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ICD

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for the HI-FI hobbyist

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How to get better middle-range quality

Audiocraft's 1958 FM Station Directory

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THIS MONTH'S COVER. Perennial harbingers of spring, drowsy-eyed frogs all over America may awake this month to find anxious tape recordists cued to record their first hungry bleatings in full-blown stereo.
Photo credit: Culver Service

THE MAGAZINE FOR THE HI-FI HOBBYIST

MAY 1958
Volume 3 Number 5

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The Grounded Ear

What's new for your future in sound reproduction?

by Joseph Marshall

The KT88 Tube

The KT88 arrived from England about eight months ago and has not yet found wide application in high-fidelity amplifiers. But I have no doubt it is destined for wider usage, for it possesses some of the same virtues which made the KT66 the most popular of all hi-fi output tubes, as well as some of its own, including the ability to deliver up to 75 w per pair with reasonable plate and screen voltages.

From the point of view of the designers (especially the amateur), the most useful and reassuring advantage of the KT88 is its tolerance to widely varying operating parameters. For one thing, it is quite uncritical as to loading; anything between 4,000 and 5,000 ohms primary impedance seems to provide equally good results, and even greater variation downward or upward does not have serious consequences. As a result, an amplifier using these tubes is far less critical in regard to matching with complex speaker systems, especially those with dividing networks or those using electrostatic speakers. Conversely, variations in speaker impedance curves are not nearly so noticeable either to the ear or to instruments.

In a tapped-screen circuit the KT88 appears to work just about as well with screen taps anywhere in the range from 20% to 50%. Some other tubes are quite fastidious in this respect, and will give impaired performance unless the screen feedback is adjusted precisely. It is similarly tolerant in respect to variations in voltage. Screen voltage may be as high as 550 v, which means that in a practical amplifier using this or lower plate voltage the screens can be fed from the same point in the power supply. With about 475 v on plates and screens, a pair of KT88's with fixed bias can deliver up to 75 w with a well-regulated power supply, and an easy 60 w with a practical and simpler power supply.

With the above plate voltages the bias should be 56 v; but, again, a small variation either way does not produce disastrous effects. If bias is adjusted for about 70 ma per tube or 140 ma for a pair, excellent results are obtained with plate voltages between 425 and 500 v.

With fixed bias KT88's can tolerate grid resistors up to 120,000 ohms, rather than the lower values required for some other high-power tubes. This is a big help, for the KT88 needs some 55 v peak drive, which is easier to obtain with high-value grid resistors.

The KT88 is not quite so linear, judging by my experience with it, as the wonderful KT66 — but it is a close second. The distortion curves are very flat and gently sloped right up to the point where clipping begins. It is quite possible with a balanced pair to keep IM distortion below ½% within 1 db of the clipping point.

Although it is too new to have yielded a great deal of performance experience as yet, it appears to be as rugged as the KT66 and to possess the same ability to maintain its characteristics over long periods of use. The latest version of it is actually more compact than the KT66, at least in height. It has only one fault, and that is shared by all high-power tubes: it dissipates a lot of heat. I would not recommend that any amplifier with a pair of KT88's be placed in an unventilated space. Out in the open, or in an open-backed cabinet, a shielded amplifier using the tubes should not get hot enough to cause any damage.

Dynakit Mark III

The performance of KT88's is well exemplified in the Mark III Dynakit, one of the first amplifiers to use them. This is a deluxe version, which delivers 60 w (rather than the 50 of the Mark II) and costs some $10 more. I have been using one for some weeks now and I can recommend it without reservation for any application in which 60 very clean watts are needed. The circuit of the Mark III is identical with that of the Mark II except for a different output transformer, the higher bias, and a few changes in the power supply. Even the feedback-stabilizing capacitances are exactly the same.

It does not seem possible that the very simple front end would be capable of driving these big tubes, but it does so very nicely up to 60 w.

The Mark III has the small common unbypassed cathode resistor for reduction of distortion which is now also incorporated in Mark II's. This actually reduces residual distortion by more than 50%.

Another small refinement which serves two purposes nicely is the .02-μfd capacitor from the center tap of the filament winding to ground. One of its purposes is to make it possible to plug in a Dynakit preamp (which has a hum-balancing potentiometer) without any need for breaking a jumper or unsoldering any connections. However, the capacitor also builds up a small DC charge if there is any heater-cathode leakage in the 6AN8 tube, which then biases the heater string and lowers the hum level.

Another refinement is the 10-ohm resistor wired from chassis ground to the "ground" terminal on the socket to which the preamp is connected. This

Continued on page 43

Dynakit Mark III, which uses KT88's.

More on Thermal Barriers

It seems as if everyone had an idea for a thermal barrier to use when soldering diodes, transistors, etc., but I haven't yet seen in print the obvious one that doesn't require a third hand or other special equipment of any kind.

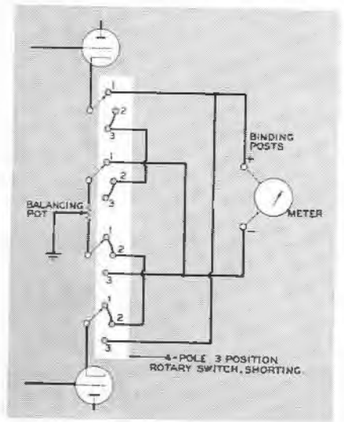
Instead of any special gear, use your long-nose pliers and keep them closed on the lead with a rubber band wrapped around the handles.

L. E. Johnston
Madison, Wis.

Balancing Output Tubes

Many amplifiers, kit, home-brew, or factory-built, contain a pot for balancing output-tube static currents, but no provision for convenient insertion of the meter. Since the milliammeter has to go in series first with one cathode and ground, and then with the other, two circuits have to be alternately opened and closed by unsoldering and resoldering leads until balance is achieved, and the process repeated every time output tubes are changed.

The diagram shows a metering circuit that can be installed in less time than it takes to go through this monkey business once. The balancing pot shown between the cathodes works in conjunction with a fixed-bias output stage, but the switching can easily be adapted to other arrangements. The four-pole, three-position rotary switch should be of the shorting type, to avoid momentarily opening tube circuits. The amplifier plays normally when the switch is in the center position. In position 1, the top current is metered; in position 3, the bottom tube. Be sure to connect the switch so that current always flows through the meter in the same direction.



The binding posts for the meter should be color-coded, red for +, black for −, and insulated from the chassis. If your junk box contains a spare DC milliammeter of the proper range, you can install it permanently on the front panel of the amplifier.

For maximum convenience, place the switch on top of the chassis and wire it so that in either of the metering positions the knob points to the tube being measured.

Hugh Kenner
Peterborough, Ont.

Color-Coded Connections

The number of interconnections involved in the average hi-fi system, which naturally includes signal as well as power connections, is surprisingly large as well as complex. Not only is there the question of proper signal connections but often the additional problem of speaker phasing and polarity of the power connections. In assembling sets for friends or for one's own convenience it is a good idea to use small spots of color to indicate the proper method of reassembly of the set in the event that it must be moved.

This can be done in one of several ways without too much difficulty or expense. An ordinary paper punch, usually of the ¼-inch variety, can be used to punch out dots of color from various shades of adhesive-backed tape, such as Mystick. If enough colors are not available, similar results can be had by securing a supply of pressure-sensitive labels from the stationer and using colored pencils or crayons to color them, punching out the dots afterward. It is not a good idea to use colored cellulose tape since the heat of the set has a tendency to deteriorate the adhesive in a year or so.

If Junior builds models, either planes or trains, he will have a supply of dopes on hand of various colors that can be used in the following way. Place a piece of wax paper backing on the adhesive side of a short length of plastic electrical tape. Punch holes through the tape and wax paper every ¾ in. or so and cut into ¼-inch squares with scissors. Remove the backing and place these above the jacks and on the skirts of the RCA plugs used. These squares may also be placed on the proper side of power plugs and their outlets to insure proper polarity for minimum 60-cps hum. When they are in place use the different dopes to color the masked spots so that proper connections will be indicated. After the dope has dried, remove the tape and a neat dot of color will be the result. On cables equipped with plugs at both ends, such as that connecting the output of the preamp to the input of the amplifier, the same color can be used at both ends of the cable and at both jacks.

Those who find that they have occasion to do this often for friends in assembling sets for them may want to invest in the very convenient set of standard RETMA colors, put out in a neat kit of ten bottles with several brushes, for a little over a dollar (General Cement No. 667, Color Coding Kit). They are a useful addition to the workbench for standard coding jobs.

Edward T. Dell, Jr.
Millis, Mass.

Magnetic Phono Input

It is probable that many owners of the Heathkit WA-P2 preamplifier would rather have an additional magnetic phono input circuit than the MIC input provided. To convert the MIC input to PHONO, it is necessary to provide a loading resistor across the MIC input, and to alter the selector switch connections so that the turnover and rolloff circuits are active in the MIC position.

If you are building the kit, omit step 22 (blue wire to SD10). Instead, install a jumper from SD10 to SD11. This jumper completes the rolloff circuit to ground in the MIC position. In step 50, omit the blue wire connecting SD10 to T5; this is the connection which deactivates the turnover by grounding in the MIC position. Insert a loading resistor (22 K for GE cartridge) across the MIC input, from KS2 to LG (similar to step 83).

If the kit is already built, it is a fairly simple matter to go back and perform the steps outlined above.

References are to the WA-P2 Instruction Book dated 12-14-56.

R. L. Browning
Texas City, Tex.

Built-in Lock Washers

When drilling a chassis for switches, controls, etc., do not remove the burrs. These make excellent lock washers and will hold the parts tightly.

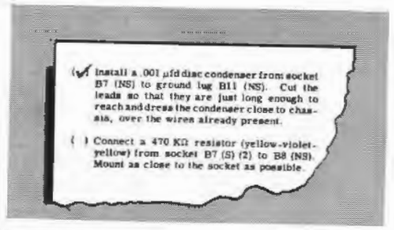
Frank S. Levy
Charlotte, N.C.

easy-to-build

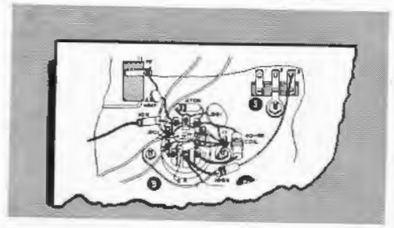
high quality

HEATHKITS®

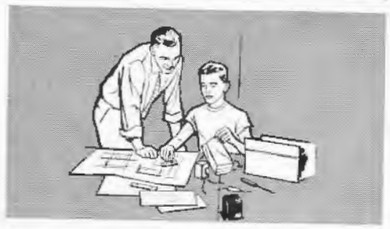
Look . . . how simply you can assemble your very own high fidelity system! Fun-filled hours of shared pleasure, and an everlasting sense of personal accomplishment are just a few of the rewards. Heathkits cost you only HALF as much as ordinary equipment and the quality is unexcelled. Let us show you how easy it really is! . . .



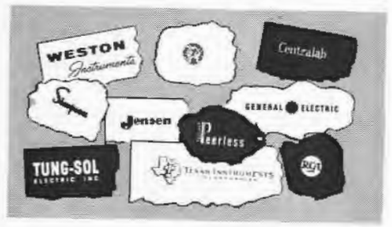
Step-by-Step Assembly Instructions . . .
Read the step . . . perform the operation . . . and check it off—it's just that simple! These plainly-worded, easy-to-follow steps cover every assembly operation.



Easy-to-follow Pictorial Diagrams . . .
Detailed pictorial diagrams in your Heathkit construction manual show where each and every wire and part is to be placed.



Learn-by-doing Experience For All Ages . . .
Kit construction is not only fun—but it is educational too! You learn about radio, electronic parts and circuits as you build your own equipment.



Top Quality Name-Brand Components Used in All Kits . . .
Electronic components used in Heathkits come from well-known manufacturers with established reputations. Your assurance of long life and trouble-free service.

HEATHKIT

bookshelf 12-watt amplifier kit

MODEL EA-2

$27.95

NEW

There are many reasons why this attractive amplifier is a tremendous dollar value. You get many extras not expected at this price level. Rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern" styling, making it suitable for use in the open, on a bookcase, or end table. Look at the features offered by the model EA-2: full range frequency response (20—20,000 CPS ± 1 db) with less than 1% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control—and it's easy-to-build. Complete instructions and pictorial diagrams show where every part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Front panel features brushed gold trim and buff knobs with gold inserts. For a real sound thrill the EA-2 will more than meet your expectations. Shpg. Wt. 15 lbs.

TIME PAYMENTS AVAILABLE ON ALL HEATHKITS WRITE FOR FULL DETAILS

HEATHKIT

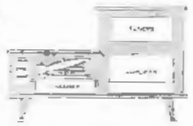
chairside enclosure kit

NEW

This beautiful equipment enclosure will make your hi-fi system as attractive as any factory-built professionally-finished unit. Smartly designed for maximum flexibility and compactness consistent with attractive appearance, this enclosure is intended to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier, along with the majority of record changers, which will fit in the space provided. Adequate space is also provided for any of the Heathkit amplifiers designed to operate with the WA-P2. During construction the tilt-out shelf and lift-top lid can be installed on either right or left side as desired. Cabinet is constructed of sturdy, veneer-surfaced furniture-grade plywood ½" and ¾" thick. All parts are precut and predrilled for easy assembly. Contemporary available in birch or mahogany, traditional in mahogany only. Beautiful hardware supplied to match each style. Dimensions are 18" W x 24" H x 35½" D. Shpg. Wt. 46 lbs.

CE-1C Mahogany
CE-1CB Birch
CONTEMPORARY

CE-1T Mahogany
TRADITIONAL



Be sure to specify model you prefer

$43.95 each

HEATHKIT

high fidelity FM tuner kit

For noise and static free sound reception, this FM tuner is your least expensive source of high fidelity material. Efficient circuit design features stablized oscillator circuit to eliminate drift after warm-up and broadband IF circuits assure full fidelity with high sensitivity. All tunable components are prealigned so it is ready for operation as soon as construction is completed. The edge-illuminated slide rule dial is clearly numbered for easy tuning. Covers complete FM band from 88 to 108 mc. Shpg. Wt. 8 lbs.

MODEL FM-3A $25.95 (with cabinet)

HEATHKIT

broadband AM tuner kit

This tuner differs from an ordinary AM radio in that it has been designed especially for high fidelity. A special detector is incorporated and the IF circuits are "broadbanded" for low signal distortion. Sensitivity and selectivity are excellent and quiet performance is assured by a high signal-to-noise ratio. All tunable components are prealigned before shipment. Incorporates automatic volume control, two outputs, and two antenna inputs. An edge-lighted glass slide rule dial allows easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

MODEL BC-1A $25.95 (with cabinet)

HEATHKIT

master control preamplifier kit

Designed as the "master control" for use with any of the Heathkit Williamson-type amplifiers, the WA-P2 provides the necessary compensation, tone, and volume controls to properly amplify and condition a signal before sending it to the amplifier. Extended frequency response of ± 1½ db from 15 to 35,000 CPS will do full justice to the finest program material. Features equalization for LP, RIAA, AES, and early 78 records. Five switch-selected inputs with separate level controls. Separate bass and treble controls, and volume control on front panel. Very attractively styled, and an exceptional dollar value. Shpg. Wt. 7 lbs.

MODEL WA-P2 $19.75 (with cabinet)

pioneer in "do-it-yourself" electronics

HEATH COMPANY · BENTON HARBOR 18, MICHIGAN

a subsidiary of Daystrom, Inc.

HEATHKIT 25-WATT

HEATHKIT 70-WATT

MODEL W-5M

$59.75

high fidelity amplifier kits

MODEL W-6M

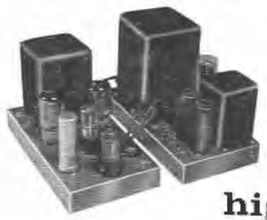
$109.95

To provide you with an amplifier of top-flight performance, yet at the lowest possible cost, Heath has combined the latest design techniques with the highest quality materials to bring you the W-5M. As a critical listener you will thrill to the near-distortionless reproduction from one of the most outstanding high fidelity amplifiers available today. The high peak-power handling capabilities of the W-5M guarantee you faithful reproduction with any high fidelity system. The W-5M is a must if you desire quality plus economy! Note: Heathkit WA-P2 preamplifier recommended. Shpg. Wt. 31 lbs.

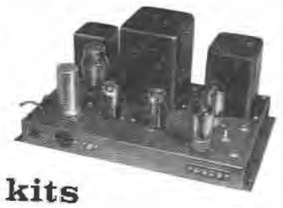
For an amplifier of increased power to keep pace with the growing capacities of your high fidelity system, Heath provides you with the Heathkit W-6M. Recognizing that as loud speaker systems improve and versatility in recordings approach a dynamic range close to the concert hall itself, Heath brings to you an amplifier capable of supplying plenty of reserve power without distortion. If you are looking for a high powered amplifier of outstanding quality, yet at a price well within your reach, the W-6M is for you! Note: Heathkit model WA-P2 preamplifier recommended. Shpg. Wt. 52 lbs.

HEATHKIT DUAL-CHASSIS
MODEL W3-AM
$49.75

HEATHKIT SINGLE-CHASSIS
MODEL W4-AM
$39.75



HEATHKIT



high fidelity amplifier kits

One of the greatest developments in modern hi-fi reproduction was the advent of the Williamson amplifier circuit. Now Heath offers you a 20-watt amplifier incorporating all of the advantages of Williamson circuit simplicity with a quality of performance considered by many to surpass the original Williamson. Affording you flexibility in custom installations, the W3-AM power supply and amplifier stages are on separate chassis allowing them to be mounted side by side or one above the other as you desire. Here is a low cost amplifier of ideal versatility. Shpg. Wt. 29 lbs.

In his search for the "perfect" amplifier, Williamson brought to the world a now-famous circuit which, after eight years, still accounts for by far the largest percentage of power amplifiers in use today. Heath brings to you in the W4-AM a 20-watt amplifier incorporating all the improvements resulting from this unequalled background. Thousands of satisfied users of the Heathkit Williamson-type amplifiers are amazed by its outstanding performance. For many pleasure-filled hours of listening enjoyment this Heathkit is hard to beat. Shpg. Wt. 26 lbs.

HEATHKIT

high fidelity amplifier kit

MODEL A-9C **$35.50**

For maximum performance and versatility at the lowest possible cost the Heathkit model A-9C 20-watt audio amplifier offers you a tremendous hi-fi value. Whether for your home installation or public address requirements this power-packed kit answers every need and contains many features unusual in instruments of this price range. The preamplifier, main amplifier and power supply are all on one chassis providing a very compact and economical package. A very inexpensive way to start you on the road to true hi-fi enjoyment. Shpg. Wt. 23 lbs.

HEATHKIT

electronic crossover kit

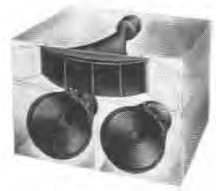
MODEL XO-1 **$18.95**

One of the most exciting improvements you can make in your hi-fi system is the addition of this Heathkit Crossover model XO-1. This unique kit separates high and low frequencies and feeds them through two amplifiers into separate speakers. Because of its location ahead of the main amplifiers, IM distortion and matching problems are virtually eliminated. Crossover frequencies for each channel are 100, 200, 400, 700, 1200, 2000 and 3500 CPS. Amazing versatility at a moderate cost. Note: Not for use with Heathkit Legato Speaker System. Shpg. Wt. 6 lbs.

HEATHKIT "LEGATO"

high fidelity speaker system kit

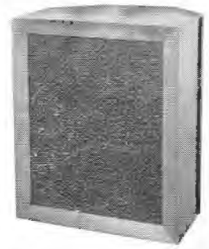
Wrap yourself in a blanket of high fidelity music in its true form. Thrill to sparkling treble tones, rich, resonant bass chords or the spine-tingling clash of percussion instruments in this masterpiece of sound reproduction. In the creation of the Legato no stone has been left unturned to bring you near-perfection in performance and sheer beauty of style. The secret of the Legato's phenomenal success is its unique balance of sound. The careful phasing of high and low frequency drivers takes you on a melodic toboggan ride from the heights of 20,000 CPS into the low 20's without the slightest bump or fade along the way. The elegant simplicity of style will complement your furnishings in any part of the home. No electronic know-how, no woodworking experience required for construction. Just follow clearly illustrated step-by-step instructions. We are proud to present the Legato—we know you will be proud to own it! Shpg. Wt. 195 lbs.



MODEL HH-1-C
(imported white birch)
MODEL HH-1-CM
(African mahogany)
$325.00 each

HEATHKIT
BASIC RANGE

HEATHKIT
RANGE EXTENDING



high fidelity speaker system kits

MODEL SS-1 **$39.95**

A truly outstanding performer for its size, the Heathkit model SS-1 provides you with an excellent basic high fidelity speaker system. The use of an 8" mid-range woofer and a high frequency speaker with flared horn enclosed in an especially designed cabinet allows you to enjoy a quality instrument at a very low cost. Can be used with the Heathkit "range extending" (SS-1B) speaker system. Easily assembled cabinet is made of veneer-surfaced furniture-grade ½" plywood. Impedance 16 ohms. Shpg. Wt. 25 lbs.

Designed to supply very high and very low frequencies to fill out the response of the basic (SS-1) speaker, this speaker system extends the range of your listening pleasure to practically the entire range of the audio scale. Giving the appearance of a single piece of furniture the two speakers together provide a superbly integrated four speaker system. Impedance 16 ohms. Shpg. Wt. 80 lbs.

MODEL SS-1B **$99.95**

Free Catalog!

Don't deprive yourself of the thrill of high fidelity or the pleasure of building your own equipment any longer. Our free catalog lists our entire line of kits with complete schematics and specifications. Send for it today!

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pioneer in "do-it-yourself" electronics

☐ Please send the Free HEATHKIT catalog.

☐ Enclosed is 25c for the New HI-FI book.

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city & state

ALSO SEND THE FOLLOWING KITS:

QUANTITY	ITEM	MODEL NO.	PRICE

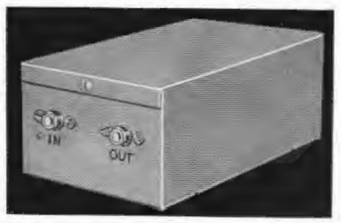
Enclosed find $ ..... Please enclose postage for parcel post—express orders are shipped delivery charges collect. All prices F.O.B. Benton Harbor, Mich. NOTE: Prices subject to change without notice.

