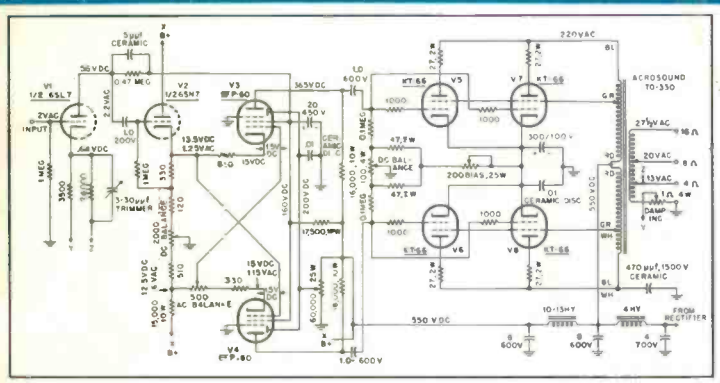
JUNE, 1955

50¢

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

Including 32-page PHONOGRAPH EQUIPMENT section



The search for more power, lower distortion, and better listening quality goes on ad infinitum. *Using secondary emission tubes in a cross-coupled phase splitter and four KT-66's in the output stage, one author claims great improvement.* See page 15.

This elaborate installation is capable of giving recording studio quality—it has to be for its owner is a recording technician. AUDIO IN THE HOME *takes us to see it, describes it thoroughly.* See page 18.

NOVEL TAPE RECORDING AMPLIFIER

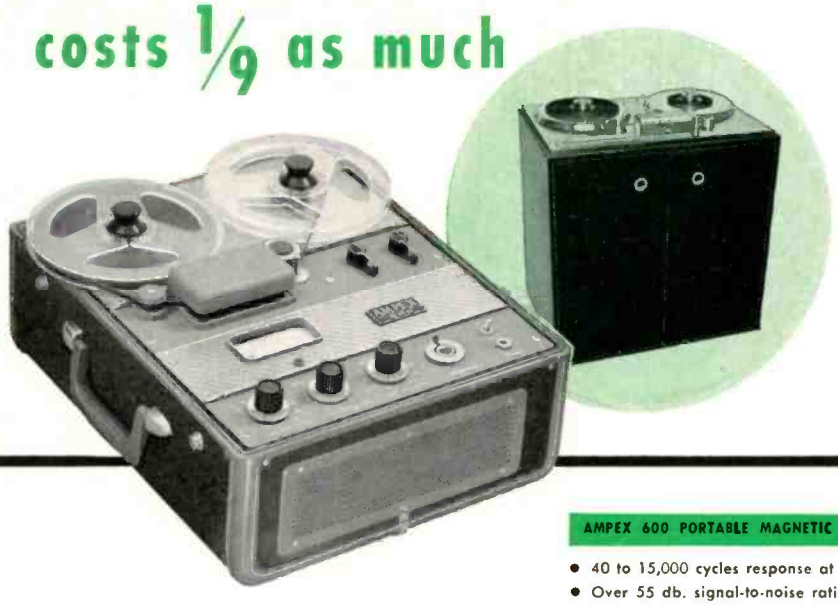
VALIDITY OF SOUND TRUCK RESTRICTIONS

NEGATIVE FEEDBACK

HIGH-POWER LOW-DISTORTION AMPLIFIER

NOW supreme fidelity

costs 1/9 as much



Today the Ampex 600 is a tape recorder in a class by itself. At $545 it provides a degree of fidelity that is beyond reproach — and it is a modest machine that weighs only 28 pounds. It is a professional recorder priced within reach of thousands of critical music listeners and tape recording enthusiasts.

In 1947 this same class of fidelity could only be had by buying an Ampex 200 for $5200. It was worth its price because it was the only thing of its kind. It was the first commercial recorder that made radio transcriptions sound like live broadcasts. But the Ampex 200 weighed 250 pounds. Few, if any, were bought for home use.

AMPEX 600 PORTABLE MAGNETIC TAPE RECORDER

- 40 to 15,000 cycles response at 7½ in/sec.
- Over 55 db. signal-to-noise ratio
- Flutter and wow under 0.25% rms.
- Separate record and playback heads to permit monitoring while recording
- Built-in mixing between microphone and line
- Prices — $498 unmounted, $545 in portable case

AMPEX 620 PORTABLE AMPLIFIER-SPEAKER

A companion unit that not only matches the 600 in portability and appearance, but also in quality as well. Price is $149.50 in portable case.

The man who has seen it all has this to say:

"When I bought the first Ampex Model 200, folks thought I was a goner, springing for $5200.00. But it was a bargain — transcribing my radio program without losing any of the freshness of a live appearance. Some of my records came off the same tape. I could be three places at once. But now here's an Ampex I can carry with one hand. Records and reproduces perfectly, but costs little compared with the first one. So I have a commercial recording studio wherever I roam."

Bing Crosby

For full information, write today to Dept. B-1888

AMPEX CORPORATION

Signature of Perfection in Sound

934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Distributors in principal cities (see your local telephone directory under "Recording Equipment"). Canadian distribution by Canadian General Electric Company.

(continued)

JUNE, 1955 VOL. 39, No. 6
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

Audio Patents—*Richard H. Dorf* 2
New Literature 5
Letters 6
London Letter—*Richard Arbib* 8
Editor's Report 12
A High-Power Amplifier with Minimum Distortion—*Bruce DePalma* 15
At Home with Audio—*Lewis C. Stone* 18
Negative Feedback—*Edgar M. Villchur* 22
A Novel Tape Recording Amplifier—*A. F. Fischman* 24
Phonograph Equipment—A complete 32-page section 25
Record Revue—*Edward Tatnall Canby* 57
Equipment Report—*Crestwood 304 Tape Recorder, "Dual" Record Player—Pilotrol Preamplifier-Equalizer* 60
New Products 64
Audio E T C—*Edward Tatnall Canby* 68
Coming Events 69
Employment Register 71
About Music—*Harold Lawrence* 72
Industry Notes and People 79
Advertising Index 80

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

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

AUDIO PATENTS

RICHARD H. DORF*

THE USUAL AUTOMATIC gain control limiter, or volume compressor operates on the basis that a negative-going d.c. control voltage derived from the signal is applied to the grid of a control tube, usually a variable-mu tube, which reduces the gain of the stage as the signal input level increases. Angus A. Macdonald of Catonsville, Md., is the inventor of a volume-limiting device which does not affect the gain of the amplifier but actually limits the signal itself at the grid of a voltage-amplifier stage by voltage-divider action. Although the inventor states in his preamble that his device obviates the disadvantages of the usual types, he does not specify just what the gains over the prior art are. He has at least come up with something different and interesting, covered by Patent No. 2,703,825, which is assigned to Westinghouse.

One circuit of his invention is shown in *Fig.* 1. Signal comes in through blocking capacitor C_3 and passes through R_1 to the grid of V_1, which is the amplifier stage. Output is taken in the usual manner across plate resistor R_2 through blocking capacitor C_4, R_3 is an unbypassed cathode-bias resistor.

Output signal from the amplifier tube is also passed through blocking capacitor C_5 to the grid of V_2, which is the signal rectifier which produces the d.c. control voltage. A negative delay bias may also be connected to the grid of V_2 to prevent any control action until the signal level reaches a certain maximum point. The delay bias keeps V_2 at or near cutoff under no-signal or low-signal conditions.

When the signal reaches the level at which limiting is to begin, its voltage at the grid of V_2 is sufficient to overcome the delay bias. V_2 begins to conduct and cathode current passes through cathode resistor R_6, electrons moving from ground to cathode and creating, as usual, a pulsating d.c. voltage at the cathode which is positive with respect to ground. This voltage is filtered by C_1, C_2, and R_5, so that it passes through R_4 and R_1 to the grid of V_1 as pure d.c.

The positive voltage at the grid of V_1 causes V_1 to draw grid current. In accordance with normal tube action, the positive grid voltage lowers the impedance between grid and cathode, the magnitude of this impedance at any time being inversely dependent on the magnitude of the positive control voltage. The grid-cathode impedance of V_1 is the shunt leg of a voltage divider, the series leg of which is R_1. The signal passes through this divider, and as the grid-cathode impedance becomes lower, the signal voltage on the grid also decreases. According to the patent, the grid voltage can, in this manner, be kept from increasing beyond a certain point (selected by adjusting the delay bias, no doubt) despite increases of several hundred times at the input point.

Just what happens to the tube's operating point when the grid voltage is played around with in this manner we have not bothered to figure out. Very likely R_2 creates enough additional voltage drop when the grid goes negative and plate current increases to help keep actual bias fairly constant. Or perhaps it doesn't matter in this application. Anyway, the inventor says it works and in this column we generally take his word if it doesn't look too outrageous. He says the system can be used with any voltage-amplifier stage, and that parameters should be adjusted initially for normal operation without control voltage. Naturally, higher signal levels initially can be handled by low-mu than by high-mu tubes. The control voltage can, of course, be derived from anyplace, the method of *Fig.* 1 being only a for-instance. Delay bias is also a matter of choice and need not be used at all.

Cutaneous Signalling

Attell B. Anderson has recently been granted Patent No. 2,703,344, which contains some interesting implications in the field of signalling and warning of blind and deaf persons by passing currents through the skin. The patent, which is assigned to Bell Labs, should be read by anyone much interested and we will just skim the surface here.

The general idea is that if electrodes are attached to the skin, the wearer can detect changes in both the level and the frequency of alternating currents passed by the electrodes through the skin. As long as the level is kept below about 10 db above 1 ma and between 100 and 10,000 cps, the sensation received is similar to tactile stimulation (translation from patentese:

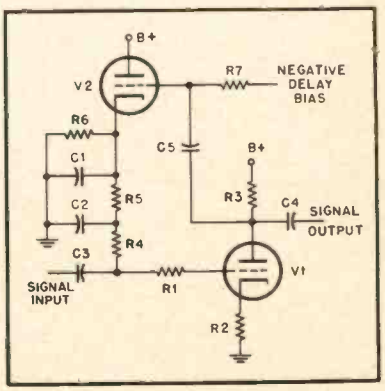


Fig. 1.

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

Encore for a magnificent performance

12 NEW

Encore Treasure Tapes

ONLY 59c EACH
AVAILABLE ONLY FROM
YOUR ENCORE DEALER

long playing, authentic excerpts from the actual Master Tapes of famous High Fidelity Recordings

exclusively reproduced to introduce

Encore WIDE LATITUDE *tapes*

A brilliant new innovation in recording perfection that insures flawless, professional tape reproductions with most recorders, regardless of the experience of operator or recording conditions.

- Quality tape-recorded results
- Broad enough bias range
- Exceptional abrasion resistance
- Superior frequency response
- Top performance regardless of volume
- Performs well on any recorder
- Greater tensile strength
- Unaffected by storage conditions
- Consistent mechanical endurance
- New self-threading reel

LONG-PLAYING MYLAR
PROFESSIONAL ACETATE

SPECIAL MAIL OFFER:

You pay only 59¢ for this Exclusive Encore Treasure Tape, "Excerpts from Dubbings Test Tape No. D-110"... the measure of your tape recorder's performance. Tests for maximum and normal recording, rough and fine head alignment, timing and tape speed, wow and flutter, signal-to-noise ratio. NOT for sale anywhere. Obtainable only by mailing this coupon.

Because of the anticipated demand, this offer is necessarily subject to cancellation or change without notice.

TECHNICAL TAPE CORP. Dept. A-6
Morris Heights
New York 53, N. Y.

Gentlemen:

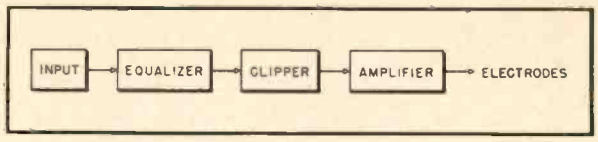
Please send me Treasure Tape "Excerpts from Dubbings Test Tape No. D-110". Enclosed is 59¢ plus 10¢ for postage and handling.

NAME:_____

ADDRESS:_____

CITY:_____ ZONE:_____ STATE:_____

Fig. 2.



touch) and is not painful or uncomfortable. However, the electrodes must have a certain minimum size and separation so as not to give too high a current density.

At frequencies up to 5,000 cps, changes in level are more easily detected than those of acoustical signals are by the ear. Frequency discrimination is relatively poor but does exist. The inventor's idea is to employ such amplitude and frequency sensitivity as does exist, combined with multiple sets of electrodes placed at different parts of the body and carrying different pieces of the intelligence, to convey information to the subject.

The basic device used to transmit signals to the electrodes might be simply an input device and amplifier. However, things work out better if something equivalent to the block diagram of *Fig.* 2 is used—a signal source, equalizer, clipper, and amplifier. *Figure* 3 shows the form such a system might take. The sound source is a microphone. Human speech has most of its content in the region around 400 cps so the equalizer is used to give a low-frequency attenuation beginning at about 1000 cps; this makes the input signals roughly equal over the spectrum. The peak clipper gets rid of the signal peaks which might cause pain or be outside the region of amplitude discrimination. The amplifier has positive feedback so that its effective output impedance is high and it is essentially a constant-current device. This is desirable because the resistance of the skin varies with moisture, pressure, heat, and the like, and if the signals were of a constant-voltage nature the current would vary widely, destroying the subject's ability to discriminate.

This is, of course, only one section of a speech system. Since frequency discrimination by this method is poor, it would be desirable to separate the speech into several frequency ranges by means of filters, each band then being passed through a separate amplifier to a separate set of electrodes located at a different portion of the body.

One suitable electrode structure would be a pair of conducting "buttons" fixed in a nonconducting block and strapped to, say, the wrist. For this structure the inventor suggests electrode area of no less than 3/16 inch square and separation of at least 1/8 inch. Another electrode structure comprises several concentric electrodes, adjacent groups of two constituting each circuit. Presumably the subject would learn to localize the sensations and determine from which set the stimulation came.

Speech signals are not, of course, the only type which can be used. In addition to any of many signals to indicate various conditions, one good use might be with the radar-like obstruction-detecting devices which have been under development for the blind for some years. These signal distances to obstructions by time separation of the transmitted and received signals, and the cutaneous receiving method might be desirable, not only for the deaf blind but also for the hearing blind who would like to reserve their hearing for normal use in hearing what goes on about them without confusion from ranging beeps.

Recorder Failure Alarm

While we doubt that the problem solved by this patent is very important, we report it for what it is worth. German inventors, Wolfgang Stoff and Egon Neumann, have a patent on a system of signalling the failure of a magnetic recording circuit. The invention, Patent No. 2,703,877, is assigned to (take a breath) Leowe Opta Aktiengesellschaft.

The idea, for which no drawing is really necessary, is to hang on to the output of the recording amplifier a circuit tuned to the frequency of the fundamental or a harmonic of the bias-oscillator frequency. This frequency is then made to operate a plate-circuit relay through a tube. When something goes haywire in the amplifier or bias circuit, the bias signal, which normally goes through the amplifier or is injected in somehow, disappears. The relay then drops out and causes bells to ring, sirens to sound, lights to flash. . . .

If this patent or any other one is worth a quarter to you, send your two bits to The Commissioner of Patents, Washington 25, D. C., who will send you a copy provided you have given its number.

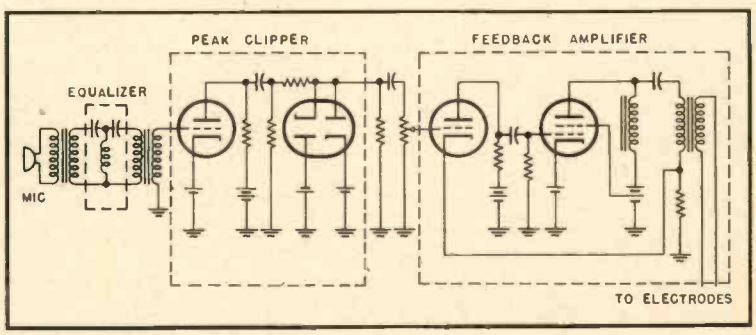


Fig. 3.

NEW LITERATURE

• **Switchcraft, Inc.,** 1328 N. Halsted St., Chicago 22, Ill., announces publication of a new condensed four-page catalog No. CS-55, containing description and technical specifications of more than 200 electronic components, including many recent additions to the Switchcraft line. Of particular interest to users of audio equipment are the Switchcraft "Mini-Mix"—a miniature two-position mixer which plugs directly into the microphone input of tape recorders and amplifiers, and the new "Tini-Jax" and "Tini-Plugs" which add greatly to the miniaturization of audio devices. **K-1**

• **Acoustic Research, Inc.,** 23 Mt. Auburn St., Cambridge, Mass., has recently published a new brochure on its "acoustic suspension" speaker system. Included is a brief explanation of the acoustic-suspension principle, performance curves on both frequency response and harmonic distortion, and model numbers and prices. The brochure will be mailed free on request. **K-2**

• **Astatic Corp.,** Dept. RC, Conneaut, Ohio, has compiled a new master cross-index replacement chart covering all makes of phonograph cartridges, which is available free to distributors and dealers. Consisting of eight letter-size pages, the chart lists not only Astatic cartridges, but those made by other manufacturers as well, together with their current Astatic replacement number. It is compiled in booklet form, with a three-hole punch for insertion into any standard loose-leaf binder. **K-3**

• **Radio Electric Service Co.,** 709 Arch St., Philadelphia 6, Pa., is making available at no charge a full-scale chassis layout which may be used as a template by anyone desiring to build a 60-watt ultra-linear Williamson amplifier using the Acro TO-330 output transformer and four KT66 tubes. A copy of the diagram will be mailed on request. **K-4**

• **Cornell-Dubilier Electric Corporation,** South Plainfield, N. J., in a new eight-page illustrated booklet, describes in detail the applications, uses and advantages of printed circuits in various electrical products, as well as technical information to aid in design or planning of printed circuitry. Titled "Printed Circuitry," the attractive two-color publication explains simply and authoritatively the different types of base materials, laminate characteristics and circuit designs. Various chapters explain how to prepare master drawings, soldering techniques, and pricing variables. "Printed Circuitry" will be mailed free on request. **K-5**

• **Sun Radio & Electronics Co., Inc.,** 650 Sixth Ave., New York 11, N. Y., has just published an interesting 72-page book under the title "Sun's 1955 Hi-Fi Facts." Available at 35 cents per copy, the publication is a complete and comprehensive book with a large number of illustrations. Features included in the book include: how to construct speaker enclosures; the function and evaluation of high-fidelity components; how to select a hi-fi system suited to the individual's needs, and a simple glossary of high-fidelity terms. Requests for copy must be accompanied by remittance. **K-6**

• **Neumade Products Corp.,** 250 W. 57th St., New York 19, N. Y., has issued a new catalog covering equipment for the storage, filing, shipping and editing of motion-picture film of all types. With the advent of wide-screen projection and new developments in the television field, Neumade has added well more than 150 new items to its 35- and 16-mm accessory line, all of which are listed in the new catalog. Available on request. **K-7**

• **River Edge Industries,** 5 River Edge Road, River Edge, N. J., in a new 20-page catalog just released, illustrates and describes one of the country's most complete lines of equipment cabinets and speaker enclosures. The expanded River Edge line includes modern, traditional and provincial styling, with virtually all models available in a choice of eleven hand-rubbed finishes. Also listed are a number of do-it-yourself kits. Half-tone illustrations are augmented with line drawings which help greatly in cabinet selection by showing the relative positions of compartments for tuner, amplifier, record player and speaker. Copy will be mailed free upon request. **K-8**

LETTERS

Bird Deterrents

SIR:

This may sound like another Audio Audity* but it really answers the request of a reader for information. In the April issue, C. S. Clemens asks if ultrasonic frequencies can be employed for driving destructive birds from crops. Sad to say, most common birds seem to be oblivious to ultrasonics in doses that would be practial to cover large areas. Sufficient ultrasonic power to generate heat in feathered or furred creatures may be a deterrent, but requires fantastically large powers. While lethal effects have been obtained in the laboratory at distances of several inches, the high absorption of ultrasonic sound in the atmosphere makes it improbable that this means can ever be used for bird riddance on the basis of heat generation or the flocculation of organs and tissues. This requires levels at the target of 160 to 200 db.

Actually, the nervous system of common birds reacts to sound in the same frequency range as humans. Some years ago, the writer undertook to use ultrasonics at a reservoir infested by scavenger seagulls, but the project met with failure until the frequency range was reduced to the spectrum where human ears found it irritating, and the neighborhood indicated that drastic action might soon be taken to terminate the experiments.

A more successful approach has recently been used by ornithologists where communication is made with the birds in their own ornithic language. It has been discovered by Dr. Fring of Pennsylvania State University that birds have a rudimentary language which consists of cries and shrieks and other warning sounds of danger, the presence of a natural enemy, food, and that they may have other signals necessary for their survival and existence. The nature of these cries or signals varies with different species of birds. It has been shown that the distress cry of a seagull has no effect on the starling and *vice versa*. These cries have been recorded and then analyzed in terms of their significance to the birds. For example, the "danger" cry has been recorded and then played back to the birds on a later occasion with the result that they take flight and disperse, probably assuming that one of their scouts was giving a warning. Some of this work has been reported in the newspapers and the scientific press.

An organization headed by Dr. Miller McClintock of Scarsdale, New York, is now engaged in this activity, employing a device known as "Bird-E-Vict."

SAUL J. WHITE,
82 Elm Street,
New Rochelle, N. Y.

High-Frequency Resonance in Pickups

SIR:

Mr. Preisman refers to the curve in *Fig.* 4 of his article in the May issue as "satisfactorily flat," although there is a 3 or 4 db resonance around 8000 cps. The strict requirements in design and manufacture of pickups for proper reproduction of LP vinyl pressings are not well known, but if the vertical stylus force is reduced to the recommended 3 or 4 grams, the peak at stylus resonance (mechanical) can attain an amplitude of 16 to 18 db, and it is probable that Mr. Preisman used a pickup which employed mechanical damping, which reduces the peak somewhat, along with the response above the resonant frequency.

This type of resonance is one of the major

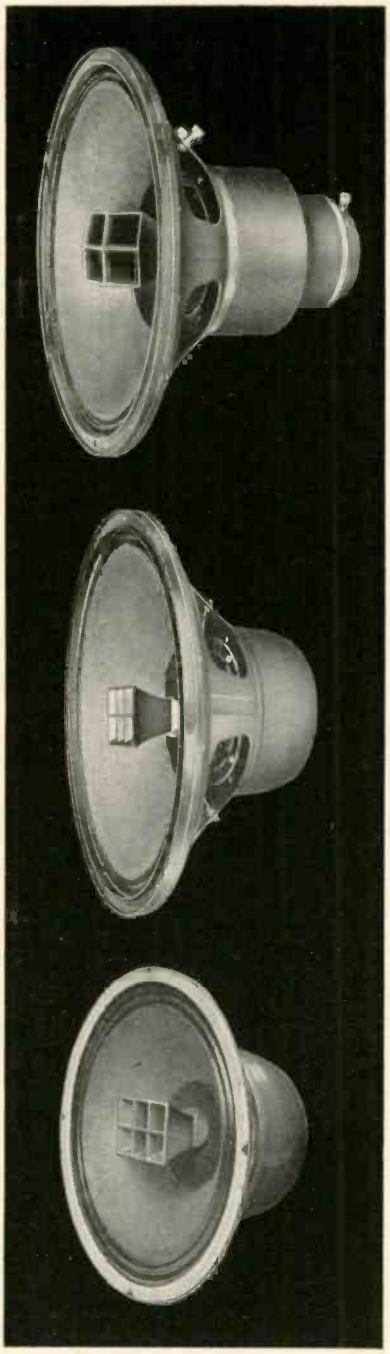
(*Continued on page 70*)

Only ALTEC

DUPLEX® speakers

are guaranteed from

30 to 22,000 cycles.



604C

15 inches
35 watts
16 ohms
$156.00
(with network)

602A

15 inches
25 watts
8 ohms
$114.00
(with network)

601A

12 inches
20 watts
8 ohms
$99.00
(with network)

Altec Fidelity is highest fidelity

ALTEC® LANSING CORPORATION

LOUDSPEAKERS • AMPLIFIERS • PREAMPLIFIERS • TUNERS • ENCLOSURES

DEPT. 6-A—9356 SANTA MONICA BLVD., BEVERLY HILLS, CALIF. • 161 SIXTH AVE., NEW YORK 13, N.Y.

London Letter

RICHARD ARBIB*

H.M.V. DEMONSTRATES STEREOSONIC TAPES

NEARLY A QUARTER OF A CENTURY AGO, the then Master of the King's Musick, the late Sir Edward Elgar, conducted a symphony orchestra in a building which had just been erected in the gardens of an Edwardian house in London's fashionable St. John's Wood, which is just about 2 miles from the West End of Britain's capital.

The leading members of the British Press and technical experts were present on that occasion which was a landmark in the development of recording for it was the opening of what was then claimed to be the largest gramophone recording studios in the World which had been built specifically for that purpose. Since that time, nearly 25 years ago, the majority of the World's greatest artistes have made recordings for posterity in the three studios which have, for nearly all that time, been occupied hy the E.M.I. Company whose records are marketed in England under His Master's Voice, Columbia, Parlophone, Regal, and M.G.M. trade marks and in the U.S.A. now under the R.C.A. Victor and Angel marks.

A few weeks ago a further landmark was made in recording history, when one of Britain's greatest conductors, Sir Malcolm Sargent, introduced to a gathering of the Press and sound experts, H.M.V. Stereosonic tapes. Sir Malcolm said "This is the one fundamental development in sound recording and reproduction which musicians have been awaiting for years." Sir Malcolm, who has followed with keen interest the recent work on this subject and has co-operated enthusiastically in making special recordings for the demonstration programme, emphasized his point by saying that even the very high degree of realism now obtainable from modern tape and microgroove records on good equipment has necessarily been "flat;" the sound has been in one plane, as it were. This was inevitable so long as recording and reproduction were confined to one channel—like listening with one ear or looking with one eye. "If you close one eye and look around you" continued Sir Malcolm, "objects appear flat and in one plane, like an ordinary photograph taken with one lens on one negative. Look at a stereoscopic picture—taken with two lenses on two negatives—and the photograph imediately comes startlingly to life, with every detail standing out clear and sharp in solid three-dimensional realism. So it is with single channel recording and reproduction. Good though this is today—and at its best it can be very, very good, it can never be quite as natural as real 'two-ear' listening. Opening the other ear by bringing in a second channel is like opening the other eye or the second lens and negative of a stereoscopic picture. The re-created sounds immediately leap into life and movement; they acquire breadth and depth and solidity, so that you can hear all round them, just as you can see all round the objects in a stereoscopic picture. No longer does the music of an orchestra, a choir, or a dance band appear to be static and funnelled through a loudspeaker aperture; it has all the character of being spread out across the width and depth of the stage, with the instruments and voices in their correct perspectives. A grand piano no longer 'sounds like a piano;' it IS a grand piano possessing breadth and depth and a full-length keyboard with the bass and treble notes at either end of it."

Two-Channel Reproduction in 1881

After his introductory remarks, H. A. M. Clark, Technical Manager of the Record Division of E.M.I. gave some technical information concerning the history of two-channel recording and the developments that have been made recently by H.M.V. He said "The idea of reproducing sound at a distance in such a way that the listener can use the natural function of the two ears to give a sense of direction is very old, and the first known example of two-channel sound reproduction is an experiment made at the Paris Opera House in 1881 and described in *L'Ectricien* of October 1st, 1881." He claimed that the beginning of the present development went back to 1929 when the Columbia Graphophone Company commenced experiments two years before it joined forces with H.M.V. to form the present E.M.I. organization. "At that time", he said, "it was realised that the use of headphones (although simplifying the technical problems to some extent) was impracticable and that the mere substitution of two loudspeakers fed from two microphones spaced at ear distances was not capable of producing the required result.

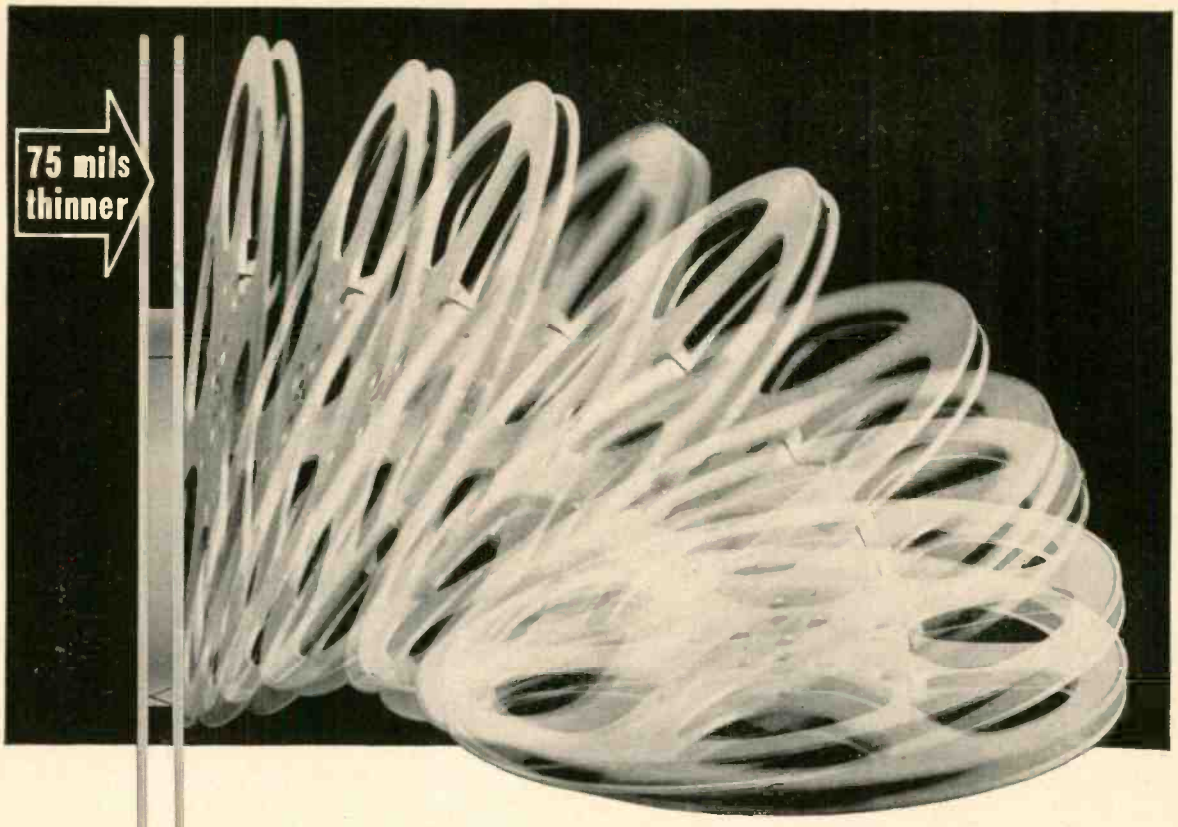
"During normal listening the ear locates the sound source at frequencies below about 1000 cps by the difference of phase of the sound wave reaching the two ears. The ear which receives the sound in phase advance indicates that the source is towards that side of the head. The amount of phase difference will indicate the degree in which the sound source is off centre. Whether the sound source is in front of or behind the listener is indicated when he automatically moves his head. If turning the head, say to the left, makes the spund in the left ear appear louder, then the source is behind the listener. If, however, the sound decreases or remains constant in the left ear and rises in the right ear, then the source of sound is in front.

"At frequencies higher than 1000 cps, where the dimensions of the human head act as a shield, the ear depends more on the difference of level of the sound reaching the two ears, the sound source being on that side of the head on which the sound appears louder to the ear. For steady sounds, phase difference is often too ambiguous at the higher frequencies, time of arrival is a very critical test of direction.

"In 1929, the late A. D. Blumlein realised that it was necessary to convert the outputs of the two microphones into two different sorts of outputs having the correct amplitude differences for feeding the loudspeak-

W. S. Barrell (left), manager of EMI recording studios, talking to two of the members of the Record Division largely responsible for the technical development of the new Stereasonic system—Dr. G. F. Dutton of Advanced Developments Section (center) and H. A. M. Clark, Technical Manager.

* *Multicore Solders, Ltd., Hemel Hempstead. Herts., England.*



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

Write on it!

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

5/16" center hole for better balance

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

REG. U.S. PAT. OFF.

SCOTCH

BRAND

New 10½" Professional Reel

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

3M COMPANY

ers. In this way, the effective time of arrival of the sound at the two ears could be made to simulate what happens in natural hearing, even though each ear could hear both loudspeakers. While this effect could be approximated by the use of widely spaced microphones, improved methods are now available whereby the two microphones can be placed in close proximity and still achieve the required outputs to the loudspeakers. In this sense the new system is comparable to a single microphone technique—resulting in a simplification of the problems of studio balance and acoustics.

"In 1933, the E.M.I. Recording Research Department successfully made a single groove record containing both recording channels by using a complex cut involving both lateral and "hill and dale" recording. When, however, this method was applied to modern LP records, it was found to be very difficult to achieve the high standard of reproduction quality associated with single-channel disc recordings. Magnetic tape, however, offered a recording and reproducing-medium which was inherently free from many of the disadvantages of discs, and attention was therefore concentrated on this field, with its promise of quicker and more effective results.

Difference Between H.M.V. and other 2-Channel Systems

"The H.M.V. Stereosonic system differs from most other systems that have been tried by the fact that the stereophonic effect is operative over the whole frequency range. Other systems have been demonstrated for which it has been quite erroneously claimed that it is not necessary to reproduce the stereophonic effect below about 500 cps. It has, however, been found by H.M.V. engineers that boominess is one of the greatest difficulties in sound recording and reproduction, and that this boominess is due to lack of stereophonic definition in the low frequencies. This definition is fully restored in the new "Stereosonic" system so that a bass drum sounds like a bass drum and not like a door banging, and one can discriminate between the original sound of the double bass, for instance, and the reverberation of this sound in the studio.

"The system requires two independent channels from the recording studio to the listener. In practice, the two channels are put on two tracks on a ¼-in. magnetic tape and replayed through two identical sets of amplifiers feeding two loudspeakers. The spacing of these two loudspeakers will vary according to the size of the room and they will generally be heard to best advantage when placed in the corners at each end of one wall of the room, so that the subtended angle to the listener is between 60 and 90 deg."

The audience was then treated to a demonstration of stereosonic recordings of which the first item was the Philharmonia Orchestra conducted by Sir Malcolm Sargent, playing a Tchaikovsky Suite. The reproduction sounded spacious and realistic but from the rear of the studio it was not particularly apparent that some of the instruments of the Orchestra were grouped on the left, whilst others were on the right. Although the sound did not come from a "funnel" as described by Sir Malcolm Sargent, one had the feeling that the sound came from the centre of the studio somewhat as one would have heard from an orchestra present in it. The next item was a reproduction of Brahms pianoforte solo by Malcuzynski. The effect here was not convincing. Although the quality of reproduction was of the highest order, the reproduction was too loud and the piano did not sound natural. The third item was, however, truly remarkable. An excerpt from the Finale of Act 4 of "The Marriage of Figaro" was reproduced from a stereosonic tape, made by members of the Sadler's Wells Opera Company and Orchestra. The effect of movement from side to side of the studio was immediately apparent, and the whole reproduction of both the voices and the Orchestra was most natural. The fourth item was a reproduction of a dance orchestra.

It was obvious that once again H.M.V. had tried to establish their claim to be first in the field by giving a demonstration of a new development before being in a position to satisfy public demand for their new product. Whilst they did show the equipment for the reproduction of stereosonic tapes

(*Continued on page 77*)

The latest HMV development in sound recording and reproduction, "Stereosonic Tape Records" employs these two prototype consoles comprising the domestic equipment which will be available in the Fall.

HERE'S the all NEW HORIZON *Criterion* AM-FM TUNER

NEW

Calibrated FM and AM logging scales

†

THE exciting NEW Criterion AM-FM tuner advances the art of receiver design to a NEW frontier in radio reception. Its Criterion predecessor began a revolution in the design of AM-FM tuners which is now brought to a rich fulfillment of perfection. Only a company with National's more than 40 years' reputation for technical excellence in receiver design and performance could accomplish such rapid strides in bringing you an improvement on the best.

For the *cleanest* sound and appearance, for the *greatest* in sensitivity, for the *finest* in performance, the NEW Criterion AM-FM tuner can be your *only* answer.

Compare these features combined in the NEW Criterion and found together in no other AM-FM tuner—

- Flush mounting
- Binaural or simultaneous AM-FM tuning and reception
- Drift free reception
- Mutamatic tuning
- Flexibility—the same unit is available with or without plug-in preamp
- Greatest sensitivity of any receiver
- .8 capture ratio—makes sensitivity usable for fringe area reception . . . areas formerly inaccessible to FM can now receive quality FM signals
- FM multiplex output
- Handsome styling and cabinetry
- Simple assembly of completely integrated units

NEW

- "Lock-in" tuning—broad & non-critical. When you hear program the station is perfectly tuned—without meters, eyes or other complicated tuning indicators—the only non-critical tuning unit on the market.
- Wide range—adjustable Mutamatic*
  *An exclusive National feature that eliminates all hiss and noise when tuning between stations. Music leaps out of velvety silence and stays locked in.
- Incomparable AM & FM selectivity—complete adjacent channel rejection.
- Superb stability both long and short term.
- Completely Hi-Fi AM reception—distortionless and burble free—
- The greatest sensitivity of *any* AM-FM tuner . . . *plus*
- .8 capture ratio—rejects all interfering signals up to 80% as strong as the desired signal—making signals "ghost" or "reflection" free.

†*Pictured with plug-in preamplifier*

tuned to tomorrow **National** NC®

NATIONAL COMPANY, INC.
61 SHERMAN ST., MALDEN 48, MASSACHUSETTS

EDITOR'S REPORT

JUDGE FOR YOURSELF

ONE THING that practically all products have in common—be they hi-fi, groceries, or garden tools—is the continual struggle to convince the potential purchaser that each is better than its competitors. This is a natural and healthy condition, and it makes for improvement in the finished products from day to day and year to year in order for each manufacturer to maintain his position in his particular field.

Every manufacturer extols the virtues of his own product—carefully stressing the features that are obviously and noticeably superior to his competitors' goods, and equally carefully placing a minimum of emphasis on those points that are not "tops" in their field. We are often asked for an opinion as to what *is* the best loudspeaker, best enclosure, best pickup, best amplifier, and so on, and our answer is invariably the same—the one you like best.

Fortunately, the equipment offered in the high fidelity field is almost uniformly excellent. True, one loudspeaker may sound different from another, but that is easily explainable. Presumably, every loudspeaker manufacturer does his best to produce a unit which reproduces music as perfectly as possible—or if he doesn't, he should be trying to—but since there are no accurate means for evaluating the subjective effect of loudspeakers, the judgement of quality must come from an individual, or a group of individuals. Thus, if A builds the best loudspeaker he knows how to, and B makes the best one *he* knows how to, and so on with C, D, and E, yet all *sound* different, no one can truly say that one is better than the other. One listener prefers the first one, another the second, and so on, and the success or failure of each manufacturer depends on what percentage of the market he can best satisfy. And so it goes with all components—not just loudspeakers alone. Even amplifiers may measure exactly the same by measurement techniques we know about, and yet sound different. The point is that all the hi-fi manufacturers are specialists, and that they all make an honest effort to build the best products they can.

Such is not always the case with some of the pseudo-hi-fi products that are offered in competition to audio components. To be sure, the same claims are made in the advertising—or more generally even superior performance is claimed. This is unfortunate for the great mass of people who are not yet familiar with the quality with which hi-fi components are normally associated, for they do not know where to go to compare. And in most instances, quality audio components are not demonstrated in the same room with these so-called superior products—because they aren't sold by the same stores—so it is difficult to make direct comparisons. The audio-fan knows why they aren't demonstrated together, too.

