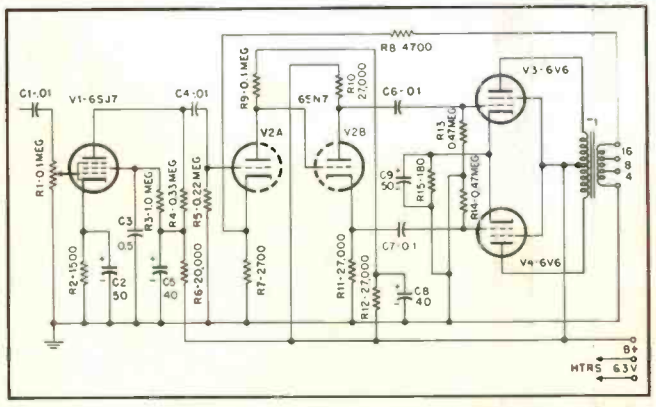
AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

APRIL, 1955

50c

ANC



This small amplifier, designed originally as a monitor amplifier for a broadcast station, will serve admirably for a home music system where the power requirements are not too severe but where quality is extremely important. See page 26.

Building a portable phonograph in a case suitable for travel and designed for use under varying conditions proved most interesting. See page 17.

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THE BRITISH INDUSTRIES

Sounding Board

*Wm. Joseph *Says* "Leave well enough alone in Speaker Enclosures"

LC: Mr. Joseph, the title of this conversation seems to indicate that there isn't anything further to be accomplished with the design of speaker enclosures. Do you really mean this?

WJ: I should say not! However, Mr. Carduner, a genuine high fidelity enclosure really does leave "well enough" alone, because it will *not* affect that part of the reproduction which is already satisfactory . . . and which usually occurs above a certain frequency range. What it does is to influence and bring out the low frequencies . . . those below 150–200 cycles. Though originally engineered into the speaker, these sounds cannot be realized without a proper speaker enclosure. If the enclosure changes the sound of the speaker, it is no longer a high fidelity enclosure, because it automatically negates what we are trying to do in high fidelity . . . duplicate the original performance, undistorted.

LC: In other words, it's not only how you bring out the bass . . . it's just as important not to change the middle and upper frequency notes.

WJ: That's right. For one thing, it is important that there be no places where extensive standing waves can be built up near the face of the speaker. I recently saw a bass reflex enclosure—which, in order to get a folded pipe to the reflex port, and still keep manufacturing costs down, mounted the speaker 4 inches back of the frontal aperture. Now, I have no doubt that the cylinder which was produced from the speaker to the frontal opening will color the sound, just like blowing into a tube.

LC: You mentioned the element of cost. I think the difference in the cost of constructing two speaker enclosures of approximately the same size and amount of wood needs some explaining.

(continued)

PERFORATED FOR YOUR CONVENIENCE IN CUTTING THESE OUT AND SAVING THEM.

The Sounding Board

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WJ: Well, there are many construction points which may affect the results obtained from the cabinet. Furthermore, many cabinets look alike, but they are entirely different inside.

LC: I'm glad you mention this, because there are more and more enclosures on the market, which look alike. There are small ones—large ones—corner baffles. How would you suggest that a buyer choose between the similar looking enclosures in each of these categories?

WJ: Because he usually cannot establish optimum conditions for listening tests, he is forced to rely upon the reputations of the manufacturers and of experts in the field, for his best guidance.

LC: Bill, this sounds a bit strange to me, frankly. After all, if everyone were buying only the equipment which the experts had already approved, wouldn't this serve to exclude new developments? I cannot help but remember that your own R-J was new and untried when it was first introduced.

WJ: Well, Leonard, that is my point. New speaker enclosures *which are original in construction principle* compel attention. For example—the first folded horn was radically different in concept and response. Our R-J design, fortunately, filled the need for a small, inexpensive enclosure which would fit into available living space, and at the same time, provide listening with full bass response. For that reason, acceptance was almost immediate.

LC: Isn't this a good example of one place where you think the public must rely on the experts, in order not to choose enclosures which look the same on the outside, but are not engineered or constructed the same on the inside?

WJ: Yes. There may be enclosures which are designed differently on the inside, but are still perfectly good. However, we have to guard against an increasing number of manufacturers . . . furniture makers, not electronic engineers, who do not have the technical know-how to design an enclosure on the inside and who are providing a *box* without authentic engineering. They manage to sell, because people do not understand. It was very surprising to me, at some of the Audio exhibitions, to find that many people didn't know why an enclosure was required in the first place. Many are now buying completely packaged units in which the back is completely open and the speaker is undamped.

LC: These are some of the reasons why we have to depend on the readers of "Audio," who know how to explain to others that a good enclosure is required in order to get high fidelity performance from a speaker, and that it must be right inside as well as *look* right outside, in order to guarantee results.

**An interview between William Joseph, co-designer with Franklin Robbins of the R-J Speaker Enclosure, and Leonard Carduner, President of British Industries Corporation, New York. BIC is an American company which offers you the finest audio equipment . . . fully guaranteed, with service and spare parts available throughout the U.S.*

The British Industries Group consists of the following products:
Garrard Record Players
Leak Amplifiers
Wharfedale Loudspeakers
R-J Enclosures
Ersin Multicore Solders

The Soundling Board

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CONTENTS

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Culver City, Los Angeles County, Calif.

AUDIO PATENTS

RICHARD H. DORF*

LIKE ANY OTHER electronic organ, the Wurlitzer requires some means of controlling how loud it wurlitzes, and Francis M. Schmidt of North Tonawanda, N. Y., home of the organ plant, has invented a new circuit for use with swell shoes. It is essentially a d.c.-operated volume control compensated so that as level decreases bass is emphasized to make up for the ear's relatively poor response to low frequencies at low levels and keep over-all balance constant.

What makes this rather simple circuit interesting even to a great many people who for some unaccountable reason don't care to build electronic organs is that it could be used to great advantage by any sound-system owner as a remote loudness control. Due to the d.c. operation, the control line (just three wires or perhaps a 2-conductor shielded microphone cable with a pot on the end) can be run as far as you like without any impairment of operation of either the control or the system. The bass-boost-at-lower-levels feature probably doesn't give the authentic Fletcher-Munson curves to great accuracy, but human ears come off an assembly line subject to large manufacturing variations and probably Fletcher's personal loudness contours didn't even match Munson's.

The patent, which is assigned to The Rudolph Wurlitzer Company, is numbered 2,695,386. The three principal objects of the invention are (a) a frequency-compensated control, (b) one which tends to wash out the effects of "noisy" pots, and (c) probably a remote-type control which didn't involve problems of carrying high-impedance leads all over, though this isn't stated.

The circuit of the primary embodiment of the invention appears in *Fig.* 1. The triode doesn't do any amplifying—doesn't even carry signal; it is simply a variable resistance. The incoming signal passes through R_1, which acts as the series leg of a voltage divider. Ignoring C_1 for the moment and treating it just as a d.c. blocking capacitor, the shunt leg of the voltage divider is the plate resistance of the tube. The level of the output signal is controlled by varying the plate resistance.

As a matter of fact, C_1 has a definite role. It is in series with the plate resistance, that is, with the shunt leg of the voltage divider, and it has a significant reactance. When the plate resistance is low, the reactance of C_1 is relatively large. This means that the shunt leg of the divider is composed mainly of a reactance which varies with frequency. At high frequencies the reactance is small, so that highs tend to be bypassed to ground. At low frequencies, the reactance is high so there is greater output. Curve B of *Fig.* 2 shows the frequency response at lowest level, while curve A shows that response is flat at maximum level. It varies between these limits at intermediate volume settings.

A return to *Fig.* 1 shows how the system is controlled. A definite positive voltage is applied to the cathode by the voltage divider R_2–R_3 operating from the B-supply. R_3 is bypassed by C_2 in the standard manner.

R_4 is the control potentiometer, probably a wirewound in real life for long wear and current carrying. The arm carries direct voltage to the grid through a time-delay network consisting of R_5 and C_3; the latter can also be made big enough to ground the grid for any stray a.c.

When the arm of R_4 is at ground the grid assumes its maximum negative potential with respect to cathode. The tube barely conducts (or may be brought to cutoff), the plate resistance is at maximum, and output level is highest and response flattest. With the pot arm at cathode, grid and cathode potentials are equal, the tube conducts, the plate resistance is least, and level is minimum, though not zero. Also, plate resistance is small with respect to the reactance of C_1 at the lower frequencies, so there is relative bass boost.

The timing network R_5–C_3 has two effects. First, it makes volume changes smooth because the grid voltage must change ex-

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

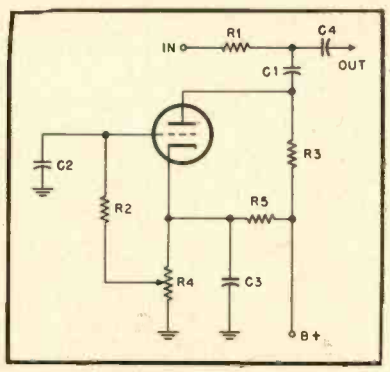

Fig. 1.

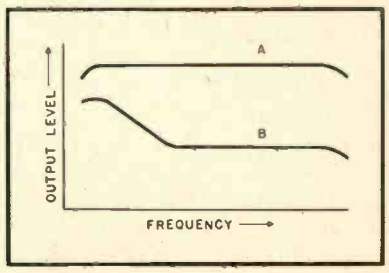

Fig. 2.

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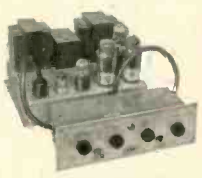

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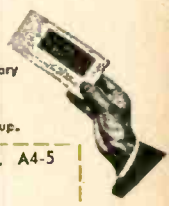

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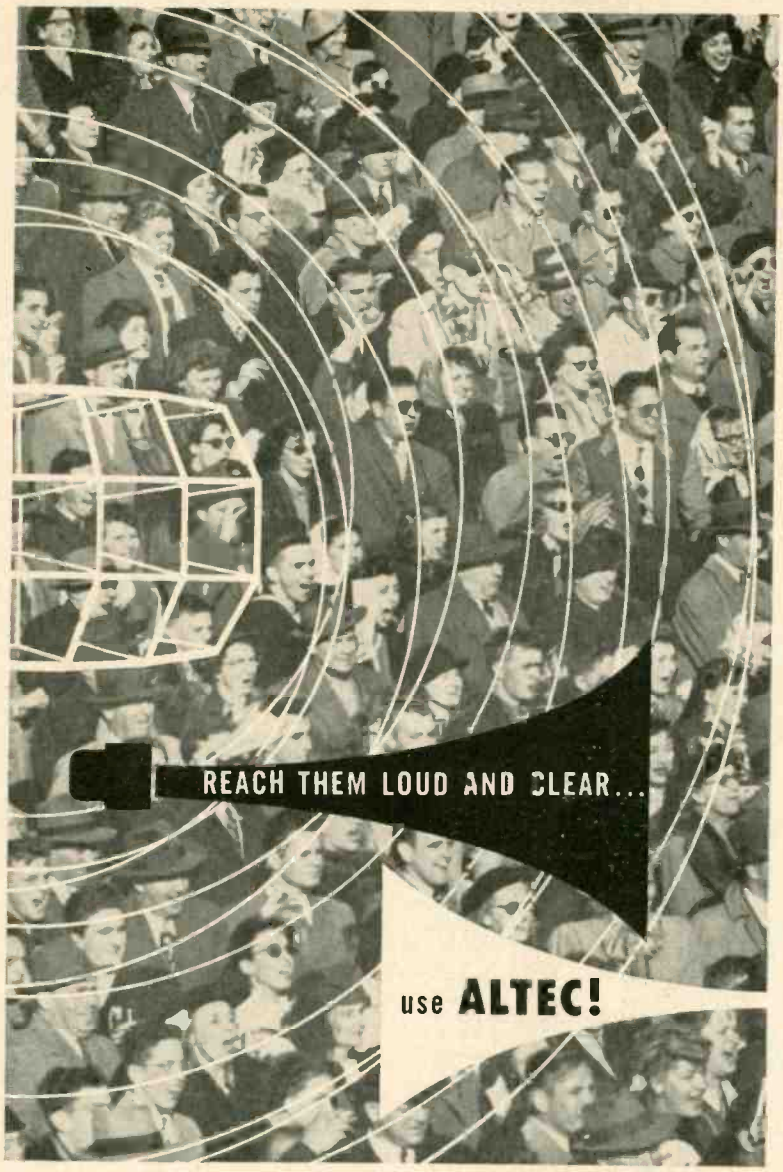

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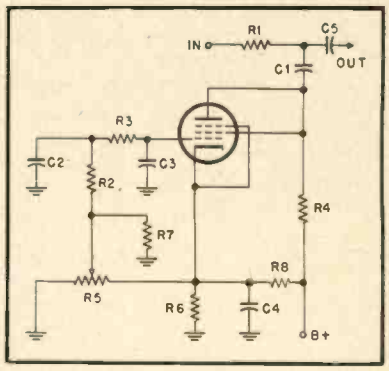

Fig. 3.

ponentially at a rate determined by the component values and arm voltage to charge C_3. Second, the network may be looked on as a low-pass filter, so that abrupt small changes of voltage at the pot arm caused by imperfect contact and dirt on the resistance element are filtered out.

No component values are given in the patent specification but they should be easy to find. R_2 should be rather large relative to the maximum plate resistance of the triode; since this is infinite at cutoff, perhaps a value such as 0.47 meg or so would be useful. Proportion R_1 and R_2 so that with the arm of R_1 at ground plate current is almost but not quite cut off. A time constant of about 0.1 second is a guess at a good time constant for R_1–C_3 and 0.1 μf and 1 megohm seem reasonable values. Now substitute temporarily a large value, say 0.25 μf, for C_1 and select R_1 so that volume-control action is suitable when R_1 is varied. Then select a permanent value for C_1 which gives the right amount of bass boost at various settings. The larger the value, the lower the turnover frequency. The adjustment can be made by ear while listening to music which has some bass, middle, and treble well distributed. C_4 is just a blocking capacitor and depends for its value on the following grid resistor as in any voltage amplifier. R_1 can be lifted from the circuit and placed on the end of a cable.

For those who care for a somewhat different type of compensation, the circuit of *Fig.* 3 is offered. *Figure* 4 shows what happens, with three curves illustrating frequency responses between maximum level (A) and minimum (B). In the earlier circuit, *Fig.* 2 shows that the middle and upper response remains flat and drops straight down with decreasing level. In the circuit

(*Continued on page 67*)

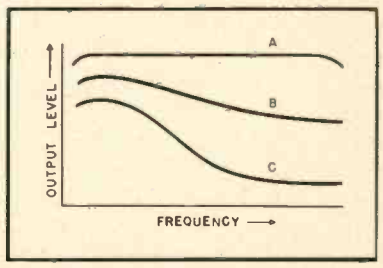

Fig. 4.

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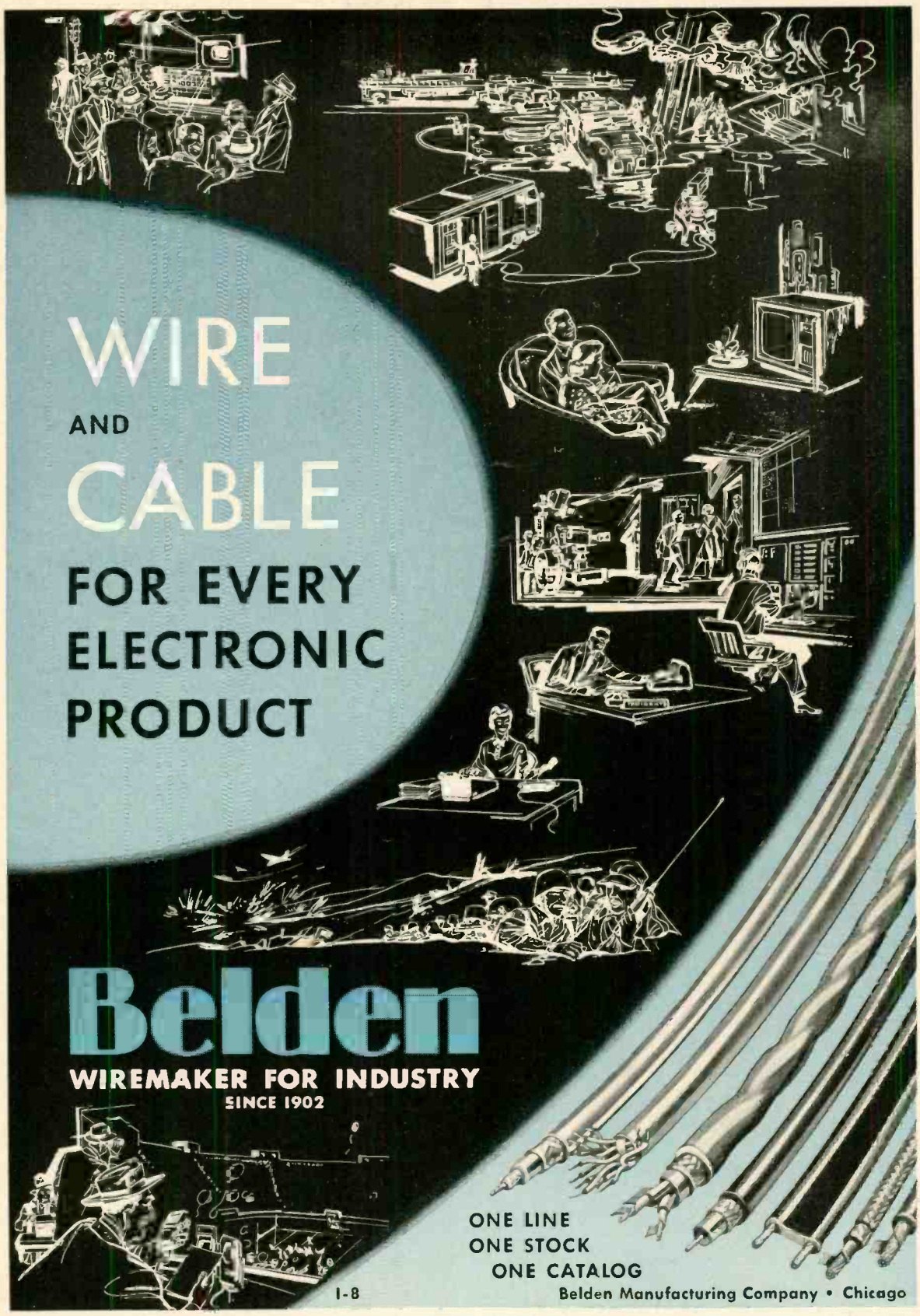

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NEW LITERATURE

• **Premier Metal Products Co.,** 3160 Webster Ave., New York 67, N.Y., describes its complete line of metal housings in a new 1955 catalog which has just been released. Tabbed for easy reference, the 16-page booklet illustrates more than 450 standard stock metal housings for the electronics industry. Included are full details of many newly-designed items not found in previous catalogs. Copy of Catalog No. 550 may be obtained by writing direct to the manufacturer, or through local distributors. **A-1**

• **Atlas Sound Corp.,** 1451 39th St., Brooklyn 18, N. Y., designers and manufacturers of public-address loudspeakers and microphone stands and accessories, has just released two catalog sheets on two new Atlas products, namely, the Model CJ-30 Cobra-Jector speaker, and the Model BS-37 Porto-Boom professional microphone boom stand. Both sheets list complete specifications, applications, and prices, and will be mailed free on request. **A-2**

• **Telex, Inc.,** Dept. KP, Telex Park, St. Paul 1, Minn., outlines the advantages and applications of the company's new miniature jack-and-plug combination in a catalog sheet which will be mailed on request. One-third the size of previous models, the combination can be installed in computers, dictating machines, tape recorders, and miniature radio receivers. The sheet lists complete specifications. **A-3**

• **Terminal Radio International, Ltd.,** 85 Cortlandt St., New York 7, N. Y., radio-TV-electronics equipment and parts distributor serving the export market exclusively, has issued a 4-page folder which describes the company's facilities and special services. It also provides a complete list of American manufacturers whose products Terminal International sells. Brief information on export-import procedure, packing, and transportation is also incorporated. Free copy will be mailed on request. **A-4**

• **Altec Lansing Corporation,** 9356 Santa Monica Blvd., Beverly Hills, Calif., is now distributing a new Jobber Sound Products Catalog in which is displayed and described the comprehensive line of sound equipment manufactured by the company for specific applications in the field of commercial electronics. Included in the listings are microphones, utility speaker assemblies, amplifiers for p. a. use, and 70-volt matching transformers. Professional users of quality equipment should have a copy of this catalog in their file. **A-5**

• **New Jersey Electronics Corp.,** 345 Carnegie Ave., Kenilworth, N. J., has developed a simplified approach to buying regulated power supplies which is described in a new 8-page catalog titled "A Sensible Approach to Regulated Power Supply Design." By standardizing the great majority of conventional power supply applications into single and multiple variations of eight basic ranges, arising out of two basic circuit designs, selection of the most flexible and least expensive supply to suit a given requirement is easily accomplished. Sixty-four variations of single and dual supplies are described. **A-6**

• **General Transistor Corp.,** 95-18 Sutphin Blvd., Jamaica 35, N. Y., manufacturers of transistors and related semi-conductor products, has just released a new catalog sheet of diffused p-n-p junction transistors. The bulletin, which is available for the asking, illustrates the company's unique double sealing process. It also includes absolute maximum transistor ratings and characteristics. **A-7**

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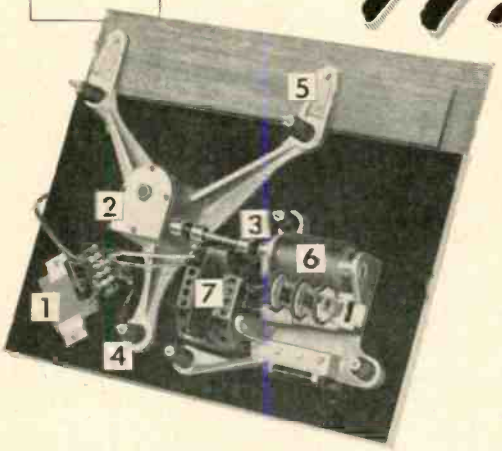

The 710-A incorporates major new contributions to turntable engineering. These include: dual-stage mechanical and torsional filtering, expanded-scale optical stroboscope, Vernier speed drive and integral connection of pickup-arm mounting-board to main turntable bearings.

Revolutionary NEW design

1. **Expanded scale optical stroboscope,** with electronic peak pulsing for greatest clarity, is visible even while record is playing, for exact speed control at all times.

2. **Precision helical drive gears,** of hardened steel and nylon, for smooth silent flow of power to turntable. Gears housed in an oil-filled transmission for quiet trouble-free operation.

3. **High-compliance torsional filtering** reduces annoying speed variations, such as wow and flutter, to less than 0.1%, far below audibility.

4. **Dual-stage mechanical filtering** between motor and turntable reduces motor rumble to more than 60 db below recording level, an outstanding engineering accomplishment.

5. **Integral pickup-arm mounting board,** accomodating all leading pickup arms, is rigidly connected to turntable bearings by a heavy aluminum casting. This eliminates acoustic feedback and other undesirable vibration differences between pickup arm and turntable.

6. **Vernier speed drive** with special long-life neoprene idlers permits separate adjustments of 33⅓, 45, and 78 rpm speeds by ±5% to match the pitch of accompanying musical instruments. Convenient push-button selection of each speed and OFF position. Unique clutch permits cueing turntable.

7. **Heavy-duty induction motor,** with dynamically balanced-rotor and extremely low external hum field, designed specially for this turntable.

Prices *710-A Turntable, finished in stainless steel with mahogany pickup-arm mounting board. $102.00* Net*
710-XT Hand-finished modern mahogany base for convenient, attractive installation: $14.95 Net*

*West Coast Prices: *710-A $107.10*
710-XT $15.70

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Compare this Sonotone HFA-100 for both performance and appearance with any amplifier you can buy—at any price!

Its 12-watt output is ample for the largest living room. Frequency response is flat beyond audible limits, at any volume setting. At normal listening levels distortion is virtually unmeasurable, and only 0.15% at maximum! Hum and noise, too, are completely negligible.

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The Sonotone HFA-100 is for use with fine ceramic phono cartridges, tuners, tape recorders, television, etc. If splendidly reproduced, noise-free *music* is your interest, rather than gadgetry and knob-turning, here is the amplifier for you. **$117.50.** ($99.50 less cabinet).

SONOTONE CONTROL UNIT

Similar in appearance to the HFA-100 above, this CU-50 is a self-powered control amplifier, designed to work with *any* power amplifier. Used with ceramic phono cartridge, tuner, tape, or television sound, the CU-50 gives you complete chairside tone, volume and selector control, for your relaxed listening pleasure. $59.00. (549.50 less cabinet).

SONOTONE Corporation Elmsford, N. Y.

*MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS, INC.

We will gladly supply full technical information on request to Dept. AA-45

LETTERS

Minimal Plate Current?

SIR:

In Fig. 9, p. 30 of your March, 1955, issue, the first tube V_{1a} looks silly sitting in plain view with only 3.7 microamperes of cathode current. Did the author mean this to be a transistor instead of a vacuum tube perhaps? It seems a shame for Mr. Schwartz to spend thousands of dollars on audio equipment and then not be able to enjoy it because his amplifier won't work. Or perhaps the gremlins have been busy again?

A. REEDER, (*nom de plume*)
Dallas 30, Texas.

(*They have, but not on this. Mr. Reeder fails to note the 9000-ohm feedback resistor R_{28} and the secondary of the output transformer which is a parallel path for the cathode-to-ground circuit of this tube.* ED.)

Ultrasonic Bird Cure Wanted

SIR:

All over central Florida, corn and rice growers are fighting a losing battle with red winged blackbirds, using airplane patrols at $7 and up per hour and shotgun sentinels riding on high-clearance corn-dusting machines at $50 per day, with losses running from 20 to 100 per cent.

Do you know of any experiments with sound which may have resulted in the determination of a frequency which will annoy the birds enough to discourage them? Do you have any recommendations about oscillators, amplifiers, and speakers that you could pass along. Any information would be greatly appreciated.

C. S. CLEMANS, Chief Engineer,
Radio Station WSWN,
Belle Glade, Fla.

(*Back in '48 the same question was asked of S. Young White who wrote a series on Ultrasonics for Æ. His answer was that the power required would be prohibitive. However, work may have been done in this field since then, and we too would like to know about it.* ED.)

More AES Fellowships

SIR:

We appreciate your interest in the Los Angeles Section activities in connection with the 1955 Audio Fair—Los Angeles. In your March EDITOR'S REPORT, you mentioned that Bert Berlant was honored for his work in magnetic tape recording and made a Fellow of the Society.

It should be noted that Mr. Berlant was not the only one so honored. The full list of those awarded Fellowships is as follows:

Ralph E. Allison
Alexis Badmaieff
Emmanuel Berlant
Arthur C. Davis
E. H. Uecke.
William A. Palmer
William V. Stancil
Howard M. Tremaine

In addition, Certificates of Recognition were presented to William L. Cara, C. T. Kierulff, and Harry Reizes.

Since AUDIO is recognized as a source of industry news, and since all of the people honored are of importance in the audio field, we feel that you will want to give them recognition.

RICHARD F. HASTINGS,
Western Vice President,
Audio Engineering Society

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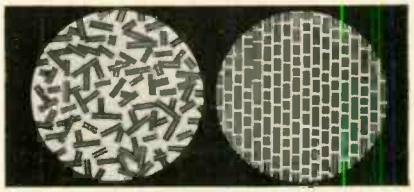
Now...record the whole performance...

without a break!

Got a favorite concert or opera program you'd like to preserve on tape? Symphony or dramatic production? Now, *record it all* using new "Scotch" Brand Extra Play Magnetic Tape. With 50% more tape wound on each reel, Extra Play Tape gives you as much recording time as 1½ reels of standard tape, plus strength to spare. This means annoying interruptions for reel change are sharply reduced to offer more perfect recording results.

You'll notice a crisper tone and higher fidelity, too—the result of "Scotch" Brand's exclusive oxide dispersion process. By packing minute, fine-grain oxide particles into a neater, thinner pattern, "Scotch" Brand has been able to produce a super-sensitive, high-potency magnetic recording surface. Hear the difference yourself. Try new "Scotch" Brand Extra Play Tape on your own machine.



Electron Photo Microscope Shows the Difference!

At left, artist's conception of magnified view of old-fashioned oxide coating still used by most ordinary long play tapes. At right, "Scotch" Brand's new dispersion method lays fine-grain particles in an orderly pattern to give a super-sensitive recording surface that contains as much oxide as conventional tapes, yet is 50% thinner.

New! REG. U. S. PAT. OFF.

SCOTCH

BRAND

Extra Play Magnetic Tape 190

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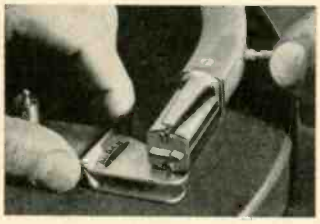
Universally acknowledged as the most efficient arm, barring none; yet it costs less. Useable with other cartridges too. Adapter is of all metal construction.



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75% of cartridges in use operate with incorrect stylus pressure. This means distortion and record destruction. Stroboscope-like, STYLUS-BALANCE indicates correctness or incorrectness of stylus pressure. Works with any cartridge, any arm. All metal construction. Gold finished.

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ABOUT MUSIC

HAROLD LAWRENCE*

The Composing Machine—Cont'd

IN THE SEPTEMBER ISSUE of AUDIO, this column dealt with the imminent appearance on the musical scene of the composing machine, a device that would enable the composer of the future to create, score and record his own work simultaneously without once putting pen to paper. While this article was being written, Dr. Harry F. Olson, director of R.C.A.'s Acoustical and Electro-Mechanical Research Laboratory, and his senior engineer, Herbert Belar, were quietly putting the finishing touches to just such a mechanism. On Friday, January 28th, the doors to their laboratory were thrown open to reporters. Along one wall were six large panels containing 300 electronic networks and something that looked remotely like a typewriter jutting out from one of the panels. Its name: the R.C.A. Electronic Music Synthesizer. It is claimed to be able to duplicate any sound and to be able to synthesize sounds that have never on earth been heard, literally bringing to man the "music of the spheres."

The debut of the Synthesizer was no venture into outer space. Musically, it did not even get off the ground. The program consisted of a Chopin *Polonaise*, Bach's Fugue in C Minor from Book I of the *Well-Tempered Clavier*, *Holy Night*, a Stephen Foster medley, and *Blue Skies*, as though played by a piano, clavichord, electric organ, hillbilly band, and jazz band respectively. *Home Sweet Home* and *Nola* were heard in "new" instrumental sounds. Although crude-sounding, the results nevertheless came near to the actual qualities of the instruments, near enough to make them almost credible. As for the "new" sounds, that will have to be left to the creative musician rather than to the engineer to exploit. But to criticize the "performance" in terms of absolute musical values is to quibble. Far more significant is the very fact that it was done at all.

Before they could start building their machine, Olson and Belar had to break down and calibrate such sound-wave characteristics as frequency, intensity, growth, duration, decay, portamento, vibrato and harmonics. The machine's "keyboard" is a set of keys which performs varying functions: four keys are for frequency, three for multiplying and dividing frequencies, four for harmonics or overtones, three for attack and decay, and four for amplitude. Another "register" of seventeen keys duplicates the first, offering countless possibilities for tonal variations. As reported in the New York *Times*: "When pressed down on coated paper the keys make perforations not unlike holes on player-piano rolls. Then the perforated paper feeds its message to the synthesizer. The machine responds by sending the desired sound wave to a stylus and turntable. Here the sound is recorded on a disk. When the disk is connected to a conventional amplifier and loudspeaker the sound is heard by the listener.

"At present the machine can send the tones of one instrument at a time. If a number of instruments are required the part of each must be recorded on a disk and then all must be brought together on a new recording to cause them to sound simultaneously."

A laborious procedure, indeed. But, after all, the crank-operated turntable was a pretty clumsy device, too. And no doubt a more streamlined method of operating the synthesizer will come along.

Now what does this latest development mean to music as we know it? In terms of standard repertory and of works composed for specific instruments and voices, the synthesizer is of as much use as the mechanical nightingale in Hans Christian Andersen's story. Only 'live' performers can convincingly re-create a Beethoven symphony or a Bach prelude and fugue. And since works of lasting value may be given any number of valid interpretations, why not call upon the artists and instruments themselves? A musician thoroughly at home with an improved synthesizer could perhaps turn out a creditable electronic performance. But then, without the impetus of living and breathing musicians, how many music lovers do you suppose would go to Carnegie Hall to listen to a concert played back through a bank of impersonal loudspeakers?

A glimpse into the future however might very well include new recordings of symphonies as performed by conductors who have never appeared before an orchestra in their lives, by singers who have never sung a note, by quartets that do not exist. With the synthesizer, any recording company could create a new singer whose range would put even Yma Sumac to shame. To carry this a step further, the technical limitation would become a thing of the past; speed, fingering, range, etc., throwing no obstacles in the path of the all-powerful electronic device. With painstaking experiments, the machine could be made to reproduce the sound characteristics not only of an orchestra, but of its concert hall as well. There would be no need for the recording director to tour churches, auditoriums, and

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Until then, we offer you the Rondine Turntables, representing the closest approach to such perfection.

If you are not yet familiar with the Rondine Turntables, write for a complete description to Dept. YD-1.

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AC can be produced by reversing the flow of DC, like throwing a switch 120 times a second. But ROTARY converters actually generate AC voltage from an alternator, same as utility stations. That is why ROTARY power is such clean AC, so dependable . . . essential for hash-free operation of recorders from DC power.

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theatres in quest of the "perfect" acoustical setup. Come to think of it, there would be no need for the recording director at all. Only the relatively easy task remains of selecting, in the case of an electronically recorded concerto, for example, names for the "orchestra," the "conductor," and the "soloist."

