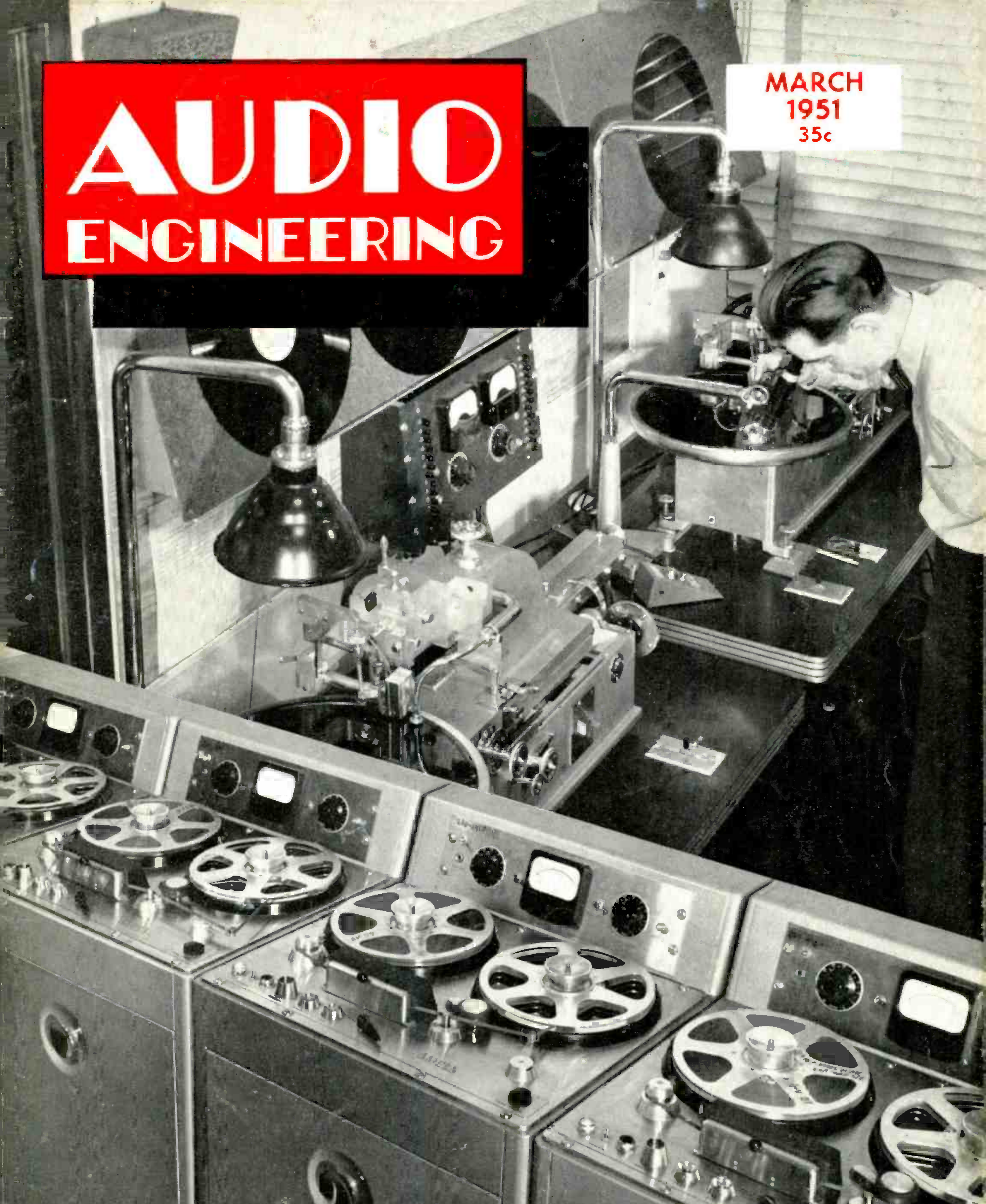
AUDIO ENGINEERING

MARCH
1951
35c



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That's why the Audiotape line has grown so large and so fast. In addition to the standard ¼" tapes, Audio is now supplying a wide variety of special sizes — up to 8" in width — for specialized applications of sound reproduction. The new Audiofilm*, developed for the motion picture and TV industries, is a typical example.

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AUDIO ENGINEERING

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Established 1917

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CONTENTS

MARCH, 1951 Vol. 35, No. 3

COVER

A few of the sixteen Ampex tape recorders—part of the facilities of the Audio Video Recording Company—are shown in montage with the disc microgroove master cutters. This installation is at 1650 Broadway in New York City. Complete facilities provide for original recording and production editing on tape and for dubbing and mastering on disc. Equalized lines connect to major studios in the city for program feeds. Photo by Jack Sharin.

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Ave., Lancaster, Pa., by Radio Magazines, Inc., D. S. Potts, President and Publisher; Henry A. Schober, Vice-President. Executive and Editorial Offices: 342 Madison Avenue, New York 17, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A.

Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

LETTERS

5U4G Shortage

Sir:

Stupidity is common these days, one can see it even in high places, alas, but for an example of absolute *asininity* I have yet to see anyone attempt to equal *your sensational contribution*. To print not once, but *twice*, the exact designation of a radio tube in critically short supply strikes me as a superb example of a lack of the *slightest trace* of common sense. By printing in two issues the name of the tube, together with appropriate comments indicating its scarcity, you have, as a child of ten could predict, increased the shortage fiftyfold. Did you think you were doing a service, by warning readers in plenty of time to let them stock up? Rot! For every bonafide user, there will now be a hundred who place orders, thinking to use the big bottles in their auto radios, the family portable, or perhaps to design a nice new circuit around it. And even those who do need this particular type of tube legitimately, now, being warned will place orders with ten distributors, rather than with one, and will hold onto each and every copy they are able to obtain! Nothing you can do now will undo the damage you have done. Just class yourself with the idiot who yells "Fire!!" in the crowded theatre, or "Atom Bomb!!!" when a paper bag breaks during subway rush hour. No words can begin to express my contempt for such a lack of intelligence. I defy you to print this, and let the readers judge!

John H. Cone, President,
ADvice, A unique and specialized Service for Advertisers
2327 Arthur Street,
Los Angeles 65, Calif.

Intermodulation

Sir:

In the January issue Sarser and Sprinkle, in their article on "The Musician's Amplifier Senior," refer to a statement of mine concerning the acceptability of IM distortion as high as 10 per cent when using frequencies of 400 and 4000 cps.

To avoid any possible implication that this value is acceptable for amplifiers, I would like to point out that the 10 per cent figure pertains only to disc reproduction, and then only when using frequencies of 400 and 4000 cps. It is also assumed that the amplifiers do not contribute appreciably to this value. As pointed out in another article ("Analysis by the two-frequency intermodulation method of tracing distortion encountered in phonograph reproduction," *RCA Review*, Vol. 10, No. 2, June 1949) a different distortion value will result for any change in IM frequencies. Personally, I like to have the IM distortion of the amplifiers that I use for recording and reproduction below 1 per cent whenever possible.

H. E. Roys,
Sound Engineering Section,
Engineering Products Dept.,
Radio Corporation of America,
Camden, N. J.

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The recording room at Indiana U. showing PRESTO disc recorders and reproducers, PRESTO rack mounted amplifiers and the famous PRESTO PT-900 portable tape recorder.

INDIANA UNIVERSITY AT BLOOMINGTON now has a professional-quality recording laboratory in continuous operation.

Made possible by pooling the resources and knowledge of the Department of Radio, School of Music and Audio-Visual Center, this new lab is the result of painstaking care in every detail of planning, purchasing and construction.

PRESTO was selected as the equipment best suited to the quality and budget requirements. The basic machines are Model 8-DG disc recorders, installed with a specially designed relay control system and operational status lights on each unit. These are supplemented by an 8-D disc recorder, a PT-900 portable tape recorder for studio and on-location use, and a rack containing two 41-A limiting amplifiers and two 92-A recording amplifiers.

The selection of PRESTO equipment was preceded by a study of the facilities of established commercial recording studios, contacting other Universities with similar programs and visiting the Library of Congress recording laboratory. The continuous use of the equipment these past months verifies this selection.

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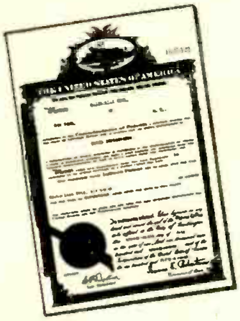


AUDIO PATENTS

RICHARD H. DORF*

WHILE TRACKING ERROR in phonograph pickups is hardly to be considered one of the major causes of distortion in playback, it is a minor source, especially with short arms. Most of us tend to think of it as just one of those unavoidable things that probably could be eliminated only by some contraption resembling a recording lathe.

Archie E. Coppleman of Los Angeles presents the solution to tracking error in a patent of the typical "Why didn't *I* think of that?" kind, No. 2,522,997. The basic thinking behind the invention is illustrated in *Fig.* 1. Instead of a rigid arm, the assembly might consist of two rods, connected at the outer end to a pickup mount and at the inner to a plate. All four connections are rotatable in the horizontal plane. The rear plate is hinged for vertical movement to a support block which is fixed to the wood or metal baseplate of the entire record-player assembly.

Now, as any lever mechanic will tell you, if you move the pickup mount across the disc toward the center, the mount will remain in the same angular position with respect to the starting point. In *Fig.* 1 we have shown it at the start (solid lines) perpendicular to a diameter of the disc, for perfect tracking. At the inner position (dashed lines) it is still perpendicular to that same diameter line A-A′. The rub, so far, is that it has moved rearward; if a new diameter is drawn through the new pickup position (line B-B′) we can see that tracking is very poor.

The inventor's answer to this dilemma appears in *Fig.* 2. A third rod has been added in the center, and this is connected at the outer end to a short shaft which supports the pickup. The rod is held in a yoke which is the termination of the two rods of *Fig.* 1. The short shaft is free to move to some extent lengthwise but is prevented

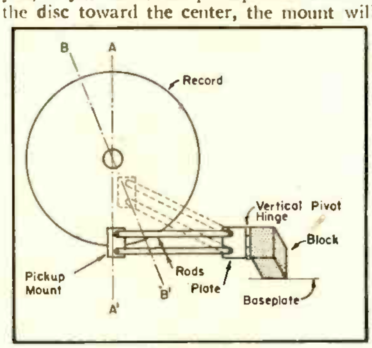


Figure 1

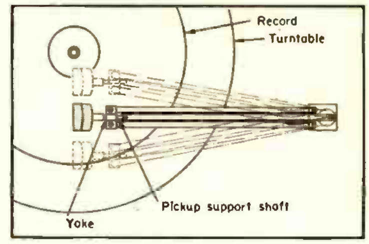


Figure 2

*Audio Consultant, 255 West 34th Street, New York, N. Y.

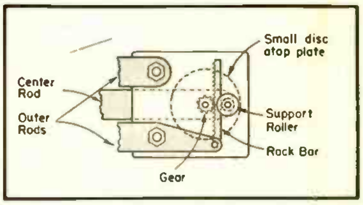


Figure 3

from circular movement so that the pickup will not turn over on its back.

At the rear of the pickup, the two outer rods operate just as they did in *Fig.* 1. *Figure* 3, however, an underneath view of the rear support plate, shows that the inner rod also drives a toothed rack bar back and forth. The rear of the rack bar is held in place by a small support roller and the toothed front drives a small gear. The gear is attached to a short shaft which goes through the plate and turns a small disc on its upper side. As *Fig.* 4 shows (this is a sketchy drawing of the top of the support plate), the new center rod is connected to a pivot on the outer area of the small disc.

Now for the sequence of events. At the beginning (solid lines in *Fig.* 2) the assembly is entirely straight and the pickup is on the center of the recorded area. If it

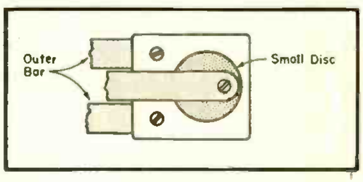


Figure 4

is placed nearer the inner diameter of the disc, the outer rods keep the pickup's relative angle the same, as in *Fig.* 1. But in addition, the little disc atop the rear support plate is turned by the rack bar and gear, and the center rod, which is eccentrically pivoted to the little disc, goes forward. This pushes the pickup outward, having the effect of making the entire assembly longer and putting the pickup on the same diameter line (such as A-A′ in *Fig.* 1) as it was when it started. And the result is perfect tracking. Similarly, if the pickup is placed at the outside of the record, the outer rods do their work the same way, and again the center rod pushes the pickup outward to take its correct position.

The idea here seems quite ingenious and shouldn't be difficult to manufacture—though, as you have probably noticed—it isn't easy to explain. If it could be made cheaply enough, but with good enough bearings and without bad mechanical resonances, a pickup like this might well give us at least some improvement in reproduction and record wear—and would undoubtedly give some manufacturer a wonderful promotion angle.

TECHNICANA

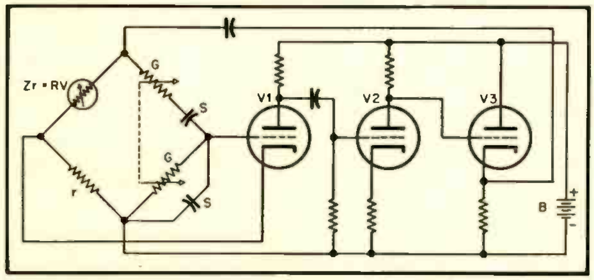


Fig. 1. The basic Wien bridge circuit used with its associated amplifier and cathode follower.

The design of a new magnetic record-reproduce head is the subject of an article by M. Rettinger in the J. Soc. Mot. Pic. Telev. Engrs., October 1950.

The equation for the inductance of the head is given and the manner in which the inductance decreases with increasing thickness of both front and back gap spacers is plotted. The stacking factor for various lamination thicknesses is plotted and discussed as is gap leakage for various front gap spacers. The insertion of a back gap in the recording head is shown to be of importance because of a "shearing" of the hysterisis curve and the attendant reduction in d.c. magnetization. Also discussed is the variation in output of the head used for reproducing as the back gap is varied, as the ratio of front and rear gap are varied, and as the face (front-gap thickness) is worn by use. By the use of the material presented a head has been designed with a width of 0.200 inches that may be used for both recording and reproducing and when used with film running at 18 in./sec. has a response from 30-18,000 cps. The test bias current was 68 kc. with only 0.016 ma required, while the recording signal current was 2 ma. The output from a fully modulated track is 2 mv.

Physically the new head, known as the MI-10795 record-reproduce head, is only ⅞ in. in diameter and mounts with a single stud. It is housed in a mumetal shell which consists of two halves telescoped together, with the core supported by and embedded in plastic. This type of construction reduces microphonics and the small size minimizes hum pickup.

Stable Oscillator

The use of a Wien bridge to control the frequency of oscillation in audio oscillators is not new. However the bulky components and poor mechanical stability have frequently made other audio oscillators more desirable for applications requiring a high degree of frequency stability. Mr. C. H. Young in the *Bell Laboratory Record* describes "A Precise Decade Oscillator" based on the Wien bridge as the controlling element. The usual formula for the balance frequency in the Wien bridge circuit, *Fig.* 1, as given in any textbook is

$$f = \frac{1}{2\pi RC}$$

However this expression may be rewritten in terms of conductance, *G*, and elastance, *S*, which give for the balance frequency

$$f = \frac{1}{2\pi} (GS)$$

The usual designs have varied *S*, which requires the use of a large bulky capacitor with its attendant mechanical instability. If instead the conductance is varied in

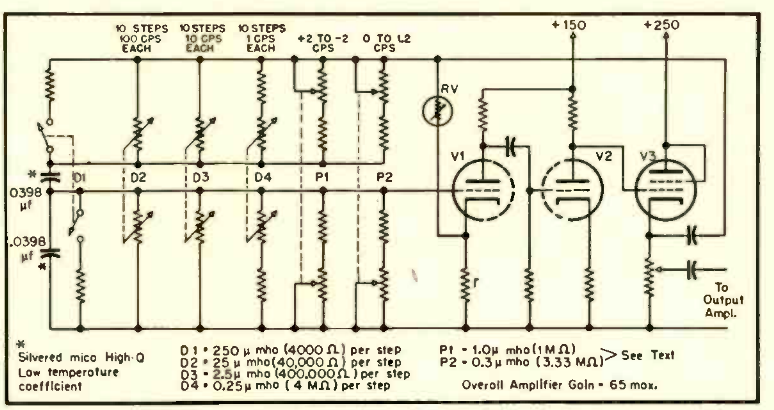
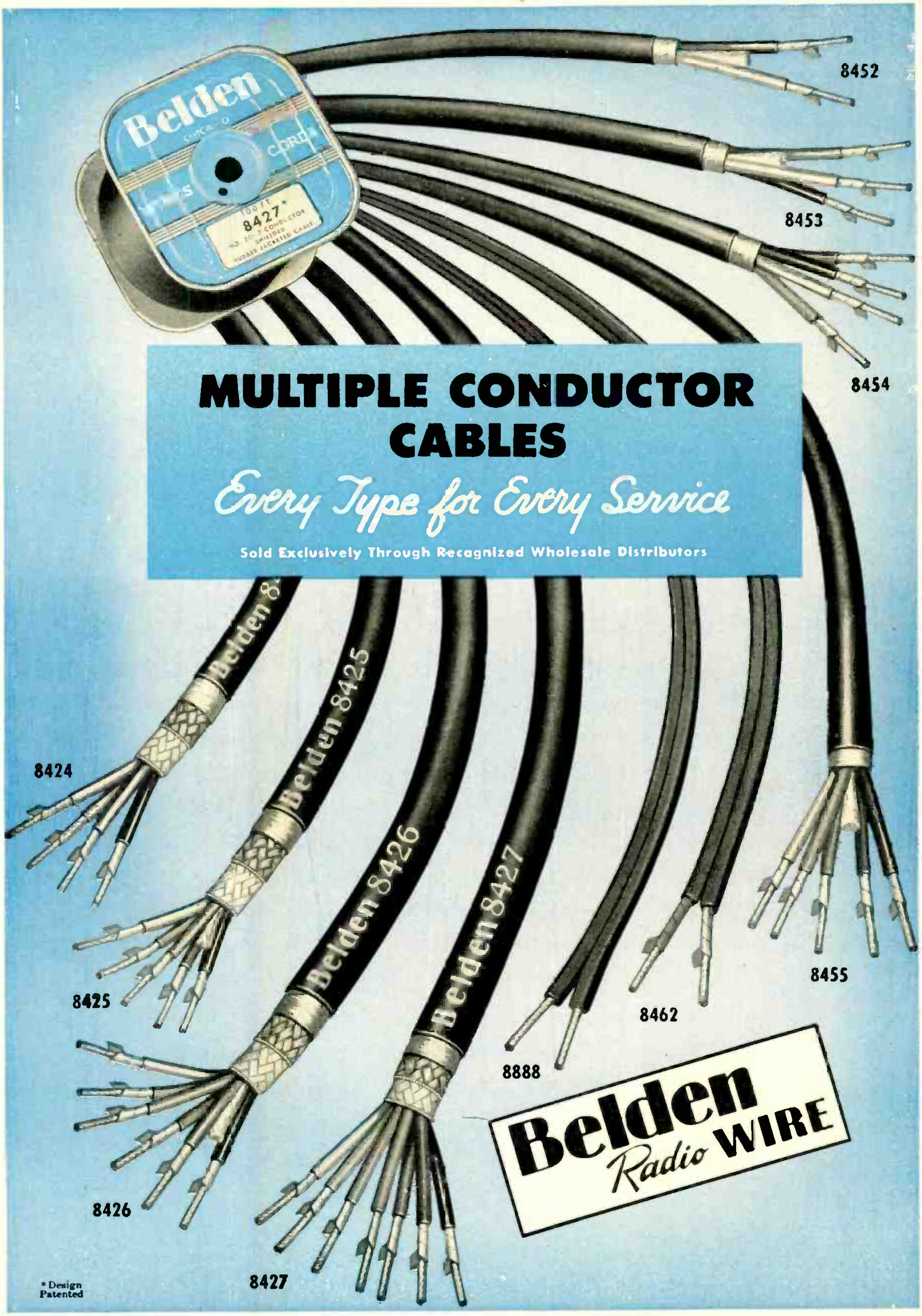


Fig. 2. The oscillator with the arrangement of each decade and the values per step. The bridge arm r is now shown in the cathode of first amplifier and the other arms have been rearranged for convenience in illustration.



