AUDIO

JULY, 1963
60¢

...the original magazine about high fidelity!

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Coming NEXT Month

In August we will present our Annual Product Preview wherein the component equipment available for 1963–1964 will be shown and described. This year's Preview promises to be the most extensive we have had to date, listing literally hundreds of items. For those who intend to buy new components this Fall, the Product Preview is an invaluable aid. DON'T MISS IT!

• • •

In keeping with the spirit of our Product Preview, we are presenting articles in the August issue which are intended to be thought-provoking about equipment specifications and testing:

1. Knobs—the shame of it all. Don Nort, a new AUDIO Author, has unearthed a hitherto unpublished report on knob testing.

2. Daniel R. von Recklinghausen tells AUDIO readers what he considers the most important FM tuner specifications for stereo, and his order of preference.

3. The staff of AUDIO presents its report as to what we consider minimum standards for high fidelity which the FTC might adopt.

In the August Issue—

On the newsstands or in your own mailbox

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
Joseph Giovanelli
3420 Newkirk Ave.
Brooklyn 3, N. Y.
Include stamped, self-addressed envelope.

Series Capacitors and Breakdown Voltage

Q. A circuit calls for a 750-pf, 1000-v. capacitor which is not available locally. Instead, I connected in series two capacitors, each rated at 1500 pf, 600v. Do I have to shunt each capacitor with a resistor to distribute this high voltage?

In another instance, the power supply calls for a filter capacitor of 30 μf, 525 v. Instead I used two capacitors, each rated at 60 μf, 450 v. I shunted each capacitor with a 1-watt resistor, 100,000 ohms. Edilberto P. Bustillo, Ormoc City, Philippines.

A. Getting first to the 750-pf capacitor and the series connections you used, there is no reason to use an equalizing resistor because the individual capacitors have little or no leakage resistance. The purpose of the equalizing resistors is to account for the leakage current present in electrolytics. Little or no such leakage current is encountered in ceramic capacitors, and only a very small amount in paper units of good quality.

Look at it this way. Two electrolytics are connected in series. A small amount of current exists in the units when voltage is applied because of the leakage which is always present in electrolytic capacitors. When this happens, a voltage drop is produced across each capacitor. If the value of leakage resistance in each capacitor is not quite equal, it means that the voltages developed across these resistances are not equal. One of the series of capacitors would have to withstand more voltage than would the other unit. If this difference is too great in comparison to the combined voltage across the two units, the unit having the largest leakage resistance or smallest current would probably hold up better than the one having the least leakage. The purpose of the equalizing resistors is to provide a path of lower resistance than offered by the leakage resistance within the capacitor, thus equalizing the voltages across them.

In the event that the values of the two capacitances are not equal, another problem arises. The smaller capacitor will have the largest amount of voltage developed across it. This is understandable when you remember that the leakage increases with the size of the electrolytic. The need for different amounts of equalizing resistance can be accounted for by unequal voltage drops within the capacitors.

Your choice of a 100k resistor is about right considering the fact that the values of the capacitors you used were equal. Probably the internal leakage resistance of each of these units is about 0.5 megohm under load. You can see that the 100k is considerably lower than this value but is still high enough so as not to cause too great a drain upon the power supply.

Plate Voltage Stability

Q. I own a 60-watt amplifier. I have trouble setting bias. When the unit is turned on, I have about 420 volts on the output plates. When this unit runs for approximately two hours, plate voltage gradually comes up to 460 volts which I think is the correct operating voltage. I have based my bias adjustments on this plate voltage.

Why do I have this low voltage when the amplifier is first turned on? I notice that the a.c. line voltage rarely changes more than 6 or 7 volts either way during this warm-up period.

My amplifier has a 200-mA power transformer and a 200-mA choke. It uses a 5V4 rectifier. Can I correct this trouble by replacing the above with a 2000-mA power transformer and choke and use a GZ34/5AR4 rectifier? J. W. Welch, D.D.S., Wall Lake, Iowa.

A. Your problem is very common and is not serious in terms of the over-all performance of the amplifier. Because the change in voltage is less than 10 per cent, it can usually be assumed that a ten per cent change in operating voltage will not be sufficiently important to cause degradation of amplifier performance.

Remember that if the line voltage rises by 7 volts, the voltage at the rectifier cathode will rise somewhere in the neighborhood of 32 volts because of the step-up ratio of the power transformer.

There will be a drop in the plate voltage even though the line voltage has not changed when a rectifier tube is low in emission or loaded beyond its capacity. Try a 5U4 or two 5V4's. You can try the 5AR4, and in fact, you may wish to use two of them in parallel.

Increasing the capacity of the filter choke and of the power transformer will not help in stabilizing the plate voltage in those instances where these components are working within their capabilities. However, when the power required by the load is greater than that which can be comfortably provided by your transformer and choke, the regulation of the power supply will suffer. This is reflected in the variation of voltage as the power output of your amplifier is increased. Only if you have this condition do I recommend increasing the capacity of these components.

You are correct in adjusting the bias for conditions of highest plate voltage.

Reducing Power Supply Load

Q. I have a power transformer rated 410-0-55-410 volts, at 200 mA. The "roll-my-own" basic amplifier I plan to construct will use matched KT88's in a push-pull con-

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figuration with fixed bias. It will use three 12AT7's in the front end. All of this will take more current than can safely be delivered by this transformer.

Can I use the above-mentioned power transformer in a separate power supply for output tubes and bias, and another power supply for voltage amplifier, phase splitter, and cathode-follower driver without the power supplies being connected other than through ground? W. J. Dubie, Kankakee, Illinois.

A. There is no reason why two power supplies cannot be used in the manner you describe, as long as the ground circuits for these supplies are connected to the chassis and tied together. I believe you should know that the driver stages require so little current that their effects on the main power supply would be negligible. If the power transformer has marginal capacity for this particular application, I recommend that you do not use it to supply filament voltage to the KT88's.

In addition, the rectifier filaments should be lit from a separate suuply. As an alternative the thermionic rectifiers can be replaced by equivalent solid-state units. This last change would improve the voltage regulation of the main power supply.

The reason that you would not want the rectifier filaments to be run from the power transformer is that there would be somewhat less current in the primary winding, and this would allow the transformer to run cooler.

Voltage Dropping Resistors

Q. Using Ohm's Law, please show me how to figure the value of the resistors to use in a power supply with a transformer rated at 300–0–300 volts at 120 mA. I wish to get 250 volts or less for the front end of a power amplifier which is to employ three 12AT7's drawing 10 mA each. Would choke input be an advantage for better regulation of the front ends? W. J. Dubie, Kankakee, Illinois.

A. There are a couple of ways to do what you wish. One is to use large decoupling resistors at each stage, with values depending upon the manner of decoupling. The other method involves arriving at a common voltage source for all stages. We shall assume that this latter arrangement is the one in which you are interested.

The chances are that this transformer, and its associated circuitry, will be such that you will obtain more than the 300 volt rating of the transformer secondary, especially since you will probably use capacitor-input filtering. This arrangement will give you the best possible filtering so essential for front-end circuitry. Because the current taken by a front end is virtually constant, even under dynamic conditions, you should not be concerned about the regulation of this portion of the circuit.

For purposes of this discussion I shall assume that the voltage will rise to 325 volts. Because each of the three tubes used in the front end draws 10 mA, the total current drain by these tubes will be 30 mA (0.03 ampere). Assuming that you require 225 volts, 100 volts must be lost across a dropping resistor. By dividing 100 by 0.03, you will obtain this resistance value, in ohms (roughly 3300 ohms), which is required to make this circuit work as you wish. By multiplying 0.03 times 100 you obtain the wattage this resistor will dissipate. Double this power for a good safety factor. However, there is no such thing as a 6-watt resistor (the dropping resistor dissipates 3 watts); the closest available rating is 5 watts. To be really safe, use a ten-watt resistor. Æ

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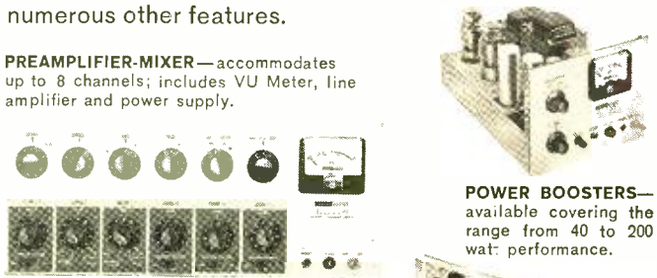
■ Monitor headset jack and monitor volume control . . . plus space and facilities on the front panel for plug-in monitor speaker or VU meter. **Takes the guesswork out of system adjustments; detects and isolates program problems quickly.**

■ Complete remote control facilities are provided . . . for control of program levels, putting the system on "standby" or turning the system on and off. **Place the equipment where it ought to be, control the system from where it's most convenient.**

■ **Professional performance, quality and construction throughout.** Power ratings are given at 1% T.H.D.—the industry practice for packaged amplifiers is **twice** this distortion. Power band-width, hum and noise level and regulation are exceptional . . . as good as you might expect from "high fidelity" amplifiers. Parts are conservatively operated; tubes are run well within manufacturers' tolerances for greatest reliability and life.

■ **Plus many other special operating and installation advantages, such as:** output to a tape recorder, independent of tone and master volume controls; four position Lo Cut Filter; bridging In-Out connections; on-chassis sockets for plug-in low impedance mike and line input transformers, phono and tape equalizers; both balanced and unbalanced 25V and 70V constant voltage outputs; choice of flush-panel, cage or rack-mounting facilities . . . and numerous other features.



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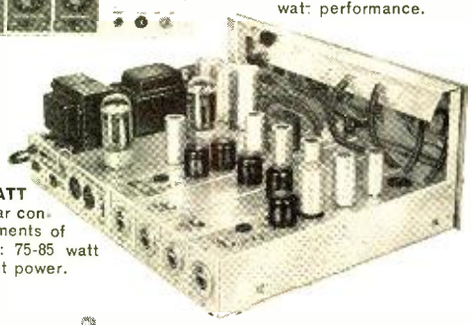
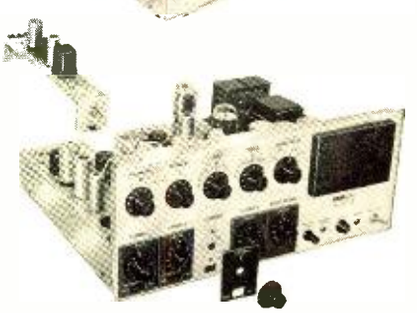


REAR VIEW 40-50 WATT GALAXY—note modular construction and arrangements of inputs. Other models: 75-85 watt and 150-200 watt output power.



FRONT VIEW of the amplifier showing a module withdrawn from the main chassis.

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LETTERS

There's More to Testing Amplifiers . . .