Turning now to the place of the "live" musician in the age of the synthesizer, the the future does not look entirely black. It may be years before the machine will be made to equal (not merely resemble) the sound of actual instruments and voices. More important, the primary function of such a mechanism should not be to *imitate* the quality of existing sounds, but to create and experiment with new sound. This is not to imply, by any means, that composers have exhausted the potentials of available timbres. According to men like Cage, Schaeffer and Varèse, there are still worlds to explore. However, as another medium of expression, the synthesizer may some day offer remarkable opportunities to the composer—provided he has the patience and skill to manoeuvre his way around the complicated networks.

To some composers, the synthesizer will be looked upon hopefully as the whip with which to drive the performers out of the Temple of Music. In a letter to AUDIO, "electronic" composer Ivor Darreg of Los Angeles, California, wrote of his eagerness to "cooperate with those developing any method whereby the composer can communicate directly with the listener, without the distortions or intervention of performers. The sooner something is accomplished in this realm, the better for all concerned." Like a number of other composers, Darreg has been increasingly dissatisfied with the shortcomings of the instruments at our disposal in the symphony orchestra. He has built an "amplifying clavichord," a "keyboard electronic oboe" and a "keyboard drum." (He has played the "oboe" in an orchestral work and claims it blends well with other instruments.)

Many other electronic instruments have been devised over the past thirty years, and there will probably be many more to come. But, with the construction of the Electronic Music Synthesizer by the Radio Corporation of America, electronic music has taken its first giant step. Now it's up to the composer.

COMING EVENTS

Apr. 13–15—Symposium on Modern Network Synthesis, II. Part of the celebration program of the 100th Anniversary of the Polytechnic Institute of Brooklyn. Engineering Societies Bldg., 33 W. 39th St., New York City.

Apr. 27–28—Canadian High Fidelity Show, Prince George Hotel, Toronto, Ont., Canada.

Apr. 27–29—Seventh Region Technical Conference and Trade Show, I.R.E., Hotel Westward Ho, Phoenix, Arizona.

May 16–19—Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

May 24–26—NARTB Broadcast Engineering Conference and the Annual Convention, Shoreham and Sheraton-Park Hotels, Washington, D. C.

May 26–27—Electronic Components Conference, Los Angeles, Calif.

July 18–21—MUSIC-ORAMA—Music Industry Trade Show, Palmer House, Chicago.

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

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

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

Oct. 13–16—The Audio Fair, Hotel New Yorker, New York City.

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

Nov. 4–6—Philadelphia High Fidelity Show, Benjamin Franklin Hotel, Philadelphia, Pa.

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Partial view of CDP installation at modern Lincoln Fields Race Track, located just south of Chicago at Crete, Illinois

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Electro-Voice CDP Public Address Loudspeaker System was chosen for the 8,248 seat North Side Gym, Elkhart, Indiana, one of the nation's largest high school gyms. Cluster of stacked CDP's can be seen in photo taken during construction.

Model 848 CDP. 25 watts. 16 ohms. Conservatively rated ±5 db from 175 to 10,000 cps. Crossover at 1000 cps. Variable polar patterns. Size: 10½ in. wide, 20½ in. high, 20 in. deep over-all. **List Price: $69.50 Net Price: $41.70**

Outdoors or indoors, everyone can comfortably hear everything when you use the CDP. Listeners off the axis, where the majority of audiences are, do not have to strain to hear, while those on the axis are not assaulted by blasts of sound. The CDP provides smooth peak-free wide-range response, with 120° sound distribution at all frequencies up to 10,000 cps. Unit energy is far more efficient—there's no wasted power. You can do a better job with fewer units at less cost. CDP utilizes two coaxially mounted diffraction horns, working from both sides of a single diaphragm, plus optical slit diffraction for smooth sound dispersion. CDP delivers 2½ octaves more musical range than comparative units. Molded of glass fibers, CDP is weather-proof, blast-proof, splash-proof. Compare the CDP with any other unit in the environment in which it actually will be used—in the field or in an auditorium. Prove to yourself why it is so superior, why it is the best value ever!

*Pat. D169,904 and Pat. Pend.

Send for CDP Public Address Handbook Bulletin No. 195. Gives complete and helpful information.

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EDITOR'S REPORT

AUDIO SHOWS STILL GO ON

WE NEVER TIRE of hearing about audio shows—whether near or far—and as we have said many times before, the more people that hear high-quality reproduction, the larger will our industry become, the more money will be poured into research, and the better and better will our sound reproduction become. For some years, those who live in or around New York, as well as those who were willing—nay, anxious—to come from afar, were the only ones who were able to see a wide display of audio equipment in action.

That condition has long since passed, of course, and now we have shows in Los Angeles, Chicago, Boston, Philadelphia, Tokyo, Washington, Montreal, and others too numerous to mention if we include the small shows arranged by one or more dealers. The next one to come up is to take place in Toronto on April 27–28, at the Prince George Hotel, and a sell-out has already been accomplished by the show's *entrepreneur*, Emory Justus. (Dare we suggest that Emory is the big Wheel of the Canadian Shows, since he also operated the one at Montreal?) Anyhow, we'll be at Toronto.

The most recent event was the Washington High Fidelity Fair of 1955 which occupied Hotel Harrington in the nation's capital on March 4, 5, and 6, and which claims an attendance of 34,000 despite three solid days of rain. This show is sponsored by WGMS—Washington's Good Music Station. The international interest at the Fair was evidenced by coverage of the opening ceremonies by the Voice of America, for later overseas broadcast.

With the frequency of the shows increasing, there can not aways be some new and important improvements, particularly when we must consider that some very fine quality is available in present equipment. But we must admit that there will always be some room for improvement, even though we are approaching the diminishing returns point. But the important thing about the increasing frequency of the shows is that the idea of high fidelity is becoming more and more widespread throughout the world, less and less restricted to those who have followed audio as a hobby for years.

For example, a glance through the pages of *Wireless World*, a respected British publication, will show that more and more of the advertising space is being taken up by purveyors of high-fidelity equipment. Britain has never lagged behind us in quality of product—far from it—but, if we may be permitted to say so, hi-fi has been considerably less common there than it has become here in the last year or so. An unbiased observer would probably say that those who follow the hobby of audio over there are even more sincerely dedicated to their hobby than their equal numbers over here. We would be willing to predict that hi-fi will come into its own with the general public in Britain within the next year or so at the most.

We receive regularly a small magazine from Mexico—LP, *La Mejor Musica del Mundo Para Discotecas Selectas*—which we translate approximately as "the best music of the world for select record collections." In the center of this book is a section called Alta Fidelidad—High Fidelity—which is listed as "the first magazine in Spanish dedicated to electronic problems and equipment." The magazine is now in its third year, and offers some good advice to its readers.

We continually welcome the spread of information about audio equipment—its use, construction, operation—and we are glad to see that the spread is not limited to the U. S. Magazines from France, Japan, Italy, Turkey, Denmark, and Switzerland have sections devoted to audio—we only wish we could read all of them.

What is the point of these remarks? Just this. Many people here have been heard to say that this is just a passing fad, and that it couldn't possibly last more than a year or two more. Frankly, we don't think so—we think that the desire for good music will continue for as long as there are people, and if it is possible to reproduce music so that it sounds more and more like the original, people will flock to good audio equipment from now on, television or no television.

MAY WE HAVE YOUR CHECK?

May we *please* have your check on the blue classification forms that we mail out to you periodically? There are two reasons for this classification sheet: most important to the reader is the information we get which helps in the selection of editorial material to interest the greatest number; important to us is the fact that AUDIO is a member of the Audit Bureau of Circulation which asks us the questions about our readers that we, in turn, have to ask you in order to give the right answer. Just a few seconds of your time and we won't bother you again. No postage is required in the U. S. or Possessions. This information is held strictly confidential as to the individual—it ends up as a part of a percentage figure on the semi-annual circulation statement.

So, if you don't mind—may we have your check?

QUESTIONS AND ANSWERS?

Many times we have considered the idea of having a Question and Answer column in AUDIO. Individual answers to inquiries are costly, and many times one answer would serve dozens of readers all at once. That's why we have to restrict our replies to those which are accompanied by return envelopes and postage.

But with the Question and Answer column we could probably serve more people more effectively. Is anyone in favor of the idea? Your answer on a postcard (add it on one of those in the back of each issue) would help us to make up our mind.

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The Most Nearly Perfect Phono Pickups Ever Produced

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These characteristics have real meaning to those who understand that maximum performance depends upon components which meet professional standards. If you want the best that high fidelity can offer, ask your dealer to demonstrate the 220, 240 and 260 Pickering cartridges . . .

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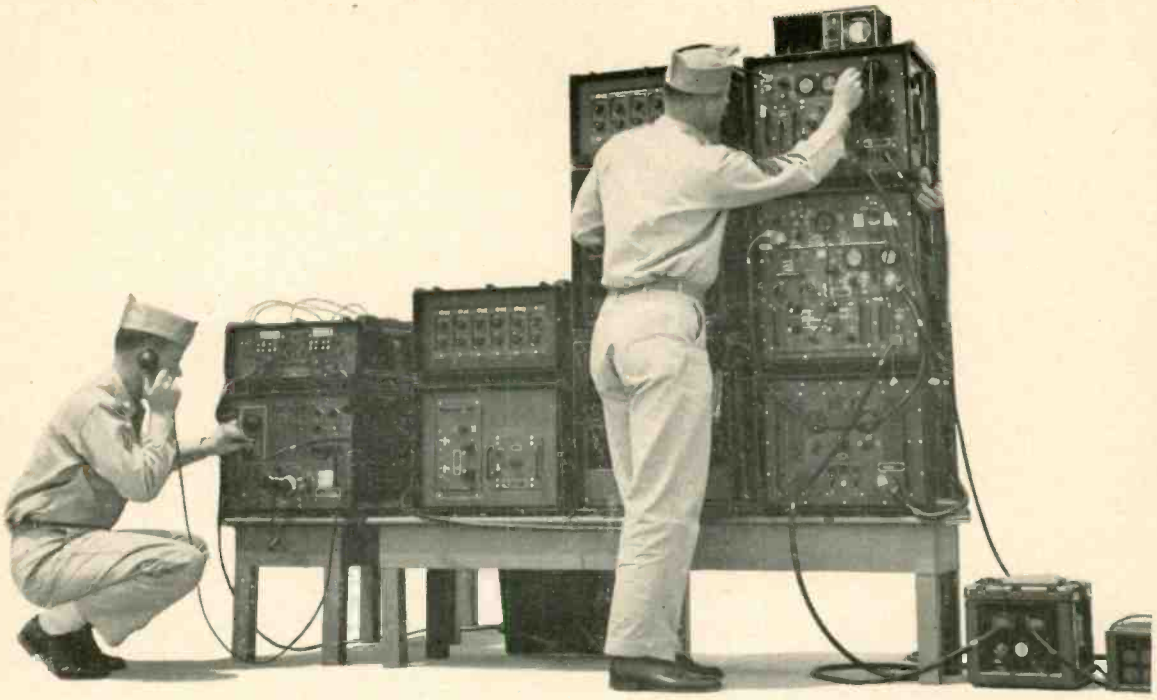

Tuning in for radio transmission. Each item of equipment is not much bigger than a suitcase.

A leapfrog telephone system for the Armed Forces!

A new communications system, which takes to the air when water or rough terrain prevents the stringing of wires, has been developed for the U.S. Signal Corps by Bell Telephone Laboratories.

The system uses cable and radio relay interchangeably over a 1000-mile range. It is easily portable, unaffected by climate, and rugged enough for global use. Twelve voices travel at once over a pair of wires or radio waves—as clearly and naturally as over the regular telephone system.

This is the first time a completely integrated wire and radio system of this large a channel capacity has been available for tactical use by the Armed Forces. It is already in production at Western Electric, manufacturing and supply unit of the Bell System.

The new system is a joint achievement of the Signal Corps, Bell Laboratories and Western Electric . . . one of the many results of long and fruitful co-operation. It shows again how techniques which the Laboratories develop contribute to our national strength.

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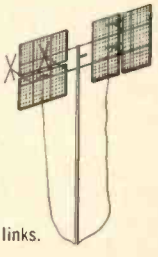
Amplifiers like this are used every 5¾ miles in the cable portions of the system. They are weatherproof, can be used on a pole or the ground, and will even work under water. The system uses a spiral wound cable developed by the Signal Corps.



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ARNOLD J. GASSAN*

THE GENESIS of a complete sound system is rarely a casual occurrence. One does not often say "Today I'll build myself a phonograph," and sit down at the workbench, like that, to build a complete unit. Except for inveterate gadgeteers there is usually a specific need, or purpose. In the case of this portable, the reason was the need for a fine gift.

Certain criteria came to mind when the possibility developed of a phonograph as that gift. First, it had to be portable—at least it had to have a handle. Second, it must sound good.

The third condition was that it must be quite sturdy, able to take great shocks without developing troubles and to exist without damage in damp or dusty climates.

Fourth, it had to be able to operate most places in the world, wherever 50- or 60-cps power is available.

With these basic requirements outlined, the development was not as difficult as it was simply hard work. The first step was to develop a compact amplifier with certain basic requirements. Unfortunately there was a time limitation between the conception and delivery dates; therefore the final circuitry is not so much original as it is a gleaning from various previously tried and approved sources. This, however, is not too unusual, and the accent here is on the complete system rather than component parts.

The requirements that were felt to be necessary for the amplifier were these: (1) sufficient power to provide clean *average* power of the order of 1 watt to the speaker, which meant that eight reasonably clean watts of reasonably clean peak power should be available; and (2) a minimum of controls should be provided, as the gift was to be for a person who did not care to be bothered by engineering technicalities. Fortunately the recipient did not have a large library of recordings, and with the new policy of using the RIAA curve being followed by most of the recording companies, it was felt that fixed equalization to this curve would be sufficient. That may be a mistake, but time will be needed to prove it one way or another. By doing away with equalization controls, only four functions were left: volume, power, treble, bass. These functions were reduced to one dual-purpose knob and one concentric control-knob set.

Keeping these qualifications in mind, a tentative circuit was sketched out, and then assembled after a rough check showed that the parts could all be fitted into a small enough chassis box. The complete amplifier and power supply were assembled on a standard chassis box 2¾ × 3 × 13 in. The box was of the type formed out of two interlocking U-shaped pieces of aluminum, and the half with the most surface area was used for mounting the components.

Because of the physical qualifications necessary, it was felt that the amplifier should be sturdily shock-mounted within the enclosure. Partially on this account, it was decided that the volume, power, and tone controls would have to be mounted remote from the body of the amplifier. The amplifier was tied to the floor of the enclosure rather than to the turntable mounting because the floor was stronger, and because there was no room on the turntable mounting board, it being just a half-inch larger than the turntable. The controls were mounted in

* *2176 S. Washington St., Denver 10, Colo.*

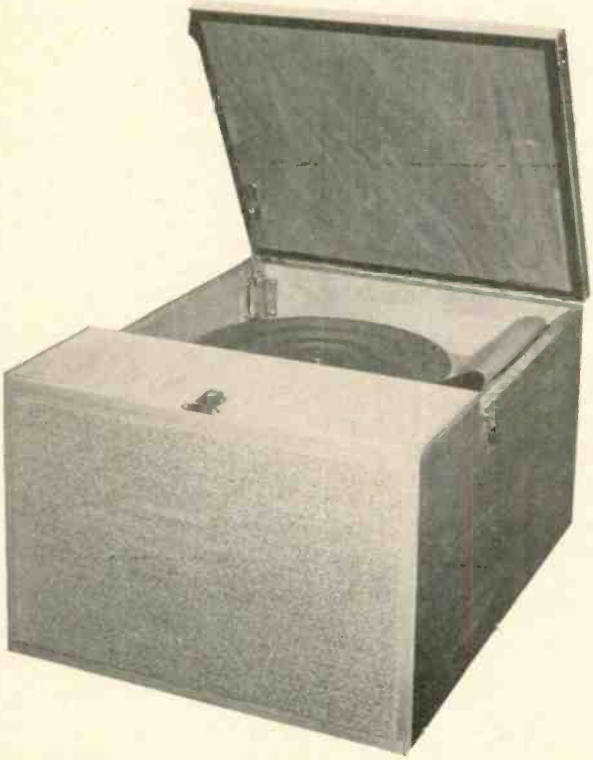

Fig. 1. (Left) The Around-the-World Portable open for placing a record on the turntable. Fig. 2. (Bottom) Top view of the portable showing the volume and tone controls located on the forward edge of the turntable mounting plate.

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two small utility boxes, both to simplify the fastening of the controls to the wood construction and to provide shielding. There were inevitable losses associated with the extra inches of shielded cable from the amplifier to the control mounting boxes and back, but after measuring the effect it was decided to let it go, since there was still a sufficiently wide range of treble control available.

The decision to make the controls remote from the body of the amplifier simplified the construction, since there wasn't really room within the amplifier for three potentiometers and a switch. Besides, the method of mounting the controls had already been decided upon: the Bogen turntable finally selected has two vent-plugs located in the front half of the mounting plate. With these knocked out and the utility boxes holding the controls mounted directly below them, the shafts of the controls came up through the turntable board and the large concentric control knobs covered the holes left by the removal of the vent-plugs. See *Fig. 2.* At least an inch in front-to-back measurement in the size of the motorboard was saved by this expedient.

Since this unit might very well be repaired anywhere in Europe, it was deemed best to use terminal-board construction. This method, when used properly, is the easiest for strange repairmen to handle.

Terminal boards do take up more room than point-to-point wiring, and they must be used properly to eliminate this disadvantage. For example, the principal advantage, other than the fact that they do not load the pin connections of the tube socket, is that it is easy for a relatively unskilled wireman to replace a component on a terminal board, much easier, anyway, than replacing components on turret sockets or in a point-to-point wiring scheme. All this is true provided the components and leads are put on the terminals in a standard manner, and that sufficiently clear text and drawings correlated with photographs accompany the unit to make identification of elements unequivocal.

In line with this, a repair manual was finally made, showing these essentials.

After the amplifier had been decided upon and laid out, and was in the process of being built, checked, tested, etc., the next step was to decide upon a suitable turntable, arm and loudspeaker. Desire was toward the best available, but in turntables the best is large and heavy. Also, there was the requirement that the turntable must operate well on either 50 or 60 cps. There was one unit on the market with a continuously variable turntable speed, a reasonably well designed tone arm, and a suitable price. This was the new Swiss-manufactured turntable by Lenco, sold in this country by Bogen. And in that there was another, hidden, advantage: parts for repair could probably be obtained in Europe.

A loudspeaker was the final consideration. There was, to the author's knowledge, only one loudspeaker specifically designed for very small boxes that was of good quality. This speaker is the Western Electric 755A (now made by Altec Lansing). The 755A is an 8-inch unit designed to work best in a box of 2 cubic feet—not even a vented box, but simply a box. As the final dimensions of this enclosure worked out, there was only 1.46 cubic feet enclosed, so a bass-reflex-type enclosure was finally decided upon.

The next step was to determine how the three main units would fit together into the smallest attractively proportioned volume. The external dimensions finally decided upon were 11 × 16¼ × 20 in. *Figure* 3 shows how the parts are arranged within the enclosure.

One important aspect of the external features of the phonograph was the necessity for the unit to operate well in any environment. This meant that there should be some way of completely sealing the unit from outside influences when it was left unused for any length of time. This introduces another advantage—if the unit were to be sealed, then the sealing method should also make the characteristics of the unit as an enclosure repeatable. That is, if there were a simple positive sealing method the access door to the turntable would present no problems as an unpredictable opening into an otherwise sound-tight baffle. *Figure* 4 shows the sealing strip on the top cover.

The final design added about an inch to the length of the phonograph from front to back, because of a ¾-in. thick door (with "break-away" hinges) which

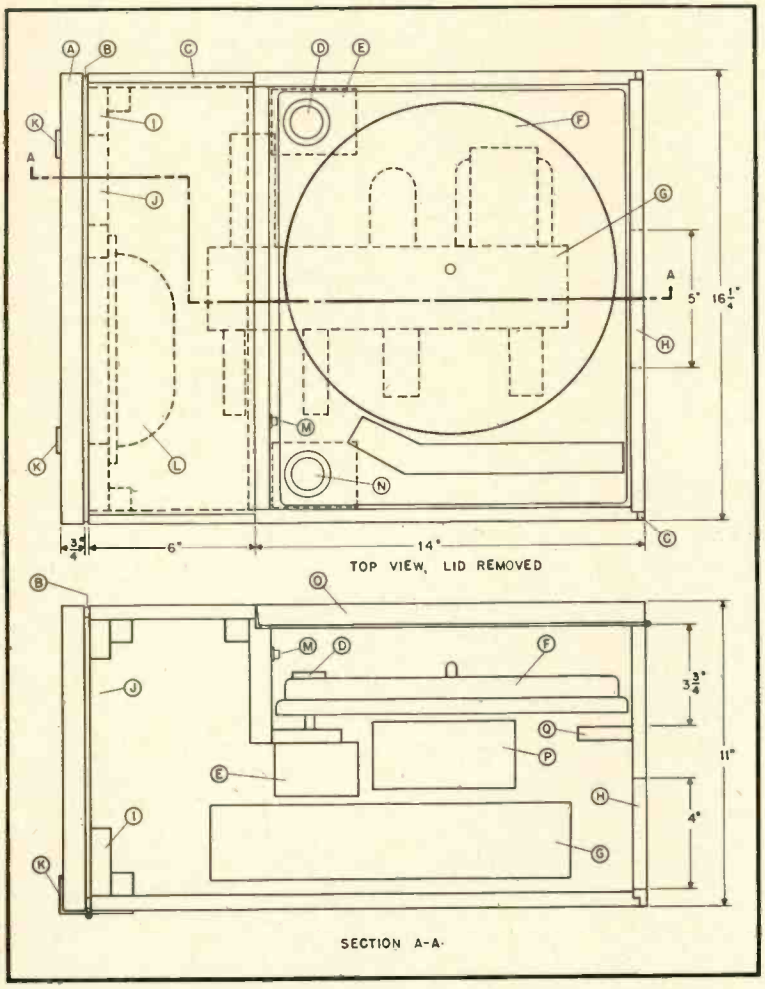

Fig. 3. Sectional drawing to show placement of components in the cabinet. The letters refer to the following parts:

A Front protective door
B Rubber gasket
C Corner block
D Bass and treble control
E Utility box shielding tone controls
F Turntable
G Amplifier
H Utility plate access port
I Speaker mounting board
J Bass reflexing vent
K Front "breakaway" hinges
L Loudspeaker
M Pilot lamp indicator
N Volume control, on-off switch
O Lid of cabinet
P Turntable motor
Q Motor board

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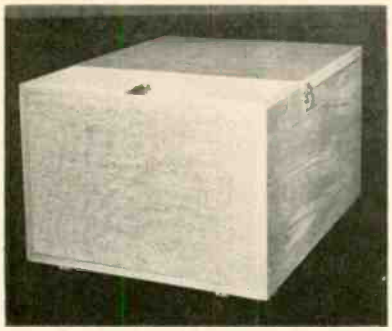

Fig. 4. Complete phonograph in playing position. Lid is closed to provide back enclosure for speaker.

protects the grill-cloth and loudspeaker. Both this front protective door and the "lid" or access door to the turntable carry a ring of sponge rubber ¼ in. thick by ⅜ in. wide, set in a slight trough. This strip of rubber functions as an efficient sealing gasket. The front door is hinged rather tightly, so that a definite effort must be made to latch or unlatch it, thus guaranteeing a positive seal. The lid is hinged so that it will normally remain all but about 1/16 in. from being flush with the adjacent surface at the front edge when it is just lying in place. This was found to be "acoustically closed" even if it were not mechanically shut tight. The side latches are not normally used on the lid, except when the unit is being shipped, or standing idle for some time.

The trouble with most portables is that they look like portables. Because of this it was decided to finish it in a good hardwood—birch in this case. Plywood, ½ in. in the body, and ¾ in. in the doors, was used, and a method of cabinet construction which incolved mortising the edges of the ½ in. plywood in such a way that a 3/16-in. corner was left empty, this corner then being filled with a solid chunk of hardwood. All this was to prevent splintering of the plywood at corners where end-grains meet.

The finish was made up of ten coats of synthetic lacquer, and then polished with rubbing compound. The advantage of this finish is that waxing is unnecessary. If the finish begins to dull, one needs only to rub violently with a soft cloth to renew the gloss. Another advantage is that alcohol has little effect on lacquer, and in these days that is important.

However, if one has a nice finish one would like to keep it nice, and this can be done by having a protective carrying case. The case was finished on the outside with a vinyl-on-canvas truck seat fabric, and then lined with a protective layer of half-inch sponge rubber, with an inside lining of the fabric used in automobile upholstry for "headlining."

When the front protective door is removed and the unit set on a table, it is not immediately obvious that this is a *portable* phonograph, as seen in *Fig.* 4 in fact, it makes a rather handsome, if severe, piece of furniture. The extreme cleanness of line enables it to mix with other styles of furniture fairly well.

At the rear of the unit is a suitcase-type carrying handle which normally hangs down over a recessed utility plate, *Fig.* 5, protecting it from accidental exposure to idle hands. The utility plate

Fig. 5. Utility plate, located on the back of the cabinet, provides fuse mounting, a.c. inlet plug, and jack for tuner or tape recorder.

carries an open fuse-clip, an a.c. power inlet, and a phone jack. The fuse-clip was used, rather than a neat fuse holder, because European fuses are unlike our own. Both German and English manufacturers produce fuses with tapered (i.e. conical) end contacts rather than square ones. The phone jack on the plate is a closed-circuit type which connects between the first and second stages of the amplifier, making use of the gain control but bypassing the effects of the equalizing feedback loop. The utility plate is also sealed to the wood body with a rubber gasket, in order to make the unit a closed box with constant characteristics.

The Amplifier

The amplifier is quite straightforward, and is shown schematically in *Fig.* 6. The first stage, V_{1A} provides amplification. The gain control is located between the second and third stages. The third stage, V_{1B}, makes up the loss in the

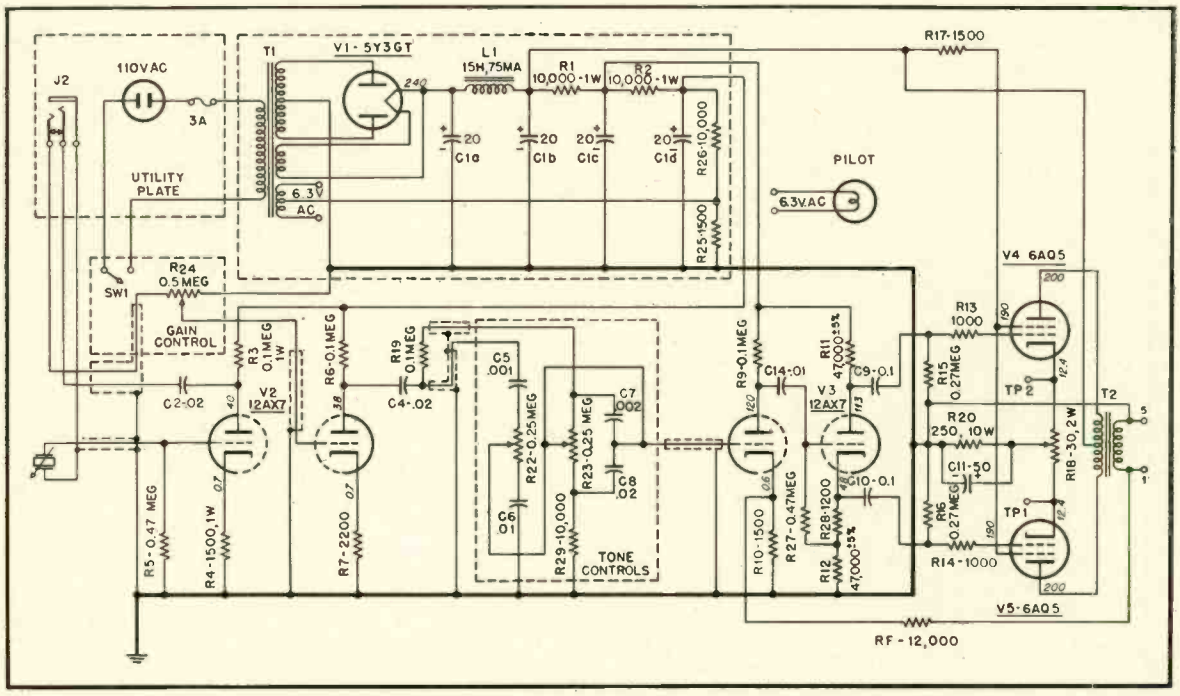

Fig. 6. Schematic of the entire amplifier unit. Figures in italics indicate d.c. operating voltages.

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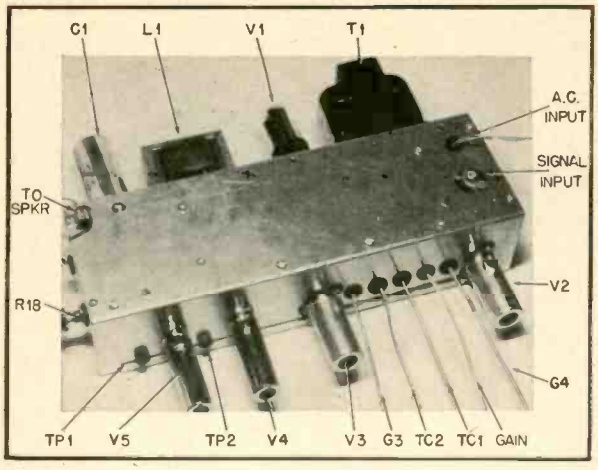

Fig. 7. External view of the amplifier. Arrows refer to components in the schematic.

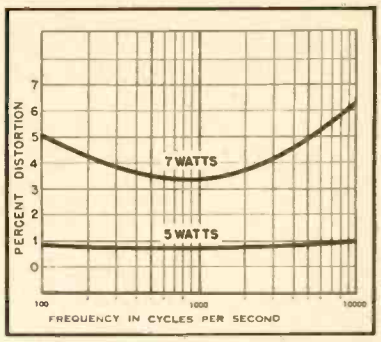

Fig. 9. Distortion vs. frequency characteristic of the amplifier.

tone-controls and also provides a convenient place to tie in the negative feedback loop from the transformer secondary. Since the transformer, was not a high-quality unit, relatively little feedback was used—just as much as could safely be applied, experimentally. The third stage also drives a paraphase splitter.

The inverter feeds the two output tubes, V_4 and V_5, a pair of 6AQ5's.

The power supply is conventional, using a capacitor-input and a 15-H choke for filtering. The d.c. output to the power tubes has a calculated ripple factor of 0.02 per cent. The normal decoupling circuits follow the first filter. The hum figure for the amplifier at 60 cps is fairly good, 8.2 millivolts across 6 ohms, which is about 60 db below 3 watts.

Performance

The author was quite frankly pleased at the results of the various response checks (see *Figs.* 9, 10, and 11), principally because of the dubious quality of the output transformer, which was the only fairly heavy duty, easily replaceable, transformer that would fit into the space available. The lack of pedigree does show in the graph of distortion *vs.* frequency (*Fig.* 9) at a fixed power level, and this is not what would be desired. However, the upper curve is at quite a high power-level in terms of the *listening* qualities of this unit. And, it must always be kept in mind that this unit has to be easy to repair anywhere —and while the chances are that the output transformer will last longer than any other part, there *is* the chance that it will blow.

Once the entire unit was realized, the necessity of creating a repair manual developed. Most units built by experimenters spend their lives within reach of a soldering iron. Since this unit may very well never again be seen by its maker, it was necessary to prepare a thorough manual to accompany it. This includes a standard schematic, and a *semi-pictorial schematic* in which the components are shown pictorially on the terminal boards to a scale of 1½ times normal size, and the interconnecting wiring is schematic. See *Figs.* 7 and 8.

The manual also includes photographs of the amplifier from two views, both showing overlapping sections of the interior construction, as well as a photograph of the outside of the amplifier. All the photographs have arrows indicating the components by number, correlating the visual aspect of the opened amplifier with a pictorial-schematic, and a standard-symbol schematic. This redundancy is felt to be necessary since it is not practical to provide a multilingual text explaining each stage of the circuitry and each item of the construction.

Assembly

The unit is assembled with both glue and screws in some parts, with wood screws alone in other parts. For example, the front board which carries both the speaker and the grill cloth, is bolted to a hardwood ring and then the ring is held to the inside of the case by a number of wood screws. This assembly was made so that the grill cloth could be changed if necessary. The bottom piece is also held on only by woodscrews, since all access to the amplifier, etc., is through the bottom. The screws, in this case, tie into an internal ring of ¾ in. square hardwood rather than into the edge of the plywood.

The final assembly and testing was made with some sense of worry. Attempting to put a wide-range unit into a small package can be disastrous, from at least one viewpoint. There is always the possibility of acoustical feedback at

(*Continued on page 63*)

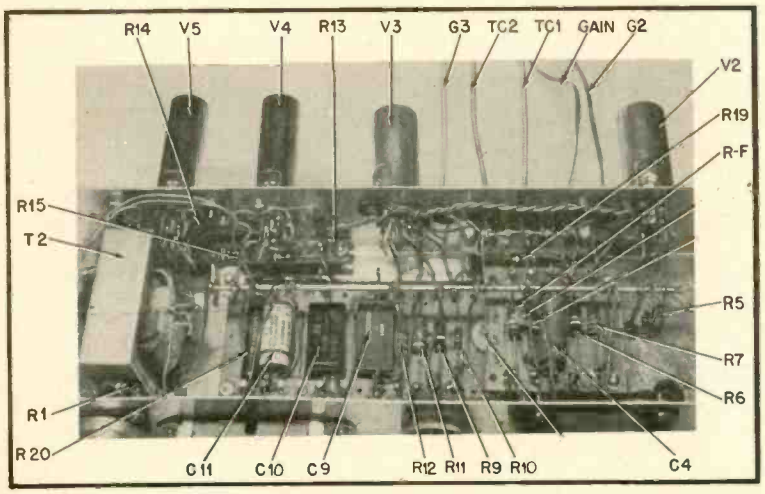

Fig. 8. Inside of the amplifier, with identifying arrows. Arrows not labeled result from last-minute changes.

