXVALVE has easily replaceable styli. The styli for standard and microgroove record playing can be inserted or removed by hand, without the use of tools.

For a new listening experience, ask your dealer to demonstrate the new FLUXVALVE...words cannot describe the difference...but you will hear it!

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ABOUT MUSIC

HAROLD LAWRENCE*

Are Critics Necessary?

SOMEONE ONCE SAID, "Critics have but one right, that of keeping quiet." Although many music lovers would at one time or another sympathize with this remark, the plain fact is that reviews of last night's concert or the latest recording are widely read, debated, and challenged. The reader seldom finds himself in total agreement even with his favorite critic, just as he rarely sees eye to eye with a companion over a recital both attended. Yet he will want to know exactly how the review differs from his own impressions. When the morning papers arrive, he will spread out the music page on his desk, muttering: "Now what did X have to say about Y's debut, or yesterday's Philharmonic performance?" If it is a favorable report of a concert or opera he heard and disliked, the reader may be bewildered, indignant, or both: "Ha! He didn't even stay for the final scene," or "I caught him dozing in his aisle seat." In the case of record reviews, the dissenting discophile may end up by resorting to such tactics as: "He probably listened to it on a measly seven-watt amplifier with a one-position equalizer," "His stylus is worn," or "He wouldn't know what an orchestra sounded like if he heard one." Of course, when the same critic happens to confirm the reader's opinion, the verdict is a wise and penetrating one.

Is the critic therefore merely someone whose words are more broadly disseminated than those of his fellow music lover? Or is he, as Benjamin Britten put it, a type of parasite existing on the body of music, or on any other art, for that matter? Perhaps both, in some instances. What then, ideally speaking, is the function of the critic in the world of music?

First and foremost he is a cultural middleman between the art and the public, put on earth and into print to uphold standards of performance and composition with the same passion and zeal with which the company of holy Knights guarded the Grail. But with all due respect to the valiant men of Monsalvat, the task of the music critic is a more demanding one. He is confronted with the fearsome dilemma of translating an antiverbal language into words. There are many ways of accomplishing this, and some pitfalls as well. Here are a few examples.

The scientific method

A composition is discussed in terms of theme, development, inversion, modulation, recapitulation, and other such "Mesopotamian words," as Bernard Shaw described them. G.B.S., by the way, penned a classic parody on this manner of music criticism in his 'analysis' of Hamlet's soliloquy on suicide: "Shakespeare, dispensing with the customary exordium, announces his subject at once in the infinitive, in which mood it is presently repeated after a short connecting passage in which, brief as it is, we recognize the alternative and negative forms on which so much of the significance of repetition depends. Here we reach a colon; and a pointed pository phrase, in which the accent falls decisively on the relative pronoun, brings us to the first full stop." (*Music in London*)

The autobiographical method

"The opening *Allegro* took me straight back to childhood and gave me in turn the rusty windlass of a well, the interlinking noises of a goods train that is being shunted, then the belly-rumblings of a little boy acutely ill after a raid on an orchard, and finally the singular alarmed noise of poultry being worried to death by a Scotch terrier. . . ." (From a letter written by Alan Dent, quoted in *The Later Ego* by James Agate, London, 1951. The work referred to is Bartók's Fourth String Quartet.)

The Nature method

"And so we may call Brahms' Third Symphony a North German heroic epic, the finale of which conjures up the heroic landscape of the old Beowulf saga, with its procession of driving, heavy clouds, ending in a wan, tempered gleam of sunshine such as one sees in Schleswig-Holstein." (*Brahms* by Walter Niemann; Knopf.)

The imagery method

"The choruses (in Alessandro Scarlatti's Passion according to St. John) are written in a way suggesting the pale gold that encircled the profile of virgins seen in frescoes of that time." (Debussy)

The Marxist method

"In the Finale (of Miaskowsky's Sixth Symphony) we hear the marching of masses of men (whose) energies are not merely the energies of a crowd: they are the energy of organized masses." (*The Soviet Symphony by Asafiev.*)

★ ★ ★

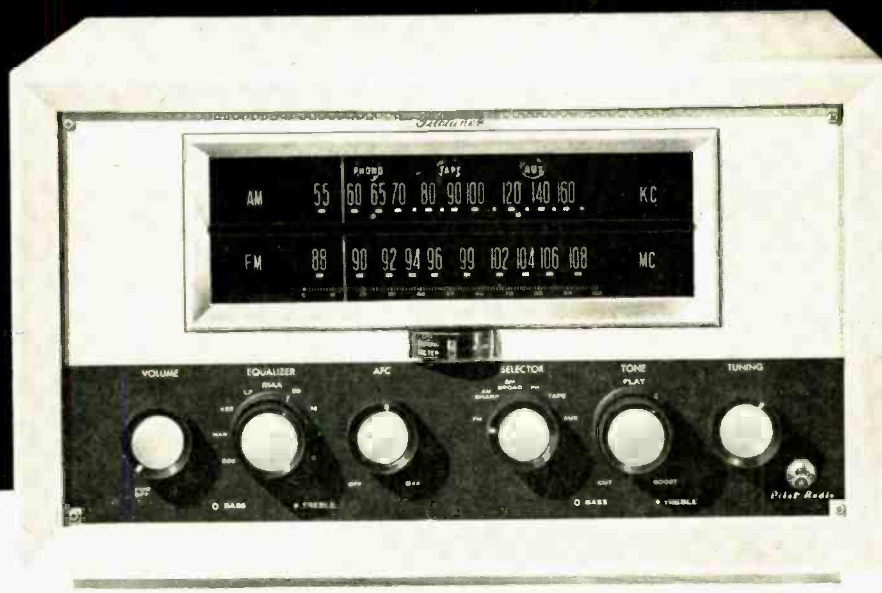
Some of the above approaches may be valid, and often enlightening, but not one of them grapples with the fundamental problems. Ultimately the music critic will have to deal with the form, shape, and character of the work he is reviewing, or the interpretation of that work. The less courageous of the species will postpone that decision as long as possible, exploring the peripheral aspects in great detail. He may wiggle his toe in the pool but leave it to others to take the plunge.

His reluctance is understandable, for, as Ernest Newman, the dean of English critics, said: "It is more difficult to criticize a piece of music than to compose it." For the past sixty years, through his reviews in

(*Continued on page 61*)

* *26 W. Ninth St., New York 11, N. Y.*

you are face-to-face with a **Pilot** *Tuner*



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Behind it is more than 35 years of specialized experience

The design and construction factors of a tuner are much too complex for the average buyer to evaluate. Yet, he must have some basis for making his choice. Simply labeling a product — 'Armstrong Circuit' or 'Foster-Seeley' — is only part of the story. And you can't rely upon the 'skin-deep' beauty of a showy exterior, alone. How then to choose?

Most of us are neither chemists nor pharmacists — and we are unequipped to analyze the simplest drugs we use daily. But, we have learned to place our confidence in the reliability and skill of recognized drug firms who, by devoted study of our problems and by their demonstrated experience, have earned the right to our trust.

The approach to the selection of a radio tuner — or other electronic product — is a compelling parallel.

Pilot is one of the oldest, respected names in electronics. Two generations have learned to regard it as a synonym for product quality and progress leadership. To the field of high fidelity, Pilot has brought a rich storehouse of specialized knowledge and experience, and has applied it to the task of creating better ways for better listening in the home.

When you stand before a Pilot Tuner, you are face to face with an instrument expertly engineered to provide you with the finest in FM and AM reception.

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AF-860* (illus.)	$179.50	AF-724 FM-AM	$89.50
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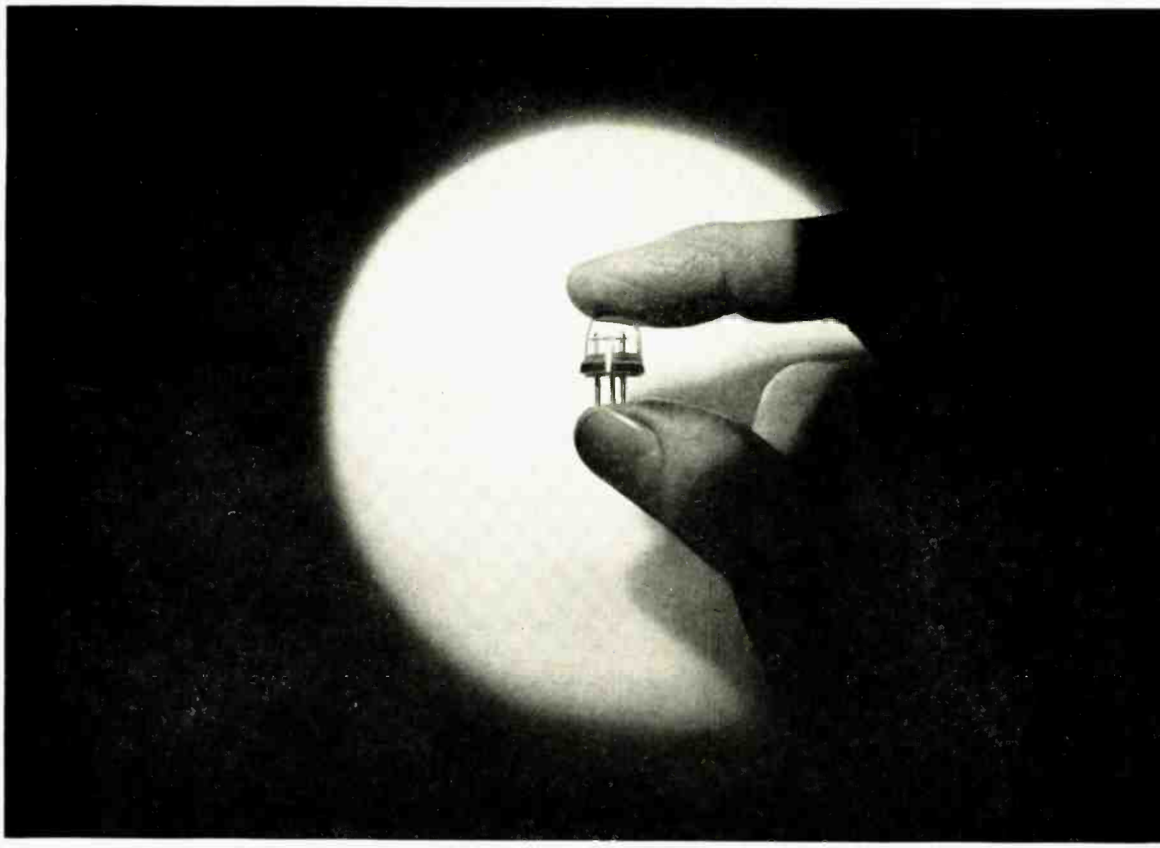

Experimental model of Bell's new high-frequency transistor. It has a cut-off frequency of at least 500 mc and can be used to amplify 2500 independent voices simultaneously.

THE TRANSISTOR
that smashed a frequency barrier

A new transistor invented at Bell Telephone Laboratories can provide broadband, high-frequency amplification never before possible with transistors. The big leap in frequency is made possible by a diffusion process that earlier enabled Laboratories scientists to create the Bell Solar Battery.

This transistor is a 3-layer semiconductor "sandwich." High-frequency operation is obtained by making the central layer exceedingly thin. This was difficult to do economically by any known method.

The new diffusion process, however, easily produces microscopic layers of controllable thickness. Thus it opens the way to the broad application of high-frequency transistors for use in telephony, FM, TV, guided missiles, electronic brains and computers.

The new transistor shows once again how Bell Laboratories creates significant advances and then develops them into ever more useful tools for telephony and the nation.

A Bell scientist checks temperature as arsenic vapor diffuses into germanium, creating 4/100,000-in. layer.

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Transistor Tips and Techniques

PAUL PENFIELD Jr.*

A short introduction to the mysterious world of transistors, for audio fans and engineers who haven't yet done any experimenting in the field. Practical tips are given, to supplement theoretical material already available.

Of all the recent inventions in the electronics and audio fields, the transistor will undoubtedly have the greatest effect. Such great promise is held for these little "miracles of matter" that their use is expected to become widespread before long.

Most professional engineers have by this date had experience of one kind or another with transistors, possibly in the audio field. However, the chances are that hobbyists, experimenters, serious audiofans, and even some engineers have yet to try their hand at transistor audio applications. For these people, this article is written and dedicated, to make their entrance into this strange new field as painless as possible.

One difference is immediately apparent between transistors and vacuum tubes: their small size. Small-sized tools sometimes are required for constructing transistor circuits. A pair of tweezers is a handy tool, and long slim-nosed pliers are easier to work with than conventional chain-nosed pliers. However, ordinary soldering irons, contrary to popular belief, usually do as good a job of soldering transistors as the lower-power soldering pencils. Making a quick, hot joint is preferred to making a slow, not-so-hot joint, which may burn out the transistor. The amount of "re-tooling" necessary for experimenters to start work in transistors is quite small. The budget-minded experimenter will do well to get along on his present tool supply.

Transistor Components

Audio engineers and audiofans should have no trouble adapting themselves to transistors. Since use of transistors will be widespread in the near future, serious enthusiasts have no choice but to get some experience in with the units. If this article will help to bridge the gap into the unknown for some of the readers, it will serve its purpose. Experimentation with transistors is, incidentally, much easier than experimenting with vacuum tubes. No expensive, bulky high-voltage power supplies are required, and there are no filaments to heat. All of the circuitry directly contributes toward the function of amplification.

No radically new and different types of components are required for use with transistor circuits. Resistors, capacitors, transformers, batteries, plugs, sockets, coils, meters, fuses, etc., perform the same functions in transistor circuits as they do in vacuum tube circuits. However, because of the low voltages and impedances present in transistor circuits, different values for these components will be appropriate.

Coupling capacitors must normally be quite high in value—up to and even beyond 50 μf at times. Fortunately the voltage requirements are low, and electrolytic capacitors are available with these ratings. Tantalum capacitors (see *Fig.* 1), although appropriate in value, are quite expensive. Conventional low-voltage units, however, are quite reasonable.

Transistor sockets are available—in most cases the standard subminiature in-line tube sockets, such as the Cinch-Jones type 2115, will serve well. (See *Fig.* 1) "Transistor sockets" are available commercially, but cost a trifle more.

Transistor circuit power supplies will generally be batteries. Conventional batteries do quite well, and can be selected for the purpose on the basis of voltage and expected current load, the same way batteries for any other purpose are selected. Hearing aid batteries or mercury cells may be useful. Some companies have "Transistor batteries" which are nothing inherently different from other batteries. For experimental purposes, on the bench, storage batteries do as well as any. Line-operated power supplies are generally complex, because of the amount of filtering necessary, but, if properly designed for the correct voltages and current ratings, do as well as batteries. Use of ordinary laboratory-type power supplies should be avoided, however, because of the high no-load voltage, which may easily cause transistor break-down.

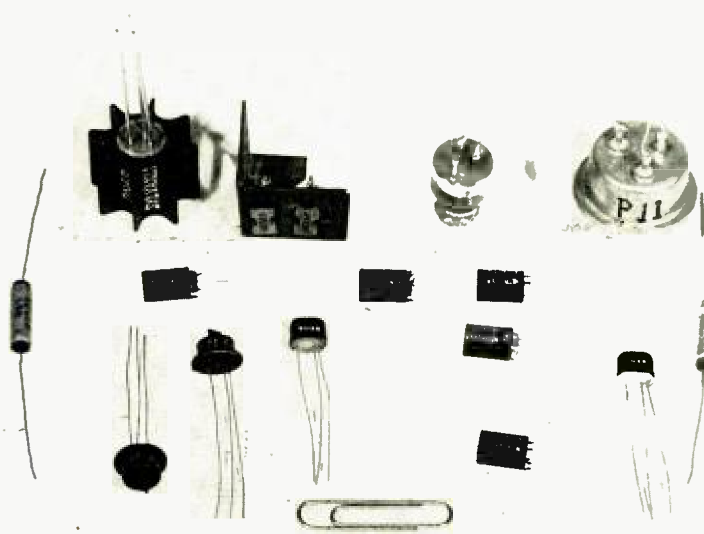


Fig. 1. Various transistors and components. The five Raytheon transistors have been adapted to fit into subminiature tube sockets, two of which are shown mounted in a universal power transformer mounting bracket, upper left. Two tantalum electrolytic capacitors are at extreme right and left positions. The rear row shows power transistors, the foreground common low-power transistors.

* 752 Lakeside, Birmingham, Michigan

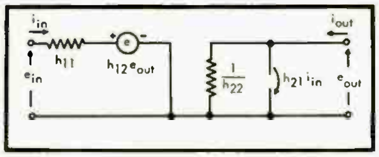


Fig. 2. Most commonly-used small-signal equivalent circuit for low-power transistor stages.

Transistor transformers have appeared on the market; however these transformers generally sacrifice quality for small size, and so where fidelity is important should not be used. Unfortunately at this writing a line of high-fidelity transistor transformers is not available. In most cases, luckily, the use of transformers can be avoided altogether. When this is not possible, obtaining a suitable transformer can be a real problem.

High-impedance microphones, such as crystal mikes, are less suitable for transistor work than low-impedance models, such as dynamic types, inasmuch as the latter may generally be coupled directly to a transistor amplifier, without the use of a step-down transformer.

Other components, such as loudspeakers, meters, resistors, fuses, potentiometers, switches, and terminals are either normal types, or else miniaturized versions of their vacuum-tube counterparts. No special difficulty should be encountered by use of standard parts.

Simple Audio Amplifiers

Well, we've now got the transistors, and the necessary transistor tools and components, so the question becomes, "what can we do with them?" The design of simple audio amplifiers is not difficult.

It is customary for design engineers, when making transistor audio amplifiers, to use an equivalent circuit of the type shown in *Fig.* 2, which is much like the vacuum-tube small-signal equivalent circuit shown in *Fig.* 3. Using the transistor equivalent circuit, however, is a bit more complicated than using the vacuum tube circuit, and can be avoided for a while, until the reader gets the "feel" of transistors, at which point it can be taken up with the least pain. The industry is now standardizing on the so-called "h-parameters"[1], as used in the equivalent circuit of *Fig* 2, and with which the serious audiofan is well advised to familiarize himself. However, for the first plunge into transistors, the load-line technique, so useful in vacuum tube work, will prove adequate.

Graphical analysis is necessary in any event to determine the bias at which the transistor operates, but it can tell more as well. For example refer to *Fig.* 4, which is a typical pentode plate characteristic. The load line XY is drawn, determined by the supply voltage X and the load resistor. The bias, or the "quiescent point" is determined by the intersection of this load line with the grid bias line chosen, of course. As the grid voltage varies about its quiescent value, the point of operation moves between points R and S, as shown. Here, of course, the a.c. load line is the same as the d.c. load line, as is usually the case for vacuum-tube voltage amplifiers.

Now, however, look at *Fig.* 5, which is a typical audio transistor grounded-emitter characteristic. Notice the similarity in shape, except that the determining parameter of the family is now base current, instead of grid voltage. Shown is a d.c. load line XY, determined again by the supply voltage X and the load resistor. This line, together with the value of quiescent base current determines the quiescent point Q. It could be argued from analogy that a small change in base current would produce a change in the collector voltage in exactly the same way, following the line XY, but this is not so. In most practical transistor amplifiers, the a.c. load line and the d.c. load line are not the same.

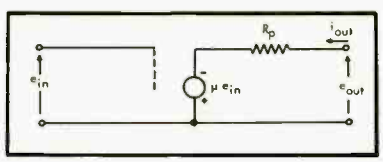


Fig. 3. Conventional grounded-cathode vacuum tube small-signal equivalent circuit, shown for comparison.

The load presented by the succeeding stage is not negligible, as is usually the case in vacuum tube circuits of this type.

An a.c. load line, corresponding to the a.c. resistance that the transistor "sees" at its terminals, must be drawn, looking something like the line RS in *Fig.* 5. Now a given base current change produces a smaller voltage change at the output than before we took account of the different a.c. load.

The quiescent point may, of course, be chosen anywhere within the ratings of the transistor; however good engineering practice usually dictates a choice such that on high signals, the a.c. load line will go into saturation S and cut-off R simultaneously—that is, RQ = QS. This point can be determined by observing the graph.

It may be handy to know such things as voltage gain, current gain, input and output impedances, power gain, etc., at this point. Indeed it is essential to know these quantities. The graphical analysis here can give only the current gain. The rest can be had only by investigating the equivalent circuit, and cannot be told from the load-line graph.

At this point the author will beg off the subject of amplifier design, because of the splendid array of material already available on the subject. The bibliography at the end of this article lists several books dealing in part or in whole with transistor audio applications. Instead, the author will present material not found in these theoretical books, but still highly important to anyone working with transistors for the first time. The more practical aspects of amplifier design and of handling transistors, are of more than passing interest to the experimenter who wants to keep from burning out his transistors.

Transistor Protection

Much has been made of the high life expectancy of transistors, implying that they can be permanently wired into circuits just like other "reliable" components, such as resistors and condensers. It is true that transistors are much longer-lived than vacuum tubes, and even other components, but this alone is not justification for permanent wiring, especially in breadboard and experimental designs. There are powerful reasons why transistors should be modified to plug into sockets.

First, heat from a soldering iron can permanently damage a transistor in no time flat. Even experts sometimes overheat connections, and this practice is fatal to transistors, especially if the leads were cut short. Also, the leads are quite flexible, and when bent usually bend and break right next to the body of the transistor, leaving you with an electrically good, but still unuseable transistor, and a very frustrated feeling. Of course these remarks apply more to experimental and breadboard circuits—in assembly-line manufacturing operations the transistor should be welded in place by its leads.

Using a standard subminiature tube socket, or other transistor socket, precludes the disappointment of damaging

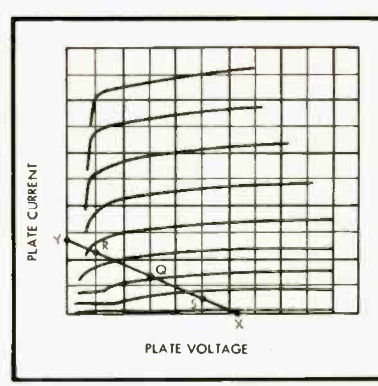


Fig. 4. Load line on a pentode plate characteristic family. Note that the a.c. load line and the d.c. load line coincide.

[1] Refer to Shea: *Transistor Audio Amplifiers.* Wiley, New York, 1955.

a transistor during construction. Transistor leads should be cut off to a length of about a quarter of an inch, with the base lead left slightly longer than the other two.[2] This was done with five of the transistors pictured in *Fig.* 1. One end of the socket should be painted red, or some other color, to distinguish it from the other end. This end can be used for the collector lead, to prevent plugging in the transistor backwards. Most transistors either have a distinguishing dot next to the collector lead, or else have a larger separation between collector and base leads.

Mounting the transistor socket can be somewhat of a puzzle in building transistorized equipment. A retaining ring is supplied with the sockets; however the mounting requires an oblong hole. Fortunately, several types of universal mounting brackets (such as intended for power transformers, loudspeakers, etc.,) have elongated holes of the correct size, and these may often be used as an inexpensive, convenient socket mounting. The socket may be held in place either with the retaining ring, or with a touch of plastic cement. *Figure* 1 shows two sockets mounted in a power transformer universal mounting bracket.

Several common vacuum tube practices must be forgotten when working with transistors—for example, battery polarity. With p-n-p junction transistors (the most common type at present), the collector lead must be supplied from the negative lead of the battery—not the positive. Forgetting this polarity and connecting a transistor backwards is asking for trouble. Sometimes it will not harm the transistor (especially if large current-limiting resistors are used in the collector lead), but more often the transistor goes off to transistor heaven with a sometimes visible puff of smoke. N-p-n transistors are connected just the reverse from this, with the collector lead positive. It is always wise, especially if working with both types, to check each circuit each time the power is applied. Special care should be taken when both p-n-p and n-p-n units are in the same circuit, as for instance in complementary circuits. People familiar with vacuum tube practice may be a little careless, for in vacuum tube operation, reversing the B-plus does no harm except keep the circuit from operating. But in transistor work, the price paid for carelessness is higher.

[2] This is to prevent accidently connecting the emitter and collector, but leaving the base free, which connection might be dangerous to other components.

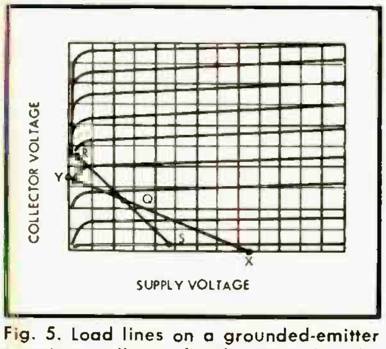


Fig. 5. Load lines on a grounded-emitter transistor collector family. Note that the a.c. load line and the d.c. load line do not, in general, coincide.

Similarly, care should be taken with all polarized components—sometimes a little thought is needed to remember just what the correct polarity is. Some typical polarized components likely to give trouble: milliameters, electrolytic capacitors, diodes, voltmeters.

When working on a breadboard, it is wise to protect the transistor continually with a fuse. A rating of about three-quarters of the maximum recommended collector current is best. Slow-blow fuses, sometimes used to protect motors and other equipment which pass transients, are definitely not to be used in protecting transistors. The fastest-blowing fuse is the best, for by the time a slow-blow fuse gets around to blowing, the transistor is already shot. And don't be tempted to use a higher rating if you continue to blow fuses. Fuses are at present a bit cheaper than transistors, although there is every indication that this will not always be so.

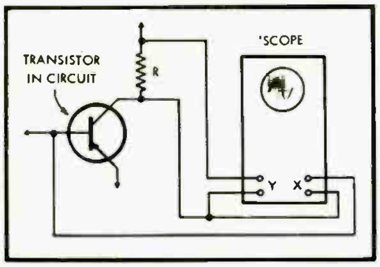


Fig. 6. Method for continually monitoring the load line of a transistor stage on an oscilloscope.

One arrangement that is sometimes useful with low-power transistors is shown in *Fig.* 6. Continual monitoring of the load line (collector current *vs.* collector-to-base voltage) is done by displaying the quantities directly on an oscilloscope. The voltage across a known sampling resistor R is fed to the vertical amplifier, and the collector-to-base voltage is fed to the horizontal amplifier. The value of the sampling resistor must be large enough to produce a reasonable-sized pattern, but not large enough to interfere with amplifier operation. By considering the value of this resistor, and by using a voltage calibrator, the pattern on the face of the scope can be calibrated to read directly in volts and milliamperes. Once that is done, the instantaneous power dissipation (which must never exceed the manufacturer's ratings) is merely the product of the two at any point on the trace, expressed in milliwatts.

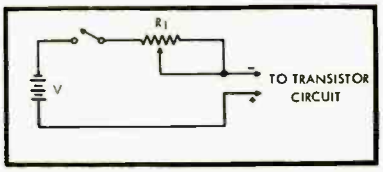


Fig. 7. Method to prevent transients from harming transistors in experimental set-ups.

This monitoring can also be used to detect large transients in the circuit. When the power is turned on or off, large transient currents may be drawn by the large capacitors. Transients as such do no damage, unless they exceed the manufacturer's ratings, which is often the case.

