States Audio Magazine about the New Empire 980... world’s most perfectly balanced playback arm. "We tried to induce acoustic feedback by placing the turntable on top of our large speaker system and turning up the gain: we were unsuccessful." This is the new Empire 980! Featuring: the sensational Dyna-Lift* self lifting device which eliminates stylus abuse and undesirable run out groove sound at the end of the record; fundamental resonant frequency at 8 cps; cartridge overhang adjustment; exact stylus force calibrations; precise lateral and vertical ball bearing suspension; 5 wire plug in shielded cable assembly; tracks as low as 1½ gram. Empire 980 Arm with Dyna-Lift, $50

*Patent Pending
January, 1962 Vol. 46, No. 1

Successor to RADIO, BE 1917

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With FM Stereo broadcasting (multiplex) an established reality, Sherwood proudly offers every component you need for superb stereo reception. Sherwood stereo amplifiers and tuners are pre-eminent in the field; and now—in the S-8000 Receiver—the ultimate in compact reception quality is achieved. The exciting new Ravinia Model SR3 3-speaker system features extremely low intermodulation distortion and unusually flat frequency response. Cabinet is hand-rubbed walnut. The perfect setting for hi fi components is Sherwood's Correia contemporary furniture modules—in hand-rubbed Walnut and Pecan. Sherwood Electronic Laboratories, Inc., 4300 N. California Ave., Chicago 18, Illinois.

For complete technical details, write Dept. A-1.
Note:
Here we are in 1962. Many of you have made resolutions. For my part, I hereby resolve to maintain my present standards of service to all of you who have so kindly expressed confidence in my column and in me. It is sometimes difficult to help some of you; do you know why? It's because you either omitted your address or printed it so badly that it could not be read. Sometimes it is impossible to determine just what you wish to know. Those of you afflicted with this particular problem, please resolve to let me read your letters by writing more clearly hereafter.

While resolving, please resolve to enclose a stamped, self-addressed envelope with your questions; that makes me able to write out more letters during the time I now must spend on envelopes.

One further point and I shall get down to the work at hand. Many of you have stated that you hesitated to write to this column because you needed immediate help and did not want to wait for the publication of the questions in the column. All that can be said is "don't hesitate." I answer all letters by mail, regardless of their suitability for use in "Audio Clinic." It sometimes takes a long time before a particular question is used, and the writer of the question need not wait around all of that time for his answer. Many questions received and answered by me are not used in the magazine for some reason or other. These questions are given the same treatment as the material which does find its way into print.

NOW, TO WORK.

HOW DO YOU ANSWER THIS ONE?
Note: The following two questions belong in this category.

COMPONENT SELECTION
Q. I am now in the process of assembling a high fidelity system. I have narrowed my choice of amplifiers to the Marantz Model 7 and the Citation 2. Which would you choose?
A. Since I receive many questions of this sort, I did not want to choose one particular letter. I will, therefore, try to give all of you the only answer possible.

If you think that such discussions do not pertain to live music, listen to those sitting near you at a concert as they discuss orchestral balance and tone quality. There again all ears will tell the same story.

Well, then, how do you—you alone—select your components? In the first place, what do you want your system to do for you? You do not know? Read as much as you can about high fidelity. Note the various forms in which a sound system may be used today for use in home music systems which contains a wide variety of features and is available in a wide price range.

Some installations require equipment which features inputs complete with level adjusts for each output. Others require perhaps no more than one single input circuit.

The problem of evaluating the relative merits of a record changer versus a turntable poses other difficulties. Does the user hold many parties? At such gatherings it is bothersome to change records. If the user is one who listens to complete symphonies or other works requiring more than a single record side to perform, however, he will find it necessary to turn the record over in order to hear the final portion of the performance. It is obvious that in the first instance the use of the changer would be indicated. In the second instance, the automatic features are not necessary and a turntable would be suitable.

Along with operating flexibility, operating convenience and price of the equipment, attention must be paid to the space to be occupied by the entire system. Modern homes are compact. The space demanded by the equipment producing stereophonic sound may be as important a determining factor as the previously mentioned points.

Last, but certainly not least, is the question of the sound produced by any single component of the system and the sound of the system as a whole. No two people hear the same sound system in the same way. The quality of reproduction produced by the components of your sound system may sound ideal. To obtain the same degree of pleasure, your neighbor may need to choose entirely different components. Whose judgment is more accurate—yours or your neighbor's? The answer is that you are both right.
Here, in its brilliant tone arm, you see a striking example of the calibre of Garrard design and engineering. For up to now, you would have had to buy this type of arm as a separate component. A cast aluminum tubular tone arm, dynamically balanced and counter-weighted—it is a professional arm in every respect—yet it comes integrated with the AT6, assuring perfect installation. This is just one of the precision features that enable the AT6 to deliver the quality performance required of a Garrard Automatic Turntable, built for knowledgeable, critical listeners. All the skill, the experience and the established facilities which the Garrard Laboratories have put behind the development of the Type A (most desired of all record players) have also gone into the AT6. Yet this new automatic turntable is so compact in design that it has been possible to price it at only $5450.

The AT6 arm is balanced and tracking force adjusted in two easy steps: First... it is set on zero tracking pressure, by moving the counter-weight until the arm is level, in perfect equal balance.

Now... you fix the tracking force desired, on the built-in stylus pressure scale conveniently mounted in upright position at the side of the arm.

The turntable is oversized, heavy, and balanced. Tension is high, yet there is no noise, no wow, no waver, no interference with the sound of your records.

Garrard’s Laboratory Series motor, in a version designed and built especially for the AT6, delivers perfect speed with complete silence—and it’s double-shielded against magnetic hum.

The AT6 will now track each side of the stereo grooves accurately at the lowest pressure specified, even for cartridges labeled “professional”, and even if the player is intentionally tilted.

The plug-in shell will accommodate any stereo cartridge you favor, and the bayonet fitting with threaded collar, assures rigidity, banishes resonance.

The convenient short spindle for simple play is interchangeable with the automatic center-drop spindle, which removes for safety in handling records.

While on automatic play, AT6 will accept a mixed set of records—any size, any sequence. Far in addition to its other features, AT6 is an intermix changer, offering complete record-playing luxury.

FOR LITERATURE WRITE DEPT. GA-12 GARRARD SALES CORP., PORT WASHINGTON, NEW YORK.

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Barrington, N. J.

Built. Examine typical home music systems at your dealer. By now, you should have an idea of your own requirements.

From what you have learned, select the various sets of components which you believe will meet your needs. Make your selection of components with the space limitations of your home in mind, as well as the limitations of your budget. Never test systems or components which do not conform either to your space or budget limitations. Go back to your dealer. Have him connect one of your chosen systems for you. Then, have him change one of the components of the system — i.e., the cartridge. Using the same recording, note which of the two cartridges sounds better to your ears. Compare the one which sounds better to you with a third cartridge. Again select the cartridge which sounds best to you. (I do not attempt to compare all three cartridges at once.) After your final choice of cartridge, use this cartridge in testing all other components of your music system. Proceed in like manner when selecting the units for the rest of your system. In other words, if the speaker is the next thing to be selected, compare one speaker to another and select the one which sounds best. Then compare that one with a third one, and so forth until you find one which suits you.

After making your selections of components according to what sounds best to you, pay for them, take them home and enjoy them.

TO PLAY MONOPHONIC RECORDS

I have a high-quality monophonic amplifier and high-quality speaker system. This system is used to play monophonic records only. I have about 1000 33⅓-rpm high-fidelity monophonic recordings, all purchased in 1955 or after. The automatic changer I use has a magnetic monophonic cartridge ($20 with diamond variety), about 1958 design. It tracks at about 5 grams. I intend to buy a later model automatic changer with removable spindle for single or automatic playing. With the new changer (which will track at 2 or 2.5 grams) I want to buy a better cartridge ($30 to $35 with diamond variety) and with the stylus replaceable by the user.

In checking I find that available cartridges are mostly stereo. Everybody tells me that the stereo cartridge of 1960 or 1961 design ($30-$35 variety) will give better monophonic reproduction with the two outputs paralleled than my 1955 $20 monophonic unit. When asking about a 0.001 or 0.0007 mil diamond stylus to use in a stereo cartridge for monophonic records only, I get different answers.

My specific questions are:

1. Will a 1960-1961 design ($35) stereo cartridge give better reproduction than my present 1955 $20 monophonic cartridge?
2. Do you know of a quality magnetic unit?
3. The $30-$35 stereo variety cartridges can be had with either 0.001 or 0.0007 mil radius stylus. Bearing in mind that I will use this cartridge only for monophonic records which radius stylus should I get?

Samuel Podell, Newburgh, N. Y.

A. Even in the days of monophonic sound, cartridges suffered from the effects...
SMOOTH ACTION FOR EFFORT-FREE CONTROL

Only four grams of static friction need be overcome to accomplish rotation of Langevin Mixers. Effortless control is the result of long research into the mechanical requirements of friction-free bearings and brushes along with the employment of modern printed circuit techniques for the contact rows.

SUPER ACCURACY THROUGH PRINTED CIRCUITS

Correct contact positioning is guaranteed through printed circuitry derived from master layouts made on dividing heads. This insures satin-smooth, low-drag, bump-free action as the control is rotated.

LONG, TROUBLE-FREE LIFE IN EXCESS OF 100,000 CYCLES

Langevin controls have a noise-free life expectancy in excess of 100,000 cycles. Low, uniform contact pressures decrease wear and give decades of service without cleaning.

SEALED AGAINST DIRT AND CORROSION

Langevin Mixers are pre-lubricated and sealed against moisture. Cycling and accelerated aging tests prove quiet operation for the life of the control.

GOLD PLATED CONTACTS FOR LOW NOISE OPERATION

All contacts in Langevin Controls are gold-plated. Gold is a noble metal and does not form noise-producing oxides. Alloys such as nickel, nickel silver and brass do form oxides, which are insulators and produce noise as time passes. Contrary to popular belief, the gold does not wear off of the contact, but, rather, galls and works its way into the pores of the base metal through usage. This increases conductivity and smoothness with age.

BRUSH CONTACT IS GOLD PLATED

Brush contacts are also formed of gold. Thus, no electrolysis takes place between the contacts and brushes, further insuring quiet operation.

QUIET OPERATION IN LOW-LEVEL SERVICE

The combination of accurate printed circuitry for uniform contact, non-oxidizing gold and low brush pressures give noise free operation at -130 dbm. This means satisfactory operation before preamplification for low-level service.

GENERAL DESCRIPTION

Langevin Rotary Mixers and Attenuators are available in three diameters, as well as in single, double and triple gangs for two and three channel use. Printed circuitry is employed throughout for precision and uniformity. Contact decks are formed of non-hygroscopic phenolic, type FBE. Stainless steel shafts and brass bearings are used for long life, non-squeaking properties, and to give friction-free action. Frames are formed of satin-black anodized aluminum. A universal mounting bracket allows replacement of all attenuators and mixers of alternate make because of three different mounting centers provided. These are 1¼", 1½" and 1⅜". All connections are conveniently made to solder terminals at the rear of the control, facilitating wiring and making a neater appearance. An extra "C" center or common terminal is provided on each control to eliminate two wires to the usual "common". This also gives balanced circuitry on the interior of the control, allows maximum cut-off, and eliminates crosstalk. In addition, this makes for easy test and wiring changes. Case grounds on all Langevin controls appear on another terminal, completely separated from signal ground, or "C" common. Controls are sealed against dirt, moisture and corrosion.

POPULAR TYPES OF ROTARY MIXERS—ALL OTHER TYPES AVAILABLE

The "MX" suffix on these units listed below denotes "mixer" function and these attenuators are not supplied with detents unless specified (no additional charge for detents). Units are tapered to infinity, come supplied complete with knob, dial plate etched to suit and universal mounting bracket. Standard impedance unless otherwise specified is 600 ohms in and out. Other standard impedances of 150, 200, 250, 500 and 600 ohms in or out supplied in any combination if specified at no additional charge; add 15% for impedances in or out not standard to prices shown. Specify if cue position is desired; charge is $3.00 single, $6.00 dual and $9.00 triple gang. If no knob or dial is desired, please specify; deduct allowance of $0.75 for knob and $0.75 for dial.

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<td>3·Gang</td>
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</tbody>
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*With de luxe K-111 WE type mixer knob or K-108 RCA type knob, add $1.50 (please specify).*
LETTERS

Sineward Distortion Again

Sir:

Old "Demagogue John" has certainly made an intriguing point in his article on "Sineward" distortion in the November issue. Even if only a recasting of emphases ("Oh, we knew that all the time"), any concept that can lead to the results Mr. Campbell describes is worthy of serious consideration.

I am eagerly awaiting the reactions to this article from you "regulars," the professional audiomen. There ought to be some nice fireworks.

JONATHAN S. ROOT
206 East 25th St.,
New York 10, N. Y.

(There was, too. In fact, too much for this column. Next month a full roundup of the comments. But following is one more. Etc.)

Sir:

What are you trying to do, start a fight?

John Campbell's "Sineward" article in the November issue could do just that.

For more than thirty-one years the writer has made his living in the field of high fidelity sound. Mr. Campbell is a fine writer but I find it hard to believe he is serious. If he is—and if he is right—I've been an awful fraud for a long, long time.

WILLIAM N. GREER
511 El Imparcial Building,
San Juan, Puerto Rico

(You said it, we didn't. Etc.)

Electronic Organs

Sir:

Mr. Walker's article on the electronic organ certainly does not tell the complete and unvarnished story of the instrument nor of its many drawbacks and limitations, but holds the pipe organ up to ridicule and scorn.

In the first place, which of the various electronic organs in high fidelity? I have examined many of them and have yet to find one which has harmonics higher than 5000 cps, and this is true only with some of the better vacuum-tube oscillator types. The chromatic magnets, using their own higher frequencies as additives, have an upper frequency limit of slightly over 2000 cps. Certainly the accepted definition of high fidelity implies a frequency spectrum greater than this. Coupling an electronic organ into a really high fidelity amplifier and speaker system is a serious mistake, as it shows up all of the inherent defects of the instrument and reproduces the inharmonic distortion products and keying noises which are most distressing.

Why does an electronic organ have to be a cheap imitation of the real thing? Why do all of the manufacturers strive to produce a facsimile of the pipe organ, when the electronic should emerge as an instrument in its own right?

The article fails to state that the tone color of a particular stop is seldom uniform. The reeds, for example, may sound passable in the middle octaves, but they will go "blurry" in the bass. This is not true in the pipe organ. Those electronics with locked oscillators are totally lacking in ensemble, and are sterile sounding because this is an unnatural condition for complex wave forms to be heard.

True, the electronics designers have made

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That's a fact. But all Harman-Kardon COMMANDER Series public address amplifiers incorporate a master volume control. These unique, popular-priced units include features generally found on much costlier "deluxe" equipment. For instance: Outputs for tape recorder, booster amplifiers and both 25 and 70 volt speaker lines; input for magnetic cartridge; DC on filament of hi-gain stages; lock­ ing covers, etc. PLUS COMMANDER exclusives such as: multiple inputs for greater installa­tion flexibility and optional single-control mixing of two program sources for convenience and ease of operation. Discover why sound men are switching to COMMANDER for all their needs. Write today, Commercial Sound Divi­sion, Harman-Kardon, Plainview, L.I., N.Y.

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Audio Magazine
The PRITCHARD PICKUP SYSTEM comes completely assembled and wired with cable ready to plug into amplifier.

This is the new Pritchard Pickup System. Named after Peter E. Pritchard, president of Audio Dynamics, the system combines the famous ADC-1 stereo cartridge and a remarkable new tone arm.

Although the ADC-1 raised stereo reproduction to levels never before possible, this highly compliant cartridge has to be combined with a quality tone arm. The combination must enable the cartridge to track at a force low enough to eliminate distortions and record wear, and also preserve the linearity of the stylus tip suspension. Selecting the proper tone arm was a problem for the buyer. The new Pritchard Pickup System eliminated guesswork. It combines the ADC-1 and a newly designed tone arm that is compatible with this outstanding cartridge.

The Pritchard Pickup System gives you a true, dynamically balanced tone arm. Unlike other systems, the heavy adjustable counterweight occupies a minimal amount of space behind the pivot. To adjust stylus tracking you simply move the counterweight until the arm is in perfect balance. Fine adjustment allows the system to track at the precise force required by the cartridge design.

Because of its low inertia the system will track each side of the groove perfectly even if the record is warped. To stabilize the force created between the disc and the arm, a side-thrust compensator permits the stylus to maintain even pressure on both groove walls. Precision single ball bearings in gimbals minimize vertical and lateral friction.

If you are an owner of an ADC-1 stereo cartridge all you need for a major improvement in your system is a Pritchard tone arm. If you do not possess the ADC-1 and are searching for some way of upgrading your present set of components, visit your dealer and hear how the Pritchard Pickup System makes records sound better than you thought possible. Once you have, you will not settle for less.

Audio Dynamics presents an entirely new concept in pickup design that marks a new era in record playing performance by guaranteeing the five essentials of stereo reproduction.

In designing a cartridge for high quality tone arms, Audio Dynamics engineers perfected the highly compliant ADC-1. This cartridge made it possible for the first time to achieve the five essentials of true stereophonic reproduction.

Now Audio Dynamics has gone a step further... they have designed a remarkable tone arm and combined it with the ADC-1 in an entirely new pickup system. Results? The five essentials of true stereo reproduction are guaranteed!

Audio Dynamics Corporation
1677 Cody Ave. • Ridgewood 27, N.Y.

Here are the five essentials of true stereo reproduction. They are yours with an ADC cartridge.

Essential #1—Highs free from peaks and distortion...by lowering stylus mass and eliminating heavy damping.

Essential #2—Clean and well rounded bass tones... by increasing compliance, lowering tone arm resonance.

Essential #3—Record compatibility... through lowered tracking force.

Essential #4—Proper channel separation... by removing resonances from the audible range.

Essential #5—Reduced surface noise... by eliminating resonances and using super-polished diamond styli selected from perfect crystals.

ADC-1 cartridge for high quality tone arms. $49.50
ADC-2 cartridge for high quality tone arms and record changers... $37.50

Please send me descriptive literature on the Pritchard Pickup System and ADC cartridges.

Name _______________________
Address _______________________
City _______________________
Name of My Dealer _______________________

AUDIO • JANUARY, 1962
The Symbol \( \text{\textcopyright} \) indicates the United Stereo Tapes 4-track 1/2 ips tape number.

**CHESTER SANTON**

**Don Baker:** The Sound of 94 Speakers

**CAPITOL ST 1626**

This stereo disc will interest anyone who has been following the fortunes of the electronic organ. The thirty-four-speaker band in this release are part of the three-manual, 600-note Rodgers organ. Last July, Capitol sent Don Baker and a recording crew to Portland, Oregon with instructions to stay there until the mechanics were put out a way to the speakers arrays of the Rodgers organ located at that city's ultra-modern, $14,000-seat Coliseum.

In order to distribute sound to every seat in the arena, Baker had to invent a machine that could locate the speakers individually. He attached 167 amplifiers, were placed in a two-ton "basket" suspended from the center of the arena ceiling. Pounding slightly downward, the entire assembly forms a high square whose sides radiate sound throughout the entire arena.

After considerable trials and failure, the final microphone placement agreed upon consisted of two rows of speakers suspended from the ceiling at opposite sides of the "basket" and about 20 feet away from it. For best stereo results, the speakers were removed so that the voice families would be grouped at left and right.

The organ itself is quite a unique affair. It is completely electricised, using neither simple pneumatic nor electronic-pneumatic action. Housed within the console, are 600 separate match-boxed transistors etched circuits—one for each tone the organ produces. Don Baker, who played and engineered the recording, claims the Rodgers is the only electronic organ with individual transistors etched circuits. The entire assembly may be right although it is not easy to judge the full capability of this organ in the program of movie tunes played by Baker. The dynamic range of the music offers no great challenges to the instrument. Adequate variety is displayed in the voicing considering the limitations imposed by the limitations used for background in motion pictures. Any low-distortion recording made under these circumstances is an impressive achievement. I'd like to hear the same live acoustic put to more exciting use in a future release devoted to some of the showpieces in the organ repertory.

**How To Succeed In Business Without Really Trying (Original Broadway Cast)**

In the latest Frank Loesser-Abe Burrows show, Broadway has its first smash hit in several seasons. You can sense it immediately in the manner of the cast as soon as the overture is over. You realize then what a formidable task the lack of applause the next night could be when the company assembles for a recording session. From the first note of "Breakfast at Tiffany's," the cast reacts on the ball and rides it with virtuosity to the last note of "In the Numbers." Stereo listeners take on fresh glitter in the process. "How To Succeed in Business" should do as much in spreading the popularity of stereo recordings as "South Pacific" and "Kiss Me Kate" did in converting to L/S the show public of an earlier day.

Tossing of hats in the air at this date may be anticlimactic after the theatre critics have already plastered the ceiling with theirbs but this recording rates a place with the very top show albums. The boot by Shepherd Mead becomes a sharp-pointed stepping stone to an ever new cutting edge. By Albert, Jack Weinstock, and Willard Gillet. The lyrics and the music of Frank Loesser are in a clean with his great score for "Guys and Dolls." Two years in preparation, the show was made popular under the working system that director Abe Burrows has found successful in past shows. The showing humor of this speed of big business hits its mark unerringly because Burrows did not start work on the line until he had selected the key players who would deliver them. To play the role of the deftly scrambling hero, J. Pierpont Finch, Burrows and Loesser chose Robert Robert whose work in "The Matchmaker," "Day Dream," and "Take Me Along" had caught their fancy. Rudy Vallee was a natural choice for the part of J. B. Biggley, the president of World Wide Wickets Paper, because Burrows became closely familiar with the Vallee comedy talent back in the days when he wrote the hilarious radio shows that starred Rudy and John Barrymore. Vallee appears in only two songs on the record—"Love From a Heart of Gold" and a college-lyric song Grand Old Ivy. He is A-1 in both of these but most of his part with the Company Way, been a Long Day, and I believe in You. The last item is delivered with the same verve and the same force in the mirror of the executive's washroom. Joining the first group of electric shakers is a second made up of voice harmonies, a group of electric shakers with steel by the unhappy executives Morse has bypassed. The second version of the song is a slightly faster and sharper through the liquid as the rough is harmonised.

