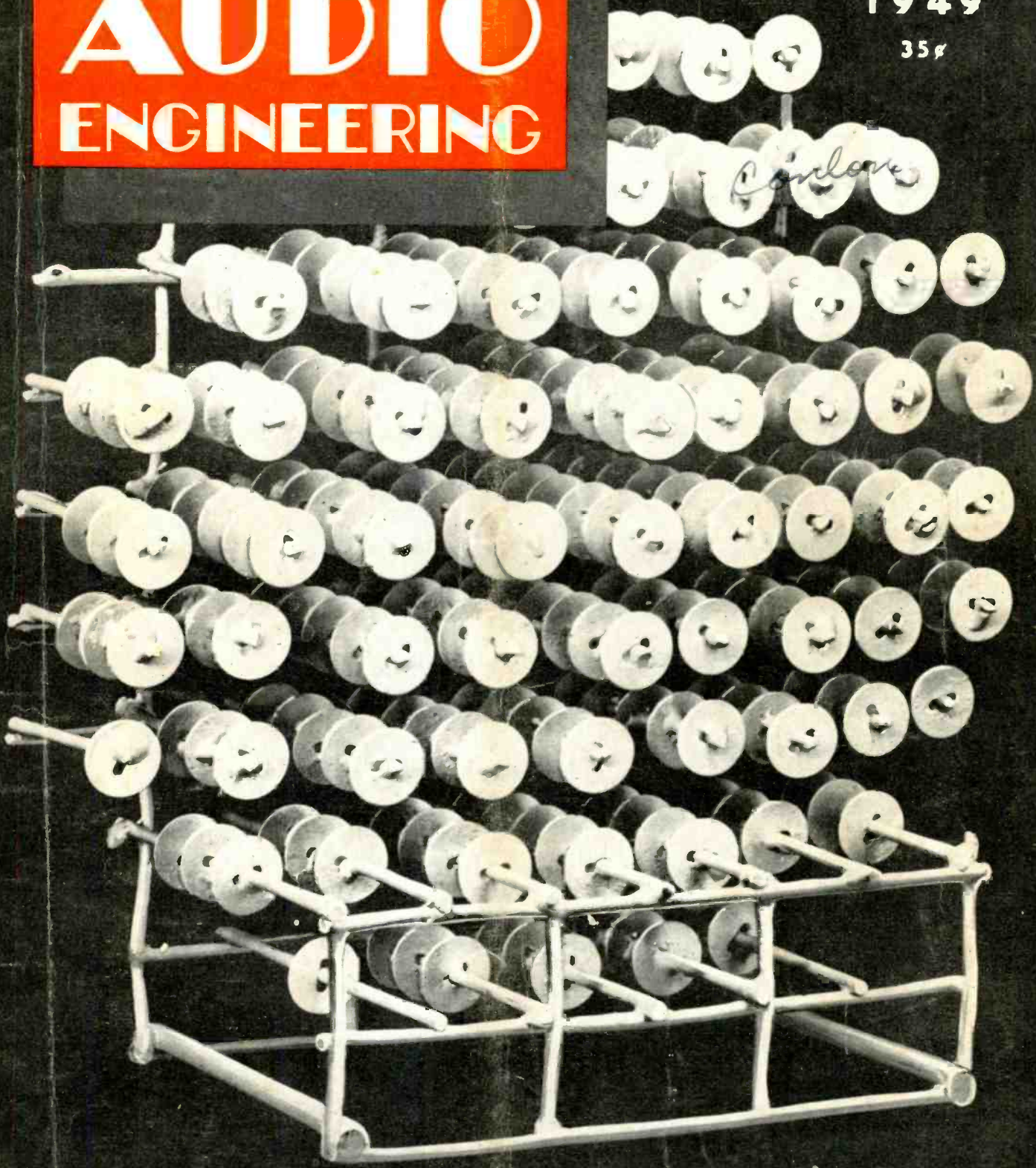
AUDIO ENGINEERING

JULY
1949
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THE JOURNAL FOR SOUND ENGINEERS

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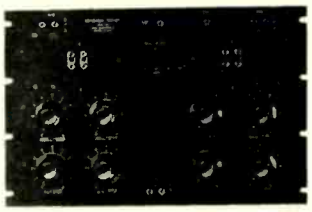
HIGH FIDELITY OUTPUT TRANSFORMERS

Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	Watts from	Maximum level
F1950	Push pull 2A3's, 845GA's, 300A's, 275A's, 6A3's, 6L6's	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 845GA's, 300A's, 275A's, 6A3's, 6L6's	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250, 6V6, 42 or 2A5 A prima	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1956	Push pull 245, 250, 6V6, 42 or 2A5 A prima	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6N6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1957	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6N6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1963	Push pull parallel 2A3's, 845GA's, 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	30 watts
F1962	Push pull parallel 2A3's, 845GA's, 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	30 watts
F1964	Push pull 6L6 or Push pull parallel 6L6	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

PRECISION LABORATORY EQUIPMENT

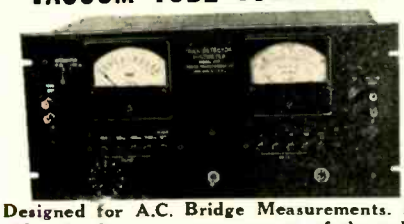
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COVER

Bell Telephone Laboratories' "disc" lens, by means of which sound waves are delayed and thereby focused. Consisting of metal discs arranged in an open structure, the lens was built originally for three-centimeter microwaves, but can be used for simultaneous focusing of microwaves and sound waves.

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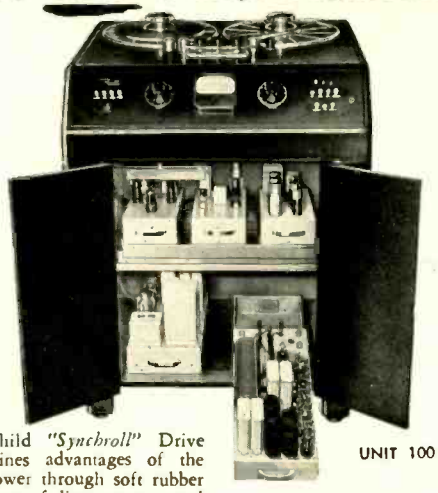
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★ The Fairchild *"Synchroll"* Drive System combines advantages of the transfer of power through soft rubber idlers with those of direct gear control of the capstan. This unique development of Fairchild results in a *no-slip synchronous* tape drive.

★ High Frequency Flutter causes roughness in a reproduced sine wave tone. *Smooth motion* in the Fairchild Tape Recorder is apparent in the *cleanliness* of simple musical tones.

★ Hum problems are generally recognized as inherent in magnetic recorders. The high efficiency of Fairchild Playback Head design and amplifier construction results in a hum measurement at least *68 db down.* (ref. 2% distortion).

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Above are some of the features that have gained FAIRCHILD the reputation for the finest in recording equipment. Fairchild Synchronous Disk Recorders are manufactured in 3 models; Unit 523 for the finest fixed studio installation; Unit 539K for the small budget studio; Unit 539G (shown above) for console performance in a portable unit. Maintain your reputation for making the finest transcriptions and masters with Fairchild equipment. Write for illustrations and complete specifications.

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— Letters —

Sir:

Your June issue gives me several incentives for letters comment:-

(1) Charles Irwin Cohn's letter is strongly remindful of mine (in your July issue of 1947) in which I stressed the psycho-acoustic conditioning of reproduced music listeners by their previous musical experiences with live music, and with reproduced music of varying degrees of quality.

(2) Ted Powell's letter re: (a) Prof. Richardson's conclusions that the attack and decay times of sounds, rather than their harmonic overtones, largely determine their tone quality and (b) transient distortion.

(a) In the *Proceedings of the Radio Club of America*, January 1934, the *Journal of the A.S.A.*, January 1935, and *Proceedings I.R.E.*, November 1936, and elsewhere, I have described my electronic piano, which has controllable attack and decay time period for the hammer-excited string vibration, as translated by capacitance and magnetic pick-ups, amplifier and speaker. With this instrument, a normal piano tone may be made to sound (as reproduced) just like an organ or other wind instrument tone (of moderate duration) with percussive transients removed. Also, with normal percussive attack, the damping rate of the reproduced tone may be greatly increased. Both the attack and decay rates may be continously varied through wide limits, so that the reproduced tone, always of the same harmonic content (as determined by mixing of the out-puts of several pickups along the string) can be made to sound all the way from the highly damped, banjo type, thru normal piano (attack and decay) to a thoroughly organ-like tone. This I have called "tone envelope control" and is a very important means of controlling "quality", if by that we include more than mere control of the relative amplitudes among the tone partials.

I do not agree that such envelope differences are *more* important than the harmonic (or inharmonic) content of tones or sounds, but they are certainly *equally* important.

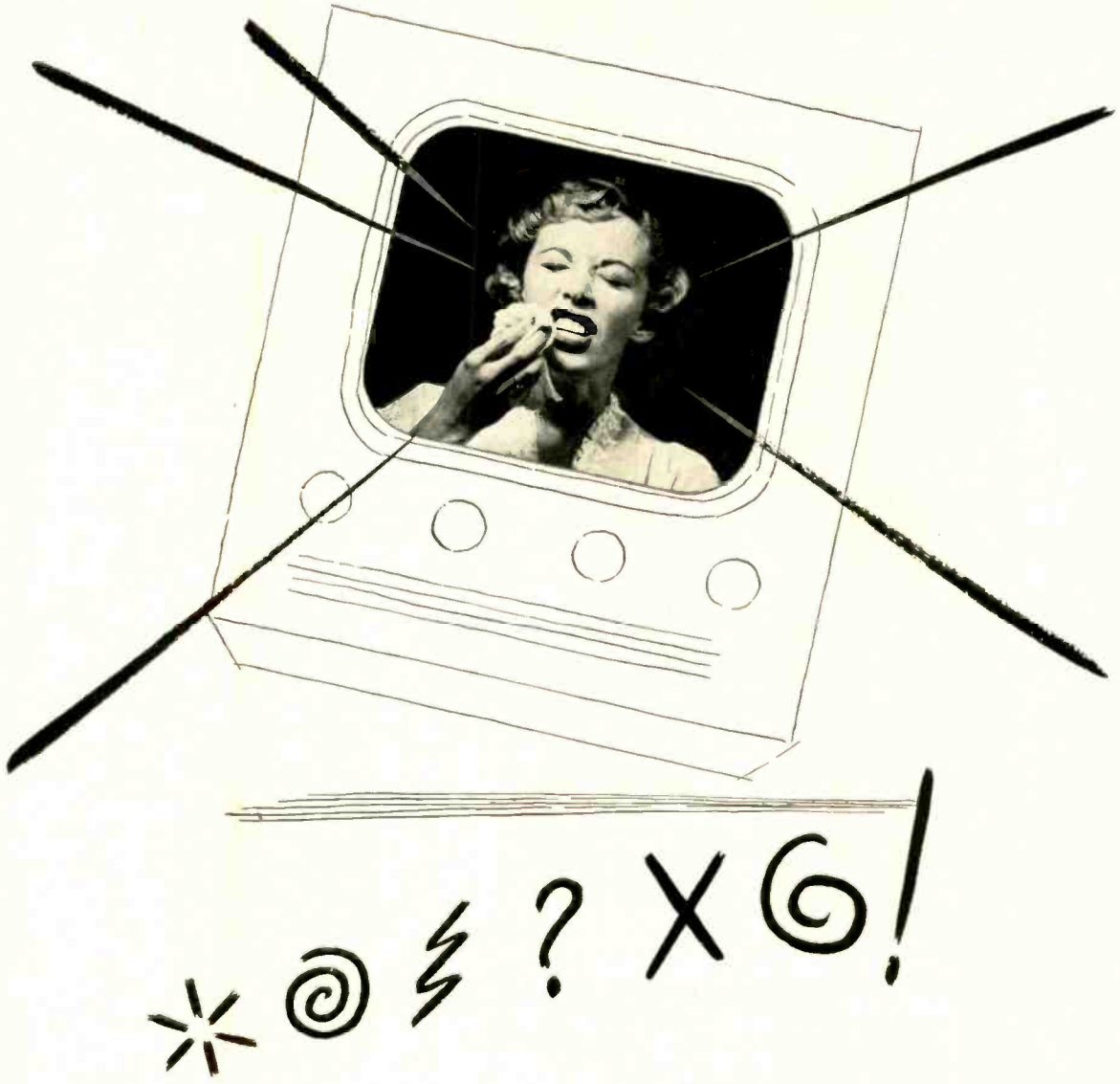
(b) I used the term "transient distortion" in 1921, in my electro-phonographic researches, concerning the effects of more or less rapidly damped mechanical and electrical resonances in the recording-reproducing system. In 1931 and later, I tested electronic piano amplifier-reproducer a.f. systems for inter-modulation by striking two piano keys in the 2000-2500 cycle range and separated by say 200-300 cycles in frequency, while listening for the inter-modulation beat tone. (See my letter I.R.E. 1942, page 429, re John K. Hilliard paper on "Distortion Tests by Inter-modulation Method".) This test indicated that power ratings of such a.f. systems were overated (by the total-harmonic-content test for pure tones) by about 400 to 500 per cent.

(3) There is one more matter on which I have speculated for years and have referred to the Harvard Pyscho-Acoustics Laboratory (without reply): I listen a lot to sounds of 120-cps frequency, sometimes quite loud, from loud speakers, a.c. motors, airplane motors, and from an old Model A Ford truck without muffler, which I have on my place for odd transport jobs.

After listening to such loud 120-cps tones for some time and then going to a quiet place, I can *still* hear intermittently, slowly pulsating, and weakly, this abolutely def-

[*Continued on page 39*]

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You've seen this, or something else "unfortunate," on too many live TV shows. It simply couldn't happen if the show were on 16-mm film.



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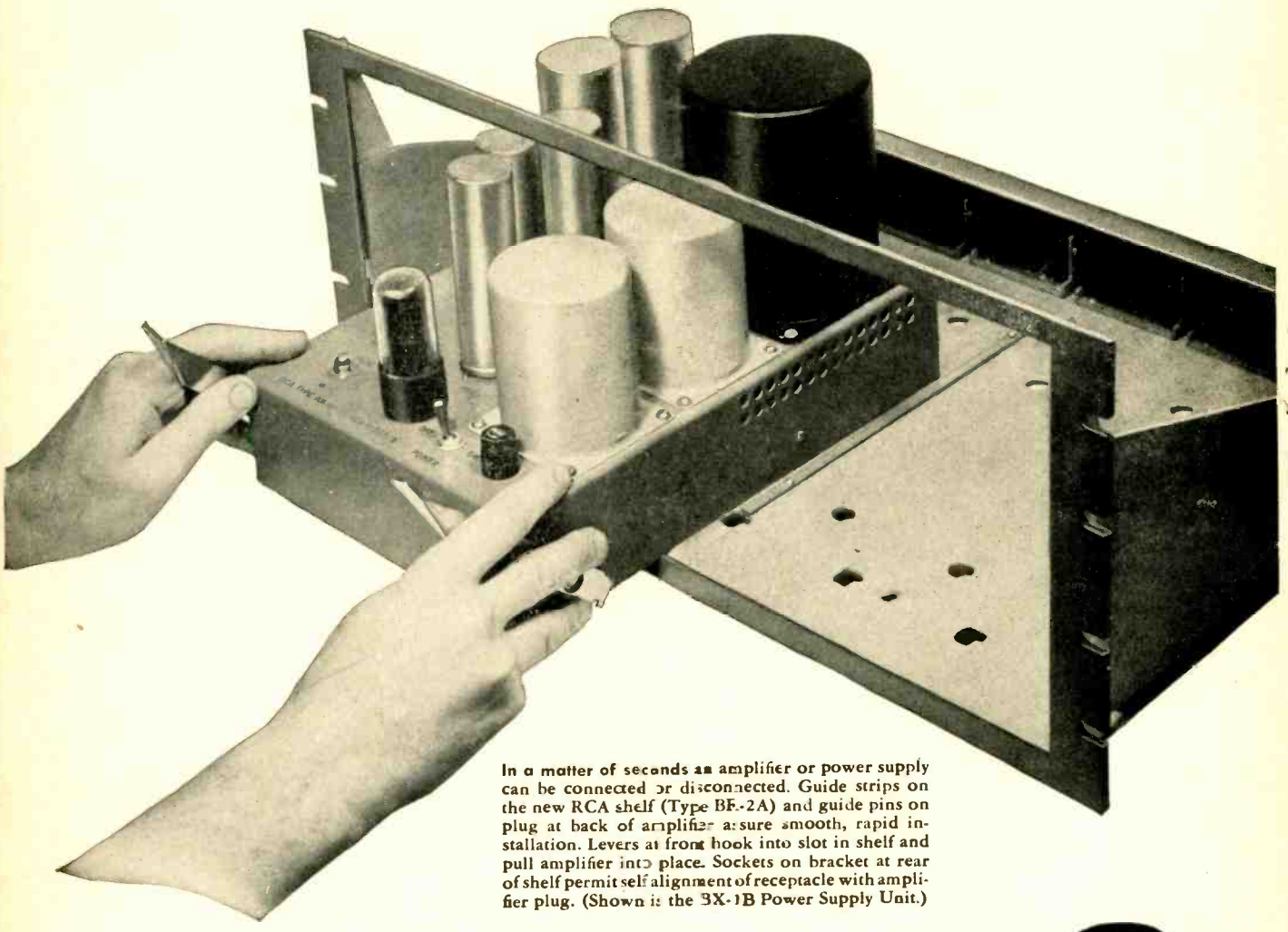
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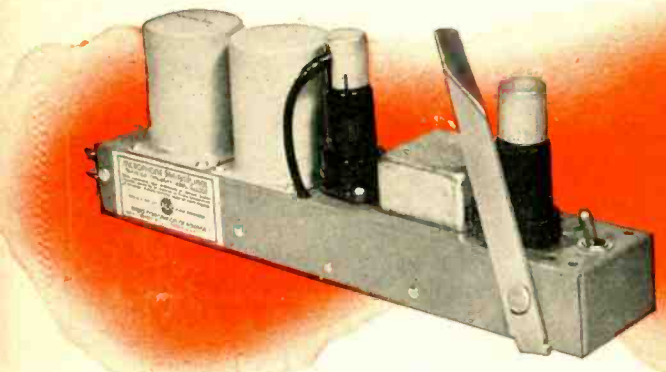
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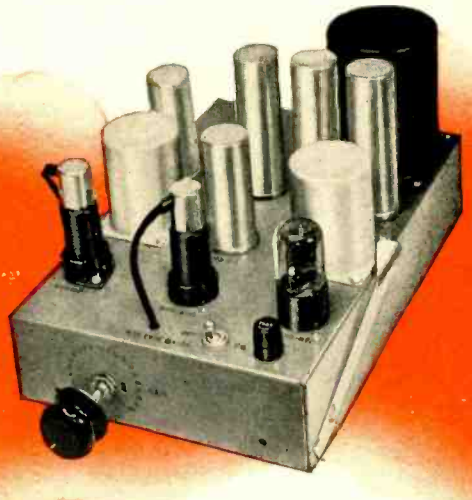
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In a matter of seconds an amplifier or power supply can be connected or disconnected. Guide strips on the new RCA shelf (Type BF-2A) and guide pins on plug at back of amplifier assure smooth, rapid installation. Levers at front hook into slot in shelf and pull amplifier into place. Sockets on bracket at rear of shelf permit self alignment of receptacle with amplifier plug. (Shown is the 3X-1B Power Supply Unit.)



