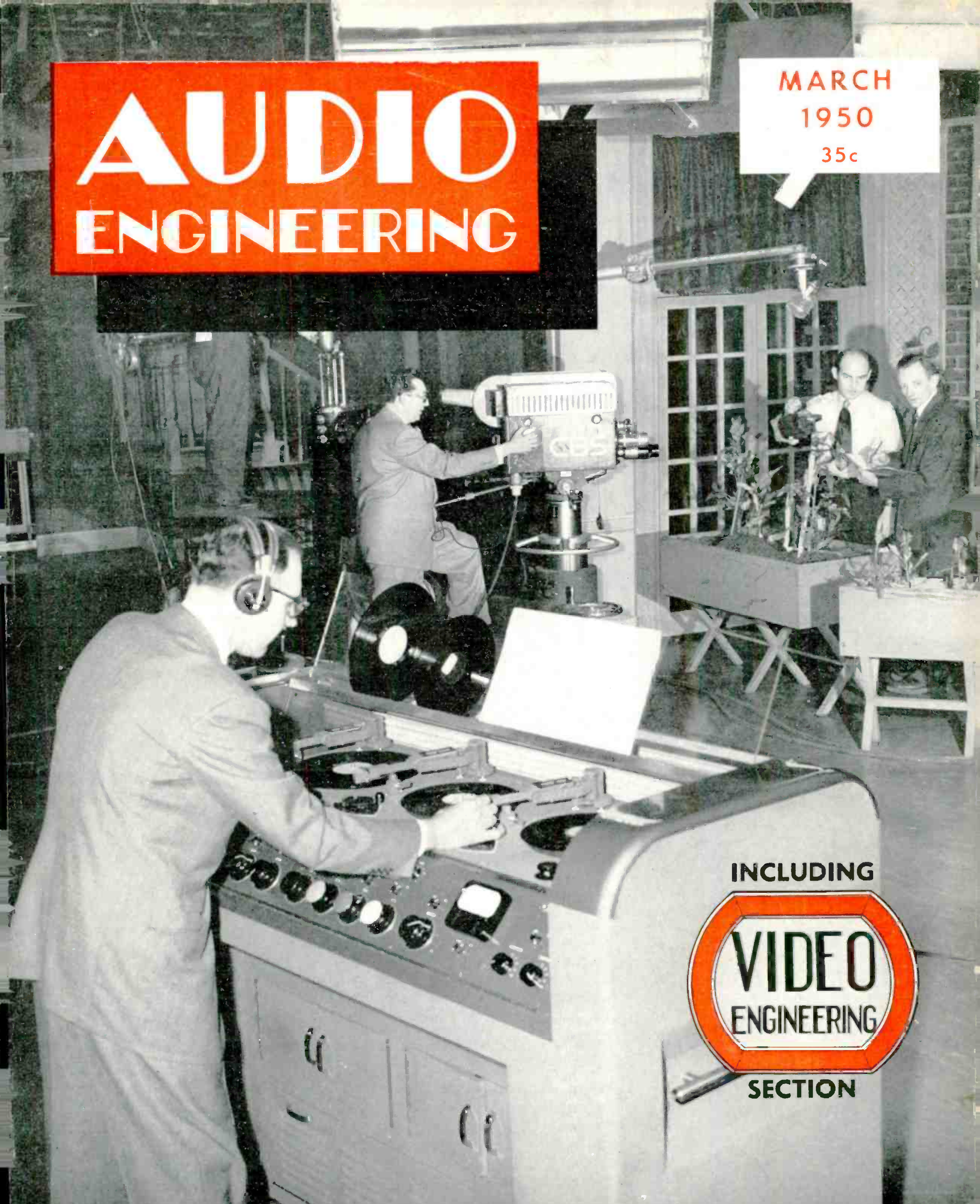
AUDIO ENGINEERING

MARCH 1950
35c



INCLUDING
VIDEO ENGINEERING
SECTION

Published by RADIO MAGAZINES, INC.

What to look for

when you buy recording tape!

THESE PHYSICAL PROPERTIES

Straight-Line Slitting that makes the tape track and wind absolutely flat

Freedom From Curl so that the tape will ride flat over the heads with minimum tension.

Smooth, Non-Absorbent Surface that permits the tape to unwind freely, without any tendency to stick layer to layer.

Uniform Dispersion of Oxide Particles, with freedom from "clumping" which causes high noise level.

Low Surface Friction which results in reduced wear of the magnetic heads.

Strong Adherence of the oxide to the base, so that the coating will not chip or peel off.

THESE MAGNETIC PROPERTIES

Maximum Signal-to-Noise Ratio, for utmost clarity of reproduction, especially on soft musical passages.

Wide Bias Range, with minimum sensitivity to possible fluctuations in amplitude of the machine bias.

Excellent High-Frequency Response, for maximum fidelity where full tonal range is desired.

Low Distortion, for more life-like reproduction of either voice or music.

Freedom From Audible Low-Frequency Modulation Noise. This avoids the rasping hum that is often blamed on the recording machine.

Uniformity of Output, within the reel and from reel to reel—without the frequently-encountered magnetic "weak spots."

AND THESE BOXES

Yes, when you look for these distinctive red and blue boxes you can be *sure* that you're getting all the physical and magnetic properties that are so important for truly fine recording and reproduction. Audiotape is made in our own plant—under our own constant supervision and control. It is manufactured to the same exacting standards of quality and uniformity that have characterized Audiodiscs for the past decade. And *every foot* of Audiotape is monitored for output, distortion, and uniformity — your assurance of the finest, professional-quality tape available anywhere.

●

Try it—and let Audiotape speak for itself! See your Audiodisc and Audiotape distributor. He will be glad to fill your requirements. Or, drop us a line and we'll send you a free 200-foot sample reel of whatever type of Audiotape you're interested in.

PLASTIC-BASE audiotape*

● A plasticized cellulose acetate base with a perfectly smooth surface, permits maximum uniformity of coating thickness, with resulting minimum noise level. Will not stretch or break even at *many times* the maximum tension encountered in service.

TYPE NO.		COATING	WOUND ON REEL WITH
1250 Foot Reel	600 Foot Reel		
1240	640	Black Oxide	Oxide Out
1241	641	Black Oxide	Oxide In
1250	650	Red Oxide	Oxide Out
1251	651	Red Oxide	Oxide In

PAPER-BASE audiotape*

● The base especially developed for Audiotape, is a strong, durable, supercalendered kraft paper which provides the necessary smoothness of texture without the use of any fillers, which either tend to come out or stiffen the paper.

TYPE NO.		COATING	WOUND ON REEL WITH
1250 Foot Reel	600 Foot Reel		
1200	600	Black Oxide	Oxide Out
1201	601	Black Oxide	Oxide In
1220	620	Red Oxide	Oxide Out
1221	621	Red Oxide	Oxide In

NOTE: Audiotape is also available on larger reels. Write for information.

AUDIO DEVICES, INC.

444 MADISON AVE., NEW YORK 22, N. Y.

Export Dept.: ROCKE INTERNATIONAL, 13 East 40th St., New York 16, N. Y.

* *Trade Mark*

THEY SPEAK FOR THEMSELVES

Successor to RADIO

Established 1917

AUDIO ENGINEERING

MEMBER AUDIT BUREAU OF CIRCULATIONS

CONTENTS

MARCH, 1950 Vol. 34, No. 3

COVER

A CBS Type 4A sound effects console, which is fully described elsewhere in this issue, in operation at the WCBS-TV Grand Central studios. Davidson M. Vorhes, manager of CBS-New York Sound Effects Department, is at the controls of the console.

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Ave., Lancaster Pa., by Radio Magazines, Inc., D. S. Potts, President; Henry A. Schober, Vice-President. Executive and Editorial Offices; 342 Madison Avenue, New York 17, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

EDITOR'S REPORT

VIDEO ENGINEERING

PURSUANT TO REPRESENTATIONS made on this page for the last two months, this issue contains the first appearance of VIDEO ENGINEERING—a magazine within a magazine. It is directed to engineers in broadcast and TV stations and engineers engaged in receiver, transmitter, and component manufacturing. Readers will note that this issue contains 72 pages; of these, 52—slightly more than usual—are devoted to audio, and the remaining 20 are devoted to video and are separately paged. Audio-minded readers will also note that video material is contained completely within its own section—they may possibly read it, or they may ignore it, or they may even cut it out. May we respectfully suggest, however, that the first issue of AUDIO ENGINEERING is now quite scarce?

Many readers have come to feel that Æ is *their* magazine—which is as it should be. We sincerely hope that the new section will achieve as much esteem in as short a time. Although planned originally as a quarterly supplement, VIDEO ENGINEERING is already growing—its next appearance will be in the May issue.

"AUDIO IN ENGLAND"

In an endeavor to bring news of audio from overseas, we recently solicited an article from H. A. Hartley, and it ran under the above title in the January issue. It now appears that there is some difference of opinion on this subject, as evidenced by a number of letters and one cablegram. One manufacturer mentioned in the article by implication has asked for an opportunity to state his case just as openly, and next month you can read his views on this subject.

Readers are left to judge this matter on its merits. Æ, with no ax of its own to grind, will try to present all sides, and still more viewpoints will be welcomed from anyone in England—individual, manufacturer, executive, or audio hobbyist—who may agree or disagree with Mr. Hartley or any of the others who may register their opinions.

As an afterthought, though, is there no audio activity in other countries?

BUSINESS IS GOOD

Operative X99 has perused a number of financial statements for the past year, and reports that by and large business *was* good during 1949. But he also reports a trend which is in contradiction to this condition. It seems that there is a growing tendency to put off the purchase of needed test equipment until it becomes absolutely indispensable, with the result that engineers must necessarily improvise equipment at three or four times the cost of available apparatus, and with much less reliability and performance. This practice makes it necessary for one technician to borrow a meter from another—almost to the point of interrupting work—instead of employing another unit from the instrument stock. When the user must put together some test equipment from available material rather than get a specialized instrument for the work, he is most certain to spend much more in time and material than the apparatus would cost if purchased in completed form from a reputable manufacterer.

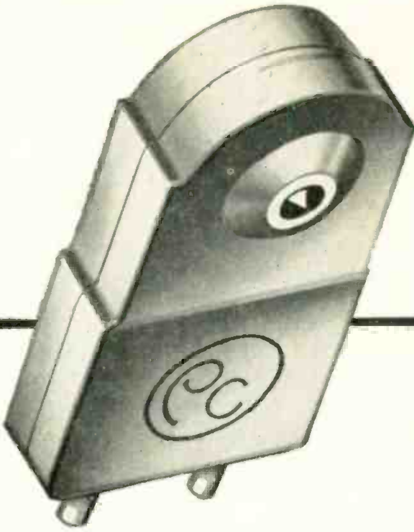
This attitude is primarily one of management, rather than of engineers, and it is suggested that a survey be made of instrument requirements and inventory, and that needed equipment be ordered. In many instances apparatus of this type is made to order, and not stocked where it may be purchased over the counter. For this reason, it is necessary to anticipate the needs well in advance to ensure that the equipment will be available when wanted.

George O. Milne

It is with deep regret that we must chronicle the passing of a friend and fellow worker, George O. Milne, who died Saturday, January 28th, in a Miami Beach hospital of a heart attack.

Born in Mamaroneck, N. Y., on September 21, 1902, and educated in Paterson, N. J., grammar and high school, Milne was a real pioneer in the radio industry. With the National Broadcasting Company in the twenties, he played an important part in setting up the technical facilities for network broadcasting. He entered radio in 1923 as maintenance man for WEAF, and for four years occupied a wide variety of positions, advancing in 1928 to operations supervisor. In 1930 he was named division engineer for NBC, where he remained until 1942 when he joined ABC, then the Blue Network, as director of technical operations, a position he filled until his death.

Milne was one of the engineers responsible for the formation of the Audio Engineering Society, and was a senior member of the Institute of Radio Engineers and a member of Radio Pioneers.



PICKERING PICKUP CARTRIDGES FOR THE FINEST AUDIO QUALITY

No other Pickup will reproduce LP records with the fidelity of Pickering Cartridges . . . they are the most widely used by record manufacturers, recording studios, broadcasters and music enthusiasts who demand the effect of a live performance from their records.

The nearest approach to a live performance is a recording played by a system equipped with Pickering High Fidelity Audio Components . . . Speaker, Cartridge, Arm, Preamplifier, Record Compensator, etc.

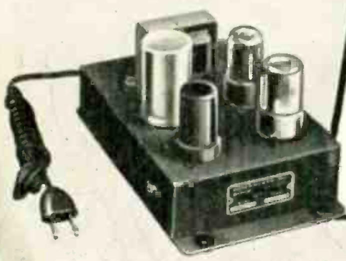
Pickering Cartridges Series 120 and 150 are for standard records . . . Series 140 are for microgroove records . . . They track with phenomenally low record wear and virtually eliminate harmonic and intermodulation distortion as well as frequency discrimination . . . all Pickering Cartridges available with either sapphire or diamond stylus.

LOUDSPEAKER MODEL 180L

Designed to satisfy the musical ear. A low-cost high quality loudspeaker with smooth wide-range response (within 5 db, 45 to 12000 cycles) and low distortion . . . the only loudspeaker with acoustically adjustable bass response . . . occupies less floor space than any other high quality loudspeaker — less than one square foot.

RECORD COMPENSATOR MODEL 132E

This compensator, with 6 positions of equalization, provides the flexibility required to properly equalize for the different recording characteristics used by various record manufacturers . . . it is a most important addition to record playing systems using magnetic pickups.



PREAMPLIFIER MODEL 130H

This preamplifier represents the most advanced design ever achieved in phonograph preamplifiers . . . it equalizes the bass response of records and transcriptions and provides the necessary gain for high quality magnetic pickups . . . its intermodulation and harmonic distortion is exceptionally low — better than most professional equipment.

PICKUP ARM — MODEL 190

The only arm specifically designed for optimum performance on both microgroove and standard records.

- Statically balanced to eliminate tendency to skip when jarred.
- Minimum vertical mass to track any record without imposing extra vertical load on grooves.
- Sensitive tracking force adjustment.
- Magnetic arm rest.
- Rugged frictionless bearings.
- Plug-in cartridge holder.
- One-hole mounting — self-contained levelling screws.

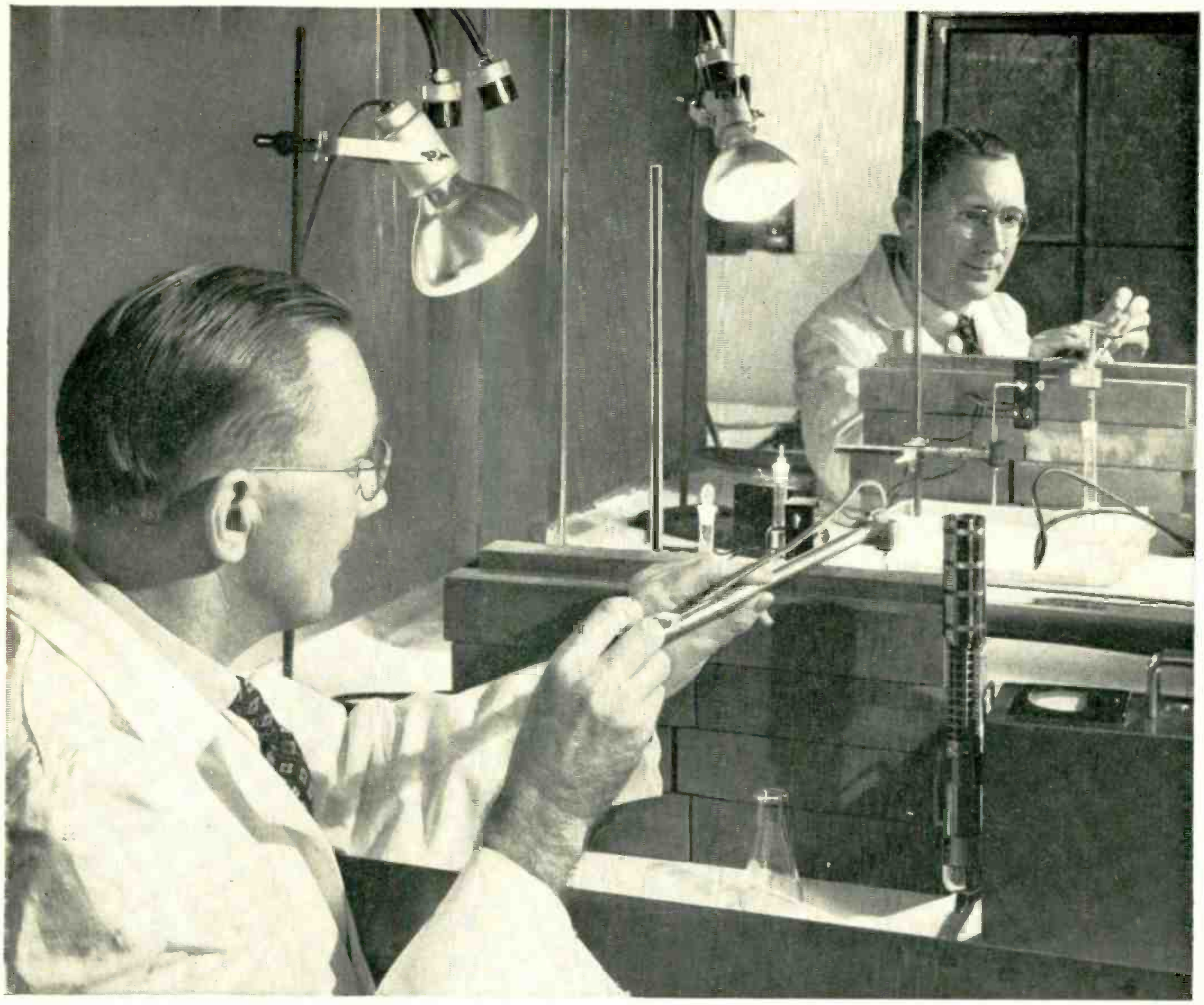
Cartridges used with this arm require 50% less vertical tracking force than when used in conventional arms.

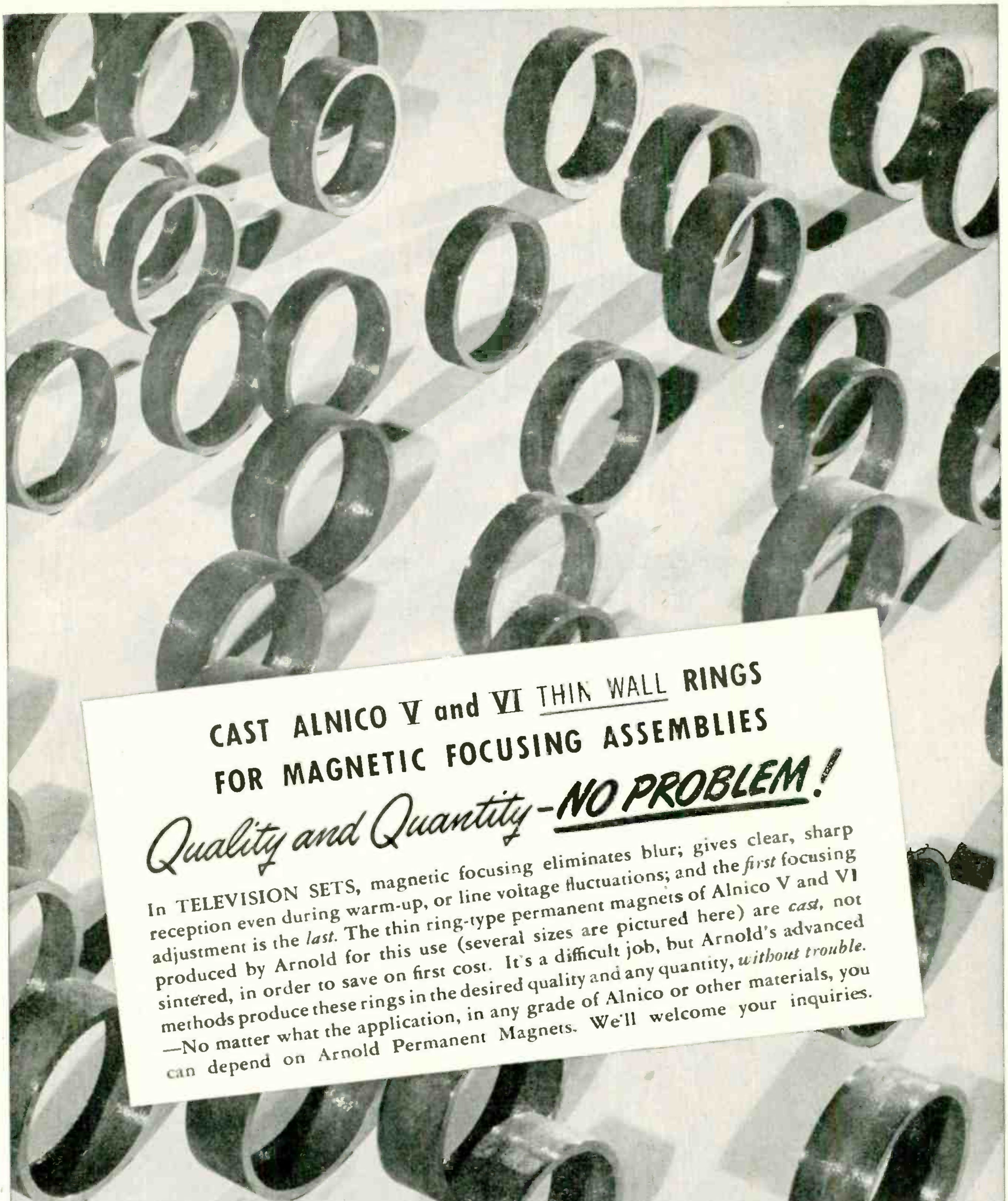
Pickering & Company, Inc.

Oceanside, N. Y.

For the finest audio quality specify Pickering Components

Pickering High Fidelity Components are available through leading jobbers and distributors everywhere . . . detailed literature will be sent upon request.





THE ARNOLD ENGINEERING COMPANY

Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

LETTERS

Record Dust

Sir:

While dust may be avoided to a great degree in the care of master lacquer discs, the playback grindings that form in the base of grooves and which retard quality in the making of quiet dubs is a greater obstacle. The conventional "atom" brush recently announced apparently does no more than take care of dust and does not remove these grindings which constitute a time-honored headache; cold-water washing is also of little value. While good quality velvet is a fair help, the use of it does hardly more than pile the grindings still within the grooves.

We are interested in knowing if any other recordists have discovered a cure for this problem, and would appreciate any information available.

C. E. Benton
26 Espy Road,
Caldwell, N. J.

Bright Eyes

Sir:

I am a constant reader of your magazine, and enjoy it because of its balance between the theoretical and the practical.

In the January issue, page 24, reference is made to *Fig.* 7. I was unable to locate this figure, and couldn't find any connection in the written material with *Fig.* 6

D. L. Ackworth, Chf. Engr.,
Radio Station WRSW,
Warsaw, Indiana

(This can happen, and occasionally does. For his alertness, Mr. Ackworth has been sent a reprint of the entire article, which includes Fig. 7. However, we believe the mention of Fig. 6 is contained in the second column of page 24. Ed.)

Canby Fan

Dear Mr. Canby:

Good Work Deserves A Pat On The Back—You Are Doing Fine, Keep It Up. . . .

In Retrospect, I Can Chuckle Over Your Often Written Remark That You Are Not An Engineer. At First I Thought It Was Your Modesty That Was Responsible For The Prefacing Remark—After Purchasing Nearly Every Gadget You Write About, I've Discovered It Was Not Modesty—You Are Honest—You Are Not An Engineer. I Have So Many Tone Controlling Devices, Etc., I Am The Only One In The Family Who Can Operate—"The Machine." Undaunted And Loyal To You, I Have Sent For The Loudness Control—Some Day One Of These Gadgets Will Make A Discernible Difference And My Faith In You Will Be Justified. . . .

Thanks Again, And Congratulations On The Good Job You Do Each Month.

Victor W. Sisung,
52A Hillcrest Village
East Lansing, Michigan

RCA Remote Amplifier
Type BN2A
—with self-contained battery kit

Now—this remote amplifier

✓ operates from a self-contained battery
✓ operates from an a-c line

Here it is—RCA's Portable Remote Amplifier type BN2A, with the new self-contained battery kit. It is the same in every respect as the standard BN2A amplifier, but it provides instant selection of a-c or battery operation—with everything in one package, *batteries and all.*

The new self-contained battery kit is actually a top cover which replaces the one on the standard amplifier. The kit includes: a-c receptacle, ac-dc selector switch, battery holder, new cover, and handle—yet the assembly is so compact that it adds only ⅝-inch to the overall height of the original amplifier.

NEW LOW PRICES* Type BN2A

- With standard cover . . . $425.00 (*less tubes*)
- With self-contained battery kit . . . $462.00 (*less tubes and batteries*)

Take advantage of the best buy in remote amplifiers . . . at new low prices. Order your BN2A Remote Amplifier . . . either the standard or the self-contained battery model . . . from your RCA Broadcast Sales Engineer. Or order from Dept. 7C, RCA Engineering Products, Camden, N. J.

SPECIAL! **New Battery Cover Kit—**

—for owners of the standard BN2A Remote Amplifier

- ✓ Remove present cover
- ✓ Slip new kit cover into place
- ✓ No tools needed

PRICES*

Battery Cover Kit (less batteries), MI-11279 $37.00

Standby Battery Kit, MI-11281 $7.66

**Prices apply only within continental U. S. A.*

AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

FREED *Instruments & Components*

Famous for • QUALITY • ACCURACY • DEPENDABILITY

"PRODUCTS of EXTENSIVE RESEARCH"

"Q" INDICATOR

No. 1030 FREQUENCY RANGE: From 20 cycles to 50 kilocycles. "Q" RANGE: From 0.5 to 500. "Q" of inductors can be measured with up to 50 volts across the coil. Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dielectric losses, and power factor of insulating materials.

INCREMENTAL INDUCTANCE BRIDGE

No. 1110 IMPEDANCE RANGE: One mh. to 1000 h. in five ranges. Inductance values are read directly from a four dial decade and multiplier switch. This range can be extended to 10,000 henries by the use of an external resistance.
INDUCTANCE ACCURACY: Within plus or minus 1% through the frequency range from 60 to 1000 cycles.

NOW AVAILABLE

SUB-MINIATURE HERMETICALLY SEALED J.A.N. COMPONENTS FOR SPACE SAVING APPLICATIONS.

Sub-miniature Hi-Q Inductors featuring toroid coils — Diameter: 7/8" x 1" high. Hermetically sealed. Compression type terminals.

Sub-miniature hermetically sealed transformers—Diameter: 13/16" x 1" high . . . Glass type terminals.

Sub-miniature transformers with octal sockets.

ALSO .... MAGNETIC AMPLIFIERS DISCRIMINATORS AND NARROW BAND PASS FILTERS FOR TELEMETERING APPLICATIONS. Send us your requirements.

A NEW LINE OF HIGH FIDELITY OUTPUT TRANSFORMERS

High quality output transformer combines unusually wide frequency range together with very low phase shift and harmonic distortion. Frequency range 1/2 Db 20-30,000 cycles.

Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	± 1/2db from	Maximum level
F1950	Push pull 2A3's, 6A5G's, 300A's, 275A's, 5A3's, 6L6's	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 6A5G's, 300A's, 275A's, 5A3's, 6L6's	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250 6V6, 42 or 2A5 A prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's, 300A's, 5A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's, 300A's, 5A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

SEND FOR LATEST CATALOG!

FREED TRANSFORMER CO., Inc.

DEPT. MA 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK

Magnetic Recording in Motion Pictures

M. RETTINGER*

PART I. The fundamental aspects of magnetic tape recording, particularly for motion pictures, including a description of magnetic recording, reproducing and erasing head construction, and a discussion of a.c. biasing, together with experimental results.

The purpose of this paper is to outline the present state of magnetic tape recording. While much of the following is applicable to wire recording, too, emphasis is given to magnetic tape—particularly plastic tape with a ferro-magnetic coating—since it has brought about a revival of this sound recording method. Wire recording has been known for over 50 years and is still employed extensively, but it was tape which, by its non-twisting character and easy means of splicing, has engendered an increased interest in magnetic transcriptions.

In the past, high-quality recording of sound was effected chiefly by optical means, as in the case of motion picture sound film recording, and to a lesser degree, by mechanical devices, as in wax disc recording (although lacquer disc recording has produced very notable quality, too). *Figure* 1 shows advantages and disadvantages for optical and magnetic recording.

* *Engineering Products Department, RCA Victor Division, Hollywood 28, California.*

TABLE I

	Perpendicular	Transverse	Longitudinal
Advantages	Constant-aspect ratio[2]	Constant-aspect ratio	May be used with wide coated tape
Disadvantages	Not suitable with coated tape	Requires narrow tape to avoid spreading of flux lines with resulting poor high frequency response	Aspect ratio decreases with frequency

In magnetic recording, the signal along the sound track takes the form of variations in the remanent magnetization of the magnetic medium. Three types of magnetic recording are recognized—longitudinal, perpendicular, and transverse. When the recording medium is tape, longitudinal recording exists when the magnetic force is parallel to the direction of motion of the medium; perpendicular recording occurs when the magnetic force is perpendicular to both the direction of motion of the tape and the face of the tape; transverse recording is produced when the magnetic force is perpendicular to the direction of motion of the medium and parallel to the face of the tape.[1] The three types of recording are illustrated in *Fig.* 2. When the recording medium is a round wire, transverse and perpendicular recording are equivalent. Table I shows the advantages and disadvantages of the various types.

	Optical Recording	Magnetic Recording
Advantages:	1. No direct contact between modulator and film. 2. Ease of duplication—direct contact printing. 3. Permits visual inspection of developed sound track.	1. Permits immediate monitoring of recorded sound-track. 2. No processing required. 3. Sound-tracks may be erased. 4. No noise reduction amplifier required. 5. Track has no definite overload point. 6. No optical system required. 7. No exposure lamp or power supply for it required. 8. Recorder unit need not be light-tight. 9. No light-tight film magazines required. 10. No light-tight film loading facilities required.
Disadvantages:	1. Requires developing before playback. 2. Track itself cannot be monitored immediately. 3. Medium must be handled in the dark. 4. Unexposed film has expiration date. 5. Recording apparatus more expensive.	1. Head contacts film—producing wear, clogging problems. 2. Sound track cannot be easily and accurately inspected.

Fig. 1. Compilation of advantages and disadvantages of both optical and magnetic recording methods.

Terminology

While a technical discussion of magnetic recording might well be prefaced by a definition of magnetic terms, *Fig.* 3 illustrates the more common designations. Currently, three systems of electromagnetic units are in use: the c.g.s., the nonrational m.k.s., and the rational m.k.s. Engineering texts, usually, employ the c.g.s.; physics books, including Prof. G. P. Harnwell's well-known "Principles of Electricity and Magnetism," use the "rational," while others employ the "non-rational." Table II gives conversion factors for the units of the three systems.

It should be noted that remanent and residual induction are the same only when, in a closed magnetic circuit (that is, in one without free poles), the mag-

[1] Suggestions have been advanced to reverse the meanings of transverse and perpendicular recordings as defined in the past and above. See N. M. Haynes, "Magnetic Tape and Head Alignment Nomenclature." Audio Engineering, June, 1940.

[2] By aspect ratio is meant the ratio of length of magnet (λ/2) to width of magnet (width of sound track). The smaller this ratio is, the greater is the tendency for the individual magnets to demagnetize themselves. Constant aspect ratio is not necessarily an advantage unless the ratio is such that demagnetization is not serious. If the ratio is such that demagnetization exists at all frequencies, the output voltage at the low frequencies will also be down, and noise will become a greater problem.

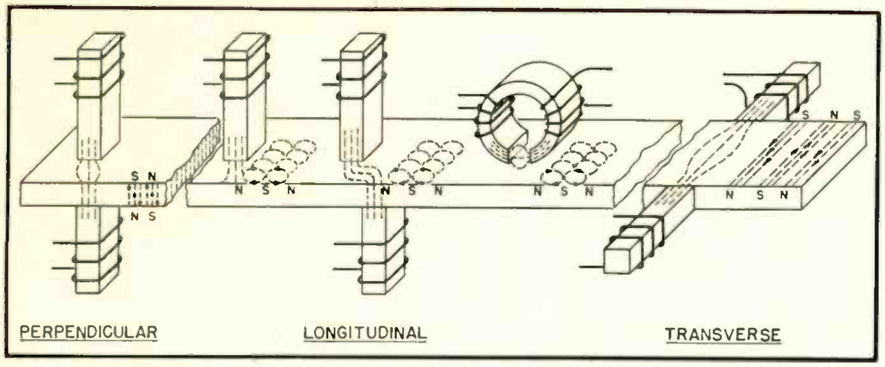


Fig. 2. Diagram to illustrate three types of magnetic recording.

netizing force is reduced to zero. When this is not the condition, as when the ferromagnetic core has an air-space, the flux per unit area remaining in the core when the external magnetizing force has been removed, is spoken of as the remanent induction, since it exists in the presence of a demagnetizing force. Thus, the sound track of a magnetic recording is characterized not by a variation of residual induction of the medium, but by a variation of remanent induction.

The flux in the iron placed within a coil may be considered to be made up of two fluxes—one set up by the circulating atomic currents in the iron and the other set up by the magnetizing coil current, acting on a vacuum. This can be expressed by the equation

$$B = \beta + \mu_o H$$
$$\text{or } \beta = B - \mu_o H$$

where B = flux density, gauss
μ_o = permeability of vacuum, gauss/oersted
H = magnetizing force of magnetizing coil, oersteds
β = intrinsic flux density, or flux density caused by the currents in the iron, gauss

Figure 4, applicable for powdered iron media, shows a plot of β, and it is seen that the intrinsic flux density for high magnetizing forces becomes constant, and that the "intrinsic coercivity" is greater than the normal maximum demagnetizing force. Powder-coated tapes usually have a coercivity of from 100 to 500 oersteds and a remanence varying from 300 to 1000 gauss.