Audionews

REVERBERATION UNIT

Ultron Company is marketing the *Model U-2* reverberation unit, which is designed to produce an illusion of stereo presence without the necessity for dual-channel inputs.

The U-2 is connected to the output of a power amplifier in a conventional system, and provides a controlled phase



Stereo effect from monaural source.

shift over the audio range. Its output is fed to an auxiliary amplifier and speaker (which may be a radio or phonograph) and, according to the manufacturer, the result simulates the effect obtained with more costly stereo installations. Price: $18.75.

STEREO MAGNEMITE RECORDER

A stereo version of Amplifier Corp. of America's completely self-powered lightweight precision tape recorder, the Magnemite, has just been announced. Three single-speed models of the *Stereo Magnemite* are available: 3¾ ips, 7½ ips (meets secondary NARTB standards), and 15 ips (meets primary NARTB standards). Weighing only 17 lbs. and with dimensions of 8½ by 11 by 10 in., the Stereo Magnemite has bat-

Lightweight portable stereo recorder.

tery-operated dual recording and playback amplifiers. Batteries are said to last 100 operating hours.

Independent gain adjustment is provided for each channel, with provision for stereo headphone monitoring. Output of the recorder can be used to drive ordinary stereo or monophonic amplifiers or control units. A removable flywheel maintains a claimed flutter content of 0.1% over a full winding cycle of the spring-driven motor. Recordings may be made while the machine is in motion.

HEATH CATALOGUE

Several new recently added products bring the total number of Heathkits to well over 100. All are described in the latest catalogue, available free of charge, from the Heath Company. Kits include hi-fi and amateur radio equipment of all types, and a complete line of test equipment.

ACOUSTIC RESEARCH AR-2

The *Model AR-2* speaker system, with a 10-inch woofer and two 5-inch tweeters, is only 13½ by 24 by 11⅜ in. over-

AR-2 is an acoustic-suspension system.

all, yet the manufacturer invites direct A-B comparison with systems of any size and considerably higher price. Air sealed within the enclosure provides the elastic restoring force for the woofer, an arrangement designed to reduce bass harmonic distortion. This acoustic suspension system is the same as is used in the AR-1. Both systems are products of Acoustic Research, Inc.

H. H. SCOTT 99-D AMPLIFIER

The price of *Model 99-D*, a 22-watt control amplifier from H. H. Scott, Incorporated, is $109.95 east of the Rockies — *not* $99.95, as was announced in our March issue (p. 12).

E-V STEREO CARTRIDGE

Electro-Voice has announced production of a low-cost ceramic stereo cartridge for playback of the 45/45 Westrex-system stereo discs. It is said to be compatible with monophonic discs, and virtually to eliminate the vertical rumble component from the stereo playback. The cartridge is provided with a diamond stylus approximately half the size of the ordinary one in use now. Cost of the cartridge is $19.50.

FM TUNER — KIT OR WIRED

EICO's *HFT 90* FM tuner is available either completely wired or in kit form with prewired, prealigned front end. Performance features include an "eye-tronic" indicator for accurate tuning, fly-wheel tuning, automatic gain control, broad-band ratio detector, full-wave rectifier, and heavy filtering. A 300-ohm input, outputs for cathode follower and multiplex, and controls for TUNING and VOLUME are provided. Sensitivity is said

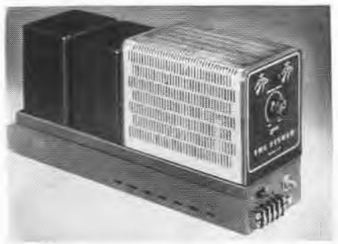
FM tuner is equipped for multiplex.

to be 1.5 μv for 20 db quieting and 2.5 μv for 30 db quieting, with full limiting from 25 μv; stated frequency response is ±1 db from 20 to 20,000 cps. Other manufacturer's specs include: IF bandwidth — 260 Kc at 6-db points; stability — maximum drift of 20 Kc from cold start, stable after approximately one minute; and hum — 60 db below 1 volt. In kit form, the tuner is $39.95, and wired, it is $65.95; a cover for it costs $3.95.

FISHER 30-WATT AMPLIFIER

Fisher's new *Model 100* high-fidelity amplifier is designed to supply 30 watts of continuous power with 70 watts on peaks. The stability of the amplifier is said to be excellent because of controlled frequency response above and below the audible range, with good transient characteristics under adverse conditions. According to the manufacturer, harmonic distortion is less than 1% at 30 watts,

For more information about any of the products mentioned in Audionews, we suggest that you make use of the Product Information Cards bound in at the back of the magazine. Simply fill out the card, giving the name of the product in which you're interested, the manufacturer's name, and the page reference. Be sure to put down your name and address too. Send the cards to us and we'll send them along to the manufacturers. Make use of this special service; save postage and the trouble of making individual inquiries to a number of different addresses.



Amplifier supplies 70 watts on peaks.

with intermodulation distortion less than 1% at 30 watts peak and with inaudible hum and noise. A push-pull power-amplifier stage with three feedback loops for low internal impedance, the Fisher Z-Matic variable-damping-factor control, and an impedance-matching switch for 4-, 8-, and 16-ohm speaker systems are included. The control panel is brass-plated and a matching cage is available. Dimensions of the 100 are 11½ in. wide by 15½ deep by 7 high. The price is $119.50 (slightly higher in the far West).

BASS-REFLEX CABINETS

Assembled bass-reflex cabinets are available in two sizes from Country Workshop. Made of solid poplar, these cabinets have brass-tipped legs and are sanded, ready to finish as you wish. The front panel has cutouts for a 12-inch speaker and reflex vent, or can be supplied with cutouts to order. Both cabinets are 16 in. deep and 29 in. high over-all; the 24-inch-wide unit costs $25.95, and the model 36 in. wide costs $35.95.

BOGEN FOUR-SPEED PLAYER

Lower in price than preceding models, the *Model B-21* manual record player has been improved in performance, according to the David Bogen Company.

The B-21 can play any record up to 12 in. in diameter, and each of the four standard speeds can be varied within a 5% range by the user. Simple and positive start-stop provisions, a serrated rubber turntable pad, a four-pole motor, and a universal plug-in head are also featured.

Price of the B-21 is $25.95 without a cartridge. It is available equipped with various cartridges and styli at higher prices.

Each speed can be varied up to 5%.

Readers' Forum

Gentlemen:
. . . I am a new subscriber to AUDIOCRAFT having just become overwhelmed by the possibilities of high-fidelity reproduction in the fall of this year. Since then, I have read all of your past copies (which are on file at the local public library). I've avidly read each page and "ad" of each issue and although not sure at all of any really technical reasons, feel a little more able to judge equipment from the many articles of yours I have read. For those of us having to build our outfits from kits and on limited funds, your articles have proved most valuable . . . .

Russel W. Van Norman, M.D.
Peoria, Ill.

Gentlemen:
As a serious student of audio (for about a year now) and a recent subscriber after six months of newsstand buying of AUDIOCRAFT, I wish to express my sincere approval and liking for the content of your magazine. From the standpoint of one interested enough in the subject to want to know what makes things tick, to keep abreast of new developments, new products and thinking on the same, and who wants to learn enough to build kits and assemble components with authority — AUDIOCRAFT has many of the answers in its varied content. I particularly enjoy the opinions expressed on new products and your analysis of some of them; also your reviews of records. In ads regarding new records the writers' superlatives are often misleading and the opinions both musically and technically that your reviewer gives are a guide that one feels can be trusted.

Charles Munro
Carpinteria, Calif.

Gentlemen:
Why all the fuss about making loudspeakers inconspicuous such as painting the horn of the midrange and tweeter black? In my opinion, a well-engineered speaker is a thing of beauty, and if it were practical, my speakers would be out in the open for all to see and admire.

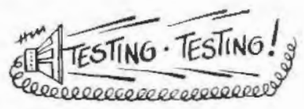
Let me add, however, that the opinions expressed in this letter are not shared by my wife.

Ronald S. Stewart
Detroit, Mich.

Stereo-Disc Compatibility

THE HOTTEST SUBJECT in audio is still stereo disc records. In the middle of March, as this is being written, there is no longer any doubt concerning the standard method by which stereo on discs will be accomplished — it will be, basically, the 45-45 system proposed by Westrex. What *is* being argued heatedly is the question of compatibility, and with good reason.

In a conventional LP record all the information is recorded laterally; there is no vertical movement of the cutter at an audio rate. Ideally, a pickup stylus to play such a record should have to be able to move only in a lateral direction. But because the cutting stylus is shaped like a pointed chisel, the groove becomes narrower at high cutting velocity as the stylus moves sharply sidewise. The playing stylus, which must have a generally circular cross section to minimize record wear, is forced upward slightly as the



V-shaped groove narrows. The effect is particularly pronounced toward the inside of the record, where the smaller diameter results in slower lineal groove motion that accentuates the sharpness of the lateral excursions.

Still, the vertical excursion capability required of the playback stylus for laterally recorded discs is extremely minute. Designers of pickup cartridges have concentrated on obtaining linear stylus motion in the lateral plane, together with minimum dynamic stylus mass and high lateral compliance. These properties in the vertical plane have been usually considered to be unimportant, so long as the stylus could move vertically a bit at high frequencies. Consequently, variations in these respects among cartridges of different manufacture have been considerable.

Stereo discs have quite a different set of playback requirements. The information represented by the vertical component of groove motion is just as important as that of lateral motion, and — more important from the compatibility viewpoint — vertical groove excursions are very much greater than in conventional LP's. Any stereo playback cartridge ideally should have a stylus mechanism with just as much compliance and excursion capability, and just as low dynamic stylus mass, for motion in any given direction as for motion in any other direction. Provided stereo-pickup designers succeed in keeping these properties comparable in magnitude to the corresponding lateral properties of our best present-day pickups, the new units certainly will be able to play conventional LP's; they may even do a better job of it than our old pickups. There is no question on this aspect of compatibility.

The disagreement concerns whether or not standard pickups can be, and if so should be, used to play stereo records. At first thought the answer would seem to be yes, since in-phase components of the two stereo channels produce lateral modulation of the stereo-record groove. A standard pickup, responsive only to lateral groove motion, would obtain a composite monophonic signal from the stereo-disc groove. The trouble is that the stylus, even while producing output only for the lateral component, must follow the vertical component as well. Many conventional pickups can do this but, in doing it, will they wear the record enough to spoil it for future stereo playback? Will the records stand up under repeated use even for monophonic playback? How serious is the loss of quality when a stereo disc, compared to a conventional LP of the same thing, is played by a monophonic cartridge that is stiffer than average in the vertical plane?

No one really knows the final answers to these questions. But they are important, because they will determine how long record companies will have to issue both monophonic and stereo versions of each new release, and accordingly how long we will have to pay premium prices for the stereo versions. There is a sharp division of opinion; some record companies have committed themselves to dual lines, while others have stated that they are not decided, or found no problem of compatibility and will change over completely to stereo discs.

Beginning very soon, AUDIOCRAFT will publish a series of articles on the results of tests made to determine some practical answers to the questions of stereo-disc compatibility. — R.A.

Build this

by Lee Beeder

Presence Filter

to smooth and improve your middle-range response

IN GERMANY, so I've read, "*3-D Klang*" is the expression employed to describe a fine audio system. It's roughly synonymous, I gather, to our "high fidelity"; at least, what our high fidelity meant before it began to be used as a label for $39.95 phonographs. In any event the expression has an intriguing sound, and it connotes, to me, low distortion, level response, and smooth listenability. And no portion of the audible range is more in need of *3-D Klang* than the very important middle range.

I realize that the primary concern of the audiophile seems to be the bass — that part of the audio range containing what are referred to half-facetiously, yet with some justification, as the "expensive notes." Usually, though, he perseveres, and despite a bewildering number of choices available he finally selects a snitable bass enclosure.

Presumably the bass has been taken care of. But what of the rest of the audio range? If we think of music as analogous to a great cathedral, we have completed only the foundation. If the topmost half of the spire represents the extreme treble range handled by a tweeter, all the rest is left to the middle-range reproducer. The stained-glass windows, the mighty pillars, the tower with the sonorous bells, the altar with the flickering candles, the nave with the statues of the saints — all these, and more, represent the middle range of music.

Now, viewed in this light, it seems desirable to pay some attention to proper middle-range performance. This can be done quite inexpensively as follows: take the middle-range frequencies out of the woofer enclosure by selecting a low crossover point; install a tuned filter in series with the voice coil of the middle-range speaker; and finally, mount the speaker on a small sand-filled baffle placed on top of the woofer enclosure. Removing the middle-range freqnencies from the bass enclosure allows the woofer to handle only the low bass without leapfrogging back and forth with the middle-range speaker in the troublesome octave between 350 and 700 cps. Of conrse, if the crossover is higher than 700 cps, the two-point-source effect can be even worse. The tuned filter will flatten the worrisome peaks that occur so often in both direct-radiator and horn-type middle-range speakers. I know that these are sometimes referred to as "exciting presence peaks"; but that is certainly a matter of opinion. I believe a rise in the 2,000- to 4,000-cps area is always undesirable and out of place. If you do nothing else suggested in this article but make and install one of these filters, I think you'll be glad you gave it a try.

Fig. 1. Mounting board for midrange speaker and filter built by the author.

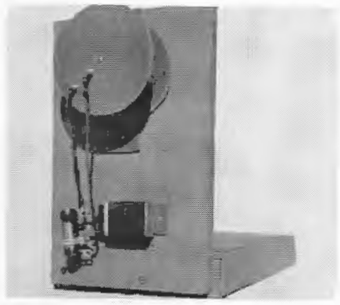
As for mounting the middle-range speaker on a baffle separate from the woofer enclosure — there seem to be very good reasons for doing so. You can then move the baffle back and forth nntil you get the sound source of each speaker in the vertical plane. With both speakers bolted to the same baffle, this is in many cases impossible. When the sound sources of both speakers are nor as nearly as possible coplanar, you might notice some slight phase differences (particularly with a low crossover frequency). Also, the back wave of the speaker (if a cone type) can be utilized, the walls acting in a fashion analogous to an orchestral reflective shell.

I used a direct radiator for the middle range because it matched my cone-type woofer. If you have a horn for the bass, you'll probably want a middle-frequency horn too, although a horn for use with a 325-cps crossover will be quite large.

The baffle for my middle-range cone, shown in Fig. 1, is a simple 2-by-2-foot piece of ¾-inch sand-damped plywood. It might be larger but it should not be any smaller; a 2-foot-square size has an acoustic cutoff right around the electrical crossover point. The baffle is attached to a sand-weighted base and has a simple stick, acting as a prop, which rests against a board secured to the back of the base. This board holds the tuned filter mentioned earlier.

Fig. 2 is a larger view of the filter, and Fig. 3 is the schematic. The filter is tuned to about 3 500 cps and is very effective in removing peaks around, and to both sides of, this freq'ency. The ranges below 1,000 cps and above 5,000 cps are affected little if at all. An oscillogram showing its really remarkable smoothing effect is shown in *Sound Reproduction.** If you think your resonant peak is higher in frequency, use the same values for the resistor and capacitor but use a coil of lower inductance. The resistor can be made variable in value to adjust the amount of peak suppression;

Fig. 2. A closer view of the filter shows coil, capacitor, and resistor.



*G. A. Briggs, *Sound Reproduction* (Yorkshire, 1953), pp. 27-30.

a 50-ohm, 25-watt rheostat will serve very well.

Figs. 4 and 5 show the layout of the baffle, snbject, of conrse, to any changes necessary to make it fit your middle-range unit. The cutout should not be in the center of the baffle, because speakers so placed usually give very poor acoustic results. Also, a speaker mounted near the bottom of the baffle is closer to the woofer, which helps to eliminate any two-source sound effects.

Construction of the baffle is quite simple. All that is required is to nail strips of cleating (approximately ¾ by 1½ in.) around the edges and fill the enclosed space with dry sand. Then, after putting gun-type calking compound on top of the cleating, add a top. I used ⅛-inch hardboard for the top, which is obtainable from any lumber yard at less than a dollar for a piece 2 by 4 ft. in size. The hardboard is nailed securely in place and that is that. You'll notice that I cut off all four corners of the baffle, which isn't necessary.

After this, the baffle is mounted with wood screws to a weighted base about 8 in. wide, 13½ in. long, and 1¾ in. thick. The base can be made of a sand sandwich bnilt in the same way. It is made so that the baffle, when mounted, tilts back slightly. Then a stick of wood is cut as a brace for the baffle (which is moderately heavy). This stick rests against a board secured with wood screws to the back of the base, on which I have mounted the tuned-filter components.

This more or less completes the carpentry work. All that remains is to drill the holes to be used for mounting the speaker. The speaker, when mounted, can be covered in the back with a porous cloth which acts as a dust catcher, yet offers the speaker's backwave very little opposition.

The crossover network is, to me, one of the most fascinating parts of a speaker system. The network shown in Fig. 6 is a parallel, 12-db-per-octave type, using air-core coils and oil-filled capacitors. This is the type used in many of the very best speaker systems. We need two coils and two capacitors for a two-way crossover; the values shown are for a 16-ohm speaker system crossing over at 350 cps. You probably have your own ideas for a crossover arrangement between the middle-range nnit and your tweeter.

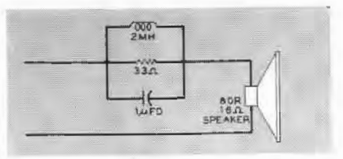


Fig. 3. Schematic of presence filter with values for 3,500-cps resonance.

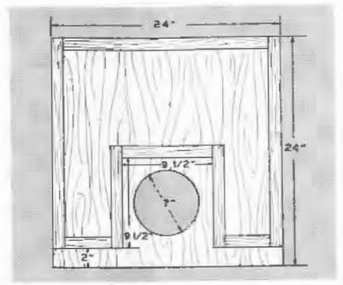


Fig. 4. Dimensions of speaker baffle. Cut hole to fit speaker you plan to use.

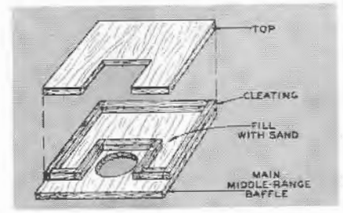


Fig. 5. Exploded view of baffle shows how sand is held in place with cleating.

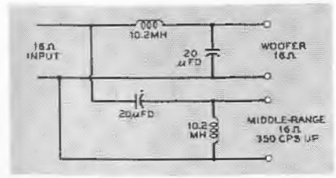


Fig. 6. Schematic for 350-cps crossover using air-core coils and oil capacitors.

For 8-ohm speakers it will be necessary to halve the inductor values and double the valnes of the capacitors. At 350 cps this is 40 μfd for the capacitors and 5.1 mh for the coils.

These coils, from 2 mh to 10.2 mh inclusive, are wound with No. 17 single-cotton covered wire on wooden dowels (such as a piece of broomstick) 1 in. in diameter and 1½ in. long. End pieces for the coil forms are round pieces of wood or hardboard 4 in. in diameter and attached to the dowel with solid brass screws. Fig. 7 is a drawing of the coil form. Turns of wire necessary for the inductance values mentioned are as follows: 10.2 mh—627 turns, 2 mh—322 turns, and 5.1 mh—477 turns.

The wire is sold in one-pound spools costing about $1.62 each. One spool will furnish about 350 turns on the form. Splicing another spool to the first will give you up to 550 turns. From this you can see that the 2-mh coil can be wound, almost exactly, from one spool. while the pair of 10.2-mh coils will take about five spools. It might be a good idea to get six spools; then you'll be very sure of having enough. No special winding technique is observed; just wind fairly tightly and make good, tape-covered splices.

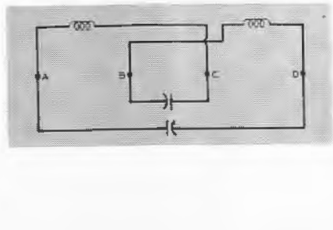


Fig. 8. Wiring diagram for crossover. Text explains how connections are made.

The oil-filled capacitors, which are virtually free from deterioration, can be obtained quite inexpensively (less than $2.00 each) from many surplus outlets, as well as several radio and hi-fi dealers. I'd try getting them from these sources, because the net prices from the usual retailers are quite high.

Thus, the cost of the tuned filter and the 350-cps network — figuring two 20-μfd capacitors and seven spools of wire — will be about $17.00. This, totaled with the $4.00 or $5.00 worth of materials required for the middle-range baffle, gives us a grand total of about $22.00. That amount, when compared with what it buys, is practically insignificant.

The next thing to do is mount the crossover network components on two 6-by-13½-inch pieces of wood screwed together at right angles. The capacitors are mounted in the center and the coils at the ends. In this way the coils are monnted at right angles to each other and 12 in. apart (to minimize interaction), and about 5 in. from the nearest magnetic metal. The coils are mounted with solid brass screws. Leads to the components are brought out to four terminals marked A, B, C, and D. A and B are the input terminals, B and C are the woofer terminals, and the range from 350 cps up is taken off at terminals B and D. Fig. 8 shows how these connections are made.

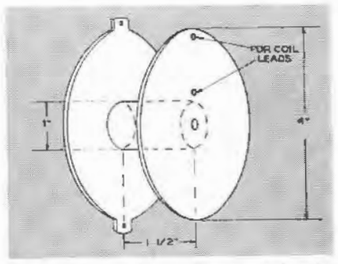


Fig. 7. Forms for coils may take this shape. End pieces: wood or hardboard.

Next, if you wish, the network may be covered with a medium-weight material, allowing only the terminals to protrude. This will keep the dust out and enhance the appearance. The middle-range baffle can also be disguised or dressed up as you choose.

Prepared by Hirsch-Houck Laboratories

AUDIOLAB

Test Reports

An objective analysis of high-fidelity components

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WEATHERS K-730D TURNTABLE AND PICKUP

The unit tested was a combination turntable and pickup, mounted on a wooden base. The turntable and pickup are available separately, and will be treated individually in this report.

Pickup

The Weathers FM pickup is no newcomer to the hi-fi scene. For several years it enjoyed a reputation for top-quality performance combined with a certain amount of fragility and need for frequent readjustment. A number of design improvements were made in the oscillator and arm, and all units manufactured in the last three years have been free from the "orneriness" which plagued the early models.

