AUGUST, 1955

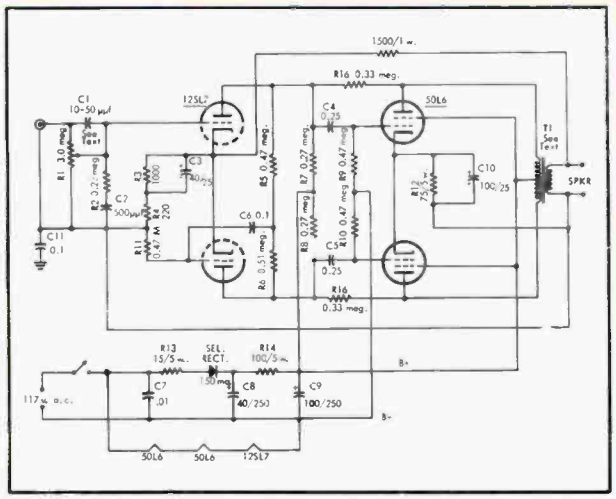
50¢

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

Including 16-page TUNER section

ANC



Good quality can be obtained for low-power applications by the proper choice of tube types and feedback circuitry without the need for an expensive output transformer. Performance is adequate at both ends of the frequency scale, and component cost is satisfactorily low. *See page 11.*

Hollywood Bowl's Symphonies Under the Stars are heard in a new dimension with the stereophonic system recently installed. *See page 14.*

THE STANDARD OF COMPARISON FOR OVER 20 YEARS

HIGH FIDELITY TRANSFORMERS

FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

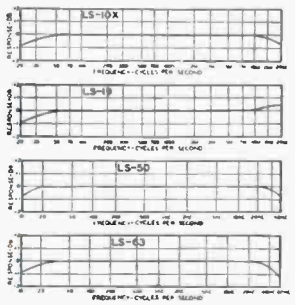
TYPICAL UNITS

LINEAR STANDARD series

Linear Standard units represent the acme from the standpoint of uniform frequency response, low wave form distortion, thorough shielding and dependability. LS units have a guaranteed response within 1db. from 20 to 20,000 cycles.

Hum balanced coil structures and multiple alloy shielding, where required, provide extremely low inductive pickup.

These are the finest high fidelity transformers in the world. 85 stock types from milliwatts to kilowatts.



LS-10X Shielded Input
Multiple line (50, 200, 250, 500/600, etc.) to 50,000 ohms . . . multiple shielded.

LS-19 Plate to Two Grids
Primary 15,000 ohms.
Secondary 95,000 ohms C.T.

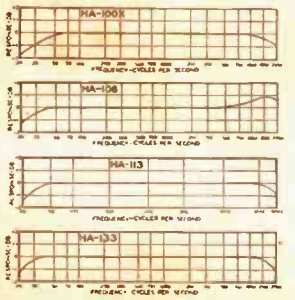
LS-50 Plate to Line
15,000 ohms to multiple line . . . +15 db. level.

LS-63 P.P. Plates to Voice Coil
Primary 10,000 C.T. and 6,000 C.T. suited to Williamson, MLF, ul.-linear circuits. Secondary 1.2, 2.5, 5, 7.5, 10, 15, 20, 30 ohms. 20 watts.

CASE	LS-1	LS-2	LS-3
Length	3⅛"	4-7/16"	5-13/16"
Width	2⅝"	3½"	5"
Height	3¼"	4-3/16"	4-11/16"
Unit Wt.	3 lbs.	7.5 lbs.	15 lbs.

HIPERMALLOY series

This series provides virtually all the characteristics of the Linear Standard group in a more compact and lighter structure. The frequency response is within 1 db. from 30 to 20,000 cycles. Hipermalloy nickel iron cores and hum balanced core structures provide minimum distortion and low hum pickup. Input transformers, maximum level +10db. Circular terminal layout and top and bottom mounting.



HA-100X Shielded Input
Multiple line to 60,000 ohm grid . . . tri-alloy shielding for low hum pickup.

HA-106 Plate to Two Grids
15,000 ohms to 135,000 ohms in two sections . . +12 db. level.

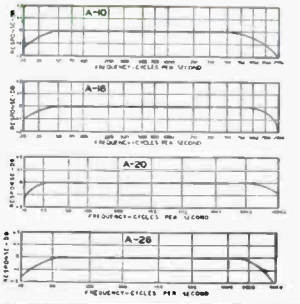
HA-113 Plate to Line
15,000 ohms to multiple line . . . +12 db. level . . . 0 DC in primary.

HA-133 Plate (DC) to Line
15,000 ohms to multiple line . . . +15 db. level . . . 8 Ma. DC in primary.

Case	H-1	H-2
Length	2⅜"	3-9/16"
Width	1-15/16"	2-13/16"
Height	3⅛"	3½"
Unit Weight	2 lbs.	5 lbs

ULTRA COMPACT series

UTC Ultra Compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. The frequency response is within 2 db. from 30 to 20,000 cycles. Hum balanced coil structure plus high conductivity die cast case provides good inductive shielding. Maximum operating level is +7db. Top and bottom mounting as well as circular terminal layout are used in this series as well as the ones described above.



A-10 Line to Grid
Multiple line to 50,000 ohm grid.

A-18 Plate to Two Grids
15,000 ohms to 80,000 ohms, primary and secondary both split.

A-20 Mixing Transformer
Multiple line to multiple line for mixing mikes, lines, etc.

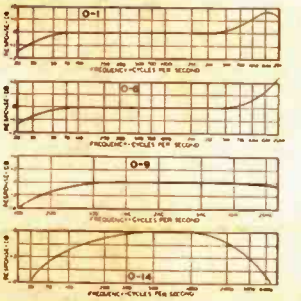
A-26 P.P. Plates to Line
30,000 ohms plate to plate, to multiple line.

A CASE

Length	1½"
Width	1½"
Height	2"
Unit Weight	½ lb.

OUNCER series

UTC Ouncer units are ideal for portable, concealed service, and similar applications. These units are extremely compact . . . fully impregnated and sealed in a drawn housing. Most items provide frequency response within 1 db. from 30 to 20,000 cycles. Maximum operating level 0 db. These units are also available in our stock P series which provide plug-in base. The 0-16 is a new line to grid transformer using two heavy gauge hipermalloy shields for high hum shielding.



0-1 Line to Grid
Primary 50, 200/250, 500/600 ohms to 50,000 ohm grid.

0-6 Plate to Two Grids
15,000 ohms to 95,000 ohms C.T.

0-9 Plate (DC) to Line
Primary 15,000 ohms, Secondary 50, 200/250, 500/600.

0-14 50: 1 Line to Grid
Primary 200 ohms, Secondary .5 megohm for mike or line to grid.

OUNCER CASE

Diameter	⅞"
Height	1-3/16"
Unit Weight	1 oz.

SPECIAL UNITS TO YOUR NEEDS

If you manufacture high fidelity gear, send your specifications for prices.

HFT

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

AUGUST, 1955 VOL. 39, No. 8
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

AUDIO (title registered U. S. Pat. Off.) is published monthly by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary, Executive and Editorial Offices, 204 Front St., Mineola, N. Y. Subscription rates—U. S. Possessions, Canada and Mexico, $4.00 for one year, $7.00 for two years, all other countries, $5.00 per year. Single copies 50c. Printed in U. S. A. at Lancaster, Pa. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.

AUDIO PATENTS

RICHARD H. DORF*

THE TWO IMPORTANT TYPES of distortion in audio amplifiers and other equipment are harmonic and intermodulation. The basic cause of both is amplitude nonlinearity at some point in the equipment—a stage or device in which the amplitude of the output is not always exactly proportional to the amplitude of the input signal.

The two types of distortion are measured differently. Harmonic distortion is measured by passing a sine wave through the equipment, filtering out the original frequency, and measuring the amplitudes of the spurious harmonics. Intermodulation is determined by passing a low and a high frequency through the equipment and measuring the percentage of modulation of the high frequency by the low. Both methods are frequency-sensitive and there has never been any really successful coordination of distortion tests with the subjective effects distortion has on the listener.

Inventor Barry C. King, Jr., of Collingswood, N. J., has designed a simple method for measuring the basic cause of nonlinearity distortion—the nonlinearity itself. While he has not made evaluation of the results in subjective terms any easier so far as we know, this method of testing does seem more basic than usual, and it appears to be more readily suitable for production checks. The equipment itself is not especially simple, but once built it should be quite easy for unskilled operators to use. The covering patent is No. 2,646,545.

The block diagram of *Fig.* 1 indicates how the nonlinearity "meter" works. The unit first generates a step or staircase wave such as that shown at (A) in *Fig.* 2. The entire step wave is repeated at an audio frequency which is low enough so that the amplifier to be tested can reproduce the straight sides of the steps. The step wave gives a series of amplitude increments which ideally are equal. The step-wave output of the tested amplifier may then be viewed on an oscilloscope. When the amplitude of each step on the oscilloscope is measured, it is easy to see where in the amplitude range nonlinearities occur. The nonlinear scope presentation of (B) in *Fig.* 2 is an example. Obviously the output amplitude increase for constant input amplitude increases is greater as the absolute amplitude becomes greater in the wave at (B)—or, to look at it another way, compression is taking place at lower amplitudes.

Measurement of the individual step heights on the scope screen is rather difficult, however, because each step is relatively small. Continuing with *Fig.* 1, therefore, the output step wave is differentiated, a process of passing the step wave through a high-pass filter, usually simply a series capacitor and a shunt resistor. If the cutoff frequency of the differentiator is made sufficiently high with respect to the repetition rate of the step wave, the voltage will fall back to the zero axis during each horizontal stair "tread" and the result will be a series of sharp spikes, each with an amplitude above the zero axis the same as that of the vertical part of the step which produced it. The result of the differentiation of a nonlinear staircase is shown at (C) in *Fig.* 2. The spike train can be amplified as much as is desired and since each spike is much larger than each stair rise it represents, measurements of the amplitude linearity can be made more easily and accurately. The ideal result is, of course, a straight line increase across the tips. A line outlining the tips at (C) in *Fig.* 2 would be curved and would show the distortion.

(*Continued on page 37*)

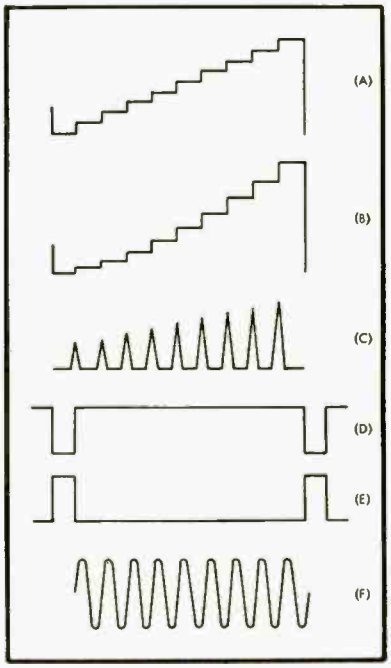


Fig. 2

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

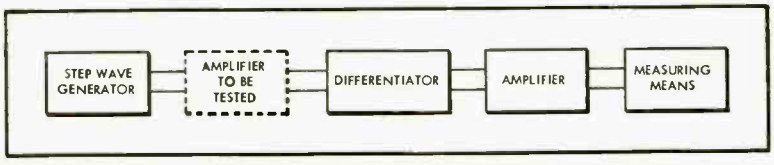
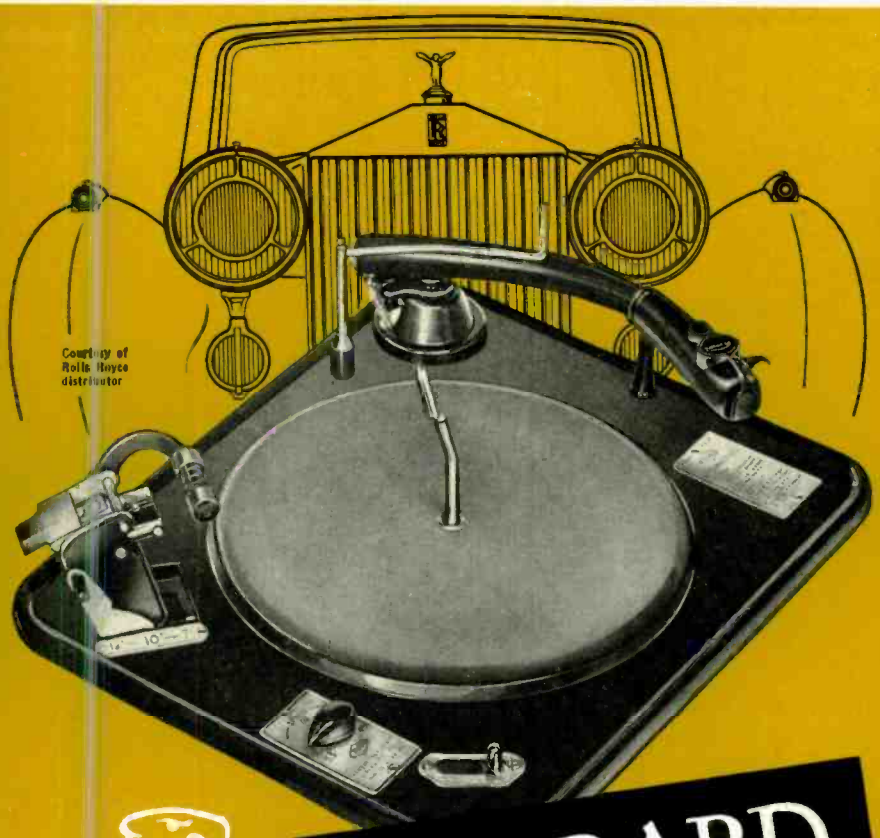


Fig. 1

Incomparable...

Since 1935
the Garrard has been sold and serviced throughout the United States.

It is recognized every where for superior performance, ruggedness and reliability.



Courtesy of Rolls Royce distributor

CHECK CRAFTSMANSHIP, FEATURES, PRICE AND SERVICE . . .
and you will understand clearly why this is the world's No. 1 high-fidelity record changer.

"RIGHTS" and "WRONGS"
of record changer design
(important in protecting your records).

RIGHT:
Garrard Precision Pusher Platform . . . the only record changing device that insures positive, gentle handling of records with standard center holes.

WRONG:
"Overhead Bridges" (as on ordinary changers) . . . which may damage or dislodge records accidentally.

RIGHT:
Garrard removable and interchangeable spindles . . . Easily inserted; accommodate all records, all sizes, as they were made to be played; pull out instantly to facilitate removal of records from turntable.

WRONG:
Fixed Spindles (as on ordinary changers) . . . which require ripping records upwards over metallic spindle projections after playing.

Other Garrard features include: 4 pole motor —no rumble, no induced hum • heavy drive shaft —no wows, no waves • weighted turntable— flywheel action, constant speed • muting switch —silence between records • silent automatic stop—shuts off after last record; no disturbing "plop". • easy stylus weight adjustment—protects long-playing records • balanced-mounted tone arm—true tangent tracking • universal shell —fits all popular high fidelity cartridges

GARRARD "Triumph"

MODEL RC 80

World's Finest Record Changer

A Quality Endorsed Product of the BRITISH INDUSTRIES GROUP, which also includes

WHARFEDALE LOUDSPEAKERS . . . designed and built under the personal supervision of G. A. Briggs . . . world renowned authority on sound. Wharfedale Loudspeakers offer the unique construction feature of cloth suspension—a felt buffer between speaker frame and cone—and cast chassis.

LEAK TL/10 —High fidelity AMPLIFIER complete with "Point One" REMOTE CONTROL PRE-AMPLIFIER. Most economical amplifier combination ever built by Leak. Harmonic distortion only one tenth of one percent. Insures flawless reproduction. *EXCLUSIVE FEATURE!* Convenient tape recorder jacks (input and output) on front panel for instantaneous use!

R-J LOUDSPEAKER ENCLOSURES—"Maximum Bass—Minimum Space" Hearing is believing! R-J Speaker Enclosures have established an entirely new trend in audio design with thrilling performance from any loudspeaker. Bookshelf and Floor Models.

THE R-J WHARFEDALE . . . First and only complete R-J unit! Two great products—the R-J single shelf ENCLOSURE and a special WHARFEDALE SPEAKER have been brilliantly matched in this . . . the definitive combination among compact high-performance speakers.

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NEW LITERATURE

● **British Industries Corporation,** 164 Duane St. New York 13, N. Y., is distributing as a service to the electronics industry an entirely new and up-to-date edition of the world-famous International Radio Tube Encyclopedia. Published in London, the encyclopedia consists of 607 pages and gives all details of more than 18,500 valve and tube types from all over the world, including television, industrial, and military c.r. tubes. Tube base connections are shown in columns immediately following operating characteristics data. The section containing technical matter and instructions for using various tables and charts is written in 14 languages. Available in limited quantities, the encyclopedia is priced at $9.00. Orders should be mailed to Dept. IRT at the address shown above. **B-1**

● **Micamold Electronics Manufacturing Corp.,** 1087 Flushing Ave., Brooklyn, N. Y., describes its plant facilities, lists typical capacitor products, and gives a capsule biography of key personnel in a new two-color 12-page booklet which highlights major aspects in the company's 31-year history. Both photographs and text are used in presenting Micamold's production facilities, shielded research laboratories, and test equipment. Plant views show assembly lines, machine shops, and four of the Micamold factories. Requests for free copy should be addressed to Mr. A. S. Gartner, vice-president, sales. **B-2**

● **Brush Electronics Company,** 3405 Perkins Ave., Cleveland 14, Ohio, details the TapeDRUM, a new type magnetic storage device which combines the advantages of a magnetic drum and tape recorder, in a new folder which will be mailed free on request. Rapid access time and large storage capacity at reasonable cost are the outstanding features of the new instrument. Principal applications are in the fields of inventory control, data reduction, trend recording and table storage. The device can also be used as an auxiliary memory or storage instrument for large scale computers. **B-3**

● **Permoflux Corporation,** 2835 N. Kedzie Ave., Chicago 18, Ill., covers the new Permoflux Model 32KTR super tweeter and Model NK-60 crossover network in Engineering Data Sheet JC-101 which will be mailed on request. The sheet contains schematic diagrams, response curves, and a detailed description of performance characteristics on both units. Requests for copy should be directed to the Distributor Division. **B-4**

● **Radio Receptor Co., Inc.,** 251 W. 19th St., New York 11, N. Y., announces the availability of Bulletin G-50A, a descriptive sheet which covers the company's new low-priced transistor Type RR125. The RR125 has been especially designed to meet the tremendous demand for a transistor which can be used by the professional or amateur experimenter who desires to familiarize himself with various circuits utilizing these popular devices. The bulletin contains specifications and a diagram for an experimental crystal receiver with one stage of transistor audio amplification. Requests for copies of Bulletin G-50A should be addressed to the Sales Department, Semi-Conductor Division. **B-5**

● **Electro-Voice, Inc.,** Buchanan, Mich, gives full details for home construction of the E-V Patrician high-fidelity 4-way reproducer in Bulletin 220. Utilizes the Klipsch principle of folded corner-horn loading with extended taper rate down to 35 cps for augmented bass reproduction. Included in the bulletin are a listing of all components required together with prices and full constructional details for cabinetry. Available on request. **B-6**

COMING EVENTS

Aug. 24–26—Western Electronic Show and Convention, I.R.E., Civic Auditorium, San Francisco, Calif.

Aug. 26–Sept. 4—The Great German Radio, Television, and Phono Exhibition, Düsseldorf, Germany.

Sept. 12–16—Tenth Annual Instrument Conference and Exhibit (International), presented by the Instrument Society of America, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

Sept. 23–24—Fifth Annual Fall Symposium of the I.R.E. Professional Group on Broadcast Transmission Systems, Hamilton Hotel, Washington, D. C.

Sept. 23–25—Hi-Fi Home Music Show, Claremont Hotel, Berkeley, Calif.

Sept. 28–29—The Industrial Electronics Conference, sponsored jointly by the Michigan Section of the AIEE and the Detroit Section of the IRE, Rackham Memorial Auditorium, Detroit, Mich.

Sept. 30–Oct. 2—Third Annual High Fidelity Audio Show, NCAS, Sheraton-Palace Hotel, San Francisco, Calif.

Sept. 30–Oct. 2—The 1955 High Fidelity Show, Palmer House, Chicago.

Oct. 3–5—National Electronics Conference, Hotel Sherman, Chicago.

Oct. 13–16—The Audio Fair and the Seventh Annual Convention of the Audio Engineering Society. Hotel New Yorker, New York City.

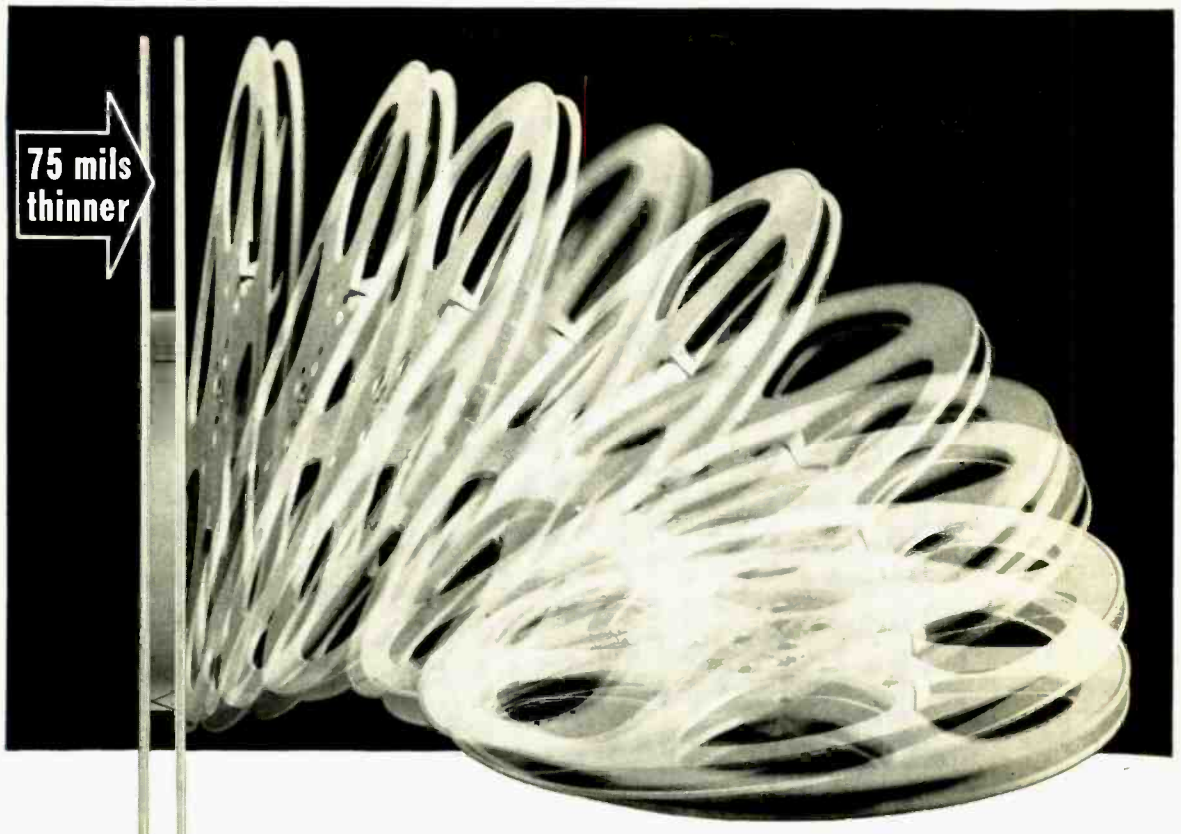
Oct. 21–23—New England High Fidelity and Music Show, Hotel Touraine, Boston, Mass.

Nov. 3–4—Eighth Annual Electronics Conference, sponsored by the Kansas City Section of the IRE, Town House, Kansas City, Kansas. Subjects to be covered: Components, Microwaves, Automation, and Audio. (Committee can be reached at P. O. Box 391, Kansas City 41, Mo.)

Nov. 4–6—Philadelphia High Fidelity Show, Benjamin Franklin Hotel, Philadelphia, Pa. A fifty-cent admission charge has been agreed upon to assure attendance by an interested hi-fi conscious audience.

Nov. 3–6—First Mexican Audio Fair, Hotel Reforma, Mexico City. For information, write Mario R. Aguilar, Lopez 43-301, Mexico 1, D. F.

Jan. 18–20—Canadian Audio Show, Windsor Hotel, Montreal, Canada. Managing Director, Emery Justus, 1022 Sherbrooke St. W. Montreal, P. Q.



"SCOTCH" Brand's new thin groove reel prevents tape tangles!

Write on it!

Won't dent... won't warp!

5/16" center hole for better balance

NO MORE "ZIG-ZAG" WIND to tangle tape! "SCOTCH" Brand has come up with a *sure* way to make magnetic tape wind smoother and reduce side play to a minimum. It's "SCOTCH" Brand's new, 10½" professional reel. Made from glass-reinforced plastic, the new reel measures just .270" wide . . . 75 mils *thinner* between flanges than older type aluminum reels. Offers plenty of other advantages, too! "SCOTCH" Brand's reel spins true because of 5/16" center hole conforming to RETMA specifications. Won't dent or warp, thanks to tough fiber glass reinforcement. And you can write on it for identification. All these features, plus exclusive slot threading—at no increase in cost.

REG. U.S. PAT. OFF.

SCOTCH

BRAND

New 10½" Professional Reel

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. Export Sales Office: 99 Park Avenue, New York 16, N.Y.

3M

EDITOR'S REPORT

1955 WESCON

WHILE NOT OPEN TO THE PUBLIC and not devoted solely to audio—as are the many audio shows throughout the country—the West's biggest electronic event of the year is the Western Electronic Show and Convention—WESCON—which opens in San Francisco's Civic Auditorium on August 24 for a three day run. Always a good show—comparable to the mammoth IRE show in New York every March—it opens our eyes to the fact that there is more to the electronics industry than audio, and actually lifts us out of the trees so that we get a glimpse of the forest.

But even though little audio equipment will be exhibited we must always bear in mind that the components which go into audio equipment come from the laboratories of manufacturers who also supply the materials that go into microwave, radar, computer, automation, and dozens of other fields. It is the result of constant improvement demanded by the rigorous requirements of military and certain types of commercial applications that shows up in more reliable components that go into audio equipment, for continuing research could not be supported by the audio industry alone—consider, for example, the improvement in such a "simple" item as the common 1/2-watt resistor over the past twenty years.

But strangely enough, many electronic engineers who pour over the complications of computors during the day, or whose work may be with automation or circuit development or instrumentation or medical electronics —many of these engineers turn to audio for a hobby. Electronics is likely to get into the blood to the extent that a person feels compelled to select it as an avocation as well as a vocation. As a hobby, audio is rewarding, for one can see the result—or hear it—and there is relatively little need in the average home for a computor, although we did see a $15,000 device used in sonar training during the war that would have made a delightful game for the play room.

We are grateful for the reception accorded us at the professional shows and we are constantly pleased that AUDIO is read and enjoyed by the engineer as well as the non-technical music lover. So we'll be in San Francisco with our eyes wide open at the hundreds of interesting and informative exhibits, and we hope we'll see many of our old friends there.

AUDIO IN CANADA

Just as there are many happenings in Melbourne which are of little interest or import to the resident of Memphis, so also are there occurrences in Vancouver and Toronto—in the world of audio—that might be of great interest to a reader in Winnipeg. And AUDIO has many readers from north of the border who—so far—have no direct line on what the audio industry in their own country may be doing, and judging from the turnout of non-U. S. equipment at the audio show in Toronto last April there is plenty doing up there. To provide a medium for the dissemination of audio information originating in and of interest principally to residents of Canada, AUDIO will include an additional section in those copies which go to Canadian subscribers, commencing with the October issue.

This section will not contain any technical articles, since these are considered of interest to everyone, and as such are accepted from everywhere. It will be devoted primarily to announcements of new products and new literature and to news of the audio industry in Canada. Data about equipment that is available in Canada but not in the U. S. is also welcome, and it is hoped that this section will serve a useful purpose.

Emery Justus, well known in New York circles and now the *entrepreneur* of the Canadian Audio Shows, becomes our Canadian Editor, with offices at 1022 Sherbrooke St. West, Montreal, P. Q., and will welcome announcements of new products and literature from Canadian manufacturers who wish to have them read by audio engineers and hobbyists in Canada. He will also accept subscriptions and will act as agent with respect to advertising in the Canadian section.

We hope our Canadian readers will consider this section as their own and that they will find it useful and entertaining.

INTRODUCING—THE TIBIA,

a new quarterly magazine devoted to the interests of those who have nostalgic memories of the theater organ and who—not wishing to see it pass into oblivion—are doing something about it. Just before the Audio Fair in Los Angeles last February, the American Association of Theater Organ Enthusiasts was formed, and THE TIBIA was proposed as a magazine to chronicle its doings. While rather a limited field, it would appear to the unenlightened, it develops that there is a great number of people who are very much interested in this particular type of organ—as well as almost a whole generation of people who have grown up since the advent of talkies and who has not been thrilled by the "mighty Wurlitzer" or Robert Morton, or whatever. THE TIBIA will be published by Radio Magazines, Inc. for the ATOE, but one does not have to be a member of ATOE to read or subscribe to this journal. The first issue—Fall, 1955—will be out this month.

(For the really unenlightened, Tibia is the name of an organ pipe that is indigenous to the theater organ, just as the Diapason is to the classic organ. And *Diapason* is a magazine, also.)

the 3rd audio anthology

This is not a commercial announcement—just a hint of the future. It is expected that **the 3rd audio anthology** will be on sale at the Audio Fair in October. Same size, same number of pages, same price, but all new material, covering from July, 1952, to June, 1955. And this time, we won't advertise it until it's actually on the presses.

PICKERING

Pioneers in High Fidelity

. . . and leaders today!

Ask those who know—the experienced professionals and the veteran hi-fi owners—and you'll get answers like these:

"Pickering was first to introduce many high fidelity features that have become accepted standards today."

"Pickering has always been the pace-setter in the race for perfection."

"Pickering still sets the goals to which others aspire."

There are good reasons for such praise. Every product bearing the Pickering name is *precision engineered* to give optimum performance. Each individual component is rigidly tested before it reaches the dealer . . . subjected to the severest quality control procedures to make *sure* that every component comes up to the high standards expected of Pickering equipment.