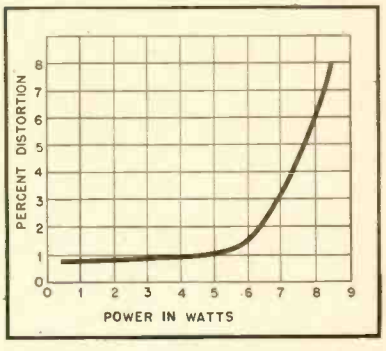

Fig. 10. Distortion vs. output, using a 1000-cps signal into a 6-ohm resistive load.

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Simple Design for Station-Built Console

Designing and constructing a console for the specific requirements of an FM station proves to be effective from the standpoint of operating flexibility as well as money-saving—also in operating convenience.

C. M. EDMONDS*

WE HAD BEEN on the air at KCMS-FM about one year when it became almost painfully obvious we needed more control facilities and more flexibility. The new equipment would have to meet the high standards of the critical Audiophile listener and be within the cost limitations imposed by an FM station's budget. The preceding sentence contains an inconsistency that was solved only by building the equipment ourselves.

We established the standards and the abilities. They were:

- 6 microphone inputs
- 6 remote telephone lines or 0-db inputs, balanced, and with automatic cue
- 3 turntables, with record cueing and control of turnover and rolloff
- 2-channel operation (for possibility of binaural)
- 2 monitor amplifiers, one for control room and one for studios
- 3 provisions for interlocking phone bells and warning lights

Standards:

- Maximum of 0.2 percent distortion
- Noise down 80 db from operating level into transmitter. (+10 VU max)
- Sine-wave frequency response, 10 to 50,000 cps ± 1½ db
- Minimum number of tube types

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Fig. 1. The completed console in its operating position with the announcer's microphone directly above it.

The Basic Design

Referring to the detail schematic, *Fig. 2*, it will be seen that all of the preamps, both microphone and phonograph are essentialy identical. A single 12AX7 is used in a regular phonograph preamp circuit using negative feedback equalization. The microphone stages had an A-10 (UTC) input transformer loaded with 50,000 ohms (UTC's recommendation for best response) and the feedback capacitor and resistor were selected for flat response and 8 db of feedback. This value brings the microphone control to "straight up" position to match the average LP record at "straight up" (Fairchild or GE pickup). The phono stages are equipped to provide turnover frequencies of 200, 400, and 800 cps, in addition to flat, and a fifth position connects the preamp to a remote line transformer. Note there is no grid input resistor; this is in accord with GE's specifications for the A1–900 high-frequency compensator.

The program amplifier and control room monitor are similar and will be recognized basically as Williamson types. The program amplifier is located on the main chassis, and the spare—which is used as the control-room monitor—is located on the power-supply chassis. The "house" or studio amplifier is beside the spare and is single ended. This latter amplifier has only 3 watts output, which has proved enough for the purpose it serves—two 8-in. speakers in two studios. The power

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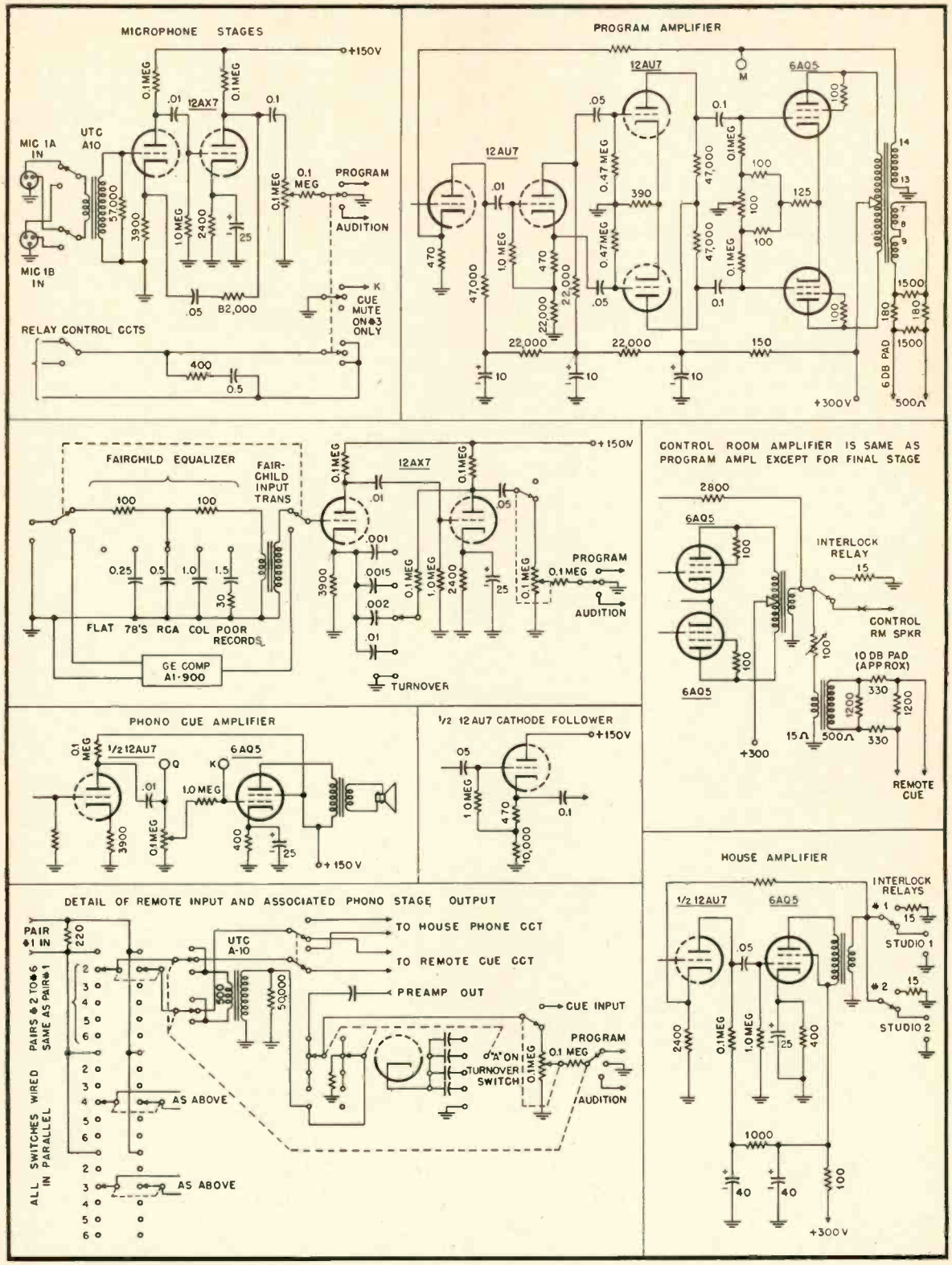

Fig. 2. Detail schematics of the various individual sections of the entire console. These units are interconnected as shown in the block schematic, Fig. 3.

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supply has two sections—a regulated low voltage of 150 volts for the preamps and a regulated 300 volts for the program, spare, and house amplifiers. The filaments in the main chassis are d.c. and the remainder, balanced a.c. to ground. *Figure* 1 shows the unit in operating position, and *Fig.* 3 is a block schematic which uses the detailed sections of *Fig. 2.*

Actual Construction

Six microphone inputs were required. Actual practice indicated that seldom more than two were used at one time, so three stages were installed, which should give a reasonable safety factor. One is located behind each key, and each key can select between two microphones, which also selects the proper interlock relay. The three phono stages were similarly installed, one behind each key.

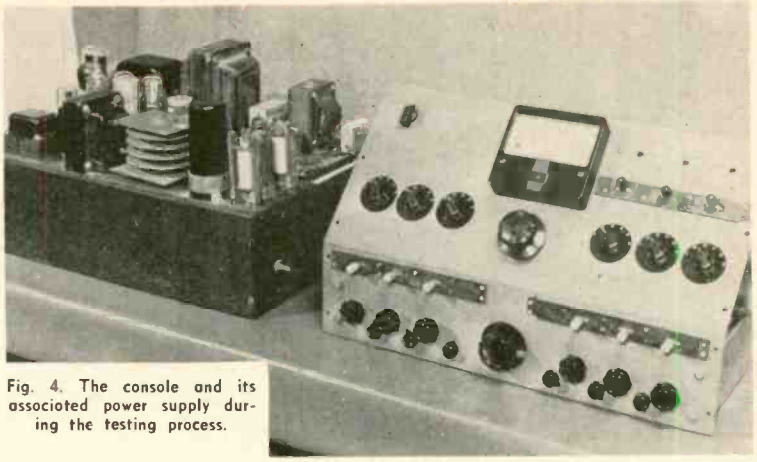

Fig. 4. The console and its associated power supply during the testing process.

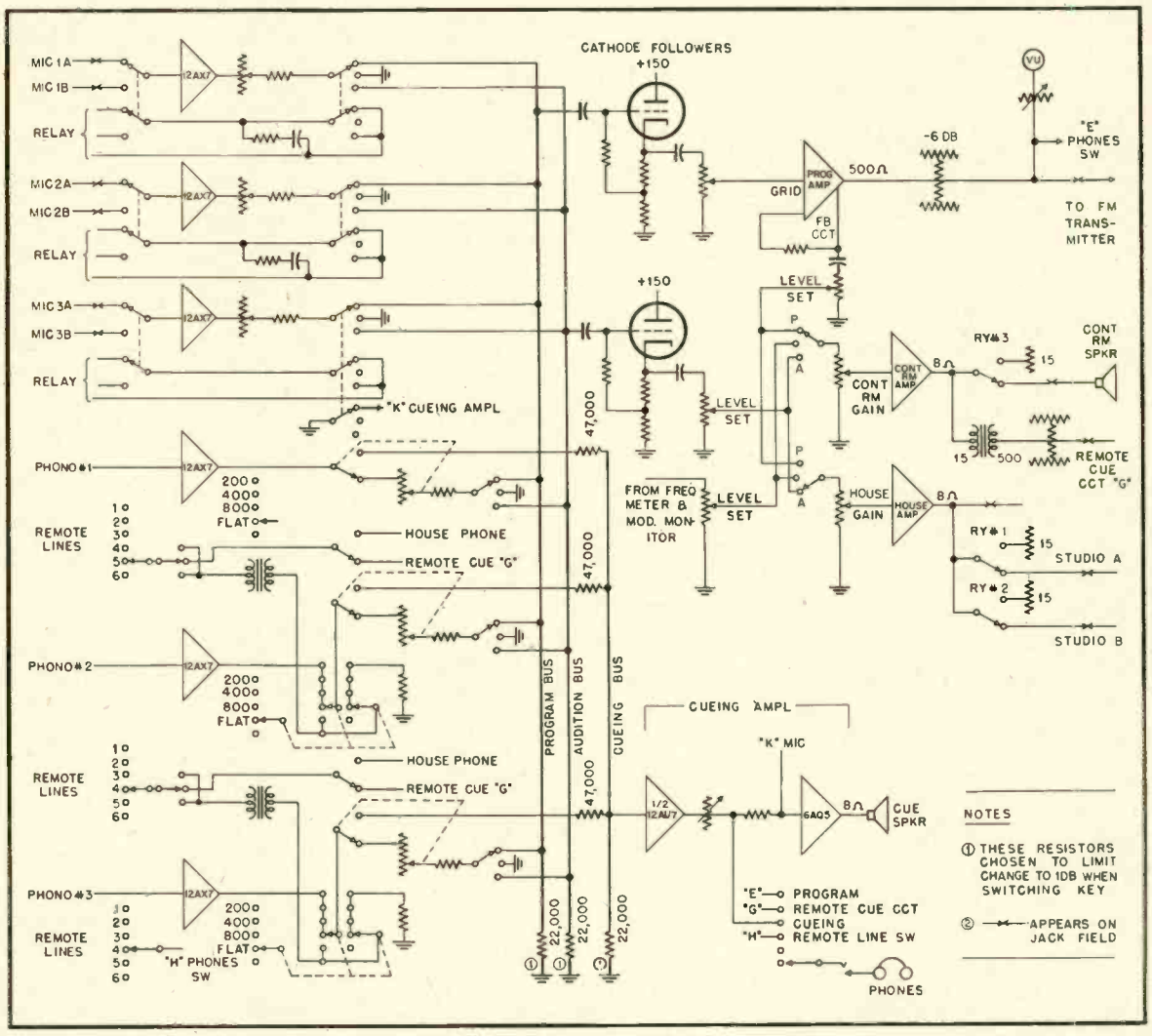

Fig. 3. Block schematic of the console. The actual schematics of the various sections are shown in Fig. 2.

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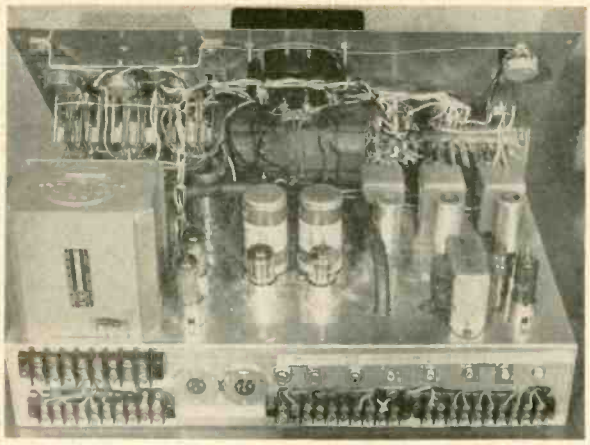

Fig. 5. Topside view of the console chassis.

On the front of the panel, above PHONOS 2 and 3, are installed two six-position double-pole switches. Six remote inputs are tied to these two switches wired in parallel. The output of each switch goes to the key. The center position of the key feeds cue out on the remote position selected. The small toggle switch above PHONO KEY 1, removes this cue and substitutes the house phone. This makes it very simple to talk to an engineer on a remote. Moving the key to PROGRAM or AUDITION automatically disconnects the cue and connects the line to the input transformer, which is strapped for 500 ohms. Each of the six inputs has a 220-ohm resistor across it. This presents the proper load of 125 ohms for Western Electric 23-A equalizer. This equalizer is on the patch field and can be dropped across any pair. A 200-ohm wire wound pot is in series with it and is adjusted for equalization necessary. The 23-A was designed for 8500 cps, but we have found that we can equalize local lines so they are down only a few db at 15 kc. Under each key is its gain control. Turning any one of the three phono gain controls to zero switches the input to the cue bus. Just below and to the left of each gain control is a small knob which selects the turnover position; the fifth position removes the phono output and picks up the remote line transformer output. Remote lines may be auditioned on the local cue bus. This same switch loads the secondary of the remote lines transformer to prevent cross talk if a remote line selected has high level accidentally switched in (guess how we found we needed this?). It was also necessary to roll off the high-frequency response of the remote cue level. Since the amplifier supplying this cue had negative feedback over the output stage, it was necessary to pad the level down 12 db, then roll off the high-frequency response. The response is down 6 db at 5000 cps. The six-position switch above phono No. 1 switches the headphones as a balanced pair to any of the six remote lines. There are three switches below and to the left of the three microphone gain controls. These switches select between microphone 1A and 1B, and operate the interlock relay. They also complete the symmetry of the front panel.

Circuitry

The stage following the preamps is a cathode follower. This was done so the control room and house amplifiers could be located on the power-supply chassis. There are three of these cathode followers, one for the program amplifier, (to maintain circuit symmetry) one for the control room and house amplifiers, and the third is used for a recording output or AM transmitter. This required two 12AU7's. The fourth triode section is used as the first amplifier for the phono cue system. The final portion of the phono cue system is identical to the house amplifier except it has no feedback. Please note the series resistor from the cue volume control to the 6AQ5. The grid of the 6AQ5 is shorted when the control room microphone is in program position. The series resistor prevents grounding of the audio to the earphones.

The cue volume is above MIC 1 key. The control above MIC 2 key is a six-position double-pole switch. Position 1 is balanced and is across the program output line; position 2 is balanced and is across the remote cue. Position 3 is unbalanced and across the phono cue position; 4 is balanced and is fed from the six-position selector for remote lines. Positions 5 and 6 are not used. Note that the head phone jack is insulated from ground. Note also the series resistor of 1,000 ohms—this prevents inexperienced personnel from dropping a 50-ohm headset across the program loop. The control above MIC 3 is a VU multiplier, providing for 4, 8, 12, 20, 24, and 30 VU levels at the indicated "0". The control in the extreme upper left edge is house amplifier gain. The three keys to the right of the VU meter are (1) house amplifier input, (2) control room amplifier input, and (3) recording output. All are wired the same—left for program, center "off air," and right for audition. The three small holes above each key are screwdriver-adjusted gain controls for program, off air, and audition. Circuits may thus be switched from one position to another with no change in volume.

Two controls are yet to be noted. Immediately under the VU meter, the master gain control and under this on the vertical portion of the panel is the control room gain.

Construction

The amplifier was constructed on a pan, the front panel was assembled and then the two were joined and the interconnections made. Volume controls may be replaced and switch keys may be cleaned without disassembling. *Figures* 5 and 6 show the above- and below-chassis appearance.

Two other controls are located on the power supply chassis—a series resistor to set the d.c. filament voltage, and a level control for remote cue. The power-supply is shown schematically in *Fig.* 7, and its underside is seen in *Fig.* 8.

Other construction details of importance are now noted. Both chassis have a one-point ground; a piece of No. 10 copper wire then passes over the various components. The grounded point in both cases is the low-level input. One ground wire is carried from power supply to amplifier chassis. Filaments are balanced in the main chassis, so in the event of a

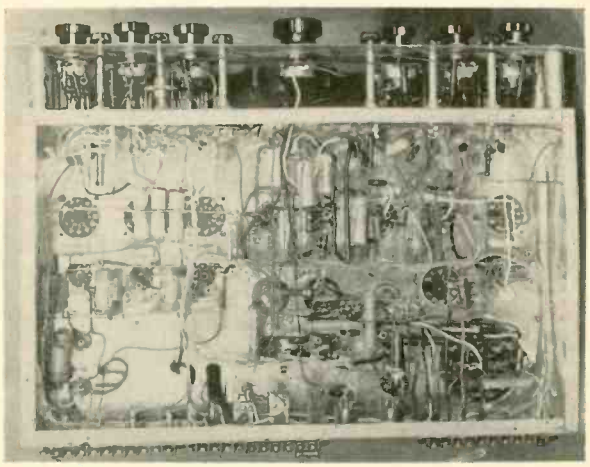

Fig. 6. Underside view of the console chassis. Note that there are no shielded wires, and the one heavy ground bus serves for all ground connections.

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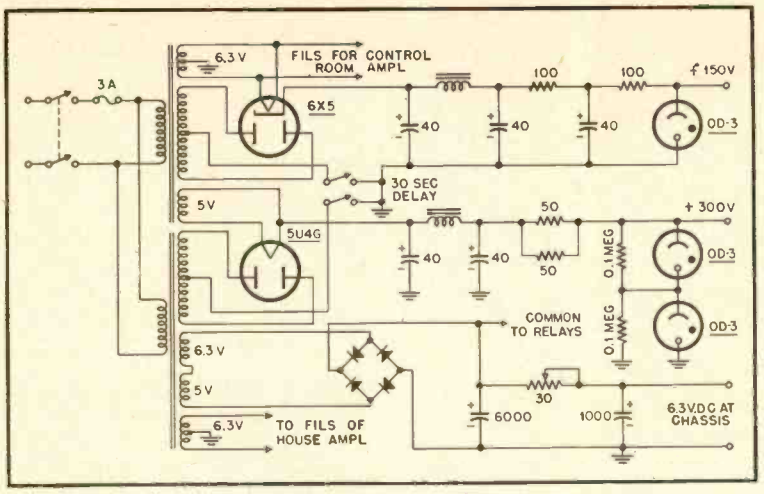

Fig. 7. Schematic of the power supply circuits.

d.c. failure, they may run on a.c. until the trouble is cleared. To prevent ground loops, the two shielded lines carrying audio for control room and house amplifiers are grounded at the main amplifier chassis only. The ground connection on the input transformers is not connected to the ground bus.

The telephone type relays, shown on the power-supply chassis at the left in *Fig.* 4, are operated on d.c. ahead of the series dropping resistor; the terminal strip next to them is for phone interlock and red lights. The output transformer for the control room did not have a balanced 500-ohm circuit, so a small line-to-speaker transformer was connected in reverse to provide balanced remote cue. The voltage to feed the bridge rectifier was obtained by connecting the 6- and 5-volt filament windings in series. The output of the bridge rectifier was connected to a 6,000-μf capacitor (never underestimate the peak-to-peak value that 6,000 μf can provide). The rectifier supplies thirteen volts under load at its output terminals. The 5-volt filament of the small transformer operates the 5U4GA and the low-voltage supply uses a 6X5GT. Only 6 tube types are used including the rectifiers and VR's; 6–12AX7's, 7–12AU7's, 6–6AQ5's, 1–6X5, 1–5U4GA, and 3–OD-3's (VR-150)—a total of 24 tubes.

A time delay of thirty seconds is incorporated in the B– leads to prevent overload of the VR's during the tube warm up. No shielded wire is used in the construction of either chassis, yet crosstalk is down 50 db. The big rectifier was obtained from an old pin ball machine. High-frequency equalization was accomplished by the cut-and-try method in the case of the Fairchild pickups, using the Dubbings test record, and follows within 1 db. We sent our equalization system and the values chosen to Fairchild. We quote from their letter, ". . . with regard to the circuit which you propose for equalization, we feel that this may very well prove satisfactory as far as matching is concerned. However, it should be pointed out that high-frequency attenuation at this point in the circuit will result in a poorer signal to noise ratio since the total noise of the first stage is passed on to later circuits."

The instruction sheets issued with the Fairchild pickups advise rolling off the highs in a plate circuit. This was impossible since the stage involved has negative feedback and following stages are mixed with other signals. Further, we wanted to be able to use other manufacturers' pickups, and most of these use some type of front end equalization. The output of the new Fairchild 220 with the new coupling transformer is more than a GE. All of the resistors in the program amplifier are wire-wound to keep down noise.

Post Mortem

The console has been in operation for three months now. During this time we have had no break-downs, but we can suggest some improvements. The telephone type keys could be replaced with lever action rotary. This would greatly simplify their wiring. The 6-position switches for remotes should be pushbutton types so wired as to give one input priority. We have found on some remotes that we needed an electrostatic shield, so we patch in a W.E. 111-C line-to-line transformer (repeating coil) for this condition.

UTC has informed us that the LS-55 can be wired for an approximate Ultra-Linear operation, and we have since tried this with the result that the amplifier is apparently more stable, and it provides a "richer" sound in the low-frequency range. The connections to the LS-55 for this type of operation are, to quote from a letter from UTC: "tie the present plate points together to B+ (terminals 1 and 6; connect terminal 4 to plate 1, terminal 2 to screen 1, terminal 3 to plate 2, and terminal 5 to screen 2. This will result in a somewhat higher stage gain than is possible with the triode connection, and will require a change of the feedback resistor to maintain 10 db of feedback." We did not find it necessary to change the resistor.

It is also desirable to remove the 51,000-ohm resistors from the secondaries of the three microphone input transformers when used with the W.E. 639A, and the RCA velocity microphones. The resistor should remain in the circuit with the Altec 21C and with most dynamic models, however.

We have had no trouble with microphonics. You can pound on the front of the console and not hear a thing.

The most gratifying part of the construction of this console was the response of our listeners. Some of them are most critical and they tell us how much they like it. When listeners call in and tell us the same record sounds better "off the air" than it does on their own equipment, we feel that we have "clean" operation.

The approximate cost of this console was $200, but we used many parts from the junk box. It took approximately four weeks to build it, including testing, but the work was spread over about a year. With steady work it could be done in a 40-hour week. We will be pleased to answer any correspondence concerning this "station-built" console.

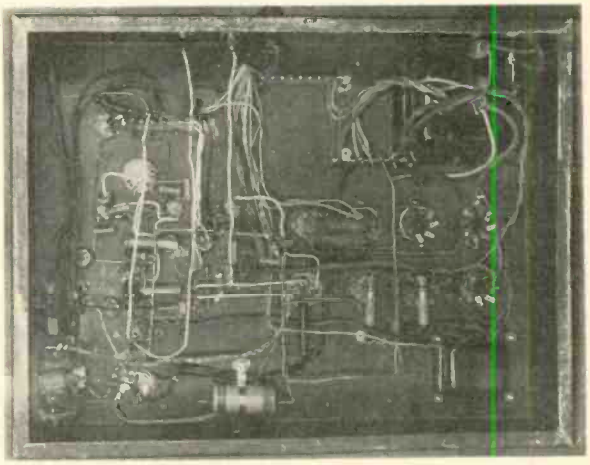

Fig. 8. Underside of the power supply chassis.

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High Quality . . . Ten Watts . . . Small Package

Adequate for the average home system, this unit which was originally designed for broadcast monitor applications is relatively inexpensive, simple to construct, yet capable of excellent reproduction.

HAROLD REED*

THE audio amplifier described in this article was designed originally for use as a program monitoring amplifier in conjunction with a broadcast station audio console. Because of its compactness, its possibilities for numerous other applications became apparent as it approached its final form and reached the production department.

The photographs of *Figs.* 1 and 2 are of the original laboratory model. The component parts are assembled on an aluminum sheet 5 × 8½ in. The reason for this type of construction is that the unit was to be mounted on a chassis side by side with other equipment constructed on aluminum plates of the same 8½-inch dimension. Construction, of course, can be in the conventional chassis or cabinet form but regardless of the manner selected it is recommended that there be little deviation from the parts placement shown in the model.

* *3917 Madison St., Hyattsville, Md.*

Referring to the *Fig.* 1 (left), the layout is as follows. At the top is the 6SJ7 input stage. Beneath it is the 6SN7 voltage amplifier-phase splitter tube, followed by the pair of 6V6 output tubes working into the output transformer located at the bottom. The electrolytic capacitors can be seen mounted alongside the tubes. All small parts are mounted beneath the plate, mostly with point-to-point wiring as shown in *Fig.* 2 (right). The other unit in the photos is the power supply, of which more later.

The schematic is shown in *Fig.* 3. The input stage is a 6SJ7 voltage amplifier with provision for coupling to the signal source provided by capacitor C_1 and through the 0.1-meg potentiometer, or volume control, R_1. The 6SJ7 is followed by a 6SN7 twin triode tube, the first half functioning as a straight amplifier and the second half as a phase splitter. The output stage consists of a pair of 6V6 tubes in push pull. The negative feedback loop extends from the secondary winding of the output transformer to the cathode of the second voltage amplifier stage.

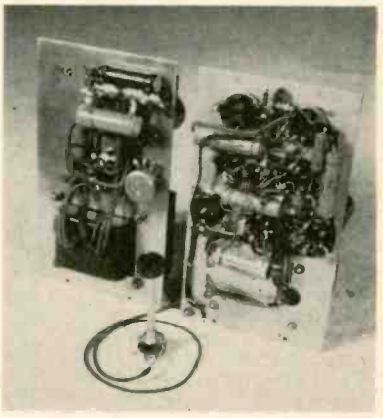

Fig. 2. Underside of the amplifier. The volume control is on an extension cable to permit flexibility in mounting.

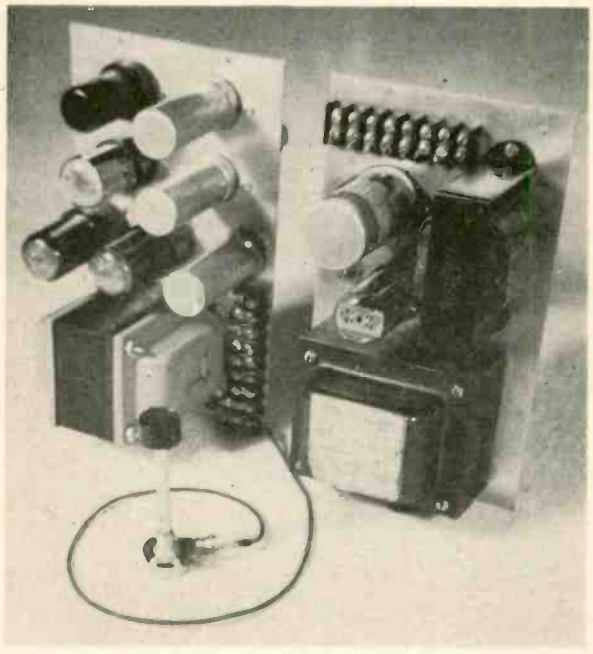

Fig. 1. The author's amplifier and power supply. Note the use of separate filter capacitor cans.

It is to be noted that direct coupling is employed between the plate of the second stage and the grid of the phase splitter. This contributes to the stability of the amplifier as this point in the circuit is included within the feedback loop, and the direct coupling reduces phase shift.

The constructor should recognize that with this phase splitter the cathode of V_{2B} is at a relatively high positive potential with respect to ground, and because of the direct coupling, the grid of V_{2B} is at the same positive potential as the plate of the driver triode, V_{2A}. The bias on the grid of V_{2B} is then determined by these two positive potentials, and is, therefore, dependent on the values of R_9, R_{10} and R_{11}, so these are fairly critical components. The phase splitter resistors R_{10} and R_{11} should be as closely matched as possible. In the unit described here, the plate voltage of V_{2A} is 79 volts, which of course, is also the potential on the grid of V_{2B}. The voltage from V_{2B} cathode to ground is 84 volts. The difference between these two voltages—that is, 5 volts—is the bias on the grid of V_{2B} with respect to its cathode. Resistors R_{12} and R_{13} and capacitors C_6 and C_7 should also be fairly well balanced.

The response characteristics of this little amplifier are quite good. A signal input of 80 millivolts will drive the unit

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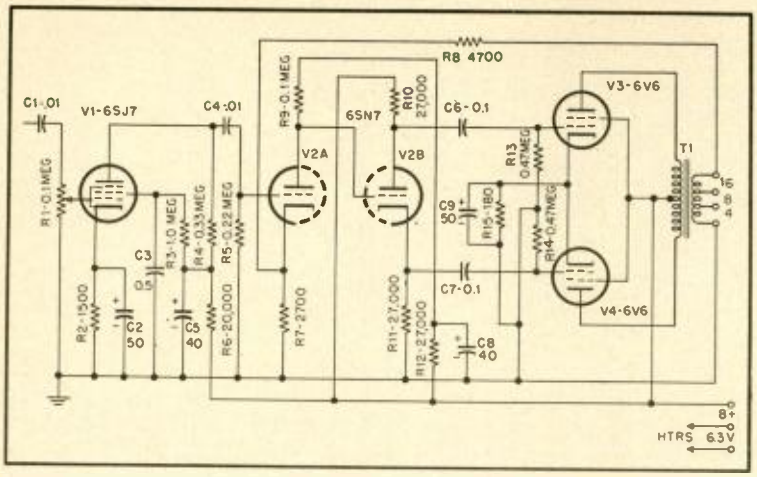

Fig. 3. Schematic of the amplifier section.

to 10 watts output across a 4-ohm load. The frequency response is flat within ± 1 db from 30 to 20,000 cps. Distortion at 1000 cps for 2 watts output is 0.7 per cent at 4 watts 0.8 per cent. 8 watts gave a 1 per cent reading, with 2 per cent measured at 10 watts. Measurements were made with a Hewlett-Packard distortion analyzer.

To the constructor who does not hesitate about pushing tubes a little harder the following may be of interest. It was observed that by increasing the supply voltage to 300 volts, which is 15 volts above the maximum rating for the screens, distortion at 2 watts measured 0.68 per cent, 4 watts 0.78 per cent, 8 watts 0.84 per cent, 10 watts 0.88 per cent, 12 watts 1.4 per cent, 13 watts 1.6 per cent and at 14 watts 3 per cent.

This compact amplifier can be utilized by the audio enthusiast as a companion piece with a preamplifier-equalizer-control unit as it can be built nicely into a sound system for record reproduction and AM/FM tuner outputs. With proper transformer input coupling it may be employed in broadcast and studio applications as a bridging amplifier across balanced low-impedance lines.

Power Supply

The power supply voltages for this 10-watt amplifier were furnished by the main power supply of the audio console with which it was associated. However, so that the unit could be used as a general purpose amplifier, an individual power supply is shown which will furnish the filament and d.c. voltages. This supply was assembled on an aluminum plate of the same dimensions as used for the amplifier, that is, 5 × 8½ inches, and is seen in *Figs.* 1 and 2. The constructor will, of course, have his own ideas as to the layout desired. The schematic of the power supply is shown in *Fig.* 4.

The power transformer secondary provides 350 volts a.c. each side of center tap and is rated at 125 milliamperes. The filter choke is also rated at 125 milliamperes, which is approximately 25 milliamperes higher than the current requirements of the amplifier, so that the power supply can also be used to power a preamplifier in a complete audio reproducing system as well. Sufficient filtering is provided by the choke coil, L_1, and the 20-µf capacitors.

Resistor R_{16} serves as a bleeder resistor, contributing to improved power supply regulation. R_{17} is a voltage dropping resistor to provide the proper d.c. voltage to the amplifier as well as additional filtering. The value of this resistor may be varied to obtain higher or lower supply voltage.

The total current required for the amplifier filaments is 1.8 amperes. The current rating of the 6.3-volt filament winding of the transformer specified for the power supply unit is 4.5 amperes, which is sufficient leeway to furnish power to preamplifier tubes.

