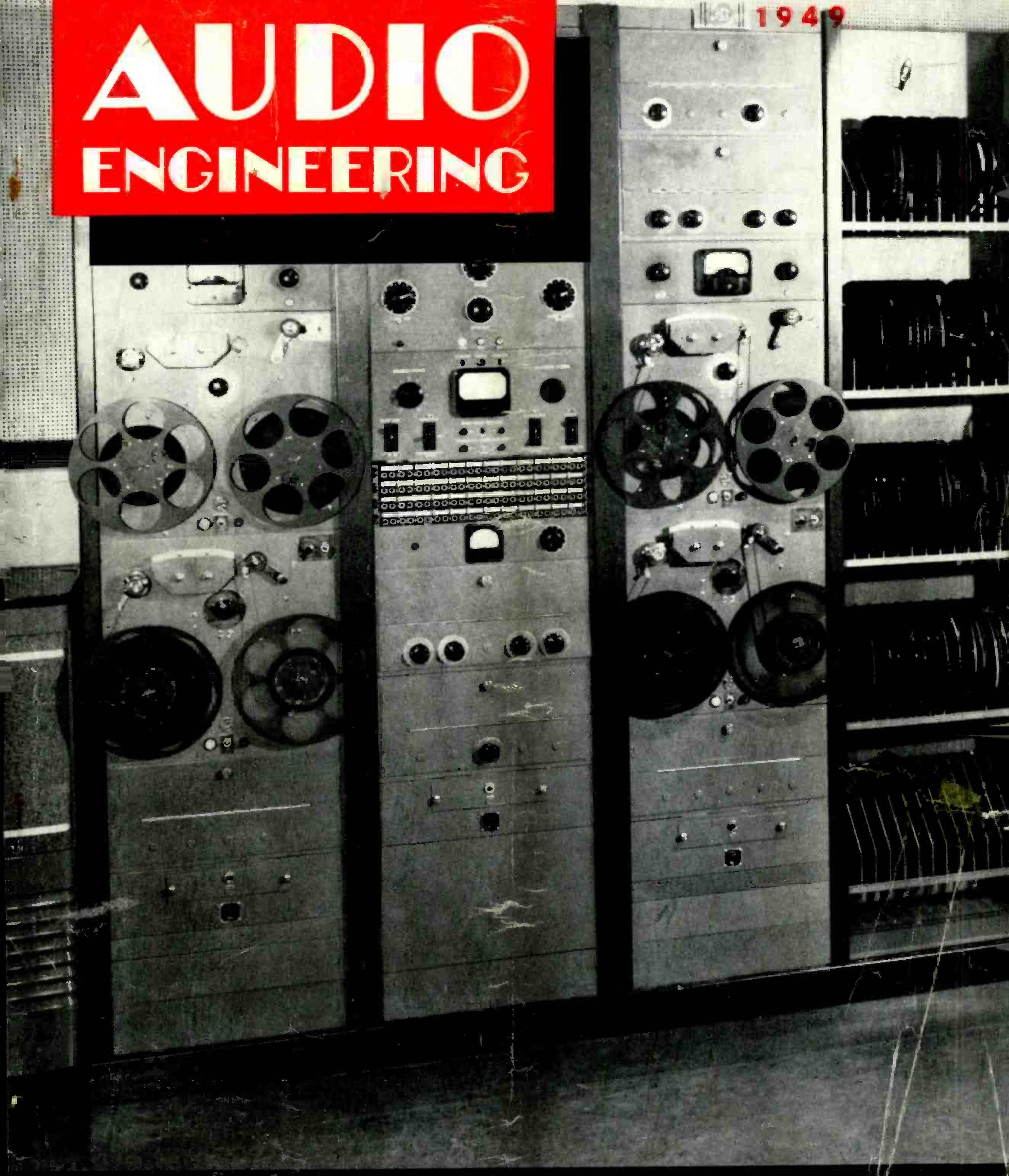
AUDIO ENGINEERING

MAY 1949



THE JOURNAL FOR SOUND ENGINEERS

Whatever the

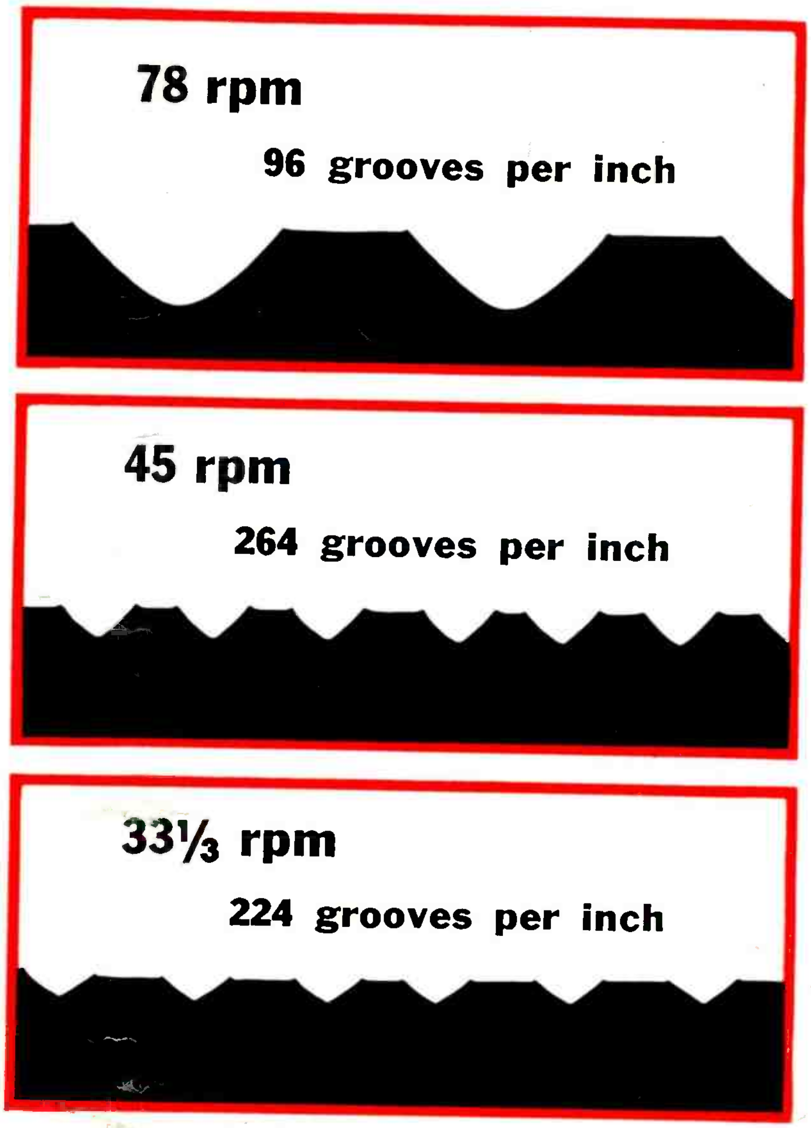
SPEED

Whatever the

PITCH

audiodiscs*

are your best assurance of truly fine recording and reproduction



Un-retouched shadowgraphs, showing Audiodiscs recorded at 78, 45, and 33⅓ rpm. Magnified 125 times.

Today, with the trend toward higher and higher fidelity, the *quality* of a recording disc is more important than ever before. The new recording and reproducing techniques — slower speeds, finer grooves, and feather-weight pick-ups — demand a lacquer coating of truly flawless perfection.

Professional recordists everywhere are finding that Audiodiscs meet the most exacting requirements for every type of conventional or microgroove recording. The automatic machine-coating process, the selection and blending of lacquer ingredients, the tireless testing — from raw materials to finished Audiodiscs — are your assurance of matchless quality. *And for the finest results, it pays to cut Audiodiscs with precision-matched Audiopoints — now available for microgroove as well as conventional recording and playback applications.*

**Reg. U.S. Pat. Off.*

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris

Audio Devices, Inc., 444 Madison Ave., N. Y. C.

Export Dept: Rocke International, 13 East 40th Street, New York 16, N. Y.

they speak for themselves **audiodiscs**

SETS A NEW PERFORMANCE STANDARD!

YOU GET ALL THESE FEATURES IN THIS NEW HIGH FIDELITY SIGNAL GENERATOR

- **Voltage accurate within 0.2 db**
- **Distortion less than 0.1%**
- **Continuously variable a-f voltage**
- **Frequency range 20 cps to 20 kc**
- **High stability of frequency**

-hp- 206A Audio Signal Generator

For the first time *all* the features listed above are combined in one precision instrument, to give you signals of *utmost purity and accuracy* for high fidelity measuring work.

In addition, the new *-hp-* 206A Generator includes low-temperature coefficient frequency determining elements for high stability and unvarying accuracy over long periods of time. A precision attenuator varies output signal level in 0.1 decibel steps throughout 111 decibels.

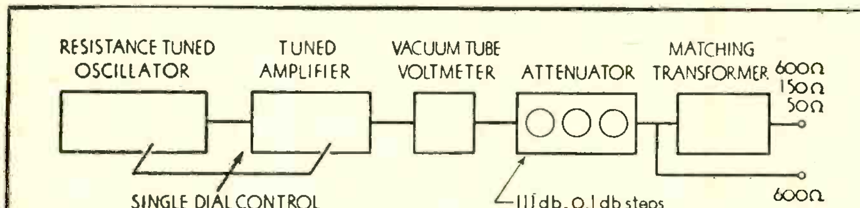


Figure 1 — Circuit Structure of *-hp-* 206A Generator

Resistance-tuned Oscillator

The resistance-tuned oscillator is followed by an automatically tracked amplifier whose high selectivity reduces oscillator harmonics. Following the 111 db attenuator is a transformer which can be matched to loads of 50, 150 and 600 ohms. A 600 ohm single-ended output is also provided (Fig. 1).

Specially designed for testing high quality audio circuits, the *-hp-* 206A is ideal for FM transmitter maintenance, studio amplifier and console testing, a source for bridge measurements, a-f voltage or transmission measurements; and for other applications requiring a very low distortion signal of known amplitude.

Full details available on request

HEWLETT-PACKARD CO.
1640L Page Mill Road, Palo Alto, California
Export Agents: Frazar & Hansen, Ltd.
301 Clay Street • San Francisco, Calif., U. S. A.

SPECIFICATIONS

FREQUENCY RANGE: 20 cps to 20 kc, 3 bands.

CALIBRATION: Direct in cps on lowest band.

STABILITY: Better than 2%. Low temperature coefficient frequency network.

OUTPUT: +15 dbm into 50, 150, 600 ohms. Approx. 10 v into open circuit.

OUTPUT IMPEDANCE: 50, 150, 600 ohms balanced. 600 ohms single ended. Matched internal impedances.

FREQUENCY RESPONSE: Within 0.2 db, 30 cps to 15 kc, beyond meter, at all levels.

DISTORTION: Less than 0.1% above 50 cps. Less than 0.25% below 50 cps.

HUM LEVEL: 70 db below output signal, or 100 db below zero level.

OUTPUT METER: Reads in dbm or volts.

ATTENUATORS: 111 db in 0.1 db steps. Accuracy approximately 0.1 db.

hp laboratory instruments
FOR SPEED AND ACCURACY

Power Supplies · *Frequency Standards* · *Amplifiers* · *Electronic Tachometers* · *Frequency Meters* · *UHF Signal Generators* · *Square Wave Generators* · *Audio Frequency Oscillators* · *Attenuators* · *Audio Signal Generators* · *Noise and Distortion Analyzers* · *Wave Analyzers* · *Vacuum Tube Voltmeters*

AUDIO ENGINEERING

Successor to RADIO

MEMBER AUDIT BUREAU OF CIRCULATIONS

Established 1917 CONTENTS MAY, 1949 Vol. 33, No. 5

COVER

Part of NBC Daylight Saving rebroadcast installation recently completed at Chicago, showing four of the eight panel-mounted RCA magnetic tape recorders with their associated amplifiers and control equipment. Remaining four recorders are mounted on three identical racks to the right of the reel storage shelves.

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at New York, N. Y., by Radio Magazines, Inc., J. H. Potts, President; Lawrence LeKashman, Vice Pres. Executive and Editorial Offices at 342 Madison Avenue, New York 17, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years: elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A.

Entered as Second Class Matter July 29, 1948 at the Post Office, New York, N. Y., under the Act of March 3, 1879.

— Letters —

Comments on 45 Report

Sir:

I have read with great interest the article "Characteristics of the New 45 rpm Record" by "Stylus", in the March issue of AUDIO ENGINEERING.

I believe that two statements in this interesting article are inaccurate and should be corrected.

First, the author states, in referring to the changing cycle, that due to the time needed to play the lead-out and lead-in grooves, observers have checked the total elapsed time at 3 to 4 seconds. Since we are here obviously comparing the X record with the Columbia LP, I think it is reasonable to count as elapsed time between records, the entire period of time taken from note to note. In other words, from the cessation of music on one record to the commencement of music on the next. If this is done, it will be found that the average time is not 3 to 4 seconds but nearer 8 seconds and occasionally as much as 12 seconds. Obviously, this is no better than has already been achieved in ordinary drop-type mechanism changers. In point of fact, it is somewhat slower.

The second point which deserves consideration is that the author has stated that a comparison between LP and X is valid only if one studies nominally similar discs, that is 7" against 7", and that the unwary have compared 7" RCA with 12" Columbia which the author considers incorrect as they fall in entirely different price ranges and fit different markets. This, I believe, is all wrong. It is perfectly proper to compare the RCA 7" with the Columbia 12" because both these companies will be releasing identical music on the two types. In other words, if both should issue a new recording, for example, of Beethoven's Fifth, Columbia should do so on 12" disc and RCA should do so on 7" discs. Consequently, it is correct and proper to compare these two. Eliminating pop records from consideration, the comparison is perfectly valid.

I believe that these comments regarding the two points mentioned above, should be taken into account in any over-all consideration of the two new-type records.

Leonard Carduner
Garrard Sales Corp.
315 Broadway
New York 7, N. Y.

Comments on Comments

Sir:

In their ivory towers of perfectionism, AUDIO ENGINEERING readers share one fault: They forget all about the earthy problems of keeping an industry solvent. I was therefore very happy to find that Mr. Carduner inadvertently had answered his own objection—"Eliminating pop records from consideration". How can you eliminate 80% of the record market from consideration? The symphonic record market is a mere excrescence, a wart on the surface of the record field, a relatively unprofitable scar that survives only as a by-product. Record processing and pressing facilities are supported

[*Continued on page 41*]

EDITOR'S REPORT

ONE MORE FALLACY

THIS SUBJECT hardly falls into the classification of fallacies, but it is one worth some consideration by both manufacturers and constructors alike. This is the matter of tone control placement.

The technical person is familiar with the portrayal of the audio spectrum on a sheet of conventional graph paper which always places the high frequencies at the right, lows at the left. The musician—and nearly every layman to both arts—is familiar with the piano keyboard, with the treble keys at the right, bass keys at the left. Yet it is often that an amplifier reaches the market with this natural placement reversed, so that it requires an unnatural action to vary either control without consciously thinking of its location.

It would seem that some standardization of the placement of controls is desirable—the selector switch always at the left, followed in turn by the low-frequency control, the volume control, the high-frequency tone control, and finally the power switch. Not that it makes much difference, because a user will eventually become accustomed to control placement, no matter how illogical it may seem, but a uniform arrangement deserves some mulling over in a world where standardization is becoming more and more important.

BOOK DIVISION ACTIVITIES

The announcement in the March issue regarding the plans of the book division attracted considerable interest, and it is now definite that the first volume to be published will consist primarily of articles which have appeared in these pages since the first issue of AUDIO ENGINEERING made its bow. Many readers will welcome this announcement because of the scarcity of back copies, and a compilation in one volume will make it possible for the audio hobbyist or experimenter to fill out his files of reference material. Unfortunately, the first announcements of the magazine went almost entirely to engineers and professionals in the audio field—not from any desire to restrict its distribution—but mainly because experimenters and hobbyists are a nebulous group which it was then difficult to reach. Because of this, many who would have been readers from the beginning joined the ranks long after the magazine came into being and therefore missed some of the important early articles. The subjects to be covered include: amplifiers; phonograph reproducing equipment; loudspeakers, dividing networks, and enclosures; and residence radio systems.

CONVENTIONS

Spring is the season when fancies are reputed to turn — and those in our field turn theirs to the conventions which occur almost weekly during this period. Beginning with the massive IRE show in March, Spring includes the conventions of the Society of Motion Picture Engineers, the National Association of Broadcasters, and the Acoustical Society of America. The IRE-RMA Spring Meeting falls in between, being held this year on April 25-27 in Philadelphia.

Aside from a natural interest in conventions, the principal reason for bringing up the subject is to express a wish that the SMPE and the NAB might consider the possibility of holding their meetings during different weeks. Both were held this year during the week of April 4, making it a bit difficult to cover both adequately. Of course, most of those interested in one are not interested in the other, but with the gap between them being narrowed by television activities, more and more engineers are becoming involved in both arts. Apropos of this, the SMPE has proposed to its members that the name of the society be changed to the Society of Motion Picture and Television Engineers. It appears to be a logical forward step.

AUDIO IN TV RECEIVERS

Many are the complaints heard about the audio quality in commercial TV receivers. As long as the picture is seen, it may not be so important that sound quality be held to an optimum, but *radio* is to be commended for its realism, and particularly for its perspective. When an actor looks for a needle in a haystack, you can actually hear the hay rustling, for example. In direct comparison with sound pictures, radio does a better job of setting the scene with sound quality alone. To a large extent, this is understandable, for if the viewer can see the actor in the haystack, it is perfectly obvious that he is there; in radio the illusion must be created entirely by sound.

The comparison with sound pictures is reasonably valid because no one normally attends a movie without watching the picture—so the sound and picture complement each other. But when TV becomes the principal home entertainment medium, many owners will want to hear a program while doing something else, and the same care should be exercised in program production for TV as it is now for radio. And in order to appreciate perspective and sound quality, a better audio channel will be needed.

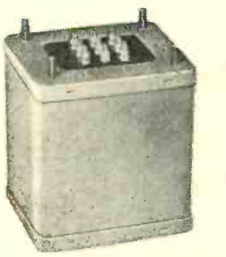
One reader reports that he made a few simple modifications to his TV receiver, and that sound is in all ways comparable with that from his FM receiver. But why should the set owner have to make these modifications? If a four, five, or six inch speaker is not adequate, why not use a larger one? Good speakers, good amplifiers, and proper speaker placement are all essential in making the TV receiver a completely satisfactory replacement for the radio receiver.

FREED

"PRODUCTS of EXTENSIVE RESEARCH"

INSTRUMENTS & COMPONENTS!

HIGH FIDELITY OUTPUT TRANSFORMERS



Type No	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	± ½db from	Maximum level
F1950	Push pull 2A3's, 6A5G'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, 6A5G'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 prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

"Q" INDICATOR

No. 1030 Frequency range from 20 cycles to 50 kilocycles. "Q" range from .5 to 500. "Q" of inductors can be measured with up to 50 volts across the coil. Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dialectric losses, and power factor of insulating materials.

INCREMENTAL INDUCTANCE BRIDGE

IMPEDANCE RANGE: One millihenry to 1000 henries in five ranges. Inductance values are read directly from a four dial decade and multiplier switch. This range can be extended to 10,000 henries by the use of an external resistance.

INDUCTANCE ACCURACY: Within plus or minus 1% through the frequency range from 60 to 1000 cycles.

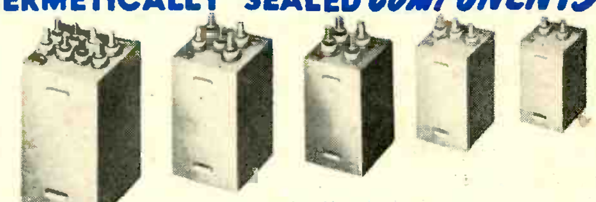
COMPARISON BRIDGE

No. 1010 An invaluable instrument for precision laboratory adjustment and incoming inspection of resistors, capacitators and inductors . . . Entirely self-contained, A.C. operated and includes a three frequency oscillator, an A.C. bridge and a null detector.

NULL DETECTOR

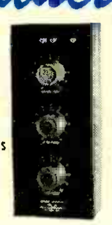
No. 1140 For bridge measurements, providing visual null indications or aural indications when used in conjunction with headphones. The unit may also be used as a high gain amplifier for general laboratory work. Functionally, the instrument consists of a high gain linear amplifier with a 30 db input attenuator in addition to the variable gain control. Output voltage is 40 volts undistorted into 1 megohm load, and 10 volts into 20,000 ohms.

HERMETICALLY SEALED *COMPONENTS*



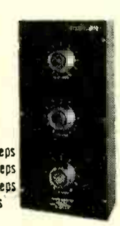
Decade Inductors

No. 1161
10 x .1 HY steps
10 x .01 HY steps
10 x .001 HY steps
2000-50,000 cycles



No. 1162
10 x .01 HY steps
10 x .001 HY steps
10 x .0001 HY steps
10,000-300,000 cycles

No. 1164
10 x 10 HY steps
10 x 1 HY steps
10 x .1 HY steps
50-1000 cycles



Discriminators

For telemetering and remote control applications using audio and supersonic frequency subcarriers.

Toroidal Inductors

Type T1 1000-15,000 cycles Inductance Value	Type #	Type T1-2 2000-30,000 cycles Inductance Value	Type #	Type T1-3 10,000-300,000 cycles Inductance Value	Type #
5 MHY	F-800T	1 MH	F-1800	.5 MH	F-1850
10 MHY	F-801T	2 MH	F-1801	1 MH	F-1851
15 MHY	F-802T	3 MH	F-1802	2 MH	F-1852
30 MHY	F-803T	4 MH	F-1803	3 MH	F-1853
50 MHY	F-804T	5 MH	F-1804	4 MH	F-1854
75 MHY	F-805T	10 MH	F-1805	5 MH	F-1855
100 MHY	F-806T	15 MH	F-1806	10 MH	F-1856
200 MHY	F-808T	30 MH	F-1807	15 MH	F-1857
500 MHY	F-809T	50 MH	F-1808	20 MH	F-1858
750 MHY	F-810T	75 MH	F-1809	30 MH	F-1859
1 HY	F-811T	100 MH	F-1810	40 MH	F-1860
1.5 HY	F-813T	150 MH	F-1811	50 MH	F-1861
2 HY	F-815T	200 MH	F-1812	75 MH	F-1862
3 HY	F-819T	300 MH	F-1813	100 MH	F-1863
4 HY	F-821T	400 MH	F-1814		
5 HY	F-823T	900 MH	F-1815		

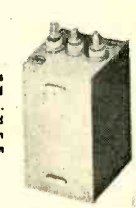
High quality toroidal coils wound on molybdenum permalloy dust cores. All those listed above can be supplied in hermetically sealed cans, commercial type construction or open units. Other types can be supplied out of stock on special orders.

LOW FREQUENCY HI "Q" COILS

#1900	100 HY
#1901	75 HY
#1902	50 HY
#1903	25 HY
#1904	10 HY
#1905	5 HY
#1906	1 HY

Available from stock in the indicated inductance values.

Filters



Narrow band pass filters for remote control and telemetering applications. High pass, low pass, band pass and band elimination filters for communication and carrier systems.

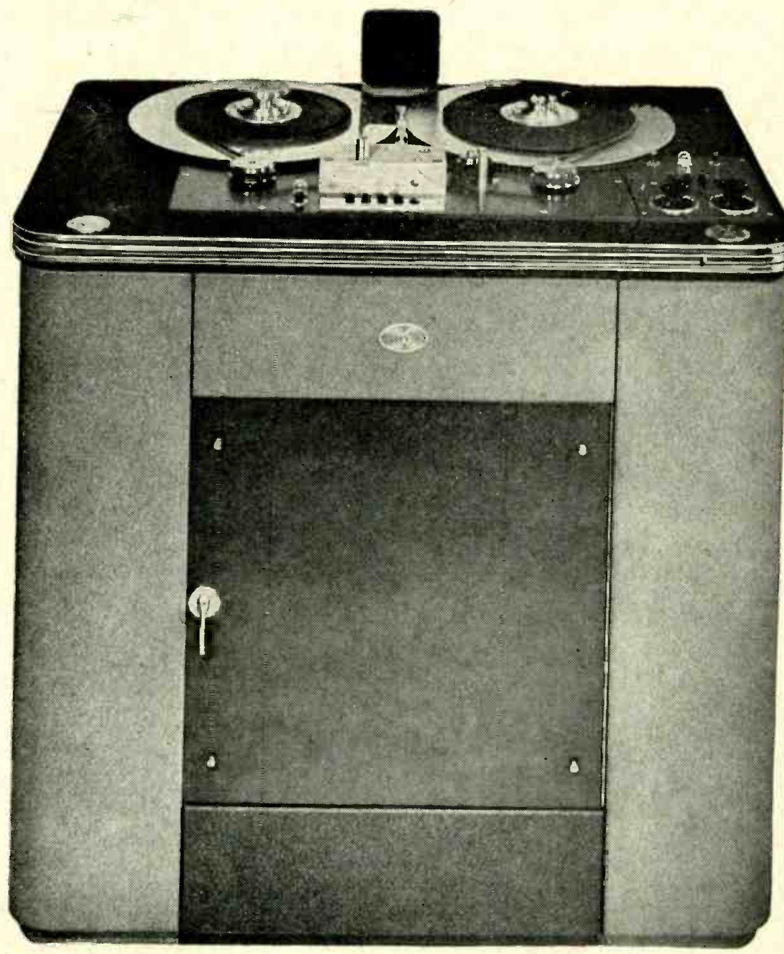
SEND FOR COMPLETE DESCRIPTIVE LITERATURE

FREED TRANSFORMER CO., Inc.