SIR:

With reference to the article "Testing Amplifier Response with an Oscilloscope" by Herbert Malamud, I should like to point out a slight error and a point which might cause some misunderstanding.

The statement is made that when the output signal from an amplifier is fed into the vertical channel of an oscilloscope, and the input signal into the amplifier from an oscillator is fed into the horizontal channel of the oscilloscope, the angle of the trace with the horizontal will decrease from the normal 45 deg. slope with the horizontal to some lower value when the amplifier is overdriven: "If the input voltage to the amplifier is then increased until the amplifier overloads, the amplifier output drops relative to the input, and the angle of the scope trace with the horizontal drops below 45 deg."

The output does, in fact, drop as compared with the input, but the conclusion is incorrect, since the amplifier merely begins to clip. Unless the recovery time of the amplifier is exceptionally bad, the slope of the trace at the origin will change little, if at all.

In addition to the above, *Fig.* 1 is misleading since it shows the X-input at the left edge of the 'scope and the Y-input at the right edge. Most oscilloscopes are reversed. If one doesn't notice the letters X and Y, and tries to connect the circuit as shown, the data in Table 1 no longer hold.

Finally, a "0.1 μf or larger" capacitor is *not* ample, with a 1-megohm input impedance on the 'scope. The reactance of such a capacitor equals 1 megohm at about 16 cps. With a tolerance of ±25 per cent, which is possible, it may go from 12 to 20 cps. The phase shift in the input into the oscilloscope may therefore be between 45 and 31 deg. If one of the capacitors is at the high end of the range, and the other is at the low end, any angle measurement will automatically be off by 14 deg. Very large capacitors will avoid this problem.

PETER A. STARK
519 E. 86th Street
New York 28, N. Y.

The Blushing Author Replies

SIR:

On his first point, Mr. Stark is absolutely correct. I blush to have been guilty of careless thinking.

With respect to the second point, the labeling on a diagram is also part of a diagram, and should be looked at. In any case, it is the deviation from a 45-deg. angle which is important, and a 46-deg. slope may be interpreted exactly the same as a 44-deg. slope.

Mr. Stark is correct again on his last point, but so was I. My handwritten copy of the article has "1.0 μf." I don't know if the 1 and the 0 were interchanged by my typist, or by AUDIO's. The capacitor should, of course, be large enough so that the value of RC (where R is the 'scope input resistor) is one (or at least one half), for the reasons that Mr. Stark points out.

HERBERT MALAMUD
30 Wedgewood Drive
Westbury, N. Y.

Isn't It a Small (Polyminoe) World?

SIR:

It has often been stated that different sciences are nothing more than different interpretations given to the same basic equations. This point was forcefully illustrated to me when I happened to look at Erhard Aschinger's article in the March issue and noticed a similarity between his equations for the first stage resistances and the formulas that give the number of distinct polyminoes of orders four, five, six, and seven.

Polyminoes are geometrical objects made by joining together a number of squares along their edges. For example, five squares in a row and a Greek cross are both polyminoes of order five, and a simple square made of four smaller squares is a polyminoe of order four. Mathematicians have been interested for a long time in the problem of how many different looking polyminoes one could make of a given order, and although they have found no general formula it is known empirically

(*Continued on page 46*)

THIS MONTH'S COVER

The installation shown on the cover this month is in the Merrick, Long Island, N. Y., home of Stanley L. Horowitz, AIA. The components include: a Leak "Point-One" stereo preamplifier and "Stereo 60" power amplifier; a Leak "Trough Line" tuner with multiplex adapter; a Connoisseur 2S turntable, with Connoisseur arm and stereo cartridge; and a pair of Leak "Sandwich" loudspeakers.

The loudspeakers are presently enclosed in the two lower and outermost cabinets. In the planning stage, however, is an extension of the living room that will greatly increase the listening area. Then the speakers will be removed from the wall unit and will be rigidly suspended from the ceiling via a metal frame designed for the purpose by Stanley and his wife Elaine, an interior designer.

The choice of a separate control center and power amplifier was dictated by the desire to conserve cabinet space as well as have top quality. The original plans called for the amplifier to be placed in the attic, some 20-feet away. Temporarily the amplifier was installed below the control center. At the insistence of Elaine, the amplifier now is in its intended place. All wiring is concealed in tracks cut in the back of the teak standards and cabinets.

An interesting feature in this installation is the ability to control the extension loudspeakers remotely. Also, it was decided to include a control for turning the entire system on and off remotely. A very simple, efficient, and inexpensive system was used, consisting of a low-voltage relay and momentary contact switches. Because switching current is drawn only at the instant of switching, it is possible to use the wires carrying the speaker signal to carry the switching signal also. With this system an infinite number of on-off switches can be added.

Studio view of three A-7 speaker systems used for 3-channel PLAYBACK monitoring at United Recording Studios, Hollywood, where many famous musical stars do their recording.

Capitol Recording Studios in Hollywood employ more than 70 Altec PLAYBACK speaker systems for monitoring of their famed recordings.

THE POWER AND THE GLORY OF A GENUINE PLAYBACK* SPEAKER!

At the recent L.A. Hi Fi Show, a lady was so enchanted by the sound of a stereo pair of Altec A-7 PLAYBACK systems that she closed her eyes to their rugged studio-utility cabinetry. She wrote a letter conveying the wonder she felt in hearing, for the first time, faithful reproduction of live performance. This is what Mrs. Raymond O. Zenker of Whittier, California, has to say about Altec's mighty A-7 "Voice of the Theatre"®:

"I have never written 'letters to the editor' or that sort of thing, but this time I am compelled to.

"On April 4th, my husband and I went to the Hi Fi Show at the Ambassador. Of the many assorted displays, I was impressed only with two big black boxes in a small ordinary room. These boxes must have been magical for the room became enchanting. To others perhaps they were ugly, but to me they were the most beautiful things—(no, beings, for they were alive and warm), I had seen during the evening.

"When my husband and I buy, it will have to be the A-7's. Nothing else is even worth consideration. This will make the wait for music a bit longer, but the waiting becomes a necessity now for I'm spoiled and could never be content with anything else..."

Mrs. Zenker's admiration is understandable. "Voice of the Theatre" speakers are genuine PLAYBACK systems considered a *must* for leading broadcast and recording studios, as well as motion picture theatres (including Cinerama's matchless 6-channel stereo). In such professional applications, where reputations and income are at stake, "bookshelf" bass, strident highs and other aspects of audio distortion cannot be tolerated. That's why PLAYBACK speakers by Altec are invariably specified.

You can buy a pair of Altec A-7's for your home for only $279.00 each. Studio engineers will tell you that this is the finest speaker system in existence. And it *is*... next to the new Altec A7-500.

NEW... ALTEC A7-500 PLAYBACK SYSTEM

For $36.00 more, the A7-500 provides a lower crossover frequency and larger sectoral horn for the smoothest reproduction of lower mid-range ever achieved. However, whichever you choose—the A-7 or the A7-500—your records, tapes and FM will sound better than they have ever sounded before. They are priced right in their studio cabinets; all it takes is a bit of do-it-yourself ingenuity for dressing-up or building-in.

PREFER SUPERLATIVE SOUND WITH FURNITURE TO MATCH?

If you prefer your sound in finest furniture, full-sized, floor-standing, two-way

831A "Capistrano" incorporates A-7 speaker components in a magnificent cabinet 30" high, 47" wide. Price: $399.00.

838A "Carmel" contains the A-7 high frequency section in combination with two low frequency speakers. Price: $324.00 • 837A "Avalon" at $261.00 is identical except for one l.f. speaker instead of two. Decorator base (shown) $36.00 extra.

Studio A of Universal Recording Corp., Chicago, uses four Altec A-7's in monitoring 4-channel PLAYBACK.

Altec PLAYBACK systems are also available in walnut or mahogany cabinets.

Hear Altec PLAYBACK components at your nearest Altec Distributor's (see your Yellow Pages). And be sure to ask for your courtesy copy of Altec's "PLAYBACK And Speech Input Equipment For Recording And Broadcast Studios" Catalog. Although this booklet was prepared specifically for the recording and broadcast industry, many of the studio applications it describes will open your eyes (and ears). Or, for your free copy, write to PLAYBACK Dept. A-7.

*PLAYBACK: a term used in the recording industry to designate the studio sound reproducing equipment relied on by conductors, performing artists and recording engineers to carefully judge by direct comparison the realism of a recording with the live rendition. Altec Lansing is synonymous with PLAYBACK because most major professional studios have used and specified Altec equipment since the early beginnings of modern recording.

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LIGHT LISTENING

Chester Santon

Lawrence of Arabia (Original Soundtrack Recording) **Colpix SCP 514**

Sometimes it takes a period of nearly half a century before an unusual musical instrument gains a sizable audience. The soundtrack recording of the motion picture "Lawrence of Arabia" contains such an instrument—the Ondes Martenot. There is more than a little irony in the fact that the relatively unimportant medium of movie background music will probably do more to spread the fame of this electronic musical instrument than have all its previous recorded or concert appearances, including an American tour in the Thirties by its inventor, Maurice Martenot. Martenot, a French pianist, violinist and cellist, patented his device in Europe back in 1922. Although it resembles the Theremin in some respects, the Ondes Martenot is known to fewer persons than the earlier electronic instrument that preceded it by a period of only two or three years. Record listeners had a chance to become acquainted with it a few years ago on a Westminster mono disc (XWN 18360) that has since been withdrawn. In that release, the inventor's sister was heard as soloist in the Concerto for Ondes Martenot and Orchestra by Andre Jolivet. In appearance, M. Martenot's device resembles a spinet and is equipped with a keyboard of five octaves. Musical sounds are produced by oscillating radio tubes as in the Theremin but the manner of control is different. A wire extending across the keyboard is held about the operator's thumb and second finger, and is manipulated to produce the desired pitch by moving a variable condenser. The keyboard serves as a guide to give the performer an approximate idea of where he is in the scale. By pressing a set of buttons, the player controls the timbre and color of his tone. Volume is controlled by a key, similar to that of a telegraph instrument. In the soundtrack of "Lawrence of Arabia", the unearthly tone of this instrument is used to underline the eerie vastness of the desert. Its inclusion in the orchestra undoubtedly stems from the fact that the soundtrack score was composed and conducted by Maurice Jarre, himself a Frenchman. Having access to musical circles that include men capable of handling the Ondes Martenot, Jarre imported a French player and added him to the ranks of the London Philharmonic Orchestra for this recording. With only two bands of this disc devoted to tonal description of the desert, this player has far less opportunity to be heard than he would in a concerto. His mere presence, however, may stimulate interest in the instrument among other professionals in the movie field. The rest of the Lawrence score is rather predictable in nature: a theme for the hero and an assortment of Arabian percussion instruments whenever the native element is in the center of the screen. The picture's score includes a new march by Kenneth J. Alford, who wrote the very famous *Colonel Bogey March*. The new work—*Voice of the Guns*—is nowhere near as effective a composition as the earlier Alford march.