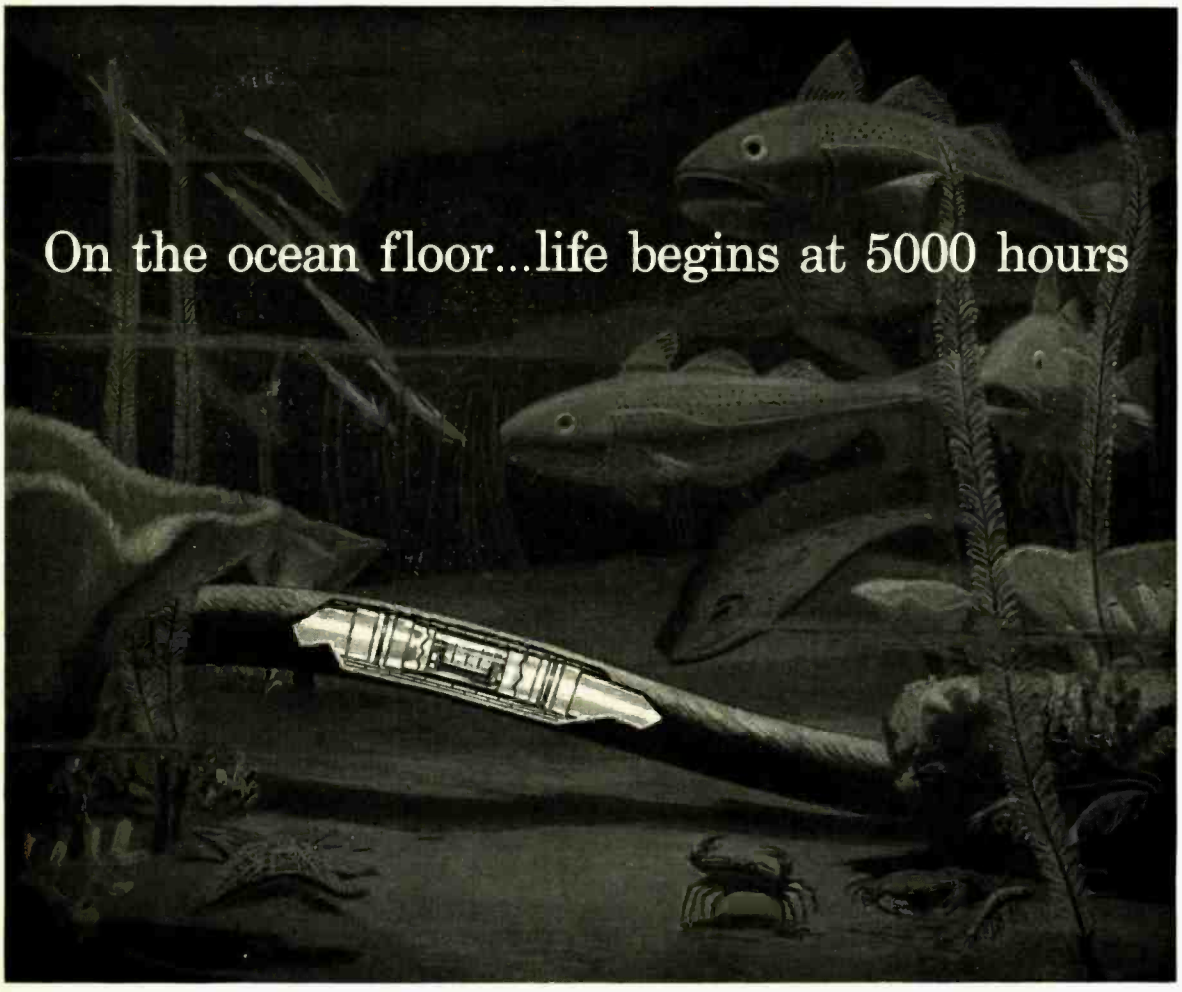
If you want the *best* that high fidelity can offer . . . if you are willing to invest just a *little* more to get a *lot* more listening pleasure, now is the time to ask your dealer for a demonstration with Pickering components. See if you, too, don't *hear* the difference!

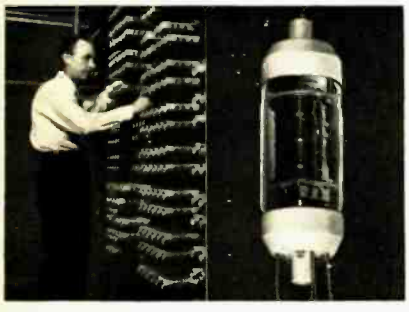
PICKERING *and company incorporated* • *Oceanside, L.I., New York*

PICKERING PROFESSIONAL AUDIO COMPONENTS

"For those who can hear the difference"

. . . Demonstrated and sold by Leading Radio Parts Distributors everywhere. For the one nearest you and for detailed literature; write Dept. A-8





Electron tubes (right) for the Transatlantic Telephone Cable between Newfoundland and the British Isles are being handmade at Bell Laboratories. Life test bank is shown left. The cable system, which can carry 36 simultaneous conversations, is a joint enterprise of the American Telephone and Telegraph Company, the British Post Office and the Canadian Overseas Telecommunications Corporation.

When the world's first transoceanic telephone cable is laid across the Atlantic it will contain hundreds of electron tubes needed to amplify voices. Deep on the ocean floor these tubes must keep on working, year after year, far beyond reach of ordinary repair services.

Bell Telephone Laboratories scientists have developed a tube of unique endurance. Before a tube is even considered for use in the cable it is operated for 5000 hours under full voltage—more than the entire life of many tubes.

But survival alone is not enough. During the test each tube is exhaustively studied for behavior that may foreshadow trouble years later. Tubes that show even a hint of weakness are discarded. For the good ones, a life of many years can be safely predicted.

Bell Telephone Laboratories scientists began their quest for this ocean-floor tube many years ago. Now it is ready—another example of the foresightedness in research that helps keep the Bell Telephone System the world's best.

BELL TELEPHONE LABORATORIES

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Amplifier Uses Cheap Output Transformer

NATHAN GROSSMAN* AND WILLIAM HELLMAN**

Pleasant sound does not necessarily mean highest fidelity. It can be obtained with inexpensive output transformers and by using feedback. The authors show designs for single-ended and push-pull jobs.

THE AUTHORS SET OUT to explore the possibilities of obtaining high fidelity from the average service-replacement output transformer produced by leading transformer manufacturers. These generally sell for about $3.00, with those intended for higher outputs running up to about $6.00. They generally have a primary inductance of 7 to 10 henries depending upon whether they are intended for single-ended or push-pull operation.

It is the low load presented by the primaries of these transformers which would ordinarily prevent their use in connection with quality amplifiers. The gain of the output stage depends upon the matching of the plate impedance of the tube used and the impedance produced by the inductance of the primary of the output transformer. Thus, a tube with a high plate impedance requires greater impedance from the primary inductance for good results. Moreover, to obtain the same response in the bass frequencies as in the middle frequencies also necessitates a high inductance, because the impedance of the inductance falls off proportionately to the decline in frequency.

To get the best results from these transformers then requires that they be used in conjunction with output tubes which require relatively low-impedance loads such as the 6B4 and the 6L6, which operate satisfactorily with loads of 2500 ohms, and the 6Y6 and 50L6, which will do likewise with loads of 1500 to 2000 ohms.

Uniformity of response can be obtained by using inverse feedback in a proper circuit. For example, 6 db of feedback in the circuit of *Fig.* 1 will flatten out the response of such a transformer, when used with a 6L6 in the output stage, down to 100 cps. Twenty db feedback will flatten out the response down to 20 cps (see *Fig.* 2). These results are much like those obtainable from increasing the primary inductance by like factors.

Such a transformer when used in the circuit of *Fig.* 1 without R_5 and fed into a resistive load produced the following harmonics: at 100 cps:

Watts	2nd	3rd	4th	5th
1	8.5%	0.49%	0.28%	0.12%
2	12.0	0.68	0.50	0.10
6.5	20.0	2.00	2.80	1.60

At the same frequency but with the application of a factor of about 20 db of inverse feedback through R_5 from the secondary of the output transformer the following harmonics were produced:

Watts	2nd	3rd	4th	5th
1	0.80%	0.13%	0.01%	.03%
2	1.20	0.30	.065	.04
4	2.20	0.90	0.32	0.16

Under the same conditions but with an input frequency of 1000 cps the following harmonics were produced:

Watts	2nd	3rd	4th	5th
1	0.34	0.14	.02	
2	0.66	0.24	.05	
4	1.20	0.52	0.15	.04
6.5	1.6	0.90	0.32	0.14

From these tabulations several conclusions can be drawn. First, for the reproduction of speech and treble instruments this is a very fine amplifier. Second, that the harmonic distortion is reduced roughly by the factor of inverse feedback. Third, that the difference in the amount of distortion resulting at the two frequencies at which the measurements were made corresponds roughly to the factor of difference in gain response without inverse feedback at the two frequencies.

In an effort to follow up these conclusions and obtain further improvement a 6SJ7 was substituted for the 6SF5 in the driver stage of *Fig.* 1. The higher gain of the 6SJ7 would permit more inverse feedback. As the cathode was not bypassed a further improvement of 25 per cent in gain, and so also in the amount of inverse feedback, was obtained by connecting the return lead of the screen bypass capacitor directly to the cathode instead of the usual connection to ground. Since the screen is

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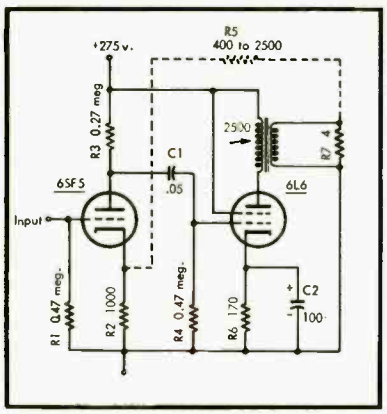

Fig. 1. The basic circuit employs feedback from the transformer secondary. Value of R_5 determines feedback.

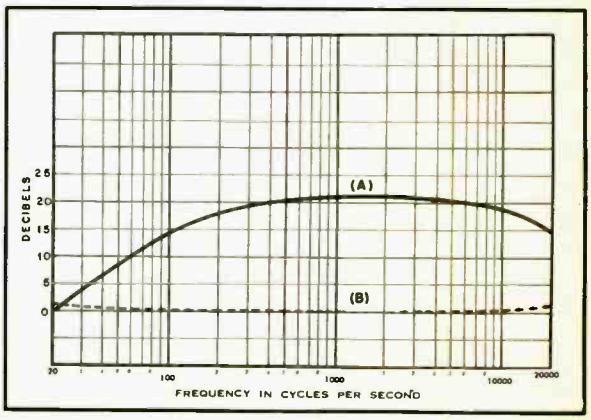

Fig. 2. Curve (A) shows original frequency response of Fig. 1 amplifier without feedback. Adding 20 db of feedback gives response of curve (B).

really acting as the plate of a triode this change in circuitry avoids degeneration caused by permitting a.c. from the screen to pass through the cathode resistor.

It was further observed that to get the same amount of inverse feedback at 60 cps as at 400 cps it was necessary to increase the screen bypass capacitor from 0.5 to 8 μf.

By connecting the plate of the output stage through a resistor and capacitor to the cathode of the driver stage as shown in *Fig.* 3, a further increase in inverse feedback can be obtained. However, on checking the over-all response of this arrangement it was found that with a feedback of only 16 db in the middle frequencies there was no response at 20 cps and that above 800 cps there was a gradual loss which amounted to 10 db at 12,000 cps. This meant that there was positive feedback present and more of it at the treble frequencies. The squeals which emanated from the loudspeaker when rotating the dial of the FM tuner showed that there was oscillation. This approach was, therefore, abandoned.

A 6SH7, which has a higher gain than a 6SJ7, was then substituted, and two loops of inverse feedback were employed. The loop through R_7 in *Fig.* 4 served to flatten out the response from the output transformer and to reduce any tendency to oscillate. It also produced a sweeter "feel," much like that of a triode, which the 6L6 resembled after this reduction in its gain. A 6AU6 may be substituted for the 6SH7, but a 6BC5, 6CB6, or 6AG5 cannot be used as these radiate badly.

The following factors of inverse feedback were obtained from the amplifier

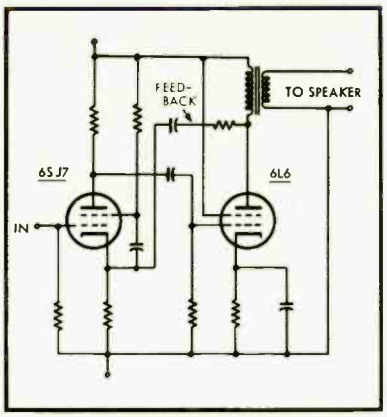

Fig. 3. Obtaining the feedback path from the plate of the output tube gave higher feedback but poorer response.

shown in *Fig.* 4 while using a Stancor A-3830 output transformer:

Frequency	1st Loop	2nd Loop	Total
60	2.8 times	6.5 times	18.2 times
400	4.2 times	6.5 times	27.3 times

With this amplifier signals were heard below 20 cps and a slight loss of amplification was measured at 300 kc. The break-up of the sine wave on the oscilloscope (generally at 3 per cent total harmonic distortion) at 60 cps occurred at 3 watts, and at 400 cps at about 4 watts. Amplifiers which employ large amounts of inverse feedback show low distortion up to a point which is considerably below the ratings published in the tube manuals and beyond which there is a sharp and very great increase in harmonic distortion. Based upon the above tables and compensating for the increase in feedback, it is estimated that at the 400–1000-cps point at just below 3 watts there should be less than 1/3 of 1 per cent harmonic distortion, and at the 60-cps point, after allowance for the lower frequency, 1.5 per cent harmonic distortion.

Where a tone-compensator stage is desired and where a variable-reluctance cartridge is to be used, the circuit shown in *Fig.* 5 is suggested. It may be necessary to increase the values of either the capacitor or the resistor, or of both, in the decoupling circuits at points A or B in order to overcome motor-boating, which can occur in this amplifier at a frequency as low as one half cycle per second.

A pair of 50L6's connected in push-pull were tried in the circuit shown in *Fig.* 5. An inverse feedback factor of about 7 and an undistorted output of about 3 watts was obtained at 60 cps. Less inverse feedback was needed for this result because the push-pull operation cancelled nearly all the 2nd and 4th harmonics and also the magnetizing effect of the d.c. in the windings of the primary of the output transformer. This latter raised effective input inductance. The 3-megohm volume control R_1 permitted the use of a broad-range crystal cartridge. Capacitor C_2 and resistor R_2 furnished some Fletcher-Munson compensation. Capacitor C_1 served to overcome losses in the shielded cable from the pick-up to the amplifier and also to afford some Fletcher-Munson compensation in the treble frequencies. Various values of C_1 should be tried until the most pleasing result is obtained. An FM tuner with a 1-volt output could be used to drive this amplifier to nearly

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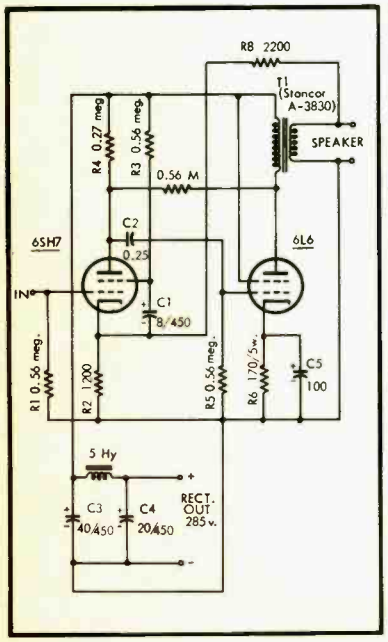

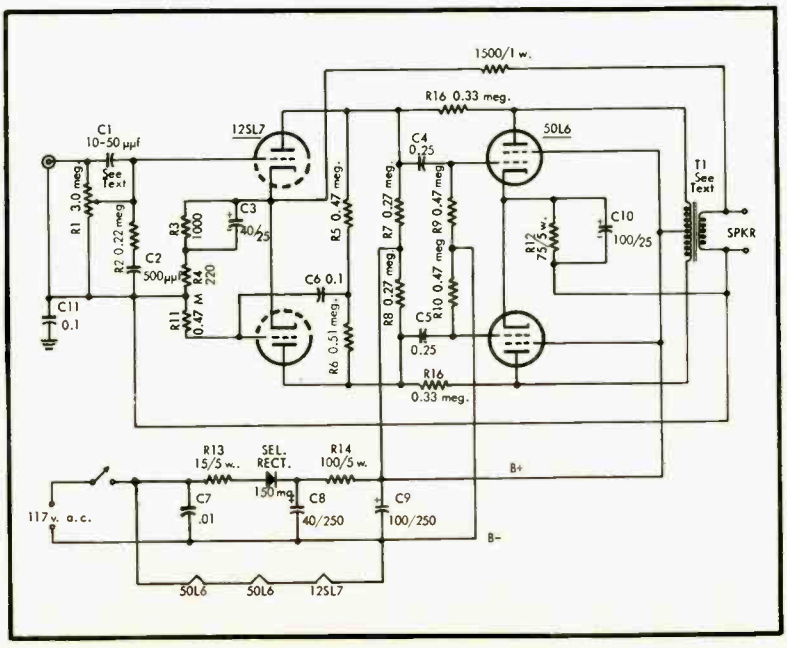

Fig. 4. (left) The final single-ended amplifier, with two feedback connections, one from the plate of the output tube to the plate of the 6SH7 and the other from the secondary of the transformer to the 6SH7 cathode. Fig. 5. (right) The push-pull version of the amplifier.

Soldering Tips for Hobbyists

LEONARD CARDUNER*

Soldering is not at all a difficult operation if a few simple rules of practice are followed.

THE CLAIM THAT "no soldering is necessary," which occasionally appears in certain components manufacturers' advertisements, seems to indicate that some audio enthusiasts think that soldering is a difficult process. However, if a few simple principles are understood and the necessary inexpensive equipment is available, any audio enthusiast should be able to tackle simple soldering jobs without trepidation.

While there are both hard and soft solders, the usual type of solder which is used in the manufacture of electronic equipment is of the soft variety and that is the only type we need consider. The best solders are made from pure tin and lead and, oddly enough, the melting points of these respective metals are both above the melting point of a mixture of them, which is called an alloy. Usually, the solders used for wire-to-lug joints in electronic work contain percentages of tin between 40 and 60 and generally the higher the tin content the lower the melting point of the solder alloy. All the usual tin-lead alloys start to melt at the same temperature which is about 183 deg. C. We say "start to melt" because all solder alloys (except the eutectic which is 63 per cent of tin and 37 per cent of lead) have what is often called a plastic range. That is, they start to melt at 183 deg. C. but do not become liquid until they reach a higher temperature. Incidentally, knowledgeable solderers always quote the tin content first when describing an alloy.

Why 60/40 Is Best

It may well be asked why there are various alloys of tin and lead at all. The reason is that aside from the need for higher melting-point solders in certain special applications, there is a very considerable difference in price between the two metals. Tin costs roughly 7 times the price of lead. When sufficient heat is available to make the solder joints there will not be appreciable difference between joints made with 60/40 alloy and those made with 40/60 alloy, except that the former will look brighter. However, many of the leading high-quality audio component manufacturers use only 60/40 alloy, and if a few cents difference is of little consequence, the knowledgeable audio enthusiast will do well to standardize on 60/40 alloy, or at least not use a lower percentage of tin than 50 per cent.

Solders can be used for joining practically any metals except aluminum. It is well to realize that when a solder joint is made it is not just a question of sticking two metals together. If the correct soldering technique is employed, the solder alloy will actually penetrate the surfaces of the metals by a form of molecular action.

However, besides having alloys made from the purest tin and lead, it is also necessary to use a flux. Most metals, unless protected by a coating such as nickel, tin, or paint, tend to oxidize and

Fig. 1. A new iron or one which has lost its brightness should always be tinned. Clean the tip to brightness with sandpaper or a fine file and apply cored solder, making sure it adheres to the entire tip surface. If a tip is untinned it will not conduct heat to the work.

it becomes difficult to get the solder alloy to penetrate the surface. In addition, when metals are heated further oxidation tends to form. A flux is, therefore, used in order to remove the surface oxides prior to the application of the solder alloy as well as to prevent them from forming during the soldering operation. About a quarter of a century or so ago, most soldering jobs were undertaken with a separate flux and a stick of solder, and were it not for the introduction of cored solder in wire form it is doubtful that the complex assembly of hundreds of different components in amplifiers, television sets, and the like could have been economically possible.

Cored solder containing one or more cores is usually supplied in wire form with the flux in a central core or, in the more modern type of solder, in 3 or even 5 cores. The idea of the multicore solder, which originated in England, is that by having several cores of flux, it is certain there will be no interruptions in the flux supply and that the flux melts out of the solder more quickly than when it is contained in one core.

In considering the use of cored solder it is absolutely essential for the audio enthusiast to use a nonacid type in order to ensure that solder joints do not become corroded. When solder is used in the fabrication of nonelectrical equipment, ranging from automobiles to jewelry, acid fluxes are usually employed because the manufacturer does not have to worry about corrosion; the soldered surfaces are always subsequently washed and it is best to use the fastest possible flux because the parts to be soldered are often contaminated with grease or oil. Luckily, the surfaces that have to be soldered in an electronic equipment are usually fairly free from contamination and thus a noncorrosive flux can be used. Most noncorrosive fluxes are made largely from rosin which has been specially activated by complex and secret processes to allow very much faster soldering than the natural rosin. Kester 5 flux and Ersin Multicore 366 are examples of these activated, noncorrosive fluxes incorporated in solder wire.

Although cored solders vary in diameter from 0.12 to .028 in., any of the finer gauges may be used, and recently .064 and .048 in., otherwise known as 16 and 18 S. W. G. have become the usual standards for electronic work. The 60/40 alloy in 18 gauge is usually found to be especially suitable for fine electronic soldering.

Soldering Tools—Guns Or Irons

While a good-quality cored solder can, under some circumstances, be used without any soldering implement, it will usually be found far more convenient to use either a soldering gun or a soldering iron. Solder guns are transformers which reduce the a.c. voltage to about 4 and then apply it across a copper wire, which heats up very rapidly. The advantage of using a solder gun is that it heats up in a second or two. The disadvantage is that it is usually rather heavy and more expensive than the simple form of electric soldering iron. Some soldering irons work from a low voltage and require a transformer. The majority, however, operate directly from the a.c. line and consist of a heating element wound around or buried in a copper rod, the end of which is called the soldering bit.

Whether a soldering gun or a soldering iron is chosen, it is essential that the end of the gun or the solder bit be properly "tinned." This job is done by heating up the tool, rubbing it with sandpaper or a file to remove oxide, and applying cored solder to the tip as in *Fig* 1, until it is evenly coated with the solder.

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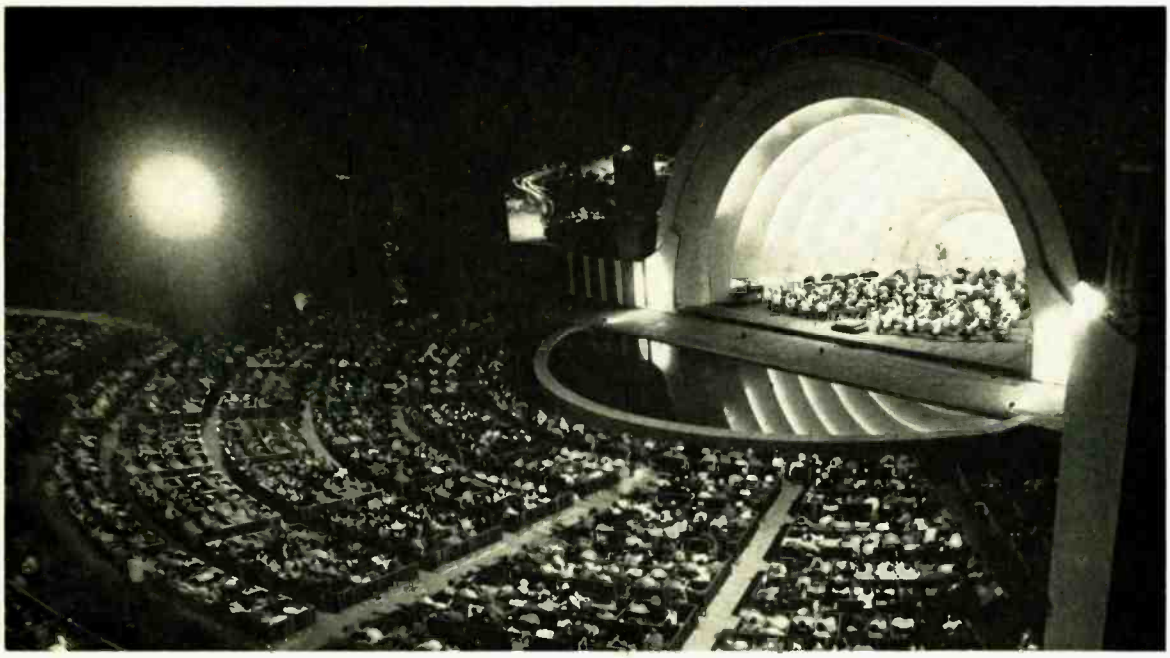
* *Ersin Multicore Solders, 164 Duane St., New York 13, N. Y.*



This photo, taken during an evening concert, gives a small idea of the Bowl's size. In the right foreground is the brick control tower.

Stereophonic Sound System Covers Hollywood Bowl

OLIVER BERLINER*

One of the country's biggest and newest sound reinforcement systems has been set up for stereophony. The stereophony and the over-all sound quality make the reinforcement as unobtrusive as it should be.

COMMERCIAL SOUND SYSTEMS have come a long way, from the early trial-and-error days of carbon microphones and electrodynamic loudspeakers to the present broadcast-quality apparatus and sound-level measuring. The industry in all its phases—paging, warning, background, music, intercommunication, and sound reinforcement—is slowly progressing from an art to a science.

A prime example of this coming of age is the new sound reinforcement system at the world famous Hollywood Bowl in California. Sound reinforcement is probably the most critical of the various types of audio systems; and at the Bowl the designers' conclusions are put to the most grueling tests. The object is to provide wide-range, undistorted sound to 20,000 patrons in the open air in such a manner that whenever possible they are not conscious that there is sound reinforcement.

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First it is necessary to review the objectives of the Hollywood Bowl, which was started in 1925. About three seasons ago the authorities decided that the Bowl could be used to greater advantage if the scope of its operations were increased beyond the customary summer concert sessions and the usual Easter Sunrise Services. With proper planning, the operating season could be lengthened and the number and types of functions materially increased. This could include plays, musicals, meetings, television and radio shows, political and other special events.

To properly accomplish this meant complete redesign of the lighting and sound systems. Besides this, rebuilding of at least part of the seating area, plus construction of new audience entrances and ramps would be required. For our purposes we are concerned principally with the effect this plan had on the sound reinforcement system, the most critical and important part of the Hollywood Bowl's production facilities.

At this time, Mr. A. W. Leach, a prominent sound engineer, was engaged to act as impartial supervisor, designer, and coordinator for the Bowl. And in the winter of 1952, RCA's John Volkmann was brought out to make the basic sound measurements and surveys. Upon these results would depend the success of the system acoustically.

Taking a cue from the popularity of stereophonic sound systems in theatres, Leach decided that perhaps this could be incorporated into the Bowl's facilities and that not only would it provide a touch of realism, but it might be generally better and more workable than a standard (previously used) monaural channel. Volkmann's measurements proved this theory valid, and the stereophonic sound system plan was adopted.

Ultimately the acoustic measurements were completed and the specifications set. Three important local suppliers of sound systems were invited to submit bids and to submit their designs for the

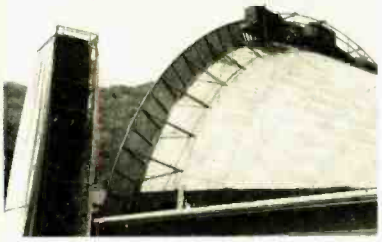


Fig. 1. View from rear of the shell shows one of the twin loudspeaker towers as well as the three speaker systems atop the shell.

electronic phases of the system. After careful examination. Leach decided that all proposals were unacceptable in original form, but that the best parts of each could be combined to make a final workable plan. Subsequently, the Otto K. Olesen Company, distributors of RCA equipment and one of the nation's largest sound systems suppliers, was selected to provide and install the equipment.

At this point, it is necessary to take note of certain aesthetic and nontechnical aspects of the Hollywood Bowl sound system. Famous musicians, speakers, dancers, and actors from all over the world come to perform at the Hollywood Bowl. For this reason, the equipment must be so operated and placed that the audience would be relatively unaware of its use and even existence. Second, a minimum of equipment should be onstage. Finally, for best realism, the orchestra should control its own volume level rather than letting the audio operator do it.

Figure 1 shows a rear view of the shell covering the stage and of the stage left (audience's right) loudspeaker tower. On top of the shell you will see three RCA theatre-type low-frequency speakers, each with its own wide-angle high-frequency horn. These assemblies were designed by Volkmann and are now standard RCA theatre equipment. Note an important fact: these three speaker combinations represent only the center stereophonic channel; for to have them function as all three channels, would be to lose the stereophonic effect a mere few feet from the loudspeakers.

The tower to the left of the shell, containing four loudspeakers (two high-frequency units in the center plus a low-frequency radiator at the top and at the bottom) provides the right-hand stereo channel; and a similar tower on the opposite side makes up the necessary third channel, for a total of seven low- and high-frequency assemblies. It is interesting to note that the average motion-picture-theatre single-channel sound system utilizes but one or at most two of these combinations.

For special productions requiring a large stage, the shell is rolled off to stage right on tracks provided for that purpose. Obviously, the center stereo channel is lost; so under these circumstances a two-channel sound reinforcement system consisting of the stage right and left towers is used. Actually, the Bowl has a fourth stereo channel available for special effects or emergencies.

Control Console

The main control console is a custom built unit designed by Walter A. Midcalf, Jr., who is responsible for the design of the entire electronic system, and consists of a three-section turret and desk, *Fig.* 2. It is presently situated in the front of the second box seat section, closer to the right side of the audience.

The left element in the photo contains the patch bay. All of the 36 microphone receptacles terminate here, as do preamplifier inputs and outputs. Below the patch bay are decibel meters which are used for checking output level of the four main power amplifiers. Many circuits are "normaled" to minimize the amount of patching.

The center element of the console is the main operating section. At the top are the VU meters with their multipliers, which read output level of the three stereophonic-channel line amplifiers and the spare/utility channel. Below these are gain controls for 10 BA-11A broadcast-type 2-stage preamplifiers; and above each attenuator is its 3-position transfer key. In the center position the preamplifier is not in line; press the key to the right and it is connected to the program line, while in the left position it goes to a special audition amplifier. This is the only amplifier actually in the console and it allows the audio operator to test the condition and level of each microphone (and the preamplifier) before putting it "on the air."

Although there are 36 separate microphone receptacles and circuits, only a maximum of any 10 may be operated at a time on this console. On the occasional situation where more are needed, the patching bay makes it convenient for portable mixers to be connected to handle the additional microphones.

Except for the theatre loudspeakers, all equipment, including the main power amplifiers, is of broadcast type. This is essential, not merely to obtain the highest-fidelity sound reproduction, but to make the system capable of feeding broadcast and recording studios with high-quality audio. Among other things, this helps to minimize the number of microphones used on the stage. However, since broadcasting necessitates microphone gain settings different from those of the public address system, broadcast preamplifiers are bridged across the outputs of the public address microphone preamplifiers before the gain control. In this manner, the public-address-system and broadcast engineers may set the gain on each microphone to suit their own separate tastes and requirements, yet only one set of microphones is used.

Part of the Hycor (Model 4201) equalizers may be seen at the far right of *Fig.* 2, and between them and the center section of the board are the line selectors and gain controls for the binaural headphones. Here either ear may listen to any one of the four sound channels for testing or monitoring the stereophonic effect. Separate volume control for each earpiece is provided.

Line equalization is a new experiment at the Hollywood Bowl. So far it has been used principally for sound effects, and on concerts of popular music it has been advantageous in providing for the audience a sound duplicating that produced in the recording studio, especially in making certain vocalists sound in the Bowl as they do on phonograph records. Other uses, such as overcoming atmospheric conditions and the immensity of the Bowl, besides feedback reduction and to enhance the stereophonic effect, may serve to show further advantages of equalization.