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decade conductance switches we have a new solution to the problem, and have eliminated the major difficulty of the system. The effect of the introduction of large variations in impedance and phase angle is overcome in large part by making the source impedance very small as compared to the minimum bridge impedance.

A thermistor (labeled RV) is used in one bridge arm to maintain the bride close to balance while the two-stage amplifier supplies the maximum gain permissible if noise and switching transient problems and component stability problems are to be avoided. Ordinary two deck wafer switches are used in the construction of the decades.

The frequency range of the instrument with the values as shown in *Fig. 2* is from 100 to 2212 cps. This range was one desired by the group developing the instrument, and can be extended with an appropriate choice of G and S.

With precision wirewound resistors used throughout, the accuracy of the oscillator after warmup is ±(0.02±0.02 cps). If one of the continuously variable dials is used as a calibration control and the oscillator set to frequency by comparison with a standard, the remaining dial readings may then be approached with an accuracy of 0.01 cps. This, of course, holds over a small range of the order of ±5 cps. It can thus be used as an interpolation device when used in conjunction with calibrated standards.

The oscillator is followed by a phase inverter and push-pull feedback amplifier which is transformer coupled to the load. The maximum output is about one watt with less than 0.5 per cent harmonic distortion. The potentiometer in the two continuous adjustment positions are 10,000 ohms each and the remaining resistance is fixed. If accuracy is to be maintained all values should be held to a close tolerance.

Portable Mixer

An article in *RCA Review* for September 1950 describes a portable three-position mixer and field amplifier. This unit, described by J. L. Hathaway and Ralph C. Kennedy, operates on batteries and fits conveniently into a briefcase, but has most of the important features of a studio mixer-amplifier.

Three subminiature non-microphonic tubes in low-level preamplifiers feed high-level mixers and a master gain control. A second stage feeds a push-pull transformer, coupling to a pair of AAGC-controlled miniature driver tubes. These in turn are resistance coupled to the 1S4 output tubes which deliver at maximum +18 dbm in the band 100 to 4000 cps with only 2 per cent distortion. This provides an additional 10 db over the normal telephone line requirement of +8 dbm.

A built-in phase shift oscillator provides four frequencies for line equalization. A VU meter is included on the panel for use both with the oscillator in line equalization and for monitoring. It is also arranged to check the self-contained batteries.

The brief case is designed to carry the amplifier, together with three KB-2C microphones, a headset, spare batteries, and spare tubes without crowding.

It plays—45's, 33⅓ fine-grooves', 33⅓ standards', 78 standards'

The All-New RCA Pick-up and Tone Arm installed on a 70-D turntable.

HIGH-FIDELITY PICK-UP... *one arm, all speeds!*

RCA's All-New Tone Arm—with magnetic lateral plug-in heads—fits all standard turntables. Only two heads are needed for all speeds.

This versatile pick-up and tone arm combination . . . installed on your turntable . . . can play every record and transcription in your library. *Just plug in the head for the right record groove—and spin the platter.* It's as easy as that.

Designed for studio-quality at all standard speeds, this unique system has outstanding features over previous types. For instance, plug-in magnetic heads need no adjustments for stylus pressure. Visibility of the stylus (from the top of the head) permits accurate groove-spotting.

Anti-friction pivots and low inertia provide easy tracking on eccentric and warped records. Lower weight assures better record service—longer stylus life. Tracking error of the arm is less than 4 degrees.

Arm assembly MI-11885 is complete with tone arm, mounting plate, hardware, and the filter modification kit MI-11874 (for 70-series turntables).

You use plug-in head MI-11874-4 with the 1-mil stylus for fine-groove records. You use plug-in head MI-11874-5 with the 2½-mil stylus for standard transcriptions and 78 rpm records.

Order from your RCA Broadcast Sales Engineer, or direct from Dept. O-7, RCA Engineering Products, Camden, New Jersey.

AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

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EDITOR'S REPORT

AN EXPLANATION

MINOR CHANGES in the physical appearance of AUDIO ENGINEERING may be noticed by readers beginning with this issue. For example, the manner of binding is changed so that the magazine is held together by staples directly through the center, rather than through the sides as heretofore. In technical terms, the magazine is now saddle-wired instead of side-wired. In addition to offering a slight economy in preparing each issue, the magazine will lie open at any desired place more readily.

Text pages are now being set with slightly less leading between the lines in order to permit more words per page, so that while the total number of pages may remain the same, there will be more editorial material than heretofore; or, conversely, the same amount of editorial material can be squeezed into a smaller number of pages. The saving in space is actually eleven per cent. To compensate contributors for this change, rates for articles have been increased by twelve per cent—not with any idea of being generous with an extra one per cent, but to make the rate per page come out at an even number of dollars. Thus, in spite of more words per page, contributors will still receive the same rate per word, with a slight advantage due to the space occupied by photos and drawings. Contributors are not to take a cut to accommodate these economies.

By this time it is obvious that we are leading up to an explanation of the reasons for these steps. It is no news to any of Æ's readers that costs are continually increasing—paper, typesetting, printing, every element which goes into the making of a magazine. The obvious cure would be to increase advertising rates—which has already been done. However, due to long-term contracts for space, the increase in revenue is not felt for nearly a year after a rate increase goes into effect. So far, it has been possible to make both ends meet without a boost of subscription rates, which again would not provide any immediate increase in revenue. A rise in second-class postage rates—which seems imminent—would have to be passed on to subscribers by an increase in rates on new subscriptions.

It may not be common practice to discuss the business of publishing with a magazine's readers, but—as we have observed before—Æ's readers are different. They look upon Æ as *their* magazine; they are in a sort of partnership with us in getting these pages out every month.

THE CANBY SHOW

Plagued by production problems, the embargo on mail and express shipments, and a host of unanticipated delays, the Edward Tatnall Canby show has gotten off to a slow start, but is gradually picking up momentum. This is the first mention of the program in Æ, but the original announcement which was mailed to broadcast stations just in time to join in the Christmas rush described the series as consisting of about half and half musical illustration and informal comment. Those readers who hear Mr. Canby regularly over WNYC, New York's municipal station, can readily imagine just what the program is like. Those who have never heard him are assured that this new transcribed show is much like his column in the magazine. He talks about records, illustrates his points with comparisons from different new records—phonomontages, he calls these comparisons—and introduces each week several of the outstanding new releases in the field of serious music.

This new electrical transcription series, produced by Æ, has already been booked by a number of stations, and days and times of the broadcasts will be listed next month. In the meantime, look for announcements of this program or ask your local station about it. The platters are now coming off the assembly line once each week, and distribution is improving.

This may appear to be a strange venture for a magazine, but Mr. Canby's followers are myriad, and they will welcome the opportunity to hear his weekly program in addition to reading his monthly column with the latest news about records.

THE I R E SHOW

Another kind of show—coincidental with and part of the convention of the Institute of Radio Engineers—will hit the boards in New York on March 19 and last for four days. As usual, everything new in radio will be shown, and thousands of visitors will drag their weary feet through the three floors of exhibits at Grand Central Palace. Some rest for the feet may be achieved by attending the technical sessions—with Thursday March 22 being billed as "Audio Day." Morning and afternoon sessions devoted to audio will be held in the Blue Hall on the third floor adjacent to Audio Center, where most of the audio exhibits will be.

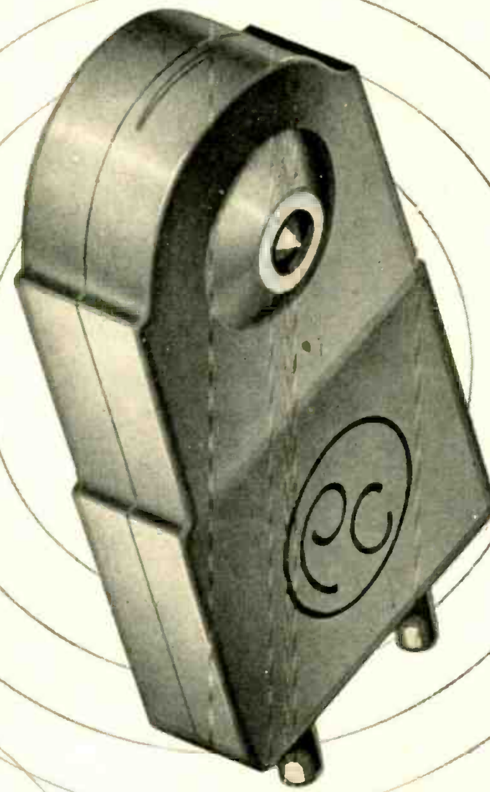
See you there?

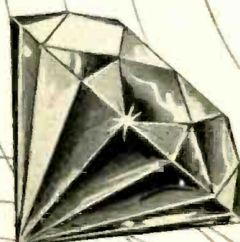
PICKERING

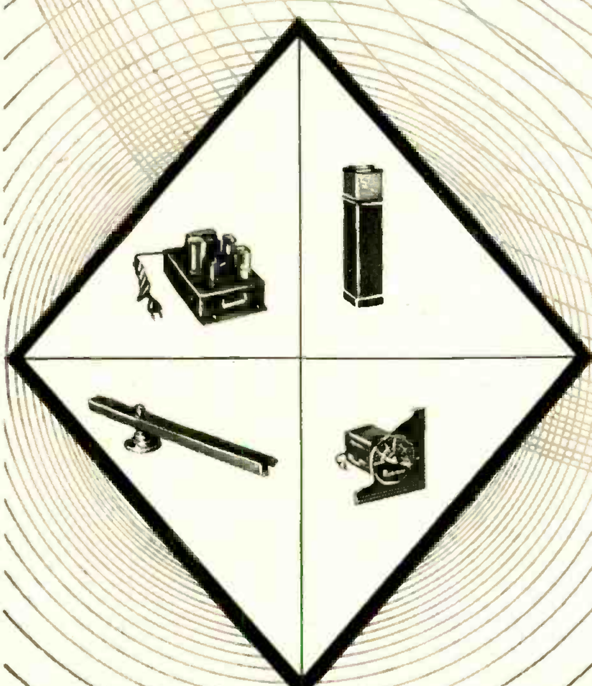
diamond stylus pickups

ACKNOWLEDGED BY ENGINEERS AS THE FINEST AVAILABLE!

- The superiority of diamond styli to styli of other materials has been thoroughly established.
- Exhaustive tests prove resistance to abrasion of diamond styli is many times greater than that of the next hardest material.
- Great resistance to abrasion means a minimum of record wear, longer record life and concert hall quality music all the time.







Pickering pickup cartridges, equipped with diamond styli, may cost more than cartridges with other stylus materials but the useful life of a diamond stylus cartridge is so much greater than is represented in the cost differential that from all practical viewpoints—length of service, listening pleasure, and record life — Pickering diamond stylus cartridges cost less.

The diamonds used in Pickering cartridges are whole diamonds, not splints. They are well cut, gem-polished to high accuracy and precisely mounted to ride free and smooth in the groove walls, recreating all the fine tones and modulations pressed into modern recordings.

The supremacy of Pickering Diamond Cartridges is unchallenged. They meet every exacting requirement of the most critical record playing enthusiast who insists upon the finest musical reproduction; who wants the realism and brilliance of a live performance and who is anxious to maintain the useful life of his record collection.

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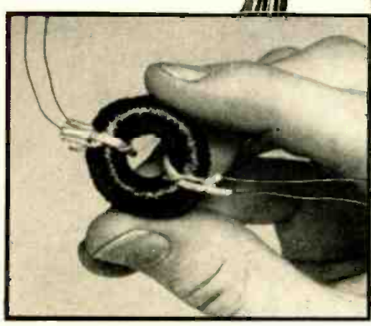
IT'S "LOADED" WITH BETTER TELEPHONE SERVICE



Twenty of the Bell System's newest small loading coils—like the one at the left—are housed in the long black case, mounted in a cable splice. This type of installation permits the economical extension of city cables to serve out-of-town subscribers.

MANY more wires can be crowded into a cable sheath when the wires are fine. But normally, wires don't transmit as well when they are fine and closely packed.

Bell engineers long ago learned to make wires do better work by loading them with inductance coils at regular intervals. The coils improve transmission and let messages travel farther. But originally the coils themselves were large, heavy and expensive. The cases to hold them were cumbersome and costly too.

So year after year Bell scientists squeezed the size out of coils. To make magnetic cores of high permeability they developed Permalloy. Tough but extra-thin insulation permitted more turns to a core.

New winding machines were developed by the Western Electric Company. Coil size shrunk to one-fiftieth. Some—like the one shown above—can be mounted right in cables themselves.

The 15,000,000 coils in the Bell System today mean thinner wires, more wires in a cable—more economical service for you. They demonstrate once more how Bell Telephone Laboratories work continually to add to your telephone's value.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST

Filter Design Simplified

BERTHOLD SHEFFIELD*

Part 1. Presenting a method for calculating the constants for low- and high-pass filters which eliminates the need for a large number of formulas.

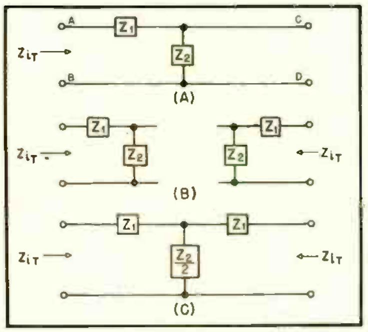


Fig. 1. (A) Half section. (B) Two half sections in proper position before combining into a T section. (C) Full T section consisting of the elements of (B).

FILTER DESIGN is considered part and parcel of the training of every full fledged communications engineer. It is therefore always regretted that the design formulas which were so painfully developed in theory classes are forgotten by the time they are needed in the field. Worse yet, the basic theory was only partially comprehended in many cases, and handbooks must be consulted with caution. It is the purpose of this article to remedy these defects and to reduce filter theory to an unforgettable simplicity. The reader will, at a moment's notice, be able to design filters of any category, including low- or high-pass, T or pi, constant k or m-derived types. Reference texts will not be required. Confusing new formulas will not have to be learned.

The basis for this simplification of filter design lies in the synthesis from half sections whose elements do not have the fractional magnitudes customarily assigned in conventional filter theory, i.e., the arms will be represented by the symbols Z_1 and Z_2, as shown in *Fig.* 1.

Two identical half sections are readily combined into a full T or Pi. By this device it will be found that in any half section the reactance X of either arm has the magnitude of the termination, R_o, at the cut off frequency, f_c, of the filter section; i.e. $X_L = X_C = R_o$. Brief theoretical considerations, as well as illustrations, will clarify the applications of these simple formulas.

In order to demonstrate the validity and value of this simplified method, it must be shown first that the image impedances obtained by half section theory are the same as if they were obtained from a full-section T or Pi. This is carried out for a T by comparing the image impedance in *Fig.* 1 (A) at terminals A-B of the half section with the image impedances of the full T section, *Fig.* 1 (C). The full T section is constructed by butting the shunt ends of the half sections as in *Fig.* 1 (B). The image impedance is defined by[1]

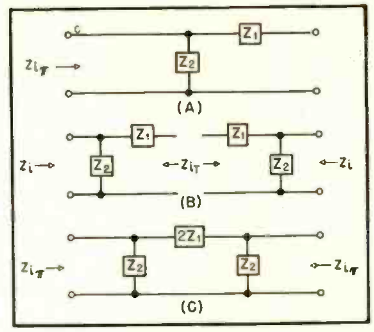


Fig. 2. (A) Half section. (B) Two half sections in proper position for combining into a Pi section. (C) Pi section consisting of elements of (B).

$$Z_i = \sqrt{Z_o Z_s} \qquad (1)$$

Where Z_o = Impedance at terminals A-B with terminals C-D open as shown in *Fig.* 1(A).

$\therefore\ Z_o = (Z_1 + Z_2)$

Z_s = Impedance at terminals A-B when terminals C-D are strapped together.

$\therefore\ Z_s = Z_1$

Substituting these values in formula (*1*) gives the image impedance

$$Z_i = \sqrt{(Z_1 + Z_2)\, Z_1}$$

This expression becomes more useful if it is written:

$$Z_i = \sqrt{\frac{Z_1 Z_2}{Z_2}(Z_1 + Z_2)}$$

$$= \sqrt{Z_1 Z_2 \left(1 + \frac{Z_1}{Z_2}\right)} \qquad (2)$$

$$= \sqrt{Z_1 Z_2}\sqrt{1 + \left(\frac{Z_1}{Z_2}\right)}$$

The image impedance for the full T of

[1] For a definition of image impedance see, for example, F. E. Terman, Radio Engineer's Handbook, p. 204.

* *RCA Institutes, Inc., 350 West 4th St., New York 14, N. Y.*
Note: The basic idea for this article was presented as part of a course on networks given by Mr. Albert Boggs at the Polytechnic Institute of Brooklyn in 1947. Permission has been granted to the writer to disclose this material.

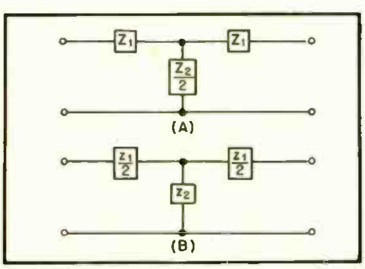


Fig. 3. (A) T section with elements as obtained using half-section theory, with large Z used to identify elements. (B) T section with conventional element values, using small z to identify elements.

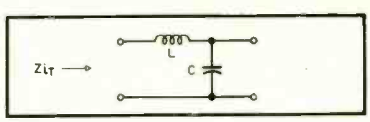


Fig. 4. Low-pass filter, constant-k type, half section.

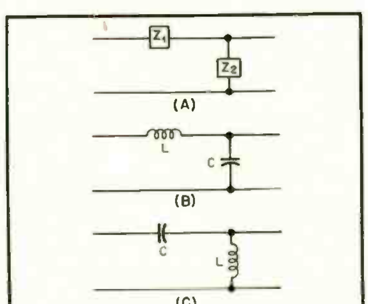


Fig. 5. (A) Basic half section. (B) Low-pass half section. (C) High-pass half section.

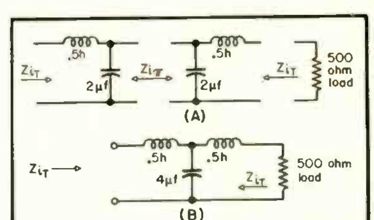


Fig. 6. (A) Low-pass half sections before connection as T filter. (B) Low-pass half sections of (A) arranged as T-type, low-pass, constant-k filter with cut-off at 159 cps.