It appears natural in a description of magnetic recording to mention first the construction of the elements employed in the process and then to explain their functions. The following, therefore, contains first a description of conventional magnetic recording and reproducing heads, which is followed by a discussion of the recording and reproducing process, together with experimental results. It may also be said that magnetic recording is still in its infancy and that improvements in both its theory and practice are likely to occur.

Ring-Type Recording and Reproducing Heads

In magnetic recording and reproducing heads of the ring type, the magnetic material forms a quasi-toroidal enclosure with one or more air-gaps. The

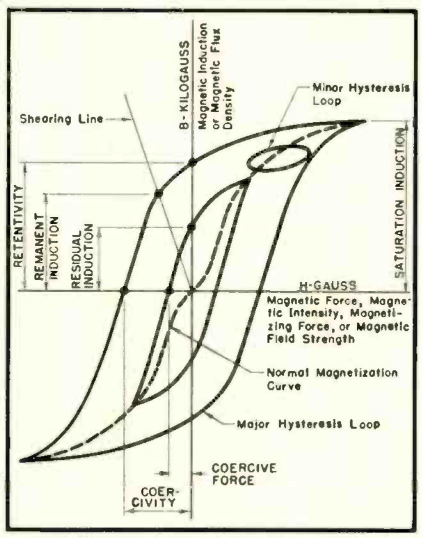


Fig. 3. Typical hysteresis curve showing designations commonly employed in magnetic recording literature.

magnetic medium bridges one of these gaps, commonly spoken of as the front gap, and contacts the structure on one side only. When a second gap is inserted in the core so as to divide it into two symmetrical halves, the second interstice may be termed the back gap. Each hiatus usually contains a nonmagnetic spacer—the "front" and "back" spacer—although some ring heads have butt joints. One or more coils may be wound around the core, and the entire head assembly is usually placed in a mumetal can to act as magnetic shield. It is the purpose of the following to discuss various features of such magnetic recording and reproducing heads.

The inductance of the head varies with the thickness of both the front and back gap spacers. *Figure* 5 shows the variation in inductance of a typical head. It is obvious that increasing the thickness of either spacer will lower the inductance. Curves of *Fig.* 5 were obtained by supplying constant current through the windings of the coil. It will be found that, in general, the inductance of the head varies somewhat with both frequency and current, as will the a.c. resistance and the "Q" of the coil. This is illustrated in *Fig.* 6. It is, of course, desirable to make these quantities as independent of these parameters as possible to avoid the necessity of equalizing networks in the circuit. The wire for the "recording" coils should also be thick enough to carry sufficient audio and bias current for saturating the recording medium without unduly heating the head.

Knowing the inductance of the toroidal head, it is possible to calculate the effective permeability of the construction. For the simple case of butt joints at the front and back gaps, the permeability at the appropriate maximum alternating flux density is approximately given by

$$\mu = \frac{Ll10^8}{.4\pi N^2 A}$$

where L = inductance of head (henries)
N = number of turns
A = cross-section of iron (not including the area of insulation between the laminations), cm^2
l = length of magnetic circuit in iron, cm

Similarly, if the permeability of the ring is known, the inductance may be determined by

$$L = \frac{.4\pi N^2 \mu A}{l} 10^{-8}$$

where the letters refer to the same quantities as before. *Figure 7* gives both accurate and approximate flux and inductance formulae for toroids of circular and of rectangular limb cross-sections.

When the inductances of the two coils have been measured separately, or when the number of turns of each coil is

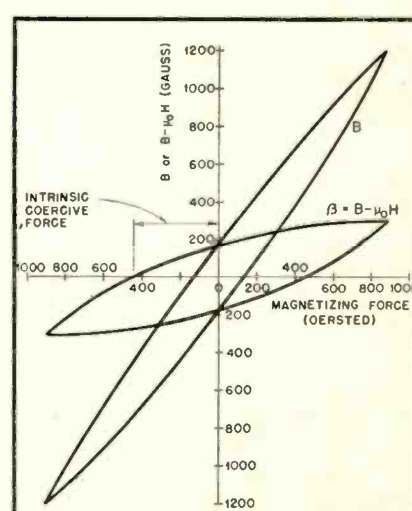


Fig. 4. Plot of curves for B and β.

TABLE II

C.G.S. VALUES	NON-RATIONAL M.K.S. VALUES	RATIONAL M.K.S. VALUES
m.m.f. = 1 gilbert	= 10 pragilberts	$= \frac{10}{4\pi}$ ampere-turns
= .1 "	= 1 "	$= \frac{1}{4\pi}$ "
$= \frac{4\pi}{10}$ "	$= 4\pi$ "	= 1 "
R = 1 magnetic ohm	$= 10^9$ (n–r) m.k.s. units	$= \frac{10^9}{4\pi}$ (r) m.k.s. units
$= 10^{-9}$ "	= 1 "	$= \frac{1}{4\pi}$ "
$= 4\pi 10^{-9}$ "	$= 4\pi$ "	= 1 "
ϕ = 1 maxwell $= 10^8$ "	$= 10^{-8}$ webers = 1 "	$= 10^{-8}$ webers = 1 "
H = 1 oersted	$= 10^3$ praoersteds	$= \frac{10^3}{4\pi}$ ampere-turns/meter
$= 10^{-3}$ "	= 1 "	$= \frac{1}{4\pi}$ "
$= 4\pi 10^{-3}$ "	$= 4\pi$ "	= 1 "
B = 1 gauss $= 10^4$ "	$= 10^{-4}$ webers/square meter = 1 "	$= 10^{-4}$ webers/square meter = 1 "
μ = 1 gauss/oersted	$= 10^{-7}$ webers/praoersted sq. meter	$= 4\pi\ 10^{-7}$ webers/meter amp.-turn
$= 10^7$ "	= 1 "	$= 4\pi$ "
$= \frac{10^7}{4\pi}$ "	$= \frac{1}{4\pi}$	= 1 "

m.m.f. = magneto-motive force
R = reluctance
ϕ = flux
H = magnetizing force
B = induction
μ = permeability

known, and the coils are then placed in series, the total inductance is not proportional to the square of the combined number of turns, but must be determined separately. The total inductance is given by

$$L = L_1 + L_2 + 2M$$

where L_1 = inductance of one coil
L_2 = inductance of the other coil
M = mutual inductance

Magnetic recording heads of the ring-shaped core type are usually constructed with a low-impedance winding, and reproducing heads with a high-impedance winding. The reason for the low-impedance winding of the recording head is that the line to the head has a certain amount of capacitance, which represents a leakage path for the high-frequency bias current if such is used. If the recording head had a high-impedance winding, the line leakage would constitute a considerable loss. In the case of the reproducing head, where no bias frequency is employed, a high-impedance winding on the head is satisfactory.

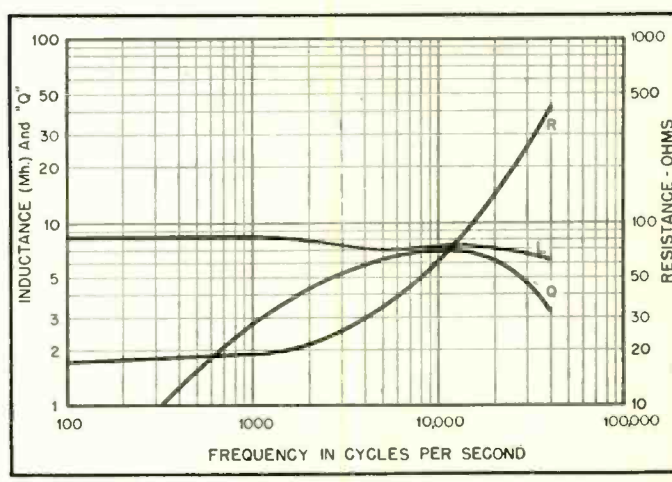


Fig. 6. Impedance characteristic of a typical recording head.

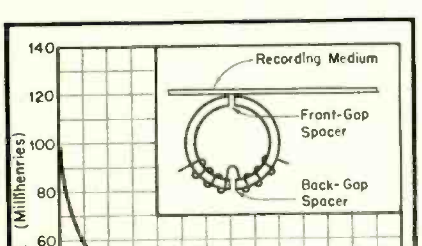


Fig. 5. Curves showing effect of gap dimensions on inductance of typical head.

Front Gap

Figure 8 shows the variation in flux distribution about the front gap of a ring-type magnetic recording head in the absence of a recording medium when spacers of different thickness are inserted in the gap. The spacer serves the double purpose of maintaining the air gap parallel and to avoid the accumulation of ferrous dirt, which would change the performance characteristic of the head. The figures, obtained by maintaining constant voltage across the head, indicate that considerable leakage flux exists about the gap even when a butt joint is used. While a 1-mil spacer shows greater leakage flux than a half-mil spacer, a loss of high frequencies would result if the 1-mil head were used for reproducing. It has been determined[3] that the output of a reproducing head varies as

$$20 \log \frac{\sin(\pi d/\lambda)}{(\pi d/\lambda)}$$

where d = effective gap length (note that the gap length is actually the shortest dimension of the parallelepiped air-space)
λ = recorded wavelength

A minimum exists where $d/\lambda = 1$ (see *Fig.* 9). In the case where the medium travels with a velocity of 18 in. per second, a frequency of 15,000 cps would have a wavelength of 18/15000 = .0012 inches, so that it might be assumed that a gap length less than this magnitude would be sufficient to "resolve" such a wavelength. However, since the effective length of such slits may be from 10 to even 100 per cent greater than the actual gap length, a spacer of the order of .0005 inches or smaller is commonly employed when reproduction of 15,000 cps is desired.

Measurements have shown that the shapes of the curves of *Fig.* 8 remain substantially independent of frequency as long as core saturation is prevented.

The curves for *Fig.* 8 were obtained by moving the head past a single loop search coil of #46 Formex wire. The

[3] Wien Schott, "Einfluss der Schragstelling des Spaltes bei Intensitatschrift," *Zeitschrift der Tech. Physik,* V. 17 (1936) p. 275.

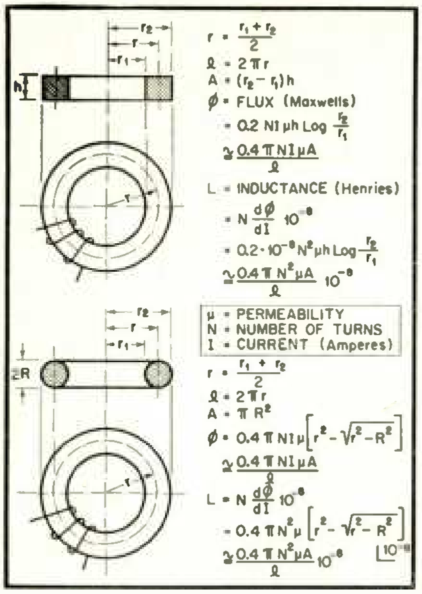


Fig. 7. Formulas for inductance and flux of toroids of circular and rectangular sections.

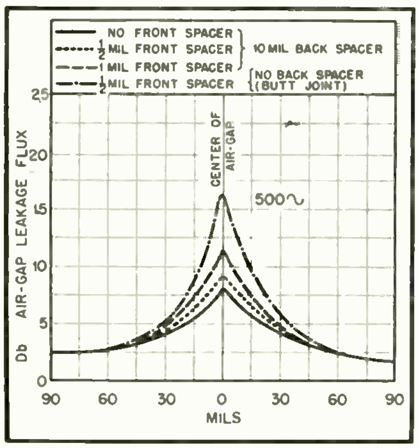


Fig. 8. Effect of gap width on flux distribution about the front gap of a ring head.

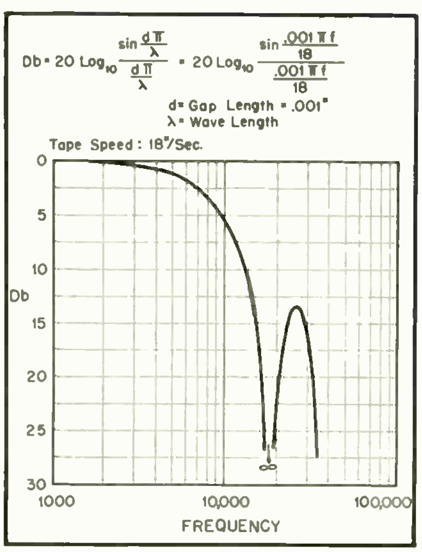


Fig. 9. Typical output curve for 18-in./sec. tape speed and gap length of .001 in., with formulas for calculating loss due to gap.

head was fastened to a brass rack, and the pinion for the rack was driven by the curve recorder; in this manner, a measure of the distance traversed by the head was secured on the curve paper.

It should be noted again that the curves were obtained without a magnetic medium over the gap. Hence, they are useful chiefly for comparing different heads, and do not necessarily show the actual leakage flux distribution when the head is in operation—that is, when magnetic tape is lying on the head or when it is passing over it. No experimental method has come to the writer's attention which will measure the flux distribution in the presence of a magnetic medium over the gap. It is believed that the flux distribution will be somewhat altered in the presence of a tape over the gap.

It may be observed that the curves of *Fig.* 8 are practically symmetrical. Clark and Merrill[4] have noted that when this is not the case—as when one side of the "branch" is much steeper than the other—it makes a considerable amount of difference in the resulting frequency response in which direction the tape is passed over the head. In particular, when the "entering" half of the branch is steeper than the "leaving" half, the high-frequency response is less (due to an erasing action of the trailing edge) than when the tape is passed in the other direction, where the "leaving" edge of the branch is steep.

In a ring-shaped recording head such as shown in *Fig.* 5, the inductance is approximately given by:

$$L_1 = \frac{KN_1^2}{r_1 + R_1} \text{ henries}$$

[4] D. L. Clark and L. L. Merrill, "Field Measurements on Magnetic Recording Heads," *Proc. I. R. E.*, December, 1947.

where r_1 = reluctance of front gap

$$= \frac{l}{wd}$$

l = gap length, cm
d = gap width, cm
w = gap depth, cm
R = reluctance of back-gap

$$= \frac{l_0}{w_0 d_0}$$

l_0 = gap length, cm
w_0 = gap width, cm
d_0 = gap depth, cm
N = number of turns
K = constant

The above equation is true as long as the reluctance of the core material is small compared to the reluctances of the gaps.

Likewise, the inductance of another similar head is given by:

$$L_2 = \frac{KN_2^2}{r_2 + R_2}$$

or

$$\frac{L_1}{L_2} = \left(\frac{N_1}{N_2}\right)^2 \frac{r_2 + R_2}{r_1 + R_1} \quad \ldots\ldots (1)$$

The action of a reproduce head may be explained by means of *Fig.* 10A. Assuming the tape to be a constant flux generator providing a flux ϕ_0, we have across the tape head a magneto-motive force equal to:

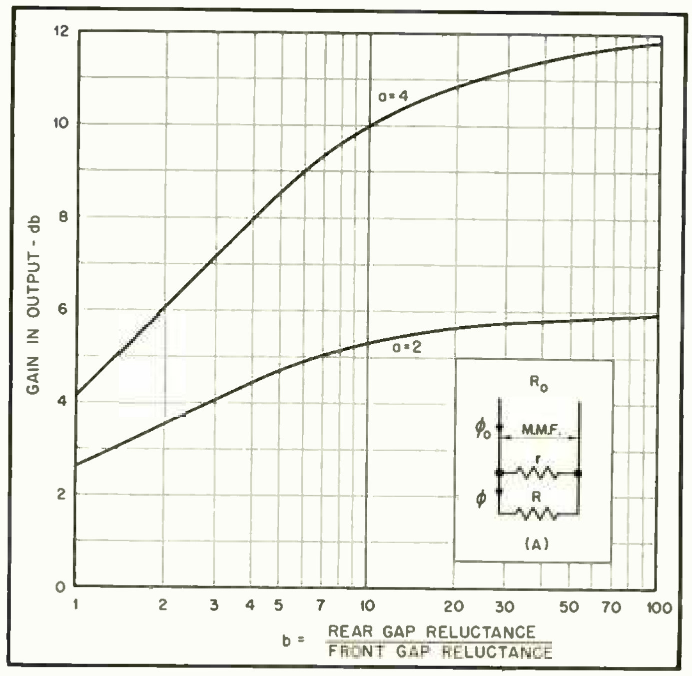
$$M.M.F. = \phi_0 R_0 = \phi_0 \frac{rR}{r+R} = \phi R$$

$$\phi = \phi_0 \frac{r}{r+R}$$

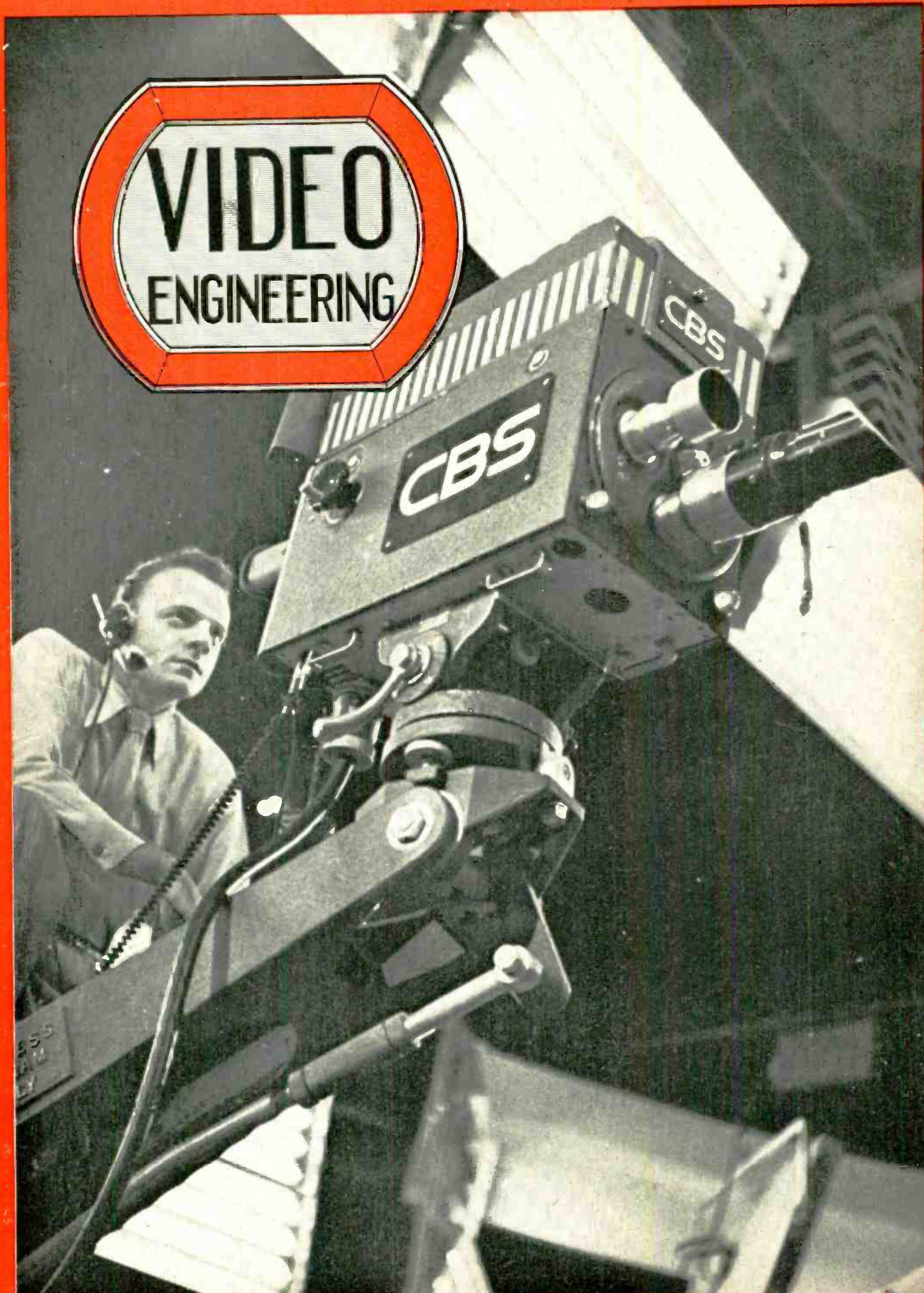
where ϕ = flux through the core
r = reluctance of front gap
R = reluctance of rear gap plus core reluctance

[*Continued on page 32*]

Fig. 10. (A, insert) Equivalent circuit for magnetic tape as a generator acting upon head gaps. (B, graph) Effect of varying front and rear gap reluctances.



VIDEO ENGINEERING



VIDEO ENGINEERING

SECTION OF

AUDIO ENGINEERING

C. G. McProud, Editor
Luci Turner, Edit. Prod. Mgr.
David Saltman, Production Manager
E. E. Newman, Circulation Manager

D. S. Potts, Publisher
S. L. Cahn, General Manager
H. N. Reizes, Adv. Mgr.
Harold J. Weisner, Asst. Circ. Mgr.

Editorial Advisory Board
Howard A. Chinn
Rodney D. Chipp
Robert M. Morris
Chester A. Rackey

Representatives
Sanford R. Cowan, Mid-West Sales
342 Madison Ave., New York 17, N. Y.
James C. Galloway, Pacific Coast Sales
816 W. 5th St., Los Angeles 17, Calif.
Technical Book & Magazine Co.
297 Swanston St., Melbourne, C. I.
Victoria, Australia

CONTENTS

MARCH, 1950

COVER

Image Orthicon camera on the stage of a CBS television theatre studio. Slim-line fluorescent light fixtures overhead and on the balcony front provide a large-area diffuse source of evenly distributed base-light.

Advertising Index

PROBLEMS IN ENGINEERING usually involve two parts: *what* to do, and *how* to do it. The first may be said to be a matter of technical policy; the second, of detail. The following material is concerned primarily with *what* to do and is intended to point out some fundamental video system requirements and to discuss means of dealing with them. Although they may seem to bear more directly on the larger than the smaller systems, actually the principles discussed herein can be applied to any video system for television operation, whether large or small.

Simplicity and straight-forwardness are important in proper system design. It is always possible to throw together a "gadget" to fit whatever operational exigency may come up, but it takes much thought and often considerable courage of conviction to understand and sell the ultimate advantage of simplicity. Stating it in another way, good technical design requires not only that the machine be designed to fit the process, but also that the process be altered, within reason, to enable simplifying the machine.

The television business, being in a state of expansion and requiring large capital investments in equipment as compared to sound broadcasting, invites technical short cuts. Attractive, expedient, and clever as they may seem for the present, they cannot but be wasteful ultimately in that many replacements and re-buildings will be required before a proper arrangement is arrived at by trial and error. Furthermore, short cuts, inadequate facilities, and unsound equipment arrangements must be made up for by man power—the most expensive of all operating cost items. It is the problem of the system design engineer to avoid this and of management to understand and support good engineering practice.

Video System Requirements

A video system for modern television broadcasting must include facilities for:

1. Direct (live) program pickup.
2. Televising of 35 mm and/or 16 mm film and slides, strips, and opaques.
3. Control and assembly of the various video sources composing the complete program.
4. Termination and control of outgoing circuits to a local transmitter and to the network.
5. Termination, processing, and control of incoming circuits from remote field pickups or from the network.
6. Output (Master Control) switching by means of which local programs can be conveniently routed into outgoing circuits.
7. Local, spot, "cut-in" or other announcements or programs involving fractions of a minute.

Last, but not least, the system should be so designed and laid out that reasonable expansion can be provided at minimum expense and maximum convenience.

Video Sources and the TV Program

A complete television program is an assembly of material from several video sources. Examples of such sources are:

1. Studio cameras.
2. Film and slide cameras.
3. Incoming field pickup programs.
4. Incoming network programs.
5. The output of a complete secondary studio.
6. The output of a complete film studio.
7. The output of an "effects" studio.

A video source, as distinguished from a video program, may be defined as program material that requires further processing or combination with other video souces before it can be delivered into a switching system for subsequent routing to a local transmitter or to a network.

As an example of the assembly of a television program, it may contain first, a film trailer introduction including the sponsor's advertising material; second, dissolve to a performance in a live studio; third, dissolve, switch and fade among the cameras therein; fourth, switch to a field pickup; fifth, switch back to the studio; sixth, dissolve to a slide in a remote film studio; and seventh, end with a dissolve to a film trailer containing the final commercial and sign off.

Following the close of this program is another program, presumably from another studio. Usually, however, there is an interval of perhaps a half minute between programs during which system identification, local station identification, and usually one or more "spot" announcements are made.

The program described above may be perhaps somewhat more complicated than the average, but in any proper system the technical equipment must be so arranged and the operating personnel so organized that assemblies of program material of the same general nature can be handled with convenience, speed and safety.

Although various combinations may be used on different programs, all *complete* programs are assemblies of various single program elements or sources. Sometimes even the assembled output of a second studio may be used as an insert element or source in assembling the final program in the studio of which the output is on the air. This might occur when breaks in a dramatic action are required to provide for noisy re-arranging of lights or scenery or take care of a sequence in which smoke, dust, or other visible diffusion is used and would interfere with the action in the main studio.

Supervision of Program Assembly

Since the production of a television program is an assembly technique, adequate supervision is necessary to insure that the final product is technically, ar-

C. A. RACKEY

A delineation of the fundamental requirements for a complete television broadcasting plant.

Chester A. Rackey, Manager of Audio and Video Engineering, National Broadcasting Company.

The usual early experiments with electricity led Mr. Rackey into amateur radio through spark transmitters, and into era of c.w. and phone, and thence into professional radio operating including several trips to sea. Following this, he attended Renssalaer and Brooklyn Polytechnic Institute.

He started his career as technical assistant at the West St. laboratories of Western Electric Co. and later conducted early tests on selective fading at AT&T's WEAF. He joined NBC at its start in 1926 and operated both at studios and transmitter, becoming successively Plant Engineer, Design Engineer, and Audio Facilities Engineer. He is presently responsible for design, standardization, construction, and installation of audio and TV equipment, systems, and related physical properties.

Mr. Rackey was in direct charge of design and construction of all sound and TV plants of NBC from 711 Fifth Avenue through Radio City to the five new NBC TV plants at Hollywood, Chicago, Cleveland, Washington, and New York. He is a Senior Member of I.R.E., Governor of A.E.S., Chairman of R.M.A. Committee on Broadcasting Practices, member of R.M.A. Audio Facilities Committee, etc., and is on the Editorial Advisory Board for "Video Engineering."

Basic Video System Planning

tistically, and commercially acceptable. Present practice in this respect requires the presence of a program director and a technical director.

The function of a program director is to supervise and direct the production of the complete program. This includes such things as rehearsing action, determining camera shots and effects and their timing, and, on the final rehearsal or show, cueing the actual switching, fading, and dissolving of the various camera shots or other program sources composing the program.

The function of a technical director is to supervise operation of the technical equipment used in the program. This includes adjustments of cameras and control equipment, both audio and video, placement of lights and microphones, consultation with the program director with respect to new or unusual effects that may be required, cueing technical personnel, and, last but not least in present practice, the actual operation of pushing buttons and turning knobs to switch, fade, dissolve, and wipe the video source elements of the program.

The Program Assembly and Control Point

The foregoing leads us to a consideration of what is perhaps the most important technical unit in the entire television system, the Program Assembly and Control point, hereinafter abbreviated "PAC." The PAC, therefore, is the facility at which the program and technical directors do their work, and its basic function is to provide a convenient means for monitoring, switching, fading, and dissolving the program sources for assembly into the complete program.

By further definition, a PAC is the locus of all the fundamental video apparatus normally located within a television studio control booth or within a television film control booth. From the standpoint of understanding the make-up of a television system, however, the concept of a PAC as a unit is not necessarily associated with any studio, either film or live, is important.

Whether PAC is part of a live studio, or a film studio, or stands alone as a facility at which a number of field program sources may be combined with some local originations is of little importance system-wise. One or more PAC's not associated with any type of studio will generally be found necessary in a television system of any scope since, basically, any show dealing with outside pickups and requiring local film or slide inserts and live announcements should be handled through an isolated PAC. Such use of this facility is not only a fundamentally correct operating procedure, but also saves valuable space by dis-associating it from a studio, either live or film. Where a live announcement or opaque display is required, a small "commentator" type booth equipped with one or two cameras should be the program source; where a slide or a film trailer are elements, one of several camera chains in a film studio group may be split off for this purpose.

A proper plant would have all PAC's essentially alike as to layout and controls so that a crew of program and technical personnel entering any PAC location to do a show would have the advantage of familiar and standardized equipment to work with. This matter of standardization pays off in other respects, among those being easier and better maintenance, interchangeability of equipment, more attention applied to a single unit in design and construction, and so on.

Technically, a PAC consists of a video (and also an audio) control console with preview and "line" or complete program monitoring with push buttons and knob controls for selecting, fading, dissolving, wiping, etc., any of the program sources composing the complete program. It is a basic element of a television system and is the facility on which a maximum of design attention should be concentrated. Not only is this true from a strictly technical standpoint, but also from the standpoint that is *the* facility at which the non-technical personnel associated with a television program—the producers, directors, advertising agency representatives and, last but not least, the Clients—are in physical contact with, and literally in control of, the television system. It is largely at this point that the entire technical plant and services of a broadcasting organization are usually judged, and it is essential that its appearance, operating convenience, and picture and sound monitoring quality be of the best.

In motion picture production, the final product is an assembly of parts, often widely spaced as to location and time. In television, program assembly at the time the action is going on is *it*. It is an on-the-spot, one-shot process with no opportunity to stop and deliberate, and, therefore, the facility at which this process takes place is of vital importance. Nowhere are clumsy, inadequate, and inconvenient technical arrangements sensed by the paying clientele as quickly as at the program assembly and control point.

Master Control

Master Control is the location at which local, incoming, and outgoing program circuits are converged so that they may be interconnected, processed, monitored, and tested. The two major portions of a Master Control facility are, first, the output (channel) switching control and, second, a transmission section.

In general, all arrangements, controls, and techniques at Master Control should be designed so that timed action ("hot switching") is not required. This is the location at which all operating circuits are to be prepared deliberately and in advance, on a pre-set basis, the personnel in charge thereafter monitoring the various operations as they take place, standing ready to correct faulty operation or to remedy equipment faults as they may occur. Timed action should be the responsibility entirely of the operation staff at the various PAC's.

By such means not only is a logical and straightforward separation of the relative duties of the transmission and operating personnel arrived at, but it also enables economy of man power at Master Control, since many operations per man can be safely performed on a pre-set basis, whereas the number that can be performed on a "hot switch" basis is obviously limited.

Output (Channel) Switching

An arrangement must be provided so that the output of any PAC can be conveniently connected to any outgoing channel. This arrangement should be capable of handling the initially installed number of PAC's plus a reasonable additional number for expansion, with the same provision for outgoing channels. Such provision should be made at the outset since it is practically impossble to design a good channel switching system, especially one for video, which is also conveniently expandable, and the difference in original cost for the essential equipment to be held in reserve is comparatively small.

As mentioned above, Master Control switching should be handled on a pre-set basis, the PAC's being previously

Basic Video System Planning

tied together with some form of *ready* circuit so that the passing of the channel from the ending program to the beginning program is triggered by either a clock switch or the crew of either one or the other of the PAC's. If the latter system is used, the pass is best made by the operator of the ending program since, in that case, occasional run-over is most conveniently handled.

In the design of a video operating system, the concept of *preparation* and *operation* is an important one from the standpoint of proper division of labor with resulting over-all smoothness and efficiency. The Master Control personnel, both switching and transmission, are to be responsible primarily for the preparation of the system technically in advance, thereafter passing it to the PAC operator in proper condition and ready for use. At the proper time, determined by the operating personnel or by the clock switch, the controls are triggered off and the system is in use.

The Transmission Section

At the transmission section are to be located all inter-studio and other necessary patching facilities. Such patching is not only to take care of replacement of defective equipment items but, primarily, the interconnection and routing of various video sources into the PAC. This is convenient at this point since the camera relays and other video source switching relays and associated equipment are best located at Master Control, for reasons to be described later.

Here also can be located the terminal patching and processing facilities for incoming and outgoing channels, Telco video lines or radio links. Processing here refers particularly to incoming circuits which may require sync signal rehabilitation, noise clipping, etc. If many incoming channels are being handled, it will be found convenient to install a small auxiliary switching system or "dummy" PAC into which several incoming lines may be patched in advance and switched to the actual PAC to use them, merely by pushing a button. With such a system, a switchable picture and scope monitor can be worked in to provide a very convenient form of monitoring and testing during processing and, as may be required in emergencies and otherwise, while the incoming program is actually on the air.

Pulse Timing and Sync Insertion

The various output signals of the synchronizing generator, known generally as "pulses," serve to time horizontal and vertical beam deflection in the camera tubes, kinescopes, and iconoscopes. These pulses provide blanking where required and also provide the main synchronizing signal to be superimposed on blanking so that the deflection oscillators in the receivers are kept in step with the transmitted picture. The position and tolerance of this synchronizing signal, with respect to the leading edge of blanking, is important and is specified by the F.C.C.

Good switching practice requires that each video source arrive at the switching point in frame to within a very small tolerance, for otherwise synchronization will be affected, resulting in "page skipping" a loss of frame at the receiver, especially on the newer "flywheel" synchronized types. Not only for switching between program sources, but especially for laps and dissolve is matched framing or phasing required. If the operations are between the cameras in a single studio, no problem is involved since all the units will have a common pulse feed and hence will be in phase. If, however a video source from a film studio or some other studio in a remote part of the plant is to be included among the sources to be lapped and dissolved, these sources would usually be out of phase with the local video source unless special provisions were made to insure correct phasing.

One of the simplest and most practical methods of effecting correct phasing among all the video sources in the different studios of a plant is to establish a common timing point. This can be accomplished by locating the video source switching relays for all PAC's at a single point and physically so close together that inter-patching connections between studios will be so short that pulse timing is unaffected materially. To compensate for the various distances of the different studios for the common timing point, various compensating degrees of delay can be introduced into the pulse distribution system to those studios. In effect, all pulses must be delayed to match the studio which is farthest from the common timing point. Delay networks can be used for this purpose, but a simpler and much less expensive technique is to interpose the proper lengths of the same type of cable as is normally used for pulse distribution. This time-equalizing loop of cable can readily be coiled within a small box and panel mounted, if desired.