Situated below the equalizers on the console are the power-supply and loudspeaker transfer keys. In the event that a preamplifier power supply should fail, depressing the appropriate switch key will cut it out of the circuit and simultaneously connect the spare. A tally light indicates this condition both at the console and in the equipment room. If one of the loudspeaker driver or power amplifiers fails, a switch operated at the console or at the racks transfers the loudspeaker associated with that amplifier to the spare amplifier. The audio

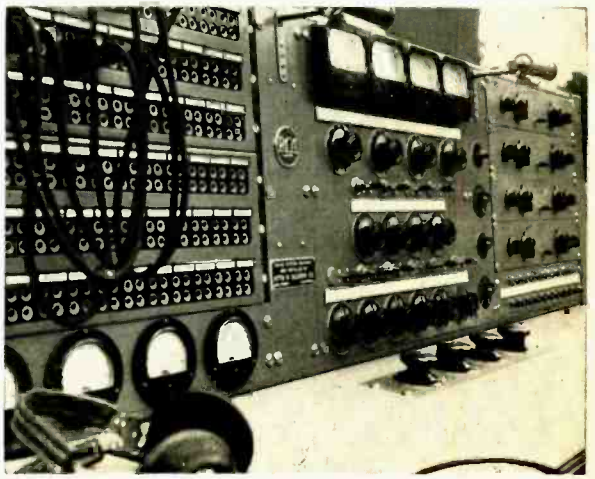


Fig. 2. The main control console contains the microphone controls, one of the duplicate patch bays, and other facilities described in the text.

operator need only patch in the proper input circuit and the channel is fully restored. Preamplifiers are substituted in emergencies merely by patching.

Another switch cancels any patched-in monitor loudspeaker near enough to a microphone to cause feedback. The remaining two switches operate a signal light and buzzer at the lighting control room and audio equipment room, respectively. This indicates that the audio operator wishes to communicate with that particular party.

In the desk area of the console, and directly in front of the center section are the four master gain controls, one for each loudspeaker channel. Once the individual microphone levels have been set, the equipment may, in most cases, be controlled by the master gain attenuators, thus greatly simplifying operation. Where possible the orchestra may control its own level, which is highly desirable and can be done only in public address work, not in broadcasting or recording due to the need of a restricted dynamic range.

The Equipment Room

The sound-equipment room is located at the base of tower number two (not the loudspeaker tower), on the right side of the stage when facing it (see shell-view photo). A large window allows the performance to be watched from here, and the audio console may be operated from one of the rooms in this building if desired, along with the portable remote amplifiers provided by broadcasters for their own use.

The other room contains the five equipment racks, four of which are shown in *Fig.* 3. Rack No. 1 (on the far left, not shown) houses amplifiers, terminations, repeat coils, and accessories for feeding telephone-company broadcast lines. Rack No. 2 contains the 10 microphone preamplifiers, the four program amplifiers, and the four preamplifier power supplies. Drop-front panels permit easy access to above-chassis components. The meter panel allows the audio operator to make a quick check on the preamplifier and line amplifier tubes by cathode-current readings. Below the four BA-13A program amplifiers are three power-supply-failure switches with their tally lights. These are duplicates of those at the console and cut in the spare BX-IE power supply to the appropriate circuit in the event of a failure.

The third rack houses the four driver amplifiers which feed the four main stereophonic loudspeaker power amplifiers with up to the required 15 watts of audio power which drives each main amplifier (rack 5, far right) to a full 75 watts output. However, each driver/power amplifier chain is operated at far less than full power which will greatly prolong their life and minimize components replacement.

The drivers have 600 ohm input, 15 ohm output, and a maximum gain of 66 db, while the main power amplifiers have but one stage, with a gain of 7 db. There is a special 15-ohm input transformer, and an output of 10 ohms. As the theatre speakers have 250-ohm dividing networks, high-level impedance-changing transformers mounted in a subpanel on the wall make this conversion, which also reduces the necessary wire size of the cable running between the racks and the loudspeakers. The Altec A-127A and A-287F amplifiers contain a meter for checking tube condition.

Rack No. 4 is the principal operations center of the control room. The main patching bay is the same as that at the control console, except that the rack's bay has precedence over the console. This means that if a patching operation is made here it will cancel any setup that has been or could be made at the console for that particular circuit. Above the twin-jack bay is a meter panel for checking various stages of audio, and hanging over this is a sound powered intercom phone.

Directly below the patch bay is a monitor amplifier for checking any of the

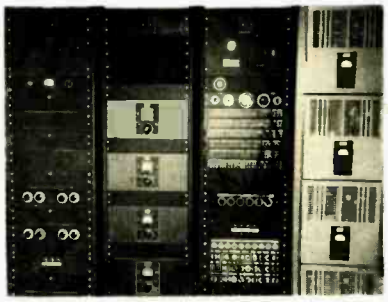


Fig. 3. The equipment room contains five racks, the first being out of sight in this photo, at left.

stereophonic channels (this also serves as a grounds paging amplifier when not used for concerts); and beneath this are the loudspeaker - amplifier - failure switches, which, as do those at the console, cut in the spare driver/power amplifier combination to any circuit where trouble is encountered. Another switch on this panel is used for signaling the console operator that the booth wishes to converse with him.

For utmost flexibility, it was decided to place all loudspeakers on a patching system, but since high currents are encountered in these circuits, Cannon Type XL connectors were used instead of standard twin-jacks. This arrangement appears at the bottom of rack 4. In view of the fact that it is often essential to place temporary portable loudspeakers at certain points, especially for backstage monitoring or cueing, the loudspeaker patching bay is a necessity.

Certain additional interesting features have been incorporated into the Bowl's over-all sound setup, one of which is a warning light attached to certain key microphones. This red light, actuated by the lever above the gain control for the microphone, indicates to the performer that his microphone is on, especially helpful in cueing and for offstage microphones where the performer cannot readily follow the action. A tally light at the audio console announces this condition to the audio operator. All tally lights and relays are 24-volt-d.c.-operated, as is broadcast standard.

Another extremely helpful feature provided by the Bowl in its endeavor to deliver complete facilities to outside organizations, is a special patch bay which will provide program material at virtually any desired impedance and level to newsreel services for feeding their single- or double-system cameras. Not only does this greatly simplify their setup problems, but it eliminates the cluttering of the stage by a battery of newsreel microphones. This patch panel is wired to connectors located just outside of the sound control room, where the motion picture equipment may be installed as requirements dictate.

The intercommunication system at the Hollywood Bowl consists of sound-powered telephones, but in a unique system. The earpieces are bridged across the terminated output of a 6-watt amplifier, while the transmitting pieces are connected to the low-impedance microphone input. With this arrangement the possible number of phones in the system is virtually limitless and the volume may be adjusted to any required level. Although sound-powered phones were not designed to be used in this manner, the system has been found to function perfectly.

In an installation of this magnitude, there naturally are certain acoustic difficulties which must be overcome. One of these is the problem of echo wherein the sound from the orchestra bounces off the front pair of brick lighting towers and cuts across the first box-seat section in such a way that these patrons receive an echo of certain instruments in the orchestra, depending upon where they are sitting. The installation of weatherproof (this is a problem in itself) sound absorbent or deflecting material is being considered and tested to meet this condition.

Secondly, it was found necessary to tilt forward the fronts of this first box section, so that the sound coming directly to it would be deflected downward rather than back to the stage. In addition, all speaker assemblies are directly on a plane with the front of the shell covering the stage. This brings them as far forward as possible without being too close to the audience area and being too obtrusive; and also it gives the essential illusion that the sound is coming from the orchestra, an effect that is so very necessary for realism.

The volume level of the sound reinforcement system is set at that point where the lowest-level musical passage can just barely be heard at the farthest point of seating from the stage. This is determined during the daily rehearsal. Once this has been set, the orchestra will control its own dynamic range for the most part. Of course, where soloists are concerned, the gain must be carefully watched by the audio operator. The average power output on each chan-

(*Continued on page 52*)

How Valid are Sound Truck Restrictions?

ALBERT WOODRUFF GRAY*

When we see them on the streets we may be inclined to say "There oughta be a a law agin . . ." but we should be informed first. There are laws, but not all "agin."

A MEMBER of the California State Federation of Labor recently sued to prevent the enforcement of a Fresno County ordinance against the use of loudspeakers.[1] Labor union members, arrested for violating this ordinance, had contended in their defense that the ordinance was an invasion of their right to freedom of speech, guaranteed by the First Amendment of the United States Constitution.

The ordinance was, "It shall be unlawful for any person to wilfully make, emit or transmit or cause to be made, emit or transmit any loud or raucous noise upon or from any public highway or public thoroughfare or from any aircraft of any kind whatever."

The ordinance refined "loud and raucous noise" as "The human voice or any record or recording thereof, when amplified by any device, whether electrical or mechanical or otherwise, to such an extent as to cause it to carry onto private property or to be heard by others using the public highways or public thoroughfares. Any sound not included in the foregoing which is of such volume, intensity or carrying power as to interfere with the peace and quiet of persons upon private property or other users of public thoroughfares."

The California appellate court said a few months ago in forbidding the enforcement of this ordinance, "It should be here noted that the emission or transmission of such sounds are made unlawful irrespective of whether such sounds are of such volume, intensity or carrying power as to interfere with the peace and quiet of users of the county highways or owners of private property.

"Such a limitation upon the use of the human voice or any recording or amplification thereof is, in our opinion, an unconstitutional abridgement and denial of the right of free speech. Under the provision of this ordinance the use of radios in private automobiles on county highways will be prohibited if the sounds therefrom carry to private property or could be heard by others using the highways and even the use of the human voice when amplified otherwise than by any mechanical device would constitute a violation of the ordinance when carried onto private property or heard by others using the highways."

The distinction of sounds tending to interfere with the peace and quiet of highway users in relation to the constitutional guarantee of free speech, which has been made by the courts, is more easily understood when read in connection with a decision rendered by a court of that state the previous year.

The ordinance in that instance was in part, "It shall be unlawful for any person other than a law enforcement or government agency, to employ a speaker mounted upon a vehicle for the purpose of giving instructions, directions, making talks, addresses or lectures, to any person or assemblage upon or over any highway without first obtaining a permit therefore as herein provided. * * The Board of Supervisors shall grant such permit at said time unless there is presented to the Board at the time of said consideration substantial and convincing evidence of a clear and present danger that the granting of such permit will result in the obstruction of the orderly movement of traffic or the peaceable passage or presence of persons to, over or upon the public highways and other popular places, or disorder or unlawful conduct, or unlawful injury of persons, or destruction of life or property, or tending to incite crime, or an invasion of the rights of privacy, or threatening the overthrow of the lawfully established government by force, in which case said permit may be denied."

Here the court held that this ordinance, which restricted but did not prohibit the use of loudspeakers, did not violate the constitutional guarantee of free speech.

"This ordinance regulates the use of loudspeakers and is not in our opinion unconstitutional and void as an unlawful restraint upon the right of free speech. It is the privilege of all persons to use the public highways and the right of free speech thereon cannot be abridged or denied. However the use of such highways may be regulated and controlled in order to assure the safety and convenience of the traveling public. The Board of Supervisors of the county has authority to specify without unfair discrimination the time, place and manner of such use in relation to other proper use of the highways.

"The use of vehicles equipped with loudspeakers emitting loud and raucous noises and objectionable amplified sound on public highways is subject to legislative control. This ordinance does not deny the right of free speech or assembly. By its terms a permit to use a loudspeaker can only be denied upon presentation to the Board of Supervisors of substantial and convincing evidence of a clear and present danger. * * The standards controlling the action of the Board of Supervisors are specifically set forth and enumerated."

This rule of law that permits a state or municipal government to *regulate* or *control* providing that it does not *deny* the use of *loudspeakers* on the streets or highways, is now firmly established by two recent decisions of the United States Supreme Court.

The first involved an ordinance of Lockport, New York, that, "It shall be unlawful for any person to maintain or operate in any building or on any premises or on any automobile, motor truck or other motor vehicle, any radio device or loudspeaker or any device of any kind whereby the sound therefrom is cast directly upon the streets or public places and where such device is maintained for advertising purposes or for the purpose of attracting attention of the passing public, or which is so placed and operated that the sounds coming therefrom can be heard to the annoyance and inconvenience of drivers upon any streets or public places or of persons in neighboring places.

"Exception.—Public dissemination, through radio loudspeakers, of items of news and matters of public concern and athletic activities, shall not be deemed a violation of this section provided that the same be done under permission obtained from the chief of police."

A member of Jehovah's Witnesses was granted a permit by the chief of police to deliver religious lectures from the top of his automobile. Complaints were made and a second permit was refused. Nevertheless he continued the loudspeaker talks, was arrested, convicted and sentenced to fine and imprisonment.

He appealed the conviction to the highest court of the state,[2] contending that the ordinance was a violation of the First Amendment of the Federal Constitution that, "Congress shall make no law * * abridging the freedom of speech."

That court affirmed the conviction and the controversy was carried to the Supreme Court of the United States. That court in setting aside the conviction and holding the ordinance unconstitutional and void, said,

"The right to be heard is placed in the uncontrolled discretion of the chief

(*Continued on page 45*)

* *3712 75th St., Jackson Heights, N. Y.*

[1] Haggerty v. Kings County, 256 P.2d 393, California.

[2] Saia v. People of the State of New York, 334 U.S. 558, rev'g. 72 N.E.2d 323, New York.

The Languad Expert Looks At Hi-Fi

GEORGE L. AUGSPURGER*

This could happen—provided we don't run out of adjectives.

A LOT OF PEOPLE don't believe me when I tell them that my friend, George Anthrubus, is a "languad" scholar. They always think I'm saying "languid" and then yes, yes, they know the type: stoop-shouldered, horn-rimmed glasses, and all the rest. Why do I associate with somebody like that? And then I have to tell them that what I *really* said was "languad" which is Mr. Anthrubus' own word for the kind of language that ad writers use. "Only in advertising nomenclature—in *languad*, to coin a word—" says Mr. Anthrubus, "are the traditional iambic pentameter of Shakespeare, the grandiose adjectives of Milton, and the polished phraseology of Pope synthesized into one artistic triumph of our age." He really means it too. He spends his time copying and classifying top-notch examples of languad and having them printed up in bound volumes at his own expense. All of which may go to make a slightly eccentric character, but still a real *character*, if you know what I mean. When you start feeling complacent, there's nothing like a little chat with George Anthrubus to make you comfortably disoriented once again.

Last week, for example, I suspected that perhaps things were running a little too smoothly so I took off the afternoon to pay a social call on Mr. A. personally. George seemed happy to have somebody to talk to, as usual, but I noticed that he had sort of a sly smile on his face as if he had a big secret and just couldn't wait to get across the punch line. Sure enough, I walked into his big studio, and there besides the usual magazines and clippings littering up the place, were enough top-quality tape recorders, speakers, amplifiers, and turntables to make NBC jealous. Anthrubus stood in the middle of the floor just sort of idly adjusting his necktie and beaming like a TV announcer.

I sensed that I was expected to provide something in the way of a fanfare, so in my best awed manner I indicated the pile of stuff with my hand and said, "I knew you were sort of a hi-fi fan, but isn't all this a little overpowering for an amateur?"

"Of course not," answered George, "although, as you say, I am merely, as Pickering puts it, 'a connoisseur of music.' But we are assured that hi-fi must be experienced to be appreciated, and according to my languad references, this amount of equipment is the very minimum for such an experience."

"How does it work?" I asked, a little jealous at the comparison with my own small installation.

My dear boy," responded Anthrubus, "This system brings you music as you have longed to hear it. It is so life-like and natural it cannot be described. It has an on-stage realism of tone and a naturalness of reproduction unparalleled in the art. I am satisfied that only the best engineering resources can produce such gratifying performance."

"I suppose the response curves look pretty good," I said surveying the array of chassis and cabinets.

"I assure you," said Anthrubus archly, "that the psychological factors affecting music are given as much weight as the measurable quantities."

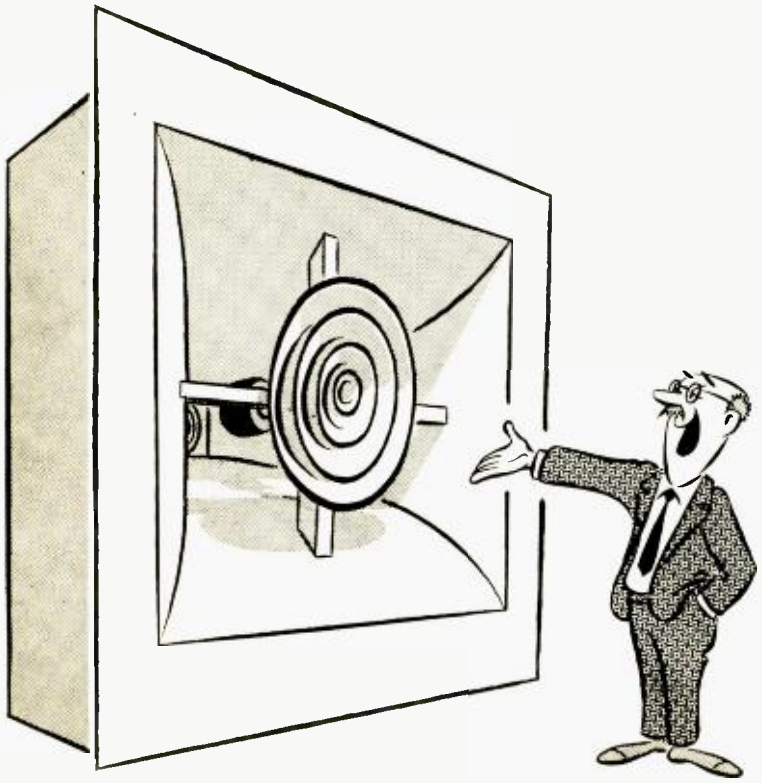
By this time I had wandered over to a series of chrome-plated, rack-mounted devices which proved to be two enormous power amplifiers and a series of preamps and equalizers that filled up the rest of the rack. "This, uh, really does the job, eh?" I asked lamely.

"This," said George patting the electronic skyscraper fondly, "is designed for the audio enthusiast with the professional ear. It is a perfect companion for those who hear the difference; for those who treasure the art of listening."

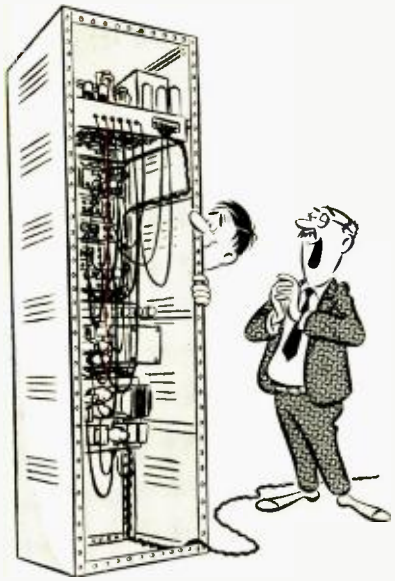
"It does look professional," I ventured.

"It is the very picture of scintillating symmetry," said Mr. A., by now rising to the eloquence of his languad quotes. "It uses an ultra-linear circuit that captivates music lovers with its thrilling accurate reproduction. It is paramount primarily by the excellence of its balanced frequencies, but it has a galaxy of other features that total to the finest instrument that electronic engineers have been able to devise. It has perfect stability, a hum level below the threshold of audibility, absolute tonal balance, and a sweep and brilliance of reproduction unsurpassed. Furthermore, reserve power has not been!"

"Reserve power has not been what?" I murmured, scarcely daring to interrupt.



* *Audio Research Laboratories, 7041 N. 14th Place, Phoenix, Ariz.*



Anthrubus looked at me through the bottom half of his bifocals. "Not been sacrificed, of course," he said in an injured tone.

"Oh, yes, of course," said I, trying to look as if I'd followed his arguments.

"It has the highest-fidelity circuit ever built into a superfidelity amplifier. It has optimum fidelity that subjects the loudspeaker to rigid discipline," declaimed Anthrubus in his best Barrymore manner.

"Talking about speakers . . ." I said

"It is an engineer's dream, a musician's delight." Anthrubus went on, ignoring me. "It supplies perfect audio designed by experts for expert ears and as such can be assured of an endlessly useful life. The companion preamplifier and control unit here in the hand-rubbed cabinet has both signal modification controls and a continuously variable electronic filter. It too was designed for the discriminating music lover." George stared at me as if daring me to utter a word.

After an unpleasant few moments of silence I cleared my throat and said, "I suppose the distortion is . . ."

"Distortion is virtually unmeasureable," finished Anthrubus triumphantly.

I winced slightly and in an effort to cover my defeat I took a sudden interest in one of the transcription arms mounted on a giant broadcast turntable console. "An excellent pickup," I remarked, trying to sound authoritative.

"Yes indeed," rejoined Anthrubus, "It captures the sound exactly as it was originally produced. No compromise has been made with quality and as a result it releases elusive pleasures that often remain hidden in the grooves of fine recordings. It is a reproducer sensitized to the *n*th degree and with its near-perfect tracking it brings out every subtle shading. It captures the missing music. It is the ultimate in record reproduction."

"Hidden in the grooves?" I questioned, trying to catch up with my friend.

"Of course," snapped George, "It brings out the latent music that other pickups leave untouched. It brings you record fidelity that you never believed possible. And it gives reproduction . . ." George hesitated.

"Reproduction unparalleled?" I tried.

"No," responded the languad expert. "Reproduction so long sought after and now a . . ."

With a flash of inspiration I finished up, ". . . now a fact!" snappy as you please.

"Bravo!" cried George. "You'll be a languad ham yourself before you know it." I tried a deprecating smile, but I was really touched. Exhilarated by my success, I turned to a giant theater horn in one corner and said lightly, "I suppose that gives you plenty of full, clean bass?"

George beamed. "It is really music you can feel," he said. "It is more than a speaker; it has a simulated point-source, radial diffraction and projection principles, high acoustic damping, a carefully designed throat configuration, a reflector-diffuser element which distributes the high frequencies throughout the listening area, and a driver cone impregnated with cellulose and molded with logarithmically graded corrugations from cone to rim."

After sipping a drink of water from the decanter at his elbow he cleared his throat and went on. "You will notice the asymmetrical speaker mounting and the consequent avoidance of spurious peaks. The horn is complemented by two independent Helmholtz resonators and intermodulation in the middle registers is kept to a minimum."

"What about intermodulation in the outer registers . . . is it allowed?" I asked innocently.

Anthrubus withered me with a glance and demanded, "Do you know what this results in?"

"Full-bodied response, I should say." I hazarded.

"Not only full-bodied response," said the expert scornfully, "but minimized speaker hangover, unequalled realism of tone, room-presence sound, perfect aural balance, and sufficient definition to suit the fastidious listener. Not only that, but it trumpets. Do you know what it trumpets?"

I was taken off guard and said I didn't know it trumpeted. Glad tidings came to mind, but I didn't think that answer would improve Anthrubus' disposition.

"It trumpets a vibrant quality of timbre altogether unique in the reproduction of music!" shouted George, his good spirits restored. "Think of hearing natural sound across . . ." he said, grinning.

"Across?" I repeated blankly.

"Across the entire musical spectrum." finished Anthrubus. "Its dynamic energy adds a flood of color to the musical canvas. It has clarity and crispness rivalling the original."

"What about resonances?" I asked.

"There are no perceptible resonances." he answered. "As a matter of fact it has nonresonant response realizing robust, live, bass necessitating only one or two watts of audio for sensational results."

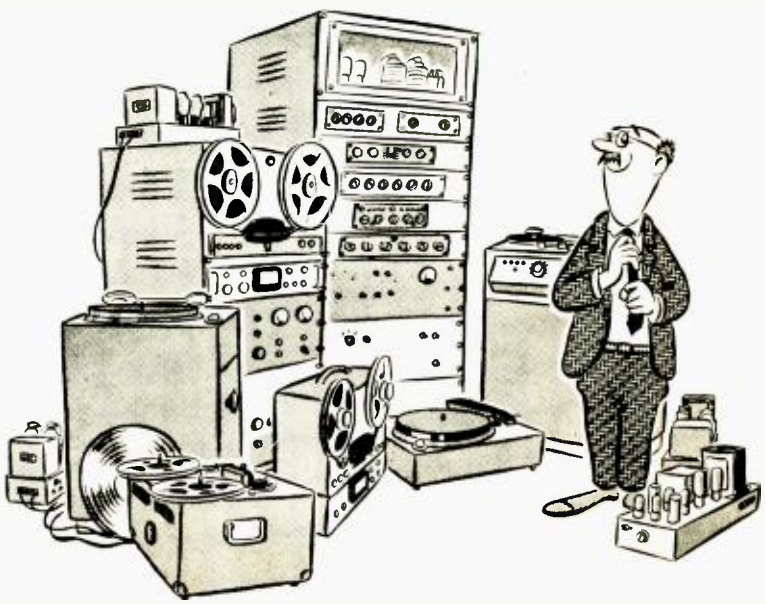
"Full tonal realism, no doubt," I murmured in an offhand way.

"Full tonal realism and unparalled listening ease," said George looking at me with admiration. "It is a fitting complement to existing systems and it is limited only by the quality of the associated equipment. How uniform would you say it was?"

"Essentially uniform, obviously."

George clapped his hands. "And with

(*Continued on page 53*)



Care of Jacks and Patch Cords

EUGENE F. CORIELL*

The author points to the importance of a supposedly humble device and tells how to keep it functioning.

ONE OF THE MOST IMPORTANT studio control room elements—and one sometimes overlooked in maintenance operations—is the patch system—the lowly jacks and patch cords. The main audio circuits are generally interconnected or "normalled" through contacts on the auxiliary springs of the jacks, and in meeting emergencies or requirements for special hookups there must be immediate and dependable access by patch cords to the tip springs on double jacks or to the tip and ring springs on the CBS-pioneered single-jack system.[1] Failure or noise in any of these springs and contacts may jeopardize the entire audio channel. The patch system is therefore the nerve center of the entire studio installation, and as such deserves the same careful, regularly scheduled maintenance as other plant elements.

We might start with the jacks. Insert a plug rapidly several times into each jack to loosen any dirt collected on the springs and contacts. Suction out the dirt with a vacuum cleaner fitted with a tapered rubber nozzle that fits snugly into the jack barrel. Clean the barrel with a rotary brush chucked in an electric drill, to assure good grounding contact for the plug sleeve.

Make sure each jack is tight in the panel assembly. Check for loose, bent, or misaligned springs, and realign them if necessary. To get at the screws holding the spring pile-up to the jack frame it may be necessary to remove the jack. While it is on the bench, it is a good idea to check the condition of the normal contacts on the auxiliary springs. These may be dressed if required with a Western Electric burnishing tool.[2] Occasionally, a tip spring may be found bent up or down enough to prevent insertion of the plug.

Look for loose, broken or otherwise defective soldered connections to the jack lugs, including the cable shield connection. (In some installations, the shields are connected to the terminal blocks in the bottom of the rack, rather than to the ground lugs on the jack frames.) Also make sure that a frayed strand of the opposite conductor or of the shield is not contacting the circuit lugs. Once or twice a year, it is well to check the continuity of cable shields to ground with an ohmmeter, and to check the bonding of each jack frame to its neighbors. Bonding is necessary even in systems in which the cable shields are not grounded to the jacks, in order to prevent crosstalk that might otherwise result from capacitance between jacks.

Clean the patch cords frequently. An easy way to do this is to put jeweler's rouge or other cleaning material on the plug and polish it on a long cloth fastened at one end to the wall or other support as shown in *Fig.* 2. The cloth is pulled taut with one hand and the plug rubbed against it with the other.

Test all patch cords regularly for continuity of each conductor and of the shield. Test also for shorts between conductors and between conductors and shield. The fact that a cord appears to work satisfactorily when patched into a circuit does not necessarily indicate the cord is OK. In some circuits, a short of a conductor to shield might not show up; also, breaks in conductors may heal themselves temporarily, due to the firmness of the cord structure. The cord should be flexed under test, and a convenient way of doing this is to plug the cord into a pair of jacks mounted at opposite ends of a board as a test fixture. A diagram of the fixture appears in *Fig.* 3. The jacks are wired through a selector switch so that each conductor in turn becomes the connection between the leads of an ohmmeter (switch positions 1, 2, and 3). Continuity of the shield can also be checked in this way if the shield is grounded to both plugs. The fixture can also show shorts (positions 4 and 5). The advantage of the fixture is that it provides firm connections and leaves the hands free to flex the cord. Tie a knot in any cord found defective and get it out of the control room pronto. Neglect of this little precaution can be very embarrassing, as the writer can testify.

Check the cord connections to the plug. If the conductors and shield have been soldered directly to the plug elements, the residue from the soldering flux may have left a high-resistance shorting path from one conductor to the other or to ground. Wash the soldered joint and the intervening insulation with carbon tetrachloride. This is one reason why cord conductors should be soldered to small lugs provided, and the lugs installed in the plug by the screws furnished.

The conductors in some patch cords are tinseled—that is, they consist of strands of copper thread wound over a cotton core. It is almost impossible to solder this material without burning it up. However, if a break must be repaired in such a cord due to lack of spares, the ends to be soldered can be wrapped with fine copper wire. This provides a satisfactory soldering surface.

Troubles due to polarity errors while patching may be blamed on patch cords or associated gear. The plug should be inserted in the jacks with the edge containing the notches or serrations always on the same side. Broadcast practice is to have the notches on the left, but left or right, the convention must be consistent. This is necessary to preserve the relative polarity of the circuits patched.

(Continued on page 53)

* *Major, USAF, Armed Forces Radio Service, New York, N. Y.*

[1] Howard A. Chinn and Robert B. Monroe, "Single jacks for broadcast applications," AUDIO ENGINEERING, July 1947.

Fig. 1. Clean jack barrels with a brush chucked in a pistol-grip drill.

[2] Harold E. Ennes, "Broadcast Operator's Handbook," 2nd Ed., John F. Rider Publisher, New York, p. 150.

Fig. 2. Plugs can be polished on a long strip of cloth saturated with jeweler's rouge.

TUNERS

A SECTION OF

AUDIO

AUGUST, 1955

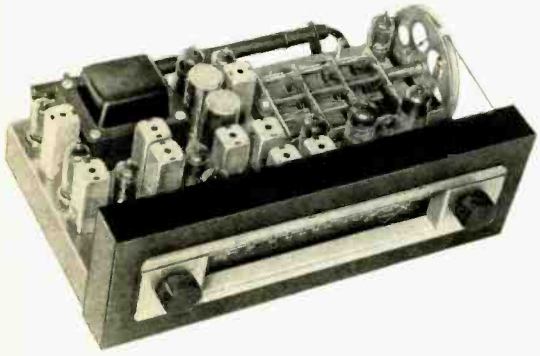
". . . coming to you direct from Philharmonic Hall."

For most complete utilization of our home music systems, we can resort to an almost unlimited supply of music which is offered at no charge to us from broadcasting stations. This is also an efficient means of auditioning phonograph records before buying them for a permanent collection. But even soap operas and news broadcasts sound better over a hi-fi tuner.

The Theme MODEL A-310

notes & technical specifications

The A-310 Theme has been termed the "definitive AM-FM tuner". Reflecting the most sensitive styling in the high fidelity field, it also delivers the measurable optimum in both AM and FM performance.



View of Model A-310 with cage removed

Model A-310

FUNCTIONAL FEATURES

Functional Features: (a) Illuminated Tuning Meter; (b) Counterweighted Tuning Control: (c) AFC defeat available on function switch or momentarily by depressing tuning knob for center channel tuning; (d) Cathode follower output to drive tape recorder.