So, to sum up our opinions and recommendations, we say, "Judge for Yourself." Hear them all, to be sure, but make sure that you judge on the basis of sound quality after adequate comparison. And judge on the basis of performance rather than claims.

H. R. 2128

Across our desk this past week came a letter from one of our regular correspondents who lives by his wits (no offense intended—he is actually an inventor with an impressive list of patents to his credit and, more important, an equally impressive amount of real estate to show how useful his inventions were) which seems rather more important than most letters which appear in the LETTERS column. This correspondent, Benjamin F. Miessner, calls our attention to a bill now pending before the House of Representatives Judiciary Committee—H. R. 2128. This is a bill which provides for the extension of those patents which could not be promoted, developed, or worked in manufacture because of the restrictions on manpower and strategic materials imposed by the government during the war years.

The idea of providing some relief for the inventor who was unable to derive income from his brainchild over a reasonable time, which is normally related to the statutory period of seventeen years, is not new. Such legislation is already in effect in the United States for war veterans, and most other patent-recognizing countries have already made some provision for relief to inventors who were prevented by circumstances beyond their control from working their inventions. It seems only fair to extend the life of patents in those instances where restrictions caused the inventor to suffer loss of income that he would normally have had.

Not everyone has a definite interest in patents, for there are many millions whose work does not lead them in the paths of inventive opportunity. But the average experimenter—whether in audio, plastics, or toxicology—is quite likely to have a patentable idea at some time in his work, and would welcome a fair shake. By writing our congressmen, we may just possibly be safeguarding our financial future. Aside from the fact that it is only right that the inventive minded—who have had such a large part in our economic development—should not be penalized for something which was not of their doing. Who knows—maybe any one of us will be in those shoes some day?

A letter to your congressman would help—and remember the bill, H. R. 2128. We should all be in favor of its enactment, and soon.

NEXT MONTH

Some months ago—last October, to be exact—we published an article describing briefly a unique loudspeaker which was somewhat revolutionary in construction. We had hoped to present more information about this unit before now, because of the large response from the readership. In fact, we even went so far as to schedule Mr. Villchur's description of its testing and performance in this issue. However, the size of the phonograph equipment section—herein—reduced the available space in the rest of the issue, and we had to leave it out. Look for it, however, in the July issue, along with many more interesting articles.

Pipes of Progress

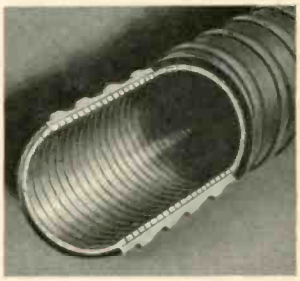
Hundreds of thousands of telephone conversations or hundreds of television programs may one day travel together from city to city through round waveguides—hollow pipes—pioneered at Bell Telephone Laboratories.

Round waveguides offer tremendous possibilities in the endless search for new ways to send many voices great distances, simultaneously, and at low cost. Today, Bell Laboratories developments such as radio relay, coaxial cable and multivoice wire circuits are ample for America's needs. But tomorrow's demands may well call for the even greater capacity of round waveguides.

Unlike wires or coaxial, these pipes have the unique property of *diminishing* power losses as frequencies rise. This means that higher frequencies can be used. As the frequency band widens, it makes room for many more voices and television programs. And the voices will be true, the pictures faithfully transmitted.

These studies illustrate once more how Bell Telephone Laboratories scientists look ahead. They make sure that America's telephone service will *always* meet America's needs, at the lowest possible cost.

Testing round waveguides at Bell Telephone Laboratories, Holmdel, New Jersey. Unlike coaxial cable, waveguides have no central conductor. Theoretically, voice-capacity is much greater than in coaxial cable.



New type of waveguide pipe formed of tightly wound insulated wire transmits better around corners than solid-wall pipes.

New type waveguide is bent on wooden forms for study of effect of curvature on transmission. The waveguide itself is here covered with a protective coating.

Bell Telephone Laboratories

Improving America's telephone service provides careers for creative men in scientific and technical fields.

A High-Power Amplifier With Minimum Distortion

BRUCE DePALMA*

In an amplifier not for construction by the novice, the author tries for a new "ultimate" in performance.

THERE IS NO DOUBT that the best of present-day amplifiers conform to very high standards. However, a study of the problem of distortion indicates that still higher standards can be set for a distortion-free amplifier and the writer has evolved a design whose principal constructional feature is a new cross-coupled phase-splitter-driver.

In working on the new design the writer realized that a somewhat new approach was necessary. To begin with, the new circuit would have to satisfy these requirements:

(1) Negligible distortion — intermodulation, harmonic, phase and frequency.

(2) No tendencies toward low-frequency or ultrasonic oscillations.

(3) A maximum power rating far in excess of that required for the reproduction of the highest instantaneous peaks found in music.

(4) A negligible incremental output impedance, and a means for making this variable in the negative direction.

(5) Complete freedom from hum, hiss, and microphonics.

For the lowest distortion, any amplifier must be critically adjusted. Therefore, for the best results, it is recommended that the construction of the amplifier to be described should not be attempted by those who do not have access to at least an intermodulation analyzer, a vacuum-tube voltmeter and a good oscilloscope.

The Circuit

The basic philosophy inherent in the design was to make the amplifier as perfect as possible before the application of negative feedback, so that with its application the distortion would virtually vanish. The signal level inside the amplifier was to be kept at the lowest possible level to keep the distortion at a minimum. In order to realize this only one voltage feedback loop is used (from the output transformer secondary to the input cathode). Each stage must operate at as low a level as possible, which cannot be achieved easily with internal feedback loops. A minimum number of stages is used, and the circuitry kept simple. Incidentally, no matched components need be used.

The input stage (*Fig.* 1) is a triode whose circuit parameters have been experimentally adjusted to produce the lowest amount of intermodulation without feedback. This drives a modified cross-coupled phase-splitter-driver V_2-V_3-V_4. This new splitter-driver circuit is primarily responsible for the performance of the amplifier.

In the original cross-coupled phase splitter[1] there were two cathode followers driving two triode voltage amplifiers. For single-ended inputs the grid of one of the cathode followers was grounded and left unused. It was found that the unused cathode follower could be re-

* *East Campus, Massachusetts Institute of Technology, 3 Ames St., Cambridge 39, Mass.*

[1] J. N. Van Scoyoc, "A cross-coupled input and phase inverter circuit," *Radio Electronic Engineering Edition, Radio & Television News,* Nov. 1948.

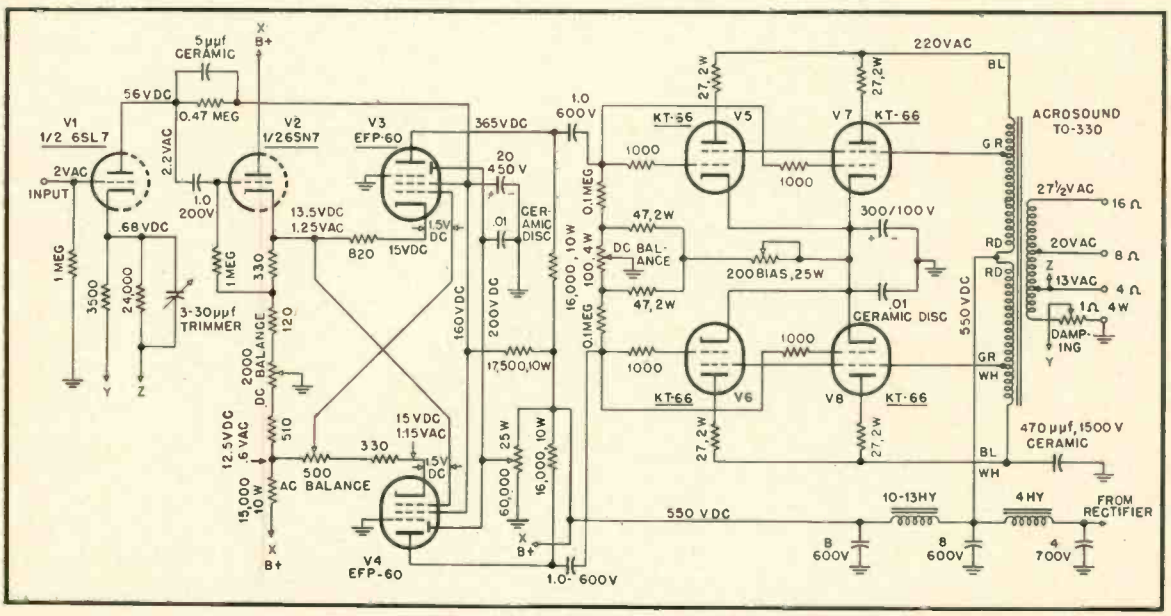


Fig. 1. Circuit diagram of the author's amplifier. Intermodulation and harmonic distortion are at lower than inaudible levels at 50 watts output. The EFP-60's are new, use a special 9-pin socket.

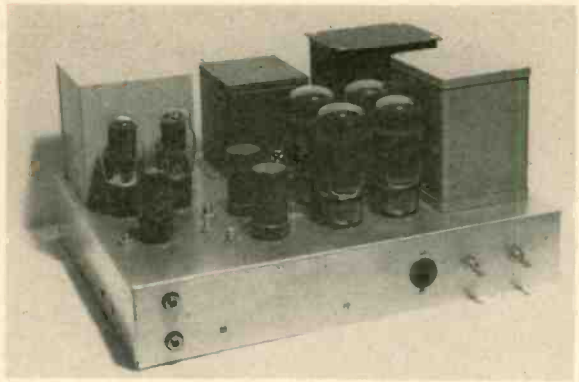


Fig. 2. Amplifier and power supply are together on the 13×17×3-inch aluminum chassis. Steel might be a better chassis material if the unit is to be handled to any extent.

placed with a resistor equal to twice the tube's nominal plate resistance with no effect at all upon the operation of the circuit except a slight additional amount of degeneration. This further helps to keep the circuit insensitive to the effects of drift and tube aging. This unused triode might then be used for the input voltage amplifier. However, tubes which make good low-distortion cathode followers in the cross-coupled circuit do not make good high-gain, low-distortion voltage amplifiers. Therefore, two separate tubes were used: one-half of a 6SL7 for the voltage amplifier and one-half of a 6SN7 for the cathode follower. The other halves of these tubes are unused and are thus free for other purposes such as a preamplifier.

Contrary to popular belief, a cross-coupled circuit is not self balancing, and the so-called balance controls incorporated in these circuits accomplish nothing but to change the d.c. biases on the voltage-amplifier tubes. Alternating-current balance *can* be accomplished by adjustment of this control to extreme values, thereby changing the mu of the tubes. This practice naturally leads to increased distortion. It must be realized that the drives to the power tubes are not necessarily equal to each other at the point of lowest distortion. Final tube unbalance and transformer unbalance, negligible in high-quality output transformers, account for this phenomenon. When final-tube and transformer unbalance cancel out the inverter unbalance, low distortion results, but this is not always the case.

Unbalance in the cross-coupled circuit can be traced to the driving of one tube by its cathode and the driving of the other by its grid. Assuming for the moment the absence of negative feedback (about 21 db of current feedback in the writer's circuit) the cross-coupled splitter reduces to a grounded-grid and a grounded-cathode amplifier driven by a cathode follower. In a grounded-grid stage the gain is equal to $\mu + 1$. In the grounded-cathode stage the gain is just μ.[2,3] When the gains of these two tubes are high they are approximately equal. There is one difference, however. Since the source is in series with the load in the grounded-grid stage, the tube has to deliver power. On the other hand, with the grounded-cathode stage, the input driving impedance is almost infinite for low frequencies. The cathode follower which drives these two stages has a low output impedance, but in order to get the least amount of degeneration from the cathode follower this output impedance cannot be reduced low enough to match the input impedance of the grounded-grid stage without drastically reducing the gain of the whole splitter.[4] Therefore, in order to get any gain out of the circuit there has to be a mismatch between the cathode follower and the grounded-grid stage, with consequent unbalance of drive to the two stages.

To adjust the drives to the final tubes for lowest over-all distortion a method had to be devised to vary the drives to the grounded-grid and grounded-cathode stages of the splitter. To see how this was accomplished refer to *Fig.* 1 and note the 500-ohm potentiometer in series with the cathode-bias resistor of V_4. The arm of this potentiometer is connected to the grid of V_3. Part of the negative feedback applied to V_3 is developed across the cathode resistor of V_4. By varying the amount of degeneration applied to the V_3 grid (by tapping down on the V_4 cathode resistor) we can equalize the loss of drive to the upper tube due to its mismatch. With this control, the a.c. balance of the inverter can be varied about 10 per cent either way—enough to take care of any final-tube or transformer unbalance. Adjustment of this control affects the d.c. balance of the inverter slightly, necessitating readjustment of the 2000-ohm d.c.-balance potentiometer.

In order to comply with the original requirements of a minimum number of stages and of keeping the a.c. voltages inside the amplifier small, a new tube just recently placed on the market, the EFP-60* was used as the voltage-amplifier-driver in the cross-coupled stage. This tube utilizes the principle of secondary emission to obtain the extremely high transconductance of 25,000 micromhos. Using this tube, one can use a very low value of plate-load resistor, thereby keeping the driving impedance low, and still obtain a very high gain. In the splitter-driver circuit, the tubes have a gain of better than 250 with a 16,000-ohm plate load resistor. Their circuit parameters have also been experimentally adjusted for lowest distortion. Naturally, using such high-gain tubes presents some problems of input-output isolation and shielding, but by careful construction one will have no trouble if the usual precautions adopted when working with high-gain, wideband amplifiers are observed.

A 60,000-ohm variable resistor across the high-voltage supply furnishes the "negative current" (a term adopted by the manufacturer) for the secondary cathode of the EFP-60. One electron impinging on this secondary cathode knocks out 5 more. These electrons are supplied from ground, while the electrode is kept at about 200 volts above ground by the B+ supply. This means that the resistor slider is kept close to its grounded end. A ceramic disc capacitor bypasses the secondary cathodes to ground at the sockets of the EFP-60's; this helps to stabilize the stage. In this circuit the suppressors of the EFP-60's are connected to ground instead of to their cathodes. It was found that when they were connected to the cathodes distortion and parasitic oscillations resulted. The fact that they are about 15 volts negative with respect to the cathodes has no effect on the operation of the tubes.

The Power Stage

The output stage is a conventional push-pull-parallel one with KT-66's ultralinear-connected, using the Acrosound TO-330 transformer. A 300-μμf capacitor and shunt .01-μf ceramic disc bypass the final cathodes to ground. It is essential to use this much capacitance to keep high-level intermodulation at a minimum. The disc capacitor nullifies the effects of inductance in the large electrolytics, thereby providing adequate bypassing over the entire useful frequency spectrum.

A 470-μμf high-voltage ceramic capacitor from the blue-white plate lead of the output transformer to ground corrects for a capacitive unbalance to ground which would otherwise exist in the transformer due to the geometry of the windings. This capacitor clears up a slight ultrasonic parasitic which developed when the transformer was overloaded. The measured capacitive unbalance existing in the transformer is actually less than 100 μμf. The 470-μμf capacitor evidently has some other stabilizing effect than just cleaning up the capacitive unbalance to ground.

[2] F. E. Terman, "Radio Engineers Handbook," 1st ed., McGraw-Hill, New York, 1943, pp. 470–471.

[3] "Reference Data for Radio Engineers," 3rd ed., Federal Telephone and Telegraph Corporation, 1949, pp. 252–253.

[4] S. W. Amos "Valves with resistive loads," *Wireless Engineer,* April, 1949, pp. 119–123.

* The EFP-60 tubes are manufactured in the Netherlands by N. V. Philips Gloeilampenfabrieken, Eindhoven, and are imported into the U.S.A. by Amperex. Usually stocked by the larger parts houses, they may be ordered from Amperex, Hicksville, N. Y. if unavailable in your locality. The socket is Amperex No. S-13211.

The negative feedback voltage is taken from the 4-ohm tap on the transformer secondary. It was found experimentally that in this way more feedback could be applied without instability (high-frequency oscillation) than could be applied when the feedback was taken from the 16-ohm tap, the conventional practice. The negative feedback is applied to the cathode of the 6SL7 voltage amplifier V_1 through a phase-advance network consisting of a 3-30-μμf trimmer capacitor in shunt with a 24,000-ohm resistor. The amplifier has a voltage gain of about 535 from the input to the grids of the KT-66's with no feedback. 32 db of negative feedback is applied in one loop from the output to the input. With this amount of degeneration, 2 volts at the input drives the amplifier to 50 watts output, so that there is a voltage gain of about 10 to the 8-ohm tap on the output transformer secondary.

Since the feedback loop includes the output transformer, it is natural to expect stability problems to arise. The amplifier is perfectly stable at the low-frequency end, due to the large ratio (greater than 400 to 1) of the coupling capacitor low frequency cutoffs.[5] There is however another low-frequency cutoff, that of the transformer. Its effect on the low-frequency stability is hard to ascertain because it varies with the level of transformer excitation. Suffice to say no low-frequency peak was found in the range ending at 1 cps. Due to the difficulty of making measurements, the region below 1 cps was not investigated. The long time constants used in the amplifier reduce the low-frequency phase shift to almost zero, while extending the low-frequency response of the amplifier to below 1 cps. This extended response is obtained without the low-frequency transient instability peculiar to Williamson-type amplifiers. Many of these amplifiers are in a condition of near oscillation at a frequency of about 2 cps and when the amplifier is excited by a low-frequency peak, it is "triggered" at this subsonic frequency, causing the reproduced sounds to have a muddy, mushy, lack-of-definition quality. These difficulties are completely absent with the amplifier discussed here.

At extreme high frequencies, the large amount of feedback employed tends to introduce problems. Since more than the 30-db limit recommended for the transformer is being applied, it is natural to expect some difficulties to develop. In this amplifier two unstable regions were found—regions where the phase lag of the amplifier was sufficient to cause it to oscillate through the feedback loop. These were 110 kc and about 1.5 mc.

The instability at 1.5 mc. was eliminated by reducing the loop gain at this frequency to a value less than unity, shunting the 470,000-ohm plate load resistor of V_1 with a 5-μμf ceramic capacitor. This expedient did not work, however, for the 110 kc oscillation. It was found that the output transformer leakage reactance was causing sufficient phase delay at this frequency to prevent 32 db of stable feedback. Various "step" selective phase-advance networks were tried in order to steer the phase characteristic of the amplifier away from the 180-deg. point in this region. None of these "step" networks had much effect, so a variable 3-30-μμf mica trimmer across the feedback resistor was finally adopted. This expedient cured the oscillation.

An adjustable incremental damping factor network has been incorporated into the design of the amplifier. The operation of this network is to control the amount of negative feedback applied to the amplifier by means of the current flowing in the load. The adjustment of the 1-ohm potentiometer is conventional.[6] If not desired, this network can be eliminated without affecting the performance of the amplifier in the slightest.

Construction

The amplifier and power supply, illustrated in *Figs.* 2 and 3, were constructed on the same 13 × 17 × 3-in. aluminum chassis. It is recommended that the amplifier be laid out and constructed in straight-line fashion. Particular attention should be paid to common stage grounds and bypassing the EFP-60 dynodes to ground directly at the socket. Radio-frequency wiring practices are advisable. It is recommended that the filament leads be shielded or twisted and kept close to the chassis. All signal wiring should be point-to-point and kept away from the chassis. In particular, the 1-μf coupling capacitors should be suspended away from the chassis by their pigtail leads. It is definitely *not* recommended that bathtub capacitors be used for this purpose. The writer suggests metallized-paper tubular capacitors for their small size, high voltage rating and self-healing properties. Only noninductive composition resistors should be used for the grid and plate stoppers of the KT-66's, and these should be connected by the shortest leads directly to the sockets. The KT-66's should be allowed plenty of ventilation, as they must be run at maximum ratings for lowest distortion. The filament supply for the amplifier must be the correct 6.3 volts; the EFP-60's are very sensitive to deviations in filament supply voltage, especially in the negative direction. The plate supply should be able to deliver a continuous 300 ma at 550 volts with good regulation. A pair of 5V4's as rectifiers is recommended. Although the manufacturer's recommended maximum plate voltage per plate is exceeded, no trouble has been experienced in several months of extended operation. It was found that the better regulation inherent with 5V4's will reduce the high-output-level intermodulation by a factor of more than 25 per cent over a pair of 5R4GY's.

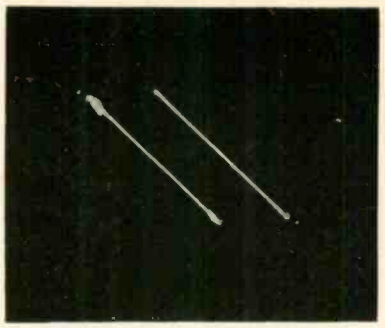


Fig. 4. Fuzzy tips on the input-output characteristic shown in this oscillogram denote instability at extreme high frequencies at very high power levels. Adjust the feedback trimmer to eliminate this trouble.

Adjustment

Perfection is no accident; distortion-free operation cannot be achieved without critical adjustment.

After checking the wiring the following adjustments are made with the power off: Set the d.c. balance control to its middle position, the arm of the a.c. balance potentiometer close to the junction of the 15,000-ohm and 510-ohm resistors, and the slider on the 60,000-ohm resistor to the grounded position. Adjust

(*Continued on page 75*)

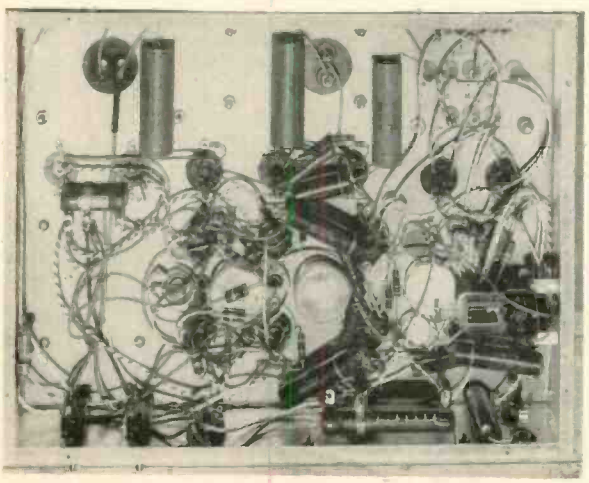


Fig. 3. Under the chassis of the amplifier. Despite experimental nature of this model the important leads are dressed as the author recommends in the text.

[5] N. H. Crowhurst "Feedback," "Audio Handbook No. 2," Norman Price, Ltd., 1952.

[6] "A new approach to loudspeaker damping," Warner Clements, AUDIO ENGINEERING, August, 1951.

At Home with AUDIO

LEWIS C. STONE*

Homework Hi-Fi

Wherein informal audio-pile yields precision audio results

AS FAR AS we can tell this month's hi-fi system points to no particular trend in "variations on the theme of housing the equipment." which is one of the topics on this department's agenda. Are there more hi-fi installations contained in music-wall erections than are cabineted separately (and we've had both here), or housed in a "projection room" (of which more another time, perhaps)?—we have no way of stating authoritatively. The fact is, these variations are seemingly endless as between one hi-fier and another. We *have* found that equipment housings are either completely deceptive or disarmingly revealing (reflection, if any, on their owners' character not intended). How a few such installations have been managed will be presented in all their grisly detail in succeeding editions. Space permitting, we expect some of these will be in the form of replies, to direct inquiries we have been getting from readers of this corner of Audio. (Corresponders please note.)

Audiophile's Audio-Pile

The home audio system we have taken on for discussion now is in essence the not so little brother to the big rigs of the professional recording studios. Like these, reader Crofford (who is a recording technician with Westminster Recording Co. Inc.) shows thoroughbred tape recording and playback equipment; plus of course tuner, preamplifier, amplifier, power supply, earphones, microphones, disc playback. It so happens that this hi-fi installation spreads itself with some nonchalance in its several "arks" (as in *Fig.* 1). They are, so to speak, pictorially sited together in intimate contiguity as of houses in, say, an Italian mountainside village. The arrangement, in fact, places what is in this case the most used article—the tape recorder—above the comfortable height for handling (which should be, as broached in this department last year, on a level with your bent elbow, neither much lower nor much higher). But let us observe the amenities of open-mindedness and hold ourselves to a quite "linear" reaction to this departure from the rules of operational convenience. For, though our audiophile's audio-pile may run counter to the tenets of the counter-top school of hi-fi component concealment, we shall have to concede that reader Crofford's array of cases and cabinets holds more than we would ordinarily permit the first casual, jaundiced glance of our interior-decoration indoctrinated eye to perceive. See the block diagram, *Fig.* 2.

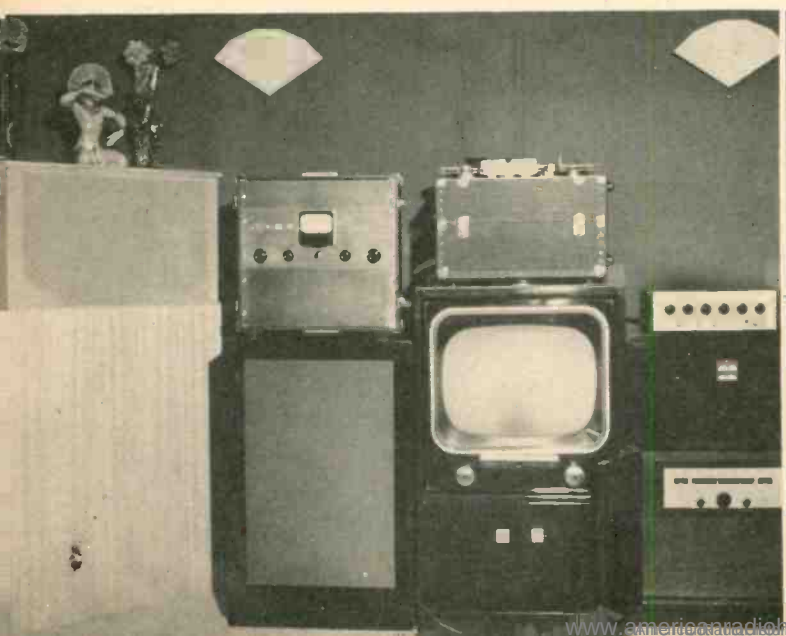
Yet it is not for want of manual skills nor for lack of desire that this system is relatively "unhoused"—as a *system*. On the contrary, our reader is far from being unhandy with a tool—even those carpentering ones we listed rather copiously in our opening article. But in the use of limited spare time he has preferred to be profligate with devotion to the cult of the cabled wire-up, the reamed-out cut-out for socket, transformer and so on, that go with making chassis build-ups for (you've guessed it) that certain U—L—amplifier circuit adaptation at the expense, up to now, of any working in homogenized cabinetry.

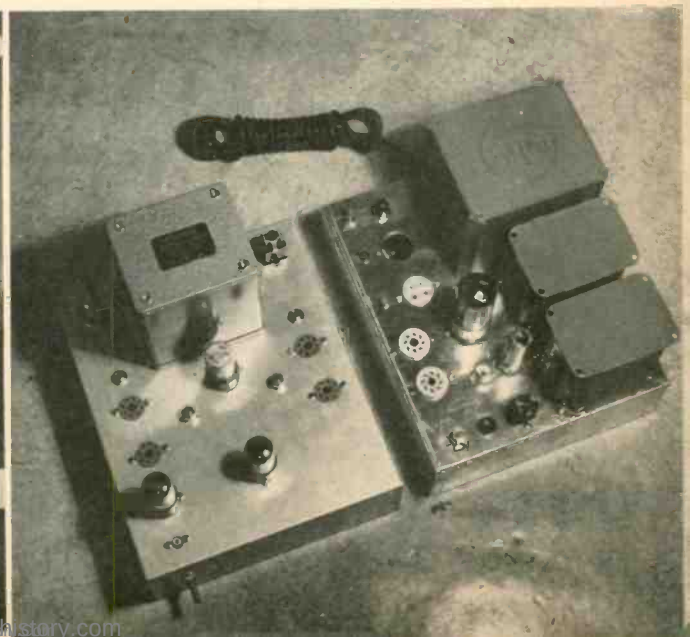
Home On the (Frequency) Range

For this man's money, hi-fi can easily be forever. His

* *235 E. 22nd St., New York 10, N. Y.*

Fig 1 (left). No wallflowers are these vociferaus hi-fi furnishings. Line-up shows Klipschorn main speaker system; Ampex electronics assembly in case over separate speaker for TV, with mechanical assembly in case atop TV cabinet. At right is Marantz Audio Consolette over phono and radio cabinet which also houses main power amplifier. Below it is the REL Precedent FM tuner. Fig. 2 (right). Chassis of amplifier and separate power supply in pre-tube-mounting stage. Tube sockets are Vectors: wiring on underside is cabled; transformers are completely potted.





audio life is rounded out with what could be (we daresay) every man's dream—a library of many hundreds of across-the-labels LP recordings of all shades of musical thought, not to mention a solid collection of original and facsimile large-reel tape-ups in total beyond the reach of most of us financially, and anyway for most of us—whose hi-fi is a hobby marginal to our daily breadwinning—regrettably unavailable. In his view the playback equipment, thoroughbred though it surely is, should be regarded as valet and handyman to this nobility of the world of recorded music. Which may go a little towards explaining (there are other reasons, of which later) why the walls of this man's audio room are also played down by being painted, if not an absolute black, then the closest thing to it we have ever "sensed." Moreover, three of the cabinets are ebon ("ebony" is just not the word for it). Another, the speaker cabinet, is blond; but black again is the portable case in which the tape recorder is mounted. Add low-key lighting (photographing the joint was quite a problem at first), dark drapes, dark upholstery —and one could pretty well imagine (*sans* the incense burner routine) a Baudelaire-ish world-well-lost emanation—perhaps, for all one can tell, a fitting setting for a sort of audio-séance kind of place. The total effect touches on space without limit, for in this dark nimbus little depth of field can be managed by the eye. But as for the ear—there's an organ gets the red (black!) carpet rolled out. The vortex of sound is held in by the dark embrace of the somber walls, at it were, and it might be damped or extinguished but for the clear assertiveness of the highly efficient speaker system, which leaves no wave or impulse without its due measure of reporting.

Housed in the tallest single cabinet (nearly five feet high) is this speaker system. The main unit is the whopping 18-

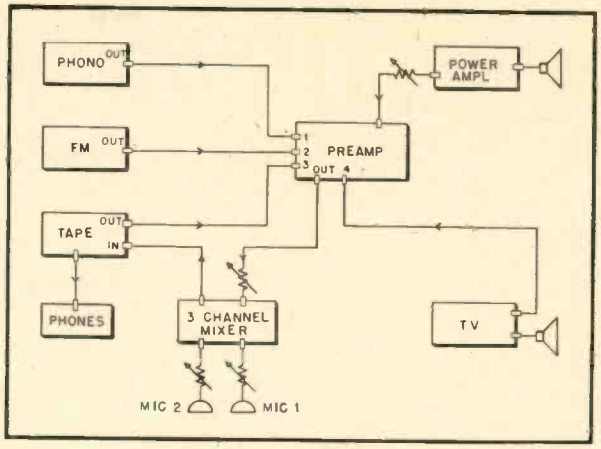


Fig. 3 (above). Block schematic of the entire system as this reader uses it. Important is fact of flexibility and convenience. Fig. 4 (below). Schematic of the unusual 60-watt amplifier and power supply. Note use of voltage regulation in circuit of latter. See parts list for components.

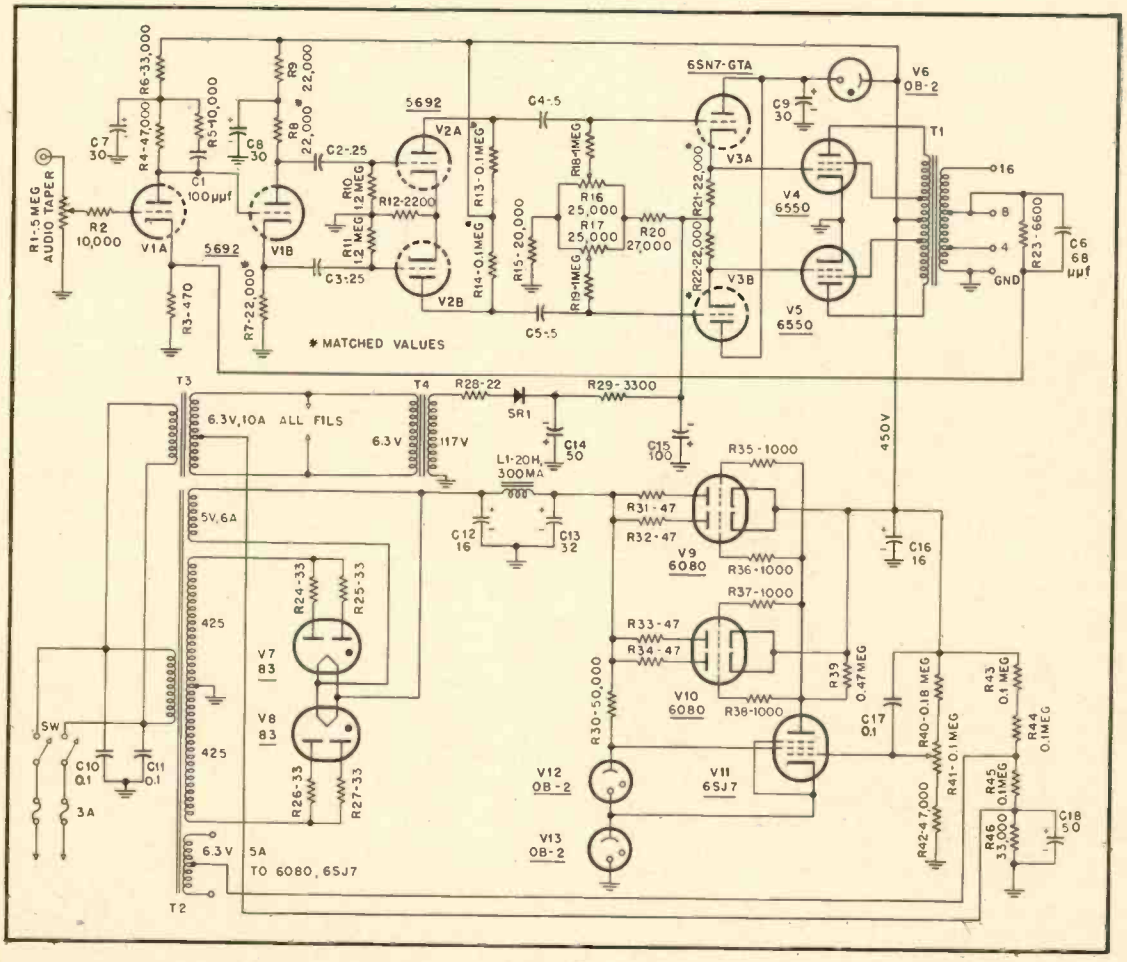


Fig. 5 (left). With hand on record-level control, operator is positioned to set proper level for recording while he monitors with earphones through phone jack. Fig. 6 (right). With both hands on editing knobs, tape is jockeyed slowly through head assembly to spot noises heard in playback. With aid of earphones, exact spot is located and marked, then eliminated and spliced.

inch Electro-Voice model 18WK, in Klipsch K baffle (folded horn enclosure). Shelf-borne right over this, the mid-range hollers through a Jim Lansing 500-350 horn assembly and its 375 driver, with crossover at 300 cps, the 12 db per octave network self-built. The high frequencies clarion through a pair of T-35 Electro-Voice tweeters, placed one on each side of the mid-range assembly, both faced towards the back of the enclosure and triggered into chorusing by their own 8,000 cps crossover network. This, with the other cases and cabinets are ranged across the narrower wall of the approximately thirteen by nineteen foot room. It should give you an idea of the real informality of the hi-fi furniture layout, although the total bill came to a rather stuffy hi for all of this fi and one would think a music-wall might be indicated for safekeeping this rich hi-fi fare, if nothing else. But it ain't necessarily so. For one—and this seems to be the heart of the matter—as a seasoned hi-fier reader Crofford often is called upon to use his tape recorder on the outside. Perched atop the Craftsmen TV cabinet, the portably cased tape recorder can be easily removed to be taken out on off-premise assignments. These might be for A-B comparisons, recording

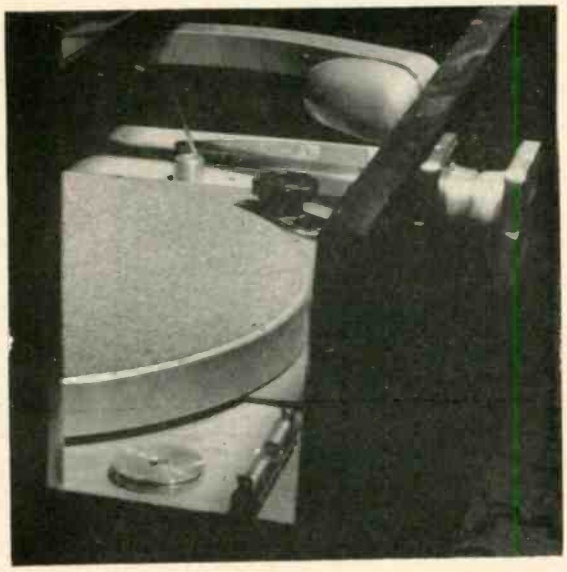


Fig. 9. Record playing equipment in slide drawer with shallow pullout for stability. Shows Rek-O-Kut turntable, Fairchild arm and cartridge; also spirit level, stylus pressure gauge, 45-rpm adapter disc.

wedding and other ceremonies or special meetings for later dubbing to disc, and so on. A thing impractical to do if the recorder were an integral built-in.

Testing, Testing . . .

And again, as to safeguarding this thoroughbred equipment (music-wall or no) our reader is strong on maintenance and observes religiously the prescribed rites, such as keeping tape recorder heads sterile by brushing with tetrachloride before and after use, and so on through the mechanical assembly of his 350P Ampex. Neither is recording undertaken without checkups with an audio oscillator to assure those results we call optimum. Not excepting also, frequent checking of the general systemic signal level: voltage analysis of amplifier with an RCA WV97A VTVM, or current measurements of tubes and resistors with a Triplett 625NA unit. By measuring d.c. and a.c. voltages, the former reveals troubles in the shape of burned-out resistors, open or shorted capacitors, etc.; and with the latter, he checks adequacy of circuit operation to the functional requirements of the entire system.

You would tend to use such instrumentation, as our reader unfailingly does, to check out the equalization and record-head alignment so that the recording on tape will be held to unvarying maximum output of the upper frequency ranges. And you can use the audio oscillator to test the amplification wing of your own system for frequency range, output voltage and power. Indeed, this checking and re-checking of equipment for security as to optimum hi-fi results becomes important as you progress from taking your early pleasures in audio results by the "strength of your ignorance" and learn, while you listen, to listen—finally to appreciate the finer points of the technique of sound reproduction as you hi-fi with audio at home. The notion that test instruments are for trouble shooting (after the event) is OK but they are also, as used here, the electronic trouble preventive. Test instruments have a place, we venture to suggest, not only on the serviceman's bench, but just as assuredly in the dedicated audiophile's sea chest. All of this goes to show how goes the safari of a hi-fier a-hunt for linear results that will come ever closer to reconciling fact with dream. Fact, such as that amplification is developed further along than speakerage; dream, a seeking for the greatness of reality in sound created as pure as can be with such, at the moment, disparate efficiencies.