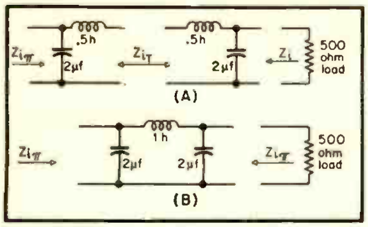


Fig. 7. (A) Low-pass half sections before connection as Pi filter. (B) Low-pass half sections of (A) arranged as Pi-type, low-pass, constant-k filter, with cut-off at 159 cps.

Fig. 1 (C) is obtained in the same manner, i.e.,

$$Z_{iT} = \sqrt{Z_0 Z_s}$$

$$= \sqrt{\left(Z_1 + \frac{Z_2}{2}\right)\left(Z_1 \frac{Z_1 \frac{Z_2}{2}}{Z_1 + \frac{Z_2}{2}}\right)}$$

$$= \sqrt{Z_1 Z_2}\sqrt{1 + \left(\frac{Z_1}{Z_2}\right)} \qquad (2a)$$

Comparison of expressions (*2*) and (*2a*) shows the equality of the image impedances of the full T of *Fig.* 1 (C) and of the half section of *Fig.* 1 (A) at the series end A-B.

In a similar manner one may prove that the half section of *Fig.* 2 (A) presents the same image impedance at shunt end terminals C-D as the Pi of *Fig.* 2 (B) and 2 (C). Its value for both cases is

$$Z_i = \sqrt{Z_0 Z_s}$$

$$= \frac{\sqrt{Z_1 Z_2}}{\sqrt{1 + \frac{Z_1}{Z_2}}}$$

It will be observed that the element

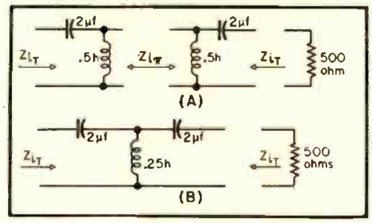


Fig. 8. (A) High-pass half sections before connection as a T filter. (B) High-pass half sections of (A) arranged as T-type, constant-k high-pass filter, with cut-off at 159 cps.

values of the T section of *Fig.* 1 (A) differ from the conventional T as treated in standard texts. To show that these two T sections are equivalent, it is necessary only to convert the respective element values. For example, the image impedance of the conventional T, *Fig.* 3 (B) is

$$z_{iT} = \sqrt{z_1 z_2 + \frac{(z_1)^2}{4}} \qquad (3)$$

This is converted to formula (*2*) for the modified T section by replacing the elements of the conventional T of *Fig.* 3 (B) with the elements of *Fig.* 3 (A), whereby

$$\frac{z_1}{2} = Z_1 \text{ or } z_1 = 2Z_2$$

$$z_2 = \frac{Z_2}{2}$$

Formula (*3*) then becomes

$$z_{iT} = \sqrt{(2Z_1)\left(\frac{Z_2}{2}\right) + \left(2\frac{Z_1}{4}\right)^2}$$

$$= \sqrt{Z_1 Z_2 + Z_1^2}$$

$$z_{iT} = \sqrt{Z_1 Z_2}\sqrt{1 + \frac{Z_1}{Z_2}} = Z_{iT}$$

This result is the same as formula (*2*),

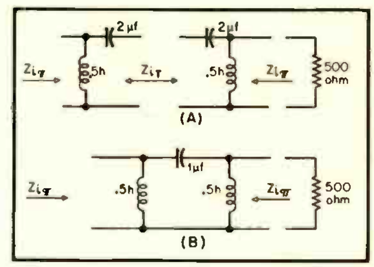


Fig. 9. (A) High-pass half sections before connection as a Pi filter. (B) High-pass half sections of (A) arranged as a Pi-type, constant-k high-pass filter with cut-off at 159 cps.

proving that the conventional T and the modified T produce identical results. The relations for the Pi sections are proved in a similar manner.

These considerations permit the application of formula (*2*) to low pass filter design, i.e. since

$$Z_{iT} = \sqrt{Z_1 Z_2}\sqrt{1 + \frac{Z_1}{Z_2}},$$

and in the low pass half section of *Fig.* 4

$$Z_1 = j\omega L, \text{ and}$$

$$Z_2 = 1/(j\omega C)$$

$$\therefore\ Z_{iT} = \sqrt{L/C}\,\sqrt{1 - \omega^2 LC} \qquad (4)$$

This formula shows immediately that the image impedance has a real value up to the frequency where $\omega^2 LC = 1$. For values of $\omega^2 LC$ greater than 1, Z_{iT} is imaginary. The term $\omega^2 LC = 1$ defines the resonant frequency, f_r, of the L and C elements of a half section.

Cut-off Frequency

Much confusion is caused for the newcomer by the meaning of cut-off frequency. Cut-off is defined as that frequency for which there is no output from an ideal dissipationless filter. If a filter is operated under ideal conditions, it must be terminated in its image impedance at every frequency in its operating range. That this is a physical impossibility is seen from equation (*4*), since Z_{iT} varies between $\sqrt{L/C}$ and zero as the frequency is swept from zero to cut off. At this latter frequency $\omega^2 LC = 1$, which is the series resonant frequency of the two arms of a half section. For a practical value of termina-

[*Continued on page 34*]

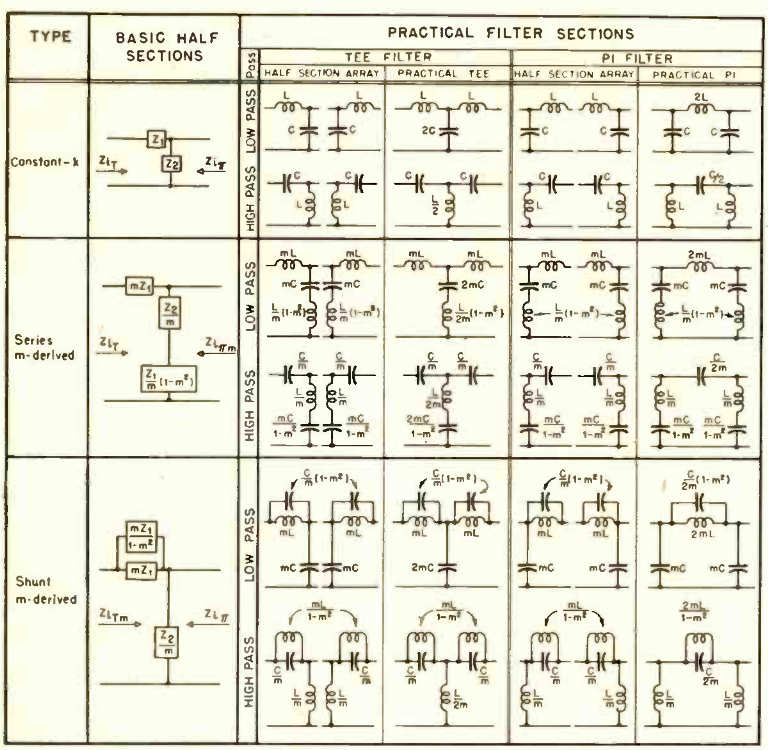


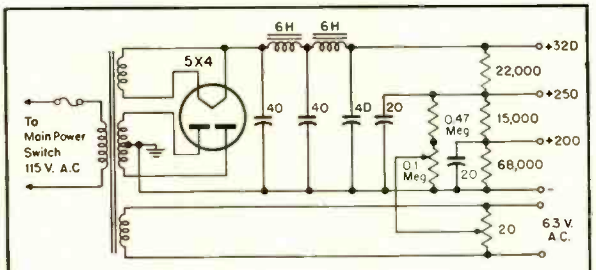
CHART I

Design formula: In any half section at cut-off frequency
$X_L = X_C = R_0$ = termination

Positive Feedback for A-F Curve Shaping

L. P. HANER*

Part 2. Describing a 15-watt power amplifier with unique high-fidelity characteristics for use in a home entertainment center.



PREAMPLIFIER SECTION POWER SUPPLY

BASS CONTROL (below 500 cps)

db. change per octave	CONNECTIONS					
	1	2	3	4	5	6
+ 7	J	I	A	B	NC	C
+ 5.6	K	NC	I	B	NC	C
+ 4.2	L	I	A	NC	NC	B
+ 2.8	M	NC	I	NC	NC	B
+ 1.4	N	I	NC	NC	NC	A
0	P	NC	NC	NC	NC	I
− 1	P	NC	NC	NC	I	D
− 2	P	NC	NC	NC	I	E
− 3	P	NC	NC	NC	I	F
− 4	P	NC	NC	NC	I	G
− 5	Q	NC	NC	NC	I	H

TREBLE CONTROL (above 500 cps)

db change per octave	CONNECTIONS					
	7	8	9	10	11	12
+ 5	R	Z	AA	BB	NC	CC
+ 4	S	NC	Z	BB	NC	CC
+ 3	T	Z	AA	NC	NC	BB
+ 2	U	NC	Z	NC	NC	BB
+ 1	V	Z	NC	NC	NC	AA
0	Y	NC	NC	NC	NC	Z
− 1.2	X	NC	NC	NC	Z	DD
− 2.4	X	NC	NC	NC	Z	EE
− 3.6	X	NC	NC	NC	Z	FF
− 4.8	X	NC	NC	NC	Z	GG
− 6	W	NC	NC	NC	Z	HH

Fig. 10. (Upper) Power supply for input amplifier. (Lower) Connections of circuit points to obtain indicated equalization. Numbers refer to switch arms, letters to contacts on switch decks.

THE PRE-AMPLIFIER shown in *Fig.* 8 is basically similar to the standard G-E pre-amplifier for its magnetic reluctance pickup. Two 6SF5's are used instead of the 6SC7. A 500-μμf capacitor is placed across the series resistor in the record turnover point correcting network to raise the high-frequency response. *Fig.* 6 gives a comparison of this pre-amplifier with the normal G-E pre-amplifier.

In the course of work settling upon a pre-amplifier design, several circuits were built. Among these were resistance-capacitance and resistance-inductance-capacitance input networks for providing the necessary 6 db per octave boost below the turnover frequency of records. One circuit involved a 3-step arrangement for different turnover frequencies. Another circuit used negative feedback with 3 steps for 350, 500 and 800 cps turnover frequencies. The best all around compromise seemed to be the circuit shown in *Fig.* 8, when used with the accompanying tone compensator.

Adjustable tone compensation is considered essential. The basic circuit utilized is supposed to provide a maximum of about 28 db boost or attenuation above and below 500 cps. Only about 20 db maximum boost or attenuation was obtained when this tone compensator was connected thru this positive feedback power amplifier as it was finally set. Two 11-point switches are used for the bass and treble controls. This provides 5 points on each side of normal and is set up to provide boost or attenuation rates as shown in Table III.

TABLE III

Bass Control		Treble Control	
+ 7	db per octave	+ 5	db per octave
+ 5.6	below 500 cps	+ 4	above 500 cps
+ 4.2	"	+ 3	
+ 2.8	"	+ 2	
+ 1.4	"	+ 1	
0	"	0	
− 1	"	− 1.2	
− 2	"	− 2.4	
− 3	"	− 3.6	
− 4	"	− 4.8	
− 5	"	− 6	

The basic circuit for the tone compensation was obtained from an article published in *Electronics*, Dec., 1948, entitled "Versatile Tone Control," by Wm. B. Lurie. With careful shielding of the switches and leads, excellent results have been obtained. A good feature of this system is that all compensating networks and switching takes place at low impedance, being in the output of a cathode follower. Signal level is kept up to a safe level by level-restoring amplifier stages properly located. Little hum and tube noise is, therefore, encountered in the output of the system.

Figure 4 shows the nature of the family of curves which are available with this tone control. *Figure* 9 shows the normal and maximum curves which

[*Continued on page 33*]

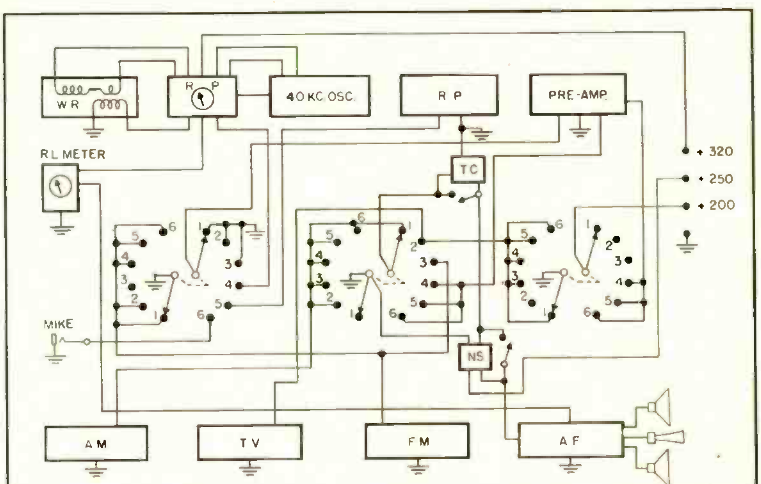


Fig. 11. Block diagram of system switching.

* *Wilmington, Delaware.*

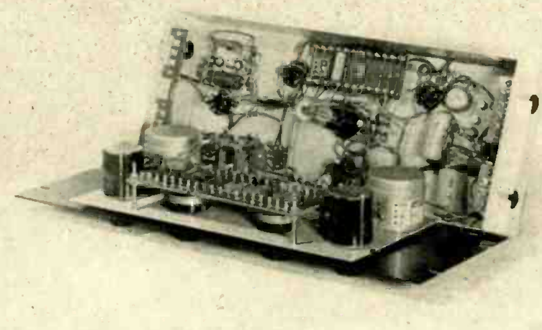


Fig. 1 (left). Fairchild Unit 627 equalizer which employs the circuits described. Fig. 2 (right). Internal appearance of variable equalizer chassis.

A Continuously Variable Equalizer

WENTWORTH D. FLING*

Electrical details of a non-passive equalizer which offers a wider range of frequency correction than is usually available

THE COMMUNICATIONS, BROADCASTING, and recording industries have been using equalizers for many, many years and they've been unhappy about it. Telephone lines have frequency losses which must be compensated for; dramatic programs require special effects; pre-emphasis for noise reduction and diameter loss compensation is necessary in record making, and frequency response must be adjustable for record playback. Every broadcaster and recordist is familiar with equalizers and their limitations in application.

Until recently, no genuine all-purpose equalizer has been available commercially. The nearest approach to versatility was an L-C resonant-circuit which could either boost or attenuate at both ends of the spectrum. One reason for the lack of equalization versatility has been the tendency among broadcasters to depend on passive circuits—those including only elements of L, C, and R, and not incorporating vacuum tubes.

Vacuum tubes with resistance-capacitance circuits are capable of producing wider and more flexible equalization effects. This is demonstrated by the new and interesting unit[1] diagrammed herein. It can produce roll-off or boost, or a combination of the two at both ends of the controllable range. The frequency at which the response curve begins to change is continuously variable at each end. Through separate controls for high- and low-frequency channels, a maximum boost of 16 db and a

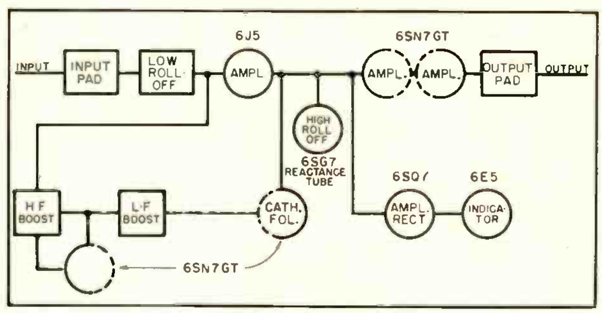


Fig. 4. Block diagram of variable equalizer.

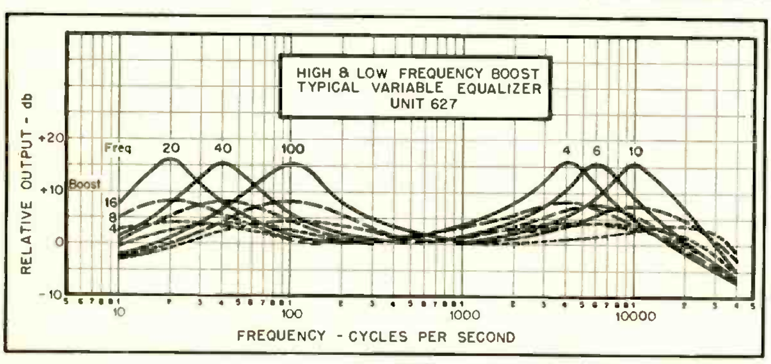


Fig. 3. Low- and high-frequency boost circuits provide response curves of this type, but frequency peak may be set at any intermediate value desired.

* *Vice-Pres. and Gen. Mgr., Fairchild Recording Equipment Corp., Whitestone, New York.*

[1] Fairchild Unit 627

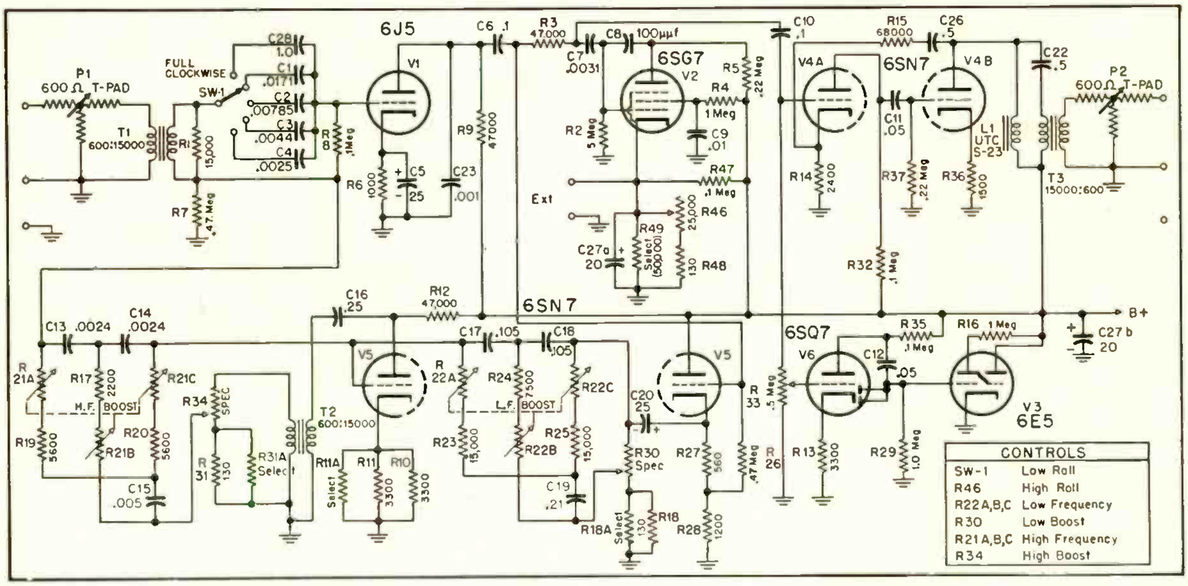


Fig. 5. Complete schematic of Fairchild Unit 627 Variable Equalizer.

maximum attenuation of 25 db at the equalization peak is available. The mid-frequency level can be held constant from input to output so that the unit causes no insertion loss whatever. As can be seen in *Fig.* 3. the boosts are comparable in steepness of slope to those obtained with passive L-C equalizers. The fact that the turnover frequencies are variable continuously rather than in steps represents a large additional operational advantage.