RF SECTION

Circuits: FM: Armstrong Circuit with Dual Limiters (Double Tuned) and Foster-Seeley Discriminator. Automatic Frequency Control. Low noise, all triode front end with tuned cascode RF amplifier and triode mixer. AM: Superheterodyne with tuned RF stage, and ferrite loop antenna. Two IF stages. 10 KC whistle filter. AVC operative over three stages.
Sensitivity: FM: 1.8 microvolts for 30 db quieting; 1.2 microvolts for 20 db quieting. AM: Terminal Sensitivity: 3 microvolts. Loop Sensitivity: 15 microvolts/meter.
Selectivity: FM: 200 KC bandwidth: 6 db down. AM: 10 KC bandwidth: 6 db down. FM Discriminator peak to peak separation: 375 KC.
Frequency Range: FM: 88-108 MC AM:530-1650 KC.
FM Drift: ± 2½ KC with AFC on; ± 20 KC with AFC off.
Image Rejection: FM: 50 db. AM: 50 db.
IF Rejection: FM: 70 db. AM: 50 db.
Antenna Input: FM: 300 ohms AM: Built-in low noise ferrite loopstick plus high impedance terminal for external antenna.
Distortion: Less than 1% harmonic on FM. Less than 1% harmonic for up to 80% mod. on AM.
Frequency Response: FM: ± ½ db 20 to 20,000 c.p.s.
AM: 3 db 20 to 5,000 c.p.s.
Hum Level: 65 db below 100% modulation.

AUDIO SECTION

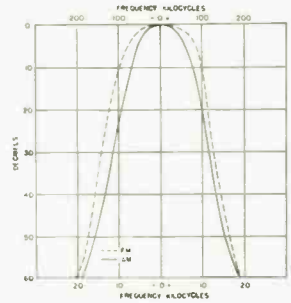
Circuits: Cathode Follower Output
Output Level: FM: 2½ volts for 100% modulation; 1 volt for 30% modulation. AM: 1 volt (average).
Output Impedance: Low Impedance Cathode Follower

OVERALL SPECIFICATIONS

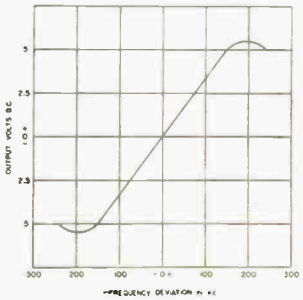
Controls: (Total 2) Function (OFF-AM-FM with AFC-FM without AFC) and Tuning/momentary AFC defeat.
Tube Complement: (Total: 12) 1-6BK7A, 1-12AT7, 1-6AB4, 1-6BE6, 3-6BA6, 1-6AL5, 2-6AU6, 1-12AU7, 1-6X4.
Dimensions: 12½" wide x 4" high x 8¾" deep (including ferrite loopstick—not including knobs).
Power Consumption: 50 watts
Shipping Weight: 14 lbs.
Finish: Chassis, escutcheon and cage: brushed copper—Display panel for escutcheon and knobs: matte black—Edge lighted dial glass: yellow and white.
Hardware and Accessory Material Furnished: Mounting screws, template, FM antenna wire, instruction booklet, shielded output cable.
Special Notes: (a) Can be stacked with C-300 amplifier in total height of 8", with C-100 amplifier in total height of 7¾"; (b) Face up mounting of Theme permissible without special precaution.

OPTIONAL ACCESSORIES

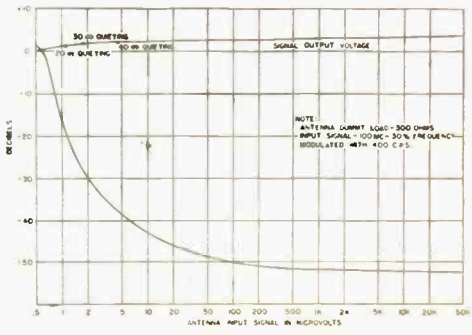
(a) Brass finished escutcheon available on special order.
(b) Brass finished cage available on special order.
(c) Vertically calibrated dial glass available on special order.



AM and FM selectivity characteristics



FM discriminator characteristics



FM detector output voltage characteristics

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Tuners—AM, FM, AM-FM

C. G. McPROUD

Introduction by Richard H. Dorf

The radio tuner often becomes the mainstay of home entertainment, introducing us to new music and giving us a wider choice than our meager record collections generally do. Here's how they work and what they're like.

IT IS A VERY STRANGE FACT that the audio hobbyist who spends so much time building amplifiers, checking pickup response curves, and stringing wires all over the house when he should be outside mowing the lawn, joins the wife and kiddies in becoming a simple button-pusher and dial twiddler when it comes to picking up radio programs. The trouble seems to be that those radio frequencies inside that complicated box are way out of the audio band and therefore the product of an exclusive engineering cult which deals in such weird items as tuned transformers—without iron cores! —and variable capacitors. The same man who unblushingly exhibits to admiring (?) friends his new audio creation with 9 inputs, 20 different fixed equalization curves, a three-way speaker system with crossover, and an amplifier with four separate feedback loops develops a classic case of cold feet when anyone suggests he ought to know at least something about how his radio tuner works.

This preoccupation with one band of frequencies and horror of others is endemic throughout the electronics industry, including hobbyists. There are microwave men, r.f. men, and audio men, each of whom sticks to his own part of the spectrum and resists being contaminated with very much knowledge about the others. The fact is, however, that it pays to be broadbanded on the subject for the simple reason that each group must use some of the products of the others.

This insular attitude among audio hobbyists stems on the whole from the fact that for some reason it doesn't seem very difficult to understand how audio circuitry works, while r.f. receiver circuitry is too complicated to bother about. Since receiving circuits bring a great deal of audio enjoyment to sound enthusiasts, however, it is worthwhile to know something about them. R.f. is not any more complicated than audio and requires no different basic knowledge. In fact, audio engineers regularly point out that the audio band covers some ten octaves, while the entire broadcast band covers only one and a half, and that techniques differ appreciably in radar bands not more than two octaves apart. Furthermore, important as r.f. is, audio people will remind you that the r.f. exists only to transmit audio intelligence, and also soap operas and some TV programs. In this article we shall cover the subject as it applies to modern tuners so that the reader will know what goes on inside the box, how to take best operating advantage of available tuners, and how to use intelligence in selecting one for purchase. In beginning at the very start of the subject, we shall take the risk of temporarily boring readers who are more advanced technically. But we shall at least be able to say that we have covered the subject and that there will henceforth be no excuse for putting the tuner—one of the more useful pieces of audio-system equipment—into the "black box" category.

The basic idea of transmitting audio by radio is predicated on a simple premise. The nature of the universe just happens to be such that electrical audio-frequency waves will not ordinarily travel very far without being carried by wires, while waves of higher frequencies can be made to travel tremendous distances without wires. Just why this is so and the physical mechanism of space wave propogation we will not go into; the fact is that it works. All broadcast systems take these two factors into account by using radio-frequency waves (which cannot operate a loudspeaker) as vehicles or *carriers* on which the audio waves (which can) ride. At the destination—your home—the tuner intercepts the desired carrier from amongst many, strips away and discards the r.f., and extracts the audio "passenger" which it passes on to the amplifier.

In all r.f.-audio transmission, the audio is put into the r.f. wave by *modulation*. This means that the two waves are combined in such a way that the audio alters the character of the r.f. without making the r.f. unsuitable for wireless transmission. Modulation is really a mixing process in which waves of two different frequencies are mixed in a nonlinear stage. The lower-frequency wave produces changes in the character of the other and the mixing produces frequencies equal to the sum of the two and the difference between the two. This sort of mixing within an audio amplifier is intermodulation and it produces audio distortion; but in a radio transmitter it is desirable, as we have seen.

Amplitude Modulation

The earliest and still most common (in radio broadcasting) method of modulation is AM or amplitude modulation, shown graphically in *Fig.* 1. In (A) is an unmodulated carrier which is the sine-wave radio frequency—something between 550 and 1600 kc in the standard broadcast band. At (B) is shown a single cycle of audio which happens to be a complex wave such as might be produced by a musical instrument. (C) shows how the two are combined when the audio modulates the r.f. The r.f. carrier departs from its normal constant amplitude and changes amplitude from instant to instant in accordance with the audio. Depending on the polarity of connections at the modulator, a positive audio excursion causes an increase in r.f. amplitude and a negative one causes a diminution in r.f. The audio amplitude required for full or 100 per cent modulation is that which causes the r.f. amplitude to double on positive peaks and diminish to exactly zero on negative peaks.

File in your memory for use later that this process causes the r.f. to have an audio "envelope," the dotted outline shown across the tops and bottoms of the modulated r.f. in *Fig.* 1. These lines

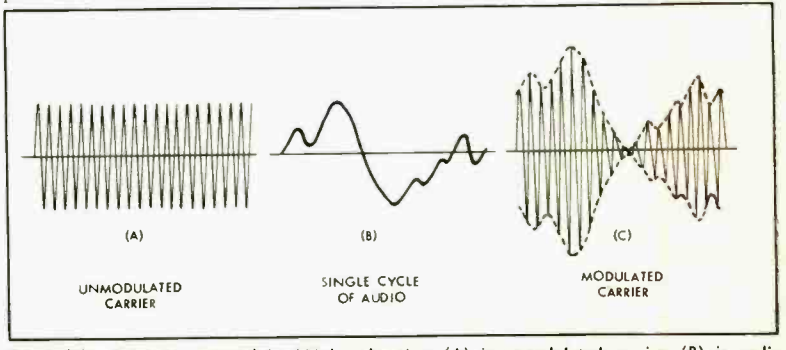

Fig. 1. Waveforms encountered in AM broadcasting. (A) is unmodulated carrier, (B) is audio signal as fed to modulator, and (C) is carrier modulated by the audio signal. Note that the top half is the mirror image of the bottom half, and that the envelope of the carrier corresponds to the audio signal.

are not actually present in an oscilloscope picture, but notice that they are two mirror images of the audio waveform.

The modulated r.f. is still r.f. and as such it can be transmitted without wires. However, after modulation the wave contains not only the single generated radio frequency, but also the results of the mixing—that is, frequencies which are the sum and the difference between the mixed audio and r.f. For instance, if the carrier is at 1,000 kc and the audio tone (assuming it to be a pure sine wave) is 1,000 cps or 1 kc, then the modulated r.f. wave contains three main frequencies. These are (1) the original carrier frequency of 1,000 kc, (2) the sum of the carrier and the r.f. which is 1,001 kc, and (3) the difference between the two which is 999 kc. The sum and difference frequencies are known as *sidebands* and in standard broadcasting every carrier is accompanied by sidebands on each side of center frequency equal at every instant to the audio modulation frequency.

It is obvious, therefore, that a broadcast station occupies not just a single frequency in the assigned spectrum but a band of frequencies equal to twice the maximum permitted modulation frequency. If, therefore, a station is on 1,000 kc and is permitted to use audio frequencies up to 10 kc, then it occupies a band of frequencies from 990 to 1010 kc. In allocating the spectrum among the various stations, the Federal Communications Commission decided many years ago that to accommodate all qualified applicants for licenses, the broadcast band had to be split up into segments no larger than 10 kc each. This indicates that AM stations must restrict audio modulation to 5,000 cps if the sidebands are not to spill over into an adjacent channel. In practice, however, most stations broadcast overtones in music up to about 8,000 cps, and many well above that. This is possible because sideband energy above around 4,000 cps on each side of carrier is usually relatively small since it represents overtones rather than fundamentals in music, and stations on directly adjacent channels are located far enough apart so that there is little interference. However, in some locations, adjacent-channel stations can be received and the receiver itself must then have a narrow reception band to eliminate the interfering sidebands. If sidebands of two stations are received, they cross-modulate each other in the receiver and produce what is called "monkey chatter," a phenomenon anyone with a shortwave receiver or a wide-band "hi-fi" AM tuner knows well.

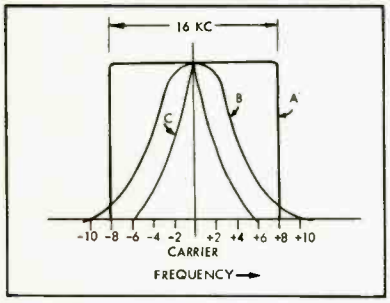

Fig. 2. Representation of selectivity curves in AM. (A) is ideal curve, with 16-kc bandwidth which would pass an 8000-cps audio signal without sideband cutting. (B) is curve typical of conventional radio receiver. (C) is sharp curve used in communications receivers when unmodulated signal is transmitted and received, with audio signal being introduced in receiver by beat frequency oscillator.

The sidebands are not mere incidentals with which we can do as we will. When an AM wave is modulated, a substantial portion of the radiated power is contained in the sidebands. If the receiver is so sharply selective as to fail to receive the sidebands, a proportionate amount of the audio will be lost. Stated another way, the band which the receiver will pass determines the audio frequencies which can be received. If the receiver can pass a band only 6 kc wide, then the maximum audio frequency received is only 3 kc, remembering that audio sidebands appear equally on each side of carrier. This brings up the important question of selectivity in AM tuners. To receive the maximum audio range transmitted, the receiver must be rather unselective and should pass frequencies at least, say, 8 kc each side of carrier equally well. However, to eliminate adjacent-channel interference bandwidth should be considerably smaller than that. Reduced bandwidth also helps reduce noise, since in any communication system noise is proportional to bandwidth.

Figure 2 shows three possible receiver bandpasses. Curve A shows an ideal situation in which the tuner can receive frequencies from 8 kc below to 8 kc above the carrier equally well—the characteristic is flat—and receives nothing outside than 16-kc band. Such a flat-topped curve is hard to attain, especially since a tuner must be tunable over the entire broadcast band and such things as coil Q in each tuned circuit vary. A curve more usual in cheap receivers is shown at (B) in *Fig.* 2. Such a curve is normally obtained with tuned circuits of moderate Q without any special provisions. Since the curve bends downward as the sideband frequency increases, audio highs are rolled off rather steeply. Curve (C) shows response of a receiver that might be used for c.w. or code reception, where there is no modulation and thus no sidebands, and the object is to eliminate surrounding interfering signals as much as possible. Such a response is almost useless for audio reception.

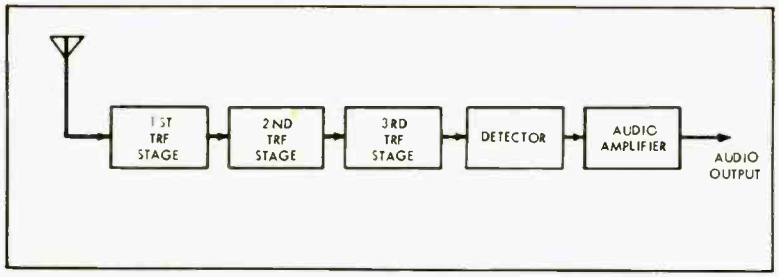

Fig. 3. Block schematic of tuned-radio-frequency receiver.

AM Tuners

There are two general types of AM receivers and tuners. The earliest is the tuned-radio-frequency circuit or t.r.f. This is the simple, straightforward approach illustrated in block form by *Fig.* 3. The antenna feeds signal to one to more cascaded amplifier stages, each of which is tuned to the station frequency. This means that the stages are transformer-coupled with (usually) air-core coils, either the primaries or secondaries of which, and sometimes both, are used as the inductors of tuned circuits and have a variable capacitors across them. All the variable capacitors are ganged on a single shaft so that the tuning knob tunes all circuits simultaneously to select the station. The last t.r.f. stage is followed by a detector and audio amplifier stages if any.

The second and more common tuner type is the superheterodyne, block-diagrammed in *Fig.* 4. The signal from the antenna is fed either to a tuned-radio-frequency amplifier stage if there is one or directly to the mixer through at least one circuit tuned to the r.f. carrier fre-

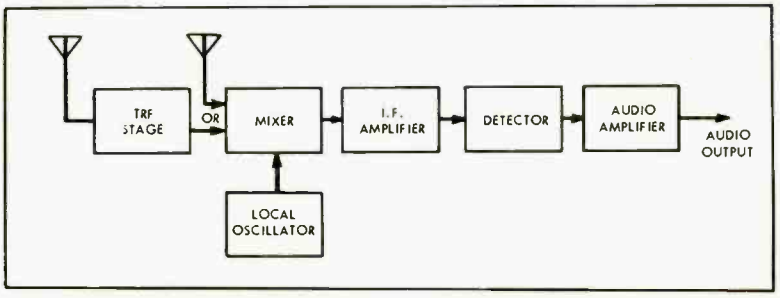

Fig. 4. Typical block schematic for superheterodyne receiver.

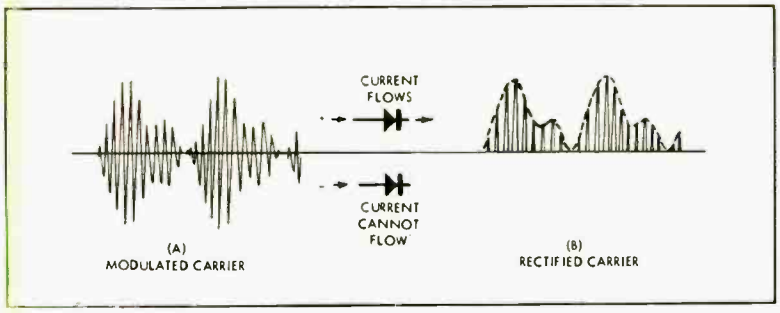

Fig. 5. Representation of action of diode detector. Modulated carrier (A) is fed to diode, and only the positive excursions of the voltage can pass through. Remaining portion of signal, (B), is passed through a filter to remove carrier frequency, leaving only the audio as shown by the dotted line.

quency. To the mixer also goes signal from a local oscillator. In the mixer stage, which is usually a multigrid tube, the r.f. and oscillator signals are mixed nonlinearly and sum and difference beat frequencies are produced. The difference frequency is passed on via tuned circuits to the i.f. stages.

At least two circuits are gang-tuned to select the station. One of these is tuned to the signal frequency and is between antenna and detector. The second tunes the oscillator so that no matter what the station frequency, the same difference or beat frequency is produced at the mixer output. For example, suppose the difference frequency selected is 455 kc. Then the ganging of tuning capacitors is so arranged that when the r.f. tuning is at 600 kc, the oscillator is at 1055 kc; when the r.f. is tuned to 1200 kc, the oscillator is at 1655 kc; and so on. It is also possible to have the local oscillator operating below the r.f. frequencies, but the range of the oscillator in octaves is then too great to cover easily with one capacitor.

At all times, then, the mixer output is at a single frequency, 455 kc in our example. This is the *intermediate frequency* and it is amplified in a series of cascaded i.f. stages, detected, and the audio amplified.

There are advantages and disadvantages to each of the two types. The reason for the existence of the superheterodyne and its almost universal use despite its apparently (but not actually) greater complication is that it is easier to design an amplifier for one frequency than for a whole range of frequencies such as are used in broadcasting. The i.f. amplifier, which does almost the entire amplification job, has fixed-tuned transformers, the response curves of which can be shaped as desired, an almost impossible job with variable-tuning transformers. At the lower intermediate frequency, more amplification may be realized per stage without oscillation, and the selectivity curve—always related to the signal frequency as a percentage—can be made sharper. For example, if a tuned circuit can be made to be 10 db down at 1 per cent off the signal frequency it will be down 10 db at 10 kc off a 1000-kc carrier, and down the same 10 db at 4.55 kc off the 455-kc i.f. signal. Equivalent selectivity and performance can be had at much less cost with a superheterodyne than with a t.r.f. tuner. As many stages as may be necessary can be used without the necessity for endless rows of variable capacitors on a single tuning shaft; only two capacitors need be varied in tuning, though the better tuners usually add an extra one together with an r.f. stage. In addition, the frequency handled in the i.f. amplifier is lower than the r.f., and it is axiomatic that handling lower frequencies is always easier than handling higher ones.

The t.r.f. tuner is traditionally the one with the wider band, though the uniformity of response depends on design. For one thing, variable-tuning transformers are not as selective as fixed ones in practice. For another, there are fewer tuned circuits in a t.r.f. receiver, but since all operate at the same frequency, the tracking problem is reduced. All of the tuned circuits can be identical in a t.r.f. receiver, whereas in the superhet, the r.f. and oscillator circuits are different and must remain tuned to frequencies exactly 455 kc apart as the dial is turned. This requires circuit design which provides for padding—to make the circuits match at the low-frequency end of the band—and for trimming, which makes them match at the high-frequency end. Even so, they do not tune to the theoretically correct agreement points at more than three places in the band, though in a good design the error is negligible in effect. The t.r.f. tuner is not ideal, however, when there is interference because it can rarely be narrow-banded sufficiently to reduce interference effectively. It is also a poor performer where signals are weak, since it is not practically capable of the amplification of a superhet.

AM Detectors

After r.f. or i.f. amplification of the modulated r.f. signal, the audio must be recovered and the r.f. stripped away. The stage which does this is the *detector*. Some old-timers refer to the mixer stage as the first detector, and the demodulator as the second detector. Modern practice, however, is to call the superheterodyne mixer just that (or the converter) and refer only to the demodulator as a detector.

The action of the detector is shown by *Fig.* 5. At (A) appears the modulated r.f. coming from the r.f. or i.f. amplifier. Note the envelope which outlines two mirror-images of the audio wave. It might be supposed that this wave could be applied directly to an audio amplifier stage, on the theory that the envelope amplitudes would produce stronger and weaker instantaneous signals at the audio rate. The fallacy here is the mirror-image repetitions of the audio outline. The period of the r.f. waves is so short that as far as the ear is concerned they do not exist, and what does exist is the envelope only. If that is so, then a positive excursion of the envelope is accompanied by an identical negative excursion, so that the average value of the two mirror-image audio outlines is always zero.

The cancellation effect of one of the mirror images is removed simply by rectifying the modulated r.f. as in *Fig.* 5 (B). The rectifier used is a half-wave type and the portion of the r.f. signal below the a.c. baseline is simply thrown away after rectification (unless it is used for a.g.c.). We are left in (B) with r.f. having only an upper outline of audio. This can be applied directly to an audio amplifier. As a matter of practice, a low-pass filter is always inserted to suppress the r.f. pulsations, leaving only the recovered audio as in (C).

Several types of detectors exist. The simplest of all is the diode detector diagrammed basically in *Fig.* 6. R.f. from the last i.f. transformer or an r.f. stage is rectified by the diode, and appears across the diode load resister (R), which usually has a high value to develop as large a signal as possible. Capacitor C bypasses the load resistor for the r.f. pulsations so that the audio emerges clean. An additional series resistor and shunt capacitor may be used for further filtering.

The diode detector is simple and cheap but it has some disadvantages for high-fidelity use. The first is that is gives linear results only on large signals, and the distortion increases with the percentage of modulation. This is because the curve of applied voltage versus conduction in a diode is nonlinear for weak voltages. If the voltage is high enough and the modulation percentage low, the envelope variations will all take place in a fairly linear region; but if the signal is weak or the modulation percentage high enough so that negative peaks extend into the diode's nonlinear region, distortion can be quite high. Under nor-

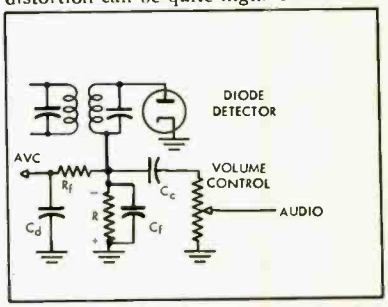

Fig. 6. Typical diode detector circuit. Rectified carrier passes through diode and develops audio signal across resistor R. Filter R_f and C_d filter out audio and leave only a d.c. voltage which is negative with respect to ground and which may be used for a.v.c. Audio signal is passed through C_c to volume control.

mal conditions, a diode detector can cause over 10 per cent harmonic distortion at full modulation, even in a good design. Modern circuitry has ways of improving this situation, however. One of the causes of distortion at high percentages of modulation is the presence of the capacitor C_f and the volume control which are in parallel across the diode load resistor R, as well as the decoupling resistor R_f and the decoupling capacitor C_a in the a.g.c. circuit. For minimum distortion at high percentages of modulation, the a.c. impedance of the diode load—which consists of the resistor R, the capacitor C_f and any other impedances shunted across it—should be as close as possible to the d.c. resistance of the diode load. In most practical applications, R is likely to be of the order of 0.25 to 0.5 megohm, whereas the volume control may be as low as, say, 0.5 megohm. Neglecting the impedance of the coupling capacitor C_c—at the signal frequency, not audio—this results in an a.c. impedance across the diode load which can range from 0.66 to 0.5 times the d.c. impedance. The value of the diode load resistance R may be reduced to 50,000 ohms, which will offset the effect of the shunting resistors to a large extent, but this is not a complete cure.

A detector which gives very good-quality sound is the infinite-impedance circuit diagrammed in simple form in *Fig. 7*. This has been most often used in past years (particularly before the high-fidelity era) in t.r.f. receivers, simply because these were the receivers most people built when they wanted quality. The detector resembles a cathode follower. The cathode resistor has such a high value that the tube operates close to cutoff. The negative r.f. input excursions simply drive the tube to cutoff and cause little output; the positive excursions drive the tube toward conduction and therefore appear across the cathode resistor with large amplitude. C_1 has a value which bypasses r.f. while not affecting audio. Therefore, the cathode-to-ground voltage assumes a value which is proportional to the r.f. envelope but cannot change fast enough to follow individual r.f. cycles. That being so, the cathode voltage is the recovered audio from the positive modulated-wave envelope outline, and it is passed on to the audio section via blocking capacitor C_2.

While this detector does not amplify the signal as some other types do, it gives linear results over wide ranges of signal inputs and modulation percentages, and does not load down the previous r.f. or i.f. stage. The reason for both these quality factors is its cathode-follower identity. Input of a cathode follower is always high in impedance because of the degeneration or feedback. For the same reason, linearity is aided. And to accommodate wide signal amplitude ranges, the cathode resistor sets the tube's bias always in accordance with requirements of the signal.

All AM tuners have some form of what used to be called automatic volume control (a.v.c.) but is now more properly called automatic gain control

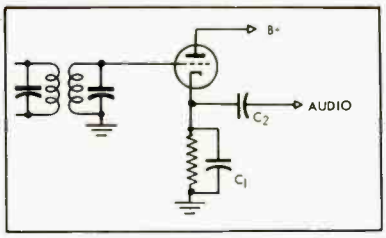

Fig. 7. Typical infinite impedance detector for high audio quality. Signal is developed across resistor in cathode circuit of tube, but polarity of d.c. is not correct for a.v.c. uses, and voltage for a.v.c. must be obtained by some other means.

(a.g.c.). The necessity for this provision is great because the signal strength of an AM broadcast station determines how loud the program will sound compared to that of another station and signal strengths vary widely. Without a.g.c. the user would tune away from a comparatively weak station and run across a powerful station which would blast his ears off. A.g.c. is so easy to obtain that there is little point in not having it.

The basic concept of a.g.c. is very simple. The signal from the r.f. or i.f. amplifiers is rectified and filtered, developing a d.c. voltage which is always proportional to signal strength. This voltage, negative with respect to ground, is applied to the grids of the i.f. amplifier tubes. When the signal strength rises, therefore, more negative bias is applied to the amplifiers and the gain is reduced. A.g.c. voltage is obtained in many different ways from circuits similar to that used for the diode detector.

Frequency Modulation

In his continuing search for a method of transmission that would eliminate, or at least minimize the effect of noise—either from atmospheric causes or from man-made sources—the late Edwin H. Armstrong developed frequency modulation. Since the effect of the noise-producing devices is to add to or subtract from the amplitude of the radio signal, any means that employs a variation of amplitude in accordance with the desired intelligence is susceptible of modulation by the unwanted noises, since it is not practical for the detector to discriminate between noise and program when both are of the same general pattern. Therefore, if some means could

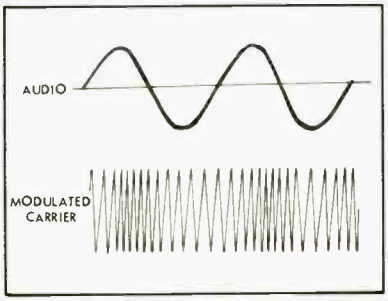

Fig. 8. Representation of FM modulation. Frequency of carrier is varied at an audio rate by the modulating signal.

be found which could be modulated with the program at will but which was not affected by static—man-made or natural—the result would be a transmission means completely free from disturbances. While this is not 100 per cent true in practical systems, there is a definite improvement in the system that was developed.

With the frequency modulation system of transmission, the modulating intelligence is applied to the signal in such a fashion as to vary the frequency of the carrier without changing its amplitude. The frequency of the modulating signal governs the rate at which the carrier frequency is varied, and the amplitude of the modulating signal governs the amount of deviation from the center frequency. Thus a very low level of modulation may cause the carrier to deviate only a kilocycle or so from its center frequency, and a very high level of modulation may cause the carrier frequency to deviate as much as ±75 kc from the nominal or center frequency. This being the case, it becomes necessary only to utilize some "detector" which is frequency sensitive, and thus translates the *rate* at which the frequency is varied into an audio signal whose *amplitude* is proportional to the amount the frequency is varied. In other words, the "detector" must translate frequency modulation into amplitude, and it must be insensitive to amplitude modulation that may happen to appear on the carrier.

Figure 8 shows a representation of the modulated carrier signal when the modulating voltage is a sine wave. For 100 per cent modulation, the deviation of the carrier above and below the nominal or center frequency is 75 kc, according to FCC regulations, in the FM band. Frequency modulation is also used for the aural signal on TV transmissions, and here the deviation is ±25 kc.

While the FM *carrier* is subject to the same disturbances from static as an AM carrier, the difference between the two occurs in the receiver. In the AM receiver, it is not practicable to differentiate between the desired modulation and the undesired modulation or noise, since they are both of the same type. In the FM receiver, it is possible to remove practically all of the amplitude modulation from the signal before it is fed to the "detector" and the detector itself then converts frequency modulation to amplitude modulation which it can convert readily into the desired audio signal. Furthermore, there are certain kinds of detector circuits which are practically insensitive to amplitude modulation, but react only to frequency changes.

The discussion of frequency modulation could be expanded to occupy several volumes, if one is to consider the many aspects of the modulating process, the formation of sidebands, the comparative freedom from noise, and so on. But for our purposes, let us content ourselves with the knowledge that there are some very important advantages to FM. The most important is that of noise reduction, of course, and it can be shown

THE 311 FM TUNER

New tuner makes FM reception better than ever before possible

Here are the reasons why the new 311 FM Tuner far outperforms tuners of conventional design

The 311 uses the new *wide-band* circuits that audio experts have called "the most significant development in tuner design in many years." Now, for the first time, you can easily separate stations so close together on the dial that ordinary tuners would pass right over them. Distant stations, that you wouldn't even know were there, come in as clearly as locals. Stations never drift out of tune, and both strong *and* weak signals tune with equal ease. This outstanding performance is made possible both by the wide-band circuits and the very high sensitivity of the 311 (3 microvolts sensitivity for 20 db of quieting).

High-speed tuning, that locates stations quickly, *plus* slow speed tuning for precise station settings, is provided by a smooth planetary drive mechanism. The edge-lighted lucite tuning dial has both frequency and logging scales. For visual tuning on weak signals, and for indicating best antenna orientation, the tuner is equipped with a signal strength meter.

Stations never fade in and out, because automatic gain control — another special feature — always keeps the tuner adjusted for perfect reception no matter how the signal may vary.

Dual output jacks permit simultaneous operation of your amplifier and a tape recorder for program recording "off the air." A beautiful accessory case, finished in durable, leather-grained plastic, is available to enclose the tuner for use on a table or shelf.

A completely new chassis design makes custom installation or panel mounting easier than ever before. All you need to do is make a simple cutout in the panel, and slide the entire tuner in from the front. No disassembly of any kind is required.