Two-stage Preamplifier (Type BA-1A)—ideal for use as a microphone preamplifier, turntable preamplifier, booster amplifier, or low-level isolation amplifier. *High gain:* 40 db. *High output:* +10 db. *Low noise level:* −80 db. *Low distortion:* 0.5% rms, 50 to 7500 cycles. *Isolation factor:* approx. 90 db; over 100 db with special Volume Control Kit. *Frequency response:* ±1 db, 30 to 15,000 cycles. *Small size:* six units will fit on a 36-B or new BR-2A shelf!



Booster Amplifier (Type BA-2C)—A two-stage unit having applications similar to those for the BA-1A; also valuable where a high-gain amplifier between announce microphone and limiting amplifier is required. *High gain:* 50 db. *Low noise level:* −68 db. *Low distortion:* 0.75% rms, 40 to 15,000 cycles. *Frequency response:* ±1.5 db, 30 to 15,000 cycles. *Compact:* two units can be mounted on one 36-B or BR-2A shelf. Features plug-in capacitors and built-in power supply.

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for quick interchanges—and easy maintenance



The RCA Type BR-2A Shelf fits any standard rack; takes 8¾ inches of panel space. If desired, however, RCA Type 36-B panels and shelves now in use can be easily adapted for plug-in amplifier service.

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This new RCA line now includes the four amplifiers and one power-supply unit shown. Others will be added in the near future. New, carefully selected characteristics make these units ideal for a large number of studio jobs.

All units use the same standard plug. To assure maximum convenience, a new shelf (Type BR-2A) has been designed. With a few easy changes, however, the conventional RCA Type 36-B panel and shelf can be used, if desired. The necessary accessories are available for this purpose.

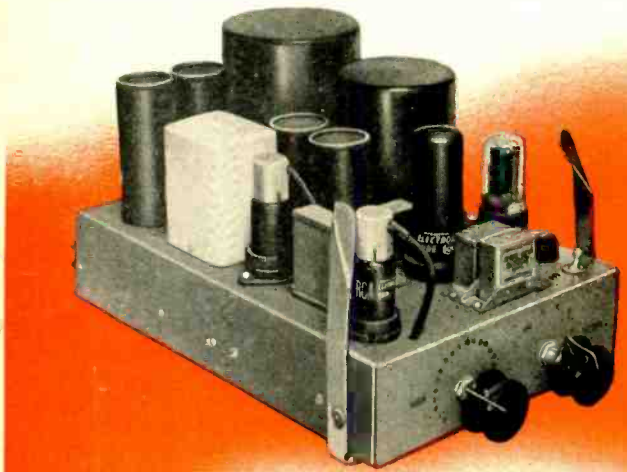
Here, we believe, is a real opportunity to modernize your amplifier system—a quick, convenient way to get better performance at low cost. Descriptive leaflets are yours for the asking. Write: Dept. 7G, Audio Equipment Section, Radio Corporation of America, Camden, N. J.

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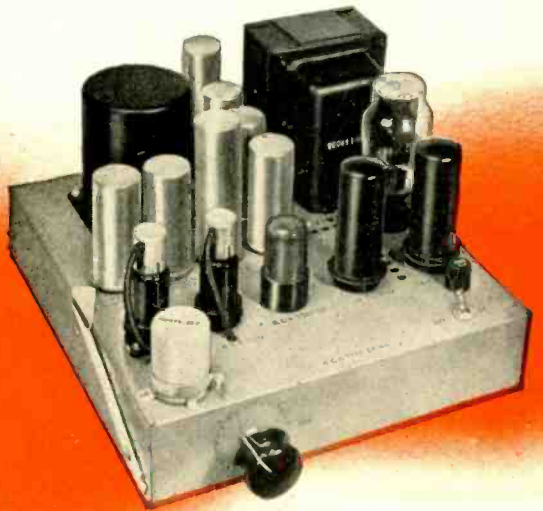
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Monitoring Amplifier (Type BA-4B)—Designed for operation at microphone levels. High output of 12 watts is sufficient to drive several speakers or, in some applications, a recording head. Other uses include application as line amplifier for portable and mobile transmitters. *High gain:* 105 db. *Low noise level:* −20 db (with maximum gain); −40 db (with minimum gain). *Low distortion:* less than 3% at 12 watts. *Frequency response:* ±2 db, 30 to 15,000 cycles.

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EDITOR'S REPORT

STANDARDIZATION (Cont'd)

ON THE SUBJECT of standardization of equipment of various types, there is always much to be said. Transformers have long been in the limelight, and circuit impedances in a complete system—such as a broadcasting plant—are intimately related to transformers, or vice versa.

Departing from the discussion of professional equipment, there is much work to be done with components in the public address and home amplifier field. As an example of this, it will be noted that amplifiers are rated in a variety of ways, usually such that the best possible *numerical* values are credited to the equipment being described. Consider the rating for hum and noise levels—in the professional class, amplifiers are described as having a noise level of *n* db below a reference level, usually 1 mw. In the p. a. line, most equipment is rated as having a noise level of *n* db below maximum power output. Obviously, then, an amplifier with an output of twenty watts, corresponding to +43 dbm, will appear to be better under its rating of "80 db below maximum output" than a professional amplifier rated at —65 dbm, although the hum and noise level of the former is actually only —37 dbm. It is not the number of db below maximum output that is of interest, for an amplifier having an output of +50 dbm and a noise level 60 db below this value is not very quiet at all—a noise level of —10 dbm is hardly acceptable for a good quality system.

The maximum noise level from a good amplifier designed for use in a home reproduction system should be no higher than —40 dbm, and preferably as low as —60 dbm, to ensure the extreme of quiet desired by critical listeners. In selecting any amplifier, therefore, it is good policy to translate the published rating to a level referred to some standard, preferably 1 mw, before comparing a number of *figures*, which unless intelligently considered, mean little.

Going to another question—it is well understood that the gain of an amplifier is based on the ratio of the output power to that delivered to the input. Thus, in a typical amplifier, the input is rated as 5 megohms and a signal of .001 volts from any source is sufficient to drive the amplifier to full output. However, if the same amplifier were rated at an input impedance of 50,000 ohms, the same signal would also drive the amplifier to full output. But—the calculated gain of the amplifier differs by a factor of 100, or a difference of 20 db. Thus, though the actual gain of the amplifier has not changed, the figures denoting this gain have changed appreciably.

The object of this discussion is to point out the fallacies in the methods of rating an amplifier. To make valid comparisons, it is necessary that all the ratings be translated to the same basis, so that the equipment can be evaluated fairly, and without prejudice to one or the other on account of the method of presenting the facts.

One other component that comes into this discussion is the microphone. In the consideration of various microphones of any type, they too must be compared on an equal footing. It will be noted that some are rated at a given output for a sound pressure of 1 bar, while others are rated for a pressure of 10 bars. This alone will make a difference of 20 db in the actual output, provided the difference in the reference is not observed.

The whole point to standardization is to make it possible to substitute equipment readily without the necessity of making extensive changes in other circuit elements in case a single element must be replaced. There is nothing wrong with the ratings usually published—but to make comparisons that are valid, everybody must be talking about the same thing. It would be helpful if all conditions were standardized. Until then, though, remember that old axiom to which every engineering student has been exposed—read the problem thoroughly before attempting to solve it.

NEW MICROPHONE DESIGNS

One of the principal troubles encountered in TV sound pickup is the inability of standard microphones to produce acceptable quality at the distances required by camera placement. Thus it appears that a new microphone design may be desirable. With all due respect to presently used microphones, most of which produce excellent sound quality when operated under conditions normal in radio, it is nevertheless a fact that these microphones—almost without exception—are merely modifications of early telephone transmitters. Instead of the microphone being designed to fit the application, the application has usually been modified to fit the requirements of the microphone, and so far it has apparently not been possible to adapt TV techniques to produce consistently good quality with any existing mike.

Perhaps the next move should be a study of present designs to determine the possibility of bringing out a completely new type of microphone which is suited for TV use. Such a design might well incorporate a pattern which is essentially a cone with an included angle of 30 to 45 deg. and with the response at the back and sides at an absolute minimum. Considering the performance of present uni-directional microphones, this should not be too difficult for the design engineers, and it is well agreed that such a microphone is badly needed.

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Read what Frank Marx, Vice President in charge of Engineering, American Broadcasting Company, says: "For the past two years A.B.C. has successfully used magnetic tape for rebroadcast purposes... A.B.C. recorded on AMPEX in Chicago...17 hours per day. For 2618 hours of playback time, the air time lost was less than 3 minutes: a truly remarkable record."

SPECIFICATIONS

FREQUENCY RESPONSE:
At 15" ± 2 db. 50—15,000 cycles
At 7.5" ± 2 db. 50— 7,500 cycles

***SIGNAL-TO-NOISE RATIO:** The overall unweighted system noise is 70 db. below tape saturation, and over 60 db. below 3% total harmonic distortion at 400 cycles.

STARTING TIME: Instantaneous. (When starting in the Normal Ploy mode of operation, the tape is up to full speed in less than .1 second.)

FLUTTER AND WOW: At 15 inches per second, well under 0.1% r.m.s., measuring all flutter components from 0 to 300 cycles, using a tone of 3000 cycles. At 7.5 inches, under .2%.

Manufactured by Ampex Electric Corporation, San Carlos, Calif.

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Fig. 1. Front panel of portable amplifier. Access plate at left end is removed to permit connection of microphone cables.

W. W. DEAN*

Practical, standard engineering provides a design which features compactness, reliability, flexibility, and performance.

New Portable Audio Amplifier for AM-FM-TV

THE FUNCTION of a portable amplifier is to receive the signals from the microphones at a remote-broadcast location, combine them in the desired proportions, and amplify the resulting signal to a level suitable for transmission to the broadcast studio. Since a.c. power is not available at all locations, portable amplifiers must operate from batteries, or from both a.c. and batteries. The electrical performance must be of broadcast quality, although the specifications of most earlier amplifiers are not as rigid as those on studio equipment. As the unit is frequently carried from studio to a remote location, and from one remote to another, it must be light in weight, easy to carry, and of sturdy construction.

In the design of any piece of portable audio equipment, some compromise must be made between the features of the equipment and the size and weight. One of the main determining factors in this compromise is the type of mixing system used. In low-level mixing, the microphone outputs go directly to the mixer system where they are combined and then amplified. High-level mixing, on the other hand, uses an amplifier between each microphone and the mixer system.

Signal-to-noise ratio in a properly designed amplifier is largely determined by what happens at the grid of the first stage. A practical average value of noise in an input stage using a modern low-noise tube is in the order of —125 dbm. This noise can be made to consist essentially of tube and circuit hiss, with the hum appreciably lower in level.

Since broadcast microphones have effective output levels in the order of —50 dbm in moderately loud sound fields, the signal-to-noise ratio at the first grid seldom starts out better than 75 db. In weaker sound fields this ratio is correspondingly degraded.

Now assume that a four-channel, low-level mixing system is interposed between the microphone and the first grid. Such a mixer has an initial loss of approximately 10 db and usually is set by the operator to have a loss closer to 20 db. It is seen that such a mixing system generally reduces the signal-to-noise ratio to 55 db.

These figures are based on the use of the very best type low-noise, low-microphonic input tubes. It can be demonstrated that the use of receiving-type tubes, especially certain types of miniature tubes, will raise the noise an additional 10 to 20 db and change its character from smooth hiss to very annoying hum or to microphonic ringing noises.

Therefore, for portable amplifiers using low-level mixing systems and receiving-type input tubes, it is not unusual to measure signal-to-noise ratios of only 40 or 45 db under standard test conditions approximating a microphone in a moderately loud sound field. Consider what the ratio becomes when the microphone is in a weak sound field. Hardly the background of "dead silence" required by today's new transmitting systems.

When high-level mixing is used, the story is much more attractive since the signal-to-noise ratio seldom goes below that established at the first grid. High-level mixing plus the use of modern low-noise tubes insures the lowest possible noise level at all times.

Consider the output of the microphone in our moderately strong sound field to be —50 dbm. In a high-level mixing system it is first given a boost of 40 db in a low-noise pre-amplifier stage. Then the signal drops, say 20 db, in the mixer. It is still 20 db above microphone level when it is applied to the tube following the mixer. By making the booster stage design the same as that of a low-noise pre-amplifier, the mixer settings can be increased to give a 40-db loss before the signal-to-noise ratio has been reduced below that prevailing at the first grid.

High-level mixing gives other advantages. Since input transformers are used ahead of each tube, the microphone lines may be operated balanced to ground. This gives a noise reducing advantage where the cables are quite long and must run through interference

*General Electric Co., Syracuse, N. Y.

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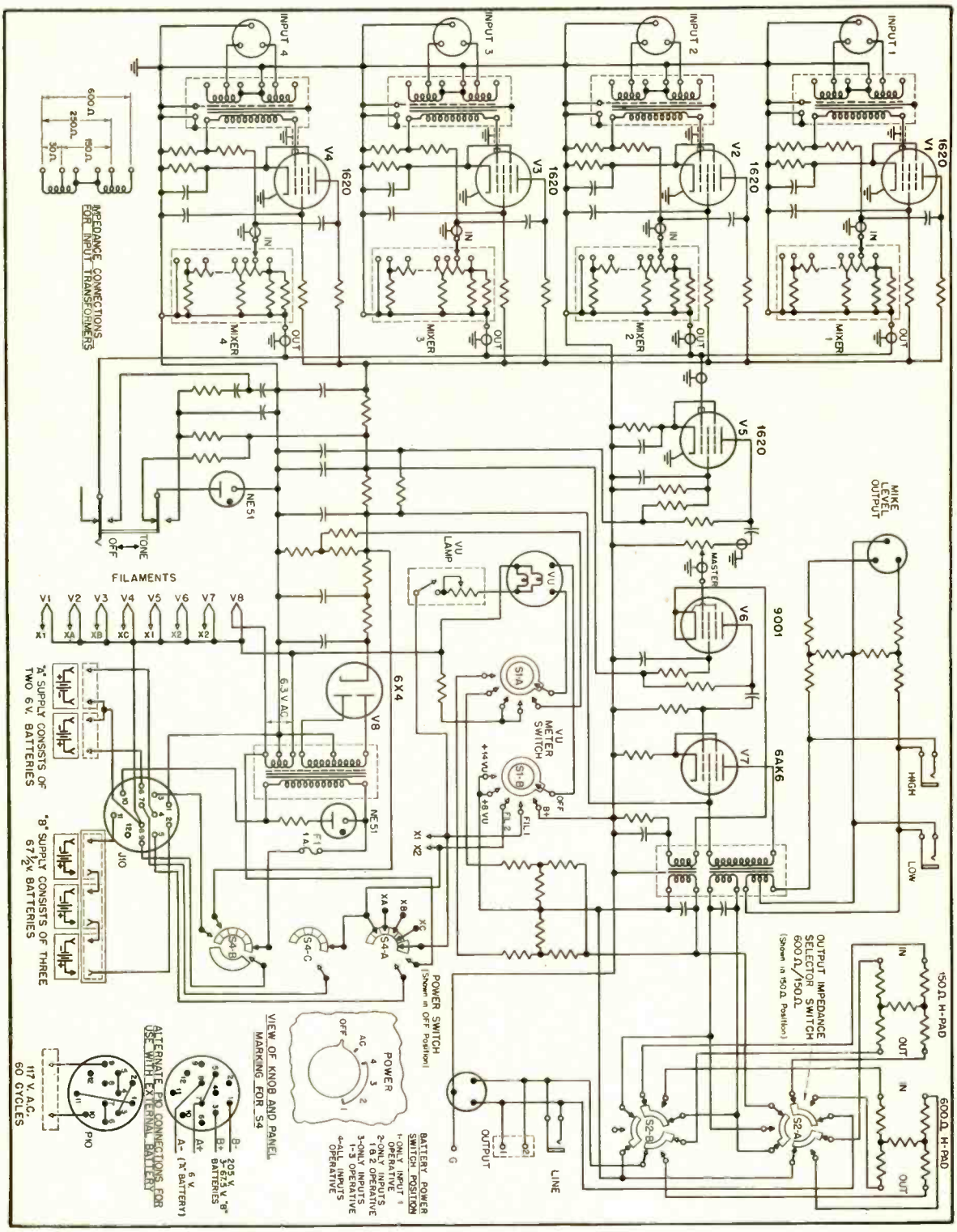


Fig. 3. Schematic of GE Type BA-6-A portable amplifier.