One method of eliminating trouble caused by transients altogether is to employ the circuit shown in *Fig.* 7. Here the battery is switched on while a large resistor R_1 is in series with it. Then this resistance, in the form of a rheostat, is removed with the power on. A safe value for this resistance is

$$R_1 = \frac{V}{I_{max}}$$

where V is the battery voltage, and I_{max} is the maximum recommended collector current for one transistor.

Of course, after the audiofan has had transistor experience, he can forget some of the safety precautions outlined here. But one unfamiliar with transistor characteristics will do well to protect his transistors, lest he have to dig into the sugar bowl for the wherewithal to replace the transistors he needn't have burned out.

Transistor Testing

Commercial transistor testers, which check many of the transistor parameters, cost so much as to preclude their use by audio enthusiasts at this date. However, a simple test given here will usually determine if a transistor is completely shot, although borderline cases, or partially burned out transistors cannot be tested reliably.

The test is quite simple; it merely consists of testing each junction separately, to see if each is a good rectifier, and then checking for transistor action. The only tool needed is an inexpensive multimeter, or a VTVM with a resistance range. For the majority of low-power transistors available now, the forward resistance of each junction should read roughly 1000 ohms or less, depending on the type instrument used, and

(*Continued on page 57*)

A New Turntable Design

A discussion of the requirements of a high-quality professional-type turntable and a description of the latest entry into the field of single-play units designed primarily for use in the home music system.

R. E. CARLSON*

ONE OF THE MOST DECEPTIVE problems which can be handed to an engineer is a simple request to design a good turntable for use in a phonograph system. After all, why should there be any trick involved? All it has to do is turn around at a constant speed—or perhaps one of several constant speeds. But, as an old negro mammy is rumored to have said, "Oughta-be ain't is".

For instance, we hear about turntables having noise levels 40, 50, or 60 db below something (just what it is "below" is seldom clearly expressed) or in some cases just "60 db" or some such figure may be stated. (That a decibel is an expression of a ratio seems to be of little importance to copywriters.) However, let us examine what a signal to noise ratio (S/N) of 40 db below a 5 cm/sec peak recorded velocity means. Since 500 cps is the turnover frequency for most modern recordings where, at least theoretically, constant amplitude recording begins, we will select that as our reference frequency for the moment.

The amplitude of such a signal would be about .0006 in. or 0.6 mil. Now 6/10 of a mil represents a fair order of accuracy for almost any industry. There are not many commercial products in which dimensions need to be held to four decimal places. But this is nevertheless the amplitude which will provide an "average" level from your pickup, and for the rumble to be 40 db below this level we should need an amplitude of 1/100 of .0006 inches. This turns out to be .000006 inches or 6 MICRO inches! This means simply that the vibration of the turntable (or of the pickup arm, of course) must have an amplitude of 6 *micro* inches, or less, for a S/N ratio of 40 db below 5 cm/sec peak at 500 cycles per second. Clearly, this is no simple task.

There are, of course, other requirements than low vibration (rumble). Wow (slow flutter) and flutter (fast wow) must be very small, of the order of a tenth of a per cent for excellent results, and this is not easy to achieve, either. Finally, the table must be convenient to operate, rugged and foolproof, as attractive as possible and—biggest "ain't is" of all—it must be reasonably priced or no one will buy it. When all of these requirements are put together, the seemingly simple problem becomes a fair-sized headache, and many are the hours of sleep collectively lost by first-class engineers in trying to solve it.

Many solutions have been proposed, some of which have been offered for sale and others not. None is perfect, despite elaborate press-agent claims to the contrary. Or, if you prefer, each design must represent a compromise, or the considered judgment of the engineer as to the best practical reconciliation of the conflicting requirements. Any basic design could probably be made to work—even satisfactorily—and certainly many different approaches have produced usable turntables. In the light of this background the following points are set down for those who may be interested in a design finally adopted by the Fairchild Recording Equipment Company for a new turntable intended for home use, and called the "Turromatic".

* *Fairchild Recording Eqpt. Co., Whitestone 57, N. Y.*

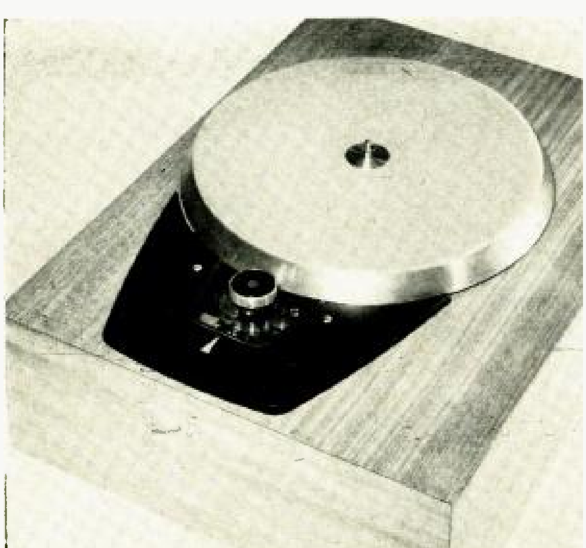


Fig. 1. The new Fairchild "Turromatic" turntable. Lucite "window" in the dress plate exposes idler-pulley turret and belt drive.

Belt Drives Flywheel

The name derives from the use of turret-mounted idler wheels which are employed, although the table is basically a belt-driven flywheel. This is certainly one of the oldest designs known to man, and it may also be one of the smoothest in inherent operating characteristics. Three practical difficulties arise, however, which have made the belt drive less attractive than the now almost universally used idler (or "puck") driven table. These are:

1. The large speed reduction (50 or more to 1) requires such a small driving pulley that too much slip results.
2. Speed changes are difficult, and speed changing devices tend to wear the belt.
3. If the belt is accessible the installation may become singularly unattractive, but if it is inaccessible both installation and maintenance may be very inconvenient.

Figure 1 shows the new Turromatic, in which the first and second objections are answered at once by the use of step-type idler wheels mounted on a rotatable plate, or turret, as shown graphically in *Fig.* 2. Since speed reduction from motor to turntable is made in two steps, the driving pulley of the motor can be made larger (in this case, nearly ½-inch in diameter) and at the same time the belt-driving pulleys range from 0.74 in. (33 rpm) to 1.25 in. diameter (78 rpm). Belt wrap is still over a large enough angle so that there is for all practical purposes no slip at all, and acceleration of the table is such that full speed is reached in less than one revolution at any operating speed.

Perhaps the most interesting part of the construction is that related to the speed shift. This is accomplished by mounting the three pulleys in such a way that the desired one can be brought into contact with the motor shaft and, simultaneously, tighten the belt to the proper tension. This requires that the two diameters of the pulleys have a certain ratio (for any given speed) and also that the total belt length remain constant for all speeds, a condition which is slightly tedious to calculate but quite simple to achieve in actual practice. (There is an infinite number of combinations of pulley radii which will give a required speed reduction. From these it is possible to select one which will run with the proper pressure against the motor pulley and also keep a belt of given length running at the proper tension. Small variations which must exist in a practical setup are easily absorbed since the travel of the tension spring is comparatively great.)

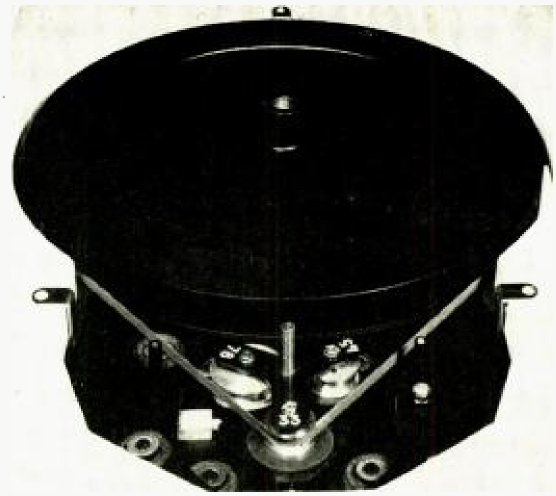


Fig. 3. Removal of platter and dress plate exposes mechanism and shows simplicity of installation.

This construction results in a speed shift which is unusually smooth in operation. As the plate is rotated the tension of the belt changes gradually, and the next idler takes up the tension gradually so that it has time to gain some speed before the belt is in firm contact with it. It therefore makes no difference which way the plate is rotated, nor does it ever come up against a stop pin. The pulleys are always in line and the belt is handled with the greatest gentleness, so speed shifts have no effect on the life of the belt. It also makes possible a simple indicator of operating speed, since the speed can be indexed to the pulley in use and the pulley is visible through a transparent piece of lucite which forms part of the dress plate. The nameplate is on the speed shift knob itself, and there is no need for any particular orientation of the table.

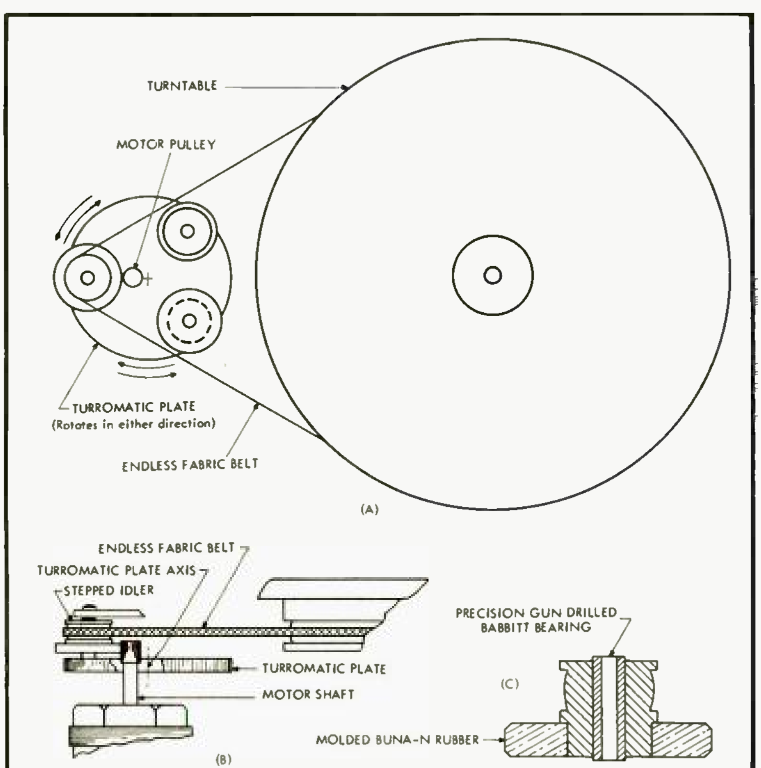


Fig. 2. Basic construction of the Turromatic turntable.

Cost of Advantages

No doubt the skeptic will say that so many advantages could not have been obtained "for free" and he will, as usual, be right. As soon as pucks are introduced into the system they bring along their disadvantages as well as their advantages. One great disadvantage of the usual puck drive has been studiously avoided. In the common assembly of the puck drive, the idler wheel is so positioned that as the load increases the idler is pulled in tighter. While this is helpful in many ways (it obviously reduces slippage since pressure is increased when the load is increased) it also acts as a sort of "wow-multiplier," especially with softly mounted motors. For this reason the pulley, motor shaft, and turntable centers of the Turromatic are all in a straight line (*Figs.* 3 and 4) and there is no "servo effect". The other principal disadvantage of the introduction of pucks is that each additional rotating member will introduce a flutter component, generally at the rate of its own rotation. To avoid this difficulty it was found necessary to use bearings in the pucks of a much better quality than is usual. The bearings are, in fact, of the same material and similar excellence to that of the main bearing itself, which is of poured babbit construction, gunbored and highly polished.

Another important difficulty with puck drives, as is well known, is that when the power is shut off and the motor stops turning, the driving pressure of the motor shaft against the rubber tire is exerted all at one point. When the motor is turning, the tire deforms and recovers as it revolves over the motor shaft, and this does no harm (in fact, it probably helps to keep the rubber in condition). But when the motor stops and time passes, the rubber tends to take a permanent set. Even an hour is enough to make a slightly noticeable thump when the motor is again started, but any extended period causes real trouble. The thump may or may not work out as the motor is run, but if the process is repeated many times the puck becomes quite useless for high-quality performance. This is so serious that only the very cheapest tables make no attempt to overcome it.

The usual solution for this problem is to link the power switch mechanically to the speed selector and to arrange it so that when the speed control is set to OFF the idler is also disengaged. The designers of the Turromatic felt that this solution did not offer adequate protection for a rather expensive piece of equipment since, although the owner himself may appreciate the care it deserves, some other member of his family (or, even worse, some of his guests) may not. In almost every case it is only a matter of time until some one accidentally leaves the motor engaged, with the usual thumps resulting. In addition, it seems very attractive to contemplate the possibility of using the table with a remote switching device, whether for increased simplicity of operation, operation on a time switch, or whatever reason.

In the Turromatic this problem was approached in the straightforward (and, no doubt, the hard) way. A d.c.-operated solenoid was placed in the motor circuit, taking its power from the line by rectification whenever the motor switch is turned on. Normally the motor is not in contact with the idler wheel. When the power is supplied to the motor the solenoid, shown in *Fig.* 5, pulls it into contact with the idler, and it is consequently impossible to damage the puck since the motor cannot exert any pressure against the idler unless it is turning. As a consequence of this construction, the motor switch does not need to be incorporated into the control plate, and a separate switch with long leads is provided so that the owner may mount the switch wherever it seems most convenient. Should he desire to operate the motor remotely he may even, should he wish, leave the motor switch on at all times and not even mount it, since it can be left below the mounting board.

As to the other mechanical aspects of the table, it was found necessary to incorporate two stages of vibration isolation in order to obtain the kind of quiet operation which was desired. The flywheel which is driven by the belt is of cast iron and weighs about 8 lbs. It is so formed, however, that most of its weight is concentrated at its rim, and it is therefore equivalent in inertia to a disk having a weight of 31 lbs. For excellent motion it was found that the best bearing surface was babbitt, which is an old and well-known bearing material. One of its greatest advantages is that it improves with use, but it is also exceedingly smooth and quiet in operation.

Another sidelight which may be of interest concerns the thrust bearing. This is the conventional polished steel ball, but it revolves *with* the main shaft and turns in the seat. Since the seat is of nylon, the rotation of the ball gradually wears a seat which is automatically centered and of the correct size. As the size of the seat increases the area increases, and since the force is constant the pressure decreases. The result is that an equilibrium point is reached beyond which practically no wear takes place, and tests indicate that the life of this thrust bearing is extremely long and that its performance does not deteriorate with age. (If the ball is held still and the steel end of the shaft is allowed to turn on the sphere, a deformation takes place with the result that we have sliding friction of steel against steel, resulting in more rapid wear and increased noise.)

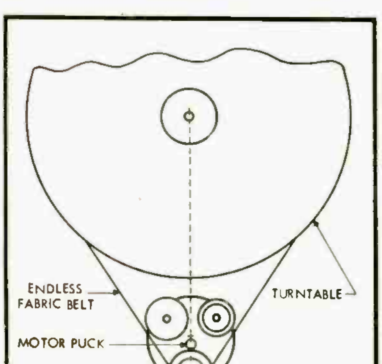


Fig. 4. "Straight-line" drive involves positioning of motor, idler-pulley, and turntable centers all on one line.

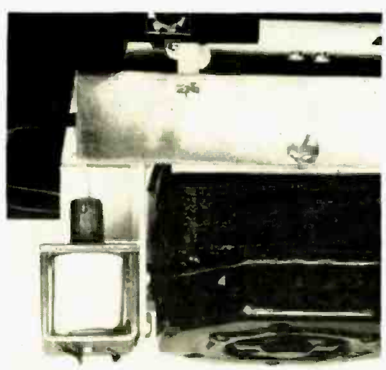


Fig. 5. Small d.c.-operated solenoid engages motor shaft with idler-pulley only when motor is running.

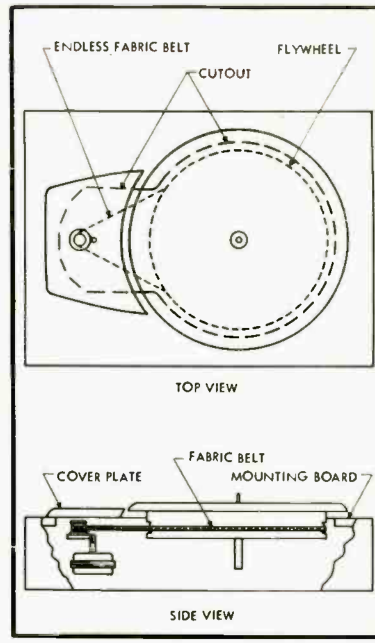


Fig. 6. Plan and side elevation of overall arrangement of turntable.

Finally, the problem of a neat and convenient installation has been approached in what may be a unique way. It is naturally desirable to have the belt and other parts conveniently accessible and it is just as desirable to protect the belt from dirt or any foreign materials. The solution adopted was to make the table in two parts, *Fig.* 6. The "working part" is the cast iron flywheel mentioned previously. The visible part is a polished aluminum turntable which presents a conventional appearance from above, but it is easily removable. This turntable keeps the distance between the iron and any pickup much greater than necessary for complete elimination of practical interaction, and at the same time serves as a handsome dress cover for the round part of the opening cut in the mounting board. The rest of the opening (for the motor and turret assemblies) is covered by another dress plate, as may be seen in the figure. The problem of proper centering of the record is not affected by this construction since the record spindle is part of the main bearing and not of the removable piece. The spindle, incidentally, contains a spring-loaded ball detent so that it may be easily raised or lowered even while rotating. Raising the spindle places a center for 45 rpm records in position.

As any one knows who has ever tried to mount a turntable, exact placement of the template is often a matter of guesswork. Also, it is quite easy for many of us to saw a little too far beyond the pencil line and if this happens, a good piece of furniture is often spoiled. Both

(*Continued on page 60*)

Electronic Organ in Kit Form For Home Construction

RICHARD H. DORF*

Description of the filters which create the pipelike tone qualities and the new type of phase-shift vibrato in the Schober Organ Kits.

In three parts — Part 3

As explained in last month's article, each of the nineteen stop filters in the Schober Organ is fed tone of the correct pitch register or registers by one or two preliminary-amplifier triodes. Several of these filters are presented in detail in *Fig.* 19. Discussing one or two examples will show the scheme of operation.

The pipe organ has normally four types of tones—flute, string, reed, and diapason: there is of course, considerable variety available within each class. All these tone types are reproduced in the Schober.

The Great 8′ Flute is typical of the first class. Here the incoming 8-foot sawtooth is passed through a three-section low-pass filter designed to roll off the upper harmonics so as to give a smooth, round tone which is not quite a sine wave. As with all the filters there is a blocking capacitor at the input to prevent d.c. from the tube plate from passing into the filter and following circuits. There is also a resistor at the output to set the comparative volume level of the stop. Stop switching is done by shorting the filter input (after the blocking capacitor) to ground.

A typical string filter is the Swell 8′ Salicional. String tone is characterized by comparatively little fundamental and large high-harmonic content; it is very "buzzy." In this filter there is little filtering action other than slight differentiation due to the small blocking capacitor, and the sawtooth comes through unchanged except for some flattening of the sweep with consequent transformation of the flybacks into near-spikes.

Reeds are used in pipe organs not only as imitation of orchestral reed instruments but also to simulate brasses. A typical true reed is the Swell 8′ Oboe, with its thin, nasal, penetrating tone. In this filter the input wave is first slightly differentiated by the blocking capacitor and the 47,000-ohm resistor and tuned circuit to ground. Then it is shunted by the tuned circuit which greatly emphasizes a portion of the spectrum in the neighborhood of 1600 cps. All reeds are characterized by a definite formant of this type.

Diapason tone is peculiar to pipe organs and is not imitative of any orchestral instrument. Typical is the Great 8′ Open Diapason which employs both 8- and 4-foot tone to give it a somewhat accentuated second harmonic at all frequencies. The tones are passed through a low-pass circuit which has a fairly high cutoff. In this way the tone retains the vitality of a good organ diapason while retaining the necessary full body imparted by the fundamental.

All the filters work in this same manner to yield synthesized pipe and orchestral tones reasonably close to the originals. All the filter outputs for each manual and the pedals are connected together permanently. Because the stop-switching ground shunt is at the input of each filter, there is no change in the loading on the output bus when additional filters are switched on. For this reason, the tone of each filter retains its integrity and can be picked out separately in an ensemble of several, just as in a pipe organ. They can be used in ensembles of many kinds, and the pitch register systems of the Schober is especially useful here; a solid 8-foot tone can be brightened by a touch of 4-foot tone from a 4-foot filter, a 4-foot ensemble can be given a little more body by an 8-foot filter, and so on *ad infinitum*. The couplers add greatly to this flexibility in making it possible to mix stops from both manuals or add them to the pedals, as well as to add the octave on either or both manuals.

Each of the nineteen filters and six couplers is mounted on a 2×4-inch etched-circuit panel, some of which are shown in *Fig.* 20. While there are too many connections on these panels to allow marking component placement, each connection point is lettered and the instructions contain charts showing which components go into which lettered holes, making construction easy and unmistakable.

All the filters are mounted on the Fil-

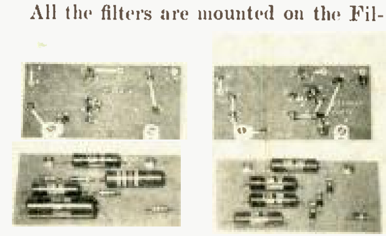


Fig. 20. All stop filters are constructed on uniform-sized printed circuit panels.

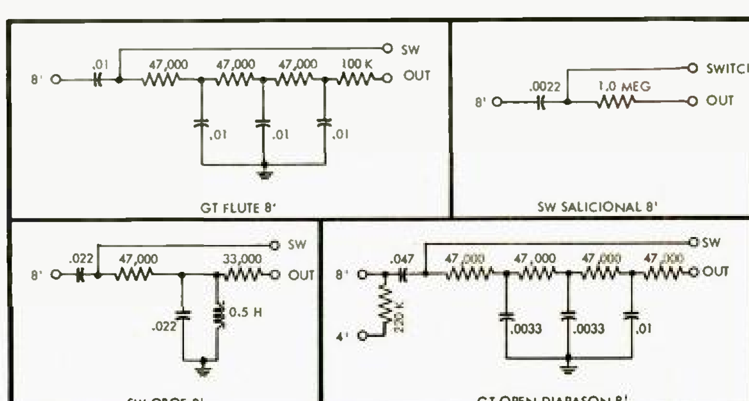


Fig. 19. Schematics of four typical filters used in the organ and described in the text.

* *Electronics Consultant, 255 West 84th St., New York 24, N. Y.*

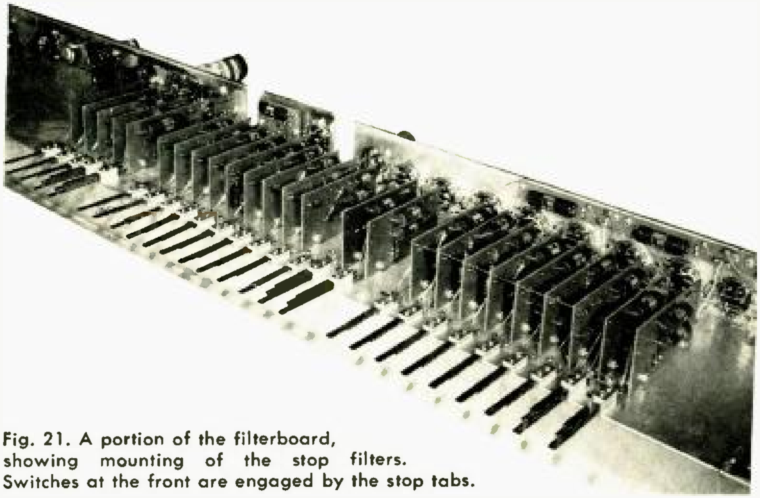


Fig. 21. A portion of the filterboard, showing mounting of the stop filters. Switches at the front are engaged by the stop tabs.

terboard, a long metal channel which runs the length of the organ, as shown in *Fig.* 21. On the front of the filterboard are the stop switches; they are actuated by the toggle-type organ tablets mounted on the wooden nameboard of the console. On the rear edge of the filterboard are mounted the chassis of the preliminary amplifier, woodwind circuit, and preamplifier-vibrato unit. All connections are made by wires "swept under the rug" to eliminate cabling by passing them through holes and running them under the filterboard.

Preamplifier-Vibrato Unit

The Preamplifier-Vibrato Unit is the final electrical assembly through which all signals go before reaching the power amplifier; the unit is diagrammed in *Fig.* 22.

Each set of stop filters—great, swell, and pedal—has a common output bus. These busses are terminated by R_4, R_5, and R_6 and from each bus one of the resistors R_1, R_2, and R_3 goes to the grid of the 6SQ7 first preamplifier tube. These isolating resistors are included to avoid the necessity of commoning all busses, which would increase the loading on the output with reactive components. Although such a common would not cause the switching in of any filter to affect the tones of filters already in use (this is due to the shunt-type stop switching), the output of almost every filter is partly reactive and commoning all of them would slightly complicate the voicing problem.

R_{33} and C_{14} to ground constitute a variable low-pass filter which is adjustable from the stop panel (or *nameboard*, as it is called) to add flexibility by giving control of over-all brilliance. Tone colors are normal with the potentiometer arm in center position.

Two 6SL7's are used in the novel phase-shift vibrato which is unique in the Schober Organ. It is common practice in electronic organs to vary the voltage of some electrode of all the master oscillators for vibrato; this varies the frequency of oscillation (at a rate somewhere between 5 and 8 cps) and produces the familiar and necessary vibrato or "tremulant" effect. It is axiomatic that an oscillator whose frequency can be varied in this manner is inherently not entirely stable, and its center frequency may be prone to vary from time to time so that the instrument does not stay in tune over long periods. While it would be presumptuous to say that all organs using this type of vibrato get out of tune easily, it is possible in a kit instrument to forego certain economies in order to achieve the ultimate in operation. This philosophy was responsible for the 14-tube Preliminary-Amplifier, a unit whose benefits kit constructors can enjoy at small cost but which would be much too expensive for most commercial factory-assembled instruments.

The Schober vibrato system, therefore, does not operate on the tone generators at all. As a result, the master oscillators could be—and have been—so designed that, for instance, a 50-volt plate-supply change has negligible effect on tuning, truly an unusually high degree of stability. The vibrato operates on the tones after they emerge from the 6SQ7 stage in *Fig.* 22 by varying the relative phase of the signal over a wide range at a vibrato rate. Such phase variation is to the ear the equivalent of frequency modulation (which is what vibrato is) just as many FM broadcast transmitters generate FM by phase modulation.

Phase modulation of the necessary type is not such an easy trick and the circuit employed was developed by the writer especially for the purpose. *Figure* 23 shows a phase-shift circuit of the usual type in which the capacitive reactance is equal to or greater than the resistance. If either element is varied the relative phase of the output signal changes. The two faults of this circuit for vibrato use are:

1. Change of phase in this way also causes change of amplitude, and amplitude changes are different at every frequency.

2. The amount of phase shift differs at every frequency, the maximum attainable at the best frequency being somewhat less than 90 deg.

Figure 24 shows a circuit of more practical value, first published for use in phase-angle measurements.[1] The input signal is in push-pull form—two signals of equal amplitude and opposite phase.