Type 311 FM tuner in custom installation

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TECHNICAL SPECIFICATIONS

Sensitivity: 3 microvolts on 300-ohm input for 20 db of quieting
Wide-band Circuitry: 150 kc IF passband, 2 megacycle detector band-width
Spurious-response rejection: 80 db rejection of spurious response from cross-modulation by strong local signals
Audio output: 4 volt output for 75 kc deviation. Two output jacks including one for tape recording. Low impedance output so long connecting cables may be used
Meter: Calibrated meter functions as tuning and signal strength indicator
Controls: Precision and quick tuning; level; power
Price: 311-A $99.95 East Coast $104.95 West Coast
Accessory case $9.95 East Coast $10.45 West Coast

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For perfectionists and connoisseurs H. H. Scott also manufactures the 310 FM tuner. High Fidelity Magazine says: The 310 " . . . is a tuner that seems as close to perfection as is practical at this time." The Audio League Report says: "The 310 is the most sensitive tuner we have yet tested . . ." Price, including case $149.95 East Coast; $157.45 West Coast.

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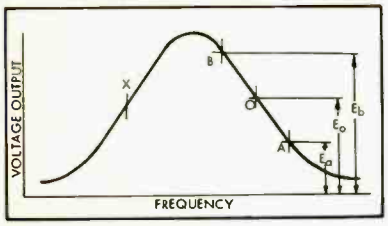

Fig. 9. When FM carrier is tuned to slope of resonance curve, output potential varies as frequency does. Slope is not linear over wide enough range for good FM quality.

mathematically that there is an improvement of 18.75 db before pre-emphasis, and when the added advantage of pre-emphasis is taken into account the total improvement is some 32 db. Another advantage is the possibility of transmitting a wider band of modulating frequencies within the allowable frequency band. Whereas an AM receiver capable of receiving an audio signal of 10,000 cps is readily possible, it is likely to be noisy unless the receiver is located in an area of high signal strength. On the other hand, an FM receiver can receive an audio signal of 15,000 cps with little or no noise, and frequencies as high as 40,000 cps are commonly transmitted for control purposes along with the audible signal. In fact, the proposed multiplexing of FM signals involves the transmission of one audio signal extending up to 15,000 cps and another of the same width on a sub-carrier operating in the range from 20 to 40 kc. Thus two signals can be transmitted on one FM carrier with no interferences. Some receivers are already equipped with output connections which may be connected to multiplex equipment when and if it becomes available.

FM Receivers

The block schematic of an FM receiver is basically similar to that of an AM superheterodyne, in that equivalent sections will be found. However, most FM receivers employ one or more limiters, which are used to remove the amplitude modulation from the signal before it is fed to the "detector" and the detector itself is different in operation. However, there is an r.f. stage, a mixer, a local oscillator, an i.f. amplifier, and the detector—which in the FM receiver is called *discriminator* or *radio detector*, depending on the circuit configuration. With the discriminator, a limiter will always be found, consisting of one or more stages.

Although the basic arrangement is the same in both AM and FM receivers, the physical components differ materially because of the difference in the frequency ranges in which the two types of receivers work. The AM broadcast tuner operates in the band between 550 and 1600 kilocycles, while the FM tuner operates between 88 and 108 *megacycles*. Thus the coils and capacitors in the FM receiver are considerably smaller (electrically) and greater care must be taken to avoid stray capacitances, unwanted oscillation, and frequency instability. Actually it is a fine tribute to manufacturers' engineers that FM sets operating in the vicinity of 100 megacycles have been developed to the point where they can be turned on and satisfactory reception follows automatically. Many of can remember when AM reception in the vicinity of 18 megacycles was unreliable and difficult to handle, even with the better grade of equipment.

The principal differences in the circuit arrangement of an FM tuner hinge on the detector circuit, and the functioning of this circuit varies considerably with different types of FM tuners.

All, however, must be able to convert a variation of frequency at an audio rate into a variation of amplitude at an audio rate, the latter being the description of an audio signal, in effect. There are several different types of circuits which will do this, the simplest being shown in *Fig.* 9. In this case, the frequency-modulated carrier is tuned to the side of a resonant circuit to the point O: as the frequency varies, the signal slides up and down the curve, as from O to A, then back to B, and then back to O again. With no modulation, the frequency is at O, and the output is represented by E_o; at a higher frequency, the output is E_a, and at a lower frequency the output is E_b. While this is simplified somewhat, it is adequate for an understanding of the action of an FM detector. We now have a carrier which varies in frequency passing through a circuit which acts upon it to make it vary in amplitude in proportion to the frequency variation. If we now detect the signal in the usual way by eliminating one half of the signal just as we do in an AM tuner, and then filter out the r.f. component, we have an audio signal, which is what we wanted. This type of circuit works—and is actually employed in the cheapest of FM receivers—but it has the disadvantage of having two points at which the signal could be tuned in, O which we have discussed, and X on the other side of the slope. Furthermore, it is difficult to design such a circuit to have sufficiently low distortion to take advantage of the high quality of FM transmissions.

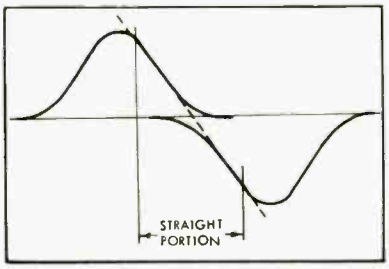

Fig. 10. By combining curves of two circuits in reversed polarity, straight portion of curve can be made much longer.

The most commonly used circuit for converting the frequency modulated signal to an amplitude modulated signal is known as a discriminator. Reduced to its simplest form, it consists of two circuits similar to the one of *Fig.* 9 placed back to back and tuned to slightly different frequencies, as in *Fig.* 10. In this arrangement, the curvature at the toe of the upper curve can be counteracted by the curvature of the toe of the lower curve, resulting in a longer straight line over which the signal varies and greater linearity throughout. The operation of this circuit is considerably more complicated than this simplified description, but the basic idea is similar. In either of these arrangements, the output is also dependent on the amplitude of the signal fed in, and some means must be employed to eliminate unwanted amplitude modulation of the signal by noise. This is usually done by *limiters*, which are—in most instances—tubes which operate over a portion of their characteristic where any increase in input signal does not result in an increase in output. These stages are then operated in the saturated condition with all normal signals so that regardless of the amount of input signal, the output remains constant in amplitude, although the frequency still varies in the output as in the input. When such a signal is fed to the discriminator, the audio output—having two "dimensions," frequency and amplitude—is of a frequency equal to the *rate* of frequency variation of the input signal and of an amplitude dependent upon the *amount* of frequency variation.

When used with two well designed limiters, the discriminator delivers a noise-free signal with very low distortion, provided the signal is tuned in accurately so that the center of the frequency band is accurately centered on the slope of the discriminator curve. Normal drift in the receiver will act to cause the signal to move away from the center, with the result that distortion may occur as the frequency swing reaches the peaks of the curve. However, this can be compensated readily by the use of automatic frequency control, which will hold the signal correctly tuned over an adequate range. The discriminator exhibits one characteristic which is considered a disadvantage, and that is the "three point tuning" which is sometimes confusing to a person not familiar with the use of an FM tuner. Referring to *Fig.* 11, f_o represents the correct tuning point, and the allowable frequency swing before distortion is observed is shown to extend over a fairly wide range. As the receiver is tuned, it will be noted that points f_1 and f_2 are also on the center

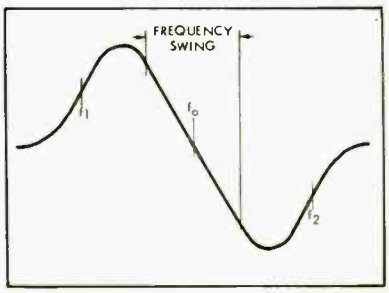

Fig. 11. Linear portion of curve is used for optimum quality; short linear portion at f_1 and f_2 will give distorted audio signal.

THE BRITISH INDUSTRIES

Sounding Board

***G. A. Briggs**

Comments upon his

Lecture Demonstrations

in Royal Festival Hall, London

LC: We have had considerable comment, Mr. Briggs, from those who read in a recent issue of "Audio" about the high fidelity demonstrations you gave at the Royal Festival Hall, London. Was this the first program of its kind, and what prompted you to undertake it?

GB: The demonstration you refer to, Mr. Carduner, was actually the second which I gave in the Royal Festival Hall, and followed several smaller ones on previous occasions held in Torquay, Studley, Ilkley, Bradford and Toronto. The object in these proceedings was not so much to reproduce music absolutely true to life, but rather to demonstrate what can be done today with the sort of high fidelity equipment which is available to the general public, and to provide an opportunity of listening to records under conditions which are free from room effect.

LC: Do you mean that the demonstration was possible with equipment of the type that is available to the public in any good high fidelity store . . . or was all or portions of it specially built?

GB: The equipment used is all readily available to the general public, and could be obtained in any shop stocking good quality equipment. It consisted of a high quality amplifier, a good pickup, a first class turntable and motor and four of our own 3 and 4 speaker systems, 2 of them lined with tiles to counteract problems found in the Festival Hall, but not in living rooms. None of the equipment used was specially made, and even the records played were readily available through any record stockist in the country.

LC: Is it correct to assume that the amplifiers used were of just normal power?

GB: We were using 4 amplifiers with 15 ohm outputs in parallel. Incidentally, the power fed into the speakers was very much lower than many people expected. For instance, playing a recording of a Mozart piano

(continued)

concerto at full domestic volume, the 2 watt indicator just flashed on the loudest passages. Most of the time the level was below 1 watt.

LC: I think it would be interesting to our readers, if you would tell us a bit about the audience and their reactions.

GB: We had a most enthusiastic audience, and a full house. The people who came to the first demonstration were perhaps a little different than the second, with probably half of the audience made up of those with some technical knowledge . . . such as people from factories and shops. The balance of the audience were just followers of hi-fi. The second demonstration was held on a Saturday afternoon when most shops are still open, so that many of the technical people were unable to attend, and probably 80% of the audience were non-technical and interested, basically, in high fidelity and music.

LC: I understand that in the demonstrations, phonograph records were used, and live musicians, as well. How were these programmed?

GB: The records were in the main classical pieces, all of which can usually be found in the average record player's library. The live performers were chosen to display the range and capabilities of their instruments. They consisted of an organist, a pianist, a harpsichordist and a choir of some 45 to 50 voices. These were all pre-recorded and were played back to enable the audience to compare the live and the recorded sound.

LC: Mr. Briggs, I should think that a similar demonstration-lecture would be cordially received in America by our high fidelity enthusiasts. Do you have any plans in this direction, at present?

GB: As a matter of fact, during the last Audio Fair in New York City, I visited one or two of your concert halls with this in view. At the present time, I am exploring the possibilities of obtaining Carnegie Hall for this purpose.

LC: Good. It seems to me that one very logical time for such a program would be right before our New York Audio Fair. Do you think that your planning might be complete soon enough for this.

GB: I quite agree that giving a lecture demonstration at that time would be most favorable, but I am not sure whether it can be arranged. However, I am trying to accomplish it, with a view toward scheduling the event on Sunday, October 9th.

LC: Well, Mr. Briggs, I do hope that your plans will mature, for I think it would be a golden opportunity to demonstrate, in a most interesting manner, what good results can be obtained from quality high fidelity components that are available now through the sound dealers.

**An interview between Gilbert A. Briggs, Managing Director of Wharfedale Wireless Works Ltd., Idle, Bradford, Yorkshire, England; and Leonard Carduner, President of British Industries Corporation, New York. BIC is an American company which offers you Britain's finest audio equipment . . . fully guaranteed, with service and spare parts available throughout the U. S.*

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of a straight-line portion of the curve. This will result in an audible output signal, but the straight-line portions of these two sides of the curve are much shorter, and distortion will be observed on signals with medium to high levels of modulation. Since the d.c. output of the discriminator can be measured—and after proper filtering it follows the curve of *Fig.* 11—it will be noted that there is only one point at which it is zero, and that is at f_o. Thus an indicator that will show when the d.c. voltage at the output of the discriminator is zero will also serve to show when the set is properly tuned in. However, assuming that another station should happen to be on a frequency which caused it to be tuned in at f_1 or f_2 when the desired signal was tuned in at f_o, then both would be heard, which would be undesirable.

In an effort to avoid this possibility, considerable design work has been done in the past few years, and the wide-band discriminator is the result. In this circuit, the slope of the discriminator circuit is made to extend over a very wide band—of the order of two megacycles—and the tuning of the receiver is dependent only on the pass band of the i.f. amplifier, which is usually designed to have a flat-top curve and to extend over a 200-kc band width. Since the deviation of the carrier is ±75 kc, the pass band must be at least 150 kc wide, and to allow for slight inaccuracies in tuning there should be some margin. Thus with the wide-band discriminator tuning of the signal depends only on the i.f. amplifier, and so long as the signal is centered in that pass band, there will be no distortion in the discriminator circuit.

Thus the selectivity of the i.f. amplifier is the controlling factor in tuning, and only one point will be found at which the signal is tuned in properly. This circuit demands a reasonably flat-topped i.f. amplifier, but it is much easier to tune in a station correctly and without distortion.

Ratio Detectors

Another circuit arrangement which is often used in tuners is the ratio detector, wherein the output is dependent on the *ratio* of the voltages developed in the detector circuit, rather than upon an absolute value. This circuit has two advantages—the first being that it does not require limiters and is thus less costly to manufacture, and the second is that between stations there is very little or no noise. Since the discriminator is amplitude sensitive, and becomes insensitive to noise only by virtue of operating the limiters at saturation with the presence of a signal, it follows that in the absence of a signal the limiters are acting as amplifiers, and all atmospheric noises are passed on to the discriminator. Therefore, FM tuners which employ discriminators often resort to the use of a squelch circuit to silence the audio portion of the set when no signal is present.

With the ratio detector, however, there is no output at all unless there is a signal because the detector is only

sensitive to the ratio of two voltages, both of which are a function of the carrier. Many of the better FM tuners employ a ratio detector and one or two limiters in addition to eliminate completely the possibility of any noise reaching the output. It is unfortunate that ratio detectors have been employed in the cheapest forms of FM sets, for in many instances they have not been well engineered and have not given satisfactory performance, and have thus gotten a poor reputation. This is not due to the circuit itself, but only the effort of the manufacturer to produce an FM set which could sell at a price. In well designed circuits, the ratio detector is easily the equal of the discriminator, and does offer some additional advantages.

Wide-band circuitry is also employed in some ratio detector arrangements for the same reasons, and with generally improved performance.

Knight "Bantam" tuner.

Pre-emphasis and De-emphasis

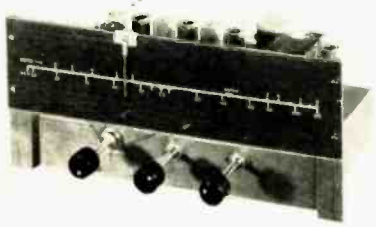
According to the standards set forth by the FCC for FM transmission, the audio signal being fed into the transmitter is to be altered from a flat characteristic to a curve which is described as having a pre-emphasis of 75 microseconds. Thus the high frequencies are boosted by a fixed amount—13.75 db at 10,000 cps, which corresponds to a turnover at 2120 cps (the point at which the curve is up 3 db above the flat level). This can be done without increasing distortion because there is relatively little sound energy in the usual audio signal above 1500 cps. But the principal advantage is that in order to secure a flat response from the receiver, it is necessary to introduce a de-emphasis of the same amount. Since noise is usually considered to consist of the higher frequencies—in fact, random noise is proportional to frequency—the rolloff in the receiver gives the same advantage to radio reception as it does in the reproduction of phonograph records. This accounts for the additional 14 db (approximately) of improvement in signal-to-noise ratio which which was mentioned as being due to pre-emphasis in the transmitter. This does require, however, that measurements of frequency response be made at some 10 to 15 db below 100 per cent modulation in order to avoid overloading the audio stages in the transmitter and overmodulation in the r.f. stages. All FM receivers have the de-emphasis built in, usually between the discriminator or ratio detector and the audio output stages of the tuner.

Audio Systems

Most tuners are provided with some form of audio output stage following the detectors of the AM section or the discriminator or ratio detector of the FM section. In most tuners there is a volume control, which may or may not be a panel control—being in some models a control on the rear apron to adjust the outputs of the two sections so that they are approximately equal. Hi-fi tuners generally employ a cathode follower for the output stage so that the impedance is comparatively low and is thus subject to a minimum of frequency discrimination due to capacitance of the output lead.

COMMERCIAL TUNERS

Up to this point, the discussion has been general, and has not been confined to those products of any particular manufacturer. The remainder of the section will be devoted to descriptions of the tuners that are currently on the market or to be introduced this Fall, with an attempt being made to point out the characteristics that are of special interest in the individual units. The writer is indebted to the various manufacturers for their co-operation in furnishing photographs, schematics, and operating instructions on all of this equipment, without which this section could not have been possible.



A.R.F. Model 400 tuner covering TV and FM channels in continuous range.

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. **BT-1**

Two AM-FM tuner models are offered: the Bantam, with a 7-tube circuit (plus rectifier), 5-microvolt sensitivity for 20 db quieting on FM and 20-volt sensitivity on AM for 1-volt output, automatic frequency control, and ferrite loop antenna for AM; and the Deluxe tuner, 11 tubes plus rectifier, 5 microvolt sensitivity for 30 db quieting on FM and 3.5 microvolt sensitivity for 1-volt output on AM, a.f.c., ferrite loop antenna, dual limiters and discriminator. Response on both models ±0.5 db 20 to 20,000 cps on FM; on AM, 20 to 5000 cps, ±3 db on the Deluxe model, ±4 db on the Bantam.

Also available is the new TV audio tuner, which plugs into the Deluxe AM-FM tuner and obtains operating voltages from it. Employs turret-type selector and fine tuning control and feeds i.f. section of AM-FM tuner to provide the sound signal from TV channels. Switch on AM-FM tuner controls operating voltages. Useful for feeding tape recorder when desired, or to permit use of high-quality audio system with conventional TV receiver for video presentation. Also available are amplifiers which match the two types of tuners in appearance and size.

A. R. F. Products, Inc., 7627 Lake St., River Forest, Ill. **BT-2**

Three models — basically in chassis form. Model 400 provides continuous tuning from 54 to 216 mc, and thus covers both low and high VHF TV bands in addition to the FM band. Sensitivity of 5 microvolts for 20 db quieting, cathode follower output. Employs "Inductuner" to cover the wide tuning range without switching. Model 500 similar in performance, but covers only the 88 to 108 mc FM band. Model 600 covers the FM band and the domestic broadcast band—550 to 1600 kc.

Bell Sound Systems, Inc., 555 Marion Road, Columbus 7, Ohio. **BT-3**

Neat and compact, the Bell 2255 AM-FM tuner is styled to match the 12-watt Model 2256 amplifier. Both are four inches high, nine and a half inches wide, and nine inches deep, and finished in satin gold and soft brown, with fully enclosed and amply ventilated housings. The tuner employs 8 tubes plus rectifier, and has a sensitivity of 4 microvolts for 20 db quieting on FM and a sensitivity of 26 microvolts on AM, using the built-in loopstick. Frequency response on FM is 20 to 20,000 cps ±0.5 db; on AM 20 to 5000 cps ±3 db. No volume control is provided, but two output jacks are available so as to be adaptable for feeding an an audio system and a recorder at the same time. Employs r.f. stage on FM, two i.f. stages, limiter, and discriminator, plus audio stage and cathode fol-

Bell Model 2255.

lower for output circuit. One i.f. stage used on AM. A.f.c. on FM may be cut out when desired.

While both tuner and amplifier are designed to be usable in their cabinets, both may be removed for panel mounting. Volume and tone controls, phono preamp controls, and loudness control on amplifier unit.

David Bogen Co., Inc., 29 Ninth Ave., New York 14, N. Y. **BT-4**

The Bogen line—one of the largest available—consists of three basic tuners (without preamplifiers), two with built-in preamplifiers and control facilities, and two which have integral power amplifiers built in.

Model AM901-1 is intended for hi-fi installations where AM only is available but where above-average quality is required. This tuner uses five tubes including rectifier, yet has a tuned r.f. stage, linear diode detector, and a cathode follower output stage. Two positions of selectivity permit wide band reception when conditions permit, with a.f. response extending up to 7500 cps at only 3 db down, or the band may be narrowed so as to be down 3 db at 4000 cps. A filter is in circuit in the wide-band position to eliminate the 10,000-cps interchannel whistle. Sensitivity is 5 microvolts for 30 db signal-to-noise ratio for an output of 1 volt.

Model FM-400A is a basic FM tuner with 6 microvolt sensitivity (IRE measurement), r.f. stage, two i.f. stages and

Bogen Model R765.

limiter, and discriminator. Temperature compensated oscillator provides freedom from drift, and frequency response is 20 to 15,000 cps ± 1 db.

Model R640 is a combination AM and FM tuner with 5-microvolt sensitivity for 20 db quieting on FM and a 5-microvolt sensitivity on AM for 1-volt output. R.f. stages are employed on both sections, with two i.f. stages, limiter, and discriminator on FM and two i.f. stages and linear diode detector on AM. Spring return switch can be used to defeat a.f.c. when desired, permitting use to tune set accurately. As with most Bogen tuners, this model can be had in several different housings—gold cage, mahogany or blonde wood cabinet, or as chassis alone.

Model R765 is an AM-FM tuner with built-in preamplifier and control section. It has 3-microvolt sensitivity for 30 db quieting on FM and a 5-microvolt sensitivity on AM for a 30 db signal-to-noise ratio. In addition to excellent performance as a tuner, it contains all necessary control facilities for a home music system. One unique feature is the "Auto-Lock," a circuit which operates to cut out the a.f.c. action while you are tuning in the desired station. A second or so later, an indicator lamp on the panel lights up and the a.f.c. circuit is again functioning. Controls include volume and loudness contour, seven positions of record equalization, and Baxendall-type bass and treble controls. Available in chassis form, or in mahogany or blonde finish wood cabinets. Wide-band AM circuit provides response down only 3 db at 7500 cps when desired.

Brainard Model ITA.

Brainard Electronics, 8586 Santa Monica Blvd., Los Angeles 46, California. **BT-5**

Combined with either a 14- or a 25-watt amplifier on the same chassis, the Brainard AM-FM tuner has an FM sensitivity of 4 microvolts, and an AM sensitivity of 15. Frequency response is 20 to 20,000 cps on FM, 30 to 9000 cps on AM in broadband position. A.f.c. with provision for disabling, but drift reduced to minimum by temperature compensation. Amplifier has six-position compensator, preamp with 10 mv sensitivity, bass and treble controls, loudness control. Construction is on printed circuit panel, and three feedback loops are employed.

Unique feature is Acoustic Balance Control which offers six positions of compensation which is claimed to correct for any acoustic condition likely to be encountered in the home. User consults chart which indicates acoustic values of listening room and adds up various acoustic weights from which ABC Guide number may be determined, then sets ABC control to correct position for optimum quality in that particular room. Patents are applied for on this feature.

Browning Laboratories, Inc., 750 Main St., Winchester, Mass. **BT-6**

Most recently introduced Browning tuners include the L-300 and L-500, known as the "Brownie Twins." Both are of the same size, 9 in. wide, 4⅞ in. high, and 8 in. deep, and may be had as a chassis, or in small cabinets finished in either mahogany or blonde wood, or with a Telechron timer in either type of wood cabinet. The L-300 is an FM tuner, with sensitivity of 3.5 microvolts for 20 db quieting, by IRE measurements, temperature compensated oscillator, a.f.c., and a cathode-follower output. The L-500 is an AM tuner covering the domestic broadcast band and the international short wave band from 19 to 49 meters. Sensitivity is under 2 microvolts for a 1-volt output, and two band widths provide sharp response for short-wave use and broader response for better audio quality for domestic broadcast reception.

Browning Model RJ49-B.

Model RV-32 is a more elaborate FM tuner employing a cascode r.f. stage, two i.f. stages, and two limiters with a sensitivity of 2 microvolts for 20 db quieting. Temperature compensated oscillator and a.f.c. serve to maintain a high degree of stability.

Model RJ-43 uses the same FM circuitry, but has in addition an AM section which is completely independent except for the coupling of the two tuning capacitors. Model RJ-49 is electrically identical, but the two tuning capacitors are separately controlled by two tuning knobs and the two sections can be used at the same time, making it possible to receive stereophonic broadcasts transmitted over AM and FM channels simultaneously. All the last mentioned models are available in chassis form, or in wood cabinets with either mahogany or blonde finish.

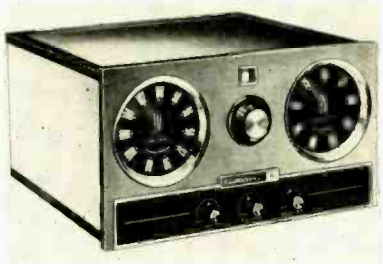
Collins Audio Products Co., Inc., Westfield, N. J. **BT-7**

One of the very few—if not the only—AM t.r.f. receiver on the market is the Collins, which is patterned after the old Western Electric 10A receiver that was famous twenty years ago for quality reception. This model employs three r.f. stages with two tuned circuits between the antenna and the first stage and two more between the first two stages. The tuned circuits are coupled with a "negative mutual" coil which gives a broadband tuning curve with steep sides for optimum AM quality. These stages are followed by an untuned r.f. amplifier stage and a diode detector, followed in turn by a volume control, an audio amplifier stage and a cathode follower. Such a circuit is capable of AM reception of the highest quality. The FM section employs a cascode r.f. stage, three i.f. amplifiers and two limiters, followed by a discriminator. The output of the FM section may be fed to the volume control and the audio section as desired by the user. This model is equipped with a large tuning meter, and is particularly suited for feeding a recording channel for superior quality. A push-button remote control unit is available for use with this tuner, if desired, and tuning, control of volume, and selection of AM or FM may be accomplished from your easy chair.

Collins DeLuxe tuner, with t.r.f. AM section.

Electro-Voice, Inc., Cecil & Carroll Sts., Buchanan, Michigan. **BT-8**

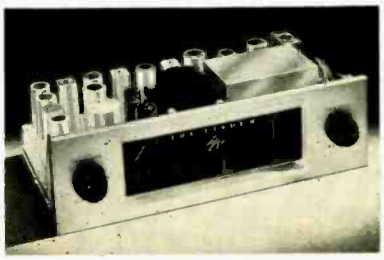
Two new tuners are being introduced this Fall by Electro-Voice—the 3304 Sonamuse dual tuner set, and the 3303 Dynamuse AM-FM tuner and music control center. The tuner sections are identical, and comprise an FM section with a sensitivity of 1.5 microvolts for 20 db quieting and a 200-kc bandwidth, continuously variable a.f.c., squelch circuit to eliminate noise between stations, cascode front end, and tuning indicator. The AM section has a sensitivity of 5 microvolts for 2 volts output, whistle filter and squelch circuit. Both sections are separately tuned, and dials are entirely separate, so that stereophonic programs may be received on AM and FM channels at the same time. Model 3303 has in addition, a complete preamplifier-control unit with provision for magnetic and ceramic-type pickups and several high-level inputs. Bass and treble tone controls are provided, as are volume and loudness controls, and a new presence control which has three positions to give near, medium, or flat characteristic. Presence control is designed to provide boost at approximately 5000 cps of up to 12 db in NEAR position. Response on AM is only 5 db down at 9000 cps with the whistle filter out of circuit, and flat to approximately 7000 cps and then an abrupt cutoff when the whistle filter is in circuit. Styling on these two models is modern and attractive, only difference being in the panel of controls along the bottom. Model 3303, having complete music center control facilities, has more knobs. Main tuning knob moves to left on toggle action to actuate FM tuning and to right to actuate AM tuning.



Electro-Voice Sonamuse, Model 4403.

Fisher Radio Corporation, 21-27 44th Drive, Long Island City 1, N. Y. **BT-9**

Fisher tuners have long enjoyed a good reputation—the Model 50-R for use with external preamp-equalizer, and the Model 70-RT with preamp-equalizer built in. Both of these models have a sensitivity of 1.5 microvolts for 20 db quieting, and both use cascode front end on FM, with two i.f. stages, two limiters, and discriminator, while the AM section employs an r.f. stage, two i.f. stages with adjustable band width, and detector. Response down 3 db at 7000 cps on wide-band AM. Cathode-follower



Fisher Model FM-80.

output permits long connecting cable to amplifier when necessary without deterioration of frequency response.

The 70-RT provides, in addition, bass and treble tone controls, loudness balance, four phono equalization positions, and channel selector. Hum and noise exceptionally low on both models.

The new model FM-80 employs similar circuitry in an FM-only tuner, and is provided with two meters for tuning indicators—one to indicate signal strength of received station, other to indicate exact center of discriminator curve. This model is compact, being only 4 in. high, 12¾ in. wide, and 7⅜ in. deep. Sensitivity control is provided on front panel, and level-set control on rear apron permits adjustment of audio output level.

Granco Products, Inc., 36-07 20th Ave., Long Island City 5, N. Y. **BT-10**

Designed to provide the advantages of FM reception where the cost of many of the more elaborate models might be a deterrent, the Granco line offers excellent value for the price. While both AM and FM receivers—including power amplifier and speaker—are available, the model of greatest interest to the audiofan is likely to be T-160, which employs coaxial tuning, offers a 180-kc linear response at the ratio detector, and 180-kc bandwidth at the flat top of the i.f. curve, 220-kc bandwidth at 3 db down, and 300-kc bandwidth at 6 db down. Circuit employs five tubes and selenium rectifier, and is designed to be plugged into the phono jack of an already-existing receiver while the phono pickup could be plugged into the FM tuner so that the phono switch on the receiver would serve switch between AM and FM, and when the FM tuner is in the off position the phono pickup is connected through. Sensitivity is 5 microvolts for 20 db quieting, and audio output is 2 volts maximum. Unit is cased in walnut plastic case with gold trim, and is 7 in. wide by 5 in. high by 4¾ in. deep.

Harman-Kardon, Inc., 520 Main St., Westbury, L. I., N. Y. **BT-11**

Three models of tuners are available, and two models combined with power amplifiers are available, each being particularly suited for certain types of installations. Model A-200 is the smallest model, and has a sensitivity of 3 microvolts for 20 db quieting on FM, and a sensitivity of 20 microvolts for 1-v. AM output. R.f. stage on FM is grounded-grid amplifier feeding conventional triode mixer, followed by two i.f. stages, limiter, and discriminator. A.f.c. is provided, and may be defeated by pressing in on tuning knob while selecting station. AM section consists of converter stage feeding one i.f. stage, followed by detector.

The Theme, Model A-310, is larger and employs cascode front end, two i.f. stages, two limiters, and discriminator, with a.f.c. AM section has tuned r.f. stage, and uses two i.f. stages. Sensitivity on FM, 1.2 microvolts for 20 db

quieting; on AM, 3 microvolts for 1-volt output. Cathode follower used for output, and illuminated tuning meter is employed to indicate proper tuning point.

The Counterpoint, Model A-400, uses a pentode r.f. stage and triode mixer, two i.f. stages and two limiters in an FM-only circuit. A.f.c. and tuning meter also used on this model, which has sensitivity of 2 microvolts for 20 db quieting, and cathode follower output.

The Recital, Model D-200, is similar to the A-200 plus the addition of a 12-watt Ultra-Linear power amplifier using 6L6GB's and offering loudness contour control, bass and treble tone controls, and six positions of phono equalization with the preamplifier. Tape recorder output on rear apron is fed from circuit ahead of tone controls.