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

Now! A Top Quality Tape Recorder at a Reasonable Price

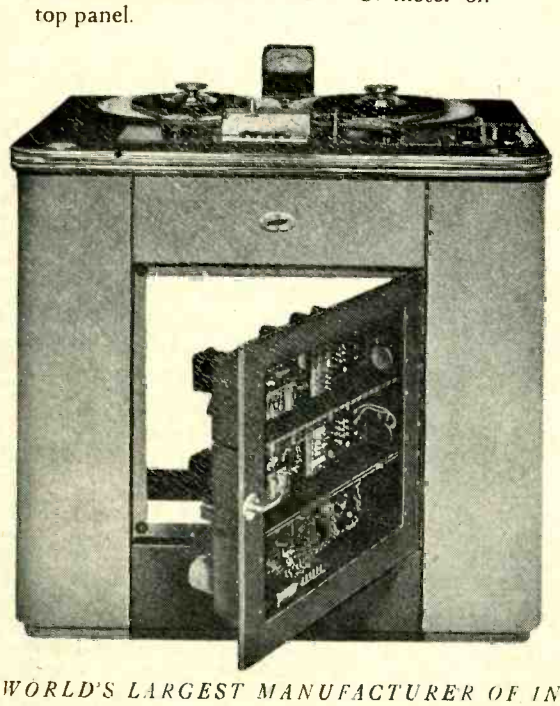
New PRESTO Magnetic Tape Recorder



AT LAST, a magnetic tape recorder that fully measures up to the most exacting requirements of broadcast network operations, independent stations and transcription producers, yet priced to have wide appeal.

Compare these specifications:

- Frequency response: 30 to 15,000 cps ± 1 db.
- Signal to noise ratio: Over 60 db below max. signal.
- Fast speed, 240 ft. per second forward and rewind, instantly reversible.
- Recording speeds 7½" or 15" per second (15" or 30" per second provided on request). Speed selection by special 2-speed motor.
- Reels direct mounted on motor shafts. Uses any type and size of reel, up to 14".
- Erasing, recording and playback heads all mounted in separate housing – entire unit connected by plug-in for immediate replacement.
- Full-size illuminated scale V. U. meter on top panel.



Now! Greater Accessibility

Illustration shows how everything mechanical and electrical can be serviced from the front and top. Amplifiers and power supply are in swinging door behind removable panels. Mechanical units are mounted on top panel, hinged at rear so it can be opened upwards.

PRESTO

RECORDING CORPORATION
Paramus, New Jersey

Mailing Address:
P. O. Box 500, Hackensack, N. J.

In Canada:
WALTER P. DOWNS, Ltd., Dominion Square Building, Montreal

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

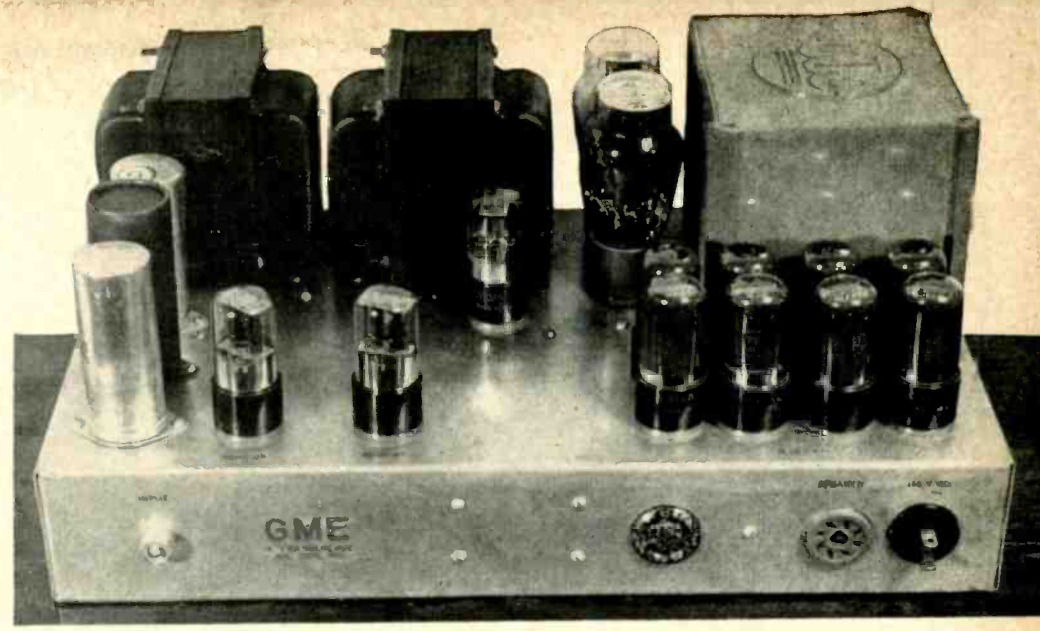


Fig. 1. Eight 6V6 tubes in push-pull-parallel cathode-follower output stage, and two paralleled power transformers give this amplifier an unusual appearance. Simple circuit arrangement provides maximum speaker damping.

A Practical Cathode-Follower Audio Amplifier

W. E. GILSON, M.D.,* and RUSSELL PAVLAT*

A design which provides high damping for the loudspeaker, resulting in excellent transient response.

SPEAKER damping is a comparatively neglected element in the discussion of high-quality amplifiers. Specifications usually state that the frequency response curve can best be drawn with a reliable straightedge, and that the percentage of distortion is negligible at a substantial number of BTU's output per second. The absolute flatness and freedom from distortion so obtained are largely of emotional value to the designer, as a slight variation at high output cannot be detected except by measurement, because the inner ear generates up to 50% harmonic distortion under that condition.[1] Such an amplifier may sound clean, or it may be quite "muddy," depending on the damping.

Such fine sounding specifications are usually accompanied by (sometimes accomplished by) the use of large amounts of inverse feedback. Thus fair damping is usually obtained, particularly if an excellent output transformer is used, or if the feedback is taken from the voice coil winding. Except in a very good transformer, there is regrettably little relation between the wave shapes of the voltages on the primary and secondary windings.

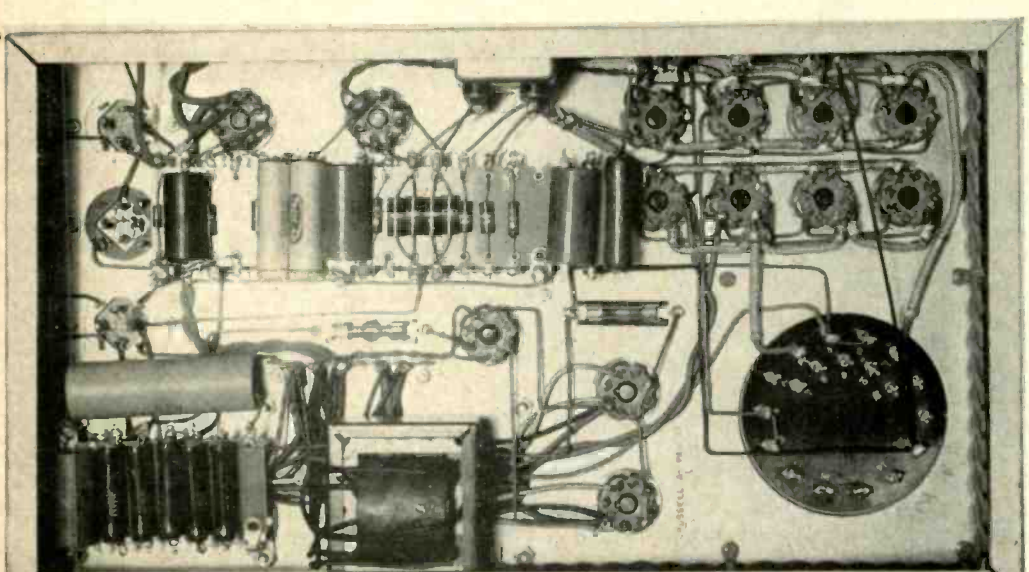
Although in comparable circumstances triodes sound somewhat cleaner than beam-power tubes to the writers, this is an uncertain subjective judgment. Many persons interested in audio reproduction will, when the proper stimulus is applied, inevitably state their dogma "Nothing can beat a pair of 2A3's." One amplifier on the market at present, with the modern equivalent of the 2A3, sounds definitely muddy, largely because of a lack of damping. No inverse feedback from the output winding is used, and the transformer is not of sufficiently high quality to provide close coupling between the tubes and the voice coil. Thus a good solid triode does not inevitably give clean reproduction. It can give very good results if used in a well designed amplifier.

The use of the 6AS7G appears to provide some improvement in damping. An experimental amplifier using this tube, constructed some time ago, sounded remarkably clean, considering that a poor output transformer was used. McProud[2] obtained an impedance of 7.2 ohms across the 16-ohm output winding, using the 6AS7G in a better amplifier with good components.

Considerably better damping can be obtained with a cathode follower amplifier. This type of audio output circuit has seldom been used, probably because of the high driving voltage required. The present circuit has been developed to provide adequate output with an economical source of distortion-free high driving voltage. The circuit appears slightly unconventional, but there is a definite reason for all of the departures from the usual. The amplifier is shown in *Figs.* 1 and 2.

**Gilson Medical Electronics, 4 Franklin Ave., Madison 5, Wis.*

Fig. 2. Underside of amplifier chassis. Note clean, straightforward wiring layout.



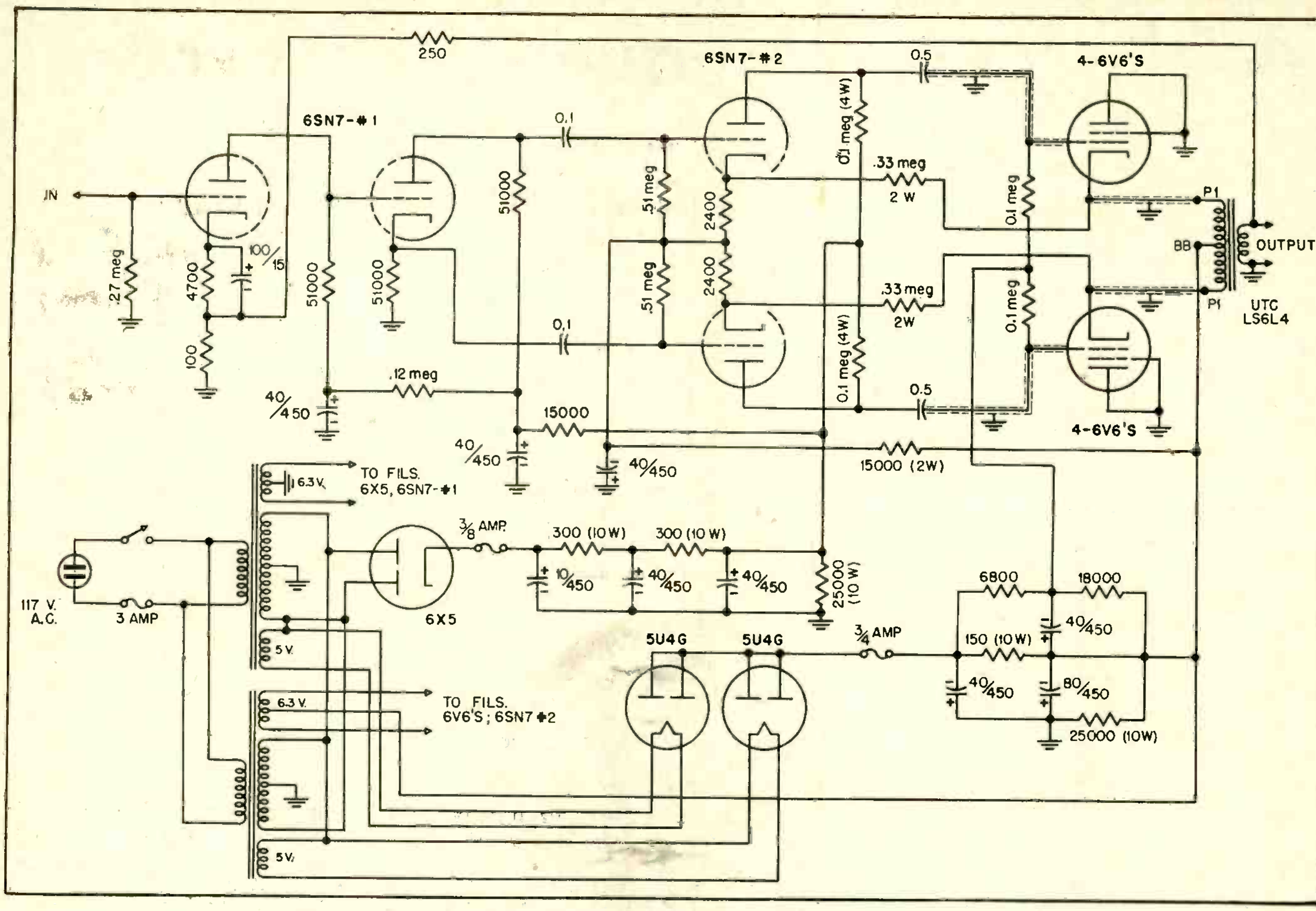


Fig. 3. Overall schematic of complete amplifier and power supply.

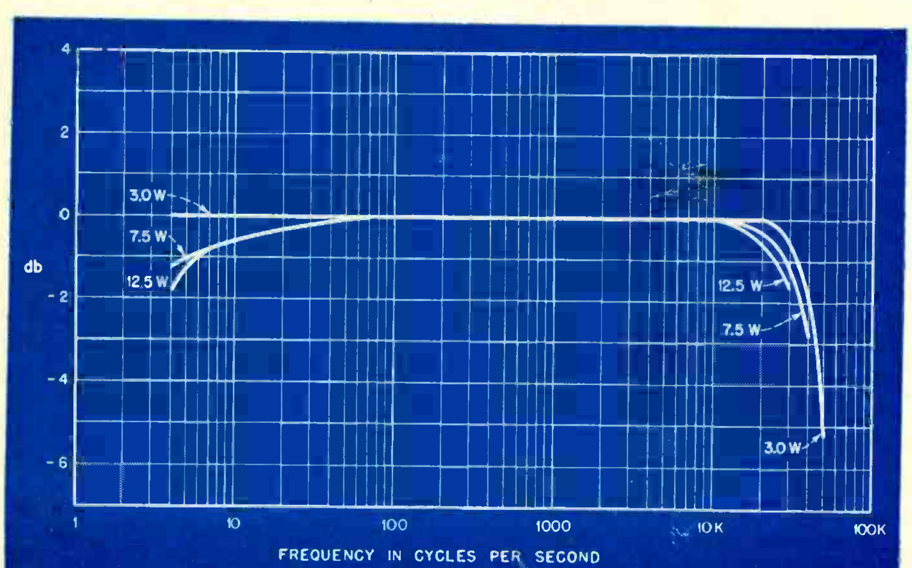
Driving Voltage

The driving voltage is obtained by using a resistance coupled 6SN7 with a plate supply voltage of 700, and a plate voltage of 300. The cathode follower output requires high current at low voltage, and the preamplifier stages require low current at low voltage. To fulfill these requirements, two SNC transformers are used with their high-voltage secondaries in parallel. The combination is then rated at 350 volts each side of the center tap, at 300 ma. Two 5-volt and two 6.3-volt windings are also available. One of the 6.3-volt windings, with its center tap connected to ground, is used for the heaters of the early amplifier stages and for the 6X5GT rectifier, which supplies 350 volts above ground at low power for these stages. The two 5-volt windings are used for the two 5U4G rectifiers, which are connected in the reverse of the usual manner to provide 350 volts below ground at high power, for the output stage. There is a total difference of 700 volts, across which the driver stage is operated. The remaining 6.3-volt winding, which has its center tap connected to minus 350, supplies the heaters of the driver and output stages.

The bias for the final stage is obtained from the pulsating d-c voltage drop across the 150-ohm filter resistor, which voltage would otherwise be wasted. This is voltage-divided and filtered and gives a 25-volt negative bias which is highly stable.

In order to obtain peak output, it is necessary to make the driver and cathode follower circuit slightly more sensitive, as the limitation lies in the phase-inverter output. Approximately 5 per cent regenerative feedback is added from cathode to cathode, increasing peak output and noticeably reducing peak overall distortion. This changes the output impedance imperceptibly because of the large amount of overall degenerative feedback. The regenerative circuit may be omitted if desired.

Fig. 4. Frequency response curves at different output levels. Note that range extends from 4 cps to well over 30 kc.



[*Continued on page 33*]

Audio Sweep Frequency Generator

GEORGE A. ARGABRITE*

Details of a photo-electro-mechanical generator which can be an invaluable aid in design and maintenance of amplifiers and associated equipment.

A SWEEP signal in the audio frequency band has for a long time been recognized as an aid in the study of the action of wave filters, the over-all response of audio apparatus, and transient and other associated electrical phenomena.

A few systems have been proposed but still fewer have been completed for the production of an audio sweep signal. The outstanding success of the audio sweep generator of Mr. Wayne R. Johnson, and of the instrument under discussion, have proved the undoubted usefulness of this type of device. Mr. Johnson's generator produces a smoother signal than the one herein described (see *Fig.* 16). It is entirely electronic, somewhat intricate in design, and more costly to build. The oscilloscopic trace of the present instrument is shown in *Fig.* 2.

For production testing, a number of manufacturers are using this audio sweep generator for final tests on recording heads, such as disc, tape, and film. A short section of one of the mediums on which the record is made is recorded and then reproduced with test equipment. This resulting signal on the oscilloscope is indicative of the quality of the piece of apparatus under test.

In testing audio amplifiers, the sweep signal is introduced to the amplifier and the output is observed on an oscilloscope. While under test, the volume control can be operated; noise is evidenced by breaks in the pattern on the screen. Linearity of the volume control circuit is observed by noting the flatness of the response with the volume control set at minimum and maximum gains, respectively (see *Figs.* 4 & 5). The action of tone controls is clearly indicated on the screen. Noisy tubes may be quickly located when they are vibrated by tapping, the resulting screen picture being highly modulated by a microphonic tube.

In production-testing transformers, the input and output characteristic impedances of the transformers are simulated with proper resistive networks and the over-all response of the transformer, either under load or with a minimum signal, may be quickly evaluated on the oscilloscope.

In the development of filter networks, such as are used for compensation in film, phonograph and transcription reproduction, the circuits are set up or bread-boarded, and the action of the circuit observed on the oscilloscope, using the audio sweep signal. Changes can be made while the pattern is being observed. In this manner, much time is saved in the development of the corrective network.

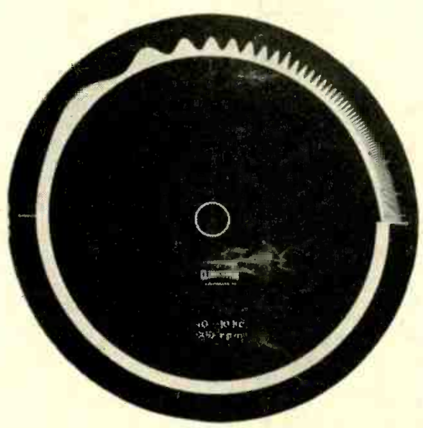


Fig. 1. The card is a transparency 5" in diameter, scanned with a .005"x½" light beam. It is rotated at 600 rpm, producing a sweep frequency of from 40 to 10,000 cps, ten times per second alternating with an unmodulated base line. The variable width of the base line compensates for photographic anomalies so that a mean average track density is maintained.

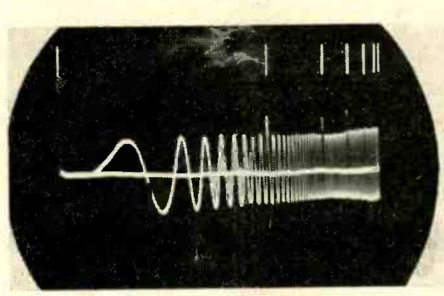
Periodical checks on the over-all performance of radio stations are necessary procedures. At the microphone input, in a typical radio station, the audio sweep signal may be introduced and the modulated carrier picked up by an external or isolated test radio receiver. The observed signal on the oscilloscope from this receiver quickly gives an over-all picture of the signal quality.

Microphone and Speaker Testing

In the design and testing of microphones, a two-way speaker system which effectively covers the band from 40 to 10,000 cycles may be used as an audio signal source in an anechoic room. It has been found that due to the nature of the sweep signal, it is not as necessary to have perfect conditions of non-reverberation as in the case of steady-state audio signals for testing. Since there is no steady state condition in the audio signal, a normally short period reverberation of less than 1/20th second does not contribute to standing waves. In a way, the action is somewhat similar to the narrow band swept signal which has been in common use for some years.

Under the above test conditions, it is expedient to rotate the microphone under test and observe its polar pattern response.

For the design and testing of speakers, the cross-over filter networks used in two-way speaker systems can be very easily evaluated when using the audio sweep signal. Here again a free field is desirable,



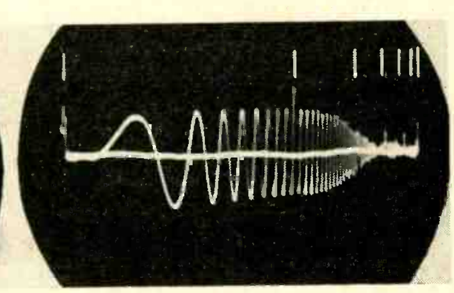


Fig. 2 (left). Normal pattern for the audio sweep generator. This is the signal produced by the card in Fig. 1. Marker pips are at 1, 3, 5, 7, 9, and 10 kc. The overall range is from 40 cps to 10 kc. Fig. 3 (right). Showing pattern obtained when there is a misalignment of the optical slit of about 7°. Deterioration of the highs is similar in the case of film and tape recording.

*Chief Engineer, The Trionic Company of America, (Clarkstan Corp.)
11927 W. Pico Blvd., Los Angeles, Calif.

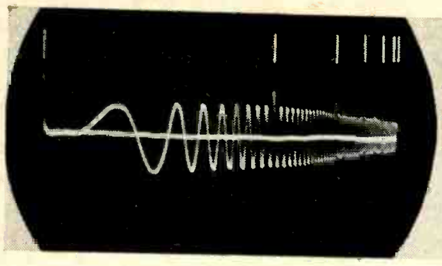
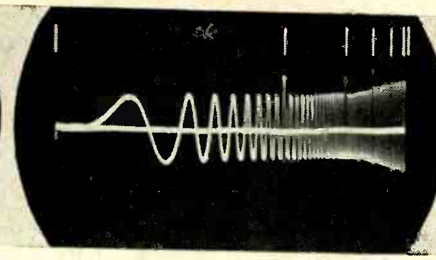



Fig. 4 (left). A commercial amplifier, with the volume control near maximum attenuation. The series resistance of the input potentiometer attenuates the highs. Fig. 5 (right). Same amplifier as in Fig. 4 with the volume control set at full volume and indicating a slight high-frequency boost.

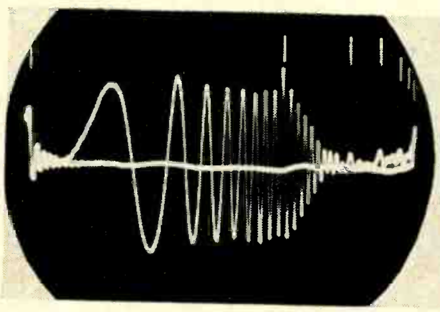
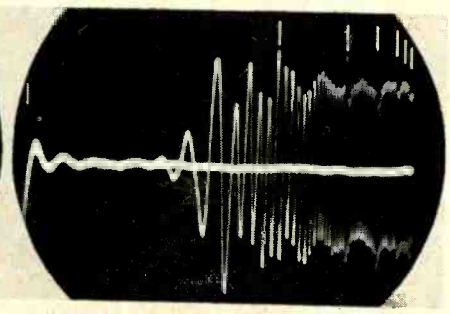



Fig. 6 (left). A high-Q low-pass filter network, with a 1200-cps cutoff. At the low end of the oscillogram can be seen the typical transient response of such a circuit. Fig. 7 (right). A high-Q high-pass filter network, with a cutoff at about 200 cps. The transient response at the beginning and the accompanying modulation of the sweep carrier are typical of high-Q circuits.

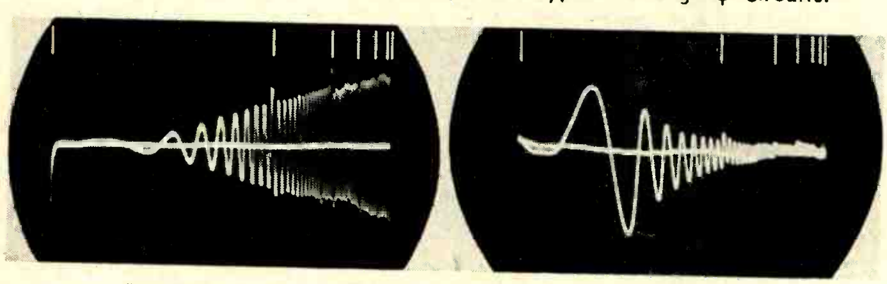


Fig. 8. Left: Series capacitance. Right: Series inductance.

but the quality of the free field need not be as high as in the case where a steady state sound source is used. The same conditions apply to the testing of speakers as to the testing of microphones. Polar patterns may be quickly evaluated from a qualitative angle.

In experimental work with the varistor, the rectifying action in both the so-called "plate" and control contacts may be observed on the oscilloscope, as well as the performance of the device circuit-wise, by using the audio sweep signal. *Figure* 15 shows a rectifying action in which about 5% reverse voltage shows up. This particular unit was faulty and a new point of contact was found which made the circuit operative. The audio sweep signal has proved valuable in experimental work on the varistor at this laboratory.

In the case of rectifiers for meters, the inherent capacity within the bridge is often found to be a limiting factor in their use at the higher frequencies. The capacitance of the rectifier acts as a shunt condenser. It is seen on the oscilloscope screen as an obvious passing of the high frequencies in the region of 10,000 cycles.