A 100-ohm, 2-watt wirewound humbalancing potentiometer is shown across the filament winding of the power supply and will prove helpful in reducing a.c. hum voltage to a minimum. This control is a necessity if the supply is used to power low-level preamplifier stages. The center arm of this potentiometer may be connected to ground, or it may be connected to the cathodes of the 6V6 output stage to obtain a positive biasing source to the heater circuit. If a.c. hum difficulties should prove to be particularly troublesome, a higher positive heater biasing source may be obtained by increasing the value of R_{19}.

As can be seen in the photographs, this power supply unit requires little space and will power not only the 10-watt amplifier described, but will handle a complete audio reproducing system, from phono input to loudspeaker.

PARTS LIST

C_2, C_4	.01 µf, 400 v, paper
C_3, C_9, C_{12}	50 µf, 50 v, electrolytic
C_5	0.5 µf, 400 v, paper
C_6, C_8	40 µf, 450 v, electrolytic
C_6, C_7	0.1 µf, 400 v, paper
C_{10}, C_{11}, C_{13}	20 µf, 450 v. electrolytic
L_1	Filter choke, 7 Hy, 125 ma.
R_1	0.1-meg potentiometer, audio taper
R_2	1500 ohms, ½ watt
R_3	1.0 meg, ½ watt
R_4	0.33 meg, ½ watt
R_5	0.22 meg, ½ watt
R_6	22,000 ohms, ½ watt
R_7	2700 ohms, ½ watt
R_8	4700 ohms, ½ watt
R_9	0.1 meg, ½ watt
R_{10}, R_{11}	27,000 ohms, 1 watt
R_{12}	27,000 ohms, ½ watt
R_{13}, R_{14}	0.47 meg, ½ watt
R_{15}	180 ohms, 2 watts
R_{16}	12,000 ohms, 25 watts
R_{17}	500 ohms, 15 watts
R_{18}	0.47 meg, 2 watts
R_{19}	33,000 ohms, ½ watt
R_{20}	100-ohms potentiometer, linear taper
T_1	Output transformer, 8000 ohms plate-to-plate, 4-, 8,-, and 16-ohm secondary (Triad S-31A or equivalent)
T_2	Power transformer, 350-0-350 at 125 ma, 5 v at 3 a, 6.3 v at 4.5 a.
V_1	6SJ7
V_2	6SN7
V_3, V_4	6V6
V_5	5Y3GT

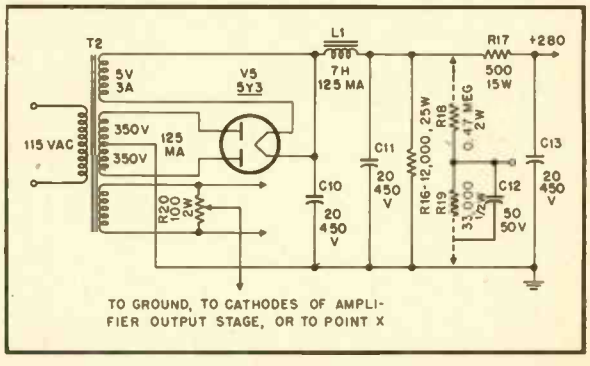

Fig. 4. Schematic of the power supply.

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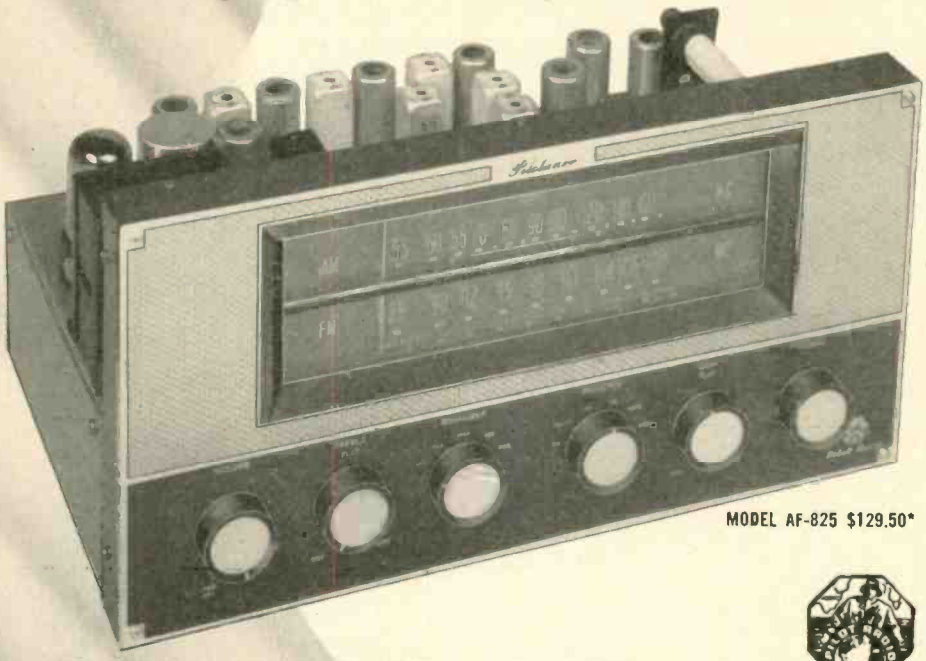

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Make Your Own Meter Scales

RONALD L. IVES*

Simple instructions on how to make scales for shop-constructed equipment to give a professional appearance with a minimum of cost and time.

METER SCALES on special instruments, in all too many instances, are poorly drawn and hard to read. With a few notable exceptions, scales on special meters are not as well drawn as the dials on bargain alarm clocks; and some of them appear to have been drawn on used blotting paper with a dime-store ball point pen. This prevalent unsatisfactory condition not only reflects unfavorably on the makers of the instrument, but also impairs the accuracy of all readings made from the instruments. Most people will read a workmanlike instrument scale with considerable care, but will give only a cursory glance to a sloppy dial.

By use of a number of improved and simplified drafting techniques—originally developed for newspaper work where speed of production is essential, and more recently applied to technical drafting[1,2,3]—workmanlike scales for special instruments can be constructed at relatively low cost in both hours and dollars.

Direct Drafting Procedures

Special instrument scales can be drawn directly on the scale card by an ordinarily skilled draftsman, using black India ink throughout, and applying the lettering with the aid of a Leroy or other lettering guide. This procedure is quite satisfactory for large scales, when only one of a kind is needed; but becomes quite difficult as the size of the scale decreases. Direct drafting is not satisfactory when a number of identical scales is needed, and the procedure is not suitable when the scale card has a special surface not suited for ink work.

Highly skilled draftsmen can draw complicated instrument scales not much larger than a postage stamp, and do "perfect" freehand lettering upon them. Draftsmen having these capabilities are few in number, and most of them are already employed full-time by instrument and watch manufacturers.

* *Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.*

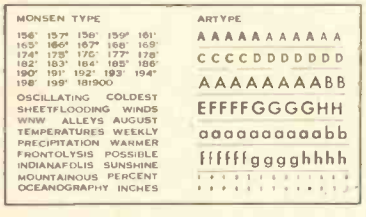

Fig. 1. Samples of trans-adhesive lettering. At left is Monsen type; at right is Artype. Note guide lines furnished with the latter.

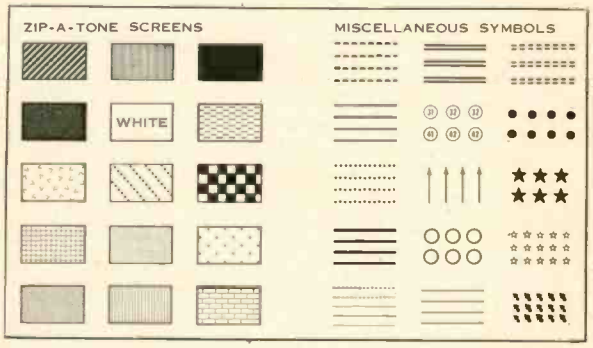

Fig. 3. Zip-A-Tone screens (left) and Artype special symbols (right).

Large Scale Drafting

Most of the difficulties inherent in the fine line work and small lettering required on most meter scales can be eliminated by drawing the scale several times as large as the desired finished dimensions, and reducing it photographically. This same procedure makes possible the production of any reasonable number of scales all alike. Both Leroy and Copperplate lettering will stand great reduction without loss of legibility; and many minor and unavoidable defects inherent in hand drafting will "drop out" in the reduction process.

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BLOOMINGTON, INDIANA

Fig. 2. Map label printed on trans-adhesive material. This is handled as a single unit, and can be applied in about 20 seconds.

Optimum results are obtainable with this method when the drawn scale is about three times as large as the finished dimensions; and when line weights and type faces are chosen so that no line is narrower than about .01 in. in the reduced scale and no letter or symbol is smaller than about 1/16-in. high. Although thinner lines and smaller letters can be produced by this method, they become difficult to read, even when perfectly executed and skillfully copied, so that the smaller sizes should be avoided. An instrument scale, no matter how accurate it may be, isn't much use if you can't read it!

Pre-Printed Letters and Symbols

Use of printed symbols, letters, and words in illustrative material has been common in the graphic arts industries for more than half a century. During the last two decades, a number of manufacturers of graphic arts supplies have produced and marketed a wide variety of pre-printed patterns, symbols, and letters. One of the pioneers in this field was the Craftint Co.,[4] who produce a variety of patterns printed on transparent acetate sheeting. The base (sheeting) is cemented to the drawing over the area to be patterned, and surplus pattern is rubbed off the upper surface. A convenient method of assembling textual material has been developed by Fototype.[5] Their product consists of individual letters, printed on cards. These are assembled upside down in a composing stick (supplied by them). The assemblage is made permanent by applying cellophane tape over it. The completed text, removed from the composing stick, is mounted, as a unit, wherever desired. More than 300 sizes and styles of type are provided by this manufacturer.

Best suited for most meter scale work is trans-adhesive type, which consists of type symbols printed on the under side of thin transparent acetate sheeting. This is then coated with a white waxy adhesive, also on the under side. Trans-adhesive type is cut from the sheet, placed in the desired position, and then burnished into place.

Several kinds of trans-adhesive material are available. Words and special symbols, to order, in almost any type face extant, are produced by Monsen.[6] Samples of Monsen copperplate are shown in *Fig.* 1, left. This material is manufactured for a setting charge plus a charge for each impression, so that

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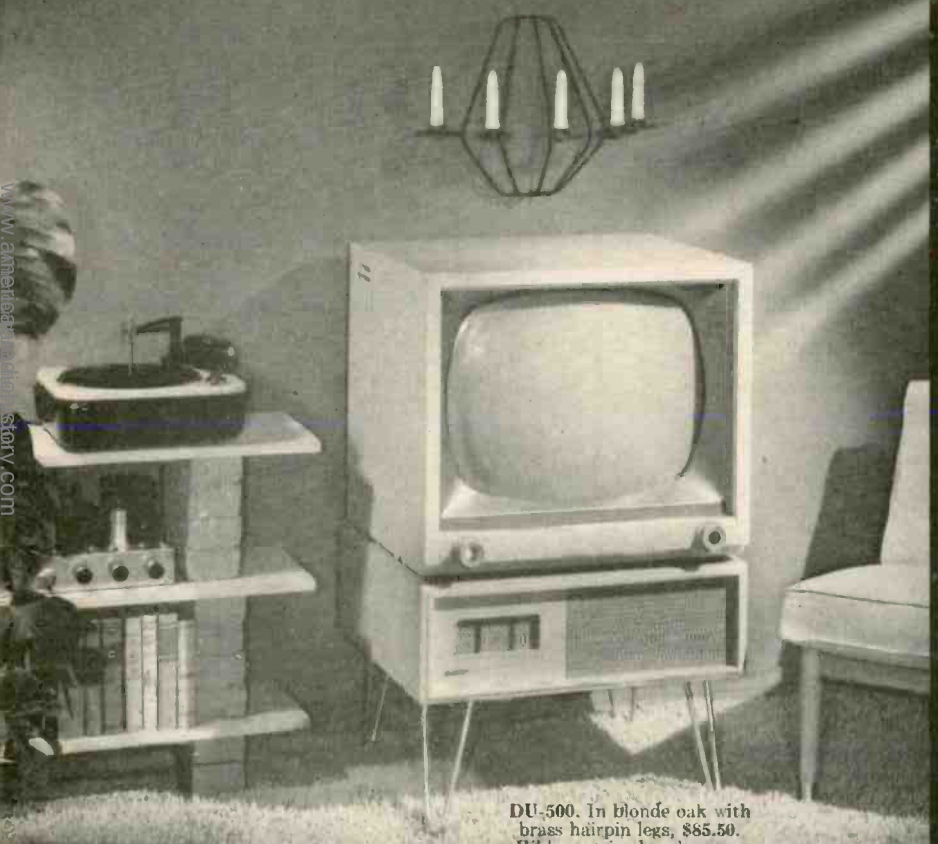

DU-500. In blonde oak with brass hairpin legs, $85.50. Ribbon-striped mahogany, wood legs, $82.50.

DU-400. Choice of mahogany or korina (blonde) finish. $49.50

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And that's not all—for the Jensen TV Duette will serve also with convenience and distinction as the basic speaker for your complete hi-fi system! The same handy switch transfers the Duette from TV to whatever else you wish . . . be it changer amplifier, tape or FM. So if you're starting in hi-fi, Jensen TV Duette is indeed your best buy. (Of course you can use this handsomely designed speaker as a coffee table or end table, too, if you wish.)

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the cost per sheet depends upon the number of impressions ordered at one time. Monsen will also print to customer's specifications, on trans-adhesive sheets, almost any trade mark, label, title-box or caption desired, as in *Fig.* 2. Use of Monsen trans-adhesive material is economically advantageous when the same words or symbols, in the same type face, are used quite frequently.

Some reduction in the amount of printing needed can be brought about by careful choice of words, as the setting charge is usually on a per word basis. Combinations of substantial parts of words can also be made quickly and neatly. For example, if the word *milliamperes* is ordered, it is not necessary to order *amperes* also; and the *micro* from *microfarads* can be combined easily with the *amperes* from *milliamperes* to produce *microamperes*. Some draftsmen, particularly those who speak more than one language, become highly skilled in finding and using desired letter groups. Although the setting charge for a "two dollar word" is usually the same as that for a "ten cent word," copy containing jawbreakers such as *polydipseudaukistrodesmus pietenpolensis* (the name of a diatom) is likely to carry an additional charge for "difficult copy."

Trans-adhesive alphabets and a wide variety of symbols are produced by Artype.[7] This material consists of individual letters, with attached guide lines (*Fig.* 1, right). The text is assembled in the desired location on the drawing, aligned by use of the guide lines, and burnished in place. The guide lines are then removed and discarded. With a little ingenuity, symbols not contained in English type fonts can be produced with Artype,[8] and only an expert printer can tell, from the appearance of the finished work, that these symbols were not printed directly from a special type font.

A few of the many special symbols made by Artype are shown in *Fig.* 3 (right). Repeated symbols, patterns, shades, and screens printed on a trans-adhesive base, are manufactured by the Para-Tone Co.,[9] and marketed under the name Zip-A-Tone. These, a few of which are shown in *Fig.* 3 (left), are useful for zoning meter scales. Solid white Zip-A-Tone is useful for blocking out parts of a drawing; and solid red Zip-A-Tone, which photographs black with most engravers' films, is ideal for filling large black areas uniformly, and without cockling the paper, as commonly takes place when a large area is inked in solid.

Scale Construction Procedure

Procedure for making a special meter scale, using these art aids, is relatively simple and straightforward. First step is to calibrate the meter in terms of any scale which you choose to put on it. Usually the scale supplied with the meter will be entirely satisfactory.

Remove the scale from the meter, put it on a piece of black paper, and make a photostatic copy of it. This, for convenience should be a positive photostat, and should be enlarged by a convenient factor, such as 2, 3, or 5, to simplify drafting procedure. Such a copy is shown at A in *Fig.* 4. The black paper backing outlines the scale, and shows the mounting holes plainly.

Mount the photostat on the drawing board using drafting tape in any alignment convenient to the draftsman. Cover it with tracing linen or matte acetate, and ink in all lines desired on the new scale. Be sure to locate the scale outline and mounting holes accurately. Tracing with completed line work will appear as at B in *Fig.* 4.

Apply the desired lettering and symbols to the scale by the standard method for the art aid employed. Trim away all guide lines and other extraneous material, and the scale is ready for photographing. Finished scale appears as at C in *Fig.* 4. Other samples of scales made by these methods appear in *Fig.* 5.

To insure that the finished scale has the proper dimensions, mark the finished dimension on some part of the scale very plainly for the photographer. A convenient method of doing this is to draw a line equal to the exact dimension between the mounting holes on the scale to be photographed, and label it "Reduce so that this line is exactly 2 inches long," the dimension here given being correct for a Triplett Mod. 327-T scale.

Copying

Reduced copies of original drawn scales are normally made by a photographer, using standard copying equipment and films. Use of a process lens is desirable, to obtain maximum resolution in the copy negative; and lithographer's films, such as *Reprolith, Kodalith,* and *Lithaloid,* exposed and developed according to manufacturer's instructions, give adequate contrast.

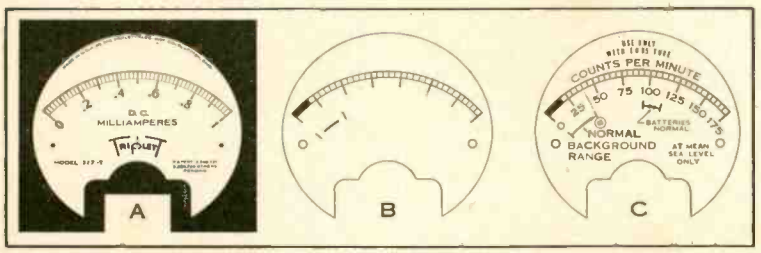

Fig. 4. Steps in making a special meter scale. (A), photostat of the scale, taken against a black background. (B), tracing of (A) on which the new scale has been drawn. (C), the same tracing, with lettering applied.

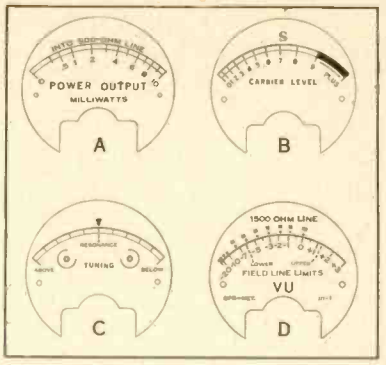

Fig. 5. Special meter scales made by use of standard drafting for the line work and trans-adhesive lettering for the text and symbols.

A wide variety of printing papers is available, and most glossy and semi-matte papers make suitable scale prints. Some care is needed in printing from scale copy negatives. Contact between negative and paper must be intimate, or lines will be widened and blurred. Overprinting must be avoided, or parts of the image will "bleed" into surrounding areas ("all the *o*'s fill in"). Development, fixing, and washing, in accord with good standard practice, will give entirely satisfactory prints. Life of a photographically produced meter scale is somewhat more than fifteen years, most of those made by the writer prior to 1940 still being in service (1954).

Prints may be mounted on the meter scale plate by use of high-grade library paste, purified rubber cement (the stationer's variety, not from the garage), or dry mounting tissue. Most of the library pastes are short-lived in this service, the paper coming unmounted from scale plate after three or four years. The better grades of rubber cement are apparently immortal if correctly used. Best procedure seems to be to coat the scale plate lightly with cement, then coat the back of the print with a medium thickness of cement, then let both dry for a couple of minutes. When the cement is tacky, align the holes in the scale print with the holes in the scale plate, and press the print firmly onto the plate. Keep the assembly under heavy pressure for a reasonable time, such as 30 minutes, then trim the edges and install.

Dry mounting tissue, which is a thin sheet of paper impregnated with wax, can also be used, and gives very good results in skilled hands. The tissue is tacked onto the scale plate with a small tacking iron, then the scale is placed over the plate in proper register, and the whole heated under pressure. After cooling, the edges are trimmed, and the scale installed in the meter.

Special Features

By combining the best features of standard drafting and trans-adhesive letters and symbols, a wide variety of special meter and instrument scales can

(*Continued on page 64*)

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Amplifiers

EDGAR M. VILLCHUR*

An analysis of the fundamental nature of amplification, and a description of the working principles of pneumatic, mechanical, carbon, vacuum-tube, transistor, magnetic, and dielectric amplifiers.

A COMMON-SENSE DEFINITION of the word "amplifier" is "a device that makes things bigger." But in technical language the term has a much more restricted meaning; the device referred to becomes an amplifier only when the things that are made bigger consist of energy-patterns. The nature of amplification can probably be better understood by considering first the operation of another energy transmission device that is *not* an amplifier—an instrument that is called, in mechanics, a machine.

The machine receives input power, shapes it for the required task, and releases it, less the inevitable losses from friction, in its new form. Were it not for these losses the amount of energy released would be exactly equal to that received. Although the Indian hunter was able to bring down buffalo with bow and arrow, his arrow was driven by less energy than had been put into flexing the bow. His machine was able to store and concentrate the power that it received when the string was drawn back, so that the shaft sped with lethal velocity. Without the machine the hunter's strength would have been totally ineffective.

The mechanical lever, the acoustical horn, and the electrical transformer are other examples of transmission devices whose useful output energy, while re-formed in such a way as to be most suitable for the application at hand, must always be somewhat less than the input energy. The word "machine" applies to mechanical devices only; the term which includes all instruments of this nature, whatever type of energy is transmitted, is *passive transducer* (from *traducere*, to lead across).

An amplifier is also an energy transmission device, and hence a transducer, but it is an active one. It does that which would be impossible without a sort of engineering sleight-of-hand—it provides a transmission channel whose output, seemingly the same in identity to the received stimulus, contains more energy than its input. The difference is that between a pulley and a powered capstan. It is obvious that the useful output energy of an amplifier cannot be greater than the total energy supplied, any more than it is possible for such a condition to exist in the case of a passive transducer, or energy will have been created out of nothing. The trick is that the input stimulus borrows and directs power from an independent second source (such as the electric company's generators), and shapes this independent power to its own form.

The need for amplifiers arises when we are dealing with impulses which must remain in a very definite time pattern if they are to be useful. One of the earliest amplifying devices was the pipe organ, whose player was able to control, with relatively light pressures of his fingers, the steady flow of air produced by sweating bellows-operators. Amplifiers in the more generally accepted sense, however, were invented when nineteenth century technology became concerned with the transmission and reproduction of vibratory power: first sound, and then radio waves.

Sound consists of successive and alternating compressions and rarefactions radiated by an oscillating source. The telephone and the phonograph therefore depended for their operation on acoustical, mechnical, or electrical forces which continually reversed their directions, and which carried the transmitted intelligence in the time sequence and pattern of these oscillations. The problem that faced engineers was to extend telephonic communication over longer distances, to make phonograph reproduction louder than was possible with the original, limited power. The first approach, successful up to a point, was to increase the efficiency of the passive transducer elements. But the best acoustical and electrical passive transducers that could be designed to harness effectively the sources of this oscillatory energy proved inadequate. Sound generators like the human voice mechanism, or the phonograph pick-up diaphragm following the record groove, simply didn't have enough driving power for the work they were called upon to perform, even with the carefully designed horns that increased their radiating efficiency. The solution was to inject outside energy into the systems and to use the original stimuli as controlling rather than driving forces, which is to say, to amplify.

Early Amplifiers

In 1876 Edison patented a device which he called an *aerophone*. It was a pneumatic public-address amplifier, illustrated in *Fig.* 1, in which the speaker's voice controlled the instantaneous flow of compressed air by means of a sound-actuated valve. The air was thus released in vibratory bursts and puffs similiar to those that came from the speaker's mouth, except that they were more powerful, and the speech, still intelligible, was louder. Edison envisioned broadcasting in stentorian tones over distances of several miles. Such a system has actually been used in ports, but it found its main application in the designs of two British inventors who applied it to the phonograph. Short developed, and Parsons further improved the *auxetophone*, whose pneumatic valve was attached directly to a phonograph reproducing stylus. Although pneumatic phonographs produced a constant background hissing noise due to escaping air, they were fairly popular in Europe, and in the early nineteen hundreds the French Pathé company experimented with them

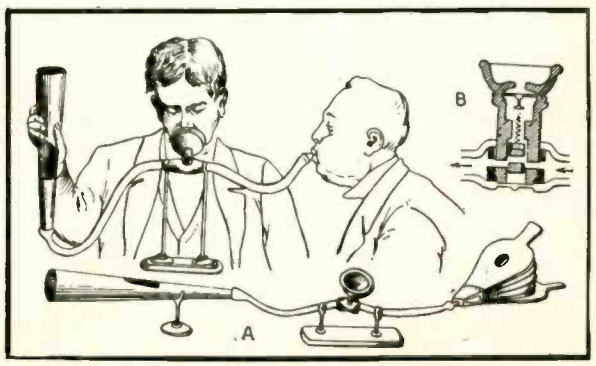

Fig. 1. Edison's aerophone, or pneumatic amplifier, provided a sound transmission channel into which additional energy was injected in the form of compressed air. Inset shows how the sound-actuated valve throttled a steady flow of air, to create an instantaneous variation in flow that imitated the original sound vibrations.

* *Woodstock, N. Y.*

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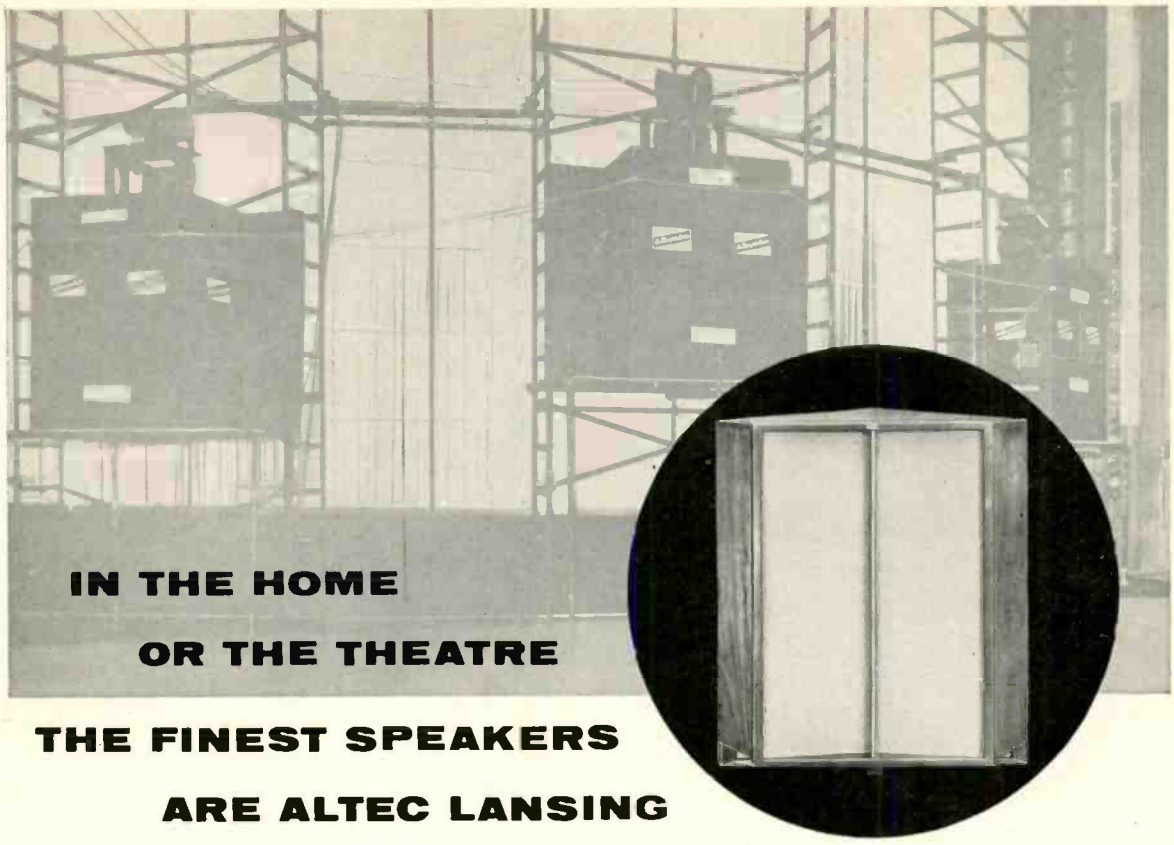

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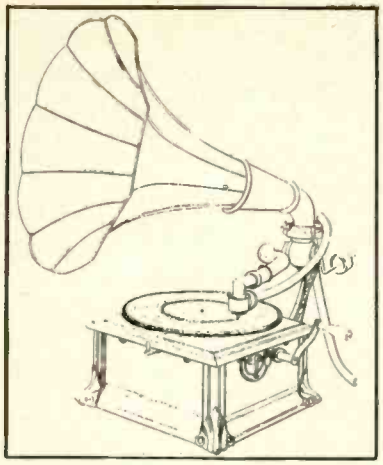

Fig. 2. The Pathé phonograph of 1905 used a compressed-air amplifier.

with a view towards developing talking motion pictures. (See *Fig.* 2.)

Another type of device, the mechanical or friction amplifier, found more favor in the United States. It was used in certain models of Columbia's cylinder "graphophone," as shown in *Fig.* 3. The reproducing stylus of these instruments, instead of being coupled directly to its diaphragm as in standard acoustical phonographs, was attached to the diaphragm via a string and friction shoe that passed over a rotating drum. When the stylus tightened up on the string, friction between the shoe and the drum was increased, and force picked up from the drum augmented the displacement of the diaphragm. When the record groove forced the stylus in the opposite direction, so as to loosen up on the string, the diaphragm returned to its original position due to spring tension. In this way the vibratory path of the diaphragm was extended by the energy of the independently driven drum, and sound output was increased.

Both of the above designs were referred to at the time as relay systems. The original stimulus was thought of as touching off latent power, like a relay runner passing the baton to his successor. These systems were the forerunners of our present-day electronic amplifiers, but they were themselves doomed to a short life. The golden age of mechanics, when the diabolical iron fingers that set printing type, tabulated sums, and rolled cigarettes were the wonders of applied science, was passing. Electronics was taking over, and the amplification of sound was destined to include an intermediary step, the temporary transformation of mechanical vibratory energy into electrical energy possessing the same characteristics in time.

Electrical amplification may be achieved (and still is, in some telephone circuits) by carbon amplifiers, which extend the principle of the carbon microphone. The carbon granules through which current is directed act as a variable electrical gate, whose resistance to current flow is controlled by the pressure of a diaphragm. Changes of pressure, such as would be created by stimulating the diaphragm with sound, create corresponding changes in the amount of current drawn from the source of electric power, and the electrical source releases energy greater in magnitude than that possessed by the input stimulus.

The Vacuum-Tube

The device which really opened up the field of amplification was the vacuum-tube. Fleming had made an electronic valve that contained two electrodes sealed in an evacuated glass chamber, a cathode emitter and an anode collector. When the cathode was heated a cloud of electrons was given off, and if the device was then connected in series with a battery, in such a way that the anode was positively charged relative to the cathode, the electrons were attracted to and entered the anode. Since electrons in motion constitute electrical current the circuit was completed through this one-way path.

The stream of electrons flowing in the empty space between cathode and anode provided an especially favorable area for sensitive control of the current drawn from the battery. The opportunity was seized by de Forest, who introduced a control element into the valve by inserting a "grid"—an open network of fine wire—across the electronic stream. De Forest's grid was a sieve mechanically, but if it was charged negatively relative to the cathode it tended to repel electrons (which are also negatively charged) and to retard current flow. A weak input "signal" voltage applied between grid and cathode, varying according to a given frequency and wave form, produced an

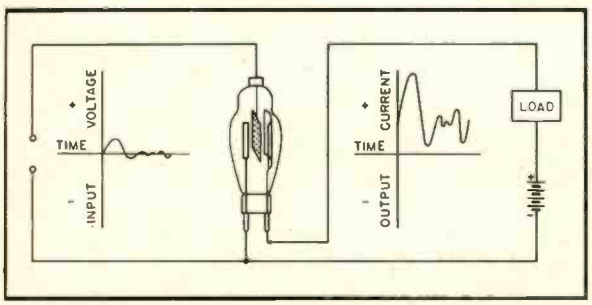

Fig. 4. Amplification of a weak electrical impulse is achieved by a vacuum-tube circuit. The input electrical stimulus has alternating polarity, while the output is in the form of pulsating one-way current. The cathode heating element is not shown.

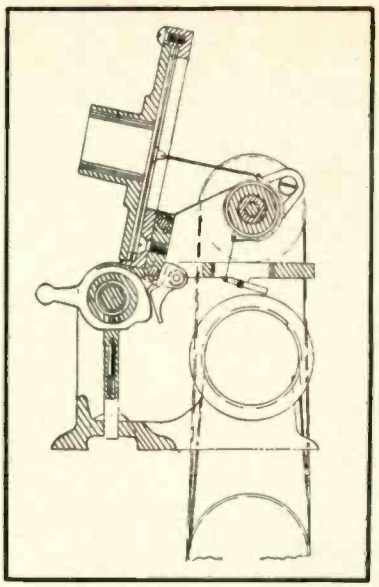

Fig. 3. The stylus of Columbia's cylinder *graphophone* was coupled to the reproducing diaphragm through a lever-type shank, a string, and a friction shoe that picked up extra energy from the rotating drum.

imitative variation in the relatively heavy output current flow, as may be seen in *Fig.* 4. This output power could follow the input characteristics more closely than had been possible with any other device designed previously. The limits imposed by mechanical systems—their intractability when subjected to forced vibration in modes foreign to natural resonances, the uneven restraint of elastic suspensions, and the fact that supposedly rigid parts become flexible when subjected to vibration at high frequencies—all disappeared, and development workers found themselves operating in a dream-world of virtually massless units, where incredibly swift oscillation could be controlled and amplified without having to reckon the price of inertia, elasticity or gravity.