Behind the Sonic Scenes

Be that as it may, the fact remains that in practice and routine our reader follows an exemplary pattern of audio-behavior. Under lab conditions by day, he listens to recordings (tape, or mother, or pressing discs) as a job to be done,

Fig. 7 (left). Splicing tape with EdiTall block. Insert tape snugly in groove and pass razor blade along diagonal slot to make true cut. Blade should be demagnetized before cutting to avoid clicks or partial erasure of tape after splicing. Small reel of splicing tape is shown. Fig. 8 (right) Operating wires and cables: Bottom row, (l. to r.) Coaxial microphone cable with phono tips used to hook up preamplifier output to amplifier input . . . Coax cable with phono plug on one end, alligator clips on other. Used for testing, phono tip into preamp out, the clips to voltmeter terminals. Will indicate signal-to-noise ratio; also checks frequency response . . . Coax cable, phono tip on one end, phone plug on other, for connecting appropriate tape recorder output to amplifier input, to play through main speaker system . . . Three-wire microphone cable with Cannon XL connectors on both ends. Shown hooked up as extension to microphone cord. Middle row (l. to r.) Three-wire microphone cables, with Cannon XL connectors on both ends. Two sets shown, giving cable extra length . . . Electro-Voice 655 microphone with connecting 3-wire cable—two conductors and ground—to assure low hum pickup and low extraneous noise pickup. Top row. Altec "lipstick" microphone and its own power supply with factory-equipped accessory hookup cable. Output is a balanced 3-wire line with Cannon XL connector. Upper right: coax cable with phono tip and Cannon connector. Hooks up output of REL tuner to Ampex input for off-the-air recording to tape.

intent then for flaws, in the sterile atmosphere of high-level lighting, stainless steel and chromed apparatus. Thus it may be that an un-bright home interior is a sort of escapist stage setting for a placid, private, unofficial kind of listening to musical offerings whose interior content is, perhaps, heard whole only there, as against the fragmented note-by-note and instrument by instrument "snooping" in the recording lab, with stop-watch holding and meter-reading intensity. Such are the means to an end result in recording that bring states of exaltation and then of deep repose to those of you who are aware that the science of cycling sound beyond the push-pedal or tin-ear level can be as brand-new young as your own discovery of it through good hi-fi instrumentation of your own.

Such are the activities behind the sonic scenes that, in the general scheme of sound "manufacture" place ahead of the workings of the inner sanctums of designer and maker of signal-source and pickup equipment. And correspondingly, should your pre-listening ritual be full of carefully poised gestures. Just so is the disc held edge-to between palms first wiped dry. Just so is it placed on the turntable, and pickup arm (rechecked for true with spirit-level, and for pressure with gauge) wafted down upon the playing surface. To experience all the ecstasy this can bring, the lover of beauty in music must perforce become a knowledgeable knob-twirler. Adequate controls provide sensitive variation of sound to suit temperament or inclination. Thus, in this case on a Marantz preamplifier are the roll-off, the contour, the loudness, the bass, the treble controls delicately turned through an infinitesimal arc each, first one way and, closely listening, perhaps the other way. Volume is opened up then and from out of—as it were—creation's void come the Voices.

The Amplifier Universe

But not exactly a "void." Say, rather, the universe of amplification—60 watts-worth of it. The self-made amplifier and power supply in this system are mounted on two separate, self-punched out aluminum chasses, each 10 by 12 by 4 inches. The logic of their construction can be told in no better terms than these notes on the components and their respective and related functionings. This version of the Ultra-Linear harbors in its circuitry two matched 5692 tubes as voltage amplifiers and phase inverters. The first stage has a phase-shift network in the plate circuit to offset that in the output transformer. Feedback is introduced from the output transformer to the cathode of the first stage. The second stage is a split-load phase inverter, and it is coupled to a push-pull driver stage; from there it goes to a push-pull cathode-follower driver, thence to the output stage, consisting of a pair of 6550's Ultra-Linear push-pull connected. An OB2 is in the plate circuit of the cathode follower drivers to keep a constant voltage at the plate of the cathode follower. Fixed bias is used on the output stage and it is adjusted by changing bias on the 6SN7GTA cathode-follower driver. (We expect you will be referring to the schematic, *Fig.* 3.) All resistors in plates and cathodes, feedback resistors and phase-shift resistors have 1 per cent

(*Continued on page 62*)

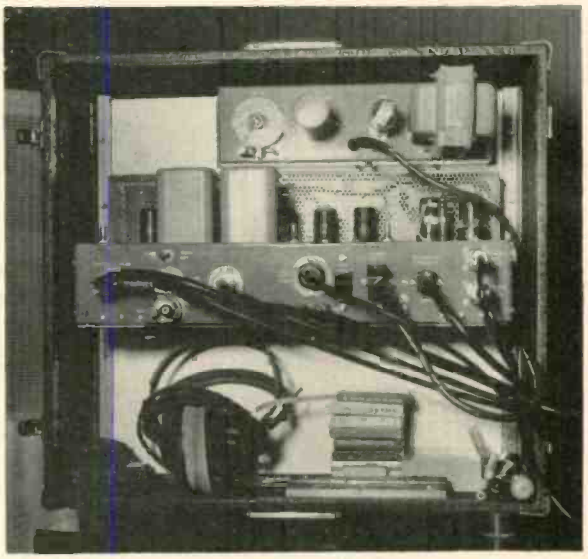


Fig. 10. Rear of Ampex electronic assembly, with power supply at top, record and playback preamp below. Cord sets are original equipment, and connect to main amplifier. Accessories on bottom shelf include Ampex head demagnetizer, Permoflux earphones, tape splicing block, and marking pencils.

Negative Feedback

The basic principles of negative feedback, and its use in variable damping factor and tone control circuits.

EDGAR M. VILLCHUR*

LET US SUPPOSE that the power steering system of an automobile is (for the sake of argument) somewhat out of adjustment, in that it over-responds when pulled to the right. The driver senses the trouble instaneously, and compensates for the defect by applying less force on right turns. This is negative feedback in operation, although it is not automatic; the feedback "circuit" includes the driver himself.

The function of an audio amplifier, as of a power steering system, is to control large amounts of power by small amounts of power. The electrical signal from a radio tuner or phonograph pickup cartridge, representing the broadcast or recorded sound, may have enough power to drive a pair of earphones but is hopelessly inadequate for a loudspeaker. Before the electrical currents can be reconverted to sound of appreciable volume they must be *amplified,* that is, their power must be increased. At the same time there must be negligible distortion—the fidelity of electrical representation must not be changed.

The electron tubes that are the heart of the amplification process perform with good, but not perfect fidelity. Prior to the universal acceptance of negative feedback as essential to high-fidelity amplification, "undistorted" amplifier power meant maximum output at which the harmonic distortion was no greater than 5 per cent. One-twentieth of the output signal could consist of spurious harmonics not present in the original input. Modern engineering techniques have been able to reduce this distortion figure by a factor of 100 (leaving pickups and loudspeakers far behind), and the most powerful of such techniques is the application of negative feedback.

Feedback In Amplifiers

A common explanation of how negative feedback reduces amplifier distortion goes something like this: part of the output signal is fed back into the amplifier out of phase, thereby partially cancelling distortion products. Such an explanation is not incorrect, but it is incomplete.

If no mention is made of the point at which the feedback signal is introduced in relation to the point or points at which the distortion is generated, the above explanation becomes a house of cards that can be easily demolished. It is only necessary to point out that the out-of-phase feedback signal can reduce the amplitude of the faithful part of the signal in exactly the same amount as it reduces the distortion elements, thus leaving the distortion percentage unchanged. Clearly we must dig a little deeper. We will see that if the negative feedback signal is introduced into the amplifier at a point *before* the distortion is generated, it acts as a pre-compensating element which reduces the percentage of distortion in the output signal.

Consider the case of a pure sine wave applied to an imperfect amplifier. The output signal fed to the loudspeaker will be a distorted version of the input, as illustrated in *Fig.* 1. It is evident that a characteristic of this amplifier is the reproduction of positive peaks with insufficient relative amplitude.

If the entire process took place very slowly we could compensate the signal input for such a characteristic and produce a pure sine wave in the output. As the signal approached its positive peak we could turn up the level control of the signal generator to just the right position at each moment (monitoring the amplifier output with an oscilloscope) so that the extra signal voltage would force the instantaneous amplifier output to conform to the sine-wave pattern. The erratic output characteristic of the amplifier would then be corrected for at every point by an inverse characteristic of the signal input from the generator. This would be a nonautomatic feedback system, in which the differences between output and original input signals are sensed by the operator, and the corrections applied manually.

The periods of time involved in the amplification of an audio half-cycle, of course, are very small, and correction for amplification characteristics through feedback must be applied automatically and without measurable time delay. The negative feedback circuit does just that; it compares the distorted output signal with the undistorted input, and applies to the amplifier a corrective signal corresponding to the differences between the two.

Automatic Correction

Figure 2 illustrates the automatic correction applied by negative feedback. The steps illustrated in sequence show the transmission of the signal through the amplifier and back through the feedback circuit; the time taken by each step is so small that it cannot be measured by ordinary methods, and the process may be considered instantaneous.

The distorted amplification of a sine wave is illustrated in (A) of *Fig.* 2. Part of the distorted signal is tapped from the amplifier output and fed back to the input in such a way that the phase is exactly opposite, as illustrated in (B). Notice that the feedback signal is fed back to a point before that at which the distortion was generated, so that the distorted signal is mixed out of phase with an undistorted signal.

Two things must happen. The original input signal will be reduced in strength, and a corrective enlargement of the first half-cycle will appear in its wave form. It is as though the circuit knows what the amplifier is going to do to the signal's positive peak and sends in the signal forewarned and forearmed. Where the defective amplifier will not furnish enough gain, at the positive signal peak, the signal itself is precompensated by having too much voltage relative to the negative half-cycle. The output signal shown in (B) of *Fig.* 2 is reduced in power but has a lower percentage of distortion.

It is important to know that while gain is sacrificed by negative feedback, amplifier *power capability* is not. The third step in the feedback process is illustrated in (C) of *Fig.* 2. The cor-

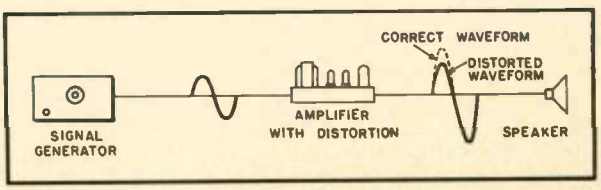


Fig. 1. Distorted reproduction of a sine-wave signal. The instantaneous amplification is reduced on positive peaks.

* *President, Acoustic Research, Inc., 23 Mt. Auburn St., Cambridge 38, Mass.*

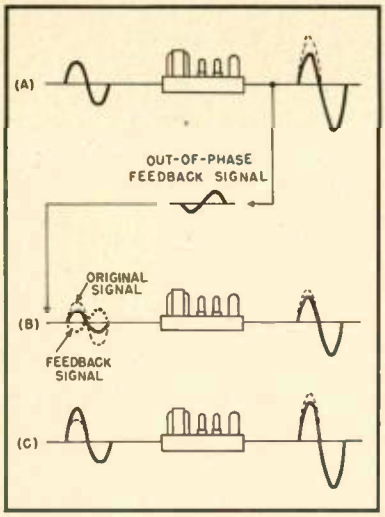


Fig. 2. How negative feedback corrects for distortion. The steps illustrated take place practically instantaneously.

rected input signal is increased to bring it back to its value before the application of feedback, and the original output power is restored at lower distortion. Not only is the power-output capability of an amplifier not reduced by feedback; the power output at the original maximum distortion rating is actually increased somewhat. It is necessary, however, to drive the amplifier harder, that is, to provide a higher input signal.

Amount of Feedback

Not too long ago audio amplifier specifications might have listed "negative feedback circuit" as one of the desirable features. Today the existence of such a circuit is assumed, and the specifications often describe how much feedback is used. The amount of feedback, in decibels, is the ratio of the original signal voltage to the corrected signal voltage; thus the number of db of feedback also refers to the reduction of amplifier gain.

For example, suppose that a 30-watt amplifier is driven to full output by an input signal of .025 volt prior to the application of negative feedback. Twenty db of feedback (a healthy amount for an audio amplifier) means that the amplifier gain has been reduced to one-tenth, and 0.25 volt input will now be required to produce the same 30 watts. If the feedback is applied in such a way as to be fully effective the distortion and noise will also be reduced by a factor of 10.

Limitations of Feedback

Negative feedback seems to work wonders, but it is not magical, and it does not work against all types of distortion. It is completely wrong to design an audio amplifier carelessly and to assume that feedback will take care of any trouble. An amplifier circuit should be as "clean" as possible before feedback is introduced.

One limitation of feedback will appear obvious if we consider again the original example of the automobile power steering mechanism. If the trouble consisted of the fact that the front wheels of the car would not turn far enough, due to a bent frame acting as a mechanical stop, no amount of increased force used by the driver would help. Similarly, if the output wave form of an amplifier is clipped because the tubes have reached saturation and cannot pass more current, or have reached current cutoff, no change of amplifier gain, automatic or otherwise, can change the instantaneous value of the current being passed. Feedback can only help in those situations where an instantaneous variation in gain will produce a change in output.

Another limitation of negative feedback is inherent in the amplifier components themselves. The feedback circuit is designed to apply its corrective signal 180 deg. out-of-phase, but this phase relationship just does not hold up at the extreme low and high frequencies, especially when the output transformer is within the feedback "loop." The phase shift that occurs at the frequency extremes can be so great that the feedback becomes positive, in which case

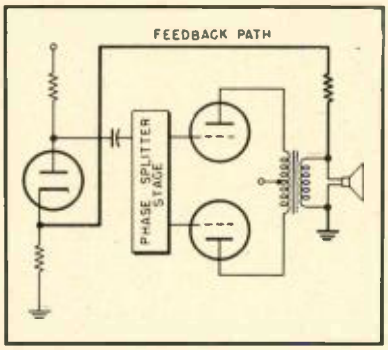


Fig. 3. Typical negative voltage feedback circuit.

amplifier gain and distortion are increased or the circuit begins to oscillate.

Too much feedback used over a circuit whose phase shift is too high results in low-frequency "motor-boating" (the name given to oscillations of subsonic frequency because of their characteristic sound), or high-frequency squeals. Some of the worst effects occur when the oscillations break out only on signal peaks, producing distortion. The effect of high-frequency oscillation often imitates speaker rattle to perfection.

The successful use of large amounts of feedback is thus only possible with amplifiers which are of high quality to begin with. However, the application of moderate amounts of feedback can produce dramatic changes in low-cost circuits.

Types of Feedback

When the corrective feedback signal is controlled by the output voltage the circuit is said to apply *voltage feedback;* when the feedback signal is controlled by the output current (which can have quite a different pattern of variation from that of the output voltage) the circuit is said to apply *current feedback.* Both of these types of feedback have the same effect on distortion and noise, but opposite effects on the amplifier damping factor.

Figure 3 illustrates a typical voltage-feedback circuit. Part of the voltage across the output transformer's voice-coil winding is applied to the cathode resistor of an earlier stage. This has the same effect as applying the signal directly to the grid, but provides the additional convenience of a low-impedance path.

Figure 4 illustrates a current feedback circuit. As the speaker's impedance changes at different frequencies, due to changing back-emf's the signal current through the secondary circuit and through *R* changes correspondingly, although the signal voltage applied to the speaker may be unaffected. The feedback signal is taken from the IR voltage drop across *R* rather than from the actual signal voltage, and is thus controlled by the output signal current.

Variable Damping Factor

A combination of voltage-controlled and current-controlled feedback can be used to provide an amplifier with a variable damping factor. The two circuits can be so ganged that the net negative feedback, and hence the net effect on distortion and noise, remains the same.

The amplifier damping factor may be defined as the ratio between the speaker impedance and the source impedance which the speaker "sees" looking back into the amplifier. A high damping factor means that the speaker sees a very low resistance, and that this low resistance acts as an electrical brake on the speaker. Any voice-coil vibrations unauthorized by the amplifier signal (such as hangover vibrations, which tend to occur after a heavy stimulus in the region of speaker mechanical resonance) must send current through the source resistance—the speaker is not only a motor but a generator—and with a low value of source resistance the speaker is immediately braked to a halt.

(Continued on page 70)

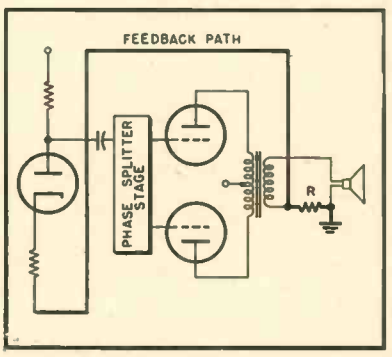


Fig. 4. Typical negative current feedback circuit. The feedback voltage is dependent upon the current flow in the speaker circuit.

A Novel Tape Recording Amplifier[1]

A. F. FISCHMANN*

The author describes a recording amplifier which provides a constant-current source for the head. This characteristic is achieved by applying current feedback from the load of the amplifier to its input.

THE PURPOSE OF A RECORDING HEAD is to provide uniform magnetization for the tape over the frequency range covered by the amplifier feeding it. As the magnetizing force is proportional to the curent flowing through the head, such a characteristic is achieved by connecting the recording head to an amplifier whose output current is proportional to its input voltage. Such an amplifier is characterized by an extremely high output impedance compared to the impedance of the load, which is in our case the recording head in series with the coupling capacitor C in *Fig.* 1. As the recording head is, for all practical purposes, a pure inductance, the constant current flowing through the recording head creates across its terminals a voltage drop increasing by 6 db per octave and reaching a considerable amplitude at high audio frequencies.

The problem of recording amplifiers is solved conventionally by connecting the recording head to a voltage amplifier through a high resistance as in *Fig.* 2. However, this has the disadvantage that over the greater part of the frequency range only a small fraction of the available output amplitude is used in the recording head, the rest being uselessly dissipated in the series resistor R. In the recording amplifier described in this article and shown in basic form in *Fig.* 3, the load is directly connected to the anode of the output tube, thereby utilizing the total output available. The necessary high output resistance of the amplifier is achieved by applying current feedback throughout the amplifier. This results in an output resistance which is practically equal to the value of the load resistor R_{L2} of the output tube in *Fig.* 3. The advantages resulting from such an arrangement are three:

(1) The amplification is linear and independent of the tube characteristics, owing to the strong feedback.

(2) The frequency response may be influenced by including a frequency-selective network in the feedback path. This network can consist of extremely low impedances and is therefore not subject to capacitive pickup. It may be connected through long leads to a conveniently located switch correcting the frequency response for different kinds of tape or for different speeds.

(3) The power delivered by the output tube is fully utilized. A 6SL7 is amply sufficient to drive a conventional high-impedance head.

* *390 Park Place, Brooklyn 38, N. Y.*

[1] Work done while with Israeli Ministry of Defense, Scientific Department.

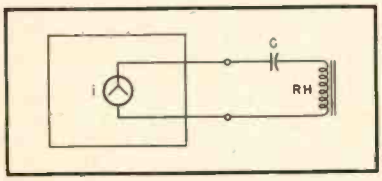


Fig. 1. The ideal recording amplifier gives constant-current output.

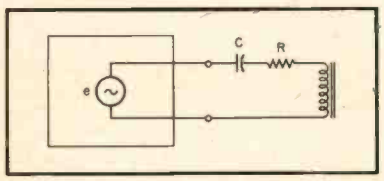


Fig. 2. Usual method of operation is to use a medium-impedance amplifier with a large series resistor to achieve constant recording-head current. This is wasteful.

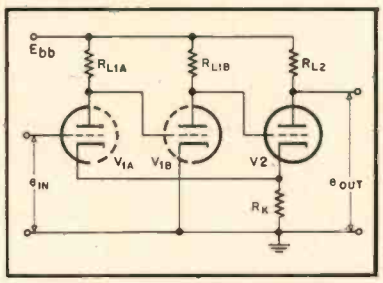


Fig. 3. Basic theoretical diagram of the author's constant-current amplifier. Note current feedback loop around entire amplifier.

A simplified version of this amplifier consisting of one tube is shown in *Fig.* 4, and might be suitable for certain applications. The output conductance of this circuit

$$Y_{out} = \frac{1}{r_p + R_k(\mu + 1)} + \frac{1}{R_L} \qquad (1)$$

R_k may be designed so as to make r_p' sufficiently high to drive a recording head over a reasonable range of frequencies. However, the tube would then need a driving voltage of about 20 volts which will hardly be provided by a preamplifier. Therefore, a double triode is added, and the feedback is extended over two additional stages as shown in *Fig.* 3. For further simplification, assuming

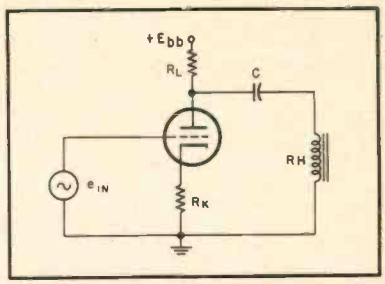


Fig. 4. A simplified form of the author's amplifier has a choke for high-frequency compensation.

$G_{L1} = G_{L2} = 0$, the value of the output conductance

$$Y_{out} = g_{p2}\left(1 - \frac{1}{1 + \beta G_k}\right) \qquad (2)$$

where

$$\beta = \frac{1}{g_{m2} + g_{p2} + \dfrac{(g_{m1} + g_{p1}) \cdot g_{m2} \cdot g_{p2}}{(g_{p1})^2}}.$$

But $\beta G_k \ll 1$; therefore $1 - \frac{1}{1 + \beta G_k} \cong \beta G_k$, and $\frac{1}{Y_{out}} = Z_{out} \cong \frac{1}{g_{p2} \cdot \beta G_k}$. For practical values of g_m *and* g_p, $Z_{out} = \frac{14.4 \cdot 10^6}{g_{p2} \cdot G_k}$ kilohms. Y_{out} may therefore be neglected in comparison with $G_{L2} = \frac{1}{R_{L2}}$, the latter solely determining the output impedance of the amplifier for all practical purposes. The idea suggests itself to insert a suitable choke in series with R_{L2} in order to make the output impedance of the amplifier rise in the high audio-frequency range at a rate similar to the rate of increase in the impedance of the recording head. This was, however, not found to be necessary in the author's design.

Bias Injection

Supersonic bias of considerable amplitude must be impressed on the tape simultaneously with the audio frequency. This bias is usually fed into the recording head in parallel with the audio frequencies. If the same method were applied to the amplifier described in this article, the full bias amplitude would appear at the anode of the output tube and would be fed into the amplifier through the voltage divider consisting of r_{p2} and R_k.

The input signal e_{in} (*Fig.* 3) is assumed to be zero, and a voltage e is applied between the output terminal and

(*Continued on page 74*)

PHONOGRAPH EQUIPMENT

A SECTION OF

AUDIO

JUNE, 1955

"Look, aren't you carrying this compliance business a little bit too far?"

Without the phonograph, our listening would be restricted to whatever music happened to be available on the radio, and would be only that which someone else chose for us. To get the excellent reproduction possible from modern LP records demands a careful attention to the selection of equipment and a thorough understanding of its characteristics and their relation to quality.

THESE PAGES PROVE HOW THE

GARRARD RC80

has maintained its supremacy

Original RC80's already had these important features

Pusher-type Platform: Adjusts simply to 7", 10", 12" records, regardless of diameter or size of spindle hole. The only device that assures positive gentle handling of all records. No overhead bridge to damage or dislodge records accidentally.

Automatic Stop: Insures positive and unfailing action at end of any type or size of record.

Pull-away Idler Wheel: Avoids flattening of drive wheel when changer is not operating.

Heavy Drive Shaft: A unique feature, providing more consistent quality at critical low (33⅓ and 45 rpm) speeds. Wows and wavers eliminated.

Convenient Start-Stop-Reject Lever; and Triple-Speed Switch: Controls are combined and located away from tone arm . . . an important precaution for safety of stylii.

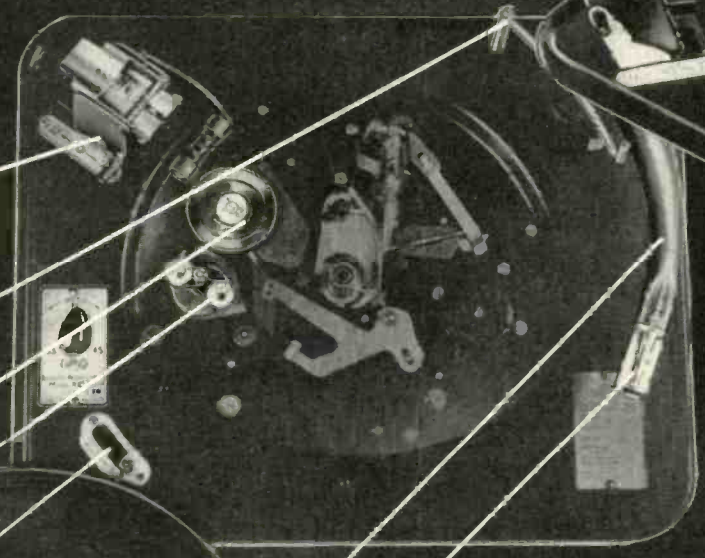
Heavily Weighted, Balanced Turntable: Imparts flywheel action, so that any variations in drive motor are not reflected in record reproduction. No turntable rumble.

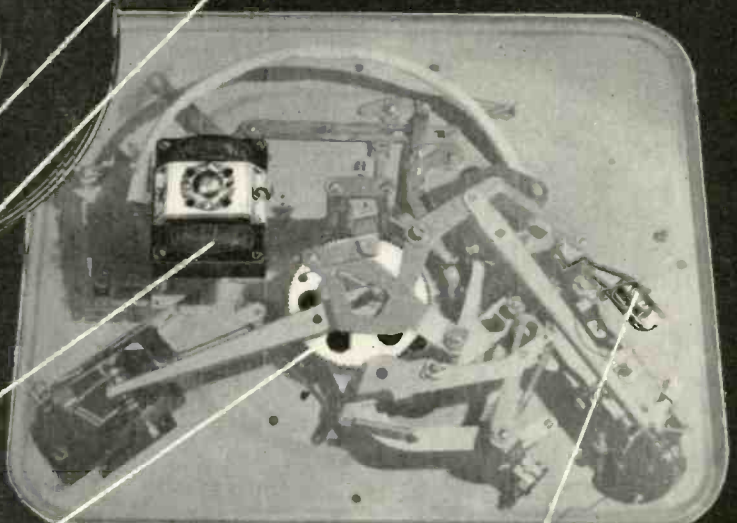
Balance-Mounted Tone Arm: Exclusive "parallel-lift" construction guarantees true-tangent tracking. Disturbing resonances eliminated.

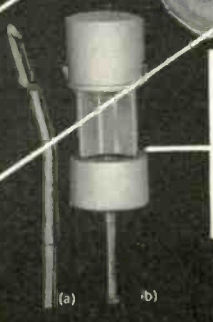
Interchangeable Plug-in Heads: Engineered to accommodate user's personal choice of virtually any high fidelity cartridge . . . crystal, ceramic or magnetic.

Advanced Heavy-duty Silent 4-Pole Motor with Absolutely no Rumble: Assures no-hum when used with sensitive magnetic pickups! Speed maintained regardless of wide variation in line voltage. No appreciable speed effect operating unit "cold" with full load or "hot" with single record, regardless of weight, thickness or diameter of records.

Watch-like Construction: All levers fully adjustable . . . easy, inexpensive to service. Bronze bearings at all moving points for longer life! Precision ground gears perfectly meshed to insure constant, smooth action through years of service.







Two Interchangeable Spindles: Easily inserted and instantly removable so that records need not be ripped upwards over metallic spindle projections after playing, as on ordinary changers. The two Garrard spindles accommodate all records as they were intended to be played. (a) Garrard "bent" spindle for standard center holes. Heavily plated, perfectly smooth, as a spindle should be. No moving parts to nick and enlarge center holes of precious records. (b) Easily inserted wide spindle, available as an accessory for 45 rpm records.

When you buy the Garrard RC80, you benefit from millions of playing hours in the home, testing every basic feature.

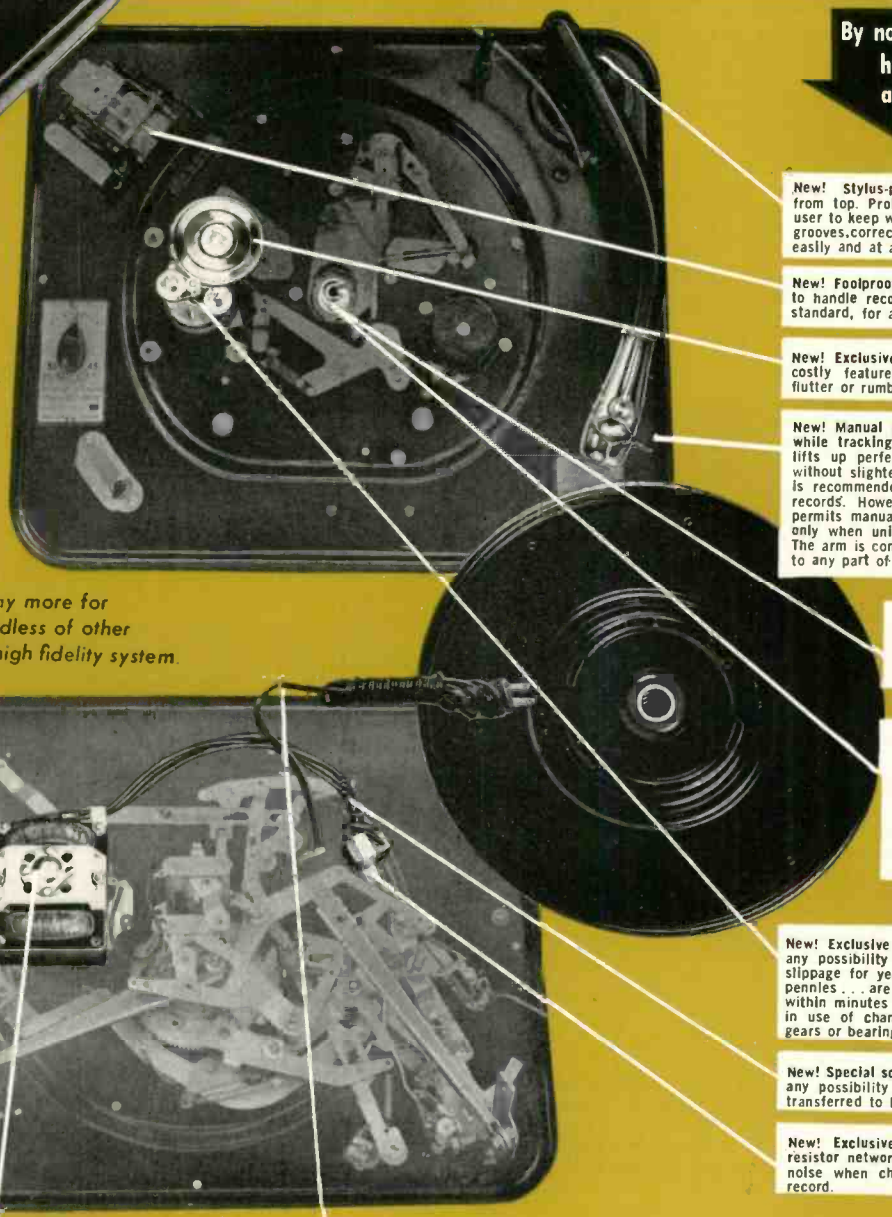
$49.50 net, less cartridge

Muting Switch: No sound while tone-arm is in changing cycle. Continuity of music undisturbed by extraneous noises.

A complete stock of replacement parts is readily available to all Garrard owners.

World's Finest Record Changer

through advanced engineering, rigid quality control



Check craftsmanship, performance, price and service and you will understand why this is truly the world's number one high fidelity record changer!

There's no need to pay more for a record player regardless of other components in your high fidelity system.

By now-all RC80's have these additional features

New! Stylus-pressure adjustment. Accessible from top. Prolongs life of records by enabling user to keep weight of stylus, on delicate record grooves, correct for any type of pickup cartridge, easily and at all times.

New! Foolproof Record Pawl Guide: Lengthened to handle records even thinner or thicker than standard, for any record material, any speed.

New! Exclusive Garrard Crowned Interwheel: A costly feature preventing even the slightest flutter or rumble.

New! Manual play . . . of selected record bands while tracking: RC80 tone arm sets down and lifts up perfectly and automatically for years without slightest danger to record grooves. This is recommended as the safest manner to play records. However, professional-type finger lift permits manual handling of pickup arm, except only when unit is in midst of changing cycle. The arm is completely free to be moved by user to any part of record while tracking.

New! Rumble-free Spindle thrust assembly . . . Supported by Garrard-designed washer of special plastic . . . more durable than metal, as on ordinary changers.

New! Main Turntable Spindle . . . prevents wow. Bearings are sintered bronze, expertly burnished to size . . . and revolve freely and smoothly in exclusive Garrard bakelite cage, eliminating noisy metal-to-metal contact and the binding "creepage" found in steel cup races used by many record changers.

New! Exclusive Drive Belts . . . Insulate against any possibility of rumble and operate without slippage for years. However, replacements cost pennies . . . are always available for changeover within minutes by owner. No long interruptions in use of changer . . . waiting for replacement gears or bearings.

New! Special soft, flexible motor leads . . . Avoid any possibility of even slight vibrations being transferred to base plate.

New! Exclusive one-piece moulded condensor-resistor network . . . eliminates startling "plop" noise when changer shuts off at end of last record.

New! Exclusive! Motor armature dynamically balanced . . . super-finished and individually weighted to very fine limits, by special Garrard process. Insures quiet, perfect speed through years of operation.

New! Mounting grommets of exclusive material, designed to keep out vibration.

New! Exclusive "snap-mount" spring assembly . . . Permits instantaneous mounting of changer and adjustments to level from top of unit, with simple screw driver.

New! Completely wired . . . ready for plug-in! RC80 comes with UL-approved line cord and moulded plug; and with pickup cable, terminating in standard jack.

A quality endorsed product of the British Industries Group: Garrard, Leak, Wharfedale, RJ, Genalex, Multicore and other high fidelity components.

For 16 page booklet. "Sound Craftsmanship" and names of dealers, mail this coupon.

British Industries Corporation, Dept. A6-5
164 Duane Street, New York 13, N. Y.
Gentlemen:
Please send "Sound Craftsmanship" and Garrard dealers' names.

Name_____

Address_____

City_____ Zone____ State_____

Phonograph Equipment

C. G. McPROUD

A practical discussion of the characteristics of phonograph pickups, turntables, and record changers and the role they play in providing high-quality sound reproduction from the widest possible source of music in the home—records.

WHEREVER WE FIND a home music system nowadays, we are likely to find the facilities for record reproduction, for even with access to radio reception in areas where there are "good music" stations, one can never be sure that he will be able to hear the music he wants when he wants it.

To be sure, there is much good music played throughout the country over the air, and depending upon where the listener is located, considerable entertainment is available without cost—if we may discount the time and nervous energy expended in listening to commercials. But even that is little enough to trade for the many hours of musical entertainment that are free for the asking. The one drawback to radio music is that the only offerings available may happen to be chamber music when we want a symphony orchestra, or an hour of modern music may be all that can be found when we want a sleep-inducing concert of organ music. Therefore, we turn to the phonograph for music of our choice, and not only do we have an enormous repertoire to choose from, but we are offered the same music played by a variety of performers. And, with reasonable care in the treatment of the records, the cost is likely to be only a few cents for each playing—far less than the price of a concert ticket.

A considerable variety of equipment is required to play phonograph records. We must first have a means for turning the record round and round at a constant and accurately maintained speed. This seems a fairly simple requirement, but the better our reproducing equipment becomes, the more critical are the demands made upon the rotating machinery. With the usual "package goods" type of phonograph, response at both low and high ends of the frequency spectrum is usually comparatively poor, and the effects of rumble and flutter are less noticeable.

Another device we must have to play phonograph records is the pickup—the device that carries the "needle." Within the last ten years, the development of pickups advanced greatly, and some of the units used today in high-quality home systems are far superior to the best used commercially before LP's.

Then we must have some means to carry the pickup over the surface of the record, remembering that the pressure at the stylus is likely to be around 6 grams on an average—rarely more than 10, and occasionally as low as 1 gram. Not only does the stylus have to carry the arm over the record and thus overcome the friction of the arm bearing, it often has to actuate stops for automatic changers. Remember that the LP pickup rests on a stylus which has a radius of only 1/1000 of an inch, and that this stylus is driven by a groove of smooth material that has sides 45 deg. from the vertical so the stylus can climb out of the groove without too much effort. It is easy to see that the bearings of the arm—both vertical and horizontal—must be almost as delicate as those for the balance staff of a watch. Let us now consider the individual units that make up a modern phonograph—up to the point where the amplifier enters into the picture.

Phonograph Pickups

The phonograph pickup is a electromechanical transducer which converts motion into an electrical signal. The motion is imparted by a groove in a phonograph record which undulates rapidly from side to side, often as rapidly as 15,000 to 20,000 times per second. During this undulation, the stylus attains a velocity of more than 25 centimeters per second on some records, although this is far too high for best quality.

The conversion of energy from mechanical motion to electric current is accomplished in a number of ways, and as far as the transducer action is concerned, one of them is as good as another. However, some require more mechanical force to move them, and resonances between the mass of the moving parts and the compliance of the restoring force introduce deleterious effects.

The first pickup to follow the old acoustic "sound box" was the magnetic. In early models, these consisted of an armature which was vibrated by the needle between the poles of a magnet. A coil of wire surrounded the armature, and as the iron armature or vane moved, it changed the number of magnetic lines of force cutting the coil, and in turn, generated a current. Early magnetic pickups were heavy, some requiring as much as 6 *ounces* of stylus force to actuate them, although most of those in use in the early 30's worked with around 2 ounces. The Western Electric 9A reproducer was a great improvement, and it worked with a stylus force of only 35 grams—1¼ oz. Catalog sheets for the 9A specify that it would give a signal to noise ratio of 45 db on transcriptions (vertical) and of 20 db on commercial phonograph records. Today we get around 40 easily.

The 9A was, however, one of the first practical moving coil pickups, and used a principle which—at least theoretically—has some important advantages. In this type of pickup, the stylus actuates a tiny coil of wire which is located in a magnetic field. One moving-coil model was placed on the market in 1938 which consisted of a structure resembling the voice coil and cone of a dynamic speaker. The outer edge of the cone carried the voice coil, and the stylus was cemented to the apex. This coil was suspended in an air gap on a thin ribbon which was under a 15-pound tension, and was "tuned" to control the resonance. However, this pickup—the Miller—was quite delicate, and the tiny cone was easily damaged. Today's moving coil pickups employ coils little larger in cross section than a shingle nail. Some have the coil arranged so as to rotate in the magnetic field like a d'Arsonval meter movement; in others the coil is simply moved within the field. One of the advantages claimed for the moving coil type is that the coil moves in a uniform magnetic field, even though it may not be perfectly centered. Therefore, the displacement of the stylus from the exact center of the magnetic field does not introduce any distortion. Furthermore, the coil mass can be reduced to a minute value, thus raising the resonant frequency between the coil and its suspension. In many models, this resonant frequency is well above audibility.

The most commonly encountered magnetic pickup is the moving iron type, in which a small vane or tube swings between the poles of a magnet, and changes the reluctance of the magnetic path, thus changing the lines of force cutting through a coil. The mass of the moving iron has been reduced greatly from early models, and performance is uniformly good in most high-quality magnetic or variable reluctance pickups.