The operation of the Weathers pickup involves an oscillator operating at a frequency in the region of 20 megacycles. In the cartridge is a small fixed electrode and a movable one attached to the stylus assembly. These form the plates of a capacitor, whose spacing varies as the stylus follows the groove modulation. This capacitor forms part of the tuned circuit in the oscillator, and changes in its capacitance affect both the frequency and amplitude of the oscillation.

The modulation of the oscillator causes its plate current to vary, and this effect is employed to obtain an output voltage proportional to the stylus displacement (not to its velocity, as in the case of magnetic pickups). The oscillator unit contains RC networks which modify the constant amplitude response to give a flat output from an RIAA equalized record, or to the equivalent of a constant velocity response for subsequent equalization in a conventional preamplifier. A slide switch on the oscillator unit selects either type of output equalization.

The compliance of the stylus is unusually high (14×10^{-6} cm/dyne) and its mass is very low (1 milligram). For

Weathers K-730D turntable and arm.

many years these important design parameters were well in advance of anything available in cartridges of conventional design, and only now are some of the finest magnetic cartridges approaching these figures. Because of the high lateral compliance, the Weathers pickup tracks at very low stylus forces. The pickup assembly includes a small sable brush which rides on the grooves ahead of the stylus and removes dust which would otherwise clog the stylus gap. A portion of the downward force exerted by the pickup is absorbed by this brush. In the case of the unit we tested, the pickup force was 2.5 grams, yet the actual force of the stylus on the groove was only 1.7 grams. This was determined by lifting the pickup with a Weathers stylus gage while it was playing a record and noting the force which was required to lift the stylus from the groove while the brush remained in contact with the record.

The accuracy of equalization of the Weathers pickup was checked by playing the RCA Orthophonic test record, No. 12-5-49. This covers the frequency range of 30 to 15,000 cps, recorded with an accurate RIAA characteristic. The result of this measurement is plotted in the accompanying curve. In general, it is excellent, with only a slight dip in the 6- to 7-Kc region to mar it slightly. It should be remembered that few preamplifiers are more accurate in their equalization, even when coupled with a perfect cartridge.

The output of the RIAA-equalized Weathers is approximately 3 v for a signal of 7 cm/sec at 1,000 cps. This is more than enough to drive any power amplifier to full output, and if the power amplifier is equipped with a volume control, no preamplifier is needed. For those who prefer to have tone controls, loudness controls, and the like, the Weathers' output should be connected to the AUX input or other high-level input of most preamplifiers.

For the purist who is not satisfied with RIAA equalization or who possesses records which employ widely different equalization characteristics, the output of the Weathers oscillator unit may be switched to MAG and fed to the magnetic cartridge input of the preamplifier. A word of caution is in order here. The output on MAG is approximately 40 mv at 1,000 cps, 7 cm/sec. On peaks it may well reach levels of several hundred millivolts. This will overload many preamplifiers and cause distortion. Be sure that your preamplifier has a level control ahead of the equalizing stage and keep it turned well down. We would consider it wiser to employ the built-in equalization of the Weathers unit and drive the AUX input, which usually has a level control ahead of any amplifying stages.

To check the response of the pickup over the entire audio band we played the Elektra 35 test record. This sweeps continuously from 20 Kc to below 20 cps, with no high frequency pre-emphasis and RIAA equalization below 500 cps. When this is played with the MAG setting of the oscillator, it can be seen that the response is very smooth and peak free, except for a gentle rise of some 3 db in the 12-Kc to 20-Kc region. We did find a very sharp peak of 3 db or so at about 18 Kc, which would not have shown up on any but a continuously sweeping test record. It, of course, was not audible under any conditions.

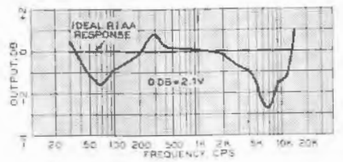
This and other measurements made on this pickup which were made with sweeping test records, were recorded on an oscilloscope camera with a very slow horizontal sweep. These photos, which accompany this report, are very useful for disclosing peaks and holes in the response, but cannot be relied upon for absolute response measurements since they are not calibrated in frequency.

The Weathers arm is as unusual as the pickup. It is made of wood, and is very light but easy to handle. The pivots are viscous damped in both vertical and lateral planes. The pickup may be raised to an angle of approximately 45° and released, and will float gently down to the record. It is unusually easy and pleasant to use in spite of its apparent delicacy.

The main purpose of viscous damping is to damp the low-frequency arm resonance. A cartridge with such a high compliance as this one has would be expected to have a very low resonant frequency, even mounted in such a light arm. We used a Components 1109 test record, which sweeps from 100 cps down to 10 cps, but were unable to find any resonant peak. Either it occurs below 10 cps, or is completely damped out, or both.

Although the Weathers oscillator is self-powered, hum is conspicuous by its absence. Listening under a number of different conditions failed to disclose the slightest hum — only a smooth hiss at maximum gain and dead silence under any usual listening conditions. Measurements confirmed this, with a noise level of —77 db relative to the 1,000 cps, 7 cm/sec output level. Absolutely no hum could be measured.

Needle talk was low, though not so low as that of several high-quality magnetic cartridges we have used. The arm is not laterally balanced, but is very nearly so. As a result, leveling is not critical so long as it is within a few



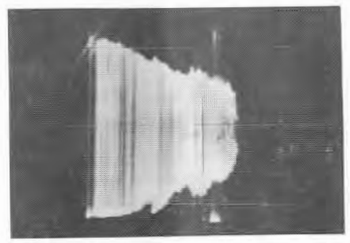
Weathers pickup and oscillator response to RCA 12-5-49 test record (RIAA eq.).

degrees of horizontal. Adjustment of the oscillator is simple, with instructions pasted on the bottom of the turntable base. Our test unit was in perfect adjustment as received, but we went through the procedure anyway.

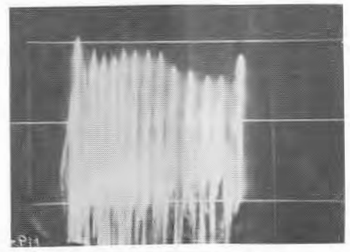
Turntable

It is obvious that Paul Weathers is not bound by convention in designing his products. This was further emphasized when we examined his unusual new turntable.

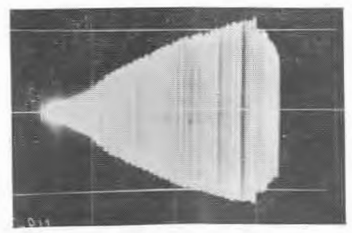
Conventional turntables are heavy, precision-machined discs, weighing from 5 to 25 pounds, and driven by rather bulky motors which are mounted on complex vibration isolators. When a high order of speed constancy is needed, a hysteresis-synchronous motor is used. This is larger, heavier, and much more expensive than the four-pole motors found in lower-priced turntables and record changers. The chief difference between the various makes of turntables is in the manner of driving the turntable, and in the design details of the motor mounts. Gear drive, inside idler drive, outside idler drive, and belt drive are used, with no clear advantage to any one of them.



Glide tone, 300 to 20 cps.



RIAA equalized, 15 Kc to 30 cps.



Max. level glide tone, 20 Kc to 20 cps.

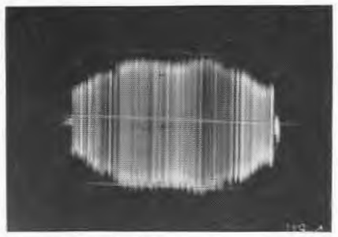
Oscilloscope traces showing response of the Weathers pickup and oscillator to Popular Science Test Record No. 2 do not show any significant resonances.

In practically every respect, the Weathers turntable is the opposite of any of the more conventional ones. Instead of a heavy and expensive motor, turning at 1,800 rpm, it uses a diminutive synchronous motor, with 12 poles, which turns at 600 rpm. It is in essence a glorified clock motor, and measures about 2 in. in diameter and ¾ in. deep. The massive turntable is gone, and in its place is a drawn aluminum platter whose weight can be measured in ounces instead of pounds. Instead of a ½-inch- or ¾-inch-diameter shaft, the turntable revolves on a small ⅛-inch shaft set in a Teflon bearing. There is no idler wheel, with the usual rumble components it contributes. The motor shaft drives the turntable directly, on its inner rim, via a soft gum wheel which is pressed on the motor shaft. This wheel may be easily and inexpensively replaced when it shows signs of wear.

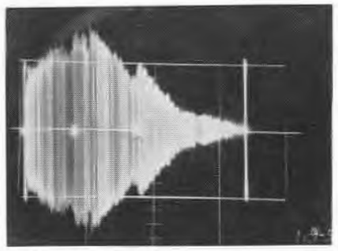
With no heavy turntable or motor to be supported, the need for a heavy motor board vanishes. The Weathers motor board is a light sheet of aluminum, gold anodized to match the turntable itself. The entire turntable assembly is floated on very resilient springs, with plastic-foam damping material surrounding them. The entire system has a resonant frequency of about 3 cps, which completely eliminates the possibility of acoustic feedback from speaker to pickup. This was confirmed in practice when we used this turntable and pickup in a system which had been plagued with severe acoustic feedback. With the Weathers system, the gain and bass tone control could be fully advanced without running into difficulty.

The entire Weathers system, comprising the turntable, pickup, and oscillator, was mounted on a simple black wooden base. The motor switch is a mercury switch mounted on the side of the base. It is smooth and quiet in operation. The total weight of this system was approximately 10 pounds. Most conventional turntables weigh from 20 to 50 pounds.

In the form described, this is a single speed turntable, operating at 33⅓ rpm from a 60-cps power line. We understand that an electronic drive unit will be made available which will permit operation at all standard speeds. The fact that the motor requires only 5 w instead of the usual 15 to 25 w of the larger



Normal level glide tone, 30 cps to 15 Kc. Response is down 3 db at 15 Kc, and 5-6 db at 30 cps. No peaks are apparent.



Elektra No. 35 test record. Slow sweep from 18.75 cps to 20 Kc. No resonances.

motors should make the electronic drive system relatively inexpensive.

So far it might seem as if the chief claim to fame of the Weathers turntable is its light weight and low cost, which should certainly make it desirable for portable systems as well as fixed installations. Our tests show, however, that it can meet or exceed the performance specifications of practically any conventional turntable on the market.

We measured wow and flutter, using the Components 1106 test record. Flutter was 0.1%, mostly at freqnencies above 200 cps. Wow was about 0.15%, though once per turntable revolution there was a sudden peak of 0.25% wow. This apparently was due to an eccentricity of the turntable itself. Neither wow nor flutter was audible in any listening test we were able to apply.

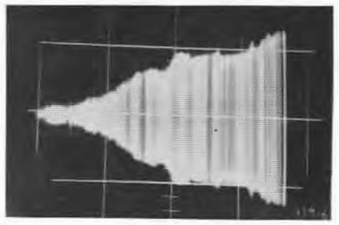
Rumble was measured with the Components 1108 test record. The unweighted reading was —40 to —45 db, relative to 7 cm/sec recorded velocity at 1,000 cps. With the Popular Science Test Record No. 1, which also has a section of silent grooves, we measured —40 db. These measurements were made using the RIAA equalization of the Weathers oscillator. To appreciate those rumble figures fully, one must realize that the basic rumble frequency of this turntable is 10 cps instead of the usual 30 cps found with four-pole motors. Some 20-cps rumble was also observed, but it was predominantly 10 cps. Due to the lack of sensitivity of the human ear at very low frequencies, the audible effect of 10-cps rumble is much less than that of 30-cps rumble. Also, there are a number of speaker systems which will deliver some output at 30 cps, but none which can produce the slightest audible sound at 10 cps. In other words, the rumble of the Weathers turntable is absolutely inaudible under any conditions which we were able to apply, including the use of large amounts of bass boost.

The speed of the turntable is very constant, and nearly exact when using the Weathers pickup. The stroboscope pattern indicated the speed to be slightly high, with the pattern rotating once in four or five minutes. With another pickup tracking at 6 grams, the speed was exact. The turntable maintained exact speed down to a 20-volt line, and would start up easily from line voltages as low as 70 v. After hours of continuous operation, the motor was barely warm to the touch. Most phono motors run very warm, but we have a feeling that this one could be left running continuously with no ill effects.

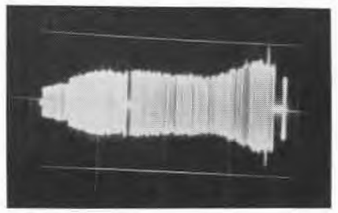
Summary

Based on these laboratory and listening tests, we conclude that the Weathers system, separately and collectively, ranks with the very finest available. The pickup is characterized by smoothness and freedom from resonance and peaks at any part of the spectrnm. Its listening quality is easy, transparent, and effortless.

The turntable, representing a radical approach to the design problem, offers phenomenally low rumble levels, excellent speed accuracy, and wow and flutter levels on a par with other fine turntables.



Components 1109 test record. Slow sweep from 100 to 10 cps. No arm resonances.



Elektra No. 35 test record. 200 cps to 20 Kc, with oscillator set in MAG position.

The remarkably low noise level of the pickup system makes it possible to use relatively inexpensive amplifying equipment and obtain a system noise level unmatched by the most expensive preamplifiers when used with magnetic cartridges.

Despite its light construction, the turntable does not appear to be delicate. The pickup, of course, must he handled with respect, but this would apply to any high-quality pickup. The unusually effective shock mounting of the motorboard makes the system impervious to the effects of jarring and vibration, as well as acoustic feedback.

Manufacturer's Comment: We feel that the report is exceedingly well done and does represent an accurate review of our product. There are a few comments which we would like to make. Recommended tracking force for the Weathers pickup is 1.0 to 1.5 grams. Unfortunately the force was slightly high for the tests (1.7 grams) but the results would have been exactly the same if the pickup had been tested in our recommended range of tracking force. The tone arm is accurately balanced. If the over-all force had been 2 or 2.25 grams instead of 2.5 grams, the balanced condition would have resulted.

Our quoted rumble specifications are measured according to NARTB methods. With this method, frequencies below 20 cps are cut off. This is the reason for our figure being much higher than the 45-db "unweighted reading" reported by the reviewers.

GENERAL ELECTRIC PA-20 AMPLIFIER

The GE Model PA-20 is one of a group of competitive amplifiers delivering in the order of 20 w and selling for about $100. It offers several novel and unique features which serve to set it apart from its competitors, however.

From the outside it appears to be a rather conventional "flat" amplifier, with a brown leatherette-finished case, and an attractive brushed-gold panel with black knobs and accents of blue. The controls are conventional, including BASS and TREBLE tone controls, a function selector with several phono equalization

General Electric PA-20 amplifier.

characteristics, radio input, and two auxiliary inputs, plus separate level and londness compensating controls. Two smaller knobs control the power to the amplifier and a rumble filter.

A close look at the panel reveals that two inconspicuous holes permit access to level controls for the AUX 1 and RADIO inputs by means of a small screw driver. This convenient location allows these level adjustments to be made after the amplifier has been permanently installed, even if the rear of the amplifier is no longer easily accessible. No level controls are provided for the phono or AUX 2 inpnts, and the instructions make it clear that the other levels are to be set to match the phono level.

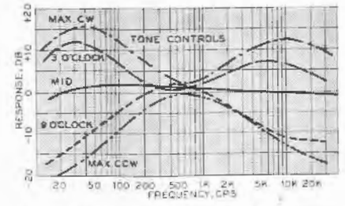
A unique characteristic of the PA-20 is its "convertible" feature. The preamplifier and power amplifier/power supply are on separate chassis, fastened

together by a U-shaped metal cover and electrically connected by a short cable and an octal plug. The two units, joined together, are supplied in a case and of course may be used in that form. For installation in a cabinet, the metal cover may be removed and the two joined chassis mounted on a shelf in the usnal horizontal position. In some installations it may be desirable to mount the unit with its panel in a horizontal plane. Most amplifiers built in this form are qnite deep (this one is 12 in. deep), which may be inconvenient in a limited cabinet space. Also, when the output tubes are horizontally mounted, as they are in this and most other "flat" amplifiers, positioning the amplifier vertically is likely to cause excessive heating and short life for the tubes and other components.

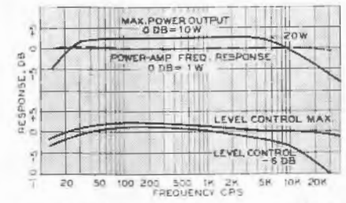
The PA-20 solves this problem rather neatly. The two chassis are detached and the preamplifier, with all the controls, is mounted vertically (with the panel horizontal). An extension cable is available, which allows the power amplifier to be located in a suitable position for proper cooling, and with the tubes upright and on top.

The rumble filter in this amplifier is also a little out of the ordinary. Most such circuits either employ one or two RC sections of high-pass filtering which remove as much low-frequency signal as they do rumble, or use feedback circuits which sharpen the cutoff but put the maximum rejection frequency at the mercy of a number of component tolerances which may add up to produce a less effective rumble filter than the designer intended.

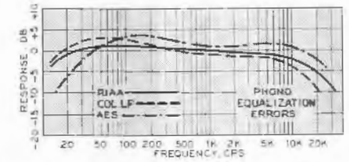
The PA-20 employs an LC filter which produces a 12 db/octave slope below 50 cps. It is located in the LO MAG phono input and therefore is effective only with phono cartridges connected to that input. Although the instruction booklet implies that it will function properly only with GE cartridges, our measurements made with a 600-ohm generator impedance confirmed the published cutoff curve, and listening tests with a low-impedance cartridge (Fairchild 225A) proved its effectiveness. This is one of the few rumble



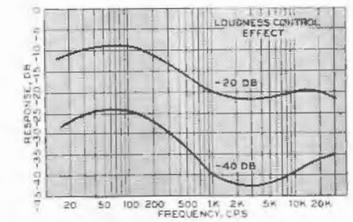
Bass and treble tone-control response.



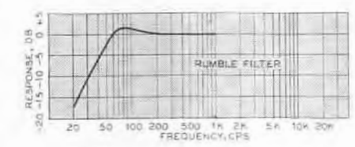
Power and frequency response, and level-control characteristics at two settings.



Deviation, phono equalization network.

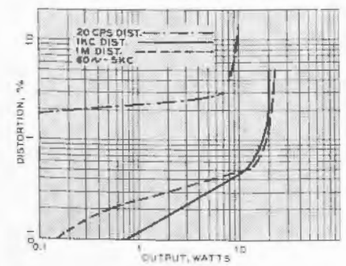


Loudness contours at two settings.



Slope of rumble filter cutoff.

IM and harmonic distortion.



filters we have seen which are truly effective in removing rumble yet produce absolutely no audible loss of low frequency in music. It is unfortunate that it is not usable with the RADIO input to remove some of the rumble which appears in broadcast program material with disturbing frequency.

One of the things about the PA-20 which made a most favorable impression on us was not a part of the amplifier at all. We refer to the instruction booklet which accompanies it. It presents unusually complete installation and operation instructions, which leave virtually nothing to the imagination or previous experience of the user. The technical data pertaining to the amplifier's performance is complete and (as we found) accurate. A second, abridged instruction booklet is provided for the beoefit of the nontechnical user who does not do his own installation. It presents clearly the operating instructions for the amplifier, without technical details which might prove confusing.

Test Results

Our test of this amplifier included the routine measurement of frequency response, tone-control characteristics, power output, and distortion. These data are plotted on the accompanying curves.

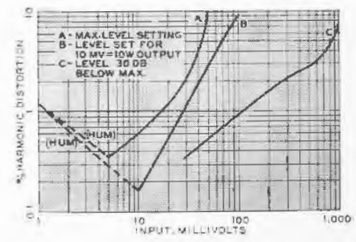
The frequency response with the tone controls in the indicated flat setting was suitably flat. A separate response curve was run on the power-amplifier section, and proved to be nearly flat enough to be drawn with a straight edge. The midrange maximum power output was 20 w (the published rating), but fell off appreciably at the ends of the spectrum. It seemed particularly deficient in the extreme highs, being able to deliver less than 5 w at 20 Kc.

The level control of this amplifier is a 1-megohm potentiometer, and it suffers from a fault common to amplifiers which use such high-impedance level controls. When the control is set to a level 6 db below maximum, there is a considerable loss of high-frequency response due to capacitive loading of the control by the following stage. In this case the response fell 4 db at 10 Kc and 7.5 db at 20 Kc, as compared to the response at maximum level setting.

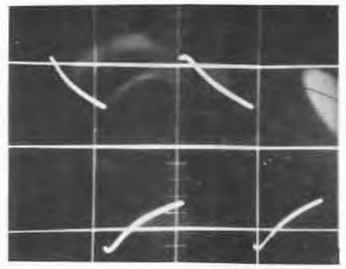
The phono equalization is quite accurate, and in the case of the RIAA curve, notably smooth throughout its range. The loudness control is capable of considerable compensation, although we found it a bit "tubby" if a great deal of compensation was used. The use of separate level and loudness controls on the front panel is very convenient and permits complete flexibility in setting up the conditions most pleasing to the individual listener.

The distortion curves show that the PA-20 has truly negligible distortion at middle audio frequencies at the levels

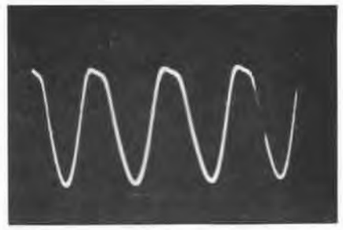
Distortion in phono preamplifier stages.



1-Kc input-output Lissajous trace at 20% overload through power amplifier only.

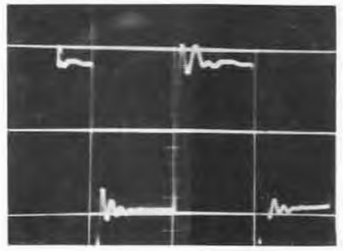


60-cps square waves.

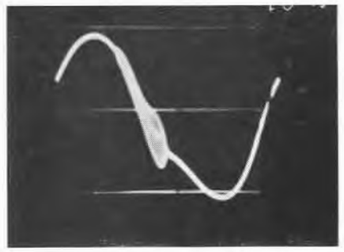


10-Kc wave with 3-μfd capacitor load in parallel with 8 ohms. Output, 1.5 w.

Same as above, but including preamp.



10-Kc square waves.