An early application of vacuum-tube amplifiers was to the generators and receiver of radio waves. Like sound, electromagnetic radio energy is oscillatory, although at frequencies which may be millions of times higher than those of acoustical vibrations. The element analogous to the phonograph horn is the antenna, acting as a passive transducer to the "atmosphere"—and, as in the case of the horn, more efficient antennas were not enough. With transmitter output amplified, however, from a few watts to hundreds of kilowatts, and receiver sensitivity raised to the point where a few millionths of a volt at the antenna created usable reception, wireless global communication became possible. Other applications followed quickly. The recording and reproduction of sound, the detection and measurement of very small quantities of light, sound, pressure, or voltage, the myriad

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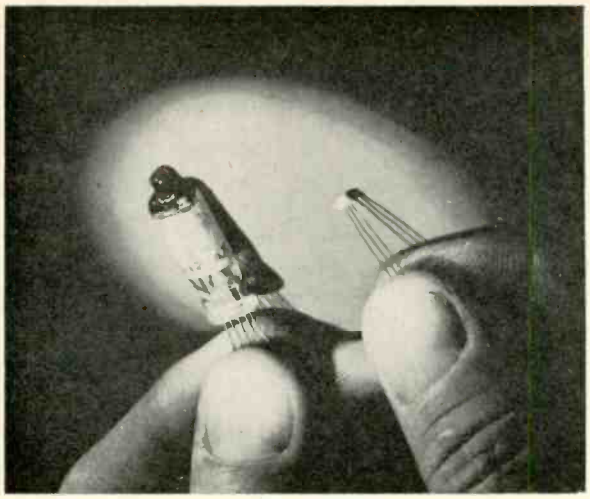

Fig. 5. The junction transistor is tiny compared to the "sub-miniature" tube, the smallest type made. These are approximately full size. (Courtesy General Electric Co.)

tasks performed by calculating machines, and the sensitive control and regulation of massive machinery became part of the electronic field.

But with poetic injustice, after the vacuum-tube has served as the vehicle for the modern science of electronics, it is being prepared for the scrap-heap, at least in certain applications. The vacuum-tube has several disadvantages, foremost among which is its unreliability. Besides having too short a normal life, the possibility of failure at any time after installation must always be taken into consideration by design engineers. The unreliability of the vacuum-tube is such an accepted fact-of-life that instead of being wired permanently into the circuit, like other components of electronic apparatus, it is plugged into a tube socket to facilitate periodic replacement. In addition to this unreliability the vacuum-tube requires a separate power supply to heat its filament (diverting and wasting most of the energy taken from the independent source), it must be given a warm-up period prior to service, and it is too bulky in some applications. The feature which redeems all of these disadvantages is the superb control which may be exerted over the captive electron stream.

Without abandoning the last feature, new ways in which electrons can be made to submit to instantaneous regulation at high frequencies are being investigated. The transistor, a revolutionary experimental device a few years ago, can aready be ordered by the part number at radio dealers, and development work is also being performed on magnetic, dielectric, and other types of amplifiers.

Transistors

From the electrical point of view materials may be classified according to their resistance to the passage of current, as conductors, insulators, and semi-conductors. In an atom of a good electrical conductor the outermost electronic shell is held so loosely that its electron inhabitants are not associated exclusively with any particuar parent atom. The attachment, originally weak because of the relative distance from the nucleus, disappears with the close atomic spacing typical of these materials, and the outer electrons are free to rove. These *free* electrons are able to respond to the force of an electric potential applied across the conductor, and form an electronic wind blowing across the relatively stationary atoms themselves towards the positive terminal, constituting the flow of current. Current does not flow to any appreciable extent in non-conductors because the atoms of insulators hold on grimly to their outer shell electrons, which are more numerous, closer to the nucleus and much more difficult to dislodge.

To impart motion to an electron is to give it added kinetic energy. Quantum requirements dictate that the electrons must fill certain discrete energy levels, that is, that they cannot possess a random amount of energy, and that each energy level can only accommodate a given number of electrons. Therefore the energy of an electron can only be increased or decreased by an amount which brings it into a new step level in which a vacancy exists. The quantum levels of the atoms of a conductor have vacancies, permitting electronic transfer from one level to another. The energy levels of the atoms of insulators, on the other hand, are all filled, so that the system is locked.

The energy level states of semi-conductors (substances such as germanium, selenium, silicon, and the oxides of copper and barium) form a special case. The locked system is upset by the presence of minute impurities, whose outer electronic orbits contain electrons in a number either greater than or less than the amount normal to the pure substance, and which introduce energy levels capable of releasing or accepting electrons. Where the number of outer electrons is greater than normal, excess electrons are available for current flow in the form of an electronic wind, and the substance is called a donor. Where the number of outer electrons is less than normal, the substance is called an acceptor, and vacancies are available for electronic current flow in the form of "hole" conduction (an effective migration of the unfilled spot from one atom to another, a phenomenon which has been aptly compared to the motion of an air bubble in water). These two modes of conduction occur in opposite directions and are called, respectively, *n-type* for negative, and *p-type* for positive. Hole conduction has a positive designation because the migration of holes has the same experimental effect as the transfer of positive charges.

The development of semi-conductor devices has followed the same course as that of the vacuum-tube, from two-terminal systems providing a one-way electronic path, to three-terminal systems in which the electronic flow is made subject to control from an area astride the path. Semi-conductors were used as rectifiers of alternating current long before the word transistor was coined. A potential applied in one direction across the junction of a *p*-type and an *n*-type substance will encounter relatively low resistance to current flow, but relatively high resistance if the polarity and hence the direction of current flow is reversed. This is because the electrons and holes travel towards each other for one polarity, facilitating transfer across the junction, and away from each other for the opposite polarity. The rectifying action may also be described from the point of view of energy-level states; for one polarity, electrons belonging to energy levels capable of releasing electrons are driven towards atoms containing energy levels capable of receiving added electrons, while for the other polarity the opposite effect occurs.

A *p*-type substance sandwiched between two *n*-type substances, or vice-versa, creates the basic design of one type of transistor amplifier. The conducting properties of one of the junctions for "wrong-way" current may be controlled by creating either hole or electron carriers in the sandwiched element (by means of a current through the other junction)—to put it another way, by causing a shift in the electron energy level states responsible for conduction. The pattern of variation of a small controlling current shapes the instantaneous resistance of the unit, and large currents may then be forced to follow the same pattern in time.

The transistor requires no warm up period, is smaller (see *Fig.* 5), cheaper in operating cost, and is potentially so much more reliable than the vacuum-tube that it may be wired permanently into the circuit rather than plugged into a socket. Transistor hearing aids, for example, which are already produced commercially, are smaller than their vacuum-tube counterparts, consume only a small fraction of electrical power for the same amplification (they have no *A* battery) and may ultimately be expected to require less service. The tran-

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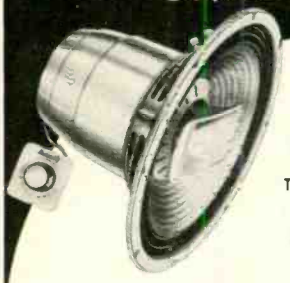

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sistor has been developed to a point where it can duplicate many, although not all, of the vacuum-tube functions. One application of the transistor is illustrated in *Fig.* 6.

Magnetic Amplifiers

The electrical amplifiers that have been here described provide circuit paths whose resistance to current flow is varied by an input signal. Such a path may also be produced by an electro-magnetic rather than a resistive unit, which is called a *saturable reactor*.

The impedance of an electrical coil to alternating current is far more than would be expected from the inherent resistance of the wire. Each time that the current increases, drops to zero, and then increases in the opposite direction a magnetic field around the coil builds up, collapses, and builds up again with reversed polarity. This pulsating magnetic field cuts the wires transversely each time that it builds up and each time that it collapses, inducing current of such instantaneous direction as to oppose and reduce the original flow. This is the descriptive analysis of inductive reactance. In the magnetic amplifier the input signal controls the intensity to which the self-induced field can build up, and hence it controls the electrical impedance of the coil.

Among the factors that determine the intensity of the field are the number of turns in the coil, the size of the core, and the material of the core. None of these can be manipulated at high frequencies, but there is another, more easily controllable characteristic that can influence the coil's field strength and a.c. impedance—the magnetic condition of the core. The core will not continue to accept added magnetization indefinitely; there is a natural limit to its capabilities. As the current is increased the core begins to *saturate*, which means that a further increase of current flow through the coil will produce less than the corresponding increase in magnetic field strength.[1] The degree of this saturation may be controlled, electrically, by the input signal.

A separate winding on the same core, through which the controlling input current flows, will cause the degree of saturation to increase and decrease according to the instantaneous polarity and value of the input signal. A larger current flowing in the output winding, drawn from an a.c. source of power, will then vary in step with the varying impedance.

If the input current must do all of the saturating the power gain will be low, as an appreciable amount of energy is required to saturate the core. A third winding is therefore assigned the major burden of saturation. This winding may carry direct current from a separate electrical supply, or it may carry rectified current from the output circuit. In the latter case the third winding introduces "positive feedback," because the effect of a small input current is re-introduced into the circuit in such a way as to intensify the effect on the output. Small input currents can then control very much larger output currents, and power gains of the order of 100,000 times are obtainable.

In practice it is found necessary for the independent energy source of the magnetic amplifier to supply pulsating direct current rather than alternating current, as shown in *Fig.* 7, so that the saturation effect of the current in the output winding can never oppose that of the input winding. Pure direct current in the output circuit, however, such as is used with vacuum-tubes and transistors, will not work. Direct current would remain uninfluenced by the changes in core saturation; the impedance of the coil to d.c. is entirely a matter of the resistance of the wire conductor. Thus the power that is varied by the input signal is itself a steadily oscillating quantity, but it is a relatively simple matter to separate and extract the amplified impulses from the alternations of the power source. For this purpose the frequency assigned to the power supply is made much higher than the highest-frequency input that is to be amplified.

Magnetic amplifiers are very reliable, have the ability to withstand severe shock, and require no warm-up period. They are also exceptionally efficient, because most of the impedance which they introduce into the output circuit is of a type called reactive, which does not itself absorb energy. (The resistive barrier to current flow introduced by vacuum-tubes and transistors wastes energy in heat.) Magnetic amplifiers are at present advantageously applied in circuits which must control appreciable amounts of power at relatively low frequencies—adjustable-speed motors, winding reels, automatic pilots, voltage and frequency regulators, and other automatic control apparatus. A magnetic amplifier used in servo work is illustrated in *Fig.* 8.

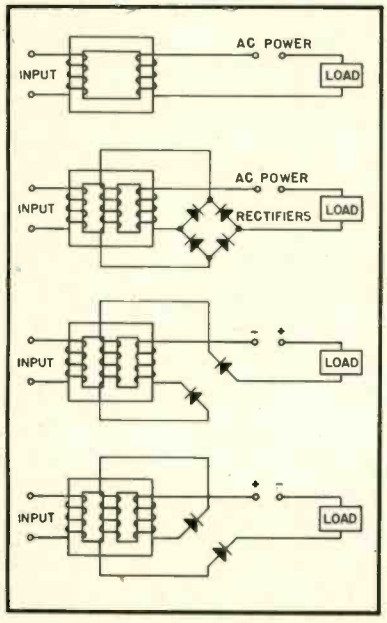

Fig. 7. The top diagram shows the essentials of a magnetic amplifier circuit. Current in the input winding controls magnetic saturation of the core, which in turn controls the impedance of the output winding to the flow of alternating current. The bottom diagram includes rectification of the a.c. power to pulsating d.c., and use of an additional "positive feedback" winding to increase power sensitivity.

[1] A familiar example of this phenomenon is the decrease of inductance in a choke when the current rating is exceeded.

Fig. 6. With the transistor reducing space requirements of tubes and batteries, an electronic megaphone can contain microphone, amplifier, batteries and speaker in one independent unit. (Courtesy General Electric Co.)

Dielectric Amplifiers

In the search for new, more compact, and simple amplifier devices research is being pursued in yet another direction, that of the capacitor or dielectric amplifier. The principles of operation are quite similar to those of the magnetic amplifier, in that a circuit element with variable a.c. impedance is connected in series with an a.c. source of power. The element is not a coil, however, but a capacitor, a system of parallel plates separated by an insulating material or dielectric.

If a battery is connected across a capacitor there will be no steady-state current flow. Electrons move from the negative terminal and charge one side of the capacitor by surfeiting its plates with negative charges; at the same time electrons move from the opposite plates of the capacitor into the positive battery terminal, and leave these plates positively charged by reason of their lack of the normal number of negative charges. The process continues for a short time, until the storage "capacitance" of the device for electric charge is reached, at which point the short-

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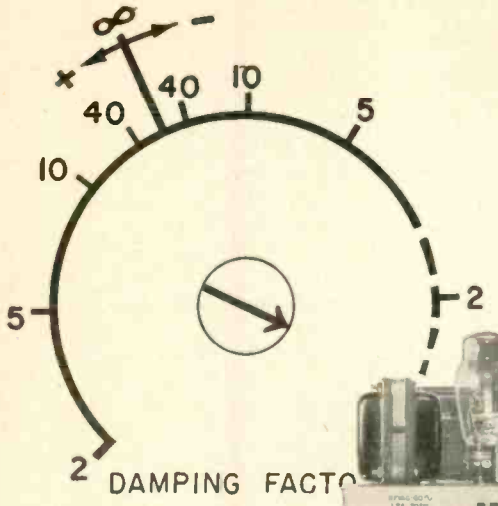

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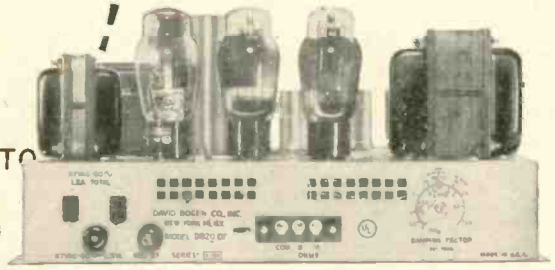

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lived current drops to zero again. If the battery is then disconnected, and the two sides of the capacitor are connected through an electrical conductor, there will be another momentary surge of current, this time in the opposite direction. The second surge is created by the capacitor's discharge, which brings the plates back to their original neutrality of charge.

Except for the initial surge, then, capacitors are non-conducting devices for direct current. In an alternating current circuit, however, they are effectively conductors. Although electrons never actually cross the dielectric bridge between plates, each side of the device alternately accepts and discharges electrons, so that as far as the a.c. source is concerned it is able to send electrons into the circuit and receive them back again. The impedance which the capacitor offers to the flow of alternating current is inversely proportional to the frequency of reversal of the electrical alternations and to the value of the capacitance.

In the dielectric amplifier control of current flow is achieved by varying the capacitance. One of the elements upon which the value of this capacitance depends is the material of the separating dielectric. The electrostatic field created by the application of voltage across the capacitor plates produces a molecular strain in this material, and potential energy is stored by the dielectric in a manner comparable to the storage of mechanical energy by a stretched spring. It is this molecular strain and storage of potential energy that makes it possible for the plates to accept and retain their unnatural charges. The amount of charge that will be accepted, and the capacitance of the system, is therefore limited by the amount of energy that can be stored in the dielectric. The quantitative index of this characteristic of the insulating material is called the dielectric coefficient.

It was discovered that the dielectric coefficients of certain materials such as the barium titanates, Rochelle salt, and tungsten trioxide are not constant, but vary significantly with the applied voltage. Since the electrical impedance of the capacitor is directly dependent upon the value of the dielectric coefficient, the latter characteristic may be used as the control element in an a.c. power circuit, using circuits as in *Fig.* 9. A high degree of amplification may be achieved in this way, with many of the same advantages that are achieved in the case of the transistor. The same oscillating power supply that is used by the magnetic amplifier will work here, so that the dielectric amplifier is suitable for use in conjunction with magnetic amplifiers. It is cheaper than the magnetic amplifier, although not as stable, because the dielectric properties of the titanates that are currently being used are affected by temperature changes, and the gain of the amplifier tends to drift, requiring compensatory measures.

Functional Categories of Amplifiers

In the beginnings of radio an experimenter was able to buy a single type of "audion" or three-element vacuum-tube. Today the number of specialized tube types that have been designed for particular jobs runs into the thousands. Amplifiers may, nevertheless, be classified into a few basic functional categories. These concern (1) the amount of output power required, (2) the band and band-width of frequencies covered, and (3) the degree of wave form distortion to the original stimulus that can be tolerated. The total amount of amplification may be regulated by the number of amplifying stages, of whatever type, connected in cascade.

Heavy tasks, such as the radiation of sound into a room, the engraving of the undulated groove in a disc record, the control of machinery, or the radiation of radio waves by a transmitting antenna, require "power" amplifiers, so-called because of the relatively large amounts of power regimented to the appointed duty. "Voltage" amplifiers or amplifying stages do not differ in principle. They, too, increase the input power, but they are used where the primary requirement is to raise the signal voltage, without a corresponding decrease in current, and where the amount of output power needed is not very great. These conditions are normally present, for example, when the output of a stage of amplification is used to drive another amplifier, perhaps a power amplifier insensitive to weak signals, or when the ouptut is connected to a final load with

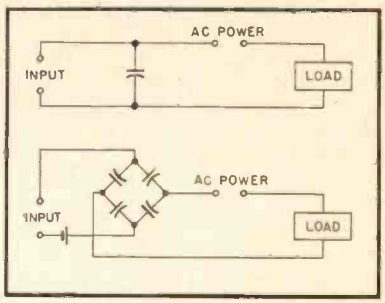

Fig. 9. The dielectric amplifier permits a small input voltage to control the dielectric coefficient of a special capacitive unit. The more elaborate circuit incorporates d.c. "bias" and a bridge arrangement that keeps a.c. power out of the input circuit.

modest power requirement, such as a pair of earphones.

Amplifiers are designed for various frequency ranges between zero cycles (direct current) and the microwave band. The upper limit of the latter is considered to be about 100,000 megacycles, approaching the infra-red region of the electro-magnetic spectrum. Microwave amplifiers are used in radar and television-relay stations. An amplifier that can build up d.c. stimuli, or stimuli that change only slowly, is required for various types of measurement, including such medical applications as the detection of minute body potentials. Each frequency region has its own problems of amplifier design, with regard to both the amplifying units themselves and to circuitry. Microwave circuits, for example, use hollow-pipe wave guides instead of connecting wires, and the transmission lines are often referred to as plumbing because of their physical appearance. Special tubes for microwave oscillators and amplifiers—magnetrons, klystrons, and traveling-wave tubes—have been designed.

Most amplifiers cover only a small portion of the electrical frequency spectrum, but certain types of signal embrace an unusually wide band of frequencies. Video signals, for example, which represent variations of dark and light across successive strips of the picture screen, cover the range from thirty cycles to four megacycles, a ratio of better than 1,000 to 1. Amplifier stages for such signals require special design treatment. A sacrifice in gain must be made in order to achieve broad-band operation.

Increasing the magnitude of the input signal invariably involves a certain amount of wave form distortion, and amplifier stages are classified (as Class A, B, or C) according to the compromise that is made between fidelity and efficiency. A method has been found, called push-pull operation, in which most of the distortion of a compromise amplifier stage can be cancelled by a second compromise stage working alongside.

The degree of output inaccuracy in a high-quality audio amplifier is ordinarily less than the degree of hearing

(*Continued on page 65*)

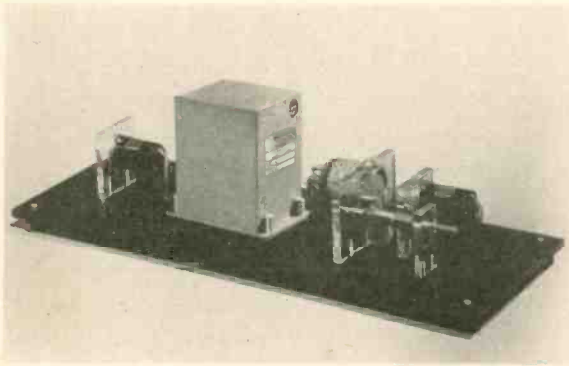

Fig. 8. This "servo" magnetic amplifier may be used to drive a mechanical positioning system. (Courtesy Magnetic Amplifiers, Inc.)

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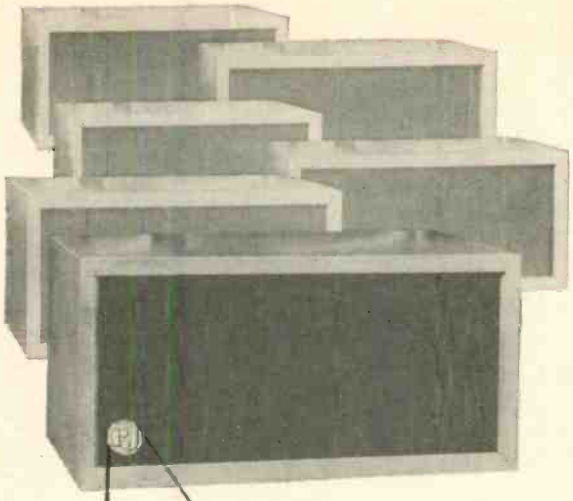

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Equipment Report

McIntosh C-8 Audio Compensator and Mc-30 Power Amplifier—B-J Phono Pickup Arm—General Electric AI-901 Record Filter

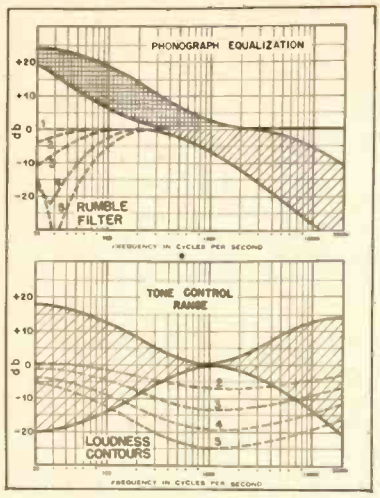

Fig. 1. Performance curves for the McIntosh C-8 Audio Compensator.

Fig. 2. The Audio Compensator, Model C-8.

PROVIDING an almost unlimited variety in response curves, the McIntosh C-8 Audio Compensator is one answer to a desire to accommodate any present or probable future recording curve, as well as to adjust for the acoustics of the listening room, deficiencies in the speaker system, or practically any other condition that may arise.

This unit—which is available either to work with the entire line of McIntosh power amplifiers or with its own small power supply—is equipped with the usual bass, treble, selector, and volume controls, and has in addition a rumble filter control, a loudness compensator switch, five switches to control the turnover frequency, and five switches to control rolloff. That may seem like unduly complicated for the average listener, but there are many who are of the opinion that this unit is the only one which can provide a range of control which is sufficiently wide for the most critical listener. The Compensator is designed to mount in an existing panel, using an opening 10 1/16 × 3 5/8 in., or it may be installed in a small cabinet as shown in *Fig.* 2 and used on a table top, if desired. When feeding a McIntosh amplifier, it draws operating power from sockets built into the power amplifier chassis; if used with the D-8 power supply (in this form, the Compensator is known as C-8P) it will furnish a 2.5-volt output to any other power amplifier.

Referring to the schematic, *Fig.* 3, it will be seen that there are five input channels. The first two have input impedances of 0.66 meg, and are designed to accommodate high-level inputs, working down to a minimum of 70-mv input for full output. The third channel is designed for low-level inputs, with a minimum of 10 mv for full output. The input impedance of this channel is 0.1 meg. These three channels provide flat amplification from 20 to 20,000 cps, and all panel controls except that for turnover are effective.

Channel 4 is designed for a high-level magnetic cartridge, and is terminated for use with the Pickering models. Changing resistors R_6 and R_7 will permit the use of G.E., Audak, or most other "low-level" cartridges, since normal output may be obtained from an input signal of 10 mv. Channel 5 is equipped with a variable load resistor to accommodate any of the low-level cartridges without any internal changes. The gain is sufficient that full output can be obtained with an input of

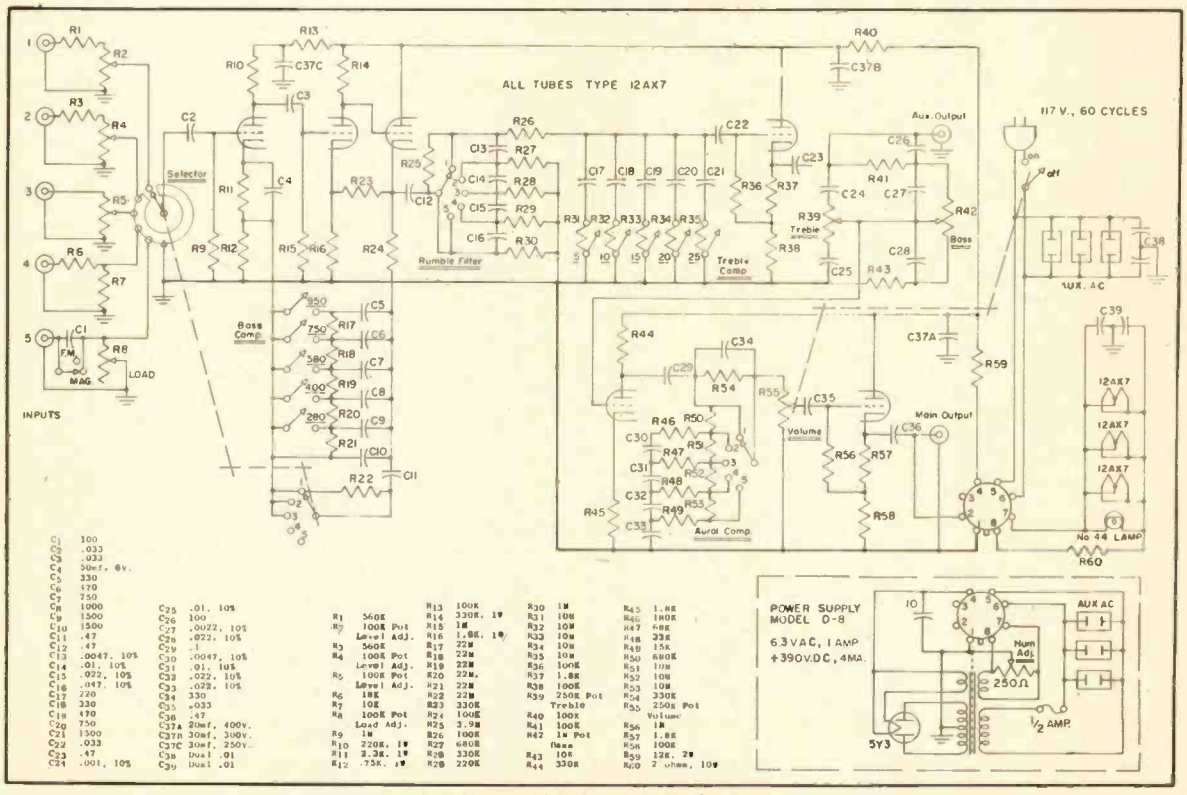

Fig. 3. Schematic of McIntosh Audio Compensator.

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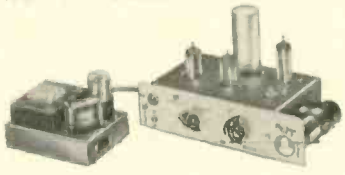

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Fig. 4. The McIntosh Mc-30 Power Amplifier.

10 mv, which is adequate for Audak and G.E., or for Leak, Fairchild, or Electro Sonic pickups when used with an input transformer. The input impedance may be varied from zero to 0.1 meg, and by operating a slide switch on the rear apron to "F.M.," and the load switch to "100"—representing 0.1 meg—the input will accommodate amplitude-responsive cartridges such as ceramic and crystal types and the Weathers FM pickup. All panel controls are effective with both channels 4 and 5.

The Bass Compensation switches work only with the last two channels, and provide a number of turnover frequencies in discrete steps when only one switch is operated, or for a somewhat wider range when two or more are used. Note that all stages of the compensator are used for all inputs, the signal being reduced in level to apply a maximum of 10 mv. to the grid of the first tube. The selector switch eliminates the frequency-selective components from the feedback around the first tube when set for channels 1, 2, or 3.

Treble compensation is accomplished by adding capacitors to the circuit by means of slide switches—one for each capacitor. Both compensation circuits employ the slide switches, and by this means almost any degree of correction may be obtained by simply operating two or more switches. The phonograph compensation curves are shown in *Fig.* 1, and while there are five discrete curves available for both bass and treble, the range obtainable is best shown by the shaded portion which indicates a very wide variety of curves.

The Auxiliary output is connected at the cathode of the stage prior to the tone and volume controls, and is therefore not affected by them, although compensation and rumble-filter controls are in the circuit, making it possible to dub from phonograph records to tape, for example, with the proper equalization.

The main output—also from a cathode follower—can be influenced by the aural or loudness compensator as well as the volume, bass, and treble controls. The curves for the rumble filter indicate that this would be useful in applications where bass response from a high-quality speaker system made the rumble objectionable. Tone-control and loudness-compensation curves are also shown in *Fig.* 1.

The Compensator is equipped with three a.c. outlets for phono motor, tape recorder, power amplifier, or any other devices intended to operate with the input unit.

Figure 4 shows the power amplifier, Model Mc-30. Performance curves for this model are not shown, since frequency response is (naturally) flat from 20 to well over 20,000 cps and no controls are provided, and IM distortion remained below 0.4 per cent to over 40 watts output (equivalent sine-wave output, which is the method used in all of these Equipment Reports). This value is well beyond the limits of our standard graph sheets.

By now, most audio fans are familiar with the McIntosh amplifier circuit. *Figure* 5 is the schematic of the Mc-30, with the output transformer which provides load for both plate and cathode. Since the transformer has a 1:1 ratio, the same signal voltage exists at both ends of each of the two windings—one being connected to the plates and the other to the cathodes. Note also that the screens are connected to the opposite plates. Thus the *signal* on the screen and cathode of either output tube is identical, which means that the screens are perfectly bypassed to the cathodes—a condition wherein pentodes and tetrodes operate best. At high powers, the signal on the cathodes is quite high, which necessitates the use of a tube which will withstand a high cathode-heater potential.

The stage line-up in the amplifier consists of a single-ended amplifier tube, followed by a "long-tailed pair" phase splitter, a push-pull amplifier stage, and a cathode follower stage which drives the output tubes.

Feedback from a tertiary winding on the output transformer returns to the cathode of the first stage, and the output is taken from a fourth winding, with 4, 8, and 16-ohm taps being available. A 600-ohm output is provided, being taken from taps on the cathode winding of the output transformer. This output is likely to be several volts above ground (d.c.) since it is taken from a winding in which current is flowing, but for most applications this would not be important.

Construction of these two units is neat and compact, with ready accessibility to all parts. While most high-quality equipment in the audio field seems to show a minimum of need for part replacement, there is always the possibility that such a need may arise, and it is well not to have to "unbuild" the amplifier any more than necessary if a resistor or capacitor has to be changed. Most small components are mounted on resistor boards; in the C-8 both sides of the resistor board may be reached by removing the top and bottom of the unit simultaneously, while in the Mc-30 the resistor board is mounted in a vertical position, and all components may be reached readily when the bottom cover is removed. Octal sockets are used to make interunit connections as well as for output circuits, so that a plug-in installation can be made readily. This offers advantages when the user has occasion to use an amplifier in more than one location—he can simply unplug it and plug it in again whenever he has need to move it.

The first McIntosh amplifiers—50-watt units—were noted for their performance and efficiency. The new 30-watt model seems to live up to that reputation, and it does give excellent listening quality. With the C-8 Audio Compensator, sufficient flexibility is available for any application likely to be encountered.

THE B-J PHONO ARM

Anyone who has ever read anything about the requirements for good phonograph reproduction, minimum distortion, low record and stylus wear, and reduced noise has noted that it is considered desirable for the axis of the pickup to be tangent to the record groove at all times. With conventional arms this is impossible, and it is likewise impossible with any simple arm whose pivot is not at an in-

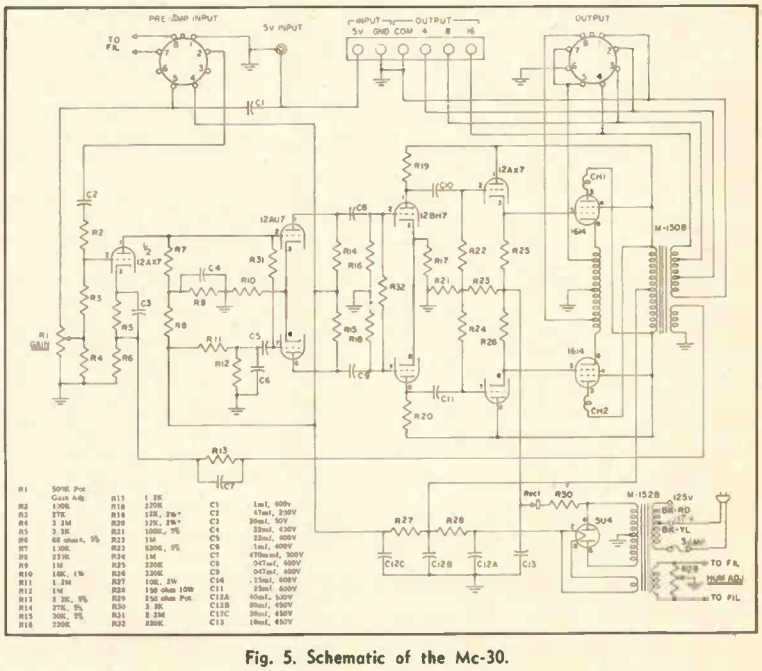

Fig. 5. Schematic of the Mc-30.