[1] Robert C. Moses, "Phase-angle measurements at a.f.," *Radio & TV News*, Radio-Electronic Engineering Section, July 1953.

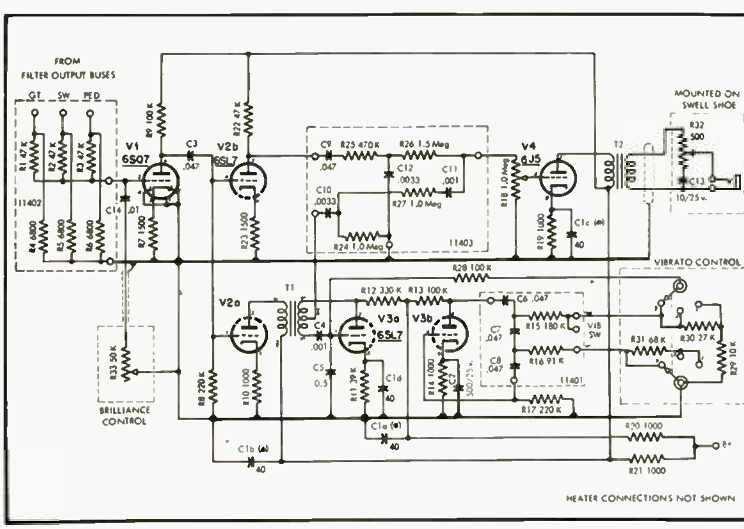


Fig. 22. Schematic of preamplifier-vibrato unit.

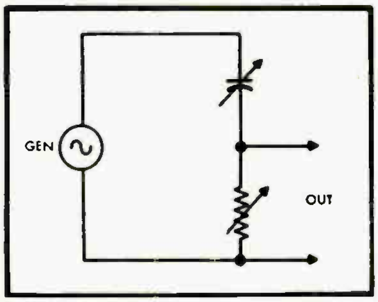


Fig. 23. Basic equivalent circuit of the phase-shifting operation of the preamp-vibrato unit.

With connections as shown, variation of either impedance component will cause changes in relative output phase over a maximum possible angle of about 175 deg. While the phases of outputs of different frequencies with respect to either half of the input signal are different, varying a component shifts the phase of a signal of any frequency within a wide band over a considerable range with respect to its resting phase.

The action of the circuit can be seen superficially with the aid of the theory of extremes. If the resistor value is reduced to zero, the output is directly across *GEN 2,* and it has the phase of that half of the input. If the capacitor is at zero reactance, the output has the phase of *GEN 1.* It follows that at intermediate values of resistance and reactance the phase of the output is somewhere between these two 180-deg. extremes. The crowning—and a most important—point is signal output amplitude does not change during phase shift, nor is the input-to-output path frequency discriminating under any conditions.

To translate this to an actual vibrato circuit several things are necessary. It is obvious that either output lead could be grounded in *Fig.* 24; that shown is deliberately chosen for our purpose. The input signal must be translated from single-ended (as it emerges from the 6SQ7) to push-pull; this is easily done by feeding it through V_{2A} to T_1, which has a centertapped secondary. Next, either the resistance or capacitance must be replaced by an element with the same characteristics but which can be varied electronically. The solution to this is to replace the resistor with the plate resistance of a tube—V_{3A} in *Fig.* 22. With the grid of V_{3A} driven by signals from the phase-shift oscillator V_{3B}, which operates at a vibrato frequency of around 6 cps, the plate resistance of V_{3A} varies at a vibrato rate and the signal output between the transformer centertap and ground is phase-modulated. The capacitance of *Fig.* 24 is the series value of C_4 and C_5.

Some further refinements are necessary. First, the vibrato rate and amplitude are made variable and controlled by S_1 on the organ nameboard. This is simply a matter of controlling the frequency of the oscillator and the signal input to the grid of V_{3A}. Both are done simultaneously by the switch, so that in the first position vibrato is slow and narrow, in the second position slow and wide, and in the third position fast and wide. Position 2 is used normally; position 1 gives an unobtrusive vibrato suitable for serious music, while position 3 is used for some popular music or where a rather ethereal and novel effect is desired.

Because it is not convenient for the player to use a three-position switch for control of vibrato in the middle of a selection, on-off control of vibrato is assigned to a tab similar to those used for stops and marked in red. With this tab in the up position, the connection marked VIB SW in Fig. 22 is grounded and the vibrato oscillator stops. When the tab is flicked down, the ground is removed and the vibrato begins quickly but smoothly due to the finite time required for oscillation to build up.

One problem with this system is that if used without further modification the vibrato-frequency signal applied to the grid of V_{3A} will come through to the output as a series of thumps. This is easily cured, however, and the cure solves another requirement—that for good musicality the bass tones should have much less vibrato than others. Output from the transformer centertap passes through a high-pass filter C_{10}-R_{24}-R_{27}-C_{11} on its way to the final preamplifier stage V_4; this reduces the thumps to inaudibility and also greatly reduces the level of bass tone from the vibrato circuit. The missing bass, unvibrated, is then supplied to the final tube by V_{2B} through the low-pass filter R_{25}-C_{12}-R_{26} in its output circuit. The two networks are complementary, so that the final tube receives all input frequencies in correct proportion but with bass obtained mostly from V_{2B} and therefore low in vibrato.

Although the vibrato circuit in the Schober Kit is furnished as shown in *Fig.* 22, it is obvious that enterprising individuals could use separate vibratos for the two manuals to achieve additional musical flexibility as well as a chorus effect.

R_{18} is a potentiometer with a short or screwdriver shaft located on the Preamplifier-Vibrato Unit chassis. It is preset at the time of installation to limit the maximum output volume to that desirable in the room, so that the expression pedal can be used fully. V_4 is an ordinary transformer-output voltage amplifier which furnishes a maximum of 2 volts in 600 ohms to the high-quality carbon potentiometer R_{32} which is mechanically coupled to the expression pedal or swell shoe. C_{13} adds additional impedance at low frequencies so that when the volume is made low the overall tonal balance between bass and treble does not alter appreciably—a sort of loudness control.

Output taken from J_1 is fed by a cable to any power amplifier the constructor wishes to use: none is furnished in kit form. Any of the good modern "high-fidelity" amplifiers is satisfactory, though it is recommended that the amplifier be rated at a minimum of 20 watts to take care of the high-level 30-cps tone of the pedal division. Common practice in homes is to use the same amplifier employed for the home music system, with the organ line coming up on the same switch in the regular control unit which selects phonograph and tuner.

The same loudspeaker as in the home music system is usually used, but it must be a good one, particularly from the bass standpoint. Tweeters are not really necessary, though they add some brilliance, the important point being one—and preferably more than one—good bass speaker in a solid enclosure and able to withstand large cone excursions.

A few years ago, most people would have laughed at the idea of constructing a full-scale concert electronic organ at home. The Schober Organ Kits are evidence that the phenomenal advance of electronics has not stopped at the fine reproduction of sound typified by the modern high-fidelity era, but has gone on to make possible the synthesis of traditional music by electronics entirely practical and artistically satisfactory.

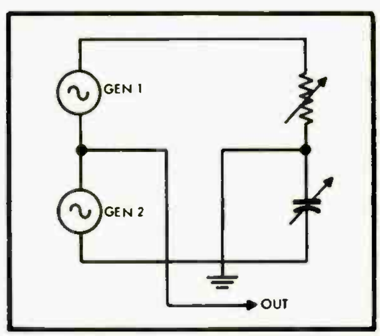


Fig. 24. Simplified circuit of the phase-changer which introduces an effect resulting in vibrato. GEN 1 and GEN 2 are actually the same tone, but with a 180-deg. phase difference.

Noisy Volume Control

Q. How should I clean a noisy volume control? Ira May, Baltimore.

A. First, remove the knob. With an eye-dropper, apply a drop of "No-Noise" or carbon tetrachloride to the point where the shaft enters the main body of the control. Next, rapidly rotate the shaft to allow the cleaner to flow into the control and to be deposited over the entire surface of the element. "No-Noise" is probably the better choice as it deposits a protective film on the element which helps keep the control free of noise for a greater period of time than would carbon tetrachloride.

Noisy switches can be cleaned by applying either of these cleaners directly to the contacts. This will probably require taking the amplifier or whatever out of the housing in which it is enclosed in order to reach the switch.

that the receiver is. Because of this use of tuned circuits the possibility of image interference is drastically reduced. The Q of such circuits makes such a booster a more efficient amplifier. These two basic types are used with various vacuum tube circuits.

Preamplifier Requirements

Q. What are the qualities of a good preamplifier? H. V. Cioni, Yonkers.

A. "Preamplifier" now is actually a misnomer, since what was originally intended only to amplify weak voltages from phonograph cartridges is now used to select the input source (e.g., tape recorder, radio tuner, television tuner, phonograph), accomplish tone compensation for treble and bass, and control volume and/or loudness in addition to its original function.

Input Selection: The number of inputs required will depend on the number and kind of sources the owner intends to use. They are selected by the rotation of a single switch on the front panel. A high-gain input requiring between 0.001 and 0.01 volt to drive the preamplifier to full output is required for a microphone and also for a magnetic phonograph cartridge. The same tube is generally used for both. Its circuitry is such, however, that when the microphone is switched in, this stage operates as a flat amplifier; as a phonograph input is switched in, selective feedback circuits are switched in at the same time which accomplish the base boost and treble rolloff. These controls should have separate knobs to allow greater flexibility. If only records made after 1953 are to be played, this will be unnecessary as the RIAA curve will probably suffice. The remaining inputs generally required are of the low-gain type requiring between 0.25 and 1.0 volt to drive the preamplifier to full output. They are fed by such things as tape recorder, wire recorder, radio tuner, television tuner, and crystal cartridge. In a high-quality preamplifier the circuit is so arranged that all inputs not in use are grounded to prevent unwanted transfer of signal from the sources feeding them to the preamplifier.

Tone Compensation: In order to correct for room acoustics, variations in loudspeakers and enclosures, program sources, individual preferences of listeners and so forth, bass boost and droop and treble boost and droop must be provided. These controls should appear as separate knobs on the front panel of the preamplifier. 15 db each of treble boost and droop measured at 10,000 cps and 15 db each of bass boost and droop measured at 30 cps should give adequate compensation.

Volume and Loudness: At a sound level which is comfortable for average home listening, the sensitivity of the ear to low frequencies is somewhat diminished and high frequencies are lost due to masking. Therefore, only the center section of the audio range will be heard. To overcome this characteristic of hearing, the loudness control boosts treble and bass automatically as the sound level is lowered. In some instances, such as when the preamplifier is feeding a recorder, it is necessary to have a switch which will convert this loudness control to a standard volume control.

Outputs: To prevent undue attenuation of high frequencies, especially when the preamplifier is located some distance from the power amplifier, it should have a cathode-follower output.

Single-Note Bass

Q. What is meant by single note bass? Nicholas Guida, Great Neck, N. Y.

A. This is a condition wherein one bass note is heard or found by measurement to stand out above all other low-frequency notes. When this trouble is present to an extreme degree, this one bass note will be loud and boomy and yet all low tones above and below it will be practically inaudible. The effect is that of listening to an amplifier with highs, a mid-range, and one bass note. This is caused by speaker resonance, enclosure resonance, electrical peak response or any combination of the three occurring at the frequency of this one note.

AUDIOCLINIC ? ?

JOSEPH GIOVANELLI*

Wow and Flutter

Q. What is the difference between wow and flutter? Bob Bloom, Cheyenne.

A. Wow is a slow variation in pitch caused by similar variations in turntable speed. Either the recording or play-back turntable may be at fault. Flutter is a rapid variation in pitch caused by variations in turntable speed or capstan speed of tape recorders or tape phonographs.

Loudspeaker Requirements

Q. What are the characteristics of a well-designed loudspeaker? Martin Ames, Tulsa.

A. Hold the speaker to your ear and lightly tap the cone with a finger. A dull thud indicates a good speaker; a poorer speaker will ring or bong. A good speaker will have a rigid frame, a large magnet, a flexible and suitably-damped edge suspension or surround, and low cone resonance. A good general purpose speaker will have a paper matte type cone hardened near the center for good high-frequency response.

FM Booster

Q. What is an FM booster? R. T. Green, N. Y.

A. An FM booster amplifies the weak radio-frequency signals before they enter the antenna terminals of the receiver. In areas where signals are strong, boosters are not needed. They are used in fringe areas where reception without a booster causes the receiver to operate below the limiter's threshold, leading to unwanted noise interference. The booster builds signals up to a level which will allow the limiter to operate. There are two types of boosters: one, called a broadband booster, has no tuned circuits and so amplifies all signals, improving the receiver's performance but at the same time tending to increase the response to unwanted images; the other type of booster employs tuned circuits and therefore must be tuned at the same time

* *3420 Newkirk Ave., Brooklyn 3, N. Y.*

Extending Record Life

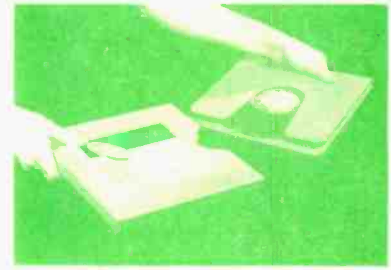
Q. What is the best way to extend the life of my record collection? Harry Hahn, White Plains, N. Y.

A. (1) It is likely that records will be played very often when they are very new and later be played only occasionally. That being the case, if the collector has a tape recorder available, it would be helpful to record them on tape and play the tape instead of the discs until such time as the new records would be played less frequently. After that, the records themselves would be played, leaving the tape free to be used for some other new discs. (2) It is necessary to use needles which are in good condition. A needle which is worn should never be used. A sapphire is good for not more than thirty hours; a diamond is capable of perhaps a thousand hours. These times may vary somewhat, depending on the force of the pickup tone arm, the condition of the record surfaces, accidental dropping of the needle and other factors. (3) Needles designed for standard grooves should never be used to play microgroove recordings. It is obvious that the reverse is equally true. Also to be avoided is the use of the so-called "compromise needle" which is just that. It is too small for standard-groove recordings and yet too large for microgroove discs. (4) It is important that dust and other foreign particles be prevented from collecting on record surfaces. This can be accomplished by placing each disc in a plastic bag. Before being stored in the record album, the edges of the bag should be folded to cover the disc as completely as possible. If dust should collect, it must be removed before the record is played. This can be done by using a damp, lint-free cloth. (5) Stylus force should be as small as possible, consistent with good performance. A force which is too light for the arm and cartridge combination will cause distortion in the reproduction as well as add to the damage done to the records. (6) When selecting high-fidelity equipment, it is advisable that an arm with the least amount of tracking error and a cartridge which can operate with the least possible amount of tracking force be chosen. All swivels and pivots on the arm should be able to move freely to prevent needless strain on the bottom and side walls of the grooves. (7) All dust should be removed from the needle, turntable, and other parts of the phonograph in order to prevent it from being deposited on the surfaces of the discs.

Tape Recorders, Tape, and Equipment

C. G. McProud

A brief discussion of magnetic tape recorders and the principles under which they operate, together with a description of some of the features of currently available machines and the tape and accessory equipment that is used with them.



Magnetic tape recording is relatively new on the audio scene, having been introduced in the United States for general use only nine years ago. And while the first machines were fabulously expensive professional machines, models are now available for less than a hundred dollars. Their many advantages have brought the fun of recording right into the home, in addition to making it possible to produce phonograph records more economically and better than ever before. Beyond the audio field, tape is performing yeoman service in computing machines, and we may soon expect to see television pictures that are the result of a stored electrical signal—a method that will displace photography in the TV station to a large extent. Our interest in the tape recorder is limited strictly to its applications in audio, but even those are myriad.

To the non-professional, tape recording offers many advantages—to the professional it undoubtedly offers many more. But while the engineer can become proficient in recording on acetate discs, it is not a process that lends itself to the inexperienced user with any degree of success. On the other hand, even a child can learn to operate the modern tape recorder with consistently satisfactory results which, while undoubtedly not saleable material for wide distribution as LP records, will gladden the hearts and ears of his parents. In addition to the ease with which good results can be obtained, there is practically no cost involved, since the tape can be used over and over again until it wears out physically. Yet when some important material is recorded, it may be stored and played back at will years later, if desired.

The machines themselves are no longer prohibitively expensive, being in the general vicinity of a good television set. Yet the average medium-priced tape recorder will produce tapes which are far superior to many phonograph records of, say, fifteen years ago, with respect to frequency response, distortion, and noise. Since there is no mechanical contact in the playback process as there is with the disc record, noise is largely dependent on the design of the amplifier and the quality of the tape. Furthermore, tape is the most easily adapted medium for stereo recording, since the two tracks that are required are always maintained in the same physical relation—a necessity for satisfactory stereo performance.

Tape Recorder Requirements

For satisfactory performance, a tape recorder should have a minimum of wow and flutter, with the percentage figure being less than 0.5 per cent—a value that is about the maximum listed in the specifications for any machine. For professional use, the figure should be 0.25 per cent or lower. Frequency response should be as wide as the state of the art permits, which means that a range of 50 to 15,000 should be possible at a speed of 7½ inches per second. Distortion should be as low as practicable. Hum and noise should be at least 40 db below the tape overload point, which is usually stated as the point at which distortion is 3 per cent. Because of the proximity of transformers and a.c. motors to the playback head, which by its very nature is sensitive to changes in magnetic fields, hum is likely to become a problem with the lower-priced recorders. Absolute speed should be constant, and should be less than 0.5 per cent off from the correct value.

How It Works

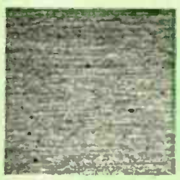
For a short but effective description of the principles of tape recording, we can think of no better condensation than that which appears in the maintenance manual for the Ampex 600 and 612—the former a small portable recorder which is rapidly gaining favor as a high-quality home machine, although it differs from most in many features. We are indebted to Ampex for permission to reproduce the following material which follows.

THE TOOLS OF TAPE RECORDING

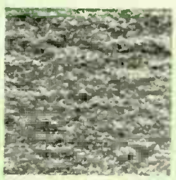
At right, from top to bottom: A Presto R-11 recorder, suitable for professional use, but equally satisfactory for the hobbyist whose budget will permit; a more conventional "home" model, the Bell RT-88; Audiotape in 2500-foot rolls suitable for use on the machines which will handle the large reels, but for the smaller models, smaller reels are readily available; an inexpensive splicer, the "Gibson Girl" which makes editing easier; "Scotch" brand leaders provide means for identifying reels of recorded tape; to erase a whole reel at one time, one can use a bulk eraser, such as this one from Amplifier Corporation of America; and finally, tape reels can be stored safely in 8-mm film cans, kept in order in Brumberger storage chests.

It Won't Come Off!

These actual unretouched photomicrographs (50X) of FERRO-SHEEN *and ordinary tape, taken under identical lighting conditions, emphasize surface irregularities of both tapes. See how irregular the eggshell surface of the ordinary tape appears in comparison with that of* FERRO-SHEEN. *See how much smaller are the shadows and highlights of the* FERRO-SHEEN *process tape, indicating a greater uniformity of oxide coating and a smoother surface.*



FERRO-SHEEN PROCESS TAPE



CONVENTIONAL TAPE

ALL RECORDING TAPE is coated with magnetic oxide. On ordinary tapes this coating rubs off in use and forms a harmful deposit of abrasive dust on the recording head. Unless the head is constantly cleaned, the collection of abrasive dust eventually wears it out. A further disadvantage of oxide-shedding, common to all ordinary tapes, is that after a few playings, the tape loses enough coating to alter its original frequency response characteristic.

Make Your Own Test In Twenty Seconds!

Send for free Comparator Card, which has strips of all the leading tapes mounted side by side for your own visual comparison. You will **SEE** the difference at a glance! The difference you will see is responsible for the improvement you will **HEAR** . . . *the mirror-smooth surface of the* ***FERRO-SHEEN*** *tape results in vastly improved contact between recording head and tape and gives you optimum magnetic performance . . . all the highs, all the lows.*

WITH TAPE MADE BY THE EXCLUSIVE

irish

FERRO-SHEEN PROCESS

The Oxide Will Not Rub Off!

The **irish *FERRO-SHEEN*** process of tape manufacture anchors the oxide coating to the base permanently, inseparably and much more smoothly. The obvious advantage of the homogeneous bond is that *the entire vicious cycle of shedding and abrasion of recording head and tape is eliminated, resulting in longer life for the tape, longer life for the head and flat frequency response over a wider range.*

***FERRO-SHEEN* IS NOW AVAILABLE IN THESE THREE QUALITY irish TAPES:**

SHAMROCK #300: The ultimate in premium, professional tape for broadcast and studio use. 1.5 mil plastic base. Comes with 5' Mylar leader in dust-proof polyethylene bag.
1200 feet on standard 7" reel.

LONG-PLAY #600: Extends playing time 50% over conventional tapes on same size reel. Same premium qualities as Shamrock #300, but on Dupont's 1 mil new miracle film Mylar.
1800 feet on standard 7" reel.

DOUBLE-PLAY: Doubles your playing time with 2400 feet on standard 7" reel. For all applications requiring uninterrupted operations. Dupont Mylar base.
2400 feet on standard 7" reel.

If not available at your local dealer, write:

ORRADIO INDUSTRIES, INC., Opelika, Alabama

World's Largest Exclusive Magnetic Tape Manufacturer

EXPORT DIVISION: Morhan Exporting Corp., N. Y. C.
IN CANADA: Atlas RADIO CORP., Ltd., Toronto, Ontario

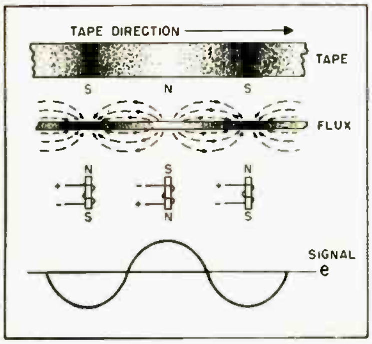


Fig. 1. Tape magnetization.

Principles of Magnetic Recording

If a material capable of being magnetized is placed in the proximity of a magnetic field, the molecules of the material will be oriented according to the direction of the field. Any of several methods may be used to produce the magnetic field, but of most interest in magnetic recording is the field produced by a current flowing through a coil of wire. The current itself may be derived from a transducer. Such a transducer is a microphone which converts the mechanical energy of sound to electric current.

Magnetic recording tape consists of finely divided iron-oxide particles deposited upon a plastic backing. During the recording process, this tape is moved through a magnetic field in which the magnetizing force is alternating and the iron oxide particles are aligned according to the instantaneous direction and magnitude of the field. (See *Fig.* 1.)

The magnetic field is produced in the gap of a recording head, over which the recording tape passes. The recording head is essentially an electromagnet. It consists of an incomplete ring of highly permeable material inserted in a coil of wire. The discontinuity in the ring forms the gap and the ring itself is the core of the electromagnet.[1] The recording head and its gap thus constitute a series magnetic circuit.

Consider the equation $H = B\mu$, where H is the magnetizing force (proportional to the current through the coil), B is the magnetic flux density (or flux per unit cross sectional area), and μ is the permeability of the material. In a series magnetic circuit the flux is the same in all parts of the circuit, just as the current is the same in all parts of a series electrical circuit. When the cross sectional area is constant throughout the circuit, B is also constant throughout the circuit. Then it can seen from the above equation that in the case of a core material such as iron with a μ of 50,000 and an air gap with a μ of 1, the magnetizing force across the gap will be 50,000 times that in the iron core.

The magnetization curve of the iron oxide used as the recording medium is similar to that shown as the heavy line in *Fig.* 3. At points near the origin, the curve is extremely non-linear and the signal recorded on the tape would not be directly proportional to the signal applied to the head. This would result in a high degree of distortion upon reproduction. This distortion is greatly reduced by the application of a high-frequency constant-amplitude bias signal which is mixed with the signal being recorded. The bias frequency is generally selected to equal five times the upper frequency limit of the recorder to prevent beating between the bias frequency and harmonics of the recorded signal.

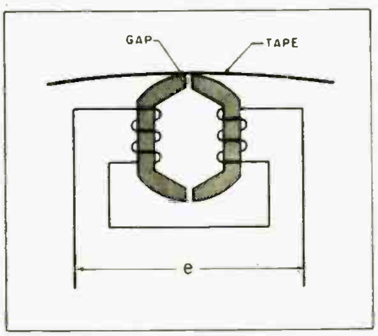


Fig. 2. Recording head diagram.

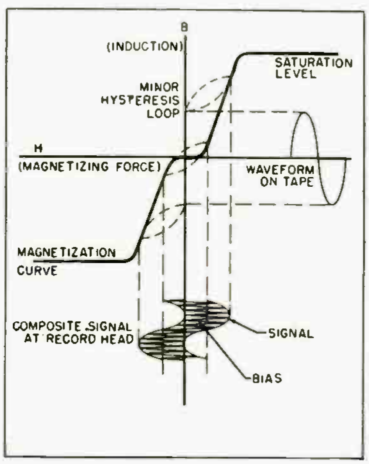


Fig. 3. Recording medium magnetization curve.

While the tape is in the recording gap, the bias causes the magnetization characteristics of the iron oxide to follow the dashed-line loops in *Fig.* 3, known as the *minor hysteresis loops*. As the tape leaves the gap, the influence of the magnetic field created by the bias is reduced to zero and the tape assumes a permanent state of magnetization, known as *remanent induction*, determined by the gap flux at the time the tape leaves the gap and represented by points on the B axis.

After the recording process, there exists on the tape a flux pattern which is proportional in magnitude and direction to the signal recorded on it. If the tape is then moved past the gap of a reproduce (playback) head which is similar in construction to the record head, the magnetic flux of the moving tape will induce a voltage in the coil of the reproduce head. This induced voltage is proportional to the number of turns of wire on the head and the rate of change of flux. This is expressed by the equation $E = N(d\phi/dt)$ where E is the induced voltage (in electromagnetic units), N is the number of turns of wire, and $d\phi/dt$ is the time rate of change of flux.

It is desirable that the gap in the reproduce head be as small as possible so that the gap will intercept less than one wave length of the signal on the tape at the highest frequency to be reproduced. However, as the gap is made smaller, the induced voltage decreases, so there is a practical limit to how small the gap may be made and still maintain an adequate signal-to-noise ratio.

The voltage induced across the reproduce head during playback is computed by the equation $E = B_m v \sin \pi w/\lambda$, where E is the induced voltage, B_m is the maximum flux density of the recording material, v is the velocity of the tape across the gap, w is the gap width, and λ is the wavelength of the signal on the tape. From this expression it can be seen that the voltage across the coil increases directly as the velocity increases and as the wavelength decreases (frequency increases). If the tape velocity and gap width are assumed to be constant, the output voltage from the head is directly proportional to the frequency as long as the wavelength on the tape is large compared to the gap width. This results in an output *vs.* frequency characteristic such as shown in curve A of *Fig.* 4. The voltage does not continue to rise indefin-

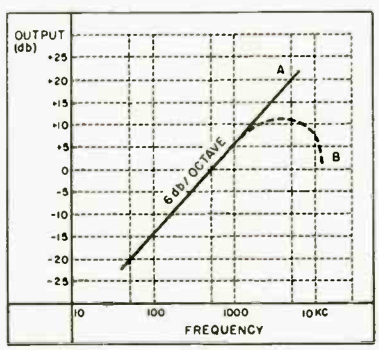


Fig. 4. Playback head characteristics.