Harman-Kardon Model A-310

Model D-1000, The Festival, employs an AM-FM tuner essentially similar to the A-400 combined with a 30-watt Ultra-Linear amplifier using 5881's. Other features are essentially the same as in the D-200, except for addition of tuning meter.

National Company, 61 Sherman St., Malden, Mass. **BT-12**

The new model of the Criterion tuner which has just been introduced continues most of the features of the original model, and offers some minor improvements. The wide-band discriminator is still used, and the squelch circuit functions to eliminate interstation noise on FM. The i.f. amplifier serves for both AM and FM, and is so arranged that both can be used at the same time for stereophonic reception or for any application requiring both AM and FM signals simultaneously. Such an arrangement is particularly convenient for the recording enthusiast, since it is thus possible to listen to one program while recording another.

The i.f. amplifier is exceptionally selective with steep sided curves, permitting reception of adjacent-channel FM stations without interference. Capture ratio—the ability of the circuit to hold onto one station without having a stronger one on an adjacent channel pull it away—is such as to reject signals with intensities up to 80 per cent of the desired signal. Unit is wired to permit use of a multiplex unit when such transmissions are available, and recorder feed is selected by panel-mounted switch. Circuit arrangement is such as to feed both AM and FM outputs through preamp-

National Criterion tuner

control unit which may be plugged into open in front panel. Separate level-set controls on tuner chassis permit adjustment of level to balance two channels for stereophonic reception, and then use of volume control on preamp will vary volume of both channels simultaneously. Flexibility of the Criterion tuner makes it particularly desirable for the user who is likely to demand variety of different services from his tuner.

Pedersen Electronics, P. O. Box 572, Lafayette, California. **BT-13**

Two tuner models are offered by this company, whose products are well known on the West Coast, though not so often seen in the East. Model AFM-2, the Paragon, offers sensitivity of 3 microvolts on FM for 30 db quieting, and of 3 microvolts on AM for 1-volt output. A.f.c. may be defeated when desired, and cathode follower output is employed. Multiplex output is available for use when necessary. Aluminum panel and chassis, together with special filament system and power transformer give better signal-to-noise ratio. AM response is flat to 7000 cps.

Pedersen Model AFM-2.

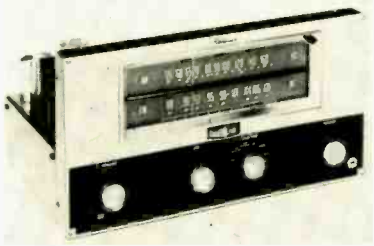
Model AFM-6 employs same tuner circuitry combined with preamp-control unit with input selector, four phono equalization curves, microphone input; bass, treble, loudness, and volume controls, and outputs for tape recorder and multiplexing. Both units are the same size—4 in. high, 14½ in. long, and 8 in. deep, and may be used in individual cabinets or mounted on panels in any desired cabinet.

Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y. **BT-14**

Comprising five models of tuners and one model combined with a 25-watt amplifier, this line is one of the most complete available. The smallest model is FM-607A, a compact FM-only tuner with a sensitivity of 3.5 microvolts for 20 db quieting, and employing a tuned r.f. stage, two i.f. stages and ratio detector, an amplifier stage and a cathode follower. A.f.c. is available, and is defeated by a switch on the front panel which selects phono input and the two positions of FM reception.

The second model in the Pilot line is model AF-724, an AM-FM tuner with sensitivity of 3.5 microvolts for 20 db of quieting on FM, and a sensitivity of 5 microvolts on AM. This model uses an r.f. stage common to both AM and FM, mixer, two i.f. stages on FM and one on AM, diode detector on AM and ratio detector on FM, followed by an amplifier stage and a cathode follower. Response on AM is down 6 db at 9000 cps. A.f.c. may be disabled when desired.

Model AF-825 utilizes a similar front end for both AM and FM, but the second FM i.f. stage is a transformer-coupled



Pilot Model AF-850.

limiter which provides considerable amplification, and it is followed by another limiter stage and a discriminator. In addition, this model is equipped with a preamplifier stage with five equalization curves, and with tone and volume controls. Separate cathode followers are provided to feed the audio line and the recorder line, the latter being connected ahead of the tone controls. Sensitivity is the same as for model AF-724.

Model AF-850 employs two i.f. stages on both AM and FM, with variable bandwidth for AM. These are followed on FM by two limiters and a discriminator, with an audio amplifier stage and a cathode follower after the volume control. A tuning meter is provided to aid in correct tuning, and a 10-kc filter eliminates interstation whistles on FM, and in broad position response is essentially flat to 9000 cps. Sensitivity on FM is 1.5 microvolts for 20 db quieting; on AM, 2 microvolts. Phono input is provided which is suitable for use with ceramic or crystal pickups; external preamp is required for magnetic pickups. Cathode-follower output furnishes maximum audio signal of 10 volts.

Model AF-860 is identical in the tuner section, but includes preamp with separate bass and treble equalization controls —five positions on each—volume control and separate bass and treble controls. Separate cathode followers feed audio line and recorder circuit, the latter ahead of the controls. Sensitive tuning meter indicates correct tuning point. Performance of AM and FM tuner section identical with AF-850. This tuner, in conjunction with a control-less power amplifier would serve as a complete control center for a home music system.

Radio Corporation of America, Engineering Products Division, Front & Cooper Sts., Camden 2, N. J. **BT-15**

Two tuners are available in the RCA Intermatched High Fidelity line—ST-2, as a basic tuner, and SVT-1 which is identical except for the addition of preamplifier and bass, treble, and volume controls. Four positions of phonograph equalization are provided in this model.

RCA Model SVT-1.

The tuner section of these models has a sensitivity on FM of 5 microvolts for 20 db quieting; on AM, 5 microvolts for 0.5-volt output. Separate r.f. amplifiers are used, and FM section employs two limiters and a discriminator. A single audio amplifier stage is provided, and a cathode follower feeds the signal out. A.f.c. is provided to prevent drift and simplify tuning.

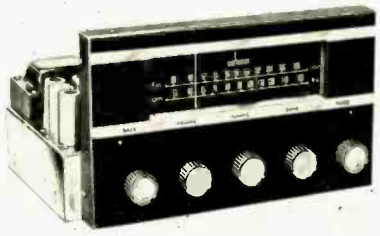
The Radio Craftsmen, Inc., 4401 N. Ravenswood Ave., Chicago 40, Ill. **BT-16**

The Craftsmen line, now sold direct to the user and therefore not to be found on distributors' shelves, consists of three AM-FM tuners and one FM model. The latter is model C900, and offers a sensitivity of 1 microvolt for 20 db quieting. It employs a cascode front end, three i.f. stages, two limiters, and discriminator, followed by an audio amplifier stage and a cathode follower. Features amplified a.f.c. which locks oscillator frequency more closely than possible without this circuit, it is claimed. Circuit operates at i.f. of 20.6 mc and has 250-kc bandwidth; most tuners operate at 10.7-mc intermediate frequency, but higher i.f. reduces possibility of spurious images.

Model C10 is an AM-FM tuner with fixed-turnover phono preamp, and bass and treble tone controls. Sensitivity on FM is 3.5 microvolts for 20 db quieting; on AM, 5 microvolts for 0.5 volts output signal. Circuit employs r.f. stage on both AM and FM, with a.f.c. two i.f. stages and two limiters and a discriminator on FM, and one i.f. stage and a diode detector on AM. Two audio stages are provided to furnish sufficient gain for tone controls and these are followed by cathode-follower output stage. Separate 12AX7 serves as phono preamp.

Model C810 is a basic tuner with FM sensitivity of 3 microvolts for 20 db quieting, and an AM sensitivity of 5 microvolts for 1-volt output. Employs two i.f. stages on AM, three on FM followed by two limiters and discriminator. Audio amplifier stage and cathode follower provide output signal. R.f. stage used on both AM and FM, with a.f.c. on latter.

Model C1000 is top set in the line, with cascode front end on FM, two i.f. stages and two limiters, followed by discriminator and amplified a.f.c. circuit as



Radio Craftsmen Model C10

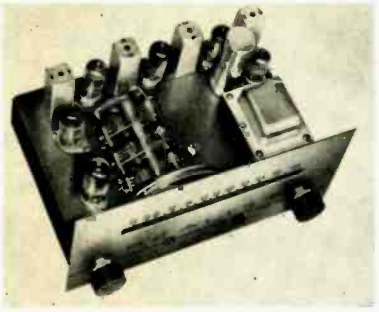
used in C900. Phono preamp has four equalization curves, and selector switch feeds cathode follower with output to recorder feed circuit and to second cathode follower which drives tone-control circuit. Third cathode follower feeds audio signal out. Sensitivity on FM is 1 microvolt for 20 db quieting; on AM, 1 microvolt for 10 db signal-to-noise ratio. With complete controls and phono preamp, this unit serves as control center for entire system.

Radio Engineering Laboratories, Inc., 36-40 37th St., Long Island City 1, N. Y. **BT-17**

Deluxe model, the "Precedent," which has sensitivity of better than 1 microvolt for 20 db quieting; specification claims sensitivity of 2 microvolts for 40 db signal-to-noise ratio. Two outputs are provided—one for high impedance with 2-volt output, and one for 600-ohm line with 0.2-volt output. Two meters are used, one to show signal strength and one for tuning to center of discriminator band.

REL "Precedent."

Circuit uses 15 tubes plus 10 germanium diodes, and utilizes cascode front end, slug tuning of coils with dual-tuned antenna and r.f. coils, five i.f. amplifier stages, three pre-limiters, two limiters, germanium diode discriminator rectifiers, two audio amplifier stages, and cathode-follower output. "Thermocube" design, which provides for air flow up through large flue through center of set, reduces drift due to thermal changes to an absolute minimum. No a.f.c. is provided, but stability is more than adequate without it.



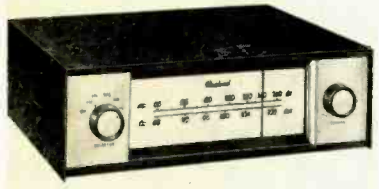
Radio Shack "Realist" FM tuner.

Radio Shack Corporation, 167 Washington St., Boston 8, Mass. **BT-18**

Two small and compact tuners are available in this line, one for AM and one for FM. Both are of the same size, and are available in wooden cabinets or as chassis for installation as desired. The AM tuner has a sensitivity of 5 microvolts, and employs an r.f. stage, mixer, one i.f. stage, and a diode detector. The FM model has a sensitivity of 3.5 microvolts for 20 db quieting, utilizes a tuned r.f. stage, two i.f. stages, limiter, and discriminator, with a.f.c. being applied to the oscillator. Compactness of these two models would permit installation where most models would not fit.

Rauland-Borg Corporation, 3515 W. Addison St., Chicago 18, Ill. **BT-19**

The HF-155 "Golden Gate" tuner is an AM-FM unit with sensitivity of 3.5 microvolts for 20 db quieting on FM, and a sensitivity of 5 microvolts on AM for 1.5-volt output. Separate r.f. amplifier and mixers are employed in this model, with one i.f. stage common to both



Rauland-Borg Model HF-155.

AM and FM, a second i.f. stage and two limiters are used on FM. Cathode-follower output is provided, and a.f.c. may be used or not, as desired. Particularly interesting feature is provision for plugging in an external TV front end to feed i.f. amplifier with FM signal from sound carrier of VHF TV channels. This permits use of hi-fi system to reproduce good quality sound with picture from conventional TV set. Tuner is 4 in. high, 10 in. deep, and 13½ in. wide, with perforated metal cabinet finished in marbleized charcoal black with brushed brass control escutcheon. A.f.c. is particularly effective on this model, and drift is sufficiently negligible that set can be left on a chosen station for hours without retuning, and after cooling off overnight, the same station reappears when the set is turned on.

The Sargent-Rayment Co., 1401 Middle Harbor Road, Oakland 20, Calif. **BT-20**

Two AM-FM tuners comprise this line, being somewhat similar in design but differing in physical arrangement and in the tone control section.

Model SR-707 employs a grounded-grid booster stage on FM, followed by a tuned r.f. stage which serves for both AM and FM. Two stages of i.f. are used on FM, followed by a ratio detector, while one of the i.f. stages serves for AM, and feeds a low-distortion AM detector. Phono preamp offers three equalization curves, and tone and volume controls are used. Sensitivity on both models for FM is 3 microvolts for 20 db quieting; on AM, 5 microvolts.

Model SR-808 is electrically similar, but AM and FM sections are completely

Sargent Rayment Model SR-808.

independent of each other. Two i.f. stages and two limiters are used in the FM section, followed by a discriminator; AM section employs another version of low-distortion detector, with resulting high audio quality on AM. Three equalization curves are provided for the preamplifier, and the tone flexibility is remarkable. In addition to normal bass and treble tone controls, there are four positions of low-pass filter action and there is also a 50-cps high-pass filter. Furthermore, the bass tone control has two positions of inflection—250 and 350 cps. The 250-cps turnover point is preferable for voice when some low-frequency boost is considered desirable but the shape of the curve should not introduce a boost in the "chesty" region. For music the 350-cps turnover is most desirable.

Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass. **BT-21**

The Scott Model 310-A FM tuner has been on the market for over a year, and no changes have been required, which speaks well for the original design. The circuit consists of a cascode front end, pentode mixer, three i.f. stages, two limiters, and a ratio detector. Squelch and cathode follower stages complete the line-up. Steep-sided i.f. pass band together with wide-band limiters and detector result in minimum of distortion, low capture ratio, (desirable), and minimum of effect of drift on quality. With this type of circuitry, no a.f.c. is necessary. Sensitivity is 2 microvolts for 20 db quieting; maximum audio output is 4 volts for ±75 kc carrier swing. Tuning meter indicates signal strength as well as showing correct tuning point.

Newest model just being introduced is Type 311, lower in price but incorporating many of the same features. Wide-band limiters and ratio detector com-

Hermon Hosmer Scott Model 311-A.

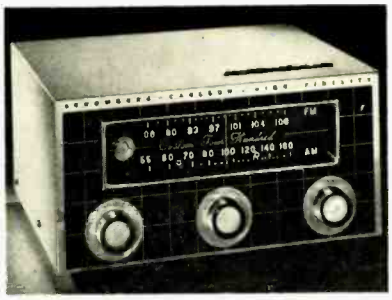
bined with 150-kc steep-sided i.f. response provide high quality with ease in tuning. Planetary dial drive on edge-lighted lucite dial gives either quick or vernier tuning. Sensitivity is 3 microvolts for 20 db quieting; meter shows both signal strength and correct tuning point. Available as chassis only, or with leather-finish plastic-covered cabinet.

Stromberg-Carlson Company, 1225 Clifford Ave., Rochester 21, N. Y. **BT-22**

Three models of tuners are available from Stromberg-Carlson—one with tone controls, phono preamp, and 10-watt power amplifier, and the other two as basic tuners only.

Model SR-405 offers a combined AM-FM tuner and audio amplifier all in one unit, and has a sensitivity on FM of 3 microvolts for 20 db quieting; on AM, 5 microvolts for a 1-volt output. Phono preamp provides two equalization curves; bass, treble, loudness, and volume controls are provided. Broadband AM response extends to 7500 cps, with whistle filter cutting response to −29 db at 10 kc.

Model SR-401 offers no tone controls, but provides volume and a.f.c. controls as well as selector switch for FM or wide



Stromberg-Carlson Model SR-402.

or narrow band AM reception. Sensitivity on FM is 3.5 microvolts for 20 db quieting; on AM 5 microvolts for 0.25-volt output.

Newest model to be introduced this Fall is SR-402, which provides for FM reception with or without a.f.c. and for either wide or narrow band AM reception. Sensitivity on FM is 3.5 microvolts for 20 db quieting; on AM, 5 microvolts for 0.25-volt output. Response on wide-band AM is ±2 db from 20 to 7500 cps. This model will employ cascode i.f. stage on FM, with wide-band detector. AM circuit to have whistle filter and temperature-compensated oscillator to prevent drift—a common practice in FM tuners, but less often used in AM circuits. The SR-402 is 12⅛ in. wide, 6¼ in. high, and 10 in. deep over all, or 9⅜ in. deep behind panel.

PATENTS

(*from page 2*)

Figure 3 is the schematic of a practical instrument for measuring amplifier linearity. The techniques of design involved are new to many audio men but they are essentially simple and are common to those who deal with pulse devices.

The step-wave generator itself is enclosed in dashed lines and comprises V_1 through V_{11}; undoubtedly the number of tubes may be decreased by using dual triodes in many cases. V_1 and V_2 are an unsymmetrical multivibrator which produces a rectangular wave such as that of (D) in *Fig.* 2, with relatively short negative pulses occurring at the repetition rate desired for the entire step wave. These negative pulses appear at the plate of V_2. Phase-reversed positive pulses as at (E) appear at the cathode of V_2 and the plate of V_1.

V_3 is a blocking oscillator which is free-running and whose frequency is controlled by the variable resistor in its grid circuit. The frequency at which it runs determines the number of steps in each step wave. The output is a series of steep-sided pulses which we have shown for the sake of simplicity at (F) in *Fig.* 2 as sine waves. The cathode of multivibrator tube V_2 is connected to the blocking oscillator cathode. The short positive pulse (E) from the multivibrator cathode cuts off the operation of the blocking oscillator once per multivibrator cycle, for a purpose we shall explain later.

The circuit which converts the blocking oscillator pulses into step form begins with the cathode-follower stage V_4 which applies these pulses to capacitor C_1 through the left section of the duo-diode V_5. On pulse alternations which are positive at the V_4 cathode, C_1 is charged; on the other alternations output goes through the right section of V_5 to discharge the transfer capacitor, while C_1 holds its charge. In this way, each succeeding positive pulse from V_4 adds to the existing charge on C_1 so that the voltage across C_1 builds up in a series of steps.

The step charging must not continue indefinitely, but only for a period corresponding to the desired step-wave repetition rate. At the end of each period, therefore, C_1 must be discharged so that it can begin step-charging anew. The discharging is done by diode V_8. Amplifier tube V_7 is normally conducting and the d.c. voltage developed across its cathode resistor is normally more positive than the maximum charge which C_1 will assume under operating conditions. Since the cathode of V_8 is connected to that of V_7, it is biased positive and the diode cannot conduct and discharge C_1.

However, when the narrow multivibrator pulse, *Fig.* 2 (D), comes along, it is negative at the plate of V_2, and this is coupled to the grid of V_7. V_7 is a cathode follower and thereupon produces a negative pulse at its cathode and at the cathode of V_8. Since the latter is now temporarily much more negative than its plate, there is a discharge path for C_1, which promptly dumps its charge to ground through V_8. After that the multivibrator goes back into the long portion of its cycle, V_8 no longer can conduct because its positive cathode bias is restored, and C_1 begins to step-charge again. This succession of events produces the wave shown at (A) in *Fig.* 2.

The wave is applied to the grid of V_9, a cathode follower provided for isolation; its high input resistance prevents any inadvertent loading across C_1 which would inhibit the step-charging. Its output is applied to the grid of V_{10}, an amplifier with both cathode and plate outputs. The cathode output is applied (through a potentiometer which controls level) to cathode follower V_6, which provides step-wave signal to the amplifier being tested. The plate output of V_{10} goes to the grid of cathode follower V_{11}, the output of which provides a positive voltage to the right diode plate of V_5. Ordinarily, as the charge on C_1 became more positive, the left cathode of V_5 would assume a positive bias and less current would flow through the left diode on each positive alternation to charge C_1; this would leave a positive charge on C_2, which would bias the right cathode of V_5 and prevent complete discharge of C_2 on negative alternations. Current flow "through" C_2 on positive alternations would then be less and less, and the steps of C_1 charge would decrease progressively in amplitude. To offset this, the amplified increase of positive C_1 charge is applied to the right diode plate, to keep potential difference between plate and cathode constant and assure complete discharge of C_2 on all negative output alternations of V_5. This is a linearizing effect which gives a step wave of equal steps throughout.

The output of the tested amplifier is connected to a differentiator with a series capacitor and shunt resistor. Since the spikes produced are caused by the vertical portions of the steps, corresponding negative spikes would then take hold on each spike. What rectifier across the V_{12} grid, which gives a flat baseline as shown in (C) of *Fig.* 2. This is not really necessary for the scope display, since the positioning controls can be operated to bring down the picture and show only the upper spike tips. The spikes, amplified by V_{12}, are applied to the vertical plates of the cathode-ray tube.

The sweep generator of the oscilloscope cannot be synchronized internally by the vertical input wave as is usual, for sync would also be produced, were it not for the should be shown is a complete succession of spikes corresponding in time to one complete step wave as shown at (A) or (B) in *Fig.* 2. Synchronizing voltage is therefore fed to the sweep generator from the multivibrator. Narrow pulses of either polarity could be used since most scopes have a sync control which can be set for either polarity. In the illustration the positive pulses from the left plate are used since no other connection happens to be made there. Since these narrow pulses occur at the step-wave repetition rate, the sweep generator can then be set with its own frequency controls to show one or more complete step waves.

This patent specification or any other can be obtained for 25 cents from The Commissioner of Patents, Washington 25, D. C.

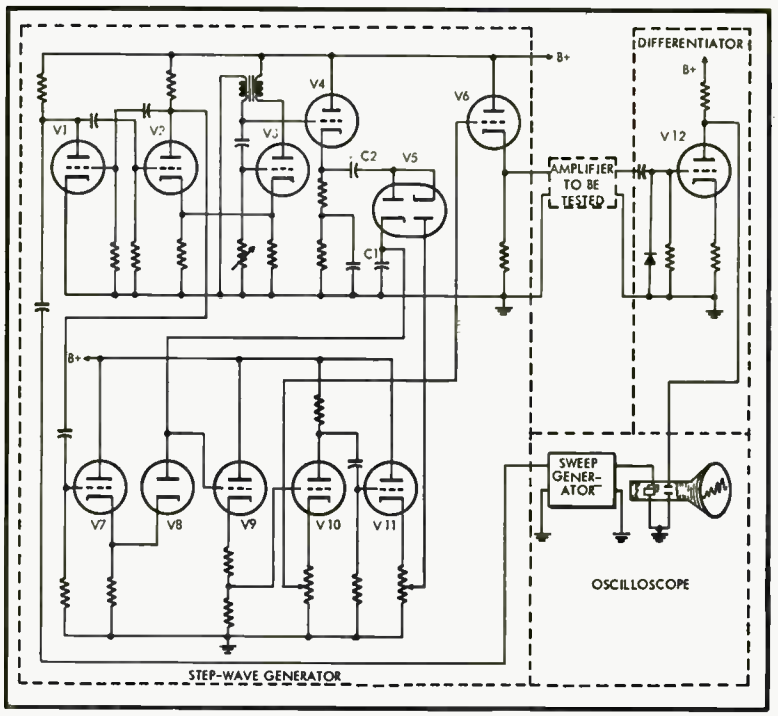


Fig. 3

Employment Register . . .

Positions Wanted and Positions Open are listed here at no charge to industry nor to individuals who are members of the Audio Engineering Society. Positions Wanted listings from non-members are handled at a charge of $1.00, which must accompany the request. For insertion in this column, brief announcements should be sent to AUDIO, P. O. Box 629, Mineola, N. Y. before the fifth of the month preceding the date of issue.

• **YES, SIR, I'M YOUR MAN!** Ten years' diversified broadcasting experience in operating . . . maintaining . . . and repairing broadcast studio consoles, tape recorders, and transmitter. Also, directing . . . producing . . . and editing studio and remote tape and live broadcasts; assisting . . . directing and engineering foreign language programs. Seeking position with future in audio field. Resume on request. Ted Braunstein, 1165 West Farms Road, Bronx 59, N. Y.

AUDIO ETC.

Edward Tatnall Canby

INTERIM REPORTS

Shakedown

IT'S ALWAYS TIME for an interim report in this department. It's not often that I will ever get beyond the "interim" stage, as a matter of fact, because, after all, there is no ending to the sort of rough and practical in-the-home test that seems most useful here. An engineering report (see our EQUIPMENT REPORT, almost any issue) is something else again; there, the concise and objective instrumental measurements of performance can be presented once and for all (at least as far as the individual part under test is concerned) and that is that.

But this column knows its own business and swings wide of engineering reporting. Instead, my treatment is comparable to that of the Shakedown, and a very good term that is, too. Put the gadget to work—hard—and just wait, to see what happens. Something always does. Like the brand new amplifier that quietly went up in smoke on me a few weeks back. Defective transformer! But that, needless to say, is a freak and unimportant since the amplifier maker wasn't responsible for the defect. I'm interested in more routine happenings, in performance as measured by Mr. Average Consumer (represented in fiendishly concentrated form by me), in features both good and bad, as dopey Canby (deliberately dopey) ignores the instruction sheets and the printed warnings and plunges happily ahead. (Who ever looks at instruction sheets *first?* Maybe you do, but the average buyer just can't resist plugging things together *immediately*—to see what happens. Later on, especially if something goes wrong, he gets around to the instructions and the warnings.)

Just plug it in—and wait. That's what I say. And if nothing happens—wait some more. If after several months or maybe a year or two nothing untoward has yet happened, by golly that product is good. And the longer I wait the better it gets, so to speak. Also, the better I get to know it in actual working conditions, for its long-term quality, its convenience, its operation in comparison to other items. So here goes with a few interim items, in various stages of interimity, if I may make up a pleasant word.

1. Pickering.

Nope, not a new Pickering, though a new one has, at this writing, been announced to the trade and no doubt will shortly be available. I'm thinking at the moment of the "old" Pickering phonograph cartridge, not the ancient models, large-size, but the current miniatures, the 200 series, which come in turnover double form and also in single models. You see, I picked up one of the first of these a couple of years ago (was it?) and that cartridge remains one of three which seem to survive every temporary inroad by constant new and lively competition. I try the others, and there are a number of them in various stages of interimity. Some of them will never get to interim first base, others are in operation, but not too dependably. What strikes me about the Pickering is its remarkable reliability. It just keeps on working and it never makes me any trouble.

The newer pickups now being introduced are technically a good step ahead of anything we've previously had, as far as sheer performance is concerned. But they bring with them weighty problems for the home user. Transformers that pick up hum most devilishly (though of course "properly mounted," they should not), odd shapes, delicate innards, ultra-low output, damping materials that prove unsatisfactory after awhile, and so on. I suspect that the Pickering 200 will not quite match the newer model that may soon supplement it, in absolute terms of ultra-high engineering performance. Possibly several of the newer special jobs can also outperform it—in the lab or under ideal conditions. But in the home, no. There just isn't anything much to go wrong in the Pickering, the performance is excellent and the voltage output is so high (for a magnetic) that hum pickup is virtually impossible and the feeblest amplifier will be driven to its heart's content.

2. Ferranti. Here's a pickup that has tremendous promise, not entirely fulfilled as yet. Under ideal conditions, i.e. correctly installed and used with good equipment, it performs beautifully and offers several pleasant features for the home user. The tiny, lightweight arm is convenient and the slip-on cartridges are easily handled. The 78 large-groove cartridge has, moreover, an oval stylus instead of round, which, though I haven't had a chance to experiment with it in detail, is intended to improve the reproduction of old 78 records, especially near the inner grooves where loud passages involve very steep and sharp corners for the stylus to tract. The oval point slips around these with greater ease than would a broad-beam standard round stylus and so "fuzziness" is reduced, more music comes through. An excellent idea and those who value their 78's should investigate at once. Any pickup that offers direct improvement in tracking the old-style discs is a priceless hope for many ardent record collectors. One important feature of the cartridge is definitely worth mentioning—low output and the need for a transformer.

Low output is characteristic of a number of new pickups and, though this offers no real problem to the engineer and the advanced amateur, it should be pointed out that in all such pickups there are inherent characteristics that may prove embarrassing to the amateur: Transformers do pick up hum, from motors, power transformers and sometimes just from nowhere—apparently—and this in spite of ingenious and thorough-going attention to shielding. When the final output to the amplifier is low and you must turn up your volume control very high, the hum problem *is* magnified.

So far, I haven't been able entirely to clear up the underlying hum in my installation of this pickup and I'm ready to admit that, as Dopey Canby, the trouble is my fault. I've heard others just like mine playing away beautifully without a trace of that annoying B-natural derived from 60-cycle AC. But I also found that even with the tranformer, there was not enough output from the pickup to drive a rather elderly ten-watt amplifier that I use for emergencies—an amplifier that is very much like a couple of million others now in use. The cartridge drives my "big" amplifiers entirely adequately but the ten-watter gave a half-hearted mezzo-forte at wide-open volume, and there was some hum.

It seems that there is an excellent reason for ultra-low output and transformers. Better sound quality, better pickup response. This is one of those typical situations where the engineers are faced with a pair of ugly alternatives and must find ways to have their cake and eat it too. If you want top pickup response, as things now stand, you must take very low output along with it.

There was a time, back seven or eight years, when the present magnetics were considered to have much too feeble an output for home practicality. The omnipresent GE cartridge was often criticized at first for too-low output. It is no longer. The attendant problems have been conquered in the great mass of home-type, medium-cost equipment and the GE reigns supreme—with the same old low output—the most widely used and most inexpensive magnetic cartridge.

Now we drop down again to a new and greater low, speaking voltagewise. The problems are back. But they may well be conquered once more and, you can be sure, the process has already begun. Bring the mountain to Mohamet. Design the better pickup, then make the rest of the equipment conform!

But, for the time being, keep an ear out for hum whenever you install a new ultra-low-output job like the Ferranti, or the Fairchild, the ESL, etcetc. They are the excellent pickups, as to performance, but they need race-horse treatment to win the performance race.

3. AR-1. I've had the new Acoustic Research speaker system in use for some time now and I must admit that I am delighted with it, so far. This is the speaker that, uniquely, substitutes a springy pillow of air for the stiffness in the usual speaker cone. Its specially designed cone speaker is limp and flabby, and would be entirely useless in any ordinary enclosure. But when it is sealed tightly into the special AR-1 box, the infinite elasticity of air itself, compressed behind the cone, provides a virtually perfect springiness against which the sound-motion of the voice coil can operate. A most ingenious idea.

The best thing about this new principle is that the required body of air *must* be small—it cannot be large—and so the size of the cabinet is *necessarily* small. It cannot be large. Now this is something! All earlier small speaker enclosures, including the R-J, represent some sort of compromise, though the compromise in the R-J models could be said to be practically non-existent. But here is a speaker system that is *required* to be small and cannot be made large under any circumstances. For that reason, the

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makers are ready to compete against any speaker system, however large, in this, their first model. Other factors are involved in sound quality, of course, but as far as sheer size is concerned, the AR-1's smallness is no impediment at all.

The AR-1 (how I wish it had a more euphonious name! This one sounds vaguely like a dog's growl. Arrrr!) costs in the neighborhood of $185, complete. It is therefore a top-quality system, competing with numerous fancy outfits most of which are very much bulkier. The Acoustic Research people will admit no restrictions at all on quality of performance. They are quite ready to meet any competition you can name head-on, no matter how elephantine. They have urged me to make any comparison I wish—but to date I haven't done it, not because the AR-1 is inconvenient to handle but because the competition is not generally in the moveable category and I have a small living room!

Besides, I prefer to put a speaker to work, as usual, under normal non-A-B conditions of use in the home. You'll learn as much that way, or more, than any set of A-B tests can tell you. I did try AR-1 against a setup already present, involving a 15-inch bass reflex speaker, plus a not-so-new cellular-type 800-cycle tweeter. The AR-1 outshone this system both on the bottom and on the top—though it also costs a good deal more, to be sure. No doubt about it, this little box is out after the big competition.