Design Details

Approaching the problem by building an audio sweep generator from a more or less mechanical standpoint has produced a piece of entirely portable equipment which is very reasonable in cost and capable in its performance. The heart of the generator is a photographic disc (transparent card). See *Fig.* 1. The original compilation of the card is 48 inches in diameter. The card for use in the instrument is 5 inches in diameter.

The production of the original disc involved some hundreds of hours of calculations and plotting. The transitional, or changing frequency sinusoidal, wave was plotted against a circular base line as an abscissa, and radii of the circle as ordinates. The design was then filled in to give the pattern a black-and-white contrast. The disc was then reduced photographically and a positive was made from the original negative. From the positive, the subsequent negatives were produced.

An unimportant form of distortion arises from slight irregularities in the plotting of the original pattern. These irregularities are peculiar not as recurrent phenomena but are indigenous to the single cycle with which they are associated and so do not cause a misinterpretation in the analysis of apparatus under test. In order to ascertain the amount and kind of distortion that was inadvertently introduced into the original pattern, successive broad band elimination filter networks were used. The residual obtained in this manner is of necessity all of the distortion components that were in that section of the original signal, the fundamental having been removed. The nature of these distortion components appeared to be for the most part triangular in wave form. See *Fig.* 13.

Image Spread

Subsequent investigations revealed a fact which has long been known in the processing of film. This is known as "image spread." Image spread, in brief, is the tendency for the exposed portion of the film to affect exposure-wise the immediately adjacent unexposed emulsion. While this factor is negligible in motion picture work, it was fairly troublesome in the production of the sweep frequency disc.

Image spread produced a small amount of odd harmonic distortion and introduced a lowering of the high-frequency signal. In the original 48-inch diameter card the wave length at 10,000 cycles is .136 inches. In the finished 5-inch card, the wave length at 10,000 cycles is .135/9.6 inches. In the case of the first and third exposures, the image has a tendency to become smaller. This is because three successive images, photographically speaking, have occurred. A narrow margin of the original wave form has been removed from all boundaries. The proportional amount of area removed is much greater in the high-frequency region than in the low-frequency region.

As a result, distortion in the low frequencies has been held to a fraction of a per cent, while in the regions above 5,000 cycles reduction in the distortion was increasingly apparent up to 10,000 cycles. Two factors have played an important part in the reduction of this distortion. One of these is by the use of a gaseous type of photoelectric cell. The other factor was in the preparation of another disc or card in which the calculated image spread was corrected for in the plotting of a new four-foot-diameter card. In the case of the use of the gaseous photocell, type 927, which is familiar in the reproduction of sound motion pictures, distortion components above 10,000 cycles were materially reduced, for if there were third harmonic distortion in a 5,000 cycle fundamental, such distortion would be of the order of 15,000 cycles, a frequency essentially out of the range of the present instrument.

The photographic reproductions of cards have to be made under extremely rigid laboratory conditions pertaining to exposure, printing, and developing.

Regarding the circuit, the characteristics of the amplifier are kept within the strictest specifications. It has been found that completed amplifiers that would ordinarily pass inspection on the production line would not adequately fill the specifications required in the photo-electric circuit. Changing the tubes is sufficient to show what are normally considered only slight variations in tube characteristics. In regard to photo cells, these too must be rigidly inspected for performance characteristics. The greatest variations of the type 927 phototube seem to be about 6 db difference in amplitude response at the low frequencies and the high frequencies. As an example, one tube may have an attenuation sloping toward the high end of about 1 db per octave, while another tube will have an opposite slope. These are extreme cases, however. Such an action from photocells is due, in part, to the slight variations from tube to tube in the gaseous pressure within. The audio sweep generator has proved to be a valuable device for checking photocell tube performance. A tip-up circuit of the feed-back type is provided with an adjustment on the chassis which takes care of any linear irregularities in the overall response of the phototube when, and if, it becomes necessary to change the tube.

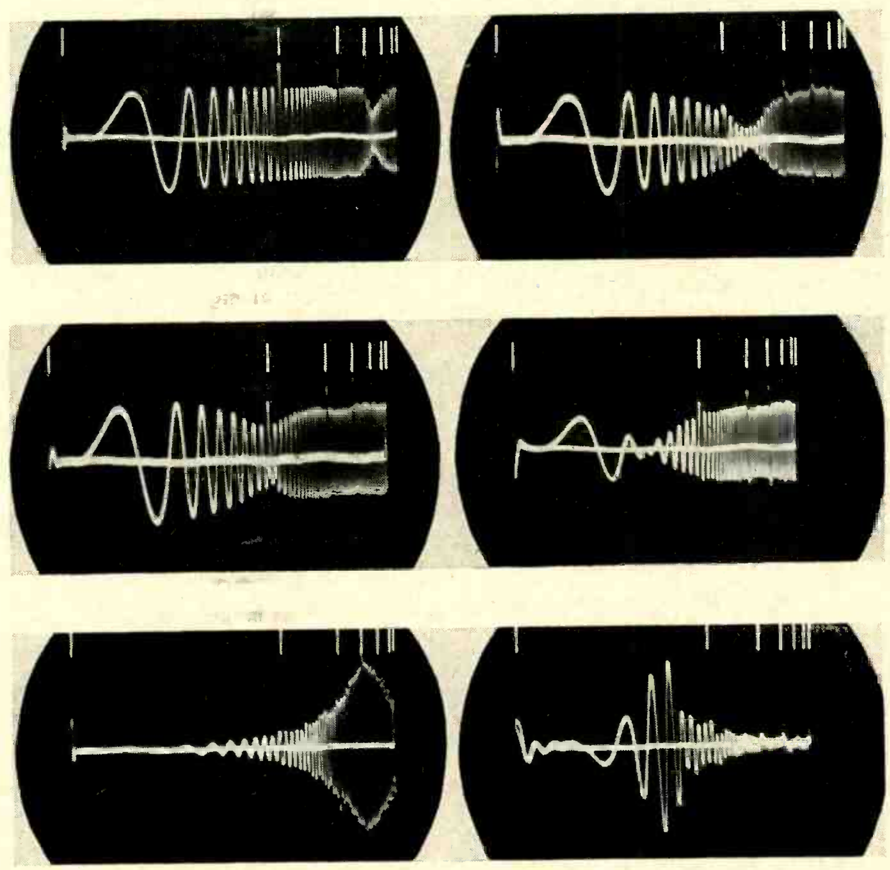
Light Source

The exciter lamp, when operated on d.c., had no tendency to introduce a 120-cycle hum component. The selection of a small, self-focusing flashlight bulb, type 222, proved to be a satisfactory and economical light source. The tube normally operates on 2.2 volts at around 250 ma. Its life is greatly extended and its current consumption materially reduced when operated from a 30 amp. hour, 1½ volt, A battery. Considerably in excess of 150 hours of service may be expected from each battery. This is the only battery in the circuit; it may be easily replaced. The life of the 222 lamp under the reduced rating is an unknown quantity, probably 1,000 hours or more.

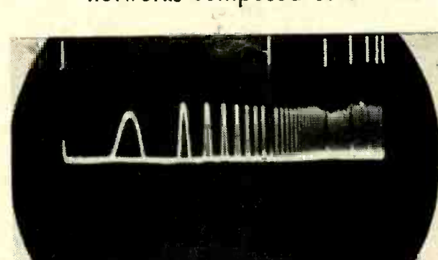
Other Cards

Different types of signals, such as the square wave and the triangular wave, have been incorporated in some of the cards for use with the audio sweep generator. In the case of the square wave, a perfectly square wave signal is not possible when using type 927 photocells. The harmonic content falls considerably above 10,000 cycles. Rounded corners appear. The use of high vacuum photo-electric cells corrects this condition but they require higher gain circuits. In the reproduction of a triangular wave which, incidentally, becomes on the card a form of spherical triangle, the wave was plotted with a changing base line. Self-generation of a sine wave becomes evident at about 8500 cps. This action is the result of nonresolution of harmonic content in the triangular wave above that fre-

[Continued on page 40]



Figures 9 to 14 (above). Simple low-Q band-elimination and band-pass filter networks composed of commercial capacitors and inductances.



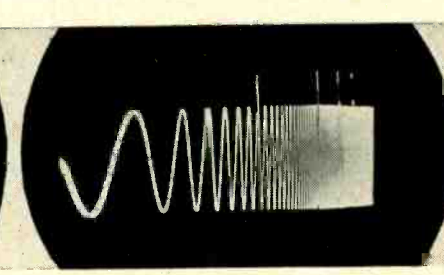


Fig. 15 (left). Germanium rectifier in a circuit showing 5% reverse voltage. Fig. 16 (right). The audio sweep frequency signal from the electronic generator of Wayne R. Johnson. The marker pips are at 1, 3, 5, 7, and 10 kc. The lowest frequency in the output of this generator is 40 cps.

Corner Speaker Cabinet for 12-inch Cones

C. G. McPROUD

THE DESIGN for a corner cabinet for 15-inch cones, first shown in the January issue, is followed here by a similar design adapted for the use of a 12-inch cone, either with or without a high-frequency unit and horn. This design has been worked out on the basis of a 7-cu. ft. enclosure, and without the TV picture tube compartment, it is considerably smaller in size than its predecessor.

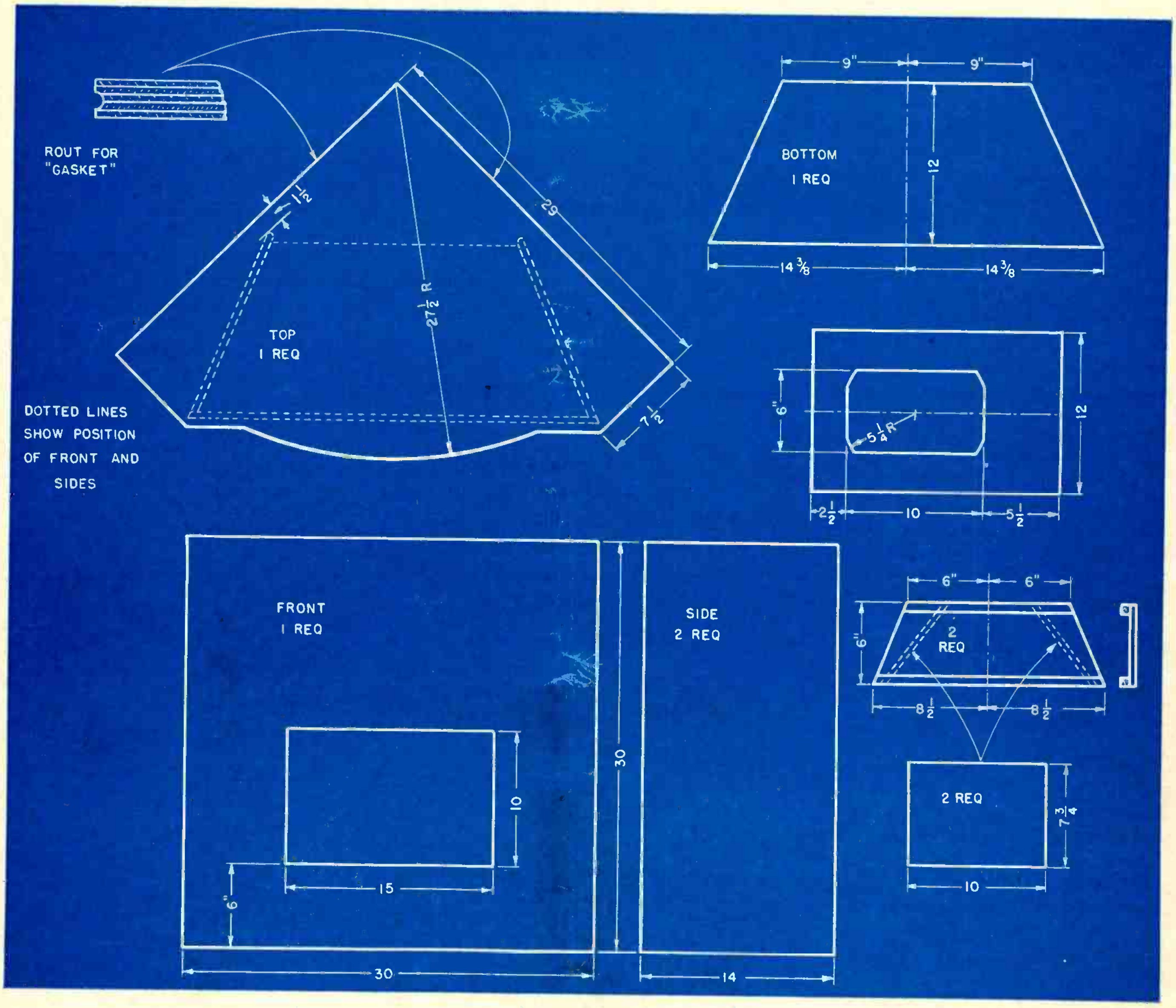
The dimensions shown in the drawing below are planned for the use of ½-inch 5-ply panels, although only slight changes would be necessary if ⅝-in. plywood were to be used instead. The mounting strips, ¾-in. square, are not shown for most of the construction, but for solid work it is desirable that all joints be reinforced by these strips. All points should be glued, and the assembly should be made by means of wood screws.

Because of the fact that there are only two parallel surfaces in the enclosure, it is not actually necessary that the entire inside of the cabinet be padded. The two parallel surfaces are the top and the bottom, and these should be padded with Ozite or some similar material. The two sides should be braced across the back after the cone is installed. The top must be gasketed against the wall to ensure an air-tight joint. The sides of the speaker-well are straight, and 1-in. material is recommended.

If a two-way system is desired, an h-f horn and unit may be installed above the cone opening. Either the Racon two-cell horn and unit, the University dual tweeter, or the Atlas HF-1 horn will mount flat against the front panel, and any of these units should be used with a suitable dividing network.

To give a finished appearance to the cabinet, a grill cloth can be placed over the speaker-well before it is attached to the front panel, and some similar treatment should be given to the high-frequency horn, if one is used.

This cabinet will ensure good loading of the cone down to about 35 cps, and the relatively small floor space required for a corner unit is a definite advantage.



Conversion Method to Increase Film Recording Studio Facilities

NORMAN T. PRISAMENT* and THOMAS F. LoGIUDICE**

When expansion of activity demands greater flexibility, an economical plan is desirable. The authors describe a successful installation of this type.

One of the major problems facing the operator of a small recording studio installation is how he can provide most suitably for a normal expansion from a single or dual-channel plant to one capable of recording on film, disc, or tape—either individually or all together—and the method of making such a transition without disrupting the regular studio business.

Many smaller studios are faced with this problem at some time in their history. Up until the last year, disc recording has usually been sufficient to fulfill the requirements of the majority of studios, with only a small number of them being involved in the production of sound films. With the increasing need for television films and the tremendous swing toward magnetic tape for intermediate operations it is becoming more and more necessary to have a plant which is sufficiently versatile to accommodate all three types of recording if the operator is to retain a volume of business adequate to ensure a financially successful operation. Assuming, however, that it is determined that such a growth must be accommodated, the actual method of making the expansion *physically* must then be considered.

Unquestionably it would be desirable to have a completely integrated plant, similar to that of a large network headquarters, if the arrangement is to be flexible in operation. Up to a certain point, this is true, but there are certain limitations which can not be exceeded. In the first place, it will usually be necessary to maintain service to the customer almost continuously, and this service can not be interrupted for more than a minimum of time. In the second place, the cost of entirely new equipment is high, undeniably, and the expenditure may not be warranted. In most instances, the latter of the two reasons will be the more important, and it is usually not considered economically sound practice to discard equipment which is performing satisfactorily just to have a completely new plant.

To find an answer for this problem, let us look at the requirements of a typical studio, inventory its existing equipment, and then consider in detail how such a transition was made. The particular studio to be studied is the News Reel Laboratory in Philadelphia, and the photos accompanying this paper were made after the transition was completed.

*President, **Sales Manager,
Arlington Electric Products, Inc.,
500 W. 52nd St., New York 19, N. Y.

Expanded Requirements

The requirements to be met for the completed plant were built around a studio console which would be able to exercise complete control over the recording operation. This console was to have facilities for mixing six inputs, each having controllable frequency response so as to compensate for different types of source material. The console was required to feed a recording bus, to which could be connected the individual recording machines, and the monitoring amplifier and the VU meter. At the outset two disc recorders were to be fed, using the amplifier regularly furnished with them. In addition, a 16-mm film recording channel was to connect to the bus, and all of the recorders were to be operated simultaneously if necessary. To avoid duplication of equipment, the 16-mm channel had to be removable as a complete unit so as to be available for location work.

For inputs, facilities were required to accommodate six studio microphones, four turntables, a 16-mm film phonograph, a 35-mm film phonograph, and a remote line, with an AM/FM tuner available for air checks. While fourteen input circuits were necessary, only six of them were expected to be necessary for any one recording session.

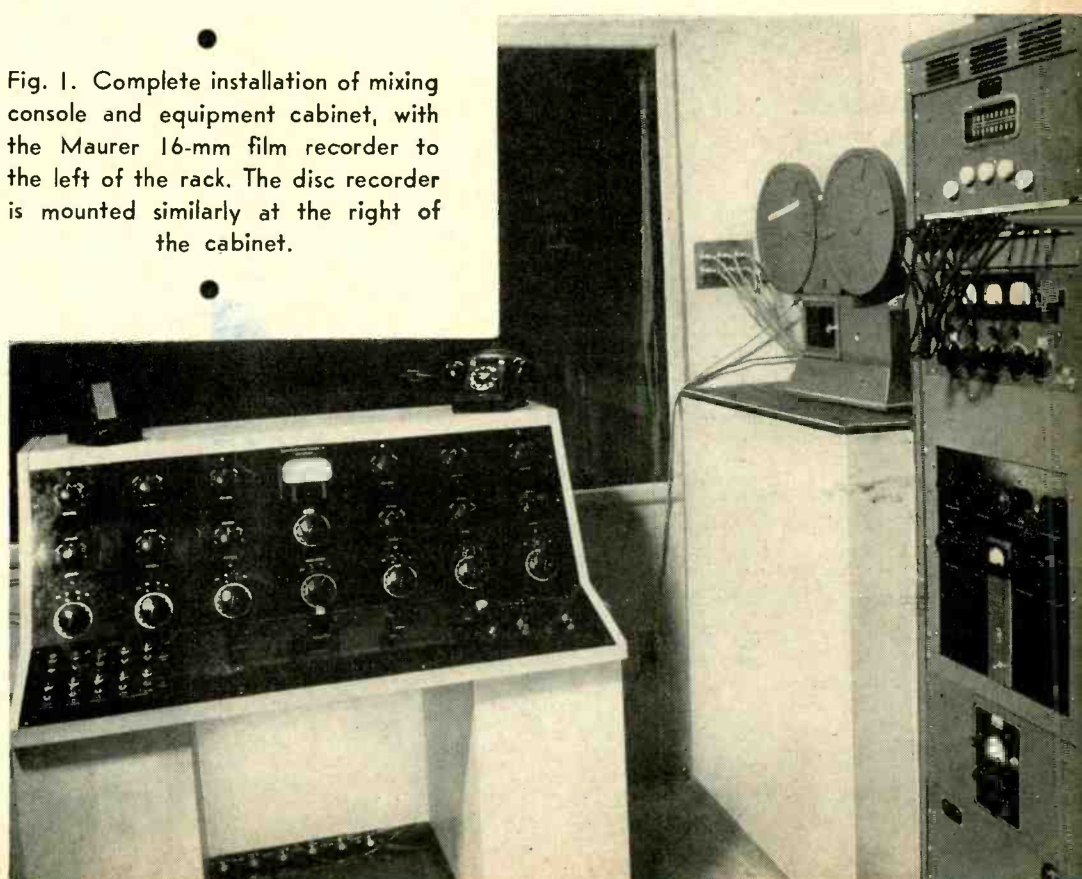


Fig. 1. Complete installation of mixing console and equipment cabinet, with the Maurer 16-mm film recorder to the left of the rack. The disc recorder is mounted similarly at the right of the cabinet.

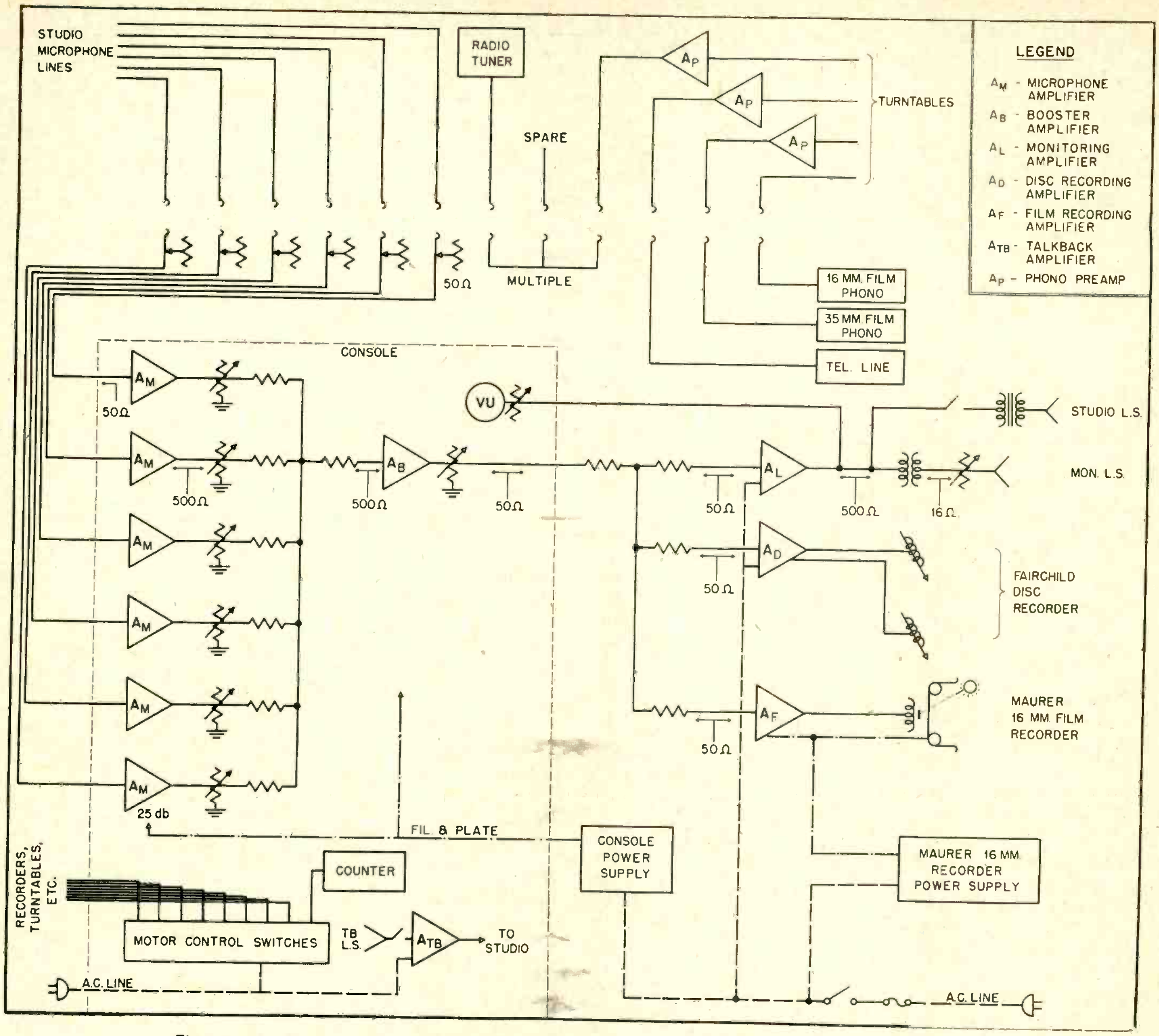


Fig. 2. Block schematic of installation, with console equipment enclosed in dotted lines.

In addition to the speech circuits on the mixing console, it was desired that any input source could be started or stopped independently, or that a number of them could be placed on a sync bus so that they started or stopped as a group, a necessity for dubbing from film to film, or in dubbing a number of pre-synchronized recordings, either film or disc. While not contemplated for immediate installation, future plans envisaged the addition of one or more tape recorders, and sufficient flexibility was required so as to accommodate them when the need arose. Also provided is a talkback amplifier and speaker.

System Layout

The existence of the individual units, each as an operating entity, made the problem comparatively simple. *Figure* 1 shows the entire installation, while *Fig.* 2 is a block schematic of the installation, with the components grouped as they are actually installed. All of the patching facilities are installed on a six-foot rack cabinet, *Fig.* 3, which accommodates—from top to bottom—the radio tuner, the jack strips, the Maurer film recording amplifier, the Fairchild disc recording amplifier and power supply, the monitoring amplifier, and the power supply for the amplifiers in the mixing console. The power supply for the 16-mm film recorder is used externally, being connected by cables and plugs. The recording amplifiers and their power supplies are readily removable, although little need is contemplated for location work with the disc recorders.

Plugs for the various inputs are installed on the sides of the cabinet, adjacent to the jack strips, and the input circuits are wired to jacks. The six input circuits to the console also appear on jacks, and any of the input sources may be patched to the desired mixer position on the console. Output plugs are also placed at locations on the cabinet sides which require a minimum of wiring in the cabinet. A-c power connections to the film recorder, projector, and the film phonographs, as well as for the four turntables, are made directly to the console, with one a-c input line feeding the console for the power circuits.

Wherever possible the various plug connections are made with the same type of plug normally used with the equipment, reducing the work of making the installation and retaining the individuality of the various units. Thus when the film recording equipment is to be used on location, it is simply removed from the rack and used as a separate channel. Since the same plugs and connectors are used, a replacement can be substituted in an emergency without the need of making adapters.