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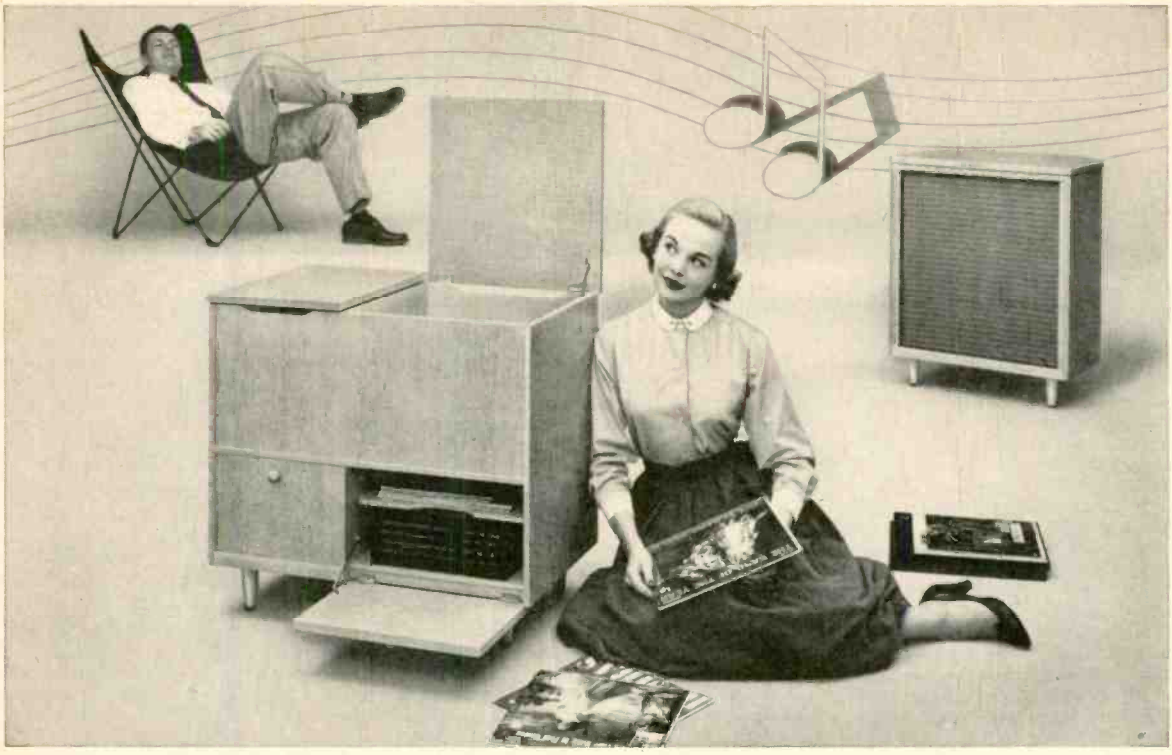

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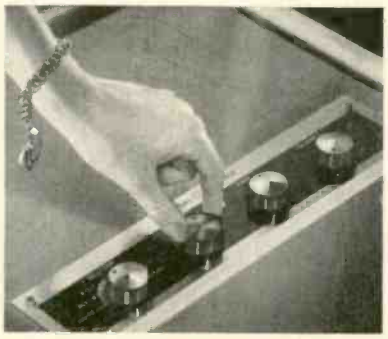

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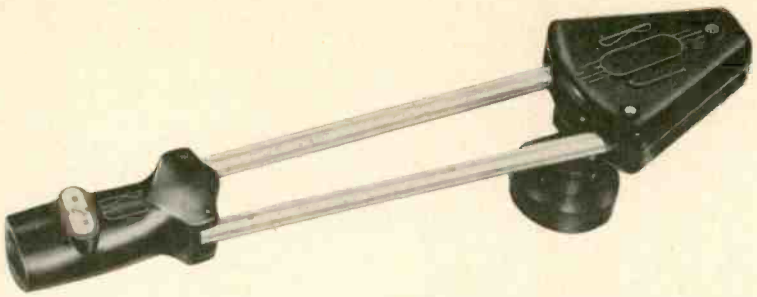

Fig. 6. The B-J Phono Arm, designed to maintain perfect tangency throughout the record area.

finite distance from the center of the record.

The B-J arm, a British design that was recently introduced into the U. S., is claimed to accomplish just this, however, and the means by which the feat is accomplished appears to be so simple that we undertook to prove to ourselves just how it was done. We made a full-size drawing of the basic elements of the arm (*Fig.* 7 is a reproduction of this drawing) and actually made a check at several points to see just how close it came to doing what was claimed for it.

In the figure, the two fixed pivots correspond to the two in the stationary assembly—that triangular section at the right in *Fig.* 6. This entire unit remains fixed to the motor board, and does not turn as the record is played. These pivots are needle-pointed screws seating in holes in the tubular arms, and are readily adjustable and equipped with locking nuts. They are clearly visible in *Fig.* 6.

The two arms—both of gold-anodized aluminum tubing—are represented in *Fig.* 7 by heavy lines. The long arm is bent slightly to clear the pivot of the short arm in the rest position, which is the position shown by the heavy lines. The two pivots on the head, also needle-pointed and readily adjustable, are shown as single circles, with the position of the stylus projected forward from the center of the line between the head pivots.

By laying out the loci of the two head pivots and scaling off the proper distances between them, one obtains the axes at various positions of the arm, and from these the stylus positions can be drawn. Outside grooves for both 10- and 12-inch records were drawn, as well as a circle with a radius of 2 in. which may be considered the absolute minimum. Two additional positions were drawn intermediate through the recorded portion of a typical record.

Tangency at the point of contact is equivalent to a 90-deg. angle between the center line through the pickup and the radius of the record passing through the stylus. This angle was measured carefully, using a drafting machine for the reference angles, with the results shown in the figure. Note that the angle is 88 deg. at the outside of the 12-in. record, and 89 deg. at the 2-in. radius, while for the remainder of the arm travel, the angle measured 90 deg. exactly. It is possible that a slight mismounting of the drawing with respect to the center of the record might cause a difference of one or two degrees, but as accurately as we could measure readily it appears that there is no greater than ±1 deg. variation from tangency throughout the entire playing time. Thus while we have to admit some skepticism at the possibility of maintaining tangency with a relatively short arm, we must also admit that the arm *does* do just that.

General Description

The B-J arm consists of a fixed base which supports the rear assembly—the triangular section at the right in *Fig.* 6. This unit is also moulded, and carries the fixed pivots. The two arms carry at their forward end the moulded plastic head assembly, which mounts any conventional cartridge. A thin section at the front may be cut out with a pocket knife to make room for the turnover knob on such cartridges as Pickering, E-V, Shure, Sonotone, and others which are operated from the front end of the head. A punchout plate in the top will permit the use of the G.E. Triple-Play cartridge. Stylus force is adjusted by adding or removing triangular-shaped weights from the bottom of the stationary assembly.

The needle bearings used throughout are sufficiently free that even with the four required for the lateral movement, there is no apparent resistance. Mounting is accomplished accurately by the use of a template which indicates the exact points for locating the mounting screws in relation to the record spindle.

Since the correct mounting location is important in maintaining tangency throughout the playing of the record, the cardboard template is obviously a necessity, but when the arm is properly mounted, there is no question but that nearly perfect tangency is maintained over the entire range that should be encountered with ordinary phonograph records.

Any opinion as to improvement in sound reproduction with the B-J arm would be subjective, but there is no gainsaying the obvious advantage of having the stylus always tangent to the groove with an arm which is short enough to be practical in a home system. Broadcast and studio equipment has normally relied on a long arm to approach a minimum tracking error, and many a music lover has insisted on using the long arm for this reason. But many users have been restricted heretofore to a short arm, due to space limitations, and they might well find that the B-J arm will provide the tangency that is considered most desirable.

GENERAL ELECTRIC A1-901 RECORD FILTER

While most preamplifiers provide many curves suitable for the present wide variety of record characteristics, many users have been limited to a single bass compensation curve such as that furnished by such preamplifiers as the G.E. UPX-003A which provides only a fixed boost at the low end, with the turnover usually set at around 500 cps. This is satisfactory for the average LP characteristic, and is nearly correct for the RIAA curve, but does not match any of the foreign curves, nor does it give completely correct equalization for 78-rpm records. Furthermore, as the user's system is improved, he may find that increased high- and low-frequency response may show up other defects, such as rumble or needle scratch, or even possibly some increased distortion from records which may not be entirely free from higher-frequency distortion products.

The A1-901 Record Filter, shown in

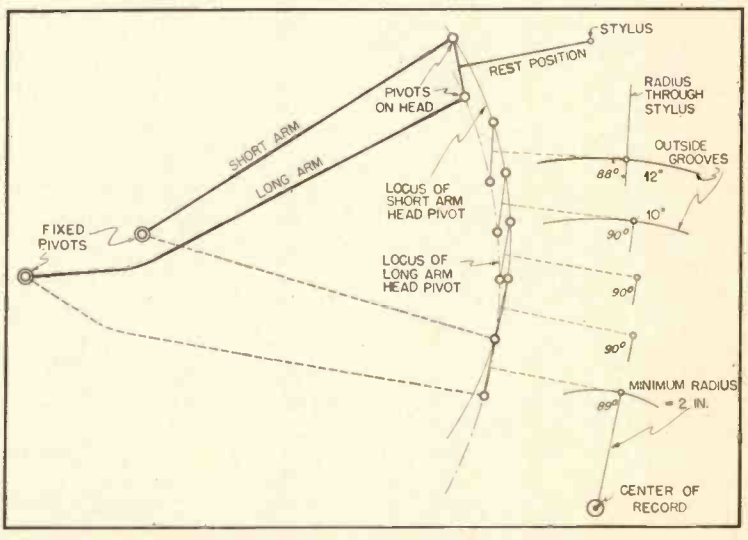

Fig. 7. That tangency is maintained over the full recorded area of a 12-inch record is shown by this diagram which represents the B-J arm in various playing positions.

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Fig. 8, is a convenient answer for this situation, when the cartridge used with the music system is of the familiar G.E. variable reluctance type. The record filter is constructed in a small moulded plastic case, so that it may be used separate from the normal installation or perhaps with an inexpensive record player; for those who might wish to mount the unit permanently in a cabinet, the chassis and front panel may be removed from the case and mounted in any other desired panel up to ¾ in. thick. The filter does not require any power supply, nor does it use any tubes—being what is called a "passive" equalizer.

However, when used with a preamplifier that already provides a fixed turnover of approximately 500 cps and a bass boost of 17 db at 50 cps—the usual equalization for a non-variable preamp—the filter provides six different characteristics as well

Fig. 8. The New General Electric Record Filter in its plastic cabinet.

as low- and high-pass filtering action. The center or COMPENSATOR control adjusts the response to flat, European 78, London LP, Old AES, RIAA, and Columbia LP characteristics. The panel is etched to show the characteristic in use, as well as the amount of rolloff at 10,000 cps—since this is the usual manner of indicating the high-frequency characteristic. Thus on FLAT there is no rolloff, or 0; for EUR 78 the response is down 6 db at 10,000 cps; for LON LP, it is down 10; for OLD AES, 12; for RIAA, 14; and for COL LP, 16. The turnover frequency is changed simultaneously, together with the bass rolloff required for COL LP and LON LP. The various curves are shown in *Fig.* 9.

The filter section is particularly interesting, since it provides flat transmission at both high and low ends, or three degrees of cutoff at each end. In the 80-cps position, practically any rumble and even some 60-cps hum is reduced appreciably, with the 40- and 60-cps positions providing somewhat less low-end cutoff. Similarly, the high-end cutoff reduces transmission above

(*Continued on page 66*)

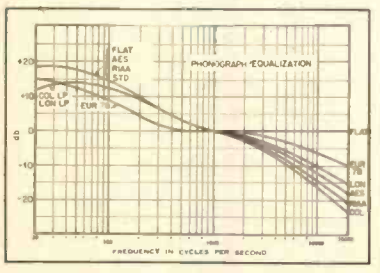

Fig. 9. Compensation curves for the G.E. filter.

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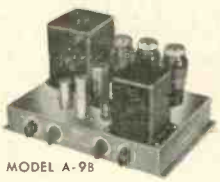
20 WATT AMPLIFIER



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1. RECORD PRICES—

Further Report.

HEREWITH A POSTSCRIPT to the comments in this space back in February, which of course were written still earlier, only a very short time after the big record price cut was announced. I'm glad to report, as perhaps symptomatic of a general adjustment, that the Dessoff Choir recording which was about to be dropped, as of that time, wasn't dropped at all, and the company in question, Concert Hall, has since recorded another LP's worth of Dessoff music. In other words, the first days of near-panic in the record field occasioned by the radical cut in prices initiated by RCA Victor gave way to more reasonable and shrewd thinking. Many outfits that had thrown up their hands in despair, hauled them back down again after a few weeks, to reconsider very carefully.

However, don't think that the panic signs were for nothing. The situation is basically as I have described it; the danger that we will lose a good part of the small-company material still exists. (The pruning, unfortunately, is not selective; the best material is as likely to go as the worst.)

Prestige

Most small business operators are, by dint of their very existence, pretty ingenious people. There are ways and ways to keep their small boats afloat. Prestige, always remember, counts heavily in any business and in small records the prestige often lies in catalogue items that may not actually show a direct profit at all. Withdraw your prestige items and you may lose more than ever. The big price cut has of course forced a complete reconsideration in just about every catalogue of LP records, from the biggest to the smallest. But that long, close look has involved a lot more than the simple numerical sales figures for each item, and for that we can be glad.

Certain very important balancing factors enter the picture. It is highly worthwhile, for instance, to play off the profits from your fast-selling, low-brow items against the sales prestige of slow-selling, higher-class items. A company that is reasonably liquid can well afford to keep a good many slow sellers in the shops, if there is a cushion to be found in another part of the line. This is a saving grace of major proportions, and, may I suggest, it poses rather a tricky question when we come to judge records.

Most serious record collectors, I very well know, tend to be horrified when an otherwise serious-minded record label suddenly blossoms forth with a line of Parisian night club stuff or music to dance by or, maybe, hi-fi sensationalism. Perhaps the stuff, in a sense, is really unworthy of the said label.

But before we jump out in condemnation, we should pause to wonder whether these same low-brow sensations aren't perhaps footing the bill for the continued production of the essential high-quality material? A record reviewer is in a particularly parlous situation here, for his duty is to review records for themselves, regardless of such hidden considerations. (Hence this discussion here, instead of in my "Record Revue" . . . .). But he's aware of all this, just the same.

It would take a full-scale professional accounting, I suppose, to pin down the factors in a given record company's current policy in this respect—prestige and quality, *vs.* popular profit-makers. I'm not even sure which items *are* the money-makers and which contribute more to prestige. The fancy hi-fi demonstration albums of Capitol, Westminster, RCA, for example: are they profit-makers, or do they contribute to prestige in the technical area? I'd guess both.

There's a further aspect of this spreading-out of available profits. Side enterprises. Some companies have side enterprises within the record field itself. Concert Hall, for example, has the Musical Masterpiece Society, selling low-priced top-notch records via mail-order, which if the impressive company offices are any indication—they're filled with row after row of busy IBM machines—must be a whopping success. I don't know the set-up, but I'm reasonably sure that the stability of Musical Masterpiece sales is a cushion which allows Concert Hall to keep up its regular and more specialized line. This may have saved my own record.

Another possibility is the cushion of a side-line outside of record selling. If I am right, Concert Hall was set up originally from chemical wealth, and the operators of that record company are, I assume, still involved. No doubt there are cost-saving cross-relations between the two enterprises. Peter Bartok's excellent recordings, mainly of Bela Bartok's music, are perhaps cushioned by his own extensive recording and master-cutting operations for others. No doubt other outside aids to the prestige of good records exist in many parts of the

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industry. Though we can't get much information about them, we should be aware of this sort of business tie-up and thankful that businessmen are ready to sink profits in one area into possible losses in another—even if, in the long run, the whole thing turns out to be a species of tax adjustment! That, too, is perfectly legitimate under the rules. As legitimate, say, as the vast bequests to universities now being made by some of the large industrial enterprises.

Made in Europe

One not-so-happy outcome of the record price cut is crystal clear. More European low-cost recording, less high-cost U. S. recording. Less work, from the smaller outfits, for the American musician; or alternatively, a cut in his royalties. The use of European musicians has always had its unhappy side, however great the musical benefits, in this necessary bypassing of our own active musicians. Part of it is related to union policy, which sets more or less uniform high rates that are basically keyed to big-time popular and radio-TV music. This is very possibly a necessity under the present conditions, but it does make limited-budget recording very difficult in the States. The rest is due simply to the difference in the larger living standards and to the exchange differences between this country and the European countries. One can "buy" music over there for preposterously low sums even now, though the rates have gone up somewhat. The same money could not support any musician over here, and that is that.

Anyhow—the very cautious trend by smaller companies toward U. S. recordings in the last few years is bound now to be stopped in its tracks. One small-company official told me he figured he would lose 9 cents on every record he recorded and sold in this country, under the new price scale. That is perhaps an arbitrary figure, but a cut of such huge proportions in the final list price as this recent one—it's far from one-half, 50 per cent, in some cases—is bound to cause havoc in any carefully calculated business where, as the old saying goes, profits (if any) are in pennies.

The Record Maker Takes The Rap

One final item that we all should keep in mind. The new price cut devolves largely on the record maker. The distributors and the dealers have taken a little of it—but they still get their pre-price-cut slices of the purchaser's payment. Dealers still are allowed that whopping 40 per cent (they can take less, if they want to sell "discount," as before) and the distributors to the dealers still take their accustomed 15 per cent ahead of that, leaving the manufacturer the same 45 per cent of the final price that he got before. But *his* costs are very nearly the same. A slight reduction in pressing prices, not nearly in proportion. A lower payment to artists, making them take a per-record cut too. Other costs, albums, art work, record annotations, are not significantly different and of course overhead expenses like office and plant rent, tape recording equipment, hall rental, are as always. No reduction at all.

(*Continued on page 68*)

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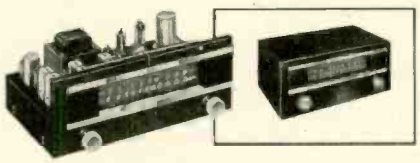

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RCA Victor LM 1888

This is a "controversial" recording in a big, wide and handsome way, and maybe the most significant release of the year for the future of music. A lot of jazz people will groan and many a Chicago Symphony adherent will moan—but the stuff went over stupendously when Fritz Reiner conducted it in ye Windy City and it ought to do well with many a record addict.

What is it? Perhaps it's not the world's greatest masterpiece, nor the best jazz either. Its composer is practically anonymous for all the attention RCA lavishes on him. He rates (from the jazz side of things) as an arranger. Arrangers don't wear halos or have laurel leaves draped around their heads, like the starving composers of the Classical.

This is merely a record in which two worlds meet without compromise for just about the first time, in which two ways of music-making, music-thinking, music-producing, are joined in a single piece of music and a single production. Two vast Systems. And the purport of this record is simply that, sooner or later, there will be but One System. Music.

This record also says, in a sort of definitive way, that the vitality for the musical art of the future is likely to come from what we've been calling Popular music all this time—from the system that includes such diversities as Dixieland and Modern Jazz, Mambo and hotel lounge music. But a lot of the structure is going to be inherited from the erstwhile Classics and the present Moderns, who hold between them a tradition that has been growing for a thousand-odd years.

This is a wow of a hi-fi record for any old listener. It's also a piece of 12-tone atonalism scarcely removed from Schoenberg, from beginning to end. It has popular dance items in it, including blues, mambo, boogie, and the dopiest dancer will spot them quick as a wink, even in 12-tone technique. It is as dissonant as the most violent evocation of the modernists in classical music, but 99 per cent of our non-classical hepcats (or their equivalents in a younger generation) will find nothing to object to—won't even notice it as dissonance. Because so much "popular" music today sounds just like this anyhow.

And here, of course, is the point. We tend blithely to ignore the momentous artistic fact that for many a year popular music and classical music, so-called, have been heading closer and closer, over-lapping more and more often, and right now they are positively rushing towards each other.

When Aaron Copland put some very mild "jazz" into his early music in 1925 the mixture was self-consciously feeble, but also very shocking. Benny Goodman's Mozart, just before the war, was also sensational in its way, as was his famous jazz concert in Carnegie Hall, and its successors. But now all that is gone. Popular music gets increasingly "classical", while hanging onto its essential popular audience (outside of the concert halls) and to its utterly different System, whereby every performer is a composer as well, whereby most of the musical work of the written-down sort is in the so-called "arranging", where indeed the concept of the composer, as we know him in classical music, does not really exist at all.

Enough said. Listen to this as a hi-fi record if you will. But listen to it as jazz, as classical-modern, as 12-tone music, as dance-derived music; try it on your ear as a classical composed Concerto, and as an "arranged" piece for jazz band—and hear how all these things are included in one, unified, over-all style, with astonishing effortlessness.

KEY

- * Outstanding recording for the type of music.
- b Heavy bass end. (Low turnover?)
- c Close-to, sharp-edged, in good liveness.
- cc Close-to, in deadish acoustics.
- d Distant, over-all miking, good liveness.
- dd Distant miking, somewhat narrow sound, lacks presence.
- e Highs sharply boosted (NARTB or more); add roll-off.
- ee Highs less boosted than U. S. normal (RIAA). Use less roll-off.
- h Good try for hi-fi.
- l Big, golden liveness.
- p Good piano sound.
- pp Piano tone rather percussive.
- r Recorded level rather high.
- s Solo(s) close-to and loud.
- ss Close-up solo, accompaniment in background.
- sss Hiss and crackle—under-par surfaces.
- ⚙ Tape record.
- v good voice reproduction.
- V Voice may buzz or blast in loud parts.
- x Some distortion—ringing or graininess, harshness.
- xx Poor resolution. Lacks clarity.
- y Solo voices oddly dead acoustically.

And imagine the scene, too, in Chicago. The Chicago Symphony, in black ties and coats—the classical tradition. The Sauter-Finegan "band," in fancy uniform—the pops-jazz tradition. All on the same stage. And chunky Fritz Reiner (uniform or tails?) who was said to have swung and swayed on his podium like a shortened Paul Whiteman! Finally, picture the audience, combining the Symphony's regular classical adherents and the S-F Orchestra's equally regular enthusiasts. We can wonder just what did happen; for even the listening-manners of classical and popular audiences are radically unlike. Was there silence in the aisles during the hottest passages? Or did people dance in them?

And the "composer?" Was he applauded afterwards in the classical manner—or did he not exist, as in the popular? Wish I'd been there.

*⚙r **Inside Sauter-Finegan.** The Sauter-Finegan Orchestra.
⚙ **RCA Victor TP 4**

In the Schwann LP catalogue this is listed, of course, under "POPULAR, JAZZ, SWING" along with two LP mates, though one of those is called "New Directions in Music." It'll have to be admitted that S-F is not exactly a "pure" popular band. It has classical-trained musicians in it and the intention, frankly, is to experiment, to exploit the assembled talent in every way that works out. But the vital thing is that the band is technically pops. It exists under the pops system, plays, makes money. It doesn't even rate an RCA Red Seal.

And so the stuff on this tape is very interesting in the light of the Concerto reviewed above. Some of this is "straight" popular, juke box, or what have you. But every piece has something in it that goes beyond the strict and sure popular conventions. Bits of this and that creep in, from anywhere and everywhere. One crooned songstress item smacks of ye Sumac, definitely. Another one smacks just as positively of Hindemith—I'll bet a nickel I could pass it off as a piece for Winds by Hindemith in any classical concert. A piece for marimba sounds purely "pops"—except that the harmonies are far more complex than usual and virtually every chord is a dissonance, a major seventh, etc. And so it goes. All within the official pops framework. No composers listed, of course. Not even the arranger(s). The printed comments merely talk about "making use of the talent" of the band.

The LP version, on disc, is LJM 1003. The tape is superb, though levels, as in other pops-orientated RCA tapes I've tried, seem rather high and there was an occasional slight overload somewhere in my system.

2. THE VOICE

V **Moussorgsky: Songs & Dances of Death; Duparc: L'Invitation au Voyage.** George London, baritone, Paul Ulanowsky, pf.
Columbia ML 4906

Schumann: Liederkreis. Brahms: Vier Ernste Gesaenge. Wm. Warfield, baritone, O. Herz, pf.
Columbia ML 4860

Song cycles by the two biggest baritone sensations of last year, and I'll have to be luke-warm on both. Warfield's big American voice is not yet matched by a natural feeling for this German music—nor should; his style is good, but forced, learned expertly from a good vocal coach. That's not enough to make a convincing lied singer.

George London's perfectly enormous voice is superb for the dramatic Russian songs—he does a famous "Boris," same composer. But he's a bull-in-a-china-shop in the pastel French music, in spite of good taste. Biggest difficulty here is in the voice reproduction; at such close range, the overtones and transients are so overwhelmingly potent that few home systems will "take" this recording even the first time through. A bad needle will be disastrous.

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xxxcc **Songs of Rachmaninoff. Songs of Moussorgsky.** (Assorted Russian singers, pianists.)

Vanguard VRS 6023

The first two Moussorgsky songs are from the Songs and Dances of Death—see above—here sung by leading Russian artists in the home-country tradition, and it's a marvelous one, too. These recordings are Russian, featuring five artists among whom the two baritones, Boris Gmirya and Alexander Pirogov, have huge, wonderfully expressive voices of the sort found nowhere but in Russia. Each sings one of the above songs; Gmirya also sings two of the Rachmaninoffs. Though the other singers are evidently celebrated, I found them so-so.

Technically the Moussorgsky recordings are fairly good, the bulk of the Rachmaninoff songs are minus all highs and somewhat distorted. Quite listenable—a more serious fault is the uneven flutter that shows up occasionally in the piano parts.

sss☆ **Songs of Brahms.** (Four Serious Songs; Two Songs with Viola; In Stiller Nacht; Sandmaennchen.) Nell Rankin, contralto. Coenraad V. Bos, pf., C. Cooley, vla.

Cap. P. 8289

The "Four Serious Songs" are the same as Warfield's "Vier Ernste" above, here sung by a contralto and so easier to understand. She's an American too, but extra-well coached—by Mr. Bos, who played the first performance in 1896 with Brahms himself present! Rankin makes these, Brahms' last songs, far more accessible than is usually the case. She has a gorgeous, Traubel-like voice which records beautifully, her musicianship is excellent, her pitch ultra-true, her only fault here a lack of clear diction. A fine record.

ss **Song Recital.** (Schubert, Brahms, Wolf, Faure, etc.) Mattiwilda Dobbs, sopr. Gerald Moore, pf.

Angel 35094

Here's another recent voice sensation. She is a wonderfully high, lilting soprano, so high you can't believe it, her pitch is superbly accurate and her diction is more natural in the foreign languages than either Warfield or Rankin, above. Some of the singing is a bit on the cute side, but most is wonderfully lyric, expressive, unaffectedly direct. Gerald Moore's piano is arrestingly good, if a bit in the background. Another fine record.

☆spV **Debussy: Fêtes Galantes (1st Series); Trois Ballades de Villon.** Suzanne Danco, sop. G. Agosti, pf.

London LD 9146 (10")

☆sp **Debussy: Proses Lyriques; Chansons de Bilitis; Ballades de Villon.** Flore Wend, sopr. O. Gartenlaub, pf.

Haydn Soc. HSL 106

Two sopranos tackle the pure French style of singing, in early and late Debussy—they overlap in the late "Villon" songs. Danco is big, operatic, though she sings strictly in the colorful French way; she may blast for you in the loud parts. Wend has a smaller voice with a slightly "popular" sound to it—in French terms, of course. Nice, and the good diction plus close-to recording brings out every word. Both are unusually fine recordings—the pianos are excellent too.

p **Dvorak: Biblische Lieder; Zigeunerweisen; Liebeslieder.** Hildegarde Roessel-Majdan, sopr., F. Holetschek, pf.

Westm. WL 5324

A formidable set of German titles but the music is simplicity itself. Biblical Songs, Gypsy Songs, Love Songs, three complete sets, most of which are unfamiliar, but should not be. ("Songs My Mother Taught Me," one of the Gypsy Songs, is the only one in the collection that is well known.)

These are the merriest, sweetest, most lyrically rosy-cheeked songs you can imagine, not of any great content but written with the wonderfully direct tunefulness that made the "New World" Symphony so widely popular, long ago. Don't be put off by unfamiliarity. The reasons for that are mostly due to stick-in-the-muddedness on the part of singers, who never look beyond the ends of their noses for likely interesting material, outside of the standard publishers' repertory. The

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soprano here is most communicative, if you don't mind a throaty voice with a fair amount of wobble, and the pianist is excellent. So is the recording.

[ssV] **Irmgard Seefried.** (Wolf and Brahms Songs). Erik Werba, pf.

Decca DL 9743

Compare this lady with the American high soprano, Mattiwilda Dobbs, above—here is a soprano from "inside" the German song tradition. She, too, has a high, light voice of extraordinary expressiveness and wonderfully true pitch. She sings with an understanding of the music that gets over the difficult harmonies and melodies of the Wolf songs to the ear with utter ease—where many singers flounder in the sudden changes of key, unable to keep afloat. Sung with musical understanding, plus real drama, these songs are pleasurable for anyone (as are the simpler Brahms songs) and so this is a highly recommended disc for all who are curious about the lied, the German song—and for those who are already experts in either singing or listening to this kind of music.

3. HIGH ROMANTIC

[cd] **Dvorak: Legends, Op. 59.** Little Orchestra, Scherman.

Col. ML 4920

These tiny little "symphonies" for full-sized orchestra—there are ten of them on two LP sides—were written as piano pieces and, like the numerous Hungarian Dances, etc., of the period, were later orchestrated by the composer. The music is as sweet as butter—each piece is complete, not like a single symphonic movement, somehow giving a sense of larger span, even in a few brief moments. There isn't anything quite like these elsewhere in music. Imagine a Brahms Symphony in its most lyric moments, lighten it up, make it more melodic, more artless, and you have this music. Big, distant recording, highly appropriate.

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[c] **Sibelius: Swan of Tuonela; Lemminkainen's Return.** Danish State Radio Symphony, Jensen.

London LD 9125 (10")

A lovely, mild, unpretentious reading of these two short works. L's return might be somewhat more energetic, but the modest accuracy of this Danish playing is enough in itself. Characteristic ffrr sound, clean and close-up in a large liveness. Superb surfaces, that add by their very silence to the musical atmosphere.

[lx] **Tchaikowsky: Nutcracker Ballet (complete).** Radio Berlin Symphony, Dobrindt.

Urania URLP 237 (2)

Evidently from a radio broadcast, this shows some uneven ensemble in the strings and some not-so-good editing. (Could be to remove sudden applause?) but generally speaking, the playing is very musical and on the lyric side. Brass is particularly good. The complete score is, of course, much longer than the long-familiar pair of Suites and was mostly unfamiliar until two recent ballet revivals and Mercury's earlier recording brought it into popular repertoire.

The Mercury version of the complete score is much more spectacular as a hi-fi item—for better or worse depending on your interest. Musically the Mercury (under Dorati) is a taut, rather hard and angular version where this one is soft and lyric, recorded in a big, warm liveness. Some persistent distortion in the string tone on wide-range equipment. Very slight for most ears.

[xl] **Strauss: Death and Transfiguration; Till Eulenspiegel; Don Juan.** Bamberg Symphony, Horenstein.

Vox PL 9060

Excellent performances. Hofenstein was born in Russia, trained in Vienna in the twenties; he is a true late-Romantic conductor, ultra-high-tension but still very Romantic in expression, without a trace of the heavy-footedness sometimes found in Germanic leadership. Very good for Mr. Strauss's early works, and these playings are highly dynamic yet beautifully lyric in the appropriate spots.

Vox's hi-fi is too brilliant for me in the louder parts, though it is lovely in the soft passages. A gorgeous over-all liveness.

[dd] **Shostakovitch: Symphony #5.** St. Louis Symphony, Golschmann.

Capitol P 8268

Golschmann has conducted this orchestra for almost a quarter century and the beautifully balanced ensemble shows it. In some composers his playing is not exactly ideal—but in the more Romantic moderns, especially Russian, he is clearly in his element. No reason why this Shostakovitch shouldn't rate as high Romantic in this sort of interpretation! A bit like the Horenstein, taut, modern in its intensity, but smoothly lyric at the same time—no harsh blats and bumps. Good.

The distant miking is rather narrow in sound, a bit lacking in roundness of perspective. My copy has a lot of pops and ticks.

[sss] **Strauss: Symphony for Wind Instruments** (1944/5) London Baroque Ensemble, Haas.

Decca DL 9761

The very late Strauss music, written in what outwardly seems a very "old-fashioned" style, becomes more and more fascinating as we get to know it extensively on records. This long piece was composed some sixty years after "Don Juan" above! In place of the heroic brilliance of the early work, this shows the typically unpretentious, wise genius of an old man who has settled his own accounts and lives in complete tranquillity—to display the unique and wonderful skill that sixty years of constant creation has left with him. Such superb wind writing you will never hear again, such easy fluency, such a wonderfully casual gift for melody, for lush, enormously complex and utterly simple flowing expression! Forget—forget entirely—that technically the language sounds a bit like 1850 or earlier. Of no importance whatsoever! (Nobody at that time could have written this anyhow, and in that way it is definitely modern.)

So acquire this one quickly, if you have any love at all for wind music, if you want to hear musical craftsmanship in the ultimate sense. Play-

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ing craftsmanship, too, for the performance matches the music superbly. It's a long piece. Take one movement at a time.

It would be nice if Decca could get rid of the sandpaper element in many of its otherwise fine classical records. In places they hiss like a wartime 78. Where there's a will there's a way. . . .

e **Sibelius: Symphony #2.** Members of the NBC Symphony, Stokowski.
RCA Victor LM 1854

A curious description, this! "Members of" is a term ordinarily used for a half-dozen or a round-dozen players in a smaller-than-symphonic work. The Sibelius score presumably called for every man-jack in NBC who was ayailable. A sort of members' party? Who knows.

Anyhow, it sounds like a good, fat, full orchestra here, and it sounds very nice, too. This moody, misty, craggy Sibelius is the kind of music that becomes harder to play each year, as the old boys of Stokowski's generation slowly retire from circulation and the young things take over. You can't play Sibelius with a jazz beat or a dead-pan face. Listening to this, you'll be reminded that for all his show, for all his exuberantly lush desecration of older music in the name of arrangements, for all his flamboyant activity, "Stoky" has been and still is a master conductor, one of the most accomplished in the first half of this century. There's nothing showy, nothing stunty, nothing sloppy about this—just a top ranking professional cooperation between expert players and an efficient and knowing leader.