Music Made Famous by Glenn Miller
Warner Bros. Tape WSTC 1468

When the featured stars of the original Glenn Miller Orchestra held their reunion in Las Vegas not too long ago, Warner Bros. taped enough material at the concert to issue two albums commemorating the event. The first four-track tape of "Music Made Famous by Glenn Miller" appeared on this label a few months ago (WSTC 1428). In this second release, the Casbar Theater Lounge of the Sahara Hotel in Las Vegas continues to ring with the applause of an overflow audience that came to pay homage to the memory of Miller. To Glenn Miller fans who have refused to get excited about the subsequent Miller-type bands that have been around since World War Two, the Las Vegas concert heard on these two tapes was a most happy occasion. Paula Kelly and the Modernaires, Ray Eberle and Tex Beneke gave the event the required touch of authenticity and the audience's recollection of the past took it from there. The original crew, in its heyday, had built up an enormous list of best-selling records before the war came along and many of their greatest hits are vigorously revived here. Ray Eberle takes the solo bow in *Blue Champagne* and *Along the Santa Fe Trail*, Tex Beneke gets into the act with the Modernaires in *Don't Sit Under the Apple Tree* and the orchestra buttons down the instrumental innings with *Rhapsody in Blue, Tuxedo Junction* and *St. Louis Blue March*. Warner's processing of the tapes captures the excitement of the occasion—providing the crowning touch to a happily sentimental journey that shows no sign of ending.

Robert Farnon: Portrait of the West
M-G-M SE 4107

This is my first encounter with the Farnon orchestra on the MGM label. It's good to see Farnon still on the active list. He is one of the veterans of the LP era deserving of more fame and fortune than the past fourteen years have brought him. Record collectors whose activities go back to 1959, when light music was available mainly on 10-inch microgroove discs, recall Farnon as one of the top three British instrumental stars on the then-new London label. Along with Mantovani and Stanley Black, he had much to do with the upgrading of standards brought about by London Records in the popular field. We all know that, of the trio, only Mantovani hit the jackpot with the American public but equally well known throughout the music industry is the fact that Farnon carried much weight within the circle of top arrangers who were not interested in a musical style based on gimmicks. The public, however, still calls the important shots in an orchestra's standing within the ranks of a given record label and London is no exception. The easiest way to gauge Farnon's present position at London is to check how many of his records are still available on the parent label and how many have been relegated to the low price Richmond roster. I daresay Farnon's agent grew restless once he saw the Richmond releases begin to outnumber the London items in the catalog and advised him to lend an ear to offers from other labels. MGM has much to gain with Farnon on its roster. His versatile orchestra, along with David Rose and Ornadel, puts the label in a good position to capitalize on any trend in public taste. Even more important from the standpoint of the film studio that owns the label, Farnon can be used to bolster interest in a wide variety of motion pictures. Anticipating an increase in the sale of all Western music following the release of its Cinerama production of the movie "How the West Was Won," MGM has drawn from Farnon an interesting album that includes his own compositions, *Open Skies* and *Gateway to the West*, in addition to staples such as *Shenandoah, Home on the Range* and *They Call the Wind Maria* from Lerner and Loewe's "Paint Your Wagon."

Bruno Canfora: Riviera
Vesuvius ST 4412

The Italian record industry has ample reason to be proud of the technical know-how that has gone into the production of this stereo disc. The Vesuvius label is new in this country, having been made available only a few months ago under the distribution of MGM Records. The sound on previous Vesuvius releases has not given me reason to erupt with joy because standards were a bit below the average maintained by the American record industry. This album, however, is quite another story. It has been recorded for Vesuvius by Ricordi, the famous Italian publishing house. It is top drawer in all respects. I can think of only one or two well-known domestic labels that manage to rival the sound displayed in this sophisticated program by Bruno Canfora's 35-piece orchestra.

Jerry Orbach: Off Broadway
M-G-M SE 4056

This release should resolve a minor problem that may have bothered some collectors ever since Off Broadway shows were first discovered by the record companies. Even the most redoubtable theater fan has found it difficult to acquire every single original cast recording on Off Broadway shows in addition to the albums concerned with the internationally famous productions seen on Broadway itself. Assuming that shelf space and a record collector's budget were to permit such a luxury, it is still doubtful whether any listener would find all the minor musicals equally appealing. MGM's solution is a disarmingly simple one. They hired an unpretentious young singer who has worked in both areas of the New York theater and recorded him in a collection of tunes representing most of the Off Broadway shows that have made a sizable impression in recent show business annals. The fact that Jerry Orbach's album may not set the world on its ear becomes one of the points in its favor. The casual charm of these low-budget songs could hardly withstand the hard sell associated with most of the big uptown shows. The softer sell of Off Broadway comes easily to Jerry Orbach who got his New York start singing the role of Macheath in the cast of the long-running "Threepenny Opera." His next move was Ward Baker's production of "The Fantasticks." While appearing in that show, Orbach was selected by Gower Champion to play the important role of the puppeteer in the noted Broadway hit—"Carnival." The twenty-two-year-old Orbach is fortunate in having the services of Norman Paris as arranger and conductor in this album. Paris presided over the music at Julius Monk's Reuben Bleu from 1947 to 1957, guiding many new acts during their formative years. Paris is particularly helpful in those songs that made their first appearance in the theater as duets and trios—or in the case of *Portofino* from "Dressed to the Nines"—an ensemble number by three girls and two men. James Chambers, the solo French horn player of the New York Philharmonic, contributes handsomely to the haunting effect of *Mack the Knife* and *There's a Small Hotel*. The inclusion of *Small Hotel* in this collection underlines the importance of one section of the theater world where newcomers are assured a welcome because Rodgers and Hart first won public notice in "Garrick Gaieties," an Off Broadway show in its day.

Jane Morgan: What Now My Love?
Kapp Tape KTL 41052
Ella Swings Gently with Nelson
Verve Tape VSTC 283

Two of our leading older-than-girl singers share a relaxed mood in these tape releases. Jane Morgan, whose popularity has never reached the world-wide heights of Ella Fitzgerald, has the backing of orchestras directed by Burt Bacharach and Peter Matz in songs with sadness as a common denominator. Ella's swinging companion is Nelson Riddle in an album that steers a smooth course through a collection of seasoned favorites. *Body and Soul, I Wished on the Moon* and *Georgia on my Mind* are typical of the tunes that turn over a new leaf whenever Ella feels rakish.

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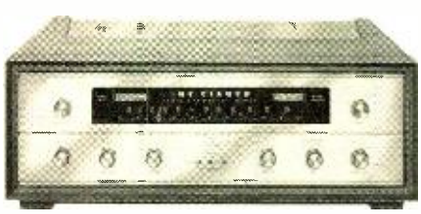

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AUDIO ETC.

Edward Tatnall Canby

CRITICAL VOLTAGE

Some people wonder just what a critic is —in any old field.

A critic, maybe, is one who sticks his professional nose into other people's business. A critic is an entertainer—at the expense of the criticized. A critic is a solemn judge, weighed down with awful responsibilities, the arbiter of fate and well aware of it. A critic, sometimes, is merely a describer, a guy whose job is to list the features, succinctly. Some people quite honestly feel that a critic is an arm of Publicity. He often is. Why not? Provided of course . . .

Provided what? Well, provided, natch, that the product is the best of all possible products, the show of shows, the acme of acmes. In which case the critic is joyfully able to extend himself as the longest arm Publicity will ever find, and for free. Which makes it even better. Look—we didn't even have to PAY him to say these wonderful things; he did it all of his own accord! Boy, have we got a super-product.

But very few products are in the acme of acmes class. Not even new plays, let alone new symphonies, paintings, ballets, hi-fi's, tape recorders. It is quite allowable for Publicity to plug the positive and negate the negative. That is part of the system, and highly acceptable everywhere. This is a kind of euphemism, by which we produce a rosier world for our own anticipation. Anticipation makes the money flow and the economy prosper. Not so in the case of the critic—whose business is of a trickier sort.

Very simply, the man who criticizes as a profession is a positive evaluator. Primarily, he is on the plus side—he is a builder-upper. Otherwise, why bother. The tear-it-down critic is merely an entertainer. Somebody recently asked me whether I wouldn't enjoy writing under a *nom de plume*, so I could say what I *really* thought. The idea didn't appeal to me at all. In fact it bored me.

I don't think any writer who is a real critic at heart, no matter what the field, wants any sort of anonymity. That misses the whole point. As individuals, we want to feel ourselves a part of the system, and a functioning and useful part, too. We are happiest when in mesh, a small cog but essential, we hope.

We are a feedback loop. Our evaluations may reduce the total output, variably, according to circumstances; but they aim to improve. And to entertain too, of course, for entertainment—as who doesn't know—is the quickest road to just about anything. Feedback without a circuit is no feedback at all, and not very entertaining either. No juice.

And let me point out, further, that as every electronics man knows, feedback loops are constructively negative, when they aren't going positive. More often than not, they are both. So is the critic's evaluation.

Relax

With this in mind, let me trace a recent positive-negative circuit that appeared in this column, naming names. As you'll remember, I had some mildly negative things to say about a certain big gray box of a tape recorder. Name? The Crown 800. There were plenty of positive points to make about the machine, but there were also a few points which I felt could be set down in a constructively negative fashion.

Well, in such a situation one writes the article, sees it wriggle slowly past the editor's blue pencil (he going pale and sprouting seven new gray hairs) and then one awaits, with a bit of nervousness, the inevitable reaction. (What could be worse than no reaction at all. . . .)

It should be, it *ought* to be a happy reaction, you think to yourself. The readers should find it useful and maybe entertaining. So too, one dares hope a little bit, will the manufacturer, whose heart and soul, whose know-how, publicity and, in particular, whose corporate profits are intimately attached to the product in question.

But one isn't too sure about this. Companies, corporations, are supposed to be entities in themselves, legal though not human. They seldom act that way. Instead, most corporations from GE, RCA, and GM right down to the local newsstand around the corner are actually the most temperamental of Personalities, bristling with raw nerves as though they were flesh and bone. Anything may happen if your critical feedback voltage is off the beam.

Well, I got a passel of good reader-reactions concerning that Big Gray Box, neatly distributed. I hit it on the nose. The Crown was a beast, it was wonderful. It was easy to use, it was tough to use. Its sound was superb, it was full of distortion. Reader-voltage: correct! So far so good. But when the expected big envelope came sailing from the Crown representative in our region (who had provided me with the machine for trial) and, hard on its heels, an even more impressive envelope from the Office of the President out in Indiana, I braced myself. Especially when I read the President's first sentence.

"It is with mixed emotions that we write you concerning the article in AUDIO magazine covering Crown recorders. . . ." Well, here we go, I thought. Fuse about to blow in the feedback circuit.