Synchronizing Signal Insertion

The problem of where in the video system to insert the synchronizing signal can be made quite intricate if all the possible locations and their various special requirements, advantages, and disadvantages are considered. This statement is not made ironically, but rather to emphasize that many schemes are possible and that perhaps a good approach is to consider at what point in the system it would be an advantage to have a complete signal. From a practical standpoint, that portion of the system at which the program sources are monitored for selection and combination seems a good location for sync insertion since, with the exception of the actual camera control monitors. which are usually pulse driven, it enables flexible use of a comparatively large number of switchable monitors which can operate on a complete signal and do not require a separate pulse drive for each unit.

One practical scheme of this sort is to combine the sync signal with the output of the amplifier terminating the bus leading to the camera switching relays of the PAC system. In such case it will be necessary to arrange to remove the sync signal when a field program is switched into the PAC since such signal is complete in itself.

Local Announce Facilities

Program time, both in sound broadcasting and television, is usually sold and scheduled with the idea that it start at a definite time—on the hour, half-hour, or a lesser unit of time—but that it end a fraction of a minute short in order to allow time for local station identification, cues and, last but not least, short commercials or "spot" announcements. The short time allowed for such program material makes it impractical to accommodate it within a pre-set-and-interlock-type channel switching scheme, since it would involve Master Control in a virtual "hot" switch. Since the number of *separate* local or spot announcements is very limited in the average plant, usually one and practically never more than two, and since usually only one outgoing channel is affected, such program material fits in well with "flash" or channel-intercept type of operation.

In channel-intercept switching, the channels to be furnished with local announce or spot program material are routed through break-in relays (or can be looped through double throw switches) in such manner that when the short announcement is to be made, the channel is interrupted and its outgoing leg connected to the output of the PAC associated with the local announce booth or studio. If desired, Master Control can be equipped to pre-set the channels to be interrupted, thus retaining the desirable pre-set and supervisory feature but without, of course, interlock. By this is meant that once channels have been pre-set to the local announce PAC, it can—if it is off time—interrupt an actual program from another studio, a contingency which is prevented in a normal switching system. It may be questioned as to why an interlock cannot be arranged to operate between programs. This is not practically possible, because one of the advantages of a cut-in system is that it can be used for flash news announcements and the like even during an actual program. In such cases, the interlock would have to be arranged to be removable at choice, and an interlock that can be cut out is no interlock.

Television Audio

An audio system which is necessary approximately parallels the video system, and it must interlock with the latter at some points. It is obvious that at output or channel switching, the audio and video circuits of a single program should operate in unison. It also is advantageous in the case of the film projection channels that the sound and picture channels be locked together. Many fairly simple relay schemes can be devised to deal with these two cases. In the case of the live studio pickup, however, simultaneous video and audio switching combining microphone and camera seems less desirable as based on present day experience. Generally a standard mixer type of audio console will be found flexible and useful, since some program conditions sometimes require more than one mike to a single camera and for others a single mike may suffice for several cameras. A requisite of a good audio console for television is a substantially larger number of mixer positions than the average number used for standard audio broadcasting, for several microphones on several sets may be used in one show. It follows that a much greater number of microphone outlets and circuits to the console must be provided also, together with patching facilities so that these outlets can be routed to the available mixer positions.

Conclusion

A functional diagram of a video system embodying the features discussed above is shown in *Fig.* 1. As mentioned above, the same general principles apply to a small system as to a larger one, and there is much to be gained as to operating convenience, economy, and safety, and with respect to the possibilities for proper expansion, by following some basic system principles and avoiding the expediencies that may ultimately prove to be limitations.

In any plant it is good practice to isolate, within reason, the controls of different system functions. In the large plant the channel switching may, for example, be a separate console in Master Control. In the smaller plant, where PAC and Master Control are at the same location, it should, at least, be a separate panel within convenient reach and not just a few buttons or switches located where some unused panel area is available. Such a panel could easily be made large enough to accommodate a few extra inputs and outputs to be held in reserve for expansion. Similarly, a small set-up of convenient facilities for patching, testing, and processing a few incoming programs, whether by Telco lines or by radio relay link, will be found very useful.

Many other similarities between the large and small system will suggest themselves and prove of advantage for comparatively small additional cost. A most important factor is to realize that the system, as compared with the component, is a special case and requires for its planning a different type of approach. This type of approach can best be described as a review of what is to be done in a particular operation setup so that a technical policy—based not only on the present requirements but also upon probable future requirements—can be set up. Once this is realistically accomplished, the details usually begin to fall into place.

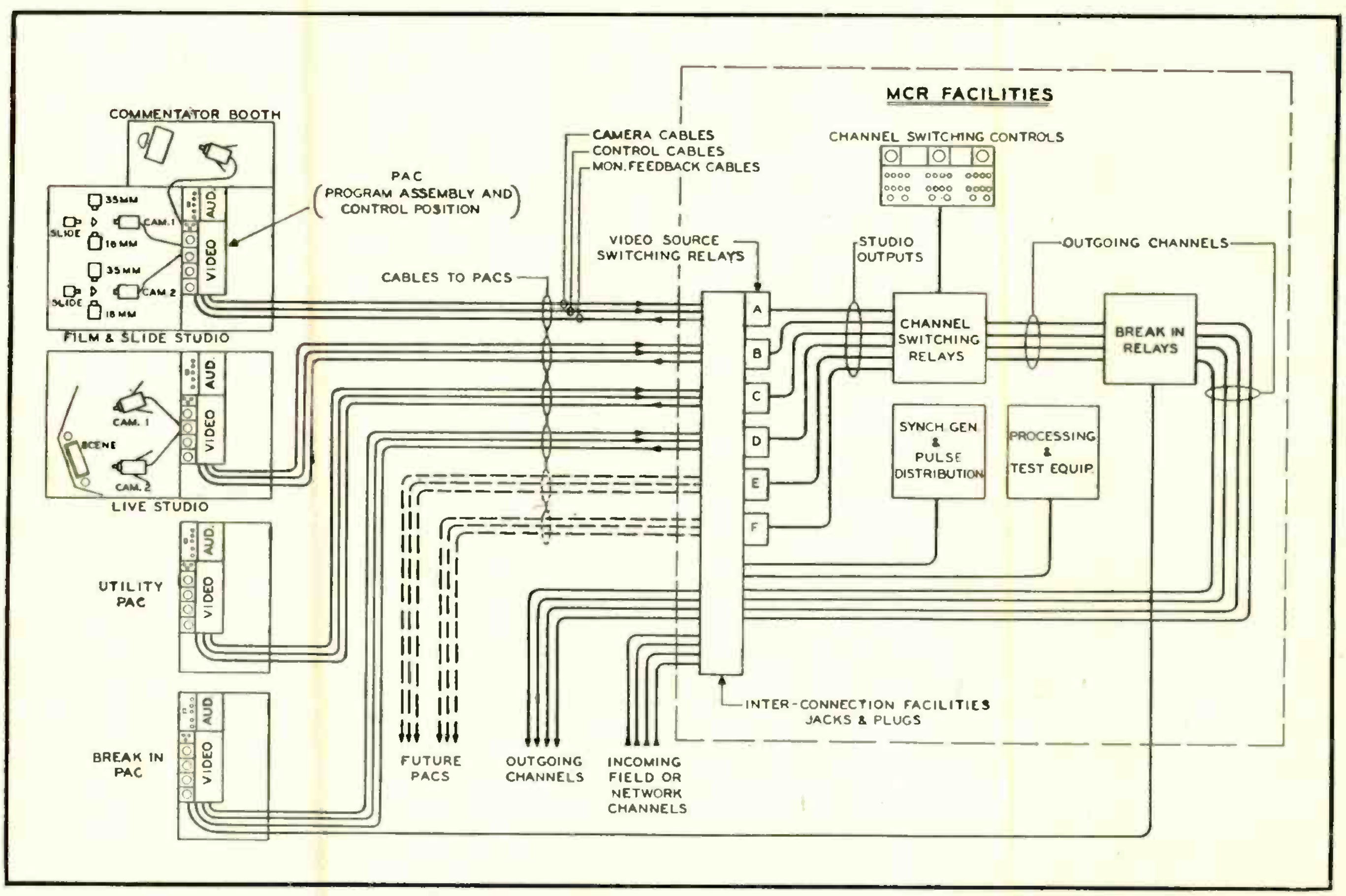


Fig. 1. Block diagram of the equipment necessary for a well integrated television plant.

VINTON K. ULRICH*

A practical discussion of methods which can be used to reduce costs while increasing picture size.

Public demand for larger screens is the greatest single force driving manufacturers of TV receivers to switch to larger picture tubes, but the economic problems are still important and consumer cost cannot be allowed to increase appreciably, if at all. The extra cost of building sets with bigger pictures must be saved by resorting to efficient designs which give the required sweep width and the necessary anode voltage with a minimum of tubes and components.

The "receiver" portion of a TV set is fairly well standardized by now and does not lend itself to much further simplification. Assuming the use of intercarrier sound, which is economical with respect to tubes, there are still at least two tubes in the tuner, three more in the i.f. amplifier, two in the video amplifier—including a combination video detector and d.c. restorer—and at least three in the audio and ratio-detector driver stages. With one rectifier tube, this reaches a total of eleven, which is almost an irreducible minimum. Some saving may be possible in *tubes* and *space* by employing crystal rectifiers, but so far this has not served to reduce *cost* appreciably. Economy measures must be practiced elsewhere, and the sweep and high-voltage section must be attacked, together with the picture tube and possibly the cabinet.

Rectangular Tubes

The use of the new Hytron 16RP4 and 16TP4 rectangular, all-glass picture tubes makes for a saving in several ways. Obviously, the rectangular cross-section occupies less volume, since unused portions of the tube at the top and bottom are eliminated, thereby permitting the use of a cabinet having less height. The use of a wider deflection angle appreciably shortens the tube, resulting in a further saving in the cabinet due to decreased depth, and the all-glass construction makes a tube self-insulating, thereby eliminating the cost of separate high-voltage insulation and special mountings. Furthermore, the internal capacitance from anode to outer coating—always present in the 10- and 12-inch types—is still available as an element in the high-voltage filter.

The rectangular tube also permits the design of a cabinet having more pleasing height-to-width ratio, as well as a lesser depth, both of which are desirable from the consumers' viewpoint. Further, these tubes are produced with a neutral-density filter in the face plate which noticeably increases the contrast ratio by reducing the ambient light reflection from the screen material.

It is the intent of this article to show how to utilize these rectangular tubes to take advantage of the above-mentioned cost-reducing features, plus further sav-

* *Chief Commercial Engineer, Hytron Radio & Electronics Corp., Salem, Mass.*

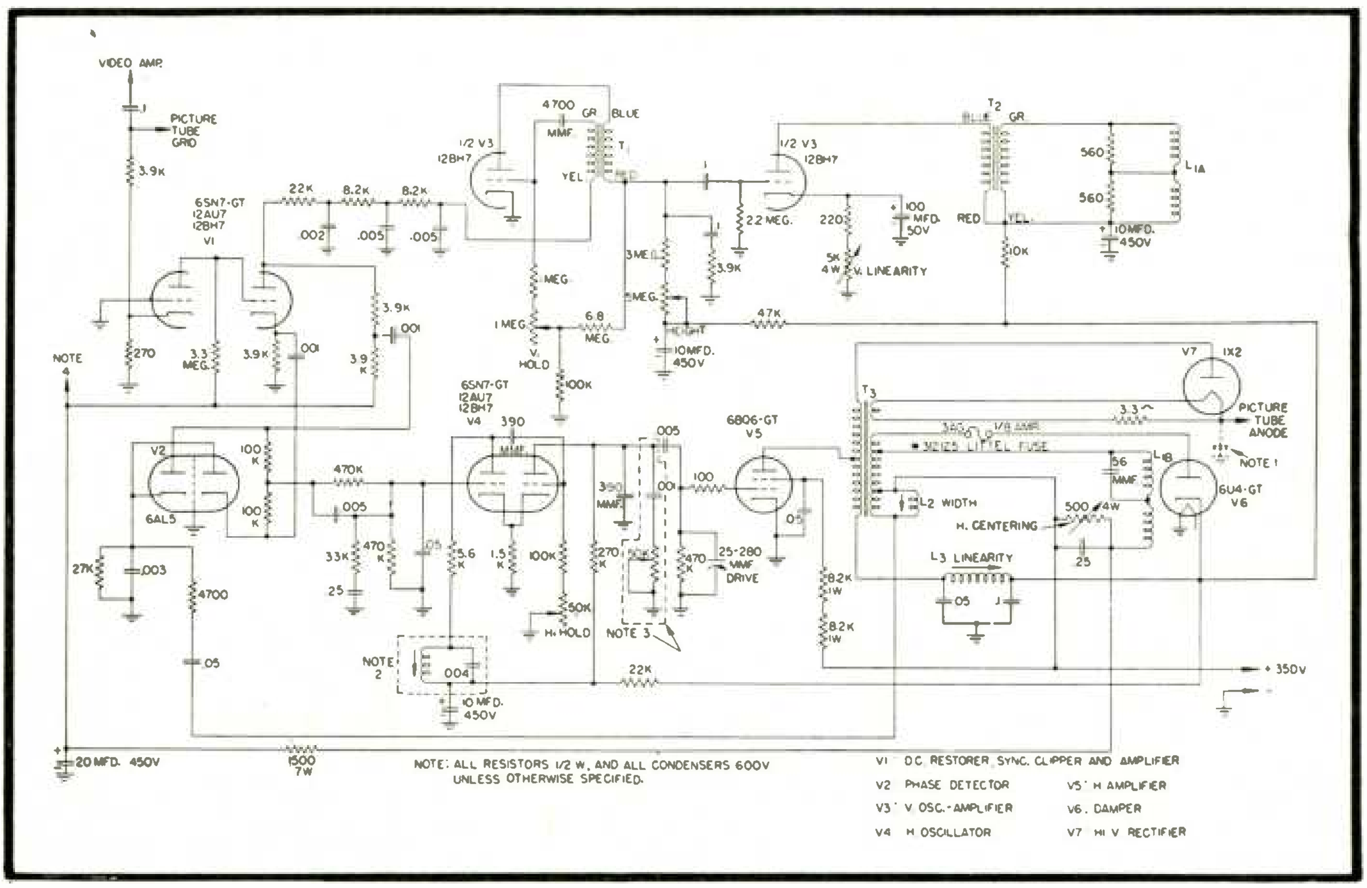


Fig. 1. Deflection circuits employing new, efficient tubes and providing wide deflection and adequate anode voltage for 16-inch tubes.

Economical 10"-16" Conversion Practices

ings in the deflection circuits. In connection with the latter, there is available a series of tubes for deflection circuits which, in combination with recently-developed deflection components, provide for high efficiency together with lower cost. These tubes are the 6BQ6GT and 25BQ6GT horizontal deflection amplifiers; the 1X2 high-voltage rectifier; the 6W4GT, 25W4GT, and 6U4GT single diodes used as damping tubes; and the 12BH7 double triode which features a low tube drop brought about by a higher perveance.

Deflection Circuits

The 16RP4 and 16TP4 tubes have a wide deflection angle (65 deg.), and the deflection circuits require different components than are used with the more common 52–54 deg. picture tubes, such as the 12LP4. With this increase in the deflection angle, a proportionate increase in deflection current is required. Also, additional sweep power is necessitated the the higher operating anode potential of the picture tube.

Figure 1 depicts a complete system which has worked successfully in the laboratory, and which develops a second-anode voltage of 12 kv. with a fully synchronized picture from a primary supply of 350 volts. This 12 kv. is the minimum anode potential recommended for both the 16RP4 and 16TP4 tubes because of the neutral-density face plate which has a 35 per cent light loss as compared with clear-faced tubes having an average of somewhat less than 10 per cent loss in transmitted light. This reduction in light output is, however, more than made up by the increase in contrast. The specific components employed have been identified by manufacturer and part number for ease in duplicating this work. It is expected that further developments in the field of deflection components will provide for more numerous choices and suitable components and even greater factors of safety with respect to available sweep amplitude.

Type 6BQ6GT was chosen as the horizontal deflection amplifier tube because of its high performance factor, resulting from an extremely low internal tube drop, as well as a high peak plate current with zero potential on the grid. Grid-current peaking has been found to be more desirable, and together with the horizontal oscillator shown provides ample grid drive for the 6BQ6GT. The use of this tube in place of the previously "standard" 6BG6G results in higher circuit efficiency as well as a considerable reduction in cost due to the lower price of the 6BQ6GT. Using the recommended transformer and circuit, the 6BQ6GT provides adequate sweep for the 65-deg. horizontal sweep as well as the required second-anode potential. The improvement in the efficiency of this circuit is not due solely to the tube used, but also results from the higher efficiency obtained through more efficient transformers and better matching of the tube's characteristics. A further improvement in efficiency is achieved by grounding the cathode, thereby eliminating the usual cathode-bias resistor and its associated bypass capacitor.

Protection of the 6BQ6GT in the event of failure of the horizontal oscillator is afforded by a 1/8-ampere fuse. Because of the relatively low mu of the 6BQ6GT under a condition of zero bias (i.e. no excitation), the plate current is sufficient to blow such a fuse in 5 to 10 seconds at normal line potential. Furthermore, this fuse protects the rest of the circuit in case of failure of either the 6BQ6GT or the 6U4GT due to breakdown.

Vertical Deflection Circuit

The vertical-deflection circuit utilizes a 12BH7 twin triode with one section functioning as a blocking oscillator and the other as a vertical sweep amplifier. The self-discharging blocking-oscillator circuit is conventional and requires no special comment. The output amplifier will develop sufficient vertical sweep with a primary supply voltage (measured at the B+ end of the transformer) as low as 325 under normal line conditions for scanning either a 16TP4 or a 16RP4 at second-anode potentials up to approximately 12 kv. A full vertical sweep will also be had at a line voltage of 105 with reasonably linearity.

Utilization of the capacitance between the picture tube anode and its outer coating eliminates a separate high-voltage capacitor, although at some sacrifice of high-voltage output. Approximately 11 kv. is obtainable using this capacitance, while approximately 12 kv. is obtained when an external capacitor is used with its low side connected to the damper plate thus taking advantage of an additional potential existing in this circuit. A 1X2 rectifier is adequate for this application. With a negative pulse approximately 25 per cent of the forward pulse, the inverse potential is 15 kv., which does not exceed the design-center maximum rating.

Deflection Yoke

It should be emphasized that the deflection yoke must be of the "wide-angle type," sometimes designated as 70-deg. If a standard 52-deg. yoke (which is longer) is used, the deflection of the beam starts at a point too far back, and before it is deflected 65 deg. it will hit against the inside wall of the picture tube bulb, causing shadowing. Therefore, the deflection of the beam must start nearer the screen, and to make this possible the yoke winding must be shorter in length as well as being formed at the funnel end so as to follow exactly the outer curvature of the tube as described by the reference-line gauge. These two changes in the yoke provide for moving the effective center of deflection nearer the screen to have the necessary clearance at the reference line of the bulb. The wide-angle yoke manufactured by the listed companies have the standard inductance of 8.3 mh and meet the requirements for the wider deflection angle.

Another important consideration is the use of the newer thin focus coils, either of the electromagnetic or permomagnetic type. Due to the shorter neck length of both the 16RP4 and 16TP4, the allotted space for the deflection system components is adequate for the wide-angle deflection coil, a thin focus coil, and an ion trap magnet; but sometimes it does not allow for the use of the older thick focus coil. Actually this restriction is not serious, since the thin focus coil is in production and is currently used by many manufacturers.

The video amplifier is the same as used with other types of magnetically-deflected picture tubes, and no further comments are required.

With respect to the circuits and deflection components, there is no difference in the application of the 16RP4 and

Economical 10"-16" Conversion Practices

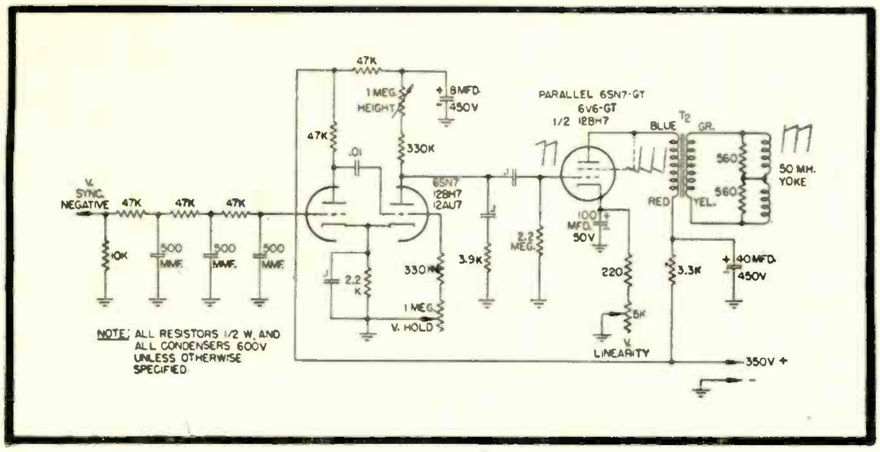


Fig. 2. Multivibrator type of vertical oscillator, preferred by some designers.

identical components. After completion, each was adjusted to give maximum output voltage maintaining a reasonably linear current through the yoke. Frequency, peaking, and drive amplitude were all adjusted to optimum, holding the input to the horizontal output tube at a point well below the maximum ratings for the tube.

The initial result of this investigation indicated wide variatons in the performance of the units. The output voltage varied as much as 5 kv. among the ten units. The frequency at which optimum performance was obtained varied several thousand cps. Some of the units were quite erratic in their performance and would jump frequency or output voltage with small changes in any of the operating parameters. Certain controls were more critical on some units than on others. One unit acted almost normal, and all controls worked smoothly over their entire range. This unit appeared to be unique for no good reason, so an investigation was begun to find out why the other units acted so differently.

One condition which caused concern was the fact that certain units caused considerable arcing of the horizontal output tube as well as the rectifier tube. One rectifier tube actually arced so fiercely that it finally shattered the glass envelope. Yet these same tubes operated without arcing at apparently the same operating point in another unit.

It was found that placement of leads in or about the test bench could cause a wide change in the performance of the units. Bypassing and grounding to vari-

Fig. 3. Mounting of 1X2 socket directly on high-voltage filter capacitor saves time, components, labor.

the 16TP4. However, due to differences in construction of the electron guns, different types of ion traps are required. The 16RP4 uses a "straight" electron gun, similar to that used in the 12LP4 and the 16AP4, and requires a double-magnet ion trap. The 16TP4 uses a "tilted-beam" gun which is designed to use a single-magnet ion trap having somewhat greater field strength (approximately 35–55 gauss). The use of the tilted-beam gun with a single-magnet ion trap permits a reduction of 5/8 in. in the over-all length, making the 16TP4 nominally 18-1/8 in. long as compared to 18-3/4 in. for the 16RP4. By comparison, the 12LP4 has an over-all length of 18-3/4 in.

Circuit Variations

Alternative circuits and components have been tried using the same circuit but with a G.E. 77J1 transformer or the Sickles 15792-2 transformer. A higher second-anode voltage has been obtained together with adequate sweep at the expense of a somewhat higher input power. *Figure* 2 shows a multivibrator type of vertical oscillator driving a triode or triode-connected pentode amplifier. This particular circuit, although it requires both a double triode and a separate amplifier, has found favor among engineers who have designed circuits in which the final vertical synchronizing pulse is of negative polarity. A blocking oscillator transformer is not required. In addition to the tubes previously mentioned, it is possible to replace the single section of the 12BH7 vertical sweep output amplifier with a triode-connected 6V6GT, a triode-connected 6K6GT, or parallel-connected 6SN7GT. In the horizontal oscillator circuit, the 12BH7 can be replaced by a 6SN7GT or a 12AU7; the same is true of the vertical multivibrator.

Constructional Economies

Each engineer designing a chassis will develop his own ideas of simplification, and when they become generally known they often become standard practices. One simple "gimmick" readily adaptable as a cost-cutting operation evolves from the use of the 1X2 as the high-voltage rectifier, and is illustrated in *Fig.* 3. The 1X2 can be mounted on the high-voltage capacitor at a saving in both material and labor. The assembly procedure is as follows: The corona ring is formed from stiff wire and soldered to the noval socket—a type which has a central ground shield. This connection is made to filament pin 2. The filament resistor is connected between pins 1 and 3, and the limiting resistor in the high-voltage circuit is soldered between pins 7 and 9. The wafer socket ground lug is then slipped over one stud of the high-voltage capacitor and soldered, together with a lead connecting the center lug with filament pin 2. The filament leads from the transformer are then connected to pins 2 and 3, the high-voltage lead is connected to pin 7, and the other capacitor terminal—which may be had with a tapped hole—is screwed to the chassis, completing the assembly. Another possibility for the capacitor mounting consists of putting the capacitor terminal through a hole in the chassis and securing by means of a speed nut. Using this technique, no expensive insulating material is required, and the labor of assembly is reduced appreciably.

Practical Considerations

One of the outstanding criticisms of certain systems is that they are nonuniform when applied to production quantities. In an effort to evaluate this situation, a quantity of ten units was assembled in an identical manner using ous points on the chassis also introduced additional variables. What appeared to cure one unit did not necessarily cure another unit.

It became apparent that the problem involved over-all r.f. feedback loops which were affecting the driver performance as well as that of the output tube. Shielding the driver proved effective at times, but when all ten units were shielded and an attempt made to set them all operating in the same manner side by side, instability again appeared due to interaction between the units, and no amount of shielding would correct it.

Tests indicated that an r.f. loop existed in the plate lead of the horizontal output tube and that this spurious oscillation was one of the causes of the erratic performance of the units.

A small 10-ohm wire-bound resistor inserted directly into the plate lead as close to the plate cap as possible eliminated all traces of this oscillation. With this added, the shielding was then unnecessary under any condition, and the units became stable throughout the range of all drive, peaking, and frequency controls, as well as at all levels of input up to and beyond maximum ratings. Under this latter condition, the previous findings on non-uniformity between the units proved false. All of them could be optimized at the same frequency and at the same input power with an identical output in high voltage and sweep. The complete absence of critical adjustment on all controls emphasized the need for over-all stability in circuits of this type. It raises a serious doubt regarding the stability of many commercial applications now on the market which have critical controls and which can be made to break into spurious oscillation by only slight misadjustment in peaking or driving circuits.

Such circuits are inherently critical to tubes as well as to components and may lead to incorrect assumption on their true performance. It is interesting to note that had only one unit been built, with no others for comparison, some very misleading information could have been obtained regarding tube and circuit performance, since the conditions could have been chosen for drive, peaking, etc. which, while they might have resulted in stable operation for that particular unit, would not have represented the best performance obtainable from the tubes and components under completely stable conditions. As an example, one unit appeared to give optimum performance, in terms of maximum output, when the drive voltage wave form was almost a perfect sawtooth, with little or no negative peaking. The horizontal output tube required a high average level of power to maintain approximately 10 kv. If it was forced to 15 kv. by overloading the input, the tube sputtered and arced considerably.

After stabilizing the units, a number of tubes were run for long periods of time at voltages in excess of ratings, and none arced or showed any signs of being run beyond their limits. In other words, there are reasons for believing that conditions exist in an unstable amplifier which can give rise to abnormal or abusive operation of the tubes and components, and yet may give all the appearances of normal performance.

Design Care

These experiments using a number of presumably identical units further emphasize the need for unusual care in the design of this type of power supply to prevent spurious oscillations, which may vary from chassis to chassis and from one set of components to another. It indicates why one manufacturer may report completely satisfactory results, whereas another, supposedly operating at the same potentials, may report trouble. It must be remembered that the problem in designing an efficient supply of this type is not unlike a wide-band amplifier design. The horizontal oscillator and amplifier stages very definitely constitute a wide-band amplifier, and large fields exist in the vicinity of the output transformer and its output tube. Large r.f. currents are apt to exist in the chassis, and the fundamental multivibrator or blocking oscillator can give rise to all sorts of instability and poor performance. All of the precautions common to good wide-range amplifier design are pertinent in this case. Short leads, common grounds, sensible mechanical layout, proper shielding and filtering are all important. Close coupling between the windings of the output transformer will help prevent oscillations due to leakage reactances setting up independent parallel resonant circuits. These are some of the factors which will influence the performance of tubes and components, independent of the bare operating potentials.

Conclusions

These suggestions are not intended as a complete answer to the problems of power supply design, but they do represent one specific answer to one specific problem. This one problem does, however, point to the need for a *thorough* study of a circuit before considering it complete. It has often been said that a designer is unlucky if his first model performs perfectly—he never has to chase the "bugs" out of the circuit, and the original may have been just a fluke.

For reference purposes, the outline diagram for the 16RP4 is shown in *Fig. 4*. Table I lists the components for [*Continued on page V19*]

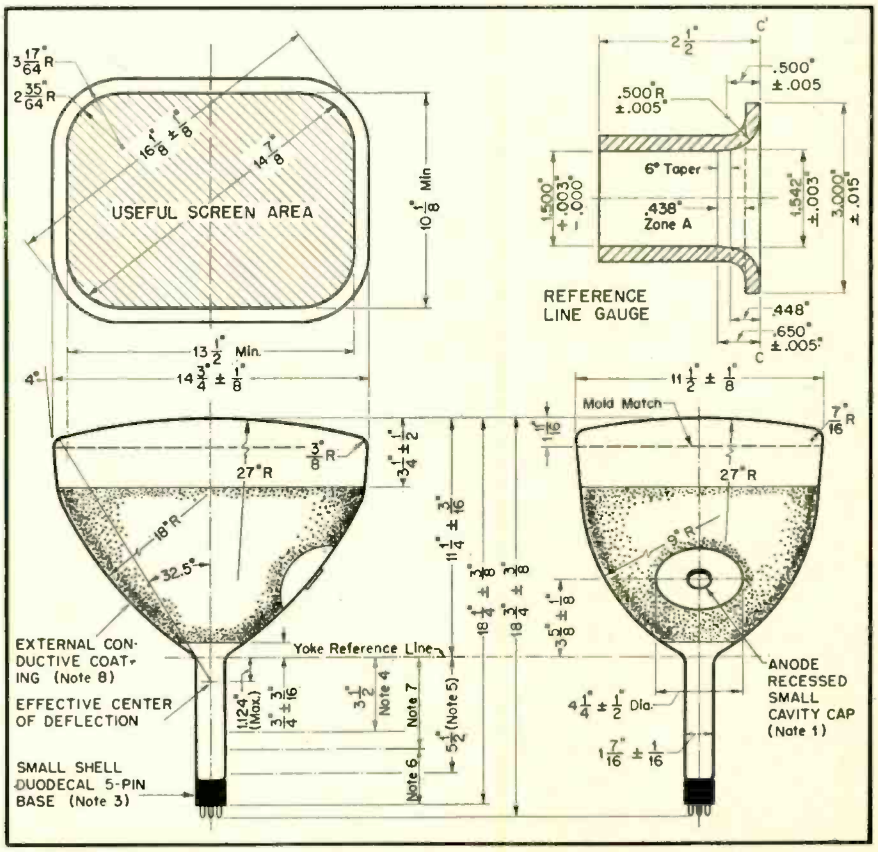


Fig. 4. Outline diagram of 16RP4 rectangular tube, together with gauge used for locating reference line.

CBS-TV Sound Effects Console—1

Robert B. Monroe, Project Engineer
CBS General Engineering Department

Born in Brooklyn, New York on October 17, 1908, Mr. Monroe attended Pratt Institute from 1937 to 1942 while being employed by Columbia Broadcasting System, Inc., where he went in 1934 and where he has since been continuously employed except for the war years.

From 1942 to 1945 he was associated with the Radio Research Laboratory, Harvard University (sponsored by the Office of Scientific Research and Development). He served successively as head of the Planning Department, head of the Standards Laboratory, and assistant to the Executive Engineer.

Mr. Monroe is a senior member of the Institute of Radio Engineers.

TELEVISION PROGRAM production calls for a wide variety of sound effects, and many ingenious and unusual devices have been developed to produce these sounds. However, one of the most valuable sources of sound effects is the phonograph record. A large library of authentic recorded sounds is available, and these recordings are employed, whenever possible, to create the desired sound effects and sound backgrounds for radio and television programs.

The sound effects operator must be provided with adequate audio facilities to permit him to reproduce and control the sounds originating on records. In addition, he must also be equipped to handle sounds originating from other sources, such as special sound producing devices where the output may be either sound waves or an audio signal. The CBS 4-A sound effects console was designed for this purpose and provides all the audio facilities normally required to handle the sound effects requirements of network radio broadcast and television productions. This sound effects console provides these facilities in a single, compact, mobile unit which can be moved from one studio to another, if desired.

Design Considerations

A photograph of the CBS 4-A sound effects console is shown in *Fig.* 1, and a block diagram of the equipment arrangement is given in *Fig.* 2. As can be seen, three *variable-speed* transcription turntables and four transcription reproducing arms are provided. The mounting arangement permits two reproducing arms to be used with any of the three turntables.

The fact that two reproducing arms may be used on any turntable makes it possible to play a record continuously. For example, a sound such as rainfall, which is to be the background for a long scene, may be produced from a single record without a break in continuity by starting a second pickup at the beginning of the record when the first pickup is nearing the end of the record. Other effects may also be created employing two pickups on a single record. For example, an echo may be obtained by setting the second pickup a portion of a groove behind the first pickup.

Fig. 1. Sound effects console built to CBS specifications by Gray Research & Development Co.

Variable Equalizers

The sounds reproduced from recordings may be further modified by means of low- and high-frequency equalizers, which are provided in *each* of the four reproducing channels. These equalizers are quite effective in permitting still further modification of the sound to obtain the desired effect and are especially useful when recordings are being reproduced at a speed other than normal. The bass equalization of the transcription channels may be varied from the full amount required for normal reproduction to a condition of no equalization at all. This latter condition results in a falling off of the bass response at a rate of approximately 6 db per octave below the recorded turnover frequency. High-frequency response may be varied from a flat characteristic on a velocity basis to a degree of roll-off considerably in excess of that specified for the standard NAB lateral transcription reproducing characteristic. With these two equalizing controls, considerable variety of reproduced tonal balance may be obtained.