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fields. Also, the use of input transformers permits tap changing to match various source impedances.

A. C. and Battery Power Supply

Portable amplifiers which operate from both a.c. and batteries may be divided into two general classifications: (1) Those which have the batteries in a separate case, and (2) Those which have the batteries included in the same case with the amplifier. The advantages of a.c. and battery power in the amplifier case, rather than in a second container, are many. It is safe to assume that most pickup locations have reasonably reliable a.c. power available. However, this power has been known to fail, and in such cases, the inclusion of batteries in the amplifier case where they are *always* available is a great asset.

Because of the additional space and battery power required by the pre-amplifiers of a high-level mixing type of remote amplifier, it is not feasible to include an extended-life complement of batteries in the single-case design. However, lightweight, emergency batteries may be included. In the event of a.c. power failure these would be expected to operate only until the end of the program.

To make this single unit design practical, it was necessary to reduce the power drain to a minimum. In fact, miniature tubes were used throughout the entire amplifier during the early stages of the design because of the reduced heater drain (150 ma for the miniature 9001 tube as compared to 300 ma for the octal base 1620). Type 9001 tubes were employed in the pre-amplifiers and also in the booster and driver stages since this tube makes a very effective high-gain pentode stage, and can also be used as a triode where desired. A 6AK6 tube was used in the output stage and a 6X4 tube as a rectifier. Unfortunately, the hum and microphonics resulting from the 9001 tubes in the pre-amplifier and booster stages were intolerable and these tubes had to be replaced by 1620's, which are especially designed for low-level audio applications. The 9001 was retained in the driver stage, as this stage operates at a level sufficiently high that overall performance is not degraded by the tube. The 6AK6 was chosen since it is the only available tube with a 150 ma. heater which would deliver the required +18 dbm output through a pad of adequate size. The drain on the "B" supply is small enough so that it presents less of a problem.

In addition to the partial use of low-heater-drain miniature tubes, the "A" battery life was further increased by opening the heaters of tubes not in use. Many remote broadcasts use only one or two microphones; therefore the power switch was wired to disconnect the heaters of the pre-amplifier tubes not in use. This switch has five operating positions in addition to the OFF position. The first position permits a.c. operation with all tubes connected, the next four positions are for battery operation with either four, three, two or one pre-amplifier heater connected.

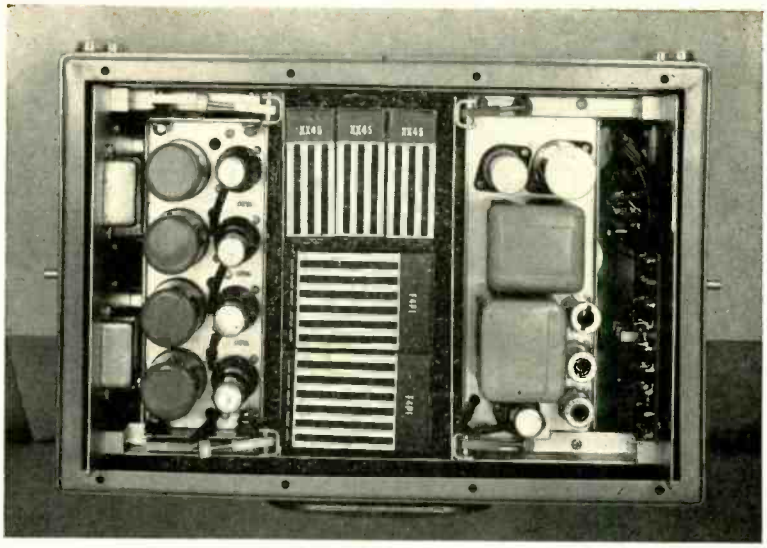


Fig. 2. Portable amplifier with rear cover and battery cover removed.

When the amplifier is operating from its a.c. supply and a power failure occurs, the VU meter pilot lamps and a neon a.c. indicator lamp will go out. The operator then has approximately two seconds in which he can turn the power switch to one of the battery positions without noticeable loss of program level or quality. In the event that a.c. power is restored before the end of the program, the operator is notified by the a.c. indicator lamp and he may then turn the power switch back to the AC position after allowing time for the rectifier cathode to heat. The power changes are not noticeable on the air.

To eliminate the possibility of the internal batteries running down due to the operator forgetting to turn off the amplifier at the conclusion of a broadcast, the batteries are interlocked with the a. c. power cord. This cord must be plugged into the amplifier for the internal batteries to be operative and must be removed to close the case for transit. The power receptacle is also arranged so that external batteries may be used when desired.

Test Tone

A unique feature of the amplifier is the inclusion of a 400-cycle test oscillator for adjusting operating levels. The oscillator is of the relaxation type and employs a 1/25 watt neon-lamp which also serves as a low-drain d.c. pilot lamp when it is not used for adjusting levels. This oscillator provides a direct method for adjusting the level to the control room, eliminates the necessity of setting up a separate microphone near the amplifier, "woofing" the sound peaks and watching the VU meter. Test-tone is also a help where the set up and level check must be made under conditions where "woofing" into a microphone is not desirable. This sometimes happens during a nightclub floor show where quiet is demanded, or in a church where the set-up must be made during part of a service.

Monitoring Circuits and P. A. Feed

In the use of many portable amplifiers, it has been found that sufficient volume has not been provided for headphone monitoring in noisy locations, so two jacks are provided for the phones. The low-level jack is connected across half of an isolated secondary winding and operates at line level which is normally satisfactory for headphone monitoring. The high-level jack is connected across the full winding and allows the operator to monitor at a 6 db higher level, which helps to overcome extremely high background noise.

A third monitoring jack, for two-way talkback to the control room, is connected directly across the line terminals on the line side of the output pad. When the headphones are plugged into this jack, the operator can communicate with and receive program cue from the control room preparatory to going on the air.

The monitoring winding is also connected to a pad which furnishes microphone-level output to a 50-ohm balanced load. The connection is very useful for feeding public address system inputs

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or other portable amplifier. In the latter case seven input channels, with sub-master control over four of the channels, may be provided by connecting the MIKE LEVEL OUTPUT of one G-E portable amplifier to one of the inputs of a second portable amplifier.

A full-size illuminated VU meter is provided for convenience of operation. A dimmer control and switch are used to dim the pilot lamps or turn them completely off if it is desired to decrease the drain on the batteries. In addition to two volume-indicating range positions on the VU meter selector switch, there are positions for checking the two "A" batteries and the "B" batteries. This makes it possible to check the condition of the batteries without the necessity of using external meters. The normal operating position of the VU meter selector switch is the +8 VU position corresponding to normal line level. A +14 VU position is also included so that the telephone lines can be fed at a higher level in case of an emergency condition where it may be necessary to override high line noise. Although the amplifier is rated at +18 dbm (+8 VU with a 10 db peak factor), listening tests have demonstrated that quality was acceptable at +14 VU even with reduced battery voltages.

6-DB Output Pad

The output of any amplifier which is intended to feed a telephone line should first go through an isolation pad. Such a pad performs the following functions:

1. Provides an essentially resistive source for the telephone line by minimizing the effects of varying amplifier internal impedance.
2. Provides an essentially resistive load for the amplifier and VU meter by minimizing the effects of varying telephone-line impedance.

The reason for the pad, then, is to minimize the effects of impedance variations in amplifier and line. It follows that the larger the attenuation of the pad the less will be the effect of varying impedances. Use of an adequate loss pad will permit better line equalization, give more accurate VU meter readings and permit the amplifier to function at peak efficiency.

Examination of curves showing the reduction of impedance variations versus pad loss indicated that at least 6 db must be used for high-quality performance. More than 6 db loss would require an excessively large output stage. A loss of 6 db in the isolation pads was therefore indicated.

Either 600- or 150-ohm output transformer connections and isolation pads may be used. Selection is by means of a screwdriver-operated switch. 600 ohms is standard for use on 600-ohm equalized circuits. 150 ohms is used on relatively short, unequalized circuits where the low sending impedance provides a degree of equalization which tends to compensate for the transmission characteristics of the line.

Construction

The Type BA-6-A Portable Amplifier is housed in a lightweight aluminum alloy case 12 inches high by 17⅞ inches long, and 8⅝ inches deep. It weighs approximately 35 pounds, including the weight of the emergency batteries. When operated without internal batteries it weighs approximately 30 lbs. A neat appearance is presented by the grey baked-enamel finish of the case proper and the contrasting blue vinyl plastic-coated fabric applied to both front and rear covers.

Removal of the front cover gives access to the panel, *Fig.* 1, on which all of the operating controls are located. The center section of the panel is finished in blue. The remainder of the panel is finished in satin aluminum. Above each mixer control is a write-in space in which notes may be pencilled and erased. Provision is made to store the a.c. power cord within the front cover.

Removal of the rear cover provides access to the tubes, transformers, and the battery compartment, *Fig.* 2. The batteries are clamped in place by a cover which is easily released by means of four thumb nuts. Spare tubes and fuses are clamped to the inside of the rear cover.

Flush-mounted, snap-in access plates are provided on the sides of the case for access to the input and output connectors of the amplifier. The four input receptacles are mounted on the left side, while the power, line output, and mike level output receptacles, the line output terminals, monitoring jacks, and the output-impedance selector switch are all located on the right side. The access plates are attached to the amplifier by small head chains.

Audio Circuits

The schematic, *Fig.* 3, shows that the unit consists of four pre-amplifiers, a mixer system, and a program amplifier with booster, driver and output stages. The master gain control precedes the driver stage.

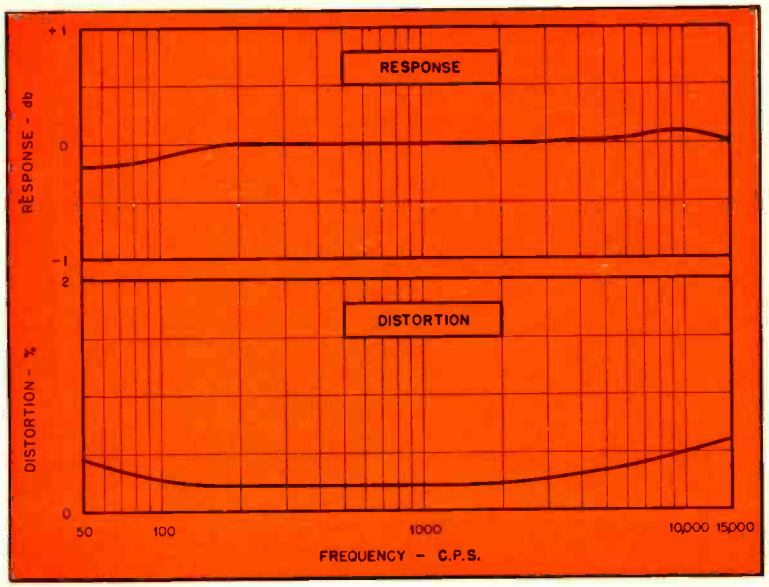
The pre-amplifiers use type 1620 low-noise, low-microphonic tubes, pentode-connected for maximum gain. Inverse feedback is used in these amplifiers to reduce distortion at high input levels. The taps on the input transformers may be adjusted so that the amplifier will operate from 30, 150, 250, or 600 ohms depending upon the type of microphone used. To further reduce microphonic and shock disturbances, the pre-amplifier assembly is cushioned with soft rubber shock mountings.

The four pre-amplifiers feed directly into a high-impedance mixing system which eliminates the need for all transformers between pre-amplifier and program amplifier. The impedance ratio of the ladder network attenuators is 1:2 for minmum loss. High-quality, step-type attenuators are used throughout for smooth, noise-free operation and long life.

Another 1620 is used in the booster stage, as it may operate at a level only slightly higher than microphone level for extreme settings of the gain con-

[*Continued on page 39*]

Fig. 4. Measured performance characteristics of portable amplifier.



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Auditory Component Control for The Legitimate Theatre

JOHN H. BEAUMONT*

Sound for the theatre is rapidly coming into prominence, and the author summarizes the principal requirements which differ widely from broadcast and recording practice.

THE PURPOSE of this article is to outline some of the requirements for integrated systems for the control of the auditory component of theatrical production, and to indicate a line of approach to their design. Theatrical controls are a specialized application of audio equipment; mere grouping of commercially available units does not constitute an adequate control system, nor should control systems designed for other audio applications be transferred to a theatrical application without modification. The problems of the operator in the theatre are to some extent unique, as will be seen, and the demands made on his equipment more complex than those encountered elsewhere.

While there seems to have been little incentive for the development of this type of control in the past, the initiation of highly flexible electronic lighting controls, as well as a growing recognition of the importance of the auditory component of production, indicate a need for the design and further development of flexible control facilities for the legitimate theatre.

There is a general agreement among those who have worked on auditory component control that the scope of this control should include the following elements:

1. Control of the intensity of all sound sources (loudspeakers).
2. Control of the apparent movement of sound sources on the stage and in the auditorium.
3. Controlled reinforcement of speech and and other sounds originating on stage.
4. Controlled dubbing of voices or other sounds onto actors, props, or scenery.
5. Control of the audio spectrum for dramatic effect.
6. Control of the apparent reverberation of the space in which sounds are heard.

In terms of control equipment these require a system capable of controlling the gain, frequency response, reverberant quality and distribution of one or more signals. Control should be in the hands of a single operator, placed where he can see the stage and hear the sound he is controlling exactly as the audience is hearing it. This indicates a type of control which is complete, compact, easy to operate, and capable of being remoted from the bulk of its associated amplification units. Development up to this time has followed broadcast practice in many respects. Input devices have usually been associated with an input amplifier; control has been applied at line level and the resulting signal given further amplification before distribution.

Advantage of Remote Control

In theatrical control equipment, it has generally been the custom to control the signal directly. When the control console is remoted from the amplification facility, as is often the case, signals must be carried through relatively long lines to and from the control position, and other elements of control added to the signal at this point. Neither of these limitations are particularly satisfactory and this author prefers, as a design axiom, that the audio signal should not leave the amplifier facility between the input amplifier and the speaker distribution point. This requires the use of non-signal controls. There are several possible approaches to such control; electronic means being preferable to mechanical controls on the basis of simplicity. Non-signal controls, whether the control intelligence be a.c. or d.c., releases the remote console from practical considerations of line length, and renders the control cable installation non-critical in terms of hum pickup and frequency losses.

Usually a single input source is associated with a single input amplifier (no switching being done at this point), and a single loudspeaker unit with a single output amplifier. While it is not generally necessary to shift a speaker from one amplifier to another during a show, this control should be available in case of amplifier failure. Control systems should be designed to allow insertion of the number of units which will be needed for a given operation so that the above associations may be used. Use of frameworks or banks bussed for the largest expected installation not only provides this flexibility for portable equipment but allows a fixed installation to be increased in capacity as needs and budgets dictate.

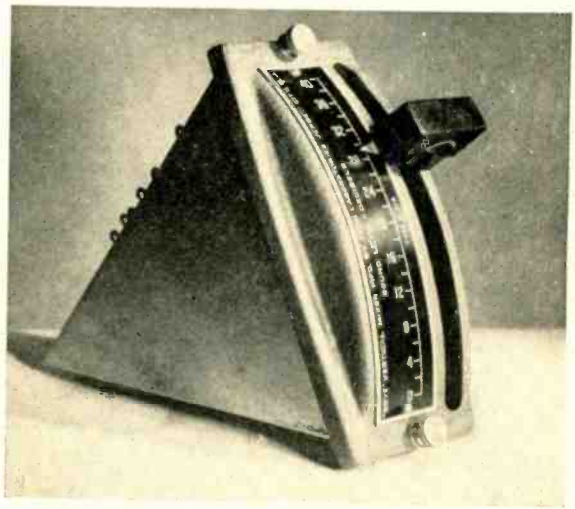


Fig. 1. Vertical type mixer attenuator manufactured by Tech Laboratories.

Photo by Bullock

Flexibility

Flexibility is usually provided by the use of a number of signal busses between input and output amplifiers. The

Vice President, Audio Facilities Corp.