"We are the owner of two 5000-watt radio stations and are cognizant of the difficulty in being able to give our listeners uncensored news. It is hard to know when all the facts are allowed to come in."

Hmmm. Good. This corporation executive is saying that a favorable report isn't always a useful report. What he means is what I mean—maybe. Evaluation is most constructive when it *evaluates*—strikes a balance.

"We have had quite a number of reports from various readers who said Mr. Canby was fair enough to give a balanced pro and con discussion on the Crown tape recorder and therefore they relaxed . . . The fact is, the American public is searching for this kind (of report) both in government and business.

"We thank you for this article and . . . for your thoroughness and thought toward our product."

You could hear my sigh of relief several feet away. Voltage: OK.

Straws in the Wind

Mr. Ed Straw, the rep (Metrorep) who was my direct contact, had written me first, in more detail. My article, he said, "was read with great relish." Phew! My negative feedback seemed to have been both constructive *and* entertaining. His letter is too long to quote, but it has answers to some of my questionings. For instance, since my Crown 800 was built there had been some changes; more were under continous study. (A big, expensive machine can afford to be altered in production.)

1. The "echo" is now fed separately from the pot in the rear and does not affect the listening level.

2. Levels on "A" and "B" settings have been equalized, eliminating overload of the associated system on "A."

3. As to the "A" and "B" nomenclature, it is rather firmly established, he says, and even beginners seem to like it. (I still disagree—indeed, I don't know which of the two "A" circuits he means, above, offhand.)

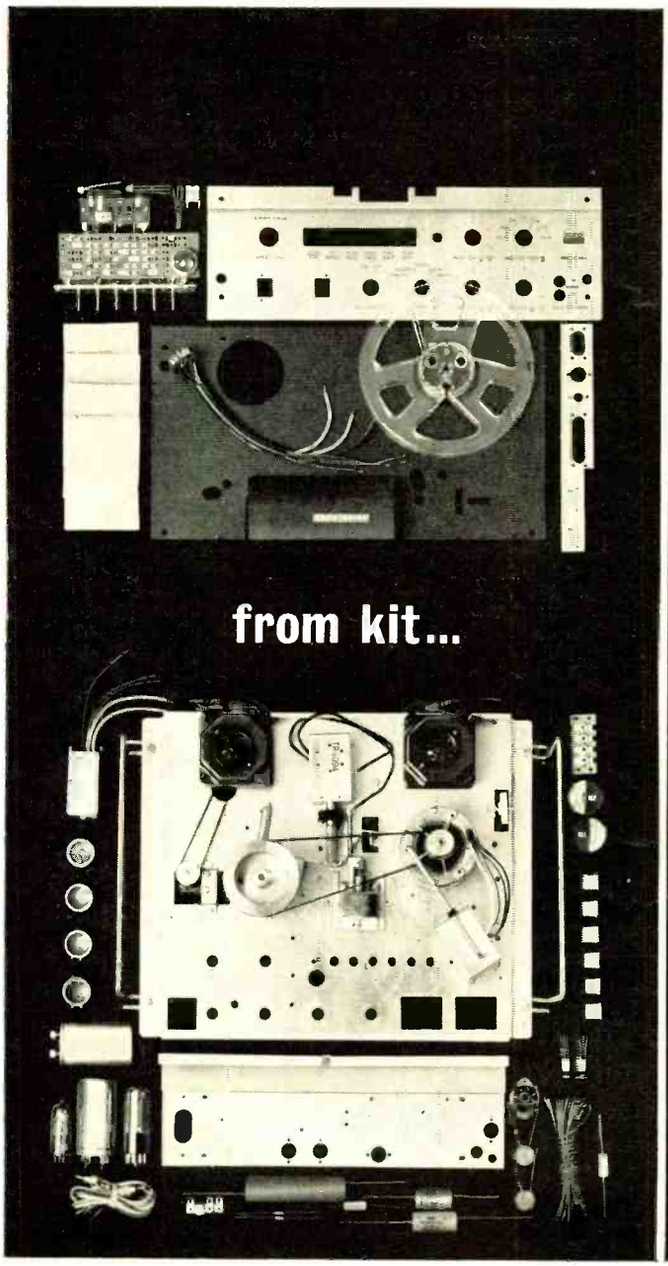
4. The errant swing arm, about which I complained and still do, has been "under investigation." No room for the air-damped pot used on the pro models; but a new solution is forthcoming, he says. Good—a serious practical problem has been recognized and an improvement is likely.

5. I noted that the pressure pad on the playback head, plus sharp edges that tended to catch the tape and a too-confined access via the "straight-line" tape path, made editing very tough for me. Mr. Straw has an excellent explanation. The pressure pad is removable, via one screw, leaving better space for editing. It is there, he says, to provide a very high defense against playback drop-out, which is vital in some of the industrial data recording for which the Crown is used. (A "home type machine?" Not entirely, you see.) Without the pad, playback drop-outs are normal for the industry.

My thought here is simply to wonder what are the relative merits and usefulnesses of the "straight-line" tape path and the curved path, as used notably by Ampex as well as in such home tape decks as the Eico. No pressure pads at all, contact maintained by tape tension against the heads. I note, mentally, that my Ampex 350 will play many tape splices without a trace of drop-out that are unpleasantly audible on other machines, including the Ampex 601. On the Crown, the hope is, Mr. Straw tells me, to eliminate the *record* pressure pad in due time, retaining the playback pad for its special anti-drop-out usefulness, if and when desired. I note that unless both are removed, tape insertion and removal is going to remain clumsy, as it is on every "slot-type" machine I have so far tried.

6. The sharp edges of which I complained are eliminated via plastic covers, already in production. Even better would be a revamping of the toggles that lie just underneath the left hand reel, ready to snag tape.

7. In addition to the trick bass and treble boost circuit available in *record* posi-



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. . . and as for quality factors: 3 motors—hysteresis synchronous capstan drive—transistorized electronics to eliminate hum and microphonics—automatic tape lifters—automatic shutoff—3 precision-lapped shielded heads adjustable in all planes—narrow-gap (0.0001 inch) playback head for maximum frequency response—consistency of high frequency response improved by hyperbolic-ground heads—separate record and playback amplifiers—high-torque tape start for precise cueing and editing—jamproof speed shift—dual recording level meters—non-critical bias setting—record safety interlock—rapid loading in sweep-line path that assures tight tape wrap-around on heads, no need for troublesome pressure pads—permanent bearing lubrication—digital tape index.

And the sound? Frequency response 30 to 15,000 cps ± 2 db at 7½ ips with 55 db signal-to-noise ratio. At 3¾ ips the frequency response is 30 to 10,000 cps ± 2 db with 50 db signal-to-noise ratio. Wow and flutter are below 0.15% at high speed, under 0.2% at low speed.

Summing up: *"THE EICO RP-100 will do as good a job as many recorders costing up to twice as much, and it is probably more flexible than any of them."* That's the unbiased test report of Hirsch-Houck Laboratories, published in Hi-Fi/Stereo Review. As a semi-kit the EICO RP-100 is **$299.95**. You can also buy it factory-wired for **$399.95**. Even then it's unmatched for the money. See the superb RP-100 and the complete EICO line of high fidelity components at dealers everywhere. For FREE 32 page catalog, 36 page Stereo Hi-Fi Guide (enclose 25¢ for handling & dealers' name, write: EICO ELECTRONIC INSTRUMENT CO., INC., 3300 Northern Blvd., L.I.C.1, N.Y. A-7

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tion, allowing direct equalization of a signal as it goes onto the tape, there's a new wrinkle underway which would allow an extra 20-db gain on the input by bypassing these boost networks. That still leaves a residue of 7-db boost in the highs, if needed, and the extra gain can be vital when working with low-gain mikes. The boosts are indeed useful for equalizing assorted cheap mikes that are lacking in bass and/or high response. Also, as I discovered, for touching up all manner of incoming signals before taping then—as, for instance, some old 78's I copied off, boosting the highs to improve speech intelligibility. . . .

This could go on and on, but my point is well enough made. This particular corporate personality has expressed an understanding of the usefulness of outside criticism of its product, both to its customers and to itself. As the old phrase goes, I'm happy to have been of some assistance. That's what a critic *always* wants to be—even when he's critical. I am heartened to feel that our particular industry as a whole is on the way to understanding that evaluation is a useful thing and never more so than when it really *evaluates*—i.e., balances the pro and the con. Especially the con!

DREAM FLIGHT

Speaking of flying machines, I had an amusing demonstration recently of the old and eternal conflict between the practical and the ideal in respect to engineering. It involved more top quality hi-fi—let's name no names, for this was a product practically symbolic, the epitome of a Type, the very embodiment of an Approach. I'm thinking of phono arms.

Let's speak of an Arm X, a hypothetical concept. Arm X, let us say, is designed to solve every problem known to arm geometry, without regard for compromise. It is all-out in its engineering. It embodies the sort of superb thinking that goes into the original concept of *every* marketable arm—and then is put nine-tenths quietly aside as impractical, under the circumstances. Ideas of the sort laid out and blueprinted in the mind at four o'clock of a sleepless night after a particularly frustrating day with the cost department and the hungry salesmen: if they won't let you have what you want, you can always dream-build—conjure up an Arm X—and then sleep the better for it.

Any Arm X, real or imagined, is bound to be a marvel of delicacy and exactitude, honed and polished to dream tolerances. Each of its precise parts meets a clear engineering problem without compromise. No factor is overlooked that might conceivably affect arm performance; nothing is spared that can make good engineering even better. This dream-creation is about as likely to "misperform" in any gross parameter as, say, New York's fancy automated subway train is likely to start off backwards with a lurch, instead of forwards. Arm X naturally is going to bring out the best in any associated cartridge, turntable or recording, given equivalent quality. It is a shining and elegant device, any way you look at it.

Well, there have been such arms, or almost. For real. Real enough so that I myself have had occasion to try out the type on my own turntables. That was the moment of truth when merciless practicality raised its ugly head. For it is a rare piece of hi fi, in this world of compromise, that combines ideal performance with utter simplicity! In a word, an Arm X is bound to be a bit complicated. And wouldn't you guess that it was my assistants, on at least two occasions, who brought home this fact to me with overtones of mayhem. Unsympathetic souls.

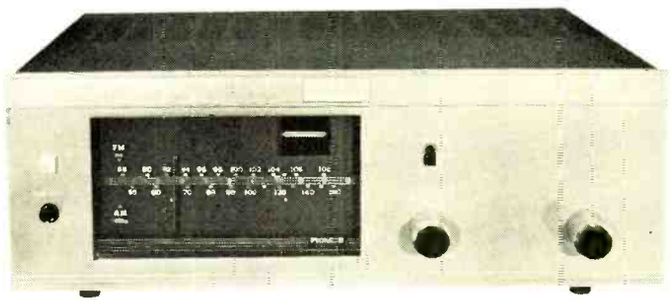
All I did was to turn over a potential Arm X for routine installation. I dodge those tasks if I possibly can. I'm Ten-Thumb Canby, and I'll take an hour to do a job that any of my varied assistants will do neatly in ten minutes. So the Arms X, like other arms, went straight to them, still in the packing box.