In sound-effect operations, speed of "spotting" or "cueing" a record is so important that it is quite justifiable to countenance a slight decrease in fidelity of reproduction to expedite quick setting of the stylus to the desired point on the record. This is aided if a pick-up device with a fairly prominent easily visible stylus is employed. An excellent cartridge employing such a stylus is the Astatic MI-2M magneto-induction unit, which is used in each of the four transcription arms. This cartridge employs an osmium stylus which, although shorter-lived than a jewel stylus, is capable of absorbing more abuse in handling without accidentally chipping during use.

Visibility in cueing records is fur-

R. B. MONROE and P. E. FISH

Production of television programs with optimum sound effects and a minimum of confusion demands flexible audio facilities designed specifically for the purpose.

ther aided through the use of a Vanco midget (grain-of-wheat) inspection bulb mounted on the head of each transcription arm. These lamps, which are a-c operated, direct a small beam of light at the stylus and at the record area immediately beneath the stylus, thereby permitting good visibility even under conditions of poor ambient lighting.

The mixer controls employed in this console are the cueing type; that is, they are provided with a CUEING position one step in a counter-clockwise direction beyond the OFF position. When set to the cueing position, the output of the mixer channel is switched to a cueing bus, whereupon it is made available to a headphone monitoring circuit, as shown in *Fig. 2.* This headphone circuit is used in setting the stylus to the precise spot required in advance of the use of the record.

In addition to mixer channels for the four transcription reproducers, the console provides two utility mixer positions which may be used to handle sound-effect microphones, additional disc or magnetic tape reproducing equipment, audio from special devices, or audio from remote program lines. Each of these utility mixer positions is provided with a preliminary amplifier which has sufficient gain to handle low-level microphones or low-level reproducing devices. Suitable pads are employed when high-

[*Continued on page V19*]

Price E. Fish, Project Engineer
CBS General Engineering Department

Mr. Fish was born in Fort Worth, Texas, on September 18, 1911. He received the B.A. degree in mathematics from William Penn College in 1935. From 1938 to 1942 he was employed by the United Broadcasting Co. in Cleveland, Ohio, and in 1942 joined the scientific staff of the U. S. Navy Underwater Sound Laboratory (sponsored by the Office of Scientific Research and Development) at New London, Conn., where he was engaged in the development of submarine underwater sound devices. In 1945 he joined Columbia Broadcasting System, Inc.

Mr. Fish is a senior member of the Institute of Radio Engineers.

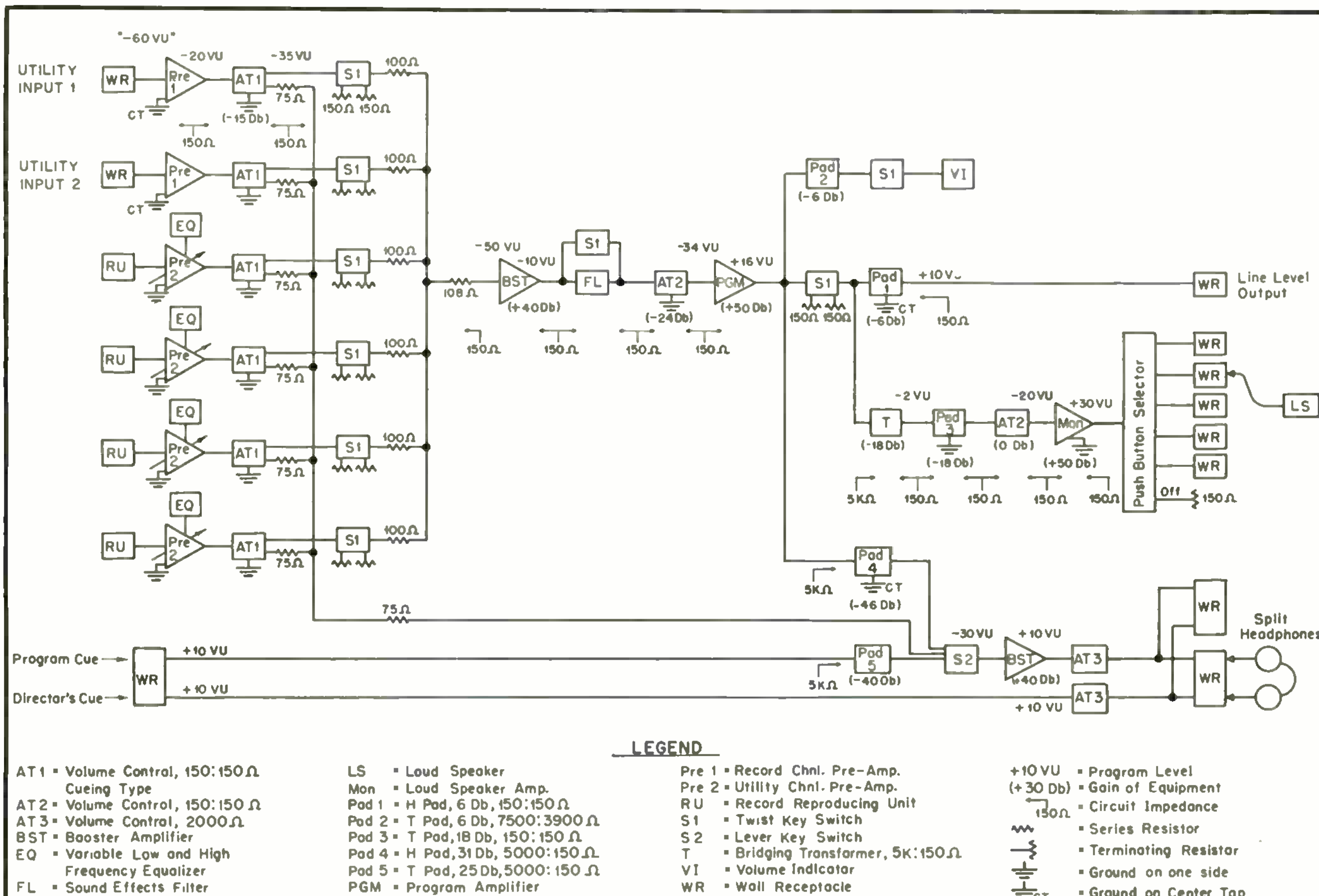


Fig. 2. Block diagram of CBS 4A sound effects console. Six mixer positions are provided, accommodating four record reproducing channels and two utility channels. The console delivers an output of + 10 vu to a program line, and loudspeaker level to any one of five loudspeaker units.

Steps to Improve TV Audio

Arthur Davis

Consistency of sound quality is more desirable than occasional perfection. The author proposes a solution which involves the use of an equalizer which is variable over a wide range.

Arthur C. Davis, chief engineer of the Cinema Engineering Co., Burbank, Calif.

To complement his fourteen years in sound recording, he has a colorful background as cinematographer and telephone transmission engineer. An early exponent of sprocket-driven magnetic tape recording, he is at present working on several advanced research projects in connection with the application of this medium to 16-mm TV films. From mixing sound to manufacturing sound equipment, he has seen the business from all angles.

Affiliated with the essential segments which have merged to make the television industry, Mr. Davis is well equipped to tell the story in this article.

UNTIL RECENTLY most television stations have been so busy getting and keeping a picture on the air that the problems of getting intelligible and pleasing sound quality have been somewhat neglected. However, now that the critical attention of sponsors is being turned to the lack of intelligibility in the sound side of commercial announcements, many TV stations are taking steps to correct the deficiencies in the unseen half of their program presentation.

Most TV station personnel has believed, as in the past, that the audio problem is no problem at all, and that ordinary broadcasting techniques could be applied to television. They are now learning that it is one thing to use a broadcast mike a foot away from a fixed performer, and another entirely different proposition with the moving performer of TV. Various strange and undesirable distortions appear when a mike swings all over a TV set. Trying to solve the paradox of staying near the actor's lips and out of the picture simultaneously is, indeed, a puzzle. Usually important intelligibility is lost in the process.

Continuously Varying Distortion

The most common and most important audio distortion in TV programs is a seeming change in frequency characteristic as the mike moves around the set. When the mike is away from the performer, one hears a disturbing gain in low frequencies and a loss in high frequencies. This variation in frequency response occurs so rapidly and so often that many engineers have believed that no solution is possible. Perhaps finding the ever-sought acoustic material that has high absorption at low frequencies and zero sound absorption at high frequencies would be the answer. Since there is no such material, and since it would only do half the job, let's get back to reality.

The reason for the change in frequency response lies in the reverberation characteristic of the average TV stage. A graph of reverberation time against frequency for a typical TV stage will show about three seconds at 100 cps, one second at 1000 cps, and about 0.3 seconds at 10,000 cps. For most types of sound, this reverberation time characteristic is effectively superimposed on the normally fixed frequency-response characteristic of the TV audio channel and thus produces a very noticable form of varying distortion on the audio signal.

Corrective Measures

The answer to this sound problem has two parts—mike placement and dialogue equalization.

The microphone part of the problem is the most difficult, and a discussion of all the factors involved is beyond the scope of this article. However, the most important factors deserve some mention and consideration, particularly as they affect dialogue equalization.

Good dialogue microphones are rare. The broadcast industry has not run into this problem appreciably, as a potentially poor dialogue microphone can give quite acceptable dialogue quality, *when used up close*. At four feet, or more, the microphone itself begins to loom large as an important factor in getting good dialogue. The most important point involved here is the somewhat intangible acoustical property called *presence*. The original dynamic microphone, the old WE618A, has never been excelled in this respect, and several TV stations have dug up those old mikes from the junkbox with satisfactory results.

The 618A is a pressure microphone and, therefore, non-directional as far as noise and reverberation are concerned. But where a set can be kept quiet and where dialogue equalization is used to fix up the reverberation difficulty, the over-all result is a vast improvement in average TV sound quality.

Some of the newer cardioid microphones can do a good job on dialogue, but they all require the use of a modern flexible boom and an expert operator who knows what he is doing and why he does it.

Microphone Placement

The key word in the saga of the boom operator is *consistency*. It he were an idealist and could forget about the picture, he would keep the mike normal to the lips, level with them, and 18 inches in front of the actor's face. Then he might achieve some measure of perfection in his sound pick up. However, he cannot do this, and he should not try. He should try for a kind of quality which might be described as 50 per cent perfection at all times. Even when the camera is pointing off the actor and the boom operator has complete freedom of mike location, he should stay away from perfection and try instead for the 50 per cent point where the pick up is less bright but more typical and consistent. The reason for this avoidance of occasional perfection in the mike pick-up will appear when we get into a discussion of dialogue equalization.

At this point, it is desirable to discuss the adaptation characteristic of the human ear. The human ear can tolerate a great deal of frequency distortion, without strain, provided the distortion does not vary with time. Articulation

Another big step forward

the new Maurer 16-mm

MULTIPLE SOUND TRACK

For many years the Maurer organization has pioneered in the improvement of sound recording on 16 mm. film. A very high quality is the standard today.

But most realistic listeners join the industry's engineers in the realization that TV films *could* sound better. New film material made for TV as well as general release *can*.

The normal 16 mm. projector in average adjustment introduces a considerable amount of intermodulation distortion into the playback of the usual variable area sound track. Much of the unpleasantness common in 16 mm. sound quality results from this cause.

The new Maurer Multiple Track Variable Area Sound Record illustrated here has the effect of reducing such excessively high values of intermodulation distortion to well within acceptable limits. *It really sounds good!*

The quality-conscious, whether station engineer, advertising executive or sponsor is invited to investigate and satisfy himself of these *facts*.

• THE NEW MAURER RECORDING SYSTEM, incorporating the six-track galvanometer, is commercially available for early delivery.

In line with the Maurer policy of protecting its customers against obsolescence as far as is possible, all owners of the Maurer Model E System will be invited to convert their equipment to the new six-track recording, at a cost which will not exceed the difference between the initial costs of the two systems

J. A. Maurer, INC.

37-01 31st Street, Long Island City 1, N.Y.

CABLE ADDRESS JAMAURER

16mm maurer

STEPS TO IMPROVE TV AUDIO

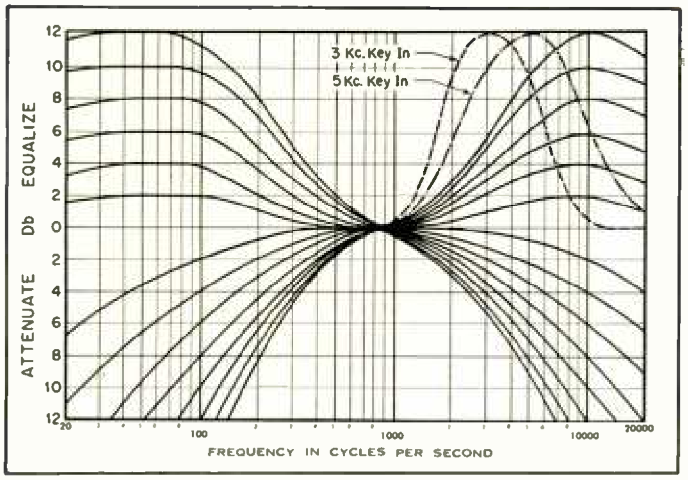


Fig. 1. Frequency response curves obtainable with Type 4031B general purpose dialogue equalizer.

tests of intelligibility show that listeners get a poor score when the frequency response is suddenly changed. Intelligibility scores pick up as the listener's ear becomes conditioned to the change. The ordinary telephone circuit is a good example of a limited transmission system capable of high intelligibility due to long conditoning of listener's ears to a particular form of response.

Naturalness and high intelligibility do not necessarily go together in voice communication. The low frequencies add a great deal to naturalness, but practically nothing to intelligibility. In fact, excessive lows or a variation in lows detracts from intelligibility.

Low End Equalization

Large variations in low frequency response are inherent in TV sound pickups. Therefore, the obvious conclusion is to attenuate low frequencies as much as possible without making the voice sound unnatural. If the lows are attenuated, the normal variation in lows will not be noticed. Now we come to the problem of how much low-frequency dialogue equalization can be used before voices start to sound abnormal. This is where the adaptability of the human ear helps out materially. Tests have shown that from 8 to 12 db loss at 100 cps is permissable on dialogue, provided the listener is not able to compare this equalized transmission with a flat system. The optimum amount of low-end attenuation will vary with the stage and the actor. Usually, a satisfactory compromise for a particular group of actors working in a particular stage can be established during rehearsal and left fixed during the show. When working outside, the 100-cps attenuation on a female voice might be only 4 db. Inside a telephone booth, with a deep male voice, 14 db attenuation might represent the other extreme. Control over this attenuation should be convenient to the hand of the sound mixer so that adjustment may be made during the show.

The shape of the equalizing curve is quite critical in order to preserve naturalness while still obtaining maximum intelligibilty. Typical curves for the range below 400 cps are shown in *Fig.* 1.

High End Equalization

At the high audio frequencies, too, there is excessive response variation. Reverberation is not an important contributor to this. The main trouble is that the actor's mouth and head assembly is imperfectly designed for the job at hand. Ideally, the sound source should be an omni-directional radiator of spherical waves. Sound intensity, at all frequencies, should be the same at all directions. Being human after all, we must expect some variations. The human voice as a sound source has been measured many times, and there is a variation of more than 20 db at 10,000 cps as the head is rotated 180 degrees. A lot of well-designed horns are less directional sound radiators. At low frequencies, of course, the human sound source is much less directional.

Many microphones show a variation in frequency response upon orientation. Some of the newer cardioid and unidirectional microphones, claimed to have constant frequency characteristics, need careful placement with respect to the sound source, even in the hands of a good boom operator.

The best solution to the high frequency problem lies in the work of the boom operator and the mixer. It is up to the boom operator to keep the mike at a point of approximately constant perspective from the actor. This distance might be three feet for close ups and five feet for long shots with four feet as a good average. The sensitive axis of the mike should be pointed, as closely as possible, at the actor's belt line, and the angle from the actor's lips up to the mike should be about 45 deg. for a cardioid mike, and about 60 deg. for a pressure mike. The mike should be kept in front of the actor's face on all dialogue. Such a microphone placement will sacrifice about 4 to 10 db of sound level at 5000 cps over a broadcast-type pick up. The exact amount of 5000-cps correction will depend upon the type of mike used and on the speaking habits of the actor. This mike placement is not too difficult to maintain throughout a show, provided an expert boom operator is working with a modern type of boom. It may not give the best possible dialogue quality, but it gives *good* quality, and this good quality can be pretty well maintained in spite of movement and action. It is the best compromise for consistent sound quality.

The other half of the quality correction is in the hands of the mixer. If he has a properly designed high-frequency equalizer, within easy reach, he can insert an initial frequency correction at 5000 or 10,000 cps whenever a radical scene change warrants it during the show.

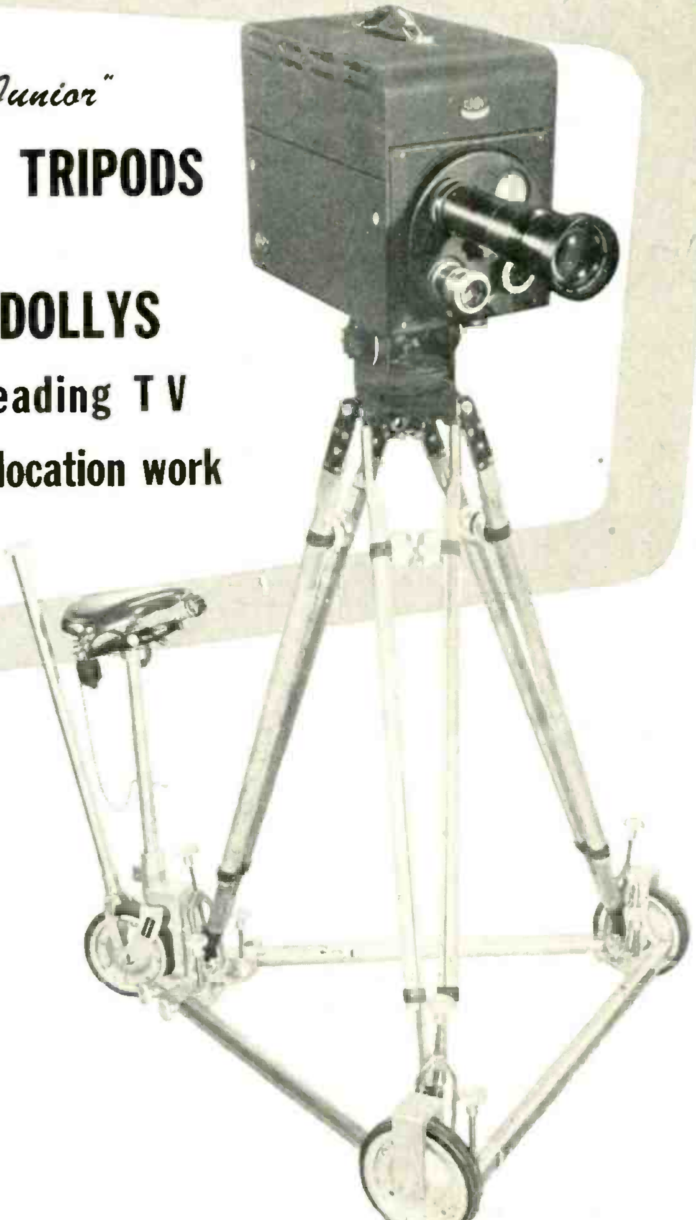
Most TV shows use only one mike to cover the dramatic dialogue. Thus,

[*Continued on page V18*]

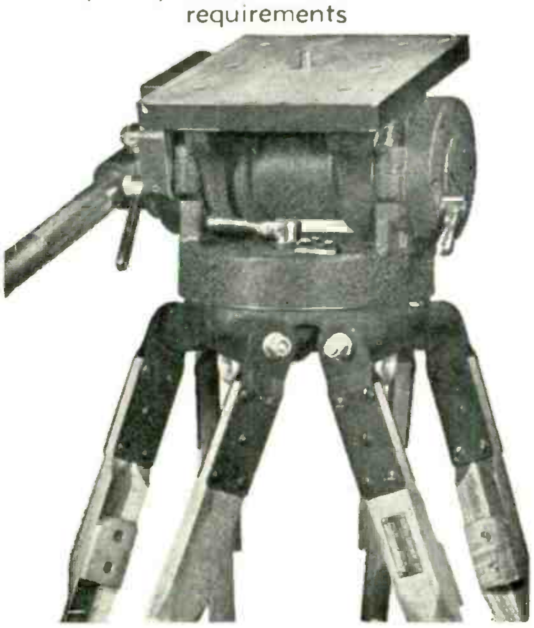
"Professional Junior"

"BALANCED" TV TRIPODS
and
COLLAPSIBLE DOLLYS

are used by all Leading T V Stations for studio & location work



Tripod and Dolly designed and engineered expressly to meet all video camera requirements



The dolly is large and sturdy, will support television camera on tripod, and cameraman. Assembles quickly without use of tools; constructed of magnesium and dural, provided with rubber tire wheels, quick-setting lock for straight line dollying. Collapses to fit carrying case. 12″ sq. by 6′ long.

The tripod handles all types of TV cameras. Complete 360° pan without ragged or jerky movement is accomplished with effortless control. It is impossible to get anything but perfectly smooth pan and tilt action with the "BALANCED" TV Tripod.

Quick-release pan handle adjustment locks into position desired by operator with no "play" between pan handle and tripod head. Tripod head mechanism is rustproof, completely enclosed, never requires adjustments cleaning or lubrication. Built-in spirit level. Telescoping extension pan handle.

Available for immediate delivery

Write for Literature

FRANK C. ZUCKER

CAMERA EQUIPMENT CO.

1600 BROADWAY NEW YORK CITY

PRECISION "T" STOP LENS CALIBRATION

Equalize your lenses of all focal lengths for proper exposure density by having them "T" Stop calibrated NOW.

Transmission calibration of all types of lenses, any focal length, latest method accepted by motion Picture Industry and Standards Committee of SMPE.

Lenses coated for photography and special TV coating. Fast service given.

STEPS TO IMPROVE TV AUDIO

[*from page V16*]

the mixer has one hand for the gain control and the other hand available to make occasional changes in the equalization. As with the low-frequency equalizer, the shape of the corrective curve is most important. (See in *Fig.* 2.)

Dialogue Equalizer Design

Superficially, a general purpose dialogue equalizer belongs to the tone-control family of gadgets and represents the extremes in subtlety of design and construction. Since about 1930 there have been at least twenty high-quality microphones offered by various manufacturers. Each type of microphone certainly was the basis for at least twenty different designs of special purpose dialogue equalizers. Each combination was tried in production and had its proponents. There is very little useful theory about how best to compromise between naturalness and intelligibility in establishing the optimum frequency-response curve of a variable dialogue equalizer. The process has been to build them by the tens and hundreds, then try them out on thousands of different production scenes and listen critically to the recorded result under a wide variety of listening conditions. From experience in designing, building, and listening to dialogue equalizers comes an equalizer that can do an over-all good job.

One modern answer to the frequency-response problem combines odd characteristics which are suitable for many purposes besides dialogue correction. Disc, tape, and film loss, music under dialogue, effort, "de-essing," pre- and post-equalization, sound-effect and FM-music equalization, all come within the scope of the available response curves on the 4031B equalizer.

This unit, shown in the photograph, consists of separate constant-*k* networks for the low- and high-end variable controls. The networks have Bridged-Tee configurations for economy and to provide constant impedance looking into both sets of equalizer terminals. The whole family of equalizing curves hinge around 1000 cps. The response curves are shaped symmetrically from the hinge point to fit the exact requirement of good dialogue equalization.

This equalizer is of the passive type using stable inductors, capacitors and resistors, and no vacuum tubes are involved in the networks. Long experience has shown that variable elements in an audio channel should be passive and isolated from the vacuum tube circuits for reliability and low delay and for minimum maintenance cost. Thus, the vacuum tube amplifiers can all operate with optimum amount of negative feedback for long life and stability.

The constant impedance feature of the 4031B equalizer allows it to be patched anywhere in the 500/600-ohm portions of the system with the assurance that it will operate as predicted, and no isolating pads are necessary. The insertion loss of this wide-range equalizer is only 14 db, as against 29 db for another typical equalizer of comparable performance.

The two ends of the equalizer frequency response are independently adjustable in 2-db steps with a smooth, detented action. The low end response at 100 cps can be varied 28 db, as can the high end response at 3, 5 or 10 kc. A key is provided to select the high-frequency equalization peak. A second key replaces the whole equalizer with a 14-db pad. These features are rarely found in wide range equalizers and should be valuable.

The coils of this equalizer are permalloy-core toroids, electrostatically shielded and normalized in a protective compound. The noise and hum pickup is below −140 dbm for normal stray fields. The standard 4031B is mounted on a 3½ × 19 rack panel, but more compact arrangements have been worked out to fit mixing consoles.

With an equalizer of this type, it is possible to accommodate practically any frequency-response condition, with the result that TV program quality may be held to a consistent quality which will be thoroughly intelligible without necessarily being optimum at any time. However, consistency is more important than occasional perfection, and engineers who have used an equalizer having these characteristics have been satisfied with its performance.

CONVERSION PRACTICES

[*from page V11*]

Figs. 1 and 2, together with the operating data.

TABLE I

PARTS LIST

- T1 Vertical blocking oscillator transformer, RCA 208T9 or equivalent
- T2 Vertical output transformer, RCA 204T2 or equivalent
- T3 Horizontal output transformer
  Model #1014 RAM Electronic Co., Patterson, N. J.
  Model #30-6049, E. I. Guthman, Chicago, Illinois
- L1a Wide-angle yoke (70°), Todd Transformer Co., 752 So. Third Ave., Mt. Vernon, N. Y.
- L1b Teletran Corp, Ramsey, N. J.
- L2 Width control, RCA 201R1 or equivalent
- L3 Linearity control, RCA 201R3 or equivalent

Picture Conditions

Fully synchronized
16RP4 or 16TP4 fully scanned at 117-volt line
At reduced line (105 v.) full scan can be obtained by adjustment of controls.

OPERATING DATA

6BQ6GT horizontal amplifier
E_{c1}: -28v. d-c across grid resistor
E_{c2}: 140v. through 16.4 k.
E_b: 350v. d-c
E_{hv}: 12.0 k.v. approx.
Peak to peak grid voltage approx. 80 volts 60% negative peak approx.
I_b: 71 ma
I_{c2}: 10 ma
Circuit input: 26.4 watts
Plate input to 6BQ6GT: 35.5 watts
½ 12BH7 vertical amplifier
E_b: 350 v. from bootstrap through 10 K decoupling resistor I_b: 15 ma approx.

SOUND EFFECTS

[*from page V13*]

level program sources—such as program lines—are used. The cueing position on these utility mixer controls makes it possible for the operator to "preview" or "audition" the material on that position in advance of its use.

The six mixer positions of the console are combined by a suitable differential network. The program material passes through a booster amplifier, sound effects filter, master volume control, program amplifier, and line key switch, and feeds a program line at a level of +10 VU. A standard volume indicator is connected across the input of the line key, while a loudspeaker amplifier with its associated volume control is bridged across the output of the line key. The VU meter therefore continues to indicate when the line key is in the OFF position, but the loudspeaker amplifier receives program material only when the line key is in the ON position.

[*To be concluded*]

ANOTHER **HYTRON FIRST** YOU'LL BE BUYING SOON

NEW HYTRON RECTANGULAR all-glass 16RP4

Meet Hytron's space and money saver. The new Hytron 16RP4. Revolutionary 16-inch rectangular picture tube. Takes approximately same cabinet space as 12LP4. Automatically sets the pace for more compact and economical TV set design. You'll be seeing it . . . buying it . . . soon.

The new 16RP4 is latest in a long series of Hytron firsts. Including: The GT tube. Over 50 GT types. The subminiature. Many new miniatures. Special low-cost TV deflection-circuit tubes: 1X2, 6BQ6GT, 6U4GT, 25BQ6GT. Check the 16RP4's many features. Watch for it. Buy the best by the leader. Buy Hytron!

OLDEST MANUFACTURER OF RECEIVING TUBES
HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

With old-style round tube, you lose the corners.

With Hytron 16RP4, you see the picture just as transmitted.

Features of HYTRON 16RP4

1. Rectangular shape permits smaller, less costly cabinets.
2. Also just as short as 12LP4
3. Weight is approximately two-thirds that of 16-inch, all-glass round tube.
4. Easy to mount. Can't roll or twist.
5. No high-voltage isolation of tube required.
6. Neutral gray face . . . increases contrast ratio.
7. Large viewing screen. You get the entire transmitted picture; no lost corners. Gives picture (with standard 3 by 4 aspect ratio) $10\frac{1}{8}$ inches by $13\frac{1}{2}$ inches.

Write for Bulletin E-147 giving complete data.

White-Noise Testing Methods

EMORY COOK*

Description of a testing procedure which permits an instantanous evaluation of amplifier or component performance and which extends beyond most constant-frequency testing methods.

With the single exception of square-wave techniques, very little attention is directed toward transient phenomena in audio engineering. Entirely too many assumptions are made on the basis of steady-state measurements, which have been the only ones available generally for the user of equipment components—amplifiers, speakers, microphones, pickups.

The true reproduction of music is the end object of nearly all high-quality audio equipment, and music displays transients in endless procession. Indeed, it might be well that the more profuse and intense the transient nature of a piece of music, the more intriguing to the engineer listener—not aesthetically, necessarily, but perhaps more as a hurdle for his equipment. Many instruments (bassoon, English horn, bass sax, etc.) seem to be more recognizable by their transients than by any other single characteristic.

The big trouble in transient testing has always been in the obscurity of methods, the expense, and the trouble of maintaining adequate equipment facilities. There has been no incentive to swell the literature with information about a philosophy of techniques that only a few can afford to implement.

In spite of all this, a moderate effort in the direction of transient testing along lines set forth herein will produce results out of all proportion to the trouble involved. As distinct from any other test signal source, thermal noise is a signal composed of *nothing* but transient energy. Anyone with merely an oscilloscope and a turntable can himself discover in much equipment flaws which even the manufacturer never suspected; and he who does not have an oscilloscope can acquire a remarkable degree of confidence (or distrust) in his equipment simply by listening to certain types of noise signals described herein.

In making generally available the ease, rapidity and other advantages of thermal noise testing, the first problem is that of equipment cost, and the following objections appear:

(1) A noise generator is an unpleasant thing to operate. It is microphonic, subject to vagaries of temperature, time and supply voltage, circuit or components, and hum. Feedback cannot be put around a noise generator.

(2) In order to use the unadulterated output of a noise generator to advantage, several thousand dollars worth of elaborate equipment is needed, starting with a band-pass wave analyzer.

In order to remove objection (1) a test record has been made under ideal conditions to provide a reliable source of wide-band noise. It is then only necessary to have a turntable, a good cartridge, and a good arm in order to have a consistent noise generator.

Switched Noise

In order to remove objection (2) this record supplies not only wide-band "white" noise, 40–20,000 cps, but also recorded bands of what we shall call "switched noise." Switched bands alternate rapidly and continually between white noise and noise which has been cut off or filtered at some appropriate high or low frequency—noise which we shall call "gray noise." For example, if by listening to a switch band of 12,000 cps gray, a plainly evident contrast is obtained between white and gray, the frequency range and effective transient response of the equipment extends well beyond 12,000 cps. It may be news to some to learn that proven steady-state response (beyond 12,000 cps, for instance) does not necessarily mean transient response—or that a contrast will be heard on a 12,000 cps switched noise signal. It is quite too easy to design a transducer (microphone, speaker, headset, cutter) whose steady-state response is acceptable, but whose transient response is down 30 db at 12,000 cps. Switched bands are provided for low-pass conditions of 12,000, 9,000 and 7,000 cps, and for high-pass conditions of 150 and 80 cps. Low-pass cutoff lower than 7,000 cps was purposely omitted, since performance giving a switch contrast at that frequency is certainly no

TABLE I

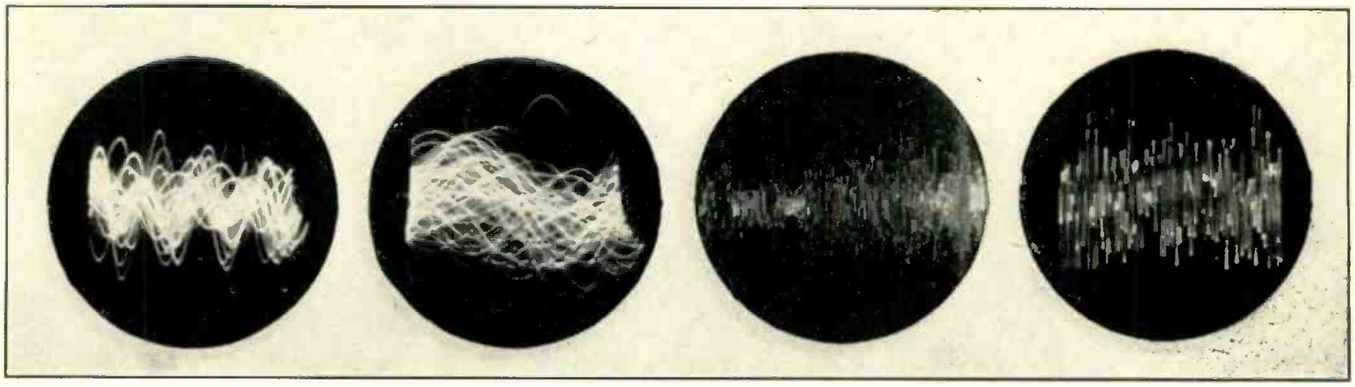
VI Readings for Switched Noise Playback

Tip Radius Used (on 55° cone-std. Pickering diamond cartridge)	Switched Noise Band				
	12 kc	9 kc	7 kc	80 cps	150 cps
.001″ R	1	2.5	3.5	4*	8*
.0015″ R	2	3	3.5	4*	8*
.0025″ R	2	3	3.5	4*	8*
Sapphire .0025″ R (small flats,—corresponding to 50-75 shellac plays)	1	2.5	4	4*	8*

* crossover equalizer used

Table I—Tabulated information can often be misleading,—i.e., the 1.5-mil follows the ideal theoretical result reduced to VI readings, but the 2.5-mil does not. The 12-kc reading on the 2.5-mil is correct only because large amounts of spurious energy are picked up in a vinylite resonance with the larger coupling area of this tip at 14 to 17 kc. Ear listening picks out the difference between the two immediately. The 1-mil pushes vinylite around at the highest frequency, giving poor transient response (see text). Size of flats on the sapphire are small, but enough to reduce the vinyl resonance to a lower frequency, giving too much contrast on the 7-kc band. Note the relatively small apparent differences between units on this table, and compare with the tremendous contrast on the E-type scope.