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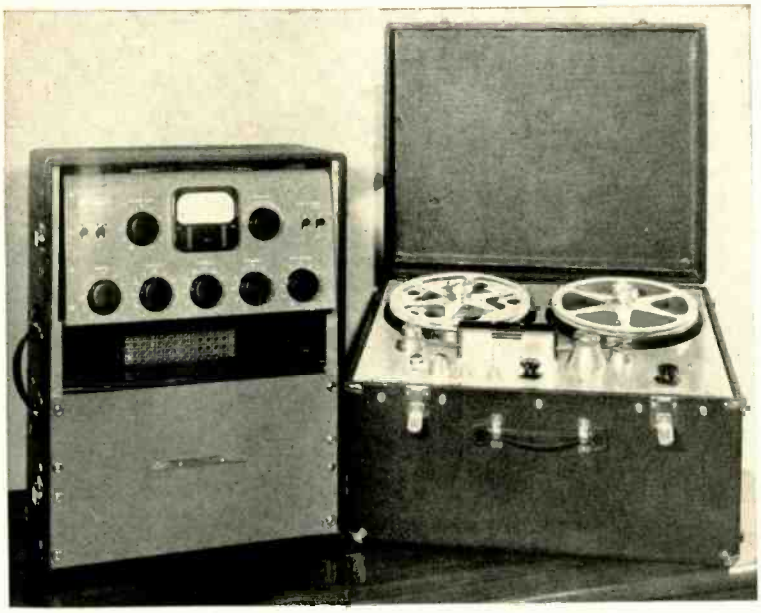


Fig. 2. High quality tape recorder which may be used on location recording, as well as for reproducing previously recorded tracks in the theatre.
Courtesy Ampex Electric Corporation

amplifiers are bridged onto these as desired, providing a number of separate channels which may be controlled independently. Control may be inserted in these busses or bridged onto them with the amplifiers, depending upon the control solution. The number of busses is indeterminate, though three has been considered an optimum. Further flexibility is generally provided in the form of speaker distribution switching, for reasons mentioned previously. When other distributions or divisions of equipment are desired, such as disposition of amplifier elements between two or more control units, they may be accomplished by the use of patching panels at the amplifier facility. Patching should be used only where it will not be changed during an operating setup.

It has seemed desirable to provide level control for both input and output amplifiers, providing, in effect, a dual control in any complete signal path. This is necessary because the general case will be a single input source operating into a number of output amplifiers whose controls will be needed to provide control of the sound distribution. Master gain control should be added in the busses when the total number of input or output controls is too great to be handled at the same time by one operator.

Trends in control element design are indicated by *Fig. 1*, which shows a type of vertical acting gain control which has been used for theatrical purposes. Vertical action finds favor with operators because of ease of operation, readability during operation, and the possibility of operating several adjacent controls with one hand. Commercially available units are still too large for effective spacing, and the best solution is a fabricated unit not more than an inch in width overall. Rotary controls are definitely unsatisfactory for theatre systems and should never be specified where settings must be made from cue sheets or where more than one control must be operated at a time.

Input Signal Sources

Operating experience leaves little doubt that tape reproducers are the most satisfactory input devices for theatrical use. Units such as the one shown in *Fig. 2* provide a convenient, quickly cued, high-quality input source. Recording is a relatively simple process, and tapes may be edited for minimum operating complexity. Most, or all of the required sound for a show may be collected on a single track, edited for sequential playback, and run with a minimum possibility of error.



Fig. 3. Transcription turntable suitable for theatrical use.
Courtesy Gray Research & Development Co.

Turntables will be needed in a comprehensive control setup in addition to tape inputs. These should be 16" transcription type tables with a cuing device such as that offered on the turntable of *Fig. 3*. Special effects may be produced with variable speed turntables, though such effects should normally be recorded on tape rather than being produced on the spot.

Other input sources will include special tone generators, effect devices, voice synthesizers, and so on. They need not be mentioned here, though *Fig. 4* illustrates a device used for the electronic production of rumbles and thunder. This device consists of the driving unit from a Farrand inductor speaker with a taut square of wire screening attached in place of the cone. It is essentially a crude form of contact microphone which produces excellent rumbles when the screen is stroked with the fingers.

There are a number of opinions about the best speaker and baffle for use in any application. Infinite baffles with high-quality cone radiators seem currently to be gaining favor over conventional reflex types because of better damping and absence of peaks in the response characteristic. In theatrical applications, where loudspeakers are often driven at extremely high levels, any housing which allows excessive cone excursions at the low frequencies is inadvisable. For this reason it is felt that the best enclosure for theatre use is a heavily constructed infinite baffle using a good cone radiator. When extended high-frequency response is desired, horns and crossover networks should be added. Enclosures should be constructed of heavy plywood and fitted with connectors capable of withstanding the rough handling they will receive. They should be fitted with flying rings for theatre use, and may have carrying handles and casters. These will be sources of rattle unless provision is made to dampen them.

With the development of high-efficiency radiators the need for high output power is being diminished. The Western Electric 728B offers an acoustic level of 93.5 db at thirty feet on the axis for a power input of 30 watts, while the 754A of the same manufacture offers a level of 94 db at the same distance for a power input of 15 watts. The frequency range of the two is substantially the same, and it would seem logical to use the lesser power in order to reduce bulk and weight in the equipment.

Equalization

Equalization networks must be cap-

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able of relatively complete and flexible control over the audio spectrum. The type most used in the theatrical work is the well known cut and boost control for the ends of the spectrum, and one should be available to every input device in a control system. In addition, a set of band-pass filters offering spectrum control over at least three bands should be available for control at the signal busses.

All equalizers should have continuously variable controls. Switching types may cause noise if used during an effect, and there is a psychological advantage to the operator in having continuous control even though it is not likely that increments smaller than those provided by switching systems will be needed.

Level Indicators

While the VU meter seems to be of little technical value in theatre control systems since there is no relation between its indication and the sound level in the auditorium, it is the standard and most economical means of indicating the signal level in the system. Meters are usually bridged onto the signal busses, where they provide a visual signal reference, and may be used as a means of monitoring. For cue setting, meter indications are inferior to an aural monitor, which may include a hearing aid type earphone.

Systems must be so designed that they cannot overload on the largest expected input modulation with all controls full open. This should be done without recourse to level limiting amplifiers or compression circuits. The use of output amplifiers having an adequate peak power capacity will aid in this, as well as providing an adequate dynamic range without the use of expansion circuits. Such circuits are to be avoided because of the resulting circuit complexity and possibility of distortion.

Discussions regarding the use of loudness control tend to the conclusion that if this feature is to be used in theatrical control systems it should be optional, under the control of the operator.

In many cases the controls mentioned may be used in a recording setup, thus simplifying the nature of the playback operation considerably. When tape is used all possible control should be applied to it during the recording process for this reason. It is probable that most theatre installations will make use of the same equipment for both recording and playback operations, so the controls must be considered part of the system.

Control consoles should be operated from the auditorium to provide the operator with maximum visibility and audibility. In the ideal case the ear should be situated in the same location as the audience ear, surrounded by no enclosure. This is seldom possible, but all compromise positions should attempt as far as possible to allow the ear of the operator to share the auditory experience of the audience. Enclosures should be no larger than needed for concealment, and should be located as near as possible to the optimum acoustic position in the auditorium. Enclosed booths using a secondary monitor for the sound are no better than a backstage position so far as the operator's ear is concerned.

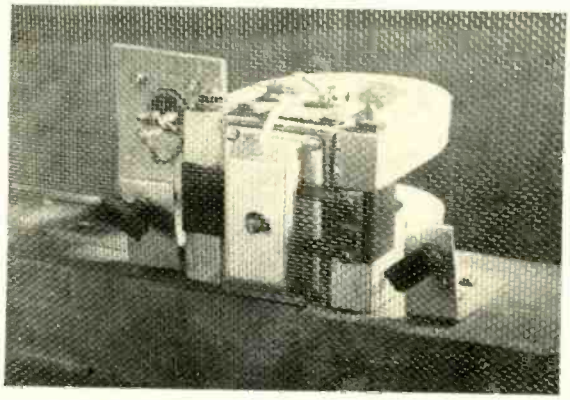


Fig. 4. Electronic thunder - screen mechanism.

Photo by Bullock

Dependability and ease of maintenance are universal requirements for electronic apparatus. Theatrical systems must be designed according to the best current practice for easy and rapid maintenance and replacement of units.

Preset Controls

No attempt, so far as this author knows, has yet been made to apply preset control to theatrical sound equipment. Preset devices have been used in stage lighting controls, and the most recent of these instruments has proved to be an important advance in the capabilities of that control. The application to sound control apparatus would be valuable in that it would further reduce operational complexity and the possibility of operational error. All functions of control described can be subjected to preset operation.

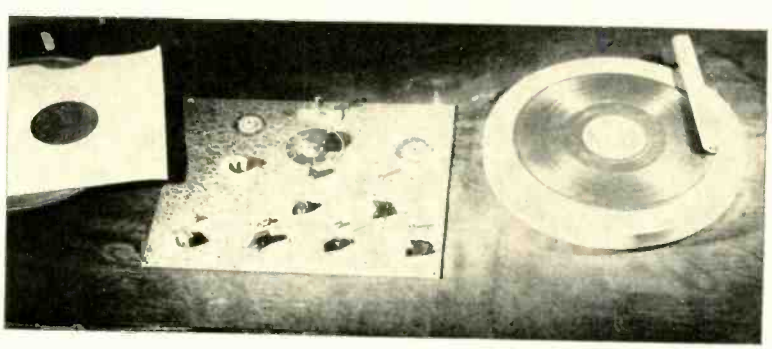
Summarizing the main requirements for effective auditory component control, we find that the following are desirable:

1. Maximum flexibility of control; all elements controlled from a single operating position.
2. Control console remoted from equipment facility; operator in position of good visibility and audibility.
3. Uninterrupted signal path from input device to output distribution; no signal leaves epuipment facility for control purposes.
4. Ease of operation; preset control.
5. Dependability and ease of maintenance.
6. Unitized construction, and standardization of units.
7. Reduction of bulk and weight to a practical minimum.
7. Assured high fidelity.

No theatrical control system up to the present time has offered all these features. While dependable, high control systems are in existence, they are not yet completely engineered in terms of the above discussion. The legitimate theatre needs this extension of its facilities for the control of production elements.

Fig. 5. Example of inadequate theatre sound system, which is simply a makeshift assembled with p-a system techniques.

Photo by Bullock



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Importance of Groove Fit in Lateral Recordings

D. R. ANDREWS*

Relating frequency response to groove fit in practical discussion.

THE process of reproducing disk recordings is done primarily with a mechanical system. The power to actuate the transducer is derived from the force developed between the stylus tip and the sidewalls of the record groove. It is obvious that good contact must be maintained between stylus and groove sidewalls for faithful reproduction. With the introduction of permanent styli, soft thermoplastic record materials, and fine-groove recording, this contact becomes even more important.

Some means of determining the amount and position of contact between stylus and groove is of fundamental importance to the development or design engineer, and:

1. Measurements of frequency response may furnish clues to groove fit if properly interpreted.
2. Another valuable source of information is a proper analysis of intermodulation distortion measurements.[1]
3. A third method, and one simpler to interpret, is simply to compare visually the size and shape of both stylus and groove.

[1] A general discussion of this subject entitled "Intermodulation Distortion Analysis as Applied to Disk Recording and Reproducing Equipment" by H. E. Roys was published in *Proc. I.R.E.*, October, 1947.

*Sound Engineering Section, RCA Victor Division, Camden, N. J.

Resonance and Damping

As stated in the introduction, a phonograph reproducer is essentially a mechanical device. Regardless of the type of electrical or accoustical generator employed, its primary system must be associated with all the advantages and disadvantages of a mechanical system. It is well to remember that a mechanical system usually has a very high "Q". Unless proper damping is employed, resonant conditions may be present.

The mass of the moving system, in conjunction with its centering spring and the compliance of the record material, resonates at some high frequency. Since the stiffness of the record material is usually many times that of the centering spring, this stiffness becomes an important factor in establishing the frequency of the resonance point. This frequency is usually kept near or above the upper limit of the usable frequency range. The mass of the entire reproducer and tone arm in conjunction with the compliance of the centering spring resonates at some low frequency. This is generally known as "tone arm resonance". In considering either of these resonant conditions, especially the one occurring at the high frequency, the stiffness and yield of the record material cannot be disregarded. The term "yield" is applied to any pliable material which changes position with time. This is the property of a material which provides good damping qualities. It does not necessarily imply that the material takes a permanent set in the changed position. When the material takes a permanent set in the changed position, it is known as "cold flow."

The driving force which operates the reproducer is transmitted from the record material to the stylus tip through a linkage formed by the contact between the stylus tip and the sidewalls of the record groove. It is obvious that any variation in the amount of contact area will change the effective stiffness and damping of this linkage, and consequently the stiffness and damping of the entire system. The record material, especially if it is a vinyl compound or some soft thermoplastic substance, has considerable compliance. Changes in vertical force on the reproducer will therefore change the amount of contact area between the stylus and record material due to compliance and yield. The contact area will vary even more with changes in vertical force when using fine groove records due to the small radius of the stylus tip. With a smaller tip, the unit pressure between stylus and record is increased. Differences in size and shape of the stylus and record groove can also vary the contact area. The effect of these differences on frequency response may be quite interesting.

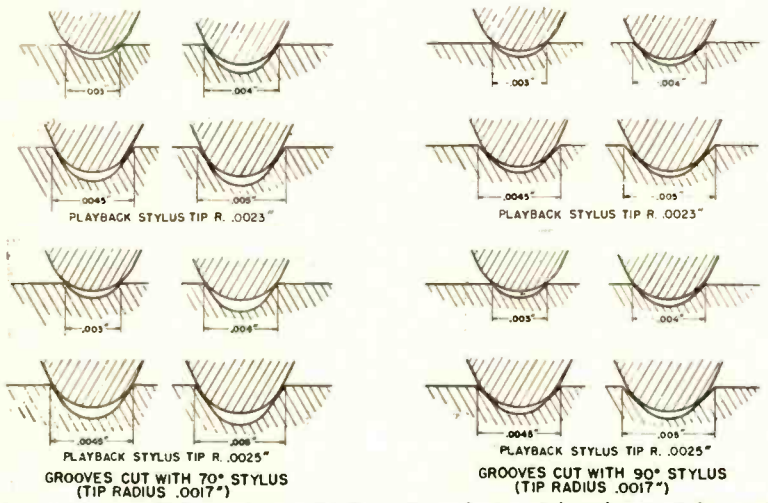


Fig. 1. Groove fit for various radii of the reproducing stylus when superimposed on different groove shapes.

Typical Groove Fit Examples

Figure 1 shows a sketch of the fit between stylus and groove when using various sizes of styli. Under ideal conditions the stylus is pinched firmly between the sidewalls of the groove. The stylus tip should also be well off the bottom of the groove. If the stylus touches the bottom of the groove, the sidewalls do not have complete control of the stylus, and if the stylus contacts the groove too near the top, the irregularities of the surface may introduce

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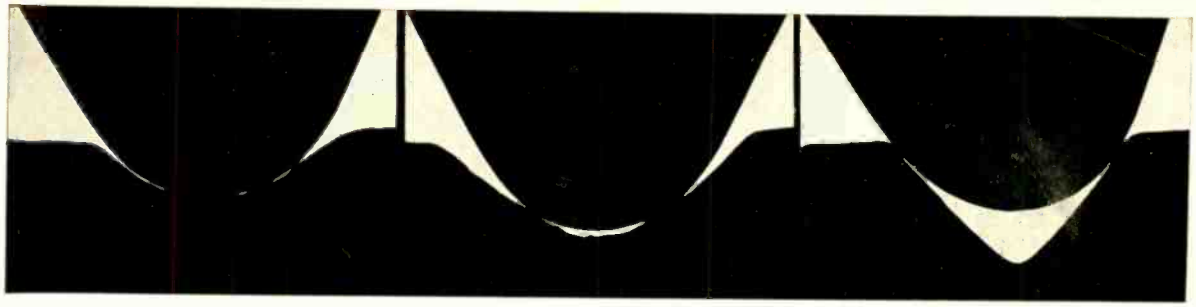


Fig. 2. Shadowgraph of stylus riding on bottom of groove, resulting in curve (A) of Fig. 3. Fig. 4. More nearly ideal groove fit, with curve (B) of Fig. 3. Fig. 5. Groove fit resulting from use of stylus too large for the groove being reproduced. Response curve (C).

noise. *Figure* 2 shows a photograph of an actual stylus and groove illustrating poor groove fit with the stylus touching the bottom of the groove. This photograph was made from a frequency test record with the aid of a shadowgraph projector. The record was first shattered. A section was then selected with a broken edge perpendicular to the record grooves. This section was placed on the projector so that the surface of the record was tilted approximately 20 deg. from a plane through the center of the light beam. The film on which the shadow was projected was tilted approximately 20 deg. from a plane perpendicular to the center of the light beam. This was done so as to correct partly for the error in the included angle of the record groove caused by the angle of the record material in the light beam. This correction method is not mathematically correct due to the keystoning effect on the film, but its simplicity seems to justify its use since the error is negligible for all practical purposes. The stylus was also projected onto a film by means of the shadowgraph projector using the same magnification factor. The two films were then superimposed making a composite picture such as that of *Fig.* 2.