The crystal pickup first became popular in the early 30's. Even the first of these types were lighter than the magnetics then available; not only that, but they were much less expensive in themselves, and they required less amplification because the output signal was much greater. Thus the manufacturer saved in cost of pickup and saved in having to put less tubes in his instrument. Early models used relatively large crystals, and the resonances of the crys-

tal itself introduced peaks and valleys in the reproduction to give what is still remembered as a typical "crystal sound." Modern crystals are considerably smaller, and the resonances have been eliminated or reduced so as to be unobjectionable.

The operation of the crystal pickup depends on the piezoelectric principle. When certain materials—among them Rochelle salt, which was the usual crystal employed for pickups—are deformed mechanically, they develop a voltage on their opposite faces, and foil electrodes cemented on these faces serve as the terminals of the generator. All piezoelectric substances are amplitude sensitive, which means that they generate a voltage which is in proportion to the amplitude of the amount of deflection applied to them. Since modern phonograph records are cut with a characteristic which is a close approximation to a constant-amplitude curve, the signal generated by this type of pickup is practically "flat" and only a small amount of equalization is required for complete correction of the characteristic.

The first ceramic phonograph cartridge was made by Sonotone in 1946, and today most of the piezoelectric cartridges use a ceramic element rather than the Rochelle salt. The ceramic element itself is not unlike a small piece of fine china. During the manufacture, it is exposed to a strong electrostatic field so as to polarize the molecules in the material. When it is completed, it is responsive to mechanical stress—i.e., it is piezoelectric—and will generate a voltage when it is bent or twisted. According to Sonotone, modern ceramic cartridges have compliance several times that of old crystal cartridges, and in addition have the advantage of not being affected by heat or humidity as Rochelle salt is. At a temperature of around 130° F., Rochelle salt is likely to melt, turning to liquid and becoming completely useless as a phonograph pickup. Sometimes permanent damage can result from exposure to high temperatures even though not sufficient to melt the crystal. They must also be protected against high humidity. Neither of these conditions affect the ceramic element, which makes this material ideal for the piezoelectric pickup.

Pickup Characteristics

In the discussion of pickups, one encounters the terms used to identify the various characteristics. These are: compliance, effective mass, weight, stylus force, impedance, load resistance, frequency range, and output signal. Some of these terms are self explanatory, but others may be unfamiliar.

Compliance. The ratio of displacement of the stylus to the force applied, expressed in centimeters per dyne (cm/dyne). This is a very small numerical value, and is expressed as $X \times 10^{-6}$ cm/dyne, with X representing the numerical unit of interest, and the one used to compare this characteristic of different pickups. The range in which high-quality pickups will fall is from 1.0×10^{-6} upward to about 8×10^{-6} for most models, with the Weathers pickup being rated by the manufacturer at 14×10^{-6}. In general, the higher the compliance the less the record wear, although other factors may enter into the performance.

The term compliance is generally used to signify *lateral* compliance, although vertical compliance is also of interest. Since the groove is cut by a chisel-pointed cutter, it is narrower during lateral excursions than it is when it is unmodulated. Thus the stylus is forced to ride up and down, since it rides higher in the groove when it is narrow than when it is wide. This is called the "pinch" effect. Vertical compliance is necessary to permit the stylus to follow the pinch effect without undue wear on the record. One other important consideration is that the vertical motion imparted to the stylus by the pinch effect or by warped records should not be translated into an electrical signal. No modern high-quality pickups have much trouble with vertical translation, however. The check for it would be to play a vertical cut record—the old "hill and dale" records formerly used for transcriptions—and listen for any output. Styli are often mounted on a "shoe" which is compliant in a vertical direction but which transmits all of the lateral motion to the moving element.

Compliance may also be thought of as the opposite of stiffness. Thus a compliant pickup is one in which the stylus is free to move from side to side easily and without stiffness.

Effective Mass. This is the name given to a lumped mass at the stylus tip that would result in the same mechanical impedance as that caused by the moving parts of the pickup. It is a value which permits calculation of some of the other characteristics, but to be readily useable in such calculations, it must be lumped at the stylus. In practice, it ranges from 1 milligram to about 5 milligrams, and the lower the value the better. It influences the resonant frequency since it is this mass which resonates with the compliance of the suspension. The lower the mass, the higher the resonant frequency is likely to be, and in the better pickups it is above the audible range.

Weight. The weight of a pickup is not important—in most instances—since it is possible to counterweight the arm to compensate for the additional weight of the pickup itself. However, with a heavy pickup it is possible that the inertia of the pickup in the vertical plane may be so high that the pickup cannot follow warped records easily. Therefore, if the pickup is heavy, it should have a highly compliant stylus suspension in the vertical direction.

Stylus Force. This term is often confused with both pressure and weight. It is the force with which the stylus bears upon the record, and can be measured with a scale or balance just as though it were weight. The correct term is *stylus force* and it is measured in grams. Modern pickups seldom require more than 6 to 8 grams for perfect tracing in the groove, with many working perfectly in the range from 2 to 4 grams, and the Weathers with 1-gram stylus force. Some authorities are of the opinion that the proper value is 6 grams for any pickup, and that any less stylus force will cause more record wear than the 6-gram value will. This is debatable, however, although it seems probable that a given pickup would cause less record wear with a certain minimum of stylus force and greater wear if the force were reduced because of a faulty contact between the pickup stylus and the groove, on the same principle that a light automobile will wear tires out faster than a heavy one, all other things being equal. The correct value of stylus force depends on both the pickup and the arm on which it is mounted.

The way to determine what minimum stylus force is required is to play a con-

"I can't find the stylus, but the cantilever's worn."

stant-frequency test record and observe the output on a 'scope although the difference can be heard by an acute ear. As the record plays, reduce the stylus force gradually until distortion shows on the 'scope screen. Then increase the force until the distortion disappears. The test should be made at a stylus velocity of at least 15 cm/sec. to ensure satisfactory operation on high-level passages.

Impedance. The impedance of a pickup is usually expressed in ohms, and will range from a fraction of an ohm for a ribbon pickup to several hundred thousand ohms for a crystal or ceramic cartridge. Most moving-coil pickups range around 1 to 10 ohms—the Fairchild 220 being an exception with 170—while the variable reluctance types are likely to fall between 1500 and 5000 ohms. The impedance of a magnetic pickup—either moving coil or variable reluctance—is made up of the d.c. resistance of the winding added vectorially to the inductive reactance. High values of impedance require the use of low-capacitance leads to the amplifier to avoid loss of high frequencies and the introduction of a peak somewhere in the high-frequency region just before the cutoff begins.

The impedance of a crystal or ceramic cartridge is high because these types are equivalent to a constant-voltage generator in series with a small capacitor—its capacitance being that of the cartridge itself. This is usually in the range from 500 to 2000 μμf. The numerical value of impedance is the capacitive reactance of the pickup at a specified frequency—usually 1000 cps.

Load Resistance. The load resistance is usually specified by the manufacturer for best performance of his pickups. When the impedance of the pickup is almost entirely resistive—as with most moving-coil models—practically any value of load resistance can be used. However, when the impedance has an appreciable reactive component, its inductance will resonate with the input capacitance of the amplifier—which includes the capacitance of the connecting leads—as well as with its own distributed capacitance, and introduce a resonant peak followed by a sharp cutoff. The correct value of load resistance will nullify the peak, and provide smooth response up to the cutoff point, beyond which the response will fall off at the rate of 12 db per octave.

Lower than normal values of load resistance will cause a rolloff of the high frequencies—in fact, some amplifiers make use of this as a rolloff control. Since the values will differ with every make pickup, this is not particularly practicable, for the user must change the values when he changes pickups.

Most moving-coil pickups are designed to work into a step-up transformer to increase the signal voltage sufficiently to over-ride the input-stage noise and hum. The secondary of the transformer may or may not require a resistor, depending upon the pickup and the transformer design.

Since the crystal and ceramic types are equivalent to a generator in series with a small capacitor, the load resistance should be high to avoid attenuation of low-frequency response. The correct value is usually specified, and ranges from 2 to 5 megohms for optimum response. When the load resistance is lowered, the low-frequency response is reduced, and by proper choice of resistance for the load, the pickup may be made to become velocity-responsive below a given turnover point—so that it can simulate a magnetic pickup. Then the bass-boost preamplifier must be employed to provide proper response. Electro-Voice makes use of this characteristic in the new 80 series which is produced in several types as exact replacements for some of the popular magnetic pickups.

By proper choice of shunting capacitor and resistor across the output of a magnetic pickup, the low-pass feature may be put to good use. To make such a low-pass filter, determine what value of capacitance will resonate with the inductance of the pickup at approximately 0.8 times the desired cutoff frequency (the point at which response is down 3 db) and connect it in shunt across the pickup. This will cause a peak just before cutoff, and by connecting a resistor having a value of 1.2 times the cutoff frequency across the pickup and capacitor, the response curve should be smooth up to the cutoff frequency and then should roll off gradually to a maximum rate of 12 db per octave. This is a simple approximation, but should fall within 10 per cent of the desired frequency. The capacitor value and the shunt resistor value should best be determined by measurement.

Frequency Range. The frequency range of a pickup is usually specified by the manufacturer in figures substantially like 20 to 20,000 cps ± 2 db, for example, In some instances this will be measured directly from a phonograph record which has been calibrated, and in others it will be the result of measurements made with some form of device which is designed to impart motion to a phonograph stylus to simulate the playing of a record. In either case, it should include the effect of the record medium, as will be observed in the specifications of some manufacturers.

The frequency range of most modern pickups is adequate for the available commercial phonograph records. While some might not be sufficiently good for dubbing in professional applications, it must be remembered that the average high-fidelity pickup of today is far superior to the best professional models in use ten years ago.

Output Signal. The output signal from a pickup is usually expressed in volts—or millivolts—and ranges from about 10 to 70 millivolts for the average variable reluctance model. Some high-output types may go as high as 100 mv, but these are rare in high-fidelity applications. With the matching transformer used with the moving-coil models, the output signal is likely to be from 30 to 60 mv, but the output from the pickup alone is of the order of 1 to 3 mv. The Fairchild 220 has an output of 5 mv, which is in line with its higher impedance of 170 ohms, and a transformer is not usually required with modern amplifiers.

Pickup Arms

Pickups must be supported over the record surface and caused to move from outside to inside in a definite predetermined line. Any longitudinal vibration of the stylus with respect to the arm pivot will be translated by the pickup into a frequency modulation of the music which is intolerable in high-quality systems.

The design of the arm has a large bearing on the performance of the pickup, since at the frequency at which the stylus compliance resonates with the mass of the arm a peak will be introduced to the response curve, usually somewhere below 100 cps. In addition, any torsional motion of the arm itself is likely to introduce another resonance somewhere between 100 and 300 cps. In good arm design, the low-frequency resonance should be below 20 cps. Increasing the mass of the arm will lower the resonant frequency, but may also introduce another problem in the form of decreased vertical compliance due to the inertia of the arm. The Fairchild and Pickering arms both employ a relatively large mass for the arm itself, but support the pickup vertically by means of a spring-loaded mechanism. This increases vertical compliance without sacrificing lateral inertia, and is considered by some to be the ideal arrangement.

If there is sufficient vertical compliance in the stylus mounting, the effect of

PICKERING *models* 220 / 240 *cartridges*

The Most Nearly Perfect Phono Pickups Ever Produced

. . . they are sold separately for all standard arms or mounted back-to-back to make up the famous PICKERING 260 TURNOVER PICKUP.

MODEL 220—for 78 rpm records diamond or sapphire stylus

MODEL 240—for 33⅓ and 45 rpm records diamond stylus only

MODEL 260—turnover cartridge for 78 or 33⅓ and 45 rpm records (the 220 and 240 back-to-back)

The 220 and 240 are engineered to maximize performance. By comparison they are without equal . . .

The **220** *and* **240** *are*

Lighter— 5½ grams
Smaller—⅝ by ¾ by ⅜ inches

The **220** *and* **240** *have*

Highest Output—30 millivolts/10cm/sec.
More Compliance with Less Tracking Force
Lower Overall Distortion
Less Moving Mass
Wider Frequency Response
Mu-Metal Shielding for Less Hum

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 . . .

The Most Nearly Perfect Phono Pickups Ever Produced

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

PICKERING COMPONENTS ARE PROFESSIONAL QUALITY

"For those who can hear the difference"

. . . Demonstrated and sold by Leading Radio Parts Distributors everywhere. For the one nearest you and for detailed literature; write Dept. A-7.

increased inertia of the arm in the vertical plane should have no deleterious effects, so the choice of arm should be governed somewhat by the pickup to be employed in it. Thus it may be considered desirable to use the arm offered by the pickup manufacturer.

In making the masters from which phonograph records are made, the cutting head is almost universally carried on a mechanism which moves the stylus along a radius. In reproduction, the stylus is carried on an arm which is pivoted at some point beyond the outside of the record, and thus the stylus moves on the arc of a circle. With a straight arm, this introduces tracking error, in addition to not following the original cutting stylus movement. The bent or offset arm eliminates this difficulty to a large extent, since by proper design of angle and overhang, the tracking error may be kept to a maximum of 2 to 4 degrees throughout most of the surface of a 12-inch record. Tracking error is the angle the axis of the pickup makes with a tangent to the groove at the point of contact with the stylus. Overhang is the distance the stylus extends beyond the center of the turntable spindle. This is usually of the order of ⅜ to ½ in., and is comparatively critical. Some manufacturers have made ingenious templates to ensure locating the arm accurately with respect to the turntable center so that tracking error will be maintained at a minimum value.

While it might seem logical to arrange to carry the pickup along a radius of the record, this is a difficult problem with conventional turntables. If a typical recording lathe were used for reproduction, it would only be necessary to mount the arm selected on a bracket carried on the moving carriage of the recording machine. Since a good recording lathe of this type usually costs several times what the better hi-fi system does, this seems like an impractical solution. It would eliminate the problem of tracking error entirely, and would, furthermore, move the pickup in exactly the same manner that the cutting stylus was moved. One device designed to move the pickup along a radius has been shown recently, but it does not appear to have achieved much acceptance so far in spite of the obvious advantage in theory. To overcome the friction of such a mechanism by means of an infinitesimal contact between a stylus and a groove, with a stylus force of 6 to 8 grams holding the stylus in the groove, does seem like an almost insurmountable problem. A separate motor drive calibrated to indicate lines per inch might be a possible solution, but the cost would undoubtedly be prohibitive.

Unless a straight arm is of infinite length, there will be some tracking error, and the average hi-fi equipment cabinet will not accommodate an arm of infinite length. Literally dozens of patents have been granted for arms which were claimed to eliminate tracking error by some arrangement of arms and levers, but only one of these has ever appeared to gain a foothold. This is the B-J arm, which employs a novel arrangement of two arms so disposed that the axis of the pickup is carried tangent to the record groove all the way from the outside of a twelve-inch record to a groove only four inches in diameter with an error of less than one degree throughout. Four bearing points are required, and in this arm they take the form of eight needle-pointed pivots riding in steel inserts. Friction is low, and there is no excessive play in the pivots.

Most pickup manufacturers offer their products in cartridge form so as to accommodate the user who wants a cartridge that will play in a record changer. Some models, however, are designed to operate with a very low stylus force and consequently do not have sufficient lateral component of force to actuate the changer trip mechanism. The minimum stylus force that will actuate a changer trip reliably is about 6 grams, so such pickups as Leak, Weathers, and the Electro-Sonic professional are denied to changer users. Each of these manufacturers provides his own type of arm, and performance of arm and pickup together is considered good in all those models. The Leak arm is a simple tube, counterweighted at the back, and equipped with a receptacle into which the pickup is plugged. The arm pivots in both planes on a single vertical pivot, and is held in place laterally by a bracket which straddles the vertical pivot. The leads from the pickup are carried through the mounting stud where they terminate in a female receptacle at the lower end of the stud.

The Weathers arm is made of balsa wood, suitably reinforced, and styled for good appearance. Balsa wood is light and free from natural resonances, and consequently is a good material for this purpose. The ESL professional arm is a long counterweighted tube with a slight offset near the head mounting. All of these arms are suitable only for use with the manufacturer's pickups.

Most modern arms have provision for all types of cartridges—the few exceptions that will not fit into the standard mounting dimensions are Audax, Leak, ESL professional, and Weathers. Adapters are available for fitting the Audax pickups to most changers, and the ESL models which will work properly in changers are designed to fit standard heads. Plug-in heads for changer arms make it a simple matter to change pickups when desired, such as from a 78 pickup to an LP model when a turnover type is not being used.

Turntables and Changers

Although perhaps the first item to be considered in setting up a phonograph system is the means whereby the record is rotated, the turntable itself is being considered last. The range of equipment in this category is large—with broadcast turntables in their own console cabinets costing several hundred dollars down to the lowly two-pole-motor-turntable which can be purchased from bargain counters at less than five dollars. There is a difference, of course.

The high-quality turntable is designed for years of reliable service with a minimum of rumble, flutter, or wow. It is often provided with integral means for levelling, has space for a preamplifier and perhaps for a controllable compensator, and it does provide a constancy of speed that is not likely to be found in any other type of equipment.

The high-quality single-play turntables offered to the high-fidelity trade are simply scaled-down professional turntables. Most home users have no need for a 16-inch table, and few would have the space available for such a model. But the performance of the typical hi-fi turntable comes close to being adequate for professional work.

Rumble is held to low values, with a minimum of 40 db signal-to-noise ratio being acceptable for critical use. This figure is determined by measuring the signal from a constant-tone record of known stylus velocity and then measuring the signal from an unmodulated groove with the same settings of the controls. A low-pass filter cutting off at not over 500 cps is desirable for these measurements, using 400 cps for the constant tone so the filter does not affect response at that frequency.

The NARTB specifies a stylus velocity of 7 cm/sec as the standard. This is an unrealistic value because practically any phonograph record today will be recorded to a velocity of 15 to 20 cm/sec. Signal-to-noise ratio—or the measurement of rumble—should be related to the normal maximum signal that is played through the system, so we take the stand that a reference of 20 cm/sec. should be used. This is approximately 10 db higher than the NARTB standard, but we feel that it is more realistic in view of today's practices.

The most convenient mechanism for playing phonograph records is the changer. These have reached a high degree of development, and many features which add to the pleasure and ease of playing records have been incorporated in current models. The modern changer handles records with care, drops them gently onto an air cushion, positions the pickup over the run-in grooves, and lowers the stylus more gently than the average user is likely to. And while the manual handling of the pickup arm *can* be as gentle as possible, human frailty is a factor and no one will *always* position the stylus over a run-in groove (so as to avoid damage to the first recorded grooves) and no one will *always* lower the stylus gently. The changer, being governed by mechanical stops, cams, and the like, will perform the same operation over and over in exactly the same manner. For general listening, the changer is by far the most convenient record playing mechanism.

Next in order of convenience is the automatized record player. Some of these do everything a changer does except actually change records—that is, they start, lower the pickup to the record at the proper place, shut off after playing and return the arm to the rest. Still simpler is the player in which the arm is

positioned manually, but is coupled to the motor switch so as to be, in effect, the switch handle. These, too, have reached a high standard of performance, and rumble, wow, flutter, and external hum field have all been reduced so that they are about on a level with the better changers. The user's choice must depend on cost, size, and convenience of operation—once he buys the product of any of the reputable manufacturers he may expect to obtain satisfactory performance in keeping with his requirements.

Accessories

Many accessories are available for the record collector's convenience. He may want to protect his records by the use of plastic sleeves; he may want to reduce static by some form of anti-static solution which he may either wipe or spray on the record; perhaps he may find it desirable to employ one of the radioactive devices which ionizes the air near the record surface and thus neutralizes static charges. Whatever he is likely to want, he is likely to find offered. In most instances, he will have to decide whether these products are of value to his own habits and customs in record collecting and playing. Some means of determining the stylus force is a very desirable addition to the complete system, and the critical user should be so equipped so he may make sure that his equipment is properly adjusted for maximum performance and minimum record and stylus wear. Some of these accessory items are described in the following pages.

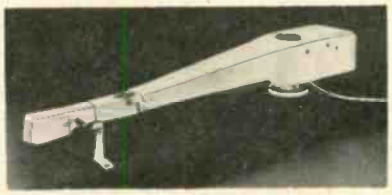
Note: In comparing the ouput voltages from the pickups in the following listings, all values have been related to a stylus velocity of 7 cm/sec, which is likely to be about average for commercial records. Manufacturers' specifications differ in the reference velocity, but all are standardized in this listing.

The KS numbers in parentheses following the manufacturers' names and addresses are for convenience in requesting further information on the Reader Service Card following page 80. If you wish any further information about any of the products described, circle the manufacturer's number, fill in your name and address, and mail—no postage is required.

PHONOGRAPH PICKUPS

Angel. Kingdom Products, Ltd., 23 Park Place, New York 7, N. Y. **(KS-1)**

One of the most recent pickups to be introduced in the U. S. is the Angel, a product of EMI, British manufacturers who also make the Angel Records, and do the recording for many of the important foreign record labels. The Angel pickup was designed primarily for professional use, which is no bar to



New Angel (EMI) pickup and arm. Arm is oil damped to retard violent movement of pickup.

home use—rather, if the unit is sufficiently good for the requirements of broadcast and recording use, many home users would consider it eminently suitable for their purposes.

The pickup employs the moving coil design, and is used with a step-up transformer to match 200- or 600-ohm lines, or to match a grid. The impedance of the pickup itself is 1 ohm, and the output is approximately 100 mv (on the grid side of the matching transformer) for a recording level of 7 cm/sec. Frequency response extends from 20 to 20,000 cps with the standard stylus, and from 20 to 16,500 cps with the microgroove stylus. The unit is normally furnished with its own arm, which employs a unique suspension system to maintain constant stylus force for various heights of the pickup above the turntable.

Audak Company, 500 Fifth Ave., New York 36, N. Y. **(KS-2)**

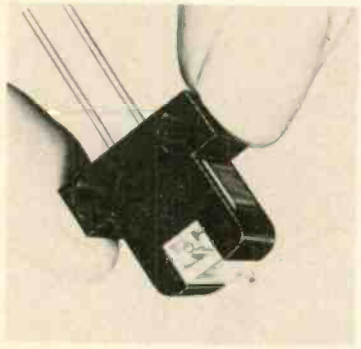
Utilizing the principle of a magnetic vane which relays the flux from the magnet poles to the core of the coil, these models—D-L-6 and the higher output Hi-Q7—are similar in design. Both employ an extremely narrow suspension for the stylus bar which eliminates needle talk to a large degree, and

Audak cartridge. All models—R-2, D-L-6, and HI-Q7 are of same appearance.

gives high compliance. The stylus is mounted well to the front of the unit and is thus readily visible for cueing the record to a specific place. Output voltage is approximately 20 mv for the D-L-6, and 30 mv for the Hi-Q7. Stylus assemblies are replaceable in seconds, making it possible to change them at home without special tools. For use on transcription-type turntables, the Audak arm provides ideal mounting for the pickup, with its simplicity of construction and freedom of motion. For use on changers, various adapters may be obtained to accommodate the Audax models.

Electro-Sonic Laboratories, Inc., 35-54 36th St., Long Island City 1, N. Y. **(KS-3)**

These cartridges are electrodynamic devices built precisely like a tiny D'Arsonval meter movement. A rectangular coil of very small dimensions is held vertically in a strong magnetic field. One end of the coil mounting is fastened to a stylus shoe so that the



Electro-Sonic Laboratories' Concert and Standard models of moving-coil pickups.

lateral excursions of the stylus cause the coil to rotate in the magnetic field. With this arrangement, the conductors cut the field at right angles and develop a signal voltage directly proportional to the velocity of the stylus, and the pickup is insensitive to vertical motion. The ESL pickups have an impedance of 1.5 ohms, and require a transformer. Three models of pickups are available —the standard series, which will perform satisfactorily in record changers; the Concert series, with greater compliance, and designed for use with high-

Professional model of Electro-Sonic Laboratories' pickup with arm (with which it must be used.)

quality arms; and the Professional series which comes with its own arm and is intended for purely professional applications. Several types of transformers are available for differing requirements.

Fairchild Recording Equipment Co., 154th St. and Powells Cove Rd., Whitestone 57, N. Y. **(KS-4)**

The new 220 series cartridge is designed to mount in all standard arms, and has an impedance of 170 ohms, which is almost purely resistive in nature, which makes it possible to operate with a relatively long shielded cable between pickup and grid, and with practically any grid resistor. Rated output is of the order of 5 mv for a 7

Fairchild Model 220 is latest cartridge in this line, which is a popular moving coil-type.

cm/sec stylus velocity. The construction of the pickup consists of a moving coil supported on a mylar vane between two pole pieces, the stylus being attached to an aluminum arm which is effectively an extension of the axis of the moving coil. High-frequency resonance has been reduced practically to zero so that response extends essentially flat to 17,000 cps and rolls off gradually beyond. While output is slightly lower than most pickups on the market, the better modern amplifiers have low-noise first stages and sufficient gain to accommodate the 220 perfectly. The Fairchild amplifier employs a cascode input stage which is especially suitable for use with this cartridge, but it will perform satisfactorily with any good amplifier.

Fentone. The Fenton Company, 15 Moore St., New York 4, N. Y. **(KS-5)**

This unit, soon to be distributed generally, is imported from Denmark, and is manufactured by Bang and Olufson Laboratories. It is a low impedance model—530 ohms at 1000 cps, with a d. c. resistance of 350 ohms—with sufficient output that a matching transformer is not needed. The unit uses 8 poles, and is so constructed as to mini-

The Danish-made Fentone pickup.

mize hum pickup from motors or power transformers. The stylus compliance is relatively high—5×10^{-6} cm/dyne, and the equivalent stylus mass is 4.5 mg for the dual stylus and 3.5 mg for the single-stylus model. Frequency response is claimed to be flat from 20 to 16,000 cps ± 2 db, with a gradual rise to over 20,000 cps. The output voltage is approximately 50 mv for the standard stylus velocity of 7 cm/sec, and the pickup tracks with a stylus force of 5 to 7 grams. It is available with two sapphire styli, or with a diamond LP stylus and a sapphire 78 stylus, or in single-stylus models with either sapphire or diamond.

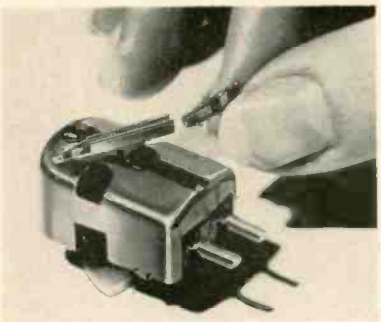
Ferranti Electric, 30 Rockefeller Plaza, New York 20, N. Y. **(KS-6)**

This model, designed by D. T. N. Williamson—best known for the design of an amplifier which is widely copied —employs a low-mass high-compliance ribbon movement. Another unusual feature of this pickup is the use of an elliptical stylus which is so placed that its major axis is perpendicular to the record groove. This reduces the effective radius of the stylus tip and more closely approximates the shape of the cutting stylus, which is invariably of a chisel shape. This shape increases the ability of the stylus to follow the high-frequency variations in the groove better than a spherical tip, and improves tracing appreciably.

The Ferranti pickup is intended for use in its own arm, and is not adaptable for use in record changer arms nor in other models. The Ferranti arm features a double ball race arm bearing, and is equipped with a built-in rest. Arm resonance is out of the audible range.

General Electric Company, Electronics Park, Syracuse, N. Y. **(KS-7)**

Undoubtedly in more general use than any other pickup on the market for high-fidelity reproduction, the G.E. cartridges have made it possible for a magnetic pickup to be within the range of the lowest budget, and without sacrificing quality. The design consists of two coils mounted vertically at the front of the cartridge with pole pieces extend-



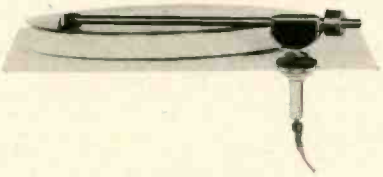
Latest model of G. E. Triple Play cartridge has simplied method for changing styli.

ing down to each side of the stylus arm. A cylindrical permanent magnet provides the field, and the magnetic circuit includes the stylus bar, two pole pieces, the coil yokes, and the magnet. Several types are available—with either single or double stylus, and with sapphire or diamond as desired. The Golden Treasure models have a diamond LP stylus and a sapphire 78 stylus in a dual assembly which is readily replaceable, and which is changed from one to the other by a knob at the top of the cartridge.

A recent improvement in the mounting provides for the replacement of either stylus independently without the need for replacing the entire assembly. The stylus is carried on a "Clip-in Tip" which simply slides in or out of the rotatable channel in the case of the double-stylus models, or out of a fixed channel in the single-play cartridges. This permits the user of a single-stylus cartridge to change from LP to 78 almost as easily as though it were a two-stylus model, yet with the economy of the single-stylus cartridge. All future models of the GE pickups will be produced with the new "Clip-in Tip" feature.

Leak. British Industries Corporation, 164 Dunne St., New York 13, N. Y. **(KS-8)**

Another moving-coil pickup which has achieved an excellent reputation, particularly in England since it has not been widely distributed in the U. S. to date, is the Leak. It is in common use by the BBC, and is used considerably in recording studios for dubbing and play-



The miniscule Leak pickup on its own arm. 78 model is weighted slightly so no change of adjustment is required when pickups are changed.

back. The newest model—which is nearly two years old—is essentially the same in principle as its predecessor, and consists of a rectangular coil which is mounted in the field of a permanent magnet. The axis of the coil is approximately tangent to the record groove. The coil itself is wound on a plastic former, and offers a minimum of mass and a very high compliance, as indicated by a high-frequency resonance of 21,000 cps ± 2000 cps with the LP stylus on a Vinyl pressing, and with the 78 stylus on shellac pressings the resonant frequency is above 27,000 cps. Low-frequency resonance with the Leak arm is at approximately 20 cps.

Using the step-up transformer furnished with the pickup, the output is approximately 70 mv from a stylus velocity of 7 cm/sec. Additional weighting in the pickup head makes it unnecessary to adjust needle force when the heads are changed. The arm is mounted through a single hole, and electrical connections are made through a small receptacle in the bottom of the mounting stud.

Pickering & Company, Inc., 309 Woods Ave., Oceanside, N. Y. **(KS-9)**

The first magnetic cartridge to be placed on the market for replacement purposes, the Pickering introduced many listeners to the advantages of high-quality reproduction for the first time, and it has long held its position of esteem amongst discriminating listeners. The current model is the 260—which consists of a 240 series LP pickup and a 220 series 78 pickup mounted in a turnover mechanism which shorts out the unit that is not in use. The 260 weighs 18 grams complete, and tracks over a range

Pickering model 260 employs two single cartridges in turnover mounting.

of 4 to 8 grams stylus force. Those who have no need for both pickups can use either model separately with an adapter clip.

In construction, the Pickering cartridges consist of a nickel tube which is positioned in the center of a coil and subjected to a magnetic field, the stylus being fixed at the lower end of the tube. Movement of the tube within the coil causes a change of flux which generates the signal voltage. At the standard velocity of 7 cm/sec, the output is of the order of 22 mv, and frequency response is flat

Single Pickering units may be used separately in special clips.

on a velocity basis over the range from 20 to 20,000 cps. The cartridges are available only with diamonds for LP use, and with a choice of diamond or sapphire for 78's.

Recoton-Goldring. Recoton Corp., 147 W. 22nd St., New York 11, N. Y. **(KS-10)**

Another imported cartridge which is likely to make a name for itself is the Recoton-Goldring model 500. Not unconventional in design, this unit features a hum-bucking coil construction, replaceable styli, and a turnover mounting which may be fitted into practically any standard arm. The stylus assembly for each "half" of the pickup consists of a cantilever mounting which is removed simply by taking one screw out. With completely separate moving parts, there is no interaction, and the idle stylus has no effect on the one that is "working." Essentially, however, the unit consists of a single stationary assembly which accommodates two styli. It is designed to work into a 47,000-ohm resistance, and has an output of approximately 22 mv

and a frequency range which is virtually flat from 20 to 16,000 cps. Lateral compliance is stated to be 4×10^{-6} cm/dyne, and the effective mass at the stylus tip is 3.5 mg. It will track with a stylus force of 3 to 4 grams with a high-quality arm, and at 6 to 7 grams in most record changers.

Weathers Industries, 66 E. Gloucester Pike, Barrington, N. J. **(KS-11)**

Employing an entirely different principle of operation than the pickups described in the foregoing, the Weathers pickup will track with a force of 1 gram, has a lateral compliance of 14×10^{-6} cm/dyne, and an effective mass at the stylus tip of 1 mg.

Part of this is the result of the method of operation, for the Weathers pickup is a device which varies the capacitance of the unit in accordance with the groove modulation, and the capacitance variation produces a change in the output frequency of an oscillator. This results in an FM signal which is detected in the same unit as the oscillator, and an audio signal is fed to succeeding amplifier equipment. It is not susceptible to hum pick-up, and the output voltage from the oscillator-demodulator-preamplifier unit is of the order of 2 or 3 volts and does not require equalization. Thus the signal may be fed into the radio, tape, or TV input of a conventional amplifier.

The Weathers pickup is available in several forms—as a cartridge, as a complete pickup system which includes cartridge, arm, and a combination oscillator and power supply, or as a complete record player (except for power amplifier and speaker).

CRYSTALS AND CERAMIC PICKUPS

Astatic Corporation, 250 Harbor St., Conneaut, Ohio. **(KS-12)**

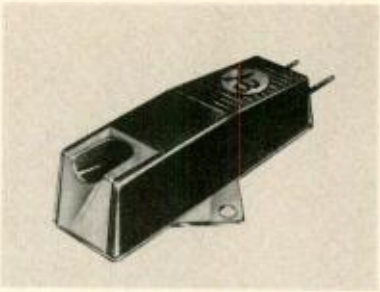
Four models of cartridges are offered by Astatic for high-fidelity use—two with ceramic units and two with Rochelle salt crystal units. All four are compensated to match the RIAA curve approximately and require no further equalization in the amplifier. The ceramic models are 51-1J with a single stylus, and

Astatic model 51-1J ceramic cartridge.

55-TJ with two styli. The former tracks at a stylus force of 9 grams, and the latter at 8 grams. Output with either type is approximately 0.9 volts from the standard reference stylus velocity of 7 cm/sec. Model CAC-J is the single-stylus crystal pickup, which tracks at a stylus force of approximately 6 grams, and which gives an output of 0.6 volts. The dual-stylus crystal unit is the CAC-D, which gives an output of 0.4 volts, and requires a stylus force of 10 grams.

Electro-Voice, Inc., Cecil and Carroll St., Buchanan, Mich. **(KS-13)**

Two models of ceramic cartridges are currently available—the 84 Ultra-Linear which was one of the first to match the RIAA curve without external equalization, and the new Series 80 which has just been introduced. The 84 has an output voltage of approximately 0.5 volts from the standard stylus velocity of 7 cm/sec, and works best into a load resistance of 3 megohms. It has a compliance of 1.2×10^{-6} cm/dyne, and a minimum of vertical pick-up. As with any ceramic cartridge, there is no hum pick-up from magnetic fields, and when worked into the specified load impedance, the output curve follows closely that of the RIAA curve. The new Series 80 has approximately the same output, but has increased compliance—the figure stated by the manufacturer to be 3.0×10^{-6} cm/dyne. The 80 series is available in several forms, each designed to work into a conventional preamplifier intended for magnetic pickups without modification. Thus the pickup may be had to work directly into an amplifier designed to accommodate either G.E., Pickering, Fairchild, or Audak cartridges, with the lower load impedance of the input stage of the preamplifier serving to reduce



Electro-Voice series 80 cartridges are now available as direct substitutes for magnetic models.

low-frequency response from the pickup, and the bass-boost characteristic of the amplifier promptly makes up for it. This permits the user to make a direct replacement in cases where the characteristics of the ceramic cartridge may be desired—a change that would be especially desirable in the case of incurable hum pick-up, for example.

Ronette Acoustical Corporation, 135 Front St., New York 5, N. Y. **(KS-14)**

One of the first crystal pickups to make a reputation for high reproduction quality is the Ronette, a unit imported from Holland and available in a number of forms. Model TO-284 is the type number applied to the turnover cartridge which is adaptable to most arms and will replace conventional crystal pickups in or-

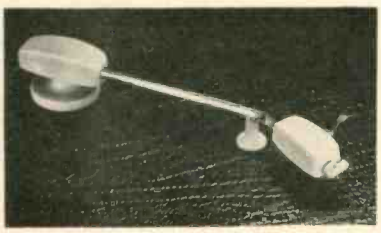
dinary inexpensive phonographs. TO-284-OV is a high-output model designed for direct replacement in equipment designed for crystal pickups. It works into a load resistance of 0.5 meg, and has somewhat more low-frequency response than the other types. The output voltage from a 7 cm/sec stylus velocity is approximately 1.5 volts, and the pickup will track with a needle force of 6 to 8 grams.

TO-284-N is the standard type cartridge for use with normal domestic

Holland-made Ronette is hi-fi crystal (not ceramic) pickup of high compliance.

radio receivers and small amplifiers. Its output voltage is approximately 1.0 volts. Both the above models are designed to provide approximate compensation for the RIAA recording curve.

Model TO-284-P is the professional type of cartridge, and is designed to work into a load resistance of 0.12 meg. With this load, the response is that of a velocity-sensitive pickup, and it should be worked into a standard type of preamplifier designed to provide the bass boost required for magnetic cartridges. Its output is approximately 0.3 volts at 1000 cps, and since this is considerably greater than most magnetic pickups, a voltage divider may be required ahead of the first tube to avoid overloading. Most preamplifiers have an input impedance of the order of 47,000 ohms—the highest load value required by presently available magnetic pickups—and the required 0.12 meg load may be had by adding a 75,000-ohm series resistor, which will re-



Ronette arm is compact, neatly styled.

duce the input voltage at the same time to about 0.1 volts (100 mv) and should eliminate the first-stage distortion. If not, the input resistor can be shunted with 39,000 ohms, which reduces the effective input impedance to approximately 21,000 ohms. With a 0.1-meg series resistor, the required 0.12 meg load is obtained, and the input signal is reduced to approximately 50 mv, which should not overload any modern amplifier.

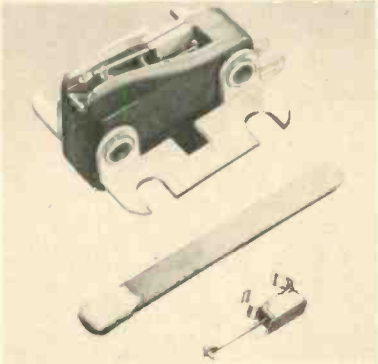
In cases of excessive hum pick-up, this is an ideal way to replace the magnetic cartridge and still retain the advantages of the variable turnover and rolloff characteristics of a conventional preamplifier. The Ronette is claimed to have the lowest intermodulation distortion of any pickup on the market. The arm is neatly styled, and provides extremely low drag, being mounted on ball bearings. Stylus force is adjustable by means of a screw from 1 to 8 grams, and the head permits turning the cartridge to a half-way position where both styli are protected from accidental damage.

Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill. **(KS-15)**

In addition to a large line of standard quality phonograph pickups made for the phonograph trade, Shure Brothers also manufactures some models intended for high-fidelity use. The most recent of these models is the "Balanced Fidelity" "Twin Lever" ceramic, which offers excellent response—tailored practically to match the RIAA curve without equalization in the amplifier—and relatively high output voltage. The "Twin Lever" feature is the stylus assembly, which is composed of a replaceable mounting plate to which are attached two parallel stylus arms approximately ⅛ in. apart. At the outer ends of these arms the styli are attached, and suitable damping material is located between the arms. The "turnover" mechanism lifts both arms together, positions the desired stylus over the coupling lever to the ceramic element, and lowers it into a notch on the lever. Both styli are replaced at the same time without tools, and the unit is ingeniously designed. This model tracks with a stylus force of approximately 6 grams, and the output signal is of the order of 0.5 volts at 1000 cps from a stylus velocity of 7 cm/sec.