* *Cook Laboratories, 139 Gordon Blvd., Floral Park, N. Y.*



Reading from left to right: Fig. 1. Acoustic output of headset, monitored with 640AA microphone. This is the most pronounced ringing resonance observed to date. Sweep rate 2000 cps.—Fig. 2. Acoustic noise output of high-quality two-way horn speaker, monitored as in Fig. 1. If a saturable amplifier is placed between the microphone and oscilloscope (see Fig. 6), it is much easier to pick out lesser ringing resonances. Sweep rate 8000 cps.—Fig. 3. Acoustic noise output of high-quality 8-in. cone, showing severe intermodulation tendencies at normal room volume. Sweep rate 30 cps.—Fig. 4. Reference noise, electrical output of playback amplifier. Note high ratio of peak to average signal. Sweep rate 350 cps. No playback network.

more than the minimum we should allow ourselves to expect from a modern system.

Low-Frequency Listening Test

The low-frequency switched-band listening test needs a bit of practice for effective use, since even with television audio, contrast of a sort will be obtained by switching due to octave distortion in the cone and by intermodulation. The sound produced by the intermodulation of the high-frequency hiss by the low-frequency roar is easy to recognize by ear. The difference between true bass response and octave distortion response, however, is not so easy to detect unless one has had the opportunity of hearing a loudspeaker reproducer which actually can reach the lowest frequencies. The most homely simile that comes to mind regarding the proper white-noise bass sound is the roar of the domestic oil burner—deep-throated, guttural, and utterly lacking in tonal pitch. Most reflexed cabinets will roar in this fashion, all right, but the roar is often drowned out by a well pitched boom. The use of white noise as a test signal for adjusting optimum port dimensions and absorbent lining of a reflexed cabinet is an interesting possibility.

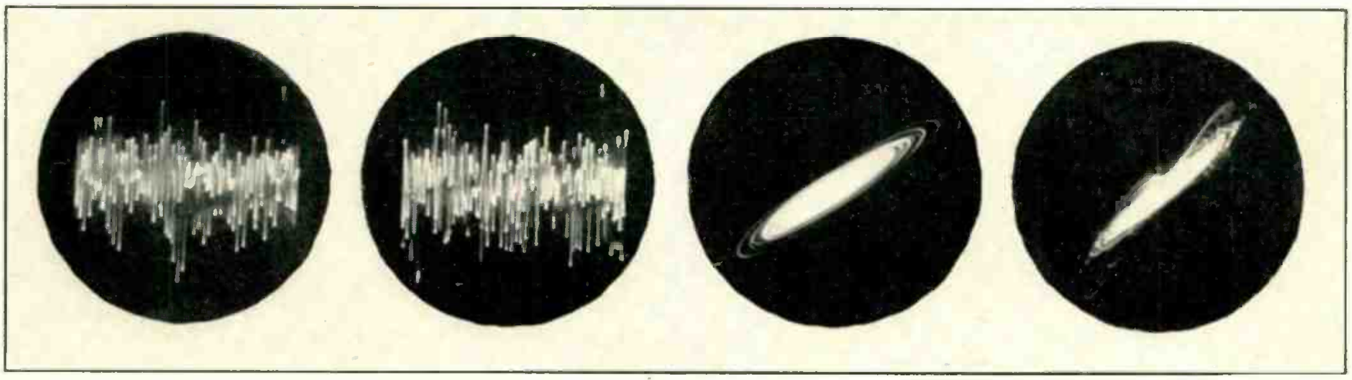
Origin of Thermal Noise

By way of review, thermal noise is the electrical disturbance produced by the random movement of electrons in a conductor or semi-conductor. Its absolute level is very low until amplified. It is distributed throughout the entire audio and radio spectrum in a most peculiar way: the same amount of noise signal (or noise energy) lies between 400 and 500 cps, for instance, as lies between 3700 and 3800 or between 4.000,000 and 4,000,100 cps. Reducing this to practice in the audio case, we see that the same amount of signal noise energy lies below 1,000 cps in the "crossover" or constant amplitude region, as lies in every other thousand-cps increment above. It therefore becomes desirable to record the noise on a true constant-velocity basis, i.e., with *no crossover*. Thus, the smaller low-frequency energy, when played back for ear-testing through a conventional cartridge and equalizer, will be loud enough to be plainly audible for switched-noise purposes. On the other hand, anyone who wishes flat noise may play back with a velocity pickup of the dynamic or magnetic type, ***without*** any equalizing network.

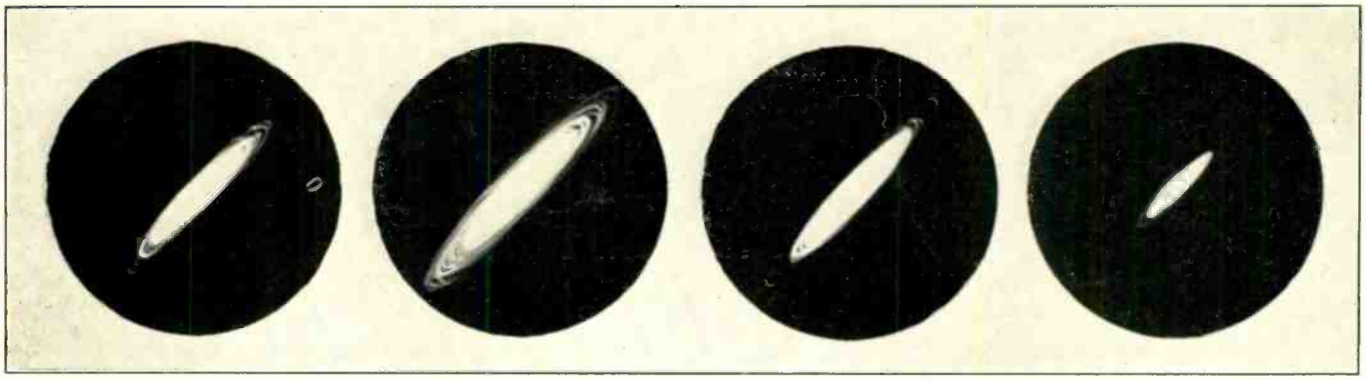
For practical purposes, and with the exception of one test band, the white noise below 40 cps is cut off in order to avoid entering the region where most arms resonate with the lateral compliance of the reproducer. With that exception, white noise as played back with the best pickup devices will be uniformly distributed within 1 db on a velocity basis through 20,000 cps. 4 db of advance correction for translation loss is used at that frequency.

Ringing Resonance

Any transducer, whether mechano-electrical, as in ***pickup***, electro-mechano-acoustical, as in *loudspeaker*, or acousto-



Reading from left to right: Fig. 5. Reference noise, as in Fig. 4, but with playback network added (500-cps turnover, flat high-frequency response).—Fig. 6. Amplifier overload. The signal of Fig. 4 has been increased so that the amplifier saturates on peaks. When a phase shift exists between the saturating tube and the 'scope, peaks will not bead, but bright lines or dots will appear elsewhere, as along the baseline. No network, sweep 350 cps.—Fig. 7. Reference E-screen (ellipse) presentation (see Fig. 17). Slightly shifting the phase between H and V plates brings a series of co-axial ellipses representing the Fourier Series of thermal noise.—Fig. 8. E-screen indication of violent amplifier overload.



Reading from left to right: Fig. 9. Incipient amplifier overload. Whiskers sprout out of the plane of the ellipse at the rim. This amplifier is not nearly as badly overloaded as that of Fig. 6, so note extreme sensitivity of E-screen as overload indicator.—Fig. 10. Reference electrical output of pickup, white noise.—Fig. 11. 12,000-cps gray noise. The difference between this and Fig. 10 is caused by the low-pass filter used in recording the switched-noise band. The same effect would be produced by two slightly dissimilar cartridges, amplifiers, speakers, or microphones.—Fig. 12. 9000-cps gray noise. The same cartridge and set-up as in Figs. 10, 11, and 13. This is an easy way to compare units for production tolerance control.

electrical, as in *microphone*, has one or more resonances of the mechanical system in the working range. In phonograph pickups it may take the form of arm resonance or as resonance of a complicated armature structure. Even the best and simplest moving elements which are effectively resonance-free to beyond 20,000 cps in the *lateral* mode, will have a *vertical* resonance squarely in the midst of the useful high frequencies, and a vertical arm resonance somewhere else. Both of these will inhibit tracking at those frequencies. Such resonances may or may not be ringing resonances, meaning that they may or may not be underdamped. As the term implies, a ringing resonance is like a door-chime—when shock excited it will continue to ring long after the blow has been struck. In thermal noise all frequencies are present simultaneously, and an under-damped resonance, wherever it may be, is continuously exposed to excitation.

Figure 1 is an example of ringing resonance in a headset so bad that it almost buries the noise signal. One of the better series of recent cone speakers using an aluminum dome over the voice coil for high-frequency air-coupling was tested and was completely unsatisfactory for this very reason. A 4-milligram annual washer of Audioid[1] attached to the dome near the center completely eliminated the ringing, giving an even distribution of noise across the sweep. Using noise as a test signal, trouble shooting in the various transducers turns into a race between the record and the engineer, where the latter spudges around the mechanism with his finger or a piece of damping in order to clear up the sinewave from the screen before the former plays through and has to be started over again.

Figure 2 shows the characteristics of an exponential horn high-frequency speaker unit of well known manufacture.

Figure 3 shows a cone speaker, with no actual feathery sine wave of resonance, but a periodic thinning out of the fine-grain high-frequency noise as intermodulation takes place better between low-frequency noise (at the main cone resonance) and high-frequency noise. This speaker, also of well-known manufacture, has an excellent high-frequency response, but has strong inclinations toward cross-modulation distortion, as corroborated by this noise test.

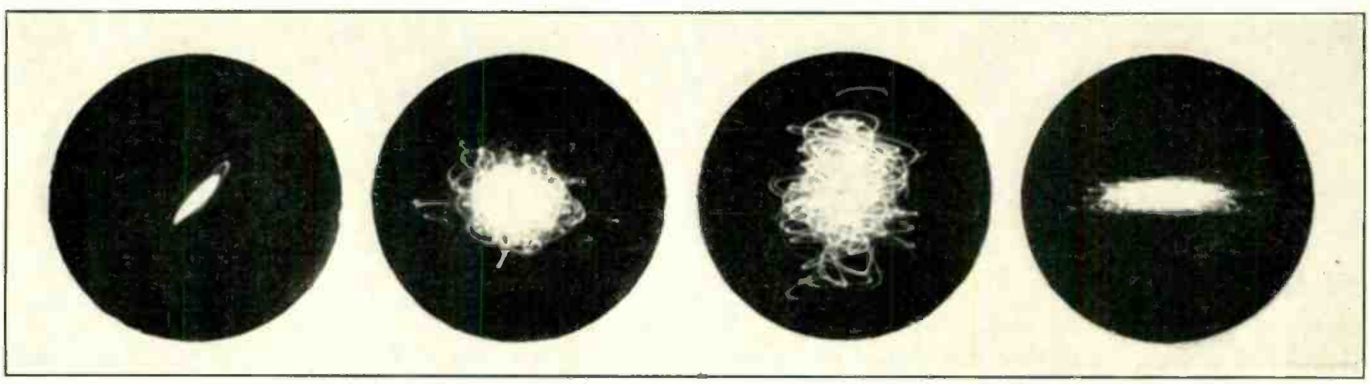
Amplifier Overload

Perhaps partially as a result of the RMA system of power output rating, speaker-monitor amplifiers are being hopelessly overworked. Sold over the counter as a 50-watt unit, an amplifier may measure acceptably at 8 watts, meaning that for a standard minimum safety margin (broadcast style) of 10–12 db, the uncompromising listener might allow himself to audition the 50-watt amplifier on program material at a *meter* level corresponding to 0.8 watts. But at this point, he finds that the noise level is competing vigorously with the signal.

By all that is logical, if it is agreed

[*Continued on page 36*]

[1] Damping stock.



Reading from left to right: Fig. 13. 7000-cps gray noise. This is approximately the difference to be expected between transient outputs of velocity vs. miniature condenser microphones. See footnote (2).—Fig. 14. CP-type screen. This is the result of sweeping random noise with random noise. Two records and two identical cartridges are used. No playback network.—Fig. 15. Conditions of Fig. 14, but with slightly dissimilar cartridges.—Fig. 16. Conditions of Fig. 14, but with distinctly different cartridges. Bright specks and lines within the periphery of the figure can all be correlated by their position, number, and design with various troubles such as turntable rumble, tracking deficiency, overload, etc.

A Symmetrical Corner Speaker

W. E. GILSON, M.D.* AND J. J. ANDREA

An exponentially loaded symmetrical corner speaker of high efficiency, simple design, and pleasing shape is described.

THE FAVORABLE ACOUSTICAL IMPEDANCE of the corner of a room has been apparent for many years, empirically as well as theoretically. Soon after the introduction of the dynamic speaker, it was noted that when mounted in a cabinet totally enclosed except for the speaker opening, it would reproduce low frequency tones much better when placed in a corner, either facing out into the room, or more particularly when facing into the corner.

This general principle was worked out effectively by Klipsch[1,2] who used a folded modification of Olson's horn of manifold exponential sections. This structure is efficient, although quite complicated.

The advantage of an exponentially loaded speaker lies primarily in the greater cleanness of reproduction, readily apparent to the educated ear. There is a lack of bass except when bass is actually present in the music being played. The average individual, accustomed to the monotone booming-bass resonance of the juke box, often considers the low tones to be missing during the first few moments of listening to an exponentially loaded corner speaker. When a low tone is heard, it is clearly and characteristically reproduced and distinct from all other tones.

The structure to be described is based on the box pointing into the corner, mentioned in the first paragraph.

For acoustical purposes, the expansion of a corner may be considered as the increase in area of a spherical surface bounded by three planes forming the corner and intersecting at the center of the sphere. This may be expressed by the equation for ⅛ the surface of a sphere, $S = \pi r^2/2$, a graph of which is shown in *Fig.* 1. The flare rate of the corner is constantly decreasing, as the distance from the corner is increased. For example, the area doubles in one foot from 2.5 to 3.5 sq. ft., and in two feet from 4.8 to 6.8 sq. ft., the latter providing a theoretical cutoff at 32 cps.

Exponential Horn

The desired variation in area of the horn is an exponential of the form $S = (\sqrt{2})^n$, also shown in *Fig.* 1. It is obvious that the natural expansion of the corner can be modified to an exponential for a considerable distance by subtracting a suitable area at each point on the radius, shown as the shaded area in the figure. The shaded area represents the structure, the area beneath it being a trisected symmetrical exponential expansion, which conforms to the equation above and doubles in area every two feet.

The area at the point of transition from the horn into the room is 750 sq. in. If this were considered as the mouth area, it would give a theoretical cutoff at 30 cps, but as there is at this point a moderately smooth transition into the natural corner expansion, the cutoff, both theoretical and actual, is considerably lower.

It was desired that the area subtracted from the corner and enclosed in the horn structure be large enough to provide an adequate compliant air mass for the front of the speaker. A volume of seven cubic feet was found empirically to be sufficient, and to correspond closely with the desired subtracted area.

Upon first consideration, it seems illogical to use the back radiation of the speaker as the source of sound. However, at low frequencies it makes little or no difference. In our design there are three advantages to this unconventional mounting.

1. It permits fastening the speaker to the horn structure with no gasket other

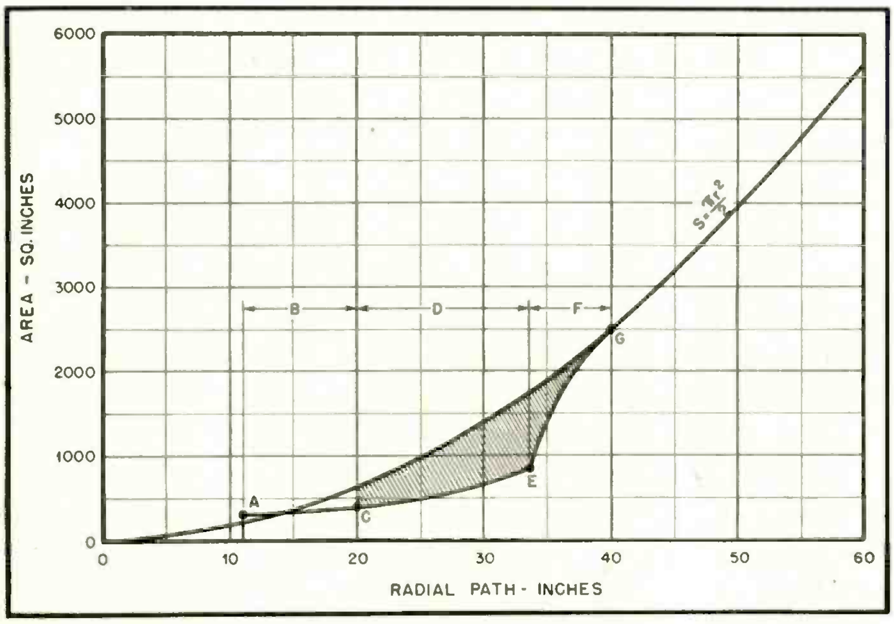


Fig. 1. A graph of $S = \pi r^2/2$, the surface area of ⅛ sphere, or the area variation of the corner of a room. The shaded area represents the area subtracted by the speaker enclosure. The horn is the shaded area under C-G. The transition into the room is E-G. A, area of speaker cone; B, distance from the speaker cone in to the corner on a mean path, and out to the plane of the speaker; C, area of enclosure at speaker mounting; D, radial length of main body of enclosure; E, area at largest portion of enclosure; F, radial length of pyramidal section; G, tip of enclosure.

* *G.M.E., 4 Franklin Avenue, Madison, Wis.*

[1] Paul W. Klipsch, "A Low-Frequency Horn of Small Dimensions," *J. Acous. Soc. Am.*, Vol. 13, No. 2 (1941).

[2] Paul W. Klipsch, "An Improved Low-Frequency Horn," *J. Acous. Soc. Am.*, Vol. 14, No. 3 (1943).

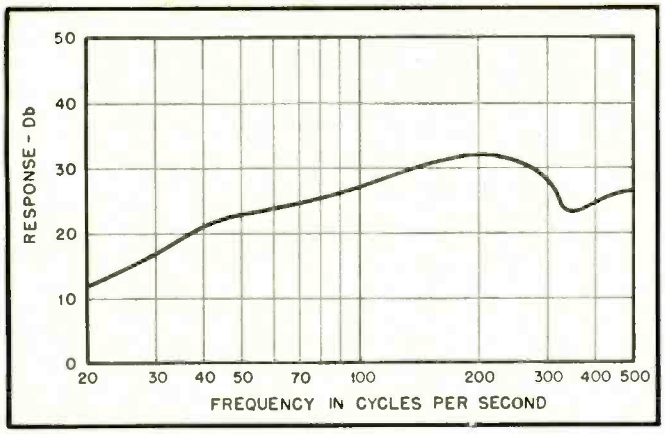


Fig. 4. The sound output of the low frequency speaker. There are no peaks between the points graphed, these representing the extremes.

than the felt which is part of the speaker rim.
2. The speaker magnet fills the corner, eliminating an air space which would undesirably enlarge the first part of the exponential curve or have to be filled with a secondary structure.
3. If the magnet and associated structures were placed inside the chamber, they would reduce the compliant air mass to some extent.

Both methods of mounting have been tried with no perceptible difference being noted.

A photograph of the resulting structure and tweeters out of the corner is shown in *Fig. 2*, in operating position in *Fig. 3*. Besides being acoustically efficient, it is generally considered to have an esthetically satisfying shape. For those offended by its simple, clean design, it could be covered with "gingerbread," hidden by extraneous structures, etc., without impairing its acoustical qualities.

It is so designed that a pair of tweeters may be placed under it. In our installations one tweeter covers the range from 500 to 4000 cps, the other from 4000 to 15,000 cps. The same horn is used for each, with a heavy driver for the low-frequency tweeter and a light driver for the high-frequency tweeter. This is an advantageous assignment of function, as it permits use of less expensive and more dependable drivers, as well as reducing intermodulation distortion. The construction of a driver unit which will handle power at 500 cps, and at the same time provide output essentially flat to 15,000 cps, is a difficult and delicate engineering and production problem.

The tweeter horn is designed to provide wide, even distribution of the frequencies within its range. In order to simplify its construction, it has three flat sides, with the top curved as necessary to produce the calculated exponential. This permits placing it under the woofer, as the flare is such that the sound is directed up and out into the room. The horns are constructed of sheet metal, covered on the outside with automobile undercoating to prevent ringing. The tweeter driver units (Jensen V20 and R101) are in approximately the same plane as the cone of the woofer (Jensen PLJ18), reducing phase differences among the three transducers in comparison with a folded system, where the path of the sound from the woofer is definitely longer (and goes around more corners).

Performance

Listening tests and comparative measurements using an uncalibrated microphone indicated that our low-frequency speaker has better characteristics, especially in the extreme lows, than an excellent commercially available corner speaker. Actual measurement of the sound output is, of course, definitive. The results are shown in *Fig. 4*. The measurements were made in the open, using an artificial corner. The nearest possible source of reflections was over a block away. The speaker was energized by a GME cathode follower amplifier[3] driven by a Hewlett-Packard 201B audio oscillator. The sound was measured with a calibrated Western Electric 640AA microphone, Western Electric preamplifier, and Hewlett-Packard 400A voltmeter. The microphone was placed ten feet from the corner on the axis of the speaker and five feet from the ground. The readings were corrected using the free field calibration. The resulting curve shows good response from 20 to 500 cps. The slight dip at 330 cps is the result of internal reflections in the speaker compression chamber, and has been reduced considerably by lining the inside of the chamber with sound absorbent material. It could be reduced still more by a simple labyrinth, but this is not at present worthwhile, as the speaker is intended primarily for use in a room, where standing waves produce peaks and dips of tremendously greater size than shown anywhere on the curve. With our present crossover point, the frequency response above 500 cps is not of importance.

[3] W. E. Gilson and R. Pavlat, "A Practical Cathode Follower Amplifier," AUDIO ENGINEERING, May 1949.

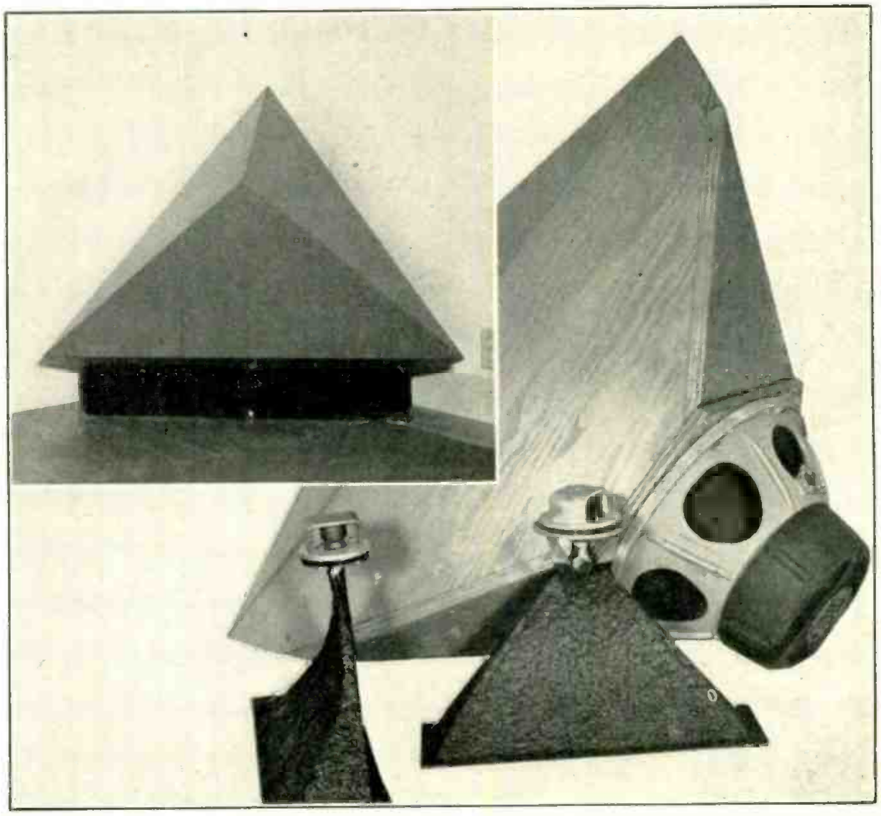


Fig. 2. Back view of unfinished low-frequency speaker with high-frequency speakers in foreground. Fig. 3. (Insert) Front view of speakers. The pyramid lacquered a conventional Chinese red.

An Impedance "Jig"

ALLEN W. SMITH*

Details of a simple instrument which will save time and provide information useful in selecting components or in evaluating those whose characteristics are unknown.

THE PRESENT-DAY DEMAND for hi-fidelity in audio amplifiers and the abundance of surplus chokes and transformers (more than often of unknown values) have made the radioman more and more conscious of "impedance" and the associated problem of impedance match. Unfortunately, due to its complex nature, impedance cannot be read directly on meters, as can resistance, voltage, and current. Even the expensive laboratory types of impedance bridges and "Z" angle meters require several manipulations.

There have been many excellent articles published covering the construction of impedance meters and bridges. However, these instruments often require built-in hand-calibrated vacuum-tube voltmeters and hand-calibrated dials for resistance values.

This article describes a simple, inexpensive "jig" or vacuum tube voltmeter accessory that requires no calibration and has the accuracy of the commercial VTVM.

Basic Theory

An inductance has a resistive as well as a reactive component, and although resistance and reactance are both measured in ohms, it is not possible simply to add the two together to obtain a quantity that will indicate the opposition offered by the combination to the flow of current. These are two vector quantities that combine to give the joint property of impedance, shown in *Fig.* 1. With the resistance and the reactance known, impedance becomes the vector sum of the two quantities.

$$Z = \sqrt{R^2 + X^2} \qquad (1)$$

where Z = impedance, R = resistance of the inductance, and X = the reactance. The resistance is the d.c. resistance of the inductance in ohms. The reactance is determined by the number of turns of wire, the diameter of the coil, and the frequency of the a.c. voltage.

$$X = 2\pi f L \qquad (2)$$

where f = cycles per second, and L is in henries. An alternating current passing through an inductance will encounter the opposing action of impedance, and the current will attain the value $I = E/Z$. The current passing through the inductance will produce a voltage drop across the inductance that is proportional to the impedance and, $E = IZ$.

Figure 2 shows a well-known method of measuring impedance. It can be seen that if an alternating current is applied at terminals *1* and *2*, current will flow through the unknown inductance L and the variable resistance R. If the value of R is then varied to make the voltage drop across L equal to the voltage drop across R, then $E_L = E_R$. Since the current in a series circuit is the same in all components in the circuit, it follows that $I_L = I_R$. From Ohm's Law, $Z = E_L/I_L = E_R/I_R$. Also, $E_R/I_R = R$. Therefore, $Z = R$, and the value of impedance is thus seen to be that of the resistance. A vacuum-tube voltmeter is used to measure the voltage drops for balance, and the resistance R is measured after the balance is obtained.

Operation

With an instrument constructed in accordance with *Fig.* 3, the unknown component is connected to terminals *1* and *2*, and the v-t voltmeter is connected to terminals *3* and *4*. The unit is then plugged into a 117-volt a.c. line. After the VTVM has warmed up thoroughly, set the range switch to the 10-volt a.c. scale. While alternately depressing and releasing the push-button switch, adjust the resistors R_1, R_2, and R_3 so that the voltage is the same for either position of the push button.

Now remove the component being measured from the terminals and measure the resistance across terminals *3* and *4*. This value is equal to the impedance. To measure impedance at other frequencies, an audio oscillator can be connected to the circuit by means of the closed-circuit jack J_3.

This device is also useful for other measurements. For example, knowing the impedance of a coil, it may be desirable to determine its inductance. Since

$$\frac{Z_L^2 = R_L^2 + (6.28\,f\,L)^2}{L = \sqrt{Z^2 - R^2}/6.82\,f} \text{ henries} \qquad (3)$$

Thus, if the impedance and the resistance of an inductance are known, the values can be substituted in expression (*3*), and the value of the inductance in henries is obtained.

When the impedance is inductive, the reactance and the resistance are in series and can be added vectorially. However, when the impedance is capacitive, the resistance (actually leakage resistance) is in parallel with the capacitor and is very large compared to the impedance—in most instances it can be neglected. Thus, the expression for C, when Z is known, is approximately $C = 1/6.28\,fZ$ farads.

[*Continued on page 44*]

* *2156 W. Van Wick St., Los Angeles 47, California*

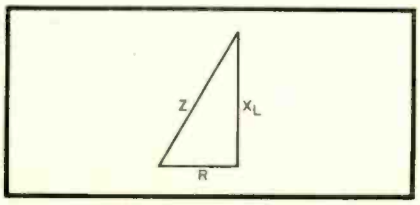


Fig. 1. The impedance triangle, showing the relation between impedance, inductive reactance, and resistance.

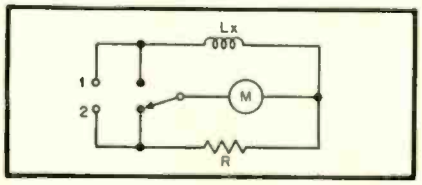


Fig. 2. Basic diagram of impedance measuring instrument described in the text.

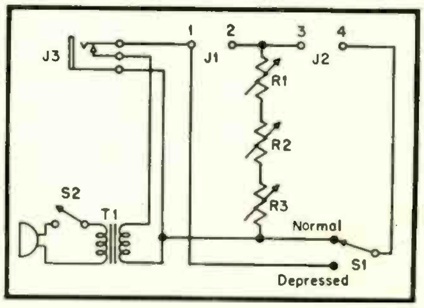


Fig. 3. Over-all schematic of completed instrument.

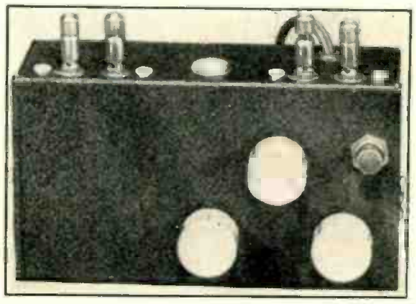
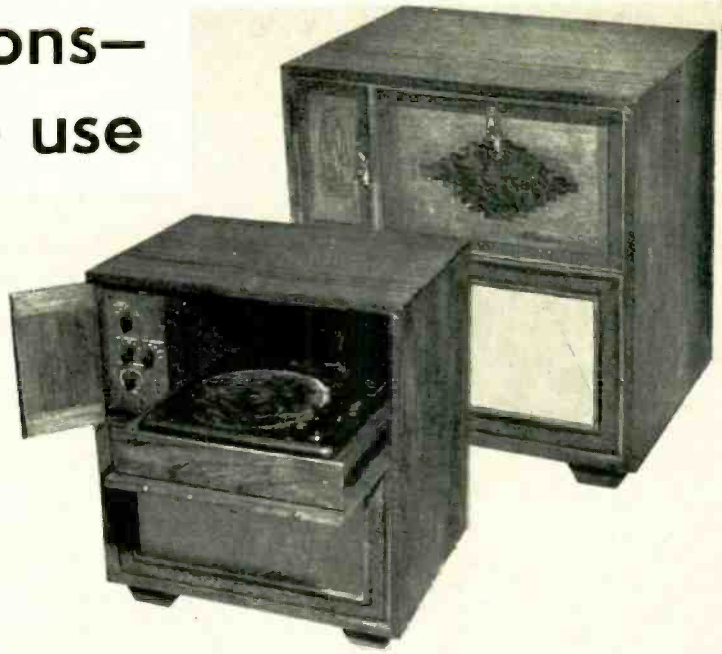
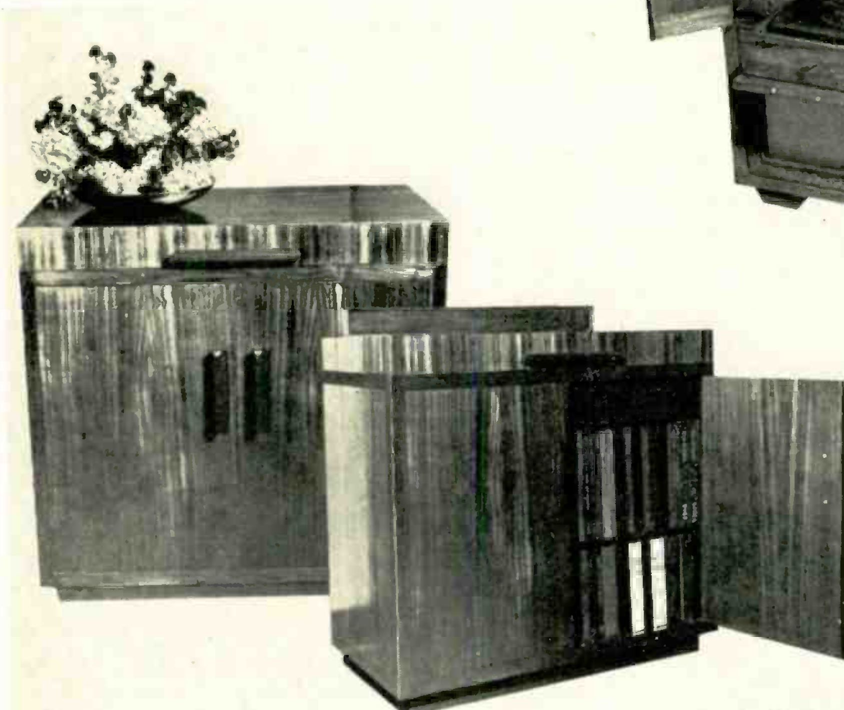


Fig. 4. External view of impedance "jig" as constructed.