The frequency record used for making the photograph in *Fig.* 2 was reproduced with a standard model transcription reproducer before shattering. The upper trace in *Fig.* 3 shows the frequency response obtained from this test record. There is a noticeable peak in the curve near 8500 cps. This peak is probably due to the mechanical resonance described above. Since there is very poor contact between stylus and sidewalls, as evidenced by *Fig.* 2, very little damping is supplied to the mechanical system from the record material.

A second frequency record was shattered and shadowgraphed in the same manner. *Fig.* 4 shows a photograph of this record. The stylus does not touch the bottom of the groove but is very near. The groove fit is not ideal but is a considerable improvement over that shown in *Fig.* 2. The center curve on *Fig.* 3 shows the frequency response obtained with this test record. The sharp resonant peak of the top curve has now been reduced to a mere hump.

A third frequency record is shown in *Fig.* 5. This photograph shows that the stylus will be pinched tightly between the sidewalls of the record groove. This is not an ideal groove fit because the sidewalls are contacted so near to the record surface that noise may be introduced. The bottom curve on *Fig.* 3 shows the frequency response obtained from this test record. The resonant peak has now been nearly entirely eliminated with damping.

By careful observation of *Fig.* 3, it may be seen that as the groove fit is improved the frequency of the resonant peak is increased. This indicates that the stiffness of the mechanical system has also been increased.

Summary

The layman will undoubtedly question the need for such painstaking care. Even many technical people do not realize the fact that standardization has not been followed in the choice of stylus size by all concerned. Many different radii have been used for the tips of recording styli. Also different depths of record grooves have been used. At the present time, it looks as if this condition will be relieved somewhat. The National Association of Broadcasters has appointed a committee for the purpose of setting up standards for disk recording. This committee has now offered proposals for establishing groove size used on transcriptions. The Radio Manufacturers Association also has a committee working on standards for use with home phonograph records. The R.M.A. committee has proposed limits of 2.5 to 3.2 mils as the radius for reproducing styli to be used with this type of recordings.

The new fine-groove records are cut with a 0.5-mil or smaller stylus and should be played back with a stylus having a tip radius of 1.0 mil. At present, the size of this playback tip is generally accepted by all those concerned with fine-groove records. It is hoped and it seems entirely possible that eventually all disk recordings will be cut with fine grooves and one standard will be established for all classes of records.

In conclusion, if consistency of results and high quality is expected, the factor introduced by the size and shape of reproducing stylus and groove cannot be disregarded.

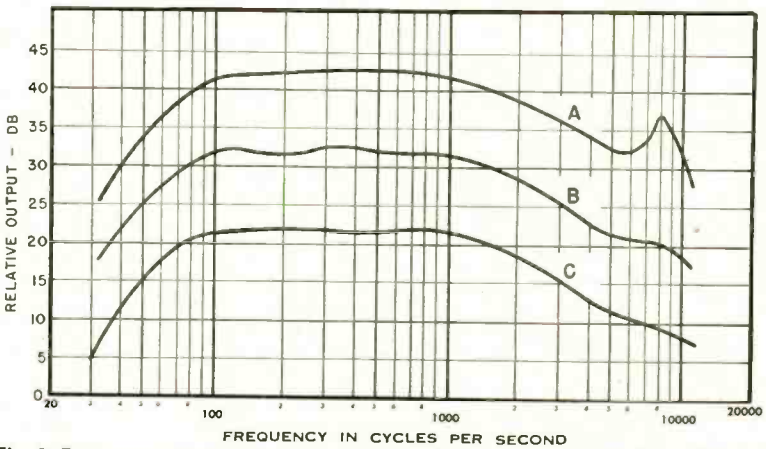


Fig. 3. Frequency response curves made from the same record with three different stylus radii.

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Fig. 1. A portable audiometer with bone conduction receiver at center and air conduction receiver at right. The small knob atleft is for calibration. The large knobs are for frequency and intensity. (Courtesy Bell Telephone Laboratories)

Problems in Audio Engineering

LEWIS S. GOODFRIEND*

Part III. Articulation, its measurement, and its relation to intelligibility in the determination of the degree of deafness.

WHEN THE SOUNDS of speech are joined to form words they are said, by definition, to be articulated and the process is known as articulation. This word—articulation—has been borrowed by audio and communications engineers to describe the ability of a system to transmit articulated speech sounds without reducing the listener's ability to understand them. In adapting the word it has been convenient to express the degree of understanding as the percentage of the original speech sounds fed into the system. This appears to be easy, but after more than thirty years of use of the method there is no standard technique available to determine the percentage of articulation. All of the common systems are similar, and it will suffice to describe only the fundamentals here.

Basically an articulation test consists of a reader who actually makes the speech sounds, the system to be tested, and a listener to record the sound as transmitted by the system. In order to obtain a quantitative result special lists of speech sounds and words have been prepared. In general several lists read by several readers and recorded by several listeners are used.

The types of sounds that go into a list such as the Bell Telephone Laboratories' "The Standard Articulation Testing List" are carefully selected to include all the sounds used in speech. These sounds are combined into vowel-consonant, consonant-vowel, and consonont-vowel-consonant forms. These tests, however, can be used only with trained observers. It is therefore necessary to have lists of English words, of either one or two syllables, and in groups such that they will include all the basic speech sounds. Using only the combined speech sounds it is possible to obtain more information in a shorter time than with word lists, but with the word lists, unskilled observers and callers may be used with the possible introduction of memory and association effects that may cause error.

In the Bell Lab's speech sounds list we find groups like hūs, moush, ár and fōn. In the list of monosyllablic words we find these: tie, thy, by, wing, high, wick, and so on. It can be seen that, with either of these or with the new phonetically-balanced word lists prepared by the Psycho-Acoustic Laboratory, if the degree of articulation of the system is poor, many of the sounds will be confused with others and hence the percentage articulation will be low.

Intelligibility Test

Another form of test that is similar to the articulation test is the intelligibility test. In this type test the listener is called upon to derive intelligence from a sentence, either interrogative or imperative. In either case a single word or mark acts as an indication of understanding or intelligibility. However in this type of test the listener receives cues to hard sounds from context. Nevertheless, it appears to be a fairer test of the usefulness of a piece of sound transmission apparatus, since that apparatus will be used to transmit intelligence, not disconnected sounds.

It is only natural that the articulation and intelligibility tests are used to study the characteristics of rooms—which are actually communications systems involving acoustical paths—and in the study of deafness, which involves both acoustical and psychological paths. To see how they are applied in this latter case we must first understand deafness.

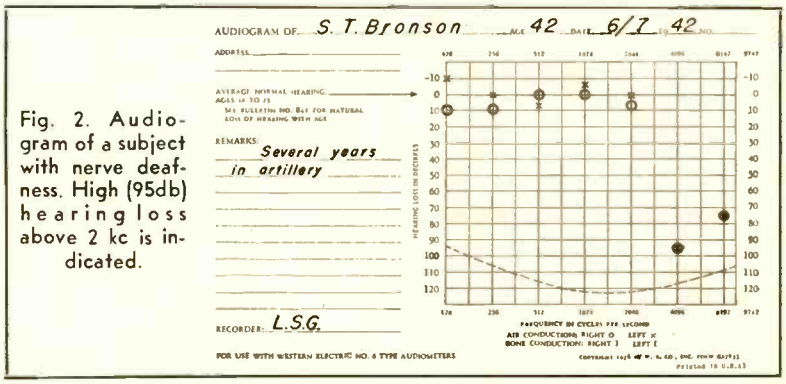


Fig. 2. Audiogram of a subject with nerve deafness. High (95db) hearing loss above 2 kc is indicated.

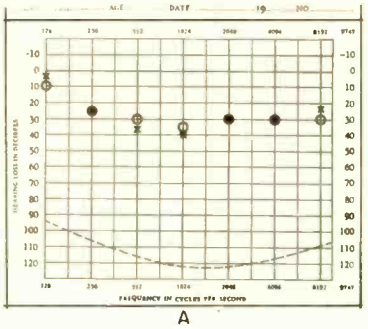
*Rangertone, Inc., 73 Winthrop St., Newark 4, N. J.

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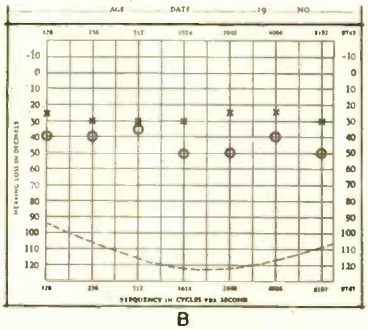
Deafness is the condition that exists when a listener does not perceive sounds of normal character and intensity but has a threshhold of hearing which is considerably above the normal, or when a listener is unable to understand speech at normal levels. Persons who have difficulty in the perception of normal speech and music are assumed to be deaf, but there are many people who are partially deaf and, although their personal efficiency and possibly their social adequacy has been impaired, they are not aware of the condition. To determine qualitatively whether one is deaf it is necessary to measure his threshhold of hearing, and his scores for articulation or intelligibility tests.

There are three common types of deafness: nerve, conduction, and central deafness. In nerve deafness, some of the sensory cells or nerve fibres of the inner ear may degenerate, and a loss of hearing in the frequency region associated with those nerve or cell tissues will result. In conduction deafness, however, the nerve cells are intact but there is some obstruction in the acoustical path which reduces the intensity of the signal as it passes through the outer and middle ear. This can result, for example, when wax blocks the ear canal or gets on the ear drum, or in otosclerosis when a bony material forms about the ossicles and inhibits their motion. In central deafness the nerves and path to the inner ear may function

Fig. 3. Two cases of conduction deafness. Subject of (A) did not require an aid, while subject of (B) did.



A



B

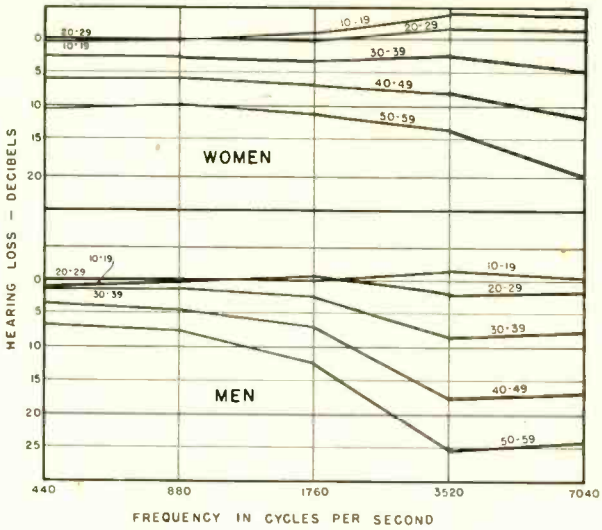


Fig. 4. Results of hearing tests conducted at 1939 - 1940 World's Fair. Hearing loss vs frequency is plotted for various age groups. (*After Steinberg, Montgomery and Gardner; courtesy J. Acous. Soc. Am. and Bell Telephone Laboratories*)

normally, but the brain itself does not take cognizance of the signals from the auditory nerve. This may be the situation in cases of psychological deafness such as battle-fatigue, and in cases of brain diseases or injury.

Threshold Measurement

In order to measure an individual's ability to hear, early tests used the distance a watch tick or coin click could be heard as an index. However, tests of this type include only narrow bands of frequencies and actually indicate threshold only for this group of frequencies. In order to compare the threshold of hearing of a given subject to the normal threshold, we need an instrument that will indicate how many decibels the subject's threshold is above or below the normal. Such an instrument has been devised and is known as an audiometer. *Figure* 1 shows a typical audiometer of the type used to obtain the data, known as audiograms, which will be discussed. To obtain these data the instrument is calibrated with a self-contained calibrating signal, and is then set to the lowest frequency with the output control set to minimum. The level is then raised until the subject indicates that he just hears the tone. To aid in determining this point a switch that cuts the signal on and off is provided. The level at which the subject first hears the tone is recorded and the data for all the other test frequencies are obtained in like manner. In performing the test the subject has the headphone on one ear for the entire run of frequencies and then repeats the test for the other ear. Several factors must be watched carefully in performing this test. The most important is the background noise, which should be very low. Another is the understanding on the part of the subject as to what he shall indicate. Several authorities believe in using cotton in the ear not under test, but this usually does not increase the comfort of the subject and, therefore, may lead to erroneous results. The audiometer may also be provided with a microphone, bone conduction receiver, sound level indicator, and a masking source or provision for masking input. This last item is used when testing the poorer ear in which case the sound travels to the good ear by bone conduction through the skull. It is necessary to mask this tone in the good ear with noise from the masking source. In conduction deafness where the sound path from the air to the inner ear is obstructed, the results of the bone conduction test using the audiometer should be about the same as bone conduction results for a person with normal hearing, and the bone conduction receiver is used for that test. This is the common test for determining whether conduction or nerve deafness exists.

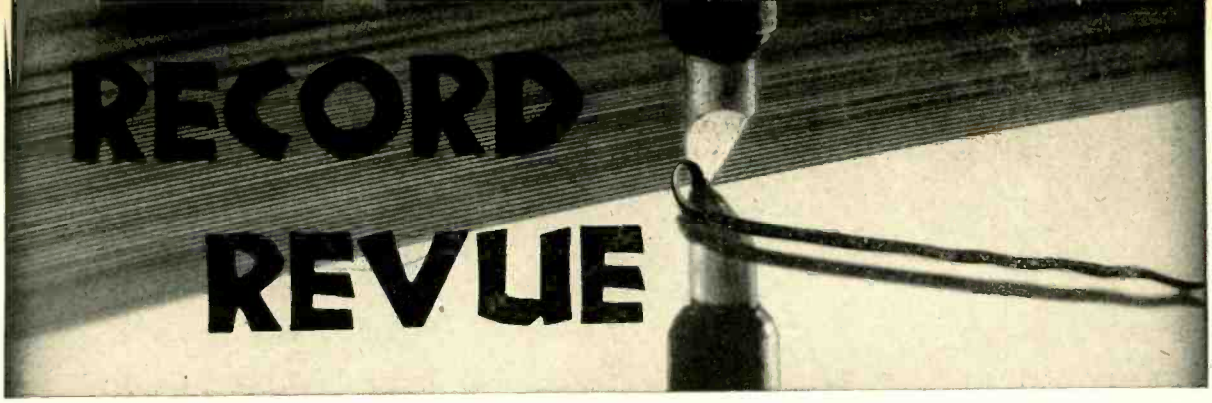
In testing for the ability of a person to meet the problems of daily life (social adequacy) articulation tests prove very useful. A person with partial hearing loss may not require a hearing aid at all in order to maintain social adequacy, although he may have a flat 20-db loss throughout the entire audio spectrum. Other people with "notches" in their audiogram may find it very difficult to get intelligence out of normal speech although their audiogram is almost normal. The microphone can be used to give audiometer articulation tests to find the speech threshold.

Determining Hearing Aid Need

It is difficult to judge whether a given subject requires a hearing aid or not,

[*Continued on page 37*]

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EDWARD TATNALL CANBY*

HAVING DISPOSED of Koeschel & Co. last month, this department moves on to more of those inexplicable terms that constantly stare you in the face (or hit your suavely in the ear as parts of musical titles. This month's main problem is Italian, *allegro con variazione.*

Two aspects to tackle here—the facts and the prejudices. Take the latter first. Now as any Italian knows, the Italian language is just another language (albeit, to him, God's Own language, no doubt). It may be high-flying and elegant or it may be slang or worse. Language, any language, is designed to cover all possible situations. It is a funny thing, then, that whenever a language is borrowed by those who speak another tongue, it turns up high brow. French frieds are just potatoes, but *pommes frites* are something else again. In French Canada a *chien chaud* is exactly what it says, a hot dawg. But in New York it might turn up daintily as a *Saucisson à la Frankfurtois*—and even though that term maybe doesn't exist, it sounds lots fancier than Frankfurter. It's hard for us to believe, but when you go to Paris you'll discover that the French use English terms when they want to be really fawncy, just as we use French.

And so the use of Italian terms in music (to be explained in a moment) is automatically a high brow business, as every radio announcer knows. The higher the brow the better. Your announcer doesn't just rattle off the Italian—he puts sauce on it. No matter that if translated it may mean nothing more than "fairly fast but not too much so"! The Italian musical menu sounds just as superduper (to us) as the French one looks. Therefore, let us first of all realize that this high brow stuff is neither here nor there, or it wasn't when Italian first became common for musical designations. It's neither the music's fault nor the performer's that we insist on it.

And why Italian? Consider first, that music is very much an international language of its own, with national dialects, so to speak, but using roughly the same musical sounds. And music is widely exchanged internationally. The musical notes themselves are universal—they have meaning anywhere—even in Russia. But musical notes (we do not often enough realize) are only the merest approximate indication of the actual sound of music. Composers either (a) expect you to know what was intended or (b) they supplement the written notes with instructions. Even so, with the fanciest instructions, music still isn't written down exactly, or anywhere near it. And so those instructions may loom quite important.