On the first occasion, I can recall, the otherwise mild and gentle soul who did the job brought the thing back to me as expected, neatly installed and ready to play. But he wouldn't go home without loosing such a diatribe concerning people who make life complicated, that I was left more confused than enlightened. The arm worked—of course. My assistants seldom admit professional defeat in my presence.

Now, I've just recovered from a renewed bout with practicality in the same fashion. It was another Arm X, or almost, an arm even better than its predecessor. My assistant at the moment is a salty character. He installed this arm circumspectly in his shop and the first hint of a reaction came to me in his very modest bill for 3½ hours of labor. On the bottom he wrote in a neat hand, "Miserable ————d!!!".

When he brought the thing around to me a few days later, I remonstrated. Look, I said, this is no ordinary arm. This is a very special design. It's supposed to be this way. Don't you understand that this

(*Continued on page 39*)



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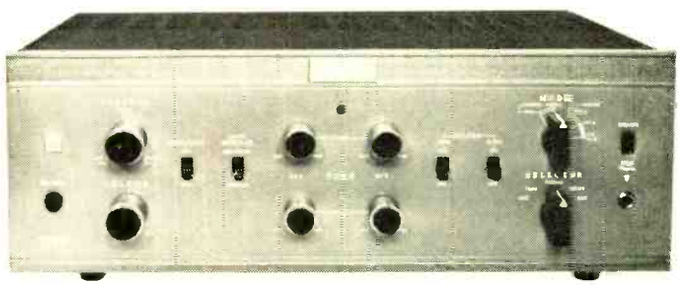

MODEL SM-500
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Now from PIONEER comes a stereophonic amplifier designed to satisfy the most critical ear, the Model SM-500, together with a matching tuner, Model AFT-14. Rich overall appearance, matching exterior designs, handsome gold-finished front panels with well-laid out and easy-to-handle controls and switches . . . these are but a few of the many enticing features of these two units.

The versatile Model SM-500 amplifier uses two pairs of the latest high-power output tubes operating in efficient push-pull circuits. Each channel provides a full 36 watts of clean undistorted power. The heaters of the preamplifier sections operate off well-filtered DC for completely hum-free operation.

The amplifier has all necessary circuits for versatile and efficient operation. These include independent bass and treble controls for each channel, or high and low (scratch and rumble) filters, to provide flawless reproductions of all material.

The Model AFT-14 stereophonic tuner, designed as a companion tuner for the SM-500, features high sensitivity and outstanding selectivity, for stable reception of AM, FM and FM multiplex transmissions.

Through the outstanding channel separation providec in reception of FM multiplex stereo, full-dimensional reception is provided for maximum stereophonic effects.

For professional applications too, the SM-500/AFT-14 combination is the ideal system.

SPECIFICATIONS OF THE AFT-14

12 tubes, Tuner; FM (88-108Mc), AM (535~1,605Kc), Usable sensitivity; FM 3μV, AM 50μV, Channel separation (FM MPX circuit); better than 30 db, Dimensions; 15 1/32 (W) x 5 3/32 (H) x 13 1/32 (D) inch, Weight; 18.7 lbs.

SPECIFICATIONS OF THE SM-500

9 tubes, 2 silicon diodes, Sensitivity; 3mV to tape amp. 200mV, 7 terminals, Music power output; 36 watts per channel, RMS rated power output; 25 watts per channel, Frequency response; ± 1 db from 5 cps to 100,000 cps at 1 watt output, Harmonic distortion; less than 1% at rated output, Dimensions; 15 1/32 (W) x 5 3/32 (H) x 13 1/32 (D) inch, Weight; 28.7 lbs.

PIONEER

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EDITOR'S REVIEW

QUICK HENRY, THE . . .

THOSE OF US who remember those well-advertised words of years ago remember that they signalled an impending attack by low-flying insects, and Henry's unnamed caller was asking him for the appropriate anti-missile missile.

We at AUDIO feel it is time to issue the same clarion call; we are being attacked.

It started a few months ago when Ed Canby took rather deadly aim at a problem confronting the owner of high-fidelity components (and the manufacturer of same)—completely inadequate service availability. That is, completely inadequate for the quality of instruments we are talking about.

At the outset it was quite obvious that Mr. Canby had touched a very sensitive nerve; we received many communications, some agreeing and some disagreeing. Without exception the communications were strong.

Last month we suggested that those technicians and service professionals who are interested in improving matters band together, set up standards of service for high-quality equipment, and proudly proclaim their adherence to high service standards. After all, the manufacturer of high-fidelity components goes to great expense and lengths to provide low-distortion high-performance equipment. Obviously we are talking about equipment which requires more of the serviceman than merely getting it in operating condition; it must be put in *top* operating condition.

Now for the attack.

In the June issue of a publication devoted to addressing the service technician the entire editorial was devoted to bitter denunciation of Mr. Canby and pooh-poohing his analysis of the problem. Frankly we were disappointed that a fellow editor would present himself so poorly. He completely missed the point.

Mr. Canby was not attacking the honesty of technicians. Nor was he attacking their ability to service TV, table radios, and other low-performance equipment. He was questioning technicians trying to service equipment that they *know* they are not qualified to service. (If they don't know, they are probably not even qualified to service TV.)

For example, it is standard practice to adjust component equipment for minimum distortion. In order to do this it requires test instruments at least an order of magnitude more accurate than the instrument under test. Thus to adjust the modern component amplifier for minimum distortion requires test equipment with less than 0.1 per cent distortion. (With some modern amplifiers it must be less than 0.01 per cent.) How many technicians have equipment that accurate?

A further example. Examining the service instructions accompanying a modern component FM-stereo tuner we note that the following (minimum) equipment is required to service it: VTVM (a.c.), FM signal generator (Measurements 210AB or equivalent), wideband oscilloscope, 400-cps null, Hewlett-Packard 200CD audio oscillator, and a multiplex stereo generator—about $2000 worth of test equipment. How many servicemen have that kind of test equipment?

Perhaps the most telling point is the note this manufacturer includes at the beginning of the alignment instructions:

> "No attempt should be made to align the tuner or repair it unless the person doing so has had extensive experience in tuner alignment and repair procedures and has the necessary laboratory equipment. Without proper experience or equipment, *the repairman may seriously damage the tuner.*" (*Italics by the manufacturer.*)

Thus, as a very minimum standard, the serviceman who wants to service component high-fidelity equipment must have test instruments capable of doing the job.

But that isn't all. Note that the manufacturer's statement requires the repairman to have extensive experience. The extensive experience he is talking about is in servicing high-quality equipment and not the get-em-out-quick kind. We are talking about the kind of experience which is painstaking and costly. Certainly it is true that nobody likes to pay a lot of money for servicing, but it is also true that a person who spends several hundreds of dollars for equipment is more concerned about top performance and is willing to pay for it. This applies to service as well as the original purchase. Most component owners are happier to pay more for service that completely satisfies them than to pay less for partial satisfaction. They demonstrated this trait by buying component equipment in the first place.

We have now presented two valid criteria for judging a serviceman qualified to service high-fidelity equipment—proper equipment and proper experience. With this as a starter we feel it is possible for servicemen who are interested in servicing component high-fidelity equipment, and who wish to proclaim their qualification, to band together and set up minimum standards. And police them!

We hope that the preceding will provide enough Flit to bring down the low-flying insects who prey on the owner of component high-fidelity equipment. Conversely, we hope that those servicemen who are properly qualified will take the spray-can by the handle.

THE CHICAGO HI-FI SHOW

We were pleased to be able to attend a good Hi-Fi Show in Chicage after so many years of rather mediocre events. Although not large either in number of exhibitors (29) or in attendance (5500), the typical spirit was there, and another show in Chicago before too many months should, with proper promotion, achieve the sort of attendance we have learned to expect from New York or Los Angeles.

Most interesting technical developments shown, according to this observer, was the multipath distortion indicator which appeared in two forms. The public seemed particularly intrigued by the Revere Stereo Tape Cartridge System, profiled in this issue.

Next time, we expect a *real* turnout at Chicago.

PARDON US

A number of people have inquired about the unidentified tape recorder at the lower left corner of the June cover. It is a Tandberg Model 64. Unfortunately it was not listed in the cover data. Shame, too, 'cause we're not even mad at Tandberg.

DIAMONDS BY CARTIER

a jewel for Garrard

save time

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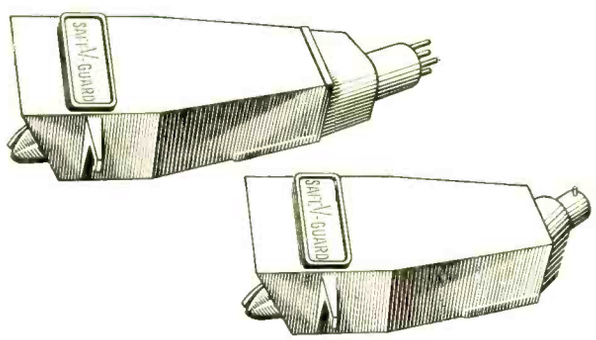
save records

Plug-in head assemblies with pre-mounted cartridges for Type A and Model AT6 Garrard Automatic Turntables.



Choose the **right** pickup for your Garrard installations — choose a Pickering — the new U38/ATG and the famous U38/AT are both available premounted in Plug-in Heads for Garrard Type A and Model AT6 Automatic Turntables.

FEATHERWEIGHT OPERATION — for maximum record protection, 1 to 3 grams tracking (recommended 2 grams) — where environmental conditions permit light tracking forces.