Sonotone Corporation, Elmsford, N. Y. **(KS-16)**

Two models of Sonotone Ceramic cartridges are available—model 1P which has a single stylus (1-, 2-, or 3-mil sapphire or 1- or 3-mil diamond), and model 2T which is equipped with two styli in a turnover arrangement for playing both microgroove and 78 recordings.



Typical Sonotone ceramic cartridge.

Both pickups have an internal capacitance of approximately 450 μμf, track with a stylus force of 8 to 10 grams, and provide an output signal of slightly more than 1 volt. When worked into a 5-meg load, the response is flat within ±2 db from 30 to 15,000 cps. Compliance is approximately 1×10^{-6} cm/dyne. Both models of cartridges are available for mounting on standard pickup mounting centers, or with no brackets for installation in narrow heads.

PICKUP ARMS

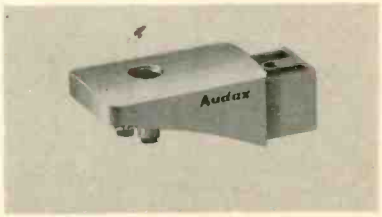
While most manufacturers of pickups are reluctant to entrust the final performance of their product to an arm made by another manufacturer and, consequently, provide an arm of their own design which should give optimum performance with their own product, there are some arms available that have special characteristics which are claimed to make them ideal for all pickups. In many instances, the arm provided by the pickup manufacturer may also be used with other cartridges—either with or without adapters—and these types are listed here along with the arms sold for general use.

Audak Company, 500 Fifth Ave., New York 17, N. Y. **(KS-2)**

The Audak arm is especially designed to accommodate the Audax Chromatic pickups, but with an adapter may be used with any standard pickup. The arm is of simple construction, having only

Audak arm is designed for Audax Polyphase pickup, but adapter is available for use with other pickups.

three moving parts—the base, with a long pointed pivot, the rotating section which seats over the pivot like a compass needle, and the arm, which is pivoted horizontally 2 in. in front of the vertical pivot. The rear of the arm is counterweighted, and current models



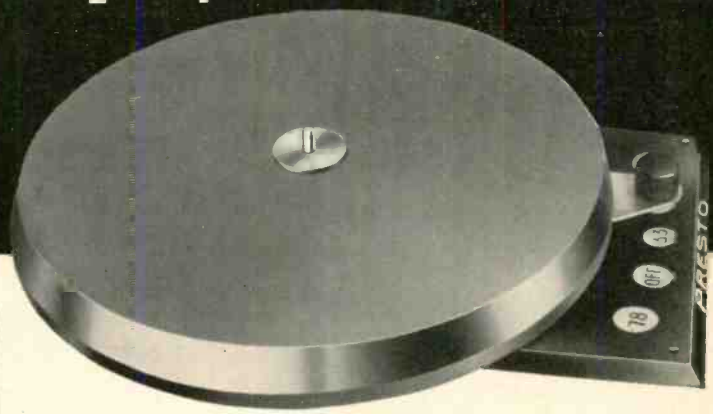
Adapter to permit mounting any pickup on Audak arm.

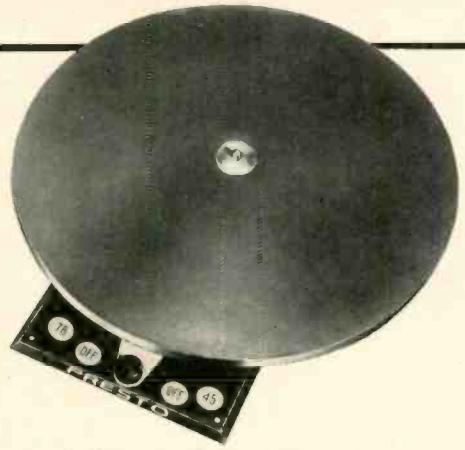
provide for stylus force adjustment. The adapter fits into the Audak arm and accommodates any standard cartridge.

B-J Arm. Hi-Fidelity Incorporated, 420 Madison Ave., New York 17, N. Y. **(KS-17)**

This arm, developed by Mr. Burne-Jones, was designed to maintain the axis of a pickup tangent to the record groove throughout the playing area. While a simple pivoted arm would need to have infinite length to provide the tangent

Here's the turntable professionals want in their own Hi-Fi setups





...and here's the 16" version for home or professional use!

PRESTO T-68 TURNTABLE

The first completely professional 16" turntable that's moderately priced — thanks to PRESTO's streamlined shift design. Like all PRESTO units, T-68 offers the reliable performance that is vital in 24-hour-a-day transcription work. It's ideal for disc programs, sound effects, client auditions, dozens of jobs... and it's wonderful for the home with a fine hi-fi collection.

T-68 specifications: turntable speeds — 33⅓, 45, 78 rpm • weight—7 lbs. • panel size — 8" x 11" • speed accuracy—max. variation 0.25% • clarity — 50 db below 7 cm/sec. signal • $79.50 with hysteresis motor, $134.

the all-new

PRESTO T-18

streamlined inside and out ...delivers top professional performance with incredible ease of operation

12" diameter...only $53.50
with hysteresis motor, $108

Nobody knows better than the hi-fi expert how good the T-18 turntable really is. T-18 fills your every requirement for performance and value...is a natural choice for your home, as well as your studio and control room.

The most exciting feature of PRESTO's T-18 is a revolutionary 3-way shift — the flick shift. A simple sideway motion of the single control lever selects any speed — 33⅓, 45, 78 rpm. Complicated up-and-down motions are eliminated because the 3 idlers are mounted on a single movable plate. Just a flick automatically engages the proper idler for the desired speed! There are no trouble-making arms or shift cams. The mechanism is streamlined down to essentials—without sacrificing a decibel of quality.

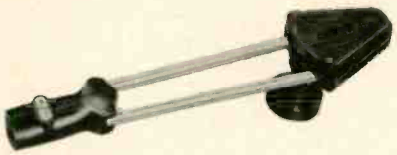
Other advantages — extra heavy weight wide-beveled table, precision deep-well bearing, built-in 45 rpm adapter, and smart modern styling in brushed chrome and telephone black. A remarkable hi-fi instrument!

PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Instantaneous Recording Service, 42 Lombard Street, Toronto

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

tracking, it is possible by the ingenious method used in the B-J arm to reduce tracking error to less than 1 degree from beginning to end of a 12-in. record. An analysis of the geometry of this design proves the claims of the manufacturer to be accurate. The pickup consists of a mounting base which is fixed, two arms pivoted independently in the top of the mounting base with their pivots approximately 2 in. apart, and pivoted on 1-in.



B-J arm maintains tangency to record groove at all diameters.

centers at the pickup head. The head will accommodate any standard cartridge, and stylus force is adjusted by adding or removing lead weights underneath the top section of the mounting base. The two arms are of different length, and consequently have different resonant frequencies, which is said to reduce low-frequency resonance.

Clarkstan Arm. Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles 64, Calif. **(KS-18)**

The Clarkstan arm is especially suited for the experimenter who has occasion to change pickups often for one reason or another, because the method of changing and the ease with which the stylus force can be readjusted makes it a most convenient arm for this purpose. Available in two lengths, these arms are of cast aluminum construction, and have an open channel at the pickup end which is of the correct width to accommodate most modern cartridges. A thumb screw —which also serves as a lifting handle— tightens a flat spring against the pickup to hold it firmly, while silver-plated spring-loaded plungers maintain positive electrical contact to the pickup terminals. The weight adjustment consists of a round counterweighting button held in place by a captive screw which slides in a slot in the arm. To change the weight, the button is loosened, moved to the position which provides the correct stylus force, and tightened in place. The range of weights is such that the arm will accommodate pickups from 5 grams up to at least 2 ounces. Height of the arm is also adjustable, and the horizontal pivots are needle pointed. Models of this arm are also available with a slot which accommodates the turnaround knob of the type used on the G.E. cartridge. Tracking error at the center of a 12-in. record is practically zero, and rises to a maximum of 6 deg. at the outside grooves.

Fairchild Recording Equipment Co., 154th and Powells Cove Rd., Whitestone 57, N. Y. **(KS-4)**

The design and construction of a pickup arm is of considerable importance to the performance of the pickup itself, particularly in the very low frequency region and occasionally in the range

Fairchild 280 arm has high inertia in lateral plane, low in vertical.

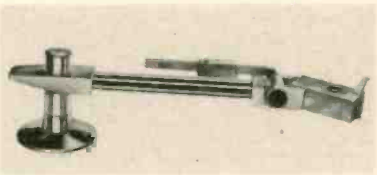
from 100 to 200 cps, the former being the resonant frequency between the compliance of the pickup and the mass of the arm, while the second is the effect of torsional resonance in the arm itself. Careful distribution of weight and adjustment of compliances can reduce the effects of these resonances to a minimum. For example, it is desirable to have a large mass acting on the arm in a horizontal direction but considerably less in the vertical plane. If turntable and record were perfectly level, a very heavy arm —suitably counterweighted— would be ideal, for the resonance of arm and pickup would be at a very low frequency. However, records are not always perfectly flat and the stylus may tend to lose contact with the groove at the high spots in the record, causing distortion under optimum conditions, and groove jumping in worse cases. Thus the Fairchild arm has considerable effective mass in the lateral plane, but because of spring-aided suspension has somewhat less in the vertical plane. These features result in a minimum of distortion due to the arm alone.

The cartridges are carried on a "drawer" in the Fairchild arm, and can be replaced instantly, providing each cartridge is mounted in a separate drawer. When the drawer is removed, the spring contacts short together, preventing an open circuit hum while the cartridge is taken out of the arm. The height is easily adjustable, and stylus force is adjusted by a screw on the bottom of the arm.

The arm—the 280 series—is available in two lengths, one for 12-in. records, and the other for 16-in. transcriptions.

General Electric Company, Electronics Park, Syracuse, N. Y. **(KS-7)**

Two models of arms are offered by G.E. to accommodate 12- and 16-in. discs. Both are of aluminum construction to offer a minimum of lateral and vertical inertia. These models consist of a mounting base with the vertical bearing, two parallel aluminum tubes serving as the arm and terminating in the horizontal bearing, and a cartridge head which will accommodate most cartridges. The head tilts upward 90 deg. for easy stylus

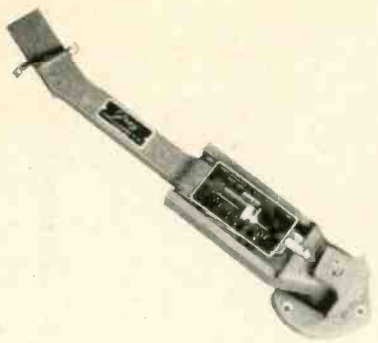


General Electric "Baton" arm has easily adjusted weight; arm hinges upward for stylus inspection.

inspection, and when in the operating position is counterweighted by an arm which extends back parallel to the two aluminum tubes, and which carries a sliding weight. The calibration is directly in grams when used with a G.E. cartridge. Both lateral and vertical bearings use precision ball races which are dust proof and lubricated for limetime use. The bottom of the mounting base is slightly curved to permit levelling by the three screws which affix it to the motor board.

Gray Research and Development Company, Inc., Manchester, Conn. **(KS-19)**

Two types of arms are available from Gray—the 106 and the 108 series. The 106 models are precision instruments made to provide a complete range of adjustment and using precision ball bearings for both vertical and horizontal pivots, with cone point adjustment to ensure minimum friction without excessive play. The arms are equipped with levelling screws, and the stylus force may be adjusted by the knurled thumb screw shown adjacent to the scale. Slides to fit



Gray 106S arm offers precision workmanship, ease in adjusting stylus force.

most cartridge types are available, and slip into the end of the arm, making electrical contact at the same time. The earlier 103 arm was designed for fixed cartridge use, and was not equipped with the readily changeable slides.

Another Gray development is the viscous damped arm. Damping aids in suppressing any resonances of the arm by introducing mechanical resistance into the mechanical resonant circuit. The methods of obtaining linear mechanical resistance are limited, but the method employed in these arms is simple and effective. In construction, these arms consist of a conical pivot which supports the arm just free of contact between a convex spherical surface on the arm and

Gray 108C arm is newer, lower priced, but still employs viscous damping.

a concave spherical surface on the base. The space between these spherical surfaces is partially filled with a silicone oil —a product which maintains a practically constant viscosity regardless of temperature. The thickness of the oil film is controllable by the user by a simple adjustment of a thumb screw on the top. The damping also helps to protect records because of its retarding action. In case the arm is dropped accidentally over the record, the pickup falls gently to the surface of the disc, and does not bounce up and down on the record surface.

Pickering & Company, Inc., 309 Woods Ave., Oceanside, N. Y. (KS-9)

Another concept of the proper design for pickup arms is represented by the Pickering design. In this model the cartridge is carried on a pivoted plate in the forward end of the arm, with the dis-

tance from stylus to the horizontal axis being less than 3 in. The mounting plate is spring balanced, and thus provides a minimum of vertical inertia while the lateral inertia is relatively high. This meets the requirements previously dis-

Pickering arm; cartridge mounting plate is hinged near front and offset for proper tracking.

cussed. The cartridge is lifted by an extension of the hinged plate projecting out in front of the arm, permitting it to be carried to the record and lowered in place. The usual arm rest is replaced by a small permanent magnet in the arm which contacts a metal stop and holds the arm in place. The cartridge plate is offset inside the arm so that tracking error is reduced to less than 2.5 deg. at any point on a 12-in. record. As a protective measure, the arm is installed so that the stylus cannot come in contact with the top of the turntable.

PROFESSIONAL-TYPE TURNTABLES

Garrard. British Industries Corporation, 164 Duane St., New York 14, N. Y. **(KS-20)**

The Garrard Model 301 turntable is a heavy-duty single-play unit which is designed for transcription use, or for those who prefer professional-type equipment for home reproduction of records. This model is furnished on a cast mounting plate of attractive design, and employs a cast aluminum turntable which is machined to extremely close tolerances.

Garrard Model 301 transcription turntable.

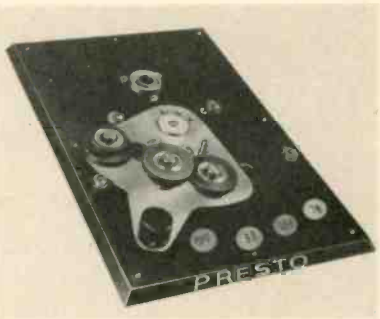
Three controls are provided—a motor switch, a speed selector, and a vernier speed control. The turntable is covered with a ribbed soft rubber disc to provide reliable traction without any dust-collecting characteristics. The motor drive is exceptionally well designed for minimum rumble and flutter, and the heavy turntable shaft is carried in adequate bearings.

Presto Recording Corporation, P. O. Box 500, Paramus, N. J. **(KS-21)**

The new Model T-18 turntable—introduced only this Spring—is of extremely simple construction. The drive incorporates three heavy-duty idlers, one for each turntable speed. These idlers are mounted on shafts which are rigidly

Presto T-18 is one of newest models on the market, employs simple and effcient mechanism.

fixed to a base plate, and all three are identical, permitting a quick substitution in case of any failure, and requiring the stocking of only one idler for replacement purposes. To select speeds, the entire plate is moved, being pivoted about half way between the turntable shaft bearing and the motor shaft. The turntable is an aluminum casting balanced for smooth running. The bushing for 45-rpm records is permanently placed, and is raised to operating position by lifting the spindle. Since the entire mounting consists of an 8 × 11 panel, a simple rectangular hole is all that is required for the installation, and the



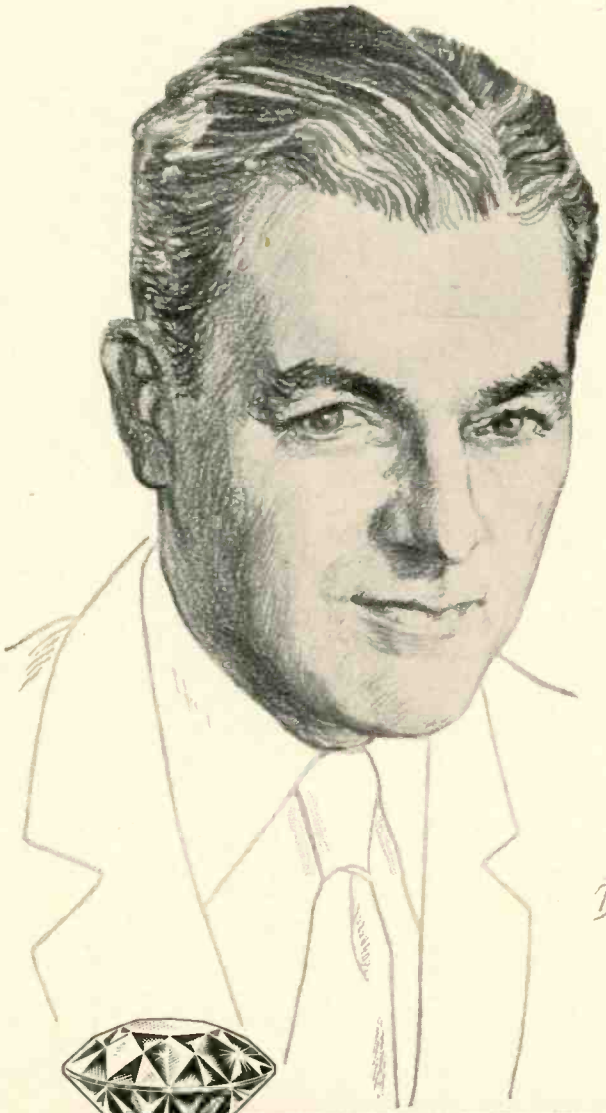
Three separate idlers—one for each speed—couple motor shaft to turntable in Presto T-18.

mounting plate does not interfere with the placement of the pickup arm. The T-18 is available with either a hysteresis motor or with a shaded-pole motor. The model using the hysteresis motor is said to be 10 db quieter than the other, but the improved performance is obtained at a considerable price differential.

Model T-68 is essentially identical in mechanical construction, but is equipped with a 15¾-in. turntable.

IRVING KOLODIN

comments on diamond phonograph needles:



"Only one material really suffices—(as a phonograph needle) the diamond. Nothing else matches it . . . anything else may categorically be denied consideration as . . . high fidelity."

Music Editor
Saturday Review

PLAY SAFE
PLAY DIAMOND

TETRAD

WORLD'S LARGEST MANUFACTURERS OF DIAMOND STYLI

Ask your dealer or serviceman for a BRAND NAME DIAMOND
Record-Needle Care Folders: Dept. UC-6, 62 St. Mary Street, Yonkers, N. Y.

Rek-O-Kut Company, 38-01 Queens Blvd., Long Island City 1, N. Y. **(KS-22)**

With the introduction of the new model L-37, there are now four turntables in the Rek-O-Kut line that are designed for home playback use, in addition to others intended for recording and for uses that require 16-in. models. Model B-12H consists of cast aluminum chassis on which is mounted a hysteresis motor, the idler mechanism, and the turntable shaft bearing. The base plate

Rek-O-Kut B12 and B-12H look alike, differ only in motor. Deluxe B-12H uses hysteresis motor.

is large enough to accommodate the pickup arm mounting, except when transcription types are used, and mounts in a rectangular opening 13 1/16 × 14 13/16 in. The drive mechanism consists of a stepped motor pulley which drives an idler, which in turn drives the inside of the turntable rim. The idler is carried on a bracket which is isolated from the turntable from by rubber shock mounts, and the idler bearing is large enough to ensure true operation. The idler pulley is a machined aluminum wheel with a bonded neoprene tire ground to a high degree of concentricity. The motor pulley is a phenolic rod pressed onto the motor shaft and then ground to size to make sure that it, too, is perfectly concentric. The 45-rpm hub is retractable, being held below the surface of the turntable by a bayonet catch, requiring only a quarter turn to release it. The speed selector knob actuates the motor switch and at the same time it places the idler in the proper position for the desired speed. A neon pilot light glows when the motor switch is on, and serves as a reminder.

Model B-12 is identical in construction except for the use of a 4-pole induction motor instead of the hysteresis model.

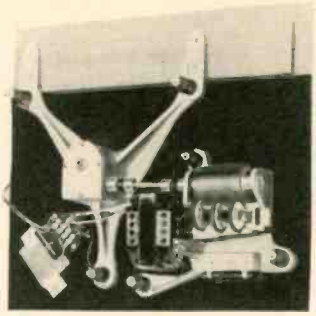
Rek-O-Kut lower-priced two-speed models are available for 33 1/3 and 78 or 33 1/3 and 45, as desired.

Models L-34 and L-37 are somewhat smaller, and mount with a base plate which extends only in front of the turntable. L-34 has two speeds—33 1/3 and 45—which are most useful for modern installations where no 78's are already in the collection. Model L-37 also has two speeds, with 78 being substituted for the 45. All models have a turntable covering of neoprene-bonded cork which eliminates slippage entirely.

Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass. **(KS-23)**

The Scott 710-A Stroboscopic Turntable has several unique design features, and differs appreciably from others. Briefly, it consists of a horizontally mounted motor with a long stepped shaft, each step being tapered slightly. Parallel to this shaft is a phenolic drum which is driven by one of three idlers, depending upon the speed desired. The drum is connected to the turntable drive through two soft rubber universals, and the drive consists of a hardened steel worm and a nylon gear located on the turntable shaft, and machined in place on the shaft. The turntable is driven by the shaft through a slip clutch which permits holding the turntable stationary for cueing, and which permits turning the table without damage to the worm.

The turntable bearing is mounted on a Y-shaped casting which is attached to the mounting plate by rubber-damped spring mounts, with extensions on the casting carrying a mahogany platform for mounting any standard arm. Thus the turntable and arm are rigidly attached to each other, but are shock mounted from the base plate. The motor and speed-change mechanism is also shock mounted from the base plate, and the only connection between the motor and the turntable is the drive through the soft rubber "universals." This construction is claimed to reduce motor rumble to more than 60 db below recording level.



Turntable and arm platform are isolated from base plate with springs and rubber dampers in Scott unit to eliminate vibration from outside sources. Motor and speed-change assembly are also isolated from base plate, providing two stages of mechanical filtering.

Each speed has its own vernier adjustment, by means of a knob on the panel, permitting a variation of ±5% of the nominal speed to match the pitch of an accompanying musical instrument, for example. A built-in stroboscope permits adjustment of the speed to the exact

Scott Stroboscopic Turntable uses push buttons to select speed, has vernier adjustment for each of the three speeds.

value. Speed selection is made by depressing any one of three buttons, which simultaneously starts the motor. The fourth button stops the motor and disengages any idler.

This construction permits mounting the base plate solidly to any cabinet without the need for isolation, with all shock mounting built into the unit integrally. The base plate and pickup arm mounting board is 14½ × 16⅞ in., and requires a depth of 4¼ in. below the mounting board.

D. & R., Ltd., 402 E. Gutierrez St., Santa Barbara, Calif. **(KS-24)**

Utilizing a new principle in turntable design, the DR-12 model locates the motor on isolation mountings outside of the turntable area and drives with an idler on the outer rim of the table. All parts are easily accessible and machined to professional tolerances. With this type of construction, the motor is well away from the path of the pickup, and thus eliminates any induced hum from the drive motor. The design requires somewhat larger mounting space than most turntables, but this would not be a disadvantage to many users. Turntable covering is a cork-latex compound to eliminate slippage.

Components Corp., Denville, N. J. **(KS-25)**

Several interesting features are incorporated in this design, which consists of a 25-lb. cast steel turntable mounted in a nylon sleeve bearing and supported by a single ball thrust bearing and driven by an endless cloth belt direct from the motor shaft. This reduces the rotating parts to just two—the motor and the turntable—and isolates the motor from the turntable by the long belt. The motor is mounted with double sets of shock mountings to further reduce vibration. The entire base panel is supported by steel springs which are damped with felt. Another interesting device is the expanding collet-type spindle which accurately centers the record on the turntable and holds it from shifting or slipping.

RECORD CHANGERS

Collaro. Rockbar Corporation, 215 E. 37th St., New York 16, N. Y. **(KS-26)**

The Collaro RC-54 record changer retains most of the basic features that contributed in establishing the reputation of its predecessors, but embodies several improvements. This changer intermixes all sizes of records—presuming that all are of the same speed—and these may be stacked in any order of play without any adjustment or presetting. The changing cycle requires only 6 seconds at all speeds. The steel turntable is weighted, and runs on a hardened spindle with a ball-thrust race for smooth operation. The unit is constructed so that when the changer is switched off by the user, or at the end of a stack of records, the idler is disengaged from the motor shaft to prevent development of flat spots. Records are stacked on a center spindle which remains stationary, and when the change cycle is initiated, the record is slipped off the stepped spindle by an internal lever. As with all drop changers, the air cushion below the record provides adequate delay in the fall to avoid injury to the records. Stylus force is adjustable to as little

The Collaro RC-54 changer.

as 3 grams, and two heads are furnished for installation of any desired pickup cartridge. The mounting plate is 12 × 13½ in., and the changer requires a clearance above the mounting board of 5⅛ in. and 2⅝ in. below.

Two knobs serve as the controls—one for speed selection, and one for turning the power on and off and for rejecting a record. During the changing cycle the pickup is shorted so the user does not hear clicks and pops. A separate 45-rpm spindle is available as an accessory to accommodate the smaller records, dropping them in the usual way. After the last record side is played, the mechanism is shut off automatically.

Dual. United Audio Products, 202-4 E. 19th St., New York 3, N. Y. **(KS-27)**

The Dual Automatic Record Player combines the features of a single-play turntable for 33-1/3 and 78-rpm records with the advantages of the changer for 45's. Some users have felt that there is no need for automatic operation with LP's and that they would therefore prefer the use of a single-play turntable for this speed, but when they want to play 45's the changer feature is practically a necessity.

The Dual operates as a single-play turntable at both LP and 78 speeds, and with the 45 spindle plugged into place becomes a changer for this one speed. The starting and stopping at all speeds

"Dual" Automatic record player is manually operated for LP and 78, changer for 45's.

is automatic once the starting button is depressed, which selects the proper stylus and inaugurates the starting cycle. The arm moves to the center, determines the record diameter and moves the arm to the proper position, then lowers the stylus to the first groove. In the automatic position—on 45's—the arm is moved out at the end of the side, another record is dropped, and the cycle is repeated. When finished with the last side of a stack of 45's or when a side is finished at LP or 78 speeds, the arm is lifted automatically, moved to the rest position and locked in place, and the motor is turned off. Normally furnished cartridge for this player is a crystal, but a magnetic cartridge will soon be available. The top plate is 13 × 10¾ in., and requires 3 in. below the mounting board and 5¾ in. above.

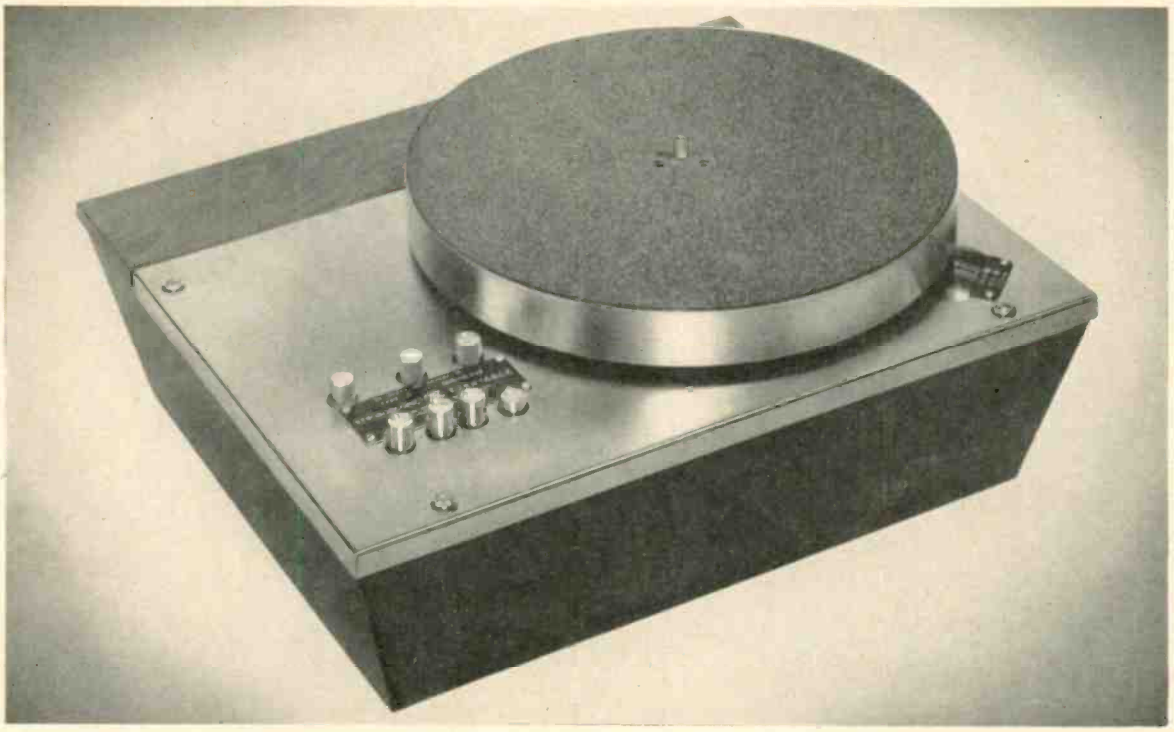
Garrard. British Industries Corporation, 164 Duane St., New York 13, N. Y. **(KS-20)**

The Garrard RC-80 was first advertised in the pages of this magazine in November, 1950, and a comparison of the unit as shown in the following month's issue with the same model of changer as shown today would seem to indicate that there had been no changes. But this only serves to stress the fact that the original design was fundamentally excellent, and that any changes made in the RC-80 over the years have been minor improvements to perfect the operation rather than to bring out a new model each year to attract the customer's dollar in the manner of the U.S. automobile industry. And while the external appearance of the 1950 model is practically identical with that of the current RC-80, the changes that

The Garrard RC-80 has had no major changes in years, but minor refinements have raised it to present high quality.

have been made are in the nature of refinements. The motor is now mounted on specially developed composition grommets which serve to eliminate rumble, and a tension lever releases the intermediate wheel from contact with the turntable drum and the motor pulley when the unit switches off and also applies a brake to the turntable so that it stops quickly. Stylus force adjustment now has sufficient latitude to accomodate all types of pickup cartridges. Because of the rather extreme variation in thickness of records, the pawl guide has been modified so that the changer will handle both unusually thin or unusually thick records equally well. A new spring mounting assembly now makes it possible for the entire changer to be snapped into holes in the mounting board, and permits levelling from the top of the plate.

The turntable spindle is ground and lapped to a fine finish, and the bearings fitted into the spindle are burnished bronze. The ball race is located in a phenolic cage to obviate the metal-to-metal contact and to prevent creepage, and the whole thrust assembly is supported on a plastic washer instead of metal—a more durable and rumble-free arrangement. Rotor of the drive motor is dynamically balanced to a high degree of accuracy—and this we have seen for ourself—and the spindle is finished with an eccentricity of less than .001 in., with the motor pulley held to an eccentricity of less than a quarter of a thousandth. To further reduce rumble and flutter, the rubber tire on the idler is ground with a crown to eliminate small burrs on the edge which might detract from smooth operation.



NEW STROBOSCOPIC TURNTABLE

Makes Any Music System Sound Better

Here's why recordings really do sound better when played on this amazing new turntable.

The new "floating frame" suspension, developed by H. H. Scott engineers, isolates both the turntable and pickup arm against all effects of sound, room, and motor vibrations. This system makes music reproduction entirely free from the "muddiness" and distortion inherent in conventional installations.

Stroboscope and Vernier Speed Controls

Here are more professional features of the H. H. Scott Model 710-A turntable. A convenient built-in optical stroboscope assures you of precision speed adjustment even while the record is being played!

Three vernier-controlled speeds, each adjustable by ± 5%, let you change the pitch of the record to match an accompanying musical instrument.

Gear Drive and Torsional Filters

A precision, helical-gear drive assures constant-speed operation. This drive was developed for H. H. Scott by Professor Earle Buckingham, of M.I.T., designer of the drive mechanism for the Mt. Palomar 200-inch telescope.

Unique torsional and mechanical filters cut "rumble" and other extraneous disturbances far below the audible level.

Styled in Mahogany and Stainless Steel

The motor board is finished in beautiful, durable stainless steel. The contrasting hand-rubbed mahogany pickup-mounting board is furnished as an integral part of the turntable.

The unique mechanical design lets you mount the turntable board rigidly to any cabinet. No extra mounting springs or vibration isolators are needed: a scientifically designed shock-mounting system for both turntable and pickup arm is already built in.

No matter how perfect your music system may sound to you now, the revolutionary design of the new 710-A turntable will add startling new realism to music reproduction.

Once you *see* and *hear* the 710-A, you won't be satisfied with less! Why wait any longer—now you can enjoy music as it *should* sound. Ask your dealer for a demonstration TODAY!

TECHNICAL SPECIFICATIONS

Motor Rumble: more than 60 db below the recording level.
Wow and Flutter: less than 0.1% of rated speed.
Speeds: push-button selection of 33-1/3, 45, and 78 rpm.
Turntable: machined from a single heavy aluminum casting; aluminum construction eliminates magnetic pull on reluctance cartridges.

Dimensions: Including pickup-arm mounting board 16⅞ x 14½ inches.
Power: 55 watts, 105-125 volts, 60 cycles.
Prices: 710-A turntable—$102.00 net; West Coast price—$107.10
710-X1 mahogany base—$14.95 net; West Coast price—$15.70

Write for Bulletin A-655.

by H. H. Scott

H. H. SCOTT Inc. 385 PUTNAM AVENUE, CAMBRIDGE 39, MASSACHUSETTS

Drive from motor to idler is direct from motor shaft on 78 rpm, and through flat rubber belts to intermediate drive shafts for 45 and 33 1/3 to further isolate the motor from the turntable at these more critical speeds. Belts are readily replaceable by the user. Except during change cycle, the arm is free, and may be moved from band to band at will. For starting and stopping, the arm is actuated mechanically—considered preferable to manual handling in average service.

The RC-90 is essentially identical with the RC-80, but has several additional features—principal one being vernier speed adjustment, which is of interest to the musician who is likely to play along with his records and wishes to set record speed accurately to match pitch of reproduced music with that of his instrument.

Miracord. Audiogersh Corporation, 23 Park Place, New York 7, N. Y. **(KS-28)**

The Miracord XA-100 is a German import which offers a number of unique features that are considered desirable by many. Among them are the push-button operation, incorporating a "start" button which inaugurates the playing cycle; a "filter" button which reduces scratch and high-frequency noise when actuated; a "pause" button which introduces a variable interval between successive playings from a stack of records; and a "repeat" button, which may be depressed at any time during the playing of a side and which causes the record to be repeated at its finish rather than continuing with the succeeding record on the stack.

The Miracord operates with a "Magic Wand" spindle which is essentially a thin version of the familiar 45 spindle. The records are stacked on the spindle, being held with three fingers equally spaced around the spindle. At the change cycle, the fingers are retracted to release the bottom record while three expanding spring leaves hold the remaining records in place until the fingers return to their normal position. 10- and 12-in. records may be intermixed in any order, the larger ones actuating a lever at the back of the unit to direct the set-down position of the pickup arm. Positioning the speed selector to 45 rpm signals the mechanism to set the arm down at the required 7-in. diameter.

"Magic-Wand" center drop mechanism, push button operation, and "Pausamatic" control have proved attractive features of Miracord XA-100 changer.

A conventional 45 spindle is used for the smaller discs, operating in the usual manner. A single-play spindle is also provided which disables the change mechanism when inserted in the turntable opening in the normal position, and when inverted causes 10-in. records to repeat continuously.

The "Pausamatic" control gives intervals ranging from 5 to 140 seconds at 78 rpm, between 9 and 240 seconds at 45, and between 12 and 328 seconds on LP's, the lower figures being the minimum change time for the respective speeds. The arm has provision for adjustment to accomodate any available cartridge weight.

The Miracord chassis is 12½ × 10¼ in., and requires 4¾ in. clearance above the mounting board and 2¾ in. below. Plug-in heads will accept most cartridges, and a new adapter is now available which will accommodate the Audax models.

Radio Corporation of America, Front and Cooper Sts., Camden 2, N. J. **(KS-29)**

The hi-fi components line of RCA includes two record changers—the de luxe model SRC-51, and the lower priced SRC-61 which is available as a "component" chassis, or in an attractive base as model 6JSH-1.

The SRC-51 is well known, and provides the user with reliable, trouble-free service. The newer model, developed by RCA, is more modern in appearance and employs a permanently mounted spindle for LP's and 78's, with a slip-on 45 spindle being used for the smaller discs. When not in use it is stored in a well in the base. A standard type variable reluctance cartridge is provided with either model.

The deluxe model of RCA changers—SRC-51.

The 6JSH1-SRC-61 has a fingertip speed control which selects speed, turns set on and off, and rejects records. The arm is returned to its rest after the last record is played, and the motor is turned off. It mixes 10- and 12-inch records of the same speed, and has a simplified manual operation which allows repeat playing or skipping of portions of a record.

Rex. Fenton Company, 15 Moore St., New York 4, N. Y. **(KS-30)**

The Rex changer, manufactured in Western Germany, is currently avail-

able in four models—the Rex A with a high-quality reversible crystal cartridge; the Rex AM with two high-output four-pole magnetic single cartridges; the Rex A Special with a built-in preamplifier for the magnetic cartridge; and the Rex AA which is similar to the Rex A but has a plug-in shell to accommodate any U.S. cartridge. Operation of the Rex models is unusual in that the record is dropped about ½ inch at the start of the cycling operation, pauses while the arm moves in to "measure" the diameter, then retracts slightly while the record drops onto the turntable. The arm then moves in to permit the stylus to land on the record at the correct position. Thus the changer will work with any record size from 6 in. to 12 in. intermixed and in any order.

The preamplifier in the Rex A Special incorporates three degrees of low-frequency turnover and three cutoff positions, and is thus suitable for replacement in a home system which does not have sufficient amplification or control to accomodate a magnetic pickup.

Thorens Company, New Hyde Park, N. Y. **(KS-31)**

The Swiss-made Thorens changer differs considerably from most models now in use in that the motor drives the turntable shaft through a worm and gear, the speed being controlled by a

Thorens model CD-43 has pause mechanism, is gear-driven from governor-controlled motor.

flyball governor, and the motor is mounted with the shaft parallel to the turntable. The speed-change mechanism employs a series of planetary gears.

The model CD-43 changer intermixes 12, 10, and 7-inch discs, and is fitted with stop, start, pause, and reject controls on the panel. It is easily adjustable for stylus force, and comes with shock mounts; a switch permits semi-manual operation.

V-M Corporation, 280 Park St., Benton Harbor, Michigan. **(KS-32)**

Model 935HF is the current model intended for the "hi-fi" market. This model is a center-drop design, using a guide arm to steady the record stack. The arm is cast aluminum, and is equipped to accept plug-in cartridge holders, and most cartridges may be fitted to the holders with little effort.

The laminated turntable is weighted and balanced to assure smooth operation, and a four-pole motor minimizes external hum fields. The 45 spindle slips

V-M 935-HF record changer features cast aluminum pickup arm, interchangeable plug-in cartridge heads.

over the permanently fixed small spindle, and when not in use is stored in a well on the base plate.

Model 1200 is a 4-speed changer—offering in addition to the usual three speeds required by present-day phonograph records the fourth and talking book speed of 16 2/3 rpm. All V-M models offer attractive styling, and are obtainable as chassis, or mounted in various cabinets as complete phonographs.