The unit contains six tubes and mounts on a standard 19-inch rack, taking up vertical space of 7 inches. Eight controls are on the panel. An indicator tube aids the operator in setting the input level at a point consistent with optimum distortion-less conditions. The completed continuously variable equalizer is pictured in *Figs.* 1 and 2, and the circuit is block-diagrammed in *Fig.* 4.

Circuit Description

A 600-ohm line is connected to the variable input pad and a line-level signal applied. A low-frequency roll-off circuit precedes the first stage. Between its plate and the following grid a 6SG7 reactance tube is in shunt with the signal to provide high-frequency roll-off. A variable attenuator enables the output level to be adjusted to provide operation as a zero gain device. The high- and low-frequency boosts are provided by a pair of parallel-T networks in a feedback loop around V_1 as seen in the schematic, *Fig.* 5.

Three input terminals are provided. though the unit is designed for unbalanced-line operation, to conform with good practice of carrying audio on two-conductor shielded line to minimize the danger of developing a hum loop. The secondary of the input transformer T_1 is loaded.

The transformer secondary is capacitance coupled to V_1. The coupling capacitor is not fixed, however, different values being selected with the LOW ROLL switch. With the 1-µf capacitor in use, transfer to the grid is nearly uniform down to below 2 cps (down 3 db at 1.6 cps), but each of the others causes a drop in low-frequency response. This is illustrated by the curves of *Fig.* 6.

[*Continued on page 29*]

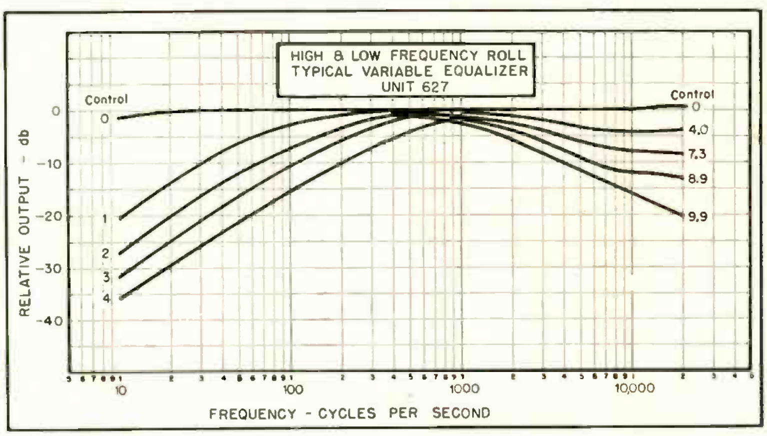


Fig. 6. Low- and high-frequency roll-off curves obtainable with the equalizer.

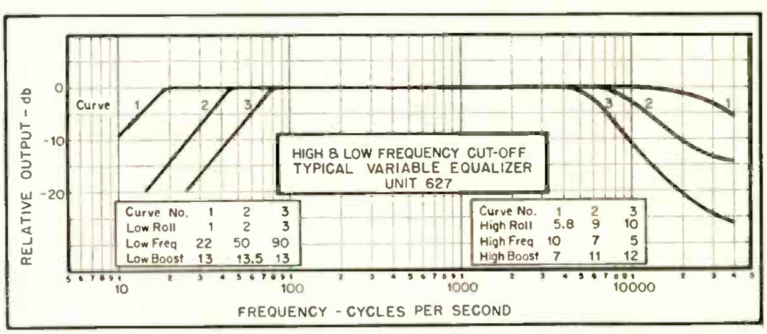


Fig. 7. By combining effects of roll-off and boost circuits, additional curve shapes may be obtained easily.

New Broadcast Lightweight Pickup and Tone Arm

L. J. ANDERSON* and C. R. JOHNSON*

A discussion of the effects of tone arm on the overall performance of a pickup designed for broadcast station use.

Fig. 1. New pickup and arm designed for playing both fine- and standard-groove records in broadcast station use.

The new lightweight pickup and tone arm (MI-11874 and MI-11885 respectively) have been designed to fill the need for a high-quality broadcast pickup combination for playing fine-groove records, both 33 1/3 and 45 r.p.m. The most popular application of this new design will be in combination with the present Universal Pickups for broadcast station installations with RCA 70-D Transcription Turntables, thus providing broadcasters with transcription pickup facilities for handling all three speeds—33 1/3 and 78 r.p.m. with standard groove, and 33 1/3 and 45 r.p.m. fine groove. Existing turntables are easily adapted, and present filters in these turntables may be utilized by a simple addition of a few small components such as resistors and capacitors.

Design Considerations

The introduction of fine-groove records made of relatively soft materials, coupled with a desire of the user for extended frequency range and lower distortion, has emphasized many of the problems inherent in the design of pickups and tone arms. Stylus pressures must be low to assure both long record and stylus life; since the fine-groove stylus diameter is about one-third that used for the 78-r.p.m. home records, the total force which may safely be applied to the stylus will be still further reduced. The fact that the stylus pressure must be low also makes it necessary that the mechanical impedance of the moving system of the pickup be low as viewed from the stylus tip. If it is not, the pickup will not track well and records will wear rapidly. On the other hand, the force must not be too low or the pickup will skip grooves when the turntable is subjected to mechanical excitation such as might be caused by building vibration.

A truly universal pickup is no longer possible without considerable compromise because the difference in groove dimensions between 78-r.p.m. records and fine-groove records is so great. A stylus which will play 78-r.p.m. records satisfactorily will ride the top edges of the cut on fine-groove records, and a pickup stylus specifically designed for fine-groove records will ride the bottom of the groove in the 78-r.p.m. records. Both conditions result in noisy reproduction and possibly poor tracking. It is, therefore, desirable that the pickup and arm—though designed to operate as a unit—be separable to the extent that for each type of record a pickup having the optimum stylus size be available.

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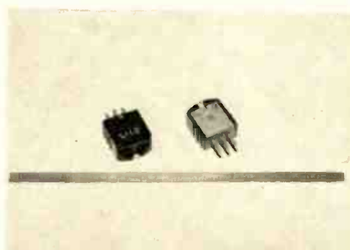


Fig. 2. Pickup heads compared to a standard steel scale to show their size.

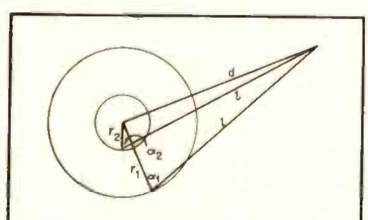


Fig. 3. Essential tone arm and disc dimensions.

The tone arm should have bearings with low coefficients of friction, and the inertia about both horizontal and vertical pivots should be low so that excessively large forces will not be applied to the stylus when wavy records or records with eccentric grooves are played. Care must also be taken to place tone-arm resonances below the audio range, but not in the range where the system may be excited by the wavy starting grooves which are present in some 78-r.p.m. records.

Figure 1 shows the complete pickup and arm mounted on a conventional broadcast turntable, along with the Universal Pickup. *Figure* 2 shows two views

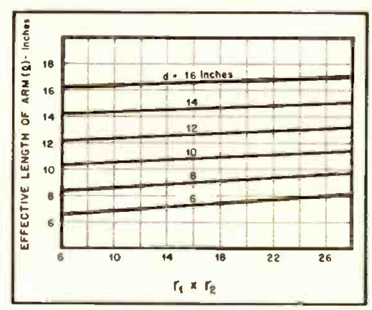


Fig. 4. Curves showing correct length of arm as a function of center distance and radii of records.

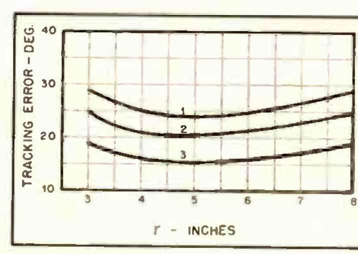
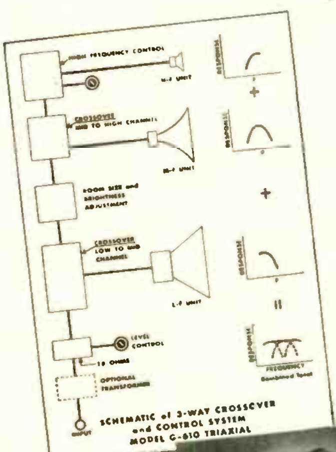


Fig. 5. Curves showing tracking error for a straight arm.

1) $d = 10$ in. and $l = 11.0$ in. 2) $d = 12$ in. and $l = 12.8$ in. 3) $d = 16$ in. and $l = 16.7$ in. $r_1 = 8$ in. and $r_2 = 2.5$ in. for all three conditions.

CUTAWAY VIEW

ADVANCED DESIGN FOR ULTRA HIGH FIDELITY



The Jensen G-610 is designed to achieve the highest possible quality of sound reproduction, and yet be a compact unitary assembly. This 3-channel system in one package has the widest frequency range and the lowest distortion available today. Typical of the advanced know-how in acoustics represented here are such features as very low crossover plus compactness, due to articulation of mid-channel horn with low-frequency diaphragm . . . the unique precision compression driver unit . . . built-in ruggedness and reliability combined with precision construction throughout. Write for data sheet 160.

Crossover and Control Network is a separate chassis unit, with plug-in connections for speaker and impedance-adjusting transformer (if needed).

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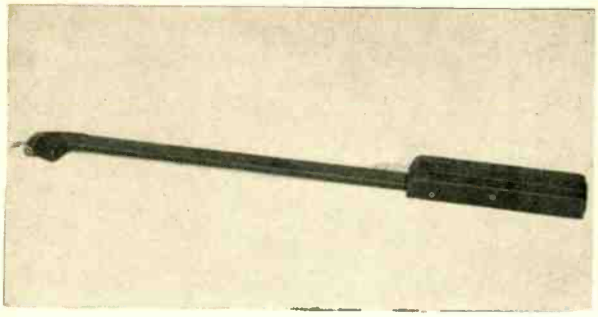
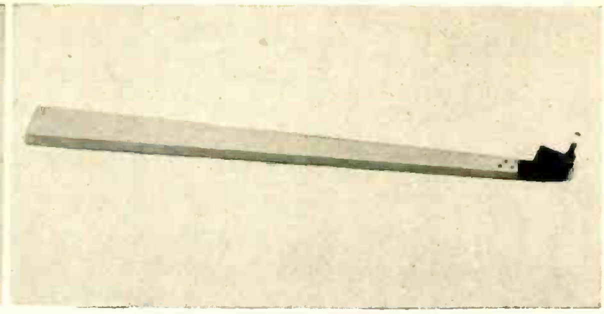

Fig. 6 (left). Experimental light-weight tone arm. Fig. 9 (right). Experimental arm of box section.

of the commercial version of the pickup, which is available with two stylus radii —1.0 and 2.5 mils—both of diamond to assure long life. A total force of 8 grams is required for the 1.0-mil stylus and 12 grams for the 2.5-mil stylus. The pickups may be interchanged readily, and the difference in the required stylus force is obtained by internally weighting the pickup which has the 2.5-mil stylus. No change in tone arm balance is required when the pickups are changed.

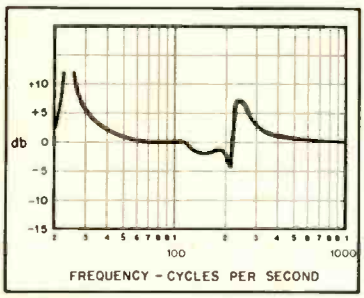

Fig. 7. Torsional resonance in tone arm.

Tone Arm Design

Although the design of the pickup itself is important if good quality and tracking are to be assured, this paper is principally concerned with the requirements of the tone-arm design. The arm used with the lightweight pickups is the result of a long series of experiments with arms of different types—arms which were spring balanced instead of counterweighted; in which ball bearings were extensively used; and in which the arm section was rigid and the pickup head pivoted—but all were discarded for one reason or another and the problem resolved itself into refining the design of the more or less conventional tone arm.

Tracking Error

Error in tracking occurs whenever the record radius through the stylus point does not coincide with the path along which the stylus is driven by the record modulation. The distortion introduced is a function of the wavelength of the recorded signal and becomes increasingly serious for high frequencies and the inner record grooves. The tracking error is a function of the effective tone-arm length, the distance from the center of the turntable to the vertical axis of rotation of the arm, and the position of the pickup on the record. The effective length of the arm is the distance from the stylus tip to the vertical axis of rotation for the arm.

Increasing the length of the arm will make decreasing values of tracking error possible. Since there are obvious physical limitations to the arm length, the expedient of turning the pickup at an angle to the arm is an excellent means of reducing the tracking error. The scheme is to so select the effective arm length and pivot position that the angle of error at the outside of the largest, and the inside of the smallest records to be played will be equal. The head is then offset by this angle and as a result the tracking error at the extremes will be zero, and as will be shown, the error at intermediate points is also small. *Figure* 3 shows the essential tone arm and disc dimensions.

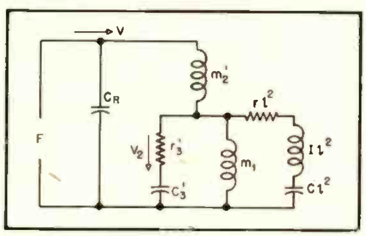

Fig. 8. Equivalent circuit of pickup and tone arm.

l = the distance from the stylus to the vertical axis of rotation for the arm.

D = the distance from the center of the turntable to the vertical axis of rotation for the arm.

r_1 *and* r_2 = the radii at which the tracking error is to be made equal for a straight arm.

β = tracking error $(90° - a)$.

From the cosine law for a triangle

$$\cos a_1 = \frac{r_1^2 + l^2 - D^2}{2 r_1 l} \qquad (1)$$

$$\cos a_2 = \frac{r_2^2 + l^2 - D^2}{2 r_2 l} \qquad (2)$$

If a_1 is then assumed to be equal to a_2, equations (*1*) and (*2*) may be solved for

$$l = \sqrt{D^2 - r_1 r_2} \qquad (3)$$

This function is plotted in *Fig.* 4 and the only restriction, for practical purposes, in the selection of D and l is that D should be larger than r_1.

When the proper arm length has been calculated or selected from the foregoing, the offset angle β to make the tracking error zero at both the inside and the outside of the record may be calculated from

$$\beta = (90° - a_1) \qquad (4)$$

$$\beta = 90° - \cos^{-1}\left[\frac{r_1^2 + l^2 - D^2}{2 r_1 l}\right] \qquad (5)$$

Figure 5 shows a plot of the above for several conditions. If the head is offset by the angle shown for the end points of the curves, the maximum tracking error will be the difference between the highest and lowest points. For the worst condition shown this is less than 5 deg.

The radius at which the deviation will be a maximum may be determined by:

$$\frac{d \cos a_1}{dr} = \frac{r^2 - l^2 + D^2}{2 r^2 l} \qquad (6)$$

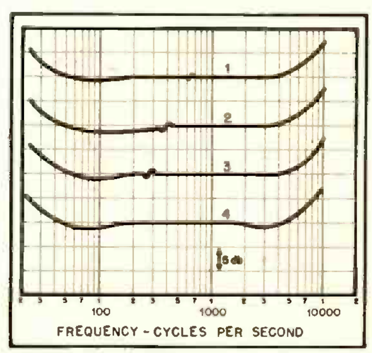

Fig. 10. Torsional resonance in experimental tone arms.

1) Tone arm with plate welded to bottom. 2) Tone arm with 1/8-in. wall. 3) Tone arm with 3/32-in. wall. 4) Final design.

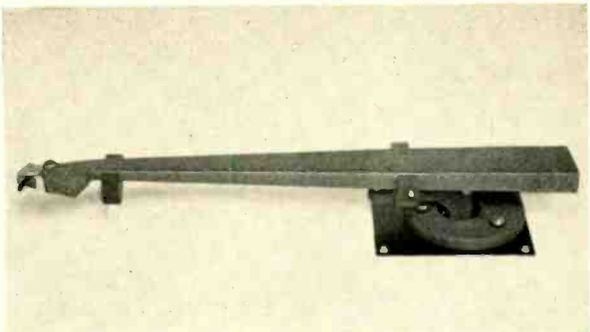

Fig. 11. Lightweight tone arm and pickup in final form.

$$r=\sqrt{l^2-D^2} \qquad (7)$$

The value a_s at this value of r will be:

$$a_s=\cos^{-1}\left[\frac{\sqrt{l^2-D^2}}{l}\right] \qquad (8)$$

The maximum tracking error which will result when the head is offset an angle β will be (a_t-a_s). The effective length chosen for the first experimental arms was 16.7 in., resulting in a maximum tracking error of 3° 40′.

Tone Arm Resonances

Test records having discrete frequency bands resulting in point-by-point data are generally not suitable for exploring tone-arm performance because of the sharpness of the arm resonances encountered. Therefore, continuous curves were taken on all tone arms by the following method: A disc record was cut from the output of a beat-frequency oscillator when the oscillator was driven through the frequency range by mechanical linkage to a continuous curve recorder. The testing then consisted simply of playing back the disc, using the arm and pickup under test, and recording the output on the curve recorder which was used to drive the oscillator when the disc was cut. The result is a continuous record of output vs. frequency. Final data were taken by the Variable Speed Turntable method for greater accuracy.[1]

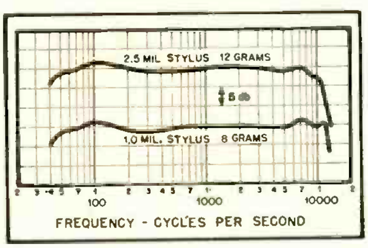

Fig. 12. Typical response of pickup, tone arm, and filter.

Figure 6 shows the first attempt at a lightweight tone arm and the response-frequency characteristic of this arm is shown in *Fig.* 7. This model employs an arm built of a box section of thin aluminum alloy in order to keep to a minimum the moment of inertia about the vertical and horizontal pivots. In addition to the usual resonance at about 25 cps, another disturbance takes place around 160 cps. This is due to a torsional resonance in the arm. The equivalent circuit and the responsible elements are shown in *Fig.* 8; rl^2, Il^2, and Cl^2 are respectively the torsional resistance, inertia, and compliance of the arm referred to the stylus tip. The remaining elements involved in the performance are: C_R, mechanical compliance of the

[*Continued on page 39*]

[1] H. E. Haynes and H. E. Roys, "A variable speed turntable and its use in the calibration of disk reproducing pickups. *Proc. IRE*, vol. 38, no. 3, March 1950.

AUDIO engineering society

Containing the Activities and Papers of the Society, and published monthly as a part of AUDIO ENGINEERING Magazine

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Loudspeaker Damping

ALBERT PREISMAN*

Part 1. A discussion of theoretical considerations of loudspeaker characteristics, together with a practical method of determining the constants of the unit as a preliminary step in obtaining satisfactory performance.

One of the considerations in the design and application of loudspeakers is the adequate damping of their motion. Thus, owing to the masses and compliances involved, the sudden application or removal of current in the voice coil tends to produce a transient oscillation of a damped sinusoidal nature.

In particular, the sudden cessation of current in the voice coil may find the loudspeaker continuing to vibrate in the manner described, so that the sound "hangs over". Any one who has experienced this unpleasant effect will seek ways and means to eliminate it.

In the case of a horn type loudspeaker, the horn imposes in general sufficient mechanical loading to damp out such transient response of "hangover", and also serves to limit the excursions of the voice coil so that it does not operate into the nonlinear portion of the air-gap magnetic field. The damping also serves to minimize nonlinear compliance of the suspension system by limiting the amplitude of oscillation.