In producing the recording for RCA Victor, George Avakian and Joe Linhart have taken charge. For background, they have turned to the musical direction by Pierpont Finch, Burrows and Loesser. "As Long As I Have You" is one of the thirteen numbers on the record. The song is a hit, and the record company has a gold record on their hands. The mildly infectious rhythms of the Indecisions, Day Hour provides a first-rate highlight amid a large number of average love songs. Molly Picon, for fifty years the first lady of the Yiddish theater, makes her first Broadway musical comedy appearance in the show and seems to steal a good part of it on the back of "A Night in Old Munich." Jerry Herman's music has a strong yidshe flavor, but the song "All Or Nothing" provides the only other exceptional item the company assembles for a recording session. The effect is sudden and hasty. I assume the motion because I don't intend to go out and buy any more console record. Where speakers are six feet apart, the shift of sound becomes artifical when the shift of the sound is too abrupt for my taste. There can be little doubt that this recording will find many buyers who have not heard the show. The song is asking a lot to saddle the typical Fritzi character with an extra share of the melody of this kind when he already has his hands full trying to get reasonably consistent levels on the meters from cast members for a mix for the first time. Partly as a solution to problems facing a recording engineer on such occasions, RCA decided to move the cast by means of electronic gear similar to that used in its Stereo Action series of pop recordings. How does it work out in practice? The "action" of the actors, as you can imagine, has a certain smoothness and unreality unassociated with human behavior. The movement is plausible enough so long as the singer moves medullary across the stage. The effect becomes artificial when the shift of sound and harmony is. I assume the movement appears less abrupt and rapid if the singer moves only three feet when going from one microphone to another in the same area.

The lyrics and sly music of Frank Loesser continue to be heard. The new, low-down, down and dirty style that is not easy to judge the full trying to get reasonably consistent levels on the meters from cast members for a mix for the first time. Partly as a solution to problems facing a recording engineer on such occasions, RCA decided to move the cast by means of electronic gear similar to that used in its Stereo Action series of pop recordings. How does it work out in practice? The "action" of the actors, as you can imagine, has a certain smoothness and unreality unassociated with human behavior. The movement is plausible enough so long as the singer moves medullary across the stage. The effect becomes artificial when the shift of sound and harmony is. I assume the movement appears less abrupt and rapid if the singer moves only three feet when going from one microphone to another in the same area.

Manny Album: More Double Exposure

**RCA Victor LSA 2432**

If this release isn't the last word in stereo motion on records, it will certainly do for a monopoly. Two more volumes of stereo action extravaganza comes along. Not only does the sound and the speaker sounds great, the music which has been used in the past; the twenty tunes in the next few pages.
If you can't afford a Fisher tuner...

build one!

Introducing the newest Fisher StrataKit: the KM-60 FM-Stereo-Multiplex Wide-Band Tuner

Fisher FM tuners have always been reasonably priced considering their unsurpassed sensitivity and matchless overall design—but, even so, not everyone can afford them. If economics have thus far deterred you from buying the very finest, the new Fisher KM-60 StrataKit solves all your problems in exchange for a few evenings of entertaining and instructive work. It incorporates Fisher FM engineering at its most advanced, including built-in Multiplex and sophisticated wide-band circuitry—yet it costs almost one-third less than the nearest equivalent Fisher-built tuner, which it also matches in physical appearance.

This spectacular saving involves absolutely no risk, even if you are 'all thumbs.' The StrataKit method of kit construction has eliminated the difference between the expert technician and a totally unskilled person as far as the end result is concerned. You assemble your StrataKit by easy, error-proof stages (strata), each stage corresponding to a particular page in the Instruction Manual and to a separate transparent packet of parts. Major components come already mounted on the chassis, and wires are pre-cut for every stage—which means every page! You can check your work stage-by-stage and page-by-page, before you proceed to the next stage. There can be no last-minute 'surprises'—success is automatic.

In the KM-60 StrataKit, the front-end and Multiplex circuits come pre-aligned. The other circuits are aligned by you after assembly. This is accomplished by means of the tuner's laboratory-type d'Arsonval signal-strength meter, which can be switched into each circuit without soldering.

The KM-60 is the world's most sensitive FM tuner kit, requiring only 0.6 microvolts for 20 db quieting! (HFQ-standard sensitivity is 1.8 microvolts.) Capture ratio is an unprecedented 2.5 db; signal-to-noise ratio 70 db. The famous Fisher 'Golden Cascade' RF stage, plus four IF stages and two limiters, must take most of the credit for this spectacular performance and for the superb rejection of all spurious signals. Distortion in the audio circuits is virtually non-measurable.

An outstanding feature of the Multiplex section is the exclusive Stereo Beam, the Fisher invention that shows at a glance whether or not an FM station is broadcasting in stereo. It is in operation at all times and is completely independent of the tuning meter. Stereo reception can be improved under unfavorable conditions by means of the special, switchable sub-carrier noise filter, which does not affect the audible frequency range.

Everything considered, the Fisher KM-60 StrataKit is very close to the finest FM stereo tuner that money can buy and by far the finest you can build. Price $169.50.* The ideal companion unit is the Fisher KX-200 80-watt stereo control amplifier StrataKit, $169.50.*

*Walnut or Mahogany cabinet, $24.95. Mahogany cabinet $15.95. Prices slightly higher in the Far West.

USE THIS COUPON FOR FURTHER INFORMATION

Fisher Radio Corporation
21-29 44th Drive, Long Island City 1, N. Y.

Please send me without charge the complete Fisher StrataKit catalogue.

Name________________________

Address________________________

City_________ Zone_________ State________________________
How To Be Terribly Funny
Riverside RLP 7516
Shelley Berman: A Personal Appearance
Verve 150027

Working on the theory that one comedian may wear thin before a record is over, River­
side has put together a set that offers six humorists. Peter Utstein and Henry Mor­
gan carry off the major honors in an album that also features the highly diverse talents of Stan­ley Holloway, Louis Nye, Ronnie Graham, and Alton Elmore. Utstein and Morgan have the advantage of distinctive comedic accoutrements. In his two appearances, Peter Utstein is heard in samples of his sporting car material. His sly gibe at the jargon of racing is rated tops by many impartial connoisseurs. Hilarious bits of having the audience as well. Berman is really

Sound Effects Library
Offbeat 5702/4

These three records form the nucleus of a new library of sounds being offered through channels of distribution that are open to the public. Although material of this type has been released for decades, few record shops carried in their stock the specialized sounds once used in quantity by radio and television producers. Offbeat 5702 is limited to carnival sounds, 5703 and 5704 cover a large ground area, above us. They, too, are original recordings of eighty backgrounds, bridges, and effects of every conceivable kind played on an electronic organ by Paul Renard. With a choice that great, the possibilities for straight

LETTERS

Great progress in imitating the pipe or­
gan, and some of the newer designs have eliminated the blips and key clicks. One company is even injecting white noise to simulate the chuff of the baroque pipe voicing. Why not? Why not take advantage of all this energy to be inimitative when with the wonderful world of electronics before them they could do something better?

Richard C. Simonton,
Tellico Lakes, Fla.

All of their stop nomenclature is derived from the pipe organ, and even after 30 years of work in the theater it is still the only original work in musical elek­
tronics. It will add up to the fact that "whooing air pipes" still sound the best, and after all, the car is the final judge.

But really, Mr. Simonton, not all of us have two pipe organs in our homes! Ed.)
TRIPLE TREAT SPECIAL

ONE FULL HOUR OF PRE-RECORDED 4-TRACK STEREO MUSICAL ENTERTAINMENT

Silk Satin and Strings
- Jalousie
- Laura
- Falling in Love
- From This Moment On
- Holiday for Strings
- Sleepy Lagoon
- It's All Right With Me
- Stella by Starlight
- Out of My Dreams
- El Chocolo
- Blues in The Night
- Jazz Pizzicato

Gigi
- Title Song
- Waltz at Maxims
- Thank Heaven for Little Girls
- The Parisians
- I Remember It Well
- The Night They Invented Champagne
- Reprise: Gigi

My Fair Lady
- On the Street Where You Live
- I've Grown Accustomed to Her Face
- With a Little Bit of Luck
- I Could Have Danced All Night
- The Rain in Spain
- Wouldn't It Be Loverly
- Show Me

★ Original Broadway arrangements of 13 top tunes from both “Gigi” and “My Fair Lady,” re-creating the sparkle of opening night for thirty entertaining minutes

★ PLUS “Silk Satin and Strings,” a half-hour of all-time favorites including “Blues in the Night,” “Holiday for Strings,” and ten more memorable melodies...two current catalog albums (Concertapes No. 4T-4001, $7.95, and No. 4T-3006, $6.95) combined on one hour-long Tarzian Tape to give you a $14.90 value

★ PLUS a full 7-inch reel of blank Tarzian Tape, factory-sealed in protective plastic and quality-guaranteed.

This entire “Triple Treat” package is now available at leading tape dealers for only the price of two reels of blank Tarzian Tape and $1.49.

Here is music for pleasurable listening, imaginatively interpreted by Caesar Giovanni and the Radiant Velvet Orchestra in true stereo sound. It covers the entire range of popular music at its best...from the romantic “Falling in Love With Love” to the toe-tapping tempo of “The Night They Invented Champagne.” This is current catalog music, available now at a price far below the retail cost—and combined on one professional-quality Tarzian Tape to provide a full hour of musical entertainment.

As you listen, your ears will detect a wide frequency response and dynamic range; a smoothness and clarity of sound unusual even in high-fidelity stereo tapes. That's when you should unwrap the blank reel of Tarzian Tape. Use this tape to record a special FM program, or several favorite records. We'll bet that the playback will reveal the same depth and realism that you enjoyed on the studio-produced tape.

Hard to believe? That's exactly why we are making this special offer. More surely than anything we can say, your ears can prove to you that Tarzian Tape does indeed make possible a new fidelity in sound reproduction, in your home as in the professional studio.

Try it. Visit your favorite tape dealer today and get your “Triple Treat” package from Tarzian.
I. HEADPHONES

What about headphones? I am still unable to get over my astonishment at the dramatic rise of the lowly headphone, after all these years of reputational degradation. Suddenly, phones are a sensation, and in these last months dozens of brands of "hi-fi" phones have been made available for the purpose of home listening, where a half-dozen years ago phones were still mainly used by telephone operators, tank crews, airplane pilots, radio men, and a handful of hi-fi cranks who were obviously out of their minds.

Headphones! Who could imagine, a half-dozen years ago, that advertisers would be billing headphones as more desirable than loudspeakers!

The idea, whatever the billing, that phones are heading toward the top in the scale of desirability, if it is a somewhat zany and decidedly diffuse top right now, Headphones are wonderful but nobody is really quite sure what they are supposed to be for—though they are for "hi-fi," naturally. What area of hi-fi? Home use mainly! Professional use? Both, via the same model! (Natch. Any sensible manufacturer will try to sell both sides of that sort of service appeal, if his equipment warrants it.) One-channel? Two-channel? For records and tape? For radio broadcasts? For voice? For music?

For home recording, monitoring and playback! For professional recording, the same! For stereo! For binaural! For mono?

And so headphones are billed for everything, so long as it can be called hi-fi. Headphones for the living room and head-phones for the patio. Headphones, (maybe tomorrow) for the swimming pool and for the skin dive's hi-fi helmet. Headphones for the bedroom (while your husband, or wife, snores beside you). Headphones for the bathroom and the living room and maybe the kitchen. Keeps out that noisy frowning sound. Headphones for "stereo" listening, with or without a Bauer Circuit. (We've been through all that.) Headphones for the tape machine as well as the phone player. Above all (I say) headphones for the greatest recording hobby of all and the only area where headphones are essential as well as desirable—true binaural home recording.

All this and more, and along with such uncomprehendingly joyous thinking goes an equally inspiringly approach to proper耳机 design; for you must fit your phones to their purpose, match them to the situation in view and, especially, to the equipment with which they will have to operate.

Plug Them in—to What?

Now at this stage of our hi-fi development, practically no home equipment provides specifically for two-channel headphone listening. If it does, then the phones are assumed to be high-impedance, as phones mostly have been these dozens and dozens of years back. Even the professional tape recorders have monitor phone jacks intended for high-impedance phones, or at most middle-impedance.

But virtually all the new home-style (and professional) hi-fi phones, even so, are low-impedance—very low. They range in ratings from 4 to 8 ohms. They will not work out of "conventional" phone jacks, whether mono or twin-channel, even if the plugs happen to fit. (They often don't. There are even very few plug-in models. We come in several contact styles, including three-contact and four-contact as well as two.)

Moreover, those phones that do happen to find a home at your amplifier's speaker output, with matching jack and the right impedance, are likely to go up in smoke the instant you try them. Headphones are more sensitive than loudspeakers and their tolerance is of a much more "finicky" and extreme nature. Just plug them into your low-impedance amplifier output and turn up the volume—just a bit, to discover what happens. Short of a quick burnout, I've heard my phones squeaking right out loud in horror, to distress from as far away as two blocks. And if I'd have had them on my ears, I would have lost a far more valuable pair of transducers than any pair of phones.

No, most won't work off those very useful in-between output circuits, the cathode follower and its relatives, which provide a medium-high-impedance match that is low enough to allow for long cables and no shielding, an immensely helpful factor in the front-end area of all sorts of sound equipment. Low enough to obviate shielding, but not low enough, alas, to drive a low-impedance headphone properly. Yes, you can hear the music, with loudness that varies from brand to brand among the hi-fi phones but never anywhere near loud enough to please. Worse, if you turn the volume up (when there is a volume control) you will inevitably reach a point where the amplifier is severely over-loaded, drained dry, with resulting violent distortion in your phone sound. (On one tape recorder with stereo meters, I found that the visual playback level suddenly fell to zero on the VU scales as the phones' low- ohm circuits were brought all the way in, with the expected accompanying violent distortion.)

So what do you do with your fancy hi-fi phones when you've bought them? It all depends. One thing is clear—you'll have to do something drastic. As of now, you simply cannot just "plug them in." For one thing, they are a recording brand, the expensive German phones from Germany, provides an envelope full of resistors and a big circuit diagram showing how to feed your equipment apart from the usual dual-mono low-level switch (not provided) along with the various unwanted resistors, the net result being that you can flip the switch directly from loudspeakers to phones, at approximately the same apparent volume and with everything correctly positioned.

Fine! But who among our hi-fi friends is likely to jump with joy at this prospect? The hi-fi serviceman—yes. But the heat generated among the listening room hi-fi users is likely to be considerable.

Professional? They are relatively well taken care of, at a good price. Transformers are available for the better phones, in order to match them to standard 600-ohm lines. Also, resistors, and so forth. Professionals know all about this sort of thing. But I wonder—to turn the tables the other way—how many professionals with 600-ohm phones are going to use hi-fi headphones with streamlined styling in decorator colors? Well, that's what they'll get before long, if things go on as is. That is, if the headphone manufacturers will listen to their minds as to whether they are aiming for the pro or the non-pro market, and act accordingly.

Actually, the phone is on the other ear—I mean the shoe is on the other foot—at the moment; most of the new phones are lock, stock and barrel. Radio operator type, clumsy, uncomfortable, the earpieces always tangling up in the hair and a real mess when you have to take them down; or else they are strictly compromised half-way adaptations of the time-honored telephone earphone type, clumsy, uncomfortable, by and large the seats of the space between phones and ears that hi-fi demands for its bass.

Only one set of phones I have tried seem really comfortable to me—light in weight, neatly shaped and non-clummy, without unpleasant side-pressure on the head, minus those long ear-tubes. But they are just cutting-edge phones, very much in the experimental state of the art. Only one set of phones I have tried seem really comfortable to me—light in weight, neatly shaped and non-clummy, without unpleasant side-pressure on the head, minus those long ear-tubes. But they are just cutting-edge phones, very much in the experimental state of the art.
FM MULTIPLEX STEREO

TRANISTORIZED
4-TRACK STEREO TAPE DECK RP100
Completely assembled, wired and tested.
$399.95
Semi-kit includes a completely assembled and tested transport, electronics in kit form.
$299.95
Luggage-type Carrying Case—$29.95
Standard 19-inch Rack Mount—$9.95

A top quality stereo tape recorder permits you to build a stereo tape library of your favorite music at low cost. As your musical interests change, you may record the new music that interests you at no additional cost.


FM-AM STEREO TUNER ST6
FM & AM stereo tuners on one compact chassis. Easy-to-assemble: prewired, prealigned RF and IF stages for AM and FM. Exclusive precision prewired EYETRONIC® tuning on both AM and FM.


AM TUNER: Switched "wide" and "narrow" bandwidth. High Q filter eliminates 10 kwhistle. Sensitivity: 3uv for 1.0V output at 20db SIN ratio. Frequency Response: 20-9,000 cps ("wide"), 20-4,500 cps ("narrow").

BOOTH AMPLIFIERS: Complete stereo centers plus two excellent power amplifiers. Accept, control, and amplify signals from any stereo or mono source.

ST70: Cathode-coupled phase inverter circuitry preceded by a direct-coupled voltage amplifier. Harmonic Distortion: less than 1% from 25-20,000 cps within 1 db of 70 watts. Frequency Response: ±1/2 db 10-50,000 cps.

ST40: Highly stable Williamson-type power amplifiers. Harmonic Distortion: less than 1% from 40-20,000 cps within 1 db of 40 watts. Frequency Response: ±1/2 db 12-25,000 cps.
Natural Sound of Tandberg

Preserve the Genius of the Masters with the

**Model 6** 3 SPEED 4 TRACK STEREO RECORD/PLAYBACK TAPE DECK

The remarkable features of this superb unit speak for themselves—records 4 track; plays back 2 and 4 track stereo and mono; records/plays back FM Multiplex Stereocast with magnificent clarity, even at 3 1/2 ips. Permits sound-on-sound, track adding, direct monitor from source tape; has push button controls, three separate Tandberg engineered precision laminated heads, hysteresis synchronous motor; installs into HI-FI system. Price $199.50. Remote control “FM” model also available.

**Model 65** 3 SPEED 4 TRACK STEREO PLAYBACK TAPE DECK

Another Tandberg triumph—for pure playback of 2 and 4 track stereo and mono tapes with finest frequency response. Extremely versatile; facilities for adding erase and record heads. Price $199.50.

Tandberg remains unchallenged for clear, crisp, natural sound!

**Phase II Symptoms**

This second and most important of the quarters in my hi-fi moon-cycle, then, comes after the new product is irrevocably launched in public, but before it reaches a steady, stable, bug-free, standardized, reliable, “even keel” production and a solid place in the larger hi fi scene, the much-hoped-for Phase 3. Stereo amplifiers, for example, are now designated as a group in Phase 3. So are stereo cartridges, in spite of individual new developments and continuing changes.

Phase 2, alas, is inevitable, in spite of all the pre-testing and pre-debbuging. Phase 2, according to calculations, should not occur—it wouldn’t if men were infallible. Somehow, every major new product lives out its variably hectic Phase 2 period, and most of these moves on into the cool relaxation (relatively speaking) of a long-term Phase 3.

Here are some of the juicer characteristics of Phase 2 hi-fi production, as I’ve observed them with my own somewhat jaundiced eyes these many years. The symptoms are plenty familiar, if you’ll stop to apply these thoughts to specific products and product-types.

1. Though the advertisers have been enthusiastic for weeks and even months over the new models, blow-up pictures and detailed specs model for model, oddly enough there don’t seem to be any of the lovely things in the stores. Vast shipments are on the way, due any day now, any moment. But when it comes down to fact, there are only trickles here and there. Supply lines are strangled, though nobody quite knows where. Occasionally there is a small flood, when some smart operator gets his production into high gear, but mostly Phase 2 is the era of the Unaccountable Trickles. And of the Big Promises.

In Phase 2, the hurried promoters go around with sickly grins of outrageous optimism on their faces, making promises they know they aren’t going to be able to keep. Can’t help it. Even the best of them have to. Some day (they think to themselves) the buyers will recognize the real product, after all. And sooner or later, it is tomorrow. But that’s Phase 3.

2. Phase 2 products, especially in their earlier semi-secrecies, production, and publicity, are underexposed, not standardized, and it isn’t anybody’s fault. Everybody has been too busy fighting his own problems to bother about his rivals and colleagues.

During the earlier and semi-secret design period of Phase 1, each maker follows up his own best hunches, hoping the other guy won’t think of the same thing (he isn’t going to ask whether he has or not . . .). Thus, whatever the product may be, it is sure to be highly individual. Competition behind the scenes. Thus the Phase 2 products emerge into the light of the commercial day in a typically dizzy variety of sizes, shapes, and specs. All sorts of specifications are at odds and especially the minor non-essentials that are so important to the home owner—who doesn’t know a thing about the insides. Phase 2 is the wild specter of the Unaccountable Trickles and the wild looting of the Unaccountable Trickles. And of the Big Promises.

Now—suddenly—the manufacturers look around with sickly grins of outrageous optimism on their faces, making promises they know they aren’t going to be able to keep. Can’t help it. Even the best of them have to. Some day (they think to themselves) the buyers will recognize the real product, after all. And sooner or later, it is tomorrow. But that’s Phase 3.

(Continued on page 46)
WHAT—NO EARMUFFS?

She hears the bass without ear cushions. How come?

This unique quality is just one of the bass-ic advances that are putting AKG (Vienna) K 50 dynamic headphones on the prettiest heads — and keenest ears — this season.

The K 50 is a first-order transmitter*. This means that, like a fine loudspeaker, it delivers a full, true bass without help. It does not need a resonant cavity (formed by bulky ear cushions) to simulate the low notes, but re-creates them faithfully all by itself. With K 50, you need the small ear cushions only to shut out the noise of your environment.

The bass is all there, without earmuffs! So is every other tone and shading from 30 to beyond 20,000 cycles, with inputs as low as 0.156 milliwatts. Even with 90 milliwatts input they won’t blast.

Connect K 50 direct into your preamp output for low-impedance matching, or through a U 50 transformer for high impedance. For use in your power-amplifier output, connect a 20-ohm resistor across the terminals. That’s your admission ticket to a new world of musical realism.

K 50s remain cool and comfortable after hours of listening. They weigh less than three ounces — and only you don’t know you’re wearing them. For mono or stereo, $22.50.

For a unique experience in listening, hear K 50 at your audio dealer’s. For information write Electronic Applications, Inc., 80 Danbury Road, Wilton, Connecticut — or phone (203) PORter 2-5557.

* Patented
NEW TITLES

The new title at the top of this page is only one of new titles around Audio commencing with this issue. Because of the acquisition of Communication Engineering, announced last month in the advertising pages, several changes in duties of the staff have had to be made. David Saslaw, managing editor for the past eighteen months, is now Editor of Audio, a post which we have confidently expected him to fill ever since he joined us. The former editor and publisher continues as publisher of Audio and Lectrodex, and takes on additional duties as editor and publisher of Communication Engineering. No part of these “changes” is expected to have any effect upon the scope and character of Audio, and it is unlikely that readers would ever know the difference if they did not happen to notice the masthead on page 1.

Magazine publishing differs from the usual business or manufacturing organization in a number of ways. The major difference is that a business organization is usually presided over by one “chief executive officer,” who is likely to be the president of the company, and he is in control of all functions of his company’s operation. A magazine, however, is actually two separate organizations—one which handles the purely business aspects and one which creates the magazine itself.

The head of the business section is usually known as the Business Manager, and he is principally concerned with the more mundane parts of the operation such as getting money in, directing circulation, and finding out where the magazine can be published most economically. In most small magazines, his corporate position is that of president.