Mixing Console

The mixing console provides sufficient gain for recording from microphone with any of the equipments to be used. Since both of the recording channels are designed to work with low level inputs, it is not necessary that the output from the mixing console be as high as it would be in an installation using a zero-level bus to drive all of the succeeding equipment. Instead, the output of the console need not be more than about —30, and the amplification system therefore demands the use of only the preamplifiers and the booster amplifier. Up to this point, the circuits involved are conventional, consisting of six preamplifiers followed by individual mixer attenuators in a parallel network, and feeding the booster amplifier. This is followed by the master gain control, and the signal from this point is routed to the equipment rack, where a series of branch pads feed the monitor amplifier and the recording channels. The VU meter is connected to the output of the monitoring amplifier, since this is the first point at which an adequate level is available.

Among the features of the console, one is particularly outstanding. This is the method of mounting the preamplifiers so that they are instantly replaceable in case of any failure. On account of their circuit arrangement, they must be mounted adjacent to the panel so that the high- and low-frequency equalizers are readily available for use during a recording session. The preamplifiers, therefore, are mounted just behind the front panel of the mixer console, with the equalizer control shafts projecting through the panel. Each preamplifier case is equipped with two tapered pins which engage in holes provided in the angle-iron framework of the console, and two flat-head machine screws are inserted through suitable holes in another angle-iron member at the top. Electrical connections are made by means of cables and plugs. Thus, to remove the amplifier it is only necessary to raise the top of the console, remove two screws and two knobs, disconnect two plugs, and the unit may be lifted out.

The mixer attenuators are just below the preamplifiers, and the VU meter attenuator is conveniently placed just above the inclusive volume control at the center. At the operator's left is a group of switches for controlling the starting and stopping of the various equipments. Two modes of operation are provided—one with the machines running independently, and the other with the machines operating in sync. Three-position switches are used, one position for off, one for non-sync or independent operation, and the third for sync operation. In the latter position, the individual equipment is connected to the sync bus, which is energized by another switch to start simultaneously all machines so connected. A separate pilot light indicates when each machine is running. In addition to the various equipments, three film footage counters are employed, one each for 16- and 35-mm speeds on the console, and another which indicates both film speeds in the studio. All of the amplifiers and counters are standard Arlington Electric products, and are simply assembled in a workable arrangement.

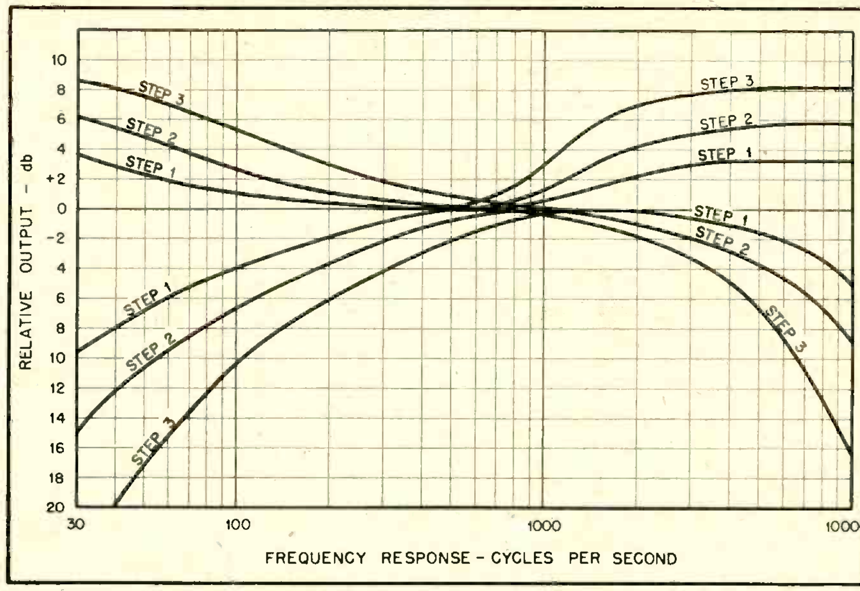


Fig. 4. Response curves obtainable with compensating preamplifiers.

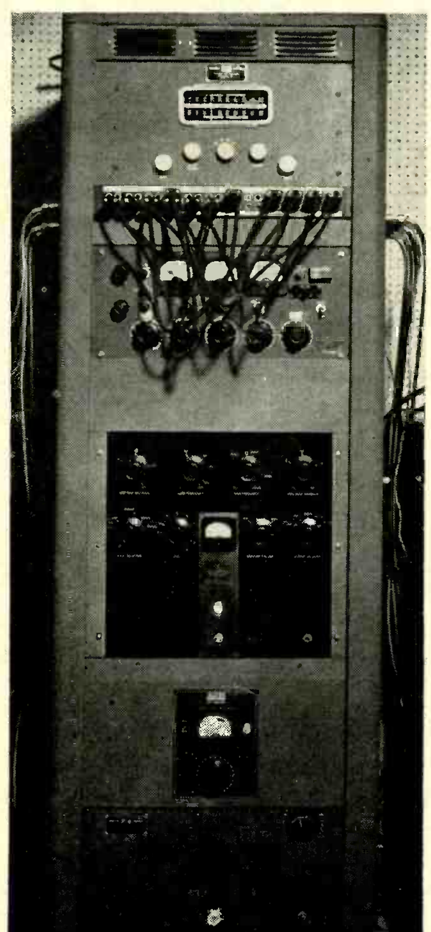


Fig. 3. Equipment cabinet with tuner, jack strips, film and disc recording amplifiers, monitoring amplifier, and console power supply, top to bottom.

Amplifiers

The preamplifiers, model EA-2, are of rather unique design, and provide means for compensating for practically any frequency response condition which is apt to be encountered in normal operation of a studio. Two controls are available, each providing seven different response curves for each end of the audio spectrum, with the curves shown in *Fig.* 4. Each preamplifier has a gain of 25 db, although internal connections may be made to reduce the gain to zero at 1000 cps. As will be noted from the schematic, *Fig.* 5, the boost positions operate in the feedback circuit, with the droop positions being simple capacitance roll-off circuits. Low-microphonic 1620's are used in both stages, and with d-c filament supply, the hum and noise level is below —90 dbm.

The booster amplifier is similar to the preamplifiers, except for the addition of another stage to give a gain of 60 db at 1000 cps. The same compensating circuits are used, but the controls for this amplifier are not accessible from the panel of the mixing console. This unit is mounted in a compartment

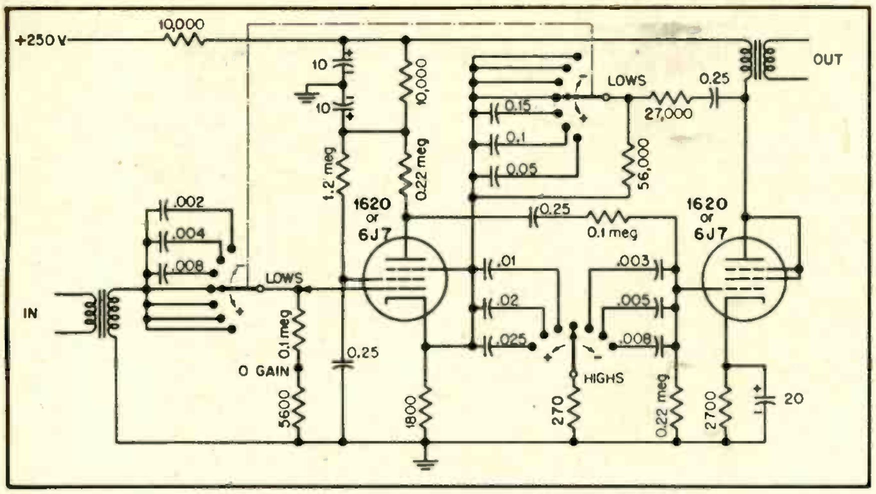


Fig. 5. Preamplifier schematic. Ten-megohm click-suppressor resistors (not shown) are connected from each capacitor across to arm of associated switch.

at the lower right side of the console, and is accessible through a door in the side.

Still another amplifier is mounted in the console for use in the talkback circuit. This unit is a standard intercommunicating amplifier, with the speaker being located on the top of the console. The amplifier itself is located at the lower left side of the console, in a position similar to that of the booster amplifier. The entire console is designed to work in the same room as the recording machines, so no signal or communication circuits are necessary between the console and the recording positions. The talkback system is provided for communication with the studio.

The monitoring amplifier, an Altec-Lansing 127A, is mounted on the equipment rack. It feeds the monitoring speaker in the recording room, and for playback, the speaker in the studio. The VU meter is connected to the output of this amplifier, and when normal operating settings are obtained, its indications are correct for all of the recording channels.

Console Construction

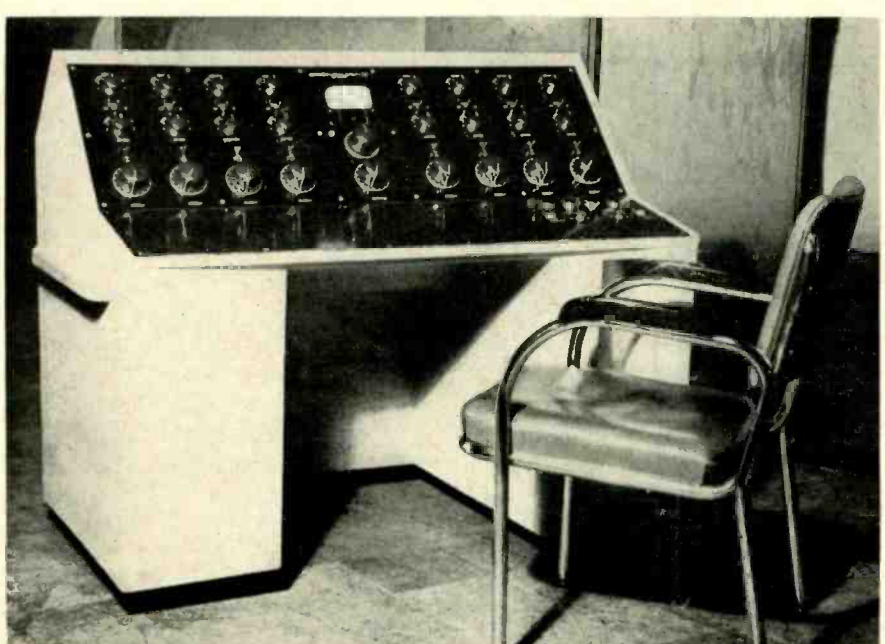
The console is fabricated with a welded angle-iron framework to ensure strength and freedom from working loose. It is covered with veneered hardwood and finished in a modern light oak. The panel and operating desk surfaces are composed of one piece of sheet dural, bent to conform to the console framework and finished in a black baked enamel. All connections to the console are made at the rear with Cannon plugs, the number of pins differing for the various types of circuits to avoid damage to equipment due to improper patching up.

Large rubber-tired wheels are employed so the console can be used in the studio, if necessary. For studio use where there are apt to be many light and camera cables on the floor, it is desirable that the wheels be sufficiently large so as to roll over the obstructions with the least effort. To ensure easy handling, two wheels are fixed in the lengthwise position of the console, while the other two are casters. *Figure* 6 shows a similar console with eight mixer positions, but without the equipment control switches.

Operation

In operation, this installation has proved to be just as satisfactory as that with a more conventional, fully integrated installation, with the additional advantage of being completely flexible. As the occasion demands, it is possible to remove any channel for use in another studio or on location, and without disturbing the remaining equipment. Furthermore, because of the utilization of existing complete recording channels, the entire installation was put into operation over a single weekend, eliminating the need of disturbing the studio on any normal work days. The elements of added cost to provide a system of this type are mainly those of the console and the rack cabinet as mountings for the equipment, much of which was already in use in the studio. Had it been necessary to adapt any of the recording channels for six microphone inputs, the six preamplifiers would have been required, as would some means for mounting the equipment. Thus the cost of the entire system may be considered to be primarily that of the components which would have been needed for any one of the channels, yet the final result is that of complete flexibility. It is on this basis that a system of this type is submitted as the economical solution to the small studio's problem of meeting increased needs for recording service, yet without any sacrifice of quality of work or convenience in operation.

Fig. 6. Similar console arrangement for eight mixing attenuators.



Audio Engineering Society News

The first student chapter of the Audio Engineering Society has recently been formed by students of RCA Institutes, Inc. The first semi-annual meeting was held on Wednesday evening, March 23, 1949, at the Johnny Victor Theater, RCA Victor Exhibition Hall, 40 West 49th St., New York.

[*Continued on page 41*]

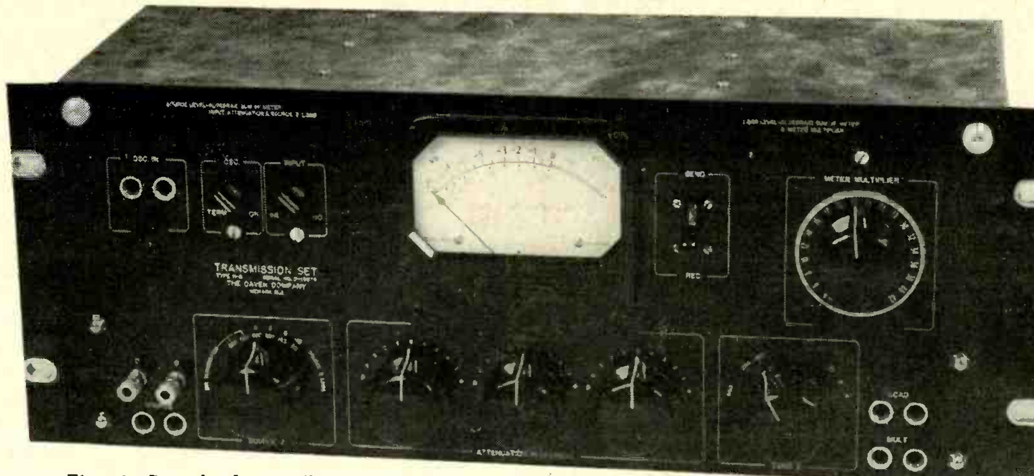


Fig. 1. Panel of new Daven 11-A transmission set.

A Simplified Transmission Set

J. P. SMITH, Jr.,* and C. F. SCOTT*

Technical details of a new instrument designed to provide accurate gain measuring facilities.

TRANSMISSION measuring sets in a variety of forms have been used in the audio field for many years in testing audio equipment and transmission lines. They may be classified in two general types: (1) those which include a calibrated amplifier and which may be used for gain or loss measurements, and (2) those which do not include an amplifier and which are normally used for gain measurements only. Loss measurements can be made on this latter type by the use of an external amplifier which can be readily calibrated before use by means of the gain set. The primary reasons for not including an amplifier are: (a) no distortion or noise is introduced in the loss type; (b) no power input is required; and (c) any laboratory amplifier can be used with the instrument to measure loss. This article deals primarily with the development, operation, and limitations of the second type of transmission measuring set, more commonly known as a gain set.

All forms of gain sets consist essentially of a calibrated attenuation section and a load section. The calibrated attenuation section, in conjunction with an audio signal generator and a meter for measuring the input level, delivers a known signal level at known impedance to the equipment under test. The load section matches the output impedance of the equipment under test and measures the power delivered by that equipment. The transmission measuring set to be described is designed for use with an external audio signal generator. This is done to keep cost low and to prevent duplication of equipment since most broadcast stations and audio equipment laboratories have one or more such signal generators which can be used conveniently with the gain set.

This description covers a simplified version of a transmission measuring set, utilizing only one transformer, one meter, and one meter range control, yet which provides most of the functions of more complicated sets. *Figure* 1 shows the general layout and arrangement of components. The set is calibrated on the basis of 1 mw into 600 ohms, and utilizes the standard VU meter. Features of the construction include sectional assembly and a hinged front panel. Each section is individually mounted with its own terminal block and is readily removable for inspection

*Engineering Staff, The Daven Co., 191 Central Ave., Newark 4, N. J.

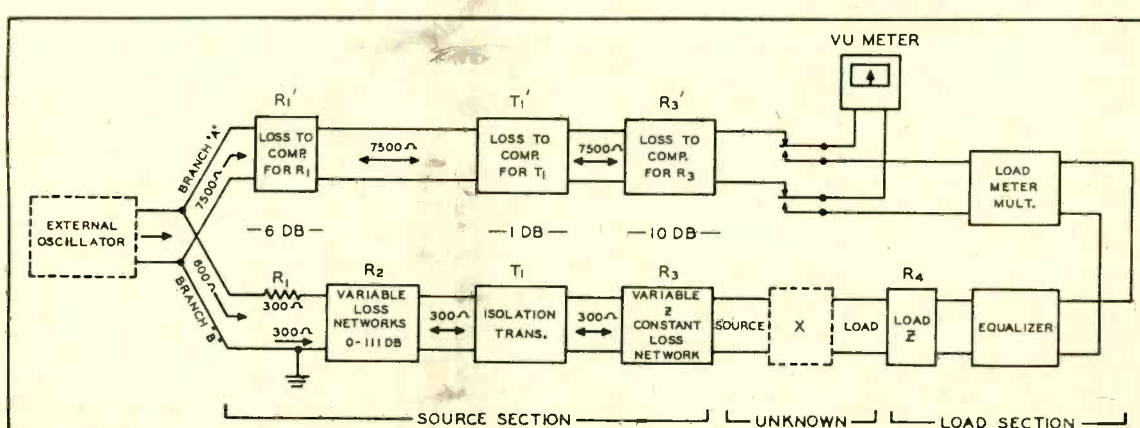


Fig. 2. Block diagram of the transmission measuring set.

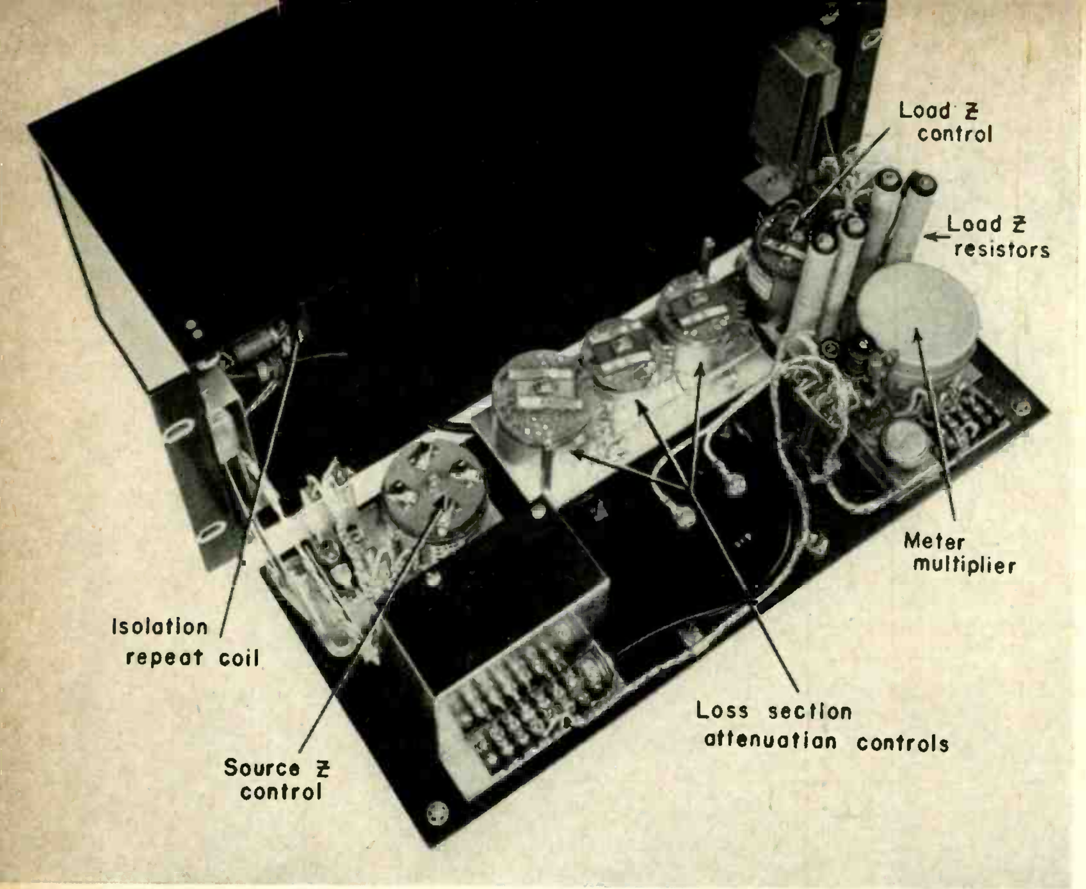


Fig. 3. Interior is made readily accessible for maintenance by hinged front panel.

and repair. Two fasteners at the top of the front panel may be released and the front panel tilted forward, allowing easy access to the parts for servicing.

Figure 2 illustrates in block diagram form the elements of the two main sections of the transmission measuring set. The characteristics and functions of these sections are discussed separately.

Source Section

This section provides the source of known level and impedance to feed the equipment under test. Note that the incoming line from the oscillator is split into two branches, branch *A* with an impedance of 7500 ohms, and branch *B* with an impedance of 600 ohms. For each loss in the 600-ohm branch (exclusive of the variable loss networks) there is a corresponding loss in the 7500-ohm branch. As a consequence, the VU meter indicates source level at *X*. The actual level provided at the source jacks is the algebraic sum of the input key setting, the meter indication, the setting of the attenuation control dials, and the db indication on the Source Z control.

Referring again to the 600-ohm branch of *Fig.* 2 the purpose of R_1 is to provide the generator impedance. Since the input voltage is held constant by means of the VU meter in the 7500-ohm branch, a resistance R_1 equal to the input impedance of the loss network R_2 must be inserted. Half the voltage appears across R_1 and half across the input of R_2. This accounts for a loss of 6 db. R_2 has a value of 300 ohms in order that the input impedance of the transmission set will be approximately 600 ohms. The variable loss network, R_2, consists of 300-ohm "T" attenuator decades providing ten steps of 0.1 db, ten steps of 1.0 db, and ten steps of 10 db. *Figure* 3 shows a rear view of the panel with the shields removed from the loss section attenuators. The purpose of the transformer T_1 is to provide means of transforming from an unbalanced source to an output independent of ground location in the gain set, since one side of the 300-ohm "T" networks must be grounded. A carefully designed transformer, shielded both electrostatically and magnetically (from

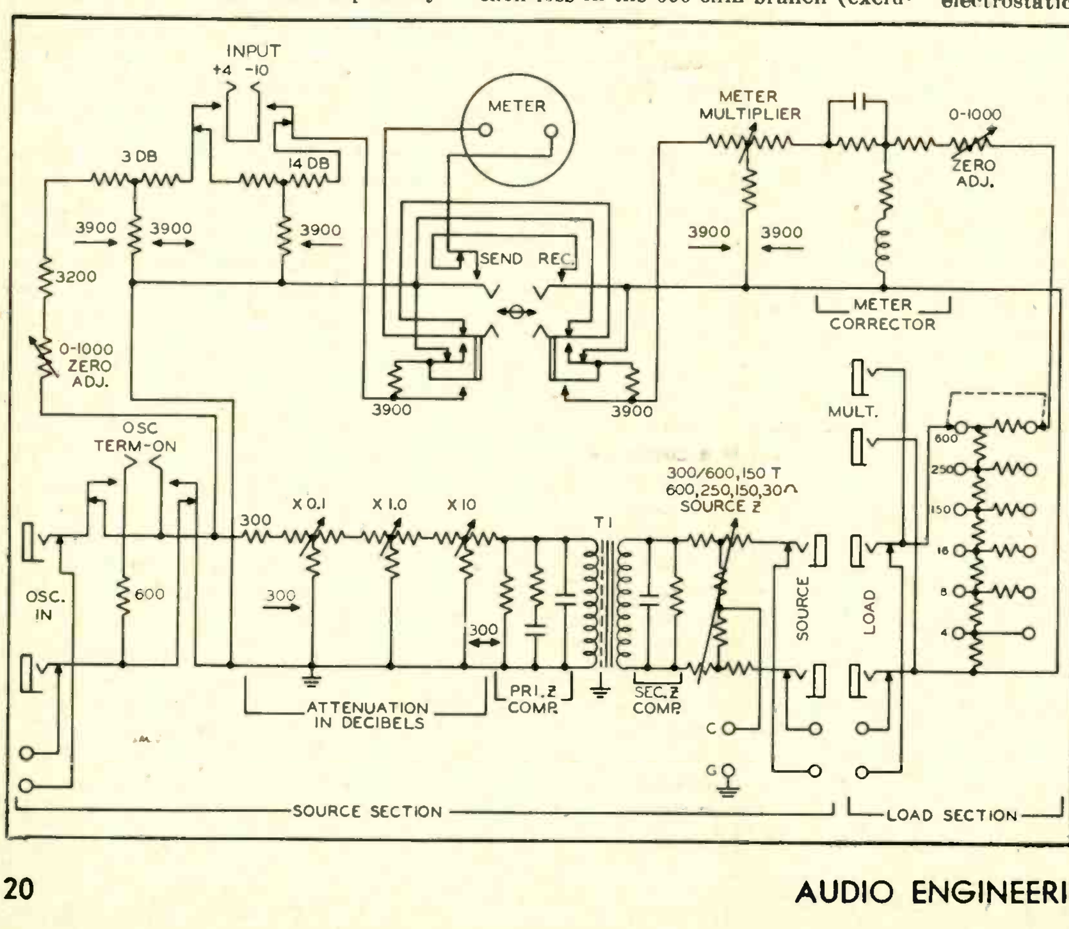


Fig. 4. Simplified schematic of the transmission measuring set pictured in Figs. 1 and 3.

external fields) is used to erase the effect of the internal ground. The location of the ground on the system to be measured thus has no effect on the transmission measurement, and both balanced and unbalanced systems can be measured equally well. The purpose of the network R_3 is to provide various load impedances. Four source impedances are provided—600, 250, 150, and 50 ohms. For ease in testing bridging-type amplifiers, two additional positions on the impedance-matching switch are provided which have internal terminating resistors. These two positions are 600 Bridging and 150 Bridging. The network R_3 has a constant loss of 10 db for the 600-, 250-, and 150-ohm positions, and a loss of 20 db for the 30-ohm step. In addition to providing several source impedances, this network also serves as isolation between the transformer windings and the Source jacks. With this isolation, variable impedance input devices such as unloaded grid input transformers, filters, and so on can be fed without interaction with the transformer. Reviewing the 600-ohm branch of *Fig.* 3, the initial loss with R_2 dials set at zero will be 6 (gain set loss due to R_1) plus 1 (transformer loss) plus 10 (R_3 loss), or a total of 17 db. Thus, in order to obtain a +4 source level, the input level must be 17 db above +4, or +21 dbm.