[1] Figure 2 shows a typical recording or playback head. Instead of a single gap, however, practically all heads are constructed with two gaps, as shown, to simplify manufacture.

itely, however. As electrical losses in the core material increase and as the wavelength on the tape approaches the same dimensions as the reproduce head gap, the actual output resembles curve B.

In order to provide an over-all frequency response that is flat (see *Fig.* 5), an equalization circuit consisting of a series resistance and capacitance is inserted in one of the early stages of the playback amplifier. This equalizer has a high-frequency droop characteristic (curve B, *Fig.* 5) which is the inverse of the reproduce head characteristic curve (curve A). In order to extend the high-frequency response, additional equalization is included in the record amplifier in the form of a high-frequency boost circuit designed to compensate for the droop in record and playback head characteristics caused by core losses.

Stereophonic Sound

Every person with normal hearing has the faculty for estimating with considerable accuracy the direction from which a sound comes. The sound waves which strike our ears differ slightly in intensity and phase and, from the time we are first capable of understanding direction, these differences are associated with the location of the source. The intensity of a sound is a measure of its energy and, since this energy is dissipated in traveling through a medium, the intensity will lessen as the distance between the sound source and the observer increases. Moreover, since sound is a cyclic variation of air pressure which repeats itself after traveling a distance of one wave length, any two points which differ in distance from the source by any length except an exact integral factor of one wave length will receive the sound at different points in its cycle. This time delay introduces a difference known as *phase difference* and serves along with relative intensity to fix the source of a sound in the listener's mind.

This sense of audio perspective may be represented graphically by *Fig.* 6. Here the sound waves radiate outward from a point source of origin toward an observer. Each individual wave will strike

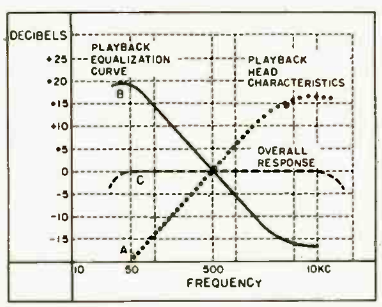


Fig. 5. Flattening effect of playback amplifier.

the observer's left ear after traveling a distance of d_1 and after completing three cycles. The same wave will strike the observer's right ear after traveling a distance of d_2 and after completing three and a half cycles. Therefore, for this particular wave, not only will the intensity of the sound be lower at the right ear than at the left, but there will be a difference of half a wave length (or 180 deg.) in phase. Thus each ear hears the same sound in a different manner and years of past experience have conditioned the observer's brain to interpret this difference in terms of direction. This faculty is known as the *binaural* sense.

Consider now the case of a point source of sound recorded in the conventional manner using one microphone. Here the sound waves impinge on the diaphragm of the instrument and generate an electric current which varies in the same manner as the sound waves. In

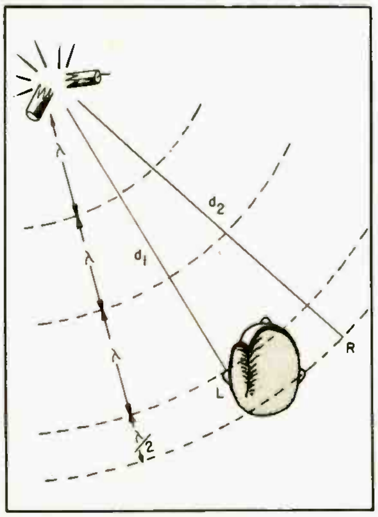


Fig. 6. Intensity difference and phase difference.

this case, however, the microphone will pick up only a sound with a given intensity which is a function of the original intensity of the source and its distance from the microphone. The microphone is "hearing" with one ear and since "difference" is meaningful only in comparing one quantity with another, both intensity difference and phase difference, the two factors which account for direction, do not exist. Even when the source is not a point source but a combination of a number of sources spread out in various directions in front of the recording microphone, the various intensities and phase angles of all the sounds are still being picked up by only one instrument. Since this instrument is completely lacking in any binaural sense, the intensity of each individual sound is merely recorded in inverse proportion to its distance from the microphone and

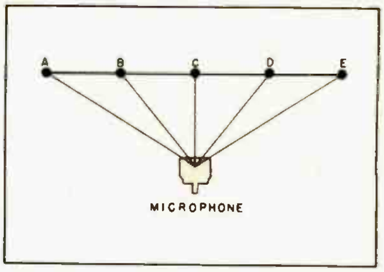


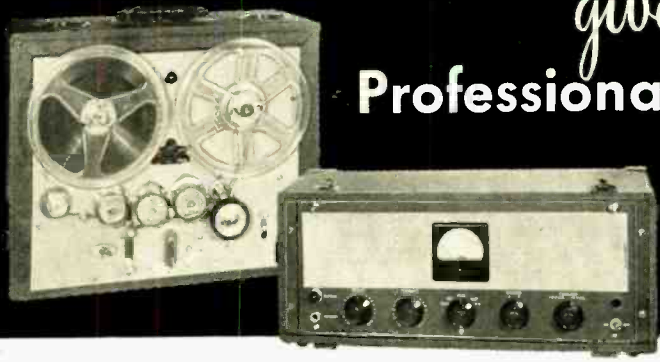
Fig. 7. Moving sound source recorded with one microphone.

phase differences for each individual sound completely disappear. The effect of the single point source described above is compounded but unimproved. In either case, when reproduced through a loudspeaker, the system can convey only what the microphone has "heard". The binaural sense of the listener comes into play only when he listens to the output of the speaker and then it only serves to locate for him the position of the speaker.

Now let us take the case of a moving source of sound recorded conventionally. *Figure* 7 represents graphically the relative intensities of a point source of sound moving from left to right in front of a recording microphone. As the distance between source and microphone decreases, the intensity at the microphone increases. Thus, at point A, the sound has a certain level of intensity. At B the intensity is greater, and at C the intensity is greatest. At D the intensity has decreased to the same level as at B and at E it has decreased to the same level as at A. The microphone has picked up a sound which has risen from a certain level to a maximum level and then descended to its original level. But, from the point of view of a person listening to the reproduced recording, has the sound source crossed the microphone from left to right or from right to left? Or has it approached from a head-on direction, stopped, and then receded along the same line? In each of these cases, the microphone would pick up the same sequence of relative sound intensities. As far as the microphone is concerned, the lateral component of direction is missing. We know by listening to the output from a loudspeaker that the sound has approached us and then receded from us. We have no way of knowing from what direction simply because the microphone has no way of knowing. The result is conventional sound reproduction with no effect of audio perspective whatever.

When once the limitations of single-microphone recording are grasped a natural impulse is to ask why stereophonic sound cannot be produced simply by using more than one microphone. The reason why this will not work can be

Only the PRESTO SR-27 Tape Recorder *gives such* Professional Performance *at such a popular price!*



The top performance features of the finest PRESTO units are yours in this 2-unit combination—R-27 tape recorder and A-920B amplifier. *Check the features of the recording unit:* 3-motor drive; separated record, erase and playback heads; fast forward and rewind. There's no take-up reel clutch or idler pulley. *Compare the features of the companion amplifier:* 10 watt output at 16 ohms, self-contained power supply, separate preamps and VU meter and *two* playback speakers. You can monitor the tape during recording. This professional performer is yours for just $588 complete.

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. . . finest low-priced professional turntable has world-famous flick shift—one sideway flick selects any speed.

There is no finer, smoother-running or easier-to-operate instrument for control room, studio or hi-fi system than the *Pirouette* T-18—the PRESTO achievement that sets a new high in turntable design. You select any speed—33⅓, 45 or 78 rpm—with a sideway flick of the exclusive PRESTO 3-speed shift. You engage the proper idler for the speed you want with one motion. There are no bothersome arms or shift cams. And check the extras you get: extra heavy-weight wide-beveled table, deep-well bearing, sleek styling in telephone black and brushed chrome. $53.50. With hysteresis motor, $108.

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K-11 is the smart new disc recorder you can fit into your sound system — or use as an on-location recorder. It's featherweight with a completely new pick-up arm, fully encased hi-fi speaker, smart new panel design with push button controls and the dependable PRESTO cutting head. You get excellent broadcast-quality fidelity. For those times when a disc recorder is preferable, the K-11 is your best bet. Cuts discs up to 13¼ inches in diameter. Three-speed operation.

**with hysteresis motor*

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WORLD'S FOREMOST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

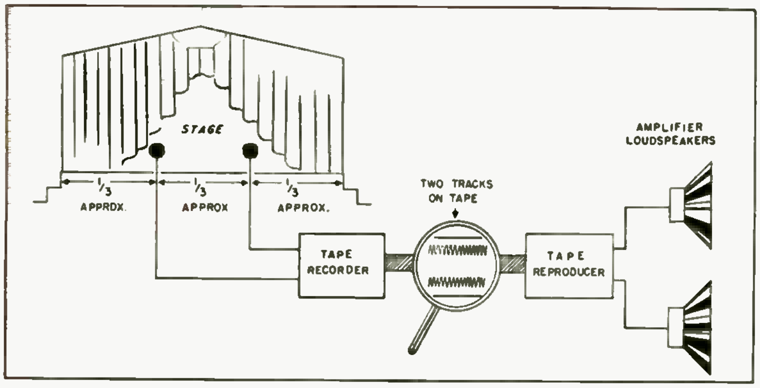

Fig. 8. Two-channel stereophonic system.

seen after a little study. It is true that if two different recording microphones were used, relative sound intensities and phase differences would be picked up. Each microphone would "hear" the same sound in a slightly different manner. But when these sounds are mixed in a one-channel system and fed to one output, the stereophonic effect is lost. The effect is stereophonic only if it is stereophonic to the listener. In this kind of a system, the listener is hearing only one output, whether this output is connected to come from one speaker or many. It is still the same output coming from different locations. The general effect will be fuller than that of a single-microphone system, but a true stereophonic system requires more than the simple addition of one or more microphones.

Let us now see how true stereophonic sound overcomes the narrow limitations of conventional recording. When sound is recorded stereophonically, two or more recording microphones are used. In two-channel stereophonic recording, two microphones are positioned a distance apart equal to approximately one-third the width of the recording room as shown in *Fig.* 8. With this arrangement, each microphone picks up a point source of sound in a different manner, much the same as the observer's ears in *Fig.* 6. Here, both intensity differences and phase differences are recorded. When the input to each microphone is impressed on a separate channel of magnetic tape, these relationships are preserved side by side on parallel tracks of the tape. If, in reproducing, the output from each channel is fed through a separate amplifier and loudspeaker, we will hear two different versions of the same sound being reproduced from two separate sources. As long as the speakers are spaced in the listening room in the same proportions as the microphones were spaced in the recording room, the acoustic characteristics are essentially recreated and the result is stereophonic sound.

When the total sound recorded is a combination of a number of sources (such as an orchestra), each individual sound source except those centered between the two microphones is picked up differently by each microphone. Thus it is possible when listening to the reproduction of this recording through the two loudspeakers to distinguish the location of each individual sound. When listening to a musical recording it is possible to detect the apparent location of the various instruments in the orchestra.

Now let us consider our moving source of sound recorded and reproduced stereophonically. This situation is represented in *Fig.* 9, L and R being the two recording microphones. Because of the difference in distances between A and the two microphones, when the source is at point A, it is picked up with a certain level of intensity at L and with a lower level of intensity at R. This difference in distance also causes each microphone to pick up the sound at a different point in its cycle; that is, phase difference is introduced. As the sound source moves from left to right, it is thus picked up by each microphone with varying intensities and phase relationships depending on the instantaneous position of the sound source on the line AE. In other words, each microphone "hears" the same sound in a different manner as it moves from left to right. When the impressions of both microphones are fed through a two-channel system to two separate loudspeakers, so arranged that the left loudspeaker reproduces the impressions of the left microphone and the right loudspeaker the impressions of the right microphone, the intensity differences and phase relationships of the actual sound are essentially preserved and reproduced in the listening room. Where the original sound was to the left, the reproduced sound will appear to be from the left. Where the original sound was to the right, the reproduced sound will appear to be from the right. And thus at every point along the path AE, the apparent direction of the reproduced sound matches the direction of the original sound. To the listener, there remains no question as to whether the sound source crossed from left to right or from right to left. He can actually hear the sound moving from left to right. Stereophonic sound has introduced a new dimension to sound reproduction.

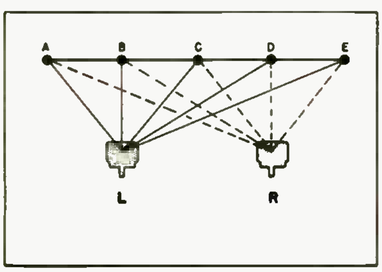

Fig. 9. Moving sound source recorded with two microphones.

Fig. 10. Ampex 612 stereo playback reproducer with matched amplifier-speaker units.

Discs made from "SCOTCH" Magnetic Tape masters earn Capitol's Full Dimensional Sound Seal!

Capitol Record's Full Dimensional Sound Review Committee. Left to right: Bob Myers; Roy Du Nann, Supervising Recording Engineer; Ed Uecke, Chief Electronics Engineer; Bill Miller and Francis Scott of the Capitol Artists and Repertoire Department.

You can thank the critical judgment of the five men pictured above for the wonderful tone and fidelity of the Capitol records you buy. They have the responsibility of listening to *every* Capitol Classical LP master recording before it is released to the public . . . appraising each disc's dynamic range, performance, background noise—in fact, judging it on *eight* critical points. Only the recordings which meet all of this Committee's rigid standards receive Capitol Record's famous gold stamp-of-quality . . . the Full Dimensional Sound Seal.

Capitol Record's Full Dimensional Sound Review Committee is *unique* in the recording field. But the magnetic tape the company uses for its original recordings is the same favored by *all* leading record firms—"SCOTCH" Magnetic Recording Tape. Only "SCOTCH" Brand makes its own magnetic coatings. This means *all* magnetic particles are alive, active—ready to record even the faintest sound with perfect fidelity. No wonder it's the largest-selling magnetic tape *in the world!*

"SCOTCH" Magnetic Tape

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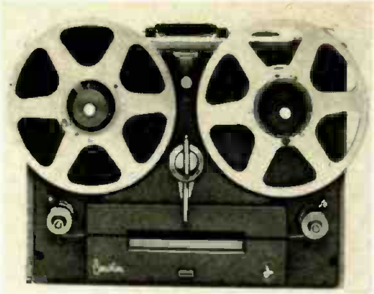


Fig. 11. Concertone 20/20 recorder—a home machine of the professional type.

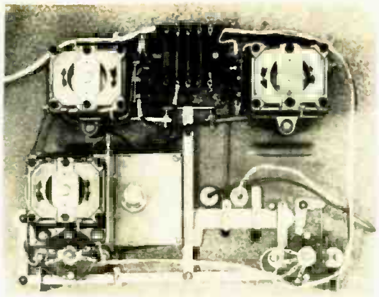


Fig. 12. Fen-Tone Brennell tape deck is kit-type unit for user installation.

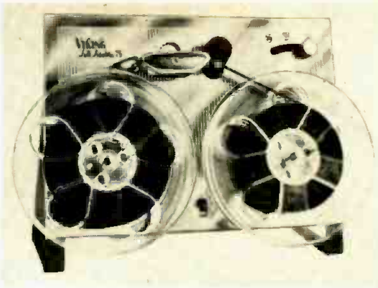


Fig. 13. The Viking "75" tape deck, which is only a playback mechanism.

Recorder Models

Tape recorders come in a variety of housings, from the large professional console type to the pocket models used for specialized applications. Most recorders for home use are built into portable cases, usually with one or more speakers. The serious music lover who envisages no need for recording at a distance from his hi-fi system is likely to be better served with an installation that is essentially permanent—solidly mounted in one of the cabinets housing his equipment. However, most of the portable models have provision for feeding the output of the preamplifier portion of their electronic circuitry to the usual preamp-control unit, and thus to a permanent speaker system. This method gives better quality, in practically every instance, than can be obtained by using the power amplifier in the recorder case to drive the home speaker. Inexpensive speakers mounted in thin plywood boxes can not be expected to provide good quality, as compared to a permanent speaker installation. The one exception to this is the Ampex 620 speaker amplifier, which consists of a heavy-duty 8-inch speaker mounted in a portable case of the same dimensions as the 600 recorder, and an amplifier which is equalized so that the acoustic output from the speaker is essentially flat—for a "flat" input signal—from 65 to 10,000 cps.

Figure 11 shows the Concertone 20/20 model, which is a "home type" machine designed along professional lines—in fact, it is similar in appearance to the Berlant professional recorders. This model can accommodate up to five heads, so that the user can have single-channel dual-track facilities combined with stereo playback and record facilities, for example. One professional application of this machine involves the use of a playback head, which is followed in turn by an erase head, a record head, and another playback head. This permits using the one machine to reproduce a delayed broadcast from the tape, erase the tape and record a program off the network, and monitor it as it is being recorded. With the one machine a radio station can, in effect, have two programs on the same reel of tape. Many other uses would undoubtedly come to mind.

Figure 12 is the underside view of a tape transport mechanism which is supplied by Fenton Company to be used with an external amplifier which can be built by the user, or one is available ready to use. This model uses three motors—one for the capstan, one for take up, and one for rewind. It operates at three speeds, and is sufficiently flexible that the experimenter can adapt it to many specialized requirements.

Figure 13 is the Viking playback chassis, which reduces to its simplest form the elements of a tape recorder when it is in the playback mode. Thus it might be called a "tape phonograph" —and sometimes it is. This model is available as shown, mounted on brackets, or in a carrying case, or simply as a chassis for mounting in a cabinet.

Typical Tape Recorder

Basically all tape recorders have the same elements—a means for holding the supply reel and the take-up reel, with a motor to drive the capstan and to rotate the take-up reel; erase, record, and playback heads (the latter two are often combined), an amplifier, and a bias and erase generator. Speakers may or may not be included in the unit, but volume and tone controls usually are, together with necessary facilities for controlling the entire recorder.

Three speeds are commonly in use—15 inches per second (abbreviated *ips*), 7½ ips, and 3¾ ips. For voice recording, such as in conferences, or for dictating, speeds of 1⅞ and 15/16 ips are generally used, but they are of little value for music recording. The best compromise for general use is 7½ ips, which is fast enough for good-quality recording, yet not so prodigal with tape as the still-higher-quality 15 ips. The lowest of the common three speeds—3¾ ips—has very little musical value, and may be considered as a toy.

Records may employ one, two, or three motors, but because of the high cost of fractional horsepower motors, it is usually less costly to use a system of belts, pulleys, idlers, and flywheels than it is to use another motor or two. Similarly, one, two, or three heads may be used—a combined erase, record, and play model in which the erase and record-play coils are wound on different legs of the same core; or an erase head and a combined record-play model; or three separate heads. In some instances a permanent magnet may be used for erasing the tape prior to passing it over the record head, but it is agreed that the high-frequency erase is more effective on a moving tape than a 60-cps field is. The latter is universally used in bulk erasers, which can completely erase a recorded tape in four or five seconds.

Portable Use

While most tape recorders are in portable cases, they are still tied to a 117-volt a.c. outlet, and thus are not truly portable. Some models are built expressly for outside use, such as for recording on-the-spot news events, interviews, and similar types of program material. *Figure* 14 shows a British EMI model which is of sufficiently good quality to be usable for broadcasting. *Figure* 15 shows another type, by Amplifier Corporation of America, that employs a spring motor for the tape drive, and a battery operated amplifier. Many of these are in use by U.S. broadcasting stations. Another model is the Tapak, made by Broadcast Equipment Specialties Co. Some portable units are equipped with battery-powered electric motors instead of the spring motor, and are perfectly satisfactory for the short term usage generally required of them.

Fig. 14. The EMI broadcast-quality portable recorder.

Fig. 15. Spring driven motor and battery powered amplifier are used in this Amplifier Corporation of America portable.

Tapes

It may seem superfluous to attempt a discussion of tape, for the average person is of the opinion that all tape is the same, which is not quite true. In the first place, all tapes are not alike, and in the second, even all tapes of the same type are not necessarily the same. Actually, recording tape differs materially in construction, performance, noise level, and output, and each appears to have its particular uses which depend on the final application to which the tape recorder output is to be put.

At the present time, three types of base material are available—paper, acetate, and mylar. Paper is not considered adequate for high-quality recording applications, since the surface coating is not sufficiently smooth to provide a signal-to-noise ratio that is commensurate with present day requirements. Acetate-based tapes have long been the standard, and may continue to be so for some time. They offer reliable performance, high quality, and reproducible characteristics. Mylar tapes, with the higher-strength of the base material, have advantages for many applications, particularly where normal strength must be maintained together with an increase in recording time.

The normal acetate tape, as provided by all the major companies, has a thickness of 1.5 mils, and spools at 1200 ft on a 7-inch reel. This is sufficient for one-half hour of recording time at a speed of 7½ ips on a single-track machine, or for one hour on a dual-track machine. Acetate tape is also available in 1-mil thickness as "Scotch" brand 190, providing a fifty-per cent increase in recording time with only a slight diminution of tape strength. On most machines, the additional flexibility of the 1-mil acetate tape will provide an increase in high-frequency response ranging up to 2 db at 10,000 cps, and only reasonable care must be exercised in its use. Practically all of the companies which produce tape are now marketing a 1-mil mylar tape which gives the additional fifty per cent of recording time per reel, but which is practically equal in strength to the 1.5-mil acetate. For those applications where the maximum recording *time* must be realized, the one-half-mil mylar tape is available, spooling 2400 feet on a 7-inch reel. While this tape is strong enough for use in the average recorder *if it is properly handled*, it must be remembered that it does not have the strength of the more common 1.5-mil acetate tape and requires considerable care in handling. For example, machines which are capable of quick stops without tape spillage may place too much strain on the 0.5-mil tapes, and while they may not break the tape, they are likely to stretch it to the point where it more closely resembles a wire rather than a tape. However, where it is necessary to get the maximum recording time from a given size of reel, the mylar is the only answer short of reducing the speed at which the recording is being made, and this is likely to entail a reduction in frequency response which is not acceptable.

The usual 7-inch reel contains 1200 feet of 1.5-mil tape, with a tuning time of 32 minutes; the same spool of 1.0-mil tape contains 1800 feet of tape, with a running time of 48 minutes; and similarly, 2400 feet of 0.5-mil tape may be spooled on a 7-inch reel with a running time of one hour and four minutes per track. A dual track machine will record twice as long as those figures on the same reel of tape, providing some one is available to turn the reels over at the end of the stated times. Some machines have facilities for reversing automatically without any attention whatever. This can be a doubtful blessing, however, for the reversal—which conceivably takes a certain amount of time—could occur at a critical time in the recording, assuming that the machine were being used to record a broadcast concert, for example.

In effect, then, we learn that while a tape recorder is capable of the highest quality of performance, it also demands some intelligence in its use.

A number of special features are offered by the tape manufacturers. For example, Audio tape is available in several colors, which permits using different colors for each type of recorded material, for example, or to the user's particular demands for identification of the varying subject matters. Reeves Micropolished tapes are claimed to be exceptionally smooth and thus to cause less wear to heads. Irish Ferrosheen tape is also claimed to be highly polished. Scotch brand tapes are also available in a High-Output form where the maximum signal output must be derived from the recording, although no claim is made for appreciably greater signal to noise ratio. Magnetic tape requirements for instrumentation are particularly severe, and most manufacturers make available specially tested tapes for that application.

Packaging differs between the manufacturers; for example, Reeves sound tapes are packaged in five-drawer boxes which are convenient for storage; Audiotape has a box for the 10½-inch reel that facilitates removal from the container and placement on the recorder without the possibility of spillage; Irish has a package which offers a combination of reels of tape, empty reels, and a practical reusable container.

The specifications of commercially available tape recorders which appear on the following two pages have been restricted to the typical home machine. AUDIO is indebted to the manufacturers for this information, and regrets that not all models nor manufacturers are included. The information which is tabulated here is taken from published specifications, and does not represent independent measurements. While every manufacturer was asked to supply information about his products, not all complied with our requests; consequently, some manufacturers are not represented.

Except as noted, all models have a single motor, accommodate up to 7-inch reels, and have erase and record-play heads. The specifications do not indicate whether the erase head is supersonic or permanent magnet, and consequently it is not shown on the charts.

TAPE RECORDER SPECIFICATIONS

MAKE	MODEL	SPEEDS	INPUT VOLTAGE Microphone	INPUT VOLTAGE Radio etc.	OUTPUT Level, v. or dbm	OUTPUT Impedance, ω	POWER AMP Output, watts	POWER AMP Impedance, ω	SPEAKERS	PORTABLE CASE	FURNITURE CABINET	FREQUENCY RESPONSE (Max. speed) From	FREQUENCY RESPONSE (Max. speed) To, cps	FREQUENCY RESPONSE (Max. speed) Down, db	BIAS-ERASE OSC. FREQUENCY, kc.	WEIGHT	SIGNAL/NOISE, db	WOW and FLUTTER, %	LEVEL INDICATOR
Ampex[1]	600	B (C)*		0.5	1.25 v	10,000			NO	X		40	15 K	4	100	28	55	0.25	M
	612	B			1.25 v	10,000			NO	X	X	40	15 K*			28	55	0.25	
Ampro	745	B C	.004	.01	0.5 v	100 K	5	3.2	2	X		60	11 K	6	62	25	40	0.35	E
	757	B C	.004	.01	0.5 v	100 K	5	3.2	2		X	60	11 K	6	62	45	40	0.3	E
	758	B C	.004	.01	0.5 v	100 K	5	3.2	2	X		40	15 K		62	34	45	0.3	E
Bell	RT75	B C D					3.5	500/3	1	X		30	12 K			35	60	0.25	IN
	RT86	B C				Hi Z	3.5		1	X		50	10 K			27	60		IN
Berlant[2]	BAX	A B	−55	0.1	6 v/+4	CF/600			NO	X	*	40	15 K	4	55	54	55	0.1	M
Concertone	20/20	A B	−60	.06	6 v/0	CF/600			NO	X	*	40	15 K	4	55	45	55	0.1	M
Columbia	461	B							1	X					50				IN
	462	B C							2	X									M
Crescent	670	B				Hi Z	3	3.2	1	X					50	20		0.5	
	672	B C				Hi Z		3.2	1	X						22		0.5	
	673	B C				Hi Z	3	3.2	2	X		50	10 K			23		0.5	E
Crestwood	304	B C	.002	.020		Hi Z	10		1	X					65	31		0.3	2N
	360	B C	.002	.020		Hi Z	10		2		X	50	12 K		65	42		0.3	2N
	404	B C	.002	.020		CF			*	X	X	30	15 K		65	28		0.3	E*
Crown[3]	Three Speed	ABC(D)*				CF		4,8,16	*	*		30	20 K	4				0.12	M/E
	Prince	ABC				CF						20	18 K	4		38		0.12	M
DeJur	TK820	B C	.0025	.088	0.7	10,000	6		5	X		40	16 K	4	60	45	55	0.1	E
	TM819	B C	.0025	.088					NO	*		40	16 K	4	60	40	55	0.1	E
DuKane	11A200	B C	.004	0.4/1.2*			7.5	8	1	X		50	10 K	3		39	50		E
Federal	37C	B C					3	4	1	X		50	12 K		40	27	43	0.5	IN
	47A	B C				Hi Z	3	4	1	X		50	12 K		40	27	43	0.5	IN
FenTone	Brenell	ABC								*		30	15 K		50			0.2	
	Motek	B (C)*								*		50	10 K	6	50		55		
Mitchell	1425	B C					3	3.2	1	X		65	10 K		50				IN
Pentron	RWN	B C					4		1			50	9 K			23	42		IN
	MP-2	B C				Hi Z				X		50	10.5 K		32		50	0.3	M
	T-90	B C					5		2							27	50	0.3	E
	HF400	B C				Hi Z	10		3							33	50	0.3	M
Presto[4]	SR27	A B			+8 dbm	500	10	15	2	X*		50	15 K		85	77*	55	0.2	M
RCA	7TR3	B C					2		3	X									2N
Revere	T700	B C	.001	0.5			5	3.2	1	X		60	15 K	6	65		50	0.3	2N
	T10	B C	.001	0.5			5	3.2	1	X		60	15 K	6	65		50	0.3	2N
	T11	B	.001	0.5	1.0 v	CF	2.5	3.2		*	*	40	16 K	6	70		50	0.2	2N
Telectro	556	C								X						16			
	220P	B C			1.0 v					*	*	50	15 K				45	0.3	
	220BMP	B C			1.0 v					*	*	50	15 K				45	0.3	
	220	B C								*	*								
Viking	75	B C			5-10 v	CF						40	14 K			9	45	0.2	
V-M	700	B C						8	2	X		60	10 K	10	65	30	45	0.4	IN
Webster	220	B C	.002	0.1			2.5	3.2	2	X		50	10 K					0.3	IN
	224	B C	.002	0.1			2.5	3.2	2		X	50	10 K					0.3	IN
	230	B C	.002	0.1			2.5	3.2	1	X		50	8 K					0.3	IN
	240	B C	.002	0.1			2.5	3.2	1	X		50	7 K			29		0.3	IN
	212	B C	.002	0.1	0.5 v	CF				*	*	50	13 K					0.3	M

[1] Ampex: Model 600 has three heads—erase, record, play—and permits monitoring from tape while recording. Model 612 is playback model only, and may be used for stereo, dual track, or single track.