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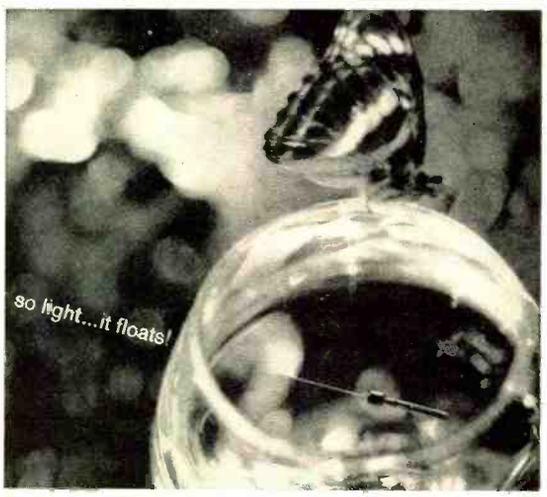
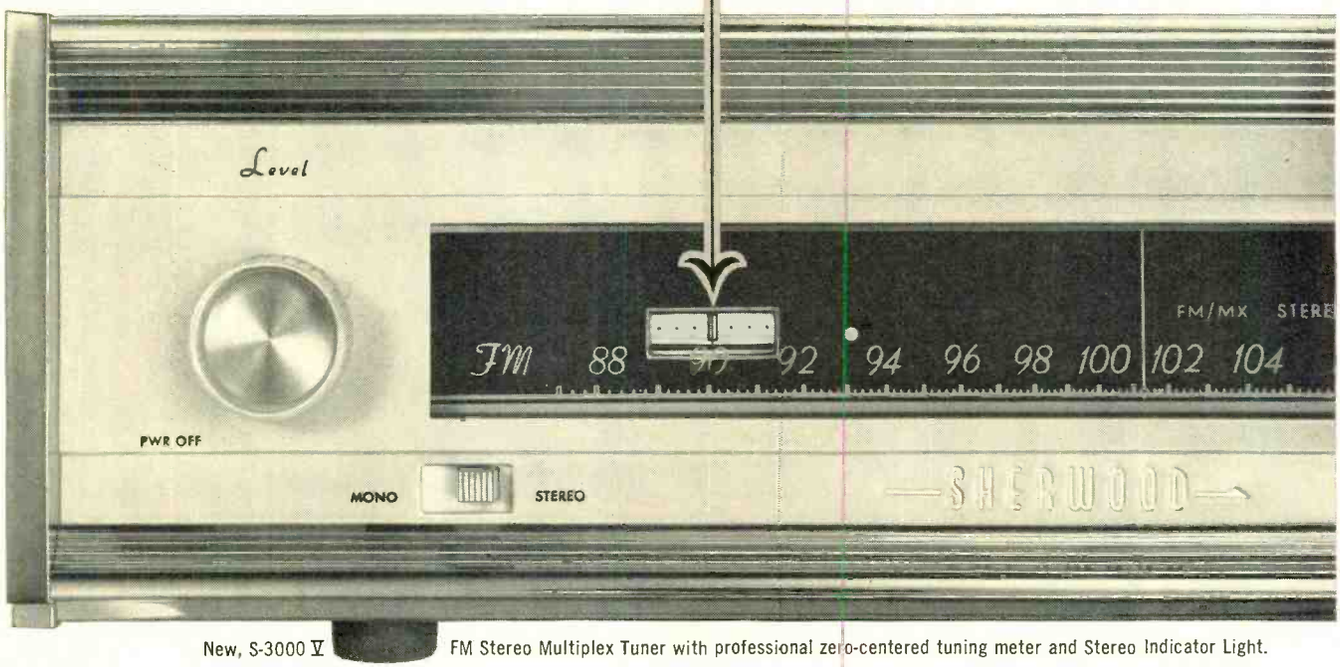


Featuring Pickering's exclusive "floating stylus" ...so little mass that it actually floats on water... so light it "floats" over the surface of your records. The Pickering "floating stylus" action protects the diamond and the life of the record while it plays.

FOR THOSE WHO CAN HEAR THE DIFFERENCE

Pickering PICKERING & CO., INC., Plainview, N. Y.

Why Sherwood "zeroed-in" on the problem of tuning accuracy



New, S-3000 V FM Stereo Multiplex Tuner with professional zero-centered tuning meter and Stereo Indicator Light.

The wider band requirements for the stereo information now being multiplexed on FM channels has made precision tuning a factor more-important-than-ever in FM reception.

Tuning eyes are good. Peak meters have value. But, these are yesterday's achievements applied to today's and tomorrow's needs.

This is why Sherwood engineers have incorporated a professional, zero-centered meter in the new S-3000 V Tuner. It tells when you are exactly on frequency. No guesswork. No maybe's. Only assuredness!

What difference does Sherwood professional zero-centered meter tuning make?

Quite a lot. It makes possible accurate, first-attempt tuning. You will find it isn't necessary to tune and then step back to listen and verify whether you tuned in correctly.

Secondly, "zeroed-in" tuning is particularly beneficial to obtaining minimum distortion and maximum stereo separation due to the added information multiplexed on FM stereo channels.

Third, you will just plain appreciate the added professional touch Sherwood has added to an already professional-quality FM tuner.

A bonus in tuning ease

Added to the professional accuracy of zero-centered meter tuning, Sherwood gives you a "can't-be-fooled" Stereo Indicator Light. Stereo broadcast identification is instant and positive.

This restless attention to all the details which can improve performance is why Sherwood components have been . . . and will continue to be . . . outstanding values.

Other value features of the S-3000 V

- **Superb sensitivity:** 1.8 μv (IHFM) for −30 db. noise and distortion.
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- **Flywheel tuning:** made with turntable accuracy for smoothest, fastest tuning.
- **Dial spread:** communications-type 20% longer scales provide professional accuracy.
- **Price:** $165.00 (less case).

If you want a component that combines tuner and 80-watt stereo amplifier in one compact chassis . . . see the new S-8000 III FM Stereo MX Receiver. Has zero-centered professional tuning meter and Stereo Indicator Light.
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A Professional Condenser Microphone

R. WILLIAMSON

In 1957 the author decided to do what amateurs are not supposed to do—build a professional-quality condenser microphone. Here are his footsteps for the serious, and extremely careful, amateur to follow.

FEW AUDIO ENGINEERS would deny that for flexibility of use and superiority of fidelity one particular type of microphone reigns supreme above all others—the condenser (electrostatic or capacitor to the technical *avant garde*). Now in almost universal use where the highest quality is demanded, the modern condenser microphone has that often indefinable "something" that makes it the preferred type amongst discriminating professional engineers and audiofans alike. Unfortunately, along with its superiority of performance, all condenser microphones share one common denominator, that of high cost. It was this last factor which induced one impecunious audio enthusiast to undertake in 1957 a detailed study of the basic design features of all condenser microphones and, if at all practicable, to actually construct one. This article is intended as a broad survey of a venture that so far has proved highly successful and more fruitful than originally anticipated. The information herein may be of some help to any other enthusiast who is tempted to tackle a rather difficult construction project.

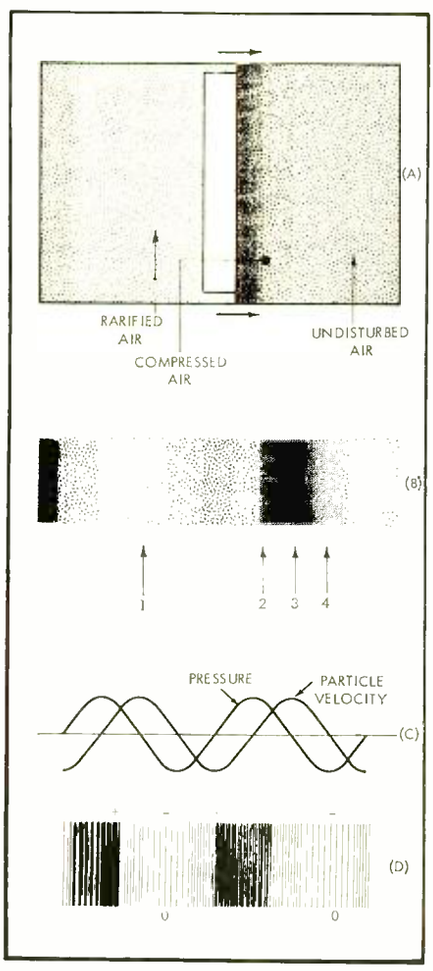


Fig. 1. (A) and (B) show generation of a plane sound wave by a vibrating body. (1) and (3) show node and anti-node of pressure component; (2) and (4) similarly show node and anti-node of velocity component. (C) and (D) show the same thing in graphical form.

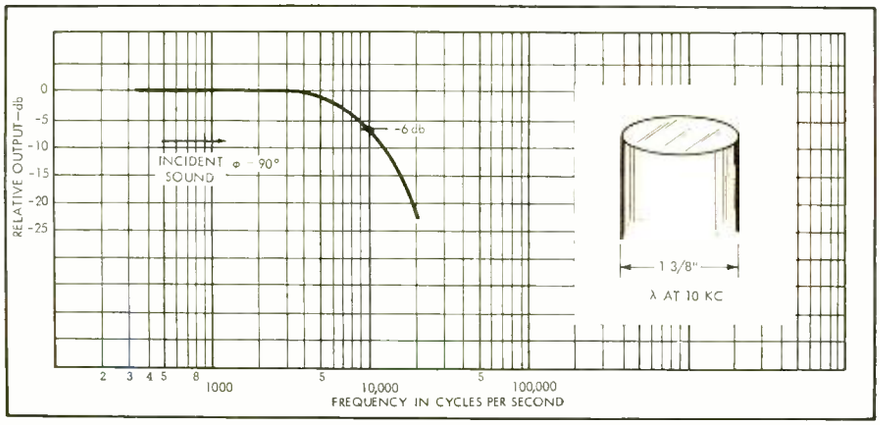


Fig. 2. Phase-loss effect.

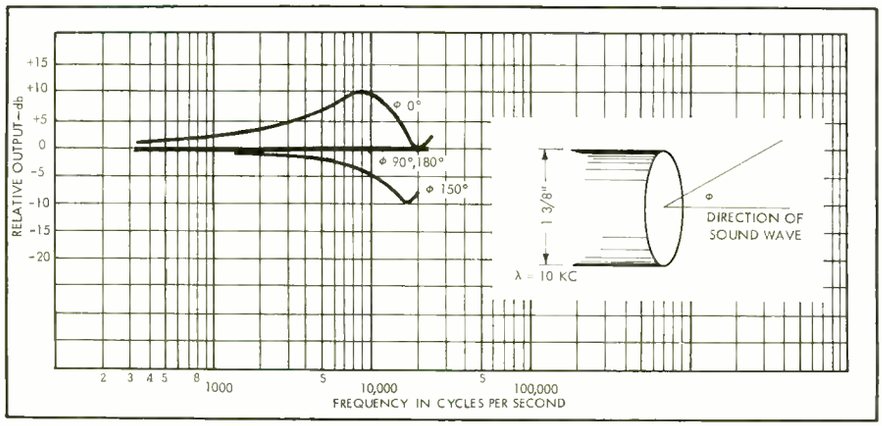


Fig. 3. Diffraction by cylinder.

To understand fully the construction of a modern condenser microphone, it is vital to familiarize oneself with the basic design features first. Otherwise it is quite easy to make what seems to be an insignificant alteration to a particular constructional detail, with subsequent adverse effects on the performance of the finished microphone.