Webcor. Webster-Chicago Corporation, 5610 W. Bloomingdale Ave., Chicago 39, Ill. **(KS-33)**

The 141 series of Webcor changers differ in the cartridges with which they

are equipped; 141 employs a ceramic cartridge, while 141-270 employs a GE variable reluctance unit with sapphire styli. Both models will play intermixed

Newest Webcor intermix changer, model 141.

stacks of 7, 10, and 12-inch records, and turntable speeds are held to narrow limits, even when the turntable is loaded. The speed control knob has a neutral position to remove the idler wheel from contact with motor shaft when the changer is not in use. An adapter is available for playing a 1-inch stack of 45's without the use of individual record inserts. All records and sizes may be played manually. After the last record is played, the arm is returned to the rest and the motor is shut off.

National Company, 61 Sherman St., Malden 48, Mass. **(KS-34)**

The National line of hi-fi equipment which was introduced about a year ago with a tuner, a preamplifier, and two power amplifiers, has recently been expanded to include a number of loudspeaker enclosures and a record changer. The Horizon 100 changer was designed for use in hi-fi systems, and is reliable, smooth in operation, and is said to be jam-proof and stall-proof. It intermixes 7-, 10-, and 12-inch records, provided all are of the same speed, and they can

The "Horizon 100" changer fills out National's high-fidelity line.

be stacked in any order of play without any adjustment or presetting. The complete change cycle requires 6 seconds, regardless of turntable speed setting. The unit employs a 4-pole motor for minimum hum field, has automatic disengagement of the large idler wheel, switches off at the completion of the last record in the stack, and is equipped with two plug-in heads which will accomodate any cartridge. The Horizon 100 includes a GE cartridge, all cables and connectors, and the mounting base, which may be either blonde or mahogany.

Sightmaster Corp., 111 Cedar St., New Rochelle, N. Y. **(KS-35)**

The Sightmaster Corp. markets a group of high fidelity units under its own name to make it possible for the music lover to assemble a complete system with a minimum of cost in comparison to the results obtained. Among the line is a record changer imported from England which incorporates most of the desirable features in such a unit. It intermixes 10- and 12-inch records, shuts off when last record is finished, mutes the pickup output during the change cycle, and utilizes a reluctance cartridge with a diamond stylus for LP records.

Stromberg Carlson Company, 1221 Clifford St., Rochester, N. Y. **(KS-36)**

Like many another manufacturer, Stromberg-Carlson does not build its own record changer, but has chosen the Garrard to offer under its own type number, Model PR-450M. All descriptive material for the Garrard RC-80 applies to the unit available as one of the components of the Custom Four Hundred line. Under the PR-450M number, the newest model of GE triple-play reluctance cartridge is supplied, using sapphire styli; Model PR-455M utilizes a diamond for the microgroove stylus.

Stromberg Carlson PR-450M changer is a Garrard RC-80.

RECORD PLAYERS

David Bogen Co., Inc., 29 Ninth Ave., New York 14, N. Y. **(KS-37)**

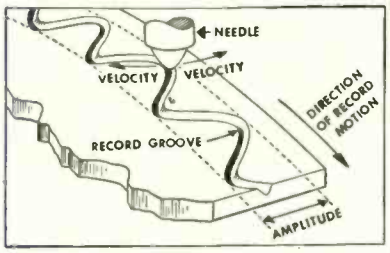
The Lenco turntable imported from Switzerland and sold in the U. S. under the Bogen name is of somewhat different design than most players. The motor is mounted with its shaft horizontal, but the shaft is a cone that actuates an idler which, in turn, bears on the bottom of the turntable. The position of the idler is controlled by the speed selector lever, and a continuous variation is obtain-

SONOTONE QUICK FACTS ON CERAMICS

By ROBERT L. LEWIS

If you haven't heard too much about ceramic cartridges, it's because this type is relatively new. Sonotone discovered the principle in 1946. Inherently, it had major advantages over other cartridge types—no deterioration from humidity or temperature...no magnetic hum pickup, no need for equalization, plus far higher voltage output. Since then, we've constantly improved the response curve, to its present superlative "flat" range.

The 1P described here is brand new. It's a single-needle type. We also make a turnover, two-needle type that operates on the same principles. Incidentally, both types eliminate one nuisance—you can remove or replace the needle in a second, just with your fingers. Simply snap it in.



This diagram helps explain why, using Sonotone ceramics, you get a flat response *without* an equalizer. With a velocity type pickup, the voltage output will be 30 times as great at 10,000 cycles as at 50 cycles. It responds to side-to-side *speed* of needle movement. But our ceramics work on the "amplitude" principle—they respond to the *amount* of side-to-side movement.

So a Sonotone ceramic cartridge will play back RIAA, Orthophonic, AES, LP and other common curves so close to "flat" that your ordinary tone controls amply cover any needed delicate adjustment for individual records...and individual ears.

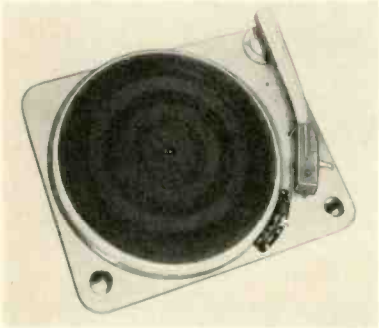
About hum—you'll be glad to know that Sonotone ceramics give a high voltage output that overrides hum, and require no boost at hum frequencies. And the nonmagnetic structure means no worry about nearby fields or turntable causes.

Sincerely,

Robert L. Lewis

Head of Electronic Applications Division

able, although there are notches in the lever quadrant to indicate the three basic speeds. The over-all range of speeds is



David Bogen model B50-4 record player utilizes idler which drives underside of turntable.

from 29 to 86 rpm. The turntable is weighted—3¼ pounds—and balanced. It is covered with a ribbed rubber pad.

The pickup arm is die cast, and employs ball bearing suspension for minimum friction, and stylus force is adjustable from 6 to 12 grams. Operation of the motor begins with a slight movement of the arm away from the turntable, and when the record is played, the velocity trip shuts off the motor. In the off position, the idler is disengaged from contact with both the motor shaft and the underside of the turntable to prevent forming flats on its rubber rim.

Two models are available—the Standard, which has a wide-range piezoelectric cartridge with two sapphires, and the De luxe, which is supplied with a GE RPX-050 cartridge. It is also available without cartridge in Model B50-4LC. The player requires a mounting space of 15 in. from left to right and 11⅞ in. from front to rear, with 2¾ in. clearance above the mounting board and 1⅞ below. It is furnished with plug-in plastic head and shock mounting springs.

Garrard. British Industries Corporation, 164 Duane St., New York 13, N. Y. **(KS-20)**

The Garrard Model T record player is a manual unit which incorporates an automatic start and stop mechanism, but which is built to Garrard standards throughout, in spite of its low cost. To start the motor, the pickup arm is lifted from its rest and moved slightly to the right to actuate the switch. When a record is finished, the motor is stopped by action of the trip mechanism.

For applications where a simple player is required, this one offers high-quality performance and ease of operation in a small and compact unit.

Miraphon. Audiogersh Corporation, 23 Park Place, New York 7, N. Y. **(KS-28)**

The Miraphon XM-110 is a very simple mechanism for playing records, but much of its virtue lies in its simplicity. It consists of a four-pole motor mounted on rubber grommets to the base plate and equipped with a stepped shaft. An idler is caused to engage the turntable rim and the proper step on the shaft by a speed control knob, being lifted out of engagement between steps. The pickup arm actuates the starting switch when moved to the right, and at the end of the record the motor is switched off automatically. Plug-in-heads and stylus force adjustment permit the use of any desired pickup. The unit has a minimum of rumble, and flutter and wow are undetectable by the ear.

RECORD EQUALIZERS

Relatively few of these are on the market today because most modern amplifiers are equipped with adequate facilities to acommodate all the recording characteristics in use, and most of those that have been used in the past. Some manufacturers provide simple preamplifiers which are designed with a turnover frequency close to 500 cps, and these can be employed with passive variable equalizers to match the many characteristics. Among these products are the following:

General Electric Co., Electronics Park, Syracuse, N. Y. **(KS-7)**

The GE Record Filter, Model A1-901, offers fourteen separate frequency adjustments to cover the full audio frequency range. The low-frequency cutoff filter has four positions—one is flat, and the other three cut off at frequencies of 40, 60, and 80 cps respectively, to eli-

G.E. Record Filter provides control flexibility when used with fixed preamplifier.

minate rumble and excessive low-frequency response when desired. The second control provides six compensator settings to match the system response to the six principal recording curves used by the industry. The third control provides for flat and three high-frequency cutoff positions—9000 cps, 5000 cps, and 3000 cps. This permits the elimination of scratch and high-frequency distortion on older records. The entire unit is housed in a neat phenolic cabinet, and is connected between a GE pickup and a preamplifier with fixed low-frequency boost. The compensator uses no tubes and therefore does not require any power supply.

Pickering & Co. Inc., 309 Woods Ave., Oceanside, L. I., N. Y. **(KS-9)**

The Pickering 132E record compensator is designed to work between a high-impedance magnetic cartridge and

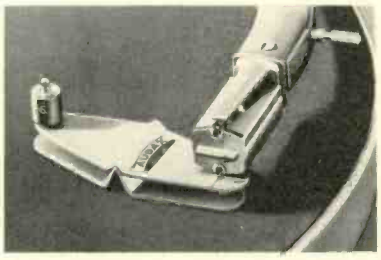
Pickering Compensator provides correct equalization for six common characteristics.

a preamplifier which has a 500-cps turnover. The compensator changes the response to match six different curves: European 78, London 33 and Old LP, Old Capitol and Old AES, New AES, (Ortho, RIAA), flat highs and a bass response that is not rolled off, and a normal bass position combined with a cutoff beginning at 3000 cps for noisy records. For the user who wishes to combine a simple unequalized power amplifier with a preamplifier with fixed low-frequency boost, this unit gives considerable flexibility, and eliminates the need for a "control unit" unless tone controls are imperative.

ACCESSORIES

Audak Company, 500 Fifth Ave., New York 36, N. Y. **(KS-2)**

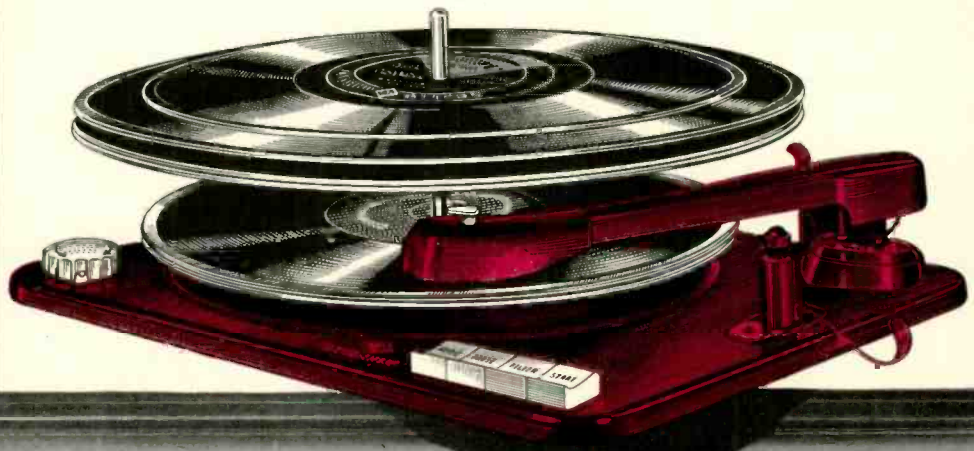
The Audax Stylus Balance employs a simple beam balance arrangement with knife-edged bearings, and two fixed weights—6 and 2¾ grams. A groove in one arm accomodates the stylus, and a small stud on the other end serves to locate the weights. The 2¾-gram weight will fit over the top of the 6-gram weight



Audax Stylus-Balance is one of simplest means of setting stylus force to desired value.

to indicate 8¾ grams, when desired, although the 6-gram value is recommened by Audak for LP reproduction. The balance arm is made of soft aluminum to avoid damaging the stylus, and for experimental purposes additional weights of 6 and 1¼ grams, respectively, are available to give a range from 1¼ to 16 grams.

Perfection



The MIRACORD XA-100

THE OUTSTANDING 3-SPEED AUTOMATIC RECORD CHANGER

Only the Miracord XA-100 has all the exclusive features that make it the most sought after changer today--

- No wow—no rumble
- "Magic Wand" spindle
- Push button control
- "Pausamatic"*
- Intermixes 10" and 12" records

Every component is held to the closest tolerances and because of the features that are incorporated brilliant and natural reproduction of tone is achieved.

Available at leading distributors throughout the United States.

*The user's choice of pause lengths between record changes.

AUDIOGERSH CORPORATION

Exclusive Distributors in the U. S. for ELAC Record Players

AUDIOGERSH CORPORATION
23 Park Place, New York 7, N.Y. Dept. A-6

Please send me descriptive literature.

Name_____

Address_____

City_____ Zone____ State_____

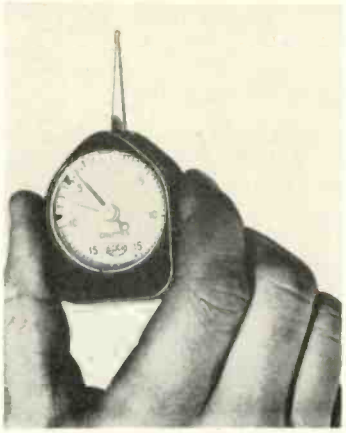
To use the Balance, the stylus is placed in the groove and the 6-gram weight is placed on the other end of the beam. The balance is held at a near horizontal position with the fingers, then released and the movement—if any—of the balance beam is noted. This unit is not intended to measure the value of stylus force, but only to permit setting the force to the correct value with ease.

Pickering & Co. Inc., 309 Woods Ave., Oceanside, L. I., N. Y. **(KS-9)**

The Pickering balance is so simple that it is usually presented as a souvenir of the audio shows. It consists of a flat aluminum strip about 1/32 in. thick with a depression in one end for the stylus, and an indication on the other for the correct placement of a penny—which may be cemented in place if desired. Markings on the strip indicate the fulcrum when the stylus force is at the value marked. For a fulcrum a thin rod may be used—even a finishing nail would serve—and the strip is rolled along the "fulcrum" until the penny and the pickup arm balance. The pressure is then read from the position of the fulcrum.

George Scherr Co. Inc., 200 Lafayette St., New York 12, N. Y. **(KS-38)**

The Scherr gauge is built like a machinist's indicator. The arm is placed under the pickup head while the instrument is held with the dial in a vertical plane, and the stylus force is read off the scale directly. This unit is calibrated in grams from 2 to 15 on either side, and is equipped with a limit pointer which is pushed to the maximum excursion of the indicator hand and serves to retain the indication. The limit pointer is reset at will by means of a knob through the cover glass. Retaining rings for the cover glass have small pointers which can be set to show where the stylus force should fall in case of rapid production measurements. Other models are available with different ranges, and with or without the limit pointer. Each gauge comes in a padded wooden box for safekeeping. This is an excellent unit for the critical fan who wishes to be able to measure the stylus force easily and accurately with a minimum of effort.



Scheer stylus-force gauge gives accurate dial indication between 2 and 15 grams.

Garrard. British Industries Corp., 164 Duane St., New York 13, N. Y. **(KS-20)**

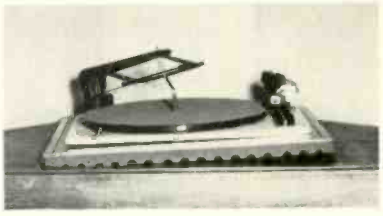
The Garrard stylus pressure gauge operates on a unique principle. The stylus is placed on a small platform at one end, and a lever is actuated by the fingers at the other to bring a zero pointer in line with a mark on the face of the gauge. The position of the hand-actuated lever indicates the stylus force. This arrangement simplifies the reading of the scale, which is calibrated to a maximum of 15 grams.

Livingston Electronics, Livingston, N. J. **(KS-39)**

The Livingston gauge has been on the market for some years and is undoubtedly one of the simplest models yet introduced. It consists of a molded plastic case which holds a spring wire in place. The stylus is put on a small platform and the deflection of the wire indicates the pressure in grams on a calibration molded in the case. The construction provides for adjustment, and the accuracy is quite good. When not in use the movable element is covered by a portion of the case.

Ingalls Electronics Co., 30 West Putnam Ave., Greenwich, Conn. **(KS-40)**

The Acousti-Pad is made of a microporous rubber material (trademarked 'Feltan' by the American Felt Company) and is an old established product resembling felted rubber. It is intended as an isolation between metal turntables and the record, and is a desirable accessory to use with flocked turntables which are known to collect dust and lint.



Ingalls micro-porous rubber is felt loaded for damping, makes good isolation for changers and turntables.

They are available in 8-, 10-, and 12-inch diameters to fit most turntables. A 17-inch model is available for use on professional turntables.

Latex impregnated felt is a felt strip cut with an "arch support" for mounting turntables and changers in cabinets where there is appreciable vibration. Since it is well known that neither felt nor rubber alone will serve to eliminate low frequencies, it is probable that the presence of the felt fibres in the porous rubber mixture serve as a resistance and prevent setting up any resonant frequencies in the material, as could be done with rubber alone.

Overwhelming

THE

Collaro

RC-54

The Automatic Record Changer That First Introduced . . . **JPF**

Just **P**lain **F**idelity

Overwhelming is the word – because that's just what the reaction has been to the new Collaro RC-54. In the past 4 months, more RC-54s have been sold than in any other similar period. And it looks like this record is well on its way to being broken.

Of course, we knew all along that the RC-54 was worthy of such popularity, but we didn't quite realize that you would recognize this fact so soon. It appears then that what you have been really looking for are the very features offered you by the Collaro RC-54: smooth, quiet operation – inter-mixing of all size records at all speeds without presetting—3-speed operation: 33⅓, 45 and 78 rpm – fast (7 seconds) change cycle regardless of record speed – minimum rumble, wow and flutter – gentle handling of records – jam-proof operation—smaller mounting deck, and all the other convenient advantages of the RC-54. **But above all, it appears that what you want in home music reproduction is fidelity . . .** Just Plain Fidelity

Sold by Leading Sound Dealers.

Write for complete specifications to Dept VF-1

MADE IN ENGLAND

$48.75 Net

Slightly higher West of Rockies

ROCKBAR CORPORATION • 215 East 37th Street, New York 16, N.Y.

Even the walls have ears...for Bogen

NEW BOGEN DB110(G) 12 WATT AMPLIFIER. An exclusive Bogen circuit makes possible "luxury" performance in this economy amplifier. 0.65% distortion at full output; ± 0.5 db response from 15 to 50,000 cps; infinite damping. Four separate controls for gain, bass, treble and 4 inputs and 3 record equalization positions. DB110 (chassis); $59.95. In gold-finished cage; $64.50. (See "Tested in the Home", April *High Fidelity.)*

NEW B50 SERIES RECORD PLAYER. An unusual value. Operates manually. to play any disc up to 16", at any speed from 29 to 86 rpm. (This includes, of course, 78, 45, and 33⅓ rpm.) "Wow", "Hum" and "Rumble" are minimal. Stylus pressure is adjustable for minimum record wear. Arm is equipped with plug-in head for simple interchange. B50-4LC (with one head, you-pick-your-cartridge); $40.40. Attractive wooden base; $4.80.

Bogen
HIGH FIDELITY
BECAUSE IT SOUNDS BETTER

Send 25¢ for 56-page book, "Understanding High Fidelity", to Dept. WF
David Bogen Co., Inc., 29 Ninth Avenue, New York City 14, New York

EDWARD TATNALL CANBY*

YOUNG BRAHMS

[d] **Brahms: Serenade #2 in A, Opus 16.** Amsterdam Concertgebouw, Zecchi.
Epic LC 3116.

One of these days we are suddenly going to discover that some of the finest music Brahms composed came before he grew that formidable beard, before he so much as wrote a Symphony Number One. To be sure, both of these events, marking Brahms' official entry into the ranks of "mature" composers, came well along in his life, in full middle age. Brahms had a long youth. But the very quality in his character that made him apply such rigorous self-criticism to his own work that he could not launch his First Symphony until his forties, also—we now can realize—acted as a drag and a limit on free expression, in the interests of supposedly "higher" artistic concentration.

You'll follow me easily enough when you try this record of the Second Serenade. It's a dilly and a lulu. The point I'm after is simple. The two early Serenades, opus 11 and opus 16, rank officially well down in the heirarchical scale of musical greatness. They are "little" works, youthful, informal, unpretentious. They rank among the Second Looeys and the Ensigns alongside the Big Brass of the four Brahms Symphonies, the piano concertos and the like. You won't find Brahms judged very often by these pieces and for that matter you won't find them on many symphony programs either. They aren't "important" enough. But I'd rather listen to this record right now than to all the symphonies and concertos, to choice, because there is a kind of music here that can't be matched anywhere else in Brahms—Big Brass or no.

Brahms is a rather special case. He was born with a marvelous gift of musical spontaneity, but he developed a rigidly critical conscience that was dead set against that spontaneity for the rest of his life. He tried hard—too hard. In plenty of ways he achieved "greatness" and his big works show it plainly enough. Yet increasingly, as we get away from him, they "smell of the lamp." They are, one might say, successfully forced.

Enough said. The serenades fall into the class of works where—thank Heaven—Brahms for one reason or another felt no need to be "great"—and wrote for sheer pleasure! The Liebeslieder waltzes are in the same category. "Little" works of no great consequence—and hence old Brahms turned off his conscience and really let loose, as the musician that he was.

Try it and see. The Second Serenade is quite stunningly and lyrically played, to perfection, by this Dutch orchestra under an Italian conductor. An unlikely combination (and the Schumann "Rhenish" Symphony in an earlier release was spoiled by it) but here it works. Big, live, distant mike pickup, warmly hi-fi.

* **Brahms: A German Requiem, Opus 45.** Frankfurt Opera & Museum Orchs., Opera Chorus, Solti. Lore Wissman, sop., Theo Adam, bar.
Capitol PBR 8300 (2)

Here, at last, is a really good recording of the Requiem. It's strange that this work, the long-time enthusiastic favorite of a thousand choruses amateur and professional (from grade-school on up) has so seldom been recorded and then with such so-so results. This performance soars far ahead of the two others now available, the ponderous, muddy (if expressive) Viennese version under von Karajan (Col. SL-157) and the chrome-plated smoothness of the Robert Shaw version (RCA LM 6004) of some time back.

The "Requiem" came at the end of Brahms' long youthful period and it marks a turning point, towards the greater concentration—and tougher discipline—of the late years. It's a big work, in size and in expression too, but it is still full to bursting with that all-out, unrestricted and juicy Romantic expression that Brahms grew increasingly away from in his later years, as though it were beneath his dignity as a "great" composer. The "Requiem" simply oozes romance. It's free and unconcentrated, according to his later standards; yet already the lines have tightened, the "higher organization" is there, the wheels within wheels are operating smoothly and marvelously. But the spontaneity is not yet affected.

This is why the piece is so extraordinarily popular among singing groups. It "sings itself," it's a natural for anybody with half a chorus voice; and its sincerity is so honest, so wonderfully straightforward, that a high school student can revel in it as well as—or better than—any professional. This performance catches that sincerity and the drive and excitement of the work as no recorded performance has before. Lovely recording, utterly natural and well balanced.

P.S. The two soloists are both superb.

KEY

*	Outstanding recording for the type of music.
b	Big bass sound.
c	Close-to, sharp-edged, in big liveness.
cc	Close-to, in deadish acoustics.
d	Distant, over-all miking in big liveness.
H	Good try for hi-fi demonstration.
l	Big, golden liveness.
p	Close-up piano sound, small-room effect.
qr	Recorded level rather low.
s	Solo (s) close-to and loud.
ss	Solo close-up, accompaniment in background.
s	Solo quite distant-sounding and/or low-level.
x	Some distortion audible.

ROMANCE

[cff] **Schumann: Symphony #3 ("Rhenish"); Overture, Scherzo and Finale, Opus 52.** Paris Conservatory Orch., Schuricht.
London LL 1037.

A gorgeous recorded sound and a lively pair of performances are enough to recommend both sides of this disc and the second piece is a seldom-heard "find" of a most interesting sort—these values counterbalanced by some typically French playing of German music that does the intensely German Schumann no great good.

The "Rhenish" never showed its orchestral textures with such clarity as here. But the sound for Schumann, is most peculiar if you know the "Rhenish" well in other versions. The French orchestra, in this day of standardization, remains astonishingly unlike all others. You can hear in this one the peculiar blatting of the French brass, the heavy vibrato of the "French" horns—unthinkable in German music—and of the trumpets, the nasal sound of the oboes, the odd out-of-tune quality to the ensemble, all elements quite foreign to Schumann. And though Schuricht himself has an echt German background, it's interestingly clear that even he cannot make French musicians play German music like Germans! A thousand small details add up to a strong sense that these players are recasting Schumann in a French mold, reinterpreting all his pet little effects into subtly different patterns of their own strong-minded devising. Interesting and alive, as I say, but not Schumann by a long sight.

The Overture, Scherzo and Finale is an early semi-symphony, in purpose not unlike the Brahms Serenade above (indeed it was called a serenade); this too, was one of the preparatory works leading to symphonic writing and this too, is a free and easy expression, turned out without heart searching after greatness on the composer's part. Always a good idea! To be sure it is somewhat repetitive, less well organized and with a lesser profusion of ideas than the symphonies; but it is even so a strong and youthful piece with catchy and memorable ideas, a highly worthwhile item to get to know.

[c] **Schumann: Piano Quintet in E Flat;** [(x)] **Piano Quartet in E Flat.** Walter Bohle, pf., the Barchet Quartet.
Vox PL 8960

[ccc] **Schumann: Piano Quartet in E Flat. Brahms: Horn Trio in E Flat, Opus 40.** Horszowski, Schneider et al (N. Y. Quartet).
Columbia ML 4892.

Overlapping recordings here of the Schumann Piano Quartet in these two discs of three pieces in the same key. The bigger name artists are upon the Columbia disc, but on direct comparison I think I like the Vox recordings better, partly on performance, partly in the recording.

The familiar and much-beloved Schumann Quintet (string quartet plus piano) needs a big, masculine, vigorous playing, with real early-Romantic gusto; paradoxically, Myra Hess has always been a prime exponent of the piece as one of the strongest of our great lady pianists. (Remember, Schumann's wife Clara was a great pianist and performed most of his works.) The playing here is just right, for my ear, without a trace of the tired sound we often hear in over-played works like this one, and the Vox recording's "hi-fi" in style, a big sound with plenty of liveness and a closeup clarity of detail, is very well suited to the mood of the piece itself.

The Piano Quartet is a work in a similar vein but less successful—yet well worth hearing. The Vox performance is again a robust and

alive one, excellent for the music. Recording has the piano closer here, and there is some key-action rattle to be heard, as well as a good deal of close-to scratching from the strings. (Also, I think, a trace of distortion.) Not important detractions.

The Columbia version of the same work is distinctly more subdued and I find it less effective. Part of the difference is in a less robust recording; Columbia's is technically a better balance, but this particular kind of music is, as I say, well suited to Vox's big, fat "hi-fi" sound. (In my copy, Columbia's surfaces are less silent than Vox's Columbia-pressed surfaces.) Part of the difference is due also to a less-than-wholehearted Romanticism in the strings, particularly the violin (Alexander Schneider) and cello (Frank Miller), who have expressive duets not well realized here.

On the reverse of the Columbia disc, the Horn Trio, another of those later youthful Brahms works, is similarly disappointing, except in the peppy last movement where things really begin to move. This is a wonderfully endearing work, close to the "Requiem" in its spirit, in its youthful exuberance already tempered, but not hampered, by a maturing sense of concentration and musical architecture. It can be warmly and directly played; here it seems fussy, labored, sententious, too slow. An academic kind of performance, professional in a not so good sense.

* **Schumann: Quartets in F, Op. 41, #2; in A, Op. 41, #3.** New Music String Quartet.

Columbia ML 4982.

* **Mendelssohn: Quartets #2 in A mi., Op. 13; #5 in E Flat, Op. 44, #3.** New Music String Quartet.

Columbia ML 4921.

Most string quartets lack pretty names, as witness the garble of numbers above; but their content is not affected. These are a relatively rare breed, the high-Romantic, which means that they are poetic, soulful, lyric, emotional, moody, and what-not. Not all quartets are dry and "intellectual!" (Some of them are—or get played that way, anyhow.)

The Schumann quartets are superbly played here and are thus most enjoyable for just about any ear. The New Music Quartet has captured the sensitive, poetic, breathless feeling of the music as it is very seldom conveyed. Good Schumann is a rare thing nowadays and this is exceptional.

The Mendelssohn works are not as persuasive in themselves, though technically they are no doubt better put together. As usual with this composer, the earlier one, #2, (actually his first) is the most attractive; it was tossed off at age 18. Mendelssohn's habitual "talkiness"—vast quantities of little notes, fussy rapid figures that go on and on, make the quartets difficult to project. (The same fussy notes in his orchestral writing are distributed here and there for plenty of instrumental color and variety.) But, again, this New Music group does a marvelous job at putting the fussiness of detail into its place, bringing out the larger romantic sweep of emotions. These two discs make a first-rate introduction to the 19th century quartet. Extremely well recorded.

Franck: Symphony in D Minor. Phila. Orch., Ormandy.

Columbia ML 4939.

It becomes more and more difficult, these days, to recapture the free, sensitive Romantic way of musicial expression. Here is a first-rate evocation of Franck, of the sort that combines a real feeling for the Franck idiom, the turns of phrase, the play of sunlight and shadow, the evanescent changes of key, with a very modern efficiency and intensity. Perhaps this is a bit faster and more nervous than Franck might have imagined his music back in the '80s, but it suits us today, and there's not a trace of hardness or coldness in it. One of Ormandy's finest jobs. Recording at a distance, somewhat hollow sounding, but ultra-clear.

ss **Franck: Violin Sonata, Szymanowski: Violin Sonata, Opus 9.** David Oistrakh; Vladimir Yampolsky, pf.

Angel 35163

Oistrakh is not only a first-class violinist in the grand tradition; he is a modest and musical player as well—somewhat surprisingly in view of all the fuss about him! This playing of the Franck is warm and lovely and unassuming; Yampolsky's piano (they often play as a team) is similar, and my only reservation is that the piano, though beautifully recorded, is too much in the background, the violin relatively too prominent. Not a good balance.

Though Szymanowski was a Pole from the Ukraine, his music, in the fairly early work (1904), is not far removed from Franck himself—very late-Romantic, chromatic (half-steps), a kind of feminine Rachmaninoff with French overtones. I'll take the Franck any day.

D **Franck: Quintet in F Minor.** Curtis String Quartet; Vladimir Sokoloff, pf.

Westminster WL 5331

This recording is a puzzler—I've been through it twice from beginning to end, trying to figure it out. The Franck Quintet, an early and very intense work of his, somehow lacks the sincerity and the impact that I've always felt in it in the past; my best explanation is two-fold. First, the Curtis group is a highly professional one which, however, plays Romantic music, especially this all-out sort, with cool precision. Too cool. (The pianist is more outspoken.) Secondly, this domestic Westminster is recorded in a wholly dead studio acoustic, the strings very close, the piano somewhat muffled. Technically it is a superb job, but acoustically it suspends Franck's warm, sensuous music in a sort of acoustic vacuum that is most disconcerting. An interesting contrast with Westminster's European chamber recordings, among the most live and warm acoustically.

*H **Bizet: Symphony #1 in C; Patrie (Overture).** Orch. de la Suisse Rom., Ansermet.

London LL 1186

Almost everybody knows the delightful Bizet symphony, only re-discovered a few years ago; this is a wonderfully recorded and very pleasing version of it, as hi in the fi as in appropriate for such an unassuming piece. "Patrie" is another matter. It's a rousing, piece of political occasion-music, musically quite preposterous, but incidentally (perhaps not quite so incidentally . . . .) a super-hi-fi wonder with enough noise to blow dozens of hi-fi fuses. Impeccably recorded, too.

Charpentier: Impressions d'Italie. Aubert: La Habanera. Nat. Opera Orch., Fourestier.

Angel 35120.

I looked forward to sampling this—there are many very pleasing things in the minor French music of the mid 19th century that are now emerging. But I was disappointed; the Charpentier ("Louise") is hardly more than salon stuff. The Aubert is a short extra at the end that didn't hit me as any special saving grace.

rdd **Tchaikowsky: Souvenir de Florence, Op. 70, arr. Winograd.** Arthur Winograd String Orch.

M-G-M E3173

This is an interesting item: it was originally written for six strings: violins, violi and celli in pairs (a string sextet) but its sound was evidently not too satisfactory to Tchaikowsky himself in this fashion, for he tinkered with it for quite some time. This arrangement sets it for small string orchestra, and the resulting sound compares immediately with the familiar and very popular Tchaikowsky music for string orchestra such as the "Mozartiana" suite and the Serenade in C. The music, dating from the time of the 5th Symphony, is mature, falls somewhere between the "higher organization" of the symphonies and the episodic character of the famous ballet scores. Very nice, though there's not a trace of Florence, to my ear!

Like most M-G-M recordings, this one is appallingly dead. (Sound stage recording?) Luckily, the string group plays smoothly and continuously most of the time, without sudden breaks, so that the lack of liveness is not too noticeable. A good, professional playing job.

p **Tchaikowsky: Piano Sonata in G; Romance in F mi., Nocturne and Humoresque, Souvenir de Hapsal.** Nadia Reisenberg, piano.

Westminster WL 5330.

Still another souvenir (wherever or whoever Hapsal might be), and along with it a goodly collection of a concert rarity—piano music by Tchaikowsky. Pianists seem to avoid Tchaikowsky, as orchestras rush for his corresponding works for orchestra, and the only reason would appear to be that T's piano technique isn't quite as virtuoso-style, at least in piano solo, as his orchestral writing.

Reisenberg is one of those big, hefty, masculinely muscled lady pianists (I am speaking strictly musically—I haven't set eyes on the lady) of whom we have a number in this country. Ray Lev is another, and the style of playing commands big audiences. It is not exactly subtle here, nor always musical, but the good natured energy that Reisenberg displays is undoubtedly attractive and the piano adds up to rousing Tchaikowsky, long-winded but in many spots very listenable. Fine piano sound of the close-up, intimate sort in dead acoustics.

eH **Wagner: Tristan: Prelude and Liebestod; Die Götterdämmerung: Dawn, Siegfried's Rhine Journey, Funeral Music.** Paris Conservatory Orch., Schuricht.

London LL 1074.

Here's that dangerous French-German combination again, as in the Schumann disc above, and results are again decidedly mixed. The "Tristan" side, the usual Overture and Love Death, comes off very well; there is something that appeals to the French musical mind in "Tristan" convoluted chromaticism (not so far removed from Franck) and it often leads to quite inspired French performances.

But "Götterdämmerung" is something else again. In spite of Schuricht's best efforts, this playing is just abysmally and willfully out of spirit. Indeed it's amazing how single-mindedly the French musicians commit honest sabotage upon Wagner's every musical whim and mysticism. A strong-minded performance by good French musicians and therefore it is all the more belligerently and flagrantly un-Wagnerian.

Again, beautifully recorded with utmost inner clarity, including those same unwonted and out-of-place French sounds, the snarling oboes, the unthinkable wavering French horns. I recommend the disc to many who will find it a most interesting study in national temperament as applied to music.

dS **Dvorak: Piano Concerto in G Minor.** Firkusny: Cleveland Orch., Szell.

Columbia ML 4967.

Dvorak's symphonics are somehow more cogent, less diffuse than his concerti, which tend to ramble on and on, lyrically. This one is a special case; the original piano part, which it is claimed was badly written so that the orchestra overshadowed it, has been re-written most zealously by a Professor Kurtz, who happens to have been Firkusny's teacher. Firkusny has a semi-monoply on the revision, by dint of much hard playing over the years.

Perhaps the piano was overshadowed; my first impression is, however, that the Professor jumped musically from the frying pan into the fire. The revised piano part is brilliant and effective but it reeks to my ear of the kind of piano pedagogy that thrives on Rachmaninoff and the like. I'd suggest that Dvorak has perforce traded some of his own fresh simplicity for a more fancy intelligibility, and I'm not sure I like it. (N.B. Who ever has heard of an orchestra overshadowing a piano part on records! Just turn up the solo mike a peg and the piano will overshadow the orchestra for a fare-thee-well. Ergo (therefore) . . . . there's no real need for a recording of this tricked up concert version. Better the original, as written, and let the engineers do the tricking up, when and if necessary.)

—Don't let me spoil a nice piece for you, on such technical grounds. The recording is big and distant, with the piano—unusually—at stage distance, 'way off, and the music, diffuse and long-winded or no, is juicy and Romantic in the best tradition of such works, the Szell performance equally in the tradition.

S **Mahler: Kindertotenlieder; Lieder eines Fahrenden Gesellen. (Songs on the Death of Children; Songs of a Wayfarer.)** Norman Foster, bar., Bamberg Symphony, Horenstein.

Vox PL 9100

The Mahler songs-with-orchestra are unique, the only important solo songs that are normally treated like songs-with-piano-suitable for any voice, male or female, that can sing them. Indeed, Mahler was such a supreme genius of orchestration that there is a peculiar close, intimate quality to these wonderfully expressive orchestral accompaniments that is utterly unlike anything else in music. According to our taste today, these remarkable songs proclaim Mahler a first-rate genius, where his huge symphonies (more important by far in his own mind) are increasingly overblown and unsuccessful in modern performance.

This performance of the two sets of songs is by an excellent and unassuming baritone who sings at seeming stage-distance, his "level" relatively low, and is even occasionally a bit hard to hear. The orchestral accompaniments are subdued but very much in the spirit, and with text in hand one can follow Mr. Foster easily and with great pleasure. This arrangement seems to me much preferable to the usual one where the solo voice is close-up and very loud. There's too much of wonder in the orchestra itself.

Believe me, if you once get this music in your head you'll never forget it. It has an extraordinary effect.

Mahler: Kindertotenlieder. (Bruckner: Te Deum.) Kathleen Ferrier; Vienna Philharmonic, Bruno Walter.

Columbia 5ML 4980.

I've only heard the Mahler half of this disc—credited by Columbia to the kind cooperation of London Records—and I am not clear as to whether the earlier 10-inch Columbia ML 2187 of the same performers is actually the same recording or an earlier one. Bruno Walter's Mahler is less smoky and sultry, more electric, than Horenstein's, but the two are of just about equal interest. My personal feeling is that the late Ferrier was a great singer but a one-style artist who sang just about everything from Italian opera to Mahler with the same noble sincerity; frankly I don't think she really penetrates this music, though the singing is, as always, noble and sincere.

*Hd **Tchaikowsky: Manfred Symphony.** Philharmonia Orch., Kletzki.

Angel 35167.

Here is a big work of Tchaikowsky, often cited as one of his important productions, that is rarely heard. The reasons are probably centered, first, on its length—four long movements—and, more particularly, about its pace; for this is one of those works of extreme Romanticism that take their time almost exasperatingly, for the modern restless ear that wants to get to the point with efficiency. The "story," Lord Byron's dramatic poem, is of the sort that is practically incomprehensible to most people today—the Romantic hero wanders murkily from eerie adventure to adventure, reeking of despair or ecstasy or what-not. The straightforward tale of Romeo and his Juliet is much more to our taste.