The head of the editorial section is the Publisher, and he and the Business Manager form the broad policy decisions affecting the entire operation, and then each carries out those policies affecting his section. He works closely with the Editor, and co-ordinates editorial and advertising production. When a company has several magazines in its “stable,” both the publisher and the business manager may serve on all of them.

The Editor is the person who actually creates the magazine as the reader sees it, and he must be a veritable jack-of-all-trades. In such a magazine as Audio, he must be technically capable, able to write clearly and convincingly, and able to recognize other writing and to edit it in accordance with the style of the magazine. He must be able to judge photographs—and sometimes to take them and possibly retouch them—as to suitability and content, check drawings, proof-read, and—occasionally—sweep out his office. Mr. Saslaw has already proved his capability in all of these capacities, and we are pleased with the realignment of duties.

In spite of this digression from the usual contents of this page for this one issue, it will be the normal Editor’s Review again next month.

NEW FISHER PLANT

Located in the heart of Pennsylvania, the brand new 50,000-sq.-ft. plant of Fisher Electronics was opened on the first of December. Modern as tomorrow, it will provide the much-needed factory space for Fisher products and it is said to be the largest high fidelity plant in the country.

The ceremonies began with a luncheon in Lewistown, attended by many of the local townspeople, some large Fisher dealers, representatives, and the press. Pennsylvania’s Governor Lawrence was guest of honor and spoke briefly. The party then moved to the plant site at Milroy where the Governor cut the ribbon which signified the official opening. Fisher employees and their families attended, as did the local high school band, and even the weather cooperated by being fair and pleasant.

We are pleased to see sufficient growth in the industry to warrant the new plant—and we hope that Fisher will have to expand again onto some of its 20-acre site.

HI FI SHOWS

The usual two high fidelity shows on the West Coast appear in March—the combined San Francisco Home and High Fidelity Show in the Cow Palace from March 7 to 11, and the Los Angeles High Fidelity Music Show at the Ambassador Hotel from March 21 to 25. The first show will be sponsored again by the Magnetic Recording Industry Association, and is under the direction of James Logan. The Los Angeles show is presented by the Institute of High Fidelity Manufacturers.

The Fourth International Exhibition of Electronic Components will be held in Parc des Expositions, Porte de Versailles, in Paris from February 16 to 20. This is the oldest show which has specialized in electronic products, having started as the National French Exhibition in 1934. The 1961 show featured some 450 exhibitors, and still more are expected in 1962.

Is everybody ready?
COMPARES...

to his...

STANTON

stereo fluxvalve pickup

PICKERING & COMPANY INC. offers the stereo fluxvalve pickup in the following models: the Calibration Standard 381, the Collector’s Series 380, the Pro-Standard Mark II and the Stereo 90. Priced from $16.50 to $60.00, available at audio specialists everywhere.

"FOR THOSE WHO CAN HEAR THE DIFFERENCE"

Pickering and Company—Plainview, Long Island, New York

AUDIO • JANUARY, 1962
HOW THE OCEAN GREW "EARS" TO PINPOINT MISSILE SHOTS

A quarter of the world away from its launching pad an experimental missile nose cone enters its ocean target area.

How close has it come to the desired impact point? Where actually did the nose cone fall?

To answer these questions quickly and accurately, Bell Laboratories developed a special system of deep-sea hydrophones—the Missile Impact Locating System (MILS) manufactured by Western Electric and installed by the U.S. Navy with technical assistance from Western Electric in both the Atlantic and Pacific Missile ranges. MILS involves two types of networks.

- One is a long-distance network which utilizes the ocean’s deep sound channel. It monitors millions of square miles of ocean. The impacting nose cone releases a small bomb which sinks and explodes at an optimum depth for the transmission of underwater sounds. Vibrations from the explosion are picked up by hydrophones stationed at the optimum depth and carried by cables to shore stations. Time differences in arrivals between these vibrations at different hydrophones are measured and used to compute location of the impact.

- The other is a “bull’s-eye” network that monitors a restricted target area with extraordinary precision. This network is so sensitive it does not require the energetic explosion of a bomb but can detect the mere splash of a nose cone striking the ocean’s surface—and precisely fix its location.

The universe of sound—above the earth, below the ocean—is one of the worlds of science constantly being explored by Bell Laboratories. The Missile Impact Locating System reflects the same kind of informed ingenuity which constantly reveals new ways to improve the range of Bell System services.

BELL TELEPHONE LABORATORIES
World center of communications research and development
Any audiofan interested in maintaining and improving his audio setup will, at one time or another, consider purchasing measuring instruments. In this article Mr. Horowitz discusses the type of instruments needed, plus their essential characteristics. Future articles will discuss how these instruments are used.

High fidelity audio amplifiers have long been involved in the battle of specifications. Hardly an amplifier is sold today that does not have a long list of specifications which define (and sometimes tend to hide) its characteristics. Practically all amplifiers have been checked and reported on by various testing laboratories which have either confirmed or denied the published specifications.

The data presented to the consumer by the manufacturer or independent laboratory requires the use of specialized instruments and careful measuring techniques. Although medium-quality instruments may be used to compare two different units with reasonably reliable results, excellent-quality instruments are available, for measuring audio equipment, claims are presented. The modes of operation and comparisons of the available types of instruments should help determine the reliability and limits of a particular unit.

Signal Generator

A source of audio signal is essential in any laboratory dealing with high fidelity amplifiers. Because the characteristics of a sine wave are easily defined and measured, a generator producing wave shapes of this type has become the universal signal source.

An oscillator must meet several obvious basic specifications to be suitable in high fidelity test and design applications. These can be enumerated briefly as follows:

1. The distortion should be low. A maximum over-all harmonic distortion of 0.1 per cent between 20 and 20,000 cps is usually satisfactory. The percentage of distortion acceptable is only a function of the severity of the test to be performed. Furthermore, the distortion should not be substantially affected by the load presented to the generator.

2. The available frequencies should range from a few cps to several hundred thousand cps. This will provide the flexibility required to check the amplifier's rolloff characteristics at both ends of the audio spectrum.

3. Frequency stability and calibration accuracy can be lumped together although they are in reality two separate characteristics. Exact frequencies are required when checking marginal and critical equipment, such as a tape deck. Large errors can also result in incorrect filter measurements.

4. A reasonably flat output over the complete frequency range is convenient. Absolute flatness is not required since the output can (and should) be carefully monitored with a wide-range a.c. voltmeter or oscilloscope.

5. A low output impedance is a necessity. 500 to 1000 ohms is perfectly acceptable. The frequency selective networks should be independent of the output load.

6. Any hum present in the signal will be measured as distortion on an harmonic distortion meter. Hum and noise must be maintained at a minimum. Hum specifications are usually stated as being
below the full rated output because absolute hum voltages are not substantially affected by the setting of the output control. The best signal-to-noise ratios are achieved at maximum or near maximum setting of the attenuator control.

When extremely low voltage signals are needed, a divider network is usually placed at the output of the generator. The network shown in Fig. 1 can be used effectively for the 2 mv, 1000-eps signal usually required at the tape-head input of an amplifier. In this illustration it is assumed that the maximum output at the generator terminals is 20 volts. In order to minimize hum and noise pickup from nearby sources, the leads of both resistors must be kept short and the connecting cables should be well shielded. Low-loss cable as well as a low-value resistor in the bottom half of the divider network should be used to minimize high-frequency attenuation. The output should be monitored at the amplifier with an a.c. meter.

Hum may be due to the way the instruments are hooked up rather than a poor signal-generator.

The a.c. meter used to monitor the output voltages from the signal generator may be partially at fault. Assume the signal generator to be connected to the a.c. meter, as shown in Fig. 1. Usually these instruments are designed so that the primary of neither power transformer is grounded to the chassis. It is thus expected that the cabinets of both units will be “floating.” This is not the case. The instrument chassis and cabinets are at some actual fixed potential with respect to the line and the secondary because of the capacity between the transformer windings and the chassis. The two chassis and cabinets (signal generator and monitoring a.c. voltmeter) are connected together through these capacitive couplings to the common a.c. line. The a.c. current in this loop is induced into the signal leads, causing hum to appear on the signal. Separating the two instruments will eliminate this loop and the resulting hum.

Another possible source of hum can be the loop formed on the one hand when the two chassis are connected together, and on the other hand when the commons of the two instruments are joined by leads. This also forms a complete loop susceptible to induce hum. Choose whichever explanation you like best. My guess is that both loops are involved along with some others that are not quite as obvious. Whatever the cause, the cabinets or chassis of both instruments should be separated physically—they must not touch each other.

The basic component of an oscillator is an amplifier, as shown in Fig. 2. Positive feedback around the amplifier causes the circuit to oscillate. A frequency selective network inserted in either the amplifier or feedback loop determines the frequency of oscillation. Any properly arranged and proportioned amplifier circuit will oscillate if several criteria are satisfied.

1. At the frequency of oscillation, the amplifier and feedback network must have zero (or multiples of 2\pi) phase shift.
2. The gain of the overall circuit (amplifier and feedback factor) must be equal to or greater than 1. This is referred to as the Barkhausen criterion.
3. The output voltage is limited by the nonlinearity of the amplifier.

The conventional audio oscillator uses the Wien Bridge circuit shown in Fig. 3 as the frequency selecting network. The output from the amplifier, \(E_{in}\), is fed to the input of the bridge. The output voltage, \(E_{out}\), from the bridge is fed to the input of the amplifier, completing the positive feedback loop.

In order to satisfy Criterion 1, at the oscillating frequency \(E_{out}\) must be in phase with \(E_{in}\). That is true can be surmised as follows:

\[
E_{out} = \frac{1}{2}(R - jR) = \frac{1}{2}(1 - j)R,
\]

Thus, \(E_{out}\) is in phase with \(E_{in}\) and can be derived simply as follows:

At the angular frequency \(\omega = \frac{1}{2\pi}

\[
Z_1 = R - j\omega C = \frac{(aRC - j\omega C)(aRC - j\omega C)}{(aRC - j\omega C)(aRC - j\omega C)}(1 - j)R/jR, a pure resistance.
\]

Also, \(Z_{23} = 1/R - j\omega C/jR\), then equal to \(jR\): \(Z_{23}\) is then equal to \(jR\):

\[
E_{out} = \frac{1}{2}(R - j)R = \frac{1}{2}R - jR
\]

Audio • January, 1962
which is used in many commercially available oscillators. The circuit shown in Fig. 4 has been used fairly consistently in many commercial audio signal generators as illustrated by the circuit shown in Fig. 4.

Here the voltage $E_{in}$ is fed from the output of $V_z$ and the voltage $E_{out}$ is applied between the cathode and the grid. The two capacitors in the $Z_i$ and $Z_2$ arms are varied simultaneously to maintain RC relationships with their respective resistors, avoiding phase shift while selecting the required frequency. The $R_1$ components of $Z_i$ and $Z_2$ are changed when different ranges are needed. A variable resistor in the form of a lamp filament is substituted for $R_2$ to maintain amplitude stability over the various switched ranges as well as guard against variations due to component aging. $R_1$ is adjusted for best waveform. $R_2$ serves a dual function. First, it completes the bridge circuit. Second, it is incorporated in a negative feedback loop from the plate of $V_z$ to the cathode of $V_y$, reducing distortion and maintaining stability with tube variations.

Another frequency-selective circuit which is used in many commercially available oscillators is the bridged-T network. In one commercial application of this type of circuit, negative feedback is supplied to the amplifier through a "notch" network which is a capacitor-shunted bridged-T. The resultant oscillation occurs at the "notch" frequency where the negative feedback is at a minimum and the phase shift is zero. Although the bridged-T network is characterized by low distortion and good stability, there has been some tendency to use the Wien Bridge configuration because of the somewhat more practical value of the resistors used. In reality there is no basic advantage of one circuit over the other insofar as performance is concerned.

There are frequency limits imposed on the Wien Bridge oscillator by its very nature. At high frequencies, the resistors in the bridge arms are too small. They load down the output tube excessively as well as introduce phase shift. The lower frequencies are limited by the practical size of the capacitor, $C$, and the resistors, $R$. Too high a resistor in the $Z_i$ arm may cause the grid of $V_i$ to be over-biased due to grid leak action, as well as make the circuit susceptible to stray field pickup.

The sine wave output from the signal generator can easily be converted into a square wave signal, useful for many audio tests. The circuit shown in Fig. 5 has been used for this purpose in a commercial generator.

On the positive half cycle of the sine wave, grid current flows through $R_1$ and $R_2$. The voltage across $R_s$ acts as a fixed bias for the diode formed by the grid and cathode of $V_y$. The equivalent circuit of this is shown in (A) of Fig. 5. When the signal is applied to this diode, only the positive peaks of the signal will be at the grid of $V_y$, where it is amplified. The negative portion is clipped by the tube when it is driven to cutoff by the high bias voltage.

The phase of the signal has been shifted 180 deg. in the plate of $V_y$. It is fed to $V_z$ where the tube is cutoff for a portion of the cycle and the negative end of the signal is clipped. The rise time is good because the signal has gone through two stages of amplification and clipping.

Other and more direct means are frequently employed to get a square wave. The popular multivibrator circuit shown in Fig. 6 is quite common. Here, one tube conducts while the second tube is driven to cutoff. The frequency is determined by the time it takes the voltages across the capacitors to leak off through the associated grid resistors and the voltage required to cut off the tubes. Symmetrical signals are obtained if both RC pairs are equal.

Excellent rise time and good square waveforms can be obtained using either configuration.

The Harmonic Distortion Meter

The details of the Wien Bridge circuit apply to harmonic distortion meters as well as to audio oscillators.

The operation of a conventional distortion meter is straightforward. The complete signal is fed from the device under test to a meter, and the voltage is measured. The fundamental is eliminated from the signal under test, with the result that only harmonics remain. These are now measured on the same voltmeter. The ratio of the harmonics to the total voltage is the amount of distortion in the signal being tested. The Wien Bridge is often used as the selective network for the elimination of the fundamental component.

The circuit in Fig. 7 shows how the Wien Bridge eliminates the fundamental frequency while passing the harmonics. Unlike the circuit used in a signal generator, the bridge here is completely balanced for the fundamental frequency, $f_0 = f/RC$. Then $Z_i/Z_2 = R_i/R_2$. Under this condition, $E_{out} = 0$ for the fundamental ($f_0$) frequency. It is not zero at all other frequencies due to phase shift.
in the bridge. Thus, these harmonic voltages are passed on to the next tube. It is interesting to note that $E_{4}$ is frequently obtained from a cathode follower and that there is a considerable amount of feedback around the bridge circuit. This is important in increasing the rejection of the fundamental frequency.

A variation of this is shown in Fig. 8, where a phase splitter is used to drive the circuit. As indicated in the discussion of the oscillator, the ratio of $Z_{1}$ to $Z_{2}$ is 1:3. Thus if voltages of proper balancing phase, but of this 1:3 amplitude ratio are fed to this network, there would be a null between the junction of $Z_{1}$ and ground only at the fundamental frequency, $f_{0}$, while all other frequencies are passed. This method is inferior to the bridge circuit because the null cannot be quite as pronounced.

Using an instrument employing either circuit can be misleading unless the resulting harmonics are observed on an oscilloscope. The meter measures everything except the fundamental. The reading will include hum along with the harmonics. The significance of the hum, as well as the frequency of the undesirable harmonics, can be observed and evaluated on the scope.

The characteristics of a good harmonic distortion meter are many, but a few are quite significant to the operator.

1. The instrument must be capable of measuring harmonics of fundamental frequencies from 20 to 20,000 cps. The voltmeter must then be capable of linear response to 60,000 cps.

2. The fundamental frequency must be reduced by a considerable amount. For measurements with up to 0.1 per cent distortion, the fundamental must be down about 50 db. However, the closest harmonics, such as the second, should not be reduced by more than 3 db. This is best achieved when the bridge circuit of Fig. 7 is used.

3. The instrument must introduce negligible amounts of distortion and hum.

4. It should be sensitive enough to read 0.1 per cent distortion on a 1 volt signal with reasonable accuracy.

A better method of measuring distortion requires the use of a wave analyzer. Here, a voltmeter measures the relative harmonic components in the signal. Thus, the amount of second or third harmonic component is checked, rather than the composite sum of all components. In this type of instrument, only one frequency component at a time is fed to, and read, on the voltage measuring instrument.

Although harmonic distortion characteristics are practically always stated in the list of audio amplifier specifications, intermodulation distortion measurements have gained in significance because of the excellent correlation with actual listening tests.

To test intermodulation distortion, two signals of different amplitude and frequency are passed through the amplifier under test. These two signals will appear at the output of an undistorted amplifier. If nonlinearity does exist in the unit under test, the two input signals will heterodyne and produce sum and difference frequencies along with the original two frequencies.

The conventional intermodulation distortion meter supplies these two signals in a 4-to-1 amplitude ratio. The frequencies commonly used are 60 cps and 7000 cps respectively. Two methods are generally used to combine these frequencies in the analyzer before they are fed to the amplifier. The first mixes the two frequencies in the type of adding network shown in (A) of Fig. 9. The combined signal appears across the potentiometer. A second method, shown in (B) of Fig. 9, uses a bridge for mixing.

The latter configuration is usually preferred because in the first method the signals can interact with each other. On the other hand, the balanced bridge isolates the two signals. Balance is maintained only if the signal is attenuated by means of a $T$-pad at the output. The bridge will then be balanced at any output level.

The operation of the rest of the instrument is straightforward. The combined signal is connected to the input of an amplifier. The output from the amplifier is sent through a high-pass filter eliminating the 60 cps component. If the amplifier has introduced distortion, the remaining 7000 cps will appear to be modulated by a low frequency. The amplitude of the total modulated 7000-cps signal is measured. The signal is then detected with only the modulating frequency remaining. This is in turn measured and compared with the amplitude of the 7000 cps. The ratio of the two is the percentage of intermodulation distortion.

This section of the analyzer is quite important. The accuracy of the measuring instrument and the quality of the filters determine the accuracy of the measurements. Low hum circuitry is necessary to eliminate any stray signals. The analyzer input impedance must be relatively high (500,000 ohms will do) to avoid putting an excessive load on a preamplifier that may be under test.

The Oscilloscope

The oscilloscope is a visual voltmeter used to observe the output of the equipment under test. Unfortunately, low percentages of distortion are not too obvious on the 'scope screen and the measuring instruments described previously must be used. A 'scope can be used as an effective indication of some amplifier characteristics. It can also be used to supplement the information gained from other instruments.

The heart of the oscilloscope is the cathode ray tube. In this tube, a potential difference between the cathode and one of the other electrodes starts the electrons in motion towards the fluorescent screen. Two groups of deflection plates are arranged so that each pair is perpendicular to the other. A potential applied to these individual pairs of

(Continued on page 71)
Test Equipment Roundup

DAVID SASLAW

For the audiofan, fulfilling New Year's Resolutions may well require audio measuring equipment. In order to simplify the task of finding "the" piece of test equipment to satisfy your needs, Audio has rounded up the specifications and description of most of the available equipment although some manufacturers are not represented because we could not get the information in time for this issue. The types of equipment we concentrated on are the mainstays of any audio measuring endeavor: audio signal generators, oscilloscopes, and voltmeters. Also included are more specialized equipment such as harmonic distortion analyzers, IM analyzers, flutter and wow meters, and an electronic switch. The price (and performance) range presented varies from the most inexpensive kit intended for the beginner up to the very expensive laboratory instrument. The specifications listed for each instrument have not been verified by Audio; they are the ratings provided by the manufacturer. Happy hunting.

VACUUM TUBE VOLTMETERS

B & K INSTRUMENTS, INC.

- True RMS VTVM. A professional instrument designed for use in the audio laboratory, the Bruel & Kjaer Model 3409 VTVM is especially valuable for the measurement of distorted sinusoidal or non-sinusoidal voltages. A.C. measurements are possible in the frequency range from 2 cps to 200,000 cps with an over-all accuracy of ±3 per cent over the full scale.

- Direct-Reading VTVM. The B & K Mfg. "Dynamatic" 375 is an automatic VTVM that provides direct readings without multiplying or converting in any way. An individual scale is provided for each range, all scales are the same size, and only one scale is visible at a time. The 375 measures rms and peak a.c. volts, and d.c. volts, in seven ranges up to 1500 volts. Over-all accuracy is given as ±3 per cent over the full scale for either a.c. or d.c. measurements. The unit also measures direct current up to 500 ma and resistance up to 1000 megohms. A single probe is provided for d.c., a.c. and resistance measurements. Price of the Model 375 is $59.95. B & K Mfg. Co., Cleveland, Ohio. A-1

- Laboratory VTVM. The General Radio Model 1566-B VTVM combines the accuracy of the laboratory instrument with the durability necessary for production use. It measures alternating voltage at frequencies up to several hundred Mc, as well as d.c. voltages of either polarity. The voltage range is 0.1 to 150 volts a.c. and d.c. in six ranges. Accuracy on both the a.c. and d.c. measurements are ±3 per cent of full scale. The frequency response is essentially flat at ±1 db from 2 cps to 500 Mc. On the higher a.c. voltage ranges the instrument operates as a peak voltmeter, calibrated to read rm sinusoidal or sine wave, or 0.707 of the peak value of a complex wave. Features of the Model 1566-B include stable calibration which is substantially independent of tube characteristics, and an illuminated mirror-type scale. Price of the 1566-B is $490.00. General Radio Company, West Concord, Massachusetts. A-4

B & K MFG. CO.

- A.C. VTVM Kit. The EICO Model 255 a.c. VTVM Kit is a high-sensitivity unit at a modest price. It measures a.c. voltage from 100 µv to 300 volts in 12 ranges. The 255 responds to the average value of an applied wave and indicates the rms value of a sine wave. The db range is ±52 db from 2 cps to 200,000 cps. Price of the 255 is $215.00. EICO Mfg. Co., Chicago, Ill. A-2

- Low-cost VTVM Kit. Featuring the same basic circuit as the well-known Heathkit V-7A, plus new improvements, the Heathkit K-1500-BVT VM is $44.95. EICO Electronic Instrument Co., Long Island City, N. Y. A-3

EICO

- A.C. VTVM Kit. The EICO Model 155 a.c. VTVM Kit is a high-sensitivity unit at a modest price. It measures a.c. voltage from 100 µv to 300 volts in 12 ranges. The 155 responds to the average value of an applied wave and indicates the rms value of a sine wave. The db range is ±1 db from 10 cps to 200,000 cps. Frequency response is within 0.2 db from 2 cps to 200,000 cps with an over-all accuracy of ±3 per cent over the full scale. Other features include a two stage RC-coupled amplifier and a full bridge meter circuit, stabilized power supply incorporating a voltage regulator, and d.c.-biased filaments and hum-adjust potentiometer. Hum and noise is 25 µv on any range. Price of the Model 155 kit is $44.95. EICO Electronic Instrument Co., Long Island City, N. Y. A-3

GENERAL RADIO

- Laboratory VTVM. The General Radio Model 1566-B VTVM combines the accuracy of the laboratory instrument with the durability necessary for production use. It measures alternating voltage at frequencies up to several hundred Mc, as well as d.c. voltages of either polarity. The voltage range is 0.1 to 150 volts a.c. and d.c. in six ranges. Accuracy on both the a.c. and d.c. measurements are ±3 per cent of full scale. The frequency response is essentially flat at ±1 db from 2 cps to 500 Mc. On the higher a.c. voltage ranges the instrument operates as a peak voltmeter, calibrated to read rm sinusoidal or sine wave, or 0.707 of the peak value of a complex wave. Features of the Model 1566-B include stable calibration which is substantially independent of tube characteristics, and an illuminated mirror-type scale. Price of the 1566-B is $490.00. General Radio Company, West Concord, Massachusetts. A-4

HEATH
the Model IM-11 measures a.c. volts, a.c. volts peak-to-peak, d.c. volts, resistance, and db. The d.c. and a.c. rms scales measure to 1600 volts full scale. The a.c. peak-to-peak scale goes to 4000 volts in seven ranges. The resistance range is from 0.1 ohm to 1000 megohms in seven ranges. Frequency response is ±1 db from 25 cps to 1 Mc with a 600-ohm source. Accuracy is ±3 per cent d.c. for the d.c. measurements and ±5 per cent for the a.c. measurements. The IM-11 is supplied with a slim, all-purpose test probe. A switch on the probe body provides simple selection of a.c. ohms or d.c. functions, and is equipped with a hook which enables clipping the probe to the circuit for "hands free" operation. The price of the IM-11 Kit is $29.95. Heath Company, Benton Harbor, Michigan.