However, if the horn design is limited by such considerations as maximum permissible mouth area and is operated at a frequency not too low to be transmitted by the horn taper yet low enough so that appreciable reflections occur at the mouth, then the horn may cease to act as a mechanical resistance, but instead become predominantly reactive, and thereupon cease to damp a resonance in the speaker unit occurring in this frequency range. In such an event other means of damping will be of value to the designer or applications engineer.

In the case of the direct-radiator loudspeaker unit, the air load is small, and is mainly reactive at the lower frequencies. Hence mechanical damping of the unit is small in magnitude, and "hangover" effects may be particularly noticeable.

A reflexed cabinet may help to load the loudspeaker, or at any rate to produce a two-mesh mechanical network exhibiting two resonance peaks, neither of which is as high as that of the unit by itself or in a flat baffle. Nevertheless. the damping may still not be sufficient to produce "clean" low-frequency tones.

Hence, in general, it is advisable or at least desirable to provide sufficient damping of the direct-radiator type of unit by means of its electrical characteristics, so that whether it is operated into a horn, reflexed cabinet, or simply a flat baffle, it will be adequately damped.

An important point about electrical damping is that it represents high rather than low efficiency of operation. just as a horn does. On the other hand. were some material such as viscaloid employed to provide the required damping, the electrical input power would in part at least be converted into heat energy in the material instead of into acoustic energy, and thus represent a decrease in efficiency. It will therefore be of interest to examine damping produced by the electrical characteristics of the system.

Capitol Radio Engineering Institute, Washington, D. C.

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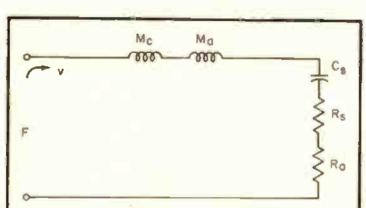

Fig. 1. Equivalent circuit of loudspeaker unit at low frequencies.

Motional Impedance

When an alternating current flows in a voice coil, it reacts with the constant magnetic field to produce an alternating force which causes the voice coil to vibrate at the frequency of the current. In so doing, the voice coil cuts through the magnetic lines, and generates a counter electromotive force, c.e.m.f.

The action is exactly similar to that of the rotating armature of a d.c. motor—the armature generates a c.e.m.f. by its rotation in the magnetic field. Consider the case of the loudspeaker voice coil. The electrical c.e.m.f. which is generated, tends to oppose the flow of current in the coil, just as if its impedance had gone up. After all, one ohm of impedance simply means a one volt drop in the unit for a one-ampere current flowing through it; i.e., volts per ampere. In the case of the loudspeaker, the force, and hence motion and c.e.m.f., are proportional to the voice coil current, so that a ratio is involved which is an apparent impedance.

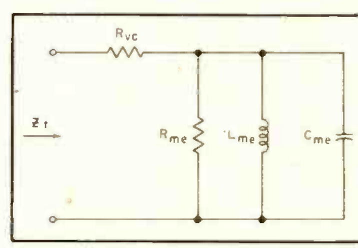

Fig. 2. Mechanical characteristics of speaker as seen from voice-coil terminals.

Hence, when a loudspeaker voice coil

is permitted to vibrate, its impedance apparently goes up. The increase in the impedance owing to its motion is known as the MOTIONAL IMPEDANCE, and it is measured in ohms just as the electrical impedance of the voice coil is measured in ohms.

Several characteristics of the motional impedance can be readily analyzed qualitatively. In the first place, the lower the mechanical impedance, the more readily does the voice coil vibrate, and the higher is the induced c.e.m.f. for a given current flowing through it; i.e., the higher is its motional impedance.

A second point to note is that the greater the magnetic flux density, the greater is the induced c.e.m.f., and the higher is the motional impedance of the voice coil. Finally, we note that if the total length of voice-coil wire is increased, there is more conductor cutting the magnetic field, and hence more c.e.m.f. induced. Therefore the motional impedance increases if the length of voice coil wire is increased.

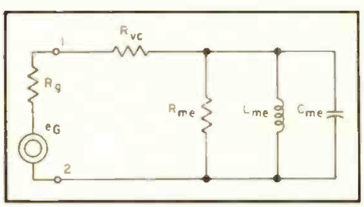

Fig. 3. Circuit of Fig. 2 with addition of generator.

The actual quantitative relations are as follows:

$$Z_{me} = \frac{(Bl)^2 \times 10^{-9}}{Z_m} \qquad (1)$$

where Z_{me} is the motional impedance in electrical ohms; B is the magnetic flux density in gauss; l = length of voice coil conductor in cm., and Z_m is the mechanical impedance in mechanical ohms (dynes/cm/sec.).

Loudspeaker Low-Frequency Resonance

The mechanical impedance Z_m of the loud speaker unit varies considerably over the frequency range. However, in a direct radiator its value and effect at the lowest audio frequencies is of greatest importance, particularly with regard to "hangover" effects, and hence will be analyzed at this point.

At the lowest audio frequencies, the loudspeaker unit acts mechanically as a simple series resonant circuit. This is illustrated in *Fig.* 1. The masses involved are those of the cone, M_c, and of the air set in motion by the cone M_a. The latter is a function of frequency, but can be assumed fairly constant over

[*Continued on page 37*]

EDWARD TATNALL CANBY*

How to Widen the Orchestra

PONDERING has continued apace, *chez* this department, on the further implications of the "Hole in the Wall" way of explaining our listener-reactions to reproduced music. (Æ for Oct.; this department, Jan. 1951.) It's inevitable, this pondering. Every person who listens to reproduced music for itself must form some conception, conscious or unconscious, of the sense of presence which his loudspeaker provides for him—he must mentally visualize, somehow or other, the actual existence of the music before his ears. And once one begins to think consciously about what one is or isn't visualizing, once a mental investigation *in medias res* gets underway (i.e., once we begin thinking about while it's actually happening), we are bound to discover that a conception such as that of an imagined hole in the living room wall through which the music enters is necessary. And useful, too, if one is curious as to an explanation of what is or isn't natural in sound reproduction. I'm *always* curious.

A considerable interchange of mail with an engineer correspondent from Vancouver, B.C. bears directly on this tantalizing business of imagined sound source—as one listens to reproduced music. Like many another engineer, this one had been working on the problem himself; he, too, had conceived of the hole in the wall independently (as no doubt have others of us in one way or another) and we had actually had some discussion of it before either of us ran into Mr. Voigt's article in the October Æ last fall.

Runt Orchestra

There's one significant addition, however, which the Vancouver hole-in-the-wall research makes to what has already been said, that widens the extent of the conception and hence its usefulness. Widen, quite literally—for that is exactly this engineer's argument.

How can one increase the seeming width of the apparent sound source, the orchestra or what-have-you, as imagined in space "behind" or on the other side of one's living room wall? For, as my friend Mr. Gordon points out, one must be able to imagine an orchestra *in its natural width* at whatever distance the recorded liveness suggests. If not, then the orchestra sounds pigmy or undersized, and the visual conception distorts the music. (If, as I suggested in January, high fidelity is faithfulness to the *imagined* original, then an imagined pigmy-sized runt-orchestra is clearly an inadequate mental image and so it is a distortion!)

Which prompts me to observe immediately that one can well think of the "hole in the wall" in another way: After all, one does not "hear" an actual hole in the wall; one hears sound which appears to be "behind" the wall. The "hole" is a purely intellectual rationalization—a common-sense explanation of the fact that one is apparently listening right straight through solid plaster and brick. There has to be a "hole." And so we imagine one.

Area of Binaural Tolerance

How, then, to widen the hole—how to make the sound source—the orchestra—seem as wide as it should be? My Vancouver correspondent has a most interesting hypothesis there which I'll take the liberty of paraphrasing, at my own risk, hoping to do it no injustice. With a point-source speaker the listener can, with his binaural sense of direction, attribute (imagine) the source only within *a very narrow angle*, an angle which includes the speaker cabinet and little more. The area of our two-eared listening tolerance—the angle of width plus the depth that we can imagine—is quite small. Any musical source that ought to sound *wider* than this included angle is distorted in the hearing. Made pigmy. This seems to me a very sound idea.

If one can increase the Area of Binaural Tolerence (i.e., imagine a larger *width* and so, combined with the imagined *depth*, a larger imagined *area*)—then one has a more natural imagined effect. This, as you will realize, is exactly what any system of reflection or other wide-source arrangement does; my "French doors" of January were

[*Continued on page 26*]

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

Pops

RUDO S. GLOBUS*

THIS MONTH'S COLUMN arises out of the pathos of a viciously distorted life, the extraordinary fulfillment of a creative life, and the stupidity inherent in the suicide of a whole aspect of our collective lives. There will be several points which emphatically repeat the conditions already stressed in this column; they are being stressed once more because of the repeated failure of a few members of our kind to accept the facts of life. My reviews this month are a necessary part of this piece, for they exemplify in a concrete way the dull, apathetic and mediocre way in which the recording industry has collaborated in *murdering* a thing of great beauty. The question will legitimately be asked as to why a piece such as this is included within the covers of a magazine directed toward those whose interests are classified under the broad category of "audio engineering." The answer is radically simple: nobody can make a recording, build instruments directed towards the reproduction of the recording, or analyze the efficiency and adequacy of "techniques" unless he is fully aware of the purpose behind his work. So sit tight . . . what follows will not make pretty reading.

The newspapers, wire services, syndicated columns and magazines carried a brief item this past month, noting the critical physical condition of one "Pee Wee" Russell. The circumstances surrounding the discovery of the noted jazz clarinetist were veiled in ambiguous and meaningless language. Found unconscious on a street in Los Angeles, Russell was removed to a hospital where the tall hulk of a body is being carefully preserved in a state called "life." Alcohol, malnutrition, and a few other choice causations are mentioned briefly. Numerous groups of the jazz faithful have organized various local benefits to supply an ingredient called "money" to assist the various wonder

[*Continued on page 39*]

** 15 Palm Lane, Westbury, N. Y.*

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* refer to August issue cover

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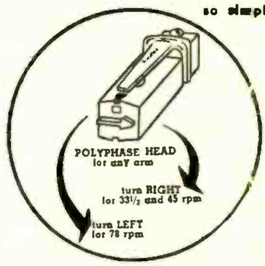

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RECORD REVUE

[from page 24]

another way of saying that I had achieved a larger imagined area "behind" my wall.

My Vancouver correspondent has gone so far as to put this theory of Area of Binaural Tolerance to the test in an actual working model, a reproducing system gets its wider area in a manner that is well worth a moment of thought. (The basic idea has been suggested to me several times, but this correspondent has developed a complete system and has got full protection on it already.)

Haphazard reflection along a wall, from a corner, or sound distribution via multiple openings in some of the new horn-loaded enclosures, or distribution from multiple speakers—these are ways of achieving the desirable wider sound source and the larger imagined original which is the thing we want. This particular system is different. The method, fully protected as I say, is simplicity itself.

The speaker, mounted rear-to-the-listener, operates directly into a concave reflector of particular dimensions determined experimentally. Simple laws place a virtual image of the speaker facing towards you, at a distance and considerably enlarged—right through an imaginary hole in the wall behind the reflector. The whole thing (bad pun) is a unit and has the virtue, obviously, of being independent of local room conditions.

As far as the ear is concerned, the speaker *is* on the other side of the wall and enlarged. It reproduces concert sounds, sending them back (apparently through the "hole," complete with liveness distance-effects that put the orchestra even further back in that nice, wide imagined area, the Area of Binaural Tolerance, which the "distant" speaker gives you. Ought to sound good, I'd say. A thought-provoking idea, anyhow.

NEW RECORDS

SUPER-MISCELLANEOUS

Twilight Concert; Program #2.
Columbia Symphony Orch. Rodzinski
Columbia LP: ML 4337

"Abram Chasins and Constance Keene"
(Brahms; Chasins) **Mercury LP: MG 10061**

A Promenade Concert.
London Symphony, Weldon
M-G-M LP: E-525 (10")

LP being what it is, (you can't put less than, let's say, 12 minutes on a 12" side or the customers grouse. . . .) the miscellaneous pot-pourri of items is becoming increasingly popular with the record companies. Package deal. The higher brows frown, but without much doubt these records offer the hi-fi man a highly convenient gathering-together of a lot of different music treated with a given recording technique, all on the one record. Good idea.

The first Twilight Concert struck me as one of the finest recordings Columbia had made to date. I don't have it at the moment for direct comparison; number 2 is a dilly also, but not exactly in the spectacular category. The recording is very live, with a rather soft, un-brassy quality that I find very pleasing.

But—here's the interesting question. Compare this with M-G-M's Promenade Concert. The M-G-M disc is the ultimate in an engineer's dream of brassy, sharp, clear-cut recording. With full NAB roll-off it remains brilliant, edgy, almost (but not quite) distorted. Sounds like a bit more pre-emphasis than the Columbia LP curve demands. On the other hand, in direct comparison, the Columbia Twilight disc, same conditions of playing, is distinctly duller in the highs and a *decrease* in the roll-off brings them out so that they are not unlike the M-G-M disc. Could it just possibly be that Columbia is quietly beginning to use somewhat less than the full official LP pre-emphasis in their recent recordings? I've been suspecting that possibility for some time, and if so, welcome it as a wise step. General engineering opinion will agree, most likely.

(But then again—it all may be an acoustical effect. Never can tell. Try these two for yourself.)

Musically the Twilight disc, conducted by Rodzinski, is on a high level of performance for such a venture. The M-G-M disc is average—acceptable playing but nothing super.

Strange that two-piano music records so well. The Mercury disc, Brahms on one side, some fairly serious and fluently, easily modern works by the pianist himself on the other, is a nice example of it. Only the high hiss level is to be deprecated.

Leroy Anderson, Classical Juke Box; Kabalevsky, The Comedians.
Boston Pops Orchestra, Fiedler.
RCA Victor LP: LM 1106

Some category—but Anderson's wonderful tomfoolery merits a separate listing of this disc. Froth, corn, but of the most delightful variety and highly musical to boot. The Jukebox number mixes "Music, Music, Music" with a most amazing assortment of ultra-familiar classics, the while imitating an elderly jukebox, complete with music starting several grooves in, nickels swooshing into slots and even a needle stuck in one groove! It remains to remark that technically in this disc and the Twilight Concert Columbia and RCA come closer together in recorded sound than I can ever remember. Same apparent pre-emphasis, too, as one listens—which is surely interesting.

★ ★ ★

RCA's new "Treasury" series, replacing the former Heritage records on 78, comes in 45 and LP and is an excellent idea. The first twelve discs are carefully processed re-issues of old Victor records as far back as 1904, grouped in convenient and reasonable categories—"Composers' Favorite Interpretations," "Caruso Sings Light Music," "Golden Duets," etc.

But most important facet of the enterprise is that it is not restricted to the old operatic acoustics; the first series gets up as far as the early 1930's (Lotte Lehmann in "Rosenkavalier") and RCA plans soon to bring out many notable electrical sets of the 30's and 40's in the 33-45 format. Fits the RCA situation perfectly, since at a time when numerous musically fabulous RCA recordings were appearing the technical end of the company was perhaps a wee bit backwards in comparison to competition; material from that era is not suitable for up-to-date LP and 45 quality standards as we all know—and yet musically the stuff is wholly satisfactory and indeed in enormous demand.

Doubtless other companies will begin soon to find ways and means of issuing the great recordings of the 1930's on LP; Decca, Vox and others have already made a stab at reissues, without, however, being entirely honest about the quality end. RCA, via its special label, is making the case absolutely clear, and it couldn't be a better case, for all music lovers.

Incidentally—here's one occasion when the issuance of both 45 and LP versions is well justified. On 45, the old records are are available singly as in the original (I hope, anyhow); on LP, they are conveniently bunched, patched when possible. The two forms are equally legitimate.

★ ★ ★

Where to turn next, what with hundreds of LP records to consider? Here's a brief cross section of items from some of the of the small LP companies whose output may not reach your notice. Some of the finest recordings of all comes from these small outfits—which seems to be typical of the Age of LP.

Mendelssohn, Symphony #1.
Stuttgart Philharmonic, Van Hoogstraten.
Renaissance LP: X-28

Hindemith, Concertmusic for Brass and Strings; Concertino for Horn and Orch.
Vienna Symphony, Haefner. Franz Koch, Horn.
Anon. Speaking Voice.
Period LP: SPLP 515

Two brilliant orchestral recordings. imported as usual from Europe via tape and pressed here, thereby avoiding the tenfold cost of musicians in this country. The early Mendelssohn symphony is overly long but surprisingly exciting even so; not very well rehearsed, by the sound of the playing. Beautiful recording, but strings are rather close, brass at a distance. The two Hindemith works are really superbly recorded, with better balance and liveness than the Mendelssohn above, a soft, undisturbed quality that still leaves excellent "edge" on the brass. Dissonant music, especially the Concertmusic, but of a satisfying sort. The horn recording is extraordinarily good—the horn being notably hard to capture. This is top rate recording. Don't jump when a woman's speaking voice suddenly enters!

Bruckner, Te Deum.
Chorus, Orch., soloist, Salzburg Festival, 1949.
Festival LP: FLP 101 (10")

J. C. Bach, Sinfonia Concertante in E flat; K.P.E. Bach, Sinfonia #1 and #3.
Vinenna Symphony, Guenther.
Bach Guild LP: BG 504

Two more taped imports. The Salzburg Bruckner is a huge work, with a huge recorded sound, ultra-hi-fi tape; soloists are too close (very realistic!), chorus and orch. in background—but still, it's an impressive sound. The music of the Bach sons, in what to most of us is a Mozart-Haydn style, is most welcome, and nicely recorded here. But watch for Westminster's duplication of the two K.P.E. Bach works, made with the same orchestra.

Handel, the Complete Water Music.
National Gallery Orch., (Wash. D. C.), Bales.
WCFM LP: #2

Dorothy Eustis plays Bach—Father and Son.
Artist LP: #501 (10")

Schubert, Three Violin Sonatas op. 137.

M. Mischakoff, vl. Erno Balogh, piano.
Lyrichord LP: LL 7

The little companies do what they can to record in this country—on a small scale, necessarily. The Handel is a long-overdue venture, bring the other fourteen movements of music to us in a rather wooden but presentable performance, nicely taped and LP'd. The Eustis Bach piano is one of those accidentally (?) natural recordings—sounds just like someone playing in her own living room; no studio effect nor concert stage either. The Schubert sonatas are wide-range, with fine liveness, but the violin is a bit close and edgy, the piano excellent in tone but a trace too much in background. This'll hold up to any big-company work nevertheless, and that easily, mark my words.

Small-company LP is a real challenge to the industry now, and those readers who live away from big cities and hear only the big-company stuff that's widely distributed in smaller towns had better keep their eyes and ears opened wide. If you have trouble in acquiring any of these—write Æ and we'll be glad to help you.

Tchaikowsky, Symphony #4.
Boston Symphony, Koussevitsky.
RCA Victor 45: WDM 1318 (5)

This work is a piece of high-intensity writing and is apt to get bleary and hysterical when a tired orchestra plays it for the hundredth time. Paradoxically, Koussevitsky's somewhat heavy touch and the comfortable resonance of traditional Boston Symphony Victor recording combine to keep things well in hand. The result isn't bad at all. I'd pick the Koussevitsky 4th (as I picked his 5th some years back) for all who like Tchaikovsky when he's quiet but distrust any kind of musical hysterics. An excellent 45.