[2] Berlant and Concertone: Berlant models available in several forms with various features for broadcast and professional use. All models of both Berlant and Concertone accommodate up to 10½" reels, and are usually equipped with separate record and play heads to permit monitoring from tape while recording. Berlant models use hysteresis-synchronous motor for capstan drive.

[3] Crown, Crown Prince: May be had with wide choice of heads so user may monitor from tape while recording. Number of different models available, with varying features, but all are essentially similar in basic design.

[4] Presto: Employs three heads, and permits monitoring from tape while recording. Adapter available to permit use of 10½" reels.

Speeds: A, 15 ips; B, 7½ ips; C, 3¾ ips; D, 1⅞ ips.
Output: Applies to output intended to feed another amplifier. CF is cathode follower.
Frequency Response: Specifications usually state range over which response is within "± *n*" db. Since response may be considered to be relatively smooth in vicinity of 1000 cps, this portion of the curve may be set at the "+ *n*" point, and the range taken as the frequencies where the response

TYPE OF EQUALIZATION	REWIND TIME, secs for 1200-foot reel	ADDITIONAL INFORMATION
LC	90	* Conversion kit available
	90	* Plays Std. Tape #5563 within ±2 db. Stereo playback reproducer
RC	120	
RC		Piano key operation
RC		
RC	70	Bass boost on playback, treble boost on record.
		Piano key operation
LC	30	Three motors. Meter measures, bias, output and record levels. 10½" reels.
LC	30	Up to 5 heads can be installed—single, dual, stereo, erase, etc.—all models.
RC	105	
RC	105	
	90	
	80	
LC	90	Piano key operation
LC	90	
LC	90	* Also has phono input, 0.6 v. Spkr and ampl external.
LC	35	* With adapter. Various plug-in heads available. Three motors.
LC	35	Three motors, electromagnetic braking. Will handle up to 14" reels.
LC	90	* Hys.-sync. motor; reverses without changing reels; relay and solenoid
LC	90	operation; electromagnetic braking. TM-819 is basic chassis model.
	80	* Phono and radio inputs
RC	90	
RC	90	
	45	Chassis only, three motors. Used with external amplifier.
		* With adapter kit. Three motors, electromagnetic braking. Chassis only.
	45	
	70	Consists of TM56 mechanism, P4 ampl.
	70	
	70	
LC	50	Consists of R27 tape transport, A920B amplifier, two cases.
	120	
RC		T800 same with addition of AM radio tuner
RC		T20 same with addition of AM radio tuner
RC		Chassis model; will take up to 10½" reels
		Monaural playback chassis only
		Binaural and monaural playback chassis only
		Playback only, with separate preamp; available for stereo.
	120	
	120	
	120	
	120	
	120	

is at the "−*n*" point. Thus "± *n*" db may be interpreted as meaning that the range covers frequencies which are down 2*n* db from the 1000-cps response. "Down, db" figures are 2*n*.
Level Indicator: M, vu meter, db meter, or other indicator employing a meter. E, electronic "eye" type of indicator; 1N, one neon lamp, which flashes at or just under maximum recording level; 2N, two neon lamps, one of which flashes at minimum usable level and other flashes at or just under maximum recording level.
Type of Equalization: LC, using inductance and capacitance so as to match tape curve as closely as possible; RC, resistance and capacitance, usually distributed between record and playback.

Accessories—Maintenance & Testing etc.

In the use of tape recorders, various accessories are required. For example, it is necessary to splice tape, to store it, to identify the reels, and to carry it about in a convenient fashion. Enterprising manufacturers have provided useful items to fulfill these requirements.

The simplest splice is made by cutting the two ends of the tapes at a 45-deg. angle, butting them together and applying a short strip of splicing tape, which should also be cut at an angle so as to reduce the "bump" as the splice passes over the heads. The "Gibson Girl" splicer is a convenient device for accomplishing the diagonal splice and trimming the edges of the tape so that no adhesive remains to foul up the heads. The Prestoseal splicer utilizes a controlled heating process to weld the ends of the tape together, thus doing away with the need for splicing tape, which is actually a thin strip of pressure-sensitive tape that uses a minimum of adhesive material so that there is little possibility of any squeezing out the sizes and coming off on the heads.

A similar tape is also available for identifying the reels, being printed with space for date and subject of the recording. The printing is repeated at short intervals, and one section is applied to the side of the reel and the information is written on with ink.

A white leader tape is often used on the ends of reels to permit identification to be written on the end of the tape itself, thus avoiding the possibility of losing the identification by spooling the tape on a different reel than that for which it was intended.

For careful storage of reels, metal cans are available with tight-fitting covers that keep out moisture. These are actually the containers made for 8-mm movie film, but they are of the same size and can be had for either 5- or 7-inch reels. Brumberger, a photo-supply manufacturer, offers sheet metal boxes which hold up to twelve of these cans and provide means for identification, a particularly convenient accessory for one who uses tapes with lectures, for example.

The Cousino magazine is useful when a program must be repeated at intervals, or for a continuous repetition of the same recorded material. These units, shown in *Fig.* 16, provide for as much as fifteen minutes of program material which may be reproduced continuously, or which may be cued by electronic controls actuated by the tape itself—either with a strip of aluminum foil applied to the tape or with a subsonic signal recorded on the tape along with the program material.

While relatively foolproof, the tape recorder does require certain maintenance procedures to ensure optimum performance. The heads should be cleaned occasionally with carbon tetrachloride or with one of the special cleaning solutions provided by some manufacturers. Acetate solutions or lacquer thinners should *not* be used, because they are likely to dissolve the bonding agent in the heads, with resulting degradation of performance.

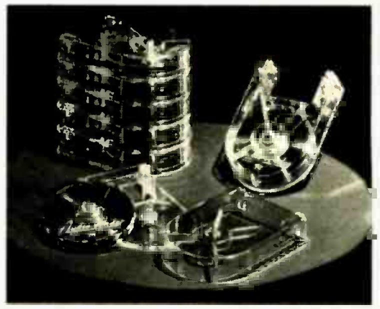
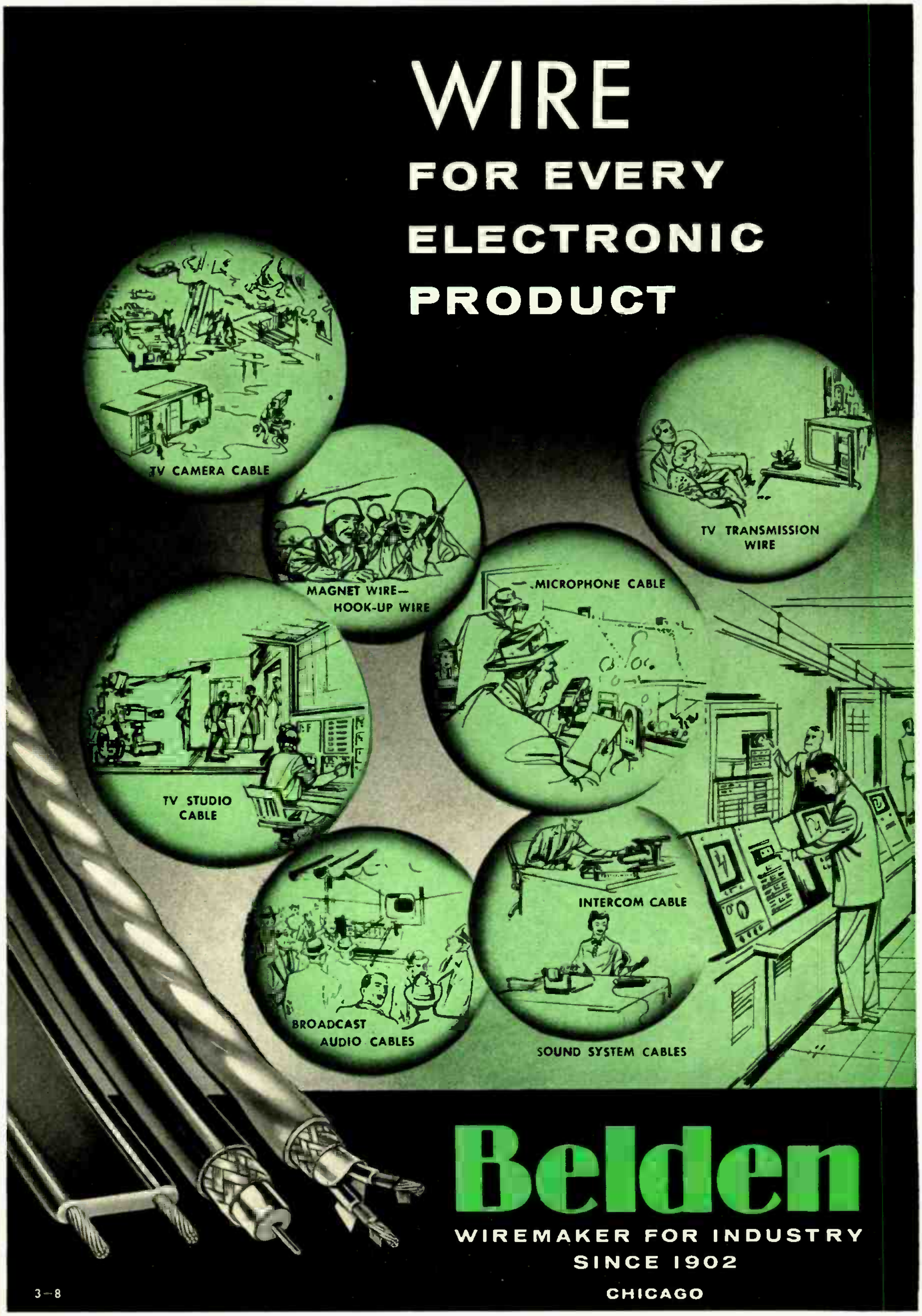


Fig. 16. Cousino repeating reels and magazine-type housings which permit up to a maximum of 30 minutes before repeating.

The head gaps should be aligned at reasonable intervals. Unless adequate maintenance records are kept which should show frequency response over the entire range and permit routine comparisons, it is necessary to make an alignment check by actually realigning the heads. This is done by playing a standard alignment tape and adjusting the azimuth of the playback head for maximum output at a frequency which approaches the maximum frequency of which the recorder is capable. This is usually 10,000 cps for a 7½-ips machine and 15,000 cps for a 15-ips machine. If separate heads are used for recording and playback, the playback head is adjusted first to the standard alignment tape; then a high frequency is applied to the recording amplifier and the record head is adjusted for maximum output from the playback circuit. The operation is relatively simple, but the adjustment is fairly critical, and should be sealed with a small drop of lacquer—or nail polish—each time it is done. Instructions for the alignment process are usually supplied as part of the operating manual.

Aside from cleaning and alignment, little else is required but normal lubrication. The user should make sure that no oil or grease is allowed on belts, pulleys, or any rubber parts, because slippage is almost certain to result in an increase in flutter and wow.

With relatively little maintenance being required, the tape recorder should be capable of giving long and reliable service, for it is a fairly simple machine which must be made to close tolerances and with a high degree of mechanical accuracy. It is undeniably a simple machine to use, and the results have little dependence on the skill of the operator—which is more than can be said about any other recording process. One can only imagine the difficulty that would be encountered by the entire audio and recording industry if it had to return to the days before the tape recorder.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Pickups, Tone Arms, and Needles

EDGAR M. VILLCHUR*

Sound-Chapter 5

Most music lovers think of a hi-fi system as, primarily, a top-quality phonograph. The first link between the groove and the listener's ear is the needle, followed closely by the pickup as the second link, and the arm as the third. Thus all three are important in the chain of equipment that translates grooves to music.

THE MODERN PICKUP, unlike the older "sound box" of the acoustical phonograph, is an electrical generator driven mechanically by the vibrations of the stylus. The pickup's output appears as an alternating voltage between two terminals; the extent to which this voltage faithfully represents the recorded signals is the degree of fidelity of the pickup.

Modern pickups that are in general use belong to one of two basic categories, with one exception. These two categories are the piezo-electric and the magnetic (there are variations within each); the exception is the capacitive pickup.

Magnetic pickups are by far the most common in high-quality installations. They may in turn be classified into two types: the variable reluctance pickup and the dynamic or moving-coil pickup.

The Variable Reluctance Pickup

In order to understand how the variable reluctance pickup works we must first briefly consider some of the fundamentals of electro-magnetic theory.

A magnetic "structure" refers to a system which includes a magnet, with north and south poles, and a magnetic path between the poles, in which magnetic forces exist. The structure is often referred to as a magnetic *circuit,* analogous to an electrical circuit in many ways. The magnet itself is like the electrical generator, and the magnetic path is like the load connected to the generator.

In an electrical circuit the amount of current flow (within the power capability of the generator) is determined by the generator voltage and the circuit resistance. For a given voltage, the lower the resistance the greater the current flow.

In a magnetic circuit the strength of the magnetic field in the path between north and south poles is determined by the field strength of the magnet and by the *reluctance* of the magnetic path (analogous to *resistance* in electrical terminology).

Different materials have different reluctances. For example, air has a high reluctance, iron a low one. For the same magnet, then, a relatively strong magnetic field will exist if the path between magnetic poles is of iron, and a relatively weak one if the path is of air. Intermediate values will be associated with a path which is partly iron and partly air.

We need to discuss one more phenomenon before completing the theoretical background of the variable reluctance pickup. If a coil is moved with its conductors perpendicular to a magnetic field (as in an electrical generator), a voltage appears at the coil terminals. The appearance of this voltage is due to the *relative* motion of coil and magnetic field, and it doesn't make any difference which of the two does the moving. The same effect will be created if the coil remains motionless, and the magnetic field expands or collapses in such a way that its "lines of force" are perpendicular to the wires.

The design of the variable reluctance pickup is based upon the above phenomena. *Figure* 4—1 shows a simplified diagram of a coil and magnet in a pickup; the magnetic path consists of the U-shaped iron, the air in the gap between the ends of the U-shaped piece, and the iron held in the gap by the needle. The reluctance of the magnetic path will thus be at a minimum when the movable iron is fully in position in the gap, and will be at a maximum when the needle has moved its iron out of the gap.

As the needle is vibrated by the record groove, the reluctance of the magnetic path is continuously changed. The strength of the magnetic field will also be changing, inversely (the higher the reluctance the weaker the field). The magnetic field expands and contracts across the conductors of the coil, and since there is relative motion between the magnetic field and the wire a varying voltage appears at the coil terminals, which is to say at the output of the pickup.

It will be seen that the only work that the needle must do is to move the tiny piece of iron in and out of the gap (the energy required to change the field is negligible). The mechanical system of the pickup can be highly compliant, which contributes greatly to the fidelity that can be achieved with variable reluctance pickups. Low distortion and extended, relatively peak-free frequency response may be expected.

Another characteristic of variable reluctance pickups is low voltage output (low, at any rate, compared to the piezo-electric type). The General Electric pickup, for example, is rated as having 10 millivolts output at a given reference

* *Woodstock, N. Y.*

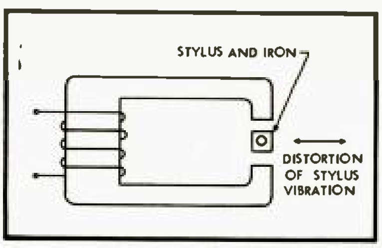


Fig. 4—1. Simplified diagram of the variable reluctance pickup.

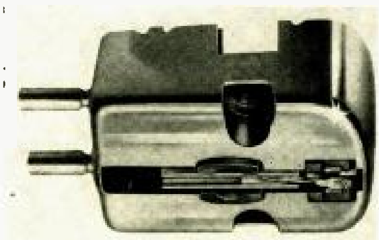


Fig. 4—2. The G. E. variable reluctance pickup. There are two gaps: when the iron in the stylus assembly is moved out of one gap it is simultaneously moved into the other.

standard of groove modulation.

A further characteristic of variable reluctance pickups is that the output voltage is proportional to stylus *velocity*, not to the distance of needle travel. We have seen that the recorded signal is doctored before it is cut into the disc. A pickup whose output is proportional to needle velocity will present us with the doctored signal, not the original one. Therefore variable reluctance pickups must always work in conjunction with a preamplifier stage, which increases the signal voltage and, at the same time, compensates for the frequency equalization existing in the recording.

Figure 4—2 illustrates a commercial variable reluctance pickup. The needle assembly itself is the only moving element in the system.

The Moving-Coil Pickup

The moving-coil pickup works in an inverse manner to the variable reluctance unit. It has a coil, and the output voltage appears at the coil terminals, but in this case the magnetic path is fixed and the coil itself is the moving element.

Such a coil must, of course, be very light and small. There is no room for many turns of wire, and the output voltage is low even when compared to that of a variable reluctance pickup. The output may be as little as one millivolt. Compensating for this low output is the extremely high quality that can be realized. The moving-coil pickup is usually considered to have the highest potentiality for faithful reproduction.

The moving-coil pickup, like the variable reluctance type, requires a preamplifier to boost its voltage and to compensate for recording characteristics. (The moving-coil output is also velocity-dependent). The low output voltage calls for high amplification in the preamplifier, and the problems of hum pickup are proportionately increased.

If a given hum voltage x from, let us say, stray fields of the phonograph motor, is induced in a pickup system with 10 millivolt output (requiring a preamplifier gain of 100), the output hum will be $100x$. If substantially the same hum voltage is induced in a pickup system with 2 millivolt output, (requiring a preamplifier gain of 500), the output hum voltage will be $500x$. Another way of describing the situation is to state that the signal-to-hum ratio is much worse in the case of the pickup with low signal output. However, since any moving element in a pickup should be very light, the moving coil itself usually consists of a small number of turns of wire, which results in a low impedance and a consequent insensitivity to hum pickup. For this reason, moving-coil pickups generally have a comparatively high signal-to-hum ratio.

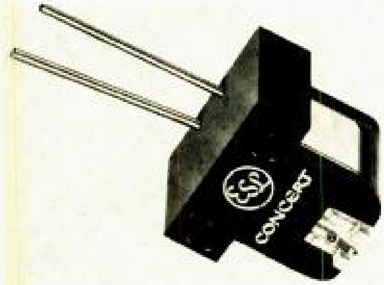


Fig. 4—3. A modern moving-coil pickup (ESL).

Figure 4—3 illustrates a commercial moving-coil pickup.

Piezo-Electric Pickups

The piezo-electric or "crystal" pickups generate their voltages in an entirely different manner from the magnetic units. Certain crystalline materials, such as Rochelle salt and barium titanate ceramics, have the property of producing voltages at their surfaces when they are bent or twisted. The stylus is harnessed to slabs of these materials through a system such as that illustrated in *Fig.* 4—4, and the modulations of the groove apply either a twisting or bending force to the slabs.

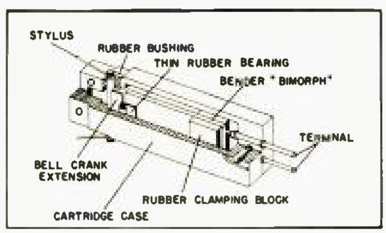


Fig. 4—4. Internal structure of a "bender" type of crystal pickup. (Courtesy Brush Electronics Co.)

The output voltage appearing at the cartridge terminals is much greater than that produced by magnetic pickups, and may be from ½ volt to as high as 4 volts. Furthermore the crystal pickup does not produce a voltage proportional to the stylus velocity, but to the amplitude of the stylus movement. The frequency characteristic of the output, however, is approximately the reciprocal of the typical recording characteristic used in modern records. Therefore the output of the crystal pickup is fed directly to the amplifier, without the use of a preamplifier. Both the voltage amplification and the equalization of the preamplifier would play havoc with the crystal pickup's output.

Modern crystal pickups are sometimes designed with a particular recording characteristic in mind (the advent of the standard RIAA characteristic makes this much more practical). Crystal pickups have not yet been designed, however, with as accurate a frequency compensation, as extended a range, or as low a distortion level as that of the best magnetics. The crystal pickup does have the advantages of significantly greater simplicity in installation, freedom from hum, and reduced cost.

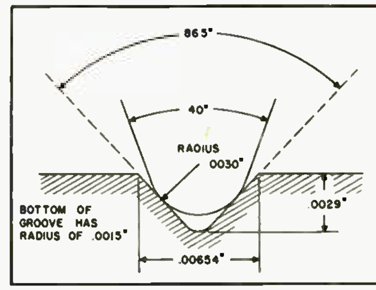


Fig. 4—5. A 3-mil stylus tip in the record groove. (After F. Langford Smith).

Some recently introduced ceramic and crystal pickups have been designed to work into a load impedance which decreases the low-frequency response so that the output is almost proportional to the velocity of the stylus. By properly adjusting the load resistance and the output voltage (usually with a voltage divider) these pickups can be fed into a preamplifier equalized for magnetic pickups with attendant flexibility of response curves.

Older crystal pickups had disadvantages which have been overcome to a large extent. Rochelle salt is subject to deterioration from heat and humidity, but the ceramics are not. The stiff mechanical system of the older units has given way to needle systems which move relatively easily, and which are designed in such a way as to largely suppress response to vertical motion caused by pinch effect. (Dynamic and variable reluctance pickups are readily designed to virtually eliminate any vertical response).

Electrical Connection of the Pickup

Pickups are normally connected to the input of the amplifier or preamplifier with low-capacitance shield cable. The "termination" of the pickup refers to the value of resistance that the amplifier input places across this cable, and is very significant in the case of both variable reluctance and crystal pickups.

Manufacturers' recommendations are usually the best guide to use when it is possible to adjust the value of resistance across the pickup (some preamplifiers allow for this), but a few general principles may be stated here:

1. With a variable reluctance pickup, too low a shunt resistance will attenuate the high frequencies; too high a resist-

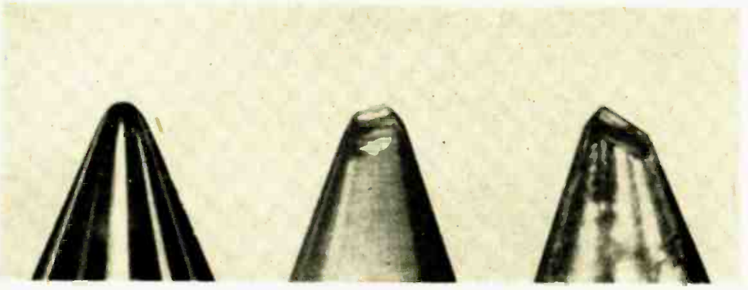


Fig. 4—6. One mil microgroove needles after 15 plays of a 12-inch Vinylite record, with 8 grams vertical tracking force. Left to right: diamond, sapphire, and osmium. (After Marcus).

ance may allow an excessive peak in the upper treble. Typical values of resistance for reluctance pickups range from 22,000 to 56,000 ohms.

2. With a crystal pickup, too low a shunt resistance will attenuate the bass; too high a resistance will over-emphasize the low frequencies and create a peak in the upper bass. Typical values of resistance for crystal cartridges are 0.47 meg. to 3.0 megs.

Needles

The type of contact established between the stylus and the record groove is illustrated in *Fig.* 4—5. It will be seen that the spherical tip of the stylus does not touch the bottom of the groove.

It is obvious that the stylus tip should be of such material that it maintains its shape in spite of repeated use. It is also important that the tip have a smooth, unmarred surface. Sapphire fulfills these conditions for a relatively short time, diamond for a much longer period. Estimates of the life of a sapphire stylus in a high quality system are rarely above twenty-five hours of playing time, while diamonds are normally good for more than a thousand. *Figure* 4—6 illustrates the relative wear of diamond, sapphire and osmium.

Although diamond needles may be, initially, as much as ten times as expensive as sapphire, one of their outstanding characteristics, at least in a high-quality installation, is economy. More important is the freedom from the danger of periodic degradation in reproduction quality and in record wear.

Vertical Force on the Pickup

The *vertical tracking force* on the pickup (rated in grams) is the force required to keep the needle in firm contact with the groove walls at all times. This is sometimes called "tracking pressure," but the latter is an improper term because units of pressure are in terms of force per unit area. The higher the vertical force the greater will be the erosion of the groove walls, but this does not mean that it is possible to arbitrarily decrease the weight on a given pickup. Only pickups with very high compliance —that is, pickups whose needles can be displaced with very little force—can afford to work under conditions of low tracking force.

Typical vertical tracking forces required by modern high-quality pickups range from one or two grams to about 8 grams. When the tracking force is reduced below its optimum value distortion, often severe, results. Therefore it is better to err in the direction of a gram too much than a gram too little. Pickup arms often allow the user to adjust the tracking force, by the use of an adjustable counterweight or by an adjustable retaining spring. The manufacturer's specifications should always be consulted carefully, but it must be remembered that the specified tracking force may be for an optimum installation, and more typical installations may require somewhat higher tracking forces. The way to really know when the tracking force is right is to note the point at which intermodulation distortion is reduced to an acceptable value. This is difficult to do without instruments.