20-cps wave at 10 watts output.

usually used in home music systems. The IM distortion, measured with frequencies of 60 and 5,000 cps, is also very low up to nearly rated output. The distortion curve taken at 20 cps, however, points up a weakness of this amplifier which was suggested also by the power-response curve. The 20-cps harmonic distortion never falls below 2% down to outputs as low as 0.1 w, and breaks sharply at 7 w. The output transformer is apparently inadequate to maintain the 20-watt performance down to these low freqnencies. Although there is little or no 20-cps content in musical program material, we do not consider it desirable for an amplifier to have a high residual distortion at very low frequencies and low power levels.

We also measured harmonic distortion of the phono preamplifier stage, including the following level control and stage of gain driving the tape output jack. These curves reflect the distortion level as a function of input signal level at 1,000 cps to the LO MAG input, (RIAA), with level set at maximum, at 30 db below maximum, and at the reference level used in our hum measurements (10 mv input for 10 w output). From these data we conclude that the PA-20 can handle extremely large phono cartridge signals without appreciable distortion. When the level control is reduced to the settings which one would normally employ with a high-output cartridge, the input signals can go as high as several hundred millivolts without clipping or other severe distortion. In addition, a HI MAG input provides a better than 2:1 reduction in signal before it reaches the preamplifier stage.

The hum levels meet or exceed the published specifications. A hum bucking adjustment is available to minimize hum. In general, its optimum setting is different for the different inputs, but since it is normally needed most on PHONO, it should be adjusted for a minimum of hum on PHONO. In practice, the hum level of this amplifier is completely inaudible.

The unused inputs are not shorted out by the input selector, and there is an appreciable amount of crosstalk from RADIO to the two AUX inputs, and somewhat less to the phono inputs. The crosstalk would be greatly reduced if low-impedance sources were connected to these inputs, as probably would be the case.

Hum and Noise

Ref: 0 db = 10 w output

Input	*RIAA Phono*	*High Mag*	*Aux 1*	*Aux 2*	*Radio*
Sensitivity	4 mv	10.5 mv	0.15 v	0.15 v	0.15 v
Hum and noise					
Input open	−53 db	−55 db	−80 db	−74 db	−76 db
Input shorted	−58 db	−55 db	−80 db	−80 db	−80 db
At reference gain	−65 db	−55 db	−99 db	−99 db	−95 db
At minimum gain	−80 db				
Crosstalk	−50 db	−50 db	−33 db	−37 db	

The deficiency in high-frequency power capability was further emphasized when a 3-μfd capacitor was connected as a load to the 8-ohm output terminals, to simulate an electrostatic speaker. The maximum output into this load was only 1.5 w at 10 Kc. Use of such a speaker with this amplifier would not be advisable.

Capacitive loads of 0.15-μfd to 0.5-μfd caused high-frequency oscillation. These values are not likely to be encountered in any practical installation, since even the longest runs of speaker cable would have much less capacitance than this.

The scope photos show further evidence of high-frequency instability under conditions of overload (such as 10 w output at 20 cps), and a fairly considerable amount of high-frequency ringing on a 10-Kc square wave.

The damping factor was measured as 4.6. This is adequate for practically any speaker system, and is a reasonable value for an amplifier with tetrode-connected output tubes.

The 6L6GB output tubes are conservatively operated at 82% of their rated maximum plate and screen dissipation. The filter capacitors, in operation, are running well below their rated voltages, but during warmup are subjected to an overload of 11% to 13% for a few seconds. Power-line leakage current was only 12 μa.

A final criticism of the PA-20 is directed at the problem of servicing the preamplifier section. This is formed of a sheet of metal bent at an acute angle, with the controls enclosed in this angle. From our examination of this unit, we could not see how these controls could be replaced without bending the chassis to straighten it out, since the clearance behind the controls was appreciably less than the length of their shafts. Perhaps there is a simple approach to the problem, but it reminds us of the automobile manufacturers who seem to build the car around the radio and leave it to the ingenuity of the serviceman to get it out without destroying it or the car!

Summary

The GE PA-20 is an attractive, unusually flexible amplifier. It is thoughtfully laid out (from the user's viewpoint). It is clean sounding, has exceptionally low hum, and a rumble filter that really works. It comes with very clear and complete instructions, plus thorough and accurate physical and electrical specs.

Due to the limited low- and high-frequency power-handling ability, it should not be used with low-efficiency speakers or with electrostatic speakers. With speakers of average or higher efficiency, it is unlikely that the amplifier would ever be overloaded; under these conditions it sounds very clean and pleasant.

Manufacturer's Comment: This is a clear, objective review. For its high-frequency power rating, the PA-20 design was based on the well-known studies of energy distribution of music by Sivian, Dunn, and White. These show peak sound pressures in the 15,000- to 20,000-cps range are at least 10 db below those at middle frequencies. Thus, a maximum rating of 2 w properly handles those high-frequency peaks. The PA-20's measured 5 w are better than twice this required power. GE felt that added high-frequency power was unnecessary because of the cost factor, and the limit of 15,000 cps on most human hearing.

The October 1956 *AES Journal* reports that in an average-sized living room, with a very low-efficiency speaker instantaneous peak levels rarely surpass 2 w. This reflects GE planning of the PA-20's power-response curve. The same balance was kept on 20-cps performance, since there is no known recorded music below 30 cps.

GE designed the PA-20, as the review indicates, for optimum performance and flexibility consistent with moderate price.

GRAY 212 TONE ARM

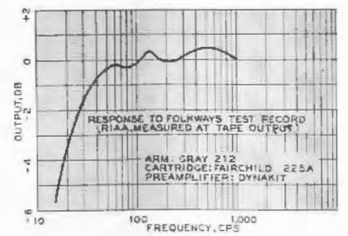
The Model 212 is the latest in the series of viscous damped tone arms which Gray has produced for the high-fidelity market in the past ten years. Its predecessors, the 108B and 108C, have enjoyed considerable popularity, due in part to the unique "feel" which viscous damping imparts to an arm.

The earlier arms employed a single pivot point, with the same amount of damping applied in vertical and horizontal planes. They were not balanced around a vertical axis, and therefore had to be operated on a carefully leveled motor board; their pivot design was such that they tended to relevel themselves automatically in the event of a slight error in motor-board leveling — thus causing a nonperpendicular stylus angle.

The new Model 212 arm employs separate vertical and horizontal pivots, each having the optimum amount of viscous damping. The arm is balanced in the horizontal plane, making the leveling of the motor board less critical. The lateral pivot is rather heavily damped, in order to eliminate the low-frequency

The Gray 212 tone arm.

arm resonance. The damping on the vertical pivot is much less, to permit tracking warped records without "digging in" on the high spots or leaving the groove on the low spots. This situation could easily occur in the earlier designs when the damping adjustment was set for a large amount of damping. Presumably because the individual pivot damping of the Model 212 has been set for optimum conditions, no damping adjustment has been provided on the new arm.



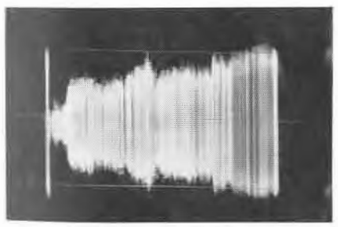
Folkways test-record response.

The design of the Model 212 reflects an increasing trend toward widely separated vertical and lateral pivots. The portion of the arm containing the cartridge is the only part which can move vertically, and the pivot is only about 2½ in. from the stylus. The basic advantage of this design is the reduction of vertical mass to a minimum, which is desirable in the interests of low record wear.

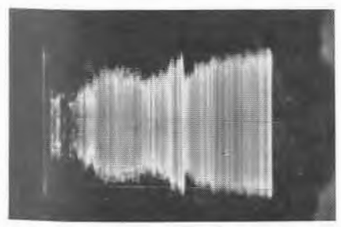
The main body of the arm is constrained vertically, and is free to move only in the lateral plane. It is balanced about the lateral pivot by an adjustable counterweight at the rear of the arm. Within the arm is a spring whose tension may be adjusted to obtain the desired tracking force with the cartridge installed. The viscous damping of the lateral pivot is very considerable. When holding the arm and trying to rotate the pivot assembly, one at first feels that the bearing is "frozen." Of course, it is a property of viscous damping that the damping force is proportional to the velocity of the sliding surfaces relative to each other. At the slow rates involved when tracking the spiral grooves of a record, the resistance of the damping material can hardly be detected.

The head of the arm is equipped with a plug-in slide which contains the cartridge. It will accommodate practically any standard cartridge with ½-inch

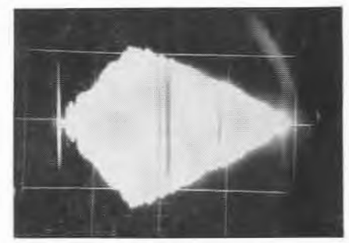
Continued on page 42



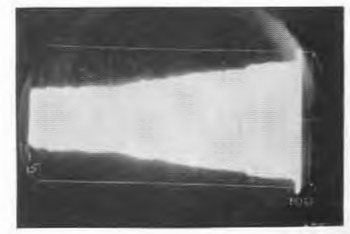
Popular Science test record No. 1. 10- to 150-cps glide tone.



Popular Science test record No. 1. 20- to 300-cps glide tone.



Popular Science test record No. 1. 10-cps to 10-Kc glide tone.



Components 1109 test record. 10- to 100-cps glide tone.

The Arkay SA-25 STEREO Control Center

An **audiocraft** *kit report*

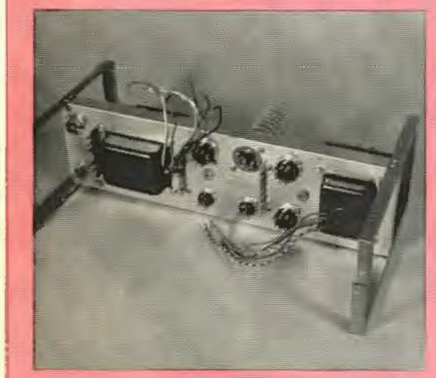
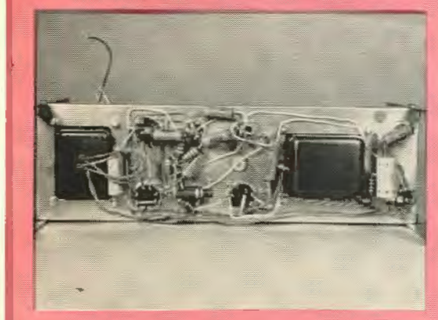


Fig. 1. The Arkay SA-25 is assembled in stages. This is the main chassis unit, with tube sockets and transformers in place. Nothing has been wired as yet.

Fig. 2. Here is the main chassis after connecting wiring has been completed. Open construction of the SA-25 places components within easy reach of tools.



IN THESE DAYS of fast moving research, with tape stereo growing in popularity and disc stereo just around a designer's corner, it is interesting to witness the multitude of dual-channel amplifiers and preamps now appearing in the catalogues and on showroom shelves. Such a unit is the Arkay SA-25 Stereo Control Center, whose features embody much of the current thinking about control units adequate for *both* stereo and monaural sound. The SA-25 is a 25-watt amplifier of "Super Linear" design, a switching center for tape or disc stereo and a variety of speaker assemblies, and *two* preamplifiers, both of which provide complete equalization facilities for three commonly encountered disc playback curves (LP, RIAA, and European) as well as tape heads. One of these preamps is followed by complete tone-shaping facilities and a power amplifier; the other is followed by a volume control and terminates in a cathode-follower output.

Tone control on Channel 1 is, however, a versatile function in the SA-25. In addition to standard BASS and TREBLE knobs (which provide, at maximum rotation, a specified 16 db of bass and treble boost or attenuation) the Channel 1 preamp contains a HI filter slide switch (which provides a choice of 6 or 12 db cut at 10,000 cps), and a LO switch of similar construction which drops 60 cps by the same amounts. Both of these switches have a center OFF position which removes them from the circuit when their action is not desired.

Furthermore, Channel 1 has the type of LOUDNESS control which is built around a rotary switch, and gives an increasing degree of compensation when rotated through its five positions.

Both channels have individual FUNCTION (selector) switches, with identical markings. Four positions on each switch connect the proper components into the feedback equalization loop around the phono/tape preamplifier stages. The remaining two positions route to the TUNER and AUXILIARY high-level inputs. Thus, each channel may have three switchable inputs connected at all times, a feature of labor-saving importance if the SA-25 is built into a wall or bookcase.

The two channels also have separate pilot lights, with the Channel-1 jewel lighted whenever the main power switch is thrown. There is a separate slide switch for Channel 2, which activates the Channel-2 pilot light and FUNCTION switch simultaneously. Although there *are* two switchable AC outlets on the back panel, both are activated when the main power switch (located on the VOLUME control) is thrown. This means that when Channel 2 is deactivated, the separate amplifier being fed by Channel 2's output must be turned off by its own power switch.

A single VOLUME-control knob is connected to a ganged potentiometer which alters the sound level of both channels simultaneously. Thus, once the channel balance has been established by external level-set controls, simultaneous volume control can be maintained in both channels through the action of the SA-25 control.

Of course, such well-thought-out convenience features have their paradoxical drawbacks. What does one do if his separate power amplifier has no input level set? Well, he adds one, presumably. On the other hand, a level control in the SA-25 Channel-2 output would have successfully banished this problem for all time. The home builder shouldn't find such an installation to be much of a problem, and it would increase the usefulness of the SA-25 tremendously.

One final feature of the SA-25 deserves mention. It is the fourth front-panel slide switch, which splits the output transformer's 8-ohm line into two branches and routes them to either of two taps on the rear panel. The user then may connect speakers placed in different rooms permanently to the speaker taps on the SA-25, and turn the speaker in one room off and the other one on at the same time by flicking a switch on the Control-Center front panel. Needless to say, for users who maintain such an arrangement, switch throwing beats screw-driver piloting any day of the week.

The Circuit

Circuits in the Arkay SA-25 are conventional in just about every respect. The schematic on page 26 shows that two identical input stages and their controlling function switches. In each channel, the TAPE-MAG input is connected to the grid of the first-stage preamplifier (a 12AX7) tube. Feedback equalization between the stages is selected by the FUNCTION switch which leaves the TUNER and AUX inputs hanging in mid air while the TAPE-MAG input is in use. The input impedance of each TAPE-MAG input is set at 100 K, but this value can easily be changed.

When the TUNER or AUX inputs are used, the first stage is bypassed and the inputs connected to the second-stage grid. Following this stage in Channel 1 are the HI and LO cut switches, the LOUDNESS control, and the tone controls. At this point, Channel 1 also provides a TAPE-MONITOR output which directly precedes the tone controls, but which *follows* the HI and LO cut slide switches. Presumably, the tape recordist would want to subdue record scratch, turntable rumble, and hum while *recording* his records as well as while purely listening.

Following the second stage in *both* channels is the ganged VOLUME control, located immediately after the tone controls in Channel 1 and the Channel 2 ON-OFF switch. The Channel-2 VOLUME control precedes a single triode (6C4) rigged as a cathode follower.

The Channel-1 VOLUME control feeds a 12AT7 amplifier/split-load phase inverter with the former direct-coupled to the latter. Since such an arrangement cannot produce sufficient low-distortion drive for the 6L6 output tubes, a 12AU7 is used as a push-pull driver stage. The screens of the output tubes are connected to separate taps on the output transformer primary, in what Arkay calls a "Super Linear" configuration. A single feedback loop from the 16-ohm tap on the traosformer is returned to the first-stage cathode.

The power supply, too, is straightforward, with a 5U4GB rectifier providing 435 v to the output tubes. All filaments are operated on AC, but a potentiometer across the filameot line is center tapped to a plus potential of 35 v. This satisfactorily renders hum inaudible at listening levels.

Construction

Because of its multiplicity of functions, the Arkay SA-25 is not a kit to be assembled in one evening. The total building time for the model pictured on these pages was in the neighborhood of 23 hours, one hour of which included final voltage checking, tube insertion, and checking to ascertain that the unit was operating normally, that no parts were inadvertently omitted, and that all leads were correctly placed and properly soldered. It was noted during this checking process that five connections remained unsoldered. Referring back to the instruction manual, two were found to be an oversight on our part, while the remaining three were holdovers from an earlier construction step which ordered NS (do not solder) and was not later followed by S. When an instruction manual is as long as this one (20 pages of step-by-steps) it is understandable that a mistake or two should manage

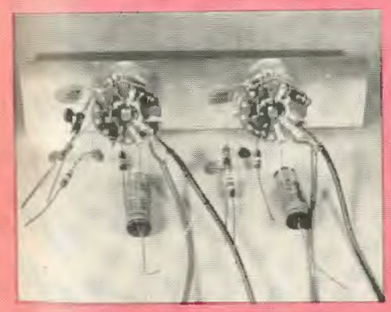


Fig. 3. Function switches are attached backwards until soldering is completed.

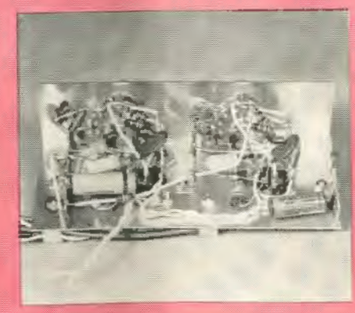


Fig. 4. Here is the subchassis, with switches installed and wired in place.

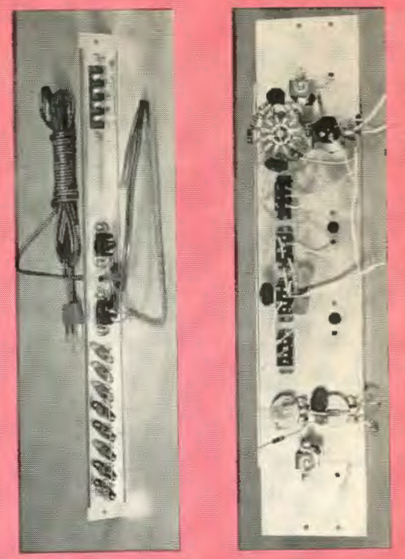
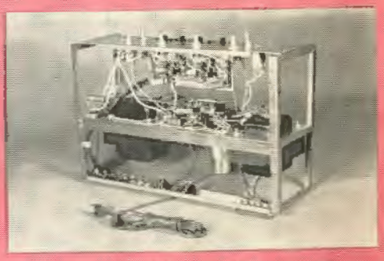
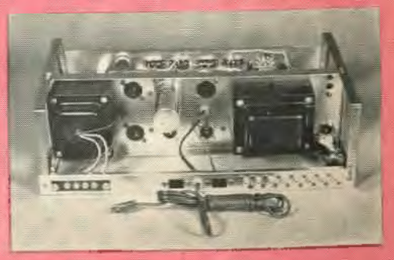


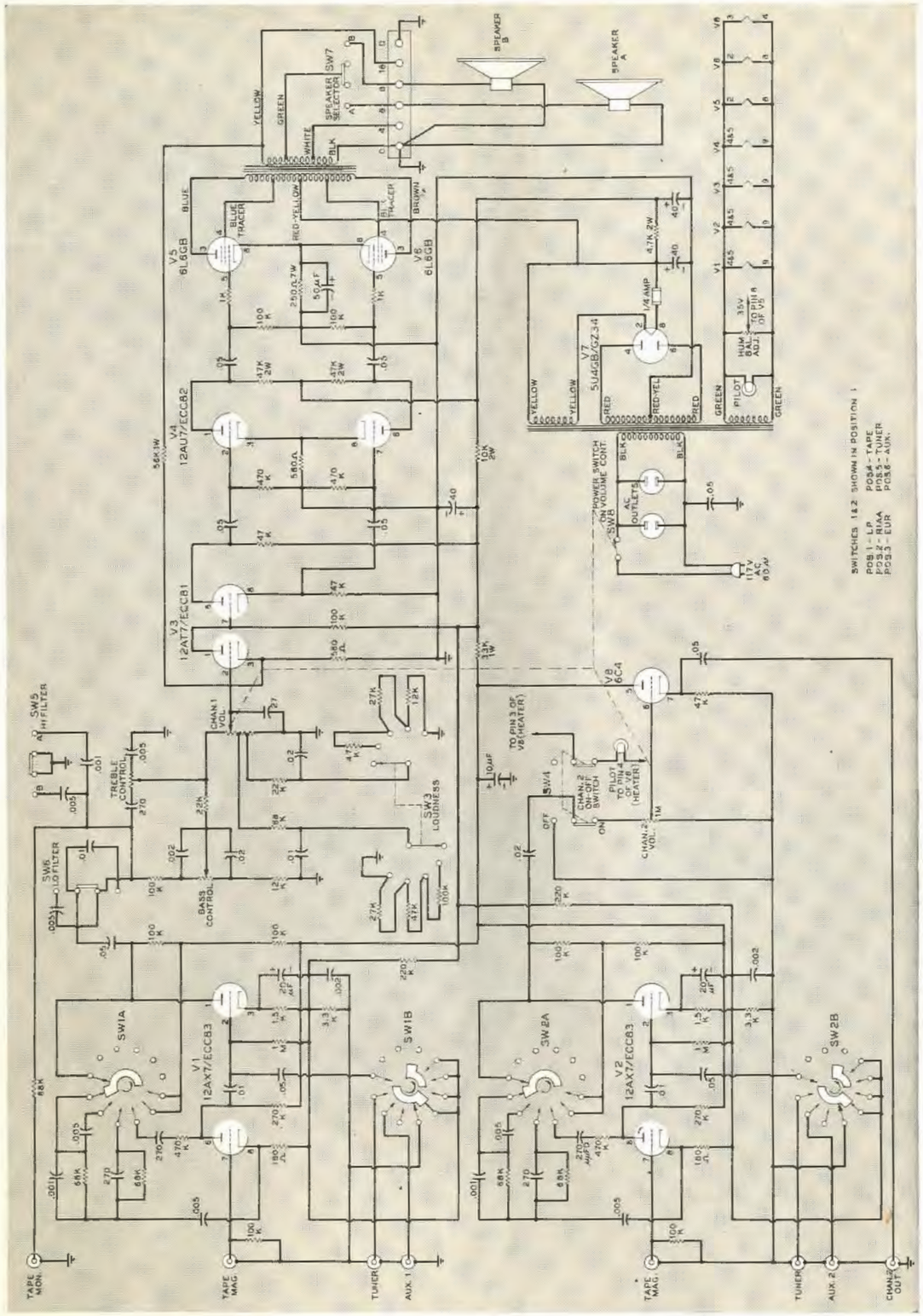
Fig. 5. Rear (left) and front panels are shown following preliminary wiring.

Fig. 6. Two views of front panel show subassembly bolted and wired in place.