All microphones are electroacoustical transducers; that is, they convert acoustics energy into electrical energy. All microphones have a diaphragm coupled to an electrical generator and, in common with ribbon microphones, the diaphragm of a condenser shares both functions. Essentially, it is a variable capacitor with one fixed element and one (the diaphragm) free to move in sympathy

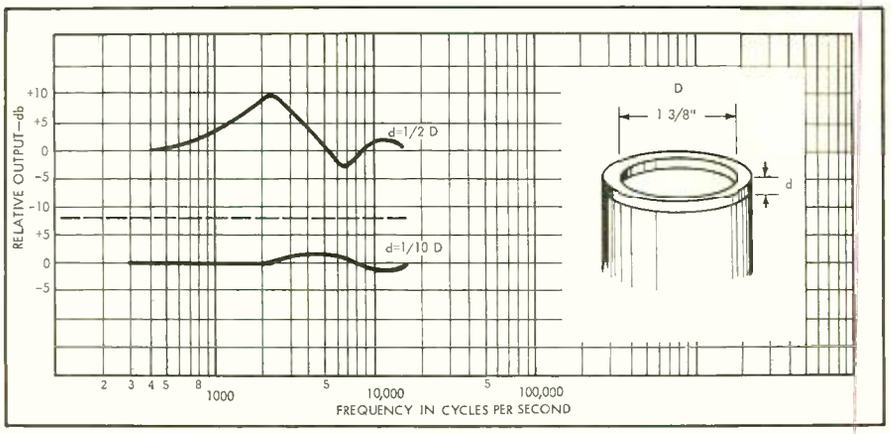


Fig. 4. Effects of clamping ring (cavity resonance).

with sound vibrations impinging upon it. Dependent upon the type of microphone, the diaphragm will respond to either the pressure or the velocity component in a sound wave, ignoring for the moment the types which respond to both (*Fig.* 1). A velocity-sensitive diaphragm will respond only to the pressure difference between the two sides, so such a diaphragm is open to the sound field on both surfaces. A typical example is the ribbon, and it is well known that all such velocity microphones are bi-directional and have maximum sensitivity to sound sources at right angles to the plane of each side of the diaphragm. Since, too, the forces which operate on each side of the diaphragm are 180 deg. out of phase, the electrical output will also be 180 deg. out of phase for sounds on each side of the microphone. Pressure-operated mircophones, on the other hand, respond only to the pressure component in a sound wave and only one side of the diaphragm is exposed to the sound field; the other side is completely enclosed and internal pressure is constant. Since the pressure component in a sound wave is also constant, irrespective of directionality of source, a pressure-operated microphone is omnidirectional, that is, gives constant electrical output whatever the direction of the sound source. Into this latter category came the earliest condenser microphones.

We can now consider the operation of a simple condenser microphone system consisting basically of a stretched diaphragm and a totally enclosed fixed electrode. The capacitance between them will vary as the diaphragm responds to sound vibrations and if a polarizing potential is applied across the diaphragm and fixed electrode through a very high resistance, the charge will be held constant. Since $V = Q/C$ the voltage across the condenser will vary inversely with its capacitance. The diaphragm of early condenser microphones was usually aluminum or one of its alloys, and a fraction of 0.001-in. thick. It was stretched so that when the compliance reactance equalled the mass reactance, the resultant resonance occurred at the upper end of the audio band. Below this frequency the diaphragm compliance determined the velocity of movement for a given sound pressure. As the reactance of the compliance varies inversely with frequency (compliance being analagous to capacitance) the velocity will also vary inversely with frequency. Thus the amplitude of movement will remain constant with frequency, but rising near the diaphragm resonance. The designer then contrives to introduce narrow channels and cavities in the space between the diaphragm and the fixed electrode, heavily damping the diaphragm resonance. This is roughly similar to resistance being introduced into a resonant electrical circuit to lower the "Q." Unfortunately, the "upper end" of the audio band has been moving steadily upwards over the past 30 years (and judging by some of our hi-fi amplifier specifications, is currently in the region of a megacycle!). Since sensitivity was inversely proportional to the frequency of this first fundamental resonance, plus the difficulty of stretching the fragile metal used as a diaphragm, the early microphones often had resonances as low as 8000–10,000 cps. Whilst this resonance was usually well damped, it did introduce coloration into the sound and it has been suggested that it was a contributory factor to the "steely" string tone of our early LP's. Superior diaphragm material came along with the rapid evolution of modern plastics—first polyvinyl chloride and now polyester film is in almost universal usage. Metal is rarely used, except where exceptional stability of characteristics is desired, such as accurate sound field measurement. Plastic diaphragms are rendered electrically conductive by an extremely thin film of metal, usually gold, silver, or aluminum vaporized in a vacuum and allowed to condense on the surface of the diaphragm. Only one surface is coated, that which is away from the fixed electrode. This provides a safety measure against accidental contact between diaphragm and fixed electrode, thus permitting a rather smaller gap than previously possible with metal diaphragms. The lower mass of these modern plastic foils has made it possible for the microphone designer to push the resonance to a much higher frequency, certainly well out of nuisance range and is determined almost entirely by the compliance of the air film in the cavity between the fixed electrode and diaphragm.

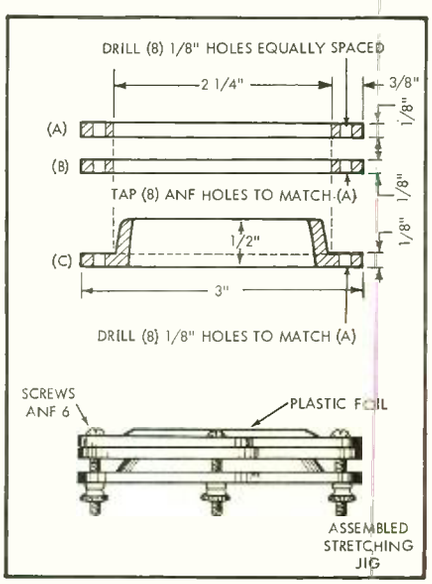


Fig. 5. Diaphragm mounting jig. Assemble by alternating ¼-in. long screws with ¾-in. long ones. Knurled nuts are screwed on the ¾-in. screws, and are used to stretch the membrane by forcing the boss on ring "C" into the plastic.

So far we have considered the function of the diaphragm and its influence on the main criterion of fidelity, frequency response, and bandwidth. There are, however, other important factors which influence the performance of a microphone —its shape and size. Ideally, the best microphone is one not there at all. This is not as nonsensical as it sounds and it is not entirely out of aesthetic consideration that modern microphones, particularly those used on TV are becoming more and more inconspicuous. A microphone literally stands in its own sound shadow, and its very presence will influence its frequency response and directional characteristics. These effects become significant when the wavelength of sound is a substantial fraction of the actual physical dimensions of the microphone. The net effect is usually to make the microphone more sensitive to the incident sound and less sensitive to reflected sound. In other words, there is a deviation from true omnidirectional characteristics and with increasing frequency to some degree of directionality. This may or may not be an advantage, dependent upon the designer's intention. With microphones designed for accurate sound field measurement, such an effect is usually undesirable and it can be

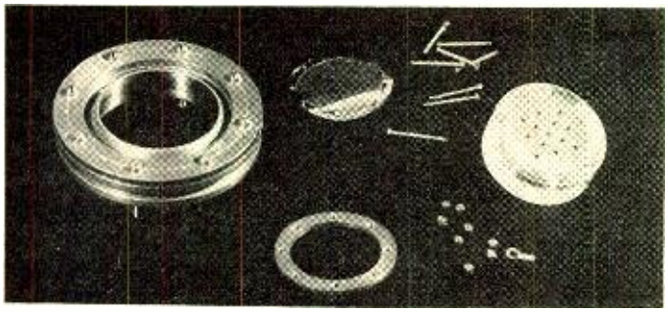


Fig. 6. A dismantled capsule with a discarded diaphragm. Assembly on left is diaphragm mounting jig.

shown that the dimensions of such a microphone should be of the order of 5/8-in. diameter or less. However, for reasons it would take too long to go into, it has been found that complete omnidirectional characteristics are rarely desirable with, for example, orchestral music, and some degree of directionality is an advantage—say, above 5000 cps. Dimensions of 1 to 1 3/8-in. are common, and the attendant non-linearity can be minimized by the actual shape of the microphone. A sphere is the ideal, but does introduce construction problems, particularly for the amateur. There is also little point in designing a small microphone element unless the casing in which it is mounted has comparable dimensions. As we will see later, the casing of our prototype condenser microphone has to contain rather more than just the microphone element and as the writer has discovered, this was not amongst the least of the problems involved. A cylinder is the next favoured shape and is a satisfactory compromise, giving a reasonable performance commensurate with constructional difficulties. *Figures* 2 and 3 show the deviation from frequency linearity resulting from the two main effects know as "diffraction" and "phase loss." Graphic illustration of these effects has assumed a perfect plane wave, that is, one in which the entire wavefront is at a right angle to the direction of propagation. Such perfect plane waves in free air are rare, although the condition is approached for spherical waves at a considerable distance from the source. Also, sound never strikes a microphone from a precise angle (except in an anechoic room) but is diffused by surrounding objects, e.g. walls and so on. So it is perhaps fortunate for all microphone designers that the subjective performance of a microphone is usually far superior to that predicted in theory, otherwise an embarrassingly large proportion of the world's microphones would have been thrown out by their owners long ago!

One final consideration remains—the avoidance of cavity resonance. Any cavities in close proximity to the microphone, having dimensions comparable to wavelengths within the audio spectrum, can resonate and so modify the sound field pattern. A simple experiment can show this effect by speaking with a can held against the mouth. The hollow sound that results is caused by the absorbtion of a narrow band of frequencies within the audio spectrum. Obviously, the microphone casing itself is a possible cause of a pronounced cavity resonance and precautions must be taken against this. Effective sealing of the main body of the microphone casing against excitation by the sound field is the only method of prevention. A less obvious resonant cavity is the actual diaphragm-clamping assembly. A shallow cavity is formed of the diaphragm clamping ring, thickness (d) and its diameter (D). *Figure* 4 shows the effects of such a resonance and clearly demonstrates that for it to have negligible effect, the depth of the cavity, and thus the thickness of the clamping, ring, should not be greater than 1/10 the diameter.