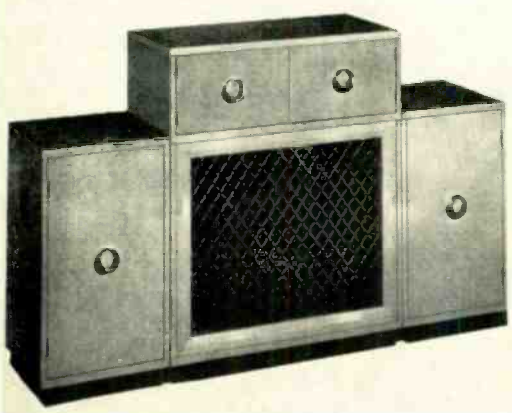
Readers' Suggestions— Cabinets for home use

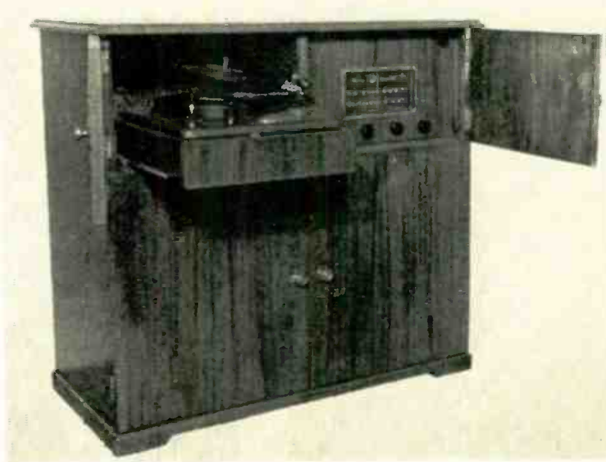
In the October issue, your ideas for cabinets for residence audio systems were solicited. Here are several attractive designs which appear to fulfill the requirements.





Upper right: Fred Paget, sound electrician on S. S. President Cleveland had this unit, of hand-carved teakwood, made to his order in China at a very reasonable cost. Left: Father A. C. Zapatocky, of Lansburg, Pa. designed and built a cabinet which features a control panel along the back quarter of the top, with a narrow door giving access to the knobs. This model is built of mahogany veneers, except for the access door which is visible on both sides. The front section of the top also lifts up, disclosing the tuner controls and the phonograph turntable.





Above, left and right: Commercial "entries" known as Uni-Mode cabinets, made by Grand Rapids Woodcraft Corp., 1400 Front St., N.W., Grand Rapids, Mich. This type of cabinet consists of individual sections, available in three different widths, which are simply stacked to the user's requirements and covered with a finished top. Available in either blonde or cordovan mahogany, these units are made to fit record changers, tuners, TV sets, amplifiers, speakers, and records.

Right: Model proposed by Turner & Co., 11 Millburn Ave., Maplewood, N. J. This cabinet is designed for tuner and turntable, with speaker and amplifier being housed in the lower sections. Separate speaker and record storage cabinets are also available, in matching design, and in a variety of finishes, although mahogany is standard. As a semi-standardized cabinet for the person who wishes to assemble a number of components, this model is priced very conservatively, and should provide sufficient space for practically any such use.

AUDIANA

C. G. McPROUD

Phonograph Reproduction—2

Concluding the discussion of the design of a control unit to be used with the Musician's Amplifier.

Last month's article dealt with the design of a control unit to be used with the "Musician's Amplifier" and covered only that part following the phono-radio selector switch. A brief mention was made of the low-frequency boost control, as well as the circuit arrangement used to feed a Webster 178 wire recorder which serves to record for later playback either of two desired programs airing simultaneously. However, principal attention was focussed on the variable low-pass filter which provides a means for controlling the upper frequency limit of reproduction. A relatively sharp-cutoff filter, together with correct roll-off circuits, gives an optimum balance between noise and frequency range, in the opinion of many listeners, and generally suffices to eliminate needle scratch without too much degradation of quality.

Considering that the unit is complete from selector switch to output, there remains only the phonograph preamplifier and equalizer circuits to be discussed, along with the constructional details.

Phono Equalizer

The writer has a preference—determined by listening tests—for the low-impedance equalizer previously discussed in these pages[1]. This type of equalizer consists of an inductance and several capacitors and resistors, together with an input transformer and a pentode amplifier stage. The output of this combination is approximately the same as that of the more commonly used dual triode with feedback. Referring to the over-all schematic, *Fig.* 1, the series inductance L_1 is tuned by one of the three *RC* circuits R_1C_1, R_2C_2, or R_3C_3, depending on the turnover frequency. These values are best determined by measurement with the pickup to be used, although any of the presently available magnetic pickups give comparable frequency response with the circuit shown. The resonant frequency of the capacitance-inductance is usually at approximately 0.8 times the desired turnover frequency, and empirically, the value of the associated resistor is approximately equal to the reactance of the inductance at the turnover frequency.

The *RC* circuit R_4C_4 determines the slope of the curve below turnover, and experimental determination of values indicates that a relatively large capacitance is required. Calculations for this equalizer circuit are extremely complicated and well beyond the scope of this series. With the constants shown in *Fig.* 1 and using the specified components should ensure similar results. The inductance L_1 should most certainly be a toroid to avoid hum pickup and to obtain a sufficiently high Q. The input transformer should be of high quality, and should be well shielded magnetically.

Amplifier Stage

To provide sufficient gain, a pentode

[1] C. G. McProud, "Residence Radio Systems III," Audio Engineering, Nov. 1948.

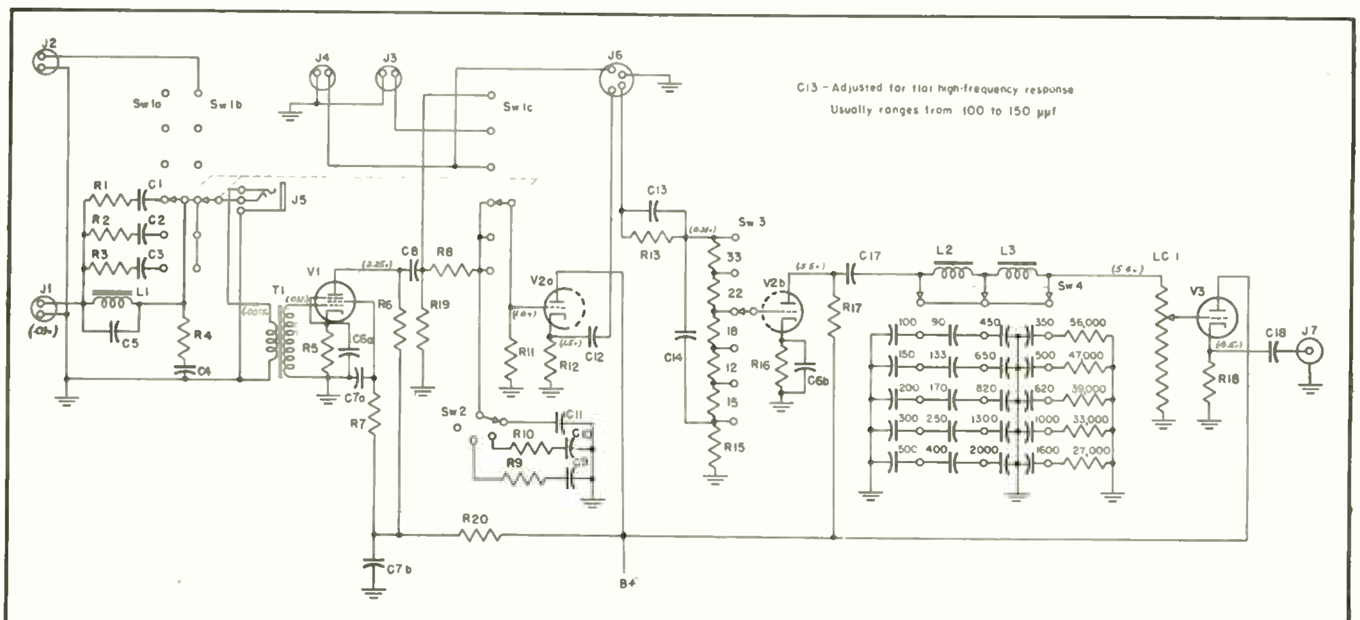


Fig. 1. Over-all schematic of control unit described.

Fig. 2. Turntable and pickup assembly used with the control unit.

preamplifier stage is required to raise the phono signal up to equality with radio tuner signals. The output of this stage is fed to the selector switch through a coupling capacitor, C_8, and the series resistor R_8. The selector switch Sw_1 is composed of three sections: (a) controls the turn-over frequency; (b) connects the transformer primary to the equalizer for the three phono positions, and in the sixth position to a separate input circuit which is intended for future connection to a high-quality tape recorder playback head; and (c) connects the following stage of the unit to the preamplifier through R_8 for the three phono positions or to C_8 directly in the sixth position. Positions 4 and 5 are for FM and AM radio tuners. The switch end of R_8 is connected to the arm of Sw_2, which is the roll-off control. This switch is a Centralab 1461 which has been altered to permit the rotor to turn over four positions instead of the three normally permitted. This alteration consists of filing the slot in the frame so the rotor turns a full 90 deg. In one position, the circuit is open, resulting in essentially flat response—this position beng the new one created by altering the stop. Actually, due to the capacitance in Sw_1, the response is down 3 db at 10,000 cps. In the second position, R_9 and C_9 cause a roll-off of 5 db at 10,000 cps, which is suitable for ffrr and most European 78 recordings. R_{10} and C_{10} give a roll-off of 8 db at 10,000 cps for most domestic 78's. C_{11}, with no series resistor, gives a roll-off which is correct for LP's. By actual check, using a pre-equalized test record, this circuit plays LP's within ±0.5 db of flat from 50 to 10,000 cps.

This type of equalizer is essentially identical with those employed in professional equipment, having been practically copied from the Pickering 163 Equalizer. When used with a high-quality pickup and a good turntable, the reproduction is excellent. The importance of a level, well balanced and *constant* speed turntable is not generally recognized. The unit pictured in *Fig.* 2, used as a test setup for various pickups and motors, as well as for regular phonograph reproduction in the home, has shown the importance of turntable quality. For example, the writer previously used a two-speed, gear-driven turntable with a 12-pound platter—presumably heavy enough to iron out any irregularities of speed. However, when the transition was made to the rim-drive unit shown, a definite improvement in quality was observed—particularly with respect to "flutter." Flutter may be considered a high-frequency speed variation as contrasted to "wow," which is a low-frequency variation. It affects, principally, the "cleanness" of the reproduction of high-frequency tones, such as those of a violin. The importance of turntable steadiness and speed constancy must not be underestimated.

Optional Preamplifier

Figure 3 is the schematic of a preamplifier which can be substituted for the one shown in *Fig.* 1, using the same switching arrangement for turnover frequency. The roll-off control is placed at the input to the preamplifier, after the manner of St. George and Drisko[2]. This preamplifier is somewhat less expensive to construct and much easier to adjust unless measuring facilities are available. It should give equally satisfactory results in most applications, and it is certainly a more conventional type for the home constructor.

Construction

The writer still favors a construction, devised some time ago, which places the tubes and other above-chassis components on one side of a chassis, with the controls on the opposite side, as shown in *Fig.* 4. The major parts are labeled in the figure, with a first model of the capacitor assembly mounted on the low-pass filter switch, Sw_4.

A few brief words of explanation may be necessary. All normal input circuits are on Amphenol 80PC2F receptacles. The jack J_5 gives direct access to the primary of T_1 for microphone use or for testing. The filament circuit is designed to work from a 12-volt d.c. supply, with V_1 and V_3 in series and with a 12-volt tube for V_2. V_1 is a 6J7 because of the lower hum possibility with the control grid connection being on the cap in case the unit should be operated with a.c. heater supply. Furthermore, if an absolute minimum of noise is required, a 1620 could be substituted immediately. C_{17} and C_{18} are oil-filled units, mounted above the chassis. The loudness control requires that some gain adjustment be provided so that the control will be operated at its normal position for average room volume. This control is a tap switch mounting a number of resistors providing 5-db steps of gain variation, and is located on the main amplifier chassis. The entire control unit is con-

[2] Paul W. St. George and Benjamin B. Drisko, "Versatile Phonograph Preamplifier," Audio Engineering, Mar. 1949.

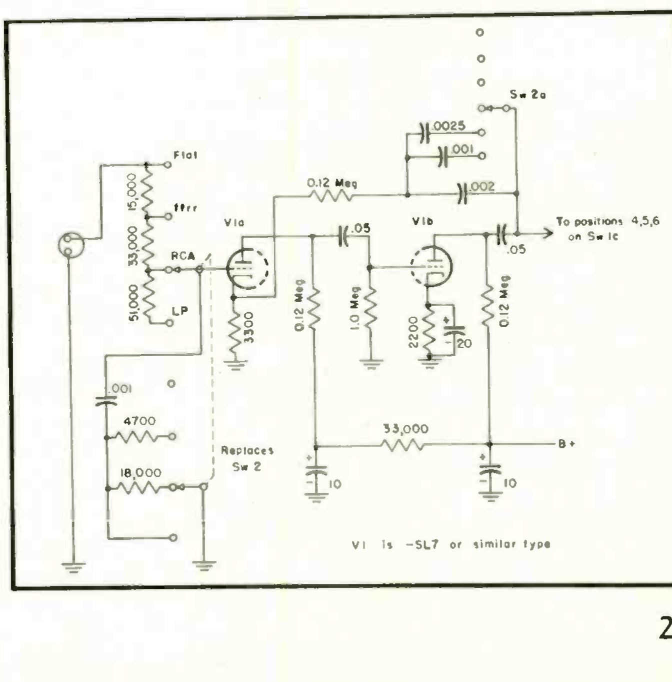


Fig. 3. Feedback preamplifier which may be substituted for all of the circuit ahead of the selector switch Sw_{1c} of Fig. 1.

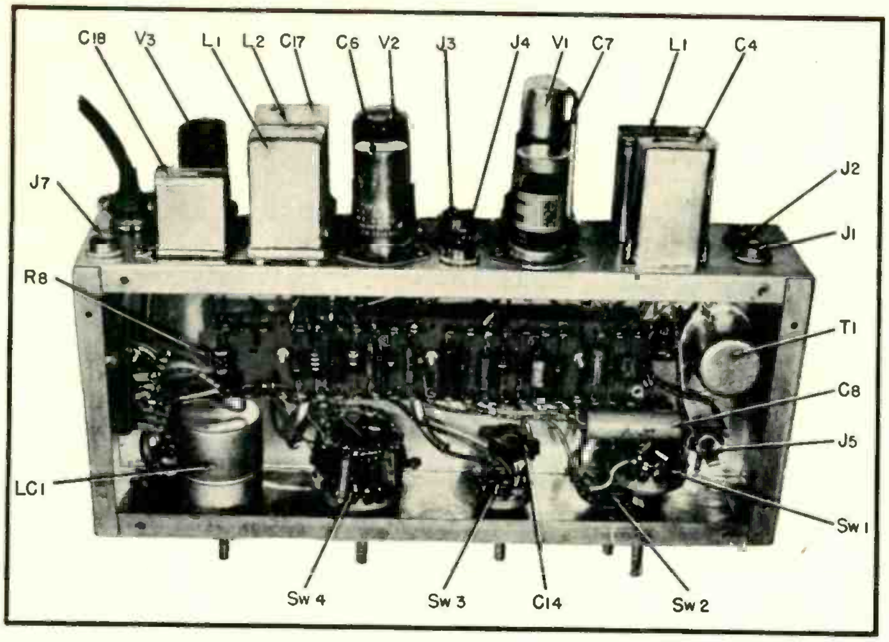


Fig. 4. Internal view of the control unit chassis.

structed on a 6 × 14 × 3 chassis, which is sufficiently large to avoid crowding of the components.

Wire Recorder Connections

As described last month, the FM radio output was permanently connected to the recorder input. Further consideration of this connection indicates the desirability of having the recorder connection made to the AM radio to take advantage of the better quality of FM for direct listening. However, the change can be made simply by interchanging the connections to the two input jacks and relearning the switch positions. The radio-recorder connection is ahead of the selector switch, so no operation of the switch can disturb the program being recorded. The Webster 178 recorder has a 4-pin plug at the rear to which connections are made. Normally, one lead is used both for input and playback output; one is a grounded shield, and the other two are used to open an r.f. cathode circuit in the radio, thus cutting the radio off during playback.

The circuit employed in the unit being described requires three shielded leads—one for the incoming signal, and the other two for a loop through the recorder switch. Thus, it is desirable to rewire the cable with three lengths of shielded wire and to shield the two leads from the pin plug to the switch in the recorder itself. Also necessary is a change in the wiring on the bottom of the switch to cause the playback output to feed the desired lead. The shielded jumper shown in *Fig.* 5 should be removed, and a strap added between two of the switch contacts. This will open the loop circuit and feed the playback output to the loop lead when the LISTEN 3 button is depressed. This will provide the operation desired.

Operating Conditions

The d.c. operating potentials are shown in *Fig.* 6 with a regulated supply of 225 volts. The signal voltages are shown on the schematic for a typical

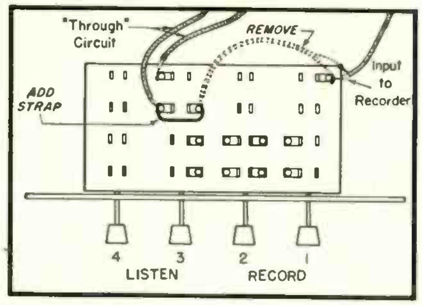


Fig. 5. Changes required on switch in Webster 178 recorder to enable switching operations described.

input from a magnetic pickup, with the selector switch in the 300-cps turnover position, at a frequency of 1000 cps, and with the loudness control at maximum volume. The parts list should give any further needed information about the components used. It will be noted that when high-resistance plate loads are used, the IRC DCF resistors are employed to ensure a minimum of noise. The socket for V_1 is rubber-mounted to minimize microphonics.

It is believed that the present design is satisfactory for general use in the home and that record reproduction is superior to much that is heard from many radio stations.

PARTS LIST

C_1 0.13 μf (0.1 + .03) paper, 200 v.
C_2 .08 μf, paper, 200 v.
C_3 .05 μf, paper, 200 v.
C_4, C_{12} 1.0 μf, 600 v. oil-filled, Aerovox 618B
C_5 500 μμf, Erie Ceramicon
C_6 40–40/25 electrolytic
C_7 10–10/450 electrolytic
C_8 0.1 μf, 600 v. molded
C_9 100 μμf, mica
C_{10} 1000 μμf, mica
C_{11} 2000 μμf, mica
C_{12} .05 μf, 600 v. molded
C_{13} 120 μμf, mica
C_{14} .008 μf, mica
C_{18} 0.25 μf, 400 v. oil-filled, Aerovox 418B
J_1, J_2, J_3, J_4 Amphenol 80PC2F connectors
J_5 closed-circuit jack, Switchcraft 12A
L_1 3.0 h; Freed F819T, UTC HQA-14
L_2 0.75 h; Freed F810T, UTC HQA-11
L_3 1.25 h; Freed F812T, UTC HQA-12
LC_1 Livingston MB Loudness Control
R_1 8200 ohms, ½ watt
R_2 10,000 ohms, ½ watt
R_3 18,000 ohms, ½ watt
R_4 1800 ohms, ½ watt
R_5 820 ohms, 1 watt
R_6, R_{17} 0.1 meg, IRC DCF
R_7 0.56 meg, 1 watt
R_8 0.1 meg, ½ watt
R_9 0.22 meg, ½ watt
R_{10} 68,000 ohms, ½ watt
R_{11} 1.0 meg, ½ watt
R_{12} 3900 ohms, 2 watt
R_{13} 0.27 meg, ½ watt
R_{14} Five ½-watt units assembled on Sw_3
R_{15} 56,000 ohms, ½ watt
R_{16} 1800 ohms, 1 watt
R_{18} 4700 ohms, 2 watt
R_{19} 2.2 megs, ½ watt
R_{20} 33,000 ohms, 2 watt
Sw_1, Sw_4 Mallory 3136J
Sw_2 Centralab 1461 modified (see text)
Sw_3 Mallory 3126J
T_1 500/50,000 input transformer, shielded. Langevin 401B, UTC A-11, Triad JO-1
V_1 6J7 (or 1620)
V_2 12SN7
V_3 6SJ7

Capacitors on Sw_4 are ceramicons, values in μμf; resistors mounted on Sw_4 are all ½ watt units.

	V1	V2a	V2b	V3
E_p	96	225	82	225
E_{sg}	40			
E_k	0.96	10.0	2.9	11.4
E_{bb}	194			

Measured with zero-current voltmeter

Fig. 6. Operating potential chart.

PERSONAL

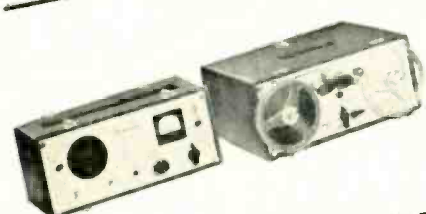
John D. Colvin, of the editorial advisory board of AUDIO ENGINEERING, has left his former position as Audio Facilities Engineer of American Broadcasting Company, and is now located with Commercial Radio-Sound Corp., 231 E. 47th St., New York 17, N. Y. as Chief Engineer and Plant Manager. This company is the RCA distributor of technical equipment for northern New Jersey, metropolitan New York, and Connecticut, and also designs, engineers, and fabricates special audio, video, and television systems.

Just over the Horizon

IN CONSOLE CABINET · RACK MOUNTED · OR PORTABLE

THE NEW MAGNECORD
PT7 SERIES
MAGNETIC TAPE RECORDERS

. . . Shown for the FIRST time at the I. R. E. Show—Booths U and V



The MAGNECORD PT6 SERIES ...Today's Leading Recording Value

- Chosen by more radio engineers than all other professional magnetic recorders combined.
- Famous for the flexibility, portability, and economy of Unit Construction, the quality of Broad Band Reproduction (40 cps to 15 kc).

New PT6 Equipment Offers Still Greater Flexibility for Every User

See it for the first time at the I.R.E. Show

Here is the new ultimate in recording equipment. No other recorder of any kind has offered such versatility, convenience and reproduction quality at any price!

The exciting new design of the PT7 series includes Magnecord positive drive and separate erase, record, and playback heads for monitoring off the tape while recording.

Write for complete specifications just released.

Magnecord, INC.

306 NORTH MICHIGAN AVENUE, CHICAGO 1, ILLINOIS

World's Largest and Oldest Manufacturers of Professional Magnetic Recorders.

Equalized Pre-Amplifier Using Single Stage Feedback

LAWRENCE FLEMING*

Single-tube circuit which offers the advantages of simplicity and easily varied turnover frequency.

Bass equalization for magnetic pickups is often accomplished by simple resistance-capacitance networks. The *RC* network is most commonly inserted between two triode stages in the preamplifier. Another widely-used arrangement employs the *RC* network in the feedback link between the plate of the second stage and the cathode of the first. Both arrangements require thorough filtering of the plate supply to the two stages, and the second type of circuit tends to be "hummy" because the first cathode is off ground.

A third possible location for the equalizing *RC* network is in a feedback connection between the plate and grid of one stage.[1] This configuration is not as well-known as it should be, but it is inherently the quietest and most stable. Two practical embodiments of this principle are shown in *Figs.* 1 and 2, and their measured curves in *Fig.* 3.

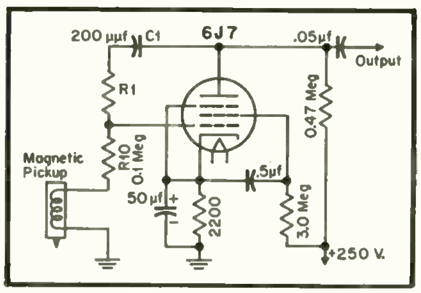


Fig. 1. Schematic for equalized pre-amplifier using a pentode stage.

As illustrated in *Fig.* 1, the circuit comprises a conventional resistance-coupled stage with three added elements: the feedback components C_1 and R_1 and an isolating resistor R_{10}. Because freedom from hum is particularly sought, it is essential that the cathode be grounded or well bypassed to ground and that one side of the phonograph pickup be grounded. Hence, the feedback must be introduced in parallel with the grid circuit. This makes the input impedance low, as is the case with the phase inverter tube in the well-known "floating paraphase" circuit. The signal therefore is fed to the grid through an isolating resistor R_{10}, and it is required that the impedance of the pickup be low compared to this isolating resistance at all frequencies in the desired range. For the average type of magnetic pickup having an inductance of the order of 0.2 henries, this requirement is easily met. The circuit is not practicable with crystal pickups, nor is the low-frequency equalization necessary. The circuit of *Fig.* 1 employs a 6J7 tube for minimum microphonics and hum.

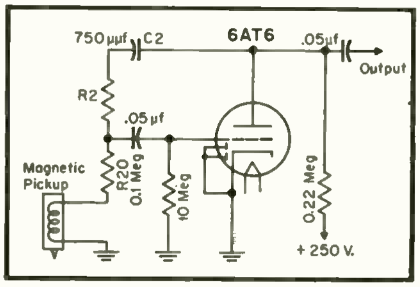


Fig. 2. High-mu triode circuit employing the same principles as that of Fig. 1.

High-Mu Triode Circuit

Figure 2 illustrates a practical circuit for a 6AT6 or any other triode having a mu of about 70. "Contact potential" bias is used here, but cathode bias could just as well be employed. The grid coupling capacitor has to be good and big so that it will not counteract part of the bass boost.

The screen and cathode bypassing in the pentode circuit of *Fig.* 1 has to be ample for the same reason. Referring again to the feedback components, the gain at high frequencies—where the reactance of capacitor C_1 is low—is the gain of a simple feedback amplifier having the fraction $R_{10}/(R_1+R_{10})$ of the output fed back to the input. The crossover frequency is approximately at the point the reactance of C_1 is equal to resistance R_1. Below this frequency there is less and less feedback, and finally the gain approaches asymptotically the gain without feedback, as in other *RC* equalizing circuits.

The measured curves of *Fig.* 3 show the value of the feedback resistance for crossover frequencies of 300 and 800 cps. for both the circuits described.

It will be noted that the asymptotic low-frequency gain is made equal for each of the two crossover frequencies in the curves of *Fig.* 3. This results in the gains being unequal at the higher frequencies. It is thought that this scheme is advisable, because below the crossover frequency it allows the gain to increase continuously down to about 40 cps. If the gains are made equal at high frequencies, the curve for the high crossover frequency will start to level off sooner on the low end than the curve for a lower crossover. This effect can be reduced by sacrificing more gain.

If, however, it is desired to vary the crossover point while holding the gain constant at high frequencies, this can readily be done by leaving R_1 constant (*Fig.* 1) and varying the capacitor C_1. To change the turnover from 300 cps to, say, 600 cps, merely reduce the capacitance C_1 from 200 μμf to 100 μμf.

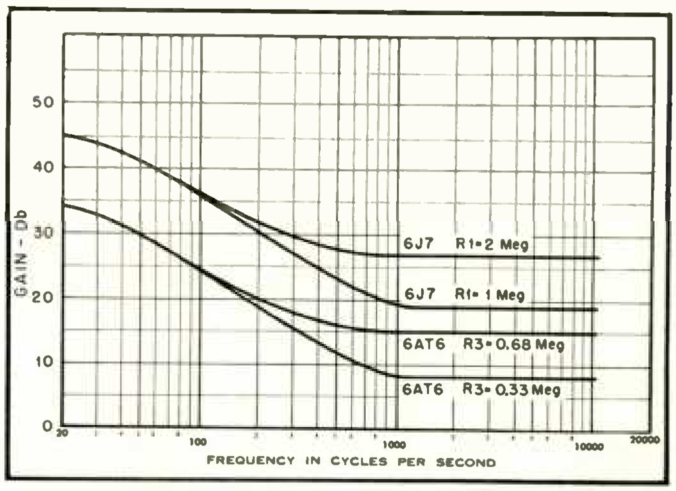


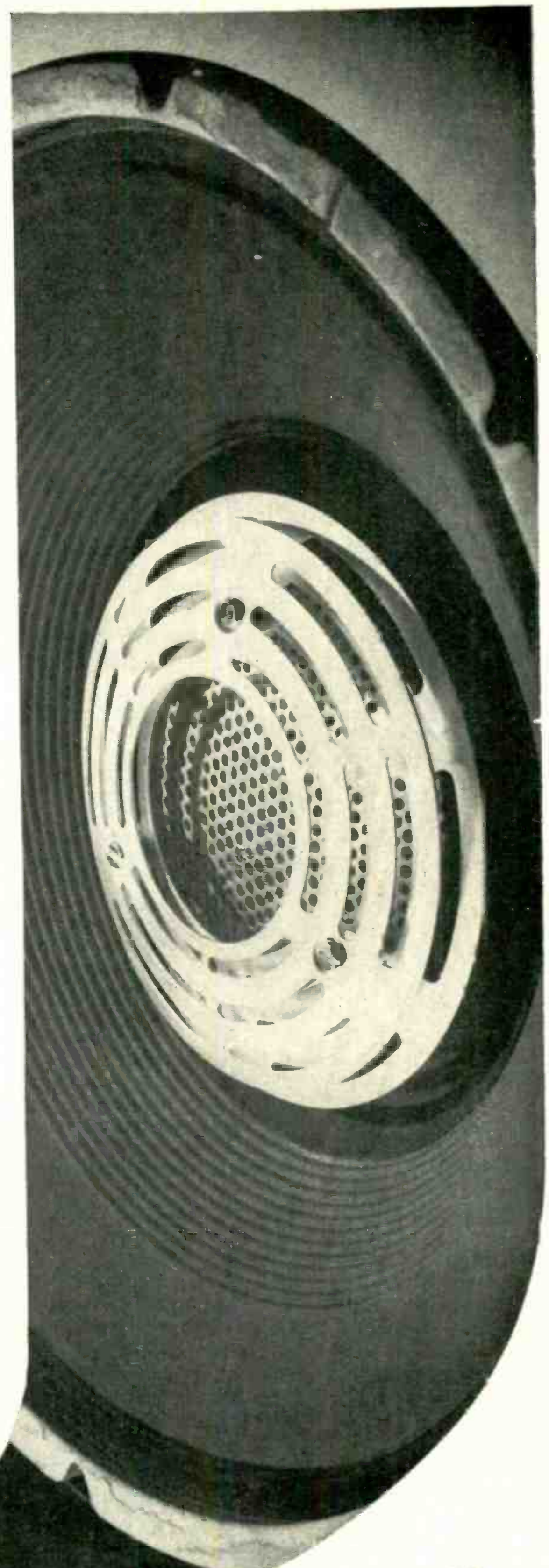
Fig. 3. Response curves for circuits of Figs. 1 and 2.

---

* *510 N. West St., Falls Church, Va.*

[1] J. Ellis, "Bass Compensation," *Wireless World*, Sept. 1947.

The FAMOUS GENUINE
JENSEN MODEL 510
COAXIAL SPEAKER



BEST AT ANY PRICE - - -

Comparative tests with the most expensive types of two-way speakers will prove that the Jensen Model 510 is the best regardless of price.

The new, wide-angle acoustic lens of the "510" is an example of Jensen leadership in loudspeaker engineering. By adapting optical principles to acoustics, this lens acts in conjunction with the h-f horn to distribute h-f radiation uniformly over a wide angle. This insures constant balance and high quality reproduction throughout the whole room.

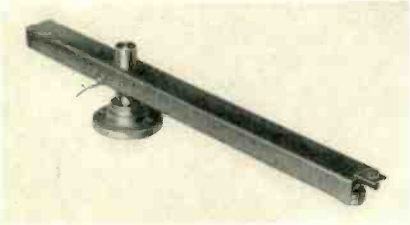
Whether the "510" is used for broadcast monitoring, professional sound reproduction, or for home entertainment systems, the advanced Jensen electroacoustic design assures the finest performance.

GENUINE Jensen WIDE RANGE

JENSEN MANUFACTURING COMPANY DIVISION OF THE MUTER COMPANY
6633 South Laramie Avenue, Chicago 38, Illinois • *In Canada: Copper Wire Products, Ltd., 351 Carlaw, Toronto*

NEW PRODUCTS

● **New Pickup Arm,** model 190, overcomes the disadvantages inherent in most arms, and permits a high-quality cartridge to meet the stringent requirements for playing LP records without distortion, and with a minimum of stylus and record wear. This model, recently announced by Pickering & Company, Oceanside, N. Y. features a low vertical-to-lateral moment of inertia, a low vertical mass, no spurious arm resonances, and



is provided with adjustments for tracking force, height, and levelling, fits a plug-in cartridge, and has a magnetic arm rest. Further information can be obtained from the manufacturer.

● **Midget "A" Battery.** Having a capacity of 1000 milliampere hours and weighing but 0.39 oz., the new RM-1 battery offered by P. R. Mallory & Co., Inc. is especially suitable for hearing aids and general applications where a minimum of size and space is desirable. The complete line includes batteries having capacities from 1000 to 3600 milliampere hours, individual cells ranging from 300 to 3200 ma. hrs., and stack assemblies in a wide variety of sizes and capacities.

These batteries are unique in design and construction, and have a long shelf life, uniform discharge voltage, a high ratio of energy to volume and weight, resistance to impact and acceleration, as well as a number of other advantages. For further information about this line of Mercury batteries, write the manufacturer's Battery Division, North Tarrytown, N. Y.

● **Magnetic Film Recorder,** the Magnefilm, has been added to the line of sound photographic equipment manufactured and sold by Movie-Mite Corporation, 1105 Truman Road, Kansas City 6, Mo. This unit is not a conventional tape recorder, but is a synchronous-motor-driven 16-mm magnetic film recorder, quality built with precision mechanical and electronics parts. It is ideal for location sound recording for film producers, radio and TV stations, or for anyone desiring the ultimate in high-fidelity sound recording. The complete unit is housed in one case.