Many low-distortion oscillators will not provide a +21 dbm level. For this reason, a —10 key has been added which removes 14 db loss from the 7500-ohm branch, so that a lower output from the external oscillator can be used if desired. While discussing the preliminary fundamentals, two factors must be pointed out. (1) Since it is a branched circuit, the overall frequency response reduces itself to this: while holding the VU meter constant at 0 dbm and varying the frequency from 20 to 20,000 cps the source voltage across a resistive load must remain constant. VU meters in general fall off about 0.5 db at 20 kc. Therefore, if the transformer T_1 had a flat frequency response, and the VU meter pointer held at zero, the source voltage would rise 0.5 db at 20 kc. To take care of this error, T_1 is loaded to droop by an amount equal to the droop of the VU meter, and hence the source voltage remains constant with frequency with reference to the VU meter indication, but the oscillator input voltage must be readjusted to compensate for this droop. No errors in measurements are introduced by this. (2) The transformer T_1 must not only be well shielded but must present constant input and output impedances of 300 ohms from 20 cps to 20 kc. A deviation of an ohm over the band will show up when inserting varying amounts of loss in R_2.

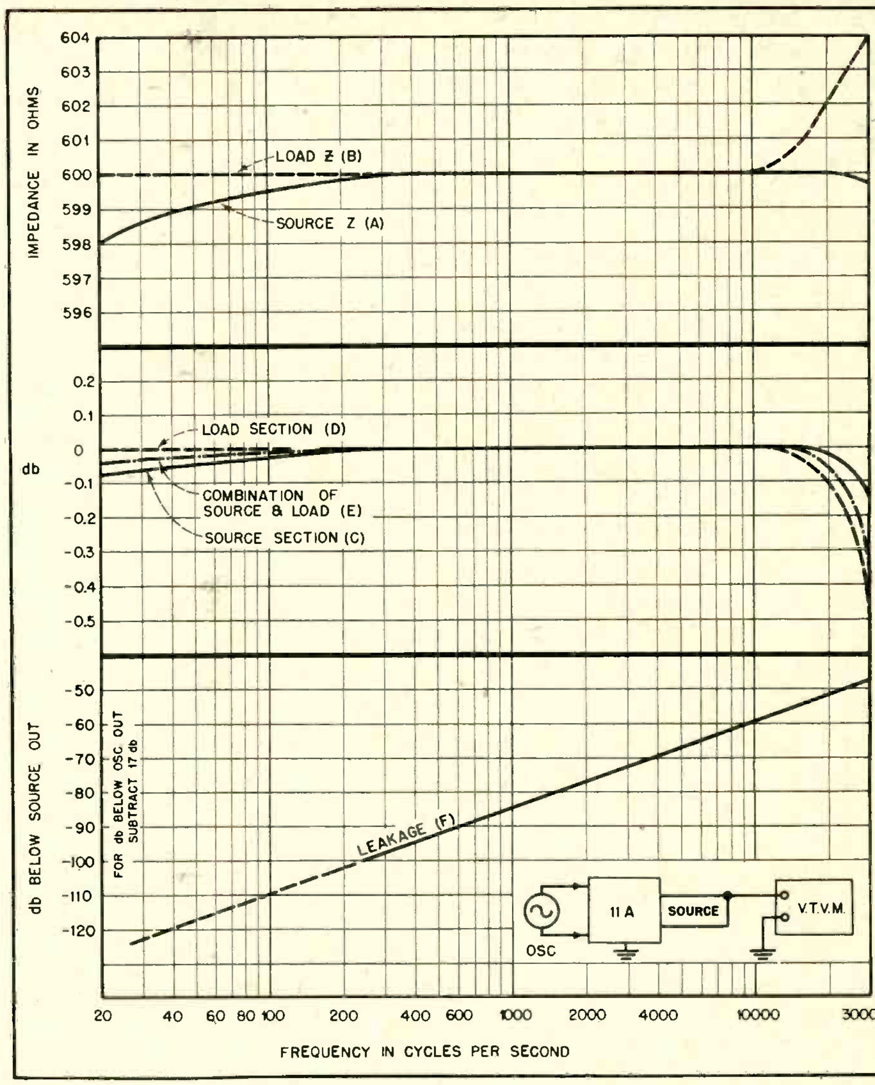


Fig. 5. Performance curves. (A) and (B)—impedance of source and load sections. (C), (D), and (E)—overall frequency response of individual sections and of both together. (F)—leakage in db due to capacitance coupling in db.

Since this transformer must also operate over the range from —111 to +4 dbm, the magnetic circuit must be so designed that the impedance will remain constant over this range of levels.

Load Section

In the previous models of Daven gain sets the load impedance matching was obtained by the use of a tapped transformer and shunting resistors. Such a transformer is a costly item and variations in production necessitate adjustable frequency compensation. The transformer has been omitted from this gain set and replaced by a variable resistive impedance-matching network on which the accuracy is easily controllable in production and which does not necessitate frequency compensation. A resistive network method of impedance matching entails a minimum level greater than that of the transformer method at impedances below 600 ohms. The impedances provided are 600, 250, 150, 16, 8, and 4 ohms. The minimum levels for a zero meter indication are +4, +8, +10, +20, +22, and +24 dbm respectively. It is believed that most amplifiers with 150-ohm outputs will supply an output level of at least +10 dbm, and that most amplifiers for speaker use will supply an output of at least +24 dbm. The confusion and chance for error which might come about by the changing minimum level for various impedances has been eliminated by an arrangement whereby the load meter multiplier dial is rotated automatically when the load impedance control is changed from one impedance to another. Thus, the zero on the VU meter scale corresponds to the level indicated by the meter multplier dial, regardless of the impedance across which the meter is connected. Without further precaution, this would allow the possibility of rotating the meter multiplier knob beyond the maximum +42 dbm level of the load section of the instrument. This has been overcome by an

[*Continued on page 30*]

Problems in Audio Engineering

LEWIS S. GOODFRIEND*

The study of audio begins at the basic transducer—the ear—in this first installment of practical course.

HEARING is the psychological response to the physiological phenomena involved in the sensation of sound. The sense organ for sound, the ear, is man's transducer for converting pressure waves in air into electrical impulses in the nervous system. It is neither a perfect transducer nor the ideal device for the purpose, but it is a well engineered device and has a number of important safety features. The ear is the fundamental transducer in all audio work, and establishes the final criteria for the judgment of sound quality by man. No matter what meters and measuring instruments indicate about the purity of a sound or its harmonic content, if it is not pleasing to the listener as presented to his brain via his ears and nervous system, then it *is* unpleasant. To quote one of the country's leading audio engineers, "if it sounds bad, it is bad."

The material that follows will give some of the details of the physiology of the ear and the manner in which the ear converts sound waves into psychological responses.

Figure 1 shows a cross-section of the right ear in a form that deviates from an exact picture in that the cochlea, the coil at the right, has been turned forward, and the middle ear muscles have been omitted because of size limitations. The position of the Eustachian tube, and the entry of the nerves through the bone of the skull are greatly simplified, since the exact positions do not affect the discussion of the operation of the ear.

*Stevens Institute of Technology, Hoboken, N. J.

It can be seen from this figure that the ear is naturally divided into three sections—the outer ear, the middle ear, and the inner ear. The outer ear functions as a collector of sound energy and a shield for the delicate structures of the middle and inner ears. The skin cells of the outer ear generate a bitter-tasting waxlike substance that inhibits the entrance of insects and prevents drying of the eardrum skin and ear canal. The part of the ear which projects from the side of the head is the auricle or pinna, and has little function in the method of hearing of modern man.

The Middle Ear

The middle ear is separated from the outer ear by a tough fibrous membrane, the tympanic membrane or eardrum. The eardrum is slightly conical, with its apex pointed inward, and on the inner side is fastened to the *malleus* (hammer) one of the three small bony pieces contained in the inner ear. These small bones, called the ossicles, form a mechanical linkage system which is supported by various ligaments in the middle ear cavity. As pointed out, the first of the ossicles, the hammer, is fastened at one end to the eardrum. The other end is fastened to the second member of the chain, the *incus* (anvil) which in turn drives the *stapes* (stirrup). It is the *stapes* that connects the middle ear driving system to the inner ear by means of its footplate.

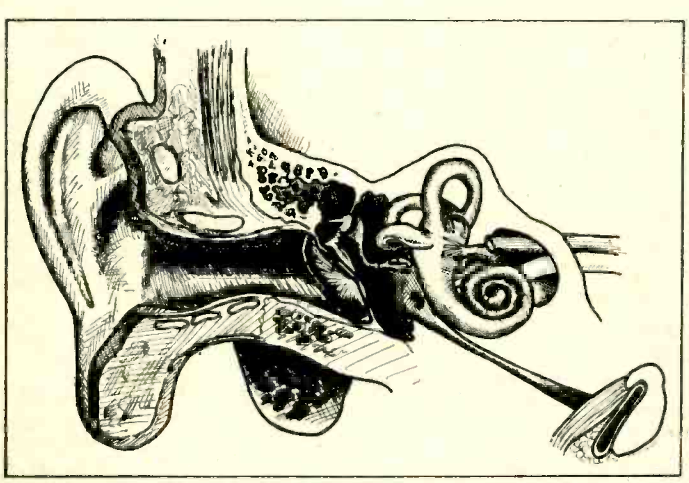


Fig. 1. Diagrammatic cross section of the ear showing the outer, middle, and inner ear together with the nerves and Eustachian tube. (From Hearing and Deafness, by Hallowell Davis. Courtesy Murray Hill Books, Inc.)

The wall separating the inner and middle ears is known as the medial wall and is made up in large part by the temporal bone. There are two openings in the temporal bone. The first, the oval window—so-called because of its shape—receives the footplate. Similarly, the opening below is called the round window, and both open on the cochlea in the inner ear. The round window is covered by a thin flexible membrane. Below these openings to the inner ear is the Eustachian tube which connects the middle ear to the throat. This tube is normally closed at its lower end and opens in the process of swallowing, equalizing the pressure between the middle ear and the surrounding atmosphere. If the pressure were not equal on both sides of the eardrum, the drum would not vibrate freely, and distortion and hearing loss would result.

The motion of the ossicles is somewhat complex even when stimulated by the simplest driving forces, but it may be stated that when the eardrum moves inward the footplate rotates about a point at its base. This is due to the nature of the ligamentary supports of the ossicles and their control over ossicular motion.

It is here in our study that two extremely important audio problems may be examined. First is the magnitude of the displacement of the eardrum during normal hearing, and the second, distortion in hearing loud sounds due to the operating characteristic of the ossicles. If we supply a barely audible (threshold) sound to an average person, that sound will cause the eardrum to move back and forth a distance that is so small that it may be compared to the size of an atom. The actual displacement of the eardrum for such a sound is about 10^{-10} cm which is less than one one-hundredth the diameter of a molecule of hydrogen gas. Sounds that cause a displacement of the eardrum of more than 10^{-3} cm (one-thousandth of a centimeter) cause pain and if permitted to continue for any length of time, can cause injury.

Distortion

The second problem, the distortion caused by the ossicles at high sound levels, is often neglected in discussions of medium—and high-power high-fidelity audio systems. *Figure* 2 shows a curve relating the force applied by the *stapes* to the rotation of the *malleus*.

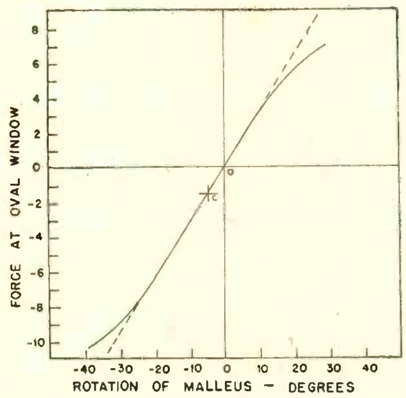


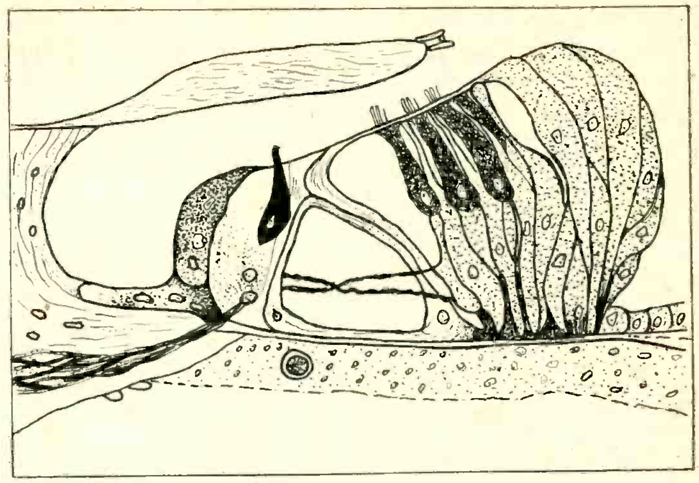
Fig. 2. Curve relating force at oval window to rotation of malleus. When the rotation is more than 30 deg. inward, the joint between the malleus and incus is dislocated. (After Stuhlman. Courtesy J. Acous. Soc. Am.)

There are three points of interest on the curve, the rest position of the *stapes,* marked *O,* and the two extremes of force. The rest position is not at the center *C,* of the linear region of the curve, and the curve deviates from linearity at the extremes of force due to the elastic characteristics of the supporting ligaments and dislocation of the ossicular joints on application of large forces. Many researchers have done considerable work on this subject and it is believed that these two nonlinearities in the ossicles may be responsible for the generation of the harmonics which are noticed when listening to loud sounds.

The inner ear consists of three semicircular canals, the cochlea, and the space joining them known as the vestibule. All of these are filled with a lymphatic fluid. The semicircular canals and the vestibule do not take part in the process of hearing, but are associated with the sense of balance. It is the cochlea that contains the mechanoelectric transducing elements.

The normal position of the two-and-three-quarter turn coil of the cochlea is horizontally in front of the vestibule. The cochlear spiral is made up of two galleries. The upper is the vestibular gallery and is separated from the lower tympanic gallery by a shelf or bone, and the flexible and thin basilar membrane. The two galleries are joined at the narrow end by a small passage, the *helicotrema,* and at the large end are connected to the middle ear by the *stapes* in the vestibular gallery, and to the round window in the tympanic gallery. Thus, although both galleries are dynamically connected to the middle ear, none of the fluid of the inner ear is in direct contact with the atmosphere. When the footplate is moved inward by a sound wave it pushes against the fluid which causes the elastic basilar membrane to displace, in this way applying pressure to the fluid in the lower gallery. The fluid in the tympanic gallery pushes the round window outward into the middle ear. When the footplate moves outward the movement can be traced in a similar manner. Several excellent works have been written covering the mechanism and dynamics of the inner ear, but only a simple outline will be presented here.

Fig. 3. Generalized cross-section of the organ of Corti. (After Fletcher, Speech and Hearing, D. Van Nostrand.)



When the *ossicles* are excited by high frequencies, the *stapes* will oscillate rapidly and only the narrower portion of the basilar membrane—near the large end of the cochlea—will be excited, while the wider far end of the membrane will be excited by low-frequency sounds which cause only a slow motion of the *stapes* and fluid. Some of the fluid may even flow around from one gallery to the other through the helicotrema at very low frequencies. It appears that the basilar membrane is tuned, that is, it responds along its length to different frequencies, and the whole system behaves as a low-pass filter. There have been no wholly satisfactory explanations of this phenomenon to date.

If a turn of the cochlea is cut, its interior would be similar to the generalized cross-section in *Fig.* 3. The membrane running horizontally across the figure is the basilar membrane and supports numerous cell structures together known as the organ of Corti. It should be noted that the *scala vestibuli* or vestibular gallery is separated into two ducts, the lower, often called the cochlear canal, being closed at the helicotrema end. The dividing membrane is the vestibular or Reissner's membrane, and is extremely thin and flexible so that it takes no apparent part in the operation of the ear. On the basilar membrane are cells called the hair cells, having little hairlike projections called *cilia,* and it is through these that the nerves to the brain run. There are four rows of cilia, comprising a total of about 24,000 separate hair cells. 20,000 of these are grouped in the outer rows which run parallel with the length of the basilar membrane, while the remainder—some 3,500—are located in the inner row. Between the inner row and the grouped outer three rows of hair cells are the rods or pillars of Corti. These rods appear to act as a stiff frame during motion of the basilar membrane. They cause the hair cells to move relative to the tectorial membrane above them which bends the cilia whose upper ends are anchored in the tectorial membrane. Several recent publications give complete details of the theorized operation of the mechanism from this point on. It will suffice here to say that motion of the cilia triggers impulses which are carried by the nerves from their endings in the hair cells along the ganglion of Corti to the eighth cranial nerve, the auditory nerve, which is the lower of the two nerves shown at the right in *Fig,* 1. Since the basilar membrane vibrates in different places when stimulated by sounds of different frequencies, only the nerves associated with a given position along the basilar membrane are activated when that portion of the membrane is vibrating.

At this stage it is possible to observe some of the effects that give rise to hearing loss, deafness, and the effects of the distortions already discussed. These will be considered in the next installment of this series.

References

ACOUSTICS, pp, 457-460.
Wood, Alexander; Interscience Publishers, Inc. 1941
THE EARLY HISTORY OF HEARING
Békésy, G. V., and Rosenblith, W. A.
[*Continued on page 45*]

Author with the station turntable. At the left is the phasing unit of the 5-kw AM WIS transmitter. In the right foreground is the transmitter console, with a portion of the speech bays behind it.

HERBERT G. EIDSON, JR.*

A turntable housing of professional quality which may be constructed at a reasonable cost to provide record reproduction facilities suitable for the most exacting uses.

Construction of A Broadcast Station Record Turntable

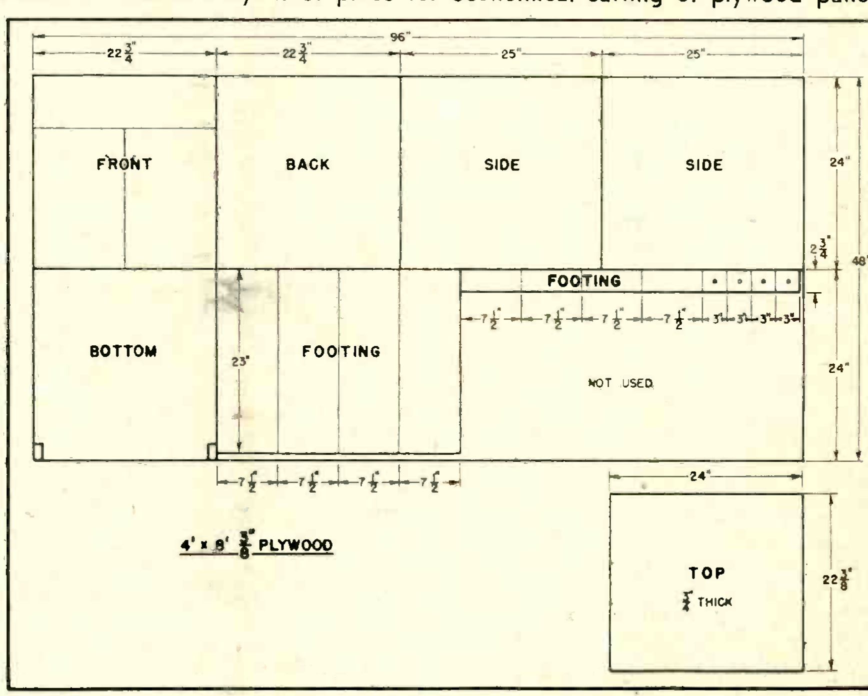
THE TRANSCRIPTION turntable herein described was designed to match a transmitter console[1] in shade of finish, type of footing, and height. The drawings seem to make the table appear a bit awkward on the 7½-inch base, but a look at the photographs will prove that this is not true. In actuality, it is a neat, commercial-looking turntable, easy to use and quite in place with its surroundings. If a table of this type were purchased from a standard manufacturer the cost would be from about $125.00 upward. The approximate cost of construction of the complete cabinet is $17.00.

List of Material

- 1 piece ¾" plywood 22⅜" x 24"
- 1 piece ¾" plywood 22⅜" x 24"
- 4 iron brackets 3" x 3½" x 3" (See drawings)
- 4 bolts, ⅝" x 8", round heads
- 8 iron angles, 90° type, 2"
- 4 cabinet hinges with ⅜" off-set
- 2 door fasteners
- 16' 1¾ x 1¾ wood stripping
- 4' 1" x 2" wood stripping
- 4' screen door wood stripping
- 4 nuts for ⅝" round head bolts
- 2 black felt strips 24" x 4¾"
- 2 black felt strips 22½" x 4¾"
- 6 sheets of #1 flint paper
- 6 sheets of fine sandpaper
- 1 box fine steel wool
- 2 2" paint brushes
- 1 pint of turpentine
- 1 small can of wood putty
- ½ pint paste wood filler, transparent
- 1 pint enamel paint, medium gray
- ½ pint enamel paint, black
- ½ pint clear varnish
- 1 pint satin-finish varnish
- screws, small finishing nails
- small tube of cement

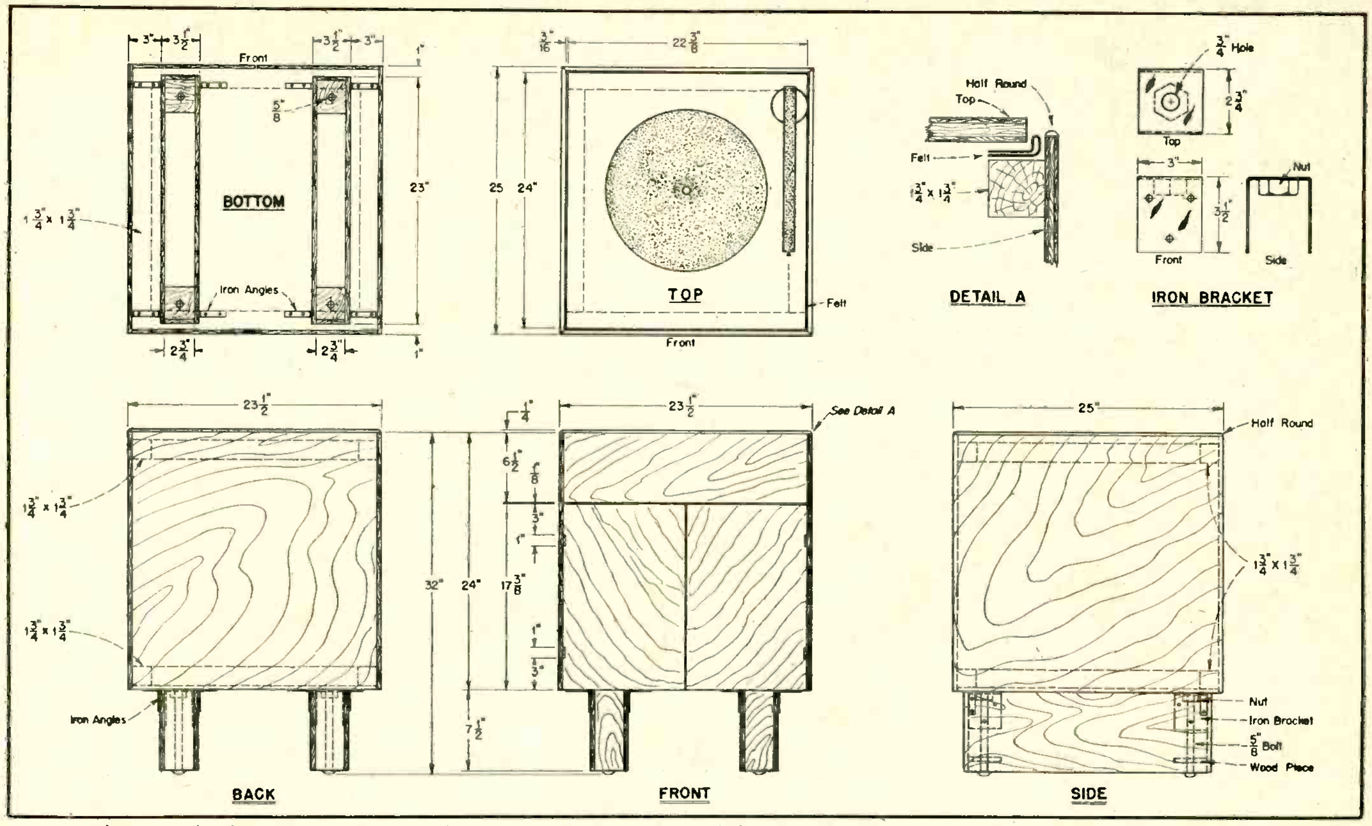
The footing consists of two elongated "legs" running from front to back, each being twenty-three inches long, seven and one-half inches high and three and one-half inches thick, held into place with 90 deg. iron angles. The corners are more heavily sanded than the corners of the cabinet, first with course-grain and then smoothed with fine-grain sandpaper. All sections of the cabinet are held together with proper woodscrews, except as before mentioned. The heads are allowed to sink into the wood about 1/16 inch so that wood putty can be used to cover them. Round-head bolts are used for the actual feet of the table, being ⅝ x 8 inches. The heads protrude about ½ inch and can be used for exact leveling of the turntable cabinet. The bolt is secured first by a wood collar fastened to the footing about an inch above the bolt head. The other end of

Pattern to facilitate layout of piece for economical cutting of plywood panel.