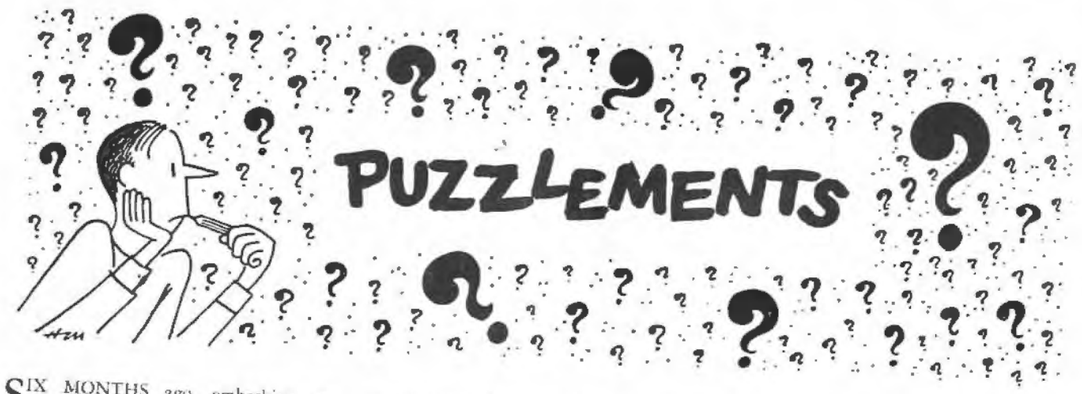
Figs. 7 and 8. The completed amplifier, here shown from two positions. Note the open frame construction, and manner in which subassemblies are finally joined.





How can stereo effects be achieved with monophonic sound sources?

by NORMAN H. CROWHURST



SIX MONTHS ago, embarking on the first of this series, it seemed like a good idea. In planning anything like this, of course, the first few have to be written before the author has any idea of how it will be received. As I write this, the first three have appeared and certain responses have been received.

Concerning the first one (November), about electrostatic loudspeakers, the most violent response was from a reader who was shocked that I should waste time writing about a loudspeaker that wasn't even a loudspeaker. I guess you just can't win with some people. Here we have thousands of electrostatic loud-

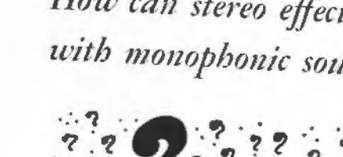


Fig. 1. Electronic crossover splits sound ahead of power amplifiers. This is not true stereo, but is an aural illusion.

speakers being sold, and this guy didn't even recognize that they exist!

The second one (about stereo) drew much more response, mostly from people who wanted to ask further questions — although one reader wanted to tell me I just don't know how stereo works at all. The third one, about different kinds of loudspeakers, brought two letters in the first mail and several others since. One of the first two was from Paul Klipsch, defending the existence of Doppler distortion (I have no argument with him about this, but more of that another time), while another was from a reader who thanked me for explaining some matters that had always confused him.

So there's room for more about stereo and loudspeakers, but I still have a list of subjects to be covered for a first time around. There certainly is no danger of running out of material for this column just yet, but if you have a particular puzzlement please write in. I will undoubtedly get around to all of them in turn.

On the stereo question, many of the inquiries suggest that we need to clarify just what stereo really is, rather than deal with specific puzzlements. Then many obscurities will resolve themselves.

For example, some inquire whether stereo could be achieved by using an electronic crossover unit and feeding its output through separate amplifiers to loudspeakers placed in stereo fashion, Fig. 1. This idea actually amounts to nothing more than cutting a two-way loudspeaker in half and putting the two sections in different corners of the room, so that the bass comes from one side and the treble from the other.

It will succeed in making the sound different from the same two-way loudspeaker all in one piece. But the result will not be stereophonic. The bass frequencies have insufficient directionality in the average living room to be definitely associated with their loudspeaker. The higher frequencies, on the other hand, *will* be definitely associated with the portion delivering them. But there will be some separation that will become evident in the region of crossover frequency because of the distance between the bass and treble units. This will give a sense of spread like a very large multiunit speaker, but is really nothing like a true stereophonic illusion. There will be no real effect of separation between individual musical instruments.

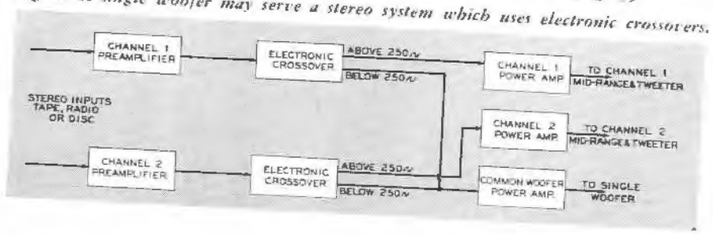
Another question concerns whether you can use a combined bass or woofer unit with two genuine stereo channels for the rest of the range. If you want to do this a good way to manage it would be to utilize electronic crossovers in the region of 250 cps, as shown in Fig. 2. Then the output from the low-frequency section of both channels can be combined, fed into an amplifier, and ultimately sent to the single woofer unit. The high-pass outputs from the electronic crossovers can be fed to separate channel amplifiers for left and right, and then to single or two-way loudspeakers for the stereo portion.

This idea certainly will work, if for some reason you feel you do not need two woofers. I can hardly see the point of doing it, however, unless there is a restricted space problem or a similar difficulty. Although you will save the cost of one woofer, you have to buy two electronic crossovers and an extra power amplifier that you probably wouldn't need otherwise. Unless there is a speaker placement problem, there is no particular advantage in separating the bass and reproducing it from a single loudspeaker while the rest of the stereo program comes over two separate loudspeakers.

Other questions received on this subject related to the possibility of using one or another of the devices that are

Continued on page 39

Fig. 2. A single woofer may serve a stereo system which uses electronic crossovers.



Sound-Fanciers' Guide

by R. D. Darrell

A Question of Relativity

Most record collectors, who never can buy or even hear more than a small fraction of the discs and tapes they'd like to know and who have to depend at least to a considerable extent on reviewer's recommendations, aren't likely to appreciate a peculiar handicap under which the professional listener-reporter labors. It's simply that he, poor fellow, hears too much.

"*We* should be so lucky!," the laymen, who never can hear enough, may ruefully retort — but what they forget is that wide differences in aural experience result in widely disparate scales of values which become extremely difficult to correlate, let alone reconcile. Such value differentials not only make for marked differences in opinion where music alone is concerned (what sounds mild enough to the professional may be earsplittingly cacophonous to the amateur, for instance), but also where recorded performances are taken into account. Those which impress the occasional listener as superbly fresh and exciting may well seem merely routine to the reviewer who has previously encountered better versions of the same works or heard more effective representations of the same artists.

I've become especially aware of — and worried by — such contradictions where certain *series* of recordings are involved, and I find myself thinking first that the latest release seems much less thrilling than its predecessors — and then suddenly remembering that I would be much more excited by it if I hadn't heard the others first. It may be every bit as good, but it just isn't so *novel* — to me, or to almost anyone familiar with the series from its beginning. So what am I to do: assume that most of my readers have heard the earlier works too, and that they won't be particularly impressed by the current one, or assume that it is entirely new to them and hence to be enthusiastically recommended? It's a real problem in relative values, and I can only hope that every reader will try to keep it in mind when he judges the personal applicability of my reports, making sure to scale these up or down to correspond better with his own individual experience and value standards.

Where Did You Come In?

Among the pertinent examples of possible multiple evaluations are this month's Vols. 4 and 5 of Audio Fidelity's *Dukes of Dixieland* series; three new releases by Vanguard's international chanteuse, Liane; and one more in Unicorn's series of Ernst Levy piano recordings in the Kresge Auditorium at M.I.T. in Cambridge, Massachusetts.

The fabulous Dukes are in characteristic vein in *On Bourbon Street* and *Minstrel Time* (AFLP 1860 and 1861), and they're recorded as ultrabrilliantly as ever, but if you already know their earlier releases, Vol. 4 seems mostly to be more of the same, with perhaps only *The Saints* and *Back Home in Indiana* matching the highest previous peaks. Happily, however, Vol. 5 ranks with Vol. 3 (reviewed here in October 1957 in its LP version and last January in a stereo taping) as one of the Dukes' finest achievements — particularly notable for its inspired reanimations of such familiar tunes as *Alabamy Bound* and *Wait Till the Sun Shines, Nellie*, as well as for its flawless technology, including as immaculate disc surfaces as the most fanatical noise hater can ever hope for.

Liane is one of the best night-club singers as far as both appealing personality and voice are concerned; perhaps it's only because I have heard her do the same sort of thing so often before that I can't get more excited about her latest *Rendezvous avec Liane, Paris Midnight*, and *Vienna Midnight* (Vanguard VRS 9012, 9018, and 9026 respectively). But if you haven't been captivated earlier, any of these serves as a delightful introduction: and in any case you are sure to relish the ingenious way in which her accompanying Bohème Bar Trio links her various selections and varies them with instrumental interludes in the latter two discs — most attractively of all, for me, in *Paris Midnight*.

The first Levy-Kresge-Bartók recordings were so spellbinding that it may be only in my mind that the new Beethoven Sonatas, Op. 90 and Op. 101 (Unicorn UNLP 1051), seem anticlimactic. Nevertheless, I'm much more disturbed here by Levy's interpretative eccentricities, except in the truly eloquent slow movements of these works, and even the tremendous sonority of recorded piano tone begins to seem overbright and — let's face it — completely unnatural. Qualify that reaction as you will, you'll still be on much safer ground if you start off with — and perhaps stick exclusively to — the earlier UNLP 1035 (Liszt) and 1034 (Beethoven) I praised so highly in this column exactly a year ago.

And in somewhat this same general category, although it is not part of an actual series, is the sonic documentation of the 1957 Indianapolis Speedway Race, *500 Miles to Glory* (Mercury MS 2-6, stereo; or MG 20315, LP), which is breathtaking if you've never heard any other racing-car recordings (especially in stereo) before, or if you're a dyed-in-the-wool *aficionado*. Otherwise, it's gniug to seem pretty monotonous

Continued on page 46

FM stations up-to-date

Here is AUDIOCRAFT'S *annual listing of FM stations compiled from the official records of the FCC.*

THE following list of over 700 United States FM stations was taken directly from FCC records and is accurate to January 2, 1958. In addition to call letters and frequency (in megacycles), the channel (CH) number (see Table I), the effective radiated power (ERP) in kilowatts, the antenna height (HT) in feet above average terrain, and the latitude (LAT) and longitude (LONG) in degrees are shown for each station.

Effective radiated power is defined as the transmitter output power (minus line losses) times the antenna power gain. In the case of 10-watt educational stations which have been marked by an asterisk, the power listed is the transmitter output since their effective radiated power is not shown in FCC records.

Antenna height above average terrain is defined as the height of the radiation center of the antenna above the average height of all terrain which lies between 2 and 10 miles from the antenna. In the case of 10-watt educational stations which have been marked by an asterisk, the height listed is the antenna height above ground at the transmitter site, since their height above average terrain is not shown in FCC records.

Construction permits for new stations are indicated by "CP." Such stations may already be broadcasting under this permit. Some old stations have requested changes in power, antenna height, or location; these are indicated by:

DP Decrease in power
IP Increase in power
DH Decrease in antenna height
IH Increase in antenna height
CL Change in location

The data shown in each case are the new data. Where several changes are made, only the most significant is indicated.

The following table gives the channel number according to frequency for each of the 100 FM channels. Just as television channels are numbered from 2 to 83, FM channels are numbered from 201 to 300. In the station listing, the channel numbers are abbreviated by dropping the superfluous first digit (a 2 or 3). Two digits are easier to remember than three or four, so that some listeners may wish to recalibrate their dials in channel numbers going from 1 to 100. The first twenty channels have been set up by the FCC for exclusive use by noncommercial educational stations.

Table I

Freq (Mc)	Chan No.	Freq (Mc)	Chan No.	Freq (Mc)	Chan No.	Freq (Mc)	Chan No.
88.1	201	93.1	226	98.1	251	103.1	276
88.3	202	93.3	227	98.3	252	103.3	277
88.5	203	93.5	228	98.5	253	103.5	278
88.7	204	93.7	229	98.7	254	103.7	279
88.9	205	93.9	230	98.9	255	103.9	280
89.1	206	94.1	231	99.1	256	104.1	281
89.3	207	94.3	232	99.3	257	104.3	282
89.5	208	94.5	233	99.5	258	104.5	283
89.7	209	94.7	234	99.7	259	104.7	284
89.9	210	94.9	235	99.9	260	104.9	285
90.1	211	95.1	236	100.1	261	105.1	286
90.3	212	95.3	237	100.3	262	105.3	287
90.5	213	95.5	238	100.5	263	105.5	288
90.7	214	95.7	239	100.7	264	105.7	289
90.9	215	95.9	240	100.9	265	105.9	290
91.1	216	96.1	241	101.1	266	106.1	291
91.3	217	96.3	242	101.3	267	106.3	292
91.5	218	96.5	243	101.5	268	106.5	293
91.7	219	96.7	244	101.7	269	106.7	294
91.9	220	96.9	245	101.9	270	106.9	295
92.1	221	97.1	246	102.1	271	107.1	296
92.3	222	97.3	247	102.3	272	107.3	297
92.5	223	97.5	248	102.5	273	107.5	298
92.7	224	97.7	249	102.7	274	107.7	299
92.9	225	97.9	250	102.9	275	107.9	300

Of interest to many FM listeners is a plot of the location of FM stations within a radius of, say, 200 miles. The latitude and longitude are therefore given with each station. Knowing the listener's location (which can be obtained from a road map showing latitude and longitude) and the miles per degree of latitude and longitude (from the following table), a complete station map can be plotted to any desired scale, starting with a plain sheet of paper. Proper antenna rotor setting for each station can be indicated by dividing the map with radial lines from the listener's location.

Table II

Middle Lat. Deg.	Miles per Deg. Lat.	Miles per Deg. Long.	Middle Lat. Deg.	Miles per Deg. Lat.	Miles per Deg. Long.
25	68.8	62.7	38	69.0	54.6
26	68.8	62.2	39	69.0	53.8
27	68.8	61.7	40	69.0	53.1
28	68.9	61.1	41	69.0	52.3
29	68.9	60.5	42	69.0	51.5
30	68.9	60.0	43	69.0	50.7
31	68.9	59.3	44	69.0	49.8
32	68.9	58.7	45	69.1	49.0
33	68.9	58.1	46	69.1	48.1
34	68.9	57.4	47	69.1	47.3
35	68.9	56.7	48	69.1	46.4
36	68.9	56.0	49	69.1	45.5
37	69.0	55.3	50	69.1	44.5

FM activity in Canada is meager; the 29 Canadian stations are listed mainly for those living near the border who want a complete record of stations in their area. This information was taken from a U.S. Government Printing Office publication, *Broadcast Stations of the World*, corrected June 1, 1957. Unfortunately, the exact location of stations was not available.

Mexico has FM broadcast stations, but all of them are beyond reception in the United States.

	CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
ALABAMA								
	Albertville	WAVU-FM	86	105.1	4.5	360	34.24	86.16
	Alexander City	WRFS-FM	91	106.1	4.6	240	32.95	85.99
	Andalusia	WCTA-FM	51	98.1	10.0	200	31.32	86.45
CL	Anniston	WHMA-FM	63	100.5	3.7	190	33.71	85.85
CP	Birmingham	WSFM	29	93.7	20.0	450	33.49	86.80
		WAFM	58	99.5	72.0	780	33.49	86.80
		WJLN	84	104.7	23.0	590	33.48	86.81
		WBRC-FM	95	106.9	15.0	800	33.49	86.80
CP		WKLF-FM	65	100.9	.370	255	32.84	86.68
	Clanton	WFMH-FM	66	101.1	5.3	165	34.20	86.78
	Cullman	WHOS-FM	23	92.5	8.6	200	34.60	87.01
	Decatur	WRLD-FM	75	102.9	10.0	330	32.87	85.22
	Lanett	WKRG-FM	60	99.9	3.0	310	30.72	88.06
	Mobile	WHTB-FM	46	97.1	9.2	210	33.44	86.12
	Talladega	WUOA	19	91.7	15.0	120	33.21	87.55
	Tuscaloosa	WTBC-FM	39	95.7	17.5	320	33.20	87.53
ARIZONA								
	Globe	KWJB-FM	62	100.3	11.0	2270	33.34	110.87
	Mesa	KTYL-FM	84	104.7	16.0	140	33.41	111.88
	Phoenix	KFCA	03	88.5	.010*	75*	33.48	112.09
		KELE	38	95.5	18.0	115	32.45	112.07
	Tucson	KTKT-FM	58	99.5	3.1	−7	32.24	110.98
ARKANSAS								
	Blytheville	KLCN-FM	41	96.1	21.0	360	35.92	89.87
	Jonesboro	KASU	20	91.9	.760	82	35.83	90.68
		KBTM-FM	70	101.9	8.0	200	35.85	90.66
	Mammoth Spring	KAMS	80	103.9	.310	125	36.55	91.55
	Pocahontas	KPOC-FM	49	97.7	.390	170	36.28	90.96
	Siloam Springs	KUOA-FM	89	105.7	2.6	465	36.19	94.56
CALIFORNIA								
	Atherton	KPEN	67	101.3	1.5	1750	37.41	122.31
	Bakersfield	KERN-FM	31	94.1	9.1	240	35.34	119.04
		KQXR	68	101.5	14.5	360	35.52	119.07
	Berkeley	KPFB	07	89.3	.150	−100	37.87	122.27
		KPFA	31	94.1	54.0	1330	37.87	122.22
		KRE-FM	75	102.9	9.7	−15	37.85	122.30
CP	Beverly Hills	KBCA	88	105.5	1.0	−80	34.07	118.37
	Claremont	KSPC	14	90.7	.010*	75*	34.10	117.71
	Eureka	KRED	42	96.3	5.6	1520	40.73	123.95
	Fresno	KRFM	29	93.7	68.0	1680	37.08	119.43
		KMJ-FM	50	97.9	7.3	630	36.69	120.05
		KARM-FM	70	101.9	7.4	360	36.85	119.84
		KLITE	70	101.9	11.6	630	34.16	118.20
	Glendale	KRHM	34	94.7	58.0	2835	34.23	118.07
	Hollywood	KHJ-FM	66	101.1	16.8	2950	34.23	118.07
IP	Long Beach	KLON	01	88.1	1.2	425	33.80	118.16
IP		KNOB	50	97.9	11.0	430	33.80	118.16
		KFOX-FM	72	102.3	1.0	120	33.78	118.19
	Los Angeles	KXLU	04	88.7	.010*	75*	33.97	118.42
		KUSC	18	91.5	2.9	150	34.02	118.28
IP		KFAC-FM	22	92.3	59.0	2820	34.22	118.06
		KNX-FM	26	93.1	67.0	2870	34.23	118.07
		KPOL-FM	30	93.9	4.4	570	34.08	118.18
		KABC-FM	38	95.5	4.3	2800	34.23	118.07
		KRKD-FM	42	96.3	54.0	475	34.08	118.20
		KFMU	46	97.1	58.0	750	34.16	118.20
IP		KCBH	54	98.7	75.0	1260	34.12	118.39
		KHOF	58	99.5	16.5	260	34.14	118.23
		KMLA	62	100.3	58.0	1190	34.12	118.39
		KGLA	78	103.5	12.5	200	34.08	118.26
		KPLA	82	104.3	7.1	64	34.10	118.33
CP		KDBX	86	105.1	17.0	180	34.14	118.23
		KBMS	90	105.9	18.0	770	34.16	118.20
CP		KBBI	98	107.5	19.5	175	34.05	118.25
	Marysville	KMYC-FM	60	99.9	4.9	150	39.14	121.55
	Modesto	KBEE-FM	77	103.3	11.5	150	37.64	120.99
		KTRB-FM	81	104.1	4.7	260	37.67	120.98
CP	Oakland	KAFE	51	98.1	1.2	650	37.81	122.19
	Ontario	KEDO	28	93.5	.310	−110	34.08	117.66
CP	Oxnard	KOXR-FM	87	104.7	14.5	−13	34.19	119.14
CP	Palm Springs	KPSR	21	92.1	1.0	−130	33.86	116.46
	Pasadena	KPCS	07	89.3	.175	−563	34.14	118.12
CP	Riverside	KACE-FM	24	92.7	.690	−50	33.93	117.40
CP		KQXM	46	97.5	81.0	1690	33.97	117.29
CP		KPIP	56	99.1	1.55	1630	33.96	117.30
	Sacramento	KJML	37	95.3	1.0	140	38.63	121.39
		KCRA-FM	41	96.1	11.0	380	38.64	121.56
		KFBK-FM	45	96.9	3.2	260	38.57	121.48
CP		KGMS-FM	63	100.5	9.8	160	38.61	121.53
		KXQA-FM	00	107.9	12.5	170	38.60	121.45
	San Bernardino	KVCR	20	91.9	.770	−240	34.09	117.31
CP		KPAX	60	99.9	30.0	1570	33.96	117.28
	San Diego	KSDS	02	88.3	.375	37	32.72	117.15
		KFSD-FM	31	94.1	33.0	425	32.72	117.07
CP		KFMX	43	96.5	29.5	590	32.84	117.25
CP		KGB-FM	63	101.5	15.5	125	32.73	117.08
		KDFR	84	104.7	13.0	210	32.72	117.16
	San Francisco	KALW	19	91.7	3.3	70	37.76	122.41
		KYA-FM	27	93.3	4.9	710	37.71	122.39
CP		KSFR	35	94.9	9.5	1170	37.69	122.45
CP		KRON-FM	43	96.5	13.0	1230	37.69	122.44
CP		KEAR	47	97.3	125.0	1100	37.85	122.50
IP		KCBS-FM	55	98.9	35.0	640	37.79	122.41
		KNBC-FM	59	99.7	45.0	1240	37.69	122.44
		KGO-FM	79	103.7	3.8	1180	37.76	122.45
		KBCO	87	105.3	17.5	450	37.79	122.41
CP		KSJO-FM	22	92.3	1.4	−66	37.33	121.86
CP	San Jose	KRPM	53	98.5	3.3	−140	37.31	121.90
CP		KWIZ-FM	44	96.7	1.0	160	33.75	117.91
	Santa Ana	KRCW	48	97.5	10.0	−750	34.42	119.70
	Santa Barbara	KSCU	11	90.1	1.1	−55	37.35	121.94
CP	Santa Clara	KSMA-FM	73	102.5	11.0	−47	34.95	120.44
CP	Santa Maria	KCRW	10	89.9	.400	−310	34.01	118.47
	Santa Monica	KDFC	71	102.1	33.0	1050	37.85	122.50
	Sausalito	KCVN	17	91.3	3.4	70	37.98	121.31
	Stockton	KDWC	52	98.3	.840	−265	34.09	117.95
CP	West Covina							
COLORADO								
	Boulder	KRNW	47	97.3	2.0	−730	40.06	105.27
	Colorado Springs	KSHS	13	90.5	.610	1760	38.84	104.82
		KRCC	17	91.3	.165	−480	38.86	104.83
CP	Denver	KDEN-FM	58	99.5	9.1	380	39.68	105.01
CP		KLIR-FM	62	100.3	2.4	71	39.69	105.07
		KTGM	86	105.1	10.0	9	39.74	105.07
	Golden	KFML-FM	53	98.5	2.35	580	39.73	105.24
	Manitou Springs	KCMS-FM	74	102.7	10.0	−780	38.85	104.84
CONNECTICUT								
	Brookfield	WGHF	36	95.1	20.0	500	41.49	73.43
	Danbury	WLAD-FM	52	98.3	.340	280	41.38	73.45
CP	Hartford	WRTC-FM	07	89.3	.145	39	41.75	72.69
		WTIC-FM	43	96.5	8.0	705	41.77	72.81
		WHCN	90	105.9	7.0	750	41.56	72.84
CP		WMMW-FM	39	95.7	2.0	740	41.56	72.84
	Meriden	WNHC-FM	56	99.1	10.0	630	41.43	72.94
	New Haven	WSTC-FM	44	96.7	.650	305	41.07	73.54
	Stamford	WHUS	13	90.5	.010*	80*	41.81	72.26
	Storrs							
DELAWARE								
	Dover	WDOV-FM	34	94.7	8.3	200	39.20	75.56
	Wilmington	WDEL-FM	29	93.7	20.0	460	39.82	75.53
		WJBR	58	99.5	20.0	330	39.83	75.52
DISTRICT OF COLUMBIA								
CL	Washington	WRC-FM	30	93.9	20.0	480	38.94	77.08
		WTOP-FM	42	96.3	20.0	390	38.95	77.08
		WASH	46	97.1	15.0	470	39.04	77.06
		WOL-FM	54	98.7	20.0	485	38.89	77.20
		WFAN	62	100.3	9.4	320	38.95	77.00
		WWDC-FM	66	101.1	20.0	410	39.00	77.06
		WGMS-FM	78	103.5	20.0	440	39.04	77.17
CL		WMAL-FM	97	107.2	20.0	475	38.94	77.09
FLORIDA								
	Daytona Beach	WNDB-FM	33	94.5	8.5	330	29.23	81.04
	Gainesville	WRUF-FM	81	104.1	12.0	350	29.64	82.42
	Jacksonville	WJAX-FM	36	95.1	7.7	560	30.29	81.75
		WMBR-FM	41	96.1	50.0	850	30.31	81.65
		WZOK-FM	45	96.9	9.7	350	30.30	81.74
	Miami	WTHS	19	91.7	5.0	215	25.79	80.19
		WAHR-FM	30	93.9	13.0	170	25.77	80.14
		WSJG	35	94.9	17.0	460	25.99	80.15
CP		WGBS-FM	42	96.3	1.55	80	25.79	80.19
		WCKR-FM	47	97.3	15.5	285	25.78	80.19
		WINZ-FM	60	99.9	105.0	210	25.96	80.27
		WWPB	68	101.5	8.5	275	25.77	80.20
		WKAT-FM	26	93.1	285.0	420	25.79	80.14
CP	Miami Beach	WDBO-FM	22	92.3	25.0	460	28.55	81.41
	Orlando	WHOO-FM	43	96.5	59.0	460	28.58	81.45
		WORZ	62	100.3	16.5	300	28.55	81.43
		WQXT-FM	50	97.9	22.0	225	26.61	80.04
IP	Palm Beach	WDLP-FM	55	98.9	1.6	300	30.17	85.61
	Panama City	WFSU-FM	18	91.5	.010*	81*	30.44	84.29
	Tallahassee	WTUN	05	88.9	.770	240	28.04	82.47
	Tampa	WFLA-FM	27	93.3	46.0	910	27.84	82.26
		WDAE-FM	64	100.7	65.0	390	27.94	82.46
		WPKM	84	104.7	10.5	160	27.93	82.48
	Winter Park	WPRK	18	91.5	.330	90	28.59	81.34
GEORGIA								
	Athens	WGAU-FM	58	102.5	4.4	260	33.94	83.40
CL	Atlanta	WABE	11	90.1	4.3	360	33.81	84.36
		WGKA-FM	25	92.9	9.4	270	33.79	84.38
DP		WSB-FM	53	98.5	45.48	770	33.76	84.36
IH		WAGA-FM	77	103.3	36.2	965	33.80	84.33
	Augusta	WBBQ-FM	79	103.7	10.5	72	33.46	81.99
		WAUG-FM	89	105.7	5.5	100	33.46	81.94
	Columbus	WRBL-FM	27	93.3	25.0	570	32.47	85.06
	Gainesville	WDUN-FM	80	103.9	.340	175	34.32	83.83
	La Grange	WLAG-FM	81	104.1	2.3	180	33.04	85.03
CP	Macon	WNEX-FM	45	96.9	4.1	415	32.85	83.66
		WMAZ-FM	56	99.1	3.0	170	32.83	83.65
	Newnan	WCOH-FM	44	96.7	.330	240	33.36	84.81
	Savannah	WTOC-FM	47	97.3	7.9	397	32.07	81.09
	Toccoa	WLET-FM	91	106.1	.730	190	34.59	83.30
ILLINOIS								
	Bloomington	WJBC-FM	68	101.5	5.1	425	40.46	89.01
CP	Carbondale	WSRV	20	91.9	22.0	290	37.71	89.23
	Carmi	WROY-FM	47	97.3	11.0	210	38.08	88.20
	Champaign	WDWS-FM	48	97.5	27.0	430	40.09	88.25
	Chicago	WBEZ	18	91.5	16.0	550	41.88	87.63
		WENR-FM	34	94.7	4.3	580	41.88	87.64
CP		WDHF	38	95.5	30.0	270	41.72	87.68
		WBBM-FM	42	96.3	10.5	560	41.88	87.63
		WNIB	46	97.1	11.0	510	41.88	87.72
		WEHS	50	97.9	21.0	200	41.83	87.71
		WFMT	54	98.7	29.5	550	41.89	87.63
		WEFM	58	99.5	44.0	560	41.88	87.63
		WFMF	62	100.3	33.0	540	41.89	87.62
		WMAQ-FM	66	101.1	24.0	640	41.88	87.64
		WCLM	70	101.9	18.0	500	41.89	87.62
CP		WKFM	78	103.5	50.0	500	41.88	87.63
		WSEL	82	104.3	40.0	500	41.88	87.63
		WSOY-FM	71	102.1	31.0	460	39.88	88.94
	Decatur	WNIC	16	91.1	.010*	120*	41.93	88.77
	De Kalb	WSEI	39	95.7	20.0	295	39.13	88.49
	Effingham	WEPS	01	88.1	.010*	78*	42.04	88.27
	Elgin	WXFM	90	105.9	32.0	250	41.93	87.81
	Elmwood Park	WNUR	07	89.3	.010*	75*	42.05	87.67
	Evanston	WEAW-FM	86	105.1	36.0	240	42.03	87.71
DP	Harrisburg	WEBQ-FM	60	99.9	1.55	305	37.72	88.54
	Jacksonville	WLDS-FM	63	100.5	9.0	340	39.74	90.20
	Macomb	WWKS	17	91.3	17.0	280	40.46	90.68
	Mattoon	WLBH-FM	45	96.9	23.0	190	39.50	88.37
	Mt. Vernon	WMIX-FM	31	94.1	15.2	550	38.37	88.92
IP	Oak Park	WOPA-FM	74	102.7	10.0	250	41.88	87.79

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
Olney	WVLN-FM	25	92.9	18.5	290	38.70	88.08
Paris	WPRS-FM	52	98.3	1.0	225	39.61	87.73
Peoria	WMBD-FM	23	92.5	2.5	550	40.57	89.53
Quincy	WTAD-FM	58	99.5	27.0	770	39.97	91.33
	WGEM-FM	86	105.1	8.3	640	39.95	91.33
Rockford	WROK-FM	48	97.5	16.0	300	42.28	89.04
Rock Island	WHBF-FM	55	98.9	3.7	380	41.49	90.47
Springfield	WTAX-FM	79	103.7	6.7	315	39.79	89.60
Urbana	WILL-FM	15	90.9	300.0	500	40.00	88.63
INDIANA							
Bloomington	WFIU	79	103.7	33.0	300	39.17	86.52
Connersville	WCNB-FM	62	100.3	9.8	270	39.64	85.15
Crawfordsville	WBBS	92	106.3	1.0	58	40.04	86.90
CP Elkhart	WCMR-FM	36	95.1	4.4	220	41.66	86.00
	WTRC-FM	64	100.7	9.7	350	41.65	85.98
Evansville	WPSR	14	90.7	4.5	100	37.99	87.55
	WEVC	18	91.5	1.9	100	37.97	87.53
	WIKY-FM	81	104.1	19.0	450	37.99	87.60
Gary	WGVE	01	88.1	.010*	70*	41.53	87.34
Greencastle	WGRE	19	91.7	.010*	80*	39.64	86.85
Hammond	WJOB-FM	22	92.3	3.1	400	41.60	87.48
Hartford City	WHCI	20	91.9	.010*	80*	40.46	85.38
Huntington	WVSH	20	91.9	.010*	85*	40.89	85.50
IP Indianapolis	WIAN	11	90.1	.890	45	39.81	86.12
	WFMS	38	95.5	4.5	110	39.78	86.16
	WAJC	83	104.5	8.8	35	39.78	86.15
Jasper	WITZ-FM	84	104.7	1.65	280	38.35	86.94
Madison	WORX-FM	44	96.7	.350	290	38.74	85.36
Marion	WMRI-FM	95	106.9	31.0	275	40.55	85.65
Muncie	WWHI	18	91.5	.010*	110*	40.20	85.39
	WMUN	81	104.1	7.4	240	40.15	85.38
New Albany	WNAS	01	88.1	.800	−32	38.30	85.81
New Castle	WYSN	16	91.1	.010*	98*	39.94	85.36
	WCTW	73	102.5	4.0	250	39.94	85.36
Terre Haute	WTHI-FM	60	99.9	7.4	330	39.54	87.39
Wabash	WSKS	17	91.3	.010*	71*	40.81	85.83
Warsaw	WRSW-FM	97	107.3	34.0	230	41.22	85.84
Washington	WFML	93	106.5	14.0	320	38.65	87.17
IOWA							
Ames	WOI-FM	11	90.1	16.0	480	41.99	93.69
Boone	KFGQ-FM	57	99.3	.310	200	42.09	93.91
Clinton	KROS-FM	41	96.1	13.0	400	41.86	90.20
Davenport	WOC-FM	79	103.7	33.0	490	41.55	90.48
Des Moines	KDPS	01	88.1	1.5	105	41.59	93.64
	WHO-FM	62	100.3	24.0	690	41.65	93.35
Dubuque	WDBQ-FM	77	103.3	15.0	335	42.50	90.70
Iowa City	KSUI	19	91.7	17.5	90	41.66	91.53
Mason City	KGLO-FM	66	101.1	16.0	230	43.15	93.24
Muscatine	KWPC-FM	59	99.7	.780	290	41.45	91.08
Storm Lake	KAYL-FM	68	101.5	8.9	370	42.63	95.16
Waverly	KWAR	06	89.1	.010*	110*	42.76	92.49
KANSAS							
Emporia	KSTE	04	88.7	.350	105	38.42	96.18
CP Kansas City	KCBM	51	98.1	4.4	155	39.10	94.65
Lawrence	KANU	18	91.5	35.0	620	38.96	95.26
Manhattan	KSDB-FM	01	88.1	.010*	80*	39.18	96.58
Ottawa	KTJO-FM	01	88.1	.010*	80*	38.60	95.27
Wichita	KMUW	06	89.1	.010*	110*	37.72	97.30
	KFH-FM	62	100.3	11.0	410	37.71	97.24
KENTUCKY							
Ashland	WCMI-FM	29	93.7	2.75	200	38.45	82.61
Bowling Green	WLBJ-FM	66	101.1	8.6	190	37.00	86.40
Central City	WNES-FM	70	101.9	21.5	215	37.27	87.14
Fulton	WFUL-FM	85	104.9	.500	155	36.52	88.90
Henderson	WSON-FM	58	99.5	20.0	400	37.83	87.55
Hopkinsville	WHOP-FM	54	98.7	8.7	210	36.87	87.47
IP Lexington	WBKY	17	91.3	3.0	165	38.04	84.51
	WLAP-FM	33	94.5	3.5	320	38.12	84.45
Louisville	WFPL	07	89.3	.150	360	38.23	85.71
	WFPK	20	91.9	19.5	295	38.24	85.76
Madisonville	WFMW-FM	30	93.9	2.5	375	37.35	87.49
DP Mayfield	WNGO-FM	34	94.7	.610	160	36.76	88.64
Owensboro	WOMI-FM	23	92.5	19.5	375	37.74	87.12
DP	WVJS-FM	41	96.1	10.0	370	37.78	87.16
Paducah	WKYB-FM	27	93.3	31.0	380	37.01	88.61
	WPAD-FM	45	96.9	36.0	335	37.10	88.62
LOUISIANA							
Alexandria	KALB-FM	45	96.9	11.0	380	31.31	92.42
Baton Rouge	WBRL	51	98.1	7.6	460	30.42	91.18
	WAIL-FM	82	104.3	3.2	315	30.42	91.14
Monroe	KMLB-FM	81	104.1	17.0	220	32.49	92.10
IH New Orleans	WWMT	39	95.7	44.0	215	29.94	90.08
	WRCM	46	97.1	5.9	250	29.96	90.08
	WDSU-FM	87	105.3	3.4	590	29.95	89.96
Shreveport	KWKH-FM	33	94.5	13.5	390	32.70	93.88
	KRMD-FM	66	101.1	11.5	200	32.51	93.75
MAINE							
Brunswick	WBOR	16	91.1	.010*	60*	43.91	69.96
Caribou	WFST-FM	49	97.7	.220	185	46.89	68.05
DP Lewiston	WCOU-FM	30	93.9	9.6	250	44.09	70.19
MARYLAND							
Annapolis	WNAV-FM	56	99.1	16.6	370	38.98	76.52
Baltimore	WBJC	01	88.1	.125	145	39.33	76.59
	WCAO-FM	74	102.7	20.0	400	39.39	76.72
CL	WITH-FM	82	104.3	20.0	470	39.29	76.74
Bethesda	WUST-FM	92	106.3	.500	320	38.98	77.11
Cumberland	WCUM-FM	75	102.9	1.25	−4	39.64	78.74
Hagerstown	WJEJ-FM	84	104.7	9.4	1340	39.70	77.51
	WARK-FM	95	106.9	2.2	225	39.63	77.71
Oakland	WRNC	38	95.5	16.5	300	38.86	76.90
CP Takoma Park	WGTS-FM	20	91.9	.010*	60*	38.99	77.00
CP Towson	WTOW-FM	70	101.9	20.0	280	39.58	76.56
MASSACHUSETTS							
Amherst	WAMF	08	89.5	.010*	79*	42.37	72.53
	WMUA	16	91.1	.010*	109*	42.39	72.53
Boston	WERS	05	88.9	18.0	55	42.36	71.08
	WGBH-FM	09	89.7	15.5	550	42.21	71.11
CL	WBUR	15	90.9	20.0	160	42.35	71.13
	WHDH-FM	33	94.5	20.0	455	42.35	71.07
	WXHR	45	96.9	20.0	440	42.46	71.18
	WRKO-FM	53	98.5	20.0	410	42.43	71.09
	WCOP-FM	64	100.7	20.0	495	42.41	71.21
	WEEI-FM	77	103.3	20.0	430	42.43	71.09
CP	WBCN	81	104.1	20.0	440	42.41	71.21
CP	WBZ-FM	94	106.7	2.8	1040	42.31	71.24
Brockton	WBET-FM	49	97.7	.800	275	42.07	71.04
Cambridge	WHRB-FM	96	107.1	.096	44	42.37	71.12
Greenfield	WHAI-FM	52	98.3	1.0	−240	42.59	72.62
Lowell	WLLH-FM	58	99.5	12.2	600	42.65	71.22
New Bedford	WBSM-FM	47	97.3	2.5	330	41.64	70.92
	WNBH-FM	51	98.1	20.0	380	41.62	70.92

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
Pittsfield	WBEC-FM	32	94.3	1.0	−185	42.45	73.25
South Hadley	WMHC	03	88.5	.010*	60*	42.26	72.58
IP Springfield	WEDK	19	91.7	15.0	68	42.12	72.55
IH	WHYN-FM	26	93.1	3.2	1000	42.24	72.65
	WMAS-FM	34	94.7	1.35	175	42.11	72.61
Waltham	WCRB-FM	73	102.5	10.0	180	42.36	71.26
West Yarmouth	WOCB-FM	32	94.3	1.0	155	41.63	70.24
Williamstown	WCFM	11	90.1	.010*	80*	42.71	73.20
Winchester	WHSR-FM	20	91.9	.010*	93*	42.45	71.13
Worcester	WTAG-FM	41	96.1	10.0	640	42.31	71.90
MICHIGAN							
Ann Arbor	WUOM	19	91.7	115.0	440	42.41	83.92
Benton Harbor	WHFB-FM	60	99.9	9.2	230	42.08	86.47
Coldwater	WTVB-FM	52	98.3	.260	230	41.92	85.01
Dearborn	WKMH-FM	62	100.3	7.1	190	42.26	83.25
DH Detroit	WDTR	15	90.9	2.0	140	42.38	83.12
	WJBK-FM	26	93.1	30.0	440	42.46	83.21
CP	WHFI	34	94.7	20.5	220	42.54	83.13
	WJR-FM	42	96.3	24.0	483	42.37	83.08
	WWJ-FM	46	97.1	50.0	480	42.45	83.17
	WJLB-FM	50	97.9	3.3	430	42.41	83.11
	WXYZ-FM	66	101.1	14.0	410	42.36	83.07
	WDET-FM	70	101.9	52.0	320	42.38	83.24
	WMUZ	78	103.5	19.5	180	42.41	83.12
East Lansing	WKAR-FM	13	90.5	74.0	270	42.71	84.48
Flint	WFBE	36	95.1	1.3	130	43.02	83.67
	WFUM	96	107.1	.400	175	43.02	83.70
Grand Rapids	WJEF-FM	29	93.7	115.0	420	42.42	85.53
	WLAV-FM	45	96.9	1.75	210	42.96	85.67
Highland Park	WHPR	01	88.1	.010*	94*	42.40	83.10
Kalamazoo	WMCR	71	102.1	36.0	160	42.29	85.61
Oak Park	WLDM	38	95.5	20.0	430	42.46	83.20
Royal Oak	WOAK	07	89.3	.010*	126*	42.49	83.15
	WOMC	82	104.3	18.0	380	42.47	83.12
Saginaw	WSAM-FM	51	98.1	1.7	330	43.42	83.92
Sturgis	WSTR-FM	76	103.1	.285	210	41.78	85.42
MINNESOTA							
DP Mankato	KYSM-FM	78	103.5	14.0	525	44.17	94.03
Minneapolis	KWFM	46	97.1	9.7	70	44.93	93.22
	KTIS-FM	53	98.5	5.3	250	45.00	93.35
	WLOL-FM	58	99.5	9.7	320	44.96	93.20
St. Cloud	KFAM-FM	84	104.7	15.0	425	45.53	94.17
Winona	KWNO-FM	48	97.5	18.5	610	44.03	91.64
MISSISSIPPI							
Jackson	WJDX-FM	75	102.9	50.0	600	32.26	90.11
Meridian	WMMI	01	88.1	.010*	100*	32.33	88.69
MISSOURI							
Clayton	KFUO-FM	56	99.1	6.7	260	38.64	90.31
Jefferson City	KWOS-FM	53	98.5	.765	310	38.58	92.20
Joplin	WMBH-FM	41	96.1	70.0	450	37.08	94.54
Kansas City	KCUR-FM	07	89.3	.450	115	39.03	94.58
CP	KCMK	27	93.3	35.0	320	39.07	94.57
	KCMO-FM	35	94.9	56.0	390	39.07	94.58
Kennett	KBOA-FM	55	98.9	6.9	320	36.22	90.08
Poplar Bluff	KWOC-FM	33	94.5	14.0	215	36.72	90.37
St. Louis	KSLH	18	91.5	12.5	400	38.62	90.24
IP	KCFM	29	93.7	70.0	550	38.63	90.19
Springfield	KTTS-FM	34	94.7	9.1	660	37.22	93.24
West Plains	KWPM-FM	30	93.9	3.4	130	36.74	91.83
NEVADA							
IP Reno	KNEV	38	95.5	35.0	−690	39.52	119.81
NEW HAMPSHIRE							
Berlin	WMOU-FM	79	103.7	10.0	160	44.46	71.17
Claremont	WTSV-FM	91	106.1	4.8	1000	43.40	72.30
Manchester	WKBR-FM	39	95.7	3.6	940	42.98	71.59
CP Mt. Washington	WTMW-FM	35	94.9	8.9	3720	44.27	71.30
Nashua	WOTW-FM	92	106.3	1.0	195	42.74	71.49
NEW JERSEY							
Asbury Park	WJLK-FM	32	94.3	1.0	250	40.22	74.05
Bridgeton	WSNJ-FM	55	98.9	9.0	480	39.46	75.21
CP Fairlawn	WRBI	88	105.5	1.0	125	40.93	74.12
CP Hackettstown	WNTI	20	91.9	4.8	510	40.85	74.88
Newark	WBGO	02	88.3	20.0	220	40.74	74.18
	WAAT-FM	34	94.7	13.5	540	40.79	74.26
New Brunswick	WCTC-FM	52	98.3	1.0	110	40.49	74.42
Paterson	WPAT-FM	26	93.1	20.0	310	40.85	74.18
Princeton	WPRB	80	103.9	.850	195	40.35	74.66
CP Red Bank	WFHA-FM	62	100.3	1.8	105	40.35	74.07
South Orange	WSOU	08	89.5	2.0	370	40.75	74.25
Trenton	WTOA	48	97.5	14.5	275	40.23	74.77
Zarephath	WAWZ-FM	56	99.1	4.8	175	40.53	74.57
NEW MEXICO							
Albuquerque	KANW	06	89.1	.350	−55	35.08	106.64
DH	KHFM	42	96.3	1.45	−11	35.08	106.58
Los Alamos	KRSN-FM	53	98.5	4.6	−33	35.88	106.30
CP Tularosa	KMFM	50	97.9	13.0	−160	33.06	106.02
NEW YORK							
CP Albany	WMAC	14	90.7	10.0	1970	42.64	73.17
Auburn	WMBO-FM	41	96.1	18.0	520	42.76	76.53
CP Babylon	WBAB-FM	72	102.3	.760	110	40.71	73.36
CP	WGLI-FM	78	103.5	15.0	120	40.72	73.33
Binghamton	WKOP-FM	37	95.3	.420	320	42.07	75.91
	WNBF-FM	51	98.1	4.6	950	42.06	75.95
Brooklyn	WNYE	18	91.5	20.0	415	40.69	73.98
IP Buffalo	WBNY-FM	25	92.9	94.0	570	42.64	78.72
	WILY	77	103.3	4.6	230	43.00	78.82
	WWOL-FM	81	104.1	.750	200	42.83	78.80
	WBEN-FM	93	106.5	52.0	1320	42.66	78.63
Cherry Valley	WRRC	70	101.9	5.4	1080	42.79	74.69
Corning	WCLI-FM	91	106.1	4.2	500	42.16	77.04
Cortland	WKRT-FM	60	99.9	14.0	710	42.56	76.15
De Ruyter	WRRD	86	105.1	5.3	560	42.78	75.84
Floral Park	WSHS	12	90.3	.350	112	40.72	73.70
Hempstead	WHLI-FM	52	98.3	1.0	250	40.68	73.61
Hornell	WWHG-FM	87	105.3	8.3	560	42.29	77.67
Ithaca	WICB	19	91.7	.010*	80*	42.44	76.50
	WHCU-FM	47	97.3	40.0	730	42.46	76.39
CP	WVBR-FM	69	101.7	.175	−210	42.45	76.49
	WRRA	79	103.7	5.6	890	42.39	76.67
Jamestown	WJTN-FM	27	93.3	9.5	735	42.04	79.08
Massena	WMSA-FM	87	105.3	13.0	335	44.90	74.88
New Rochelle	WNRC-FM	28	93.5	1.0	190	40.93	73.78
New York	WKCR-FM	10	89.9	.010*	130*	40.81	73.96
	WFUV	14	90.7	3.5	200	40.86	73.89
	WHOM-FM	22	92.3	11.0	630	40.75	73.98
IH	WNYC-FM	30	93.9	18.0	540	40.71	74.00
	WABC-FM	38	95.5	1.5	1270	40.75	73.99
	WQXR-FM	42	96.3	11.0	630	40.75	73.98
	WRCA-FM	46	97.1	1.1	1445	40.75	73.99
	WEVD-FM	50	97.9	20.0	340	40.72	73.92