HEWLETT-PACKARD

- **Laboratory VVTM.** The Hewlett-Packard Model 460-D VVTM is a relatively low-priced laboratory voltmeter, offering wide voltage range, 2-per-cent accuracy and broad frequency coverage. The voltage range is 1.0 mv to 200 volts full scale in twelve ranges. The frequency range is 10 cps to 4 Mc, and the accuracy is ±2 per cent full scale from 20 cps to 1 Mc. The Model 499-D is calibrated to read rms value of sine waves. Other features include overload protection which guards the instruments against peaks of up to five times the specified voltage to minimize transients during switching, and output circuitry which permits the voltmeter to be used as a broad-band, high-gain amplifier throughout its full frequency range. The price of the Model 460-D is $250.00. Hewlett-Packard Company, Inc. Palo Alto, California.

- **Peak-to-Peak VVTM Kit.** Designed for ease of construction and versatility, the Lafayette KT-174 VVTM Kit measures a.c. peak-to-peak, a.c. rms, and d.c. voltage, and resistance. In addition it has a direct reading db scale. Two a.c.-range groupings are provided—a low a.c. range for audio applications and a regular a.c. range. The low range provides rms readings up to 500 mv, peak-to-peak voltage readings up to 1400 mv, with an accuracy of ±5 per cent of full scale. Frequency response in this range is ±1 db from 20 cps to 250,000 cps, with a 600-ohm source. The regular a.c. range provides rms readings up to 1500 volts and peak-to-peak readings up to 4500 volts, also with an accuracy of ±5 per cent. Frequency response in this range is ±1 db from 26 cps to 4 Mc. The d.c. voltmeter provides ranges up to 1500 volts with an accuracy of ±2 per cent. The ohmmeter section reads up to 1000 megohms in seven ranges. Other features of the KT-174 are special all-in-one probe, external calibration controls, and terminals which permit monitoring directly with an oscilloscope while making a.c. measurements. The KT-174 sells for $26.95. Lafayette Radio Electronics Corp. Janesville, Wisconsin.

LAFAYETTE

- **A.C. VVTM Kit.** Featuring the same circuitry and accuracy of the Knight automatic a.c. VTVM Kit, this new manual a.c. VTVM kit, Model 83YU975, provides a sensitive, accurate instrument at a modest price. The Model 83YU975 measures up to 300 volts in eleven scale ranges, and the db range is from -65 to +55, also in eleven ranges. The frequency response is ±1 db from 20 cps to 2 Mc. The overall accuracy is ±3 per cent of full scale. The stable 2-stage amplifier has a cathode-follower output that may be connected to an oscilloscope for simultaneous waveform observation while making measurements. The price of the Model 83YU975 kit is $59.50. Allied Radio, Chicago, Illinois.

RCA

- **Senior VoltOhmyst.** The RCA Senior VoltOhmyst Model WV-265 is an all-electronic voltmeter designed to measure d.c. voltages, resistance, rms values of sine waves and peak-to-peak values of complex waves. Rsme a.c. and d.c. voltages up to 1500 volts are measured in seven ranges with an accuracy of ±3 per cent of full scale. It also measures resistance values up to 1000 megohms and complex wave forms having peak-to-peak values up to 4200 volts. The instrument is frequency compensated for a.c. voltage ranges up to and including the 500-volt range, and can be used at frequencies up to about 2 Mc. All measurements are made with a single unit probe. Additional features include provisions for zero centering of the meter pointer, and two separate scales for low-voltage a.c. measurements. The Senior VoltOhmyst is available as a kit at a price of $62.50 and factory-wired and calibrated at a price of $75.50. Radio Corporation of America, Harrison, New Jersey.

AUDIO SIGNAL GENERATORS

B & W

- **Model 200 Audio Oscillator.** The Barker & Williamson Model 200 Audio Oscillator is intended for use where a stable, accurately calibrated source of frequency from 30 cps to 85,000 cps is required. The Model 200 achieves its 30,000-cps range in three steps, each step being continuously variable. The output is 10 volts into a 500-ohm load, with an attenuator available to reduce the output if necessary. The Model 200 utilizes an RC oscillator circuit whose output achieves harmonic distortion of less than 0.5 per cent from 100 cps to 15,000 cps at 50 volts output. Frequency response better than ±1 db is claimed over the 36 cps to 15,000 cps range (500-ohm load), with stability exceeding 0.1 per cent. No zero reset or line calibration is required and dial calibration is accurate to 0.2 per cent of scale reading. Barker & Williamson, Inc., Bristol, Pa.

EICO

- **Sine-Square Wave Audio Generator Kit.** The EICO Model 377 sine-square wave generator features versatility and modest cost. The frequency range in the sine wave setting is 20 cps to 290,000 cps in three steps, each step being continuously variable. The output is 10 volts into a 600-ohm load, with an attenuator available to reduce the output if necessary. The Model 377 utilizes an RC oscillator circuit whose output achieves harmonic distortion of less than 0.5 per cent from 100 cps to 15,000 cps at 10 volts output. Frequency response better than ±1 db is claimed over the 10 cps to 15,000 cps range (600-ohm load), with stability exceeding 0.1 per cent. No zero reset or line calibration is required and dial calibration is accurate to ±0.2 per cent of scale reading. EICO, Inc., Bristol, Pa.

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PILOT RADIO CORPORATION, 37-36 36TH STREET, LONG ISLAND CITY 1, NEW YORK

AUDIO • JANUARY, 1962
GENERAL RADIO

- Model 1206-A Audio Oscillator. The General Radio Type 1206-A Audio Oscillator features wide-frequency range with excellent stability and low-harmonic distortion. It provides a frequency range from 10 cps to 100,000 cps in four ranges, with an accuracy of ±1% per decade. The output impedance is a balanced 600 ohms and grounded 500 ohms and it provides at least 50 volts open circuit with the 5000-ohm output and 10 volts open circuit with the 600-ohm output. The 1206-A is an RC oscillator which employs an inverse-feedback circuit. The frequency-determining network is a Wien Bridge. Harmonic distortion is less than 1% from 100 cps up to 15,000 cps. Frequency accuracy is ±0.5% from 100 cps to 100,000 cps. Special features include metering terminals at the front of the panel for monitoring output level by means of an external VTVM or VU meter. A 6-inch diameter tuning dial provides scale lengths of 150 inches over the five bands. The price of the Model E-310 is $165.00. Hewlett-Packard, Inc., Palo Alto, California. A-11

- Model 1302-A Audio Oscillator. The General Radio Type 1302-A Audio Oscillator is a RC oscillation circuit and operates into high impedance load. Price for the Model 1302-A is $31.95. EICO Electronic Instrument Co., Inc., Long Island City, N. Y. A-11

HEATH

- Audio Generator Kit. The Heath Model AG-10A Audio Generator Kit features switch-selected frequencies, low distortion, and a built-in output meter. Frequency range is from 10 cps to 10,000,000 cps and can be varied in steps of 1 cps from 10 cps to 120 cps while a 4-position multiplier increases this range in multiples of 10 up to the maximum frequency. Output is indicated on a 1½-inch panel meter, calibrated in volts and db. The output attenuator operates in steps of 10 db and is calibrated in eight full-scale meter ranges. Output voltage is up to 10 volts into a high impedance load and up to 1 volt into a 600-ohm load. Frequency accuracy is ±2% per decade and harmonic distortion is less than 1% from 100 cps up to 15,000 cps. The dial switch allows selection of the built-in 600-ohm load or external load of higher impedance. Frequency determining network is a bridged-T RC oscillator circuit and operates into high impedance. Both a step attenuated output voltage control and a continuously variable level control are provided in the output stage. Distortion is less than 0.25% from 100 cps up to 15,000 cps into high impedance load. Price of the Model 35X111 is $45.50. Allied Radio, Chicago, Illinois. A-12

- Sine-Wave Audio Generator. Featuring an unusually modest cost for factory-wired sine-wave generator, the Lafayette Model TE-22 combines a sine-wave and a square-wave generator on one chassis. The sine-wave range is 20 cps to 200,000 cps ±1.5 dB in five bands. The voltage is 10 volts peak-to-peak. The dial calibration accuracy from 20 cps to 20,000 cps is ±5% per decade. The circuit of the sine-wave function consists of a bridged-T RC oscillator with a cathode follower output stage. An attenuator circuit, a clipper circuit, and an output cathode follower are combined to produce the square wave output. Price of WA-14C is $89.50. Radio Corporation of America, Harrison, New Jersey. A-18
How to Choose a Loudspeaker

The loudspeaker is potentially the weakest link in a high fidelity system. It is the most difficult of audio components to choose.

The choice should be made primarily on the basis of prolonged, careful listening to different speakers, with varied musical program material used for each. Quick demonstrations with gimmick records do not provide a valid basis for evaluation.

Acoustic Research maintains showrooms on the west balcony of Grand Central Terminal in New York City, and at 52 Brattle Street in Cambridge, Massachusetts. There you can listen at leisure to music reproduced through AR loudspeakers, from harpsichord concertos to Dixieland jazz. No sales are made or initiated at these "Music Rooms." Although attendants are on hand to answer questions, you may stay as long as you like without being approached.

Speaker Rental Plan In line with the effort to make careful auditioning of AR speakers possible, Acoustic Research has now instituted a rental plan. Any model of AR speaker, or a stereo pair, can be rented from a participating dealer for a week at a cost of one dollar per unit.

If the speaker is purchased the dollar is applied toward the price. If you decide not to buy the speaker you can feel completely free of pressure to keep it, since the trial has been adequately paid for. (AR gives the dealer an additional sum for his trouble.)

AR speakers are priced from $89 to $225. Literature, including a list of dealers in your area participating in the AR rental plan, is available on request.

Acoustic Research, Inc., 24 Thorndike Street, Cambridge 41, Massachusetts
OSCILLOSCOPES

EICO
- 5-inch Push-Pull Oscilloscope Kit. Intended for service as a general purpose oscilloscope, the EICO Model 416 features push-pull output stages in both vertical and horizontal amplifiers. Vertical and horizontal frequency range is 5 cps to 50,000 cps although the vertical response is usable up to 5.5 Mc. Vertical sensitivity is 0.05 to 0.1 volts rms per inch; horizontal sensitivity is 0.05 to 0.15 volts rms per inch. The sweep generator is a multiplier with a frequency range of 15 cps to 75,000 cps. Other features include 5-axis input, direct connections to deflection plates of cathode-ray tube available at rear of cabinet, and provision for external as well as internal synchronization. Price of the Model 425 kit is $41.95. EICO Electronic Instrument Co., Long Island City, N. Y. A-19

HEATH
- 5-inch Oscilloscope Kit. Designed to accommodate those applications where wide bandwidth is necessary, the Heath Model IO-30 5-in. oscilloscope provides a vertical bandwidth from 3 cps to 2 Mc within ±3 db. Horizontal bandwidth is ±3 db from 1 cps to 100,000 cps. Vertical sensitivity is 0.025 volts rms per inch at 1000 cps. Horizontal sensitivity is 0.3 volts rms per inch at 1000 cps. The sweep range is 10 cps to 500,000 cps in 5 steps. Synchronization is automatic. Other features include push-pull output amplifiers, positive trace-position controls, peak-to-peak calibration reference, 5-step frequency compensated vertical input, Z-axis input, and two switch-selected preset sweep frequency positions for those who use certain frequencies often. Price of the IO-30 kit is $69.95. Heath Company, Benton Harbor, Mich. A-20

HEWLETT-PACKARD
- Model 120A Oscilloscope. The H-P Model 120A 5-in. laboratory oscilloscope features direct reading calibration, automatic trigger, and automatic baseline. The frequency ranges of the vertical and horizontal amplifiers are 0.5 to 250,000 cps for d.c. measurements and 2 cps to 200,000 cps for a.c. measurements. Vertical sensitivity is 0.10 volts per cm to 100 volts per cm in 4 calibrated steps accurate within ±5 per cent. Horizontal sensitivity is 0.1 volts per cm to 100 volts per cm in 3 calibrated steps accurate within ±5 per cent. The sweep range is from 1 cps as per cm to 200 ms per cm in 15 calibrated sweeps. A sweep multiplier expands the sweep rate 5 times on all ranges. Synchronization is automatic from 50 cps to 250,000 cps. The Model 120A is supplied with an illuminated graticule and a filter appropriate for the phosphor used. Price of the 120A is $160.00. Hewlett-Packard Co., Palo Alto, Calif. A-21

KNIGHT
- 5-inch Oscilloscope Kit. High-frequency vertical range and high-speed sweep rate feature the Knight Model 82YU144 oscilloscope kit. The vertical amplifier response is ±3 db from 6 cps to 5 Mc. Sensitivity of the vertical amplifier is 25 mv rms per inch; sensitivity of the horizontal amplifier is 600 mv rms per inch. The sweep range is 15 cps to 600,000 cps in 5 steps. Horizontal sensitivity is 0.3 volts rms per inch at 1000 cps. Synchronization is automatic. Other features include frequency compensated input attenuator, 1 volt peak-to-peak calibration, retrace blanking, and Z-axis input. Price of the Model 82YU144 is $69.95. Allied Radio Corp., Chicago, Ill. A-22

PRECISION
- High-Sensitivity 5-inch Oscilloscope. Featuring high sensitivity plus unusually modest price, the Precision Model ES-150B oscilloscope is intended for use in industrial and service applications. Vertical frequency response is ±1 db from 10 cps to 5.5 Mc, and ±3 db to 6 Mc. Horizontal response is ±1 db from 10 cps to 1 Mc. Vertical sensitivity is 10 mv per inch and horizontal sensitivity is 100 mv per inch. Sweep range is 10 cps to 100,000 cps with an auto-sync circuit operating on all internal sweep ranges. A high-contrast illuminated graticule is provided. Both amplifiers are push-pull and have cathode-follower inputs. Other features include direct reading peak-to-peak voltage calibrator, vertical pattern-reversing switch, and built-in 60-cps phasing and blanking controls. The price of the Model ES-150B is $274.95. Precision Apparatus Co., Inc., Glendale, L. L. N. Y. A-23

RCA
- 3-inch Oscilloscope Kit. The RCA Model WO-33A is a 3-in. oscilloscope designed for "on location" and service shop use. The vertical amplifier frequency response is within 3 db from 5 cps to 5.5 Mc; the horizontal amplifier response is within 6 db from 3.5 cps to 80,000 cps. Sensitivity of the vertical amplifier is 0.16 volts rms per inch in the wide-band position and 0.003 volts rms per inch in the high-sensitivity position. Sensitivity of the horizontal amplifier is 0.9 volts rms per inch. The sweep range is continuously adjustable from 15 cps to 75,000 cps with external and positive or negative internal synchronization. The vertical input attenuator is frequency compensated and voltage calibrated, and the graph screen is scaled directly in volts. A calibrating voltage is automatically applied to the vertical amplifiers when the bandwidth control is set to the calibrate position. Price of the WO-33A kit is $72.95. Radio Corporation of America, Harrison, N. J. A-24

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AUDI0 • JANUARY, 1962

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Low-Noise Resistors

Q. I am trying to make some improvements in my tape recorder and plan to put low-noise resistors in the plate load of the first stage of the tape amplifier. Should I use low-noise resistors anywhere else? Are deposited carbon resistors satisfactory in this connection?

A. Unless the cathode resistor is bypassed by a large capacitor, it is just as important to use a low-noise resistor here as in the plate load. While the final amount of amplifier noise depends largely upon the amount of noise generated in the first stage, it sometimes pays to use low-noise resistors in the second stage as well, which may yield a slight additional improvement.

My own experience with deposited carbon resistors has not been very satisfactory. I prefer to use deposited metal film types, which are not much more expensive than the deposited carbon ones, but are substantially cheaper than wirewound resistors and virtually noise-free (that is, tube noise will predominate over resistor noise). On the other hand, on rare occasions one may run into a defective deposited metal film resistor (as once did happen to me), so in the last analysis you might decide to go for wirewound resistors as the safest bet. However, I am very much inclined to agree that the noise probably comes from the last stage of the tape amplifier. 

A. I do not have a specific, sure answer to your bauling problem, which appears to be of the type that requires hours of searching in order to answer. However, I am very much inclined to agree that the noise probably comes from the last stage of the tape amplifier. (1) You have used your oscillator in conjunction with the deck and record amplifier of another tape machine, and the noise decreased considerably when I disconnected the erase head. Is this still there?

Q. The noise decreases when the erase head is disconnected, which is fed by the same oscillator that supplies the record head. (2) The noise abates when you disconnect the erase head, which is fed by "worse" noise. (3) You state that the noise gets worse at faster tape speed, if "worse" noise is "louder." For a given magnitude of signal (noise) presented to the tape, the magnitude of the signal recorded on the tape goes up as tape speed is increased. This noise is due to serious distortion in the oscillator waveform. Placing an oscilloscope across the oscillator output would quickly establish this. The distortion may be caused by an excessive load on the oscillator, which could be due to a faulty record or erase head with shorted turns. Or there may be something else in the oscillator and associated circuitry which presents too great a drain on the oscillator output. In such cases the noise decreases when the erase head is disconnected—thereby removing an appreciable part of the load—excessive loading seems to be a likely cause. A defective oscillator transformer or other components could also be responsible for the distorted waveform and consequent noise.

Q. When separate heads are used, each one has its own bias oscillator, whereas in the state of the art permits. A playback-only head is built with a greater number of windings than the record head, especially for recording as well as playback. The larger number of windings requires in more head output, leading to a better signal-to-noise ratio, and so forth. Also, a large number of windings raises the impedance of the head to the point where it is not suitable for recording, because it makes excessive voltage demands upon the bias oscillator and the record amplifier. For recording purposes a low-impedance head is desirable in order to permit the record head to be driven by reasonable values of audio and bias voltage, with accompanying low distortion. Also, a record head does not require an extremely narrow gap, which is difficult to manufacture and raises the cost. Instead, the record head concentrates on making a gap with very straight and sharp edges, which is the most important thing for recording purposes.

Q. Some more symptoms might be of help. I have tried degaussing the heads but this does not seem to help much if any. The recorder uses pressure pads, which I have replaced with new felt but this does not help. Could it be that electrostatic charges are being recorded on the tape? These charges could be generated by the friction of the tape on the felt pads. The noise appears in the audio magazines. Is there a simple way or test to compare the quality of different tapes? I have a good deal of tape equipment.

A. There are many things for which a tape can be tested, including the change in response with variation of bias current and distortion. In checking frequency response, be sure you record all signals at a level at least 20 dB below maximum recording level as shown by the record-level indicator, for otherwise you will saturate the tape at high frequencies due to record treble boost, resulting in a seeming treble loss. When checking distortion, check this at various levels of output and after all, you don't mind pumping in a little bit more signal if, for the same amount of distortion, you get out a substantial increase in signal.

Three Head Machines

Q. I know that having separate record and playback heads permits one to monitor the tape as it is being recorded. Are there any advantages so far as quality of performance is concerned?

A. When separate heads are used, each one has its own bias oscillator, whereas in the state of the art permits. A playback-only head is built with a greater number of windings than the record head, especially for recording as well as playback. The larger number of windings requires in more head output, leading to a better signal-to-noise ratio, and so forth. Also, a large number of windings raises the impedance of the head to the point where it is not suitable for recording, because it makes excessive voltage demands upon the bias oscillator and the record amplifier. For recording purposes a low-impedance head is desirable in order to permit the record head to be driven by reasonable values of audio and bias voltage, with accompanying low distortion. Also, a record head does not require an extremely narrow gap, which is difficult to manufacture and raises the cost. Instead, the record head concentrates on making a gap with very straight and sharp edges, which is the most important thing for recording purposes.

Q. It should be further taken into consideration that it is much easier to make perforations—where there are signal-to-noise ratio, distortion, and so forth—on a machine with separate record and playback heads than on a machine with a single head for both purposes. Accordingly, it is more likely that such a machine will be kept in condition to provide high quality performance.
A Filterless Method for the Detection of FM-Stereo Signals

THEODORE BIALLY

The use of a demodulator switching waveform of odd symmetry and zero average value may eliminate the need for filters to separate the sum and difference signals as well as the SCA signal.

Two primary considerations in the design of a multiplex receiving system are:

1. The ability of the system to maintain consistent channel separation over the entire audio spectrum (50-15,000 cps); and
2. The elimination of audible products resulting from the detection of signals in the SCA region (60,000 to 74,000 cps).

The scheme which is commonly employed to recover stereo information from the composite multiplexed signals which appear at the ratio detector consists of isolating the \( L-R \) (difference) sidebands and the \( L+R \) (sum) channel from each other through the use of band-pass and low-pass filters. Then the \( L-R \) sidebands are demodulated and matrixed with the \( L+R \) signal to obtain the left and right channel audio signals. It has been pointed out that even slight errors in the phase of the \( L+R \) channel with respect to that of the detected \( L-R \) sidebands will place serious limitations upon channel separation. In order to preserve proper phase relations several excellent linear phase shift filter designs have been offered by the industry.

Although the method described is a solution to the problem, it requires extremely delicate alignment. Stringent tolerances must be rigidly maintained if reasonable channel separation is to be realized. Practical difficulties also arise from the fact that "linear phase shift" filters are not completely linear thus making channel separation dependent upon frequency.