* *Chief Engineer WIS, WIS-FM; Technical Director WIST, Columbia, S. C.*

1 *Western Electric 5-kw AM transmitter 405B2 console.*



Plans and elevations of turntable cabinet, together with details of metal parts needed for assembly.

the bolt threads into a nut which is in turn welded to an iron bracket screwed tightly to the footing adjacent to the bottom of the cabinet, using six wood screws.

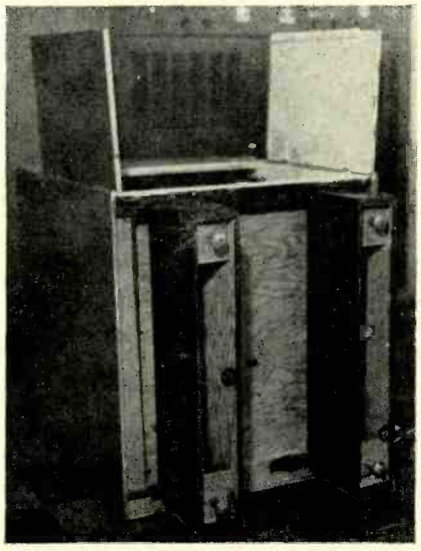
Painting and Finishing

Mix about five tablespoons of wood putty and fill in all screw and nail holes and small cracks, leaving the putty protruding above the surface slightly to allow for shrinkage while drying. After twenty-four hours sand the cabinet thoroughly with #1 sandpaper and finish with fine sandpaper.

Stir wood filler so as to mix well and, if necessary, add turpentine to obtain a consistency of thick cream. Using a two-inch brush, apply wood filler over all outside surfaces, brushing across the grain at all times. After five minutes, to allow for absorption, rub with a large clean cloth across the grain, thus removing all excess wood filler. Do not use wood fillers that require no rubbing; they will not give the desired results. Allow filler twenty-four hours to dry. Now, using fine steel wool, go over the outside lightly, leaving a smooth, flat surface.

Stir thoroughly a new can of gray enamel. Thin with ⅕ volume of turpentine. This will allow the paint to flow more freely. Apply one coat, using long even strokes with the grain of the wood. When cabinet is covered, stroke the edges over, to be certain no paint is running. Allow one full day for drying. Now sand lightly with fine sandpaper, go over the surface with a moist clean cloth, let dry and apply a second coat of gray enamel. When this is dry, work well with fine steel wool, wipe with a moist cloth, let dry and apply coat of satin finish varnish with new, clean brush. This last coat will tone down the lustre produced by the enamel and give the cabinet a finished look.

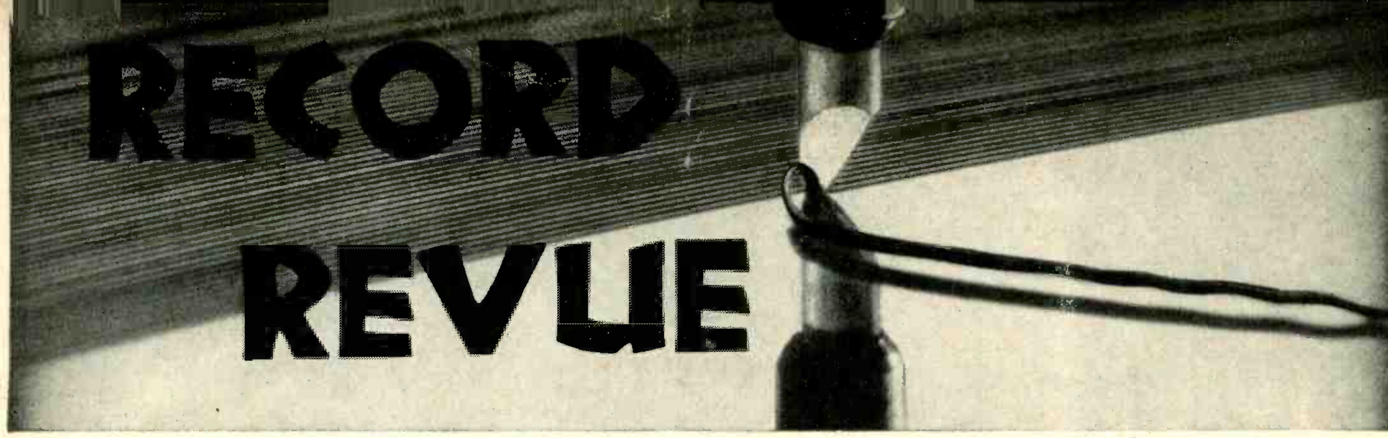
During the painting and drying cycles of the cabinet, the "legs" should be treated with wood filler just as the cabinet was and given two coats of black enamel, lightly sanding after the first coat. The enamel should be thinned with turpentine in the same manner as the gray enamel.



Bottom view. Note boltheads which have become feet for the cabinet.

The turntable[2] shown in the photographs is a well-known make, as is the pickup arm and head.[3] No cutout was shown for the turntable because different makes of turntable require different size apertures. The motor switch shown is a standard 120-volt mercury switch mounted into the front with a standard chrome finish covering plate. The output from the pickup head is brought out through the under side of the top section and soldered to phone tips. These then slip into two phone tip jacks which are mounted on a Bakelite strip near the top of the cabinet. Shielded wire is then used to carry the audio signal to the amplifier. This lead should be kept as far from the turntable motor and 120-volt wiring as possible. A separate heavy copper braided ground strap should be connected to the motor chassis from a good ground. Do not use the shield of the pickup audio lead for this or there will be hum induced by the circulating alternating currents. All wires should be brought out from the bottom of the cabinet to be as inconspicuous as possible. The large space in the bottom of the cabinet can be used for record or transcription storage by mounting shelves inside. If this is contemplated, install them before painting and finishing to ensure a neat construction job.

[2]Rek-O-Kut Model G-2.
[3]Astatic HP-16 with GE head.



EDWARD TATNALL CANBY*

JUST IN TIME for discussion here, I've had a most interesting delayed reaction on my January comments (general subject of the Fletcher-Munson curves) concerning the relative levels of broadcast music and the announcer's voice. Howard A. Chinn, Chief Audio-Video Engineer at CBS writes in, sending along a 1947 article[1] describing complaints from radio listeners that—exactly the opposite of my contention—music was often found relatively too loud, the announcer or other voices too low, and detailing a careful listener test that CBS staged to get information which resulted finally in a whole new set of transmission standards being put into effect in 1946, designed in general to tone down the music, relatively, and bring up the voice. If you will read my article on p. 20 of the January issue, you will understand why Mr. Chinn writes me that he is "puzzled" that my observations seem to be the reverse of those made by his listeners and amply confirmed by his tests! (As you may have noted, I wrote that announcers' voices were often *too loud* in relation to the music level.) Somebody appears to be off the beam, and when you see how methodically and expertly CBS went about measuring its listeners' preferences, you will suspect that it is this column that was befuddled.

The answer to the contradictory viewpoints is quite simple. It all can be found on one little word "music" and in the phrase, "radio concerts, both live and broadcast from phonograph records" that I used. My trade being what it is, you may guess that I meant so-called "classical music." (Not that I would for an instant subscribe to the idea that all "classical" music can be usefully lumped together in any one category.) Mr. Chinn is referring to a body of music technically quite different, as is indicated in his report.

Now it may be beside the point to mention the sad dearth on the air (from the musician's viewpoint) of that enormous wealth of music of a thousand varieties, new and old, that is lumped as "classical." I don't know what the percentage of "classical" music on the air is, whether 5 per cent or .005 per cent—more likely the latter. In Mr. Chinn's listener test the percentage was not even that. It was, as far as I can gather, *zero* per cent. No criticism at all—for the test, after all, was a practical one, based on the average radio program. The test included popular music (theme music, songs with orchestra), music to go with a comedy quiz show, a radio drama (bridge music, etc.) a comedy-variety show, and a crime drama of the more ghastly sort; most of it was thickly interspersed with spoken passages. The longest complete slice—voices-and-music—was eight and a half minutes, the shortest was two minutes and 17 seconds. There was no semblance of a "concert" in this except possibly the popular music, presumably uninterrupted by speaking voices for three minutes at a time. *Given this typical radio material*, and it was of course deliberately chosen as typical, Mr. Chinn got the reaction exactly opposite from mine, and there is not the slightest question that he was right in his conclusions.

But I was not speaking of this music. Perhaps I was wrong in limiting myself to the tiny minority of radio programs that can be labeled "concert." But remember that in the field of recorded music the classical (let's omit the quotes for convenience!) is of much greater relative importance than in radio and this for a simple reason: *not* because the record people are more virtuous or more highbrow than the hard-boiled radio men, but because in the record field classical music can make money; in radio it very seldom can. And this, because radio depends on a super-mass audience of enormous size and a microscopic return per listening head, nor can it please more than one audience at a given moment; whereas records may be profitably channeled to many smaller and more select audiences without interfering in the least with simultaneous larger mass audiences. When I said that radio concert music was often plagued by announcers' voices at far too high a relative level (again, see the January issue for reasoning behind this) I spoke of the sort of music that lasts, unbroken, for anywhere from fifteen minutes to an hour. In such broadcasts the listening conditions, the listeners' minds, interests, tolerances, are utterly different than in listening to the radio programs used in Mr. Chinn's test. More important, the music itself is utterly different.

Given this style of musical program, I think my observations, the reverse of Mr. Chinn's, will prove sound. And so there is no contradiction, but rather. one more example of how careful we must be, in this doubtful area where music and psychology overlap into engineering, not to omit some vital variable in our calculations. as I did in calmly ignoring the rest of radio!

Let me detail a few more specific items or difference in the conditions of Mr. Chinn's programs and mine.

1. There is an actual physical difference between the average symphonic or "chamber" (horrid word!) work and the average popular or incidental dramatic music. Though radio uses some quite large orchestras making plenty of *phons*, the average volume level is, for continuous music, fairly uniform. That is part of the popular and light symphonic style. Much music of other periods, however, features enormous dynamic ranges, notably music such as that of Beethoven or Tchaikowsky. That music was written, first, for uninterrupted, concentrated listening; and, second, for live concert performance with every bit of the dynamic range counting. Most present day light or popular music is written, perhaps unconsciously at times, with an electronic sound in mind and with radio or recorded dynamic possibilities strictly in effect. Classical music, even chamber music for a small group of instruments, benefits enormously in the direct listening from high volume levels that give a realistic approximation of the actual musical level, non-radio, as the composer intended. Most serious music listeners—with a notable exception to be mentioned in a moment—will give Beethoven all the volume that the reproducing instrument can take with reasonable distortion (often in spite of dreadful distortion). The longer the piece is—the longer the freedom from the sound of a broadcast voice—the more likely is the musical volume to creep up to the high level the music itself *demands*, for those who know it. Hence, when, after a *long* voiceless interval, as in a symphony, the announcer suddenly comes in (speaking, as always, in a low voice, close to the mike) his tones are stentorian! For the rest, see the Fletcher-Munson observations in the January article.

In contrast to this, the average radio program has music that by its very nature does not demand a high level, since it was expressly written for radio-style listening. Equally important, the music is *short*; there is never very long between voices speaking. The mind keeps the sound of the speaking voice to the fore and the radio level is adjusted to it. In all but the straight popular music program, in all the varieties of comedy, drama, quiz show, crime show, the speaking voice is far the most important item for listening attention. Music is incidental and must at all costs keep it place. Hence Mr. Chinn's accurate observation that in such programs—the very backbone of radio—music must *not* be too loud, voices must be kept well up in level.

2. But there is one condition which to my mind would bear a lot of investigating both in the area which was covered by the CBS tests on relative levels and my own classical music area. Some radio listening is done directly, *in silence*—that is, listener silence. A great deal more of it is done indirectly, to the accompaniment of conversation. Still an-

[*Continued on page 34*]

*279 W. 4th St., New York 14, N. Y.

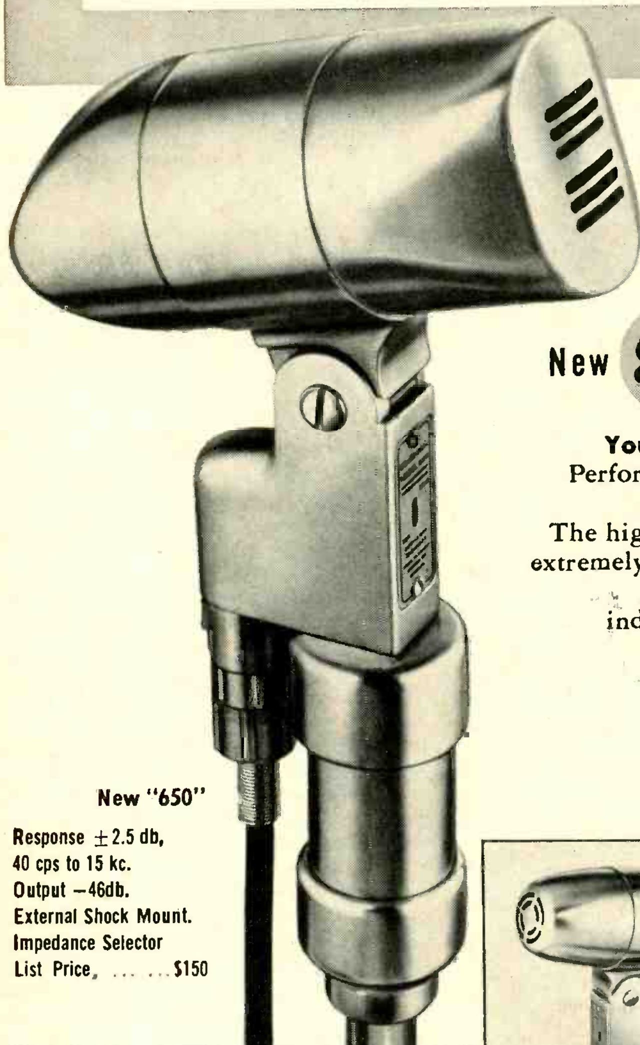
[1] *Proceedings of the I.R.E.*, Dec. '47, "New C.B.S. Program Transmission Standards." Reprinted as CBS Gen. Eng. Dept. Publications E611-H.

Response ±2.5 db, 40 cps to 15 kc., Output –46 db.

Broadcast Engineers Helped Design it!

Network Shows Use it!

Now Compare it with Any in Your Studios!



New E-V High Fidelity Broadcast Dynamic

You've wanted microphones like these! Performance meets the highest FM and AM broadcast standards. The bass end is smooth and flat. The highs are particularly clean and peak-free. Construction is extremely rugged and shock-resistant. Has E-V Acoustalloy diaphragm. Omni-directional. Each microphone individually laboratory calibrated and certified. Try one. Compare it with any mike in your own studios.

Write for full facts today!

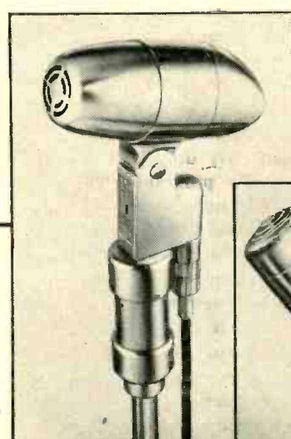
Electro-Voice

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN

Export: 13 E. 40th St., New York 16, U. S. A. *Cables:* Arlab

New "650"

Response ±2.5 db,
40 cps to 15 kc.
Output –46db.
External Shock Mount.
Impedance Selector
List Price. $150



New "645"

Response ±2.5 db,
40 cps to 15 kc.
Output –50 db.
External Shock Mount.
Impedance Selector.
List Price. $100

The "635"

Response ±2.5 db,
60 cps to 13 kc.
Output –53 db.
Impedance Selector.
For Hand or Stand.
List Price. $60

NEW PRODUCTS

THE old order changeth—and instead of only one phonograph turntable, the user now requires three, or will within a few weeks. Many dual-speed changers are already available, but for those who either do not have the space for additional units or who wish to avoid the complication of such equipment, the new Microverter provides one solution, making it possible to convert a 78 rpm record player or changer directly to 33-1/3 rpm operation in very few minutes. The Microverter consists of two units—one being a planetary-geared turntable which is simply placed on top of the regular 78-rpm table. An extension arm projects beyond the rim of the turntable, and when operating at 18 rpm, rotates along with the two tables. A separate playback arm on its own mounting is attached to the motor board at the side of the turntable. This mounting has a slide which performs two operations—one being mechanical and the other electrical. In the normal position, the regular playback arm is connected to the amplifier, and the slide is out of the way, permitting normal operation of the turntable at 78 rpm. In the long-playing position, the slide engages the arm on the turntable, causing the planetary to function and the upper turntable then rotates at 33-1/3 rpm. Movement of the slide to the long-playing position disconnects the regular playback arm and connects the microgroove arm to the amplifier.

• For those who use transcription-type turntables, or who shun the conventional record players for one reason or another, a new Trionic arm is shown by Clarkstan Corporation, 11927 West Pico Blvd., Los Angeles 34, Calif. This arm is so arranged that the cartridge can be replaced instantaneously without soldering, using silver plated plunger contacts to make connection with the cartridge pins. The arm will accommodate any pickup cartridge, magnetic or crystal, not over ¾-in. wide, and a thumb screw clamp holds the cartridge in place. A quick-acting weight adjustment provides for the range from 5 grams up, and the arm is available in two sizes—one for a maximum of 12-in. records, the other for transcriptions of 16- or 17-inch diameter.

• Using the new Titone ceramic pickup principle introduced last year, the Sonotone Corporation recently exhibited a new universal pickup which employs dual points set in one stylus in a side-by-side arrangement. The change from standard to long-playing points is made by the flip of a lever, which can also change the pressure with which the stylus contacts the disc. The Titone pickup, which uses a barium titanate ceramic for the piezo-electric element, is unaffected by temperature or humidity, and is thus capable of giving consistent reproduction throughout the year, regardless of weather conditions.

• Incorporating a new wrist action pickup arm which accommodates two needles on a reversible head, a new transcription player has just been announced by the Califone Corporation, 1041 N. Sycamore St., Hollywood, California.

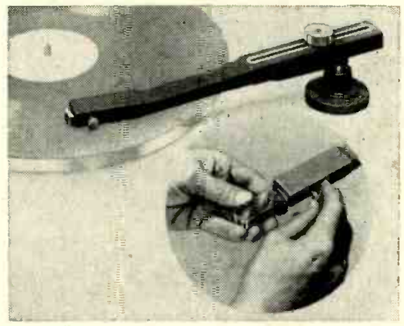
• Ever try to play vinylite records in dry weather in a room where there was much dust? A new product known as Anti-Static No. 79 is a liquid which is either sprayed or wiped onto any surface which is prone to generate static. The liquid is non-inflammable, fast drying, and when dry is non-visible, yet it effectively prevents the crackling noise often noted when reproducing this type of record. It is also useful for acetate masters, and when sprayed or wiped onto meter faces prevents the effect of static on the indication. Another use is to prevent dust attraction on—you should forgive the expression — television tube masks and lenses.

• Now is the time for all good manufacturers to come to the aid of the tape recordist—which they have done with a vim. One of the handiest devices to appear is the E-Z-CUE, a product of the Accessories Division of Amplifier Corp. of America, 398-4 Broadway, New York 13, N. Y. The E-Z-Cue is a counter which indicates the number of revolutions of a wire or tape spool, reversing as the spool does, and showing the exact position of the wire or tape at any time. At average speeds, this device maintains accuracy within approximately one second of recording time, and is a genuine time-saver where much indexing or editing is necessary. Along with full information on this device, the manufacturer is also distributing a 12-page booklet answering "99 Questions Most Often Asked About Magnetape Twin-Trax Recorders," the title of which thoroughly describes the contents.

• Built along the same lines as an 8- or 16-mm film splicer, the new Elken tape splicer makes perfect cuts and patches on magnetic tape, saving from one to five minutes over the conventional method. Splices made on this machine are not readily detectable by the naked eye, and the joints pass over playbackheads without any audible evidence. The Elken Splicer is distributed by W. V. Stancil Co., manufacturers of wide-range magnetic tape recorders. located at 1016 N. Highland Ave., Hollywood. Calif.

• The new Knight Wire Recorder, a product of Allied Radio Corporation, 833 W. Jackson Blvd., Chicago 7, Ill. is a low-priced combination instrument which features simplicity of operation, and serves also as a phonograph playback unit, wireless phonograph oscillator, or a PA system.

• There is always room for more good equipment on the market, and more is constantly being announced. Fairchild is adding to its line of broadcast equipment with an NAB recording equalizer, either with or without an amplifier mounted integrally; a standard vu-meter panel providing three inputs; and a new diameter equalizer for disc recorders. This latter item has an insertion loss of 10 db, and is arranged to give a maximum boost of 8 db at 10,000



Clarkstan Corporation

Sonotone Corporation

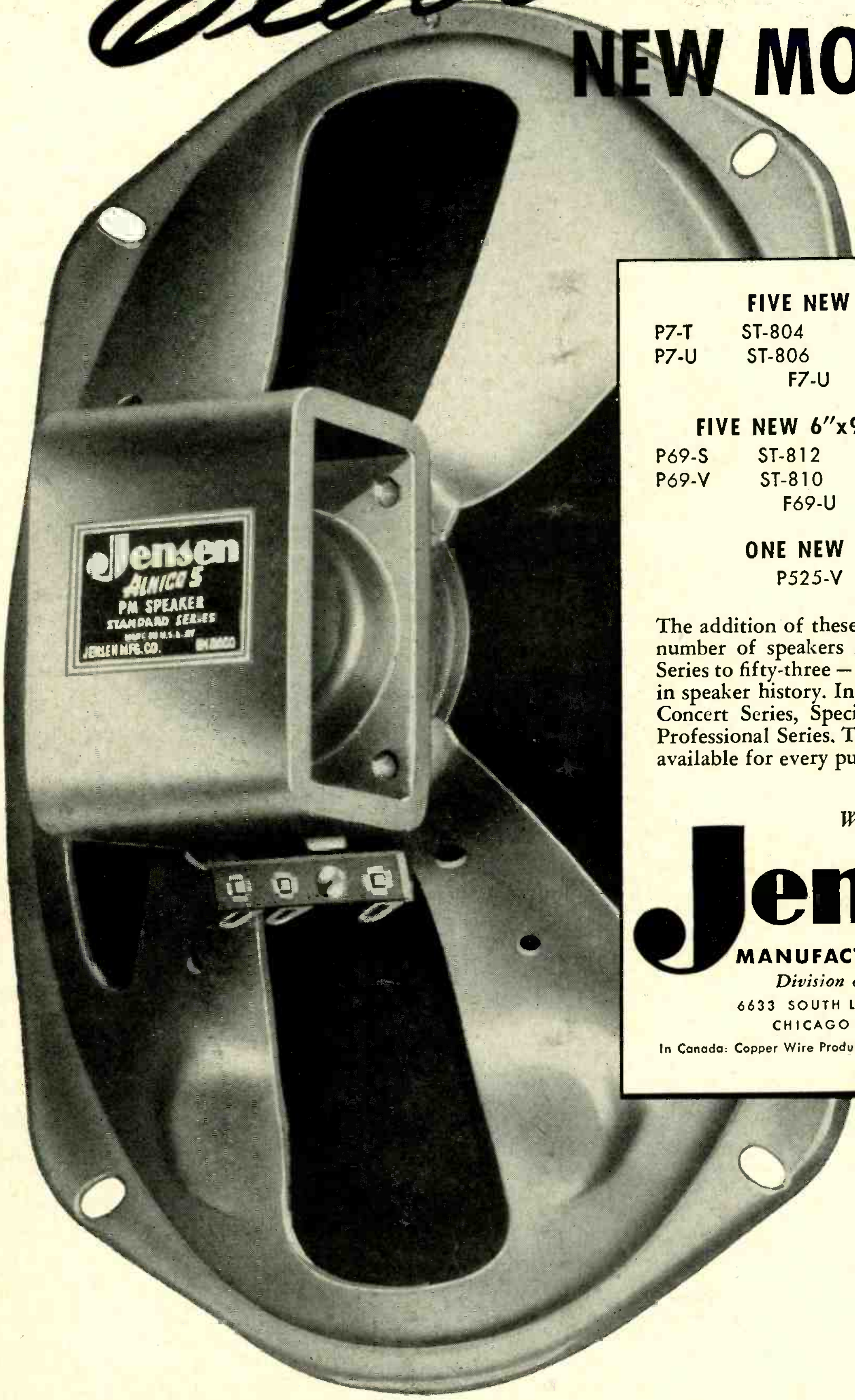
Califone Corporation

Elken Splicer

Knight Wire Recorder

[Continued on page 45]

Eleven NEW MODELS



FIVE NEW 7″ MODELS

P7-T	ST-804	P7-T	ST-807
P7-U	ST-806	F7-T	ST-809
F7-U	ST-808		

FIVE NEW 6″x9″ OVAL MODELS

P69-S	ST-812	P69-T	ST-811
P69-V	ST-810	F69-T	ST-814
F69-U	ST-813		

ONE NEW 5¼″ MODEL

P525-V ST-803

The addition of these new models brings the number of speakers in the Jensen Standard Series to fifty-three — the most complete array in speaker history. In addition are the Jensen Concert Series, Special Series, Coaxial, and Professional Series. There is a genuine Jensen available for every purpose.