Wagner, Siegfried, Act. 3, Scene 3.
Eileen Farrell, Set Svanholm; Rochester Philharmonic; Leinsdorf.
RCA Victor 45: WDM 1319 (5)

There hasn't been much Wagner hereabout lately. Biggest recent news was the reissue on LP of the several Traubel Wagner albums, originally issued on 78. This album adds a third speed to Wagner's power plant (I can't help it—whenever I listen to a *total* Wagner recording like this—the works—I get involved in power analogies!). Not top performers, as in some of the great Wagner recordings of the past; but these do a sincere and musical job with the difficult third scene. Svanholm is dramatically moving, but wobbles a bit to much for comfort, nor has he the steely brilliance of a Melchior. Farrell has a beautiful Wagnerian voice, her only difficulty being a lack of the superhuman breath capacity Wagner takes. Good orchestra, under Leinsdorf and the whole marvellously recorded.

EQUALIZER

[from page 17]

In the case of a signal applied across a series combination of resistance and capacitance with the output taken from across the resistance, the turnover frequency at which the response is down 3 db is that at which the capacitive reactance and the resistance are equal. Below that point there is some curvature, after which response drops off at a steady 6 db per octave. With the values selected for the LOW ROLL switch, the turnovers take place at approximately 100, 200, 350, and 600 cps for positions 2, 3, 4, and 5.

The plate of V_1 is coupled to one grid V_4, a dual triode operating with the two sections in cascade. A non-frequency-discriminating feedback is applied between the two stages to improve characteristics and stability. The output triode plate is loaded by an audio choke and coupled through a blocking capacitor to the output transformer and the output pad.

High-Frequency Roll-off

The high frequency roll-off is controlled by the reactance tube, V_2. When the tube is adjusted to plate-current cut-off, the circuit has no effect on the main audio line, with which it is in shunt.

As R_{46} is adjusted, however, and plate current begins to flow, the tube becomes active and the continuously variable roll-off characteristics shown in *Fig.* 6 are obtained. The figures on the curves indicate the settings of the roll-off control. Maximum attenuation of 16 db at 10,000 cps is possible with the circuit as it was designed.

The principal reason for using a tube for high-frequency roll-off may be seen by referring to *Fig.* 5. R_{47} and the series-parallel network of R_{46}, R_{48}, and R_{49}, make up a voltage divider across the B-supply. By adjusting R_{46}, the cathode may be made more or less positive, determining the plate current and the degree of roll-off. Note that between cathode and ground there are two terminals to which an external control may be connected.

One use for this feature is in diameter equalization for recording. The high-boost controls can first be adjusted to give the maximum emphasis required at the innermost diameter. A variable resistance with its slider mechanically linked to the cutting lathe is then set initially for small enough resistance so that, when connected to the EXT terminals, the roll-off will approximately cancel the boost. Then, as the cutterhead moves inward, the resistance automatically increases to lessen the roll-off and allow the net response to rise and compensate for the diameter loss.

Boost Circuits

The basis of the bass and treble boost circuits is the parallel-T network. It is is the equivalent of a Wien bridge and the values are calculated in the same manner for a null at any given frequency. An important difference is that one end of the generator and one end of the load may be connected to a common point, usually ground. The boost circuits are employed in a negative feedback loop around V_1.

In *Fig.* 5, the two sections of V_5, are used with the boost networks. The grid of one triode is fed signal from the output of V_1. The first section of V_5 is a cathode follower, loaded by a series combination of R_{30} and R_{18}. The latter has a resistor R_{18a} across it which is especially selected at the time of factory test to give, in combination with R_{18} the low-boost calibration.

The resistances of the "T" are variable on a ganged shaft so that the frequency of null can be shifted between 20 and 100 cps. The broadness and degree of the null are controlled by R_{30}. This control directly affects the voltage passing through the "T" by regulating the a.c. potential difference between the input and ground points. It has, however, no substantial effect on the over-all level of the signal, as would be the case if the more obvious method of grounding the vertical leg of the "T" and placing the input on the potentiometer arm were used.

The output of the low-frequency parallel-T is fed directly to the input of a similar network "tuned" to "resonate" or reject continuously between 4,000 and 10,000 cps, according to the settings of its three ganged variable resistors. The amplitude of the high-boost peak is controlled in the same manner as is the low-boost circuit. Here, the second section of V_5 is used to isolate the high- and low-boost controls. The transformer T_2 adds a 180-deg. phase shift to offset the phase inversion caused by the second section of V_5.

The curves of *Fig.* 3 show what frequency response can be obtained with typical settings of the low- and high-boost controls. Maximum peaks at either end of the range approximate 16 db.

Figure 7 indicates how fairly steep low-frequency cut-offs may be obtained. For curve 1, the LOW ROLL switch is in position 1 for a gradual roll-off beginning at 100 cps. In addition, however, the LOW FREQ and LOW BOOST controls are set to boost frequencies somewhat below 100 cps and so to offset the early part of the roll-off. When the roll-off is allowed to begin, the result of the net effects of the two, the steep slope at the lower end of the boost circuit's peak takes over and gives a cut-off effect.

Figure 7 also shows three examples of variations at the high frequencies. In curve 3, the HIGH ROLL control is set for a point near maximum roll-off. The HIGH FREQ control, however, is set for boost to offset the early roll-off. As a result, the effective frequency at which roll-off begins is shifted at will, and the operator has the valuable advantage of varying both the slope at the roll-off and the frequency at which it begins.

NEW PRODUCTS

• **Four-Position Mixer.** Flexibility of any audio system may be greatly expanded by means of the Audio-Mix, claimed by the manufacturer to meet the most exacting demands of multi-microphone recording on tape, wire or disc. Low in price and simple in operation, the Audio-Mix has ample gain for microphone and all types of

phonograph pickups. Built-in attenuators permits balancing of high- and low-output signal sources. Frequency response is 20–20,000 cps. Size of the Audio-Mix is 8 × 6 × 5 in. and weight is 4¼ lbs. For full technical description write direct to Pentron Corporation, 221 E. Cullerton St., Chicago 16, Ill.

• **D.C. Power Supplies.** Precision control of d.c. output is featured in a new series of general-purpose low-voltage power supplies recently introduced by Opad-Green Co., 71 Warren St., New York 7, N. Y. Available in ranges of 0–8, 0–12, and 0–28 vdc, all models in the new series have continuous output ratings of 10 amperes. Both d.c. voltage and current may be read directly on two 3-in. meters. The units are designed for operation from standard a.c. line voltage and bench space requirements are 8 × 16¾ in. Descriptive bulletin GPA1 will be mailed on request.

• **Attenuator Units.** Adding to its line of precision attenuators. Daven announces Model 650 r-f attenuation network, and Model 795 carrier-frequency decade attenuator. Model 650 is a moderately-priced

unit with zero insertion loss and flat frequency response from d.c. to 225 mc. Range is 100 db in 1-db steps. Operation is by means of push-button-type unit with conventional rotary-decade-type switches. Model 795 is a box-type unit with conventional rotary-decade-type switches. It permits extremely accurate measurements from d.c. to 200 kc. Switch stops prevent return from full to zero attenuation when adjustments are being made. The Daven Company, 191 Central Ave., Newark 4, N. J. will supply further information on request.

• **Noise-Suppressor Amplifier.** Although it represents many improvements over the original Model 210-A, the new Scott Model 210-B amplifier is announced at a considerably lower price. Specifications of the Model 210-B, as supplied by the manufacturer, are: Frequency response, virtually flat from 12 to 22,000 cps; harmonic distortion, less than 0.5 per cent at full 20-watt output; intermodulation, less than 0.1

per cent at full output; hum level, down 84 db. Included in the circuit is the Scott dynamic noise suppressor. Loudness control compensates for reduced sensitivity of the human ear to low frequencies at low levels. Pre-amplifier is operated entirely on d.c. and has 500-cps turnover frequency. Effective turnover frequency adjustable between 250 and 1000 cps by means of bass control. Descriptive bulletin may be obtained by writing direct to Herman Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.

• **Self-Locking Set Screw Demonstrator.** The improvement in holding power of set screws to be obtained by the use of the new Zip-Grip self-locking design is shown

conclusively by the use of the new demonstrator model just developed.

These set screws have a unique arrangement of thread which provides a definite "contra-thrust" action even though the screw is not set up against the shaft solidly. When augmented by the additional pressure of the screw against a shaft, Zip-Grip set screws do not loosen even under appreciable vibration, as shown by the demonstrator.

Engineers, purchasing agents, and manufacturing executives having vibration problems for which self-locking set screws or adjusting screws may prove the answer are invited to request a Zip-Grip Demonstrator, addressing the manufacturer—Set Screw & Mfg. Co., 342 Main Street, Bartlett, Ill.

• **High-Voltage TV Resistors.** Designed especially to withstand the high d.c., pulse and transient voltages encountered in TV power supplies, RPC Type T resistors are

of particular value in voltage doubler circuits and as bleeders. Available in 2- and 3-watt sizes with resistances ranging from one to ten megohms. Type T resistors are processed at high temperature to insure high stability with minimum effect due to aging and humidity. Resistance change due to either of these will not exceed two per cent. Manufacturer is Resistance Products Company, 714 Race St., Harrisburg, Penn.

• **Tape Recorder Kit.** A unique tape recorder kit is now being marketed by Judge Industries, 676/8 Romford Rd., London, E.12. As shown, the assembled unit attaches to a standard 78-r.p.m. turntable, the spindle serving as the shaft for the

tape supply reel and a takeup reel. The recording head is mounted adjacent to the turntable, and two idlers perform the dual function of maintaining tension and serving as guides. The arrangement provides for the use of existing turntables, requiring only the addition of a single dual-triode as the amplifier and oscillator. The kit also provides for the home construction of the recording head, and necessary parts are included.

• **New Tape Mechanism.** The Sonar model PTM tape mechanism employs the latest in electrical and mechanical design, and when combined with the Sonar PRA amplifier is said to provide a frequency response from 30 to 15,000 cps at a speed of 7½ in. per sec. This is comparable to most machines operating at 15 in. per sec.

The PTM employs three motors, and uses a magnetic clutch and braking sys-

tem which requires no mechanical adjustment. Separate heads are used for erase, record, and playback, permitting the choice of optimum head construction for each application. This unit will accommodate both RMA and NAB tape reels from 3 to 10½ inches in diameter. Fast forward and rewind time for 2500 feet of tape is 58 seconds.

The six-tube PRA amplifier has an illuminated VU meter, built-in loudspeaker, and monitor jacks. It provides for low-impedance microphone inputs, as well as bridging standard circuits; the output impedance is 600 ohms, at +8 dbm.

For complete information, write Sonar Radio Corp., 59 Myrtle Ave., Brooklyn 1, N. Y.

POSITIVE FEEDBACK

[*from page 15*]

may be used as the amplifier was finally adjusted.

This tone compensator makes it possible to compensate for unbalanced program source material. It also provides a means of adjusting for hearing characteristics. The curves in *Fig.* 1 provide an idea of the type and amount of compensation that is needed. It is interesting to note how the frequency-response curve obtained at the PREAMP INPUT, shown in *Fig.* 3, compares with CURVE-3 in *Fig.* 1. Apparently, some of this desirable basic characteristic is lost in actual playing, shown in *Fig. 7*. The adjustable tone compensator makes it possible to adjust this curve to produce the most natural sound for the particular volume level desired.

The charts in *Fig.* 10 provide the key to connections for wiring the compensator. All compensating network parts can be mounted on the 11-position 6-wafer rotary switches.

Dynamic Noise Suppressor

The system for dynamic noise suppression as originally developed by H. H. Scott has been studied with much interest by a large number of investigators. Several variations are possible. This circuit is a composite of several circuits that have been variously published. This one works as well as any that have one high-frequency gate and one low-frequency gate that have been heard by the author. However, this noise suppressor is seldom used and is only included here because it is built into the system and is therefore available for use. If this system were to be rebuilt or duplicated, the dynamic noise suppressor would be left out. Most new record material has a low scratch level that is much less objectionable than the losses incurred in the dynamic noise suppressor.

Two separate power supplies are used with this system. One, shown in *Fig.* 2, supplies filament and d-c voltages for the power amplifier. The other, shown in the upper section of *Fig.* 10, supplies power to the preamplifier section and the wire recorder oscillator.

Figure 11 is a block diagram with an interconnection switching schematic. A double-pole 6-position 3-wafer switch is used to select and interconnect the various units as desired.

Conclusion

The finished home entertainment center is shown in *Fig.* 12.

A General Electric 1201-D speaker (W_2) is located in the left section, and a 1939 Jensen extended-range 12-inch speaker (W_1) is located in the right section of the cabinet. A University tweeter (T) and a 5-inch television set speaker are located in the center section. The baffle extending across the cabinet is made up of a 1¾-inch laminate of Celotex. It is inclined to point upward at about a 30-degree angle. The back is covered by a sound absorbing curtain. This spacial arrangement of speaker results in a stereophonic effect that is pleasing. All who have heard it prefer the effect produced by the widely spaced speakers better than when a single woofer and tweeter are used.

An RCA 45-rpm changer is located in a bookcase nearby. Results from it compare favorably with the 45's played with the GE pickup.

At maximum gain, the hum through the power amplifier alone is inaudible. However, slight hum is experienced through the preamplifier section, especially when the magnetic reluctance pickup is connected.

Results from this system have been gratifying. Listening fatigue seems nonexistent. However, a super-critical attitude towards music sources has been developed. Record sources have improved greatly in the past year. Now, the hope is that radio material will likewise improve thru the use of more live-music programs, high-fidelity recorded tape material, and wider frequency range on chain transmission lines.

Acknowledgments

The basic idea for using positive feedback in an audio amplifier for high fidelity came from Frank H. Shepard, Jr., an electronics consultant, whose patents, filed in 1940 and 1942, suggest this application (see references). His advice and counsel over the whole period of amplifier development were of inestimable value both in the development of the amplifier and in judging the results from it.

R. T. Bozak, speaker engineer and manufacturer, also provided many helpful criticisms and suggestions and helped in listening and comparison tests.

PATENT REFERENCES

U. S. 2,313,096, "Reproduction of Sound Frequencies," F. H. Shepard, Jr.

U. S. 2,313,097, "System for Compensating Anode Supply Potential Variations," F. H. Shepard, Jr.

U. S. 2,313,098, "Methods and Means for Reproduction of Sound Frequency Vibrations," F. H. Shepard, Jr.

FILTER DESIGN

[from page 14]

tion, engineering texts recommend the maximum real magnitude of the image impedance. i.e. $\sqrt{L/C}$. Numerous researchers have shown the error of this choice.[2] With this termination a T-type low-pass filter *does not cut off when* $\omega^2LC = 1$. In fact, the insertion loss of such a single-section filter is only approximately 3 db at the so-called cut-off frequency. The reader can prove this by substituting $+jR_0$ and $-jR_0$ respectively for the Z_1 and Z_2 elements of a full T. Thus the term "cut-off frequency" has been carried over from the ideal filter.

With the above facts in mind, it is seen that the element values of a half section are specified at once, given the so-called cut-off frequency and the desired termination. For example, if the termination

$$R_0 = \sqrt{L/C} \qquad (5)$$

and $\omega_c^2 LC = 1, \qquad (6)$

where f_c = cut off frequency of ideal filter, and

$$\omega_c = 2\pi f_c$$

Equations (5) and (6) are combined to give the promised simplifications, as follows:

$$R_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{\omega_c L}{\omega_c C}} = \sqrt{X_L X_C}$$

$$\text{At } f_c \begin{cases} \omega_c^2 LC = 1, \text{ hence } X_L = X_C \\ \therefore\ R_0 = \sqrt{X_L X_C} = \sqrt{X_L^2} = \sqrt{X_C^2} \end{cases}$$

[2] For example, L. J. Giacoletto, "Optimum resistive terminations for single section constant-*k* ladder-type filters". *RCA Review*, Vol. VIII, Sept. 47, #3, page 460–479.

This results in the simple equation $R_o = X_L = X_C$, which specifies the basic elements of many filter types. The reasoning for evolving high-pass, *m*-derived and band-pass filters follows along the same lines. Numerical examples will serve to illustrate the application of this simplification of the basic design formulae.

Let it be assumed that it is desired to find the elements of a constant-*k* low-pass, T-type filter, to operate between 500-ohm loads and to cut off at 159 cps. Referring to the basic low-pass half section, *Fig.* 5 (A), since it was stipulated that $X_L = X_C = R_o$ at the cut off frequency f_c, the values of the elements are obtained from

$$L = \frac{R_o}{2\pi f_c} = \frac{500}{(2\pi)\frac{10^3}{2\pi}} = 0.5 \text{ henry per } \tfrac{1}{2} \text{ section}$$

$$\text{and } C = \frac{L}{(R_o)^2} = 2\mu f \text{ per } \tfrac{1}{2} \text{ section}$$

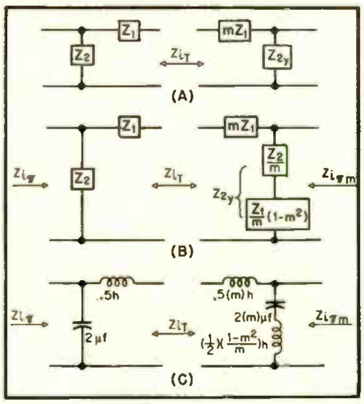


Fig. 10. (A) A constant-k and an m-derived half section with identical mid-series image impedances Z_{iT}. (B) Element values of an m-derived section having the same image impedance as the T end of the section which it faces. (C) Low-pass constant-k half section and its related low-pass m-derived half section.

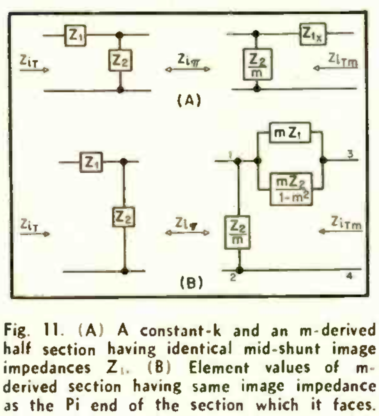


Fig. 11. (A) A constant-k and an m-derived half section having identical mid-shunt image impedances Z_i. (B) Element values of m-derived section having same image impedance as the Pi end of the section which it faces.

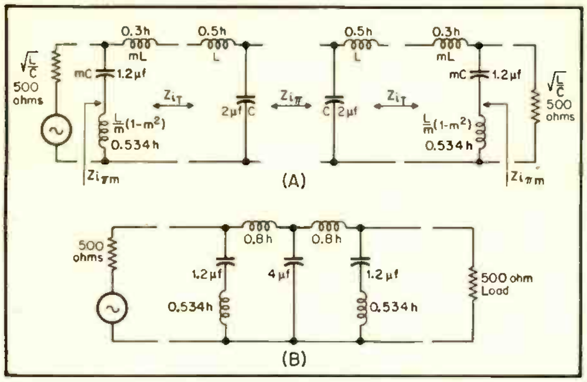
The filter arranged as a T consists of two half sections placed with their pillars in parallel, *Fig.* 6 (A), and appears in its final form in *Fig.* 6 (B). The correctness of this and subsequent filter designs may be checked by referring to any standard text.