The Magnefilm recorder employs a film speed of 72 feet per minute, and the freqency response is within ±1 db from 50 to more than 10,000 cps. The recording amplifier includes a pre-amplifier, and has inputs of 50 and 500,000 ohms. An interlocking arrangement prevents the possibility of erasing recorded material while rewinding before checking the recorded signal, and monitoring can be accom-

plished either aurally or visually from the playback head through a separate amplifier, thus ensuring the actual recording of a signal if it is heard or if its presence is indicated by the VU meter.

● **Wire Dictating Machine.** A complete system for office use has just been announced by Pentron Corporation, with the name of "Sonograph," and selling at so low a price that the smallest office can afford it. Comparing costs, it is noted that wax dictation costs about 40 cents per hour, disc dictation from 6 to 12, whereas the Sonograph costs only .005 cents per hour. The same unit is used for both dictation and transcribing. This unit has toe control for starting, stopping, and reversing, and features a Synchronized Word Meter which counts and indexes each word.

Certain features of an office-type machine are likely to appeal to those who have unique requirements for magnetic recording machines. For further information, write the manufacturer, 613 W. Division St., Chicago 10, Ill.

● **Crystal Cartridges.** The new "AC" series of miniature cartridges offers appreciably improved performance characteristics and quality for midget cartridges because of a new type of mechanical drive system. Smooth response, better tracking, lower needle talk, and longer life for both stylus and record are specific results partly attributed to the low-inertia system, and frequency response is maintained throughout the range from 50 to 10,000 cps.

[*Continued on page 41*]

Mostly Records

EDWARD TATNALL CANBY

My dissertation in the January issue on Monaural and Binaural Liveness Factors ambled to such length that ye dazed editor perforce sliced out a number of record reviews in order to keep the mag. from busting its seams. The Fall Rush of new records last season was unprecedentedly large (there are always more records when business is punk), and the reissues on LP, the re-recorded oldies, the spate of new ventures, all have added up in the last few months to a perfect avalanche of plastic—thank our stars it's economical of physical space, if not of playing time! The flood continues into the '50s, not much abated, and in order to keep happy those readers who—with some justification—may think this column is a Record Revue, I'm devoting most of our space this month to a catch-up survey of what's new and almost new on the records themselves. That over, this department will resume its rambles hither and yon. A couple of items before we get to the records:

Cool War

As this appears, the first of the new RCA long playing 33 1/3 records should be appearing too, and the event should be officially noted here—otherwise somebody might think I hadn't heard. For my general feelings on the 33 vs. the 45, see last summer's issues of this magazine; I think what was said then stands up pretty well in the light of what has followed. It seems to me no time for snickering now—but rather for a preliminary sigh of relief that at least one stage of the war is over, and that from here on out the three speeds may find their proper place in a slightly more neutral manner, as public acceptance dictates. A huge amount of advertising (are the ad agencies happy!) has been thrown into the war, and without a doubt it has had considerable effect in swaying the public towards one side or the other. But in the end, over a long spell of time, the chances for a real decision on merit increase and this is all to the good.

Which speed for what? It would be silly to forecast, but as far as I'm concerned, given a large distribution of three-speed equipment, there will no doubt be some place for all three types for a good while to come. Frankly, I can't see how RCA's 45's can keep up with their own 33's for the longer works; but who knows? In the 7-inch single, the competition will be very keen, and I don't see why the 45 shouldn't hold its own and perhaps win manufacturing converts. Remember, there are millions of single records to be made.

Biggest headache? What we need is a batch of *really* simplified two- and three-speed changers, and we are likely to get them. If the changer can be as neatly streamlined as the tape recorder has been in the last year or so, then a lot of us will be much happier. The most obvious need—already answered in some new models—is a spindle system which will automatically take either size of hole, eliminating those pesky spiders and what-not; next to this, a bit more automatic adjustment in respect to sizes and speeds. A lot still can be done here, though one brain-twister—how to choose the right stylus *automatically*—will be beyond ingenuity, I fear. (Yes, I know there are "compromise" points, to play all grooves. You show me.) One glaring hole in the present picture: there is no wide-range, quality changer for the wide-range 45 record. Only those of us with manual equipment or three-speed plug-in head changers can hear the 45's as they really can sound, which is plenty good. What say, RCA?

A Year's Work for Somebody

I meant what I said when I suggested in the January issue that "maybe some of you readers with know-how will do something about my rats"—i.e., the problems of binaural vs. monaural sound; also when I said, at another point, "there's a year's work for somebody."

[*Continued on page 46*]

Pops

RUDO S. GLOBUS

Recording Criteria—Part 1

Beginning as of now, three articles on the general "pop" situation. As a result, Uncle Rudo will probably lose his teeth as well as his nerve. But nevertheless, our all for the cause.

First dangerous contention . . . . you can't talk about the mechanical aspects of recording before you establish your musical criteria. We are not concerned here with the question of whether it is in poor taste to blow one's top over Sammy Kaye and his slumpy sashay. Therefore, to begin at the beginning . . . .

We (namely R.S.G.) contend that there is probably only a handful of people in existence who know or remember what a band, a pop vocalist, or any of the infinite pop combinations really sound like. What may sound like the raving of a diseased mind is in reality quite, quite shrewd. Think it over for a minute. Eliminating the musicians themselves, who have to suffer through their own sounds, there are only three ways to hear pop music—via radio, records, or live performances. We will forget radio and record reproduction for a moment and recognize the snide character in the last row who contends that he only attends "live concerts" of the lighter stuff. Leave us examine the "concert" situation for a moment. The band that plays in ye local theatre plays through ye local p.a. system. The band that plays in ye local night club plays through ye local nightclub p.a. system. The vocalist who sings with either piano, small group, or band accompaniment, sings through ye local mike, and therefore through ye local p.a. system. Even the lonesome piano man, he who produces cow eyes at the flick of a digit, plays through ye local p.a. system. Who has the audacity to speak of *live* popular music?

Returning to the radio and record situation, we will eliminate for the moment the problem of the relation between radio and record reproduction and the real thing. What is of importance is the sudden, stark realization of the fact that there is really no opportunity for the "music consumer" to hear live, popular music. On what, therefore, does he base his value criteria? In the case of classical, or serious music, there is still a chance to hear true instrumental sound. But . . . . is there? I leave this to my cell-mate at the left to decide.

This is a record column. Therefore we are concerned with criteria for establishing the quality of any given recording. Let us go one step further towards the inevitable punch in the nose. What do we want to "hear" in a popular record? It has been the opinion of some of the giants of the industry that we want to hear our music, if we deign to call it that, with the virile assistance of an echo chamber. Let's not kid ourselves. Sounds produced through the utilization of le bon echo chamber bear as close a resemblance to the real thing as a toy piano resembles a concert grand in sound. An echo chamber has never elicited sounds remotely resembling what comes from the relation of lung, embouchure, and tube . . . . or string, sounding board, and hammer. But a sound is produced . . . . no doubt about that. It is also obvious that there are many people who are particularly fond of such sounds. If we forget about the echo chamber proper, what about echo in general? How much, how little, in the case of each given recording, is right? What are the specific acoustical conditions proper for best "pop" music reproduction?

Time for a pregnant example. Several weeks ago I spent a dull afternoon with a musician, whose name will go unnoted here. The afternoon was spent in the hurling of recriminations at a local "audio engineer" who had attempted to make the musician's already marvelous record player a marvelouser record player. The addition of two more efficient tweeters, a better woofer, and a few devilish changes in the amplifier ended in the marvelouser instrument intended by the mad engineer. Aforementioned engineer was satisfied that the resultant creation was magnificent . . . . as good as possible. But . . . . the musician wept bitter tears. He agreed that the highs were more brilliant than they had been . . . . everything that good engineering can provide was there. But . . . . clarinets didn't sound like clarinets; all the woodwind sounds, for that matter, were not true woodwind sounds. Brass sounds were unreal, string sounds were unreal . . . . in other words!

Here was a case in point of somebody who after years of experience as instrumentalist and conductor, knew accurately and acutely true instrumental sounds. His reproduction system satisfied all the requirements of the engineer . . . . and for that matter the requirements of a good proportion of the people whose conception of instrumental sound is dedicated to the proposition, "the shinier it is, the better."

"Classical" Example

Now let's take it the other way round. There has always been a small class of people (or record collectors, if you care to make the distinction) whose criteria were non-musical. This class has been enormously enlarged by the entrance of the ffrr technique into the sound world. We cannot refer to a "pop" case in this connection, but since we are simply setting up general principles, any case will do. London has recently released a performance of the Ravel "Alborado del Gracioso" played by the Paris Conservatoire, conducted by Ernest Ansermet. The recording is fabulous, the music is lush, resplendent with all the elements of a brilliant Ravel orchestration. Everything is there, whereas in previous recordings very little was. But . . . . and the but should be as big as possible . . . . the performance is foul. Tempi and accents are wrong; orchestral balance is way off, etc. Yet the recording is a big seller and is the prize of many, many sophisticated record collectors.

In the above case, the criterion is obvious. It is certainly not a musical one.

What about the average "pop" record collector? Certainly he is not concerned with technical criteria. Further, we would maintain that with the exception of a select group of jazz collectors, musical criteria are non-existent as well. What is left? The only thing we can think of is the monstrosity combined of novelty and sentimentality, plus the eager assistance of heavy, solid plugging by those enterprising members of the under-world, the song plugger and the disc jockey.

If this is true, how can we hurl abuse at the record manufacturer for deplorable conduct technically? We can . . . . but that will have to wait for next month's installment. Meanwhile, out of the confused mess, let us draw some simple but devastating conclusions:

1. To all but a few favored children, accurate sound criteria do not exist. We did not go into the raido situation above, but a mere mention of the usual late night dance-band pick-up will enforce our point. With one mike, generally placed in the left stocking of the announcer, with acoustical conditions resembling those typical of the stomach of a giraffe in a local zoo, with no balance whatsoever . . . . need we discuss this further?

2. In the pop situation, musical criteria are practically non-existent. Let it suffice to say that this is not entirely the fault of the consumer who has been at the mercy of ten years of almost total decline in the pop music business. Means for establishing musical criteria have been practically non-existent.

3. No formal attempt has been made to standardize recording techniques throughout the pop field. The problem of the best possible recording of anything has never been important. What has been important has been a rough experimentation within an area of mediocrity (with a few notable exceptions).

In the following two articles, we shall suggest a basis for standardization. Nobody else need follow it. We shall, however, in our reviews and in our comments. Call Uncle Rudo a purist if you will, but he's darned if he can find a way of dealing with the technical and musical problems of recording without setting up some kind of standard. If nobody else will do it for him, he'll have to do it for himself. And he happens to think the Columbia job on South Pacific was terrific . . . so there!

LATEST RELEASES:

Preamble: For two months now, we've been opening our yaps on the jazz situation. Lo and behold, somebody has found it worthy to bless our efforts. Below will be found four new recordings theoretically of the commercial variety. But look at what's happened. This is a time for action. If you want more of the same and feel it in your hearts to agree with some of the premises contained in our last two articles, you . . . yes, you . . . can make something come of it. If enough of you gentle people will listen to the records, think of what we've had to say and what you want, a card from you to us will be forwarded to the geniuses who made the first step possible. We may yet accomplish big things together.

That's A Plenty — **Columbia 38710**

Clarinet, Jimmy Dorsey; trumpet, Charlie Teagarden; trombone, Cuddy Cutchall; saxophone, Frank Maynes; guitar, Carl Kress; piano, Dick Carey; drums, Ray Beduc; bass, Bill Lolatte.

Well, well, well. Believe it or not, this is the Jimmy Dorsey of "Green Eyes" and other dubious accomplishments. This, for those of you who haven't heard yet, is a dixieland combo. And what a record! Technically not the best that could be, but oh, so much better than practically anything else. The drive is enormous . . . . our breath has been completely taken away. A revolution, to say the least. Whatever prompted whoever to do it deserves at least a lemon lollypop. Our own theory is that things were so bad in the business that somebody in desperation had to take the chance. This, incidentally, is not Bob Crosbyism, despite the presence of Ray Beduc on drums. It is further not the greatest dixieland combo we've ever heard. But for a commercial group to come out with as fresh, as live a jazz performance as this is enough for today. Unfortunately, we still are dealing with ten inch discosis. The group is good enough to allow for more solo work (especially Mr. Teagarden who's tramming is welcome indeed). We may get an LP out of them yet.

Copenhagen — **London 604**

We're completely devastated. This job is another dixieland affair with a vocal by a very young and supposedly attractive thing called Teresa Brewer. More about her below. This baby has a backing by Max Kaminsky, one of our favorite trumpet men, and an all-star group. Limited, of course, by the very nature of the job . . . vocal and ten inch . . .it still beats. Two record companies in one month going out of their way to get out of the rut! This recording is a little neater than the Columbia's listed above, but not as interesting musically. Very nice microphone treatment . . . but we've come to expect that of London.

Music, Music, Music — **London**

Teresa Brewer again and the same group as above. Now we can talk about the little lady. The music itself is a throwback to a bad technicolor movie. We have reached the limit of our endurance on it. But . . . Miss Brewer has many accomplishments. During the past month we've heard six assorted sides she's made, and she doesn't sound the same on any of them. This is not the fault of the engineers, as you might expect from this month's article, but is an indication of the possession by T. Brewer of many, many styles. She has a lot of bite and a better know-how when it comes to jazz phrasing than a lot of other stellar people. On some sides she is perfectly obnoxious. She handles Copenhagen and M.M.M. extremely well and will certainly make a lot of money. With good material selection, we would also take our heads off to her. Leave us wait and see.

Pot Luck:

3rd Man Theme
Cafe Mozart Waltz — **London 536**

Since everybody is going to review this sooner or later, we might as well have our say. These two babies are played by Anton Karas and zither. He is the guy who does the background music for the forthcoming Carol Reed movie, "The Third Man." We have been told by the people who should know that this will be one of the biggest selling items in the history of the zither.

[Continued on page 39]

MAGNETIC RECORDING

[from page 12]

The voltage generated in the coil of head No. 1 will be:

$$E_1 = \frac{d\phi}{dt} = \frac{K'r_1}{r_1 + R_1}$$

The voltage generated in the coil of another, similar head No. 2 will be:

$$E_2 = \frac{K'r_2}{r_2 + R_2}$$

or

$$\frac{E_1}{E_2} = \frac{r_1\,(r_2 + R_2)}{r_2\,(r_1 + R_1)}$$

or

$$db = 20 \log \frac{E_1}{E_2} = 20 \log \frac{r_1\,(r_2 + R_2)}{r_2\,(r_1 + R_1)} \quad (2)$$

Assuming two reproduce heads, of the same inductance, but with unequal number of turns, so that equation *(1)* can be written as:

$$\left(\frac{N_2}{N_1}\right)^2 = \frac{r_2 + R_2}{r_1 + R_1}$$

then equation *(2)* reduces to:

$$db = 20 \log \frac{r_1}{r_2}\left(\frac{N_2}{N_1}\right)^2$$

Also, if we now make the following substitution:

$$r_1 = ar_2$$
$$R_1 = R_2 = R$$
$$R = br_2$$

we can write equation *(2)*

$$db = 20 \log \frac{a\,(1 + b)}{a + b}$$

It is seen from (B) of *Fig.* 10 that an increased reluctance at the front gap increases the output of a reproduce head; this increase is to some extent dependent on the reluctance of the back gap. In this curve the abscissa represents the factor by which the reluctance of the rear gap is larger than that of the front gap, and in which the ordinates show the db gain in output resulting from increasing the front gap reluctance by the factor "*a*". For example, a head having a rear gap reluctance equal to the front gap reluctance ($b = 1$) will provide a 2.6 db gain in output when its front gap reluctance is doubled ($a = 2$); a head having a rear gap reluctance which is ten times as great as the front gap reluctance ($b = 10$) will provide a 5.3 db gain in output when its front gap reluctance is doubled ($a = 2$).

In addition to the gain achieved when the reluctance of the front gap of a reproduce head is increased, another gain is secured by the additional number of turns of wire required to provide a reproduce head with a certain inductance. Increased reluctance for a reproduce head can ordinarily only be achieved by

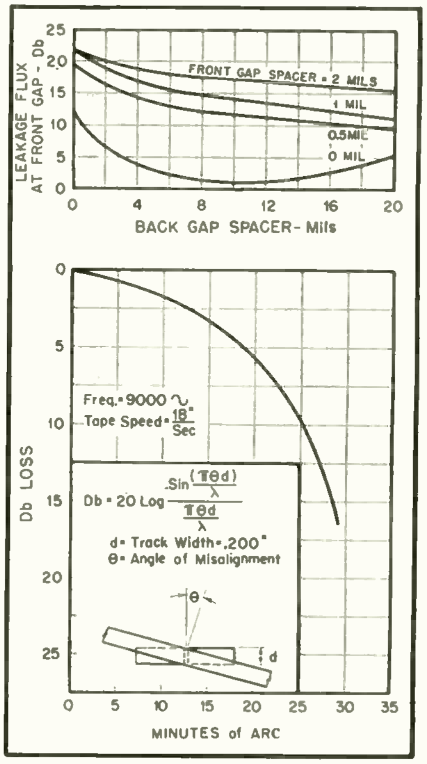


Fig. 11. (A, above) Leakage flux at front gap as a function of back-gap spacer. (B, below) Reduction in output as a function of the angle of misalignment.

reducing the depth of pole face, since the length of the air gap is fixed by frequency-response considerations. Still, there are limits also for the pole-face depth: a very small depth, say 5 mils, means that the life of the head is rather short, since the wear on the head by the tape will decrease the inductance quickly, with a corresponding change in the performance of the unit. In general, when the inductance of the head has been reduced by 20 per cent, due to wear, the head should be replaced.

Figure 11(A) shows the leakage flux at the front gap of a magnetic recording head as a function of the thickness of the back-gap spacer; the curves were obtained for different front-gap spacers, maintaining constant current through the head for all measurements. It is seen that the leakage flux decreases with increasing thickness of back-gap spacer, and that it increases with increasing thickness of frontal spacer. The head with the frontal butt joint represents, within the limits considered, an anomaly in that the leakage flux increases for very thick back spacers.

Another condition frequently observed, particularly with rectangular reproducing heads, concerns the increase of low-frequency reproduction when the head width equals a half wavelength of the recorded frequency. While the author has never measured as much variation in the low frequency response as was noted by J. S. Boyers,[5] an increase of 2 db at 100 cps can frequently be realized by permitting the tape to run over the entire width of the (rectangular) core of the head.

Spacers are usually made of beryllium copper or some other hard non-magnetic material to prevent burring of the pole tips. Following is a table giving the Brinell hardness for various materials:

TABLE III

Material	Brinell Hardness
Aluminum, annealed	23
Aluminum, work-hardened	44
Copper, annealed	30
Copper, work-hardened	105
Brass, annealed	60
Brass, work-hardened	150
Iron, annealed	67
Iron, work-hardened	220
18-8 Stainless Steel, annealed	135–185
18-8 Stainless Steel, work-hardened	180–330
Phosphor Bronze, annealed	73
Phosphor Bronze, work-hardened	234
Beryllium Copper, annealed	125
Beryllium Copper, heat-treated	300–350

[5] J. S. Boyers, "Factors Affecting Frequency Response and Distortion in Magnetic Recording," AUDIO ENGINEERING, May, 1948.

From the foregoing, it is seen that beryllium copper represents an ideal material for a non-magnetic spacer; it is even harder than material used for the core.

To avoid high-frequency losses, it is important that the gap of the reproducing head, in respect to the sound-track, be in the same position as the gap of the recording head was when the recording was made. Of course, if the same head is used for both recording and reproducing, no misalignment losses are suffered. *Figure* 11 shows the db reduction in output as a function of θ, the angle of misalignment, when the tape speed is 18 in. per second and the sound-track width is .200 in. The figure also gives the general formula for calculating the db loss for any wavelength, λ, and angle of misalignment, θ.

Back Gap

A back gap is frequently introduced in ring-type magnetic recording and reproducing heads to reduce d.c. magnetization with a consequent lowering of the noise produced by such magneti-

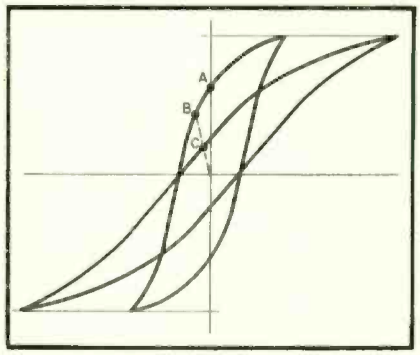


Fig. 12. Sheared hysteresis curve.

zation. This is effected by "shearing" the hysteresis curve, as shown in *Fig.* 12. When the magnetizing force in a closed ferrous ring is reduced to zero, the ring will have a residual induction, as indicated by the point *A* in the figure. When free poles exist in the ring, as in the case of a very fine air gap in the core, and the magnetomotive force is removed, the ring will have a remanent induction *B*. When a large back gap is inserted in the toroid, however, a "shearing" of the hysteresis curve is effected as shown in the figure, and the remanent induction *C* becomes rather small.

Cores are usually built up of laminations to reduce eddy-current losses. A coil having eddy-current, hysteresis, and copper losses may be represented as shown in *Fig.* 13. While the eddy-current loss increases with the square of the lamination thickness, it should be noted that very thin laminations make for a poor "stacking factor." In the case where a 200-mil thick core is built up of fifty 3-mil laminations, the insulation between laminations comes to 50

R_c = Resistance representing Copper Losses
R_h = Resistance representing Hysteresis Losses
R_e = Resistance representing Eddy-Current Losses $\approx \frac{0.4\, d^2 f^2 \mu L}{\rho}$

d = Thickness of Lamination (cm.)
f = Frequency
μ = Permeability of core at maximum flux density
ρ = Resistivity of core material microhm - cm
L = Inductance (henries)

Fig. 13. Equivalent circuit of typical head to represent losses.

mils (allowing a one-mil insulating layer between laminations) or 25 per cent of the core thickness. When 6-mil laminations are used, it can easily be calculated that. for the same thickness of insulation between layers, the insulation comes to only 14 per cent of the core thickness.

Erasing Heads

Erasing heads employing supersonic current for "wiping" are similar in construction to recording heads, but have a much longer and somewhat wider front gap. The gap length may be as much as 0.020 in., and the width is usually 10 per cent greater than the width of the sound-track. As the tape moves over the front gap, it passes through an alternating magnetic field whose peak value is great enough to saturate the medium and which decays so gradually as to reduce the magnetism on the tape to zero. The number of decreasing field reversals required to "erase" tape magnetism is chiefly a function of head construction. The peak value of the erase field is usually equal to several times the coercivity of the medium.

The laminations for an erasing head usually consist of silicon steel, and not of mumetal, since the former material saturates at approximately 20,000 gauss, compared to 8000 gauss for mumetal. To avoid undue heating of the non-magnetic front spacer, this wedge is frequently made of a non-metallic material, such as plastic or mica. It has also been suggested to employ head shape such as shown in *Fig.* 14 to effect a more gradual reduction in the leakage flux distribution on the side where the magnetic medium leaves the head.

(*To be Concluded*)

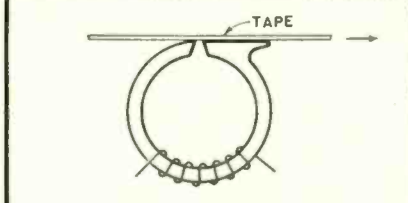


Fig. 14. Suggested head shape to improve leakage flux distribution.

WHITE NOISE

[*from page 15*]

that booster, program and line amplifiers are to be operated with a 12-db overload margin, then it follows inexorably that the monitor amplifier—which has the extraordinarily unpleasant job of driving a non-linear and reactive loudspeaker—must be operated with the same margin. As a matter of fact, there is plenty of evidence to show that 12 db is not nearly enough, especially using material which originates with the new miniature condenser microphones.

Figure 6 displays the beading of noise peaks that results when an amplifier is substantially overloaded. The a-c output meter reading for the level at which this reading *first starts* to appear is the *peak meter swing* allowable on program material for that amplifier. Investigation on this basis of monitor amplifiers in existing use will usually call for a lower operating level or a larger amplifier, or both.

The pattern displayed by speaker overload is similar to *Fig.* 3. No reading will occur as a result of the speaker, but if the amplifier is capable of over-driving the speaker, a ragged and possibly a periodic interruption of the fine noise will appear when the sweep rate is low (in reflexed cabinets it is usually periodic). Attempts should be made to determine at what meter indication this *first starts* to appear, and then back off 10–12 db for program material.

In all cases involving speakers and headsets, a miniature condenser microphone was used as a source for the oscilloscope screen. It is interesting to note that using white noise as a testing medium it is practically immaterial whether or not the microphone and speaker are *flat* acoustically, as long as some response is obtained at the extremes of the spectrum. Ringing resonance and overload analyses do not depend for validity on a flat response, but test the components as they are.

In viewing an undesirable noise picture, the question may arise as to where the defection lies—in microphone, loudspeaker, pickup cartridge, or even amplifier. It must be pre-supposed that a first move has been made to verify a white-noise output from the monitor amplifier which is beyond reproach, and a suitable playback cartridge—if possible, several similar ones—acquired for comparison by methods discussed later. Once a firm electrical input to the unknown device is established, the number of suspects reduces to two—speaker and microphone. Spudging the speaker, or the process of substitution, will quickly resolve this problem. Phenomena responsive to changes of volume level are usually attributable to the speaker.

Transient vs. Steady-State Response

The steady-state and transient responses of any transducer are comparable at frequencies below the main resonance of the mechanical system of the transducer. At frequencies *above* the main resonance, the device is mass-controlled, and the transient response appears inevitably to drop off at the rate of 6 db/octave with respect to the steady-state response. This will be true for microphones, loudspeakers and cutters, and has an electrical parallel in filters employing L and C, line loading sections, and probably some circuits involving reactance tubes. When the circuit is inductive, or the mechanical system is mass-controlled, the transient response drops off with respect to the steady-state response. In the case of a transcription or phonograph pickup, this is not true if full tracking obtains, since in that event the stylus must follow the groove no matter what the groove may do. But the force due to transient acceleration, $F = Ma$, exerted by the stylus against the groove walls may cause the record material to give way, causing the same end result.

In playing back the noise record, attention must be directed toward the matter of tip radius of the playback stylus. The average stylus is not less than .0025" in radius, and as would be expected, has an unsatisfactory transient response. The natural conjecture would be in the direction of the .001-in. radius tip, or even smaller, but this turns out not to be the case, because, at higher frequencies, transient accelerations produce the same lateral reaction force on the sidewall as on a larger sized radius, but in the case of the 1-mil tip, that force is distributed over such a small area of plastic sidewall that the unit pressures cause deformation at the moment of the transient acceleration. Result: no transient. The .0015-in. radius dimension in diamond seems to produce the highest electrical transient output of any tip size. Its superiority over the other two standard sizes is well evidenced by intermodulation measurements made comparing it with other sizes and using high-frequency carrier tones progressively from 5,000 to 20,000 cps. The 1.5-mil radius intermodulation reading is constant within those limits of frequency and the steady-state frequency output is flat, neither of which is characteristic of the other two sizes. The 1.5-mil radius also plays LP records at least as well as the smaller size.

If the implications of this discrepancy between steady-state and transient response as applied to loudspeakers are not depressing enough, then consider the ribbon microphone, which has a main resonance somewhere between 2 and 10 cps, and is mass-controlled throughout its entire operating range.[2] Tentative equations set up to prove this could cover several pages, but there are experimental ways to get corroboration.[3]

Oscilloscope Noise Patterns

In *Figs.* 7 to 13 inclusive are shown repeated proofs of the Fourier analysis as applied to pure transient impulses. This presentation has been termed the E type (for Ellipse). As is known, in order to obtain an ellipse or circle on the screen, it is only necessary to put a sine wave on one set of plates and the same sine wave shifted by 90 deg. or less on the other set. The external oscilloscope circuit used to produce these screens is shown in *Fig.* 17.

Fourier might say that random thermal noise is the continual[4] presence in

[2] This may help to explain a common complaint of engineers that a velocity and a pressure microphone by the same manufacturer, and with not dissimilar directional patterns, placed side by side in a room with an orchestra sound intangibly different, even though they measure up to be practically identical in the manufacturer's free-field response curves. Such comparisons customarily are resolved by discarding the pressure in favor of the velocity because the pressure microphone reproduces the transients, at least in part, thereby overloading those various system amplifiers and speakers which are being operated at some arbitrarily rated level far in excess of that which could be permitted by a noise overload analysis as previously outlined.

[3] Place a pressure and velocity microphone side by side about 6 feet from a horn loudspeaker on the axis. Set respective levels on both microphones to be equal using some low-frequency tone out of the speaker, such as 200 cps. Then play thermal noise through the speaker, and compare VI readings of one microphone with the other. The only current microphone which is thoroughly acceptable on a transient basis is the miniature condenser, which has no resonance whatever before 8 to 15 kc, depending on the manufacture. No other alternative is possible when choosing a reference standard for quantitative comparisons between microphones.

[4] Not steady state—just about as continuous as energy quanta in a Geiger counter.

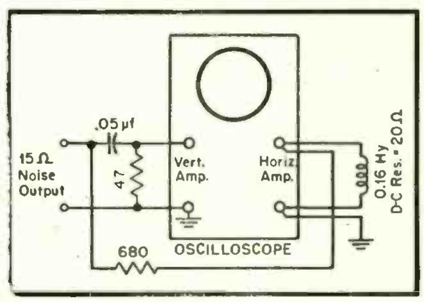


Fig. 17. Circuit employed to shift phase of the Fourier equivalent of the noise signal to make the screen progressively more sensitive the higher the noise-frequency components.

equal degree of all frequencies—not just 1,000, 1,001, etc., but also 1,000.5 and all other intermediate fractional tones. That this is true is evident by the multiple ellipses of the *E*-type picture. The circuit is so arranged that the higher frequency components produce the larger ellipses, because it is the higher frequencies in which we often happen to be interested. It is easy enough to reverse the network to get the opposite effect.

Note the colossal difference in *E*-pattern size between white, and 12,000, 9,000, or 7,000 cps gray noises. Here is a sure and rapid-fire method of production testing of reproducers. All that is needed, in addition, is a low-frequency tone for an accurate level set to match efficiencies to reference. *Figures* 10 to 13, inclusive, also represent what would happen on four different cartridges or loudspeakers having these effective frequency responses.[5]

In the *E* presentation, ellipses appear as circles in perspective, thus establishing an imaginary reference plane in the third dimension. Now if amplifier distortion or overload occurs, hairy protuberances will appear to spring up out of this imaginary reference plane at the rim of the ellipse, *Fig.* 9, even when the degree of what we would otherwise call r.m.s. distortion is very slight. The noise *peak* distortion is high, and is thus plainly revealed. A well saturated amplifier is shown in *Fig.* 8.

In the *E*-type screens of *Figs.* 7 to 13, the horizontal and vertical signals are obtained from the same original noise source. When two separate noise sources or records are used simultaneously for vertical and horizontal deflection, then noise is being "swept" with noise, and the result is as shown in *Figs.* 14, 15 and 16. This has been called the *CP* type screen (Concentric Persistence), for if a high-persistence CR tube is used, the presentation becomes basically circular, various fringe and internal aberrations from concentricity being interpretable as correlating with frequency, overload, tracking, etc.[6] For sake of brevity these will not be entered into here, but in both the *E* and *CP* types, any bright spots, measled patches or solid lines within the outer periphery of the patterns are readily indentifiable by position and shape with various unwelcome occurrences in amplifiers, pickups or other circuit links.

Conclusions

To sum up, it is reckless adventuring to assume transient performance on the basis of steady-state measurements, but within limits to infer steady-state results from observation of transient performance is quite in the framework of logic. In *noise*, all frequencies are present simultaneously. How else but in the *E* or *CP* type noise screens can the whole story be seen in one glance simultaneously — frequency range, distortion, tracking, ringing resonances, and relative transient response. Time, experience, and the resourcefulness of the user will surely find many valuable uses for "canned noise."

[5] The difference between white and 12,000-cps gray noise is not in proper proportion because it is difficult to take oscilloscope pictures which reveal the faint feathery ellipses of 20,000 cps.

[6] One ardent observer of the *CP* picture on a *short* persistence tube suggested "CP" from another standpoint, because it looks for all the world as though a Custard Pie had been hurled at the screen.

Pops [*from page 31*]

What makes the proposition worthy for review here is the fact that the zither is not an easy instrument to record. The recording is technically exemplary. Treatment is just right so that one is not overwhelmed by irrelevant harmonic blasts. It is also our feeling that this will also make an interesting test recording. It does not sound well on a poor instrument, for obvious reasons. Actually, for the same reason that good harp recordings—of which there are few—make good tests. Let us go even further. Any recording involving the striking or plucking of a string (this includes piano, harp, etc.) is a hard baby to make. When it is well made, there is still the problem of reproduction . . . but you know all this, why go on!

Employment Register

POSITIONS OPEN and AVAILABLE PERSONNEL may be listed here at no charge to industry or to members of the Society. For insertion in this column, brief announcements should be in the hands of the Secretary, Audio Engineering Society, Box F, Oceanside, N. Y., before the fifth of the month preceding the date of issue.

- **Wanted:** E. E., electronics major, with extensive bkgnd in magnetic and audio cct design and acoustical theory and practice. Must have at least 5 yrs exp. in product design on products now being sold nationally. Must be capable of following product from experimental through production, and be responsible for specifications, quality control, field tests, operation and service manuals on product developed. Must be creative and have an exceptionally high degree of mechanical aptitude. State age, education, and qualifications when answering. Location: Minnesota. Box 102.

- **Audio Engineer.** BEE from CCNY, 25, married. Superior knowledge of music; some informal experience with magnetic recording. Desire position in audio. Salary and location secondary. Box 301.

- **Graduate Student** of radio and television desires Junior Engineering position in audio or recording industry. Age 23, married, child. Willing to travel occasionally. Prefer midwest or south. Box 113.

- **Recording Engineer.** Experienced mixer; knowledge of classical music. Knows motion picture and radio mixing techniques, 30, married, presently employed. Graduate of Hollywood Sound Institute. Box 121.