Write for Catalog 1010-F

Jensen
MANUFACTURING COMPANY
Division of the Muter Company
6633 SOUTH LARAMIE AVENUE
CHICAGO 38, ILLINOIS
In Canada: Copper Wire Products, Ltd., 351 Carlaw Ave., Toronto

MEASURING SET

[*from page 21*]

arrangement whereby a mechanism changes the load impedance control back in the direction of 600 ohms if the operator inadvertently attempts to go beyond the +42 dbm point on the meter multiplier. The VU meter in the load section presents a problem due to the falling characteristic, as mentioned before. Unlike the source section, the falling meter characteristic in the load section does not show up as a rise in response, but as an actual fall. An additional complication is that any equalization used must present a constant impedance (with frequency) across the load. The reason for this is that the equipment to be measured has a finite output impedance, and the load impedance should not change with frequency nor with a change in the setting of the load meter multiplier switch. If the impedance of this meter corrector changed with frequency, a different frequency response would be obtained for each setting of the load meter multiplier switch. An "L" network equalizer in the load circuit provides compensation for the meter frequency-response characteristics. Thus the load level is the algebraic sum of the meter multiplier control setting and the meter indication.

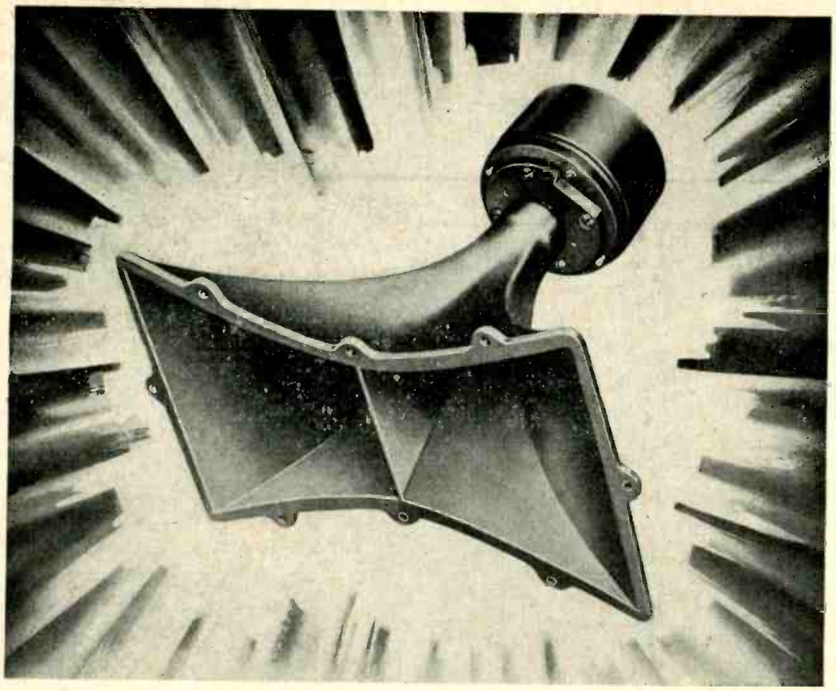
Meter Switching

In this transmission set, a single meter is employed, and is switched by means of a shielded lever key from the source section to the load section. As the meter is removed from a section, a resistive load is substituted in its place to keep the level constant. Since the meter is used at, or near, zero VU in either position, the level difference across the key is quite small. *Figure* 4 is a complete simplified schematic of the actual circuit used. The functions of the jacks, keys, and other components are merely to perform the operations outlined on the block diagram of *Fig.* 2.

Shielding between sections is especially important at the higher audio frequencies when there is a great difference in levels between the sections, as in testing high-gain amplifiers. With adequate shielding at the proper points the accuracy is maintained when level differences are at maximum. The precaution of adequate shielding and placing of leads in making connections to equipment under test must be observed if the optimum results are to be obtained.

Technical Data

The curves of *Fig.* 5 illustrate the data taken on the set. Since the only



transformer used is a 1:1 isolation coil, there is no change in frequency response between the various impedance steps. To simplify the curves only 600-ohm values are given. The same percentage ratios will hold for the other impedances. Curve *A* is the source impedance looking back into the set from the Source jacks, with attenuation dials set at maximum. Curve *B* is the load impedance looking into the load jacks with the meter range switch set at +42 Curve *C* is the frequency characteristic of the source section. In taking this data, the VU meter was held constant and the source voltage across a resistive load was recorded. Curve *D* is the frequency characteristic of the load section. To obtain this data, the source was a zero-impedance generator (voltage held constant) feeding through a 600-ohm resistor into the Load jacks. Curve *E* is the overall frequency response characteristic taken by holding the source VU meter constant and recording the indications of the same meter across the load. Curve *F* is a measure of the shielding of the isolation transformer T_1 and the impedance matching network in the source section. This leakage was measured by holding the input level constant and varying the frequency. The leakage voltage was measured between the Source jacks (tied together) and ground. Note that the leakage increases with frequency. The db leakage is additive with the db loss; for example, if there is a 60 db loss in the controls, and at 15 kc there is 60 db leakage, then the leakage is 120 db below the input level. Another way to consider this is that at 15 kc if the leakage is down 60 db at 15 kc, the error in measurement may be off by one part in one thousand (corresponding to 60 db) due to this leakage. The leakage measurement represented in Curve *F* is for overall source section, including wiring, the transformer, and the impedance matching network.

This simplified transmission measuring set was developed to provide a popular priced instrument for small station and laboratory use. By this simplification, the overall accuracy is actually better than that found in many more complex sets.

AUDIO AMPLIFIER

[*from page 10*]

Early models of this amplifier manifested a variety of motorboating. Because of the low impedance of the output stage, and its consequent control of the power supply voltage, in-phase motorboating is likely to occur due to the push-pull tubes acting as if they were in parallel. The first model using this circuit had the lower ends of the 2400-ohm driver bias resistors connected directly to minus 350. Motorboating occurred even with only the drivers and output tubes plugged in. This can be explained by regarding the minus 350 as the reference point, with ground moving up and down in voltage, depending on the drain by the output stage on the power supply. Ground is coupled to the grids of the drivers through various capacitors and resistors. A negative pulse on the grids of the drivers will cause the grids of the output tubes to become less negative, causing greater drain on the power supply. Ground and the grids of the driver will thus become more negative, and motorboating results. This interesting but undesired phenomenon was eliminated by inserting a 15,000-ohm resistor between the 2400-ohm bias resistors and minus 350, and connecting a 40-μf capacitor from the junction to ground. As it is now connected, when ground moves up and down both the grids and cathodes move with it, and the output is practically zero.

Speaker Damping

The primary purpose in the design of the amplifier was to achieve unusually good damping. This has been carried to such an extent that the limiting factor is the d-c resistance of the output winding, less than one ohm. The cleanness of reproduction obtained is definitely noticeable. A good demonstration is side 4 of Columbia's "Young Person's Guide to the Orchestra", which has excellent low notes as well as the crack of a whip near the end of the record. The extreme low frequencies are more naturally reproduced because of the added control of the voice coil. There is no muddiness. Another test of the damping, somewhat analogous to definition in a camera lens, is the separation of rapidly rolled drumbeats.

It is usually suggested that the output of a tweeter be reduced by means of a resistor network, because it is higher in efficiency than a woofer. In listening tests it has been found tentatively that the introduction of a resistance in series with a good compression type tweeter reduces its sharpness and clarity, making it sound like an ordinary cone type tweeter. It is thus suggested that other methods might be tried, such as multiple tweeters spreading the sound more widely, for example.

The amplifier is used primarily in our "Gilson", a radio-phonograph combination using a Jensen 18-inch theatre speaker with two Jensen tweeters. Passably good reproduction can be obtained, however, even with a 15-inch

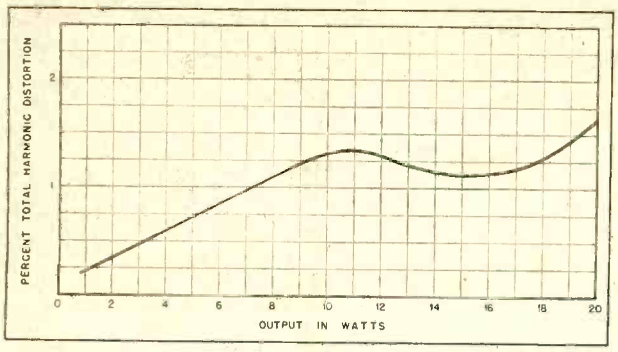


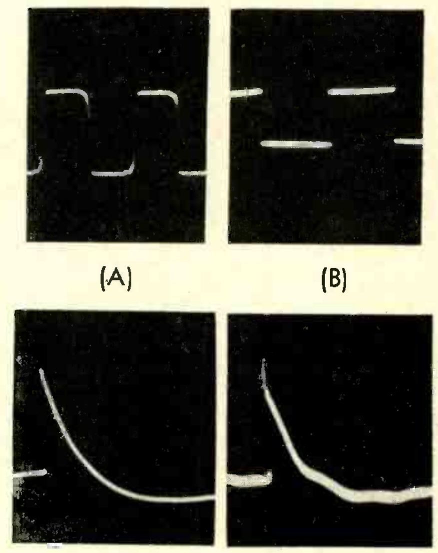
Fig. 5. Total harmonic distortion vs output at 50 cps.

speaker designed for home use, because of the control of the voice coil.

The frequency response is shown in *Fig.* 4, the total harmonic distortion in *Fig.* 5. The deviations shown cannot be detected by the ear.

Figure 6 shows oscillograms taken from the 16-ohm voice coil of a 15-inch speaker. The response to a square wave at 200 cps is shown at (A), at 5000 cps at (B).

The effect of damping is demonstrated at (C) and (D). A 0.5-volt d-c pulse is applied to the input, producing a transient, the shape of which depends on a number of factors. (C)



(A) (B) (C) (D)

Fig. 6. Oscillograms of output for various input signals: (A) 200-cps square wave; (B) 5000-cps square wave; (C) 0.5-volt d-c pulse at input, speaker connected normally; (D) same signal as at (C), but with 10-ohm resistor in series with voice coil. Last two oscillograms show effect of damping.

shows the lack of overshoot and smooth exponential return as the coupling capacitors discharge. At (D), a 10-ohm resistor has been connected in series with the 16-ohm voice coil. The potentials produced by the marked overshoot and continued vibration of the voice coil can clearly be seen.

REFERENCES

[1]E. G. Weaver and C. W. Bray, *J. Acous. Soc. Am.*, Vol. 9, pp. 227-233 (Jan. 1938).
[2]C. G. McProud, AUDIO ENGINEERING, Mar. 1948.

RECORD REVUE

[*from page 26*]

other huge chunk of listening is done as an incidental to other foreground activity, reading for instance; phonographs similarly.

It is my contention that in every field of radio and in listening to recorded music as well, these different types of listening pose utterly divergent listener problems. I suggest that Mr. Chinn's tests of listener relative volume preference might have been applied interestingly not only to the first condition, but to the more prevalent second and/or third conditions. Let's face it: people practically never listen to the radio in silence and with direct attention these days! Something else almost always shares the listener's direct attention, and all too frequently monopolizes it except for that priceless subconscious mind which, as the ad men know only too well, hears everything and especially the commercials!

Just how CBS could re-arrange its 1945 listener test to cover the listening housewife at her Monday laundry or the family sitting at dinner with the radio going is more than I can imagine—but the situation is certainly a normal one. And equally normal is the listener to classical music who prefers it as a quiet background, to reading, napping, or especially, to conversation. I have just spent an afternoon (Sunday) during which two Mozart violin sonatas, five Mozart opera arias, the Brahms Clarinet Quintet, and a Haydn symphony were played complete, on LP records, to a constant accompaniment of conversation and Sunday paper reading. The volume level was discreet. The highs and lows were entirely missing and not missed. (The speaker was a 3" model in a table radio.) Yet to say that the music went unheard would be a gross misstatement. It was heard and appreciated. There would have been objections to its being turned off. I have heard innumerable Sunday afternoon Philharmonic broadcasts come through the same little radio, under the same conditions.

In this sort of listening the desirable characteristics of reproduction are strikingly different from those we might outline for *direct* listening, in silence, with direct concentration on the music. Both types exist widely among classical music lovers, often with one and the same person—such as myself. With the one, we listeners want high volume, wide-range reproduction, a very large dynamic range, a maximum of good bass and highs, and this even at the risk of much hiss and scratch and rumble. With the other kind of listening, the listening-against-conversation (and do not underestimate this kind of listening) we want no highs, little dynamic range; we can get along perfectly without bass. Smooth, even performance is at a premium, regardless of the composer. And all that because we as a nation have developed the ability to listen to radio or records and do other things simultaneously; generally we find this easier to do than to listen directly, twiddling our thumbs the while.

All of which, if you will think it over, adds up to a lot when it comes to the engineer's simple decision—*where shall I ride the gain when the spoken voice is being broadcast?*

RECENT RECORDINGS

Tchaikowsky, Symphony No. 3 ("Polish"). RCA Victor DM 1279 (5)
Royal Philharmonic Orchestra, Beecham.

Tchaikowsky, Francesca da Rimini (Fantasia for Orch.) Columbia MM 806 (3)
N. Y. Philharmonic, Stokowsky.

• For engineers who want a big orchestra playing plenty of skillfully loud music, these two albums will be of interest. For those who—musically speaking—like Tchaikowsky but would just as soon not hear the same five or six works over and over again, these two will also be of interest. The "Polish" Symphony, though a relatively early work, is full blown and as expertly put together as any later symphony of his, including all the stock Tchaikowsky effects, big climaxes, ominous low-level passages, big, romantic tunes. "Francesca" for some reason not too often heard, is another "Romeo and Juliet", quite similar to it, a tone poem based on a similar story of two lovers who die (via murder in this case!) and consequently it is replete with both love and woe. I find "Francesca" a striking piece, well above a lot of Tchaikowsky in its dramatic impact. The Stokowsky performance is exceedingly good, plenty emotional, but never slushy and sloppy, as Stokowsky has been known to be. The basic horror-theme, a short Wagner-like phrase of music, will give you the creeps. The Beecham interpretation is just a little bit sedate, for my taste, in the "Polish" symphony.

Technically the recordings are similar, one being of British E.M.I. origin, out of Victor, the other Columbia domestic, following the European-style recording that Colum-

RECORD LIBRARY

Music with interesting combinations of instruments, voices.

Bach Arias. Aria.
Bach Group (instruments, voices); Wm. Scheide.
Vox 637 (4)

*Beethoven, Septet, opus 20.
B. B. C. Instrumental Septet.
RCA Victor DM 571 (5)

*Brahms, Clarinet Quintet, opus 115.
Reginald Kell, Busch Quartet.
RCA Victor DM 491 (4)

Grieg, Cello Sonata in A Minor.
Raya Garbousova, Artur Balsam.
Concert Hall AD (3 pl.)

Hindemith, Sonata for Viola D'Amore and Piano.
Milton Thomas, Sara Compinsky.
Alco AC 204 (2)

Mozart, Adagio and Rondo for Glass Harmonica, K. 617.
E. Power Biggs (celesta), with flute, oboe, viola, cello.
RCA Victor 11-9570 (1)

Mozart, Clarinet Quintet, K. 581.
Reginald Kell, Philharmonia String Quartet.
Columbia MM 702 (4)

Prokofieff, Overture on Hebrew Themes, op. 34.
Wm. Nowinsky, vl., Vivian Rivkin, pf. and Strings.
Disc 4020 (1 pl.)

Stravinsky, Pastorale for Violin and Wind Quartet.
Joseph Szigeti, wind quartet.
Columbia 72495-D (1)

Pee Wee Russell Jazz Ensemble.
Russell, Jackson, Dickenson, Casey, Palmer, Grauso.
Disc 632 (3)

Telemann, Trio Sonatas; Loeillet, Trio Sonata.
Alfred Mann, recorder, Edith Weiss-Mann, harpsichord, Lois Wann, Oboe, Ernest White, organ.
Technichord T-13 (4 10")

Bach, Sonatas for violin and harpsichord.
Alexander Schneider, Ralph Kirkpatrick.
Columbia MM 719 (14) (2 vols.)

*Bartok, "Contrasts", for Violin, Clarinet, Piano.
Joseph Szigeti, Benny Goodman, Bela Bartok.
Columbia MX 178 (2)

Brahms, Violin Sonata No. 3, opus 108.
Isaac Stern, Alexander Zakin.
Columbia MM 730 (3)

Brahms, Clarinet Sonata, opus 120.
Benny Goodman, Nadia Reisenberg.
Columbia MM 629 (3)

Brahms, Piano Quartet No. 3, Opus 60.
Alex. Schneider, violin; Milton Katims, viola; Frank Miller, cello; Mieczyslaw Horszowski, piano.
Mercury DM 9 (4)

Debussy, Danse Sacrée; Danse Profane
Ravel, Introduction and Allegro.
Marcel Grandjany, harp; RCA Victor String Orch.
RCA Victor DM 1021 (3)

Mozart, Piano Quartets No. 1, No. 2, K. 478, 493.
Budapest Quartet, George Szell.
Columbia ML 4080 (1 LP)

Shostakovitch, Trio in E minor.
Compinsky Trio (violin, cello, piano).
Alco A-3 (3) T-103 (1 16")

*Villa-Lobos, A Festival of Brazilian Music.
Braz. Festival Orch., quartet, Schola Cantorum, etc.
RCA Victor DM 773 (5)

**Pre-war recording.*

bia has been doing. Both are excellent. The Columbia, I'd venture to say, has somewhat cleaner high tones, notably in the louder parts. Fine cymbal crashes, a wonderful after-reverberation of the cymbal at the very end of the work. The Columbia acoustics-plus-recording-curve give a somewhat heavier over-all sound, the British one (strangely enough) a lighter, more brilliant tone quality.

Mozart, Divertimento in D, K. 251.
Mercury DM 4 (3)
Dumbarton Oaks Chamber Players.

Mozart, Sonatas for Violin and Harpsichord
Columbia LP SL-52 (2)
Alexander Schneider, vl; Ralph Kirkpatrick, harpsichord.

Okay—you don't *like* Tchaikowsky! Well, try these, then. The Divertimento is one of Mercury's ultra-wide-range domestic recordings (presumably single-mike technique). Its tonal qualities are most astonishing, particularly for the first violin which, even though the acoustics are big and very live, has an extraordinary "edge" to it such as I've not heard on a record before except, perhaps, the single-record Stravinsky Pastorale (7304-M) from Columbia, which has had much notice given it in the last year or so. To tell the truth, I'm not sure this violin "edge", on a record, adds to the musical effect; I find it rather distracting musically. But as an accomplishment of the recording art it is certainly unusual. Other instruments —oboe, two French horns, as well as strings —are admirably differentiated in tone. The music is of the casual semi-outdoor entertainment type of Mozart; for those used to big Romantic symphonies it may sound uninspired at first; but the general gaiety and fine tone quality should put it over.

The first (shellac) volume of the violin sonatas, played with the harpsichord instead of the now-usual piano, came out some time back, and was a model of wide-range "chamber" recording. Now, on LP, a new set of sonatas is added to the old, probably recorded at the same time and, as of the moment, this new set is available in the LP version only. In Mozart's youth the harpsichord was still used more or less interchangeably with the developing piano, even though the two are in reality very different instruments of quite different capabilities and the piano is in no sense a mere improvement on the harpsichord. (Otherwise why the present return-engagement of harpsichord popularity, after a century and half or more!) Value of this recording is double: (1) Technically speaking, the harpsichord is far easier to record than the piano and so relatively more effective; it has little percussion, being plucked, and lots of tone-color highs. (2) Musically, the harpsichord's strong, nasal tone color is closely related to that of the violin and hence, once the unfamiliarity has worn off, the violin-harpsichord combination is easier to hear as a whole than the violin-piano mixture, which opposes utterly different tone qualities that, nevertheless, are supposed to "blend" in harmony most of the time. The inner mental ear must work the harder in order to "hear" the two as one.

Scarlatti-Tommasini, "The Good Humoured Ladies". (Ballet suite).
Decca ffrr EDA 92 (2)
London Symphony Orch. Sargent.

● An interesting example of misplaced acoustics. This music is arranged for orchestra from the brilliant and virtuoso harpsichord sonatas of Scarlatti. Each is only a few moments long, packed with very rapid, clean, precise keyboard figuration; the same applies to the orchestral arrangements. In the characteristic ffrr liveness, with distant-mike style of pickup, these little sonatas lose their crisp neatness, in spite of good playing. This music should be done close-to, in a relatively dead, dry acoustic.

Beethoven, An die Ferne Geliebte (Song Cycle).
Mercury DM 8 (2 10")
Wm. Horne; Franz Rupp, piano.

● Also an interesting example of somewhat misplaced acoustics. This is done with the Mercury liveness and single-mike technique, but it seems to me to miss the mark. The voice, in such a large, live studio, sounds rather thin, off-mike, even though diction comes through clearly thanks to extended range. In these intimate, fairly personal songs, a close-mike technique would bring over the singer's personality and projection better, I would think. The piano accompaniment, on the other hand, is superb with this pickup. (Not a serious criticism of the recording—it makes good listening; rather, merely a technical point of interest.)

Mahler, Eight Songs.
Columbia MM 809 (3 10")
Desi Halban; Bruno Walter, pianist.

● How could it have happened? The voice here is very nicely recorded, close-up and clear (as suggested above) though in a surrounding liveness that could be more live. But the *piano*—not only far too weak, but it sounds like a guitar or a zither somewhere in the background. Extremely poor piano recording, and of one of the most distinguished artists of the day! Don't ask. Whatever the reason, the piano sound must have run into violent distortion along the electronic route somewhere; the peculiar plunking sound might be sick transients—very sick? Try it and judge for yourself—better still, compare it with the Mercury piano above.

Music of the Navajo Indians.
Folkways 1401 (4 10")
Recorded by Wm. Rhodes in cooperation with Bureau of Indian Affairs.

Indian Songs of the Southwest.
Candelario (4 10")
(Apache, Hopi, Navajo, Taos)

● Two unrelated but very similar albums of great interest. Engineers will find these striking examples of the change in quality of portable recording now spreading through the scientific fields—we all know the characteristic "on location" recordings of pre-war days, distorted, scratchy, very limited in tonal range, blasting, badly microphoned, and so on. These new records, both albums, are printed with low surface noise; the recordings, if not wide-range, are certainly well up to the average of good recording today (something to be heard without undue distortion up to, say, 9000 at least) and the "acoustics," control of recording level, microphone placement, are astonishingly good considering what must have been the circumstances. Of the two the Candelario job has the wider range, but the Folkways album is not significantly different.

Artistically (and as amusement) these show what few of us realized—how very extensive Indian music still is and how completely untouched it is by our "Western" ideas, in spite of its existence right in the middle of the U. S. If you want to scare the neighbors, try a few of these—but don't fail to give them a serious thought, too. This isn't play-music nor is it simple, crude or easy to perform. Far from it. The Candelario company is at Taos, N. M. Folkways Records (succeeds the Disc Company) is at 117 West 46th St. N.Y.C. Some stores may carry the albums.

French Organ Music (Widor, Gigout, Dupre, Alain, Vierne).
Columbia MM 802 (5)
E. Power Biggs, (Organ of St. Paul's Chapel, Columbia Univ.)

● As organ recordings go, this one ranks high—even if the music is of the sort highly prized by organists and cordially disliked by a great many other people! If it did nothing else, this sort of music at least could show anyone what can be done with a high-powered super-organ, late 19th century variety. The recording is very brilliant, resonant, with much stone-echoed high sound as well as the expected pedal lows, always useful for the engineer.

● Though it is impossible to re-review the increasing list of reissues by Columbia in LP form, this column has no intention of belittling this phase of activity in favor of the strictly new releases. For the musical significance of LP, see this department in the March issue. Technically there is no doubt that many LP reissues are improved in quality over the original shellacs, in particular those of pre-war recordings when dubbing (from 16" originals) was not as perfect as it is now. Here are some notable reissues of the last few months in the LP form, of interest both musically and for the sound-conscious engineer:

● *Recent (postwar) recordings*: **BEETHOVEN**, 9th Symphony (Phila. Ormandy); Leonore Overture No. 3 (Philharmonia, Kletski) SL-50 (2); "Ghost" Trio op. 70 (Busch-Serkin) ML 4218; Symphony No. 2 (Pittsburgh, Reiner) ML 4085. **BACH**, Organ Music (Biggs) ML 4097; Sacred Arias and **MAHLER**, Songs of a Wayfarer (Brice) ML 4108. **HANDEL**, The Messiah SL-51 (3). **MOUSSORGSKY**, Scenes from Boris Godounov (Pinza, Met. Opera Orch. & Cho.) ML 4115. **DVORAK**, Symphony No. 4 (N. Y. Philh. Walter) ML 4119. **SAINT SAENS**, Symphony No. 3 with Organ (N. Y. Philh. Muench) ML 4120. **CHOPIN**, Mazurkas for piano (Maryla Jonas) ML 2036. **SIBELIUS**, Symphony No. 2 (Phila. Ormandy) ML 4131. **MENOTTI**, The Medium, The Telephone (operas: Ballet Society Production) SL-54 (2). **STRAVINSKY**, Symphony of Psalms (a new recording) (CBS Symph., chorus, Stravinsky); Symphony in Three Movements (N. Y. Philh. Stravinsky) ML 4129. **GRIEG**, Peer Gynt Suite No. I; **LISZT**, Hung. Rhaps. Nos. I, 2, (Phila. Ormandy) ML 4132. **BRAHMS**, 8 Hung. Dances; **STRAUSS**, Waltzes (Pittsburgh, Reiner) ML 4116. **CARNEGIE POPS PROGRAM** (from single records) ML 4118. **MUSIC OF RICHARD ROGERS** (Kostelanetz) ML 4130. **SPIRITUALS; ROBESON RECITAL** (Paul Robeson) ML 4105. **MORTON GOULD SYMPHONIC BAND** ML 2029. **MUSIC OF VICTOR HERBERT** ML 4094. **STEPHEN FOSTER** (Nelson Eddy) ML 4099.