But if music is international, language isn't. And hasn't been since Latin went out as an internationally used language. What to do, if you want your instructions to go along with your written notes? That problem came up first when Europe began to get out of the feudal state and the invention of printing made it possible really to distribute knowledge in written form from one place to another in the mass. Music was a bit late in getting down to the idea of specific written notation, complete with instructions. (Earlier scores take a large amount for granted, including even the choice of voices or any instrument that happened to fit.) By the time it did, the great center of music happened to be Italy. For some two and a half centuries Italy was *the* musical country; almost all musicians were as a matter of course Italians, and Italian music and musical style were carried everywhere. (Germany became a top musical center only in the 19th century and lasted in top position just about a hundred years.) What could be more natural then, that during this period musical instructions were written in Italian, the language that went along with the music and most of the musicians that played it. Italian was so universally used that Handel in England wrote operas in Italian and, later on, so did Mozart, in Austria.

And naturally, the Italian instructions tended to form a kind of slang; they crystallized into fixed phrases that quite often *were* slang—that is, their literal meanings were changed for a special meaning that everybody knew. *Andante* is, literally, a term meaning "to go"; but in music it has been applied to music of a certain speed which seems to "go" right along—yet not fast. Everyone knows, within a rather large plus-or-minus tolerance, what kind of music "Andante" indicates. We find, today, the same kind of thing in our own language, applied to our own musical specialties where we Americans are on top. "Hot", for instance—and that term with its special meaning is already international, as witness the famous French book, "Le jazz hot".

In the long history of music the top ranking place was Germany's for only a short while, and today it is anybody's with Russia and France about equally important and America clearly on the upswing and likely to take over. Many composers have patriotically (if somewhat impractically) used their own language for instructions. Schumann always used German and so did other German musicians. Numerous Britishers have used the British tongue, and Debussy—typical Frenchman—plastered his scores with quite elaborate French. But so far Italian remains, out of convenience, the language that one uses for international purposes; musically it is every composer's second language. The tradition continues because it is still useful, even though Italian music is relatively but a memory nowadays. (Remember that since we today spend most of our musical time in the past, playing older music, the great period of Italian importance is for all intents and purposes still very much with us, even though living Italian composers and performers no longer dominate music.)

I'll save the question of what is meant by the various and confusing Italian terms for a later opus, but one more point before the editor begins to cut this to size. Why do they use Italian instructions for *titles*—especially if they are not really highbrow but merely so much matter-of-fact slang? Why do we solemnly print on our programs such jargon as "*allegro con moto ma non troppo*" as the "name" of a piece? ("Fast—originally it meant happy—with movement, but not too much"). Why, in a symphony of four or even more movements, do we print, one under the other, a whole set of these terms?

Logical, if you look at it. In the first place, music makes its own sense and it doesn't necessarily have to have an explanatory title in the usual sense. It may be just music. A piece doesn't have to be named "Mount Fiddlesticks by Moonlight in September" to make sense. Most music is not given any name at all unless merely to indicate its general type or shape—in which case we usually print that as its official title—rondo, for instance—plus an identification of some sort to distinguish it from a thousand other rondos. But there may be lacking even this, and there usually is. Composers write music, not stories. In fact the only bit of description in printed words that is attached at all to many pieces of music is the simple indication in Italian at the beginning that gives an idea of the speed and/or the mood.

So, if you are to print a program which lists the music to be played and you want a handle for it, there's nothing to get hold of except that—unless you give it a real *musical* title and print actual musical notes! That being slightly impractical, the printed instructions at the beginning are taken as an official title and we speak of "the" andante ma non troppo from so-and-so symphony, which is utter nonsense if taken literally ("We will now play the going but not too much") but quite reasonable and in fact inevitable, if you follow my somewhat lengthy logic!

[*Continued on page 33*]

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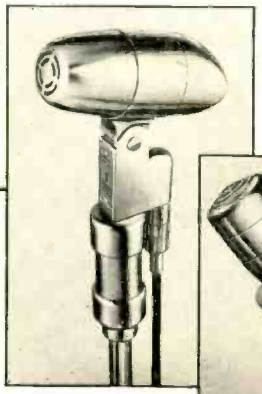
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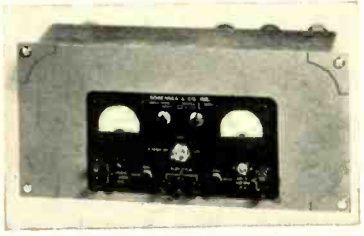
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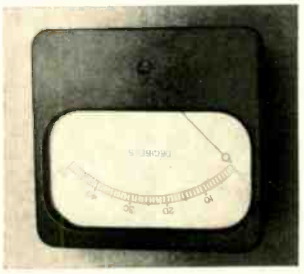
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● **The Sorensen B-Nobatron**, bearing no relation to the above, is a regulated d.c. power supply which provides easily adjustable output voltages in two ranges—from 0 to 325 volts at a maximum of 125 ma, and from 0 to 150 volts at a maximum of 5 ma. Either terminal of the high-current section may be grounded, but the 150-volt supply is connected internally to the negative terminal of the 325-volt supply. In addition, the unit provides 6.3 volts a.c. at a maximum current of 10 amperes. The regulation is within 1 per cent for any voltage setting from 20 to 325 volts over the range from no load to full load. Regulation also compensates for line voltage variations between 105 and 125 volts, holding within 1 per cent over this range at full load current.

The unit, weighing approximately 45 pounds, is available either in a cabinet or for rack mounting. Complete specifications may be obtained from Sorensen & Co., Inc., Stamford, Conn.

● **Anti-Static No. 79**, mentioned in this column in the May issue, is the product of Merix Chemical Company, 1021 E. 55th St., Chicago 15, Ill. This material is a liquid which is simply wiped onto a surface, and when dry will prevent static formation.

● **The Model 121 Logger**, a product of the Audio Instrument Co., 1947 Broadway, New York 23, N. Y. indicates both maximum and minimum program level on the same meter range, and measures system noise level in silent intervals. The output is linear in db, and is indicated on the scale of a meter calibrated uniformly over a range of 50 db, as shown. With the output feeding a direct writing oscillograph through a suitable amplifier, it will record acoustical reverberation, the efficiency of studio operators in riding gain, or numerous other measurements. With generally available oscillographs, the Logger will record level variations as fast as 2500 db per second.

The logarithmic operation is instantaneous, and is achieved by the use of a new material operating with accurately stabilized bias. The built-in meter has the same operating speed as a standard VU meter, and for more rapid action, output may feed a 'scope. Unit includes preamplifier and necessary power supplies.

● **Magnecord, Inc.**, 360 N. Michigan Ave., Chicago, announces a new portable tape recorder mechanical assembly, the PT6-MA, for the professional user. This assembly consists of the basic tape drive mechanism and the auxiliary spooling unit in a portable carrying case, and is designed to work with any of the amplifiers manufactured by the same company. With the larger spools, the combination has a capacity of 64 minutes at a speed of 7½" per second or 32 minutes at 15" per second. At the higher speed the instrument has a frequency response of 50 to 15,000 cps ± 2 db with less than 2 per cent harmonic distortion at full modulation. The unit form of construction permits the user to purchase only such components as are required.

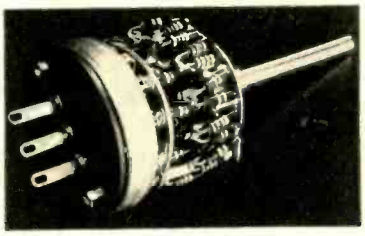
● **"Sig-Max,"** a simple means of matching FM and TV receiver inputs to the antenna, is a device which slips over the transmission line to improve the strength of low-level signals. To adjust, it is only necessary to tune in the weak signal, clip the unit onto the 300-ohm line, and slide slowly along the line to the point where the signal strength is adequate for good reception. Once the correct position is determined, Sig-Max may be secured tightly by squeezing, or it may be held in place by tacks or screws. The device is a product of Telcite Television Corp., East Islip, N. Y.



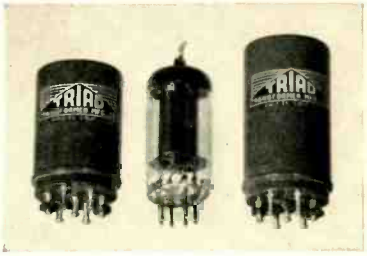
Magnecord, Inc.



"Sig-Max"



Livingston Electronic Corp.



Triad Transformer Co.

● **Livingston Electronic Corporation,** Livingston, N. J. has added to its line of audio products a commercial version of the Loudness Control. This unit provides twenty-three steps of attenuation compensated in accordance with the Fletcher-Munson curves. Fabricated in an aluminum shield can with a three-terminal connection on the rear, it is designed to be substituted for the usual audio grid potentiometer. This control employs a single hole mounting, and requires a rear space of 2⅛" in diameter and 2½" deep. The photo shows the unit with the shield cover removed.

● **Miniature transformers** for a wide variety of low-level, low-power applications are available from Triad Transformer Mfg. Co., 423 N. Western Ave., Los Angeles 4,

[*Continued on page 32*]

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The Language of Audio

JOHN D. GOODELL*

Words are less precise than the means usually employed by engineers to convey a thought. The author clarifies meanings of many common audio terms.

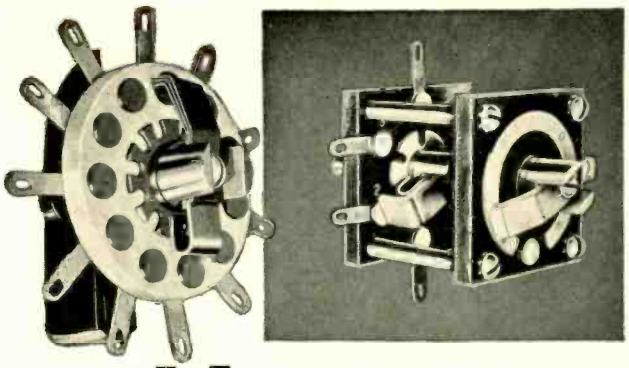
ANYONE who has attempted to describe the character of a certain sound has found himself baffled in an attempt to find words that will surely convey his meaning. In a letter recently received, a correspondent tried for several paragraphs to describe adequately how piano records sounded played on a certain commercial phonograph. He finally wound up with the phrase, "*. . . . .as though someone were beating on a mattress with a wooden spoon.*"

When a group of people are discussing cabinets for radio-phonographs and someone says, "I don't like a lot of fancy carving; I'd rather have the cabinet functional and simple," there is a good chance that everyone will know exactly what is meant. However, if the discussion concerns music reproduction and someone says, "The fiddles sounded a little mushy," the concepts of individuals in the group may vary considerably. Most audio engineers will relate this term to a specific quality of tone, usually to low frequencies, a quality that is the opposite of "crisp." Many people associate the term (as does the dictionary) with excessive sentimentality. It is equally likely that someone checking on the dictionary definition might find under "mush"—'Radio, a noise, like that of frying, heard when a receiving apparatus is tuned to waves from an arc transmitting station; it is due to irregularities in operation of the arc.'

Language of Audio

The language of audio, not the technical terminology but the language with which the character of sound is described, is a bastard sort of language made up largely of words borrowed from visual and tactual terminology. For the novice the terms are often extremely confusing, and even with professionals who have dealt with the problem of such discussions for years, misunderstandings are not uncommon. Many of the arguments about reproduction quality unquestionably stem from semantic confusions. Two people hear the same thing, have the same re-

*The Minnesota Electronics Corp., St. Paul, Minn.

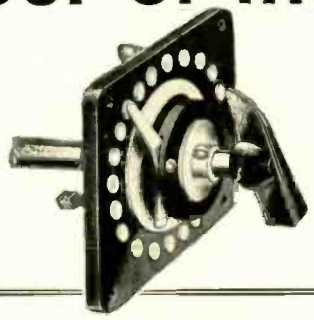


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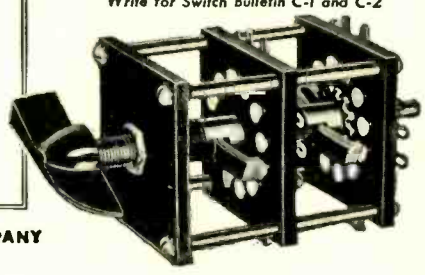
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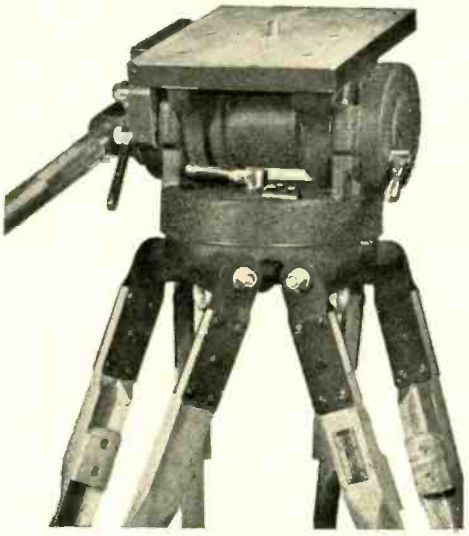
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action to it but use different words to describe it, and wind up debating a non-existent disagreement at endless length.

It is in the hope of providing a basis for accepted meanings of more descriptive terms that this article is written. Perhaps it will be only the basis for arguments, but even this would be desirable if it would lead to a recognition of the problem and an effort at closer mutual understanding. Definitions are a result of accepted usage and they change with time. In most applications of words it is possible to refer to a standard dictionary and find reasonably accurate references for determining approximate meanings. In discussing music reproduction there is a great lack of words that have been sufficiently defined. On the other hand, an unabridged dictionary does contain an amazing variety of audio terms. The trouble is that relatively few people use it to full advantage.

There are certain basic dimensions for sound that can be tied down tightly; others are more difficult to establish. It is unfortunate that even such common terms as frequency and pitch, intensity and loudness, are used loosely as being synonymous. Conveying intelligence by means of words is difficult at best, and in dealing with a subject so inherently controversial as music reproduction it is surely important to make an effort toward rigorous definition and usage.

Among the more serious dangers is the one illustrated by the two pairs of words mentioned. In each case one is a subjective observation, the other a physical measurement.

Basic Measurements

The basic absolute measurements that can be made of pure tones are frequency and intensity. Pitch is a subjective observation that is principally dependent on frequency but can be appreciably affected by intensity. Loudness is a subjective evaluation that is primarily a function of intensity but is strongly influenced by frequency. It is interesting that a few words have both physical and subjective validity. Typical of these are the terms "low" and "high." As a physical measure they pertain to a rate of occurrence with respect to time. Subjectively a low frequency appears to come from a lower point in space than a high frequency, though both may actually have the same source.

A considerable portion of the material that follows represents the results of a series of five listening tests. These were conducted at different periods us-

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ing between 25 and 50 observers, not more than 20% of which could be considered highly trained in listening. These tests were conducted solely for the purpose of checking the concept of terminologies. All conclusions are based on a minimum of 80% agreement from at least four out of five groups. Sources of sound included live music from acoustic instruments, electronic musical instruments, recorded music and various laboratory devices for the direct generation of sound. The tests were conducted in three different locations under considerably varied acoustic conditions. Subjective suggestion was employed only to the extent of indicating the quality to be observed. Every effort was made to avoid psychological influence. Confirming experimental work previously accomplished by others is referenced in many instances.

Volume

A term that has led to a great deal of confusion is volume, particularly in its common use as a nomenclature for the gain control. This has probably become so firmly entrenched in the minds of the public that it must be accepted but it is a peculiarly unfortunate choice. To the public at large, and even to many non-professional audio enthusiasts, the percentage of maximum output power obtained, regardless of signal source, is thought of in quantitative relationship with mechanical rotation of this control. Volume becomes a loosely used synonym for output power, intensity and loudness. This means that it may be almost impossible to recover it for usage in its valid connotation as an audio dimension. It has been experimentally determined that volume may be observed as a quality of sound that varies inversely with frequency. In this usage it is undoubtedly related to a physical concept of size. The lower the frequency, the greater its apparent size—yet size is inadequate because the concept should be three dimensional and this implication is lacking. Volume, however, is almost perfectly descriptive. Again it is interesting to note that there is a relationship between the volume of the instrument producing the tone and the subjective evaluation of the tone itself.

Density

One other dimension of pure tones has appeared to have experimental validity. The word is *density* and it is shown to be directly proportional to frequency. There has been an effort to demonstrate that the derivation of this concept is associated with the density of the stimulation in the nerve structures. In view of the fact that untrained observers with no knowledge of the mechanism of perception are able to recognize this quality and differen-



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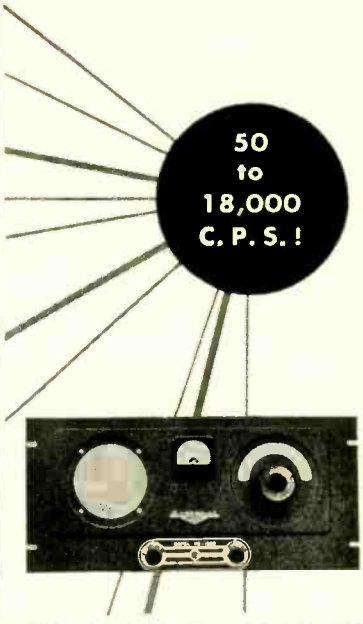
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tiate it, this seems an unlikely theory. On the other hand, high-frequency wave forms in air are obviously denser and more compact than low frequencies. At any rate, the word is clear in its descriptive quality and is readily demonstrable as a dimension upon which groups of observers will agree.