The "members' party" was held in a very fine hall with superb acoustics, and/or RCA's "enhanced sound" treatment is better than ever; this is an impressive hi-fi recording though some of us would prefer a bit of safe distance between onrselves and the nearest instruments. Close-up recording in a big liveness, probably multi-mike.

(P.S. What happened to Stoky's erstwhile performing group of the last few years, succinctly described on record labels as "& His Orchestra?" Could it perhaps have been "members of" the NBC?)

4. OLD STUFF

ee **The Golden Age of Brass.** The Brass Ensemble (Boston).
Unicorn UN 1003

Here is an authentic "members of" group: these are brass players from the Boston Symphony, though the name is naturally not used. They're on their own. Two of the dozen pieces on the disc are recorded in Symphony Hall (with big echo); others are in a close-up dead studio acoustic.

The Golden Age extended through the 17th century and there are three groups here—Italian, English, and German. The Italian is the earliest and the most spendid—double brass choirs, gorgeously decorative. The English music is chatty and ceremonial by turns, with bits of very British jiggy tunes that you can't miss once you've noticed them. The group includes some excellent Purcell, hitherto unknown.

The Germans were the big brass people, after the Italians, right up into the 18th century. The second side here is all German and the variety of spirit and expression attests to the great popularity and wide use of brass music.

This group plays as would be expected—technically with top ensemble and accuracy as befits a symphony group, but also with a typically limited conception of style. The music is simply brass music—not music of this and that composer, in this and that period; the tone, the phrasing, the slight vibrato, are those of an expert symphony orchestra group whose experience clearly lies outside of this music—that is, they do not know intimately other types of music from the same times and composers and so are honestly unable to play beyond their legitimate brass limitations.

This is common enough among all sorts of top professional musicians. Only a rare few achieve a wide enough education and experience to rise truly above their own immediate professional field. Listeners on the outside—who take it easy, not having to spend a lifetime learning technique—can hear these discrepancies quickly enough. Thus the Purcell work here simply doesn't have a "Purcell" touch to it—in terms of many other sorts of Purcell, from anthems to harpsichord works, string fantasias, etc. etc. The earlier Gabrielis are played choppily, non-legato, in what to my ear is a somewhat anachronistic style.

Relatively minor criticism, in view of the expert playing and the sincere dedication of the group.

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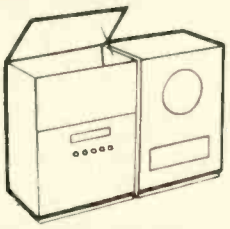

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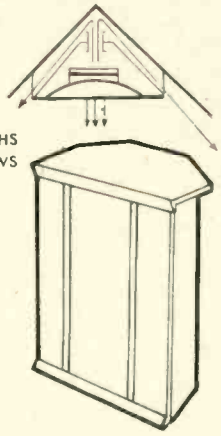

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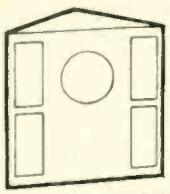

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d **Frescobaldi—Organ Music.** Guiseppe de Dona.

Vox PL 8780

Not exactly a hi-fi disc for organ sound men, this is a source of some lovely music played on a rather juicy "old-fashioned" organ, not at all in the now-popular German classic or Baroque manner. Frescobaldi was a superbly alive old boy, flourishing in the early 1600's, one of the first real virtuoso organists, who played (it says here) to 30,000 people once in Rome, and was enormously popular in his day, exerted a vast influence on later organ writing.

Frescobaldi is a big composer. Writing in that peculiar period when modern instrumental music and modern harmony first developed, he had a wonderful sense of melody and a grand feeling for the strange, wandering harmonies, especially the half-step (chromatic) ones, that had not yet settled comfortably down into the later major-minor system of keys. Finally, his music (like his name) was highly decorative, often very serious but just as often humorous, whimsical, dance-like, with a strong feeling for popular tunes.

All of this appears on the record. The first side has four big, massive Toccatas, masculine, for full organ; the second side has the softer, lighter, more whimsical music, written primarily for harpsichord but equally playable on his own instrument, the organ.

Very musical playing by Signor Dona.

Giovanni and Andrea Gabrieli—Organ Music. Giuseppe de Dona.

Vox PL 8470

Two famous Venetian relatives, of a slightly earlier period than Frescobaldi, a generation or so. Their music is more of a square sort, more impersonal and also very decorative. The harmonies are less important—the great brilliance of the passage work, the echo effects, loud and soft, the clearly treated motives, short ideas, being the main interest. Wonderful music for long acquaintance, though not as easy first-off as the Frescobaldi. The organ is evidently not the same; the reverberation is considerably less in this record than in the Frescobaldi preceding.

Paul Hindemith, Vol. 1. Collegium Musicum, Yale University. (Monteverdi, Weelkes, Gesualdo, Bach.)

Overtone LR 4

Publicity! Hindemith is the conductor of the unaccompanied chorus that sings this music and so he gets top billing, the composers coming last.

Three of the four composers are of the same times as the above music, given a few decades. Choral music was still the most expressive and well-advanced medium, as you'll quickly hear if you listen to the powerful expression of Monteverdi (a set of tragic madrigals about a lover at the tomb of his beloved) and the slightly crazy genius, Gesualdo, who wrote experimentally with almost Wagnerian harmonies. Weelkes represents the more reserved English version of the same kind of intense expression.

If you enjoy amateur singing at its very best, this is for you. If you have had doubts about chorus music because of too much fuzzy, wobbly confusion, then try these accurate, expressive amateurs, hear every note, every harmony on pitch and unconfused.

Always remember that, today, few professional singers can sing ensemble music with other singers, outside of opera (where competing soloists are intended); they don't know how to blend, can't sing in pure intonation, seldom produce convincing harmonies, usually wobble so much that pitch is obscured. Amateurs, in these respects, are 'way out in front. They sing on pitch—or not at all. They don't wobble, they do blend, they often are more intelligent, more expressive than the over-trained professional soloists.

—Especially when led by an outstanding musician like Hindemith, a composer who has a remarkably wide knowledge of all Western music and is an indefatigable enthusiast at bringing it to life—from the oldest to the newest. See also Volume Two of this same series.

5. LOOKING 'EM OVER—CLASSICS

*he **Liszt: Prometheus; Mephisto Waltz #1.** Paris Cons. Orch. Munchinger.

Lon. LD 9153 (10")

A seldom-heard, pompous and noisy but genuinely musical tone-poem, in the vein of familiar "Les Preludes," very well played; an orchestral "waltz macabre," more familiar, to accompany it. Excellent sound, old-fashioned hi-fi, and a good conservative demonstration record.

Schumann: Symphony #3 ("Rhenish"). Amsterdam Concertgebouw, Carlo Zecchi.

Epic LC 3092

Phew! A very odd "axis" here, what with the Dutch orchestra under an Italian, playing German music; the interpretation is strong but very odd, too, heavy-footed, exaggerated in the beginning, with Italian lightness in the finale, full of Italian-style explosive emotion but lacking altogether that lyric, personal quality that is the essence of Schumann. Fine sound—Epic's problems are now solved.

*r **Debussy: Pelleas and Melisande.** Soloists, Lamoureux Orch., Fournet.

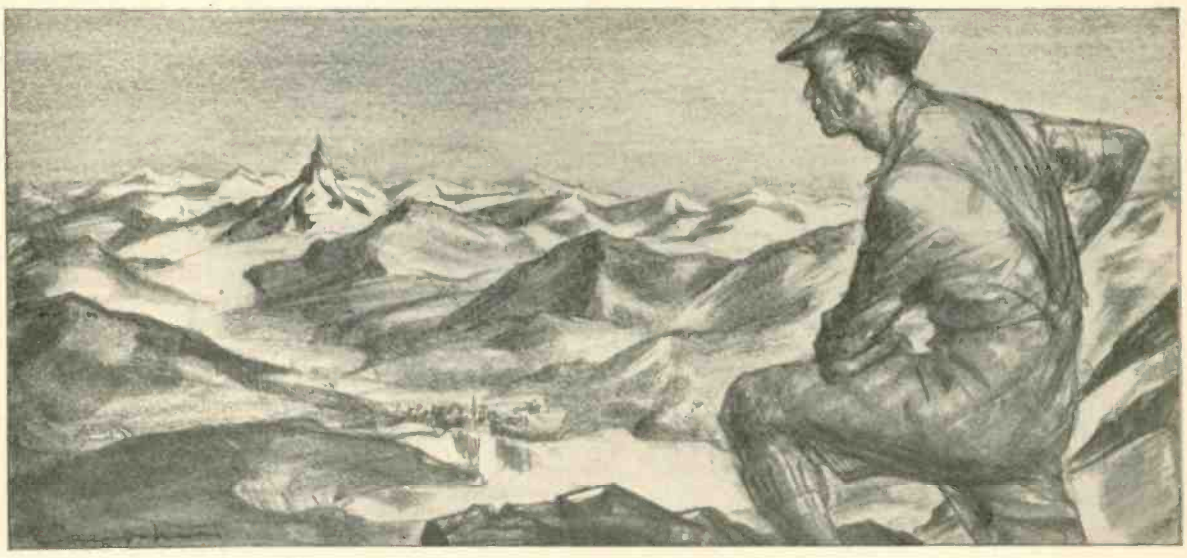
Epic SC 6003 (3)

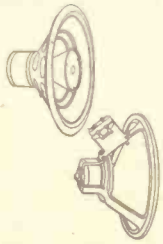
A valuable new version of this long and unique French opera, so remarkably conversational yet so mystic, impressionistic at the same time. The men are, for once, superb here, notably Pelleas (Camille Maurane) and Golaud (Michel Roux), the women good. All-French, as is vitally necessary, the voices recorded very close but with superb naturalism, every word easily audible. Fine French lesson, incidentally. Big lack—no libretto; a most unwise economy.

*s **Handel: Messiah.** Soloists, Huddersfield Choral Society, Liverpool Philharmonic, Sir M. Sargent.

Angel 3510C (3)

This is essentially the same performance as the older Columbia recording (same British source) but with radically improved modern sound. The





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old-fashioned large-scale "Messiah," in the British tradition, far removed from the newer "authentic" performances but extremely musical just the same and of top-notch effect. The best "Messiah" I know of in any tradition.

x **Mozart: Masonic Music.** Soloists, Vienna Symph., Ch. Choir, Baumgartner.

Epic LC 3062

Mozart was an ardent Mason and in addition to writing his opera "Magic Flute" about Masonry he did numerous occasion-pieces for his friends in the movement, here collected together. Orchestra, male solos and male chorus, and though outwardly these were intended for such matters as the dedication of a new building, the funeral of a member, this includes some of the finest and most moving Mozart there is—much in the spirit of Beethoven's "brotherhood of man" in the 9th Symphony and elsewhere.

A superbly felt set of performances, too. One piece is all-orchestral, the Maurische Trauermusik, K. 477, one of Mozart's greatest slow movements. A top disc for any Mozart lover. Some ringing distortion in the sound (this is an Epic from some months back), won't bother the musical ear.

cepp **Mozart: Fantasia in C mi. K. 475; Sonatas in C mi., A, K. 457, 331.** P. Badura-Skoda, pf.

Westm. WL 5317

Badura-Skoda is about the best Mozart pianist alive. But the strange and difficult (interpretation, not fingers) Fantasia strikes me as not too successful here; the sonatas are better. Piano recording is so-so. Percussive. Not B-S's best record to date.

y **Gluck: Orpheus and Eurydice, Act II.** Soloists, NBC Symph., Shaw Chorale, Toscanini.

RCA Victor LM 1850

"His mastery of the Gluck style is overwhelming," say the record notes of Toscanini. Yes—if you remember that this opera was first written in Italian (for Viennese audiences), then re-done into French, in which version it is far better known. This is, of course, sheer Italian in style (in Italian) and an interesting contrast to French versions of the music. Amazing how the same music can sound so different.

From a broadcast, the sound is somewhat dead and strident, the solos sing in padded closets into private mikes—or so it seems. Odd effect. (Common enough in radio announcing.) The orchestral ballet music is best. Nan Merriman is the contralto Orpheus.

obe **Haydn: Trumpet Concerto in E flat;** **Harpsichord Concerto in D.** G. Eskdale, tp., Erna Heiller, hps.; Vienna State Opera Orch., Litschauer.

Vanguard VRS 454

The two best-known Haydn Concertos, aside from the Cello Concerto, in warm, beautifully recorded performances. The trumpet work was for the first chromatic trumpet that could play all the notes, not just the overtone series. Justly famous for its easy tunefulness over a fine structure. It's odd that Haydn's harpsichord music, though evidently not intended for the then undeveloped piano, is nevertheless really pianistic in style, makes the harpsichord sound tinny and tiny—where Bach's and Handel's harpsichord writing is big, impressive, only a generation earlier. A rapid shift in composing technique that seemed to get ahead of the actual development of the instruments themselves, briefly.

age **St. Paul's Cathedral Choir.** (Assorted works, from the repertory).

Angel 3516B (2)

A wonderful visit "inside" a famous British working choir, with a big cross-section of the typical Church of England choral repertory and the English singing style. Lovely older music, seasonal carols, a brace of modern British anthems, very British and most impressive but a wee bit empty under the surface, a batch of madrigals sung by too many voices but nicely—and, the unexpected and stunning item, a superb long excerpt from Haydn's great "Nelson" Mass, most movingly sung.

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The First Christmas in Carols. Societas Musica Choir (Copenhagen), Hansen.
Haydn Soc. HSL 150

Never too late for this sort of Xmas singing. Danish choirs, we're beginning to find, are extremely good. Funny thing about this is that the music is strictly in the English-American tradition—no doubt it was chosen for export purposes—and is sung in remarkably faultless English, too. Just a trace of "foreignness" that lends a piquant touch.

6. ODDITIES

kleinsinger-marquis: archy & mehitabel. carol channing, eddie bracken, d. wayne, narr., orch. cond. kleinsinger.
col. ml 4963

far be it from me to break a forty-odd-year tradition that all material concerning archie the cockroach should be l.c., lower case. (archy couldn't bump typewriter keys hard enough to write in caps.)

this is the recent comic opera (plus an extra piece added) that wowed a portion of off-b'way, ny, and will probably wow a bigger piece before it ends. a very nice evocation of the archie story, complete with mehitabel the cat's alley adventures, reform, return to alleydom. excellent acting-singing by mehitabel-channing and archie-bracken, conventional narration, ok, by david wayne.

music? sorry i can't rave. the kleinsinger tunes stick archly around one or two tones, back and forth, back and forth, with the melodic subtlety and sophistication of trained seal music. it's the same tune everywhere, if you can call it a tune. his orchestra, on the other hand, is far more engaging with lots of bright ideas, good color, rhythm. why? very nice recording, ultra-clear vocals.

Edgar Allan Poe. (The Raven, Annabel Lee, etc.; Masque of the Red Death; The Black Cat.) Basil Rathbone.
Caedmon TC 1028

Solo reading (poems and two complete stories) by the well-known Basil, and very easy listening if you enjoy his brand of British speech. An interesting experiment here in acoustics—the voice speaks against a faint but golden liveness, surrounding and in the background. Personally I prefer a "dead" voice, so that it may take on the color of whatever room it reads into from the record. Absolute recording. But this is an interesting alternative.

Passion in Paint. Famous Paintings Set to Music. Henri Réné and His Orchestra.
RCA Victor LPM 1033

If RCA put on its own paint a little less thickly, things like this might find their way to their own happy level of usefulness.

Here we have a dozen real masterpieces (paint) tonally matched by a dozen fussy salon pieces, described as music in a "continental" style. I suggest that the connection between this slithery stuff (wonderful hi-fi) and the works of Leonardo, Goya, Manet, Renoir, Botticelli, et al, is—shall I put it—exaggerated. If you must match it to equivalent art I'd suggest the nearest over-decorated cafeteria.

"Here, as far as I know," say the notes, "is the first attempt to link popular paintings with what is usually called 'popular' music. I'm not sure I know precisely what popular music is: I am certain that [this is music] which everyone can enjoy . . . understand, and from which everybody can experience an emotional lift."

OK, try it and see. I'm not sure what popular music is either—see the beginning of this Revue. But maybe I should pass on a hot tip. The popular Italian composer Respighi wrote a piece called "Trittico Botticelliano," which sets three Botticelli paintings to music. (Two LP versions available.) Come to think of it, I'm not so sure I'd like it any better than RCA's tone-painting. I'm not exactly a Respighi fan.

Let's leave Botticelli & Co. alone with their paint for awhile. If you want hi-fi mood music, this is it.

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Stravinsky: Danses Concertantes; Dumbarton Oaks Concerto; Concertino and Three Pieces for String Quartet. Rochester Chamber Orch., Hull; the Gordon String Quartet. **Concert Hall CHS 1229**

For Stravinsky-likers this is an interesting disc, with two of the late-style choppy orchestral works with their foot-tapping beat and short, jagged, jazzy music-hall bits of tune, plus two early and dissonant bits for string quartet. Fine recording—especially the Gordon Quartet, in view of the fact the Jacques Gordon died nine or ten years ago, if I remember rightly. A transfer from the old Concert Hall Limited Edition 78's, disc-made, and you couldn't tell them from new tapes.

* **Anna Russell's Guide to Concert Audiences** Eugene Rankin, pf. **Columbia ML 4928**

Volume Three of this zany lady's musical take-off acts, with audience, and its another party stopper if you know your way around singing well enough to appreciate her many-languaged double talk—and the musical double-talk in the parody-songs she has invented. Wonderfully recorded—she's right in your room with a beaming pussonality, and the audience loves it.

*! **Greek Folk Songs and Dances.** Royal Greek Festival Company (Dora Stratou). **Esoteric ES-527**

Made in New York by a traveling road company (untrained), this record is a beautiful example of clean recording with superb close-up mike presence, ultra-silent surfaces. The folk music is what the British call "traditional"—i.e. current folk music, still in free active circulation, without benefit of collectors and restorers. Such music is, of course, entirely free to absorb whatever influences that come its way and so it is generally pretty up to date in sound, using whatever modern instruments or styles may have happened along to catch the local fancy.

Thus the Greek music here is a mixture, with plenty of "authentic" semi-oriental stuff, exotic scales and the like, but also with a strong dose of recent Western influence, quite casually. Some of it is pure barber-shop-harmony stuff and don't be surprised to hear a good old guitar, American-style, going oompah-pah, oompah-pah. Side 2 has the more pure native sounds on it, for my ear. Pure or mixed, the whole is very natural, musical, unforced, and pleasurable in the listening.

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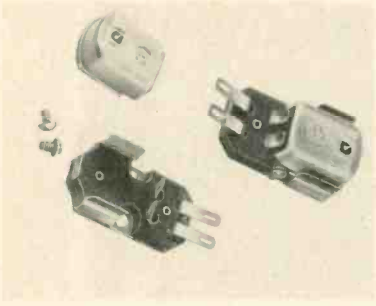
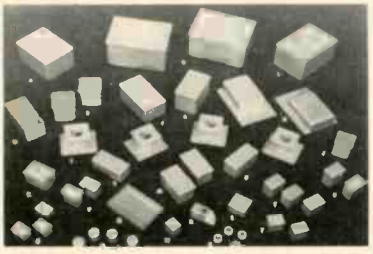


● **Speaker-Headset Control Box.** This unit, known as the "Maestro," permits the use of headphones or an extension speaker with any hi-fi system. Two jacks are mounted on the front panel of the control box; use of one cuts out the main speaker of the system, while use of the other leaves the main speaker in operation simultaneously with an extension speaker or headphones. A volume control is provided for adjustment of signal level to extension speaker or headset. The "Maestro" cabinet is finished in mahogany with a gold-finished perforated front panel. Permoflux Corporation, 4900 W. Grand Ave., Chicago 39, Ill. **A-9**

● **Deep-Drawn Aluminum Chassis.** Many applications will be found in the audio equipment industry for various models among the more than 500 types of deep-drawn aluminum enclosures now being made by Moorlee Manufacturing Company, 515 DuPont Circle Bldg., Washington 6, D. C. Available with matching covers, the enclosures are seamless, single piece, light in weight and ruggedly constructed. Included among standard sizes are units ideally suited for amplifier or tuner chassis, record changer and turntable bases, and preamplifier housing. A complete catalog detailing all sizes and shapes will be mailed on request to interested designers and manufacturers. **A-10**



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● **Tune-A-Port Speaker Enclosure.** Characteristics of this enclosure may be varied from the outside simply by adjustment of two external knobs which alter the port opening to meet the requirements of the speaker enclosed. The cabinet accommodates 12- or 15-in. single, coaxial, or triaxial speakers. It has an internal volume of 10,000 sq. ins. and is constructed of ¾-in. mahogany veneer stock. Internal reflections are minimized by means of acoustic padding. Overall size is 36"h x 24"w x 17"d. Available in mahogany, blonde, or walnut finish. Manufactured by Standard Wood Products Corp., 47 W. 63rd St., New York 23, N. Y. **A-12**

● **Twenty-Watt Hi-Fi Amplifier.** Designated as the Model S-1000 "Music Center," this new amplifier manufactured by Sherwood Electronic Laboratories, Inc., 2902 W. Cullom Ave., Chicago 18, Ill., features push-pull 6L6GB's in a wide-range ultra-linear circuit designed to handle 40-watt peaks. Other unique features include push-button control of record equalization, speaker damping selector, center-set loudness control, Z729 low-noise preamplifier, low-distortion tone controls, and special tape recording facilities. Front panel controls include scratch- and rumble-filter switches. Housed in a handsome cabinet which measures but 4" x 14" x 10½". The "Music Center" is available in several finishes including mahogany, black, and white gold-tooled leatherette. Descriptive sheet available on request. **A-13**

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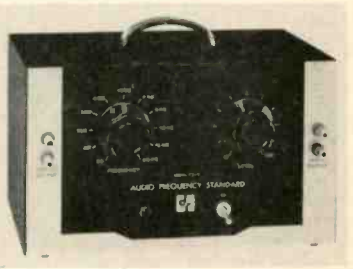
● **Compact Signal Generator.** Availability of a new compact signal generator which acts as a secondary frequency standard with a short-time accuracy of one part per million was announced recently by D & R, Limited, 402 E. Gutierrez St., Santa Barbara, Calif. Generating twelve selected standard frequencies between 20 cps and 100 kc, the Model FS-1 has a long-time accuracy of 20 parts per million over normal ambient room-temperature range. Eleven sine-wave frequencies, available at approximately 1-volt level and selected by front-panel controls, are: 1, 3, 5, 10, 15, 20 kcs, and 20, 60, 100, 300, 400 cps. In addition, a constant 100-kc signal may be used for reference to a primary standard or to WWV for precise correlation. Full technical information is available on request. **A-15**



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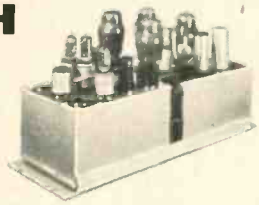

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SIGNATURE SPEAKER SYSTEM
Model D-31050

One of the few truly front-loaded horn enclosures, augmented by two independent Helmholtz resonators to provide unusual realism of response to extremely low frequencies. Equipped with two Model 130B 15 inch low frequency units, one Model 175DLH high frequency driver, horn, and Koustical lens assembly, together with a Model N-1200 dividing network, the entire unit operates as an effective three-way system with balanced, clean response over the entire audible spectrum. Height 50"; Depth 28"; Front Width 37". Shipping Weight 215 lbs.

Model D-31050M (mahogany) **$539.25**
Model D-31050B (blonde) 546.75

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

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The NEW
SCOTT
Model 310
FM TUNER

An unusual FM circuit featuring 2 mc bandwidth for more effective quieting on weaker stations and more reliable, drift-free tuning without the need for AFC. Single sweep tuning mechanism permits rapid location of desired station on dial. Calibrated tuning meter insures precise station selection. Adjustable suppressor reduces characteristic FM interstation noise. Employs three cascaded limiter stages.

Sensitivity is 2 uv for 20 db quieting and 4 uv for 40 db. High capture ratio permits noise-free reception of stations only 2½ db stronger than interfering stations on same channel. Two low distortion, feedback stages of audio amplification provides 4 volts maximum output voltage. Low impedance permits long interconnecting cables between tuner and other units. Power supply is built-in. Aluminum cabinet measures only 13⅜" wide, 10" deep and 4⅞" high.

Complete with tubes **$149.50**

New PILOT
Preamp-Equalizer-Audio Control
PILOTROL
Model PA-913

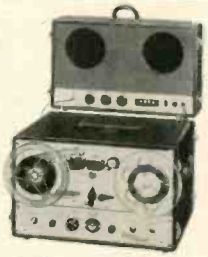
A professional-type front-end control featuring a sensitive, calibrated meter for indicating output level.

There are 4 inputs: phono, radio, tape, and auxiliary, operated by push-button selectors with illuminated indicators plus an additional input channel for high impedance microphone. There are 5 push-button controls for treble roll-off and 5 for base equalization. Other features include separate, continuously variable bass and treble controls providing 19db boost and attenuation at both 20 and 20,000 cycles — microphone volume control — master level control — loudness compensator — meter switch and meter sensitivity range selector.

Convenient AC outlets are provided for auxiliary equipment, and is controlled by power switch. Microphone channel may be mixed with any one of the other 4 channels. Cathode follower output permits up to 100 feet of connecting cable. Cathode follower recorder output is independent of volume, loudness and tone controls. Power supply is self-contained. Cabinet is finished in mahogany and measures 6" high, 13¼" wide and 9½" deep.

Complete with tubes **$119.50**

PORTABLE
MagneCordette



Combines the famous PT6-AHX mechanism, the PT6-G recording amplifier together with the 91X742 speakers-amplifier-case unit. Features include: separate erase and record-playback heads, fast forward and rewind speeds. Frequency response: 50 to 15,000 cycles ±3 db at 15 inches/sec., and 50 to 7,000 cycles ±2 db at 7½ inches/sec. Mechanism is driven by hysteresis motor, and induction motor is used for rewind. The 91X742 unit has two wide-range loudspeakers. Separate bass and treble controls provide means for continually variable boost and attenuation. May be used with microphone, phono pickup, or tuner, and as PA system. Power output is 10 watts with less than 1% distortion. Power requirements: 117 volts, 60 cycles AC, 85 watts.

Complete portable MagneCordette **$529.00**
PT6-AHX Recording Mechanism only 299.00
PT6-G Recording Amplifier only 99.50
91X742 Speakers-Amplifier-Case Unit 160.00

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Audio Response—55 to 16,000 cps.

Speaker Components—8 inch bass driver in 36 inch exponential horn. 3½ inch tweeter and specially designed crossover network. Impedance: 8 ohms.

Construction—Korina veneers finished in Blonde, Walnut, Mahogany or Ebony hand rubbed lacquer. Wrought iron legs.

Unique Features—Curled, not folded, exponential horn (1% of formula). Multiple flare formula (patent applied for). Passive phasing chambers. 24db/octave acoustical crossover. Distributed throat characteristic (not found elsewhere).

Size—19 x 12 x 9 inches.

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Esquire—30" x 24" x 16", Frequency Response: 30 to 16,000 cycles..194.00
Hi-Fi—4' x 30" x 20", Frequency Response: 20 to 16,000 cycles.....645.00
4-D—5' x 3' x 2', Frequency Response: 15 to 16,000 cycles.....994.00

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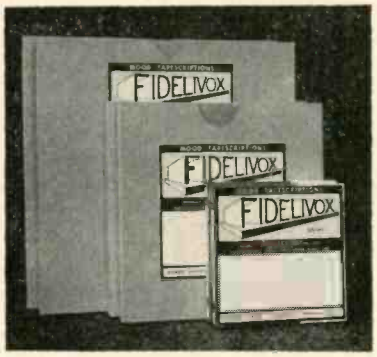
Chicago 5, Illinois
A Division of Eddie Bracken Enterprises

● **Three-Speed Professional Turntable.** Although similar in design and construction to the original turntable manufactured by Components Corporation, Denville, N. J., this new model is considerably reduced in size without any sacrifice in performance. The new unit occupies a space 19" long,

13½" deep, and 8" high, at the same time providing ample room for mounting any standard pickup arm, including 16-in. transcription arms for broadcast use. The "Professional" features a 25-lb turntable which is belt-driven from a three-step motor shaft pulley. Rumble is down 70 db and wow is negligible. **A-16**

● **Mood Tapescriptions.** Pre-recorded tapes featuring Robert Elmore, prominent organist, performing on a large cathedral pipe organ, are now available from Electrosonic Specialties, 7230 Clinton Road, Upper Darby 3, Pa. The tapes are equalized to achieve a close, intimate sound quality



which lends itself particularly well to sustained listening. Merchandised under the trade name "Fidelivox," the tapes are all music, interrupted only by a 30-second break once each hour. They are available in 2-, 4-, 6-, and 8-hour lengths, dual track. Fidelivox tapes are sold direct by mail. Inquiries should be directed to the address shown above. **A-17**

● **Pilot FM-AM Tuner.** Extreme sensitivity is principal among features of the new Pilot Model AF-850 tuner. FM and AM sensitivity are 1.5 and 2 microvolts, respectively. Circuitry includes an Armstrong limiter-discriminator circuit on FM with continuously-variable AFC. Provision

is made for broad or sharp I-F bandwidth on AM, with 10-kc whistle filter to eliminate heterodyne interference. The exclusive Pilot "Micro-Meter" assures precise tuning on both AM and FM. A built-in power-line antenna provides excellent reception in normal locations. Essentially a basic tuner, the 850 is virtually identical in all respects with the well-known Pilot Model 860, except that the 850 does not include a preamplifier or tone controls. Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y. **A-18**

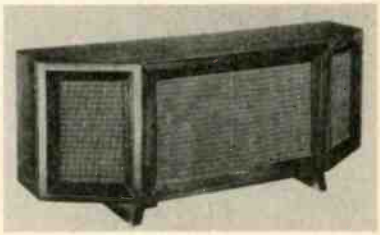
● **Heathkit High-Fidelity Amplifier Kit.** Features to satisfy the most critical listener are inherent in the new 25-watt Model W-5M amplifier kit recently announced by the Heath Company, Benton Harbor, Mich. Frequency response is within 1 db from 5 cps to 160 kc at a reference level of 1 watt. Noise level is 99 db below rated output. Incorporated in

the amplifier is a new-type balancing circuit which results in closer dynamic balance between the KT-66 output tubes. Intermodulation and harmonic distortion are reduced, and low-frequency response is extended a full octave below that of present Heathkit Williamson-type amplifiers. Further technical information will be mailed on request. **A-20**

● **Twelve-Watt Hi-Fi Amplifier.** Many features normally found only in more expensive units are included in the new Model LA-54 12-watt amplifier recently introduced by Lafayette Radio. Frequency

response is 20 to 20,000 cps. Incorporated in the amplifier are: a record equalizer system with individual controls for bass turnover and treble roll-off; separate bass and treble tone controls, and a special take-off jack for tape recording. Written request will bring technical specifications. **A-20**

● **Compact Speaker System.** Equally at home on a table, in a bookcase, or on a wall, the new Electro-Voice "Skylark" incorporates two horn ports which properly load an E-V Model SP8C low- and mid-frequency reproducer from 79 to 3500



cps. A Type T35B tweeter takes over at 3500 cps and extends the range of the system beyond the limit of audibility. Dimensions of the Skylark are 33" w x 14" h x 10¾" d. Finishes available are mahogany and Korina blonde. Complete specifications of components as well as the complete system are described in Bulletin No. 219 which will be mailed on request. **A-21**

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AROUND-THE-WORLD PORTABLE

(*from page 20*)

some low frequency, feedback which becomes positive in sense and makes the entire system unstable. Fortunately this condition did not develop except at such high average power levels that heavy clipping was taking place within the amplifier. The acoustical feedback problem could probably have been lessened by a more elaborate shock-mounting of the turntable, but the trouble was not severe enough to justify the extra expense and time in experimentation. The only deficiency of the *Bogen* turntable is that no shock mounts of any sort are provided. There was no noticeable acoustical fedback through the amplifier principally because it was mounted on ½ in. rubber cylinders, and the first two tubes of the amplifier were separately isolated from the chassis by rubber grommets.

The final testing of the unit involved tuning the port, using the system described in the *Audio Anthology*. After completing the tuning, a qualitative check of the amplifier and enclosure was made by driving the unit with an audio oscillator and observing the output of the loudspeaker by means of a microphone and amplifier connected to an oscilloscope. The output was reasonably level to about 70 cps, and then fell sharply. There was no doubling, however, and the fundamental was clean until the limitations of the 8-in. cone itself were reached, at about 50 cps.

After it traveled the first time a buzzing resonance developed at a certain frequency, and on close inspection two loosened screws were found in the speaker mounting board assembly. After reseating these the resonance cleared away. A test trip seems to be in order with equipment of this sort to show flaws in either design or construction. This unit has already traveled two thirds across the country by railway express, having just been slipped into an outer, protective, cardboard box. At the end of the trip, the cardboard box was practically demolished, and only sheet-metal screws holding the two halves of the chassis together were loosened. This condition was corrected by using four bolts long enough to pierce the chassis box completely to clamp the two halves together.