Let's get a better mental picture of this piece of equipment. The AR-1 is an oblong box slightly larger of girth than the "bookshelf" type 8-inch enclosures now so popular, but only by an inch or so. It could easily be mistaken for one of them; several onlookers have been confused by the small size. The box holds two speakers behind the grill cloth. For the lows there is the special limp-cone job, ten inches in the outer opening as you feel it with your fingers. For the highs—and this appeals greatly to me—there is a 6-inch cone speaker, the familiar Altec 755, once Western Electric. A tricky set of binding posts on the rear allows for both 4 ohm and 8 ohm hook-up, and also provides normal, increased and decreased high response to compensate for varying acoustical conditions. Good. (Mine has, in addition, external means for connecting as a woofer alone, eliminating the tweeter. I suspect this is not standard equipment, but installed for my edification in making comparisons.)

How does it sound? Excellent! The feature of the speaker is, of course, the unique system for propagating lows through the limp-cone infinite sealed baffle arrangement, but I must quickly say that the highs impressed me immediately as very lovely, smooth, unprepossessing, musical (for music) and unusually natural. No fancy super-hi-fi screetch and scratch. Congrats, here, to the Altec, which was chosen from numerous tweeter possibilities as the best sounding. I agree.

As to the lows, I made no instrumental measurements of course. (See the article in Audio on this speaker, October, 1954, entitled "Revolutionary loudspeaker and enclosure" for a technical account and, more recently, "Commercial acoustic suspension speaker," July, 1955.) But I was no end impressed, from the first time I ran my finger over a pickup stylus and got that hearty, wall-shaking thump that betokens real bottom bass to the time when I had played records and tapes on the speaker for some months on end. There are excellent indications of good response in the sound. The bottom is clearly apparent and there isn't much indication of frequency doubling, for spurious big bass—indeed, the bass from the AR-1 is reassuringly modest and not overloud, a very good indication of genuinely flat response, as opposed to tricked-up or faulty bass.

Another excellent indication of quality in the bottom tonal range is, paradoxically, the response of the system to the speaking male voice. It's a well-known principle that a "boom-box" with resonant, peaky bass will reproduce the voice in boomy fashion, whereas a really flat system brings it through cleanly and without added "bottom." That's the way the voice sounded on the AR-1. Sounded as though the bass speaker weren't even working, which is just as it should be.

The AR-1 is small, but remarkably heavy for its size as I found when I started to carry it around. It's still easily portable and has already travelled hundreds of miles on the back seat of my car. But the iron in that woofer must be plenty big, and the woodwork in the cabinet is, for a fact, enormously solid and thick, far beyond most cabinets. This is a necessity in order to provide the rigid support needed for that internal air-spring behind the speaker cone. But it's also highly desirable in any piece of furniture that is supposed to last awhile without warping or coming apart. Good.

There is only one significant compromise necessary in the AR-1's general design. I didn't find it half as much a problem as I had been led to expect. The speaker is inefficient, necessarily. It doesn't make much noise for a given input. I don't know how it compares with "average" in terms of db down, but the difference is certainly noticeable. Yet with a good quality amplifier, I found, there is plenty of gain to fill any large living room to bursting with volume. On a 20-watter I didn't come anywhere near to the full available volume before my hands were in my ears.

The speaker is not recommended for use with small ten-watt amplifiers, and so—natch—I immediately hooked it up to one (the same elderly model mentioned above) to see what it would do. Shakedown system. I can describe the results easily. Indoors, in a fair-sized living room, the ten-watter did all right with AR-1 at a moderate listening volume. But I had the throttle advanced a good ways up. Just for kicks, I took the speaker outdoors on the lawn and tried listening to music as I mowed the lawn. (A silent-type hand-push mower, that merely produced a good, solid background of whirring white noise.) Well, that did it. Not many systems will sound "loud" outdoors, with nothing to reflect and plenty to absorb—tress and bushes and grass for miles in all directions. So I revved up the ten-watter and got a listenable volume as long as the music stayed in the mezzo-forte range. But when it began to get real loud, the sound broke up badly. Too much for the ten-watter.

Now nobody in his sane mind is going to use the AR-1, at $185, to accompany outdoor lawn-mowing. And so I suggest that the inefficiency of the system is not very important for most of us. The place where it will show up most, of course, is in that utterly artificial situation, the sound salon AB comparison. With the same signal input the AR-1 will play noticeably less loud than many other speakers. To some, therefore, it won't sound as good. But anybody who listens that foolishly, with nearly 200 bucks in the balance, is worse than a dope. Just equalize the volume levels on all the tests speakers, for a fair comparison, and you'll know what's what.

Nevertheless—you'd better hook up the AR-1 to at least 20 watts or you'll have

(*Continued on page 49*)

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EDWARD TATNALL CANBY*

ORDINARILY THE RECORDS covered in these pages are clumped into convenient categories, in whatever way seems interesting and useful, regardless of manufacturer or label. This is as it should be, for the primary interest of most readers is in the content of the new records, not the color of their labels.

But in the long pull it turns out often enough that for purely categorical reasons a good many discs just don't get included —they don't happen to fit in the scheme-of-the-moment. And no matter how many subjects I dream up, like "Audiosities" and "Pot-Pourri," to take in as wide a choice as possible, I still don't always keep up with everything I'd like to. So, for a change, I'll begin looking at a few labels this month, brand by brand. Justice where justice is due and, incidentally, an interesting new slicing of the pie.

M-G-M

This "classical" label, stemming from the huge film enterprise, has made commendable use of American-located talent, where other labels have featured mainly European-recorded material. The entire stack of M-G-M records I have on hand from recent months is American-performed.

This is commendable for, as we all know, recording in this country has its problems, not the least of which is the much greater expense. But there are even more important problems, as far as engineering and artistry are concerned. We have acoustic troubles here. Too many of our engineers are still attached to film and TV techniques and to the dead, ultra-close-up sounds essential for that kind of work. M-G-M has suffered for a long time from over-dead studio recording.

A second problem is musical in nature. Music costs money hereabouts and rehearsals are more often than not cut short. We have plenty of expert musicians—too expert. They are perfectly capable of playing really difficult music with scarcely a rehearsal, but the results, especially with unfamiliar music, are rarely as good as when the music is intimately known after long and careful rehearsal. At European rates of pay, rehearsals generally can be longer and more thoroughgoing, and, it seems, the traditions over there are such that longer rehearsals are more or less taken for granted, as shorter practice is here. These things are major problems for all who try "classical" recording in the U.S.A. and M-G-M has gleefully stuck its head into a hornet's nest of them with its forthright all-American policy. I think we can afford to be understanding, then, though in the interests of honest reporting the shortcomings (measured against European-recorded competition) must be noted as they show up.

M-G-M has been singularly fortunate in its solo piano department, notably in the performances by Menahem Pressler, who is one of the finest and most musical of the younger pianists. The M-G-M stable is now expanding with such names as William Masselos, Marga Richter, Lenore Engdahl, artists whose names are relatively new on the scene and whose reputations will rise along with M-G-M's as a result of their records.

Other new forces are appearing at M-G-M and there are good signs of a more imaginative and competitive musical approach than has been evident in the past. M-G-M does a superb job on piano recording and, aside from the prevalent dead-studio acoustics, turns out excellent hi-fi in its instrumental ensembles as well, though pressing is a bit erratic here and there.

A special mention should be made of the excellent and detailed jacket notes for M-G-M by Edward Cole. They are so long that the print is often microscopic but, if your eyes can take it, they offer fresh and original comments on the music in a most readable essay form.

(P.S. I'd like to see a nice, new M-G-M label to replace the present somewhat jaundiced yellow job—now that the M-G-M albums have been dressed up with a shiny finish. Adds dignity.)

Lambert: Concerto for Pianoforte and Nine Players.
Lord Berners: Piano Music. (Fragments Psychologiques; Le Poisson d'Or; Three Little Funeral Marches.) Menahem Pressler; ensemble cond. Theodore Bloomfield.
M-G-M E 3081

Constant Lambert, of the once-popular 'Rio Grande" and a lot of other lightish British music, here writes a serious piece of modernity dating from 1933 that is probably a fairer representation of Lambert's real aspirations than his easier stuff ordinarily heard. It's a nicely colored piece combining a mild (for our advanced ears) jazziness with a rather academic modernism, tinged still with a trace of that unmistakable Elgar-Delius elegance that still haunts British music even today. Nice sonorites and the dry, close-to recording is in this case musically appropriate.

Lord Berners was one of those musical amateurs of great talent who are to all intents and purposes professional composers. Borodin was another—his proper occupation being a doctor. Lord Berners was a miniaturist. Like Satie (and well after Satie) he turned out small, pungent satires with tricky titles—his funeral marches here are For a Canary, For a Rich Aunt, For a Statesman; his Psychological Studies are only seconds long and involve a Hate, a Laugh and a Sigh—outward humor which, of course hides a seriousness of purpose underneath. The music is very dissonant, in a somewhat dated sort of way, and rather too fragmentary for sustained listening though well constructed.

A good "period" coupling, this record, and it should be in every school and college music library, along with—

Piano Music of Erik Satie. William Masselos. **M-G-M E 3154**

Old goat-bearded Satie was the driving force, the impishly persistent leader of the young radicals in France before the First War. He wrote pieces with preposterous titles—"Piece in the Shape of a Pear"—ripping the last remnants of sentimental Romanticism to shreds, and thereby vastly stimulating a whole generation of new composers, French and otherwise. Everybody in music knows about Satie and most composers look up to him, especially the French and the French-trained Americans. But nobody ever hears him.

Now, if you can wish, you can decide for yourself just why, via this interesting collection, which includes such items as a group of Veritable Flabby Preludes for a Dog, Chapters Turned every Whichway, Dessicated Embryos. An old devil, this Satie.

But the reason Satie is talked about but not often heard is fairly clear to me, at least. The plain fact (blasphemy!) is that his music just doesn't measure up to its saucy subject matter. The man was undoubtedly a tremendous personality, what is usually called a "seminal influence," the sort that gets everybody else to going full steam. But his own music is really ordinary, all things considered. Nice and catchy, well written, but with more than a touch of music-hall commonness to it and an over-all style not so different (though less forceful) than much of the saucier Debussy piano stuff.

Masselos plays forcefully and well and the piano recording is tops. As I say, this one, too, should be in every library. But it won't land in many home collections, I predict.

Hindemith: Educational Music for Instrumental (string) Ensembles, op. 44. Maurice Levine Sinfonietta. **M-G-M E 3161**

Here's a remarkably interesting and listenable disc that, on first glance, might seem hound for the school study library too. Not at all!

Hindemith, you see, was a 20th century pioneer in the revival of what is actually about the oldest kind of music there is—music for use, composed on specifications for a particular need.

There was no other kind, until Romanticism came along and proclaimed that art was for art's sake. Music, like other arts, has always been most successful when a concrete goal has been in mind, with a concrete and appreciative audience that knows the rules and, indeed, creates the demand. What would baseball be like if ball players suddenly became artists and demanded freedom to make up their own rules! It's a wonder, I say, that music survived at all under this sort of Romanticizing. It still suffers a lot from it.

So—Hindemith wrote "practical" music and, it happens, he was good at it, perhaps better at it than at writing big, "important" pieces. Bach

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

was, too, as witness the piano Inventions and many another study piece. An etude, nominally and often practically, is a study piece—but there are some mighty fine etudes that are good for listening, too.

These string pieces, many and short, date from the late 20's when Hindemith was at the top of his youthful maturity and possibly a better composer than he is now. (A fresher one, anyhow.) He starts with violin for beginners and the first little piece, for two groups of fiddles or two fiddles alone, employs only two notes in each part. How can you write music with two notes only? That's the point! Beginning with such drastic limitations, Hindemith gradually adds more difficulties, more notes and faster rhythms, for progressive violin study. The audible spectacle of a first-class musical mind doing stunts within such drastic limitations, building little miracles out of almost nothing, is quite the most absorbing thing I've run into in a long period of record sampling.

The thirty pieces, in four groups, include a whole first side for violins only. After this long and intensely interesting exploitation of the violin choir by itself, the appearance of the other stringed instruments, on side two, has a remarkable impact of newness and drama. This is the essence of real music-making, the principle that the great early composers (beloved by Hindemith himself) knew so well. After pages of simple diatonic music with, say, all "white" notes, the old fellows knew that the entrance of a single E-flat or A-flat, a "black" note, could by sheer dramatic contrast produce an extraordinary effect. Economy of means! That's what we lack today.

The Levine strings play Hindemith most sympathetically and the recording is excellent, the not-so-live acoustics entirely appropriate for the music. I heartily recommend this disc for straight-through listening, as a basic experience in the growth of music out of the simplest beginnings into complexity. I'll eat my hat if, after one or maybe three playings, you don't feel its cumulative power.

Mozart: Serenades #11 and #12, K. 375, 388, for Winds. Wind Ensemble cond. Arthur Winograd. **M-G-M E 3159**

Until recently M-G-M's instrumental ensemble and small-orchestra recordings, mostly under Izler Solomon, have shown a rather distressing lack of style and feeling for the many types of music involved. In comparison to competition there has been an unmistakable "give us anything and we'll play it" sound of professional routine that is singularly out of place in any permanent music in recorded form. Engineering, of the ultra-dead muffled studio type, has been equally at fault.

This disc would seem to be transitional. The recording is the same close-up type but at least it is not hopelessly out of place in this fairly intimate type of music. Yet other competing versions of the same music feature gorgeous resonant liveness that for most ears is bound to seem more attractive and natural. Ultra-dry acoustics always make for tough listening, in any music.

I'd feel happier if I thought M-G-M really believed in this dry, close sound as appropriate to Mozart. But, instead, I suspect it was merely automatic and a happenstance, indicating a lack of imagination somewhere along the production line.

The playing of the Mozart is curiously uneven. Some pasages, notably by the oboe, are produced with great beauty and sensitivity, but the whole impression, nevertheless, is one of lumpiness, too-rigid rhythm and no poetry. There is, again, that indefinable sense of routine, the "we'll play anything you give us" attitude of the professional musician doing a job. This is not a "dedicated" Mozart performance with heart and soul put into it by all participants, and it should be.

For these happen to be two of the finest works in the Mozart repertory, both extraordinarily vivid and intense, and the competition, on other LP labels, is formidable with excellent recordings of the same music from Vox, Westminster, and others. Has M-G-M heard them?

Hovhannes: "Khaldis" and other works. Wm. Masselos, piano, with Chamb. Ens. cond. Izler Solomon. **M-G-M E 3160**

Hovhannes is a curious composer—an Armenian-American whose formal musical education was strictly Boston-made, whose first thousand works, many in a vaguely Sibelius-like style (we are told), were destroyed when the composer set out to com-

bine fundamental Armenian orientalisms with Western techniques, for Western instruments. He's been at it now for some years and the Hovhannes stamp is unmistakable and inimitable, as abundantly illustrated by these works for variously colored instrumental combinations.

This is oddly un-Western music. It does not, like other Western music, rise to climaxes, fall into hills and valleys of emotional force, it has no fixed center, no very conclusive beginning or ending, it simply is, in a hypnotic, repetitive but endlessly interesting way. As Virgil Thomson said, this music is like a long roll of hand-made wall paper, no two designs just alike but with a compelling sense of dynamic motionlessness. Unique!

The "Khaldis" concerto features piano, four trumpets and percussion but it is unlike any concerto you can imagine. The piano writing is the typically liquid, plunking, oriental sort Hovhannes has developed, most effectively; the trumpets play fascinating silvery repetitive counterpoints among themselves for minutes at a time, then fade gently away; the percussion makes irregular background rhythms that pulse, but never march. And the "key," the "harmony," mostly modal in a rather beautiful way, stands still for long periods, supporting lovely, sensitive, flowing, dynamically static melody, like the monotonous flow of fountains.

On side 2 there are exotic new sounds, piano solo, beginning with a strange piece played in part with a rubber mallet inside the instrument, for long, slow, ominous rumbles of musical distant thunder, which seem to grow without percussion, defying the laws of piano tone-production. A good deal more effective music and much less pretentious than the piano experiments of John Cage, I'd say. Later on we hear a mandolin sound, via a soft plectrum that picks at the piano strings. And throughout, there is that same, hypnotic, dreamy oriental mood that is so characteristic of Hovhannes. Most interesting to hear.

I'm inclined to feel that it really doesn't matter whether we classify this sound as "good music" or bad, or even whether it is music at all. Like Varese's "Deserts" (see "AUDIO, ETC.," July), you'll find this of interest simply as Organized Sound, sound in patterns that are perceived by the ear and the emotions.

The performance is, so to speak, from the horse's mouth; Masselos has been closely associated with Hovhannes since the beginnings of his oriental style and is, indeed, about the only Hovhannes pianist available who really has absorbed the music to the hilt.

Gorgeous recording, particularly nice in the trumpets and in the piano. The dreamy quality of the music seems oddly to create its own liveness; there is no problem at all here in the actual acoustics though the recording is not particularly live.

Hovhannes: Incidental Music to "The Flowering Peach" (1954); Suite from the Ballet "Is There Survival?" (King Vahaken) (1950-1955), Orbit No. 1. Various instr. ensembles conducted by the Composer. **M-G-M- E 3164**

An interesting sequel to the above, for here Hovhannes travels the time-honored road from "pure" music to music on Broadway. In a sense the "Flowering Peach" represents commercial music. The show was a vast success in a big way. But, as you'll quickly hear, the compromise is very slight, if there can be said to be any at all.

Yet there is a difference, in the "Peach," perhaps simply the latest constructive advance in the prolific Hovhannes technique. Least important, though first to be noticed, is the use of the more conventional theatre instruments—alto sax, harp and the like. More interesting is the beginning of motion. For here, though the dreamy, exotic atmosphere remains, there is a change which may represent a new consolidation of the timeless East and the dynamic West in Mr. Hovhannes' fertile East-West mind. Somehow, ever so intangibly, these melodies move onward a bit. Western-style, and the fascinating hypnosis is lifted a trace.

The "Survival" score, rewritten in 1955 from a 1950 ballet, combines audibly the two eras. At the beginning there are the same trumpets as in "Khaldis," here composed originally a few months earlier, and the same hypnotic repetition without motion. But there are other parts that move outward, more like "Peach," and these must be in part the 1955 revision-expansion. Highly colored again (and nicely hi-fi to match), with strangely used celesta, sax, percussion, harp and what-not. Exceptionally good sound quality throughout with excellent, imaginative microphoning. This is the New Order at M-G-M, I should guess, and it rates a hi-fi double star.

Piano Music for Children by Modern American Composers. (Copland, Cowell, Diamond, Hovhannes, Harold Lawrence, Persichetti, Marga Richter, Alan Skelly, Virgil Thomson, Stanley Wolfe). Marga Richter, piano. **M-G-M E 3147**

M-G-M has been issuing, intermittently, an excellent series of documentary piano recordings, so to speak, spreading forth a vast repertory of modern pieces for children's piano study—playing, not listening—by many composers of today. Notable in the catalogue are Manahem Pressler's sensitive playings of the immortal Bartok "For Children" (E 3009, E 3047), (though several other equally good readings exist also on LP) and another disc that includes Malhaud, Bloch, and the rather dull Shostakovitch "Six Children's Pieces" as well as the ineffably beautiful and moving "Music for Children" ("Summer Day Suite," in the orchestral version) by Prokofieff.

Here, Marga Richter plays a sympathetic host to a mixed group of moderns, all writing as well as they are able for children, and from their various viewpoints towards the needs and emotional abilities of the childish fingers and mind. Too much to describe in detail—and the listening is tough, too, since the order of the pieces is different on the record and in the album commentary and so you must stop the disc at the end of every band to see what comes next.

My general comment is that, though these are generally a bit either too cute or too sophistcated for kids' minds (missing the bull's eye on both sides), they are on the whole very well put together, reasonably expressive and well within the graded categories that are conveniently provided (also the publishers) for teachers' use. Yet few of them, it seems of me, really approach the high plane of communion in simplicity that really first-rate children's music must have. Children are not dopes, nor are they incapable of emotion—far from it. A genuine sympathy for children's unlimited musical intuition, as in the case of Prokofieff, is as rare in music as the same thing in the field of children's books.

Still—when you think back to the utter dishwater that is ordinarily served up to kids for their piano practice in the early stages (will I ever forget "Fun, Fun, O what fun, Music Lessons have begun!"), these many little pieces are superb in comparison. The classics, yes—Bach and Mozart and the rest. But let's have at least a bit of today in our kid's training. These pieces will do the job nicely, especially (as my ear caught them), the "Little Piano Book" of Vincent Persichetti and the short items by Harold Lawrence, out of Prokofieff.

Note: A sequel, "Piano Music for Children by Modern Composers," including Hindemith, Satie, Hovhannes, Surinach and Toch (E 3181), is worth investigating thoroughly if you are interested. I'm putting it aside for later digestion when I've caught up with the ten composers and the dozens of individual pieces in the first volume, above.

Milhaud: Saudades do Brazil.
Villa-Lobos: Saudades das Selvas Brasileiras and other piano works. Lenore Engdahl, piano. **M-G-M E 3158**

A logical pairing, I admit, and fine for those who are interested. But, after four or five of the Milhaud evocations of Brazil from the early 20's, in that slightly Latin-American, smart-aleck, dissonant style of his, I get entirely bored, though each one in itself is piquant and pleasantly acid. Too much of one not very important good thing.

The Villa-Lobos just goes in one ear and out the other, try as I will to concentrate. I'm afraid I hear V-L about as he composes—as endlessly as a babbling brook that never stops. He seldom does, and I seldom can keep my attention on him.

A personal reaction and if you feel otherwise you'll find Miss Engdahl a powerful pianist with a vast dynamic range, from smooth and lyric to trip-hammer double-forte. Not exactly a poetic or sensitive pianist here, but perhaps that isn't her fault but V-L's. Excellent piano recording, ultra-natural.

SOUND TRUCK RESTRICTIONS

(*from page 17*)

of police. He stands athwart the channels of communication as an obstruction which can be removed only after criminal trial and conviction and lengthy appeal. A more effective previous restraint is difficult to imagine.

"Loudspeakers are today indispensable instruments of public speech. The sound truck has become an accepted method of political campaigning. It is the way people are reached. Must a candidate for governor or the Congress depend on the whim or caprice of the chief of police in order to use his sound truck for campaigning? Must he prove to the satisfaction of that official that his noise will not be annoying to people?

"The present ordinance would be a dangerous weapon if it were allowed to get a hold on our public life. The highways and places of public discussion can be controlled. But to allow the police to bar the use of loudspeakers because their use can be abused is like barring radios because they too make a noise.

"The police need not be given the power to deny a man the use of his radio in order to protect a neighbor against sleepless nights. Any abuse which loudspeakers create can be controlled by narrowly drawn statutes. Courts must balance the various community interests in passing on the constitutionality of local regulations of the character involved here. But in that process they should be mindful to keep the freedoms of the First Amendment in a preferred position."

Loudspeaker Uses Limited

Six months later in a controversy involving a similar ordinance of Trenton, New Jersey, which prohibited the use of an amplifier "which emits therefrom loud and raucous noises," the court set the boundaries to the use of loudspeakers.[3]

"If enforced, freedom of speech in disregard of the rights of others would be harsh and arbitrary in itself. That more people may be more easily and cheaply reached by sound trucks, perhaps barred from some zealous supporter, is not enough to call forth constitutional protection for what those charged with public welfare think an annoyance, when easy means of publicity are open. This ordinance bars sound trucks from broadcasting in a loud and raucous manner in the streets.

"There is no restriction on the communication of ideas or discussion of ideas by the human voice, by newspapers, by pamphlets, by dodgers. We think that the need for reasonable protection in the homes or business houses from the distracting noises of vehicles with such sound amplifying devices, justifies the ordinance."

[3] Kovacs v. Cooper, 52 A.2d 806, aff'd. 336 U.S. 77, New Jersey.

NEW PRODUCTS

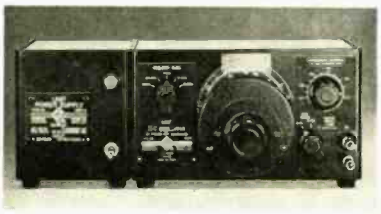
• Weatherproof Portable Tape Recorder. Housed in a weathertight aluminum case to assure complete protection against rain, spray, sleet, dust, fungus, and other hazards, the new Magnemite Model VU tape recorder is available in one-, two-, three-, and four-speed models utilizing speeds ranging from 15/16 to 15 ips. A built-in VU meter serves as a level indicator as well as a means for checking "A" and "B" battery voltages. Measuring 7½ × 9 × 14 ins., the instrument weighs only 19 lbs. Inexpensive flashlight cells power the record-playback amplifier for 100 hours. Constant tape speed with flutter ± 0.1 per cent over the full winding cycle is achieved by a patented centrifugal ball-bearing flyball governor on the spring-wound drive motor. Quick change of

speeds is accomplished by simply changing capstans. Precision head alignment assures interchangeability of tapes with all studio or portable recorders operating at the same speed. Recordings can be made while the instrument is in motion or in any position, and incoming signals may be monitored with headphones while recording. Complete technical specifications and prices may he obtained by writing to: Magnemite Division, Amplifier Corp. of America, 398 Broadway, New York 13, N.Y. **B-7**

• Presto Three-Speed Turntable. Known as the "Pirouette," a name chosen from more than two thousand entries in a recent prize contest, this new turntable replaces the popular Model T-15 in the Presto line. Like the T-15, it is a three-speed unit with cast aluminum turntable. As an added feature, however, the Pirouette is equipped with a 45-rpm adapter disc, permanently

attached to the spindle, which retracts to the surface of the table when records of other speeds are played. Another improvement is the drive system which utilizes three rubber idlers, one for each of the turntable speeds. The idlers are interchangeable so that a single spare may replace any one of the three. A single control lever selects the desired operating speed or shuts off the mechanism. In the off position the idlers are retracted from the drive shaft to prevent "flats" from developing. The Pirouette is available with either four-pole shaded induction motor for average applications, or with hysteresis-wound motor for applications which are exceptionally demanding. Presto Recording Corporation, Paramus, N. J. **B-8**

• General Radio R-C Oscillator. In addition to two sine-wave outputs, the new GR Type 1210-B R-C oscillator provides a square-wave output over the entire frequency range from 20 cps to 500 kc. The square-wave output is 0 to 30 volts peak-to-peak with about ¼-microsecond rise time. Output impedance is 2500 ohms. One sine-wave output of 0 to 7 volts is available from a 50-ohm output impedance



with no-load distortion less than 1 per cent from 200 cps to 200 kc. A maximum of 45 volts is available from a 12,500-ohm output. Frequency calibration accuracy of the instrument is ± 3 per cent. Output control is logarithmic and is calibrated from 0 to - 50 db. General Radio Co. 275 Massachusetts Ave., Cambridge 39, Mass. **B-9**

• Fairchild Input Transformer. Designed specifically for use with the Fairchild Series 220 moving-coil cartridge, the new Model 235 input transformer is recommended with amplifier systems which require extra gain. Especially effective in installations where strong a.c. fields exist, the Model 235 has a mu-metal case which results in hum-free operation under the most difficult operating conditions. The transformer has a built-in phono jack

to accept the cartridge output and a 30-in. secondary lead with a standard phono plug to feed directly into the preamplifier. No other wiring of any type is required. Frequency response within 1 db is 20 to 20,000 cps. A 5-to-1 voltage gain gives approximately 30-mv output from average records. Fairchild Recording Equipment Company, 154th Street and 7th Avenue, Whitestone, N. Y. **B-10**

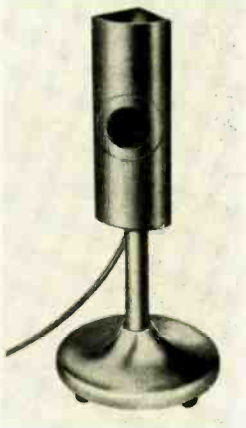
• Silicon Solar Cell. Many experimenters will find delight in the commercial availability of this device recently placed on the market by National Fabricated Products, Inc., 2650 W. Belden Ave., Chicago 47, Ill. The solar cell, shown full size, comprises a hermetically-sealed large area silicon p-n junction, designed for the direct conversion of solar energy into electrical energy. Design of the unit is based on research and development by

Bell Telephone Laboratories, Inc. When exposed to direct noon sunlight, a typical cell will deliver .25 volt across a resistive load of 10 ohms. Cells may be connected either in series or parallel for increased output. Under optimum conditions of sunlight and exposure, a single cell will convert solar energy to electrical power at a rate up to 10 milliwatts. There is no apparent deterioration with use. **B-11**

• Transistorized Mixer-Amplifier. Weighing but three pounds and only a little larger than a pound package of butter, the new dual-channel portable transistorized mixer - amplifier announced by Baird Associates, Inc., 33 University Road, Cambridge, Mass., is a field pickup unit designed primarily for broadcasting and recording. Powered by a 2-battery self-contained power supply composed of 10 hearing-aid mercury cells, the instrument accomplishes high-level mixing by incorporation of two input preamplifiers followed by two stages of stable amplification. A VU meter is provided for visual monitoring of program material and as a direct-reading voltmeter for determining battery conditions. A phone jack is in-

cluded for aural monitoring. Frequency response is 100 to 8500 cps within ± 3 db. Power gain is greater than 90 db. Signal-to-noise ratio is 60 db for – 60 dbm microphone input with distortion 1.2 per cent at 0 dbm output. Output is designed to work directly into a standard 600-ohm load. Further information is available on request. **B-12**

• Bass Boosted Microphone. Many deficiencies in recording and p. a. systems may be minimized through use of the new Model CR-BB crystal microphone manufactured by Frank L. Capps & Co., 20 Addison Place, Valley Stream, N. Y. The unit is designed to amplify acoustically frequencies between 40 and 150 cps as much as 12 db. The exact frequency band to be emphasized is selected by a control knob on the microphone. The 60-cycle hum picked up by recorders and p. a. amplifiers under certain conditions can be reduced considerably by adjusting the bass boost of the microphone to the 60-cycle range



and turning down the bass tone control of the equipment. This provides an improved bass response to below 60 cps without the annoyance of induced hum pickup. Although the microphone can be set to amplify the lowest piano notes when desired, its sharp cut-off characteristics below 40 cps eliminate the pickup of rumble and other extraneous sounds. Also provided is an off position, for use when bass boost is not desired. **B-13**

HARVEY the House of Audio

The NEW BOGEN AUDIO CONTROL

Model PR100

Designed to meet the most exacting demands of advanced high fidelity systems, the PR100 preamp-control offers the ultimate control flexibility and reproduction quality. Frequency coverage is from 5 to 150,000 cycles ±0.5db.

Six input channels with individual level adjustments are fed through a push-button selector and permit its use with tuner, phono, monaural tape, binaural tape, TV, etc. Three outputs are provided for main amplifier, tape recorder and for binaural reproduction. Separate Turnover and Rolloff controls, each with 6 positions, permit any record equalization characteristics to be set. In addition, there are separate bass and treble controls for 15 db cut and boost at 50 and 15,000 cycles, respectively.

Sharp cut-off filters provide 5 positions or frequencies at which abrupt attenuation can be introduced to cut-off any low frequency noise or high frequency distortion originating in the signal source. There is a normal volume or level control, as well as Loudness Contour Selector. All control knobs are of the dual-purpose, coaxial type.

Complete with tubes and mounting front panel $99.50

In Cabinet (specify mahogany or blonde) 119.50

The NEW GARRARD TRANSCRIPTION TURNTABLE

Professional Model 301

A unit designed specifically for discriminating listeners and owners of home sound systems. The turntable itself is a 7½ lb. disc, precisely machined, accurately centered and balanced. A 4-pole induction motor was specially developed by Garrard for use in this unit. Armature is dynamically balanced and the rotor set in self-centering phosphor bronze bushings. A newly designed motor mounting technique, employing counter-balanced springs, absorbs virtually all vibration.