In logical sequence, terms should now be considered that apply to isolated tones of complex wave form. All the terms used for pure tones are equally valid with regard to complex tones, provided that the fundamental is strong enough so that the observation of pitch may be definitely ascribed. There are endless adjectives that *may* be used to describe the character of complex tones as differentiated from pure tones, but only a few of the more common ones are mentioned here. Brightness is a characteristic that is observed in connection with pure tones, but appears experimentally to be synonymous with density rather than being a separate dimension. In connection with complex tones it is a function of harmonic structures and is particularly influenced by the odd order of higher harmonics. Experimentally, the addition of a second harmonic does not appear to affect appreciably the quality of brightness, while even a relatively small amount of third and fifth harmonics has a pronounced effect. This quality is also affected directly by intensity, is directly proportional to fundamental frequency and is influenced considerably by the rate of attack. A bell tone, for example, even though it may be produced from a pure source, appears to have appreciably greater brightness than a continuous tone or one with a slow attack. Doubtless this could be tied down to the presence of upper partials in transients inevitably associated with abrupt attack. An excellent example of this is observable with recorded piano tones. If the recording is observed by playing it normally versus playing it in reverse, the normal rendition of the tones will appear to be very bright by comparison with the tones played backwards where the attack is extremely slow and gradual. The frequency content and the average intensity will be essentially the same, and the only factor that is obviously varied in this experiment is the rate of attack. The term also bears some relationship to the rate of decay for staccato playing appears brighter than the same music from the same instrument where the notes are largely sustained.

Brightness

Musicians often refer to one key as being brighter than another. It is conceivable that some musicians are able to differentiate this on a basis that is



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not related to any specific piece of music but, if so, the quality appears to be as rare as perfect pitch. In all experiments with random observers, the higher keys for a specific piece of music sounded brighter. In the one experiment conducted with musicians this was equally true, except for a few who insisted that they could differentiate the sharp keys from the flat keys on the basis of brightness. The only physical basis readily conceivable for this would have to do with fact that the perfect pitch of C sharp, for example, is not the same as D flat.

Many terms for complex tones stem directly from concepts of shape. "Round" is associated in the observer's mind with a tone that he thinks of, literally, as being round in shape. Experimentally this seems to be associated with tones that have a predominance of even harmonics (although this is far from a limiting factor), and especially with tones that have a fairly slow attack with a minimum of initial transients. It has to do with continuous tones rather than abrupt tones. It is most often applied to horn tones, vocals (especially sopranos) and to certain organ tones. On the other hand, it would rarely be applicable to a violin tone or an oboe.

"Thin" might be chosen as an antonym although it must not be implied that this is a matter of black and white. A violin tone might not be considered round, but still not be thin. The word "thin" is recognized as being descriptive of sounds with a relatively weak fundamental and strong, very high harmonic content, particularly odd order harmonics. It is also used to describe orchestral arrangements lacking in adequate bass, as well as reproducing systems with poor low frequency response.

In discussing the quality of a reproducing system, it is seldom that its ability to reproduce a straight melodic line from a single instrument is considered. It is worthwhile to digress to the extent of pointing out that this fact may well be the basis for some of the confusion experienced in listening tests. It is not intended here to minimize the importance of having a system capable of responding properly to the full impact of an entire symphony orchestra. The point is that listening tests are terribly confused by psychological factors and also by the extremely complex dynamic wave forms the ear is required to judge. It is educational and interesting to investigate the qualities of a system on the basis of reproduction of individual instruments. For many reasons, a discussion

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of which in detail would be out of place here, it is often easier to select the better of two high quality reproducing systems on the basis of such an observation. Many engineers find speech more revealing than music, perhaps for this very reason.

Fuzziness

"Fuzzy" is applicable to single tones, and also may be used to describe the over-all characteristics of a system. Usually it has its source in non-linear distortion where it is applied to reproducers. Deliberately introduced harmonic distortion, however, appears to bring a response from observers of a change in character—an increase, for example, in brightness or even harshness. Fuzziness is more related to intermodulation or to extreme alterations in quality such as might stem from a rubbing speaker cone or a stylus striking the pole piece of a magnetic pickup.

The antonym for "fuzzy" is "clean." This is perhaps the most expressive and satisfactory word available for describing extremely good reproduction. Still, it is by no means an all encompassing term. It means freedom from non-linear distortion when applied to reproducing systems. It means unwavering attack of each note (whether it be abrupt or slow) in describing live music. "Clean" is probably synonymous with "clear," but in the mind of the audio engineer is more satisfactory because it expresses freedom from fuzziness and from any non-linear distortion. Again, though, a limited amount of harmonic distortion does not always reflect any lack of cleanness to the observer, while intermodulation is instantly detected as affecting the clean quality of reproduction. There is one more difference between "clean and "clear." "Clean" does not contain any implication of frequency response. "Clear" may, on the other hand, indicate something about the high-frequency characteristics of a system, particularly with reference to some instruments with very high fundamentals.

Serious music (either classical or jazz music may under proper circumstances be so classified) is recognized as a vehicle for conveying an idea or mood—call it what you like—between the composer or performer and the listener. It is reasonable then that the words chosen for describing it should be words that correspond to a subjective experience that the music suggests. "Hard" is a term that is commonly used for tones that are relatively loud, that have a fairly abrupt attack and have harmonic content that may be small numerically but is strong in relation to the fundamental. It would seem reasonable that this word would

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be the antonym for "soft," but such is not the case. A tone may seem hard and still not be loud, while "soft" is used to describe relative loudness only and not to indicate other qualities.

If the reactions to sound were objectively measurable quantities, the problem of conveying understanding by means of words would at least be simplified. Anyone who believes that the problem is unimportant is invited to review the literature of semantics. It isn't too easy to talk about everyday practical matters and be sure of conveying exact meanings, much less a subject of such tenuous and complex ramifications as subjective reactions to audible energy.

Audio Language Growth

The language of audio grows as a result of one person's expressing his reaction to a certain quailty of tone in terms of his subjective association of it with something quite different. An observer feels that the adjective applies in terms of his own reaction and uses it again himself. This is the history of all language except for words that are deliberately built from other words of long established meaning. It is a natural but dangerous and difficult way for a language to grow. Many words that have purely subjective implications must develop in this manner through usage and somehow, intuitively, most people who hear the word may understand its meaning almost exactly as it is intended by the individual who uses it. It is important that this be a hoped for goal, and not one that is taken for granted. With words that can be tied down to objective definitions, it is of utmost importance that they be used correctly. It is well worthwhile for everyone periodically to check the dictionary definitions of the words they most commonly use, and to make an effort to conform reasonably with this reference for established concepts.

In connection with spoken words, there is the great advantage that the listener may question the meaning (though he doesn't do so as often as he should when he isn't certain of understanding), and elaborations will serve to clarify any possible misunderstanding. Inflection and all of the remarkably varied qualities of the voice may lend intelligence and understandability to words when they are spoken.

The written word is quite another matter. Requests for definition are not possible from the reader. Usage is considered to be more authoritative and may more greatly influence general concepts. Few people ever reach with the spoken word the enormous audience that is possible to the person who writes. Consequently every word that is written has much more influence,

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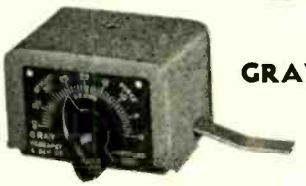
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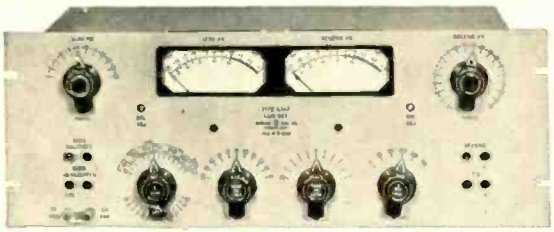
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may lead to greater misunderstanding and greater confusion, than a thousand words spoken in general conversation. It therefore behooves every person who has the privilege of conveying his knowledge, his thoughts and his ideas by means of words on paper to be extremely careful that he be rigorous and accurate in his use of the language.

It is more than likely that this article contains many of the mistakes it condemns. It is not possible in its limited length to do more than present the problems involved in very brief outline and to indicate the derivation and definition of a few of the most commonly used words. If it serves only to emphasize the importance of the problem, to aid a few people in examining the meanings of the words they use, it will have been well worth writing. Words are without doubt the most powerful tools that men possess, and progress of all kinds depends directly on the development of associated verbal methods of conveying intelligence. Unquestionably a large portion of the misunderstandings, arguments and disagreements in the audio industry are a function of semantic confusion. Progress has been and will be intimately related to the accuracy with which knowledge is disseminated by means of words.

NEW PRODUCTS

[*from page 24*]

Calif., with two new hermetically sealed types known as "Trijets." Both are $\frac{13}{16}$" in diameter, and mount by means of two 2-56 studs on $\frac{7}{8}$" centers. Type JO is 1-13/32" high, while Type JOA is 1-25/32" high. Where needed, 40-db alloy shielding can be supplied, and transformers can be fabricated to specification in a minimum of time.

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RECORD REVUE

[*from page 22*]

Naturally if there happens to be a better title it gets used. If your composer calls his piece "The Sunken Cathedral" or "The Afternoon of a Faun," so much the better. But, again, it must be remembered that such titles are in a way freaks, for music speaks in terms of *music* first of all and to describe music in exact *words* is like trying to translate something that can't really be translated, rather merely suggested. From this point of view, you see, the use of the Italian terms is an excellent idea for at least they tell you something specific about the music itself. What more could you ask?

Recent Recordings

Walton, "Facade" (to the poems of Edith Sitwell).
Edith Sitwell, Reader; Chamber Orchestra. F. Prausnitz.
Columbia LP: ML 2047 (MM 829)

● Here is an extraordinary LP. (The standard album is not yet released.) It is recorded here as performed with great *éclat* this spring in New York's Museum of Modern Art, with the great Sitwell herself reading her own poems to the music, as in the first performance twenty-five years ago. This will fascinate you or violently repel you—perhaps both! The stuff was put together in the high 20's, when William Walton (he was 19) and Miss Sitwell were strictly *avante garde* young people; it was one of the typically dizzy, jazzy, experimental efforts of that time, out to shock, funny, brassy, inelegant (but it seems elegant now, in spite of the jazz in it). It shocked all right. Noel Coward walked out before it was halfway through. But the early recording, made soon after, has kept turning up here and there ever since as an increasingly valuable collector's item; now, what with the enormous publicity the Sitwells, Edith and brother Osbert, got on their visit here (see recent *Life* magazine) the piece finally comes into its own, and if you don't enjoy it, or enjoy being mad at it, your blood pressure must be low.

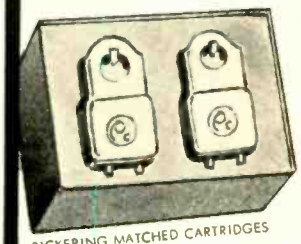
The piece is a combination of music and narrator, but, as you'll very quickly find out, something utterly different from the now-so-smooth radio technique of music and voice that we are so accustomed to. Today, it's the fade technique: music down, voice up, musical bridges, music in and around and behind the voice. And a wonderfully effective technique it is. But Walton and Sitwell were strictly pre-radio. Background music didn't exist, nor did bridge music. Here you have a squawky, weedling, jazzy waltzy small orchestra that never stops a second except between poems, and you have Miss Sitwell's jazzy mellifluous, full-bottomed poems, never stopping for a split second. An extraordinary effect, for the two occur exactly in time, simultaneously, and neither gives way a fraction of a decibel to the other. The battle is humorous but relentless to the very end; the forces are exactly equal and the energy produced is fabulous. Only way to cope with it via the ear is to listen first to one, consciously, then (on the next playing) to the other. La Sitwell has Personality-plus

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such as you've seldom heard, a deep bass voice and a balloon-full of breath plus a superb sense of rhythm and timing. Moreover there is a devilish spark of enjoyment perfectly visible in her eye! No need to see it; you can hear it.

Recording? Excellent. Of all pieces this perhaps takes top prize as benefiting the most from "high fidelity". I've heard it wide range, and on a small radio (approx. cut-off 3000 cps) and the difference is incredible both in the orchestra's tone color and in the sibilants of the spoken words. Music? Dry, witty, humorous, good stuff for a 19-year old (or anybody, for that matter). A fine tango and a fox trot, some fake hill-billyish stuff, a wonderful take-off on "William Tell" (the figures in the accompanying poem) with odds bits of the familiar music worked in. Poems? Amusing, surrealistic, semi-intelligible, highly expressive mumbo-jumbo. You get a bit more on each hearing. Shades of Gertrude Stein (who also had a sense of humor)!

Strauss, Salomé; final scene.
Ljuba Welitch; Metropolitan Opera Orch. Reiner.
Columbia MX 316 (2)

● And here is the extreme opposite and an excellent contrast to the Walton-Sitwell madhouse. This, twenty-odd years before, was one of the two operas-to-end-all-horror-stories perpetrated by Richard Strauss upon a staggering world. (The other was the suave, murder-ridden, lustful "Elektra", recently recorded in part by Beecham.) Salomé, the gal who asked for John the Baptist's head and then made love to it, does exactly that in this scene and in the greatest of detail. She smacks her lips and you shiver your spine. Nevertheless, it's a scene whose clinging horror is undoubtedly a masterpiece of music drama. Welitch is one of the superb voices of our time, newly discovered in this country. Absolute control, a fantastically accurate sense of pitch, a high feeling for drama, an intuitive sense of style are a few of her outstanding accomplishments.

The recording made practically yesterday and rushed through processing, is as fine as anything Columbia has done. A departure from earlier Columbia Met. Opera recordings is the placing of the voice at stage distance (as one hears it) instead of close-up. It was interesting, for instance, to hear a voice like Pinza's almost tonsil-close in his "Mozart Opera Arias" album; but the present arrangement is musically far better. Keep an eye and an ear on Welitch.

Bartok, Concerto for Orchestra (1943).
Amsterdam Concertgebouw Orch. Van Beinum.
Decca ffrr EDA 105 (5)

● If you tried out the recent Columbia version of this, standard or LP, by Reiner, you may want to compare. This is a fine performance of the modern but very easily listenable music, though at times it seems a bit stolid and heavy as compared with the always dynamic Reiner version. It has all the beauty of ffrr recording, but once again the standardized ffrr acoustics (always the same ultra-live effect) are not entirely suitable. The Columbia version comes out better. Trouble, though slight, comes from the fact that this is a concerto for

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whole-orchestra and numerous soloists within the orchestra—there is wonderful music for solo clarinets, trumpets, oboes, etc. Columbia, with considerable close-to accentuation, brings out these solo passages beautifully; ffrr, smoother and finer in over-all sound, keeps the soloists in the background via (evidently) a distant, one-mike pickup. In either version, in any case, this is a fine piece for test purposes, what with the combination of a big, romantic orchestra, lots of brass, and the profuse solo work for all sorts of instruments.

Liszt, Orpheus (tone poem).
Debussy, Printemps (symphonic suite).
Sir Thomas Beecham, Royal Philharmonic orchestra.

RCA Victor DM 1295 (2)
DM 1293 (2)

● Two more in the current series of odd Beecham items being reissued here by Victor. Both are well recorded with appropriate acoustics, both a somewhat less than brilliant in the highs, posing the usual question —what did the British originals (they're suppose to reach 20,000 cps) sound like? "Orpheus" is one of the quiet, introspective pieces; its moods, today, seem corny—all sweetness and light, with a harp (lyre) for Orpheus. But L. was no piker; the stuff grows on you and may well become your favorite bit of romantic music, for a while. "Printemps" is early and seldom heard Debussy, written before he had worked into his later and famous Impressionist style. This one impresses all right but it's about one half sweetened Tchaikowsky. Fine if the style pleases you. Though it's hardly important music this is a great deal better than a lot of the pretentious music in similar style we hear today at the movies. It makes a fine background.

Liszt, Les Préludes (symphonic poem).
Leopold Stokowsky and His Symphony Orchestra.

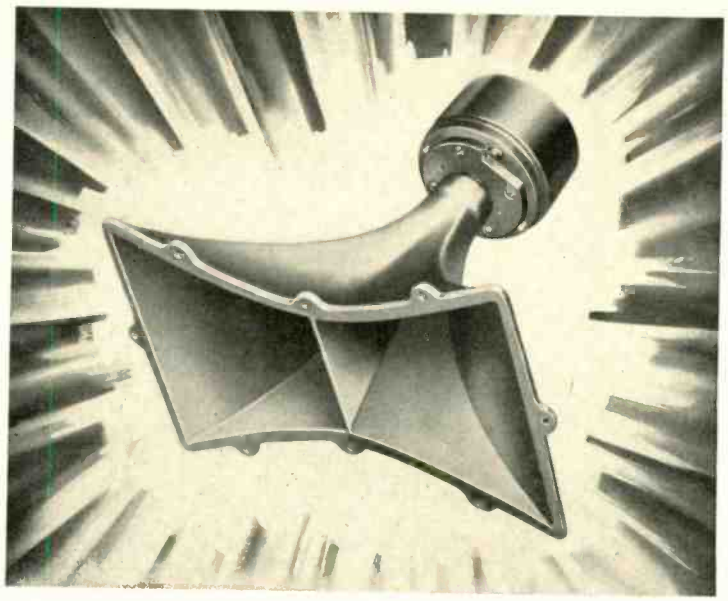
RCA Victor DM, WDM 1277 (2)

● This stands next to "Orpheus" in a Liszt group of symphonic poems and it couldn't be more opposite in effect. "Les Préludes" is the brash, noisy, brilliant kind of Liszt. It has every stock movies mood you've ever heard but the dominant one is the heroic. This is Lizt as the P. T. Barnum of music and it is hardly surprising that as a show piece it's heard in a thousand performances to one of the more quiet "Orpheus", as well as in dozens of earlier recordings. The Stokowski performance here, plus the best of RCA's recent recording, makes it sound good; this is one of "Stoky's" more careful and (relatively) restrained efforts. When he's in that mood. Stokowski is absolutely tops.