Pickup Arms

The pickup arm holds the pickup in place over the groove. It should supply the proper tracking force, be free of significant resonances of its own, and always present the pickup to the record in a position tangent to the groove being played, or as close to this ideal as possible.

One method of subduing pickup arm resonances, and of stabilizing the arm so that it is less subject to the influence of outside shocks, is to use a pivot damped with a viscous silicone fluid. Although the sluggish characteristics of such a damped pickup arm might seem to be undesirable, the nature of the viscous resistance (coupled with the almost universal "side thrust" force toward the center of the record) is such that the slow sweep of the arm across the record is not hindered, while erratic and unwanted motions are suppressed. The needle hugs the groove in spite of record eccentricities and imperfections, or outside jars. The elimination of erratic pressure of the stylus against the groove walls is claimed to reduce record wear.

A rigid pickup arm which is pivoted at one point cannot keep the pickup parallel to all grooves. The divergence from tangency is called *tracking error,* and it results primarily in increased distortion, due to the fact that the vibration axis of the pickup is held obliquely to the groove that drives it.

It is possible, however, to keep the pickup within a few degrees of tangency at all points by mounting a fairly long arm, of bent shape, in a special way. The arm is mounted so that the needle would "overhang" the turntable spindle if it were swept past, as illustrated in *Fig.* 4—7. Such a mounting position, when calibrated properly to the length of the arm, keeps the cartridge-groove angle almost constant, although the absolute angle between groove and pickup would be far from correct with a straight arm. The cartridge is therefore mounted in the arm at an "offset" angle, to bring it back to tangency. The exact amount of overhang depends both on the length of the arm and on the offset angle.

It will be seen from the foregoing that the offset angle of a bent pickup arm does not correct for tracking error in itself. The most critical element is the amount of overhang, and this should be correct to at least 0.1 inch. A bent arm incorrectly mounted is at least as bad as a straight arm in the same mounting position, and very probably much worse.

The correct mounting position for a pickup arm relative to the record spindle is usually furnished by the manufacturer, often by means of a template, and this should be followed with painstaking care.

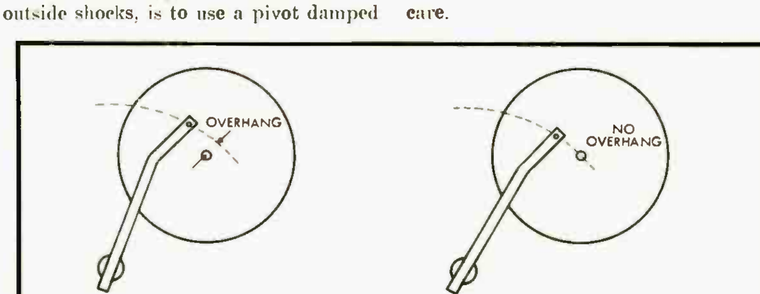


Fig. 4—7. Mounting position of the offset tone arm, showing overhang.

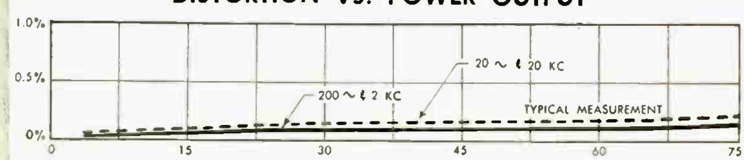
Here's Proof of McIntosh superior performance!

For *clean amplification, low distortion* and *abundant power* no other amplifier compares with the McIntosh—long the standard of high fidelity excellence. The fundamentally-different McIntosh circuit delivers amplification within 0.4% of theoretical perfection. Nothing is added to or taken from the input signal. The result: a realism, clarity and listening quality without "fatigue" caused when tones are lost, distorted or intermixed within an amplifier. There are more *plus* values with the McIntosh. Hear it at your dealer's.

Distortion: 1/3% Harmonic and 1/2% IM, even at full rated output, from 20 to 20,000 c.p.s. *Power:* 30 watts continuous, 60 watts peak (for Model MC-30); 60 watts continuous, 120 watts peak (for Model MC-60).
Frequency Response: 20 to 20,000 c.p.s. ±0.1 db at full rated output. 10 to 100,000 c.p.s. ±1.0 db at one-half rated output. High efficiency of the McIntosh circuit means longer life, less heat dissipation and less power consumption for greater output.

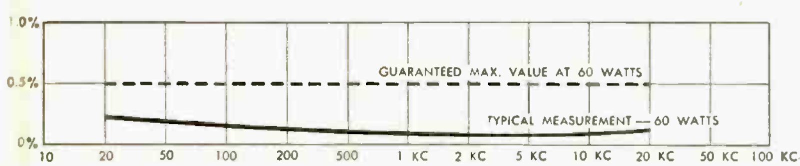
The exclusive, patented McIntosh Bi-filar Circuit, first with Unity Coupling, is inherently superior by design, laboratory measurement and listening test. Wave-form distortion, due to switching transients between each half of the class "B" amplifier is eliminated at all frequencies. The result is the purest amplification possible.

DISTORTION VS. POWER OUTPUT

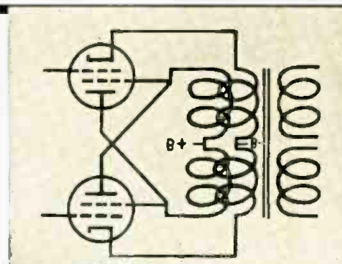


POWER OUTPUT IN RMS WATTS

SINGLE FREQUENCY HARMONIC DISTORTION



FREQUENCY IN CYCLES



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AUDIO ETC.

Edward Tatnall Canby

1. TIBIA AND STYX

Believe you me, I must joyfully explain, it was a remarkable coincidence that found an extensive and enthusiastic review by me of George Wright's MIGHTY WURLITZER theatre organ recordings (HiFi Records) in the January RECORD REVUE virtually at the moment this magazine was promoting a new offspring, *TIBIA* by name, a magazine concerning theatre organs. Looked like a handy bit of publicity cooperation, didn't it?

But the plain fact was that I didn't even know there was a new offspring, nor had any idea that the subject of theatre organs was a rather lively one at the moment in the AUDIO offices! 'Course it might have been something less than a coincidence that the records arrived *chez moi* at, shall we say, a highly favorable moment, but of this I was blissfully unaware; I just opened 'em up and put 'em on the machine.

This sort of thing has been going on ever since our editor heaved himself out of his Manhattan hustings and betook himself & staff to that very apotheosis of Styxes, Mineola, a local stop on that (ugh) famous line, the Long Island Rail Road. Change at Jamaica. Now I commute 200 miles every week to *my* hustings in Northwestern Connecticut, fair weather and flood; but, New York being what it is, I'd rather fly to the moon than entrain for that utterly distant sphere in the outer nebulae of commuterhood, Mineola. (*It ain't that bad—20 miles, 40 minutes, maybe.* ED.) So I visit regularly via the P.O. to a certain Box 629; or I dial direct (four message units) to the boss's desk, and thus we maintain a perilous contact, somewhat more tenuous than those interchanges now zooming up from Little America.

What's 100 miles into Conn. compared with 30 into the wilds (the tames, should I say) of L. I.?

So . . . most hearty success to *TIBIA* from me, belatedly, and may I assure *TIBIA* that my interest in MIGHTY WURLITZERS is precisely as described in the Jan. issue, no less.

But I still like the other kinds of organs too, and the other kinds of organ music.

2. POWDERED DISCS

The demonstration of the new "Microfusion" process of record pressing from powdered vinyl at last fall's Audio Fair struck me instantly as highly significant and though I have no extensive information on developments since then, except that Emory Cook has adopted the new system for his excellent hi-fi records (see RECORD REVUE), I suspect, purely on the direct evidence, that here is the biggest advance in record technology of the year just finished.

The new system Has Everything—and if it has bugs, too, they will be ironed (or pressed) out. I suspect that though investments in older-type equipment may slow up its adoption, the time will come when this method becomes pretty much standard for quality record manufacture.

There was a time, a few years back, when it seemed that the injection process was "it". Squirt your record automatically into molds, do the job by machine with minimum handwork. What could be better? The trouble seems to be, if I'm right, that vinylite still makes the most satisfactory disc and you can't squirt it. It softens but doesn't liquefy.

Until now, vinylite could be flowed only, in the traditional manner of the ancient shellac discs, the material being spread out under heat and high pressure from a floor-tile-like biscuit. In that process every record is made individually by hand, (except for the automatic heat and cold cycling inside the presses) and hand work it has been, right along.

The new process isn't nearly as radical as the "squirt" method, injection molding. As far as I can see, it represents very little outward change from the standard system in use for so many years. The presses, like waffle irons, are still fitted with two stampers, upper and lower, somebody still puts a vinyl "blank" and two labels into each one by hand, closes it up and after a moment opens it again, to remove a pressed record. No very great revolution here and no serious disturbance of existing personnel set-ups and the like.

But the differences between the new and old are technically vital—and amazingly simple. That's why I'm waxing enthusiastic, though I'm not yet exactly an authority on record pressing. For this is one of those things that's been right under a lot of people's noses, I suspect, without having been seen. It took somebody with imagination to see the light.

The trick is this. The old-type vinyl biscuit, like its predecessor the shellac biscuit, is *flowed* across the two stamper faces. Squashed would be a better word. The bulk of the plastic must travel a considerable distance over the grooves and under the high pressure required to fill all the "cracks," the tiny groove wiggles. This squash-flow is bound to cause deformation of the groove walls, sidewise in the direction of the flow. That's distortion, in the finished record. And, after two or three hundred pressings, the distortion begins to accumulate appallingly fast. The stamper wears out. But even the very first pressing is somewhat distorted, under the heavy push of that thick-flowing plastic.

Moreover, there are the eternal problems of surface irregularities—bubbles and the like—that are inherent in the flow process, where the plastic is violently pushed around.

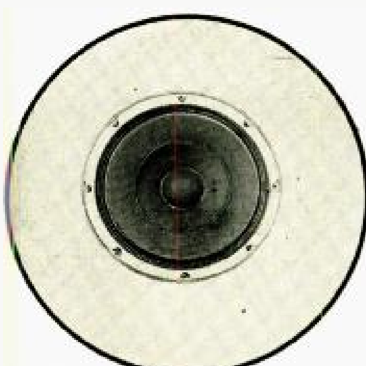
(*Continued on page 58*)

We beg your pardon!

A short time ago we announced the creation of a new series of Altec Lansing loudspeakers, representing a new advancement in loudspeaker design. The use of multiple concentric compliances permitted stepped sections of the cone to radiate different frequencies, thus achieving a smoother, more extended frequency range than that previously attainable from a single cone loudspeaker. We announced that the guaranteed frequency range extended to 13,000 cycles.

This is no longer true. And because it is not true we do beg your pardon. Because of improved production techniques and production controls we are pleased to announce that the 408A 8″ *biflex* speaker now has a guaranteed range from 60 to *16,000* cycles, the 412A 12″ speaker from 40 to *15,000* cycles and the 415A 15″ speaker from 30 to *14,000* cycles. These ranges, measured in Altec's anachoic chamber, are guaranteed by the manufacturer.

We suggest that you hear these remarkable speakers at your earliest opportunity. Ask your Altec dealer for a demonstration of their range and fidelity today.



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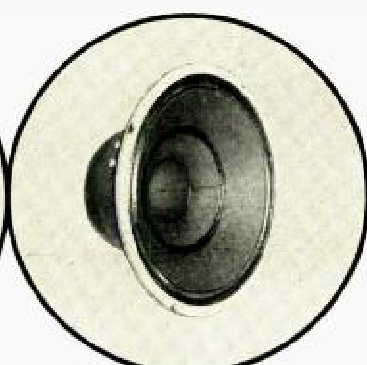
8″, 15 watts, 60-16,000 cycles, $24.00



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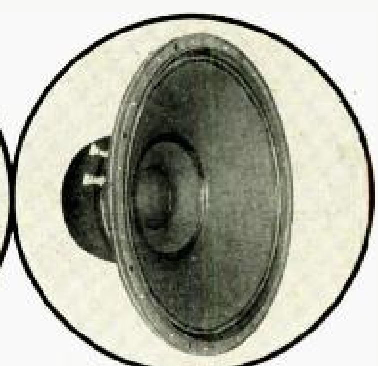

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Equipment Report

Brociner Mark 10 Integrated Audio Amplifier—Fen-Tone Anti-Static Pickup, Model 350A+

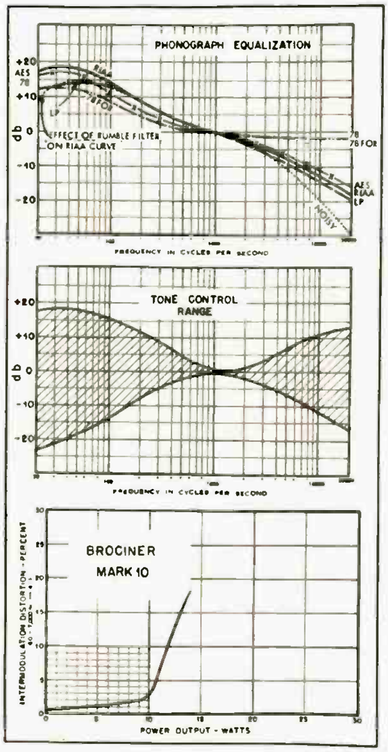

Fig. 1. Performance curves for the Brociner Mark 10 amplifier.

In a field which includes dozens of medium-powered amplifiers, there is always room for one more, particularly when its specifications and performance come up to the standards exhibited by the Brociner Mark 10. Physically it is 4¾ in. high, 10⅞ in. long, and 8 in. deep, and is thus small enough for the most modest installation. The front panel is 3 × 10 9/16 in. and mounts with only the control shafts passing through the cabinet, if desired, or it may be used in the open in its attractive maroon-and-gold-finished case which is perforated for ventilation.

The amplifier employs a printed circuit chassis on which all tubes are mounted, together with most of the resistors and capacitors—all, in fact, except those directly associated with the equalization and tone controls. Low-noise resistors are used in the preamplifier section, and coupling and bypass capacitors are tropicalized. The power supply section employs a choke for greater filtering, and the heaters of all tubes are biased 22 volts positive to reduce hum from that source to a minimum. On the whole, the amplifier is designed along good engineering principles and does not rely on "gimmicks" for its performance.

Performance curves are shown in *Fig.* 1, with the six phonograph equalization positions in the upper portion, tone control range in the center, and intermodulation distortion in the lower. The effect of the rumble filter on the RIAA curve is shown, although the same reduction of extreme low-frequency response can be had with any of the phono settings. The tape-recorder feed jack is connected electrically just following the tone-control section, and while the tone controls do affect frequency response, the volume control does not. The secondary of the output transformer is so arranged that most of the winding is in use regardless of load impedance, a practice which improves coupling with a resulting increase in stability.

For a 1-watt output, an input of 0.55 volts is required on the RADIO, TAPE PLAY, and TV jacks; the same output is obtained in the phono positions from an input of

PARTS LIST FOR THE MARK 10 AMPLIFIER

R1	27 K	R24, R38	100 K	C3, C5, C17	.02
R2, R3, R6	4.7 meg	R26	560	C6, C8	.03
R4, R5, R9	62 K	R27	3300	C7, C21	.01
R7, R14, R21	1.0 meg	R28	820	C9, C10	330 µµf
R8, R30, R31	220 K	R29, R34, R36	270 K	C11	1000 µµf
R10	10 K	R33, R37	1000	C12	.0039
R11, R12, R13	100 K	R35	300, 5w	C14, C24, C25	0.1
R15, R22, R25	47 K	P1, P2	1.0 meg	C15, C22	.05
R16	6800	P3	500 K	C16, C18	.0025
R17, R20	1600	P4	500	C23	390 µµf
R18, R19	100 K	C1, C19, C20	220 µµf	C26	20–20/450, 50/50
R23, R32	22 K	C2, C4, C13	.05	C27	10–20–20/450

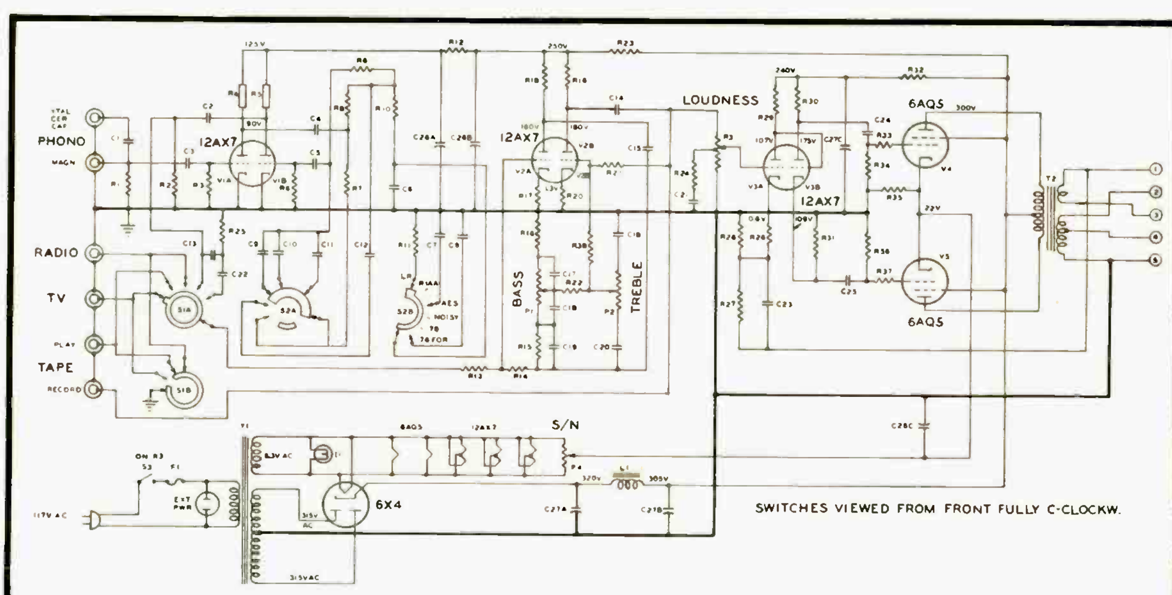

Fig. 2. Schematic of the Mark 10. Parts values are tabulated above.

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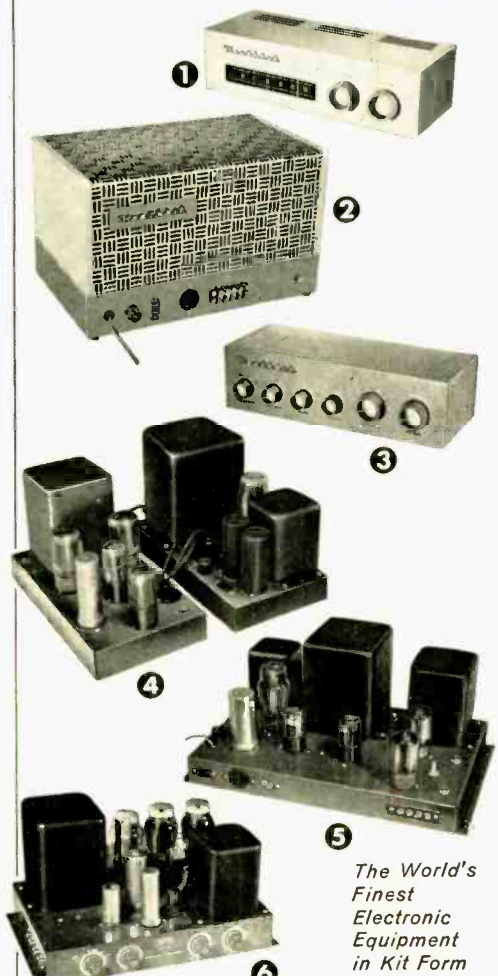

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❶ Heathkit FM TUNER KIT

Features brand new circuit and physical design. Matches WA-P2 Preamplifier. Modern tube line-up provides better than 10 uv. sensitivity for 20 db of quieting. Built-in power supply.

Incorporates automatic gain control—highly stabilized oscillator—illuminated tuning dial—pre-aligned IF and ratio transformers and front end tuning unit. Uses 6BQ7A Cascode RF stage, 6U8 oscillator—mixer, two 6CB6 IF amplifiers, 6AL5 ratio detector, 6C4 audio amplifier, and 6X4 rectifier. Shpg. Wt. 7 Lbs.

MODEL FM-3 $24.50

❷ Heathkit 25-Watt HIGH FIDELITY AMPLIFIER KIT

Features a new-design Peerless output transformer and KT66 output tubes. Frequency response within ±1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts. 4, 8, or 16 ohms output. Hum and noise, 99 db below rated output. Uses 2-12AU7's, 2-KT66's and 5R4GY. Attractive physical appearance harmonizes with WA-P2 Preamplifier. Kit combinations:

W-5M AMPLIFIER KIT: Consists of main amplifier and power supply, all on one chassis. Shpg. Wt. 31 Lbs. Express only. $59.75

W-5 COMBINATION AMPLIFIER KIT: Consists of W-5M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. wt. 38 Lbs. Express only. $79.50

❸ Heathkit HIGH FIDELITY PREAMPLIFIER KIT

Designed specifically for use with the Williamson Type Amplifiers, the WA-P2 features 5 separate switch-selected input channels, each with its own input control—full record equalization with turnover and rolloff controls—separate bass and treble tone controls—and many other desirable features. Frequency response is within ±1 db from 25 to 30,000 cps. Beautiful satin-gold finish. Power requirements from the Heathkit Williamson Type Amplifier. Shpg. Wt. 7 Lbs.

MODEL WA-P2 $19.75

❹ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This amplifier employs the famous Acrosound TO-300 "Ultra Linear" output transformer, and has a frequency response within ±1 db from 6 cps to 150 Kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 88 db below 20 watts. Uses 2-6SN7's, 2-5881's and 5V4G. Kit combinations:

W-3M AMPLIFIER KIT: Consists of main amplifier and power supply for separate chassis construction. Shpg. Wt. 29 lbs. Express only. $49.75

W-3 COMBINATION AMPLIFIER KIT: Consists of W-3M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 37 lbs. Express only. $69.50

❺ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This is the lowest price Williamson type amplifier ever offered in kit form, and yet it retains all the usual Williamson features. Employs Chicago output transformer. Frequency response, within ±1 db from 10 cps to 100 Kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output 2.7%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 95 db below 20 watts, uses 2-6SN7's, 2-5881's, and 5V4G. An exceptional dollar value by any standard. Kit combinations:

W-4AM AMPLIFIER KIT: Consists of main amplifier and power supply for single chassis construction. Shpg. Wt. 28 lbs. Express only. $39.75

W-4A COMBINATION AMPLIFIER KIT: Consists of W-4AM amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 35 lbs. Express only. $59.50

❻ Heathkit 20-Watt HIGH FIDELITY AMPLIFIER KIT

This model represents the least expensive route to high fidelity performance. Frequency response is ±1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's and has separate bass and treble tone controls. Preamplifier and main amplifier on same chassis. Four switch-selected inputs, and separate bass and treble tone controls provided. Employs miniature tube types for low hum and noise. Excellent for home or PA applications. Shpg. Wt. 23 Lbs.

MODEL A-9B $35.50

New Heathkits are easy to build..

Heathkit construction manuals are full of big, clear pictorial diagrams that show the placement of each lead and part in the circuit. In addition, the step-by-step procedure describes each phase of the construction very carefully, and supplies all the information you need to assemble the kit properly. Includes information on resistor color-codes, tips on soldering, and information on the tools you need. Even a beginner can build high quality Heathkits and enjoy their wonderful performance.

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2.7 mv, which indicates adequate gain for any pickup commonly available. Hum and noise was measured at 70 db below 1 watt with volume control in the maximum position on radio and the auxiliary inputs, and at 55 db below 1 watt on the RIAA phono position. These values will differ slightly from those stated by the manufacturer, since it is common practice to state hum and noise related to the maximum output of the amplifier, whereas AUDIO is of the opinion that hum and noise should be related to a fixed output signal. If it is not, a low-powered amplifier suffers by 6 to 10 db in comparison with specifications. What is wanted, actually, is an *absolute* measure of hum and noise output, for the average user will reproduce music at about the same level in the home whether he has a 10-watt amplifier or a 50-watt one. A fairer measure would be to measure the hum and noise at a setting of the volume control which would give a 1-watt output with a signal of 0.1 volts on the high-level inputs and of 10 mv in the phono position. The Mark 10 measures 6.4 db by this method, which is excellent.

The volume control is partially compensated for loudness, but only to a small degree so that if more bass boost is required for low-level reproduction, the user can add it by the tone control. This compromise would appeal to those who do not favor loudness controls. **F-17**

FEN-TONE ANTI-STATIC PICKUP MODEL 350 A+

As little as five years ago, it was possible to make measurements on pickups and come up with startling results—there were few really good ones then, and those that were good were outstanding when compared to the average. Now we have a wide variety of good pickups on the market which, like loudspeakers, are uniformly good yet may sound slightly different. In other words, if we choose any of the recognized cartridges we are almost certain to get a good one, and it only devolves upon the user to choose the one which sounds best to his ears.

But therein hinges the story on the unit described in this report—to date the Fen-Tone cartridges are less well known than some of the models that have been on the U.S. market long enough to become established. Yet this should not keep the interested observer from hearing everything that is available, else he might miss some very good products.

The Fen-Tone magnetic pickup is manufactured in Denmark by the internationally celebrated Bang and Olufsen, whose microphones and professional equipment have achieved an enviable status throughout the world. Shown in *Fig.* 3, the model 350 A+ consists of a plastic housing which is so mounted that it tilts laterally to present the proper stylus to the record groove. Electrical contact is made through the mounting, eliminating possible breakage of connecting leads due to continual changing from LP to standard stylus. The stylus assembly consists of a protective sleeve attached to a spring clip. The armature moves within the protective sleeve, and is actuated by a stylus shoe which—on the dual-stylus models—carries two styli positioned side by side. Extrusions on the spring clip prevent damage to the stylus shoe in case the pickup is dropped onto the record.

Figure 4 is a diagram of the mechanical construction to show the eight poles of the pickup coil and the armature which is constructed with a 90 deg. twist to mate with the pole pieces. Because of the coil and armature construction, hum pick-up is reduced, and the Fen-Tone shows excellent characteristics in this regard.

Stylus changing is effected by simply lifting off the spring clip with the tip of a knife blade, or with the fingernails if available.

Most recent innovation of the Fen-Tone cartridge is the use of a small piece of foil laminate which gives off alpha rays. This foil irradiates the space around the styli and extends its effect to the record surface while it is playing so as to ionize the air and dissipate the static charge on the record. This can be shown dramatically by noting the presence of a static charge on a record by holding it over a pinch of cigarette ashes. Then, after brushing and wiping the ashes off the record as well as possible, play the record once with the A+ cartridge and repeat the test. This time the ashes will not be picked up by the record. Continual use of an anti-static pickup—and it is certainly an advantage to have the anti-static feature a part of the pickup rather han to be attached as an accessory—should reduce the dust-attracting propensities of vinylite records with a resulting longer life of both records and styli.