I tried the Manfred Symphony once before in an earlier recording and got lost in its murky wanderings; this time things fared much better and the work was enjoyable to the end, partly due, I suppose, to having heard it before; but also, I hasten to say, it was thanks to an excellent performance and superb recording on this Angel disc. If you have an hour or so of leisure and are in the mood, you'll find this well worth a try, as a sort of stretched-out "Romeo and Juliet." It's really a very good piece and there are, incidentally, some fine, big-bottomed "hi-fi" passages, as well as plenty of sweet Tchaikowsky melody.

LOOKING 'EM OVER

*I **Stravinsky: The Story of a Soldier (Histoire du Soldat).** English version. Instr. Ensemble, Vardi; Fritz Weaver, John Harkins, Frederic Warriner.

Vox PL 8990.

Vox put out a version with the original French dialogue and now follows it up with a new recording in English translation. The symbolic "story" (with stage action, originally) seems to me very worthwhile along with the music, adding much meaning to the musical intention; but the translation into English doesn't come off easily; this one is further hampered by over-acting and Hollywoodish mannerisms on the part of the

(Continued on page 78)

Equipment Report

Pilotrol PA-913 Preamplifier-Equalizer—"Dual" Automatic Record Player—Crestwood 304 Tape Recorder.

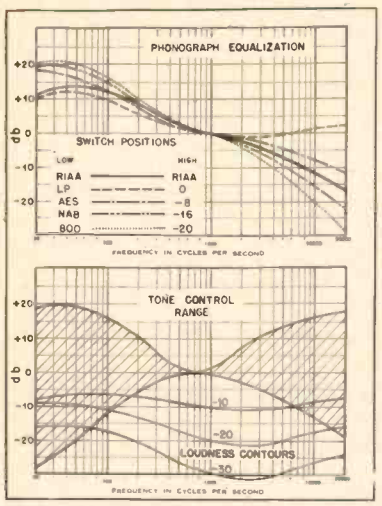


Fig. 1. Performance curves for Pilotrol PA-913.

OUR FIRST THOUGHT in seeing the Pilotrol PA-913 Preamplifier-Equalizer for the first time was that this was an item that many audiofans would "go for" because of its appearance and because of what it would do. That was before we had ever had an opportunity to play with it or even to inspect the circuit schematic (*Fig. 3*).

Gimmicky, perhaps, but down under that fancy exterior stands some good engineering sense and—in our opinion—some good product sense. And while the true audoifan will find some of the so-called gimmicky features extremely useful, he—or anyone else—will find that the operation is convenient and that the flexibility offered to the occasional tape recordist who may wish to put his own announcements on a tape along with a favorite radio program would be attractive.

The Pilotrol consists of a phonograph preamplifier with separate turnover and rolloff controls operated by interlocking pushbuttons, another five-button gang which serves as selector switch and power control, volume and loudness controls, separate bass and treble controls, a microphone amplifier with its own volume control, and a calibrated output meter which may be used on either of two output circuits—one of which is intended for feeding a recorder and not affected by the tone, volume, and loudness controls, and the other intended for feeding a monitor amplifier and speaker. But the main advantage of the meter to many users will be that of serving as an audio VTVM. Using certain inputs and with controls set in accordance with a chart in the instruction book, signal voltages as low as 165 microvolts will give a deflection to the scale "0" on the output meter. *Figure 2* shows the input voltage required to give "0" deflection from four separate set-ups and with the six indicated meter switch positions. When used conventionally as an input amplifier, the meter indicates output voltages at scale "0" of .06, 0.19, 0.62, 1.9, and 6.2 volts respectively for the 0, +10, +20, +30, and +40 positions of the meter switch. For the amateur recordist, this unit would find many uses.

Aside from these features, however, the Pilotrol is a good home system input unit. The curves are quite accurate, the loudness

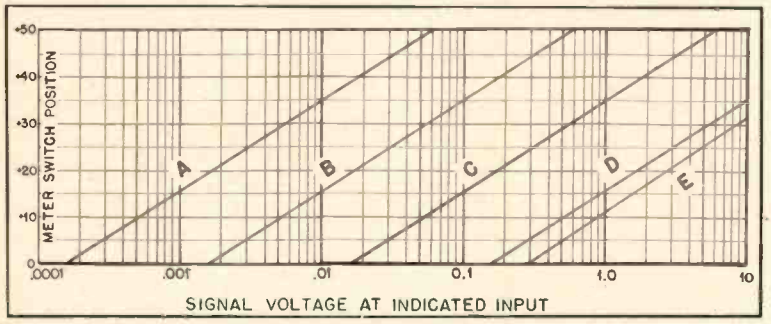


Fig. 2. Input voltages corresponding to meter switch setting for different modes of connection. With volume and loudness controls at maximum and tone controls flat, (A) is input at Mic jack, with microphone control at maximum and meter switched to Monitor. (B) is the same as (A) but with meter switched to Record. (C) is input at radio jack with mic off and meter on monitor. (E) is the same as (C) but with meter on Record. (D) is basic meter characteristic.

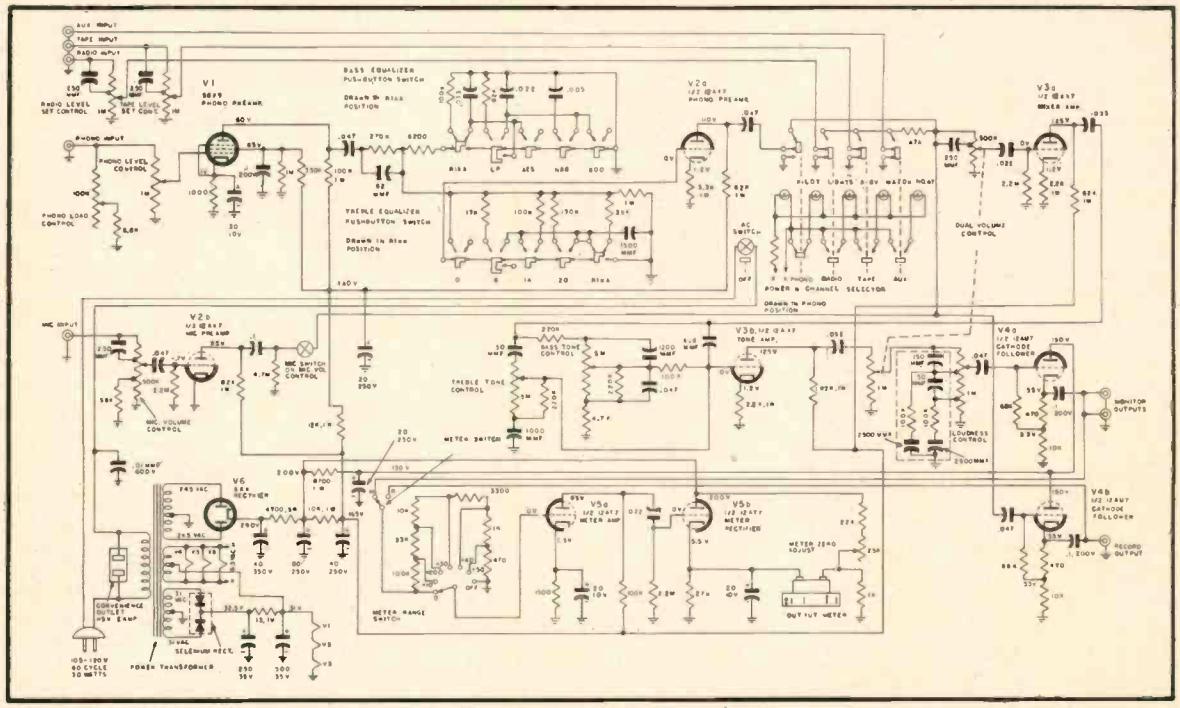


Fig. 3. Over-all schematic of Pilotrol PA-913.

and volume controls are separate, tone control curves are satisfactory, and the hum level is exceptionally low—due largely to the use of d.c. on the heaters of the first three tubes. On the phono input, the unit will produce a 1-volt output from a 2.7 mv input signal; on microphone, from a 0.65 mv input; on the high-level inputs it will give the 1-volt signal from an input of 0.15 volts. With volume and loudness controls at maximum, the hum level on phono is 54 db below 1 volt, and at normal settings of these controls the hum level is better than 75 db below 1 volt.

Performance is excellent throughout, and the indicator lights showing which channel is in use are an attractive feature. The entire chassis may be removed from its case and mounted in a conventional cabinet,

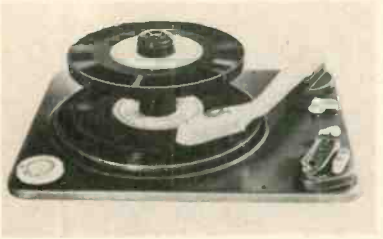


Fig. 4. "Dual" Automatic Record Player with 45-rpm spindle in place.

if desired, the change being made within minutes (after the hole is cut in the new cabinet). *Figure* 1 shows the performance in the various departments.

"Dual" Automatic Record Player

The Dual Automatic Record Player, described again in the PHONOGRAPH EQUIPMENT section, was tested thoroughly, and the results are listed here. This unit is planned for those who want to play LP's and occasional 78's manually, but when they play 45's they want a changer. This device is the answer for that need. It is an automatic player in that the user has only to place the record on the turntable and press a button—and the record may be of *any* size from 6 to 12 inches. As soon as the button is pushed—to select the proper stylus and start the mechanism—the arm lifts, moves to the center of the record, and lowers to the surface of the disc. A small rubber tired wheel mounted at an angle rolls on the record and carries the arm out to the edge. As the wheel falls off the edge of the record, it retracts and lowers the stylus to the starting groove. When the record is finished, the arm is raised and returned to its rest and locked in place, where it remains until the button is depressed again.

A tip-up crystal cartridge is employed, and pressing the Microgroove or Normal button selects the proper stylus and unlocks the arm.

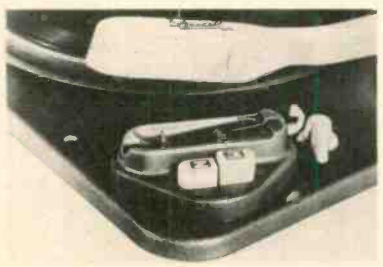


Fig. 5. Push buttons select desired stylus and start the mechanism.

The mechanism is well built—being finished in the European fashion with guild craftmanship showing up in places where the user wouldn't be expected to look. Quality of reproduction from the crystal cartridge was good, and a three position rolloff switch provides some measure of tone control.

With the 45 spindle inserted in the unit, the operation was not greatly different from any other center-drop 45 changer, except for the locating act of the arm. This mechanism is made under license from the Swedish firm, Luxor, and appears to be sturdy and reliable. An interesting machine to watch, in any case, besides sounding quite normal and having a low noise and rumble content. Neither wow nor flutter were perceptible on piano records.

Crestwood 304 Tape Recorder

It was over a year ago that we reported on the 400 series of Crestwood tape recorder and amplifier-speaker units, and we have recently seen and tested the newer single-case model, the 304. This is an attractive model employing a new drive system which is simple to operate and which also works at two speeds—7½ and 3¾ ips. The unit operates from a set of "piano keys" which actuate separate phenolic strips along the printed circuit preamplifier chassis over etched copper contacts, thus resulting in an integral switch assembly. As seen in the lower section of the performance curves, *Fig.* 6, the playback from an Ampex Standard Alignment Tape #5563 is reasonably flat from 50 to 6000 cps, with usable response to 8000.

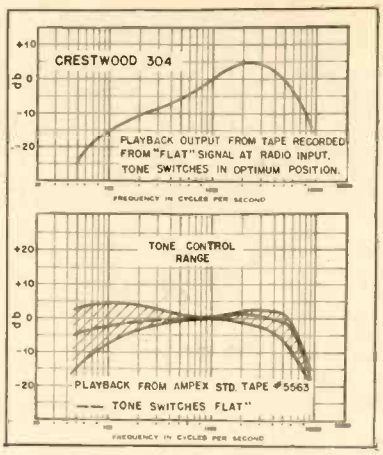


Fig. 6. Performance curves for Crestwood 304 Tape Recorder.

The tone switches—two of the five piano keys—provide the tone control range shown.

Recording from a signal fed into the RADIO input and playing back through the high-impedance output gave the curve shown in the upper section of *Fig.* 6. Considering the performance from the standard tape, we were surprised at the IN-OUT curve. However, for voice, this is ideal, for the reproduction is crisp and sharp, and of excellent clarity. Bass response was lacking on music, but distortion is apparently low.

This mechanism is apparently a modification of the earlier one used in the 400 series, and it is somewhat simplified in operation. It is easy to load, starts and stops without making any unnecessary loops, and if the user follows the directions there is no reason to break tape when switching from FAST FORWARD to PLAY. If he doesn't follow directions that's his own fault.

The power supply and power amplifier are constructed on a chassis separate from the recorder itself. The preamplifier is constructed on a printed circuit panel incorporating the switches and the input stages, and is attached to the top plate. The first stage is a 5879, and it is followed by the two sections of a 12AX7 connected in cascade. A 12AU7 serves as the bias oscillator. The power supply and amplifier chassis is conventional in design and employs a 12AU7 and two 6V6's in pushpull, together with a 6X5 rectifier. The 12AU7 is used in a Williamsonish fashion, with the first section as a simple triode amplifier direct connected to a split-load phase inverter which uses the second section, and which drives the two 6V6's connected as pentodes.

In the record position, the internal speaker is switched off, but an external speaker may be plugged in so as to have monitoring during recording from the radio, for example. A high-impedance output is available from the input amplifier section to permit connection to an amplifier from a hi-fi system, or for a pair of monitoring phones.

AT HOME WITH AUDIO

(*from page 21*)

tolerance, are non-inductively wirewound. Also on the 1 per cent tolerance level are the coupling capacitors, feedback-shunt capacitors and the phase-shift capacitors. Transformers are fully potted. The Ultra-Linear output transformer is an Acrosound TO-330, 60-watt rated at 20/20,000 cps. Power transformer is a UTC LS74; UTC also is filament transformer T_3, giving 6.3 volts at 10 amperes, center-tapped. Of the same brand is filament transformer T_4, which is faced around to give 117 volts for the bias supply, and is rated at 2½ amperes. This procedure provides adequate isolation from a.c. line. The B-plus smoothing choke; L_1 is 20H at 300 milliamperes. (Amplifier and power supply are shown in *Fig.* 4.)

The circuitry of the separate power supply contains two 6080 tubes as regulators for B-plus current (equivalent to 6AS7's); two 83 tubes in parallel to increase current capacity; two OB2's used for reference voltages; one 6SJ7 as a d.c. amplifier used to control the 6080's. Filaments are biased with a positive voltage to reduce heater cathode leakage. Dropping resistors are inserted in each of the plates of the 83's to maintain uniform conduction. Fixed bias utilizing a selenium rectifier gives 130 volts negative.

Patch? No, Splice . . .

For the owner of this system, living with fine audio results is not a taken-for-granted thing. In his case the ramparts of hi-fi are always alertly scanned. See (as in *Fig.* 5) how he monitors with a set of Permoflux earphones through the phone jack on the Ampex preamplifier control panel; on the same panel is a complement of controls for juicy flexibility—record switch, record indicator light, power off-on switch, standard VU meter, speed equalization switch, input selector (for microphone, balanced or unbalanced line). The meter and output selector switch connects the meter to indicate playback or record level, and bias and erase current—the latter two only when the recording circuit is energized. Also provided is a playback-level control affecting only the output from the tape. Another earphone monitoring operation (as in *Fig.* 7) shows the owner with hands on editing knobs of the tape reels, moving the tape slowly through head assembly to spot extraneous noises and clicks. Where they occur is noted by marking the tape at a point directly over the playback head, then processing on the tape splicing block (as in *Fig.* 7). This hand operation see-saws the tape through minute lengths so the defective signal or excess noise spots can be accurately located and spliced out.

To this dedicated hi-fier all is suspect until it proves itself out. On the score of alert scanning, for example, there is the A-B comparison gambit, between test pressings and the original recording on tape. Although this is the professional's way with a disc, you yourself can adapt the procedure to your own way of living at home with audio when you occasionally dub from a fine LP record to tape. Here's how you might do it: 1) Play the record on your well-balanced turntable with absolutely level tonearm. Note the point on the disc that has the greatest volume. 2) To avoid overloading the tape, adjust recording level control on the preamplifier of the tape recorder so that the VU meter reads the loudest possible peak permissible for the volume of the record. With tape at 7½ ips speed, for example, the maximum peak with an orchestral selection should be set at either plus 1 db or plus 2 db. With a vocal selection the peak should be below zero, either −1 db or sometimes −2 db maximum peak. (Otherwise distortion—unpleasant, unwelcome, and inexcusable). 3) Set tape on "record," start the disc, and the dub is now underway. 4) By using the input switch on the preamplifier, you now listen to a comparison between the tape and the disc, alternately. It is very important that levels of both disc and tape be of the same magnitude, which the VU meter will reveal. This does it, and all of it is herded through the amplifier into the main speaker system, heard in the manner of ordinary playbacks. The odds are you will more frequently be likely to dub from FM to tape, but the procedure

is the same. With foreknowledge of the selection coming in over the air, you should have no difficulty setting your dubbing sights for the same kind of undistorted tape results.

Dub-a-dub Dub . . .

Used alertly and with some practice, you can attain skills in dubbing from disc to tape to a point where (as we have seen and heard demonstrated) the quality of sound on the one is twin and mirror to the other. But not without the aid of your newly fine ear and your "green" hi-fi thumb—the one encased in foam-rubber covered earphones, the other ensconced fondly on the volume buttons. To add to your talents for precision, you might look into the problem of tracking error. This can be (if discovered) cured effectively if you have well-engineered pickup and turntable equipment. Our reader does it this way: On the T43H Rek-O-Kut two-speed turntable he places a Cook or similar recording of a 3,000-cps note. There's a 220A Fairchild cartridge in the same make 16-inch 202 arm, which is viscous damped horizontally, with ball-bearing point suspension, roller-bearing drive, and spring-loaded vertical tension. (A glimpse of this in *Fig.* 9). The pressure of the stylus on the record groove is adjusted (usually about 8 grams) until the LP-gaited disc is heard to generate a single, pure note. With a vast (really) collection of LP's it is not a question of determining this or that stylus pressure for any one of them (an impossible task), but rather one of achieving either minimum tracking error *or* stylus pressure. The end result is the same, but this man's angels are all on the side of favoring true tracking, for marked tracking error leads to marked record wear, the stylus having a tendency to ride up on the side of the groove instead of centering within it.

The precision turntable is mounted on foam-rubber since the extremely low frequencies which this system so capably handles and produces tend to generate acoustical feedback, heard as a rumble. And because the efficient low-frequency responses of the speaker system would tend to cause vibration through the floor in this man's establishment, the entire cabinet which houses the amplifier, preamplifier and tuner in addition to the record playing equipment, has been set over a one-inch sheet of foam rubber between it and the floor. Helps.

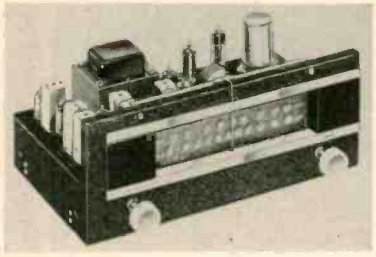
There's no doubt about it: hi-fi homework *can* be forever. And both time and energy can be conserved only with a program of considered first steps, and sufficient practice, leading finally to confident know-how. The latter means that sooner or later, the dedicated hi-fier will acquire coffee-canfuls of those audio components —the capacitors, resistors, sockets. And for utterly flexible handling and manipulation of his hi-fi gear, those yards and yards of cord and cable sets some of which are shown (*Fig.* 8). How they "get their hooks in" is shown in the rear view of the tape recorder preamplifier chassis (*Fig.* 10).

NEW PRODUCTS

• **Lowell Audio Console.** Users of sound distribution systems of every type will find distinct interest in the new line of Lowell equipment consoles designed especially for airports, schools, broadcast studios, industrial plants, and similar applications. Constructed of 18-gauge steel with gray hammertone finish, the consoles are equipped with a matching heavy-duty linoleum top which serves as a durable work surface. Illustrated is a single-turret model which is available with or without a sliding drawer to accommodate a 16-in. transcription player. Variations of this

basic design include 2- and 3-turret consoles of similar construction. For full details write Lowell Manufacturing Co., 3030 Laclede Road, St. Louis 17, Mo. **K-9**

• **Knight FM-AM Tuner.** Notwithstanding its modest cost, the new Knight Model 728 FM-AM tuner recently announced by Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill., incorporates many features that assure fine reproduction of musical broadcasts. Tuning of FM stations is simplified by means of an AFC circuit that "locks in" stations as their dial setting is approached. This feature also eliminates drift while the tuner is warming up. Equipped with only two controls—



tuning and function selector—the 728 is designed for use with amplifiers having full sets of controls. Sensitivity on FM is 5 microvolts for 20 db quieting; AM sensitivity is 5 microvolts for 1 volt output. Audio-frequency response is 15 to 15,000 ± 1db. The function switch is equipped with a position for disabling AFC. A tape recorder output jack is afforded for recording programs while they are being played through a high-fidelity music system. Complete literature will be supplied upon request. **K-10**

• **Heathkit Portable Oscilloscope.** Extremely light in weight and small in size, the new Heathkit Model OL-1 portable 'scope kit employs a three-inch cathode-ray tube and is designed for all utility functions. Sweep operation up to 100 kc, push-pull deflection amplifiers, and improved color and knob styling are among its features. The remarkably low price of the OL-1 brings the instrument well within the reach of the average hobbyist, amateur and experimenter. It is practical also for the serviceman as an extra 'scope for bench use or for application on outside

service calls. For complete technical specifications and price information, write to The Heath Company, Benton Harbor, Mich. **K-11**

• **Brociner Compact Ten-Watt Amplifier.** Printed circuit techniques are used extensively in the new Brociner Mark 10 Audio Amplifier. Included in a single compact housing are a power amplifier, bass and treble tone controls, selector switch,

record compensator and phonograph preamplifier. Moderately priced, the Mark 10 is ideally suited for use with tuners, all types of high-quality phono cartridges, and for tape recording and playback. A simplified record compensator affords convenient selection of record equalization and includes a special position for noisy records; a rumble filter is controlled from the front panel. Frequency response is 20 to 20,000 cps within 1 db and power rating is 10 watts with less than 1 per cent distortion. Bass and treble controls range from 15 db boost to 15 db cut at 50 and 10,000 cps, respectively. Full power output is achieved with 5 mv into the phono input or 0.3 volt into the tuner input. Dimensions are 4¼"h x 10⅞"l x 8"d. Brociner Electronics Laboratory, 344 E. 32nd St., New York 16, N. Y. **K-12**

• **Low-Cost Portable Tape Recorder.** The new Royalton tape recorder combines the advantages of light weight, compactness, and portability. It is especially well-suited for laboratory use where observation notes can be recorded during experimental processes, thus eliminating the loss of time for hand-written memoranda. Essentially flat response over a wide range of audible frequencies permits good reproduction of speech and laboratory sounds, including bubbling, combustion, and electrical discharges. Recording of laboratory noises may be used to increase value of reports and to reduce time required for precise description. The Royalton is supplied in an attractive luggage-type case complete with plug-in crystal microphone for operation from a standard 117-volt

60-cycle wall outlet. Meyer Scientific Supply Company, Inc., 1672 62nd Ave., Brooklyn 4, N. Y. **K-13**

• **Automatic Broadcast System.** Automation in the broadcast industry has become a reality with the introduction of the new Ampex automatic programming equipment which can broadcast a ten-hour schedule without the need for human assistance of any kind. Basically, the system consists of two electronically-interlocked tape playback units, one capable of playing eight hours of recorded material from a single tape, and the other up to four hours. On the first unit is placed program material, either from the station's music library or from a network or transcription service. Spot announcements, local programs and station breaks are recorded daily in the station's own studio and placed on the second machine. After each segment of program material and after each local announcement, a subaudible tone is recorded. At the end of each program segment the electronic "brain" hears this tone and starts the announcement another tone starts the program.

This see-saw action continues until, at each half-hour, a timing device corrects for any slight time deviation in the system and inserts a station break. In a recent six-week field test at Station KEEN, all of the advantages claimed for the system were fully realized. Currently 12-day delivery is being quoted for the equipment. Included in the $4950 package are two tape playbacks, a recorder-reproducer for recording local program material, an electronic timer-control unit, and a special control console. Use of the equipment results in many economies which add greatly to a station's operating efficiency. Ampex Corporation, 934 Charter St., Redwood City, Calif. **K-14**

hrc HARVEY the House of Audio

The NEW

REK-O-KUT *Rondine*

3-Speed, 12-inch

PRECISION TURNTABLES

Represented to be the result of more than 5 years study, these new record playback units are offered as the closest approach to perfection in turntable performance. Like all Rek-O-Kut units, the turntable is cast Aluminum and exerts no pull on magnetic cartridges.

The following new features have been included: • single selector knob for setting speeds 33⅓, 45 and 78 rpm. • built-in retractable hub for 45 rpm records—requires no external adapter • permanently affixed 3-speed strobe discs for instantaneous speed checking • neon pilot light as 'on/off' indicator • special cork-neoprene mat material to eliminate record slippage • rectangular deck to fit conventional record changer boards.

Two identical Rondine models are available which differ only in the type of motor employed.

Rondine *Deluxe* Model B-12H hysteresis synchronous motor..... **$119.95**

Rondine Model B-12 with 4-pole induction motor..... **74.95**

New ELECTRO-SONIC

Concert Series

Electro Dynamic

PHONO CARTRIDGE

Designed for use only in high quality pickup arms, the Concert Series Cartridge provides performance in home systems equalled only by the Professional unit. As with other ESL cartridges, the Concert Series is built around D'Arsonval moving coil. Dynamic mass has been kept to .001 grams with unusually high compliance. Frequency response extends from 16 to beyond 30,000 cycles. Intermodulation distortion is immeasurably small. Because of the low output voltage and impedance, a matching step-up transformer may be required. The output of this transformer feeds directly into the magnetic phono input of any conventional preamp-equalizer.

ESL Concert Series diamond stylus only..... **$35.95**

Specify .001" or .003".

Matching Transformer Assembly Model ESL 201M—consists of an ESL 201 transformer mounted on small chassis with input jack and output shielded cable with pin plug..... **11.00**

Deluxe 3-Way Speaker System

WHARFEDALE

Loudspeakers

RIVEREDGE

'Briggs' Corner Enclosure

An unusual reproducer system employing recognized high quality components. Consists of Wharfedale W15/CS 15" 20 watt woofer, Wharfedale Super 8/CS/AL 8" mid-range loudspeaker, and the Wharfedale Super 5 cone tweeter, electrically isolated and balanced by means of a Wharfedale 3-speaker Crossover Network.

The enclosure is built in accordance with acoustical specifications of Briggs, famous British designer. Entire front is sand filled for added stiffness and to eliminate spurious resonances.

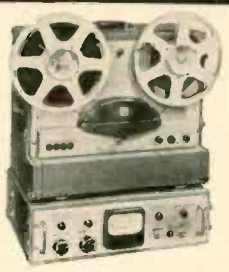
The performance of this system will be a distinct revelation. Efficient loading gives clean fundamentals to below 35 cycles. Use of similar material (cones) in all three speakers provides smooth response up to the 20,000 cycle limit of the tweeter. Finishes available: Mahogany, Walnut, Fruit Wood, Blonde on Birch and Maple veneers.

Deluxe 3-Way Speaker System complete with speakers, crossover, enclosure and specially treated sand..... **$259.50**

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

HARVEY ESTABLISHED 1927 **RADIO COMPANY, INC.**

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



MAGNECORD

M81 Series

Portable

TAPE RECORDER

The basic tape transport mechanism operates at 15 and 7½"/sec. A switch is used for speed selection. Other controls are push-button operated. Accommodates reels up to 10½". Frequency response at 15"/sec. extends from 40-15,000 cycles ±2db. Employs 3 heads: erase, record and playback. In 'record' position playback head serves as monitor.

Separate record and playback amplifiers are available thus permitting simultaneous monitoring from tape. Record amplifier has high impedance, unbalanced microphone input and unbalanced bridge input. Balanced 50 ohm mike input and balanced bridge input available through use of optional plug-in transformer. Meter is provided for bias, record and playback. Has cathode follower output. Optional plug-in transformer provides balanced 600 ohm output.

M81-A	Recorder Mechanism in portable case	**$635.00**
M81-AX	Same as above but less case, for rack mounting	575.00
91X1552	Case only for recorder mechanism (with blower assembly)	62.50
M81-C	Record/Playback Amplifier in portable case	245.00
M81-CX	Same as above but less case, for rack mounting	225.00
81D50	Case only for Record/Playback Amplifier	28.00
M81-AC	Recorder Mechanism and Amplifier combination in Portable carrying case	870.00

New PILOT

AM-FM TUNER

PILOTUNER

Model AF-850

A newly designed broadcast tuner featuring the Illuminated Micro-Meter for greater ease and accuracy in tuning. **FM Section** employs Armstrong dual cascade, limiter-discriminator circuit. Sensitivity is better than 1.5 uv for 20db quieting. Micro-Meter tuning indicator employs a laboratory-sensitive micro-ammeter. AFC is continuously variable from complete cutoff to maximum. **AM Section** employs two-stage IF amplifier with selector for either sharp or broadband AM, plus a 10kc cutoff filter. Tuner has dual cathode follower output permitting up to 100 feet of interconnecting cable. Power supply is self-contained.

Complete with tube..... **$154.50**

The New GRAY

Viscous-Damped

High Fidelity ARM

Model 108C

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

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

Model 108C..... **$39.95**

HARVEY SHIPS EVERYWHERE. Use this handy coupon

HARVEY RADIO CO., Dept. A-6, 103 W. 43rd St., New York 36, N.Y.

Please ship the following.....

.....

I enclose ☐ check ☐ money order for $..... including estimated shipping charges. Unused surplus will be refunded.

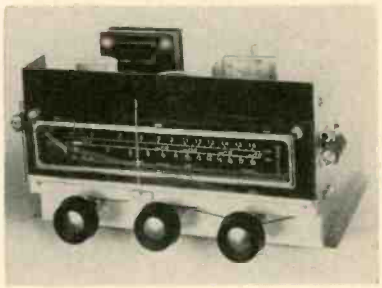
Send: ☐ New FREE High Fidelity Catalog
☐ Details of your TIME PAYMENT PLAN

NAME.....

ADDRESS.....

City..... Zone..... State.....

• **Browning BC-SW AM Tuner.** Introduced as the first high-fidelity AM tuner equipped for short-wave reception as well as for reception of regular broadcast stations, the new Browning Model L-500 is a companion unit to the Model L-300 tuner for FM only. As the first tuner to cover short wave, the L-500 opens a new dimension in high fidelity—permits the reception of noted symphony orchestras, summer music festivals, and the like. In addition to

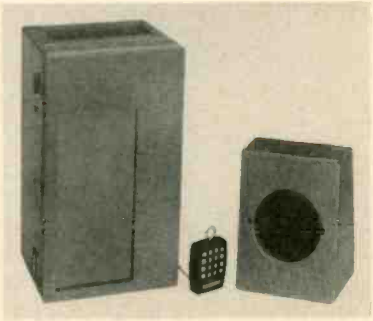


covering the domestic AM band, the unit covers the international short-wave band of 19 to 49 megacycles. Among its features are: selection of broad or standard bandwidth; 10-kc whistle filter; sensitivity better than 2 microvolts; built-in high-gain ferrite antenna; cathode-follower output, and built-in power supply. Full specifications may be obtained by writing Browning Laboratories, Inc., 750 Main St., Winchester, Mass. **K-15**

• **Ronette Microgroove Cartridges.** Available to manufacturers of 45- and 33-1/3-rpm players as well as to individual users, the new Ronette "Fonofluid" Model RA-284P high-fidelity piezo-electric cartridge has extremely low intermodulation distortion. It is of the constant-velocity type and requires a load resistance of 120,000

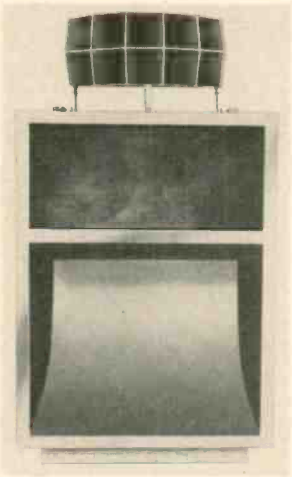
ohms. When so loaded it is designed to feed into any magnetic-cartridge input. Other models in the 284 Series have considerably greater output and are designed for improving the characteristics of existing record players. For complete literature write to Ronette Acoustical Corporation, 135 Front St., New York 5, N. Y. **K-16**

• **Tape Message Recorder-Repeater.** An ideal adjunct for point-of-sale advertising and for increasing the effectiveness of window displays, the Magneloop Jr. is a continuous-loop magnetic-tape record-playback device recently introduced by Amplifier Corp. of America, 398 Broadway, New York 13, N. Y. Available in two mod-



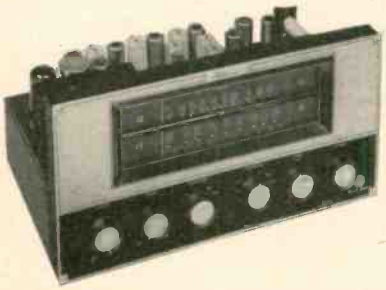
els, Magneloop Jr. affords instant recording and immediate playback without the necessity for rewinding or resetting. Announcements up to 12 minutes in duration may be recorded on Model A which operates at a speed of 3¾ ips. Model B with a tape speed of 7½ ips is able to record up to six minutes and is recommended where greater fidelity is required. Messages may be preserved by replacing the easily removable tape-loop cartridge. The speaker may be placed at a distance from the record-playback unit which is easily concealed. Dimensions are 15⅝"h x 7⅜"d x 9"w. Supplied complete with enclosure-mounted 5-in. speaker, crystal microphone, 6-ft. speaker cable, and tape cartridge. Complete information will be mailed on request. **K-17**

• **Stephens Theater Speaker System.** Meeting with wide acceptance in stereophonic sound installations is the new Stephens Model 432 multi-unit speaker system, developed primarily for use in theaters. The system consists of a Tru-Sonic Type P-30 high-frequency driver coupled to a 10-cell multicellular distributor. Crossover fre-



quency is 600 cps. Bass response is provided by two Tru-Sonic Type 103LX low-frequency drivers. The enclosure is finished in flat black and is 69"h x 36"w x 30½"d. Further information is available from Stephens Manufacturing Corporation, 8538 Warner Drive, Culver City, Calif. **K-18**

• **Pilot FM-AM Tuner.** A phono preamplifier input with variable loading from 6800 ohms to 100 megohms for precise matching of the load requirements of all variable reluctance cartridges is among the prominent features of the new Model AF-825 Pilotuner. The r-f section features sensitivity of better than 5 microvolts on both FM and AM. The circuit is a full Armstrong limiter-discriminator type with temperature-compensated drift-free oscillator. The input-selector switch



is provided with a position for disabling AFC when desired. Full control facilities are incorporated in the built-in preamplifier, including bass, treble, compensated volume control, and five positions of record equalization. The attractive front panel is finished in etched brass with maroon trim. Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y. **K-19**

AUDIO ETC.

Edward Tatnall Canby

1. EARTHQUAKE

SOME ACCUMULATED ITEMS of peculiar interest come first this month. Peculiar is just the word for my currently favorite publication, Emory Cook's *Audio Bucket*, which gives the latest dope on the Cook formula for greater happiness—for Emory Cook and for a lot of us too—through zany audioisms. The *Bucket*, to be sure, has got ahead of the records themselves for me and so I haven't heard his Earthquake disc, but that won't stop me from mentioning it. Not precisely what you might think, or what I had first imagined (*vast crumbling sounds of buildings toppling, at 10 cps., 500 db.; screams and agonized cries of the wounded, the crackling flames, fire sirens . . .*) but simply a disc of the *very* slow vibrations taken down by earthquake measuring devices, seismographs, speeded up (I understand) to bring them within the audible tonal range.

Now of course if you're going to speed up a vibration of 1 or 2 cps into audibility, you might as well make it sound like an earthquake, which would suggest to me (the speed-up being entirely a matter of choice) a nice, crumbling 20 or 30 cps. average. Any lower and even the ten-ton speaker systems would do no better than pump a breeze of air in and out of their ports and mouths and apertures. Good way to stir up extra ventilation in summer. Any higher than 30 cps, and the earthquake wouldn't be more than a sort of moon-quake, or maybe just a dump-truck-at-the-town-dump sound.

Anyhow, this Cook item is the real thing, technically speaking, and no tricked-up sound effect. Too bad Cook wasn't on hand for the collapse of the New York Coliseum's newly poured concrete floor last month. That would have made a gorgeous record —210 by 160 feet of steelwork and nice sloppy wet concrete dropping some ten yards straight downward! The papers said it sounded like thunder—a most unsatisfactory description. Cook could have done better than that.

Incidentally, Cook's next opus in this general category is the darndest yet. He's already tried (reverse of the earthquake) converting the mysterious radio sounds that come from outer space into audio, for the hi-fi man's delight. Now, being a "binaural" man of long standing, he's got the radar-sonar-lofar-navigation bug. Why not *locate* these radio emanations by triangulation (so to speak), taking *two* measurements simultaneously, from a respectable space-distance apart, then calculating direction?

Now that's the sort of thing that should occur to some of our very advanced ultra-secret nuclear specialists and probably has. Of course, to get any sort of triangle on Betelgeuse or Alpha Romeo (whoops, that one is an ancient auto; I'm thinking of some super-nova or double start or something . . .) you'd have to set up your recorder on a neighboring sun or a convenient low-power star, maybe a couple of dozen light years off to our right, or left; but let that pass. The scientists would get around it. And so does Emory Cook.

He's got hold of signals taken all of a thousand miles apart, Hanover, New Hampshire and Washington, D. C., which ought to give at least slightly more than an angle of maybe .0000001 degrees, enough for all sorts of useful purposes.

What to do with two readings of outer-space radio signals taken simultaneously at this useful angular separation? Make a "binaural" record of them! Reports the *Audio Bucket*, no sooner said than done. The rest is up to you. Now all you have to do to join in the great space derby is to acquire Cook's Road Recording 5013, and play it on your two-headed "binaural" phono system.

If you hear the *bonk* and the swishes and the space whistlers from the direction of your Aunt Jemima's bedroom, first floor South, you may draw your own conclusions. If the sounds are heard to come from the cellar right over the oil furnace, then run for your life.

Now it's possible that I've got this all mixed up. The "sounds" (r.f. signals, I should say properly) emanate, or seem to emanate, from the ionosphere, a mere centamile or so straight up. If that's where they come from in actuality, maybe Cook has a pretty good angle after all. Might even be an obtuse one. If so, even the most obtuse of binaural listeners should be able to figure out *that* triangulation. Aunt Jemima better look out.

You can get the *Audio Bucket* from Cook Laboratories, 101 Second St., Stamford, Conn., and when you look it over you'll see why I keep getting magnetized back towards Cook's records every so often. Most attractive.

2. SEALED RECORDS

'Twas all of two years ago (I think) that this department took up the cudgels for sealed records. It didn't really seem very likely then, but look what's happened. Sealed records right and left, from all sorts and varieties of record companies. But there's just one aspect of this interesting development where the prophet Canby missed the boat, most indisputably. I hereby bite the dust and roll in ashes.

For, you see, *my* sealed records, as I imagined them, it now appears were strictly obsolete in one respect. I sealed them (in imagination, of course) *with old fashioned lickum style gum*. You wet it and you stick it.

Whereas, the up-to-date sealed record, as I ruefully observe, has left me hopelessly behind. It uses the ultra-modern way of sealing, the rubber-base adhesive.