Strauss, "Rosenkavalier" waltzes.
Boston "Pops" Orchestra, Fiedler.
RCA Victor 12-0762 (1); 49-0307 (1 Vg)

● One of the first offerings on both standard and 45. (Why must RCA assign different numbers—when the *albums* in standard and Victorgroove have the same number?) Musically a rather heavy-handed job for the usually sprightly Fiedler gang (better known as the Boston Symphony). The phrasing here is oily, greasy (the phrases

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run together without the clean, crisp articulation one might expect from Boston) and the whole adds saccharine to maple syrup. Acoustics good, recording variable: side 1, shellac, seems distorted, as though playing stylus were worn, but side 2 is markedly clearer. The same is apparent on the Victor-groove versions, indicating perhaps a common faulty original at some stage. (Possibly this applies only to a few copies.)

Chausson, Symphony in B flat, opus 20.
Minneapolis Symphony Orch. Mitropoulos.
Columbia MM 825 (4)
LP: ML 4141 (1)

● Another example of the Columbia tendency to wide-range but overly close and dead recordings of Romantic works—that by rights should have a big, spacious, live sound. (Note that Decca ffrr is often exactly the opposite, with big, live recordings of music that should be sharp and dry.) This is probably not too recent, but that is of little matter. The string tone has technically a wonderful edge and clarity here, brasses too are sharp and piercing but clean—and for those who are not too bothered by the wrong-style acoustics it makes a good demonstration record. Musically, this is another of those post-Franck works that, if you like the Cesar Franck symphony will please you for similar reasons. Chausson was one of Franck's most devoted imitators and with considerable success. The performance here is full of life and full of rather careless playing, notably in the strings. Sounds like inspired sight reading in some spots.

Schumann, Symphony #4 in D minor.
Cleveland Orchestra, Szell.
Columbia MM 821 (3)
LP: ML 2040 (1)

● Here's another similar to the above—but with better playing, not quite such dead acoustics. Szell's Cleveland Orchestra tends to play a bit on the rough side in its recent new Columbias, making his Mendelssohn for instance, something less than suave and perfect for Schumann it is good and the Szell intensity makes it exciting. Compared to older European recordings this one is, again, too close, too dead for the romantic music; clean, sharp qualities do much to make up for it. Here I have tried both LP and standard and (allowing as always for the numerous inevitable differences in playing conditions, curves, equipment etc.) my impression is that the LP version in this case is considerably superior. Shellac sounds relatively blurred and dull.

Mendelssohn, Symphony #4 ("Italian").
Cleveland Orchestra, Szell.
Columbia MM 733 (3)
LP: ML 4127 (1½)

● Here is the same outfit, in the Mendelssohn style of music—more precise, less romantic, requiring more accurate, exact and skillful playing. Szell makes this familiar symphony more exciting and more intense than you've ever heard it before, notably in the last movement; but in the long run the RCA Victor recording (DM 1259) of Koussevitsky is much nearer the music's intentions. Acoustics in the Koussevitsky are broad, spacious, gracious, like the music; Szell's are again rather hard and dry (accentuating the somewhat harsh, driving performance). Koussevitsky's famous strings beat the Cleveland's by far. The LP reverse has a Capriccio for piano and orchestra of Mendelssohn, recorded back before the war.

Tchaikowsky, Symphony #6 ("Pathetique").
NBC Symphony Orchestra, Toscanini.
RCA Victor DV 27 (5 pl.)

● This luxury item on plastic is, I suggest, nothing you'll want to have; the Sixth is best heard on several European recordings of earlier days, occasionally to be found in this country at specializing stores. The Toscanini performance is, true to form, extremely intense to the point of nerve-frazzling, but to my ear it is cold as a stone and quite lacking in the measured expansiveness that is the only justification for Tchaikowsky's music, the broad, weeping emotion that some conductors, oppositely to Toscanini, overdo until it fairly drips. Not so here. And the recording, like most of the Toscanini jobs, is narrow, very dry and altogether unsuited to the music. (It is clearly noticeable, during the past few years, that the NBC as recorded with other conductors comes out with a better recorded sound than with Toscanini. No doubt a matter of conductorial cooperation in the always-touchy job of placing microphones, arranging personnel.)

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PROBLEMS IN AUDIO

[from page 21]

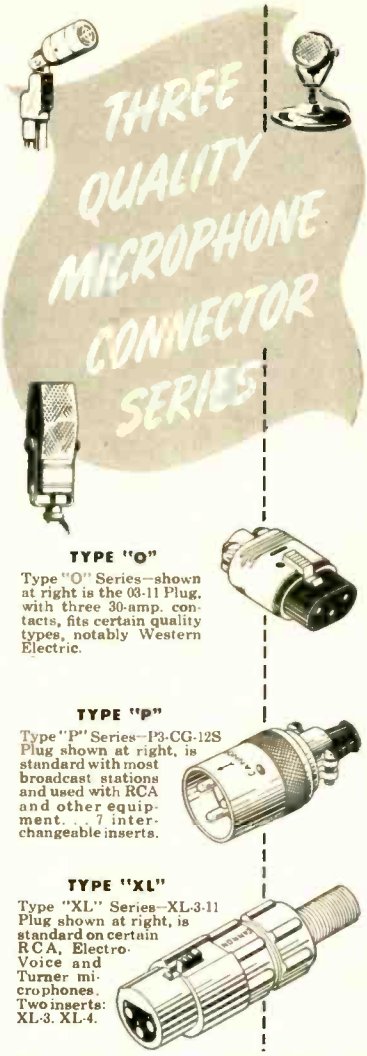
and illustrative audiograms are shown for typical cases. However, these should not be used as indices by the hard of hearing. Each person is subject to a particular set of circumstances and should consult his own physician.

Figure 2 shows the audiogram of a man with high loss above 2000 cps, but who had no difficulty in conversation or work. This is a case of nerve deafness. Examples of conduction deafness are shown in *Fig.* 3. Although the person with the audiogram of (A) has a 30 db loss, he did not require a hearing aid: the subject of the audiogram of (B) did.

It is of interest to note the results of the tests conducted by Steinberg, Montgomery, and Gardner at the New York World's Fair in 1939 and 1940. They are shown in part in *Fig.* 4. These curves show the average hearing characteristics in the age groups indicated. The increasing loss at high frequencies with increasing age is attributed to degeneration of the sensory cells. In the higher age groups particular cases may require hearing aids; this is not to be considered a strange malady, but a normal occurrence with increasing age.

Two additional effects which accompany deafness are tinnitus and recruitment. Tinnitus is the name given to the "ringing" sound heard when people are fatigued or have been subject to loud sound for long periods. It also occurs as a result of non-acoustic stimulation of the nerves in the inner ear. Such non-acoustic stimuli can be pressure on the eardrum or actual degeneration of the cell tissue or nerves. Recruitment is the name given to the phenomenon occurring with people who have hearing loss for low intensities, and normal sensitivity for high intensities. Often the sensitivity for high tones may be increased. The person suffering from this condition becomes annoyed when people raise their voices. The subject first complains that he cannot hear and then complains that the speaker is shouting.

This article has sketched the uses of articulation and intelligibility tests and has presented a brief outline of certain conditions arising in deafness. The references already listed in the previous articles have valuable material for those who wish to make a complete study of the subject. In particular, Dr. Hallowell Davis's "Hearing and Deafness" gives a good non-technical treatment of these three topics. The next article of the series will begin the study of sound generators.



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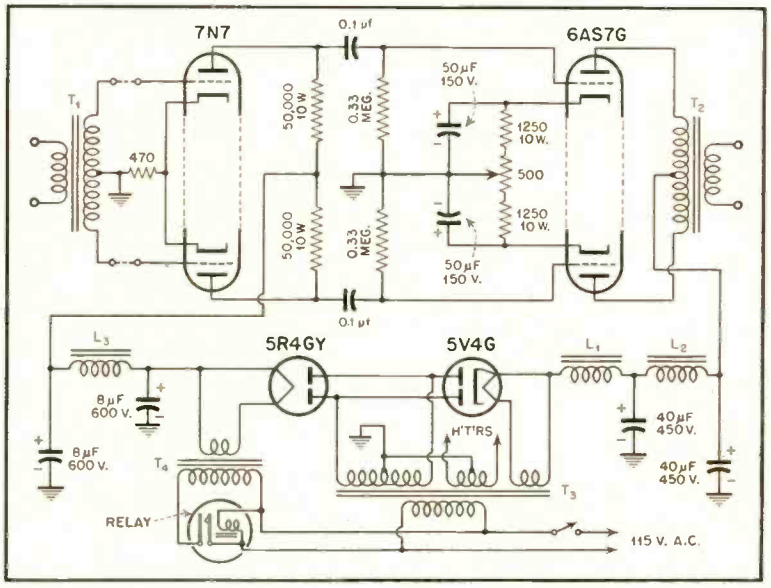
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Techni-Briefs

FURTHER NOTES ON A 6AS7-G AMPLIFIER



IN THE October 1948 issue, the writer published some notes on a 6AS7G amplifier. Since then, the driving stage has been modified; it is still push-pull throughout, but it now uses resistance-capacitance coupling instead of transformer coupling. In view of the large voltage needed for driving the 6AS7G, the voltage drop across the plate resistor is compensated by a rather large power supply voltage: with each half of a 7N7 taking 9 ma at 250 volts on the plate, the voltage drop across a 50,000-ohm plate resistor is 450 volts, and a supply voltage of 250 + 450 = 700 volts can be used without going beyond the tube ratings. The supply voltage employed is of the order of 530 volts, which is obtained by using the same power supply transformer with two different rectifiers. A 5V4G with a choke-input filter gives exactly 300 volts needed for the 6AS7G, and a 5R4GY with a capacitor-input filter gives 530 volts for the 7N7. An Amperite 15-second time relay delays this voltage until the cathode of the 7N7 is hot.

A 7N7 is used instead of a 6SN7GT, because of the symmetry of the socket connections: this allows symmetrical wiring, with extremely short connections. The circuit is shown above.

The two cathodes of the 7N7 have a common resistor. Two different resistors can be used, and a certain amount

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of feedback introduced there. There is room for experimentation at this point. If the amplifier is to be used with a single-ended tuner with a pre-amplifier, any conventional system of phase inversion can be used.

Using the same parts as for the amplifier previously described, it may be said that, there is a slight, but definite, improvement in quality. The volume is about the same.

John van Heijenoort
27 Coolidge Ave.
Amityville, N.Y.

AUDIO AMPLIFIER

[from page 14]

trols. A partially by-passed screen circuit is used to provide current feedback, which reduces distortion and raises the input impedance of the booster tube at high frequencies. This effect makes the frequency response essentially independent of mixer adjustments.

The driver and output stage use tube types 9001 and 6AK6 respectively. Inverse voltage feedback is taken from a tertiary winding on the output transformer to the driver stage to minimize the overall distortion and noise. The output impedance is changed from 150 to 600 ohms by changing the two load windings from the parallel to the series connection. The 6-db isolation pads are inserted between the transformer and the output receptacle for both 150- and 600-ohm connections.

Typical performance characteristics are shown in *Fig.* 4. The frequency response is within 1 db from 50 to 15,000 cycles. The distortion is less than one per cent from 50 to 15,000 cycles. Noise is 70 db below the standard output of +18 dbm with the controls in typical operating positions. The maximum gain is 93 db.

The proportions of the amplifier case make it very easy to carry. It is narrow enough so that it will hang freely without bumping into the operator's legs. The amplifier is light enough to be truly portable. The design objective of a single unit amplifier with high level-mixing and emergency battery operation has been accomplished.

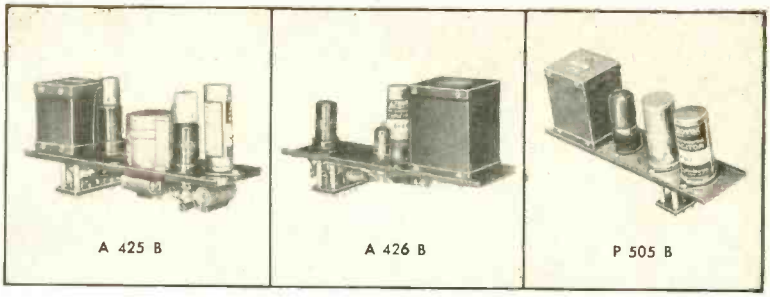
LETTERS

[from page 4]

inite 120-cps tone, even if I stopper my ears. I have observed it for many years and there is no mistake about my actually *hearing* it (no "bats in the belfry"). Is this a form of Auditory Persistence similar to the persistence of Vision? Comments through your Letters Column by others with similar experience may lead to important new knowledge in this field.

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14	—55 dbm	250, bal.	6½	135 v	2.2 ma	1.25 v	50 ma
16	1.5 mv, open cct	500, unbal.	4½	300 v	3.0 ma	6.3 v	200 ma

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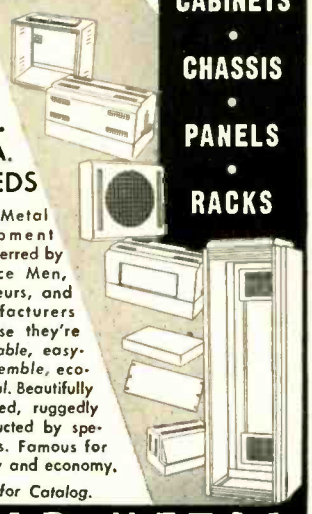
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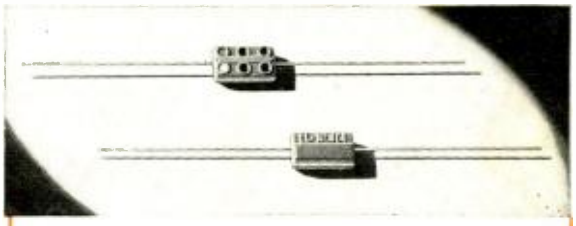


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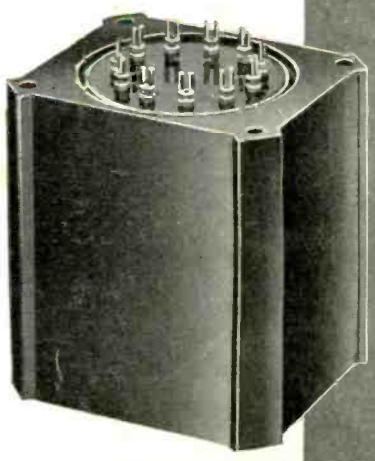
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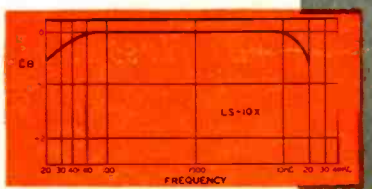
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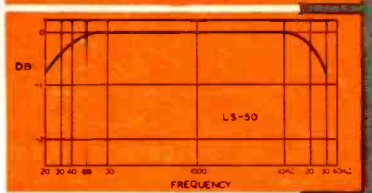


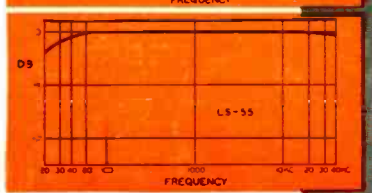
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Type No.	Application	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	Relative hum-pickup reduction	Max. Unbalanced DC in prim'y	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+15 DB	—74 DB	5 MA	$25.00
LS-10X	As Above	As above	50,000 ohms	20-20,000	+14 DB	—92 DB	5 MA	32.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+15 DB	—74 DB	5 MA	28.00
LS-12X	As above	As above	80,000 ohms overall, in two sections	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-26	Bridging line to single or push pull grids	5,000 ohms	60,000 ohms in two sections	15-20,000	+20 DB	—74 DB	0 MA	25.00
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	20-20,000	+17 DB	—50 DB	0 MA	24.00
LS-21	Single plate to push pull grids. Split primary and secondary	15,000 ohms	135,000 ohms; turn ratio 3:1 overall	20-20,000	+14 DB	—74 DB	0 MA	24.00
LS-22	Push pull plates to push pull grids. Split primary and secondary	30,000 ohms plate to plate	80,000 ohms; turn ratio 1.6:1 overall	20-20,000	+26 DB	—50 DB	25 MA	31.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125, 200, 250, 333, 500/600 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	5 MA	25.00
LS-30X	As above	As above	As above	20-20,000	+15 DB	—92 DB	3 MA	32.00
LS-27	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	30-12,000 cycles	+20 DB	—74 DB	8 MA	24.00
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Type No.	Primary will match following typical tubes	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	List Price
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LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	28.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	20.00
LS-58	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's	2,500 ohms plate to plate and 1,500 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	40 watts	50.00
LS-6L6	Push pull 6L6's self bias	9,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	30 watts	42.00

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