Analysis of the output spectrum which results when the total composite multiplex signal is applied to a synchronous demodulator indicates that if the demodulator switching waveform has zero average value, then in the region from 50-50,000 cps, only the demodulated \( L-R \) sidebands will appear. (See spectrum analysis.) Thus, in the spectral band of interest, a properly designed demodulator will deliver exactly the same signal whether or not it is preceded by a bandpass filter. The demodulator output may then be matrixed with the (unfiltered) composite input signal to yield the desired left and right stereo channels. Omission of the filters introduces high frequency components (above 15,000 cps) in the form of suppressed carrier AM signals into the output waveform, but normal de-emphasis effectively attenuates these undesired products. By eliminating the major cause of relative phase shift between main and sub-channels...
Rejection of SCA Crosstalk

Crosstalk from the SCA channel is a result of the mixing of SCA components in the 60,000–74,000 cps region with a signal between 45,000 and 89,000 cps. The result is an undesired product in the 0–15,000 cps band. This mixing occurs in the L–R sub-channel demodulator which, because of its nonlinear nature, injects, in addition to the required 38,000 cps carrier, various harmonics of 38,000 cps. Note that the second harmonic (76,000 cps) lies between the 45,000 and 89,000 cps limits and is a potential source of SCA crosstalk.

The solution to the problem lies either in preventing signals in the 60,000–74,000 cps region from appearing at the demodulator input (i.e., passing the composite signal through a low-pass filter having a cutoff frequency between 53,000 and 60,000) or in eliminating the second harmonic component of the demodulator switching waveform. Once again the filter solution is avoided because of the phase shift which it introduces in its passband. If the demodulator is designed to switch with a waveform of odd symmetry (i.e., no even harmonics) SCA crosstalk ceases to be a problem.

The block form of the receiving scheme is shown in Fig. 1.

Spectrum Analysis

Let the following notations apply:

\[ a_p = 2\pi \times 19 \times 10^4 \text{ rad/sec} = \text{pilot frequency} \]

\[ a_o = 2\pi \times 38 \times 10^4 = 2W_p \text{ rad/sec = sub-carry} \]

\[ a_m = 2\pi \times 15 \times 10^4 \text{ rad/sec = upper audio frequency limit} \]

\[ a_n = 2\pi \times 67 \times 10^4 \text{ rad/sec = SCA sub-carry frequency} \]

\[ a_p = 2\pi \times 7 \times 10^4 \text{ rad/sec = upper SCA audio frequency limit} \]

If the left channel audio signal is

\[ \sum_{k=1}^{n} A_k \cos (a_k t + \phi_k) \]

the right channel signal is

\[ \sum_{m=1}^{n} A_m \cos (a_m t + \phi_m) \]

and the SCA audio signal is

\[ \sum_{i=1}^{n} A_i \cos (a_i t + \phi_i) \]

then the composite signal \( f(t) \) which is available at the ratio detector output is:

\[ \sum_{k=1}^{n} A_k \cos (a_k t + \phi_k) + \sum_{m=1}^{n} A_m \cos (a_m t + \phi_m) \]

\[ + A_p \cos a_p t + \frac{1}{2} \sum_{k=1}^{n} A_k \left[ \cos \left( (a_n - a_k) t - \phi_k \right) + \cos \left( (a_n - a_k) t + \phi_k \right) \right] \]

\[ + \frac{1}{2} \sum_{m=1}^{n} A_m \left[ \cos \left( (a_n - a_m) t + \phi_m \right) + \cos \left( (a_n - a_m) t - \phi_m \right) \right] \]

The spectral distribution of this signal is as shown in Fig. 2.

Upon demodulation, the composite signal is effectively multiplied by the demodulator switching function \( S(t) \), i.e., the demodulator output is the product \( f(t)S(t) \) as shown in Fig. 3.

\( S(t) \) in its most generalized form may be expressed as a periodic waveform having fundamental frequency \( \omega_0 \):

\[ S(t) = \frac{\pi}{2} A_1 \cos (\omega_0 t + \phi_1) \]

The spectrum of \( f(t)S(t) \) may be determined by algebraically adding the spectra resulting from the individual products of \( f(t) \) with each of the spectral components of \( S(t) \).

Each such product \( f(t)A_1 \cos (\omega_0 t + \phi_1) \) yields the spectral distribution shown in Fig. 4.

Note that the \( f(t) \) spectrum has been translated to the frequency \( \omega_0 \) and is symmetrically distributed about this point. The amplitude of the translated spectrum relative to the original \( f(t) \) spectrum is \( A_1/2 \).

The fundamental \( \omega_0 \) component of \( S(t) \) translates the \( f(t) \) spectrum to the position shown in Fig. 5.

The portion of the spectrum which falls in the "negative" frequency region can be drawn in the "positive" frequency region as in Fig. 6.

Since the \( L-R \) information on the negative frequency axis is the exact mirror image of that on the positive frequency axis, the amplitude \( A \) of the resultant "positive" \( L-R \) spectrum is a function of the relative phases of the negative and positive frequency contributions. In particular, the translated \( L-R \) spectrum will vary in amplitude as the cosine of the phase angle \( \phi \) of the fundamental component of \( S(t) \).

In order to obtain maximum signal recovery, the phase of the fundamental component of \( S(t) \) should be identical with that of the subcarrier at the transmitter.

It is the purpose of the demodulator to deliver only the detected \( L-R \) sidebands in the audio region \( a \to a_m \). This has been accomplished by the fundamental component of \( S(t) \). However, it remains to be seen whether any of the other spectral components of \( S(t) \) will deliver outputs in the \( a \to a_m \) band.

The \( a \to (d.c.) \) component of \( S(t) \) offers no translation of the input spectrum but simply alters its amplitude by the factor \( A_1 \); the input of the demodulator due to the d.c. component \( (A_d) \) of \( S(t) \) is \( A_1f(t) \). This contains the \( L-R \)
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Audio • January, 1962
information in the region between zero and $\omega_m$. In order to obtain only the de-modulated $L-R$ sidebands in this region, the $A_e$ term of $S(t)$ should be zero.

As was previously pointed out, each spectral component of $S(t)$ produces an output which is symmetrical about that component in frequency. In fact, it is clear that each component of $S(t)$ yields an output of bandwidth twice that of $f(t)$. The input signal bandwidth is $\omega_m$ radians/second, or 74,000 cps, so that for each component $i\omega_c$ there will appear at the demodulator output a signal whose spectrum lies between the limits $\frac{i\omega_c \pm 74,000}{2\pi}$ eps. Those components of $S(t)$ which are sufficiently high in frequency so that $i\omega_c - 74,000 > 15,000$ eps will deliver no output in the 0 to $\omega_m$ (0 to 15,000 cps) region. In other words, $i\omega_c$ must be greater than 74,000 + 15,000 = 89,000 eps in order to produce no audible output signals. Since $\omega_m = 38,000$ cps, $i > \frac{89,000}{38,000} = 2.35$. However, $i$ can assume only integral values so that for $i \geq 3$ there will be no audible response. The second harmonic ($i=2$) of $S(t)$ must be suppressed, since this component delivers an output in the 0 to 15,000 cps region.

The spectrum of the output signal of a demodulator which satisfies the aforementioned requirements appears in Fig. 7.

Note that the $L-R$ information is the only audible component of this signal.

Since the matrixing process does not yield any useful signals in the $0$ to 7400 cps region, the audible output of a matrixing circuit will be composed only of the audible components of the input signals. The only audible components of the original $(f(t))$ and demodulated signals.

(Continued on page 69)

![Fig. 8. Schematic of Eico MX-99 multiplex adaptor.](image-url)
Feedback—Head Cook and Bottle Washer!

NORMAN H. CROWHURST

Feedback can reduce frequency and phase errors, gain, and distortion as well as improve stability—but rarely can it do all of these things at the same time.

LIKE A MAN IN A ONE-MAN establishment, feedback can do a lot of things: reduce distortion, adjust frequency response, improve stability from variation due to component deviation or fluctuation, adjust or control input and/or output impedance, and variations of same; but also like the one-man establishment, it is seldom able to do all these things at once.

This fact is often overlooked in various ways. We start with some algebra from which we draw a magic factor \((1 - \mu B)\)—generally identified as the feedback factor. More academic people may prefer \(\mu B\) instead of \(AB\), but it's the same thing with benefit of fraternity letters. Some people prefer to write the factor \((1 - \mu B)\) or \((1 - \mu B)\). While the difference in sign may confuse, it's really only a matter of where you start, and both ways of writing it lead to the same conclusions.

If \(B\), or \(B\), is taken to represent a negatively phased feedback fraction, we land up with the first expression, \((1 + AB)\), which is greater than unity. From this starting assumption, if the feedback is positive, then \(B\) has a negative sign, the expression becomes \(1 + (1 - B)\), which results in something less than unity.

Our more academic friends prefer to say that, if \(B\) represents negative feedback, it should have a negative sign and if it represents positive feedback it should have a positive sign. To conform with this rule, the factor should always be written \((1 - AB)\).

But most people visualize something bigger than unity any time they see \(+\) something, so I find it simpler to use \((1 + AB)\) for negative feedback and \((1 - AB)\) for positive feedback, where \(B\) is the feedback fraction in each case, without any implied sign to indicate its phase. We have taken care of that by designating it as negative or positive feedback verbally.

So it's really a matter of algebraic "semantics." I'm not fussy, so long as it's done right. Most important to the whole thing are two facts: first, and best known perhaps, although it's still often overlooked, in any practical application the expression is not a simple scalar quantity. It is complex, or possessed of both magnitude and phase.

Secondly, and this almost always overlooked, it is not constant, but subject to variation. With each of the things feedback is supposed to control, the usual presentation tells us that gain is reduced by the factor \((1 + AB)\), distortion is reduced in the same proportion, stability of amplification is improved by the same factor, frequency and phase errors are reduced by the same magic number, and impedance is stepped up or down, according to a convenient table, using the same number as operator.

The fact is, it just ain't so. Feedback can do all of these things, but seldom all at once. To illustrate, let's take some typical examples.

Cathode Follower

A common fallacy of this type is the usual understanding of a cathode follower. In this case \(B\) is unity, so the gain degenerates to \(1/(1 + A)\), which is usually a fraction slightly less than unity. Any input impedance connected virtually between grid and cathode is multiplied by \((1 + A)\). And the effective output source impedance is the normal source impedance of the plate circuit with the operating conditions chosen (plate voltage and current, and load resistor), divided by \((1 + A)\). Finally, the normal distortion for the stage is divided by \((1 + A)\).

Let's put in some figures, to see what all this means. We'll use a half 12AU7. With a 40,000 ohm coupling resistor, 250 volts plate supply and 5 volts bias, the plate current is 3.5 ma. The bias resistor should be 1400 ohms (1500 ohms is far enough for practical purposes, Fig. 1). With these values a 2.5 volt grid swing will produce a plate swing from 125 volts to 45 volts and 182 volts, according to the curves (Fig. 2). This is a gain, or \(A\), of \((182 - 45)/10 = 13.7\), with a second harmonic of 137 x 100 per cent = 8.4 per cent distortion. The plate resistance of the tube at the operating point is 12,900 ohms.

As a cathode follower, working open circuit, the degeneration will be 13.7/\(147 = .93\). The distortion will be 8.4/\(147 = .57\) per cent. This is at 137 volts output, peak to peak, or 43.5 volts rms. At lower voltages, the distortion will be proportionately lower. For example, at the 10 volts rms level, it will be .57/4.85 = .118 per cent.

If the grid-to-bias-point resistor is 1 megohm the input impedance will be 14.7 megohms. The normal plate circuit resistance is 12,000 ohms in parallel with 40,000 ohms, or 9200 ohms. As a cathode follower, this is divided by 14.7, to give 625 ohms.

From that, it sounds like a good circuit to match a 600-ohm line. But now suppose you connect it that way. The load line for the tube is now 600 ohms in parallel with 40,000 ohms, or 5900 ohms, through the same operating point. For convenience, we'll take it as 600 ohms. The ± 5 volt swing now produces a swing from 125 volts to 118 volts and 127 volts.

The gain is now \((127 - 118)/10 = .9\). As a cathode follower, the degeneration will be .9/.19 = .475. The distortion is 25/9 x 100 per cent = 28 per cent plate-coupled. For cathode coupling, this is no longer divided by 14.7, but by .9, to give 14.5 per cent, with a peak-to-peak output of only 9 volts, or 3.2 volts rms. At this output level, the open cir-
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Bootstrapping

Now let's take a case of positive feedback: the bootstrap driver, often used for unity coupled output circuits. We'll assume the output stage develops 150 volts swing in both cathode and plate circuit, for 25 volts swing at the grid. This means we need 175 volts total swing at the grid (Fig. 3).

To do this we use a relatively low plate resistor from the screen of the output stage to the driver plate, so the working plate voltage on the drive stage can be kept high at a current approaching maximum dissipation (Fig. 4). The positive feedback from the screen connection effectively multiplies this actual value to give a higher dynamic load line. If the actual resistor is 15,000 ohms, its effective value will be $175/25 = 7$ times this, or 105,000 ohms.

Positive feedback has multiplied the driver load impedance by 7 times. Does this mean the over-all gain is multiplied 7 times? And what happens to the damping factor?

Assume the drive stage has a plate resistance of 12,000 ohms and an amplification factor of 20. Without the bootstrap, its gain would be $20 \times 15/(15 + 12) = 11.1$. With the bootstrap, the gain becomes $20 \times 105/(105 + 12) = 18$. The increased gain factor is only $18/11.1 = 1.62$. Use of the bootstrap circuit increases available output swing of the drive stage much more than it increases gain, but this only a graphical approach can predict.

Damping factor is a little more involved. Starting with normal pentode operation, if 25 volts grid swing produces 300 volts total swing in a normal load value (the condition on which our earlier figures were based), open circuit operation would require only about 5 volts swing at the grid to produce the same 300 volts output swing. So in unity coupled configuration, to get the same output voltage, the grid swing needed drops from 175 (i.e. $150 + 25$) to 155 (i.e. $150 + 5$), representing a damping factor of about 7.5.

But that's assuming a constant-voltage drive stage, unaffected by feedback. Now to see what the bootstrap does:

When the load is removed, the positive feedback to the drive stage plate resistor jumps from 7 times to $155/5 = 31$ times. So the effective (dynamic) plate resistor is now 465,000 ohms. The gain will be $20 \times 465/(465 + 12) = 19.5$. (This

(Continued on page 66)

Fig. 2. Load lines on which calculations for cathode follower are based.

Fig. 3. Essential features of bootstrap arrangement. One side of a push-pull circuit is shown.

Fig. 4. Principle of the bootstrap illustrated by load lines.

Fig. 5. Some of the quantities discussed in the complete feedback amplifier.
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PILOT FM-STereo RECEIVER, MODEL 602M

The Pilot Model 602M is a complete stereophonic receiver in that it combines on one chassis an FM-stereo tuner, a stereo control center, and a 30-watt stereo amplifier. The 602M incorporates several unusual features, not the least of which is the "Simpli-Matic" test panel which permits the amplifier output tubes to be balanced statically and without the need for special test equipment. Another built-in feature is the power-line antenna which we found sufficient to receive FM-stereo signals over a distance of some 30 miles. Undoubtedly the sensitivity of the tuner more than anything else contributed with essentially the same ingredi­

ents with essentially the same ingredients. For example the original Model 602 contained the same amplifier and FM tuner as the 602M, added stereo FM with the inclusion of a multiplex adapter (built-in). Now comes the Model 602M which keeps stereo FM but drops the AM section. In other words, you can have it any way you wish.

Circuit Description

FM section. The signal enters the triode r.f. amplifier (½ ECC88) and proceeds to the oscillator-mixer (½ ECC88) where it is converted to the intermediate frequency. From there it goes through three i.f. ampli­

fier stages (6AU6) and then to a solid-state ratio detector (1N542). An "eye" type of tuning indicator (IC84) is used. After leaving the ratio detector the signal takes one of two paths: through a de-emphasis network if it is a mono broadcast, or through the multiplex network if it is stereo (assuming the selector switch is in the correct position). We will not describe the multiplex circuit as this was described in detail in the December, 1961, issue of Audio in an article by R. Shottenfeld and S. Ahlback.

Preampifier-amplifier section. Three pairs of inputs are provided: two pairs of low-level inputs and one pair of high-level inputs. The low-level signals (phono) enter a preamplifier stage (7025) which incorporates RIAA equalization. At this stage the high-level signals enter and all follow the same path from here on. The path then is through the volume and balance poten­

tiometers; through a tone driver (½ 12AX7); through the treble and bass net­

works; to the power driver (½ 12AX7); and then to the push-pull power output stage (EL84), half the signal going through a phase inverter (½ 12AX7).

Performance

The Pilot 602M easily met its published performance specifications: FM sensitivity just under 3 μV (IHFIM); frequency re­

sponse ± 1 db from 20 cps to 20,000 cps; harmonic distortion less than 1 per cent at full output; and power output at least 15 watts per channel. The power rating is achieved by operating the output tubes with a plate voltage of 325 volts which is just about the maximum rating for an EL84. Of course this is fairly common practice. Although we have not seen any other published performance specifications for the multiplex reception of the 602M we ob­served better than 20 db of separation, which RIAA than adequate. Actually these are not as yet firm standards for FM­

stereo reception, but separation of this order is considered important. In any case, the stereo sound was quite good. Our total impression is that the Pilot 602M is a fine performer at a surprisingly modest price. Oh yes, we forgot to men­

tion it looks good too.

A-40

(Continued on page 59)
HOW TO BUY YOUR FIRST (OR YOUR LAST) SPEAKER SYSTEM

If you demand magnificent sound... undistorted bass to beyond the limits of audibility—if you demand superb cabinetry and decor flexibility (with five interchangeable grille frames that snap on and off to match any decor)... then consider the unique University Medallion XII 12" Three-Way Speaker System. Medallion owners stay Medallion owners. Let's look inside the Medallion and see why.

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Amplifier requirements? Any amplifier capable of delivering a modest ten clean watts. Medallion dimensions? Only 24" x 17" x 11½" deep. Available with or without base—for use as highboy or lowboy. Finishes? Walnut, oiled walnut, fruitwood, mahogany and unfinished for custom installations. And the Medallion is the world's only system with "select-a-style" snap-on grilles. Want to change your decor at some later date? The Medallion stays where it is—all you change is the grille! In Contemporary, Italian or French Provincial, Colonial and Swedish Modern. Medallion prices start at $139.95, without grille. Grilles from $9.95. Base, $14.95.


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TIMELESS BEAUTY AND THE SOUND OF TRUTH
Stereo disc records? Phase 2 began in June, 1958 and ran well into 1959—but stereo disc settled down to relative stability. Phase 2 is a very short, very painful, rather difficult phase to fly through, in the hardest possible way.

Phase 2 chaos of non-standardization, as between rival products. You'll note that bugs and unforeseen technical difficulties typically run across the path, during Phase 2, and that they are stamina-sapping. Often they are idealists, these developers, with too few mental tracks, "pure" scientists who become so involved in a "Principle" that they can't see the practical faults. They become obstinate; they cannot admit that their principle itself, so lovely in its theory, hasn't worked out very well in practice, if at all. Phase 2 usually finishes them off.

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Specifications:

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Tuning range: MW 535 to 1,605 kc, SW 3.8 to 13 Mc
Practical sensitivity: MW 100 μV (1 Mc, output 500 mW, at 30% modulation)
SW 100 μV (7.5 Mc, output 500 mW, at 30% modulation)

Tuner right
Tuning range: MW 535 to 1,605 kc, FM 80 to 108 Mc.
Practical sensitivity: MW identical with Tuner 1
FM 10 μV (95 Mc, output 500 mW, at 30% modulation)

Audio section
Circuit: 6926p.p. 2-channels

Inputs and gain: MAG PU 3.4 mV, MIC 4 mV, XTAL PU 35 mV
TAPE (PLAY) 140 mV, AUX 140 mV

Equalizer: NF type, RIAA curve
Outputs for speaker—4, 8, 16 ohm (each channel), center channel terminal, tape recording terminal

Output power: 17W X 2
Undistorted output power: 15W X 2 (distortion below 1% at 1KC)
Response: 20 c/s to 50 kc, ± 1 db (main amplifier section, at 500 mV output)

Outer dimensions: 16 1/2 (W) X 14(0) X 5 1/2 (H) inch
Weight: 26.5 lbs

5 Otowacho 6-chome, Bunkyoku, Tokyo, Japan
Leningrad
Tchaikowsky: Symphony No. 4. Leningrad Philharmonic, Mrawinski.
Deutsche Grammophon 138674 stereo

If only the political and military future of our world could depend on the so-called cultural ambassadors—and upon the economies of a healthy trade! Here we have arch-Russian music played by an arch-Soviet orchestra, recorded and released by a leading German company to everyone’s profit, including ours over here in the States.

Listening to this really extraordinary “Fourth,” you’ll be struck, if you know the music at all, by a number of interesting thoughts. First—a splendidly disciplined orchestra and no doubt about it. Such preludial attacks, such accurate roulades of exactly tuned string notes, such perfect wind chords. Shall we chalk it up to sheer musical discipline, or is it a party matter? Anyhow, here it is, and we must listen and be amazed.

Then there is an over-all discipline of performance that makes this symphony into a new piece. The outer two movements are far less hysterical than we have expected and, if you don’t know the music, you will only have pleasant surprises, as this orchestra, under the bow of his best, his taut, tight structural discipline, is really to be performed with this sort of economy. We stress the schmaltz and the service to be performed with this sort of economy. We stress the schmaltz and the service to be performed with this sort of economy. We stress the schmaltz and the service to be performed with this sort of economy. We stress the schmaltz and the service to be performed with this sort of economy.

The two middle movements are simply beyond compare for their tender beauty and the famous pizzicato scherzo, which here is played straight out of the preceding movement as though the pairs were all one architectural plane. Not only tender, but extraordinarily careful phrasing and shaping, every note placed with incredible exactness, as part of the larger architecture.

Out of curiosity, I suggest it would be well for every owner of a “Western type” Tchaikowsky “Fourth” to buy this disc as a companion. You will hear a great deal about music in our two worlds and about Russian temperament, merely by listening here. There’s more than words can tell.

Note: Look right now at this department in last month’s issue and you will see an example of our penultimate edited version of my writing—minus all the final corrections. In the rush for the printing deadline the proofsheets got switched.

The final correcting job is a tricky one. Strange grammatical aberrations, unfinished sentences, mysterious words in the wrong places, somehow survive a series of preliminary printer’s proofreaders.

Nicely meaningless statements, positive opinions that were meant to be negative—you have to read for sense to catch these! If you want to try for your final instalment, the December installment of “Record Review.”

There’s even more to it because, with Arthur’s cooperation, I tried to rewrite in proof, improving my deathless prose via substitution of brand new words, exactly replacing the old in the same space. I find it fun, and it makes for better reading, as I trust you’ll discover in this month’s fully corrected installment. E.T.G.