PARTS LIST

C_1	20-20-20-20/450, electrolytic
C_2, C_3, C_4, C_5	.02 μf, 400 v, paper
C_6	.001 μf, 400 v, paper
C_8, C_{15}	.01 μf, 400 v, paper
C_7	.002 μf, 400, v, paper
C_9, C_{10}	0.1 μf, 400 v, paper
C_{11}	50 μf, 50 v, electrolytic
L_1	15 Hy at 75 ma
R_1, R_2	10,000 ohms, 1 watt
R_3	0.1 meg, 1 watt
R_4	1500 ohms, 1 watt
R_5	0.47 meg, ½ watt
R_6, R_9, R_{19}	0.1 meg, ½ watt
R_7	2200 ohms, ½ watt
R_{16}, R_{17}, R_{18}	1500 ohms, ½ watt
R_{11}, R_{12}	47,000 ohms, 1 watt, 5%
R_{13}, R_{14}	1000 ohms, ½ watt
R_{15}, R_{16}	0.27 meg, ½ watt
R_{18}	30 ohms, 2 watts
R_{20}	250 ohms, 10 watts
R_{21}, R_{22}	0.25-meg potentiometer, audio taper
R_{23}	0.5-meg potentiometer, audio taper
R_{24}, R_{29}	10,000 ohms, ½ watt
R_{27}	0.47 meg, ½ watt
R_{28}	1200 ohms, ½ watt
R-F	12,000 ohms, ½ watt
T_1	250–0–250, v at 75 ma, 5 v at 2 a, 6.3 v at 2.5 a.
T_2	Universal output, 20-watt.
V_1	5Y3GT
V_2, V_3	12AX7
V_4, V_5	6AQ5

Altec 755A loudspeaker
3-cct phone jack
Bogen DB-50 turntable and arm, ceramic cartridge.

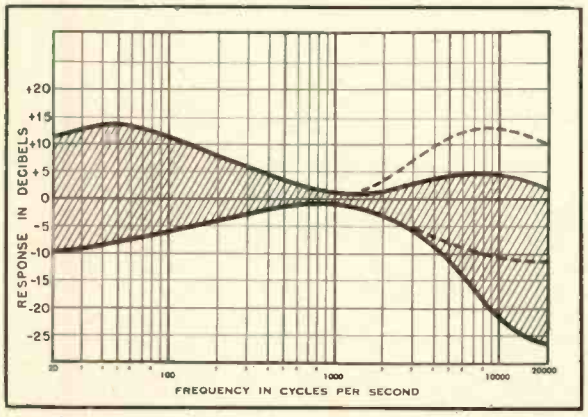

Fig. 11. Curves showing tone control range.

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Triad Isolation Transformers are especially designed for isolation of laboratory test equipment . . . reduction of line disturbances . . . elimination of undesired grounds.

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Type No.	List Price	V. A. Output	Input Volts	Output Volts
N-51X	$ 5.95	35	115	115
N-52M With switch and meter	32.50	350	115	95-100-105-110-115-120-125-130
N-53M	12.75	85	115	115
N-54M	14.30	150	115	115
N-55M	25.30	250	115	115
N-57M	40.75	500	115	115
N-59M	67.20	1000	115	115
†N-60	130.00	2000	230/115	230/115

†Special case.

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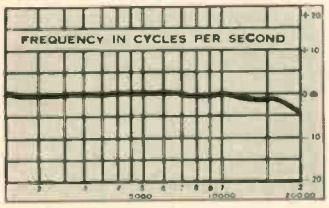
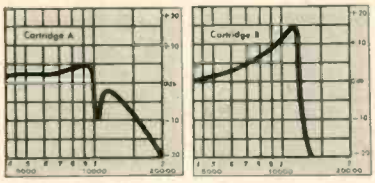
Fairchild's 220 Series cartridge guarantees this distortion-free reproduction in the entire audible range!

Just look at these frequency response curves of the Fairchild 220 and two other leading cartridges. See how Fairchild alone gives smooth, even reproduction — completely uniform to 17,000 cycles with only slow roll-off beyond. This means no unnatural harshness, no distorted sound! With Fairchild, you have only the sound you were meant to hear!



FAIRCHILD 220



CARTRIDGE A CARTRIDGE B

the **RIGHT** sound–always!

FAIRCHILD 240
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PREAMPLIFIER

Highest performance and operating simplicity in this attractive Fairchild 240 Balanced Bar Preamplifier give you the world's finest sound equalization.

Also, the Fairchild 240 features Listening Level Control. Operating independently of volume control, LLC provides pleasant low-level listening and *correctly balanced* normal listening levels — all easily, without complex adjustments.

$98.50

FAIRCHILD RECORDING EQUIPMENT

9th AVE. & 154th ST., WHITESTONE, NEW YORK

METER SCALES

(*from page 32*)

be produced rather rapidly, and at a relatively low cost. Samples of special scales other than those for use in conventional panel meters comprise *Fig.* 6. At right is a GMT dial, for use in a 24-hour "time of day" panel clock. At left is the dial for a self-computing anemometer timer. Outer scale is calibrated in seconds. Next inward scale is calibrated in miles per hour of wind, for use with a 1/6-mile contacting anemometer. Innermost scale indicates numerical significance of intermediate markings on the wind-speed scale, and was designed to reduce interpolation blunders.

Several very complicated multicolored scales have been made by an extension of this general technique, color printing being done by use of *wash off relief* film. Use of a second calibration in red is quite satisfactory, but additional calibrations in other colors are difficult to read unless overall illumination is quite rigidly controlled. Yellows become unreadable under ordinary incandescent lighting, and most blues "drop out" under fluorescent lights.

A special meter scale, made by any ordinary method, is likely to cost at least as much as the meter in which it is installed. Relatively simple scales, such as those shown in *Fig.* 5, require from one to two hours of drafting time if made as single jobs. Ten or twelve scales, of about the same dimensions and complexity, can be drawn up in a single working day if the entire group is assigned at one time as a single job; and provided the instructions are both adequate and simple.

Copying of scales entails only a few minutes of actual work, but also requires a considerable time for developing, fixing, washing and drying. Most commercial photographers can produce copies in 24 hours as "straight run" work; and in three hours, at a higher price, as "rush" work. Copy negatives cost from one to five dollars each, with three dollars for an 8 × 10 negative being fairly standard. Five 3-in. diameter meter scales, all to the same reduction, can be copied on a single 8 × 10 negative.

Contact prints cost from ten cents to two dollars, with one dollar for an 8 × 10 print being a common charge. Usually, if a number of prints from the same negative are ordered at the same time, the cost of additional prints is considerably less than that of the first.

When more than about 25 copies of a scale are wanted, multilith reproduction may be economical; and when much more than 200 prints are needed within a year, printing from a line engraving should be considered.

Mounting of the scale on the scale plate, and installation in the instrument, takes from 10 to 45 minutes, depending upon the mounting method used. Mounting of a dozen scales, however, all done at the same time, requires only slightly more than two hours.

Emergency Expedients

Although makers of trans-adhesive art aids have regular outlets in most large and medium-sized cities, there will be times when a single symbol, or group of them, cannot be obtained. When this occurs, or when material cost is more important than labor cost, symbols cut from printed texts can be cemented onto a scale, in suitable alignment, with gratifyingly satisfactory results. In one "war emergency" situation, a complicated meteorological computing scale was completely numbered and lettered with type cut from pages of the *Saturday Evening Post.*

Coloring Scales

When scales in several colors are desired, construction may become somewhat involved and difficult. The most common need, the red line accompanying instructions "Set to red line," is also the most easily applied. Clean the surface of the print with carbon tetrachloride or clean (not motor) ether, and draw in the desired line with red drafting ink using a clean ruling pen.

If the need is for a scale with black lines and letters on a colored field, a standard black and white print can be made, and the field (the white portions) dyed any desired color by use of photographic dyes (available at most photographic supply houses) or high-grade colored drawing inks (K and E or Craftint) applied by immersing the entire scale, or painted on with a clean brush or cotton swab. Use of cheap "easter egg" dyes leads to fading and ultimately blotchy appearance of the scale. Application with a pen usually plucks the paper surface, producing nonuniform coloring.

Colored zones on a meter scale, like those commonly used in tube checkers, can be produced by outlining the areas to be colored with a thin black line in the original print, and then filling in the outlines with the desired color, using dye or ink applied with a brush or swab, not with a pen. Large areas can also be colored by application of solid color Zip-A-Tone.

When multicolored scales are needed in moderate numbers, such as 25 or more at one time, excellent results can be obtained by two-color multilith. For this, the lithographer requires one original for each color used, and register marks, so that the various prints will superimpose properly in the finished scale. This process is usually too costly for only one or two scales, as almost the entire cost is the making of the separation plates and setting them up for multilithing. Cost of a single scale

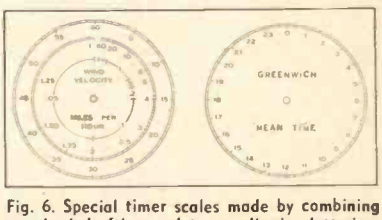

Fig. 6. Special timer scales made by combining standard drafting and trans-adhesive lettering.

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is likely to run around $25.00, but 100 scales will only cost $30.00.

As a last resort, and then only when costs don't matter, a complex scale in color can be photographed in color, and Kodachrome or equivalent prints cemented onto the meter scale plate.

By use of the methods here outlined —a combination of line drafting and "stick up" lettering—workmanlike special instrument scales can be made quickly at reasonable cost. Quality of scales produced by these methods will usually be superior to that produced by "direct drafting," but will not equal that of scales printed on the special dividing machines used by a few of our better instrument manufacturers.

In many plants, all processes of making a special meter scale can be performed within the plant, eliminating the involved and costly purchase order procedure needed to get a special scale from the instrument manufacturer. Likewise, local manufacture of special scales eliminates the prevalent delay in delivery, which currently ranges upward from 30 days.

[1] John L. Ridgway *"Scientific Illustration,"* Berkeley, 1938, 101–103, 108–111.
[2] R. L. Ives, "Fabricated diagrams," *Journal of Geology,* Vol. 47, 1939, 517–545.
[3] J. R. McDermott, "New electronic drafting tools and techniques," *Electronics,* Vol. 27, No. 8, August, 1954, 121–125.
[4] Craftint Mfg. Co., 1615 Collamer Ave., Cleveland 10, Ohio.
[5] Fototype, 1414 Roscoe St., Chicago 13, Illinois.
[6] Monsen-Chicago, Inc., 22 East Illinois St., Chicago 11, Ill.
[7] Artype is manufactured in Chicago, but is marketed in the New York area by Trans-Art Incorporated, 15 Park Row, New York 38, N. Y.
[8] R. L. Ives, "Special Symbols from Standard Type," *School Science and Mathematics,* Vol. 50, 1950, 567–569.
[9] Para-Tone Co., Inc., 343 S. Dearborn St., Chicago, Ill.

AMPLIFIERS

(from page 42)

discrimination for such inaccuracy. The main sources of distortion in sound reproducing systems are the electro-mechanical and electro-acoustic transducers —pickups and loudspeakers—but even here amplification helps matters. When the efficiency requirements of the passive transducers are reduced by virtue of the amplifier it is easier to subdue annoying mechanical resonances, a step that improves performance considerably.

The possibilities of securing amplification from new types of devices have by no means been exhausted, nor have current amplifying devices been fully covered here. Research in basic amplifier units and in applied circuitry is continually going on. The amplification of oscillatory or otherwise variable stimuli occupies a central position in modern applied physical science. Although the popular drama of nineteenth century gadgets may be missing, revolutionary work is being performed.

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KT66

The name GENALEX on the tube and carton is your guarantee that you are buying the original KT66 . . . world-famous power tetrode, often referred to as the finest audio tube ever made! The GENALEX KT66 is the hallmark of the finest amplifiers. It is supplied as original equipment in amplifiers of the highest quality. Identical pins and connections as 6L6 tubes. Only $3.50 net.

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Net price, $4.50

Centralab's Senior COMPENTROL® lets you hear the full range of the orchestral score

The deepest tones of the bass tuba

Centralab

Senior Compentrol—with special Printed Electronic Circuit*—is no ordinary compensated control. There's nothing else like it, for improving the tone performance of hi-fi amplifiers or pre-amplifiers! *Level-set* lets you control compensation *to suit yourself*. Ask your Centralab distributor — or service man. Write Centralab, Dept. 934D, Milwaukee 1, Wisconsin for Compentrol booklet. *Trademark

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Anti-Static
SPRAY

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"... deserves its fine reputation ..."
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"...nullifies static very effectively ..."
"Best product!"

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- Absolutely Safe—Non-Residual—Contains No Soaps or Detergents
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- Laboratory Tested. Unconditionally Guaranteed

Nothing stops dust as *safely* and *effectively* as STATI-CLEAN. No other cleaner has the *permanence* of STATI-CLEAN – one quick spray stops dust for *months!* Chemical-impregnated cloth cleaners are temporary and become useless after dirtying, washing, or short exposure to air... but with STATI-CLEAN, you use the *free* applicator cloth indefinitely. It may be *washed repeatedly*, is *continually restored* by use! *Further*, unlike clip-on devices that reduce static but do not *clean* the record (and are dangerously radioactive), and brushes that just generate more dust attracting static in use – STATI-CLEAN does the *whole job*, sensibly and safely.

Ask for STATI-CLEAN – the original anti-static spray cleaner – next time you visit your record dealer.

BY THE MAKERS OF THESE OTHER FAMOUS RECORD PRODUCTS:

WALCO
Contoured Bottom
DISCOVERS
Protective Polyethylene Sleeves for Records

WALCO
REPLACEMENT NEEDLES
for all cartridges and players

FREE: Write for free sample DISCOVER, plus free $1 book on record care, indexing, etc. Enclose 25c to cover postage and handling.

Walco PRODUCTS, INC.
60-A Franklin St., East Orange, N. J.
AT LEADING RECORD SHOPS

EQUIPMENT REPORT

(*from page 49*)

9000, 5000, and 3000 cps respectively. This is useful in eliminating scratch or high-frequency distortion occasionally found in some of the poorer records. The filter curves are shown in *Fig.* 10.

Figure 11 shows the circuit of the filter. Note that there are three separate controls —the low-frequency cutoff at the left, the compensator at the center, and the high-frequency cutoff at the right. The left control introduces a series capacitance of 4, 2, or 1 μf, together with a shunt inductance

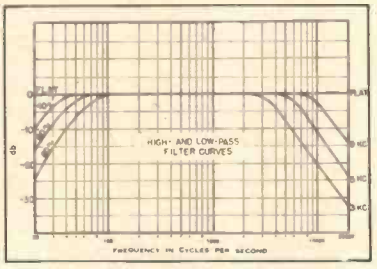

Fig. 10. Low- and high-frequency cutoff curves for the filter section.

and a suitable terminating resistance for the three positions of the switch. The two 2-μf capacitors are paralleled to make 4 μf, one is used singly to make 2μf, and the two are in series for the 1-μf position. Similarly, the high-frequency cutoff control introduces shunt capacitors with suitable terminating resistors to provide 12-db-per-octave cutoffs at the desired frequencies. The two sections of the compensator control vary the series capacitance together with the terminating resistance to provide the desired curves.

The audible effects from this filter unit are quite satisfactory, and it serves well to make the simple UPX-003A preamplifier nearly as flexible as many of the more elaborate—and more expensive—preamplifier control units. This filter is designed for use with the G.E. pickups, and would not provide the indicated compensations for other makes.

We are especially pleased to note one line in the instruction book accompanying this filter—a phrase we have often used in these pages in the nature of advice about phono equalization: . . . Provide adequate flexibility in the reproducing system controls, and then adjust the controls so the reproduction sounds best.

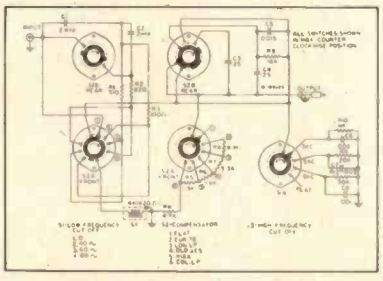

Fig. 11. Schematic of the A1-901 Record Filter.

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PATENTS

(*from page 4*)

of *Fig.* 3, the middle and treble tend to roll off somewhat as level drops. How much real difference this is we do not know.

Figure 3 is the same as *Fig.* 1 in operation except for a couple of points. The tube is a variable-mu pentode connected as a triode. Instead of making the cathode resistor R_k a potentiometer, a second, probably much larger resistor R_x is shunted across the cathode, and this becomes a pot. The d.c. the arm carries to the grid is filtered by a double time-constant network. That the extra components are worth while seems doubtful.

It should be mentioned, by the way, that this circuit is also very good for use as a non-frequency-compensating remote volume control. The usual method of remote control is to use a variable-mu tube. However, for highest-quality audio work these gadgets often introduce some distortion. In the circuit here the characteristics of the tube can introduce no distortion since the signal doesn't go through the tube. Possibly the only disadvantage would be that you can't reduce level to zero. To remove the compensating feature, simply proportion C_1 so that turnover takes place at 10 cps or less; in other words, put in the biggest convenient value you run across in the junk box. If you use a very low-mu triode so that C_1 might have to be inconveniently large for this, you can probably get out of it by using a value with reactance small with respect to R_1, then connecting the left end of C_1 (*Fig.* 1) to the tube plate. The tube in any case should be something like a 6J5 rather than a high-mu triode like a 6SF5 or dual equivalent.

Inventions Wanted Department

At this writing the last issue has just barely got to the customers, so we have no response yet to our call for ideas for inventors. We would just like to start the ball rolling, however, with one desire of our own.

Something this writer would like to see (or invent) is an artificial reverberation circuit in which there would be no resonances and transmission response would be flat so that controls could select which frequency ranges should reverberate the most. There must also be a control for reverberation time. About the only good way of doing this so far is with a tape recorder acting as a delay line with feedback from playback head to recording head. Any chemists in the audience who can come up with a substance that will transmit audio slowly but without distortion? We need a delay of about 1/16 of a second in a small space.

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(*from page 51*)

No question about it—the lower prices, even with the golden possibility of higher sales, even with the possible aid from profit-making popular sellers, even with all the aid available from outside enterprises, still are painful for small business, favorable to large business.

I think that if in the next year in spite of the price cut we find the majority of the reputable small companies still in business with their quality musical offerings still intact and new offerings still coming forth, then we will have witnessed a minor miracle of business adjustment. There are dire predictions that the mortality will be high, that it takes six or eight months (that is, from Jan. 1st when the price cuts went into effect) for the results to be felt and that the worst is yet to come. I hope not, and I have a certain sneaking feeling that maybe things will come out OK, after all.

Financial predictions, like voting predictions, are likely to go haywire, as we know. The more statistics we have to prove our predictions, the more off-base we may be. Let's see what happens.

P. S. Note that the price cuts have been staggered in many companies, the full RCA Victor price level ($3.98 list for 12-inch LP's) applying only in some cases, other records being priced higher according to their type. Even Columbia has taken on this policy, where RCA's prices go across the board. An excellent idea. Better to pay more for a specialized item any day than to find it unavailable, priced right off the market. Never forget the fabulous sums that collectors will pay for "rare" recorded items, not regularly available. Better *on* the market at $5.95 than *off* the market at $10.

2. VERIFIED.

Well, now we can have our high fidelity verified. One of the large one-piece phonograph makers offers this service and suggests that there is no substitute for verified high fidelity. You can duplicate it only by being in front of the performers themselves. The company has set up an independent panel of experts and, it says, your assurance and proof of the highest fidelity is in the panel's verification of it.

The members of the panel are Milton Cross, Yehudi Menuhin, Hoagy Carmichael, Guy Lombardo, James Melton, and Sir Cedric Hardwicke. The phonograph line that is in question starts off with a model offering "highest fidelity for your fonograf dollar," which sells for $29.95.

Wasn't it a year or so ago that the AES was considering setting up some official categories for high fidelity standards, beginning with plain "high fidelity," then going upward through "super high fidelity" (SHF) and "ultra high fidelity" (UHF)? Looks to me as though, verification being what it is, these days, they'd better consider a couple of extra categories; UHF couldn't rate much higher than $99.95. How about Very Ultra and beyond that maybe Astronomically Ultra? For real top-quality we should have something with a proper tone to it, say Galaxial High Fidelity.

That's it! That'll be the name of my next book on, *ugh* . . . audio. Verified GHF. (Verified by whom? Canby, of course.)

A special virtue of this department, I insist, is its lateness. While others jump to get in reports on new equipment before it hits the market, this column just waits and waits, to see what happens. And it's well rewarded. Any number of gadgets that have arrived here in too-hasty defective form have been replaced, later on, with de-bugged models of very much better performance. An early report would have been unfortunate.

Indeed, I hafta laff, as the funny papers say, at the surprising number of defective articles I've been sent and the red faces that have resulted in many a company's sales office! I don't mind; I'm used to it and I know that this is quite normal and to be expected in the complex and anguished business of launching new products. Pressure of competition is unbearably high and the urge to rush the first models out quick to the press and the experts is irresistible. Or, to put it another way, it's easier to advertise than to produce and invariably the publicity department gets ahead of the production department and has everybody excited long before there is anything to sell. With ads flying right and left and orders piling in, the production people are often forced to send out anything they have, half-baked or no: It happens in the best manufacturing circles.

Just to show you how impartially I am thinking, let me say that my first early Garrard changer was a lemon (the second was excellent), I've had one defective arm and two defective cartridges from a reputable cartridge maker—nameless since we're trying again with a new set—my first Collaro changer wasn't up to being written about but a new one of later vintage is a different story (to come), my first try at an Ampex 600 disclosed a faulty output circuit with bad hum, I got an early GE cartridge minus damping blocks (probably damaged in transit), and finally—

I did have some trouble with both the Miracord changer and the Miraphon manual player. Yet I'm about to record myself as recommending these last two, and very worthwhile machines they are.

3. MIRACORD, MIRAPHON.

The Miracord-Miraphon pair share the same basic drive mechanism, which shows every evidence of solid German engineering. My first one had serious wow in it, but as might be guessed this was purely temporary, an early-type defective rubber idler wheel.

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When it was replaced, in a few seconds, I got extremely steady performance—no complaint left. Same for the manual-play Miraphon. (If you have a wobbly one, you can make the same change very quickly.)

The Miracord changer has the much-touted "magic wand" spindle which does a variety of tricky changing functions at the center of the record. Unfortunately for the ads, it was right here that another difficulty cropped up, now entirely conquered. The earlier models of last season had a spindle that was slightly too thick and wouldn't change some brands of records. Naturally I got one of those. It flubbed about half the records I fed to it. But the replacement spindle is OK. I've watched it change every brand of record I could find to try. (And if you have one of the early ones the company will give you a free replacement spindle at once if you just ask.) So that's fixed too.

The present well-broken-in Miracord, then, is an excellent machine, steady, so quiet in operation that I keep leaving the table turning by mistake. It rates surely as one of the best of the middle-de-luxe changers. I have only a few negative reactions. The push-button controls include a scratch filter and a pause control. The filter on mine is set for crystal cartridge and will do odd things to a magnetic's output unless you change the components, underneath. Not a very important gadget, these days.

The pause control may be fine for those who want intermittent music, for dancing and the like, but its mechanism is diabolical—you can't stop it. Or rather, you can't start it. Once the thing is pushed, there is absolutely no way to cancel its action and in the extreme position at LP speed you may have to wait a full five minutes before you can get a sound out of your changer! Of course, you can switch to 78 and speed up the process. The pause feature is evidently popular in Europe; the Paillard changer I described on my Swiss visit in the summer of 1953 had exactly the same thing. The timing, on that one and on the Miracord, is perhaps intended for 78-rpm usage; at the long play speed the intervals are much too long.

One more suggestion. The Miracord, and the Miraphon as well, combine an automatic motor shut-off with a manual provision for disconnecting the rubber idlers to avoid flats not unlike the system used in many Webcor models—positions marked 78–0–45–0–33. A basic flaw in thinking out the design leaves it up to you to change the setting from 33 to 0 after the changer has turned off its own motor. If you don't, the drive remains engaged. Hours—or weeks.

Now any reasonable soul can manage to set the knob to 0, I know. But most of us are unreasonable and absent minded. I am, anyhow. Three times out of four I leave the thing in gear. Haven't got a flat yet, but I'm expecting it any day.

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Industry Note . . .

The New York office of PYE, Ltd., of Cambridge, England, has announced the appointment of British Radio Electronics, Ltd., of Washington 6, D.C. as nationwide distributor of PYE high-fidelity products, which will be imported into the United States in the near future.

The equipment manufactured by the high-fidelity division of PYE consists at present of a professional-quality amplifier and control unit, loudspeakers, and speaker enclosures. These will soon be supplemented by a low-cost amplifier, an AM/FM tuner, and other items. A record player is also being distributed.

A program is presently in operation for appointing sales agents and establishing distributor outlets throughout the United States.

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Industry People...

Albert Kahn, Howard Souther and **Lawrence LeKashman**, top executives of Electro-Voice, Inc., joined in hosting at an exhibition of the new Electro-Voice line of high-fidelity components. Showing, which took place in the company's headquarters at Buchanan, Mich., March 2 to 6, was attended by representatives of the press as well as by executives of leading jobbers and dealers from all parts of the country . . . Another introductory showing of a new hi-fi line was conducted on March 10 in New York by Dictograph Products, Inc., pioneer in the manufacture of hearing aids and other specialized audio devices. Host was **Stanley Osserman**, Dictograph board chairman, who was more than ably assisted by the charm of **Mrs. Osserman**, present in an unofficial capacity. . .

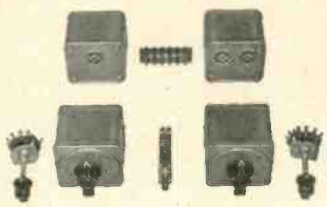
Morton D. Goldman has resigned from the sales staff of Manhattan's Harvey Radio Company to join Thurow Distributors, Inc., Miami, Fla. He will concentrate on sales of audio components and hi-fi equipment . . . **John Colvin**, former president of the Audio Engineering Society, has re-re-located and, much to the delight of his many friends, is back in the New York area in his new association with The Daven Company, Newark, N. J. . . . Another former AES president, **F. Sumner Hall**, has been engaged by the Library of Congress to develop and establish a laboratory whose function will be research directed toward the use of audio devices in aiding the blind. Preliminary reports indicate remarkable accomplishments are in the offing . . . **Joseph Martin** has resigned as music editor of The Billboard to become Eastern representative of Mercury Records, Inc.

Fred Steiner, formerly assistant sales manager for the audio department of Arrow Electronics, Inc., New York, has joined the sales staff of University Loudspeakers, Inc. . . . **Eugene F. Grant** is the newly-appointed director of engineering for National Company, Inc. Formerly an engineering manager for W. L. Maxson Corporation, New York. Another executive appointment at National finds **Vincent F. Crowninshield**, formerly personnel manager for Tobe Deutschmann Corporation, assuming the title of Technical Placement Director . . . **Marvin C. Grossman** has been named assistant sales manager of Hermon Hosmer Scott, Inc. Formerly a sales engineer with the company, his new duties will include sales promotion and sales administration.

Michael Muckley, formerly sales manager of the Espey phonograph division, has been appointed sales manager for the entire line of audio equipment made by Espey Mfg. Co., Inc., New York. He has organized a national trade and consumer advertising program which will break soon . . . **W. Walter Jablon**, veteran of the electronics industry, has joined Radio City Products Co., Inc., and its affiliate, Reiner Electronics Co., Inc., both of Easton, Pa., as sales manager—will direct all sales and advertising of commercial products and will manage a new division for special industrial contracts.

Alexander M. Poniatoff, founder, was elected chairman of the board of directors of Ampex Corporation at its March 1 meeting; he will be succeeded as president by **G. I. Long**. **T. Kevin Mallen** was named vice-chairman of the board . . . Appointment of **Robert V. Holton** to general manager of the electrical products division has been announced by Minnesota Mining & Manufacturing Co. He will be assisted by **Leonard A. Johnson** as general sales manager . . . A. D. Adams was re-elected executive secretary of the Phonograph Manufacturers Association, Inc., at its first meeting for 1955; bulk of the gathering was devoted to a general discussion on new parts and accessories recently introduced for phonograph manufacturing.

Smart merchandising is paying off in a big way for **Leon** and **Rene Grove**, owners of the High Fidelity Music Center, Roslyn, Pa., who have just announced the opening of their Sound Studio No. 2. Their "High Fidelity News," which is mailed periodically to prospective customers throughout the Center's sales area, might well be emulated to advantage by other audio equipment dealers . . . **Gene Smith**, feature writer on high fidelity for The New York Herald Tribune, has transferred his base operations to the business news department of The New York Times . . . **John K. McDonough**, formerly general manager of Sylvania's radio and television division, has joined General Instrument Corporation as vice-president of its F. W. Sickles division.



simplify custom installation

The 4200 Sound Effects Filter and 4201 Program Equalizer are now available in component form, as illustrated, for the custom builder.

In addition to the flexibility of installation, all the features and characteristics of the standard models are retained.

The high and low sections of either model may be obtained separately. Complete wiring instructions included.

Send for Bulletin TB-4

Model 4200 Sound Effects Filter
(Send for Bulletin S)

Model 4201, Program Equalizer
(Send for Bulletin E)

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ADVERTISING INDEX

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The only grid-dip meter covering the wide range of
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For determining the resonant frequency of tuned circuits, antennas, transmission lines, bypass condensers, chokes, etc. For measuring inductance and capacitance. May also be used as an auxiliary signal generator; for signal tracing and many other applications.

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SIMPLE AS A B C

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

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

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

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Weiler. $1.00

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Unfortunately, we do have to have money with your order in the case of books, for many of those our readers order are those which we must purchase from other sources. And even with our own publications, we do have to pay the printer If we expect to have him print the next book we put out. But we can help in this fashion—If you want any book from any publisher, just list the name of the book and the author and we'll get it for you. It helps if you know the name of the publisher, but that isn't necessary. If you aren't sure about the price, make a good guess and enclose that amount—we'll mail the book COD for the difference, or we will refund the overpayment if you are too generous. In any case, we pay the postage on the book, although you will have to pay the postage on the envelope you use to send us the order card. Try it once and see how easy it is!

●

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Please send me further information on the items circled as listed in New Products and New Literature

A 1	A 2	A 3	A 4	A 5	A 6	A 7
A 8	A 9	A 10	A 11	A 12	A 13	A 14
A 15	A 16	A 17	A 18	A 19	A 20	A 21

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

NAME _____

ADDRESS _____

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AUDIO— Please send me complete information

about— advertised by—

_____ _____

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

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Especially...

where SPACE is LIMITED

What can be said for the Axiette among high quality loudspeakers generally, is one thing. But, more significant is the fact that the Axiette has become the ideal solution to the limited space problem . . . and who hasn't such a problem!

Many would-be high fidelity enthusiasts have been discouraged by the lack of available space. While there are smaller tuners and amplifiers, little has been done to relieve the speaker situation. Most smaller speakers and enclosures don't quite have 'what it takes' for good high fidelity systems.

The little Axiette has changed this. Used in a suitable enclosure and operating at normal living room volume, it is doubtful whether a group of critical listeners could consistently distinguish between the 8-inch Axiette and a costlier, larger system. This listening quality has never before been achieved in a loudspeaker of such small proportions.

If you are being denied the enjoyment of high fidelity because of space limitations, you have the answer in the Goodmans Axiette . . . ***the good little speaker that was designed to be heard — not seen.***

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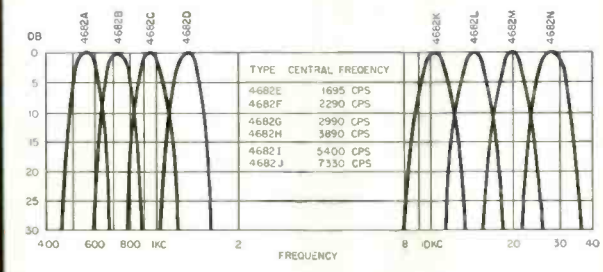
FILTERS

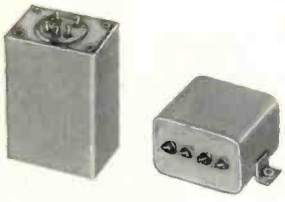
FOR EVERY APPLICATION

TELEMETERING FILTERS

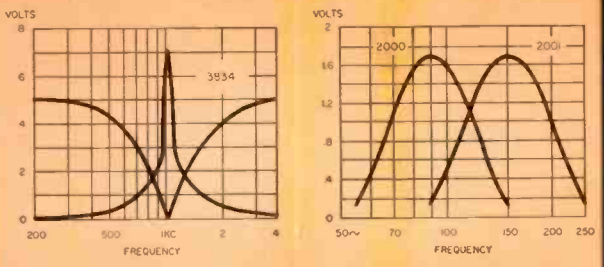
UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.



Dimensions:
(4682A) 1½ x 2 x 4".



Dimensions:
(3834) 1¼ x 1¾ x 2-3/16".
(2000, 1) 1¼ x 1¾ x 1⅝".



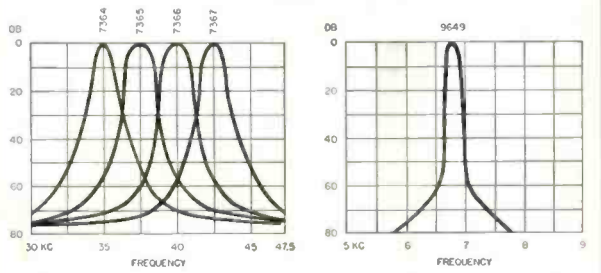
AIRCRAFT FILTERS

UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1023 cycles) range filter providing high attenuation between voice and range frequencies.

Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

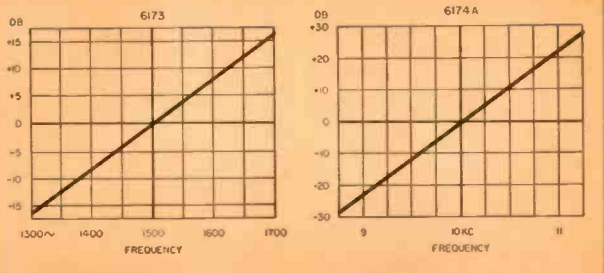
A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.



Dimensions:
(7364 series) 1⅜ x 1⅛ x 2⅛".
(9649) 1½ x 2 x 3".

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.



Dimensions:
(6173) 1-1/16 x 1⅛ x 3".
(6174A) 1 x 1¼ x 2¼".

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

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