Now this has very important economic implications. Not for the rubber industry, which is doing OK as far as I know. Rather, for the record industry. In fact the whole significance of the Sealed Record is altered, in the most fundamental way. There is not one of us, not a manufacturer, dealer, distributor, record collector, who is not directly affected by this unforeseen (by me) change in the basic sealing method.

Rubber-base seals (dare I mention it) CAN BE UNSEALED. (And sealed again.)

So, you see, we now have a most ingenious kind of Super-Sealed record, that combines in one all-purpose package the attributes of the ordinary (lickum-style sealed disc and the familiar unsealed variety. What a feat.

And don't tell me this isn't an honest business either, the record business. I will have no such suggestion from anybody. After all, any dope can tell a rubber-based seal from a stickum-style seal with the flick of a fingernail and the public is beautifully protected. If the seal comes up clean with your fingernail, you have the modern type of sealing. It peels off perfectly, leaving not so much as a trace to mar the factory finish. If it tears, it's stickum-style.

And just to indicate to you how straightforward all this modern sealing is, I give you Capitol, which takes the crown and the Oscar for the Direct Approach in customer relations. Capitol's sealed records have instructions right on the seal itself. Instructions for what? For removing the seal, of course!

"TO REMOVE SEAL, PEEL TAPE CAREFULLY, STARTING FROM CORNER."

That's what it says, right on the Capitol seal. Very good idea, because of course if you peeled it too fast, the seal might be BROKEN. No need to go around breaking seals these days, if you're careful.

COMING EVENTS

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

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

ALDRICH TO BECOME MANUFACTURERS' REP

Thomas B. Aldrich, well known Sales Manager of Presto Recording Corporation, has resigned from that position effective July 1, and will engage in business for himself as a manufacturers' representative, specializing in audio equipment in the broad sense—as compared to parts and equipment. Mr. Aldrich has been a rep before, having been in that business from 1936 to 1942 when his work was interrupted by a two-year stretch in the USAF. Returning from the service, he was again a rep from 1944 to 1947, when he became sales manager for Presto Recording Corporation.

LETTERS

(from page 6)

problems involved in the reproduction of LP records. The frequency and amplitude of the resonant peak is determined by the stylus assembly mass, its compliance, the elasticity of the record material, and the stylus radius. A 3-mil stylus will not resonate at any troublesome frequency in vinyl, but a 1-mil stylus will unless its mass and compliance are kept within very strict limits.

DAVID B. HANCOCK,
4 West 93rd St.,
New York 25, N. Y.

* *Several articles by Mr. White under the title "AUDIO AUDITIES" ran in AUDIO in 1954.* ED.

NEGATIVE FEEDBACK

(Continued from page 23)

There is a limit, however, to the amount of electrical braking that is desirable. Too much will begin to operate on the signal itself when voice-coil velocity is high, which is to say at low bass frequencies.

There are three possible conditions of operation from the point of view of damping. Too low a damping factor will tend to produce a bass frequency response peaked at speaker resonance, with attendant hangover and boominess. Too high a damping factor will produce a system which has no hangover or resonant peak, but which suffers from bass attenuation. The correct damping factor will achieve flat bass response within the capabilities of the speaker, and will also prevent hangover.

One may ask, then, why the feedback circuits of all amplifiers are not adjusted for optimum damping factor and left that way. What is the need for a variable control? The answer lies in the fact that the optimum value of damping factor for a particular system depends upon the speaker, the enclosure, and the position in which the speaker is placed in the room, particularly the solid angle into which the speaker radiates. For example, the danger of over-damping is

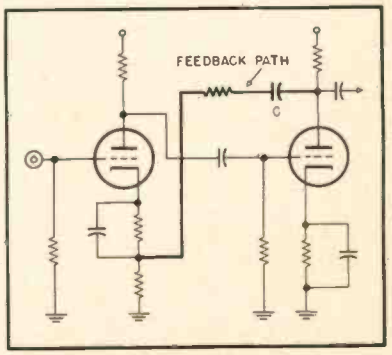


Fig. 5. Phonograph preamplifier equalization (bass boost) with negative feedback. The amount of feedback is progressively reduced below a selected transition frequency.

greater when the speaker has high magnetic flux. Modern feedback circuits make possible a damping adjustment for optimum bass operation under given conditions.

Feedback Equalization

A tone-control or equalizer circuit provides a transmission path whose gain changes for signals of different frequencies. A particular part of the frequency spectrum can thus be boosted or attenuated.

Negative feedback can be used to create such a discriminatory signal path. We have seen that the first action of negative feedback is to reduce circuit gain; if this action is made to vary with frequency we have a tone-control or equalizing circuit.

Figure 5 illustrates the use of negative voltage feedback in a phonograph preamplifier, providing bass boost to compensate for the bass-cut characteristic in records. At higher frequencies the capacitor *C* is effectively a short circuit, but as the frequency is lowered the impedance of *C* rises, progressively reducing the feedback voltage applied to the cathode resistor, and hence increasing the amplification of the circuit. The circuit constants can be designed for the particular equalization curve required.

The use of negative feedback in such equalization circuits is especially suitable, since no extra gain is sacrificed. Nonfeedback equalizer circuits must also sacrifice over-all gain, but do not possess the additional advantages of anti-noise and anti-distortion characteristics.

Employment Register . . .

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

★ Positions Open ● Positions Wanted

★ **Audio Laboratory Engineering Assistant.** Must be able to set up, operate and maintain audio equipment in audio division of major consumer testing organization; construct auxiliary equipment as required; assist division head and others in testing audio equipment sold to the public. Required: degree in electrical engineering or equivalent experience; also 3–4 years experience in audio equipment operation and maintenance and some familiarity with theory and mathematics of audio electronics and acoustics. Salary $100 up, depending on individual. Send resume to Personnel Director, Consumer Reports, 17 Union Square West, New York 3, N. Y.

★ **Hi-Fi Technician.** Top-notch man required for bench and installation work. Must have interest and specific experience in hi-fi, and must have driver's license. Good salary and fine opportunity. Highest references required. All applications will be kept confidential. Audio Exchange, Inc., 159-19 Hillside Ave., Jamaica 32, N. Y.

ABOUT MUSIC

HAROLD LAWRENCE*

Heseltine-Warlock: Man and Sorcerer

NEARLY A QUARTER of a century ago, police broke down the door of a gas-filled Chelsea flat in London in a vain attempt to save the life of 36-year-old Philip Heseltine—the most fascinating and little understood figure in modern English music. Four years later Cecil Gray published the first and only biography of Heseltine, thereby setting the tone for future articles, reviews, and studies of the man and his music. The book has obvious virtues. A friend and editorial collaborator of Heseltine for almost fifteen years, Gray had at his disposal a wealth of letters, documents, and memorabilia. Add to this a lively and imaginative prose style and the results are bound to be of interest. However proximity to his subject led Gray to some rather distorted conclusions, just as when one is standing too close to a painting, the brush strokes seem to dominate the over-all effect. What emerged from the pages of his memoir was the portrait of a sort of a Jekyll-and-Hyde character doomed to self-destruction, a schizophrenic with overtones of genius. But first, a few words to fill in the background.

Philip Heseltine was born in London on October 30, 1894. Largely self-taught, his main influences were Delius and Bernard van Dieren, the latter being directly responsible for Heseltine's first published work, a song-cycle *Sandades* written in 1916–17. Heseltine's birth as a composer was actually an offshoot of his critical activities. As early as 1911 he was devouring old and new music with astonishing rapidity. His letters to Delius at the time display a fresh and original intellect. In 1920 he founded a musical journal called *The Sackbut*. He later wrote several books, numerous essays, and rediscovered, edited and transcribed prodigious amounts of early English music. A passionate student of the Elizabethan Age, Heseltine was at the same time a perceptive commentator on the contemporary musical scene. An article on Arnold Schönberg, for instance, written in 1912 was one of the first exhaustive essays on that composer's work to appear in England. Like a famous musical journalist of another day, Robert Schumann, Heseltine had a nose for talent; as Gray pointed out, "several composers who are now well known were discovered and helped to recognition by him before any other critic was even aware of their existence." One notable example is Sir William Walton.

The careers of Schumann and Heseltine were similar in another aspect. To express the duality of his nature, Schumann invented a pair of pseudonyms which he employed in his critical writings and in his compositions. Florestan represented the active, impetuous man; Eusebius, the introspective dreamer. Around 1920 Heseltine adopted a new name for himself as a composer: Peter Warlock. At first the pseudonym was nothing more than a practical device to secure acceptance and publication of his music. Heseltine simply wished to avoid being pigeonholed in the public's mind as an editor and critic who composed in his spare time. Thus, when a group of songs was published under the name of Peter Warlock, they were received and judged on their own merits. "It gives me great satisfaction," he wrote to a friend, "to reflect what they [the critics] would have said about these same compositions had they been signed Philip Heseltine."

From the role of "convenient pseudonym," Peter Warlock grew into an extension of a hitherto submerged facet of Heseltine's make-up. On October 23, 1921 Heseltine had his last shave and began his fourth and final beard. With this facial adornment, Warlock sprang forth, a "lusty, roistering, swashbuckling, drinking, wenching" individual, as Gray described him. Songs as *Hey Troly loly, Good Ale,* and *The Bachelor,* all written in 1922, reflect this "change of life." A startling portrait of Heseltine-Warlock may be found in Aldous Huxley's *Antic Hay*. Gumbril, the novel's hero, buys himself a false beard . . . "Fan-shaped, blond, mounted on gauze, and guaranteed undetectable, it arrived from the wig-maker, preciously packed in a stout cardboard box six times too large for it and accompanied by a quarter of a pint of the choicest spirit gum. In the privacy of his bedroom Gumbril uncoffined it, held it out for his own admiration, caressed its silkiness, and finally tried it on, holding it provisionally to his chin, in front of the looking-glass. The effect, he decided immediately, was stunning, was grandiose. From melancholy and all-too-mild he saw himself transformed into a sort of jovial Henry VIII, into a massive Rabelaisian man, broad and powerful and exuberant with vitality and hair—great eater, deep drinker, stout fighter, prodigious lover—Cautiously and with neat, meticulous fingers he adjusted the transformation to his gummed face, pressed it firmly, held it while it stuck fast—One last look at the Complete Man, one final and definitive constatation that the Mild and Melancholy one was, for the time at least, no more; and he was ready in all confidence to set out."

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

Thus, Peter Warlock (who incidentally grew his own beard), Philip Heseltine's creation, repudiates the past and, like the galvanized monster in *Frankenstein*, ultimately destroys his master. So goes Gray's theory.

Peter Warlock: a memoir of Philip Heseltine was published in London in 1934. A few years later, an American composer, music editor, and Delius-enthusiast named Robert Beckhard ran across the book and was thoroughly captivated with the life of this strange, compelling figure. The fact that Warlock was a fervent admirer of Delius and Elizabethan music struck a responsive chord in Beckhard whose own musical interests parallel those of the London composer. From that time on, he began a search for any music of Warlock that he could lay his hands on—a search, by the way, that is still continuing; Beckhard's collection is now about 90 per cent complete. Although he found Gray's book stimulating, Beckhard was disturbed by the over-dramatic, intensely subjective treatment of the "conflict Heseltine-Warlock." He was also unsatisfied with the scant attention given to Warlock's musical output. Beckhard then proceeded to haunt the public libraries reading articles on and by Warlock and his contemporaries. Last summer he spent his vacation in England visiting the scenes of Warlock's life: London, Cornwall, Kent, Eynsford; looking up friends, relatives and associates of the composer. He returned home to New York with the clear impression that the "real" Warlock is a bigger, more significant man and musician than his biographer would have us believe. He toyed with the idea of writing an article on his summer's trip but shelved it. The subject was too vast. It would have to be a book. Once this decision was made, Beckhard wrote two letters, one to the Times Literary Supplement and another to the Musical Times, both in London, announcing the fact that he was preparing a new work on Warlock and would appreciate any information from anyone who knew the composer.

That did it. Letters began pouring in from many places. Unfortunately most of Warlock's close friends were dead—Gray, van Dieren, Delius, etc. But Beckhard tracked down several possibilities that have turned out to be biographers' gold mines. Another trip to England this year should round out the project. From then on, it will be a matter of organizing the tremendous quantities of correspondence and research material, not to mention the actual business of writing the book. By the looks of it now, Beckhard's work is shaping up into the first comprehensive and authoritative study of Peter Warlock, the man and his music.

Unlike Vaughan Williams, Britten, and Walton, whose music is familiar to American audiences, Warlock is virtually unknown here. His preference for smaller forms limits his popularity; the combination of voice and piano provides feeble competition to symphonies and operas. But an acquaintance with some of his hundred songs supports Constant Lambert's statement that, in this art form, Warlock ranks with Moussorgsky, Schubert, Dowland and Debussy as one of the greatest song-writers that music has known.

TAPE RECORDING AMPLIFIER

(from page 24)

ground. Under these conditions the equivalent circuit diagram of *Fig.* 5 obtains. V_{1A} and V_{1B} are taken into account by putting

$$e_{g2} = -A \cdot e_k \qquad (3)$$

where A designates the amplification between the grid of V_{1A} and the plate of V_{1B}. Using (3): $e_{c2} = e_{g2} - e_k = -e_k(1+A)$.

Then, finding e_k directly from *Fig.* 5,

$$e_k = \frac{(e + \mu e_{c2}) \cdot g_{p2}}{g_{p2} + G_k} = \frac{[e - \mu e_k(1+A)] \cdot g_{p2}}{g_{p2} + G_k}.$$

$$\text{Therefore } e_k = \frac{e \cdot g_{p2}}{(1+A) \cdot \left(\mu g_{p2} + \frac{g_{p2} + G_k}{1+A}\right)} \cong \frac{e}{\mu(1+A)}, \text{ if } A \gg 1.$$

$$\text{Using (3), } e_{g2} = -\frac{e \cdot A}{\mu(1+A)} \cong -\frac{e}{\mu}. \qquad (4)$$

This last expression reveals that a voltage $-\frac{e}{\mu}$ will appear at the grid of V_2 if a signal of amplitude e is applied to its plate The previously mentioned method of feeding the supersonic bias into the recording head in parallel with the audio frequencies would therefore result in the appearance of a considerable fraction of the bias at the grid of V_2 and the danger of crossmodulation with the audio frequencies. Even the insertion of a filter for the bias frequency between the recording head and the amplifier would meet with difficulties owing to the high output impedance of the amplifier.

The recording bias is therefore fed into the recording head in series with the audio frequencies, as shown in *Fig.* 6. The parallel tuned circuit $L-C_1$ resonates at the frequency of the recording bias, forcing the bias current mainly through the recording head *RH* and through C_2 which may be formed solely by the distributed capacity of the shielded cable connecting the recording amplifier with the recording head. As the impedance of the recording head at the bias frequency is considerably higher than the impedance of C_2, only a small fraction of the bias will appear across the output terminals of the recording amplifier. On the other hand, L represents practically a short circuit at all audio frequencies, providing an efficient ground connection for the audio currents flowing through the recording head. C_2 serves the additional purpose of tuning the recording head to a frequency somewhat beyond the highest audio frequencies which may still be recorded without attenuation. This will provide some additional treble boost which may be utilized to compensate for the losses occurring at the high audio-frequencies. As it is very desirable to make C_2 as large as possible in order to reduce the bias appearing across its terminals to a minimum, its value resulting in the most satisfactory response should be carefully determined. A further increase of C_2 is not advisable, as it would seriously affect the high audio-frequency response of the amplifier.

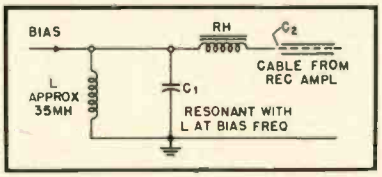


Fig. 6. The author's series-bias system employs a resonant circuit to keep bias out of amplifier.

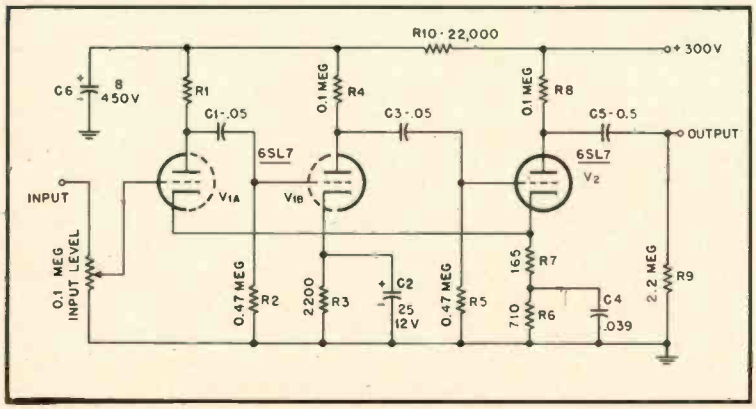


Fig. 7. The complete tape-recording amplifier. Output goes through a shielded cable to the head and bias-injection arrangement of Fig. 6.

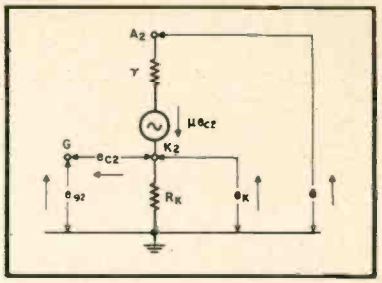


Fig. 5. Theoretical diagram shows conditions when bias is inserted in parallel with signal.

After the bias voltage across the recording amplifier has been reduced to its minimum, the residual voltage appearing at the grid of V_2 (*Fig.* 3) could be further reduced by employing a high-mu pentode, as its amplitude is approximately $\frac{e}{\mu}$. A second consideration in choosing an output tube for a particular recording head will be the current requirements of the latter which are determined by the ampere turns necessary to drive its core into saturation.

The Final Amplifier

The complete diagram is shown in *Fig.* 7. The mentioned feedback path consists of R_6, R_7, and C_4. The current amplification at low frequencies is determined by $R_6 + R_7$, the low-frequency turnover by the time constant R_6C_4 and the high-frequency turnover by the time constant R_7R_4. The design procedure for this network and C_{11} in *Fig.* 6 will now be described.

An audio generator is connected to the input terminals of the recording amplifier, and the output amplitude of the playback amplifier is plotted in decibels against a logarithmic frequency scale for an input signal of varying frequency and constant amplitude. It is now necessary to correct the bass response of the playback amplifier prior to adjusting the recording amplifier. After this has been accomplished, the procedure is the following:

(1) The playback amplifier output is plotted using a purely resistive feedback impedance $R = R_6 + R_7$ (see *Fig.* 8).

(2) The region in which this frequency response drops by about 6 db per octave may now be extended, adjusting C_2 (*Fig.* 6) to its optimum value.

(3) The frequency f_1 at which the output is 3 db below flat response, and the frequency f_2 at which the response drops by at least 6 db[1] below the 6-db-per-octave line, are found by inspection.

(4) The value of the components may now be found from f_1, f_2 and R according to the formulas

$$R_6 = R\frac{f_2}{f_1 + f_2}; \quad R_7 = R\frac{f_1}{f_1 + f_2}; \text{ and } C_4 = \frac{1}{2\pi f_1 R_6}.$$

[1] This latter point is not critical.

These values may further be modified by trial and error according to the final over-all frequency response.

The values of the rest of the components are not critical. However, care should be taken in choosing the C_3. The slightest leakage through that capacitor will cause direct current to flow in the recording head, and the resulting premagnetization will cause the signal-to-noise ratio of the recording to deteriorate considerably.

The recording head employed by the author has the following characteristic: impedance, 0.44 hy measured at 50 cps, resonating at 14,000 cps with 200 μμf; maximum impedance (self-resonating) at 60,000 cps However, any high-impedance head may be employed with the corresponding changes of the critical components R_6, R_7, C_1, and C_2 (*Fig.* 6). In the present design their value was chosen for a tape speed of 7.5 ips. A conventional reproducing amplifier was employed and yielded at that speed an over-all response of ±3 db between 40 and 10,000 cps. The highest frequency obtainable without attenuation will mainly depend on the kind of recording head, reproducing head, the tape speed, and the tape itself. The recording amplifier itself is capable of amplifying the highest audible frequencies with considerable preemphasis, and with remarkable lack of distortion.

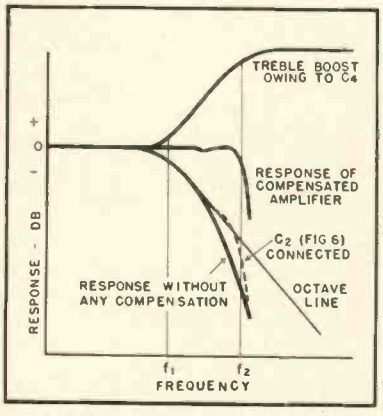


Fig. 8. Playback-amplifier output curves under various adjustment conditions.

HIGH-POWER AMPLIFIER

(*from page 17*)

the 100-ohm final-tube plate-current balance control to its middle position, set the slider on the 200-ohm final-stage bias resistor nearest the cathode end and screw up fairly tightly the trimmer across the 24,000-ohm feedback resistor.

Apply plate and filament power. After 5 or 10 minutes warmup, adjust the dynode voltage for the EFP-60's. With a d.c. voltmeter connected from dynode to ground, slowly move the slider on the 60,000-ohm resistor away from the

grounded end. As the slider is moved, the voltage will rise slowly at first, and then jump abruptly to a value of about 170 volts. Leave the slider in this position for the time being. The sudden jump in voltage means that the tubes have commenced their secondary emission and the secondary cathodes are drawing current.

Adjust the d.c. balance by placing the voltmeter across the plates of the EFP-60's and adjusting the 2,000-ohm d.c. balance control until there is no voltage differential. There will be some constant random fluctuations of the meter needle due to supply and tube fluctuations. These should be disregarded.

Connect the intermodulation analyzer and adjust the amplifier for about 50 watts into a noninductive load. Adjust the 500-ohm a.c. balance control for lowest intermodulation at this power level. Remove the KT-66's from their sockets. Feed a very small 60-cps signal to the input, and adjust the signal's magnitude until a signal of about 25 volts is measured at the output of the EFP-60's with an a.c. v.t.v.m. Be careful to isolate the test leads from the amplifier input or feedback oscillations will result. Readjust the dynode voltage of the EFP-60's for maximum gain, i.e., maximum voltage output. Leave the slider set at that position. Readjust the d.c. balance. Replace the KT-66's *in the same sockets as before*, reconnect the intermodulation analyzer, and again adjust the a.c. balance for lowest intermodulation. Balance the static d.c. plate currents in the output transformer by adjusting the 100-ohm final balance potentiometer for zero voltage differential across the plates of the KT-66's. This adjustment is very important as d.c. magnetization of the output transformer core causes its low-frequency characteristics to deteriorate badly.

Connect an oscilloscope to display the input-output characteristic of the amplifier at 1000 cps. Increase the input to the amplifier until it is on the verge of overload. Adjust the trimmer across the feedback resistor to eliminate the parasitic oscillations at the tips of the linearity characteristic (*Fig.* 4). There should be a fairly broad range to this adjustment. Reconnect the intermodulation analyzer. Adjust the input for 50 watts output and finally readjust the cathode bias on the KT-66's (with the modulation. These adjustments, if carried out properly, should yield an intermodulation distortion figure of less than .09 per cent at 50 watts, using 60 and 7000 cycles mixed 4:1. It should be noted that the a.c. balance is a fairly critical adjustment for lowest distortion and should be readjusted periodically as the tubes age. Whenever the a.c. balance is adjusted, the d.c. balance should be touched up. It is important that during all these adjustments the 1-ohm damping-factor control should be set with its moveable arm grounded.

Operation

The writer has found that with different speaker systems the adjustment of the 3-30-μμf trimmer across the feedback resistor might have to be changed to insure the greatest stabilitiy at high power levels.

It is advisable that a high-pass filter be incorporated somewhere preceding the amplifier. The extended low-frequency response of this amplifier, coupled with the fact that *the output transformer power handling capacity drops off at the rate of twelve db per octave below twenty cps,* makes the amplifier especially susceptible to overload at frequencies below, say, 10 cps. It is conceivable that record eccentricities, rumble, etc., will cause the output transformer to saturate at these extremely low frequencies, thereby generating distortion and overloading the loudspeakers.

It was found that at high power levels, parasitic oscillations appearing on the tips of the linearity characteristic caused the intermodulation to rise to very high values. It seems that even though the frequency of these oscillations is way above the audio spectrum, they have a very drastic effect on the distortion characteristics of the amplifier, and their complete elimination is of paramount importance. Even faint wisps and wiggles seen only on a wideband, triggered-sweep oscilloscope have a great effect on the distortion. The mechanism of these effects has yet to be investigated.

The harmonic distortion of the amplifier is less than 0.5 per cent at 20 cps at 50 watts. It decreases rapidly as the frequency is raised, and is too small to be accurately measured at 100 cps at 50 watts. At no frequency between 100 cps and 20 kc does the harmonic distortion exceed .05 per cent at the 50-watt level.

Some experimentation has been carried out with the use of tubes other than KT-66's. 807's, 5881's, and the new Tung-Sol 6550's have been tried. Of these, the 6550's are the most promising. The 5881's cannot deliver the high power without being overloaded, and the 807's, although capable of delivering more power than the KT-66's, are very susceptible to r.f. parasitics and are not recommended. A single pair of 6550's can deliver almost as much power as four KT-66's, and they seem to be much freer from parasitics than even the KT-66's. Since the Acrosound TO-330 is not matched to these tubes, maximum power, in this circuit, is delivered only when a different value of load resistance from the nominal values of 4, 8, and 16 ohms is used. It was found that with a load of about 11 ohms at the 16-ohm tap, the amplifier delivered the most power—in this case about 68 watts maximum. The distortion with two 6550's was not quite so low as was obtained with four KT-66's.

The author is greatly indebted to Mr. David Hafler of Acro Products Company for his many suggestions, and in particular for the suggestion to eliminate one of the cathode followers in the cross-coupled inverter. Also the author would like to thank Professor Earl W. Keller of the M.I.T. Electrical Engineering Department for the generous donation of his time, advice, and encouragement.

LONDON LETTER

(*from page 10*)

which is to be marketed later in the year, they could give no details of the cost and explained that the first three items which had been reproduced in the studio had been from their standard recording tape machines which operate at 30 ips. The dance band had been reproduced from a tape at 7½ ips but the equipment used had been the modified large E.M.I. tape recording machines which they sell to the B.B.C. and other Recording Companies and cost nearly $3,000.

Stereosonic Tapes in U.S.A.

No price could be quoted for the stereosonic tapes but it was stated that these could be played on any suitable double track machine operating at 7½ ips with the heads on the same level. It was claimed that they would give better reproduction than the tapes which are now being made by R.C.A. in America and presumably British tapes will be released in the U.S.A. under either the R.C.A., Angel, or Capitol marks, although no definite information could be gained regarding American marketing plans.

It was stated that H.M.V. reproducing equipment would be offered to the public at the National Radio Show which opens in London at the end of August. The prototypes of the equipment were on view, although no opportunity was given of hearing tapes on the machines. The reproducing equipment is housed in two identical consoles of which one contains the tape deck, two preamplifiers, one 10-watt amplifier, and one loudspeaker system, while the other contains the three-speed record changer, the second 10-watt amplifier, and a duplicate loudspeaker system.

By switching arrangements it is possible to use the two consoles for the reproduction of stereosonic tapes on both speakers, single channel reproduction of tapes or disc records on both speakers, or on one speaker. In addition to a volume control there are bass and treble controls giving approximately 12 db lift or cut at 50 and 10,000 cps respectively. The balance control enables the sound image to be centralized between the two speakers as may be required by the acoustic conditions of the listening room. It was stated that the 10 watt main amplifiers did not have a total distortion of more than 0.25 per cent at 8 watts and a noise level at least 55 db down on 10 watts. The speaker systems contained in each cabinet comprised a wide-angle electrostatic ribbon speaker, taking an input of 140 volts rms and a 13½-in. elliptical speaker enclosed in a 3½ cu. ft. critically damped enclosure, the over-all resonance of the whole system being 47 cps. The bass speaker was designed to cut off at 6000 cps. No capacitative or inductive components were required as in conventional crossover system. The wide angle ribbon speaker was stated to give a high-note diffusion over an arc of 60 deg.

Summarising the demonstration, your correspondent can say that whilst it was indeed interesting, hearing in a studio a carefully pre-arranged performance of what were possibly the original tapes reproduced on studio equipment is very different from listening to duplicated tapes on commercial equipment in the home.

No definite statement could be obtained as to whether the stereosonic tapes are going to be only the same relative price as the present English single-channel recorded tapes. Even if they cost no more per foot of music, it must be remembered that two tracks of the same performance will cost double that of single-track tapes. If no reduction is made, it will mean stereosonic tape records will inevitably be very expensive and only the larger rooms could house the equipment which will be marketed by H.M.V.

It may well be that there will be considerable modification in the design of this equipment before it is placed on the market. Owing to the peculiar position in England regarding purchase tax, it would seem that one of the consoles would be subject to tax because it contains a record changer, whilst the other console would not be subject to tax because at the present time, tape recording or reproducing equipment does not bear tax.

It seems likely that some other tape recorder manufacturers may well market a more economical arrangement whereby one cabinet would contain the tape deck and two amplifiers and the loudspeakers could then be housed in individual cabinets. Such an arrangement would probably be entirely free of tax. If it were desired to reproduce disc records, then the mechanism could be housed in yet another cabinet which could be connected up to one of the amplifiers.

RECORDS

(*from page 59*)

three voices, though the result is still worthwhile, as compared to no spoken text at all. Beautifully recorded, both instruments and voices.

[l] **Stravinsky: L'Histoire du Soldat (suite); Octet for Winds; Symphonies of Wind Instrs.** Instr. Ensemble, Stravinsky.
Columbia ML 4964

Here is Stravinsky's own present interpretation of the "Soldat" music, minus texts. I would not say it is "definitive"—because I have his own priceless older 78-rpm recording, of the very early 1930's (I bought it brand new), and it is quite different in many ways. But this is from the horse's mouth just the same, and the reverse carries a sonorous collection of other works for a similar small group of instruments, the whole recorded in a perfectly huge liveness for a big, fat sound. (The old "Soldat," interestingly, was one of the deadest recordings acoustically I've ever heard.)

[ac] **Stravinsky: Pulcinella; Divertimento (Baiser de la Fée).** Orch. Nat. Radiodiffusion, Markevitch.
Angel 35143.

An interesting pairing of two works by S. both based on music by other composers—Pergolesi and Tchaikowsky. Stravinsky's re-writing of these men into his own idiom is unique and wonderful to hear, adding a very understandable and comfortable modern "spice" to the solid musical ideas of the earlier music. Both performance and recording are tops to my ear, with some marvelous instrumental sonorities. An outstanding disc.

[ss] **Prokofieff: Flute Sonata, Opus 94.** (Roussel: Flute Trio, Opus 40.) Doriot Anthony Dwyer, fl., et al.
Boston B-208.

This is the original of a well-known and often-played violin sonata; Prokofieff rearranged it from flute to violin. The flute version is highly attractive, as played by the young lady First Flute of the Boston Symphony, with Sanroma at the piano. (You'll find the fiddle version an interesting comparison—Isaac Stern and Szigeti have done it, among others.) Close-up flute; piano in background.

[lB] **Prokofieff: Symphonies #5, #1 ("Classical").** Concerts Colonne, Horenstein.
Vox PL 9170.

A worthwhile pairing, the lyric little First or "Classical" and the lyric big 5th, of a quarter-century later, but though the "Classical" is very well played, the 5th gets what seems to me to be a strident, Tchaikowsky-like performance, stressing the grosser aspects at the expense of much vital detail-work. I don't like it (even if I did write the accompanying notes) but Horenstein is no fool and you'd better try for yourself if you like the symphony.

Prokofieff: Piano Sonatas #6, #7. Robert Cornman.
London LL 902.

The Cornman technique is plenty dazzling (as is necessary for these difficult works) but to my ear the musicianship isn't as impressive; this is more piano playing than it is Prokofieff playing. Part of a series on the Sonatas.

CLASSIFIED

Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.

IF YOU ARE MOVING

Please notify our Circulation Department at least 5 weeks in advance. The Post Office does not forward magazines sent to wrong destinations unless you pay additional postage, and we can NOT duplicate copies sent to you once. To save yourself, us, and the Post Office a headache, won't you please cooperate? When notifying us, please give your old address and your new address.

Circulation Department
RADIO MAGAZINES, INC.
P. O. Box 629 Mineola N. Y.

Industry People...

Nate Pinsley, president of Espey Mfg. Co., and **Michael Muckley,** sales manager, were joint hosts at a trade showing to introduce the new Espey hi-fi tuners, amplifiers, and complete chassis; exhibit was held during the first week of May at Espey's New York headquarters . . . Another May event occurred on the sixth when **Bert Whyte,** well-known record critic and audio consultant, and partner **David Hollister** held formal opening ceremonies for their House of Hi-Fi in Manhasset, N. Y. Inviting in every respect, the "House" handles equipment of most leading manufacturers, and is the latest of the country's hi-fi centers catering primarily to the suburban set.

New officers of Mark Simpson Manufacturing Co., Inc., are: **Miryam Simpson,** president; **Mark Simpson,** vice-president and secretary; **Bernard Zisman,** vice-president and treasurer; **George Watson,** vice-president, distributor sales division; **Phillip S. Optner,** vice-president, manufacturing division, and **Ralph Aasen,** vice-president, engineering . . . **Lawrence W. Kanaga,** since 1949 general sales and merchandising manager of RCA Victor Record Division, has been named vice-president and operations manager, reporting directly to general-manager **Manie Sacks** . . .

Harold V. Childs has moved from Motorola Communications and Electronics, Inc., to Ampex Corporation where he will be manager of the field service engineering department . . . **Jerome K. Levy** and **Robert Winston** have been appointed vice-presidents of National Musitime Corp., subsidiary of Audio & Video Products Corp., New York. **Levy** will be general manager and **Winston** will be in charge of sales . . . **Al Stroka** has been named industrial sales engineer for Pentron Corporation; in addition to serving as field engineer, he will cooperate with manufacturers in designing industrial electronic devices . . .

Vacancy created on the executive staff of Daystrom, Inc., by appointment of **Robert Erickson** to presidency of The Heath Company, a Daystrom subsidiary, will be filled by **Walter W. Slocum** who has been named assistant to **Thomas Roy Jones,** president of the parent company . . . **Gramer Yarbrough** has been named sales manager of American Microphone Company, Pasadena, Calif. . . . **Arthur Priest,** audio consultant, has joined Recoton Corporation as sales manager of the cartridge division . . . **Daniel R. von Recklinghausen** has been promoted from senior project engineer to chief research engineer of Hermon Hosmer Scott, Inc., Cambridge, Mass.

Industry Notes...

Special recognition for excellence in packaging design and sales promotion techniques for magnetic recording tape was given to **ORRadio Industries, Inc.,** manufacturers of **IRISH** brand tape, in the April issue of Modern Packaging magazine. ORRadio was spotlighted in a feature article as a leader in "sales-appeal packaging aimed at a new multitude of home users." "Attractive packaging, point-of-sale displays, and self-selling displays have played a big role in increasing sales of IRISH magnetic tape 82 per cent during the past year," according to Nat Welch, ORRadio sales manager.

Elgin National Watch Company has become one of the nation's largest manufacturers of high-precision electric relays with the purchase of **Advance Electric & Relay Co.,** Burbank, Calif. Formal transfer of ownership took place April 30. It was the 91-year-old watch company's third move into the fast-growing West Coast electronic industry, earlier purchases including **Neomatic, Inc.,** and the **American Microphone Company.** Amount of the purchase price was not stated.

Triad Transformer Corp., Venice, Calif., gave recognition to 61 of its 384 employees at a dinner held recently. Awards for five years of service were given to 52 employees while nine received awards for having been with the company ten years. In presenting the awards, O. D. Perry, vice-president, said that nearly six million dollars had been paid in salaries since the company's inception in 1944, and that the company had shipped more than six thousand tons of finished transformers to electrical and electronic firms throughout the country.

ADVERTISING INDEX

Acro Products Co. 73
Allied Radio Corp. 61
Altec Lansing Corporation 7
Ampex Corporation ..... Cover 2
Audak Co. 45
Audiogersh Corporation 53
Audio League Report 67

Belden Mfg. Co. ..... Cover 3
Bell Telephone Laboratories 14
David Bogen Co., Inc. 56
British Industries Corporation
facing p. 1, 26, 27, 30, 34, 35, 36, 37, 42, 44, 45, 50, 71
Brush Electronics Company 6

Carter Motor Co. 2
Centralab, Division of Globe-Union 75
Classified Ads 78
Collaro Record Changers 55
Cousino, Inc. 79

Electro-Sonic Laboratories, Inc. 46
Electro-Voice, Inc. 1, 13
Electro-Voice Sound Systems 79

Fairchild Recording Equipment Corp. 48, 59
Fenton Company 40

Goodmans Industries, Ltd. 77

Harvey Radio Co., Inc. 65
Heath Co. 63
High Fidelity House 79
Hollywood Electronics 79
Hughes Research and Development Laboratories 5
Hycor Co., Inc. 10

Karlson Associates, Inc. 77
Kierulff Sound Corporation 79
Kingdom Products, Ltd. 41

Leonard Radio, Inc. 79

Marantz, S. B. 75
McIntosh Laboratory, Inc. 69
Minnesota Mining and Mfg. Co. 9

National Company 11

Partridge Transformers, Ltd. 80
Peerless Electrical Products 68
Pickering & Company, Inc. 31
Pilot Radio Corp. 78
Presto Recording Corporation 39
Professional Directory 79

Radio Shack Corporation 66
Rauland-Borg Corporation 72
Rek-O-Kut Company 32

Schober Organ Corporation 70
Scott, H. H., Inc. 47
Sonotone Corporation 51

Technical Tape Corporation 3
Tetrad 43
Triad Transformer Corp. 4

United Audio Products 49
United Transformer Co. ..... Cover 4

Weathers Industries, Inc. 54

LEADERS IN MINIATURIZATION FOR OVER TWENTY YEARS . . .

MINIATURIZED TRANSFORMER COMPONENTS FROM STOCK

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight.8 oz.

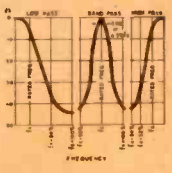
TYPICAL ITEMS

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS

UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 — 2-1/2 high . . . Weight 6-9 oz.

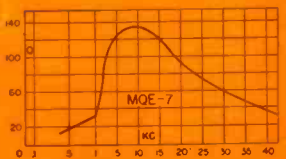


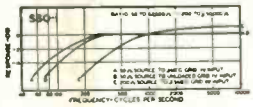
HERMETIC MINIATURE HI-Q TOROIDS

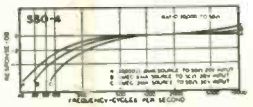
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2







SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weight 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

* Impedance ratio is fixed, 1250:1 for SSO-1,1:50 for SSO-3. Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

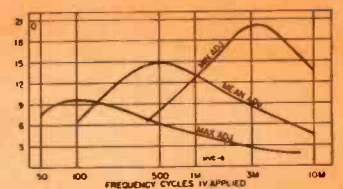
Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

Type No.	Application	Pri. Imp	Sec. Imp
O-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
O-4	Single plate to 1 grid	15,000	60,000
O-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
O-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
O-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
O-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
O-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		

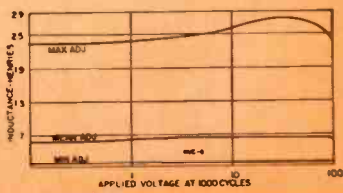
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.



TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5



LET US MINIATURIZE YOUR GEAR.

SEND DETAILS OF YOUR NEEDS for SIZES and PRICES

UNITED TRANSFORMER CO.

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

CABLES: "ARLAB"