Noble Efforts
Schumann: Cello Concerto.
Tchaikowsky: Rococo Variations. Rostropovich; Leningrad Philharmonic, Rozhdestvensky.
Deutsche Grammophon 138674 stereo

This top Soviet cellist was over here a year or so back and I heard—and watched—him in person. The weakest performance I’ve ever looked at, with the mouth wide open, the body wriggling, the face red, the eyes popping out; but the cello sound was smooth as silk and technically just what it was cracked up to be. International cellist, a cellist’s cellist too, knowing all the tricks of the trade both East and West, as well as possessing a few of his own in the way of finger dexterity.

The Bolshoi, in a particularly fine piece to make any sense out of. The somewhat classically cool Leipzig-Soviet approach is surely as successful as it can be. The attempt is to warm the music into an Romanticism merely end by being maudlin, emphasizing the peculiarly unhinged quality of the musical continuity. A tight, disciplined playing like this seems to help it forward through the two slowish movements until the more likely finale takes over. As for Tchaikowsky’s next set of “Rococo” variations, problems are purely technical and always rewarding when solved; the cello never sounded so easy to take as here. Again, the disciplined, cool accuracy of this ensemble of Soviet musicians does good things.

De Falla: The Three Cornered Hat (complete ballet). L’Orch. de la Suisse Romande, Ansermet. Teresa Berganza, mezzo.
London CS 6224 stereo (mono: CM 7992)

It is a continuing pleasure to find the complete scores of ballet music on records of this sort, in place of the familiar concert excerpts or suites that merely sample the high spots. Granted that there are parts of virtually every work that are head and shoulders above the bulk of the music, much of which tends to be routine thanks to necessary stage business. (Only Stravinsky and Tchaikowsky, in very different ways, seem to be able to keep the musical fire on a consistency even keel throughout a ballet.)

Even so, it is better to have the whole of the music. On LP it is both economically feasible and easy in the listening—the dull spots slide by so effortlessly and the good parts make their impressions within the proper context. Thus a large part of this music will be quite unfamiliar to most listeners, some of which the music is not clearly good entertainment; the well known sections show up in interesting contrast. Nice singing by Braganza in her brief flaneur-like solo passage.

Columbia M25 619 stereo (mono: M2L 3213)

The enormous “Missa Solemnis” is usually paired with the “Ninth Symphony,” both works originating in Beethoven’s excited and somewhat eccentric last years. I saw one time when he was totally deaf and remarkably well removed from concern over the petty necessities of singers, chorus and orchestra. In the orchestra he seldom miscalculated, deaf or not. But he certainly did in this “Solemnis.” Special (especially the choral voice) was always limited and simply went out the window in his later works. The music is singable, it can be sung, that is. And it is of exalted greatness in concept, too. But its vocal requirements are at times almost nonsensical in terms of results achieved. Tenors yell like demons, basses sing tenor-range treble, and nearly strange in the process, sopranos reach for whole lines of high notes fit only for coloratura work. And the soloists—in both this work and the “Ninth Symphony”—do plenty of strangling on their own. To this day, these two works are the most difficult of successful execution in the entire repertory of concert music.

So—what have we here, on records? A recording made at the time of a series of public concerts by these same performers and presumably taped at a special session after the “live” performances were complete. For maximum effectiveness, in these days, there is no better way to achieve a polished, well-rehearsed recorded performance and this one should be optimum.

Well, it isn’t. The fault might be in Bernstein’s organizational leadership of the enormously complex forces involved (mostly rehearsed separately before the actual coming-together for performance); or maybe the weather was bad, or the hour late, or the weather was bad, or the hour late, or maybe the weather was bad, or the hour late, or maybe the weather was bad, or the hour late, or... the list is endless. But all this, it seems, is not enough to explain the unsatisfactory performance delivered by these singers and these instrumentalists, who come perilously close to atonality in a couple of passages. They simply do not hear
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AUDIO JANUARY, 1962

49
ANNOUNCING A NEW PROFESSIONAL STEREOPHONIC TEST RECORD

CBS Laboratories STR-100 frequency-test record is now available to audiophiles and audio professionals.

First introduced at the 13th Annual Convention of the Audio Engineering Society last fall and widely adopted by the leading high-fidelity pick-up manufacturers, the STR-100 test record is now being made available in limited edition to audiophiles by CBS Laboratories in the interest of better high-fidelity listening.

The STR-100 is the only test record to give you all of the following features:

- **Continuous glide-tones** for left and right channels, from 40 to 20,000 cps—to check the correctness of speaker placement, smoothness of response, freedom from resonances, and channel separation of the system—in less than three minutes.

- **Thirty spot-frequency tones** for each channel, ranging from 20,000 to 20 cps, with voice announcements preceding each tone. This allows you to verify the true frequency range of your system.

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---

**What they must hear, they lose the thread of harmonic continuity and sing (with that typically hysterical sound) in a sort of dumb reciting, until things straighten out!**

**Don’t let me go too far. I must make it clear that this is a splendidly heartfelt performance of a near-impossible work of genius, and in the long run I would much prefer a family friendly presentation of this sort to a technically more perfect but less joyfully inspired job, the sort that is normal in those hard-billed times. Maybe it’s just as well there are a few strained passages; the tension is thereby increased.**

**Oddly enough, one performer who seems unperturbed from beginning to end, in spite of her difficult solo role, is Eileen Farrell. She can sing plastically when others are apoplectic! She has the technique and the understanding behind it all. For once, a bit of neutral unison is an asset here, where most singers tend to overdo, and plenty simply go up in musical smoke under the strain. I doubt if her concept of the piece is quite what the wild Beethoven had in mind but, at least on this solid earth, hers is perhaps the first performance that has ever put over all of Beethoven’s notes with technical success.**

**Schoenberg: Verklärte Nacht.**

**Loeffler: A Pagan Poem. Leopold Stokowski and His Orchestrations.**

**Capitol SP 8433 stereo**

Here are two big, fat, thick-textured late-Romantic pieces and Stokowski, the unequaled conductor of so many dripingly sentimental “arrangements,” tones them down to size as well as any present conductor can do it. Individualists who have experienced real symphonic shrinkings of the “Transfigured Night” music in its large orchestral form will be somewhat surprised at this version, which is arranged by Stokowski himself as a kind of compromise between the original piece for sextet of stringed instruments and the blotted-out orchestral version. Schoenberg’s own, that we normally hear. It is much thinner and leaner, less wildly passionate, more pensive and generally a better piece of music in this form, yet more interesting for the most listeners than the relatively limited chamber music form of the original conception. Stokowski’s version retains many solo and solo ensemble passages, blending them in with string-orchestra elements.

**Loeffler was a doughty old Alsatian, French-trained, who lived most of his life in and around Boston. This is his supposed masterpiece, but for our ears it is sadly dated—thinly, blandly, lacking in the romantic, largely in its orchestral textures, the one-scene-three-tone-scales, the heavy old-fashioned and turgid, an incongruous mixture of Debussy (“Afternoon of a Faun”) and Richard Strauss. The harmonies are of the Debussy sort, but the poetic mystery of Impressionism is wholly lacking in favor of an sort of bombastic assertiveness, nearer to a complicated John Philip Sousa than to Debussy. Beautifully written for the large orchestra plus solo English horn, piano and three trumpets offshore, but I found it very hard to take. Just rubs the wrong way in this nuclear age.**

**I have a feeling that a much earlier recording I used to own, done on 78 by Howard Hanson and the Rochester forces, put more poetry into Loeffler and managed the silvery sound of the distant off-stage trumpets—who march triumphantly onto the stage at the end—in a much more successful way than do Stokowski and his Capitol (excellent here. But the old set is long since vanished and I must depend on memories of the older sound.)**

**ROMEO**

Tchaikowsky: Romeo and Juliet Duet.

Glinka: Songs (Solos, chorus, orchestra).

S. Lemeshev, T. Lovrovich, I. Kozlovsky; Orchs. Moscow Philharmonic, Bolshoi Theatre.

**Monitor MC 2055 mono**

The gem on this disc, an extraordinary one, is the Tchaikowsky duet for tenor and soprano, composed as a sketch for a hypothetical opera on “Romeo and Juliet” out of the-
mature material taken from the famous "Overture-Fantasy" that everybody knows. The new version was left incomplete and was rounded out by another musician after Tchaikovsky's death (Tänze), who apparently did the orchestration in the style of Chalabowsky—not bad, what with the "Overture-Fantasy" available as a model.

"Work of genius! No one but the master himself—I can't help using the term—could have constructed such a masterful love duet. There is already an almost perfect version of his earlier piece. It is the daybreak scene between Romeo and Juliet, which ends with the barytone appearance of Juliet's nurse who urges Romeo to get away before Mama comes. The scene is lovely in the play, and it is lovely here in music, perhaps rivaling such famous tenor-soprano scenes as the love duets in "Die Walküre." Typically, Tänze adds to the familiar "Shakespeare" material a superb new theme, surely as striking as those already available in the "Overture-Fantasy." It would have been a glorious opera, if he had worked it through in this superb level of musical achievement.

The singing—Romeo and Juliet and, briefly, the Nurse—has a curiously distant Russian flavor, what with the characteristically old-fashioned Russian orchestral sound, sounding like something from the Nineteen Thirties (though, perfectly good "fi"). Excellent performances. As for Gliksman, on any other disc he might charm, but here (for me) he is an anticlassic. Those voices, variously arranged for chorus, soloists, and the entire orchestra, managed more or less like much Russian popular music today. On a high level, relatively speaking, but still far below the "Shakespeare" excerpt in musical impact and, more important, sadly out of style with it. I'd buy the disc any day for "Shakespeare" alone.

Shakespeare: Romeo and Juliet. Marlowe Society and professional players (anonymous).

London OSA 1407 stereo

I reviewed the "Hamlet" in this London Shakespeare series expecting that it would have to stand for all the rest; but soon afterwards I had guests at home and out came "Romeo." We listened from start to finish and now I have two of these monster productions under my belt, and am the happier for it.

I'll say only that this very different play continues the tradition I found in "Hamlet" by this company—a polished, beautifully proportioned production with a minimum of that awkwardness, that gawking and公布的 blowing, a maximum of sensibly spoken, easily intelligible poetry, sounding modern by virtue of its expertly unaffected manner. One makes no attempt to sound her supposed supposed 14-century nor does Romeo guess like a schoolboy. Neither lover, oppositely, is an elderly actor trying to sound coyly youthful.

The surrounding characters are similarly natural, well set up and easily distinguished; there are few stereo stuats to distract, but plenty of solid stereo separation where it is most useful, and the whole takes on a clarity and transparency purpose that—gives the somewhat torrid text of this play—presents the great love story as convincingly as I've ever heard it.

As in "Hamlet," I found here an unusually penetrating understanding of the subtleties in the Shakespeare lines, a projection of their meaning that is startlingly real and thoughtful. We can credit this, I'd guess, to very careful direction as well as to the integrity of the acting personnel. Shakespeare: Romeo and Juliet. Claire Bloom, Dame Edith Evans, Albert Finney, and others.

Shakespeare Recording Soc. SRS 228 stereo

It was happiness that I picked up London's "Hamlet" and "Romeo" before starting on this series; I've had both waiting for a good while. At the moment I have not completed "Romeo" but hasten to report on some interesting differences between it and London's version that have already become apparent as listing.

This is a shouter, more outwardly dramatic, more self-conscious "Romeo and Juliet" and much of the difference, I'm going to guess, stems from the anonymous teamwork in the London version versus the solo, famous-name casting for this version. To be sure, this last is the normal procedure. If we are to have Dame Edith Evans, let's not force her into anonymity—for she makes a marvelous nurse to Juliet! Here, we have some big names and many more names that are worthy to be mentioned in the billing, gathered into an assembly of individual actors each playing on his own reputation, present, past, or future. Like competition in the business world, this sort of thing makes Shakespeare go round with gusto and energy.

But what a noisy record! The party scenes really sound like parties here. Loud, boisterous talking, laughter, comings and goings, for all the world like that cocktail party next door the other day. When there's a brawl, it's a very real one and no token clashing of stage swords.

As for Juliet, Claire Bloom on the boards, is hailed as a forty-year-old and by golly, she's going to act her age. She does, and I find it uncomfortable. Romeo is a dash­

ing hero, too, matching Juliet. Somehow, to my ear, this doesn't jell. Did fourteen-year-old girls act then as they do now? Did Shakespeare really mean to be literal-minded? Or was he merely exaggerating for romantic effect?

I might be wrong and certainly would not go so far as to say this version of the great play errs seriously. But it does give us a more outward, less classic, more literal and modernized reading of the story than we find in the classically restrained performance by London's self-efficaciously anonymous team. Interesting.

EXPLORATIONS

Studies in Improvisation. Lukas Foss, Improvisation Chamber Ensemble.

RCA Victor LSC 2558 stereo

I doubt if this music will thrill the marrow of your bones on first hearing, but it could...
This tiny handied is E-V's answer to studio requests for a truly miniaturized dynamic microphone. The Model 649B is just 2 1/2" long, weighs but 31 grams, yet has the remarkably high output of -61 db. Although just half the weight and bulk of competitive lavaliers, the 649B response is smooth, peak-free and full-bodied so that you can mix its output with that of any standard microphone.

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LAVALIER!

ELECTRO-VOICE, INC., Commercial Products Division, Dept. 121A, Buchanan, Michigan

well stimulate other areas of worthwhile importance; it surely is significant and interesting for its very intensity.

Don't think that improvisation is an idea that is going to stick primarily within the jazz and folk music fields. Jazz and folk, after all, are already thoroughly mixed up with "classical" and the mixing is two-way, three-way. Not surprising that somebody, say Lucas Foss, would try improvising purely "classical" music, which is to say, music that doesn't sound either jazz or folk-y, but distinctly chamber-music-y.

And since chamber music (and plenty of other music) normally requires writing out in advance, being complex and architectural in nature are in order, between what is made up in advance, being complex and architectural, and what isn't. Otherwise—musical chaos, like five men Singing in five harmonies, instead of five men on a concert platform, coordinating their music.

It's the coordinating that takes up everyone's time and energy here. As with John Cage and Co. (see Audio, etc., for October), Mr. Foss has branched away from old-fashioned musical notation into codes and graphs, suited to the degree of randomness that he may have in mind. Certain limits, certain free choices, and these players get their cues partly from fancy diagrams (with notes, too), partly from the leader's nodded head, partly via plain individualism. As with all these new-fangled places, the two versions of the music are supposed to be exactly alike. When you have the stuff nearly memorized, you drop it quick-like and start on in a new graph.

Foss has a big glossary of terms, indicated by symbols, to help you listen. In his tricky diagrams, a square mark means "take the foreground," a triangle indicates "foreground but responding," a sort of oval, a miniature race track sign, indicates "take yourself into the background—or else." A diamond shape means "support" and you'd better support hard, if you want to be cooperative in this music-making.

It might as well suggest the inevitable, that it all seems a bit dry and calculated, as of first hearing-and-seeing. The diagrams are out of this world, and pretty, but they left me somewhat hazed. I want to listen, not to follow complicated graphs and charts. The music ... well, let's not be too quickly committed for or against. The idea of this group are obviously constructive and useful and, we can easily guess, will eventually coalesce along with other such movements into a profitable break-away from our too-great classical reliance on printed notes. Good idea.


Well, here we go again. Now, with electronics, "we have inherited a brave new world of Limitless possibilities and unprecedented artistic freedom" which, the composer's notes here suggest, have released us from the restraints of conventional instruments and performers. Maybe, maybe not.

This music, "composed" on the German equivalent of the RCA Mark II Music Synthesizer, was the basis of the much-discussed ballet "Electronics," about which I wrote at length in an earlier issue, as did Harold Lawrence in the same issue. At the performance, I found the sound exciting, the versatility of the composing machine quite fabulous, the effects remarkably alive and real—but the music itself seemed to me conventional and without very much new to say; it sounded like electronic Respighi, as of maybe 1910.

It still sounds that way, only more so. Not really at all "limitless" in its purely musical imagination, this music, merely goes to show that unlimited freedom to sound itself is no guarantee whatever of unlimited inspiration in musical terms. Still, for those who think electronic sound "all sounds the same," the noises in this work should be no less than startling. An extraordinary machine, the Studio Traumton; now let's have somebody develop a real language of originality and force, via its facilities. Give us fifty years and we'll get it, all right.

Game Calling in Hi-Fi. Art Mercier, Russ Goede.

Mercury GC 100 mono

I sent away specially for this one—I just had to hear it. How specialised can you get on LP? And yet, come to think of it, this isn't so specialised, what with millions of American hunters barging around through swamps and fields and meadows and woods and rivers and plains, and sounds for birds and squirrels and foxes and owls and bugs and wild animals. But it's not too much for the birds and the beasts, hunting lustily for the birds and the beasts, hoping they'd get away, hiding the chicanery, the deadly lure of those raucous game calls. Quite an experience. I tell you, it's a thrill.

Worst, for me, was the fox call. You don't
call the fox by sounding like a fox; you imitate a small terribly wounded animal, to bring him on with blood in his eye. Then—WHAAM! That small wounded animal is perfectly awful to hear, especially if you've heard the real ones, the little rabbits and squirrels and mice. That's one way to work up a good hate for the bloodthirsty fox, I suppose. He deserves to be shot, for responding to your faked squeals of agony.

Quite a record, this; but not for animal fanciers.


This is a semi-promotional documentary, which you'll likely find available at such agencies as Air France, though there are no commercials as such in its material. The assorted sounds, first of Paris (side 1) and then of a few spots elsewhere in the country (side 2) are accompanied by English narration with a very French accent, just as any good tourist should expect. Atmosphere.

I like Paris myself, but I fear I'm not an Air France tourist. Of course I'll admit that it is hard to find enough intelligible noise in a big city to make it "live" in pure sound, and the musical night life of said city is an obviously easy way to fill things out with on-the-spot entertainment. After all, the Metro's grunting sounds very much like the New York subway's, only slower, and the traffic is just as unpleasant to hear—the French auto horns are much more unpleasant than ours, and who wants to hear them? You've got one on your own Dauphine, anyhow. So nighttime it is, for once, takes all the time it needs, shows up its lovely harmonic contrasts to full advantage—a bit too full, for that matter.

Nice playing, but there's a certain tentativeness, a slightly wooden sound in many string passages that ought to be more alive, for instance, which probably indicates that this radically different new conductor hadn't quite yet (1960-61) got the feel of his new orchestral control. The men must have had some re-learning to do, after the driving Dorati.


Capitol Duophonic DP 8276

"N BW! One-in-a-lifetime performance now available in Capitol Duophonic!" says the cover sticker.

Well, you'll pardon me if I doubt that any performance of these standard chestnuts by the Hollywood Bowl with Mr. Dragon is a "once-in-a-lifetime" affair. After all, "Plinian-ha! on this recording we have many (Continued on page 62)"

The new Electro-Voice Model 654A can replace broadcast up to three of your present microphones... and do a better job to boot! It's the ideal size for hand-held use—and the Cannon XLR connector ends your cable problems. It's also an easy-wearing lavalier, with wide range and plenty of output. And on a floor or desk stand the 654A is the finest all-purpose microphone you can buy for voice or music. The lanyard and slide-clamp mounting supplied are easy to use and versatile, too.

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In the studio, or out on remotes, with the E-V 654A handy you'll do more jobs—better—more dependably than ever before. Write for complete technical specifications plus name of your nearest franchised E-V distributor, today.
Our hero in two words somehow outlines a figure awesome enough to cause Willie Sutton to surrender the name of the villainous bank robber. The character Fields brings to mind is so admirable and unsavory that the appearance of being shown is "The Bank Dick," television work also named jazz terms as Horace Silver does in a new thing," while Nat Hentoff puts forth a tentative "new wave," in his liner notes, to describe the fraternity of younger jazzmen to which the late Booker Little belonged. A trick album, he says, "is a little twist" that do demands of duty, first resolving the differences and then further confusing the frantic followers of Coltrane. Chubbi Plush tallied up quite a history before the public discovered it was "a new conception in this album deal with things that have concerned the yoth of more than one generation."

Progress to the 23-year-old Little was not free of the latest jazz fad, and each work summarizes the whole of his experience as well as attempting to surmount the next step. The subject matter is varied enough to create a total effect similar to the autobiographical novel all young writers are supposed to have in their system. Little's trumpet speaks of the need in jazz for Strength And Sanity, explores the literary life of Man Of Words, and suggests a palter at work on Easy Eaves. Unique rhythmic approaches are tested on Greensboro, Mockingbird On Free Time. Finally, Little advances his own term for the refreshing forces in jazz on A New Day.

Max Roach, who employed Little during the last two years, assists on the date and reveals his most modern touch on adapting syncopated tymbansi to jazz. Roach has mastered tonal colors never displayed before, and the percussive passages are captured by Bob D'Orleans to present a true stereo picture of a remarkable drummer at work. Julian Priester, another Roach colleague, is on trombone, and Eric Dolphy plays alto, bass clarinet and flute. Ron Carter and Art Davis alternate on bass, and pianist Don Friedman completes the sextet. In all a fitting testament from Little, who before his death expressed his feeling about the way jazz should go by stating, "There should be much less stress on technical exhibitionism and much more on emotional content, on what might be termed humanity in music and the freedom to say all that you want to."

Peggy Lee: If You Go
Capitol Stereo ST6130
Ruth Price with Shelly Manne: At The Manne-Home
Contemporary Stereo ST5790

Singers are known by the company they keep, and these two young ladies are heard with the top of jazz, and in the paltry world of cabaret and nightclub. But the proof of the pudding is in the singing. When news circulated that Jones was planning to open at Manhattan's Basin Street East, the rumor was round the city that the show would be a big hit. And it was. The singer was supported by a fine band, and the audience was spontaneous. The critics liked Richard Adler's score and expressed regret at the failure of the book to hold their interest. "It is evident," said the New York Times, "that the composer had dreamed of the original cast album, even though it was

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Miss Lee's emotional flame never glowed
more seductively than during
Say It Isn't So,
I Love You Gypsy Heart, and As Time Goes
By. Actually all any arranger needs to do is
keep out of this artist's way, and Jones an-
ticipates every turn of phrase or change of mood. Sensuous Latin rhythms add a touch
of variety on the title tune, I Get Along
Without You Very Well, and Maybe It's Be-
cause I Love You Too Much. Still, it would
be nice to hear Miss Lee sing with the Quincy
Jones band, and a little lend-lease maneuver-
ing may bring it about yet.

Ruth Price made her recording debut about
five years ago with two albums for Kapp,
and the fact that they are still in print is
some token of durability. She was working
with Charlie Ventura at the time, but West
Coast pastures looked deceptively greener for
the pursuit of a career as singer and dancer.
Closer inspection proved jobs to be scarce
and the inside of a recording studio much
harder to reach. Not until Shelly Manne
took her under his wing did another recording
data come along, and the singer is still
on the outside of studio walls. Instead, the
informal proceedings take place in the friend-
lier setting of the drummer's own Manne-
Hole, and Richie Kamucen, tenor sax, and
Connie Candoli, trumpet, drop casually by to
augment the house trio. Miss Price is at
home with ballads and swingers, but also
visits such out-of-the-way tunes as
They Say It's Spring, and Listen Little Girl. Assist-
ing the proprietor in the trio are the able
pianist Russ Freeman and bassist Chuck
Berghofer. Howard Holstinger's engineering
conveys the informal atmosphere of the Holly-
wood club, and Miss Price's career is now
in the best of hands.