Intended for all 3 speeds: 33⅓, 45 and 78 rpm, the 301 features an eddy current speed control for making fine adjustments. Speeds cannot be changed unless the unit is shut off, thus preventing any possible jamming of the idlers. Other features include: built-in lubricating system, R/C switch network to eliminate 'on/off' clicks, shutoff brake, and a rubber mat to prevent slippage of records.

Model 301 ..... $89.00

NEW JIM LANSING *Signature* EXTENDED RANGE LOUDSPEAKER

Model D123 12-inch

With a depth of only 3⅝" the D123 is the most compact 12-inch speaker in the field. It can actually be wall-mounted flush with the surface and between studding. In a properly designed reflex or horn-loaded enclosure, the usable frequency response extends from 30 to 15,000 cycles.

Power handling capacity is 20 watts; impedance: 16 ohms; and fundamental resonance: 35 cycles. The diameter of the voice coil is 3 inches.

Model D123 ..... $54.50

NOTE: Prices Net, F.O.B., N.Y.C. Subject to change without notice

HARVEY RADIO COMPANY, INC. ESTABLISHED 1927

103 W. 43rd Street, New York 36 • JU 2-1500

The NEW Mc INTOSH

Model MC-60

60 WATT AMPLIFIER

Employing the famous McIntosh-exclusive circuit with unity coupling, the new Model MC-60 provides performance within .4% of theoretical perfection. The tremendous reserve power made available by its 60 watt output, gives the MC-60 a distinct advantage in handling transients and other sudden surges without overloading or distortion and contributes immeasurably to the realism of reproduction.

There is less than .5% of harmonic distortion from 20 to 20,000 cycles even at full 60-watt output. Frequency response extends from 10 to 100,000 cycles ±1.0db; 16 to 60,000 cycles ±.5db; and 20 to 30,000 cycles ±.1db. Intermodulation distortion, under 120 watts peak, is less than .5%.

Socket terminals are provided for powering McIntosh and other preamps, and there are two inputs for .5 volts and 2.5 volts, respectively. Output terminals have the following impedances: 4, 8, 16 and 32 ohms. The McIntosh MC-60 employs the new Tungsol 6550 output tubes in push-pull.

Complete with tubes $198.50

The New 3-Speed BELL TAPE RECORDER and PLAYBACK Unit

Model RT-75

A single control lever permits operation of this unit at either 1.875 ips for lectures, meetings, etc., with a frequency response from 50 to 4000 cycles ±6db — at 3.75 ips for general recording purposes with a frequency response from 50 to 6500 cycles ±3db — or at 7.5 ips for high fidelity with a frequency response from 50 to 12,000 cycles ±3db. Correct equalization is automatically introduced with each speed change. Dual track recording permits 4 hours of sound on a 7" reel at 1.875 ips.

Push-button controls are provided for both fast-forward and fast-rewind. There are two microphone inputs, one for crystal and one for dynamic or ceramic — plus inputs for radio, phono and other high level program material. Microphone and high level channels can be recorded simultaneously. Playback is provided by means of a built-in amplifier and 6 x 9" oval, wide-range speaker. There are two outputs: 3.2 ohms for external speaker and 500 ohms for line. A high impedance output is also provided for feeding a high fidelity system. The entire unit is contained in a portable case measuring only 16⅜ x 15 x 9⅛" and weighing 35 lbs.

Complete with microphone, reel of tape, take-up reel, tubes, and instructions $149.95

The New GRAY *Viscous-Damped* High Fidelity ARM

Model 108C

Viscous fluid suspension provides automatic regulation of both the vertical and lateral movements of the arm. Improves tracking and minimizes groove jumping and skidding. Protects records because arm will not drop suddenly.

Mechanical resonance is virtually eliminated. Simple slide-in feature permits instant interchange of cartridges. Handles records up to 16" diameter. Has adjustments for viscosity and stylus pressure.

Model 108C $39.95

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ABOUT MUSIC

HAROLD LAWRENCE*

Watts in Salzburg

EACH SUMMER, from the end of July, to the end of August, hundreds of musicians converge on the little Austrian town of Salzburg to take part in a music festival which, for variety of repertoire, calibre of performance, roster of internationally known artists, and magnificent surroundings, is unsurpassed. Shuttling back and forth from the Festspielhaus to the Mozarteum (with occasional stops elsewhere), audiences are being entertained this year by conductors George Szell, Charles Munch, George Solti, Karl Böhm, Rafael Kubelik, Hans Knappertsbusch, and Eugene Ormandy; soloists Nathan Milstein, Geza Anda, Clifford Curzon, Edwin Fischer; the Strasbourg and Salzburg Cathedral Choirs, the Vienna Philharmonic, the Scarlatta Orchestra of Naples, and the Mozarteum Orchestra; and several chamber groups including the Barylli Quartet, Vienna Octet, Juilliard Quartet, and the Boccherini Quintet. In addition, there are plays by Molière, Hofmannsthal and Schiller, ballet performances by the Vienna State Opera Ballet, and all of five operas in lavish productions.

For months before Festival time, nearly everyone in Salzburg is busier than the violin section of an orchestra involved in Paganini's *Moto Perpetuo*. Artists have to be contacted, programs built, sets designed, accommodations reserved—not to mention rehearsals, which, in the case of a four-hour opera like Pfitzner's *Palestrina* with a cast of 22 soloists, can be a prolonged affair. Present at virtually every performance are staff members of the local radio station, under whose auspices programs are broadcast and recorded simultaneously. In charge of these and all other activities of Radio Salzburg is Dr. Paul Becker, who visited the United States last June at the invitation of the State Department. One of the purposes of Dr. Becker's trip was to make available to good music broadcasters tapes of the Salzburg Festival. Over a lunch on a hot and humid June 17th, amiable soft-spoken Dr. Becker went into great detail on the operations of Radio Salzburg where 'live' music is the order of the day and the long-playing record nearly as obsolete as the Edison cylinder.

Like the British Broadcasting Corporation, Radio Salzburg sends out more than one 'program.' Two are AM signals of 1 and 10 kw respectively, the third FM of 1 kw power. Again as in the case of their London counterpart, the Third Program is of a more serious nature: concerts, lectures, plays, documentaries, etc. The AM programs are devoted to popular and light music, news, community items and DJ's. With the exception of popular music, the recorded musical fare is on tape.

The long-playing record, so popular with good music broadcasters in the United States, failed to gain a foothold in European radio. There are a number of reasons for this: (1) highly vulnerable plastic surfaces make for a short life span (clicks, swishes, pops, and crackles), (2) the disk seldom matches the quality of the original tape recording, (3) other defects such as pre-echo, off-center pressings, end-of-side distortion. This does not mean that the latest record releases are not performed on European air-waves. Many stations, particularly in West Germany and Austria, have arrangements with the major recording companies whereby master tapes are loaned to the station for copying, even before they are processed for transfer to disk.

At Radio Salzburg, however, recorded music plays a smaller role in classical programming than at most other radio stations. Of course, it cannot be said that musicians outnumber non-musicians in Austria, but there is decidedly a performer surplus in this country of seven million. The results are extremely beneficial to radio since so many artists are available at all seasons, not only during the summer months. In addition, Mozart's native city boasts a world famous music school (also a museum and library), the Mozarteum, which maintains a permanent orchestra. Although not in a class with the Vienna Philharmonic or the Vienna Symphony, it is a thoroughly competent organization and has become what amounts to Radio Salzburg's house orchestra. (The Salzburg Mozarteum, incidentally, will be touring the United States next spring as part of the Mozart Bicentennial celebrations. Its itinerary will consist mainly of universities.) From this group of musicians are drawn smaller ensembles and soloists. Dr. Becker and his staff plan an entire season's concerts with the Mozarteum, and that includes operatic productions. As for summer programming, Dr. Becker coordinates his efforts with those of the Salzburg Festival Committee to avoid duplications.

FM broadcasting is still a relatively new development in Austria. World War II stifled any progress along these lines. Later the Soviet occupation authorities forbade ultra-short wave transmission until two years ago. Despite the ban, Austrian stations secretly built transmitters and made their tests, ready to go into operation the moment the word was given. Like the B.B.C., Radio Salzburg derives its principal income from listeners' license fees. In both cases, the postman is the authorized tax collector. England's annual fee for sound broadcasting is £1, Salzburg's, $3.60. The discrepency is accounted for, obviously, by difference in audience size. At the end of 1950 there were nearly 12 million set owners in the British Isles, 200 times the entire population of Salzburg. According to Dr. Becker, the tax is not enough to keep pace with Radio Salzburg's ambitious plans. Therefore, to supplement income, the station devotes certain segments of its schedule to "commercials." Fully aware that Salzburgians love to hear their names mentioned on the air, three-hour periods on Saints' Days are sold to friends and relatives of Peters, Pauls, and Matthews, who record birthday or anniversary greetings. After each greeting, the announcer introduces the next selection, a favorite piece of the recipient (mostly by Mozart, nat-

*26 W. 9th St. New York 11, N. Y.

urally). The station has little trouble selling these three-hour 'shows' although, sighed Dr. Becker, it still needs more money. But, for that matter, what director of any enterprise would not like to have a larger budget?

Next January marks the 200th anniversary of Mozart's birth. We need no crystal-gazer to tell us that in 1956 the air will be as filled with Mozartian melody as a Christmas day resounds with carols. Festivals have been planned years in advance. Scores of books on the Salzburg composer will no doubt be published on or around January 27th. Recording companies have also gotten into the act. No less than four different versions of *Così fan tutte*, for example, will be issued this fall and winter, not to mention the two sets of Mozart piano works on Haydn Society and Angel which have already been released (Haydn Society still has a few volumes to bring out). Salzburg will join in the festivities with a ten-day celebration including a pair of operas and featuring such stellar performers as Wilhelm Backhaus, Edwin Fischer, Irmgard Seefried, Herbert von Karajan, and Karl Böhm.

Radio Salzburg obtains special permission to record Festival performances on the condition that the tapes are erased at the end of each year. Thus, unfortunately, some superb recordings are lost forever. However, a performance of *Don Giovanni*, conducted by Furtwängler, was filmed in color during the 1954 Festival and will be released here shortly. Although the sound track is technically not up to the latest standards (as a recent showing at the Royal Festival Hall in London indicated) the performance is excellent. Through this film, Radio Salzburg's tapes, and the Mozarteum Orchestra, Mozart and Salzburg will reach their largest audience during the Bicentennial Year.

AUDIO ETC.

(*from page 40*)

the manufacturer after you with a whip. And anyhow, this is a top-quality system and you'll not be doing it justice unless you connect it up to equivalent associated quality.

A final word, or rather a question: is the AR-1 principle—limp cone and air-spring—applicable to less expensive systems? I have no official word and we'll have to wait for a hypothetical AR-2 to find out. But I can do some speculation, of an elemental sort. A speaker system using this principle must have an unusually solid and well-built cabinet, sealed tight. This costs money in any size. If you're going to build a quality cabinet you might as well put quality inside it too—so there you are. I personally doubt that the AR principle will be introduced in really low-priced systems, unless a revolutionary cabinet—say of plastic—is invented to go with it.

Meanwhile the presently available AR-1 makes a unique high-quality speaker outfit for installation wherever space is limited but quality must be tops. The speaker marks an important step along the way towards bigger bass in smaller space, as well as a major advance in speaker design.

(Note: The AR-1 comes in an unfinished cabinet, too, for about $145 and is also available with woofer alone, minus tweeter (use your own), for $40 less than the complete outfit, either finished or unfinished. A wise policy of versatility.)

4. ATR for Tape. After an unconscionable but unavoidable delay of a year or so I'm

bound and set to offer an interim report on a project that I happily conceived last summer and then never got the time to complete. Better late than never. The project: How well will a standard inverter (6- or 12-volt d.c. to 110-volt 60-cps a.c.) work on a tape recorder, for casual in-the-field jobs, of a semi-amateur sort? How about, in particular, that vital matter, exact pitch, or frequency?

Now the boys who do professional recording from stationwagonsful of "portable" tape equipment know all about the problems of portable a.c. and have long since met them in their own various ways, mostly expensive. I'm talking, rather, about the ordinary guy (or doll) who has a tape recorder, wants to make it work in places where the car goes but power-line a.c. doesn't. Campfire singing, mountain-top picnics, outdoor concerts. Frivolous pursuits, perhaps, but then sometimes they can be important, and there are times when semi-professional work can be done in this way, folk song documentation for example, that might be invaluable—if a good recorder were used, Magnecord, Presto, Ampex 600 or equivalent, *and* if (a) pitch came out correctly and (b) hash and inverter noise were low or inaudible.

So I got me a 12-volt inverter to try on my car (12-volt system) and then—didn't get around to it. But I did make one test which I pass on to you for what it is worth. I took the time one day to hook up a Columbia 360 table phonograph to the inverter, try a record for pitch, then rush the machine to a nearby power line outlet and play the same record. AB comparison.

The ATR people had been a bit afraid of hash trouble and had sent me a special capacitor to hook in if there was too much noise. There was some, but not really enough to be objectionable, except perhaps in highly professional work. I assume that a similarly modest noise level would get through into an Ampex or a Magnecorder, or a Crestwood or what-have-you, operated from the inverter. Not enough to be objectionable in anything short of strictly professional work.

So much for noise. I suspect that there is always some if it in any inverter-type system for producing a.c. and I've heard dreadful buzzes emitted by other inverters, presumably over-age and overworked. But this one purred discreetly, no more.

Pitch? Ah, there's the rub! Now the ATR inverter I used, Type 12 RHF (there is an equivalent for 6 volts) was a heavy-duty model, intended to take on a full-sized professional tape recorder, in case I wanted to try one. It may be that the Columbia 360 *under*loaded it. But the fact is that there was almost a half-step difference in pitch between the music as played via the inverter and via the power line. Too high. I.e., the inverter buzzed too fast. The three-position frequency adjustment made a difference, but not enough to bring the pitch down to its correct level, in this particular situation.

The test is still unfinished, I hasten to say—because it is now up to me to load that inverter down with enough equipment to let it work at its rated and proper wattage. It's quite possible that with a Magnecorder hooked in the circuit the inverter's pitch will be correct. But even so, I think we have some useful and legitimate information which will help potential users of this sort of equipment.

We must *never* underestimate the power of the ear when it comes to pitch accuracy! You may think you have no musical ear at all, but beware—you have. An instrumental record played a mere half-step too

high or too low sounds definitely odd to almost anybody, especially if the music is familiar. A vocal record sounds just plain ludicrous with a half-step worth of inaccuracy either way. We require extreme exactitude in pitch reproduction for all sorts of recording, whoever we are.

As you can understand, a tape recording made at a too-fast speed will play back perfectly on the same current—but will come out too *slow* when played on regular line current, and vice-versa. If you want to play your tapes forever on the auto battery and never bring them into the house—fine. But if not, then when you acquire an inverter try it out immediately for pitch and consult the dealer if in your particular situation it is not exactly the same as power-line pitch.

The difference between American 60-cps and European 50-cps incidentally, amounts to a major third in pitch, enough to hike the C Major Symphony of Schubert up to E major and make Lily Pons squeal like a stuck pig.

ATR, by the way, now sells a special inverter specifically designed to operate with the Ampex 600 portable tape recorder, which includes a storage battery (ultra-lightweight, I trust!) in order to make that machine "*really* portable." With this gadget you can walk your Ampex right into the woods and fields or the jungles of Indo-China and come out with records. *If* this inverter is really accurate as to pitch (and we can assume ATR has spent a while on this problem, unless their engineers have real tin ears) it should be a useful gadget for professionals who must have hi-fi of top quality but cannot depend on a car battery.

Just had an idea. I've got me a 50-foot extension cable for a.c. power. Tomorrow I'll run my car up on the front lawn, hook in the inverter and haul the cable through the window into my tape studio, where my present Magnecorder is more or less built-in and not exactly portable. Then I can switch like a flash from inverter to power line—and we'll see what's what, for fair. I've got my fingers crossed, and I apologize to ATR for the delay in crossing them. Report can be expected soon, and I trust it will be entirely favorable.

SOLDERING TIPS

(*from page 13*)

The golden rule which must be observed in soldering electronic equipment is to ensure that the solder wire is applied to the heated components as in *Fig. 2*, not to the soldering tool. The reason for this rule is that since the flux is contained in the solder wire, it is essential that the flux be applied to the components that are to be joined in order to remove the surface oxides and prevent them from forming again during the soldering operation. Probably 90 per cent of the trouble that is experienced in undertaking soldering jobs is due to the fact that the solder was applied to the iron or gun and the tool was then applied to the components. Consequently, the flux was just wasted.

Some of the soldering jobs which will be carried out by the audio enthusiast will be soldering shielded and unshielded wires to pins of plugs. Many of these jobs can often be made easier by fixing the iron in a vise as shown in *Fig. 3*, rather than by holding the tool in the

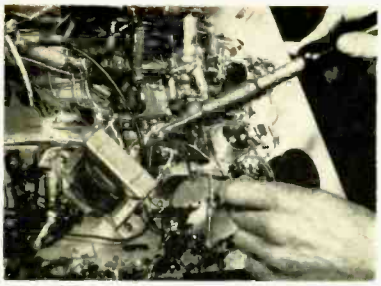

Fig. 2. Always apply the solder to the work, not to the iron. If it is touched to the iron, the flux in the cores becomes vaporized and does not clean the work.

hands. The wires and plugs can be applied to the solder bit with one hand and the solder wire with the other. When wires are to be connected to lugs, it is a good plan to follow the professional practice of passing the wire through the hole in the lug and making a good mechanical joint before soldering.

Another golden rule of soldering is cleanliness. Although modern noncorrosive fluxes will remove surface oxides, it is not intended that they should remove dirt. Consequently, if old wires are being soldered, or joints are being made to lugs of components which have been in use or in storage for a long time, it may be necessary to remove dirt by cleaning with a file, or even a knife.

If the solder does not run very easily although it is of good quality and, if possible, 60/40 alloy, this is a sure indication that insufficient heat is being applied. This may be due to too cold a soldering tool. Generally, this deficiency is the result of one of two causes. Either the heating element in the soldering iron is worn out or the whole design of the iron is too small for the job. For example, for joining wires to lugs in an amplifier a soldering iron of small physical size is an advantage. On the other hand, this type of soldering iron is quite unsuitable for soldering a wire to the ground lug of a large metal chassis. While it is possible to get unsatisfactory joints because too much heat is applied, many more faulty joints are made from applying too little heat. Even when undertaking soldering jobs in which low-melting-point insulation is used, it is

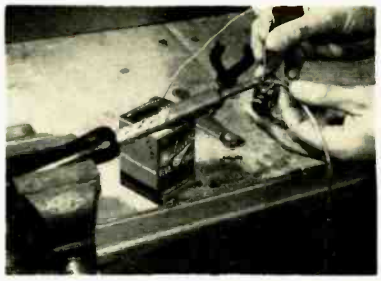

Fig. 3. Clamping the iron in a vise often lends an extra hand for "three-handed" jobs.

invariably advantageous to apply a lot of heat for a short time rather than a little heat for a long time. When soldering shielded cable to plugs, some initial difficulty may occasionally be experienced due to the insulation between the wire and the shielding being melted away and thus causing a short. If, however, the soldering job is undertaken quickly with soldering tools of sufficient bit temperature, this trouble should not occur. In some circumstances, it is advantageous to use a thermal shunt to conduct the excessive heat away quickly. A simple form of thermal shunt is a pair of pliers.

There is considerable fascination in doing a good soldering job. If the audio enthusiast invests in a good soldering tool with sufficiently high bit temperature, always remembers to clean dirty surfaces before attempting to join them, and purchases a good-quality cored solder, preferably 60/40 alloy, he should have no difficulty in undertaking any of the soldering jobs which give a high fidelity installation truly professional performance and appearance.

HOLLYWOOD BOWL

(*from page 16*)

nel has been about 7 watts, 1/10 of the total power available. As a result, any one of the stereophonic sound channels could handle the entire audience area with ease if need be. Only one microphone on each stereo channel is used on regular symphony orchestra pickups.

During the 1954 season, the first for the new sound system, most of the difficulties were discovered and isolated, and by the time the 1955 season closes, the system should be complete and finished. Far more difficult than the designing, building, and installing of some $50,000 worth of components, is the task of overcoming echos, traffic and aircraft noises, sound losses in the open air, humidity and other weather conditions, feedback, and the innumerable other situations noticeable only after the equipment has been installed. Truly, sound reinforcement has moved to the status of science from its early position of a trial-and-error art.

In addition to the others named above, thanks go to Mr. William Severns, manager of the Bowl, for his cooperation and for the many courtesies he extended for the preparation of this article.

CARE OF JACKS AND PATCH CORDS

(*from page 20*)

Failure to observe polarity will ground out the high side of unbalanced circuits. It may also throw microphones out of phase in a multiple mike setup, with resulting partial or complete cancellation of outputs. And speaking of polarity, remember when making up new cords or replacing plugs on old ones to pole the plugs consistently at both ends.

Never store cords coiled up. Hang them up vertically to avoid unnecessary strains. Avoid using unnecessarily long cords; they may hang in front of important controls lower down in the rack or dangle in strong hum fields from power supplies. Too short a cord may suffer severe strains from the resulting sharp bend at the plugs. It is customary to have a supply of cords on hand in various lengths differing by increments of two feet.

Some cords are made with the shield grounded to the plug body at both ends. However, modern practice is to ground the shield at one end only to avoid ground loops.[3] If the cords in your plant are grounded at both ends, this can be one possible cause of noise and hum.

[3] Oliver Read, "Recording And Reproduction Of Sound," 2nd Ed., Howard W. Sams & Co., Inc., p. 613.

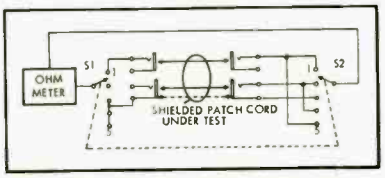

Fig. 3. This test fixture checks patch cords for continuity and shorts.

THE LANGUAD EXPERT

(*from page 19*)

respect to frequency and what?"

I had to think a minute. "With respect to frequency and intensity!" I cried.

"And," said George, "since it features selective recreation of the disparate bass tones and since it captures every minute tonal variation, we are safe in saying that it is the finest system manufactured . . ."

"The finest system manufactured regardless of price!" we finished in unison.

By this time I was feeling all warm and comfortable inside again and sensing that I had reached by level of normal befuddlement. I turned to go. As I skirted a large stack of AUDIO copies on my way to the door, I noticed a small mahogany-grained plastic cabinet perched on one corner of George's desk. It looked vaguely familiar and as I stepped forward for a closer look I experienced the audiophile's sudden shock of loathing upon being confronted with a (ugh!) commercial radio-phonograph combination. I hastily averted my eyes from the hated object and, taking a moment to assume the approved stance of righteous indignation, demanded of my friend, "What, may I ask, is that *thing* doing here?"

"Oh, that," replied George with a patronizing smile. "That is what I listen to. After all, it is unconditionally guaranteed to perform as well as the most expensive system available."

AMPLIFIER USES

(*from page 12*)

full output. It may be necesary to change the polarity of the power line to reduce hum.

These amplifiers are suitable for home use where all that is needed is an amplifier capable of delivering 2 watts undistorted at 60 cps with a flat response from 20 to 20,000 cps. (Below 60 cps there is very little program material and most loudspeakers produce a great deal of harmonic distortion.) As a matter of fact, with the present higher-efficiency loudspeakers and loudspeaker housings an input to the loudspeaker of 2 watts bass is more than enough to reproduce symphony music in the average living room; and continuous operation at this level is sure to make the neighbors complain.

Although it was not tried, it is very probable that by raising the plate voltage in the circuit of *Fig.* 5 to 135, better than 5 watts undistorted power output can be obtained at 60 cps. If a transformer supplying 6.3 volts is available for the filaments, 6Y6's can be substituted for the 50L6's. The cathode-bias resistor of the output stage R_H should then be increased to 120 ohms. A B supply of 135 volts is shown in *Fig.* 6.

Several amplifiers were constructed in accordance with the circuits in *Fig* 4, in which the following transformers were used with excellent results: Stancor A-3825; Thordarson T22S60. A Thordarson 22S74 (costing about $5.00) was used in the circuit of *Fig.* 5 with 6L6's and the following changes: B+, 285 volts; primary impedance, 5000 ohms; R_H, 125 ohms; R_{H_1}, R_{H_2}, 400,000 ohms. With these changes the undistorted power output at 60 cps on the oscilloscope was 11 watts. A Stancor A-3830 was also used in a similar amplifier with the additional change of substituting a 12AX7 for the 12SL7. With the 12AX7 it was found necessary to remove the output transformer, which was not shielded, from the chassis and mount it on the loudspeaker frame, and also to connect a 100-μμf capacitor from the plate of the input half of the 12AX7 to ground to cut out high-frequency oscillation. Despite this, there was a subtle difference in "feel" between the 12AX7 and the 12SL7 in favor of the former.

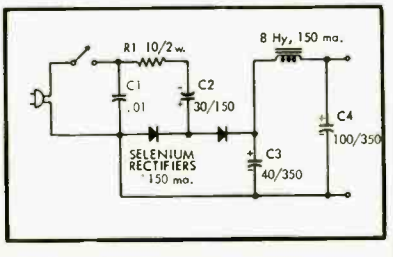

Fig. 6. A 135-volt power supply for the push-pull amplifier.

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Industry People...

Notwithstanding the East's most severe heat wave in years, energetic **Irving Greene,** sales promotion manager for University Loudspeakers, Inc., added to his normal duties the chores of furnishing speakers for the Newport Jazz Festival, delivering a number of lectures before New England civic groups, and engaging in promotional activities for his recently published "New High Fidelity Handbook" . . . Another doubler-in-brass is **Dan Cavalier,** Washington, D. C., representative for A. R. F. Products, Inc., who also heads up Washington's annual High Fidelity Fair: he is already setting up preliminary organizational plans for the Fair scheduled for next Spring.

Mort Lee, sales executive with British Industries Corporation, New York, escaped torrid temperatures with a vacation in England . . . Personnel promotions at Fairchild Recording Equipment Company include **Ruben E. Carlson,** who has been appointed manager of the high-fidelity division, and **Robert G. Bach** who has been named manager of promotion and distribution . . . **Roy G. True** has been appointed executive vice-president and **Richard C. Koch** chief engineer of I.D.E.A., Inc., according to recent announcement by **Edward C. Tudor,** president . . . **E. S. Seeley,** chief engineer of Altec Service Corporation, New York, has been named director of engineering for Altec Lansing Corp.

Arthur L. Foster is newly-appointed sales promotion manager of the Stromberg-Carlson sound equipment division—he will also be responsible for all advertising, working directly with **A. G. Schifino,** vice-president . . . Allied Radio Corporation has appointed **L. M. Burchett** as manager of the firm's stores in the Chicago area—he has been with Allied for a number of years as personnel training director . . . **Phillip L. Gundy,** manager of the audio division of Ampex Corporation, has been appointed a director.

Larry S. Racine, president of Chicago Standard Transformer Corporation, has taken an indefinite leave of absence due to ill health. **William J. Shea,** chairman of the board, will assume the office of president, and **Donald Schwennesen,** vice-president in charge of engineering, will add sales to his responsibilities . . . **Richard C. (Dick) Wells,** widely known announcer and broadcast engineering specialist, is director of the industrial sound department recently established by Newark Electric Company, Chicago . . . Acro Products Company, Philadelphia, has undergone complete reorganization and is now under the sole ownership of **Herbert I. Keroes.** A new program of sales planning is being developed by **Jack Snyderman,** who has been named sales manager.

Industry Notes . . .

Advanced degrees in electronics engineering at Stanford University are available to outstanding electrical engineering graduates on a work-study basis through the Honors Cooperative Program of **Ampex Corporation** and **Stanford University,** George I. Long, Ampex president, announced recently. Under the program participants may obtain a graduate degree at Stanford while earning a living income as employees of Ampex. To qualify a candidate must be a graduating senior with a major in electrical engineering or physics in the top 10 per cent of his class, desire a career in electronics, and be an American citizen able to obtain government clearance.

Three more independent record companies are entering the recorded-tape field, according to a recent announcement by **Livingston Electronics Corporation,** Livingston, N. J., recorded tape manufacturers and distributors. Boston Records, Lyrichord Discs, and Polymusic Records have concluded arrangements with Livingston for tapes of material which has so far been available on disc only.

ADVERTISING INDEX

SIMPLE AS

To make it just as easy as possible for AUDIO's readers to subscribe, order books, get further information about the new products and the new literature mentioned in the pages of the magazine, or to get catalog sheets and brochures describing articles advertised, we provide herewith three cards. We know that many readers are looth to cut coupons from the pages of their favorite magazine because they have told us so. And we know that many times one would like to have complete and thorough data about something he sees in these pages, yet he considers it too much trouble to hunt up paper and envelope—not to mention the stamp—and write a long letter detailing what he wants to know. This is just as simple as we know how to make it with the exception of stenciling each subscriber's name and address on each of the postcards—an operation which would be highly impractical from the printing standpoint. But from now on, when you want more information about something you have seen advertised or mentioned in AUDIO you need only indicate it on the appropriate card, print your name and address, and drop it in the nearest postbox. We pay the postage, and it goes without saying that we wouldn't include these cards if we didn't welcome your use of them. And, for the first time, you can enter your subscription without sending a penny with your order—we'll bill you later. For books, we'll have to ask for the money in advance, but only for books.

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

In just the same way you can get more information about any product that is *advertised* in the pages of AUDIO. But there is a little more work involved in this, since you must indicate the item in which you are interested and the name of the manufacturer. However, you still have to write your name and address only once for all the information you want about advertised items from a single issue—unless you want to know all about everything. If your cards indicate that this is likely to be the case, we will make them larger to fit your requirements. In the meantime, if you do need more space, you might subscribe to two copies.

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At the end of each item of **New Literature** or **New Products** you will notice a letter and a number—the letter indicates the month and the number indicates which item it is. All you have to do to get full information about the product or to get the literature described is to circle the appropriate number, add your name and address—printed if possible, so the information doesn't end up in the Post Office at Washington—and mail it to us. We'll do the rest, and you may be sure that we'll be prompt because we are just as anxious for your inquiries to get to their destination as you are—and besides, we don't have room enough around the office to accumulate a lot of cards. Circle one item, if you wish, or all of them—we'll carry on from there. This whole system breaks down if there is a charge for the **New Literature** described, so if you can suggest any improvements in this service, we would appreciate hearing about them.

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We can't think of any way to simplify this card without actually listing every product mentioned throughout the magazine, and this becomes an impossibility—we don't always get the ads sufficiently far in advance of printing time to make it possible to plan such an elaborate card. So if you want to know more about any product advertised—except from the Classified section—just write down the product and the name of the advertiser as well as your own name and address. We can't promise that no salesman will call, but we think it highly unlikely, because very few manufacturers have enough salesmen to answer all the inquiries individually in person. But we are sure that each manufacturer will be glad to send you the information you want without any obligation. If we find that this card doesn't have enough room for all the information you want, we will have to enlarge it, but let's try this one for size.

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and LOOK...9 more PRIZES, wonderful to WIN!

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WIN the beautiful Peerage console plus 30-watt amplifier, pre-amplifier, remote control and FM tuner and record changer or turntable of your choice!

3 Second Prizes . . . magnificent E-V 15TRX 15-in. three-way speakers!

3 Third Prizes . . . outstanding E-V 12TRX 12-in. three-way speakers!

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