The above filter half sections are readily arranged in the form of a Pi having the same insertion loss characteristics as the T, as shown in *Figs.* 7 (A) and 7 (B). The filter becomes a high-pass T or Pi by the simple device of interchanging elements. *Figures* 8 (A) and 8 (B) show a high-pass T, and *Figs.* 9 (A) and 9 (B) show a high-pass Pi, both having the same cut-off frequency and losses.

m-Derived Sections

The element values of a series *m*-derived section, it will be recalled, are obtained by equating the image impedances of two sections of which one uses the standard constant-*k* filter elements, while in the *m*-derived type the series arm is arbitrarily altered by the factor *m*. When the image impedance equations are solved, it is found that the *m*-derived section requires a shunt arm consisting of two elements. This is illustrated in *Figs.* 10 (A) and 10 (B).

The arrangement of the *m*-derived half-section elements is easily remembered since the series arm has the factor *m* as multiplier, while the shunt arm has *m* as divisor; further, the second shunt



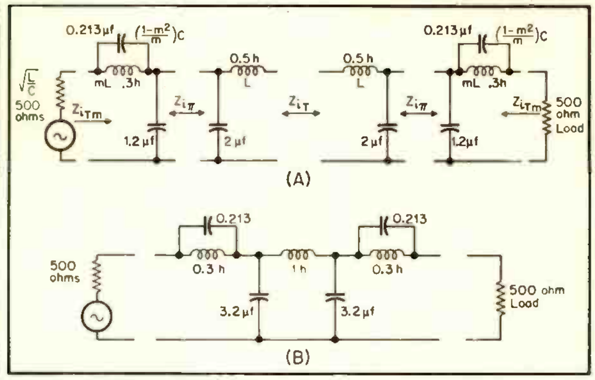


Fig. 12 (left). Filter sections (A) combined to make complete filter (B) with f_c = 159 cps. Fig. 13 (right). Assembly of filter with same characteristics as Fig. 12, but employing shunt m-derived terminating half-sections instead of series.

element has the reactance characteristics of the series arm times $(1 - m^2)$. For example, a low-pass constant-*k* half section and its related low-pass *m*-derived section appear in *Fig.* 10 (C).

Similar considerations are involved in determining the elements of the basic shunt *m*-derived section which is used for joining Pi configurations of constant-*k* filters. This is shown in *Fig.* 11.

It is very important to observe in *Fig.* 11 (B) that the image impedance at terminals 1–2 is that of a Pi for all values of *m*. However, the image impedance at terminals 3–4 is that of an *m*-derived T (Z_{iTm}) and depends upon the value of *m*. It may face either a load or another section having an image impedance Z_{iTm}. The configurations of low- and high-pass constant-*k* and *m*-derived half sections are shown in Chart I.

Design Example

A typical design example follows to illustrate the application of the *m* formulas. Assume it is desired to improve the insertion loss characteristics and matching properties of the low-pass T filter designed at the beginning of this article, by adding a half section of *m*-derived configuration. If *m* is chosen as 0.6, the filter will cut off very sharply at a frequency 25 per cent above idealized cut-off, in this case at 198.75 cps. It is important that the image impedances be the same at the junctions of all sections. The filter sections and the complete filter are shown in *Fig.* 12.

On occasion it is more economical to employ a Pi type constant-*k* section. In the present case, for example, it is possible to reduce by one the number of inductors required. Such a design demands shunt *m*-derived sections as terminations in order to produce the proper image impedances at the junctions of the half sections. This is shown clearly in *Fig.* 13.

A subsequent article will present further applications of these simplifications to the design of crossover networks and to band-pass filters.

LOUDSPEAKER DAMPING

[*from page 23*]

a narrow frequency range involving the resonant frequency of the unit.

The compliance C_s represents that of the suspension, both of the rim of the cone and of the center spider. It is apt to be nonlinear, particularly for large excursions, but is reasonably constant for moderate and small amplitudes of vibration.

The resistive factors are that of the suspension R_s, and that of the air set in motion by the cone, R_a. The latter is particularly variable with frequency, but is usually very small at the low frequency at which resonance occurs, particularly if the speaker unit is tested by itself, or at most in a flat baffle. Values for several sizes of cones are given by Olson.[1]

From *Fig.* 1, it is apparent that

$$Z_m = (R_s + R_a) + j\omega(M_c + M_a) + 1/j\omega C_s \quad (2)$$

Substituting this in Eq. (*1*), we obtain

$$Z_{me} = \frac{(Bl)^2 \times 10^{-9}}{(R_s + R_a) + j\omega(M_c + M_a) + 1/j\omega C_s} \quad (3)$$

If we divide the numerator and denominator of the right side of Eq. (*3*) by $(Bl)^2 \times 10^{-9}$ we obtain

$$Z_{me} = \frac{1}{\frac{(R_s + R_a)}{(Bl)^2 \times 10^{-9}} + j\omega \frac{(M_c + M_a)}{(Bl)^2 \times 10^{-9}} + \frac{1}{j\omega C_s (Bl)^2 \times 10^{-9}}} \quad (4)$$

Let

$$(R_s + R_a)/(Bl)^2 \times 10^{-9} = G_{me} = 1/R_{me}$$
$$(M_c + M_a)/(Bl)^2 \times 10^{-9} = C_{me}$$
$$\text{and} \quad C_s(Bl)^2 \times 10^{-9} = L_{me} \quad (5)$$

where

R_{me} is the motional resistance corresponding to the mechanical damping R_s and R_a,

C_{me} is the motional capacitance corresponding to M_c and M_a, and

L_{me} is the motional inductance corresponding to C_s.

In short, we shall assume that the mechanical resistance appears as an electrical conductance $G_{me} = 1/R_{me}$; the mechanical compliance appears as an electrical inductance; and the mechanical mass appears as an electrical capacitance. The latter transformation has been known for a long time in the power field; years ago oscillating synchronous motors were used in Europe as electrical capacitors, since a relatively small armature mass appeared as a surprisingly large electrical capacitance.

If we substitute Eq. (*5*) in Eq. (*4*), we obtain:

$$Z_{me} = \frac{1}{(1/R_{me}) + j\omega C_{me} + (1/j\omega L_{me})} \quad (6)$$

The quantities on the right side represent a resistance, capacitance, and inductance *in parallel*, since the parallel impedance is equal to the reciprocal of the sum of the reciprocals of the individual impedances.

Hence we finally arrive at the conclusion that the mechanical characteristics of the loudspeaker at the lower frequencies appear at the electrical terminals of the voice coil as shown in *Fig.* 2. Here R_{vc} represents the electrical resistance of the voice coil; the electrical (clamped) inductance of the voice coil can be disregarded at the lower audio frequencies.

The mechanical characteristics of the speaker appear as a parallel resonant circuit shunted by a certain amount of resistance; these constitute the motional impedance Z_{me} of the speaker, and the

[1] H. F. Olson, "Elements of Acoustical Engineering," p. 126. D. Van Nostrand Co., New York.

total electrical impedance Z_t is Z_{me} plus R_{vc}.

We can now analyze the behavior of the speaker from its electrical motional impedance characteristics. Thus, just as *Fig.* 1 indicated a certain frequency of resonance, so does *Fig.* 2 indicate this fact. Since the two circuits are equivalent, they must have the same resonant frequency. This can be readily shown. Thus, from Eq. (*5*)

$$L_{me}C_{me} = C_s\,(Bl)^2 \times 10^{-9}\,\frac{(M_c+M_a)}{(Bl)^2 \times 10^{-9}} = (M_c+M_a)C_s \qquad (7)$$

that is, the electrical *LC* product equals the mechanical *MC* product; either therefore represents the same resonant frequency.

It will be of interest to compare the behavior of the electrical circuit of *Fig.* 2. For example, at the resonant frequency of the loudspeaker, namely

$$f_r = \frac{1}{2\pi(M_c+M_a)C_s} = \frac{1}{2\pi L_{me}C_{me}} \qquad (8)$$

the mechanical current or velocity v is a maximum, and is in phase with the force F, *Fig.* 1.

This in turn means that the electrical c.e.m.f. will be a maximum and in phase opposition with the force F, which in turn is in phase with the current in the voice coil. Hence this c.e.m.f. will produce an in-phase or *resistive* reaction: the generator will view the voice coil as having increased in impedance, and that this increased impedance is resistive in nature.

Now refer to *Fig.* 2. At the frequency of resonance, L_{me} and C_{me} act as an open circuit shunting R_{me}, so that the electrical impedance is

$$Z_t = R_{vc} + R_{me} \qquad (9)$$

and is a maximum. Furthermore, if the mechanical resistance $(R_s + R_a)$ is small, v will be a maximum, as will also be the c.e.m.f., whereupon the electrical source will see a *high* resistive impedance R_{me}. This checks the inverse relation between R_{me} and $(R_s + R_a)$ given in Eq. (*5*); when $(R_s + R_a)$ is small, R_{me} appears large since $(R_s + R_a)$ appears in the denominator of the expression for R_{me} in Eq. (*5*).

To be concluded in the April issue.

PICKUP and TONE ARM

[*from page 20*]

record material; m_s', the mass of the pickup armature referred to the stylus tip; r_s', the resistance of the rubber bearings referred to the stylus tip; C_s', the combined compliance of the centering spring and rubber bearings, referred to the stylus tip; m_1, the total mass associated with the pickup body.

Stiffening the arm without appreciably increasing the mass will raise the frequency and reduce the amplitude quite rapidly without impairing the tracking properties. This was accomplished in the second model shown in *Fig*. 9. The arm is a tapered rectangular box section of .062 in. aluminum alloy. The response frequency characteristic of this arm is shown in curve 1 in *Fig*. 10. Box sections were used for the original experimental arms because of the relatively high stiffness-to-mass ratios which can be obtained.

Box sections do not, however, lend themselves readily to easy manufacture nor to shapes of pleasing appearance, and for these reasons experiments were continued with a channel structure of fairly large section. The general shape of the arm was the same as that shown in *Fig*. 9 and the wall thicknesses tried were 1/8 and 3/32 in. The results are shown in curves 2 and 3 in *Fig*. 10.

The final design was obtained by shortening the original arm length of 16.7 in. to an effective length of 12 in. The maximum tracking error increased to about 4 deg—not enough to be serious—and at the same time the arm length becomes such as to facilitate greatly its use with existing turntables.

Final Design

The final design of the arm and mounting is shown in *Fig*. 11. Overall playing performance with standard test records and the recommended filters is shown in *Fig*. 12.

Playing tests have shown that this pickup and arm will track eccentric records and records with wavy start grooves with stylus forces of 12 grams for the 2.5-mil stylus and 8 grams for the 1-mil stylus. Intermodulation tests yield results which are low to the point where it is not possible to determine accurately whether the distortion is in the record or the pickup.

In conclusion, the authors wish to acknowledge the extensive contributions of H. E. Roys, E. Masterson, and L. W. Ferber of the Engineering Department, RCA-Victor Division.

POPS

[*from page 24*]

drugs in what is, in the final analysis, a losing battle.

Upon receipt of this preliminary information, I contacted a correspondent on the West Coast for further information. Old "razor blade's" financial impoverishment was nothing new; he had the knack of going through large quantities of money with the ease of a fancy lawn mower doing a job on spring grass. The difference in his case was simply the fact that no effort was required in mowing. His was a power-built job. My L. A. correspondent reported that Russell was working in pictures, seemed content and was apparently making an adequate living. The other details were identical with what has already been reported. So what! The behavior of jazz men is nothing new. It is commonplace to refer to their life in the romantic terms of a school girl novelist:

"Jacko came into the room, swaying from too many shots of Old Cat. His bloodshot eyes leered at Mamie and, with a cynical laugh, he picked up his horn, played a few bars of Body and Soul and dropped dead in front of the picture of the great man, 'Ole Spitball'."

Here is the neat little sentimental tradition of Beiderbecke, Jammy Jones and the whole coterie of the tragic jazz myth wrapped up in the cloying, hot-breath moan of a stupid lie. When we make heroes out of our bad boys, we always mark them with the stigma of a bad habit, be it alcohol, a disappointing love affair, or the myriad of unfortunate and pathetic characteristics that our comic book intellectuals accord the "jazz musician". Up to ten years ago, the tragic flaw might get by because too many cases fitted into the pattern. But the real tragedy of the moment has nothing whatsoever to do with Russell's physical condition, or his purported mental breakdown. The tragedy hinges around the words "working in pictures."

Excuse me for not being fashionable and blaming all the horrors of our civilization on "dat ole demon Hollywood." The motion picture industry needs musicians and pays them according to scale. This is a legitimate way of making a living and does not, in itself, produce the disastrous emotional distress that is characteristic in the treatment of the "Hollywood Tragedy." But when a man of the stature of Russell is not devoting his time to his rightful work, and by not doing so pointing up the slow decrease of that work, it is time for some careful soul searching. I don't want to make too much of a case out of the Russell episode; listening to Pee Wee over the past five years, I came away with the sad conclusion that he was pretty much finished. He looked bad, he sounded bad; he played in a haze in which only small snatches of his earlier brilliance reached the surface. He belonged and still belongs to the great fraternity that made out of the chaotic piecework of early jazz a strong and noble structure. For this alone, he deserves everything from the deepest respect to the most superficial foot-stomp.

But, let's switch cases for a moment. This month's reviews include a large batch of LP's purporting to present great jazz and great jazz men. They are tired, ignoble, dull specimens which are marked only by the sedative content of the stuff being played and the mood in which it is being spewed forth. When a man of the stature of Sidney Bechet is accused of being dull and plodding, the world has come to an end and its time to find out why. When Red Norvo, a skilled, imaginative and productive vibes man sticks to the rutty mire of stylized and sophisticated "bop," when Art Hodes and Jesse Stacey play as uninspired a collection of blather as characterizes the recent recordings, or when Teddy Wilson takes in the shekels after the sloppy and moribund performances presented daily on a small radio station, we think it is about time to give up jazz and take up knitting.

Speak to any of the big people; ask them how they feel about the business. Their answers are as honest and legitimate as a chocolate cigarette. Some of them are making very big money (which they can use and which gives them a well fed feeling thrice daily); they give you a lot of optimistic malarky until the fifth drink and then they are likely to borrow a shoulder and cry their commercial heads off. At this point, they don't give a hoot for all our fancy, sophisticated recording techniques and they don't care about the whole plethora of technical arguments which justify what has been done to music and to the people who want to listen to it. Ten thousand microphones will never improve the quality of the stuff that is being fed into them. The diamond stylus may save the record and supply a good response curve; it will never cover up the absence of value in the sinewy grooves.

Several weeks ago, I received a letter from a reader in the middle-west who took issue with my defense of live music versus canned music and suggested the following hypothetical case (which he freely admits is probably out of the question). He suggests the possibility of the perfect recording and the perfect "play back" mechanism. By perfect, I assume he means a completely faithful reproduction of the recorded performance. According to this faithful reader, there would then be no distinction whatsoever between live and canned music. His argument continues that even if perfection itself is impossible, we can approximate the perfect to such an extent that the difference between the two would be negligible. Since recording allows for a greater flexibility in terms of listener possibilities, placing jazz within the range of everybody, no matter what geographical location and what economic status, in the interest of the public at large we should push the recording industry and the radio industry as worthwhile replacements for the live thing. He also suggests that because of the present sophistication in taping techniques, we should play ball with the radio stations that have discontinued live programming because of the concomitant efficiency involved. The sum total of his argument is . . . give the listener a break!

Give the listener a break, indeed! There is no point in repeating previous arguments which clearly indicate that the listener is not getting a break. We needn't point out the problems involved in the manufacture of the "perfect recording" and the perfect "play-back" equipment. Nor will we repeat the psychological problems involved in the distinction between live versus canned listening. Accepting what friend reader hypothecates, we need merely point out that he has left out the most important part of the argument . . . the stuff that we are forced to listen to. He is going on the assumption (like many of the wise men in this business) that the musician is merely a mechanical datum, who either blows, beats, strums, or bows an instrument, thereby producing sounds. He also forgets the distinction which has previously been made in this column between so-called classical and so-called jazz music. While we might be more or less inclined to accept his arguments as being justifiable concerning classical or "scored" music, they simply point to an ignorance concerning the conditions behind the making of jazz sounds. The validity of my arguments are being proven day after day by the kind of stuff the jazz musician is playing and recording. Completely detached from his audience, determined by various technical conditions, including time and equipment, no longer within the stimulating and exciting arena of the jazz combat, he merely plays notes. As he becomes further and further separated from the conditions out of which great moments of jazz erupt, he becomes duller and duller, finally reaching the stage where he approximates a standard announcer reading a standard commercial, with equivalent amounts of sincerity and personal participation. The jazz man becomes a typist, copying somebody else's letter and involving nothing of himself other than the physical work of hitting a key and printing a copy of what he has before him.

Even if the perfect record can be made, even if recording becomes absolutely identical of a perfect standard (whatever that is), this has nothing whatever to do with the creative job of making jazz. When jazz left the bistro and entered the respectable confines of the private home, the motion picture, recording, television and radio studio, the creeping paralysis that characterizes it inevitably set in.

Nobody can put the jazz experience on

paper. It is a personal thing which requires complete involvement. All that can be done is to create a metaphor which approximates the feeling. Try to imagine what would happen to your speech, your every day, individualistic, personal way of communicating with somebody else, if you could only stand in a room, day after day, and speak to an invisible audience. It would become dull, devoid of personal characteristics, and self-conscious. It would cease to be a living, vital, and personal experience; good recording techniques and apparatus would only reproduce the dull, dry, and impersonal character of this stilted performance of a dead task. In exchange for the convenience of our favorite chair, our own highball, and our hot-rod record player, we have sacrificed the only object that makes these things worthwhile. As long as the record industry, the audio industry, the average listener, and the musician himself collaborates in this vicious circle, great jazz will simply not exist. Just before he died, Charlie Christian gave an impromptu recital in a dressing room near Times Square for a bunch of musicians, friends, and admirers. It culminated in some of the most beautiful guitar work these ears have ever heard. He was facing an audience, not a mike, and that fact determined the experience. No recording studio could house the big notes that came out of the cigar box that night . . . no recording studio will ever be large enough. The Pee Wee Russell's of this world don't die from cirrhosis of the liver . . . they die of malnutrition of the head and heart. No matter how much money they make, no matter how satisfied the acceptors of mediocrity are with their playing, they die a slow death in which all that is left is a man blowing into a clarinet . . . manufacturers of a noise called "jazz," not the creators of a great moment, which is neither jazz nor music in general, but the thing in life called art.

NEW RELEASES

Jelly Roll Morton
The Saga of Mr. Jelly Lord, Vol. 1
Circle L 14001

Some years back, Allan Lomax engineered one of the most fantastic recording sessions in history. Under the aegis of the Library of Congress Archives, this session resulted in twelve albums comprising the life, history, and music of Jelly Roll Morton. Only available in a limited edition, the albums are now being re-released in LP form, the above being the entire first album. The dubbing is poor and no attempt was made to clean up the acetates, a job justified by the content and form of this recording. Technically, the LP is poor and the culprit responsible should hang his head in shame, especially considering who the culprit is. With eleven more to go, he should be required by law to treat the material with the respect it deserves. Jelly Roll must still exist in some tangible form somewhere in the universe and, characteristically, will not be lenient with anybody who fails in the duty of respect which the great man always felt his due.