Sauter-Finegan: Inside Sauter-Finegan Re-
visited

RCA Victor Stereo LSP2473

Following on the heels of Capitol's Dio-
phonic method of revitalizing worthy mono-
phonic items for stereo, RCA Victor is
beginning to apply its own system of elec-
tronic reprocessing to a select list of LPs.
Among the first to be refitted with two chan-
nels is this pioneering trip into the wor l d
of percussive sounds. Eddie Sauter and Bill
Finegan were before their time, and their
early experiments in fracturing originals and
pop tunes still serve as models for today's
creators of stereo spectacu l ars.

If the partnership was still in force, this pair would be
leading the pack again to the tune of
Doodletown Fifers. Some of their ideas of
nearly ten years ago sound fresher than what
is coming off the stereo production line at
present, and there should be a whole new
audience for the venturesome treatments of
Where Or When, Rain, and Moonlight On
The Ganges. Stereo adds perceptibly to the
depth of sound, and the wild bunch of drum-
mers put to good use the extra stomping
room on
Eddie And The Witch Doctors.
The engineers might follow suit and stomp on
undue echo a little harder during the vocals.

The Dukes Of Dixieland featuring Pete
Fountain

RCA Victor Stereo LSP2097

This particular Dukes of Dixieland set is
piling up mileage, and a third trip to the
pressing plant should keep it rolling right
along. This time the old carcass comes back
completely refitted for stereo via RCA
Victor's new system of electronic repro cess-
ing. The first monophonic release appeared
when the Dukes were virtually unknown out-
side their native New Orleans. After Audio
Fidelity spread the group's fame far and
wide, a release was placed on the market and
is still in the catalogue. The recording re-
unites clarinetist Pete Fountain with the
Jassiano brothers, Frank on trumpet and Fred
on trombone. All three started out as members
of the Junior Dixieland Band which won a
Horace Holden amateur contest in 1947, but
nearly a decade went by before this session
brought them together again on such dixie-
land favorites as
At The Jazz Band Ball, Tiger Rag, and The Roof Blues.
The stereo refurbishing is highly success-
ful, mainly because no attempt was made to
Joan Baez, Volume 2
Vanguard Stereo VSD2097

Enough critical praise descended upon Joan Baez's first collection of folk songs to turn the head of any girl of twenty. Wisdom beyond such tender years steadied her debut, and as yet she shows no inclination to rest on her laurels or branch out into the field of television commercials. Either prospect might seem appealing to a young performer hailed as near perfect, but the second volume indicates continued development on the part of Miss Baez, who apparently believes she can learn a lot more about the art of folk singing. One example of an expanding repertory involves a pleasant journey to the French court of a century and a half ago for Baez's first collection of folk songs to turn the singer's own guitar accompaniments are also increasingly varied in scope, and she beats the Nashville crowd of amplified wonders at their own game on Engine 11, and The Cherry Tree Carol. Her grasp of native country styles attains a new depth of perception, and she succeeds in piercing the thick layer of commercialism which encrusts so much of this music. A brief exploration of the bluegrass tradition enlists the Greenbrier Boys as guides on Rounds Of The Ohio, and Pat Of Mine. John Hartford, Ralph Kirlner and Bob Yellin combine to achieve a fine group sound, in stereo, while avoiding the slick, mechanical twang of the professionals. The singer's own guitar accompaniments are also increasingly varied in scope, and she beats the Nashville crowd of amplified wonders at their own game on Engine 11, and Old Blue. In fact, the sales of these two numbers might cause some excitement in the bastion of country music, if Vanguard decided upon the release of a single and reached the right audience. This is the sort of country singing and playing Nashville has forgotten about. Chet Atkins, audiophiles, and all "good doggies" will prick up their ears at the dynamics unleashed to call Old Blue.

The Journeymen: Introducing The Journeymen
Capitol Stereo ST1929

Funk Werber, the man who promoted the Kingston Trio before anyone thought three college boys singing folk material could sell records, has taken another trio under his managerial wing and predicts it will have a marvelous future. Distinctions between the two groups exist because the Kingstons hail from Stanford, while the new bunch got underway at New York's Folk City only a few months ago. Scott McKenzie, who started singing with pop groups, is lead tenor and soloist, as well as being the trio's pin-up personality. John Phillips, leader and banjo, collaborates with guitarist Dick Waterman on the special arrangements needed to catch the ears of the college crowd. Make A Pallet, originally a dainty hymn, now sounds like a cheerful plea from one fraternity brother to another for overnight

KLH has introduced a new speaker system — the Model Ten.

We believe the Model Ten will serve as a new standard of value among speaker systems — a standard beyond which advance for some time will be so difficult as to appear impossible. In the light of known technology, nothing further can be done to lower any costs without serious losses in performance. This performance cannot be improved without sharply increased costs.

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*Sent postpaid in the U.S., Canada, and Mexico. Please add $1.00 for foreign orders.
ness, and four-track stereo tape does it full justice. Ray Hall and Don Miller engineered the date under the supervision of Mrs. Elgert, whose feminine ear is golden enough to detect any deviation from her husband's idea of how the band should sound.

MONO

Joe Newman: Good 'N' Groovy
Prestige/Swingville 2019

If jazz writers often devote more attention to new discoveries than to established players like Joe Newman, it is because releases such as this should need no recommendation. After holding a trumpet chair in the Basie band since 1952, Newman is now leading his own quintet in clubs, with one eye open for the offer of a European tour. The group was still in the formative stage when this session was held, and the only regular member to appear is Billy English, who deserted the drum post in the house band at the Apollo Theatre to join up. Frank Foster, tenor sax, and bassist Eddie Jones were borrowed from Basie, and the always adaptable Tommy Flanagan fills in on piano. Newman takes full advantage of the chance he never had with Basie to spend some time with Neal Hefti's Lefty DeVine, the number which draws the most requests from club patrons. The other standard is Just Squeeze Me, and four choice originals complete the set. Foster also enjoys the outing, and no admirer of Basie splinter groups can afford to pass this one by.

EQUIPMENT PROFILE

(from page 44)

which holds them together. The result is that we can record stereo by the European method (mikes together—axes 90 deg. apart) or the separate mike method frequently used in this country. An intelligent arrangement which allows a great deal of flexibility on the part of the user.

The drive method for the Magnetophon 97 was obviously designed to minimize extraneous vibration. First of all the husky drive motor is shock-mounted to the main plate. Secondly the motor spindle drives the speed-change idler by means of a flat belt. The speed-change idler in turn drives a rubber-faced idler which then drives the capstan flywheel. The rubber-faced idler contacts the drive idler and flywheel only during record or playback. We noted that the capstan bearing is quite good; after the power was shut off the flywheel continued to rotate for almost a minute. The take-up reel is driven by a flat belt from the capstan, the belt being tensioned by a spring-loaded roller only when the tape is driven.

Tape handling is excellent because of an unusually good braking system and the use of tape guides and tape tensioning devices. Over-all, the mechanism is well designed and constructed. On the other hand we could not say that the amplifier circuitry was equal in calibre to the mechanism although it certainly is good as the amplifiers found in most home tape recorders.

Performance

Using a standard flutter tape, the Telefunken Magnetophon 97 exhibited 0.05 per cent wow, 0.12 per cent flutter, and 0.16 per cent over-all. The frequency response at 7½ ips is ±1.5 db from 30 cps to 15,000 cps. The signal-to-noise ratio at 7½ ips is 62 db. Clearly this machine performs extremely well in important areas. In addition it is well built and designed. It is certainly worth consideration by the audiophiles in need of a home tape machine.

Amelux is delighted to introduce the Luxor Magnefon stereo tape recorder from Sweden. The Luxor faithfully preserves the timbre of the original instrument—an oboe sounds like an oboe...a clarinet like a clarinet. A truly remarkable high fidelity home music system...you can see and hear this machine put through its paces at America's finest audio shops. You'll be amazed and thoroughly pleased with the performance and value of this new stereo tape recorder as an integrated unit relying on its own built-in amplifiers and speakers; or as a component through an external speaker or amplifier system. Every detail, every nuance of music and speech is faithfully preserved and rendered back at the touch of a switch. We believe that at $279. (slightly higher in the far west) this is really a significant discovery.

THE MAGNEFON BY
LUXOR
MOTALA, SWEDEN

Sole U.S. Distributors
Amelux Electronics Corporation
60 East 42 Street, New York 17, N.Y.

A-41

© 1961 AMELUX ELECTRONICS CORP.
NEW PRODUCTS

- Credenza Component Cabinets With 'Select-A-Style' Doors. Dedicated to the belief that a high fidelity system should look as beautiful as it sounds, and offer maximum convenience for its owner, University has introduced a complete collection of Credenza component cabinets suitable for any decor—easily integrated with other fine furniture of any period... featuring furniture-styled doors that can be removed and replaced with differently styled doors in seconds. This means—should one ever wish to redecorate... there is no need to buy a new component cabinet or to move it to another room—one simply replaces the inexpensive doors! Originally developed to complement the University Medallion XII Speaker System, the wide variety of Credenza styles enable them to match the following furniture styles and finishes: Italian Provincial, French Provincial, Swedish Modern, and Colonial—in Walnut, Oiled Walnut and Fruitwood. Over-all dimension: 36-in. wide x 29 1/4-in. high x 19-in. deep. Tuner and amplifier interior dimensions: 18 1/4-in. wide x 18 1/4-in. high x 18 1/4-in. deep. The Credenza Credenza Cabinet is priced at $179.95 with your choice of decor doors. Additional doors $42.00 University Loudspeakers, Inc., 80 So. Kensico Ave., White Plains, N. Y. A-33

- Stereo Cartridges. The Stereotwin STG-230 is a new stereo cartridge for the reproduction of both stereo and monophonic records. This cartridge, the latest of the Stereotwin line of moving magnet cartridges, features a channel separation of better than 25 db from 1000 to 10,000 cps, and excellent characteristics to 15,000 cps and beyond. The Mumetal shielding and high output (10 mv at 5 cm/sec) completely eliminate hum. The STG-220 is merchandised in a presentation case which includes the cartridge with diamond stylus and the turntable stylus. For the audioophile price of $34.50. The extra diamond stylus not only guarantees factory built replacement available to the user when his original needle is worn, but also provides continuous listening pleasure, should it be desirable to check the original needle. The Stereotwin line of cartridges are distributed by the Benjamin Electronic Sound Corporation, 27-03 43rd Avenue, Corona 68, N. Y., exclusive importers of ZLAC products.

- FM Tuner-Amplifier Kit. The PACO Model ST-26 tuner-amplifier kit features a self-contained and prealigned front end which simplifies construction and ensures good performance. The circuit features a wide-band ratio detector and automatic gain control as well as switchable automatic frequency control. IFM sensitivity is stated to be 4 mv. A "magic eye" type of tuning indicator is provided, and the tuning is aided by byphonic action. The audio amplifier section of the ST-26 contains a switched phono input (for ceramic cartridge) which permits the unit to be the center of an inexpensive music system. The ST-26 is available with either a metal or wooden enclosure. PACO Electronics Co., Glendale 27, N. Y.

- 4-Track Tape Recorder Series. The new Ampex 1200 Series 4-track stereo and mono tape recorder/player features three newly designed heads. A new tape tracking and guidance system has also been incorporated in the 1200 Series. The combination of narrow-channel heads, fitted shielding between channels, and other new techniques have been incorporated to help eliminate reverse-channel cross-talk and improve the signal-to-noise ratio. The 1200 Series records 4-track stereo and mono, and plays back 2- and 4-track stereo and 4-track mono. Speeds are 3 1/2, 7 1/2, and 15 ips. A master selector switch permits central control of stereo or mono modes, selection of an individual track, sound-on-sound recording, and automatic shut-off of both the machine and the electronics, or either individually. The new face plate permits separate erasure of each of the 4 tracks. The 1200 Series consists of the

Model 1250 which is an unmounted deck; the Model 1260 (shown) which is portable; and the Model 1270 which is a variable model with built-in pairs of amplifier-speakers. Prices range from $499.50 to $545.00. Ampex Audio Co., Sunnyvale, Calif. A-36

- Pickup System. A new pickup system that is said to track at 3/4 gram has been introduced by Audio Dynamics Corp. Named the Pritchard, the new system combines the ADC-1 stereo cartridge with a balanced tone arm thus eliminating the problem of matching a highly compliant cartridge with the correct tone arm. Features of the system include a side-thrust compensator (anti-skate) of a cer-terror weight that occupies very little space behind the pivot, and a plug-in head which accommodates other cartridges. The tone arm is fabricated from walnut wood and is available separately. It already own the ADC-1 or other highly compliant cartridge. Price of the Pritchard Pickup System, Model ADC-85, is comprised of the price of the tone arm, Model ADC-40, is $34.50. Audio Dynamics Corp., Ridgewood 27, N. Y.

- Audio Equalizer. A unique professional audio equalizer, designed for use in the recording, broadcast, acoustical measurement, and electronic music fields, has been made available by Gotham Audio Corp. The Gotham EQ-1000 Universal equalizer combines almost every conceivable function of frequency discrimination without the use of a single inductively tuned circuit. Instead it utilizes a building-block assembly of RC circuits which provide band-pass and band-reject functions with slopes as high as 24 db per octave while confining distortion levels to below 0.7 per cent total runs at an output level of +12 dbm, 50 pushbuttons and 11 selector switches make it possible to recreate any setting. Complete engineering specifications are available. Gotham Audio Corp., New York 36, N. Y.

- Bookshelf Speaker System. Featuring low price and modest size, the new Wilder Engineering Products "Playmate" speaker system costs $39.75 and measures 10 x 18 x 8. The enclosure is finished on four sides in walnut-finish veneer. It is equipped with a 6-in. woofer, a 6-in. mid-range, and a 4-in. tweeter. A suitable crossover is included. Impedance is 8-16 ohms. Frequency response is 40 cps to 18,000 cps. Wilder Engineering Products, Chicago 14, Ill.

A-35
Leading FM Station reports on Scott Multiplex Tuner and Adaptor

Richard L. Kaye, Station Manager of WCRB, using Scott Multiplex Tuner for station monitoring.

"...Outstanding stereo reception...Scott surpassed our greatest expectations..."

FM Station WCRB, Boston's leading good music station, has been broadcasting in multiplex for several months. During this period they have had the opportunity to evaluate many multiplex tuners and adaptors. Here's what they say:

"This letter is to let you know how pleased all of us at WCRB are with the H. H. Scott Multiplex Adaptor Model 335 and the H. H. Scott Multiplex Tuner Model 350. The Scott multiplex tuner and adaptor have surpassed our greatest expectations. They give outstanding stereo reception. The stereo separation, frequency response and low distortion have proven outstanding."

Richard L. Kaye
Station Manager

Many leading FM stations have chosen Scott for use in their monitoring and testing facilities. If you, too, want the finest multiplex equipment... choose H. H. Scott.

350 FM Stereo (Multiplex) Tuner Scott's widely acclaimed 350 FM Stereo Tuner has the multiplex circuitry built right in. You can use it to receive either FM stereo or regular monophonic FM broadcasts. Scott's Wide-Band design and unique silver-plated front end assure fine reception without distortion, drift, noise or loss of stereo separation. IFM sensitivity is 5.5 µv and stereo separation can match exacting FCC transmission specifications. Exclusive filtering circuits on the 350 and all Scott multiplex units permit flawless results when used with any tape recorder. $199.95

335 FM Stereo (Multiplex) Adaptor You can instantly convert any Scott tuner, regardless of age or model, to multiplex with the 335 FM Stereo Adaptor. The combination of the 335 and your Scott tuner offers the same flexibility and tape recording features as the 350 FM Stereo Tuner. Optimum performance can be guaranteed only when a Scott tuner and the 335 are used together. $89.95

H. H. SCOTT

H. H. SCOTT INC., DEPT. 035-01

Mail me your new Guide to Custom Stereo and complete information on Scott FM stereo tuners and adaptors.

Name: ____________________________
Address: __________________________
City: ____________________________ State: __________________________

Export: Morhan Exporting Corp., 456 Broadway, N.Y.C.
Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto
Prices slightly higher West of Rockies

Here's What Happy Owners Say:

"Multiplex comes in beautifully with 350 Tuner. I've heard stereo before, but never like this.
Kuchnari Ventures, Castro Valley, California"

"I am 55 miles from transmitter and get perfect reception with just my TV antenna. I had (competing brand) multiplex but it didn't work."
John Fierce, Concord, California

"...Here in Newburgh I am 100 miles from WQFM. I receive them every evening from 8 to 9 PM. . . . My hi-ft equipment is all H. H. Scott. My 910C tuner is 21 months old and has had no maintenance - not even tube replacement. My 272 Amplifier and 335 Multiplex Adaptor have been trouble-free. Your quality control must be nearly perfect. In my opinion you offer the finest Hi-Fi components than can be purchased."
Walter L. Bachman, Newburgh, New York

"Finest separation I ever heard."
Daniel M. Wolfe, Jr., San Francisco, California

"All other equipment is H. H. Scott. Reception 40 miles from station is very good."
W. A. Moss, Mountain View, California

"KPQZ stereo terrific on Command Records - perfect channel separation."
L. V. Steel, Belmont, California

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MICROPHONE BOOM CABLE

Flexibility is one of the first requirements of a microphone cable—particularly when it is used on a mike boom. Lenz Microphone Boom Cable offers you the maximum in flexibility—it's as limp as a piece of twine!

Along with its extreme flexibility, it is quiet! Twist it into a knot, there's not the slightest noise to mar the sound track.

Because it is designed for the job, this is the perfect mike cable.

Made in 3 to 7 conductor types to suit any mike.

Lenz also manufactures "Multiplex" Double Channel Audio Cable for stereo broadcast receivers, Hyanode High Voltage Lead Wire, Cables for Public Address Systems and other similar cables for special applications.

Write today for complete details and sample of Lenz Microphone Boom Cable.

THESE MONTH'S COVER

Proving that home music systems can have more uses than one, this lovely decorator-styled cabinet houses most of the necessities for a pleasant, relaxing, and convivial evening. Beginning with the built-in bar, the owner has made extremely clever use of the space below it which could conceivably house more bottle storage space, a refrigerator, or possibly a sink. He chose, however, to build his hi-fi installation into this area.

The equipment consists of a Fisher Model 100-R stereo AM-FM tuner, a Fisher X-302 stereo control amplifier, and two Fisher Model XP-2 speaker systems, all of which are visible, and a Garrard Type A Automatic Turntable equipped with an Empire Model 108 stereo cartridge, which are not.

With all of this equipment, space is still available for the storage of some 150 records.

TEST EQUIPMENT ROUNDPUP

(from page 90)

The voltage ratio between them being 4:1. The output voltage is 10 volts maximum into a high impedance, or +5 dbm into a 600-ohm load. The residual intermodulation is 0.2 per cent maximum. The voltage scale on the analyzer provides four full-scale ranges up to 20 volts rms. The intermodulation scale provides 2, 10, and 20 per cent full-scale ranges. Accuracy of the analyzer section is ±0.1 per cent of full scale. Price of the Model 31 is $250.00.

Measurements Corp., Boonton, New Jersey.

VARO

Flutter Meter. The Varo Model FL-3D Flutter and Wow Meter is designed for use in the maintenance, repair, and calibration of record and tape-playing systems. It conforms to the standards for measuring flutter and wow, as determined by the Standards Committee of the I.R.E. An internal oscillator provides a 3000 cps signal for measurement of tape recorders. The scale ranges are 2 per cent and 0.5 per cent full scale. Rms calibration is provided on sine-wave flutter. Accuracy is 10 per cent within bandwidth restrictions. The bandwidth of the discriminator is sufficient to allow side bands up to 250 cps to be demodulated with no more than 3 db attenuation with reference to 75 cps. Front panel terminals are provided for observing flutter and wow components on an oscilloscope. A rear apron terminal provides d.c. to 150 cps output for graphic recording. VARO, Inc., Santa Barbara, California.

Varo Model FL-3D Flutter and Wow Meter.

A-31

www.americanradiohistory.com
NORMAN H. CROWHURST

Starting in this issue, AUDIO is providing a new service which many readers have demanded: we provide—a department devoted exclusively to technical puzzles where the reader himself can participate. To satisfy this demand we have asked Norman Crowhurst to start the ball rolling by selecting questions from amongst the many which audio fans have addressed to him.

After a sufficient number of questions have been submitted by readers, Mr. Crowhurst will select those which seem to him to be most appropriate. To use his own words here: "So everyone can 'have fun,' we'll mix them up a bit, using some that advanced readers will find obvious, and some that have puzzled the best of us." So that readers may participate, we will pose the questions one month and give the answers the following month. Naturally we want all readers to take a crack at answering. To spice things up a bit, AUDIO will pay $5.00 for each question and answer we use. Of course, since many readers may arrive at the "correct" answer, the one we use will be the most complete and intelligent in our opinion.

Now what types of questions should they be? Simply stated, these questions should be of the type which puzzle and engage our intellectual curiosity—and not the type which ask about how to trouble-shoot or select a piece of high fidelity equipment.

Send your questions and answers to AUDIO Teasers, P.O. Box 629, Mineola, L. I., N. Y.

This Month's Questions:

**Question 1**—A volume control is required on a musical instrument that uses a ceramite pickup. If a load of 250,000 ohms is used, there is serious loss of bass. To avoid this, a value of 5 megohms is tried, which gives satisfactory bass response, but there is a hum type of hum except when the control is either full on, or off. How can such a control be installed to avoid either of these troubles?

**Question 2**—A push-pull output stage in which the screens are connected to tappings on the transformer primary is alternatively called "ultralinear" or "distributed load" connection. (a) Why is a 50 per cent tap point sometimes referred to as 16 per cent loading? (for example) (b) What proportion of the total output power would come from the screens when the fluctuation in screen current over the audio cycle is one tenth that of the plate current in this connection?

**Question 3**—An amplifier is originally built with a triode input stage, and feedback connected from the output to the cathode resistor. Because more feedback is desired, without sacrifice of over-all gain, a pentode is substituted for the first stage. Although the amplifier is still quite stable, it is now found that the distortion, with about twice the feedback, is greater than with the triode input stage. Why? How could this be remedied without sacrificing over-all gain or amount of feedback?

---

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Available in 19", 23", and 27" Sizes

Also available in KIT form which anyone can assemble.

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**2 IMPORTANT TYPES**

**FOR HI-FI SYSTEM:** Less Audio System, incorporates a Cathode Follower Circuit for operation into a Hi-Fi Audio System.

**WITH ITS OWN HI-FI AUDIO:** Includes its own Hi-Fi 10 Watt Push-Pull Audio Amplifier and Dual Hi-Fi Speaker system with 6" x 9" speaker, 6.8 oz. magnet, 3" tweeter, condenser crossover, extended range tone control.