- **Audio Engineer.** Graduate Hollywood Sound Institute, 25, married. Now attending television production school. Desires position with broadcast or recording studio, evenings, N.Y.C. Free to travel for full-time position. Box 122.

- **Graduate:** Advanced Technology course at RCA Institutes, 26, married, with knowledge of music, desires position in audio field; salary secondary. Box 101.

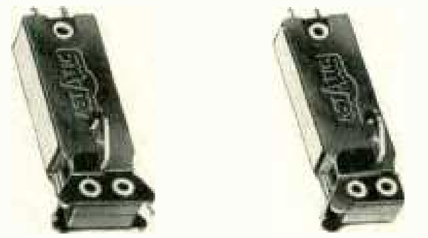
- **Audio Engineer:** M.S. Physics, Electrical Engr; ten years research, development, design experience with sound recording, acoustic measurements, and transducers. Thorough bkgnd in magnetic and mechanical recording including magnetic recording systems for computer applications. Presently employed, prefer firm in which could invest capital, small city or suburban location. Box 201.

- **Graduate VTI:** employed at present. Desires position in audio field. Some experience. Age 20, single, and in good health. Willing to learn, and will go anywhere. Box 202.

- **Audio Engineer:** experienced man with family desires position in recording, broadcasting, film, or TV sound. Excellent operator, troubleshooter, and maintenance man. Superior knowledge of classical music. Studio and equipment design and construction experience. Fluent English, French, and German. Willing to relocate. Box 203.

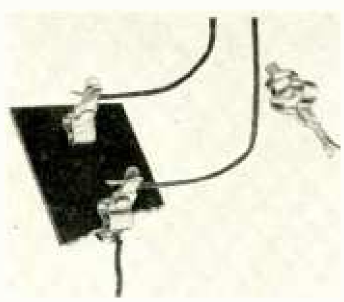
NEW PRODUCTS

[from page 27]



These new cartridges are molded of Bakelite, and have metal mounting brackets which fit standard ½-in. centers. They are equipped with needle guards, which protect the easily changeable special Type "C" Taper-Lock needle. Four models of the cartridge are available: AC-78 has a 3-mil stylus, either precious metal or sapphire; AC uses a 1-mil styus for LP's and 45's; AC-AG is equipped with a new All-Groove tip of special design to play all types; and ACD, a turnover cartridge with dual styli. All of these types are internally similar and provide an output signal of the order of 1.0 volts, using standard test records. They are manufactured by The Astatic Corporation, Conneaut, Ohio.

● **New Test Clip.** Grayhill, 4524 W. Madison St., Chicago 24, Ill. has developed a new test clip for speed and convenience in test and experimental work. This clip can be permanently mounted on various apparatus, and provides for an instantaneous connection of leads



from transformers, coils, and other equipment. Leads are held firmly until intentionally removed by the operator. Spring tension is adjustable, and complete mounting hardware is included.

Address the manufacturer for further information.

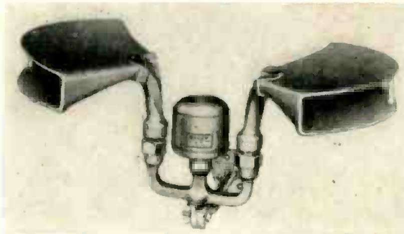
● **Recorded Magnetic Tape.** An entirely new field of home entertainment was introduced recently by Tape Recording Industries, Lansing, Michigan, with their announcement of a series of eight reels of popular and semi-classical music on pre-recorded tapes.

The reels are duplicated in commercial quantities by the L. S. Toogood Company of Chicago, which has the only machine in America capable of mass-producing recordings on tape. This machine is the electronic duplicator developed in the research laboratories of the Minnesota Mining and Mfg., Co., of St. Paul, maker of "Scotch" brand sound recording tapes.

Each reel plays for an hour and includes from 16 to 26 numbers. They are designed for use on home-type machines at 7½ in. per second, dual track, although the company will fill mail orders for any tape recorder. The original recordings were made by a Hammond organist, and by a trio composed of a Hammond organ, a piano, and a Solovox.

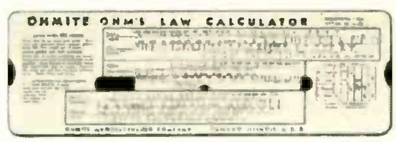
The new home recordings are a by-product of a series of recordings of various types of music for hotel lobbies, restaurants, roller rinks, and banks.

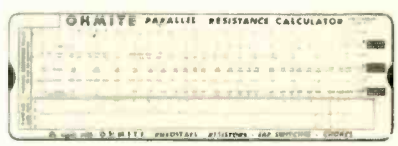
● **Cobra-type PA Speaker.** Designed to overcome the headache of installation where a wide area must be covered, or where a high noise level is encountered, the new Racon COB horn provides a uniform sound field over a horizontal angle of 120 deg. and a vertical angle of 40 deg. The cutoff point of these speakers is 370 cps, thus removing lower frequencies and ensuring clear, crisp speech reproduction, in addition to reducing amplifier power requirements.



Used back-to-back as shown, Model COB-2 is ideal where long corridors must be covered with a uniform sound intensity. Normally rated at 25 watts operating capacity, these units have a peak capacity of 50 watts. The impedance is 15 ohms, and the overall frequency range is 370 to 6500 cps. For a complete catalog of Racon speakers, write Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.

● **Ohm's Law Calculator,** familiar to most engineers and experimenters for many years, has been redesigned and is available in new form from Ohmite Manufacturing Co., 4937 Flournoy St., Chicago, Ill. at a cost of twenty-five cents. The redesigned calculator provides a simple and handy means of solving resistance problems; with one setting of the slide it gives the answer to any Ohm's Law problem, indicating directly in ohms, volts, amperes, and watts. The

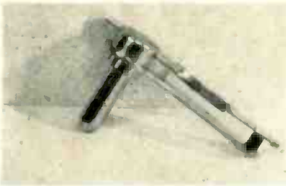




rule has new scales which serve as a standard slide rule, as well as giving the solution to problems of parallel resistances.

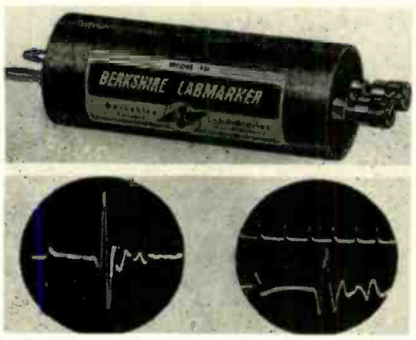
The electrical scales on the new calculator cover all values of resistance, current, voltage, and wattage commonly encountered in radio and light industrial work. Over a half million of the older models of this rule have been distributed to engineers, radio and electrical technicians, students, and teachers, and anyone working with electrical quantities will find it of considerable use.

● **Replaceable stylus assembly,** for use wth any G-E variable reluctance cartridge with the replaceable feature, has just been placed on the market. It em-



ploys a modified stylus arm which has been given a double twist and is double damped, and is known as the "Baton" stylus. With the new stylus, the G-E cartridge performs with higher compliance and improved tracking ability, and the additional damping reduces needle talk. This stylus is currently being sold in new cartridges, besides being available for replacement in older cartridges.

● **The new Labmarker** is a wave-shaping device which will produce time marks in cathode-ray oscilloscope screens. This device will convert a sinusoidal input voltage into a series of sharp unidirectional pulses, which may be displayed directly on the screen by connecting the output of the Labmarker to the



V input. If connected to the Z axis, the timing marks will consist of short breaks in the trace.

This device is compact, self-contained, and requires no power source except the sine-wave signal, and may be furnished to produce either negative or positive pips. Complete information may be obtained from Berkshire Laboratories, P.O. Box 70A, Concord, Mass.

● **Miniature Terminal Lugs,** much smaller than the Standard Line, are now available. These lugs have been designed and engineered to meet the requirements of the radio industry in following the trend toward smaller and lighter apparatus, particularly in the field of aircraft and armament equipment, hearing

aid devices, and other small size units. They are silver plated and specially treated to prevent corrosion, and rigid inspection ensures close tolerances.

Complete information about this line of miniature lugs, as well as about the Standard Line, may be obtained from U. S. Engineering Co., 521 Commercial St., Glendale 3, Calif., Dept. I.

IMPEDANCE "JIG"

[*from page 18*]

Construction

The construction of this unit is straightforward, with *Fig.* 4 picturing one possible form in which it may be assembled. There are no critical circuits, and for most work no shielding will be required. The size of the box is determined by the size of the transformer and can be of metal, wood, or plastic.

With the push-button switch in the normal position, the unit may be used as a source of 6.3-volt a.c. from terminals *1* and *4*, and as a 0 to 16,000-ohm variable resistance across terminals *3* and *4*.

Among the many uses of this instrument, one of the handiest is for the measurement of the input or output impedances of an amplifier, preferably when using an audio oscillator as a source. The output impedance of an amplifier is measured with the amplifier operating normally, but without any signal passing through it. Input impedance should also be measured with the amplifier turned on, but care should be exercised to avoid overloading the amplifier with the signal from the impedance "jig."

PARTS LIST

R_1—20-ohm, 2-w. pot; Mallory M20P
R_2—1,000-ohm, 2-w. pot; Mallory M1MPX
R_3—15,000-ohm, 2-w. pot; Mallory M15MP
J_1,J_2—National FWG terminal strips
J_3—Closed circuit jack, Mallory A-2A
T_1—6.3-volt filament transformer
S_1—SPDT push-button switch
S_2—SPST toggle switch

NEW LITERATURE

• **Audak Company**, 500 Fifth Ave., New York 18, N. Y. offers a folder just produced which describes the new Polyphase reproducer system employed in their latest phonograph pickups. A copy is free upon request.

• **Cinema Engineering Co.**, 1510 W. Verdugo, Burbank, Calif. has just issued a new catalog, 11AX. This booklet, consisting of 36 pages, lists the company's products, and includes a number of charts, tables, and schematics of attenuators and mixing circuits.

• **Soldering Specialties**, Summit, N. J. offers a new four-page bulletin describing the uses and advantages of pre-formed solder shapes. It includes an illustrated chart which shows applications in diverse fields.

• **Oxford Electric Corp.**, 3911 S. Michigan Ave., Chicago, Ill. offers a four-page catalog describing their complete line of permanent and electro dynamic speakers for radio and television, public address, and inter-communicating system applications.

• **Measurements Corporation**, Boonton, N. J. offers a 44-page catalog "C" presenting the line of standard signal generators, television signal generators, pulse generators, square-wave generators, mega-

NEW LITERATURE

[*from page 44*]

cycle meters, v-t voltmeters, and other "Laboratory Standards." The first issue of "Measurements Notes," a four-page illustrated brochure describing the use of the Model 59 Megacycle Meter in the design and construction of traps and filters for the elimination of TV interference is also available on request.

• **The Espey Mfg. Co.,** Inc. of 528 E. 72nd St., New York 21, N. Y. has joined with a number of custom components manufacturers in the production of a new brochure entitled "History Repeats," which details the growth of audio and high-quality music reproduction as a hobby, paralleling that of radio set construction in the early 20's. This pamphlet indicates a number of components which can be combined to make a system with any desired facilities, and at a lower cost than in factory-assembled radio-phonograph-television combinations.

Book Review

Communication Circuits, Third Edition, by Lawrence A. Ware, E.E., Ph.D., Professor of Electrical Engineering, State University of Iowa; and Henry R. Reed, M.S., E.E., Ph.D., Professor of Electrical Engineering, University of Maryland. 403 pages. John Wiley & Sons, Inc., New York. $5.00.

The third edition of this useful text contains much improved and up-to-date material on transmission lines, wave filters, impedance transformation, and wave guides. In a carefully revised first chapter the authors discuss the parameters of a transmission line, the high frequency "skin effect," and the effect on the parameters when the wires of the line are separated by a very small distance. The final section of the chapter shows the manner in which a transmission line may be represented by a T or Pi network or a series of such networks. The second chapter reviews Kirchoff's laws and determinants as tools in the solution of network problems, and includes the methods of transformations. Again the third chapter deals with fundamentals, stating the five network theorems; Thevenin's superposition, reciprocity, compensation, and maximum power transfer.

After the review of basic ideas, the book develops transmission lines from the line composed of finite network sections to the practical case of a line having distributed parameters. In these chapters are included developments on the propagation constant, line attenuation and power levels, the general equations of propagation, characteristic impedance, loading, and mismatch. Also the wave velocity, phase delay, open and short circuit characteristics, and insertion and reflection losses are discussed in detail. This material is not only of interest to the telephone or power engineer, but is—for audio engineers—the basis of filter theory, which the authors treat in two thorough chapters. A following chapter covers network sections used as impedance matching devices both at audio and radio frequencies.

Four excellent chapters are devoted to the theory of high-frequency wave guides and the coaxial line. The final chapter outlines several simple experiments on transmission lines which are helpful in obtaining a better understanding of the text material. For those readers who wish a thorough reference book at a high level, this book is recommended.

RECORD REVUE

[*from page 28*]

Though I would be delighted to work with a trained technician on these problems, I'm perfectly aware that the most I can do by myself, as a musician dabbling in sound, is to throw out suggestions, suggest lines of thought, and, of course, to chart some of the relationships between the musical-acoustic end and the technical, when it comes to listening with two ears.

If this column—mistakes, faux-pas, inconsistencies and all—manages to stir up some constructive discussion and/or action among engineer readers, it surely will have done its job. I'm hoping, therefore, that before I get back to the binaural-monaural stuff some of you readers will have taken over. One thing I am very sure of—there is a lot of work for *somebody* to do in that area, and it will be enormously useful. It's all yours, gentlemen!

Walteufel Memories; Kalman Memories. Robert Stolz and His Concert Orchestra
London LP: LLP 143

Strange—to begin with a "pops" record. But this one has my hearty approval, both technically and musically. As should be evident by now (but probably isn't to a lot of us), the London LP has evolved in a few short months from something the cat dragged in—last fall—into one of the finest records on the market and, according to my ear, more than a match for the already well known London 78 ffrr. This happy collection of waltz music is only one of dozens of top quality now London LP's, and I suggest that all engineers who have doubted LP take a crack at almost any one of them for a new evaluation. (Don't get one of the early lemons by mistake.) One important technical item—these apparently have the lesser pre-emphasis found on the equivalent ffrr 78's (evidently about half that of the Columbia LP). Those who have been squawking about the excessive pre-emphasis of the LP or NAB curve may be glad to have substantial working material here for practical comparisons. I don't think there's much question of the better choice for wide-range quality reproduction. On the other hand, given the average phono in the home and the usual crystal pickup, Columbia may have a good deal of argument on their side for the steeper curve . . . . in any case, here's your chance to try for yourself. (If my info is right, the rise is 3 db per octave or thereabouts.)

The music, Waldteufel waltzes on one side and stuff by one Kalman, similar style, on the other, is nothing less than delightful. It's not great or important music, but I've never heard the Viennese type waltz played so naturally, freshly, *musically* Even an aluminum ear could hear the difference—just compare this with some of our mass-production waltz playing over here! Moreover, the mike pickup and acoustic space-feeling are ideal for the music. Quite a record.

Debussy, Children's Corner Suite (transcribed by André Caplet).

Leopold Stokowsky and His Orchestra.
RCA Victor WDM 1327 (3)

Here's an excellent general-quality test record for the 45, if not exactly a spectacular one. Stokowsky's orchestra is miked by very fancy techniques, generally the opposite of the single-mike, over-all pickup used in many European recordings. (The orchestra has even been divided into widely separated groups, each with its mike, and the conductor in the middle). The quality is superb of its type—though some will insist that this rather artificially induced clarity (every instrumental a solo, in effect) is not as natural as the more blurred, distant over-all pickup.

This was originally a piano suite; but Debussy himself conducted the orchestral arrangement, thereby tacitly approving, so musical purists may rest tranquil. Lovely low-string tone, as here recorded. The Golliwogg's Cake-Walk is the most familiar number.

Bach, Clavier Concerto in E.
Louise Thyrion, piano; Pro Musica Orch. Goldschmidt.
Polydor-Vox PLP 6630

Another of the excellent new European recordings (mostly from tape) that Vox mixes in with numerous reissues, of doubtful technical quality though important musically. There's no way to tell the new ones from the old except by trying—or reading this column; still, the best of Vox is tops, and that goes for this record. Good quality piano, non-percussive, nicely balanced against a sharp, clean string tone. Wide-range sound, good surfaces (Columbia-processed).

The piano is out of place in Bach, but this is such nice playing that it really doesn't matter; and it's the only recording of a seldom heard and very worthwhile concerto. Like many orchestral recordings from small companies. the playing is a bit rough in spots, showing lack of adequate rehearsal. But rehearsals cost money, and so this we can forgive in view of a fine general sound. Backside is earlier recording of Bach E major violin concerto (Ricci); good quality, not as good as the new one.

Bach, Suite #3 in D.
Stuttgart Chamber Orchestra, Muenchinger.
London LP: LPS 147 (10")

Another superb London LP (and first of a series of Bach releases) with top quality, wide range recording, excellent acoustics and balance, the proper small orchestra with trumpets and harpsichord as Bach intended. A lovely sound, but a minor flaw is a rather mediocre rhythmic feeling; the music stomps along, march-like, instead of flowing. Not bad enough to keep you away from it.

Bach, Fifteen Two-Part Inventions.
Ralph Kirkpatrick, clavichord.
Concert Hall 78: C-6 (3)

Limited edition—unavaliable separately—but still worth a passing mention as a technical feat. The clavichord was the tiny personalized home instrument of Bach's time for individual self-playing. It carries about ten feet, but once you get used to its little voice, you discover its astonishing expressive qualities. The metal hammers also form the bridge—strings are tuned with hammers held against them. When the hammer is released, a permanent damping at the near end of the strings stops all tone. Because of this and the thinness of the tiny wires, the clavichord is the only keyboard instrument with a natural controlled vibrato; the harder you push, the higher the pitch goes. A short staccato touch produces a remarkable thump-like sound, almost like a drum, and utterly unlike any other keyboard effect, especially in the bass. All of which, of course, went into Bach's own playing of his so-called "piano" works, many of which were actually intended for this instrument, the clavichord.

The Kirkpatrick playing is expert, born of long experience with the instruments of Bach's time. The engineers did a first rate job in picking up the small wiry sound—only hitch is that you must reproduce that sound strictly at the original very low level, since obviously the record had to be made at normal modulation. Played at the correct low volume, this recording is the most perfectly realistic job I think I have ever heard, what with silent plastic, clean and wide range highs, and a natural "point source" not much different from that of the clavichord itself.

Mendelssohn, Violin Concerto in E minor
Campoli; London Philharmonic, Van Beinum

London 78: LA 98 (3)

Here's a traditional style ffrr standard shellac which I can highly recommend. (I gather that London does not duplicate its offerings on both speeds, though they don't ever let us reviewers know one way or t'other.) It's no super test record, but an excellent one of this kind of music. What I like best is the straightforward, non-exhibitionist violin playing of this gentleman who calls himself just—Campoli. The Mendelssohn Concerto is such a war-horse that every violinist of importance has to play it every other day—and it usually sounds that way. In order to be just that little bit "different," each man must put his own self-conscious quirks and affectations into the music, his trademark. All the more pleasure, then, in the hearing of this performance which sounds as though Campoli really didn't know this was a hackneyed old hoss. It isn't, as he plays it.

Beethoven, Symphony #2.
San Francisco Symphony, Monteux

RCA Victor 45: WDM 1325 (4)

It isn't often that a Frenchman does a good job on German music—but here's a case in point. The best recording I've heard of this symphony previously was the old Koussevitsky version, and it remains musically my choice. This comes very near to it—a similar interpretation, the main difference being a bit of roughness in the strings and the tempi as compared to the always accurate Boston.

There's an old and slightly crazy tradition that makes the first two Beethoven symphonies into delicate, 18th-century style fripperies (an utterly false idea of the 18th century, by the way), and there have been recordings that deliberately made them sound that way. Not so here. The real lusty, earthy Beethoven comes out, or only briefly hides behind the superficial elegance. It's good this way, and you'll like it. This album is one recent argument in favor of the 45 record. We need more like it.

"I Can Hear it Now," Vol. 2 (1945-1949)
Edward R. Murrow, Fred W. Friendly.
Columbia
LP:ML 4261
78: MM 881 (5)

"Prelude to Pearl Harbor" (1938-1941).
Dick O'Connor, Kent Stevenson.
London LP:
LLPA 1 (4 12")

Here are two notable examples of a significant new kind of history, hardly more than a few years old in recorded form. Both tell the story of a period via narration, interspersed with actual recordings of persons and scenes involved. Both, though generally objective in their comment, actually do a lot of editorializing, both directly and in the indirect method of choice of subject and choice of quotes. (From millions of recorded words quotes to "prove" almost any point of view might be assembled.)

End of similarity. It is too bad to have to report that on eight enormous LP sides the English project has managed to produce one of the most incredible examples of misguided and mismanaged technique imaginable; whereas the second volume of Columbia's "I Can Hear it Now," on only two LP sides, is a dignified and responsible sample of what can be done with this new kind of patchwork spoken history.

The "Prelude to Pearl Harbor" is an account of the Pre-Pearl Harbor job that England did, from 1938 on. Several loud, furious voices alternate in quick succession (like the more obnoxious radio ads) with a high tension, staccato newsreel effect that becomes unbearably monotonous after a few moments. A minimum of actual historical recordings are dubbed in, poorly, mostly to be drowned out by a weird species of translation in which the narrators put on fake German or Polish or Russian accents a la radio chiller-diller of the war days. Historical utterances are faked (again with those dreadful assumed accents), and at times one gets utterly confused as to who is saying what and when! The whole thing, to my ears, is childish and unworthy of the record company that launched it here as a serious documentary.

A few moments of Volume 2 of "I Can Hear it Now" will convince you, I think, of what can be done with this same new medium, used at its best. Here the approach is quiet, mature, dignified. The excerpts from historical recordings are long enough to be leisurely, expertly and wisely chosen, well recorded. (Even the earlier recordings in Volume 1, from the early '30s, have better quality than most of the much later dubs in "Prelude to Pearl Harbor.") There is plenty of both humor and tension here, good variety, constant change of pace, fine emotional timing, no sense of an overwhelming flood of words, as in the

London opus. Utterly simple sound effects—such as the locomotive background in the ingenious battle of presidential campaign speech excerpts—add dramatic scenery without being corny. This is the tape mix-patch technique at its most expert.

Haydn, Symphony #101 in D ("The Clock")
L'Orchestre de la Suisse Romande, Ansermet
London LP: LPS 54 (10")

Haydn, Symphony #93 in D.
NBC Symphony, Guido Cantelli
RCA Victor 45: WDM 1323 (3)

Haydn, Symphony #73 in D. ("La Chasse")
Indianapolis Symphony, Sevitsky.
RCA Victor 45: WDM 1312 (3)

Haydn, Symphony #31 in D ("Hornsignal")
Symphony #34 in D minor.
Vienna Symphony Orch. Sternberg
Haydn Soc. LP: 1002 AB-1

Haydn, Symphony #1 in D; Symphony #28 in A;
Symphony #23 in D. ("Jupiter").
Vienna Symphony Orch. Sternberg.
Haydn Soc. LP: 1001 A-1

Symphony in D! The above collection, all new recordings, can be taken as a vivid example of the confusions we musicians face when it comes to giving respectable handles to musical compositions. Every one of the above, except the furtive A major that crept onto one of the LP's, is a Symphony in D. It wasn't until relatively recently that scholarly research managed to put the Haydn symphonies—the ones that didn't prove to be fakes—into an accurate and permanent listing of #1 through #104. In Haydn's day the use of opus numbers was just beginning—no reliable system there for his symphonies, either. With only a dozen or so keys to go around (and a few of those decidedly the favorites), people were reduced to the expedient of inventing nick-names for these works. Taking the problem of naming with a grain of humor, like much of the music itself, they picked fanciful ones—"The Hen," "The Clock," the "Farewell," and so on, and we can scarcely quibble over them today. Gotta call 'em something.

Haydn, the so-called "father of the symphony," developed the form over a life time from what was at first a short little work for a few strings and a harpsichord into a big, impressive four-movement piece for large orchestra. But don't be fooled into thinking the early, littler ones aren't good music. True, the last symphonies on the list are about the best—but almost any of the seldom-heard earlier ones are highly worthwhile music on any man's phonograph. The Haydn Society has been especially formed to record (and publish) the huge raft of Haydn that most people ignore, mainly because it's just too much trouble to get it all sorted out and in shape for playing. The present batch, on LP, aren't all equally good music, but there is some tremendous music here, especially those symphonies in the 30's and 40's by number. If you like Haydn at all, better give them a listen. Performance is conscientious and accurate but just a bit plodding and dull—too bad. But not bad enough to spoil the wonderful qualities of this formerly unavailable music.

A brief look at the others. #73 ("La Chasse") is a fine recording technically of fine music—in one of the most unfeeling and mechanical performances I hope ever to hear. #93, one of the loveliest of all, with a first movement theme that has become a familiar hymn tune, is nicely but superficially done by a young protégé of Toscanini. Beecham does it better, on an old Columbia. #101 is a splendid performance and splendidly recorded for LP, one of the first London LP's to come through with the expected greatly improved quality.

Brahms, Symphony #3 in F.
Hamburg State Orchestra, Jochum.
Capitol LP: P-8045

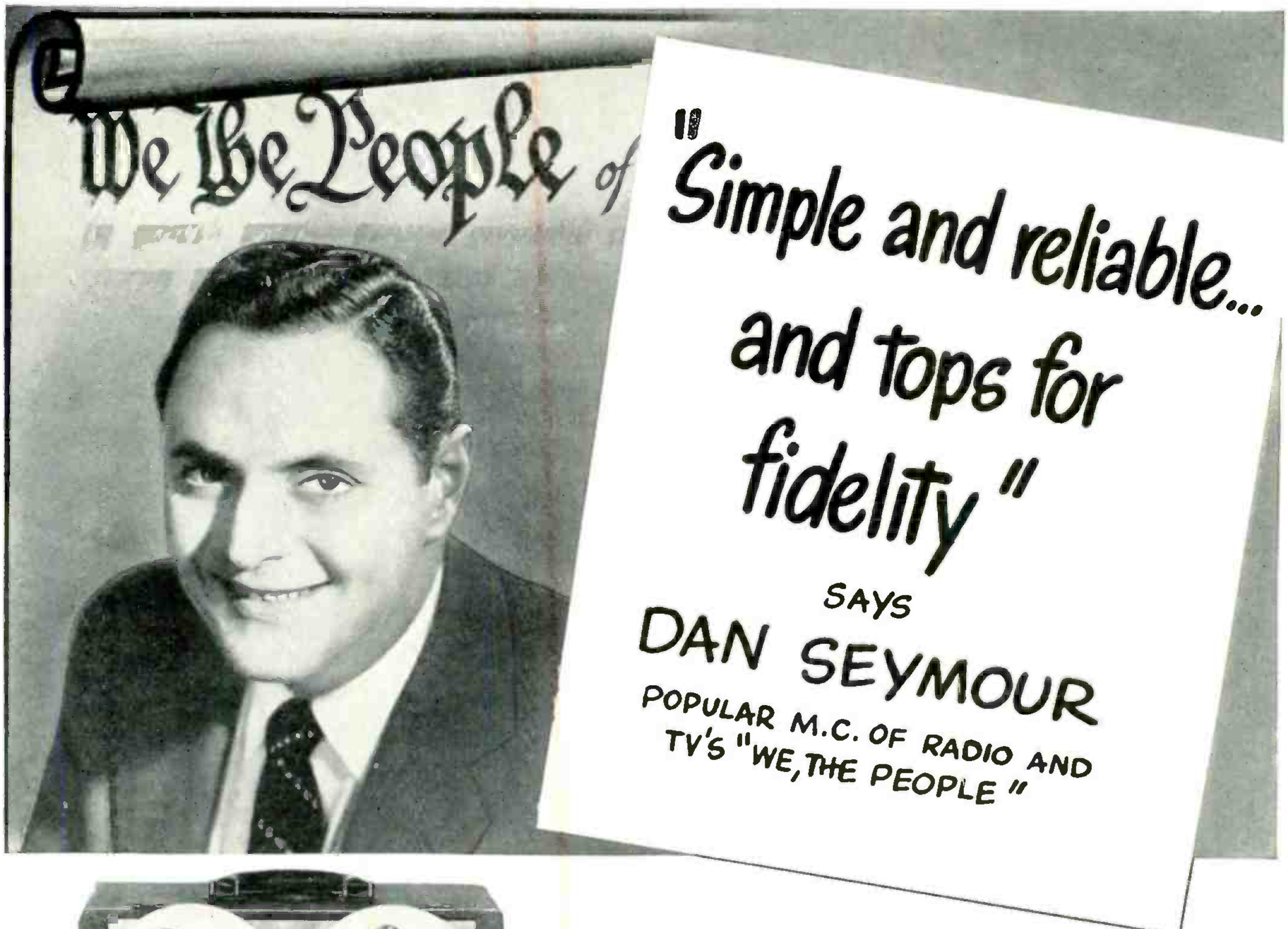
Tchaikowsky, Violin Concerto in D.
Isaac Stern; Philadelphia Orchestra, Hilsberg.
Columbia LP: ML 4232

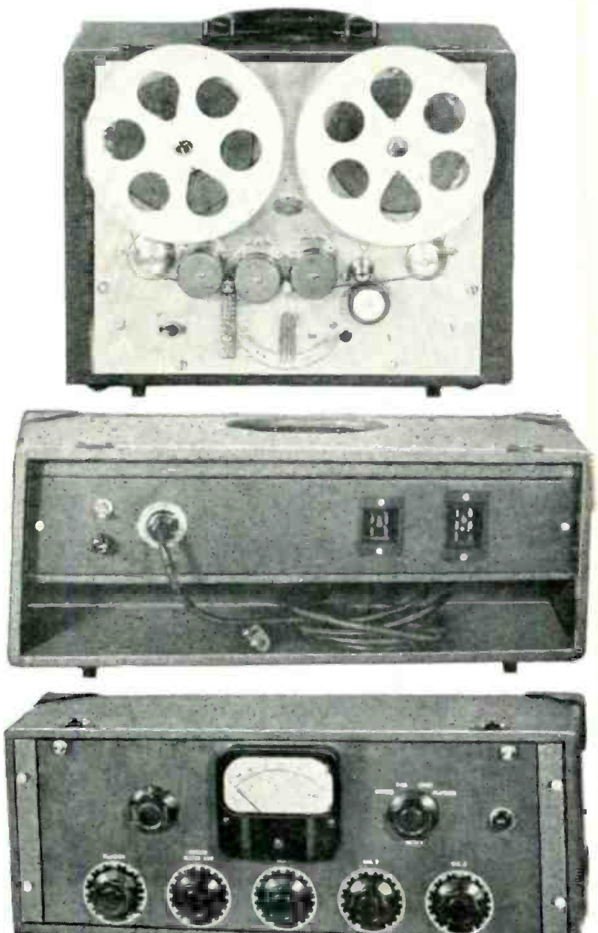
Two repertory works in out-of-the-way performances and recordings. Such works as these, especially the ultra-familiar Brahms, tend, after a thousand and one performances in the regular symphonic concert series of our large orchestras, to acquire a certain tired, overblown sound. The more they become fixtures from too frequent playing, the more they must be made to seem big, important, impressive, cost what it may.

It's hard to say just what has happened in these two recordings—but one is instantly aware of a difference. In the Brahms it is most striking. For one thing, the whole tonal balance, whether it is in the recording or the playing or maybe both, is unfamiliarly new and quite exciting to an old Brahms-lover. Most of the sound and the weight goes to the brass and woodwind; the strings, usually the gushy leaders in this music, are here surprisingly subdued. This wind-instrument coloration makes for the most astonishing new musical perspectives. The whole performance is faster than usual, and lighter, almost Mozart-like. Finally, the recording—not new—is one of the most wonderful examples of good mike technique I've ever heard. A marvellous clarity, depth, sharpness, smoothness. The inside of the orchestra gets into the mike.

In the Tchaikowsky violin concerto it's the soloist, not the orchestra, that is different; Isaac Stern is one of our leading "musician" violinists—a man who plays music first, violin second, though with all the technique you could ask for. His Tchaikowsky is not long-haired. It is neither sentimental, nor in the grandiose manner, but clean, sharp, cool. What with rather cool-sounding acoustics in this recording, this is definitely an unusual Tchaikowsky item, even if the orchestra is not exactly over-inspired. Very good for those who distrust Tchaikowsky's juicier outbursts. Excellent surfaces. Not a plop.

ADVERTISING INDEX





NEW PRESTO

PT-900 PORTABLE TAPE RECORDER

Here's the answer for delayed special-events broadcasts—on-the-spot recording—wherever there is a need for field recording of complete broadcast quality. Look at these outstanding engineering features:

Separate recording and playback heads, each with its own associated amplifier, permit monitoring direct from tape. High fidelity unit—50 to 15,000 CPS at 15" per second tape speed. 3 microphone channels with master gain control in recording amplifier. V.U. meter to indicate recording level, playback output level, bias current and erase current, and level for telephone line. 2-speed single motor drive system.

Don't choose your tape recorder until you see the *new* Presto Portable Tape Recorder. Write for complete details today.

PRESTO

RECORDING CORPORATION
Paramus, New Jersey
Mailing Address: P. O. Box 500, Hackensack, N. J.

In Canada: Walter P. Downs, Ltd., Dominion Sq. Bldg., Montreal
Export: The M. Simons & Son Co., Inc., 25 Warren St., N.Y. Cable Address: "Simontrice" New York

SEE AND HEAR PRESTO AT I R E SHOW · SOUND ROOM D · GRAND CENTRAL PALACE

High Fidelity Components

Linear Standard . . . Hipermalloy . . . Ultracompact . . . Ouncer. Four great lines for every quality application.

Hermetic Seal Components

Largest producers during the war. Largest producers today.

High Q Components

Dust Core Toroids . . . Variable Inductors . . . Complete filters . . . for every application.

United Transformer Corp.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES "ARLAB"