Six types of Fen-Tone cartridges are available: the Reversible Silver Label, with two sapphire styli; the Reversible Gold Label with a diamond LP stylus and a sapphire 78 stylus; two Single Silver Label models with either LP or 78 styli in sapphire; and two Single Gold Label models with choice of styli in diamond. Basically the characteristics are identical—with only a slight variation in equivalent mass of the stylus tip. Dual models have an equivalent mass of 4.5 milligrams; the single-stylus models have an equivalent mass of 3.5 mg. According to manufacturer's specifications, the compliance is 5×10^{-6} cm/dyne, and tracking force is 5 to 7 grams for the microgroove stylus models and 9 to 12 grams for 78's. Measured output voltage (using the Cook test record) for a 9-cm/sec stylus velocity is 61 millivolts, which is relatively high. It is, in fact, the highest output signal measured of a number of commercially available magnetic pickups. This is an advantage with many amplifiers which may be on the verge of not having enough gain, and the high output voltage permits using a lower setting of the volume control with consequent reduction of hum due to the preamplifier.

Measured response is smooth throughout the usable frequency range, and flat ±2 db from 16 to 15,000 cps, above which there is a slight rise. D.c. resistance of the cartridge is 350 ohms, impedance at 1000 cps is 530 ohms, and the inductance calculates at 63 mh; measured inductance is 83 mh. **F-18**

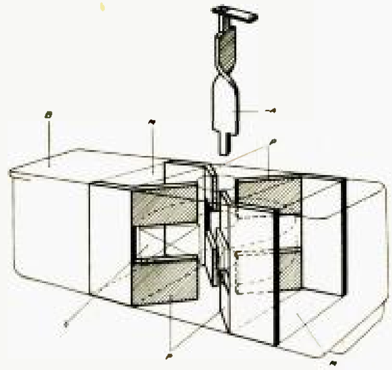

Fig. 4. Diagram of physical construction of the Fen-Tone cartridges.

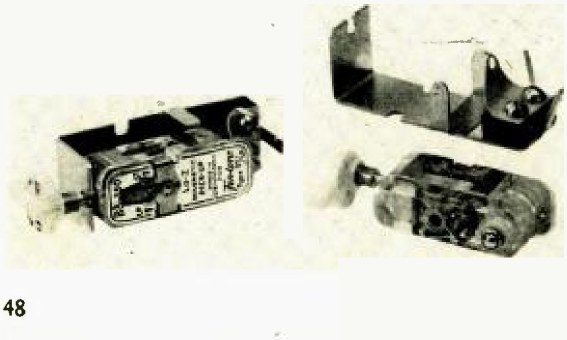

Fig. 3. Fen-Tone 350 A+ Anti-Static magnetic pickup.

H-222

H-520

H-530

. . . We believe it's time to examine high fidelity loudspeaker values. For example when you are asked to spend from $40 to $130 for a loudspeaker you are entitled to the advantages of all of these features:

- A compression driver horn-loaded tweeter
- A multi-cell horn in the tweeter
- A high frequency balance control as an integral part of the speaker system
- A true two-way system—two separate and distinct loudspeakers with expertly coordinated performance.

H-222 Jensen 12″ coaxial speaker at $54.50 meets all these requirements.

H-520 Jensen 15″ coaxial speaker at $79.50 meets all these requirements.

H-530 Jensen 15″ coaxial speaker at $129.50 meets all these requirements.

Meeting all of these requirements correctly is of course the final test of maximum performance and value. In these Jensen authentic high fidelity coaxial loudspeakers the maximum combination of performance and value is guaranteed by the recognition accorded Jensen products for more than a quarter century as the world's quality standard.

Other Jensen coaxial speakers are priced from $24.85; Jensen G-610 TRIAXIAL* at $252.75 and complete systems in enclosures from $49.50 to $525.00. 2 and 3-way Speaker Kits from $10.50 to $184.50. Write for Folder HH.

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EDWARD TATNALL CANBY*

The Spoken Word

IT HAS TAKEN a long time for the LP medium to get places in the wonderfully promising field of recorded speech—a vast area perhaps only exceeded in variety by music itself. Now, this last year, the Word has finally begun to get around. Records, LP of course, have been piling up *chez moi* at a frightening rate and the resulting sounds would be inspiring, if I didn't have so much else to listen to. For you, inspiring is the word, with darned little reservation.

We've heard a lot about the dire effects of TV, not to mention movies and radio and comic strips, upon the reading ability of our people. It's pretty clear that "good" books and, especially, good poetry, are losing ground. We are becoming more and more attuned to listening for our language-reception, less and less to reading-at-sight.

And so—why not listen? Why not return to a tradition which, after all, is even older than reading and writing, which has always been the life of all language and of all story telling and all poetry. The old 78 rpm pioneers in the field did their best to record spoken words in practical fashion—but think of their problems! Four-minute sides (costing as much as our LP sides, too) and scarce time to warm up a reader to the mike. No editing—a slip, a cough, a false start, and all was lost. Hiss and rhythmic thump, at 78 rpm, as a harrowing background to distract all but the most persistent minds. And—worst of all—not a sibilant in a carload! The old records had the intelligibility of a telephone conversation drowned in static.

It seemed to me, back in 1948, that the LP revolution might do fabulous things for the recorded spoken word. Now it has. People who simply will never *read* poetry are likely to find poetry interesting or even exciting, by ear, or profoundly moving, or (at the opposite) hilariously entertaining. School teachers have a new and more familiar way to approach a tough subject. . . .

This could go on and on—but the theme is so obvious that but one question for amazement remains: it took *eight* years for LP speech to come into its own!

Even the most simple new ideas—really new—take time and more time to develop, even in this our lightning-fast age of progress. That's what it amounts to.

Herewith a few starters—for everybody, (engineers and gadgeteers included) who's looking for new kinds of interest and entertainment. There'll be more as fast as I can squeeze 'em in between the musical numbers.

Poet's Gold. (Poems by Fitzgerald, Keats, Millay, Poe, Yeats, Browning, Gray, Southey, Kipling, Howe.) Helen Hayes, Raymond Massey, Thos. Mitchell.
RCA Victor LM 1813

Poet's Gold. (Poems by Longfellow, Swinburne, Blake, Stevenson, Emerson, Whitman, Whittier, Holmes, Field, Lear, Carroll, Kipling, Coleridge.) Hayes, Massey, Mitchell. RCA Victor LM 1812

Here are two out of a batch released under the "Poet's Gold" title, the poems spoken, for a good variety, by three well-trained voices. Good idea, for it avoids the dangerous monotony, sight-unseen, of a single voice reading unlike selections.

The reading is done close-up, without music or other extras, and for that, thank the Lord. Window dressing isn't really going to help this kind of reading, which jolly well must stand on its own intrinsic interest—and does, here. The actors produce a sophisticated and fancy sort of reading and, no doubt, their big names help make big sales. But their trained delivery does make things very clear—and reading out loud is a tricky business as anybody who has tried it will say.

Too many titles to list in detail, but these two records cover much familiar territory—familiar, that is, to those who have been pushed through schoolboy English classes. Maybe our new young fry don't get to read these any more. "The Raven", "Ode to a Grecian Urn", the Rubaiyat (which comes through particularly well in spoken form and is, indeed, quite moving and believable today), Gray's "Elegy", "Paul Revere's Ride", "O Captain! My Captain", "The Owl and the Pussy-Cat", and so on down the list. They'll delight any of you oldsters who used to hate this stuff in your tender years, and you may well find some surprises too—things you'd never thought you could like.

Excellent close-up recording, very low on distortion and extra-clear, with top surfaces.

See also others in this series. They don't have volume numbers, for some reason.

T. S. Eliot reading his Poems and Choruses. (Ash Wednesday, Love Song of J. Alfred Prufrock, etc.)
Caedmon TC 1045

Dead poets necessarily must be read by living voices and hence the choice of the actors who do the preceding "Poet's Gold" series. Live poets sometimes make dreadful readers, as composers sometimes make punk performers.

But then again, sometimes they don't. Here's the Old Master himself, one of the most tremendous readers who has lived in our time, though his reading technique isn't anything too extraordinary from the point of view of Announcer's School. He just has personality, enough to make your spine creep.

He also has a gravel voice that defies the mike. Here, the slightly burred, lispy sound is very much like that of his thrilling but ancient 78s, which I found so exciting years ago. Nevertheless—the man has got "it", mike personality, a thing that knows no reasonable laws, and his old magic still works.

Say no more, except that the material here is on the whole in much longer slices, unbroken, than on the RCA records preceding—reflecting, I think, Caedmon's shrewd and knowledgeable use of the LP medium, which gets better and better the longer is the poem or story. (Just the opposite with printed poems, isn't it.) Indeed, so much is crammed on these sides that the dividing bands are almost invisible, a disadvantage since the dreamy and hynotized listener—you or me—is apt to drift from one poem right into the next without quite knowing it.

There are some wonderful lines here, memorable as only a spoken line can be: and some memorable thoughts too, pessimistic, perhaps a bit out of date—yet not by much: for the world is no simpler today than when Eliot was so influential, before the War.

By all means don't think that you must be some sort of aesthete, that you must "like poetry", to enjoy this! Forget all about such things. The language belongs to us all, poets and engineers as well; we're all people and in plenty of ways all in the same big boat. Eliot thinks he is a master of linguistic communication, and he can "act"—project his thoughts via the spoken word. Just play him through, at least twice if the stuff is new to you, and you'll see how it begins to dig into you.

Tyrone Power Reading Byron. (Don Juan, Canto I: She Walks in Beauty; On This Day; Childe Harolde's Pilgrimage: excerpts.) Caedmon TC 1042

Caedmon's entire LP output, quite a sizeable list, is devoted to recorded speech, and always has been. Nobody in the business, as suggested above, knows quite so well the values and the possibilities of the medium—and nobody does much better engineering, either.

This record is a delight, along with the Kipling, following. Power has been "directed" by somebody, like any good movie star; no doubt there was a lot of coaching involved. So what! Results count. The reading is homey, American, at first a bit on the corny side. Some sophisticates won't like it. Not British enough. But those who listen further will find that the really vital quality of the recording is that it *makes sense*. It is well read. It gets over. What more can you ask?

The complete side devoted to "Don Juan" is absolutely delightful. Who reads Byron these days? Who, outside of school and the English Departments? Well, not enough of us! This is no hopelessly long-winded Romantic tirade, as some might fear, but a wonderfully humorous, light-touched little story about a 16-year-old who gets involved with a young married woman, hardly any older, and is discovered in her boudoir by the fierce old husband and his henchmen. He escapes, minus clothes, back to

* *780 Greenwich St., New York 14, N. Y.*

Mama; she hies herself to a nunnery (*who—Mama or the young married woman?* ED.); and old Bryon chuckles away from beginning to end. Try it!

Boris Karloff Reading Kipling's "Just So Stories" and from "The Jungle Book".
Caedmon TC 1038

Here's a companion disc, and this one will go for the kiddies as well. Believe you me, I hadn't heard these stories since I was something like 8, when my Papa (I think) read 'em to me; I was delighted with them, and so will you be and your kids. "How the Camel Got His Hump," "How the Rhinoceros Got His Skin," not to mention a good slice of the story of Mowgli, the original wolf-boy.

Boris Karloff's big, bass voice is warm and friendly, unexaggerated, beautifully recorded.

Les Poètes Maudits (Baudelaire et Rimbaud). Jean-Louis Barrault.
London LL 1010

Note this, in case you are well up on your French. Two 19th century poets, somewhat avantegarde though they will not titillate you with anything very *risqué* now, for all the title. Beautiful stuff if you can get it, read dramatically with stage-like, rather than mike-style, technique, the voice varying from a heavy whisper almost to a shout and a sob; must have posed quite a problem for the engineers.

Much of the speech is recorded very close, with a growling whisper-bass. Much too heavy at normal playback volume but it's fine if you turn the sound down to an actual whisper—but then the next piece, more prose-like, is recorded at normal distance and you must jump for your controls and readjust.

Just goes to show what a delicate business this speech recording can be. The reader must have a very special blend of knowledge and intelligence, vocal technique, personality, mike technique, each factor nicely balanced with the others. This Frenchman gets too excited for his mike to take.

Molière: Le Malade Imaginaire. Ceremonie du Malade; Evocation de la Mort de Molière. Romeo Charles, etc., Orch. dir. Cadou. **London-Int. TW 91076/7 (2)**

Here—if you can follow the French—is some of the finest recorded speech I've heard, and a marvelously alive and humorous performance, in the traditionally hectic and semi-hysterical (but superbly controlled) style that goes with Molière in all French performances. Some of the characters here are almost unbelievable, so eccentric, so vivid, so real are they! Like the best of French movies.

For awhile you'll be dizzy at the speed and intensity of the French; but after a side or two, if you're still alive and kicking, it begins to get through and make sense; for the diction, in spite of whirlwind rapidity, is ultra-clear and exact. There's even a Gilbert-and-Sullivan-like "patter song", but at least three times as fast as any G & S ever heard on earth. A rare experience, this, to hear.

Shakespeare: Scenes from "As You Like It"; Twenty Sonnets. Dame Edith Evans, Michael Redgrave et al. **Angel 35220**

Another! This, too, is some of the finest speech recording I've ever heard, and I'd hate to make a technical choice between the Shakespeare and the Molière preceding. Dame Edith, with the rollicking, up-and-down British voice, the brittle, clear British diction, the engagingly humorous personality, is positively startling in her realism. You're likely to jump and look around for her, as she starts to speak.

She is, indeed, a personality actress. Her conversations with others in the "As You Like It" excerpts are so real you will scarcely believe they are read, or were written down—except for the incomparable wit of that sly dog, young Shakespeare. A delightful recording, and a brief reading-over of the synopsis of the story (as printed in the notes) will enable you to follow the proceedings easily enough.

The sonnets strike me as less successful. Dame Edith has too much personality for the objective style of delivery that would seem best for this non-stage poetry. She can't help making them sound like her personal messages, read aloud—she does this deliberately—and, somehow, the effect is wrong, to my ear, anyhow. A complication is that the mike placement seems to have been quite uncertain, differing considerably from one sonnet to the next. Some are close, others further away; some are live, others deadish. The changes from one to another (they were made, it seems, at different times) are false and unnatural in effect.

Poe: The Pit and the Pendulum. Read by Gilbert Highet. Nat. Council of Teachers of Engl. (10")

This is a fine reading of the Poe horror story, taken from a broadcast on WNYC by Mr. Highet. There is a brief and interesting introduction by him, before his easy-going British voice gets to the work of the story itself. The horror of the work is increased by the unaffected naturalness of the voice.

A special edition (presumably for members of the Council), the record is lacking engineeringwise in the fundamentals. The tape (which I heard) was so-so in quality; the record is a bit more so, with weak high end and some distortion. Easily intelligible at that, but I should think this very large organization could have persuaded Mr. Highet to make a new tape, of better technical quality, to match current standards for such professional work. And, I suggest, all such recordings should be encased in some sort of jacket, for basic protection, as this one is not. Just a paper envelope with a hole in the middle.

Town Meeting—A Twenty-Year Cavalcade. (Town Meeting of the Air). Narr. John Daly. **Heritage LP-H-0059**

This historical disc, patterned after the Columbia "I Can Hear It Now" series, has some fascinating vocal material in it—dozens of names including Wilkie, McCarthy, Dewey, Taft, LaGuardia, Stevenson, Ickes, Acheson, Nehru, Al Capp and so on, all of whom appeared on the famous radio program from Town Hall, which seems to have been recorded regularly from its very inception in the mid-Thirties.

Unfortunately, the assembling of the recording is not good. Daly's taut, TV-style delivery is pompous and full of platitudes proclaimed with that voice of doom that seems to be required on the air these days. I found it extremely irritating. Bursts of musical fanfare, in the worst movie-radio style, interrupt meaninglessly, as if to add emphasis. Just silly. The editing is not very clever—applause is cut (to save space, no doubt) in an unpleasantly false way where it could have been done far less noticeably and more naturally. I suspect, Mr. Daly's voice-level is pretty loud, too, in comparison to the stage-distance speakers that are featured. That means you must take his bellow, willy-nilly, if you want to hear the meat of the disc at all.

But the voices themselves are priceless and the recordings otherwise entirely unavailable. Very good quality in the pre-war ones, all things considered.

Collier: Mary; De Mortuis; Back for Christmas. Read by the Author. Columbia Literary Series. **Columbia ML 4754**

Here is a trio of lovely short stories, on one of the story-records from the fabulous Columbia Literary Series, originally issued in a set of a dozen LP's and finally (as expected) released in individual discs. Mary, I'll have you know, is a trained pig, who interferes herself between a very naive young gent, her owner, who doesn't yet know the facts of life, and his newlywed, who wishes he did. Pig becomes sausage, wife gets her wish. The other two stories are both Doctor-murders-wife-buries-her-in-cellar tales, the first especially ingenious. Nice, semi-British reading, very easy to follow and unaffected. A wonderful "party record", if your guests are tired of Twenty Questions.

Everyman, A Moral Play. Burgess Meredith, Cast of 16. **Caedmon TC 1031**

This is a famous, anonymous morality play dating from the fifteenth century, of the sort that was once given to enthralled local-yokel audiences from crude traveling carts; it is the most famous of them all. In German (Jederman) it has been an outdoor feature of the Salzburg Festivals in Austria—I saw it there as a kid.

I suppose that the fancy, dramatic style of this presentation is more or less necessary for such a work, but even so, I wonder. These actors rant and tear their hair in supposed Mediaeval fashion—but it all sounds to me a bit like a high school Shakespeare production! Everyman himself sometimes reminds me, in his more tortured moments, of Jimmie Durante at his most ecstatic. He practically strangles with excitement, every now and then.

The content, necessarily, is somewhat confusing to the modern mind in its concern with the then universal concepts of Catholic Christianity. The meaning is certainly universal still, and no less true now than then, but the details of the "system" will be more familiar to present day Catholics than to others.

Honestly, I hope the schoolchildren of America don't have to be exposed to this, in the name of literature or religion! It just isn't that good a production.

Chaucer: The Canterbury Tales, dramatised version by Nevill Coghill for the BBC. The Spoken Word, Album 1 (4)

This notable BBC series is here assembled in a four-record LP album and should prove tremendously valuable. I'm rushing it in for comment having heard merely a couple of sides, but this is enough to give you an idea.

First—technical quality is partly substandard. Howcome?—when we think of the vast tape and disc resources of said BBC and of those available similarly in this country. The reason, no doubt, is that the series was done in 1949—perhaps on disc originals. Like the "Pit and Pendulum" above, this has perfectly good intelligibility; but it could be better. I note, incidentally, a considerable variation from one section to another.

The first disc has a nice introductory explanation, followed by a fascinating example of actual Chaucerian English, as established by scientific research—it sounds somewhat like good Irish mixed with Italian; the throaty words end with weak syllables in a soft and lilting way, like Italian. Wonderfully enough, you can understand a bit of it here and there. Then comes the complete Prologue, in the translation.

The succeeding discs, with more excellent and straightforward introductory explanations, are given over to some of the famous Tales, semi-dramatised. These tales, as is pointed out, were written to be read aloud, and were—to the King's court, no less. They are full of entertainment, as anybody might guess (some of it has been tactfully omitted as offensive to our delicate modern ears) and far from stuffy or academic. Alas, there's a good deal of that high-flying rhetoric that "Everyman" displays in the acting but here it is done in better style.

It occurs to me, on further reflection, that there is only one valid objection to this same fancy acting style, and it is a revealing one.

That style, the shouting, the fancy rising-and-falling of the voices, the very slow delivery, belongs to *public declamation,* without benefit of electronics. It was necessary, in olden times, for sheer intelligibility when more than two or three were assembled for listening. Exaggeration, both of actual speech and of the emotions to be conveyed, like exaggerated make-up on an actor's face.

But today we are adjusted to the microphone's closeness, and these recordings are mike-made. It is a false use of the microphone to subject it to loud oratory as though it were a vast audience at a distance, whatever the traditions may be. Somehow or other, we must use close-up mike technique, Chaucer and Shakespeare notwithstanding.

But what close-up technique? That is the problem, not really well solved here, nor in the recording preceding, evocations of the past. Yet I have not the slightest doubt that a new sort of adapted Chaucer-Skakespeare mike delivery is already arising, a new tradition that reinterprets the old words into a new style of presentation that the mike will like. We've already done the same with the old-fashioned symphony orchestra, the opera, both similarly designed to blast loud music to a big audience and now neatly captured via the new "hi-fi" techniques, for optimum loudspeaker listening at close range. We'll do the same for the older classics of stage and story.

Address for this record company: The Spoken Word, 10 East 39th St., New York 16, N. Y.

NEW PRODUCTS

• Fifty-Watt Hi-Fi Amplifier Kit. The Dynakit Mark II has a number of distinctive features which contribute to excellence of performance, at the same time providing simplicity and ease of construction. Using a newly-designed circuit built

around the Dynaco A-430 output transformer, the Dynakit Mark II amplifier uses only three tubes to deliver 50 watts at less than 1 per cent intermodulation with full power available from 20 to 20,000 cps. The small number of stages reduces phase shift to unusually low values and provides a substantial margin of stability without need to restrict frequency response. The Mark II measures only 9 x 9 x 6⅝ ins. high. Construction is simplified by use of a pre-assembled printed-circuit board on which most of the components are mounted. Complete step-by-step directions and pictorial diagrams are supplied with each kit. Data on the circuit used in the Dynakit and its performance are available on request from Dyna Company, 5142 Master St., Philadelphia 31, Pa. **F-8**

• Hartley Full-Range Speaker. Stated to be without resonance through a frequency range of 1 to 18,000 cps, the new improved Model 215 is the latest in a long line of Hartley loudspeakers whose predecessors go back to 1927 when H. A. Hartley claimed invention of the first "high fidelity" speaker. Equipped with a 5-lb. magnet, it will handle a peak power of 20

watts. It employs a single, sectioned cone and a mechanical crossover which provide excellent linearity throughout the audible range. Cloth suspension permits cone excursion of one-half inch. Distributed by Hartley Products Co., 521 E. 162nd St., New York 51, N. Y. **F-9**

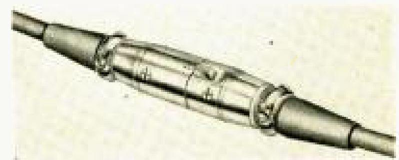
• Turntable-Pickup Arm Combination. Production of a new high-fidelity three-speed turntable and pickup arm combination has been announced by Gray Research and Development Company, Hilliard St., Manchester, Conn., makers of the well-known Gray viscous-damped pickup arm and other hi-fi products. A feature of the unit is a "cue" light in the arm rest which makes it unnecessary for those who prefer listening to music in a darkened room to turn on lights when changing records. Exceptional reliability is achieved by use of an external drive in which the motor shaft engages the neoprene-faced turntable rim without intermediate idlers. Noise and rumble are virtually eliminated by means of a long, tapered steel bearing. The unit is completely shockmounted. The viscous-damped arm included with the

combination is the Gray Model 108C. Purchasers have a choice of two motors, a heavy-duty induction type or an hysteresis-synchronous type, the latter being more expensive. Full information available on request. **F-10**

• Cabinart Hi-Fi Enclosures. "King-Sized" cabinets for hi-fi components are striking additions to the new Cabinart line of furniture for home music systems. A full sixty inches wide, the Model 65 will accommodate a tuner, amplifier, record changer or manual turntable, tape recorder, and speaker system. A companion unit, the Model 65-D, offers record or tape

storage in lieu of the speaker compartment. The 65-D storage section is finished inside and is fitted with an adjustable shelf. The practical aspect of the new models is pointed up by a combination of hinged and sliding doors. Both extreme right and left doors hinge outward, while the center panel slides right and left. Contemporary in style, detail is held to a minimum, including only a slight bevel molding, small brass door pulls and wood or brass legs. Finishes available are hand-rubbed mahogany, walnut, or korina veneer, or black lacquer. Cabinart, 99N. 11th St., Brooklyn 11, N. Y. **F-11**

• Cannon Audio Cord Connector. Built for use with quality microphones, instruments, low-level sound applications and other instances where a quiet connector is essential, the new Cannon Type XLR audio connector is equipped with silver-plated brass contacts and a unique method of shockproofing through the use of resil-



ient synthetic rubber which also acts to protect contacts from dust and moisture. Two insert arrangements are available, one with three 15-ampere contacts for No. 14 wire, the other with four 10-ampere contacts for No. 16 wire. One circuit affords a means of grounding. For free XLR Bulletin write the Cannon Electric Catalog Department, 3209 Humboldt St., Los Angeles 31, Calif. **F-12**

• Fisher Hi-Fi AM Tuner. Virtually every feature which could be desired in a high-fidelity AM tuner is incorporated in the new Fisher Model AM-80. Designed for use in areas without FM service, for reception of distant stations, and for high-fidelity listening to nearby stations, the AM-80 is equipped with a three-position bandwidth control which offers a choice of broad, medium, or sharp tuning. A built-in 10-kc whistle filter further enhances high-fidelity reception. Station selection and

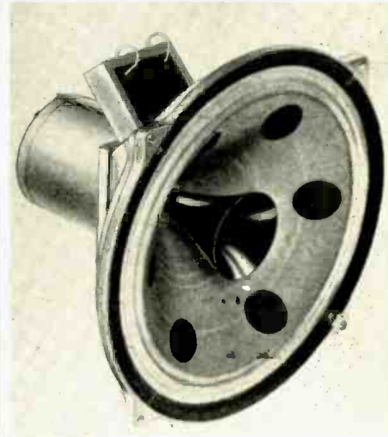
logging are facilitated by a sensitive tuning meter. Sensitivity of 1 microvolt equals that of professional communications receivers. Cathode-follower output permits up to 200-foot separation between tuner and amplifier. A logging scale is incorporated in the slide-rule tuning dial. The control panel is tastefully finished in brushed brass. Complete specifications may be obtained from Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. **F-13**

• High-Gain Power Transistors. Highly efficient heat dissipation is an outstanding feature of a new series of power transistors recently developed by CBS-Hytron, Danvers, Mass., and shown full size. The use of a copper base, which is bolted to the chassis, allows the heat to flow from the transistor to the chassis, thus providing a large area of heat radiation. A pair of Type 2N156 power transistors in an audio amplifier or radio receiver can furnish 8.5 watts of audio power output to the

loudspeaker with less than 85 milliwatts of drive power input. Four variations are available offering a wide range of current gain and operating supply voltage. Simplicity of construction permits ready adaptability to various mechanical layouts. Complete data are available by requesting Bulletin E-259. **F-14**

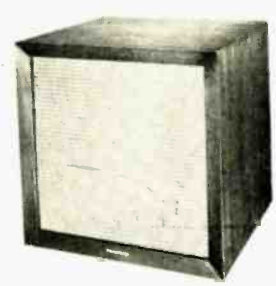
CIRCLE 56

• **Stentorian Coaxial Speaker.** Utilizing the unique cambric cone construction which has been popularized by earlier Stentorian speakers, this new 12-in. coaxial achieves remarkably smooth mid-range response through the use of new fibre stabilizing discs which are impregnated into the front of the cone. The discs are designed to eliminate mechanical "break up" in the 1000–3000 cps range. The new Stentorian has two 1½-in. voice coils operating in the field of a series magnet



system weighing 11½ lbs., said by the maker to be the largest used commercially. A British Alcomax-3 high-efficiency magnet ring is used. Bass resonance is 35 cps and frequency response is 20 to 20,000 cps. Power rating is 15 watts undistorted. For complete information write Beam Instruments Corp., 350 Fifth Ave., New York 1, N. Y. **F-15**

• **Compact Speaker Enclosure.** Although measuring but two inches larger than the speaker it encloses, the Bradford speaker cabinet affords excellent bass response due to a pressure-relief valve which reduces air pressure within the enclosure, thus permitting free cone movement. Radical in its departure from accepted design standards, the Bradford baffle is remarkably free of boominess and does not require speaker matching or port tuning. It may be operated in any position in the room with equal effectiveness. It provides virtu-



ally infinite automatic damping through coordination of internal pressures with cone excursion. In effect, the pressure-relief valve is an acoustic spring which acts uniformly over the entire rear surface of the cone. Available for 8-, 10-, 12-, and 15-in. speakers, the Bradford enclosure is solidly constructed of ¾-in. plywood and may be had in a variety of hardwood finishes. For complete technical description write Bradford & Company, 315 E. 6th St., New York 3, N. Y. **F-16**

TRANSISTOR TIPS AND TECHNIQUES

(*from page 19*)

the range it is set in. The backward resistance should read more than 50K for both junctions. Now immediately upon checking the reverse resistance of the collector junction, move the test lead from the base terminal to the emitter terminal. A lower resistance should register, indicating more current, by a factor of perhaps ten or more. This may at first seem rather startling, but a little theory and a moment's thought should convince the reader that this unexpected result is merely one manifestation of transistor action. If this increase in current does not occur, the transistor is not displaying transistor action, and is thus no good.