About the 12-inch disc itself . . . anybody who maintains an interest in jazz must own it. It is both the most fabulous history of one man, a tradition and the history of jazz which is on or ever will be on discs. Outside of the musical experience, which includes definitive versions of "Mr. Jelly Lord" and "Tiger Rag," it is by far the best way to get into the center of the creative movement in which and through which jazz emerged. Jelly Roll's constant patter, especially the detailed description of what is meant to grow up in the ferment called New Orleans (one of the most touching and magnificent stories in the whole history of Jazz), is told in a way which leaves no doubt as to what it meant to be a jazz man. You will never be able to listen to the synthetic blather of today after a complete listen to this disc. You gotta get it! The whole life blood of a great creative act comes to life (despite surface noise, fading and poor cutting).

Red Norvo Trio
Volume 1
Discovery DL 4005

This is, in its own way, one of the more interesting recent recordings to come from the "little companies." Don't misunderstand me . . . by no stretch of the imagination is it good. It has an air of staleness about it which the brilliant virtuosity of Red Norvo, Tal Farlow, and Charlie Mingus can't displace. A little bit about the group, first. Red Norvo is, for my money, the greatest vibe man we have. Given the right conditions, he can outplay and out-think anybody in the business. An impeccable technique, a broad range of ideas, and a genuine excitement when he is working with the right group, and playing the right material, make him something beyond a vibe artist . . . an outstanding jazz man. Tal Farlow is a guitarist whom I originally heard with the Teddie Napoleon trio (unfortunately not recorded) and who deserves close attention. While fantastic technically, he lacks the cuteness and banality of such so-called wonders as Alvino Rey and Les Paul. His single string work and his chording are marvelously developed and he has gotten away from the cliche'd riffs and runs of the characteristic guitar man. Charlie Mingus is a phenomenal bass man, tripling as an arranger-composer. He can get more out of the unwieldy rat trap than almost anybody in the business. Put them all together and what do they do? Play a nauseating and dull variety of stuff in the tradition of George Shearing. There is no genuine excitement elicited anywhere in this 12-inch disc; all there is is a tired, dull, complex mish mash which never gets out of the set pattern of sophisticated bop. Only one band (reserved for a thing like "Move") holds promise. The rest dies a lingering death. The jacket specifically notes that great care was taken to preserve the "intimate atmosphere" of the group in the recording. This has been achieved with some success, at the cost of an overemphasis of guitar and vibe overtones, which occasionally obscure the intricate patterns of the stuff. Intimacy, yes . . . liveness, no! The recording must have been a hard one to make, given the character of the group, and Discovery has succeeded to a greater extent than characteristic of the general run of the mill. Pay attention to Tal Farlow . . . he's quite a guitar man. Now we'd like to hear him on some really decent stuff.

Piano Moods
Jess Stacy
Columbia CL 6147

Piano Moods
Eddie Heywood
Columbia CL 6157

Two more records in the Columbia "Piano Moods" series, which don't live up to the others previously reviewed. The whole batch, so far, insist on prolonged music bridges between numbers. The bands are not separated and it is difficult, to say the least, to find the right spots. The idea is no good and makes life difficult, once more, for the selective listener. The bridges are generally foul in all cases. Technically, these recordings do not live up to the job done on the Ralph Sutton Disc. Piano is occasionally completely distorted, percussion is muted. The spaciousness characteristic of the other discs is missing. Jesse Stacy, accompanied by George Van Eps on guitar, Morty Corb on bass, and Nick Fatool, drums, lazes along through a dull uninspired session. Numbers such as Lullaby of the Leaves, Under a Blanket of Blue and Cherry, all of which Stacy has done magnificently on other occasions, are pedestrian. The sheer boredom of this session is becoming characteristic and points the finger again at what happens to a great instrumentalist under prevailing conditions.

Heywood has never been, in my estimation, a top man. He burst into fame with the stylized, tricky recording of "Begin the Beguine," and has lingered within a stylistic pattern which is cute, but unproductive. This job is dull throughout, including a so-so job on St. Louis Blues. When Your Lover Has Gone, and a bad shot at All the Things You Are. Tired, uninspired, lacking any vestige of original ideas, the recording is technically a perfect match of the musical deficiencies. This is the age of the cute boxer and the cute piano man; Heywood and Joe Bushkin are both cuties. Skillful, but lacking power and a knockout punch, they can be used for background music, especially before going to bed.

Sidney Bechet with Wild Bill Davison
Blue Note LP 7001
Sidney Bechet Jazz Classics
Blue Note BLP 7002
Hot Jazz at Blue Note
Art Hodes Hot Five
Blue Note BLP 7005

Three LP's featuring Sidney Bechet and practically every other big man in the business, including Meade Lux Lewis, Sid Catlett, Max Kaminsky, Pops Foster, Wild Bill Davison, Art Hodes, Teddy Bunn, Fred Moore and others . . . all dull, tired, banal, and terribly recorded. Soprano sax isn't easy to record, but this is just smeared all over the place. These are all dubs and characterize all the worst aspects of the process. Balance is awry, surfaces poor, range limited to the hollow of a peanut shell . . . why bother. Bechet is a genuine artist and rarely fails to produce great moments, but even the job on "Dear Old Southland," a specialty of the house, gives one a beddy-bye feeling. Abe Kaplan and Stanley Rosenberg, able mentors of the record department at Rabson's and cognoscenti of all kinds of music, shuffled these out for me with the despairing look that comes from knowing what to expect these days. Why review them? To point out and point up the argument at the beginning of this month's piece. No matter how good the discs would have been, the musical content is sorely defficient. A blast, a bang and a couple of old hat tricks don't represent a decent session in my book.

FOOTNOTE

To avoid any further confusion, it is not generally my practice to single out bad recordings for review. The above mediocrities were cited in connection with the initial part of this month's column, and should be listened to for an empirical lesson in what's what. The blood bath that would characterize this column if half the records I'm forced to listen to each month were reviewed would make Nero look like a piker. Next month, I'll wash my ears and mouth out with soap and begin the long over-due job on the "basic pops library."

Employment Register

POSITIONS OPEN and AVAILABLE PERSONNEL may be listed here at no charge to industry or to members of the Society. For insertion in this column, brief announcements should be in the hands of the Secretary, Audio Engineering Society, Box F, Oceanside, N. Y., before the fifth of the month preceding the date of issue.

★ **Wanted:** Audio Technician, thoroughly experienced, to be chief engineer of two professional-grade recording studios. Prefer man not subject to draft. State salary. Box 201, AUDIO ENGINEERING.

• **Audio Engineer:** No degree needed; must be able to expeditiously and completely design high-grade commercial radio amplifiers and associated equipment for short-run production. Excellent opportunity for a stable and conservative personality. Small nationally advertised Chicago concern. Submit photo with personal and professional history in replying. Box 301, AUDIO ENGINEERING.

• **Laboratory Assistant:** Must have fair knowledge of audio engineering, be familiar with laboratory test equipment and be able to completely build and test special one-or-two-of-a-type amplifiers. Small, nationally advertised Chicago concern. Submit photo with personal and professional history in replying. Box 302, AUDIO ENGINEERING.

ERRATA . .

The following paragraph was omitted from page 21 of the February 1951 issue of "An Effective Frequency Rejection Circuit" by R. B. Nevin.

If there is any doubt about the noise frequency that is being rejected, then advancement of R_1 right to the R_{k1} end will enable identification to be made. R_1 can, of course, be divided into a fixed and a variable part, and the junction placed at the pre-set measured nullpoint, so that overshooting this point cannot then happen.

Adjustment of R_1 affects the signal level and if this is not satisfactory for any particular application, then the . . . .

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.

FOR SALE. Feed screws, automatic equalizer mounting brackets for 128N Presto overhead. Advance ball for Presto 1-C, 1-D head. Also other quality recording equipment, pads, transformers, microphones, Leica camera equipment. For details write M. E. Boyd, 903 Salmon Drive, Dallas, Texas.

CHIEF Engineer-minor partner position desired in small existing or projected electronic or electro-mechanical manufacturing firm engaged in defense activity in central U. S. BS, MS, EE, Professional Engineer. 6 years development experience. College Professor. Box CM-1, AUDIO-ENGINEERING.

ALTEC-Lansing 604B speaker and crossover network mounted in 3-cu.ft. cabinet. Used one month. Perfect condition. $200. Box CM-2, AUDIO-ENGINEERING.

WANTED. One Amplifier Corp. of America tape recorder. 7½ and/or 15 in. per sec. speed, preferably #800C, or Concertone tape recorder. Not over $200. John A. C. Callan, 3819 Military Road, N. W., Washington 15, D.C.

PROFESSIONAL DIRECTORY

AES Sections

Additional Meeting Data

Cincinnati

Meets at WSAI studios. For information, write the secretary, W. E. Mahoney, 1730 Kleemeier St., Cincinnati.

Cleveland

Usually meets the third Wednesday of each month; for information, write the secretary, T. E. Lynch, 3120 E. 135th St., Cleveland 20, Ohio.

Rensselaer Polytechnic Institute

Meets the first Friday evening at the Sage building on the RPI Campus, at 7:30 p.m. Meetings are also held occasionally on the third Friday. *Faculty Advisor:* Dr. R. E. Whallon.

New York

The New York section has finally located a permanent meeting place—Studio 1, WMCA, 1657 Broadway, between 51st and 52nd streets. Meetings are held on the second Tuesday at 7:30 p.m.

Coming

Minnesota Alumni Luncheon, to bring together former Minnesotans, is to be held at Le Marmiton Restaurant, 41 E. 49th St., in New York at 12:30 p.m. on Thursday, March 22, during the I.R.E. Convention. Dr. Henry Hartig will be toastmaster. Reservations in advance through Arthur G. Peck, CBS, 485 Madison Ave., New York 22, N. Y. or phone Plaza 5-2000, ext. 249. Cost is $2.75 per person, which includes gratuities and checking.

Cincinnati Section, I.R.E., will hold its fifth annual Spring Technical Conference on Saturday, April 14, at the Engineering Society Headquarters in Cincinnati, with Television as the theme.

Dallas-Fort Worth Section, I.R.E. will hold the next Southwestern I.R.E. Conference on the campus of Southern Methodist University, Dallas, with the Student Branch acting as joint sponsor, on April 20 and 21. In addition to a number of important papers, the meeting will feature an Industrial Exposition and a banquet with "Texas-style" eating.

British Industries Fair, to be held in London and Birmingham, England, from April 30 to May 11 will embrace more than one million square feet of exhibits. Olympia Hall, in London, will be the center of displays of musical instruments, home entertainment units, and electronic and special sound equipment combined. This show will cover virtually the whole range of British industry—agricultural, industrial, marine, electronic, and many other branches.

Dayton Section, I.R.E., together with the Professional Group on Airborne Electronics is sponsoring the National Conference on Airborne Electronics at the Biltmore Hotel on May 23, 24, and 25. Subjects covered will range from antennas and components to radar and airborne TV.

Industry Notes--

Allied Record Manufacturing Co., Inc., of Hollywood, California, and **K. R. Smith Co., Inc.,** of New York became associated as of February 1. Mr. Smith, who pioneered the development of electrical transcriptions, will continue to head the New York plant, which will be operated as the K. R. Smith Division of Allied Record Mfg. Co. Move said to provide fuller and faster processing service for the recording and transcription industry.

International Rectifier Corporation adds a second story to its plant located at 6809 S. Victoria Ave., Los Angeles 43, Calif. Firm manufactures selenium rectifiers and photocells in modern completely air-conditioned plant.

Newcomb Audio Products, Hollywood, announces the appointment of Art Cert & Co. as manufacturer's representative in the Metropolitan New York Territory, widening rep's coverage which now includes Eastern Pennsylvania, Washington, D.C., Delaware, Maryland, New Jersey, and all of New York State and Long Island.

Permoflux Corporation, 4900 W. Grand Ave., Chicago, has just appointed **J. Y. Schoonmaker Co.,** 2011 Cedar Springs, Dallas, Texas, as their jobber sales representative covering the territory of Arkansas, Louisiana, Mississippi, Oklahoma, and Texas. New rep will promote sale of the famous Permoflux Royal line of speakers as well as head sets and other electronic equipment.

Industry People--

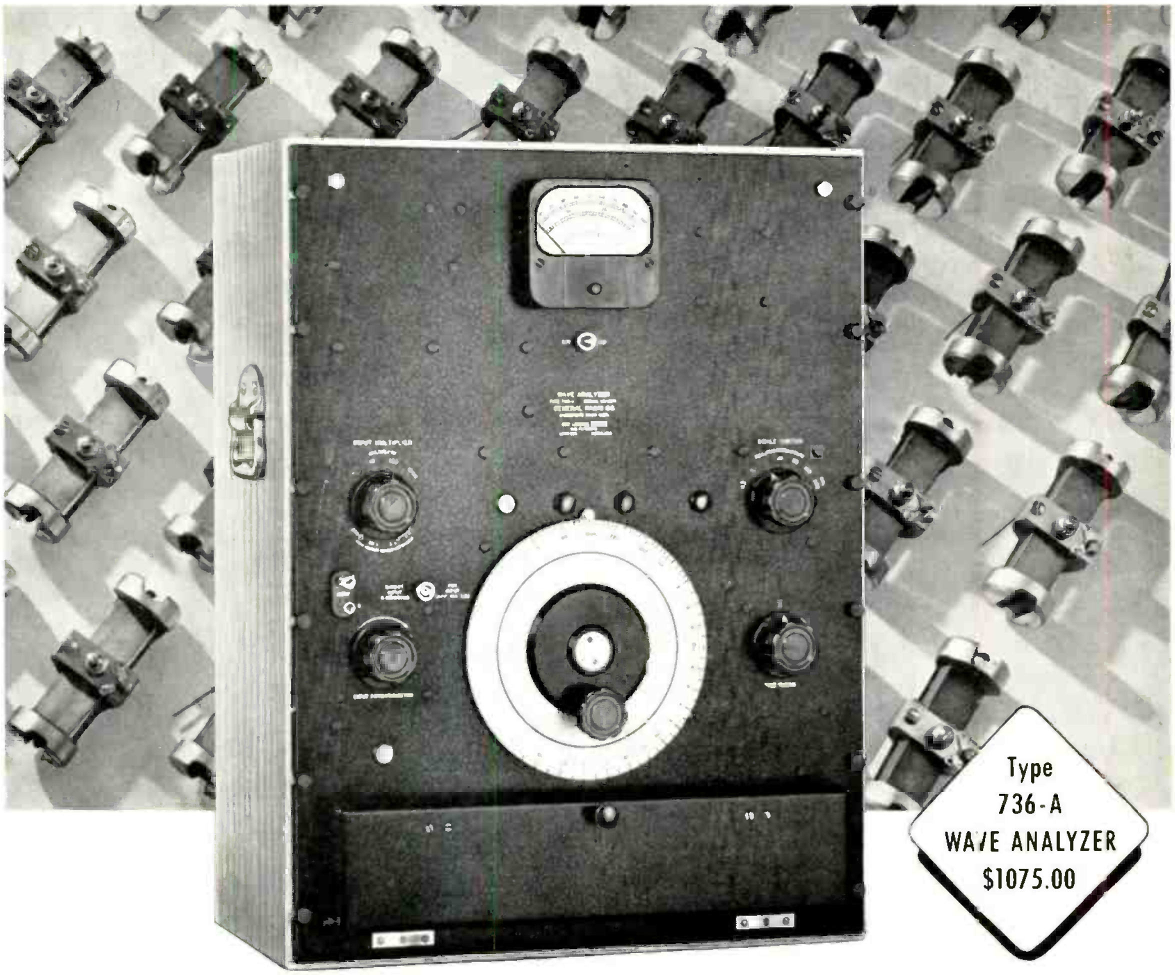
Ray F. Crews has been appointed Vice President in Charge of Sales for the Fairchild Recording Equipment Corporation of Whitestone, N. Y. . . . **J. W. Duffield** appointed eastern regional sales manager for General Electric's Tube Divisions, with headquarters at 570 Lexington Ave., New York. Duffield will be responsible for the sale of replacement tubes and associated electronic items in all states on the eastern seaboard from Maine to Florida, as well as in Tennessee and Alabama. . . . **Allen Easton** has been appointed chief of the Microwave Section of Radio Receptor Co., Inc., 84 N. 9th St., Brooklyn 11, N. Y. manufacturers of electronic and radio equipment since 1922. Mr. Easton, who was formerly chief engineer of Teletone Radio Corp., will be responsible for development of new products for government and industry.

Edwin Dorsey Foster, U. S. Navy (Ret.), has been appointed Director of newly established Mobilization Planning Department of RCA Victor Division of Radio Corporation of America. Formerly Chief of Naval Material in the office of the Secretary of the Navy, Vice Admiral Foster will guide RCA Victor's resources in development, engineering, and production facilities to fulfill all requirements which may be placed upon the company by various Government agencies. . . . **William Hargreaves** appointed Vice President in Charge of Engineering, Transicoil Corporation, 107 Grand St., New York 13, N. Y. Mr. Hargreaves, well known in the industry, has been associated with development of servo motors and other equipment produced by Transicoil. Company is expanding its facilities by adding a second floor, thus doubling its floor space. . . . **Marvin Friedman** appointed Production Manager and Secretary of Andrel Products Corp., 55 S. 11th St., Brooklyn, N. Y., one of country's leading quality tool, die, and jig plants now utilizing its technology for the production of radar and electronic equipment.

Bruce D. Henderson appointed general purchasing agent for Westinghouse Electric Corp. simultaneously with appointment of Wesley H. Lees as general traffic manager. Both have been with company for years, working up through various divisions and degrees of responsibility, thus bringing thorough familiarity with company to new jobs. . . . **Gordon C. LeRoy,** 29 Bancroft Dr., Rochester 16, N. Y. appointed sales representative for Insuline Corporation of America, 3602 35th Ave., Long Island City 1, N. Y., to cover radio parts jobbers in upper New York State. . . . **W. P. L'Hommedieu** just appointed assistant Pacific Coast District manager for Westinghouse Electric Corporation with headquarters at San Francisco. With Westinghouse for 44 years, Mr. L'Hommedieu will assist W. J. Maytham in handling special staff assignments that will include study of manpower, methods, and organization procedures.

Theodore A. Smith appointed Assistant General Manager of RCA Engineering Products Department, taking over duties of W. W. Watts who has been granted a leave of absence to serve with Maj. Gen. William H. Harrison, Defense Production Administrator in Washington. **A. R. Hopkins** was appointed General Sales Manager of the department at the same time, and **Barton Kreuzer** became General Product Manager. . . . **John A. McCone,** Under Secretary of the Air Force, has been designated the Air Force civilian member of the Department of Defense Research and Development Board, replacing Assistant Secretary of the Air Force, Harold C. Stuart. . . . **S. H. Coombs** will head electronic sales engineering department of H. E. Ramsford Co., manufacturer's agent in Western Pennsylvania and West Virginia. Coombs comes from Sales Manager's Staff of Allen B. Du Mont Laboratories' Instrument Division, and will handle similar equipment with Ramsford Company, Du Mont agents for past ten years.

ADVERTISING INDEX



This Heterodyne-Type V-T Voltmeter *has an*

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This wave analyzer offers the simplest, most accurate and most direct method of measuring the amplitude and frequency of the components of any complex electrical waveform.

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- ★ *Oscillators* ★ *Vacuum-Tube Circuits*

Essentially it is a heterodyne-type vacuum-tube voltmeter with a highly-selective i-f filter using three quartz bars. At only 60 cycles from resonance the attenuation is down by 75 db, yet tuning is very easy as it has a 4-cycle flattop characteristic at resonance. Standards for both voltage and frequency are built into the instrument and can be used to check its calibration at any time.

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