Pre-war recordings, newly dubbed—usually with great improvement over original 78 pressings. **BEETHOVEN**, Quartet No. 14, op. 131 (Budapest) ML 4106; Quartet No. 15, op. 132 (Budapest) ML 4006. **RAVEL**, Quartet (Budapest) ML 4091; Le Tombeau de Couperin and **MILHAUD**, Le Boeuf sur le Toit (Minneapolis, Mitropoulos) ML 2032. **TCHAIKOWSKY**, Theme and Variations (N. Y. Philh. Barbirolli) and Serenade in C major (Phila Ormandy) ML 4121. **SHOSTAKOVITCH**, Symphony No. I (Cleveland, Rodzinski) ML 4101. **BACH**, Violin Concerto in E Major (Busch) and 2-violin Concerto in D (Busch-Magnes) ML 4002. etc. . . .

Note that many of these are couplings of an older recording with a much more recent one, sometimes by the same orchestra, making for an interesting technical comparison from one side to the other. Columbia has finally come around to giving the original "Masterworks" number of each set, along with the new LP number, in its publicity—would have helped if they'd done it from the start.

FREQUENCY GENERATOR

[from page 13]

quency. The higher the frequency, the more nearly it approaches the sine form.

For those who may be interested in building such a sweep generator for their own use, the schematic of the unit is shown in *Fig.* 17. The transparent discs may be obtained from the manufacturer, and with the circuit shown, little difficulty should be encountered in constructing the generator, because it is little more than a high-quality audio amplifier preceded by a photocell circuit. The lowest satisfactory sweep speed of the average oscilloscope is of the order of 20/sec, so the motor speed must be determined from this figure. The card is designed so that one half contains the sweep-frequency signal while the other half is unmodulated. Therefore, 1/20 second is required for one-half revolution, or 1/10 second for a complete revolution. This indicates a motor speed of 600 rpm. A simple idler arrangement may be necessary to ob-

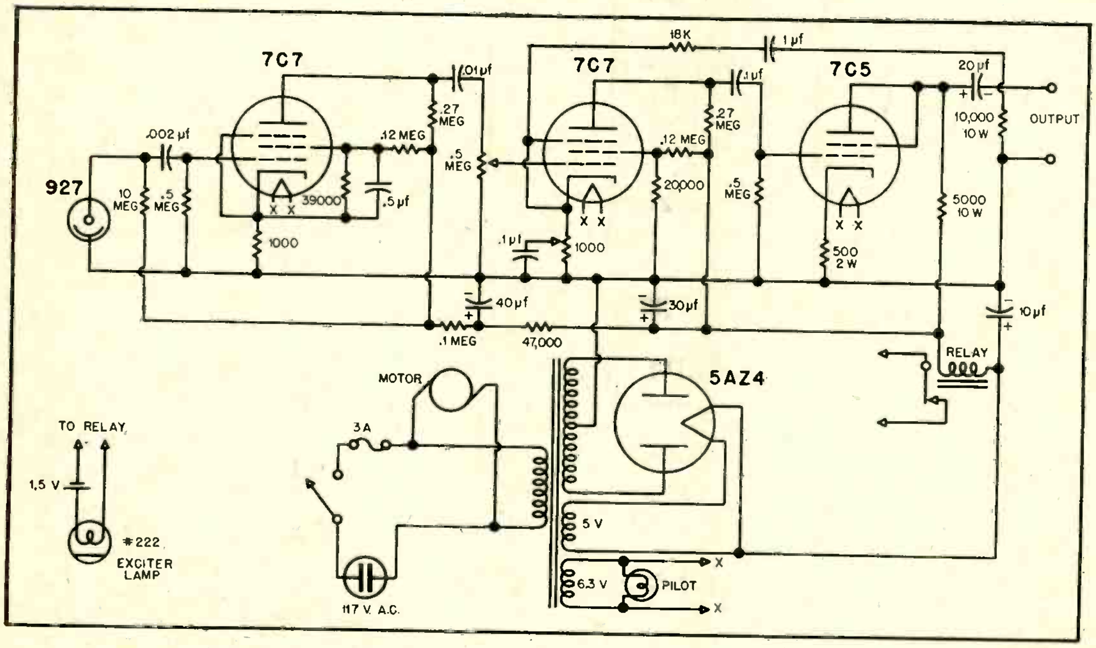


Fig. 17. Schematic of sweep generator described by the author.

tain this value. The disc is mounted so that the low-frequency section passes the slit first in rotational order, since most 'scope sweeps are from left to right and it is desirable to show the low frequencies at the left side of the screen. It is necessary that the slit be of the order of 0.5 mil in width, and of sufficient length to cover the entire modulated portion of the disc.

The potentiometer, R_8, provides for compensating for slight photographic processing and other perturbations. This adjustment is set for flat output over the entire range, and should be made with simple resistive loads, or directly into the 'scope. A simple caution is offered with respect to the discs—they should never be touched while rotating because of the tendency to build up electrostatic charges which attract pieces of lint or dust, thus producing irregular patterns.

Acknowledgement is made to Mr. Frederick P. Fox for his valuable photographic technical assistance in the preparation of the cards for the audio sweep generator.

— LETTERS —

[*from page 4*]

by income from the pop record; they could not survive on Beethoven alone. Is there any reason why 80% of the market should take inferior engineering to please 20%? The tail is trying to wag the dog! Over 80% of the material on X will certainly not be used on 10" and 12" LP.

As a matter of fact, the classical record field would be very well served by extension of 45 rpm to the larger size record. At 270 grooves per inch it would be easy to record 19 minutes on each side of a 12 inch record. The quality at every point would be superior to that on the LP at the same diameter.

There have been conflicting reports on the music to music changing speed of X changers. The answer, of course, is that the time depends much more on the record than on the changer. With the change taking only 1½ seconds, any extra time is spent playing silent grooves. By a suitable choice of lead-out groove pitch, this can obviously be reduced to any desired value. It has no relation to 45 rpm or to the changer mechanism. Competent observers have claimed a four second change. Others have observed the eight seconds Mr. Cardnner notes. It is probable that, with time, the record will be improved in this respect.

"STYLUS"

AUDIO ENGINEERING SOCIETY

[*from page 18*]

The Chapter Constitution was ratified and officers were elected. The executive committeemen elected were: Chairman, Rober[...]hell; vice-chairman, Myron Ehrli[...]cretary, Hagop Hatzakortzian; [...]rer, Joel Fichman. Chairman a[...]ere elected for the following co[...]ttees: Constitution, George Cohen[...]ogram, Weldon Squyres; Membersl[...]Paul Bezold; Publicity, Peter Gacl[...]

Plans for t[...]mmediate future include present[...]n of student papers, appearance o[...]est speakers, inspection tours of [...]nufacturing and processing plants[...]d establishment of a Chapter refer[...] library.

● The Sprin[...]ucational Series of lectures sponsored [...]he Society on the general subject of[...]ments and Practice of Audio Engineer[...]is well under way, with the lecture on A[...]fier Design—the seventh in the series—t[...] given on May 5. These lectures are hel[...] RCA Institutes, in New York City, and[...] regularly attended by about 95 subscr[...] Remaining in the series are lectures o[...]ttenuators and Mixers, Equalizers and[...]e Filters, Amplifier and System Measur[...]its, System Layout Philosophy, and S[...] Layout Methods.

The entire s[...] was arranged by Lewis S. Goodfriend[...]ucational Advisor, and F. Sumner Hal[...]urse Chairman, and presents as spea[...] a number of eminent authorities in t[...] respective fields.

● The repo[...] the Publications Committee was rec[...] mailed to the members, together with c[...] of two papers prepared by different m[...]s, and a ballot on which the members [...] register their preference. By the end of [...]nonth, it is expected that the final choice[...] publication method will have been ma[...]nd that news and papers of the Society[...] be in the hands of the members in [...]e regular fashion than heretofore.

Members in[...] Cincinnati area who are desirous of fo[...]g a local section are requested to get [...]uch with W. J. Mahoney, 3148 Queen C[...]venue, Cincinnati 11.

BOO[...] REVIEWS

Magnetic [...]rding, by S. J. Begun, Vice Preside[...]d Chief Engineer, The Brush Develo[...]t Company. 244 pages. Murray Hill [...]s, Inc., New York. $5.00.

Combining [...]n effective manner both the theoretica[...] practical aspects of magnetic recordin[...]is book is destined to become the basi[...]erence work on the rapidly expanding [...]onic art of which it treats, aside from th[...]t that it is the first book on this subje[...] reach the market.

Commencin[...]ith a history of magnetic recording and[...]mplete bibliography reaching as far ba[...] 1888, the book continues with a study [...]e basic factors involved. A review of th[...]ndamentals of magnetism conditions th[...]der on the terms used and their relation[...] the whole theory of magnetic recordi[...]hich is then covered thoroughly. The [...]pter on components deals with the rec[...]g medium itself, as well as with erasi[...]ecording, and reproducing heads and th[...]ive mechanisms employed.

The chapt[...]n recording equipment is quite comple[...]nd includes descriptions of a number of [...] of commercial equipment.

One feature of these descriptions is the line drawings showing the functioning of the mechanisms in their various operating conditions. Many applications of magnetic recording are listed and explained, and one entire chapter is devoted to instrumentation and measurement. The book closes with an evaluation of magnetic recording as a challenge to the phonograph, and a glossary of terms.

Each chapter is followed by a bibliography which should provide reading for many months, making a book which is invaluable to both the professional and the experimenter alike.

Handbook of Chemistry and Physics, 31st Edition.

Chemical Rubber Publishing Co., 2310 Superior Ave. N.E., Cleveland, Ohio. $6.00

To appreciate how far this all-inclusive handbook has come in the last thirty years, it is only necessary to compare it with one of the earlier editions. For example, the eighth edition, published in 1920, had a total of 711 pages—the newest one has 2756. It is, without question, the father of reference books in its field, and this one volume will furnish most of the answers required by the average engineer or experimenter in any of the physical or chemical sciences.

The first section is devoted to an unusually complete collection of mathematical tables. This is followed by over a thousand pages of properties and physical constants of elements, organic and inorganic compounds, and many of the newer synthetics. It is in this section that the advances in chemistry are shown most remarkably, since compared with the eighth edition, with its less than two hundred pages, it is massive. Four hundred pages are then devoted to general chemical tables, followed by six hundred relating to physics. For the sound engineer, the tables of sound absorption are alone worth the price of the book, for many items are included which do not appear in the more commonly available tables. Conversion tables, wire tables, even decibel tables are a feature of the last section, making a one-volume handbook of inestimable value to the engineer in any field.

CONVENTION HIGHLIGHTS

THE AFTERNOON SESSION on Thursday, April 7, at the convention of the National Association of Broadcasters, held at the Stevens Hotel in Chicago, offered a number of papers of considerable interest to the audio personnel throughout the industry. The first paper was presented by Frank H. McIntosh, consulting engineer and inventor, on the subject "Audio Measurements for AM, FM, and TV."

Recents tests have shown that the majority of people are able to detect distortions as low as one-half of one percent on A-B tests of pure tones, which is somewhat lower than is generally supposed. Phase and intermodulation distortion are recognized as important, but another type—impulse distortion—is not so familiar to the engineer. Impulse distortion is that which results from steep wave fronts such as occur in speech and music under certain conditions. Although impulse distortion is troublesome over only a short period of time, it is still perceptible, and should be held to a minimum.

Measurement methods are generally familiar to the engineer, but the requirements of the FCC with regard to the measurement of overall transmitter distortion indicate that distortions anywhere in the system from microphone to antenna output should be considered. In a sharply tuned system, however, distortion and percentage modulation may be different in the transmitted signal from that measured at the transmitter itself. If measurements are made off the air, they should be made in a specific area—preferably in the major lobe—since distortions may be present in the nulls which are not truly indicative of actual conditions.

While gain-frequency measurements on AM transmitters need be made only up to 7500 cps, it is pointed out that these same measurements must extend to 15,000 cps on FM and TV transmitters. In the latter case, deviation from the specified 75 μsec pre-emphasis should not be greater than 3 db over the range from 100 to 7500 cps, with somewhat greater leeway permitted above and below these limits.

Mr. McIntosh brought out one interesting point which will come as as surprise to many. It is generally accepted that a clearance between a sine-wave level as indicated on a vu meter and the actual 100-per cent modulation level is 10 db, and that on normal program material, a channel so set up will not normally run into overmodulation. To be perfectly safe, according to McIntosh, this clearance should be increased to 16 db, a difference of 100 per cent. While this is of importance in broadcasting, it should also be considered in other applications involving amplification and reproduction to make sure of avoiding undesirable distortion at peak levels.

• Dr. S. J. Begun, vice-president and chief engineer of the Brush Development Company, pointed out that there are both advantages and disadvantages to magnetic tape recording as applied to broadcasting practice, but that the advantages considerably overshadow the limitations, and the final evaluation of magnetic tape recording depends largely upon the application. Among the advantages of tape are its easy erasability, its superior signal-to-noise ratio, its permanence and repeatability, the convenience of making recordings over extended periods of time, its ease of operation without technical skill on the operator's part, and the facility with which it can be cut and spliced.

On the debit side are the cost of the tape itself, the difficulty of making copies, and the difficulty of maintaining exact time relations on playback. However, for most broadcasting uses, the recorded material is not needed for extended periods, since it is generally used within hours or days of its original recording, and after use, the tape may be erased and used again, which more than compensates for increased cost of the recording medium.

Magnetic recording is at least equal to—if not better than—other methods of recording in signal-to-noise ratio, frequency response, and distortion. Careful design and maintenance will suffice to hold the signal-to-noise ratio to a desired minimum, and attention to bias and erase current waveform and amplitude will ensure low distortion.

With respect to flutter and wow, any high quality recording system can be held to acceptable limits.

The proposed standards for magnetic tape recording are based on three requirements —high fidelity systems need a tape speed of 15 in./sec, which will permit a frequency response up to 15,000 cps under good conditions. The secondary standard calls for a tape speed of 7.5 in./sec, which gives a somewhat reduced high-frequency response. A supplementary standard of 30 in./sec is provided for use wherever special requirements make such an increase in speed desirable. All of these speeds are in general use, with the 15-in./sec speed being in most common use for high quality applications. The 7.5-in./sec speed is acceptable for home use, and for those applications where extended frequency range is not required.

● In New York on the same afternoon at the convention of the Society of Motion Picture Engineers, John A. Maurer, president of J. A. Maurer, Inc., evaluated the performance of presently available reproducing equipment in the 16-mm motion picture field, particularly in relation to the needs of the television industry. He demonstrated, with film, both recordings for optimum performance on reproducing equipment of limited frequency and dynamic range and recordings for wide-range reproduction.

The latter part of the afternoon session was devoted to a roundtable discussion of 16-mm sound recording and reproducing characteristics, being presided over by R. T. Van Niman, chief engineer of Motiograph, Inc. The leaders of the discussion included J. E. Aiken, E. A. Bertram, E. W. D'Arcy, R. O. Drew, J. G. Frayne, J. K. Hilliard, George Lewin, J. A. Maurer, F. V. Papalia, and Otto Sandvik.

PROBLEMS IN AUDIO

[*from page 23*]

J. Acous. Soc. Am., *20*, 727-748 (Nov. 1948)
Stevens, S. Smith, and Davis Hallowell. John Wiley & Sons. 1938
HEARING AND DEAFNESS, pp. 50-66
Davis, Hallowell; Murray Hill Books, Inc. 1947
SPEECH AND HEARING, pp. 111-131
Fletcher, Harvey; D. Van Nostrand Co., Inc. 1929

NEW PRODUCTS

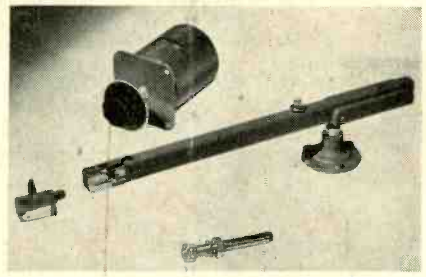
[*from page 28*]

cps at the 5-inch diameter, tapering out to flat at the 12-inch diameter, and with no equalization beyond. The equalizer may be used for either "out-in" or "in-out" recording.

• One of the weak points in a high quality residence reproduction system is too often the phonograph turntable. Not that there are not any good ones available, but that they are not used in as many installations as they should be. The use of such a turntable invariably requires some compromise —but the quality-conscious listener will usually chose the good turntable in preference to the convenience of a changer.

To the too-few list of good turntables is now added the Presto type "15" twelve-inch unit, which is styled primarily for the quality conscious and the semi-professional user, and—probably more important—priced for this class of user. Further information is available from Presto Recording Corporation, P.O. 500, Hackensack, N.J.

The same company also offers a new reproducer arm, available in two types—153-M for microgroove recordings, and 153-R for standard recordings. These arms are designed for use with interchangeable heads which accommodate Pickering cartridges.



Thus with one arm and two heads, the user can be assured of optimum results with either type of record. The compensator furnished with the reproducer provides a modified roll-off, an NAB rolloff, and a cutoff, all in addition to a flat response position.

● Patch cords, twin plugs, and replacement cords for broadcast work are often difficult to obtain. Bulletin R-7 is being distributed by Trimm, Inc, Libertyville, Ill. to describe this new line of apparatus. Screw-machine parts ensure a uniform product, and all of this equipment is of a quality suitable for continuous broadcast use.

● The new Model 425 shock-proof desk stand is described, along with a number of new Electro-Voice ultra-wide-range dynamic microphones suitable for the most exacting FM and AM broadcast service. This information is contained in bulletin No. 144, obtainable from Electro-Voice, Inc., Buchanan, Mich.

● Reader Charles L. Benson calls our attention to an announcement by Sylvania that the 6A5G, heater-cathode type of triode similar to 2A3, 6A3, and 6B4G, is again on the jobbers' shelves. Manufacture of this type was discontinued during the war under a WPB order. Use of this tube in medium-power amplifiers should aid in the elimination of hum from the output stage, often so troublesome with 2A3's or 6B4G's, and we predict a minor rush to change to the cathode type.

● The electrolytic capacitor seems to be firmly established for radio applications. But many users are unfamiliar with what appears to be a jumble of capacitance values, working voltages, and can sizes. Strangely, all of these factors are related in a very definite and predictable manner, as described in a new Engineering Data Folder just published by P. R. Mallory & Co., 3029 E. Washington St., Indianapolis 6, Ind. It seems that each capacitance/voltage value has what is called a size factor, which is an indication in arbitrary units of the cubic content of such a capacitance. Similarly, each container has a size factor figure, and the latter must be greater than the SF of all sections to be placed in it. Perfectly simple if you know the secret, which is revealed completely in this folder, along with data on surge voltage, temperature range, and other pertinent characteristics of these capacitors.

• Eighty-eight pages of useful information about speakers have recently made their appearance in a booklet entitled "Loudspeakers—The Why and How of Good Reproduction," authored by G. A. Briggs and published by Wharfedale Wireless Works, Bradford, Yorks., England. It is an interesting compilation of basic data on speakers and deserves reading, particularly by newcomers in the field. It is obtainable from most jobbers.

• Matching low-impedance sources, 50 to 600 ohms, to most PA amplifiers entails the use of some form of transformer, yet in many instances it may not be convenient to make a permanent mounting to accommodate temporary uses, or even for those applications that are likely to be in use for a long time. United Transformer Corporation, 150 Varick Street, New York 13, N.Y. has just the device, type MA-1 adapter, to

cure this problem. It consists of a tiny transformer assembled with a standard jack for the low-impedance primary and a standard telephone plug for the grid winding, permitting immediate conversion of an amplifier for low-impedance sources. Response covers 50 to 10,000 cps, and special design reduces stray pickup to a minimum.

• Most subminiature battery-type tubes introduced to date have had the disadvantage of low mutual conductance, and the performance obtainable with them is considerably below that of conventional cathode types. The new type 1AD4, made by Raytheon Manufacturing Company, Newton, Mass. has a nominal Gm of 2,000 micromhos at a 45-volt plate and screen

supply. Filament rating is 1.25 volts, 100 ma, and a sprayed shield coating makes it usable for r-f applications. The tube is a sharp-cutoff pentode, and was developed for the Thermionics Branch of the Evans Signal Laboratory.

• Business is apparently good with James B. Lansing Sound, Inc. which has had to move into larger shop space and provide complete technical and laboratory research facilities at 7801 Hayvenhurst Ave., Van Nuys, California. The entire line of Jim Lansing Signature Speakers are now available for immediate delivery, and a descriptive catalog of these quality products will be sent to anyone requesting it.

ADVERTISING INDEX

A "*Brand New*" SOLUTION TO YOUR AUDIO MEASUREMENT PROBLEMS

FEATURES

FREQUENCY RANGE:
20 cycles to 20 KC.

ACCURACY:
Accuracy is ±0.1 db, from 20 cps to 20 KC.

OUTPUT LEVELS:
Ranges of output level +4 to —110 db and —10 to —124 db in steps of .1 db.

ACCESSIBILITY:
All components accessible from front of rack panel—for ease of servicing.

IMPEDANCE RANGES:
(a) **Source Section**—600-150 ohms internally terminated.
600-250-150-30 ohms unterminated.
(b) **Load Section**—600-250-150-16-8-4 ohms.

Daven's Moderate Priced Transmission Measuring Set

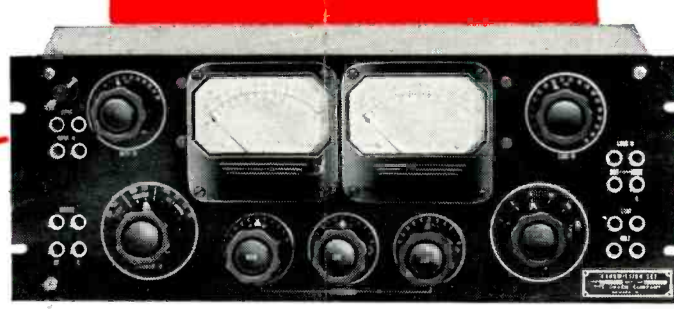
This is the instrument for which you have been waiting! For accuracy and efficiency, the Daven Type 11 A gain set, will fill your bill. Incorporating many of the features employed in more expensive models, this unit may be used to make all the precise measurements required by the FCC.

A new design feature, permits the servicing and inspection of all components from the front of the panel, with a maximum of ease and in a minimum of time. This is also a direct reading instrument, entirely eliminating time-consuming computations.

It is no longer necessary to use makeshift equipment for determining the transmission characteristics of audio systems. The Type 11 A gain set has been priced low enough to put within the reach of the most limited budget.

APPLICATIONS

- Audio gain measurements.
- Audio loss measurements.
- Measurements of matching and bridging devices.
- Complex circuit measurements.
- Measuring mismatch loss.
- Frequency response measurements.

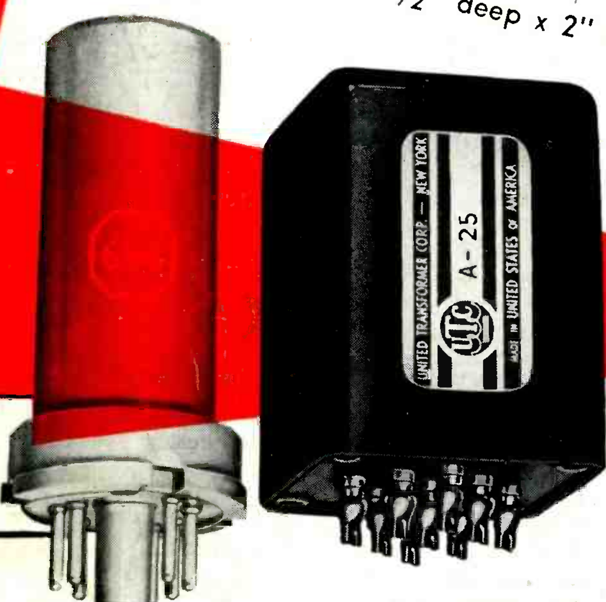


Always Specify Daven For Precision Equipment

THE **DAVEN** CO.
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

For Compact High Fidelity Equipment

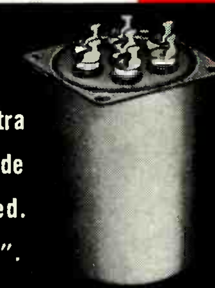
Ultra compact, lightweight, these UTC audio units are ideal for remote control amplifier and similar small equipment. New design methods provide high fidelity in all individual units, the frequency response being ±2 DB from 30 to 20,000 cycles. There is no need to resonate one unit in an amplifier to compensate for the drop of another unit. All units, except those carrying DC in Primary, employ a true hum balancing coil structure which, combined with a high conductivity outer case, effects good inductive shielding. Maximum operating level + 10 DB. Weight—8 ounces. Dimensions—1½" wide x 1½" deep x 2" high.



Unit shown is actual size. 6V6 tube shown for comparison only.

HERMETICALLY SEALED

On special order, we can supply any of the Ultra Compacts hermetically sealed per Jan T-27 Grade 1 Class A in our RC 50 case as illustrated. Dimensions: Height 2¼", Base $1\frac{9}{16}$" x $1\frac{9}{16}$".



Ultra Compact High Fidelity Audio Units

Type No.	Application	Primary Impedance	Secondary Impedance	± 2 DB from	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50,000 ohms	30-20,000	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids. Multiple alloy shielded for extremely low hum pickup	50, 200, 500 ohms	50,000 ohms	50-10,000	16.00
A-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall in two sections	30-20,000	15.00
A-18	Single plate to two grids Split primary	8,000 to 15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	30-20,000	14.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	50-20,000	18.00
A-24	Single plate to multiple line	8,000 to 15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	30-20,000	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	8,000 to 15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	50-12,000	14.00
A-26	Push pull low level plates to multiple line	8,000 to 15,000 ohms each side	50, 125/150, 200/250, 333, 500/600 ohms	50-20,000	15.00
A-30	Audio choke, 300 henrys @ 2 MA 6000 ohms D.C., 75 henrys @ 4 MA 1500 ohms D.C., inductance with no D.C. 450 henrys				10.00

The above listing includes only a few of the many Ultra Compact Audio Units available . . . Write for catalog PS409.

United Transformer Co.

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