The values of resistance to be expected in this test cannot be given accurately, because they vary from one transistor type to another, and also are quite nonconstant—that is, will read differently on different ranges of the same instrument. However, by comparison with new transistors, the reader can work out a simple test procedure for himself.

Testing Transistor Amplifiers

Normal testing procedures apply for transistor audio amplifiers as apply for their vacuum tube counterparts. Frequency response, transient response, distortion, noise, hum, etc., all can be checked in the normal way. However, a couple of points are tricky and therefore worth noting here about using normal test equipment:

First, care should be taken to be sure that any signal generator used does not have d.c. superimposed on the a.c. signal output. This of course will disturb the transistor biases. Also, some generators have a low-resistance path between the output terminals, which again can foul up the input-stage biases. Using a 50 or 100 μf blocking capacitor is recommended—watch polarity here.

Typical low-level transistor amplifiers should have a frequency response flat over the entire audio range from 20 to 20,000 cps. cycles. High-power transistors generally lack in high-frequency response, and poor low-frequency response may be due to too low a value coupling and emitter-bypass capacitor.

Simple amplifiers should not have more than about 1 per cent total harmonic distortion, except for the output stage, which may be quite a bit worse, especially if it is operated Class B. Feedback can be used, of course, to reduce the distortion in a final design, as in vacuum tube amplifiers.

This article has tried to give some practical suggestions and tips for making an entrance into the world of transistor circuitry. These practical tips and techniques should be supplemented by good solid theoretical material. If the audiofan is going to be anything but just a "tinker" he must have some idea of the physical principles behind transistor action, and the methods engineers use to attack problems of transistor circuit design. Fortunately, books are available which adequately tell the story for every level of technical background, from the experienced engineer to the novice. All the English-language books available at this writing are noted here.

R. F. Shea, *Transistor Audio Amplifiers*, Wiley, New York, 1955. The only book devoted exclusively to transistor audio applications, this book is at present the "bible" of the field. Aimed at college students and practicing engineers alike, this book covers most facets of amplifier design with succinct thoroughness. The methods used are explained in detail to enable the reader to apply these methods on future transistors, which may be quite different from present-day models. The sections on power transistors are of necessity general, because the development of power transistors is so new. This book will for some time deserve a place on every transistorized audiophile's bookshelf.

R. F. Shea, *Principles of Transistor Circuits*, Wiley, New York, 1953. The same writer's previous book covers all sorts of transistor circuitry in such a manner that the material will probably not be out of date for some time to come. This book is a good introduction to transistors for practicing engineers, but not for the beginner.

A. Coblenz and H. L. Owens, *Transistors: Theory and Applications*, McGraw-Hill, New York, 1955. This book covers some areas not handled by Shea, such as manufacturing techniques, specialized semiconductor devices, and silicon devices. As far as the audio sections go, the authors use the less-favorable "r-parameters" in developing formulas for amplifier design. Furthermore, in a few places the assumptions the authors make lead them to confusing, or downright misleading statements. Shea's treatment is to be preferred as far as audio amplifier design goes; however Coblenz and Owens' book does have other worthwhile features.

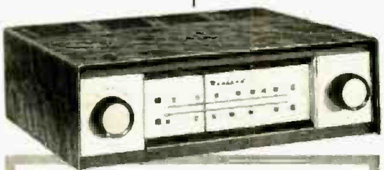
L. M. Krugman, *Fundamentals of Transistors*, Rider, New York, 1954. Claimed to be aimed at the technician and amateur, this book in reality is so well-written that it will serve the needs of experienced engineers as an introduction to the field. A minimum of formal mathematics is needed, but this does not seem to restrict the material unnecessarily. Unfortunately, this book came out before the h-parameters were in common use; therefore has the disadvantage of using r-parameters throughout. However, as a succinct introduction to the field, for students, engineers, and technicians, this book is good.

R. P. Turner, *Transistor Theory and Practice*, Gernsback Publications, New York, 1954. This book is on a slightly lower technical level than Krugman's. It will fill adequately the needs of those without much technical training, and without much mathematical prowess. More sophisticated readers will resent many of Mr. Turner's assertions "out of the blue," but this is characteristic of writing aimed at Mr. Turner's audience.

L. E. Garner, Jr., *Transistors and Their Applications*, Coyne Publications, Chicago, 1953. This is a very elementary book aimed at beginners not only in transistors, but in electronics and mathematics as well. Probably not suited for the readers of AUDIO.

28 Uses for Junction Transistors, Sylvania Electric Products, Inc., New York, 1955. A collection of 28 elementary circuits, most of them not in a form to be used immediately without more design work. This should serve as an inspiration and "idea book" for experimenters. 12 of the 28 circuits are audio amplifiers.

Raytheon Transistor Applications, Raytheon Manufacturing Co., Newton, Mass, 1955. A collection of 53 short articles, many reprinted



from popular current electronics magazines, using the Raytheon CK-722 transistor. About 20 per cent are in the audio field, including amplifiers, frequency meters, modulators, clippers, and so on.

For the audiofan who proceeds to experiment with transistors—don't worry if you burn out one or more transistors. They are not now prohibitively expensive, and accidents happen to the best of us. Even if you manage to burn out quite a few, you're still in good company. There's not a transistor research lab in the world without its pile of burned out transistors. When you burn out your first unit, you can send in to the author for your free membership card in the ACTE—the Association of Careless Transistor Engineers, a non-profit, non-purposeful, non-essential organization limited to those who have proved their prowess in the field of electronics by having burned out at least one transistor. Actually it is not necessary to enclose the burned out transistor—that should of course be hung in a place of honor.

Every audio enthusiast who tries his hand at transistor circuitry will be letting himself in for some real fun. The ease of construction of transistor circuits gives the experimenter or engineer the thrill of having his brainstorm work all the more often, and the ingenious audiophile will immediately begin designing his wrist-watch amplifier, or his sub-miniature hearing aid, his pre-amp to be mounted right in his phonograph arm, or his power amplifier to be bolted to the back of his woofer. As his skill with transistor circuitry increases, the earnest audiophile will discover the capabilities of transistor audio amplifiers, and will design his transistorized hi-fi rig to make full use of available transistors.

AUDIO ETC.

(*from page 44*)

The new powdered disc blank, compressed powder, *is just slightly larger than the finished record.* Thus—it simply melts in place. No flow. No dragging bubbles, no distorting side-pressure. The plastic is already where it has to be; it merely fuses, from powder into glassy-clear transparency.

The pressure, as I get it, can therefore be much less than in the older process because there is no squeezing-out to be done. And so there is not only decidedly reduced distortion of the groove walls in the first place, but the lighter push makes the stampers last even longer—far longer than in the old process.

Thus we have, to all appearances (and in the looks and sound of the samples I've heard so far) a basically improved record and a cheaper process. Hier fi, glassy-smooth surfaces, lower cost. What more can you ask? And the record, remember, is vinylite.

Try one of Emory Cook's, if you want to see how they come out.

3. TIPS ON TAPES

Perhaps it is too soon to say any more about recorded tapes. The promise and the actualities still seem to be an indeterminate number of miles apart.

It is, I suppose, unpopular to suggest at this late date that tape hasn't yet come into its own. I have before me two* out of a number of tape catalogues, all of which have pages and pages, hundreds and hundreds, of listed recorded tapes. It was almost a year ago, I think, that I got royally lambasted in another magazine (I never did see the article) for being pessimistic about tape availabilities, as of then.

I suppose, since they are in print, that most or all of these tapes are actually available. But where and how? I suppose that if I went out to each of these many companies with a bushel basket in hand and a 30-day railroad pass I could come back with quite a haul. Nobody is saying—least of all this department—that tapes aren't pretty wonderful and, at best, better than any comparable disc record. Nobody around here is suggesting that there hasn't been vast progress of late, both in the improvement of playback facilities, at lower cost, and in the beginnings of all sorts of interchange arrangements between disc companies and tape outfits, not to mention amplifier makers and various others who are getting into recorded tape. Fine—and good.

And yet the situation remains not very much changed. There is still, I think, serious confusion as to what markets, what audiences, recorded tape intends to reach, is still reflected in what I might call programming. What shall we put on our tapes?

The hi-fi market is the obvious one for recorded tape, and here the progress is most notable, though the content of such tapes is largely outside of my sphere. There is scads of new taped background music of many sorts. Hi-fi pops stuff is coming more and more into its own. And good jazz, too, has started a solid foray into tape. It benefits decidedly from tape quality.

Classical? There's the rub. There still remains a basic division here which is not yet clearly understood and underscored. A classical tape is either (1) a new tape—unreleased elsewhere, like any of a million new classical discs; or it is (2) a reissue of material already available on disc. The difference is important.

True, there is a third possibility, which marks the future for us—a simultaneous release on tape and disc, so that neither is an "oldie," a reissue. But this, to my knowledge, is still pretty unusual in the classical area, though I gather that it is already becoming the thing in popular areas.

At this point, a large part of the classical repertory on tape consists of reissues of disced material—taken of course from the original master tapes owned by the disc company. I don't mean to imply that there is any inferiority in quality here—far from it. Indeed, the tape issues are likely to be much superior to the formerly available discs. There is nothing wrong with the idea at all. It was inevitable, needless to say, that tape merchants should first turn to existing taped material for their catalogues and many of them have accordingly

* Harrison Catalog of Recorded Tapes, 274 Madison Ave., N. Y. 16, N. Y.
Fidelivox Recorded Tape Directory, Electrosonic, 7230 Clinton Rd., Upper Darby, Penna.

made tie-ups with disc companies, some of them already productive. (Some of them are, as far as I can see, still mostly on paper.)

Ah, but there's a further rub! One would think that the disc companies themselves would, in due time, turn to recorded tape under their own labels. Many of them have been planning it—just as some have been making two-channel stereo tapes as a matter of safety for some time, though perhaps none have yet been issued. But instead, the disc material is now almost invariably appearing on new tape labels. And in a good many cases the tie-up is not even mentioned, nor is there any indication that the material has formerly been issued elsewhere on another label (disc). (Berkshire tapes are commendably straightforward in this, the name of the original disc company appearing on each tape box.)

I've already wasted—and that is the word—quite some time ploughing through LP disc catalogues in search of various items, arrived on tape, that have had a familiar ring. Haven't I heard this before? In a good many cases I've found them, too, on older discs.

I should say again that there really isn't anything wrong with this sort of reissuing from master tapes of disc companies. And therefore I see no reason why the tape people can't come right out and say what's going on, pridefully. They have nothing to be ashamed of (unless the material is punk—which is another story) and they'd save all of us a lot of needless confusion.

Which brings up a final point, for the moment—reviewing. My twin column on records hasn't done much with tapes so far, and part of the reason is that either the material is not intrinsically up to the standards for disc reviewing (there's a lot of sleazy stuff on tape, alas) or else it is fine material—but not new.

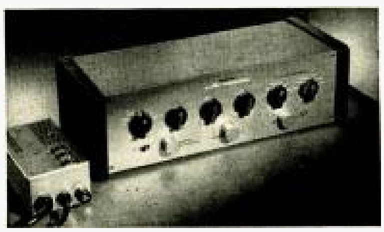
Should we start reviewing these same performances all over again in their tape guise? No. I'd say. Only, perhaps for their technical quality, which should, of course, be automatically better than the equivalent disc, especially in the case of older disc releases, reviewed.

And until the tape companies get themselves organized for regular periodic new releases, like disc companies, (who have been doing that for a half century already) it's hard to cover much ground, systematically. Some tape companies still have the naive idea that all a magazine wants for review is one nice batch of samples of the company's product. They send the samples—and that is that. (And often it doesn't occur to them that perhaps the magazine should choose *which* samples, not them! I get the d—dest things on tape, and miss the d—dest things, too.)

And we still get batches of wonderful, glowing promises and scads of beautiful literature. I'm on all sorts of salesmen's lists, too. Wouldn't AUDIO like to take advantage of their special offer, absolutely free, one 300-foot sample tape, genuine hi-fidelity, and if you don't think it is absolutely the *finest* sound you've ever heard, send it right back and we'll refund every cent of . . . whoops, I forgot it was for free, but anyway, you get the idea.

I don't think the tape boys have quite realized the importance of *content*—what's on the tape. In the end, people buy for content. Quality, hi-fi—yes. But those things should be taken for granted. Content counts.

When content on tape comes to be as valued as is content on disc then we'll be reviewing tapes right and left, and no time left for ruminations like this.



TURNTABLE DESIGN

(*from page 22*)

of these situations are ameliorated, if not eliminated, by the saw guide which is provided with the Turromatic. This consists of a piece of rigid material cut so that the outside contours indicate the general appearance and layout of the top of the table after installation *and* also, the maximum space required *under* the mounting board. Hence, placement of the unit can be determined without error before any cuts are made. The saw guide is also cut out—like a physical template—for the proper shape of the mounting hole and there are holes in it at certain points where nails or screws may safely be inserted to hold it in position.

Installation Simplified

Mounting procedure is, therefore, something as follows: The saw guide is moved around on the proposed mounting board until a satisfactory location, free of obstructions, is found. Nails or screws may be put through the holes provided in the saw guide to hold it securely to the mounting board. The cutout of the mounting board is then started, and all that is necessary is to saw close to the inner edge of the saw guide. It is not possible to make the hole too big, since doing so would require sawing through the rigid material of the saw guide. When the guide is removed the entire table assembly may be lowered through the opening, where it is supported by brackets. After securing the brackets the table top and dress cover are dropped into place and the installation is complete. It will be noted that all of the operations can be performed from above the mounting board, which is a great help in the case of built-in installations.

Performance of the table is excellent in all respects. The measured flutter and wow (all components) of a typical unit

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shows less than 0.1 per cent rms at any speed, which exceeds the requirements for professional tables. The acoustical noise is extremely low and may properly be said to be inaudible. Rumble, as implied earlier, is more difficult to specify in terms which are directly comparable with other published specifications and it is sincerely to be hoped that there will soon be some agreement among high fidelity manufacturers as to standard procedure. But, for illustration, the NARTB requirements for professional and broadcast purposes is 35 db below 1.4 cm/sec peak velocity at 100 cycles per second, with standard playback equalization. Under these conditions the Turromatic measures 37 db. If compared with the more usual 20 cm/sec 1 kc signal played back with standard RIAA equalization it will measure 47 db, and if played back flat, 65 db. If referred to a lower frequency the rating will be correspondingly higher. Since all of these figures refer to the same table, and to one which actual listening shows to be extremely quiet, it will be seen how wide the variation may be in published figures unless the exact reference is specified.

In conclusion, it is felt that this table truly extends to the high fidelity field the performance and convenience features ordinarily associated only with professional equipment. Its introduction should be of interest to owners of high-quality playback equipment for home use—a group of very critical users whose numbers are rapidly (and happily) increasing.

ABOUT MUSIC

(from page 14)

The Sunday Times and in a number of books including, "A Musical Critic's Holiday," Newman has been a lively opponent of the irresponsible, superficial, and untrained elements in his profession, exposing muddled thinking, heaping scorn upon pseudo-technical exhibitionists, and providing a healthy and invigorating force in the musical scene. T. S. Eliot suggested that only two types of men were qualified for criticism: practitioners of the art, and scholars. Certainly the great critics of the past and present fit into one or the other category. Among the scholars (and lest we be snobs, that includes musical journalists) there are the following names: Newman, Alfred Einstein, Donald Francis Tovey, Edwin Evans and W. J. Henderson. Some famous composer-critics were Robert Schumann, Hector Berlioz, and Paul Dukas.

The saying, "You don't have to be a hen to judge an egg," does not quite apply to the field of music criticism. Not that each critic must be an accomplished musician or prolific composer. But he must possess a working knowledge of the history of the art coupled with a fresh approach to comprehensive areas of musical experience.

A beard alone doesn't make a man, neither does a technical and historical background alone make the critic. It would be convenient indeed if scientific yardsticks could be employed in measuring the values of a given work. In music criticism, however, facts play an important though dependent role. There are definite limits to "objectivity" where opinions are concerned. Therefore, two seemingly contradictory factors should be always present in the critic's mind: intuition and logic. Upon this delicate balance rests his ability to form opinions, recognize talent—yes, even genius—and gauge the strength or weakness of a work or performance.

In the eyes of concert managers, the world's leading critics constitute a musical Supreme Court whose decisions will affect the lives and careers of performers for years to come. This unfortunate by-product of music criticism is the one most familiar to the layman who regulates his concert-going to the yeas or nays of the press reviews. More important than the critic's conclusions, however, are the paths along which he travels to reach them. He is no Delphic Oracle. Like Bernard Shaw, he should have no hesitation in saying, "Never in my life have I penned an impartial criticism." At his best, the critic is a happily biased individual whose ideas are engagingly presented, fearlessly launched, and designed to stimulate in the mind of the music lover renewed interest in music and musicians.

PATENTS

(from page 4)

Note that nothing is said about the body being circular or the hole being in the middle. Now nobody can make a wheel *or* a cam of any kind without infringing the claim. And the difference is simply that the invention and its original model are described *less* completely than before.

The same philosophy applies to claims on any kind of invention, from a mousetrap to a computer. The fewer words the better, the less detail the better, for every word and every detail stated constitutes a limitation on the value of the patent—opens a door for others to accomplish the same result just by changing one of the details you so unwisely mentioned!

Now, just to get the Patent Attorneys' Society for Lynching Lay Authors of Legal Material off my neck, let me add that while it is the duty of the attorney to pare down claims and get them as broad and basic as possible, the Patent Office examiner's job is to make sure they aren't broader than they should be. As science advances it becomes harder and harder to put through short, broad claims, so don't blame your attorney if you have invented an improvement on the magnetic material for the coil of a Hartley oscillator and he doesn't successfully claim that you invented the vacuum tube.

But this is important. When reading a claim—your own or someone else's—if you see what appears to be an unnecessary word, do some heavy thinking and consulting, because any unnecessary words or descriptions usually mean a narrowing of the claim. If you are the inventor, this means the patent is worth less to you; if you are trying to avoid infringement, the extra words are often a guidepost indicating a means for doing it.

As has happened before in this series, thanks are again due to George V. Woodling, from whose excellent book, "Inventions and Their Protection," the wheel claim examples were quoted.

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Industry Notes . . .

At a meeting of the **Institute of High Fidelity Manufacturers** held for the election of officers January 11 in New York George Silber of The Rek-O-Kut Company was re-elected president, Walter Jablon of Presto Manufacturing Company was chosen vice-president, and Vinton Ulrich of David Bogen Company was named secretary-treasurer. Chosen to comprise the board of directors, in addition to the president whose membership on the board is provided by the constitution, were Albert Kahn of Electro-Voice, Inc., Sidney Harman of Harman-Kardon, Inc., William Thomas of James B. Lansing Sound, Inc., Avery Fisher of Fisher Radio Corporation, and Joseph Benjamin of Pilot Radio Corporation.

The election represented a 100 per cent vote with all 47 members eligible to vote participating—23 in person and 24 by proxy.

Sidney Levy was elected president, and **Arthur Blumenfeld** secretary-treasurer of University Loudspeakers, Inc., at a recent meeting of the company's board of directors. Both are among the three founders of the company, the other being the late Irving Golin. Having always been "working partners," Messrs. Levy and Blumenfeld will continue actively with the departments they have supervised since the firm was founded—Mr. Levy as director of engineering, and Mr. Blumenfeld as director of production.

ADVERTISING INDEX

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Readers have told us that they often want to know more about some of the items mentioned in the *New Products* and *New Literature* pages of the magazine, but that they do not want to take the time and effort to write to each one of the sources individually to get all the information they need. As a matter of fact, in an average issue there are usually ten items in the *New Literature* column, and between ten and fifteen on the *New Products* pages. It is conceivable that the average reader might want information on at least ten of these items, since they are selected with the interests of most of AUDIO's readers in mind. Thus one would have to have ten envelopes, ten sheets of paper, and ten three-cent stamps, together with the need for writing the ten letters and inscribing each with name and address. We do it all for you, assuming that you are willing to circle the items about which more information is desired and to write your name and address once. We will forward your inquiries to the organization involved, and you will receive the data you want with only one inquiry. Isn't that as simple as A B C?

In just the same way you can get more information about any product that is *advertised* in the pages of AUDIO. Note the page on which the advertisement appears and circle it on the back side of this card. When there are two or more ads on the same page, the page number is followed by a letter, and the designation appears under each individual advertisement. Write your name and address clearly—someone has to decipher it—and it is a good idea to mark the card for all the information you want the first time, for there is only one card in each copy of the magazine. Of course, you *could* subscribe to two copies.

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2	10	33	45	56	60c	63c	64a
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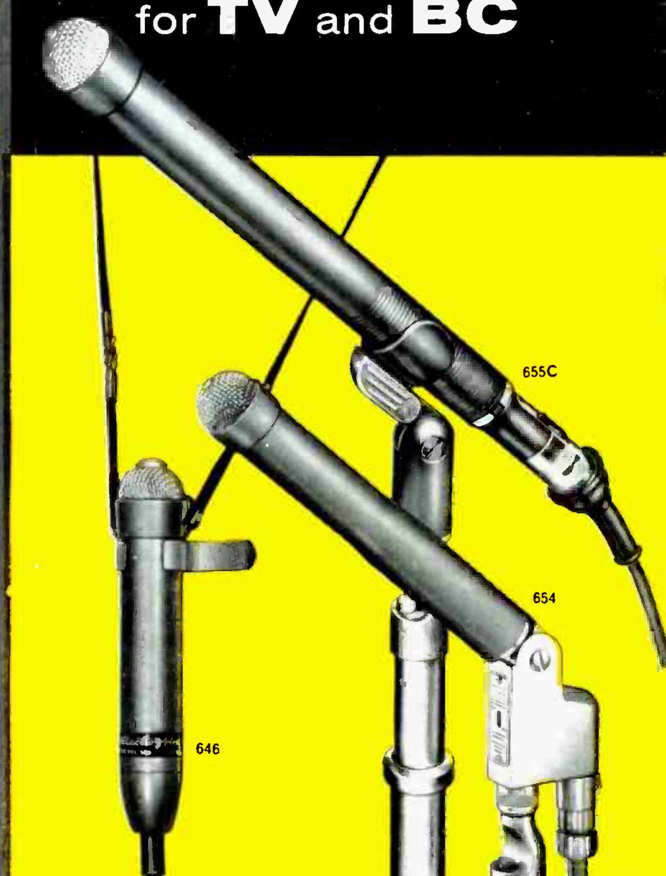

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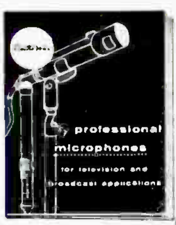

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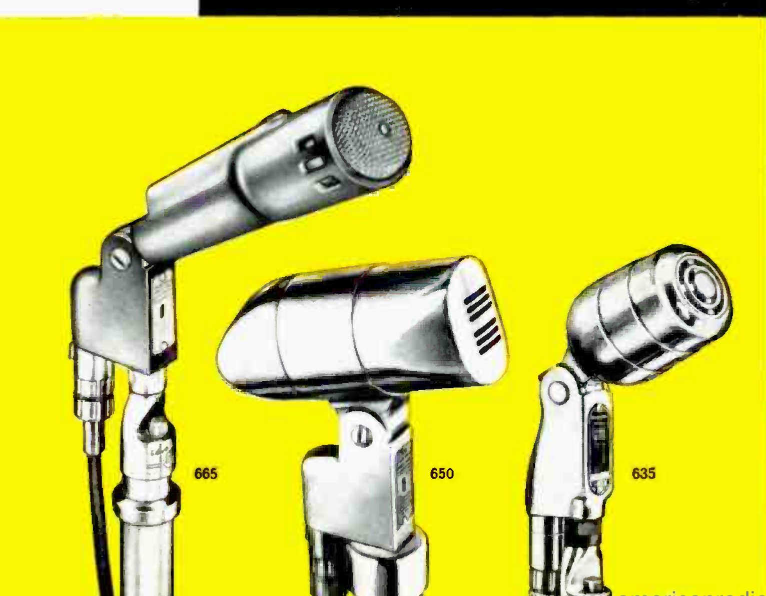

Model 666. Variable D* Cardioid. Response 40 to 15,000 cps. Output level -55 db. Provides high front-to-back discrimination. No proximity effects. TV gray. Weighs only 11 oz. **List Price** .... **$245.**

Model 655C. New Slim-Trim. Response 40 to 20,000 cps. Output level -55 db. Omnidirectional. Easily concealed in studio props. TV gray. 1-in. diam. **List Price** .... **$200.**

Model 654. Slim-Trim. Response 50 to 15,000 cps. Output level -55 db. Omnidirectional. Impedance selector. TV gray. 1-in. diam. **List Price** .... **$95.**

Model 646. Lavalier-type. Response 40 to 10,000 cps. Adjustable for chest use. Output level -55 db. Omnidirectional. TV gray. 1-in. diam. Weighs only 7 oz. **List Price** .... **$140.**

Model 665. Variable D* Cardioid. Response 50 to 14,000 cps. Output level -55 db. Unidirectional. Impedance selector. TV gray. **List Price** .... **$130.**

Model 650. Response 40 to 15,000 cps. Output level -48 db. Omnidirectional. Dual-type external shock mount. Impedance selector. TV gray or satin chrome. **List Price** .... **$150.**

Model 635. "Workhorse" of the industry. Omnidirectional. Response 60 to 13,000 cps. Output level -55 db. Impedance selector. TV gray or satin chrome. **List Price** .... **$75.**

FULL PROFESSIONAL DISCOUNT APPLIES

*E-V Pat. Pend.