**OPTIONAL ACCESSORIES:** Front panels for horizontal or vertical mounting of chassis ($15). For ease of servicing, front panel, tube, and chassis can be unitized with a "Rigidizing" assembly for sliding out from front. Slides included with "Rigidizing" assembly ($10).

**TECHNICAL FEATURES:**

- Ultra-linear sweep circuits
- Increased sensitivity
- A megacycle picture bandwidth
- Heavy-duty dual 5U4G transformer type power supply
- Special construction, hand-wired for trouble-free long life
- True FM sound circuits

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**PRICES:**

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<th>Item Size</th>
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<th>CHASSIS</th>
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<tr>
<td>16&quot; No audio</td>
<td>for use with Hi-Fi System</td>
<td>$143.00</td>
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<td>16&quot; With Hi-Fi Audio incorporated</td>
<td>292.00</td>
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<td>23&quot; No audio</td>
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Picture tubes are now bonded tubes. The protective glass is fused to the tube face improving picture contrast, reducing reflections, and eliminating dust between glass and tube. All Chassis are completely factory-tested, carefully tested and rigidly inspected. This is the Chassis selected by thousands of school systems and U.S. governmental agencies when premium type performance is required.

**Dealer Inquiries Invited.**

**OPTIONAL ACCESSORIES:**

- Cashide electrodes, RCA, Sylvania tubes, Allen Bradley relays, Cornell-Dubilier condensers. ALL PARTS Guaranteed for TWO YEARS.

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**OPTIONS**

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**ABOUT MUSIC**

**HAROLD LAWRENCE**

A New Look at Gypsy Music and Musicians

At a Hungarian Restaurant in Vienna, a Gypsy violinist wearing a brocaded vest and a florid mustache leans over your plate of stuffed cabbage and gazes mournfully into your eyes, while his quivering fingers produce wide vibratos and his bow digs into the fingerboard, grinding out a cloud of white rosin dust. In the background, the rest of the ensemble (cimbalom, clarinet, and double bass) support the soloist with an alternately languorous and frisky accompaniment. In the eyes of the gajo (or non-Gypsy), this is the real picture of the Gypsy and his music. But the melodies he hears are no more “pure” Gypsy than the jazz improvisations of the great Gypsy guitarist, Django Reinhardt.

Ever since they came to Europe from Asia in the fifteenth century, Gypsies depended for their livelihood on being tolerated by the Europeans. They therefore studied the gajo carefully, noted his social characteristics, and learned his music. In the process of absorbing the local folk song into their repertoire, Gypsy musicians imbued them with strangely attractive qualities: the melodic base remained European, but the rich embroidery had a distinctively Eastern flavor; the emotional content was broadened often to the point of exaggeration; and the pepperoy element of virtuosity transformed the essentially simple tunes they worked with. So successful were they at dressing up gajo melodies that the Gypsies became what might be called musical scribes for the people. During the heyday of the Gypsy musician (17th-18th centuries) such violinists as Janos Bihari were raised to the level of court musicians, and Gypsy bands performed at royal functions, banquets, and even in military parades. Franz Liszt was so taken with Gypsy musicians that he credited them with having invented Hungarian music.

In the *Gypsy in Music*, Liszt depicted the Hungarian peasant as a musical illiterate “who seized upon the melodies which he heard the Gypsies perform, as a sort of windfall.” In his own backward

---

**RECORDS SOUND BEST with DYNACO STEREODYNES**

Choose either the Stereodyne II (mounts in all standard arms) or the slim, trim TA-12 arm-cartridge combination for the most natural sound from both stereo and mono recordings.

**TA-12**

$49.95 net

$29.95 net

DESIGNED TO THE HIGHEST DYNACO STANDARDS

* unequalled performance
* outstanding engineering
* unsurpassed value

Rigorous laboratory testing of every unit assures that your cartridge will exceed every specification.

- Smoothest response: 22 db from 30 cps to 32 KHz. With standard Westrex 1A test disc.
- True stereo: More than 22 db channel separation effectively maintained throughout the audio spectrum, with accurate balance and proper phase relationship.
- Superior tracking; highest compliance, low mass, plus exclusive symmetrical push-pull design for minimum record wear and lowest distortion.
- Complete freedom from hum.

Hear and compare it at your favorite dealer's showroom.

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fashion, he stripped them of their "elaboration" and reduced them to crude little ditties. Gypsy instrumental music, on the other hand, Liszt praised "on the score of a bold originality full of the most noble sentiment . . . [and] of exquisite completion of a form as beautifully inspired as it is happily carried out."

Liszt's theory was demolished some 70 years later by Bartók, who toured the Hungarian countryside in 1905, collecting and classifying folk songs. It was not the Hungarians who incorporated Gypsy melodies into their national music; the Gypsies were the appropriators. Worse than this, Bartók lamented, the Gypsies were responsible for corrupting the authentic Hungarian folk songs: "They worked their own subtle transformations on everything they played." To complete their musical conquest, the Gypsies put native village musicians out of work, and virtually took over the popular music field.

In 1933, Bartók finally reached the opposite pole from Liszt when he suggested that there is no authentic Gypsy music after all.

The truth about Gypsy music, however, lies neither with Liszt nor with Bartók. For what both composers heard was Gypsy music meant for gajo ears. Even if Bartók, who ferreted out hundreds of remote Balkan folk tunes, had suspected the Gypsies of withholding their own songs from him, it would have required much more than patience and pleading to uncover them.

For authentic Gypsy music is generally performed only by Gypsies and for Gypsies. What are the traits of this exclusive music? Is it a special musical language or simply a variation of sounds familiar to the gajo? According to Jan Yoors, a Belgian-American tapestry artist, true Gypsy music departs completely from stereotyped conceptions. Mr. Yoors is uniquely qualified to speak with authority on the subject. Paradoxically, he is both a gajo and a Gypsy. At the age of twelve, he ran away from home to live with a band of nomadic Gypsies who were passing by his native Antwerp. For the next half dozen years, he spent about six to eight months out of each year with the Gypsies, who adopted him as a full-fledged member of their tribe (the Lowara) when he was thirteen. He traveled with them throughout Europe and learned many things, including how to speak Romany, a complicated language of Sanskrit derivation containing 53 characters and an eight-case declension. In constant touch with his Gypsy "relations" Yoors recently returned from a three-month trip to Europe and the Middle East, visiting Gypsy camps and communities.

Yoors points out that there are five main tribes of nomadic Gypsies: the Lowara, the Churnara, The Kalderach, the Mzchiria, and the Sinti.

The Sinti conform closest to the popular image of the musical Gypsy. They are, for the most part, professional musicians (Django Reinhardt was a Sinti). Because they play for outsiders, they are looked down upon by the other tribes and have earned the name, "outcasts." The other nomads believe that the Sinti have been corrupted by their contact with the gajos. The degeneration of their own musical life seems to bear out this charge; the Sinti have no private music—their songs and pieces today have a faded picture-postcard quality.

Unlike the Sinti, the other tribes do not manufacture counterfeit Gypsy music, not even for the gajos. Surprising to report, they play no musical instruments at all.

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Their music is strictly vocal, with hand-clapping being the only 'instrumental' accompaniment. And here's a twist—the Gypsies hire gajos hands to play for them at weddings. Gypsy songs are usually sung on special occasions such as feasts, weddings, or other social celebrations. Gypsies rarely perform their own songs for gajos. Yoors once visited a Gypsy camp accompanied by a gajo and asked one of the tribe to sing for him and his friend. Because of the gajo's presence, the chief whispered to the others, "No Romany songs." On another occasion, Yoors assembled a score of nomadic Gypsies in a recording studio to tape an LP of Gypsy songs. The Gypsy sang loud and loudly to the delight of the recording producer and to the chagrin of Mr. Yoors; not one of the tunes was authentic Gypsy—they were instead Hungarian, Romanian, Ser-bian, Bosnian, and Bulgarian. As soon as the gajo record producer left the studio, however, they burst forth into Romany song.

To hoodwink a recording executive is one thing, but to mislead a trained musicologist is something else again. Nevertheless, this is precisely what has been taking place at the University of Budapest for the past several years. Teams of Hungarian folk-song investigators have been roaming the countryside recording what they believe to be authentic Gypsy melodies performed by authentic Gypsies. A sampling of the hundreds of tunes taped indicates that the University has succeeded in accumulating a formidable collection of non-Gypsy songs performed by Gypsies—which somehow takes us back to Liszt. Obviously, this is no job for a gajo song-collector. Jan Yoors, who is writing a book on the Gypsies, knows hundreds of Gypsy songs, and plans to record many of them in the field later this year. Now at last the elusive music of the nomadic Gypsies will be brought to light.

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is neglecting the effect of any output stage grid resistors, which admittedly would modify the result, and must be reckoned into complete design calculations. With normal load, the input to the drive stage, to get full output voltage (150 volts swing at cathode and plate), is 175/3 = 9.73 volts swing. With the output stage open circuit, the input to the drive stage needs to be 155/10.5 = 7.05 volts swing. So the overall damping factor is now about 4.5. This illustrates the principle that feedback can do different things in different phases, and that different factors are involved, according to what you are calculating, and how the overall effect combine. But so far we've assumed the simple case where, although (14 + A/2) may have different values according to purpose involved, A/2 is always either positive or negative; no phase angles.

Reactance Loading

Now let's take the case of a typical feedback amplifier. We'll assume it has a midband feedback of 14 db, with normal resistance load, and uses pentode...
output stage with plate resistance (without feedback) 7 times load value.

The output shunt resistance, without feedback, is 7/6 times the load value (Fig. 5). Feedback will reduce this by 5% (equivalent of 14 dB) to 7/40 times load value. As part of this is still the actual load, the effective source resistance is 7/33 times load value, or the damping factor is $33 \times 7 = 4.71$. The feedback component, $AB$, is 4/6 of the external input. Assume distortion is 5 per cent without feedback. So with feedback it will come down to 1 per cent.

For now we'll assume that stability criteria have been taken care of, and the amplifier performs satisfactorily (at least remaining stable) when a loudspeaker is connected. We'll stay strictly in the range where amplifier phase shifts and gain changes are negligible. The phase shifts we'll talk about are not those that occur at frequency extremities. These have been discussed before. But at about 2000 cps (for one place) the loudspeaker's reactance will about equal loudspeaker load whose impedance is $\omega L$, which is likely to have risen from 38 deg. to about 67 deg. or 49 deg. by then. This means the in-phase cancellation will be $\cos 49$ deg. or 0.65 times what it was with resistance load. But there will be a sin 49 deg. component in quadrature, about 0.75 times the no-feedback value. So the 1 per cent will jump to almost 4 per cent.

That's the most optimistic case. If some of the distortion is due to clipping, that occurs during a relatively short part of the fundamental, the phase shift will mean the feedback "correction signal" will completely miss the original distortion kink, and will set up another one in opposition. This will go round the loop again, repeating the miss, until the irregularity dies out—or develops into a parasite, depending on the stability margin of the amplifier at the frequency represented by this repeated transition time.

If you don't believe this happens, set up an amplifier with a load impedance consisting of a variable phase load. As you vary the phase of the output load, the amplifier will probably go through a distortion minimum at the point where output and input voltage are precisely in phase. For other phase loadings on the output, the feedback holds the overall transfer characteristic to reduced phase deviation limits. But the loop gain phasing is upset, so it cannot be the

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some time hold down distortion according to formula.

We have simplified the discussion considerably. We assumed the distortion would not change according to output loading, which is seldom true, of course. Reactive loading itself often causes more severe distortion. This will further aggravate the over-all effect.

We have shown in this case that there's no guarantee that the same distortion-reducing factor works for all purposes.

What's the remedy? That's another story. In short it is to calculate quite specifically what the feedback effects are for each purpose in hand. In each calculation there will be a factor 1 + AB.

But it is unlikely to involve the same circuit elements or parameters for each purpose considered. So the relevant factors are not the same for each purpose, except in the very basic algebra.

AUDIOCLINIC

(from page 4)

of mass versus stylus radius. These effects are still apparent in stereo reproduction. I would say that most stereo cartridges will play back monophonic recordings better than the cheaper variety of monophonic cartridges. However, the sound from these monophonic cartridges was pleasing to many people, which fact accounts for their popularity. Therefore, if you are accustomed to a crisp sound, you may be disappointed in the sound of some stereophonic cartridges because their reduced mass makes the brightness seem less. When the mass of a cartridge is sufficiently great, the resonance resulting from the mass and compliance of the stylus assemby, together with the plastic resonance of the record, will fall well within the audio spectrum. The effect of this resonance is to create the crisp sound characteristic of the older, cheaper monophonic cartridge under discussion. This condition does not permit a smooth, flat, treble response. The lower the mass of the moving elements in the cartridge, the higher will be the resonant frequency of the moving system. A good cartridge will be designed so that this resonance falls well outside the audio spectrum.

What constitutes good sound is a matter of personal opinion. (Remember that hearing is a subjective experience.) Thus, a comparison of one cartridge to another is needed before you can reach a definite decision as to the unit you should obtain. For a method of comparing cartridges, read the answer to the previous question.

As to the matter of stylus radius, the mass and compliance of a given cartridge play a large part in the ability of a stylus with a given radius to perform properly. In other words, stylus radius cannot be divorced from the other parameters which shape cartridge performance. Therefore we must revert to the same theme—namely, consider and compare these units as a whole because they will function in this manner in your living room.

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FILTERLESS METHOD
(from page 53)

\((f(t)S(t))\) composite signals are \((L+R)\) and \((L-R)\) respectively, so that the \(L\) and \(R\) channels may be obtained from these by the matrixing process:

\[
L+R = 2L \\
L-R = 2R.
\]

An Example

The Eico MX-99 adaptor operates on the principles set forth in the preceding discussion. (See Fig. 8.) The two matrixing points \((V_{AB})\) and \((V_{AD})\) in one channel restores proper phase relations in the output signals, thus making the unit compatible with other stereo equipment (tape decks, etc.) with respect to speaker phasing.

Channel separation is controlled by varying the amount of \((L-R)\) signal which is injected into the matrix. This is effected by a gain control in the grid of \(V_{EB}\). The output signal level under the condition of optimum separation is thus determined by the direct \((L+R)\) component and is virtually independent of the phase of the injected carrier.

Note that the demodulator is of the balanced type so that the potentially troublesome \(38,000\)-cps carrier does not appear in the adaptor output. The presence of this signal might conceivably introduce harmonic distortion which could be prevented by using a uniform output which is the input signal multiplied by a 38,000-eps switching function of zero average value and odd symmetry. The audible portion of this signal is \((L-R)\), as explained in the spectrum analysis. \((L+R)\) and \((-R)\) are available at the plate and cathode of \(V_{EA}\), respectively, and these components are added to the output of \(V_{EB}\) in a resistive matrix. De-emphasis is accomplished at the matrixing points. Matrixing \((L+R)\) and \((-L-R)\) produces the outputs \(L\) and \(-R\). A phase inverter \((V_{AD})\) in one channel restores proper phase relations in the output signals, thus making the unit compatible with other stereo equipment (tape decks, etc.) with respect to speaker phasing.


does of playings available, and so too with

"The Flight of a Bumble Bee." Nothing very exclusive about this music-making. That's the standard Capitol plug for Duophonic, but it does leave the question open as to why these mono recordings should be done over into stereo. I don't think it's hard to answer. Duophonic really works, as already suggested in this column. It does, indeed, add the necessary spread to a mono recording so that it sounds wider, more natural. I don't suppose the Hollywood Bowl players are very happy—they would prefer the true stereo product, with its attendant union-scale money. But most of the background listeners would never notice the difference, since their ears are perfectly good hi-fi recordings, technically up to date except for stereo. So you see, Capitol is being very practical.

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The amount of deflection on the screen is determined by the sensitivity of the cathode ray tube. This is usually stated in inches or centimeters of deflection per volt. The sensitivity of the scope can be increased by providing voltage amplification. Amplifiers employed in a scope used in audio testing procedures must provide a linear response from d.c. to about 500,000 cps, respond faithfully to square waveforms, and present no phase shift over much of the range. The sensitivity should be great enough to show the hum components present in a piece of audio equipment—10 millivolts per inch should be satisfactory sensitivity after amplification.

The vertical amplifier is the more critical of the two although the horizontal amplifier must also be undistorted and of wide frequency range. The horizontal amplifier need not have flat response at the extremes.

To display a two-dimensional signal on the screen, a varying voltage must be applied to the horizontal as well as to the vertical plates. A sawtooth signal is applied to the horizontal amplifier so that the vertically applied signal may be swept across the screen. This sawtooth must be linear and variable to about 100,000 cps to be capable of displaying any signal significant in audio tests.

In general, a good scope has a thin bright trace, the sweep oscillator is easy to synchronize with the incoming signal, and will usually provide a signal of known amplitude to enable easy calibration of the screen in volts per inch of deflection.

Variations have appeared by the dozens. One of the most useful is the dual trace scope for displaying two signals at one time. This is particularly applicable in stereo tests.

This dual trace scope usually has a self-contained multivibrator in the form of an electronic switch. It alternately sweeps the two signals applied at the input and displays them in sequence on the screen. The persistence of the fluorescent material makes it appear as if both traces are being viewed simultaneously at different vertical positions on the face of the cathode ray tube.

A.C. Voltmeters

The a.c. voltmeter was mentioned throughout this discussion in different applications. It is the basic instrument in any test setup. All available a.c. voltmeters fall roughly into two groups.

The most common type consists of a wide band a.c. amplifier. The output from the amplifier is rectified and led to a d.c. meter movement. Although these meters are calibrated in sinusoidal rms voltage, they are actually sensitive to the average values.

A, second, and less expensive, type peak rectifies the signal. The resulting d.c. voltage is then fed to a d.c. amplifier or bridge. Once again, the scale is calibrated in rms, but at this time the unit is sensitive to peaks. A variation of this is the peak-to-peak reading voltmeter.

Both units are useful in the laboratory. The latter types are relatively insensitive and are frequently incorporated as a portion of a general VTVM used for checking d.c. voltages and resistance along with the a.c. ranges.

The former type usually consists of several amplifier stages. Feedback is provided through the meter circuit, around all of these stages. This contributes considerably to stability, linearity, and wide frequency range. The power supplies must be well regulated to avoid reading variations due to line voltage fluctuations.

The second type of meter can also have many variations. One form of peak reading meter circuit is shown in Fig. 10. Here, the applied voltage is rectified in the 60-cps ripple passes through the capacitor, C, during positive portions of the cycle. The capacitor, C, smoothes out this ripple, so that only the peaks remain. This may be used as the rectifying circuit for the a.c. ranges and can be included as part of any a.c. VTVM.

The peak-to-peak reading meter is most useful in audio work. A circuit of this type appears in Fig. 11. The operation is fairly obvious. During the positive half cycle, diode D, conducts, and a d.c. voltage is built up on C, as shown. During the negative half cycle, the negative portion of the cycle is added to the voltage across C, through D,. The sum of these appears across G, and R. These are in turn fed to the d.c. meter.

The meter movement can be designed into a d.c. amplifier bridge circuit as shown in Fig. 12. When the current through both tubes is equal, the meter reads zero. The currents are adjusted by varying resistor R in the cathodes. This resistor adjusts the relative bias on the two tubes and consequently the relative plate (or cathode) currents. Once adjusted, an unknown d.c. input signal upsetting the bias on the first triode only, resulting in a deflection of the meter.

Both types of meters are useful. The

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average reading type is usually more accurate and more stable, and should be used for monitoring the input and output. The peak-to-peak reading type is useful to measure peak amplifier output (to be discussed in the future).

One note of caution. Ordinary VOM’s are frequently provided with a.c. scales. The rectifiers used on these units commonly prevent the use of linear scales, with a resultant loss of accuracy. They are frequency-sensitive and should not be used where accuracy is essential.

The Flutter Meter

This is not an audio instrument in the conventional sense of the term. However, tape recorders and phonograph turntables are important parts of an audio system so that this type of instrument has become of common use in the audio laboratory.

Flutter and wow are variations in the speed. For testing tape recorders, a steady single frequency, usually 3000 cycles, is recorded on tape. A speed variation appears as a frequency variation of the 3000 cycles—not unlike the frequency modulation of a radio signal. When the test tape is played on a tape machine, the output signal of the machine is passed through a filter where all frequencies except 3000 cycles pass through. The remaining signal is then FM-detected and read on an ordinary a.c. voltmeter.

Once again, there are several important characteristics of a good instrument. First of all the filters must be sharp. The circuit must eliminate all extraneous amplitude variations to prevent them from affecting the final reading. Filters should be provided to separate the wow (slow speed variations) components from the flutter (rapid speed variations) components. As always, the power supply must be extremely well regulated to avoid reading variations with line fluctuations.

Other instruments, which are useful and are basic components in most laboratories, are the tube tester, the capacitance bridge, the inductance bridge, and the VOM. Discussion of these might be of interest, but their application to actual audio measurements on audio equipment are strictly limited.


**Industry Notes**

- Westrex Promotes Wight. Promotion of Ralph W. Wight to Vice President of the Westrex Recording Equipment division of Litton Systems, Inc. was announced by Executive Vice President George T. Scharff, President. Mr. Wight will continue to serve as General Manager of the division, which he has been with since 1936. He was named Manager in 1954 after serving as contract relations manager. Westrex, since becoming a Litton division in 1958, has married its recording technology into the fields of instrumentation data recording and commercial sound equipment.

- British Industries Corp. Leonard Gardner, President of British Industries Corp., announced the election of two of its veteran executives to vice-president. Franklin S. Hoffman, formerly Sales Manager for Garrard and other BIC high-fidelity products becomes Vice President for Sales. Arthur M. Gasman, formerly Marketing Director, becomes Vice President for Promotion. Both men have been associated with BIC for more than 15 years.

- 3M Opens New Plant. Minnesota Mining and Manufacturing has just opened a second U.S. magnetic tape manufacturing plant. Located at Freehold, N. J., the new plant will boost 3M's magnetic tape capacity by 150 per cent when it is in full production sometime in 1964.

- James Carroll joins Fisher. Avery Fisher, President of Fisher Radio Corporation, has announced the appointment of James Carroll as component Sales Manager at Fisher Radio. Mr. Carroll was audio Sales Manager at Harvey Radio for twelve years. In his new responsibilities at Fisher Radio Mr. Carroll will be associated with Jim Parks, Vice-President in charge of sales.

- Eric Appoints Skolnik. Named to the post of national sales manager for Eric Electronics Corp., Norman Skolnik brings to the post experience gained as field salesman for the Electronics Division of Ponden and Best.

- Tandberg Awards Prizes. Winners of the Tandberg "Sumfer Sales Jamboree" were awarded prizes based on the sale of Tandberg tape playing equipment. First place winner, Ray Billinson of Airex Radio, received a new Volvo Sports Sedan. Second prize, a Norwegian mink stole, went to Marty Stern of Grand Central Radio.

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