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
(New York)	WOR-FM	54	98.7	1.7	1260	40.75	73.99
	WBAI	58	99.5	18.0	520	40.77	73.97
	WCBS-FM	66	101.1	1.5	1270	40.75	73.99
	WBFM	70	101.9	10.3	650	40.75	73.98
	WNEW-FM	74	102.7	2.8	420	40.74	74.18
CP	WNCN	82	104.3	15.0	560	40.77	73.97
	WRFM	86	105.1	20.0	235	40.74	73.91
Niagara Falls	WHLD-FM	53	98.5	46.0	420	43.01	78.99
Olean	WHDL-FM	39	95.7	43.0	830	42.03	78.45
Patchogue	WALK-FM	48	97.5	15.0	520	40.84	73.03
CP	WPAC-FM	91	106.1	8.3	145	40.80	75.99
CP Peekskill	WLNA-FM	64	100.7	18.5	500	41.34	73.89
Poughkeepsie	WKIP-FM	84	104.7	2.3	1120	41.49	73.95
CL Rochester	WHFM	55	98.9	8.7	240	43.08	77.73
Schenectady	WGFM	58	99.5	6.0	805	42.64	74.00
South Bristol	WRRE	36	95.1	5.3	990	42.75	77.43
Springville	WSPE	01	88.1	.010*	70*	42.55	78.67
Syracuse	WAER	01	88.1	.730	24	43.04	76.13
	WDDS-FM	26	93.1	97.0	660	42.95	76.03
	WSYR-FM	33	94.5	10.0	480	42.94	76.12
Troy	WRPI	18	91.5	.710	−120	42.73	73.68
	WFLY	22	92.3	5.4	840	42.64	74.00
Utica	WRUN-FM	89	105.7	4.3	490	43.06	75.42
Wethersfield	WRRL	99	107.7	5.4	460	42.62	78.29
White Plains	WFAS-FM	80	103.9	.120	675	41.03	73.83
NORTH CAROLINA							
CP Albemarle	WABZ-FM	65	100.9	.750	52	35.35	80.20
Asheboro	WGWR-FM	22	92.3	10.0	650	35.72	79.81
Asheville	WLOS-FM	82	104.3	9.2	130	35.61	82.59
Burlington	WFNS-FM	30	93.9	2.8	250	36.11	79.45
	WBBB-FM	66	101.1	3.8	410	36.10	79.48
Chapel Hill	WUNC	18	91.5	15.5	135	35.91	79.06
Charlotte	WSOC-FM	78	103.5	35.0	415	35.24	80.82
Clingman's Peak	WMIT	95	106.9	36.0	3100	35.74	82.29
Durham	WDNC-FM	86	105.1	36.0	380	36.04	78.97
Elkin	WIFM-FM	65	100.9	.350	−35	36.25	80.87
Fayetteville	WFNC-FM	51	98.1	14.0	290	35.08	78.93
Forest City	WBBO-FM	27	93.3	1.5	345	35.35	81.90
CP Franklin	WFSC	33	94.5	.930	−310	35.21	83.37
Gastonia	WGNC-FM	70	101.9	11.1	890	35.23	81.28
Goldsboro	WEQR-FM	45	96.9	41.0	360	35.40	78.01
Greensboro	WGPS	10	89.9	.010*	98*	36.08	79.81
CP	WMDE	54	98.7	5.8	110	36.06	79.84
Greenville	WWWS	17	91.3	3.95	135	35.61	77.36
Henderson	WHNC-FM	23	92.5	9.0	260	36.35	78.38
CP Hendersonville	WHKP-FM	73	102.5	4.0	11	35.33	82.45
High Point	WHPS	07	89.3	.010*	75*	35.96	80.01
	WHPE-FM	38	95.5	13.0	395	35.91	80.03
	WMFR-FM	58	99.5	8.0	350	35.96	80.01
	WNOS-FM	62	100.3	2.7	195	35.96	80.03
Laurinburg	WEWO-FM	43	96.5	9.2	215	34.76	79.42
Leaksville	WLOE-FM	33	94.5	20.0	96	36.50	79.77
Lexington	WBUY-FM	32	94.3	.300	210	35.84	80.23
Raleigh	WPTF-FM	34	94.7	15.0	560	35.79	78.76
	WKIX-FM	41	96.1	29.5	420	35.79	78.74
	WRAL-FM	68	101.5	54.0	325	35.77	78.62
Reidsville	WREV-FM	71	102.1	1.6	330	36.39	79.65
Rocky Mount	WEED-FM	21	92.1	.270	160	35.96	77.83
	WFMA	64	100.7	33.0	400	35.91	77.84
Salisbury	WSTP-FM	93	106.5	2.9	250	35.69	80.50
Sanford	WWGP-FM	88	105.5	.490	340	35.44	79.22
Shelby	WOHS-FM	41	96.1	2.6	460	35.29	81.57
Statesville	WSIC-FM	89	105.7	2.4	335	35.80	80.89
Tarboro	WCPS-FM	82	104.3	7.0	260	35.93	77.57
Thomasville	WTNC-FM	52	98.3	.450	250	35.89	80.10
Winston-Salem	WAIR-FM	26	93.1	34.0	370	30.09	80.28
	WSJS-FM	81	104.1	12.5	160	36.16	80.30
OHIO							
Akron	WAPS	06	89.1	1.3	44	41.09	81.52
	WAKR-FM	48	97.5	4.4	260	41.08	81.52
Alliance	WFAH-FM	69	101.7	1.0	160	40.93	81.13
Ashland	WATG-FM	67	101.3	10.2	380	40.84	82.36
Ashtabula	WICA-FM	79	103.7	40.0	270	41.81	80.79
Athens	WOUI	18	91.5	.010*	72*	39.33	82.10
Bellaire	WTRX-FM	63	100.5	9.0	500	40.04	80.77
CP Berea	WBWC	02	88.3	.010*	108*	41.36	81.84
Bowling Green	WBGU	01	88.1	.010*	90*	41.38	83.65
Canton	WHBC-FM	31	94.1	15.0	390	40.75	81.44
Cincinnati	WKRC-FM	70	101.9	15.5	530	39.12	84.50
	WSAI-FM	74	102.7	14.7	550	39.10	84.56
	WCPO-FM	86	105.1	12.5	590	39.13	84.50
DP Cleveland	WBOE	12	90.3	9.1	360	41.47	81.59
	WERE-FM	53	98.5	20.0	620	41.34	81.74
	WGAR-FM	58	99.5	31.0	410	41.31	81.69
	WHK-FM	64	100.7	11.5	620	41.36	81.67
	WDOK-FM	71	102.1	9.4	120	41.41	81.68
	WJW-FM	81	104.1	2.8	510	41.32	81.73
CL	KYW-FM	89	105.7	27.0	900	41.39	81.69
Cleveland Hts.	WSRS-FM	37	95.3	1.0	250	41.50	81.57
Columbus	WOSU-FM	09	89.7	14.0	300	40.03	83.06
	WCBE	13	90.5	17.5	540	39.96	83.00
DP	WCOL-FM	22	92.3	6.8	350	39.97	83.02
	WVKO-FM	34	94.7	52.0	220	40.05	83.06
CP	WBNS-FM	37	95.3	1.0	250	41.50	81.56
Dayton	WHIO-FM	56	99.1	19.0	515	39.72	84.15
Delaware	WSLN	16	91.1	.010*	152*	40.30	83.07
Elyria	WEOL-FM	97	107.3	15.0	290	41.27	82.01
Findlay	WFIN-FM	63	100.5	8.2	240	41.01	83.63
Fostoria	WFOB-FM	44	96.7	1.0	215	41.10	83.40
Fremont	WFRO-FM	57	99.3	1.0	200	41.35	83.12
CP Hamilton	WMOH-FM	78	103.5	8.7	255	39.40	84.53
Kent	WKSU-FM	01	88.1	.010*	96*	41.15	81.35
Lima	WIMA-FM	71	102.1	15.0	250	40.68	84.11
Marion	WMRN-FM	95	106.9	25.0	330	40.62	83.13
CP Middletown	WPFB-FM	90	105.9	7.8	370	39.51	84.35
Mt. Vernon	WMVO-FM	29	93.7	2.9	270	40.40	82.44
Newark	WCLT-FM	62	100.3	8.5	370	40.03	82.40
CL Oxford	WMUB	03	88.5	.810	295	39.50	84.74
Portsmouth	WPAY-FM	81	104.1	7.0	520	38.71	83.00
CP Springfield	WBLY-FM	80	103.9	1.0	62	39.92	83.81
Steubenville	WSTV-FM	78	103.5	3.1	880	40.34	80.62
Toledo	WTDS	17	91.3	.730	200	41.68	83.59
	WMHE	23	92.5	10.0	135	41.66	83.65
	WTOD-FM	60	99.9	8.8	160	41.62	83.62
	WSPD-FM	68	101.5	23.0	440	41.65	83.54
	WTOL-FM	84	104.7	1.3	156	41.65	83.54
Wooster	WWST-FM	83	104.5	13.0	330	40.79	81.90
CP Yellow Springs	WYSO	18	91.5	.010*	49*	39.80	83.88
Youngstown	WKBN-FM	55	98.9	25.0	490	41.06	80.64
OKLAHOMA							
Norman	WNAD-FM	15	90.9	7.0	400	35.29	97.50
Oklahoma City	KOKH	05	88.9	11.0	155	35.49	97.54
CP	KYFM	55	98.9	17.5	135	35.52	97.60
Stillwater	KAMC-FM	19	91.7	.380	8	36.12	97.08
	KSPI-FM	30	93.9	3.9	300	36.10	97.05
Tulsa	KWGS	13	90.5	4.1	350	36.15	95.94

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
OREGON							
Eugene	KWAX	16	91.1	.010*	77*	44.05	123.08
	KRVM	20	91.9	.400	−40	44.06	123.10
	KUGN-FM	56	99.1	.390	60	44.07	123.07
Grants Pass	KGPO	45	96.9	3.1	−1650	42.42	123.33
Oretech	KTEC	01	88.1	.010*	70*	42.31	121.75
Portland	KEX-FM	22	92.3	56.0	955	45.49	122.70
	KPFM	46	97.1	3.3	900	45.49	122.69
	KPOJ-FM	54	98.7	4.4	1100	45.45	122.55
	KQFM	62	100.3	17.0	960	45.49	122.69
	KOIN-FM	66	101.1	48.0	1390	45.52	122.73
PENNSYLVANIA							
Allentown	WFMZ	64	100.7	4.8	835	40.57	75.43
Altoona	WVAM-FM	61	100.1	.360	−345	40.49	78.40
Bethlehem	WGPA-FM	36	95.1	10.0	630	40.62	75.29
Bloomsburg	WHLM-FM	93	106.5	8.8	600	41.00	76.50
Butler	WBUT-FM	49	97.7	.720	290	40.84	79.90
Chambersburg	WCHA-FM	40	95.9	.700	240	39.93	77.70
CP Coudersport	WFRM-FM	44	96.7	.110	690	41.75	78.00
Dubois	WCED-FM	71	102.1	3.2	660	41.04	78.70
IP Easton	WEEX-FM	60	99.9	3.3	200	40.71	75.22
	WEST-FM	100	107.9	11.0	50	40.67	75.21
Erie	WERC-FM	60	99.9	9.7	400	42.06	80.04
CP Glenside	WIFI	23	92.5	20.0	280	40.11	75.16
Harrisburg	WHP-FM	47	97.3	1.55	−35	40.30	76.95
Havertown	WHHS	07	89.3	.010*	80*	39.98	75.30
IP Hazleton	WAZL-FM	50	97.9	6.0	630	40.94	75.97
Johnstown	WARD-FM	21	92.1	.285	−87	40.33	78.92
	WJAC-FM	38	95.5	8.3	1070	40.37	78.98
Lancaster	WLAN-FM	45	96.9	6.7	80	40.05	76.34
	WGAL-FM	67	101.3	3.8	215	40.04	76.31
Lebanon	WLBR-FM	61	100.1	.720	290	40.36	76.48
Meadville	WMGW-FM	62	100.3	10.0	585	41.63	80.18
Philadelphia	WXPN	05	88.9	.010*	173*	39.95	75.19
CP	WRTI-FM	11	90.1	.790	125	39.98	75.15
	WHYY	15	90.9	20.0	460	39.95	75.17
	WPWT	19	91.7	.180	10	39.95	75.17
	WIP-FM	27	93.3	20.0	430	39.95	75.17
	WIBG-FM	31	94.1	20.0	355	40.08	75.16
	WFLN-FM	39	95.7	20.0	490	40.06	75.24
CP	WHAT-FM	43	96.5	20.0	288	40.00	75.21
	WCAU-FM	51	98.1	4.7	660	40.04	75.24
CL	WFIL-FM	71	102.1	6.3	780	40.04	75.24
	WPEN-FM	75	102.9	20.0	420	39.95	75.17
CP	WDAS-FM	87	105.3	20.0	285	40.00	75.21
CP	WQAL	91	106.1	20.0	480	39.95	75.16
CP Philipsburg	WPHB-FM	35	94.9	4.6	68	40.89	78.19
Pittsburgh	WDUQ	18	91.5	2.75	−5	40.45	79.98
	KDKA-FM	25	92.9	47.0	890	40.49	80.02
	WKJF	29	93.7	40.0	470	40.44	80.03
IP	WWSW-FM	33	94.5	50.0	940	40.46	80.00
	WFMP	59	99.7	24.0	470	40.41	80.04
Pottsville	WPPA-FM	70	101.9	2.8	650	40.83	76.21
Scranton	WUSV	10	89.9	1.35	−390	41.41	75.66
	WGBI-FM	67	101.3	1.8	1200	41.43	75.75
Sharon	WPIC-FM	75	102.9	26.0	455	41.22	80.47
State College	WDFM	16	91.1	.250	−10	40.80	77.87
Sunbury	WKOK-FM	31	94.1	4.4	875	40.79	76.70
Warren	WRRN	22	92.3	3.0	450	41.81	79.17
Washington	WJPA-FM	82	104.3	4.0	360	40.19	80.23
Wilkes-Barre	WBRE-FM	53	98.5	2.25	1160	41.20	75.82
CP	WYZZ	77	103.3	3.1	975	41.18	75.87
IP Williamsport	WRAK-FM	62	100.3	4.0	1220	41.19	76.98
	WLYC-FM	86	105.1	.840	1150	41.20	76.97
York	WNOW-FM	89	105.7	1.2	465	40.00	76.69
RHODE ISLAND							
CP Cranston	WLOV	60	99.9	10.0	225	41.78	71.50
Providence	WPRO-FM	22	92.3	15.0	560	41.80	71.47
	WPFM	38	95.5	3.2	170	41.83	71.42
	WXCN	68	101.5	20.0	500	41.85	71.78
	WPJB-FM	86	105.1	20.0	500	41.81	71.47
Woonsocket	WWON-FM	92	106.3	.390	215	41.99	71.51
SOUTH CAROLINA							
Anderson	WCAC	66	101.1	6.4	330	34.51	82.64
Charleston	WTMA-FM	36	95.1	10.0	385	32.82	79.98
	WCSC-FM	45	96.9	36.0	330	32.82	80.00
Columbia	WUSC-FM	10	89.9	.010*	129*	33.98	81.03
	WCOS-FM	50	97.9	5.3	260	34.02	81.01
Dillon	WDSC-FM	25	92.9	8.8	290	34.37	79.40
Greenville	WESC-FM	23	92.5	12.0	360	34.89	82.47
	WFBC-FM	29	93.7	10.5	1110	34.94	82.41
Orangeburg	WORG-FM	74	102.7	4.6	110	33.52	80.87
Rock Hill	WRHI-FM	52	98.3	.650	310	34.91	81.01
Seneca	WSNW-FM	51	98.1	9.4	330	34.69	82.99
Spartanburg	WSPA-FM	55	98.9	4.9	520	34.98	81.99
	WDXY	63	100.5	9.2	420	34.98	81.97
TENNESSEE							
Bristol	WOPI-FM	45	96.9	9.7	260	36.60	82.16
Chattanooga	WDOD-FM	43	96.5	42.0	1040	35.16	85.32
Greeneville	WGRV-FM	35	94.9	4.6	250	36.16	82.84
Jackson	WTJS-FM	81	104.1	50.0	640	35.65	88.83
Johnson City	WJHL-FM	64	100.7	8.1	620	36.32	82.34
Kingsport	WKPT-FM	53	98.5	10.0	960	36.53	82.59
Knoxville	WKCS	16	91.1	.310	73	35.99	83.92
	WUOT	20	91.9	70.5	125	35.96	83.96
CL	WBIR-FM	27	93.3	3.3	620	36.04	83.94
Memphis	WMCF	59	99.7	300.0	940	35.17	89.89
Nashville	WFMB	90	105.9	3.1	47	36.16	86.76
TEXAS							
Abilene	KACC-FM	20	91.1	.160	53	32.46	99.71
Austin	KAZZ	38	95.5	1.35	80	30.30	97.74
	KHFI	52	98.3	.700	125	30.30	97.74
Baytown	KREL-FM	21	92.1	.820	190	29.78	95.02
DP Beaumont	KRIC-FM	48	97.5	9.1	360	30.06	94.12
Cedar Hill	KDFW	100	107.9	88.0	770	32.55	96.98
Cleburne	KCLE-FM	32	94.3	.330	190	32.38	97.40
Corpus Christi	KDMC	38	95.5	.330	280	27.79	97.40
Dallas	KNER	01	88.1	.010*	76*	32.80	96.65
	KSMU-FM	07	89.3	.010*	60*	32.86	96.79
	KVTT	19	91.7	.780	135	32.78	96.81
	KRLD-FM	23	92.5	40.0	480	32.89	96.64
	WRR-FM	66	101.1	68.0	500	32.78	96.76
	KIXL-FM	83	104.5	25.0	470	32.78	96.72
CP	KSFM	87	105.3	11.0	200	32.76	96.76
Denton	KDNT-FM	92	106.3	.760	270	33.23	97.17
El Paso	KVOF-FM	03	88.5	.010*	185*	31.76	106.49
Ft. Worth	WBAP-FM	42	96.3	52.0	475	32.75	97.27
Houston	KUHF	17	91.3	9.8	320	29.72	95.35
CP	KFMK	50	97.9	10.5	235	29.71	95.40
	KTRH-FM	66	101.1	29.5	470	29.76	95.36
	KPRC-FM	75	102.9	48.0	550	29.73	95.46
Lubbock	KSEL-FM	42	93.7	9.6	195	33.58	101.83
Nacogdoches	KELS	61	100.1	.330	175	31.59	94.62
Plainview	KHBL	01	88.1	.010*	90*	34.19	101.73
San Antonio	KONO-FM	25	92.9	3.8	410	29.44	98.48
	KITE-FM	47	97.3	8.3	185	29.44	98.55

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT	LAT	LONG
(San Antonio)	KISS	58	99.5	12.9	570	29.39	98.35
Texarkana	KCMC-FM	51	98.1	1.4	275	33.45	94.07
UTAH							
Ephraim	KEPH	05	88.9	.010*	80*	39.37	111.57
Logan	KVSC	01	88.1	.010*	84*	41.74	111.81
CP Salt Lake City	KBFM	30	93.9	.720	−550	40.76	111.90
	KDYL-FM	54	98.7	1.2	2970	40.61	112.17
IH	KSL-FM	62	100.3	6.1	3660	40.66	112.20
VIRGINIA							
Arlington	WARL-FM	86	105.1	2.05	500	38.90	77.13
Charlottesville	WTJU	17	91.3	.010*	101*	38.03	78.51
	WINA-FM	37	95.3	.620	225	38.02	78.50
Crewe	WSVS-FM	84	104.7	14.0	450	37.20	76.17
Harrisonburg	WEMC	19	91.7	.010*	78*	38.47	78.88
	WSVA-FM	64	100.7	7.2	345	38.45	78.91
Lynchburg	WWOD-FM	61	100.1	.940	170	37.44	79.21
Martinsville	WMVA-FM	42	96.3	2.9	625	36.70	79.85
Newport News	WGH-FM	47	97.3	36.0	180	37.04	76.41
Norfolk	WFOS	13	90.5	.010*	75*	36.80	76.27
	WMTI	18	91.5	1.45	96	36.89	76.30
	WRVC	73	102.5	8.7	95	36.88	76.29
Richmond	WRFK	16	91.1	.010*	104*	37.58	77.45
	WRVA-FM	33	94.5	25.0	460	37.51	77.50
	WCOD	51	98.1	34.0	430	37.58	77.49
	WRNL-FM	71	102.1	50.0	240	37.62	77.43
Roanoke	WDBJ-FM	35	94.9	14.5	1940	37.20	80.16
IP	WSLS-FM	56	99.1	21.0	1890	37.20	80.15
Winchester	WRFL	23	92.5	13.4	1390	38.96	78.02
WASHINGTON							
IP Seattle	KUOW	35	94.9	44.0	300	47.61	122.32
	KING-FM	51	98.1	15.0	410	47.63	122.35
	KISW	60	99.9	2.1	350	47.70	122.32
	KIRO-FM	64	100.7	4.5	470	47.40	122.44
Spokane	KREM-FM	25	92.9	4.8	720	47.62	117.37
Tacoma	KCPS	15	90.9	.070	90	47.16	122.52
	KTOY	19	91.7	3.5	450	47.25	122.45
	KTNT-FM	47	97.3	10.2	410	47.25	122.46
CP	KTWR	80	103.9	.850	240	47.26	122.46
WEST VIRGINIA							
Beckley	WBKW	58	99.5	34.0	1050	37.59	81.11
Charleston	WKAZ-FM	48	97.5	9.0	124	38.38	81.71
Huntington	WHTN-FM	63	100.5	53.0	560	38.39	82.47
Logan	WLOG-FM	77	103.3	2.1	725	37.86	81.98
Martinsburg	WEPM-FM	32	94.3	.810	170	39.46	77.84
Morgantown	WAJR-FM	57	99.3	1.0	10	39.62	79.95
Oak Hill	WOAY-FM	31	94.1	14.5	660	37.96	81.15
Parkersburg	WAAM-FM	93	106.5	8.9	280	39.29	81.53
Wheeling	WKWK-FM	47	97.3	16.0	470	40.10	80.70
	WWVA-FM	54	98.7	7.4	470	40.10	80.87
WISCONSIN							
Appleton	WLFM	16	91.1	10.5	130	44.26	88.40
Chilton	WHKW	07	89.3	51.0	740	44.03	88.29
Colfax	WHWC	02	88.3	50.0	740	44.96	91.67
Delafield	WHAD	14	90.7	52.0	500	43.03	88.39
Eau Claire	WEAU-FM	31	94.1	60.0	360	44.83	91.45
Greenfield	WWCF	35	94.9	37.0	1300	43.43	89.22
Highland	WHHI	17	91.3	50.0	596	43.05	90.37
Highland Township	WHSA	10	89.9	38.0	450	46.47	91.57
Holmen	WHLA	12	90.3	39.0	840	43.95	91.13
Janesville	WCLO-FM	60	99.9	15.5	200	42.66	89.04
Madison	WHA-FM	04	88.7	22.0	185	43.08	89.40
	WISC-FM	51	98.1	1.0	105	43.02	89.40
	WMFM	81	104.1	7.5	80	43.09	89.35
Marshfield	WDLB-FM	80	103.9	.250	250	44.68	90.17
Merrill	WLIN	64	100.7	9.35	260	45.19	89.67
CP Milwaukee	WQFM	27	93.3	30.0	190	43.04	87.92
CP	WFMR	43	96.5	15.0	180	43.04	87.92
Racine	WRJN-FM	64	100.7	15.0	265	42.71	87.83
Rice Lake	WJMC-FM	42	96.3	50.0	540	45.51	91.77
Sheyboygan	WHBL-FM	62	100.3	63.0	235	43.72	87.73
Wausau	WHRM	20	91.9	114.0	790	44.84	89.69
Wisconsin Rapids	WFHR-FM	77	103.3	2.1	360	44.42	89.83

CANADA

CITY	CALL	CH	(Mc) FREQ	(Kw) ERP	(Ft) HT
ALBERTA					
Edmonton	CKUA-FM	51	98.1	.352	140
	CJCA-FM	58	99.5	.414	60
	CFRN-FM	62	100.3	.279	156
BRITISH COLUMBIA					
Vancouver	CBU-FM	89	105.7	1.4	234
Victoria	CKDA-FM	53	98.5	.370	—
MANITOBA					
Winnipeg	CJOB-FM	76	103.1	.250	253
NOVA SCOTIA					
Halifax	CHNS-FM	41	96.1	.250	40
Sydney	CJCB-FM	35	94.9	.630	260
ONTARIO					
Brantford	CKPC-FM	34	92.1	.250	180
Cornwall	CKSF-FM	83	104.5	.525	200
Fort William	CKPR-FM	32	94.3	.250	100
Kingston	CFRC-FM	20	91.1	1.270	—
	CKWS-FM	42	96.3	.350	94
	CKLC-FM	58	99.5	.310	—
Kitchener	CKCR-FM	44	96.7	.350	180
London	CFPL-FM	40	95.9	4.440	131
Ottawa	CFRA-FM	30	93.9	.383	135
St. Catherines	CKTB-FM	49	97.7	.250	79
Timmins	CKGB-FM	33	94.5	.425	101
Toronto	CJRT-FM	16	91.1	9.9	95
	CBC-FM	56	99.1	11.9	505
	CFRB-FM	60	99.9	.600	100
Windsor	CKLW-FM	30	93.9	.250	414
QUEBEC					
Montreal	CBF-FM	36	95.1	3.860	183
	CBM-FM	64	100.7	3.860	183
	CFCF-FM	93	106.5	7.7	450
Quebec	CHRC-FM	51	98.1	.595	150
Rimouski	CJBR-FM	68	101.5	.570	485
Verdun	CKVL-FM	45	96.9	10.2	74

Electronic Firsts

by MONROE UPTON

Author of "Electronics for Everyone"

THE SUPERHET is pretty much today's standard receiver for all types of space communication, including both AM and FM radio and TV. Its chief characteristic is conversion: it converts the frequency of the transmitter to a lower frequency before much amplification takes place. The lower frequency is called the intermediate frequency, or IF.

Not the least of the superhet's virtues is simplicity of tuning. By converting any frequency tuned in to the same IF, the IF stages of amplification can all be fixed-tuned.

The superhet's story begins with one of the great pinneer's of radio, Reginald Aubrey Fessenden, who was sending voice through space when Marconi and others were still concentrating on dot-and-dash. The early spark transmitters sent out a discontinuous wave, one that was broken up (modulated) by the character of the device itself. This inherent modulation was at an audible frequency, useless for transferring intelligence unless separated into dots and dashes by a key in the power supply. Fessenden early began a search for a continuous wave (CW) which could then be modulated by the audible frequencies of voice and music.

Fessenden's dreams were wrapped up in a high-frequency electromagnetic generator of CW (an alternator), which was later perfected by Dr. E. F. W. Alexanderson at GE. But when a continuous wave is used for dot-and-dash radio some way must be found to obtain an audible freqnency from it. Fessenden's solution was to heterodyne the CW by means of a second CW generated at the receiver. Heterodyning two freqnencies produces other frequencies, including a difference frequency. The difficulty then was in conveniently generating a local frequency, now readily had from an oscillating tube.

During World War I, radio-telegraph communication between the front-line infantry and the barrage-laying attillery was suffering from interference by enemy spark transmitters. A call went out to the Hammond Labs near Gloucester, Massachusetts, for a receiver selective enough to ignore this interference. The Hammond engineers had been using IF amplification, based upon Fessenden's heterodyne principle, in another connection. Their solution was to modulate the transmitter with a super-audible frequency, then heterodyne the received signal with a local frequency to produce an audible signal tone.

Performance checks on the system were made at the Signal Corps Paris Lab early io 1918, under the direction of Captain E. H. Armstrong. The superhet receiver, as later developed and patented by Armstrong for radio broadcasting, used a variable-frequency oscillator tube to reduce any frequencies on the broadcast band to the fixed IF, which could then be put through from one to three fixed-tuned amplifying stages to much better advantage than a whole band of frequencies. His circuit included both an oscillator and a mixer tube.

On October 5, 1920, Armstrong sold his superheterodyne and feedback patents to Westinghouse for $335,000. Both patents were destined to be harassed by interference proceedings for almost two decades. His superhet patent claims in the United States were awarded to L. Levy of France, while his French claims, which discussed sensitivity only, were upheld. Dr. Lee De Forest was finally awarded the feedback patent, after *two* Supreme Court decisions in his favor.

PUZZLEMENTS

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available for converting single-channel, or "monaural," sound into something more like stereophonic sound. On most of these gadgets you can get conflicting opinions. One person will like the results, while another says it definitely is not stereo. The reason for these different opinions seems to rest in the fact that different people have come to expect different things from stereophonic reproduction.

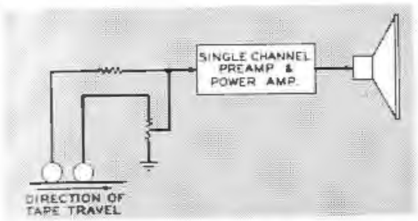

Fig. 3. Artificial reverberation may produce sense of greater spaciousness.

Many have commented (with good reason it is true) that one or the other of the pseudo-stereo devices can produce a more realistic stereo illusion than a true stereophonic recording played over separate channels. But this is not because the pseudo stereo is inherently a better way of doing it than the separate-channel method. What it does indicate is that the separate-channel program with which the pseudo was compared did not exploit to the full the advantages available to it.

If you expect stereo to give yon principally a sense of space, then an artificial-reverberation unit can often achieve this for you. With the tape variety of reverberation generator, which simply adds the reverberation to the one channel (Fig. 3), the result sounds much like extra reverberation in the recordings.

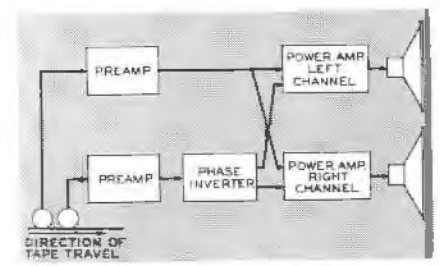

Fig. 4. Improvement on Fig. 3 is use of phase inversion in reverberation channel.

An improvement on this is a system that puts a phase inversion in the "reverberation" pickup fed to two loudspeakers via separate power amplifiers, Fig. 4. An alternative way of effecting this improved impression of expanse by added reverberation is the use of separate channels, one playing the original sound over a high quality loudspeaker, and the other playing the delayed sound over

Continued on next page

PUZZLEMENTS

Continued from preceding page

a second loudspeaker which can be of inferior quality (Fig. 5). The two loudspeakers are spaced apart in order to give the impression that the echo or reverberation comes from a different location from the original sound.

But if you have come to expect stereo to give you distribution of sound, then the use of radically different loudspeakers on a common channel can give quite an effective step in this direction. The fact that the different loudspeakers have slightly different frequency responses or different radiation patterns, while both handle basically the full frequency range, will give an impression of different components of the sound coming from different spatial positions relative to the loudspeakers. This effect can be heightened considerably by the use of a pseudo-stereo amplifier that incorporates special phase-shifting arrangements.

Finally, however, if you expect stereo, in addition to these effects, to produce a clearer definition of individual instruments, so they can be aurally separated by the hearing faculty — if not in space, in actual identity — then the best potential rests with true two-channel (or even more if possible) stereophonic recording or transmission.

Unfortunately, this statement has to be modified. We cannot say that merely acquiring a stereophooic recording and playing it over a stereophonic system definitely will provide a better effect than some of the pseudo methods. This is principally because the full possibilities or potential of the stereo technique often is not fully exploited by the recording people. The right *kind* of sound difference is not put on the recording.

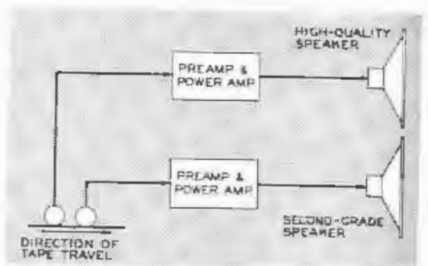

Fig. 5. Second speaker provides echo only; is spaced away from main speaker.

When this is the case, results can often be quite unsatisfactory.

Although a poor true-stereo recording will achieve a sort of pseudo effect it would seem to be a wasted effort, because one can get pseudo-stereo effects without needing separate channels of recording. So we might conclude this discussion for the time being with an appeal to the recording people to make sure that when they take up two channels, they make the best use of them.

AUDIOLAB REPORTS

Continued from page 23

mounting centers. A hole with a removable snap cover allows the use of the GE "Triple Play" cartridge. No soldering is involved in installing the cartridge, since the arm contains spring clips which can be adjusted to make contact with practically any type of cartridge terminals.

The arm mounts in a single 1-inch hole. No arm-leveling provision is made. Since proper operation of this type of arm depends on its maintaining a constant distance from the record surface, it is especially important to use a flat motor board, free from any warpage. Naturally, this is recommended for any type of arm, but is imperative for an arm which cannot move vertically.

Test Procedure

The only quantitative measurements which it is practical to apply to an arm are those involving the presence of resonant conditions. We did this by playing a number of test records and measuring the frequency response over the range of 10 cps to 10 Kc. A Fairchild 225A cartridge was used in these tests, since it is a representative high-quality cartridge in wide use, and is also completely standard in size, mounting dimensions, and mass (insofar as any standards can be said to exist). It is interesting to note that when the cartridge was installed, the arm was exactly balanced and the stylus force was 6 grams, without any adjustments being made.

All the test records available to us were recorded with a 500-cps low-frequency turnover. Our preamplifier (a Dynakit) has RIAA equalization, which measurements show to be within 2 db of the RIAA curve from 15 cps to 20 Kc (the RIAA curve is defined only from 30 cps to 15 Kc, but we have extrapolated it beyond these limits). Due to the low-frequency characteristics of the RIAA curve, there is a falling off of response below 50 cps when playing these records. For this reason, the data we have taken are not to be interpreted as absolute frequency-response data, but rather as an indication of smoothness and the presence or absence of resonant peaks and holes.

Test Results

The accompanying curve and oscilloscope photographs (showing the response to several sweeping-frequency records) all point to the same conclusion — that there is no measurable arm resonance between 10 cps and 10 Kc. Although it is solidly built, the arm mass does not appear to be so great that the fundamental resonance would be below 10 cps with the test cartridge. We must therefore conclude that the viscous damping is working most effectively to reduce the amplitude of resonance to negligible proportions.

Summary

The Gray Model 212 arm is a well-built, flexible arm which could enable a cartridge to deliver all the performance of which it is capable. It is universal, easy to install, and easy to use.

In our use tests we found that it would track a 45-rpm record placed ¼ in. off-center, which is certainly all one can expect from any arm. A record with a ⅛-inch warp was played without difficulty and with only the slightest trace of wow. This is good performance for an arm with a short pivot-stylus distance, and can be attributed to the fact that the vertical pivot is as close as possible to the plane of the record. The balanced construction combines with the viscous damping to make the arm relatively insensitive to jarring and vibration.

We noted another thoughtful design feature in the inclusion of a stop which prevents the head being raised so far that the rear of it contacts the record.

Manufacturer's Comment: Using the Fairchild 225A cartridge, the fundamental resonance resulting from the mass of the arm and the compliance of the cartridge occurs at 8.5 cps when measured with a free undamped vertical pivot in our laboratory. This resonance is not evident when the standard viscous-damped pivot assembly is used. Cartridges of lower compliance than the Fairchild 225A require viscous damping to eliminate tone-arm resonance above this frequency and provide optimum low-frequency performance.

GROUNDED EAR

Continued from page 4

minimizes the possibility of a ground loop between the preamp and amplifier, which can result in a difficult-to-eradicate hum level.

It will also be noted that the Mark III has a choke-filtered supply, but those who see the choke for the first time will probably be surprised by its small size. This, however, is not entirely the result of keeping costs down. Although high inductance provides better hum filtering, it may also result in poorer voltage regulation. The 2-henry choke was designed with optimum gap and low resistance to keep regulation good.

All these measures result in an amplifier which, for practical purposes, is entirely humless — unless, possibly, it were used with a very efficient speaker system with a big peak at 60 cps, and then I doubt that the hum would be annoying.

The performance (measured or by ear) truly deserves the label, "superb." My specimen was exactly up to the specifications. The frequency response at low levels is within ½ db from 6 to 60,000 cps, down 3 db at 100 Kc, and 2 db at 4 cps. The amplifier will deliver well over 50 w at the two extremes of 20 and 20,000 cps with less than 1% harmonic distortion. At the 60-watt level the distortion at 400 and 1,000 cps (the typical frequencies at which harmonic distortion is customarily measured) is of the order of .05%.

I mentioned the flat distortion curves of the KT88. They are well exemplified in this amplifier. The IM runs below 0.1% up to about 5 w, rises to 0.3 at 10 w, 0.4 at 20 w, 0.5 at 40 w, and 0.6 at 60 w. Unfortunately, I was not able to measure distortion above that point for lack of a load capable of dissipating the output safely. I suspect that the 2% point, at which maximum output is measured, occurs at around 65 w. That is the point at which 400-cps clipping occurs. Thus, if my specimen is representative, the 60-watt rating is conservative.

As for sound, the Mark III shares the solid authority at the low and high ends with its mate, the Mark II, though it may be slightly cleaner when overloaded — it is hard to tell because it is not easy, even in the middle of a wilderness, to operate an amplifier loudly enough to reach 60-watt outputs.

ARKAY KIT REPORT

Continued from page 27

to 0.12% at 1 w and .07% at ½ w. This also degraded the low-frequency stability to what we would call marginally good; it had been excellent. We would not recommend this change to readers because, in this case, the risk of incurring low-frequency instability outweighs the benefit of distortion reduction obtained in the power-amplifier section.

The second, and main, source of distortion is the voltage-amplifier stage preceding the tone-control/volume-control section. The second half of the phono preamplifier tube is used to build up incoming high-level signals to overcome losses in the control circuits, but it isn't designed to handle signals greater than a fraction of a volt. This doesn't matter much if an Arkay tuner is used as the high-level source — Arkay tuners are designed to put out 0.3 v maximum — but it does matter if some source with an output on the order of a volt is connected to the AUX or TUNER input. With an input of 0.2 v, which is necessary to drive the power amplifier to full output at maximum setting of the VOLUME control, we found the IM distortion of this section to be 0.55%; at 0.5 v io, 3%; at at 1 v in, 26.5%.

Obviously, unless the source you connect to these high-level input circuits cannot put out more than a fraction of a volt, or is equipped with an output level control, you must provide an input level control on the SA-25 to reduce the possibility of overload. Operate the SA-25's VOLUME control as far up as possible in all cases, adjusting the input sources to produce maximum listening volume at full roration of the VOLUME control. This applies to high-level inputs for both channels on the SA-25.

Manufacturer's Comment: We had thought that the instruction booklet for the SA-25 was quite good and that we had done quite well in the elimination of errors and oversights in the better than 20 pages of text. The reporter's comment seems to have borne us out. Nonetheless, we are indebted to AUDIOCRAFT for pointing out the three errors we did not catch, enabling us to correct them and to make the SA-25 manual a perfect "Construction" manual.

It has been our experience that kit builders of any experience generally do not follow the instruction manual when it comes to routine steps and pointers. Therefore, we have begun revision of all Arkay manuals so that, in the future, an Arkay kit can be built with the use of either the manual, the pictorial diagrams, or both.

After considering the comments of the reporter with regard to input and output level controls, we have decided to include a sheet of supplemental instructions with each SA-25 "Construction" manual. This sheet will enable the kit builder to add input and output level controls by showing, with pictorial diagrams, step-by-step instructions, and general advice, how and where to install these controls. It will also explain the circumstances under which these extra controls may be needed. Since this will not be too often, the parts are not being included with the kit.

We feel that it is of interest to the home owner and the apartment dweller to have his audio equipment fit in with the decor of his home. In our efforts to meet this need, we feel the new Arkay stereo components are the epitome, a view shared by the Fashion Foundation of America; it has awarded Arkay the Gold Medal for Distinctive Design.

specialists, they surely will consistently delight sound fanciers, both by Marchal's choice of registrations to display the versatility and individuality of the Holtkamp organs and by the combination of topnotch recording and acoustics.

Another distinctive LP is the 10-inch *Music Box Sampler* which can be obtained only by purchase of the book *Music Boxes: their Lore and Lure*, by Helen and John Hoke (Hawthorn Books, $10.00). The text itself is a good enough primer of music-box and mechanical-music-makers history, although overfancily designed and illustrated in blatantly juvenile fashion, but the slipped-in disc of sonic illustrations is better varied (including examples of carillon, barrel organ, calliope, player piano, and carousel, as well as of several different types of music boxes themselves) and more glitteringly recorded than any of its kind I've heard before.

And among current stereo tapes, two that have special — indeed unique — appeal are Concertapes 510 (*Roman Carnival* Overture and *Die Meistersinger* Prelude) and 24-8 (Tchaikovsky *Nutcracker* Suite), in which the conductorless Symphony of the Air was recorded in its famous 1954 Carnegie Hall performance of what were still well-remembered Toscanini interpretations. I have heard only the second of these, but it's a fine job even if one doesn't know that it was made some three and a half years ago, and since Toscanini himself unfortunately never was recorded in stereo, this serves poignantly to remind us of what we — and posterity — missed.

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