Construction

We have now reached the point where the actual construction details of the prototype microphone can be examined. Whilst many of the design parameters could have been worked out mathematically beforehand, it was decided that the empirical approach would be tried first. At least, if preliminary tests proved encouraging it would be some indication whether the project was worth pursuing. (It must be admitted that the original intention was some practical demonstration to silence the "doubting Thomases" amongst the writer's fellow audiofans. All had declared the whole project harebrained—amateurs just don't *make* microphones.) A number of test microphone capsules were constructed of varying diameter, in which provision was made for adjustment of the gap depth behind the diaphragm and the size and depth of the damping holes. A series of tests were made to show the influence of any variation in these factors upon the sensitivity and frequency response. The two basic tests were free field measurement and direct excitation of the diaphragm with an electrostatic disc. These early experiments revealed that a surprising degree of latitude was permissible in actual construction details, so from the data obtained a prototype capsule was made. The diaphragm material used was polyethylene terephthalate, a polyester film of British origin, marketed under the trade name "Melinex." It can be obtained in 6 μ thickness and coated with a thin film of aluminum. (No doubt "Mylar" of similar thickness would be

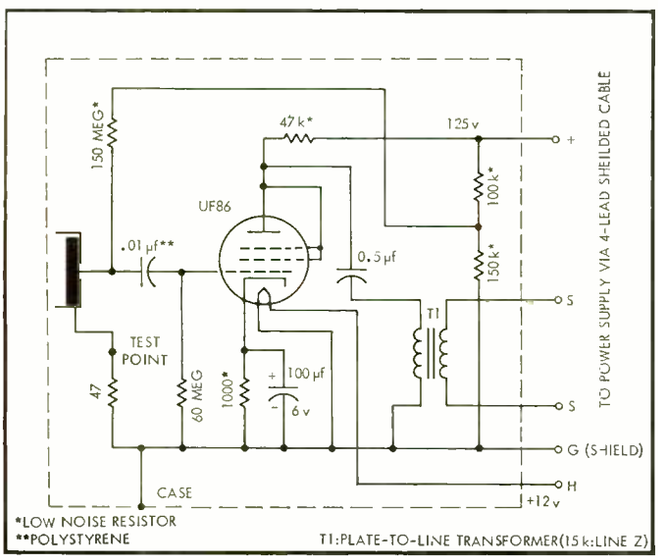
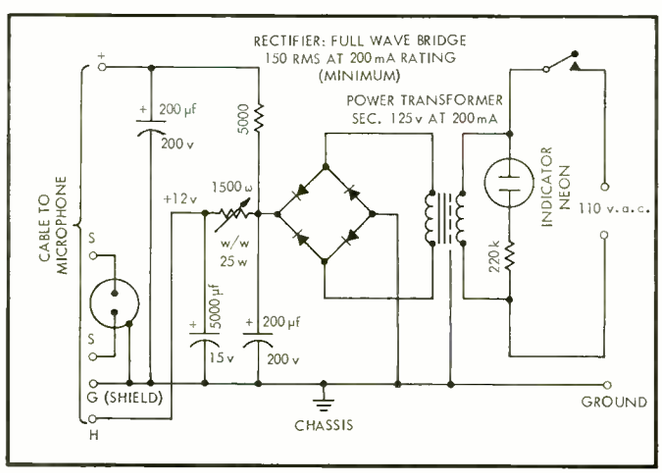


Fig. 7 (left). Schematic of microphone. Fig. 8 (below). Schematic of power supply.



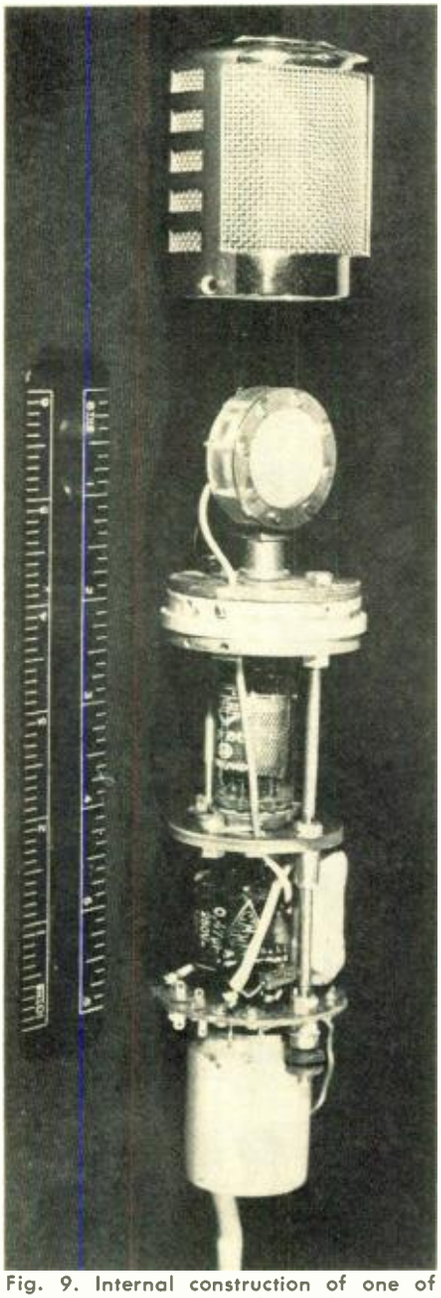


Fig. 9. Internal construction of one of the microphones. The plate-to-line transformer (balanced 30–50 ohms) is at the lower end. Note that the 2-in. diameter metal case and bottom cap are not shown.

equally satisfactory). The body of the capsule was fabricated on a lathe from one of the methacrylate plastics, "Perspex." (Again, "Plexiglas" would probably do just as well.) The clamping ring and center electrode are of brass. The construction of the capsule demands reasonable proficiency in lathe work and the simple technique adopted to provide the accurate gap between the fixed electrode, and diaphragm should be of interest. Both electrode and body are made slightly over thick, with the electrode a snug fit inside the body. A shim of 1-mil thickness is fitted behind the electrode and firmly clamped by the retaining screw into the plastic body. The face of the entire assembly is then turned down carefully in the lathe to the required dimension. Tool marks should be as little as possible, although a high polish is neither necessary or desirable. Both body and electrode are then given a minute "key" mark at the edge with a scriber and the electrode removed. With the shim discarded, the electrode is thoroughly cleaned and replaced, the "key" marks being used to ensure an identical position in the plastic body. The uniformity of the 1-mil gap can be checked visually by a steel ruler held edgewise against the surface of the plastic surround and examined whilst held up to the light. If all is well, the holes can now be drilled, again with great care, all burrs and metal particles being thoroughly cleaned away on completion. The actual diaphragm mounting technique was a minor problem and was eventually solved with a simple mounting jig (*Fig.* 5 and 6). There was some toying with the idea of a self-stretching clamping ring, but such a ring always effectively increased the diameter of the capsule. As mentioned earlier, this was undesirable and so was rejected. The plastic is clamped between the two rings, coated side upwards. The third ring with the stretching boss is carefully fitted over the four long, alternately spaced clamping screws, and the plastic very gently stretched by tightening the four knurled nuts. Stretching should be only *just* enough to remove the natural wrinkles in the plastic (which, incidentally, should be examined carefully for any minute flaws before being selected for use). It cannot be emphasized too strongly that the whole mounting process must be carried out in conditions absolutely clean and free from dust. It is admittedly difficult to create in the average amateur's workroom conditions akin to a factory "white" area, but the writer can confirm from bitter experience that the slightest particle trapped between diaphragm and electrode will eventually cause failure of the capsule and usually at the most inconvenient moment. The body of the capsule should now be held against the uncoated side of the stretched plastic and by breathing on the coated side the position of the screw holes for the clamping ring will become visible. At the same time, the surface of the diaphragm should be examined to ensure that no particles of dust or grit are trapped behind the diaphragm. If during the entire mounting procedure there is any indication of this, then the whole process *must* begin again. It is permissible to clean the surface of the electrode with a lintless cloth moistened with carbon tetrachloride, but cleaning of the plastic should be kept to a minimum, no more than a very gentle brushing with a soft sable brush.

If at this stage all is well, the diaphragm is very gently pierced with a

(*Continued on page 43*)

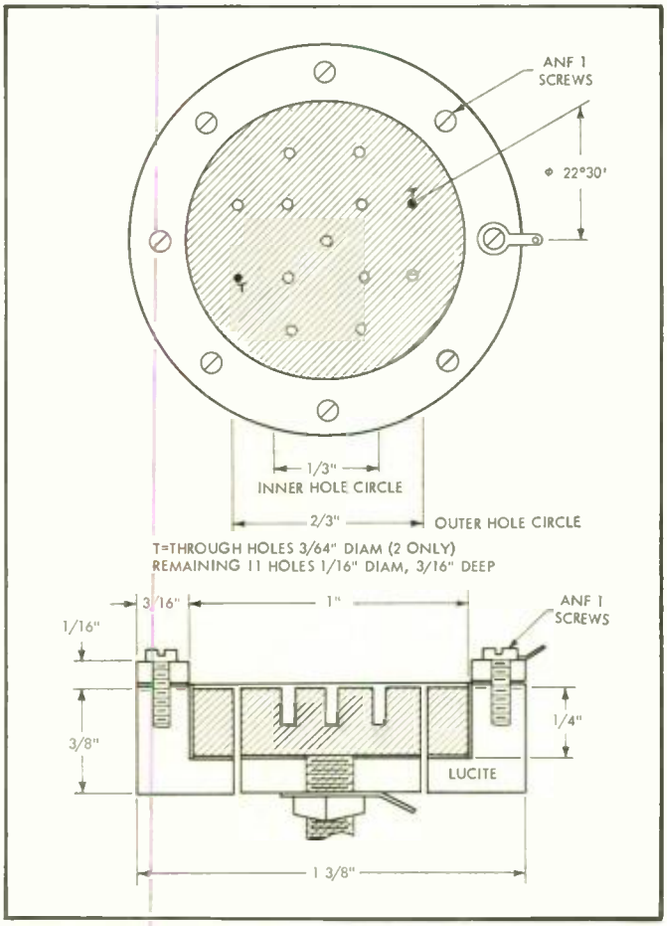


Fig. 10. Dimensions of the capsule.

Sound Reinforcement at the Ziegfeld

GEORGE SCHIMMEL

In the theater the unexpected is expected, so that the sound reinforcement system must be flexible enough to cover many possibilities.

Problem: To put together a sound reinforcement system which would satisfy the needs of the Maurice Chevalier Show scheduled to open January 28, 1963. The problems boiled down to:

1. Only 16 working days to set up system.
2. The parabolic dome of the theater required extra-careful design of the sound reinforcement system to avoid echos and other unwanted effects.
3. Decor and architecture could not be changed.

The Place—Ziegfeld Theatre

This theater, located at 6th Ave. and 54th St. in New York City, was built for "Flo" Ziegfeld in 1927 and is now owned by Billy Rose. In effect, it is a deep oval dome about 100-feet wide and 75-feet from the stage to the back of the orchestra. (See *Fig.* 1.) On top of this dome, resting on it like a hat, is a smaller dome. At the rear juncture of the two domes is a large glass viewing panel, behind which is Mr. Rose's office. The last row of the balcony begins just below this point. The balcony slopes steeply down for about 75 feet with its first row terminating about 35 feet from the stage. The seating capacity is 856 in the orchestra and 722 in the balcony; a total of 1628.

The vast unbroken curved surfaces of walls and ceilings are of plaster covered with smooth paper. The stage has a floor of tempered masonite, and its rear and side walls are of whitewashed brick. Above the stage floor, rising to a height of about 75 feet, is an open area containing various drop curtains along with the gear for raising and lowering them. Seats are of upholstered material with a fair degree of absorption, and the orchestra and balcony floors are carpeted. These construction features combine to present, over-all, a formidable set of acoustical conditions. Reverberation, echo, and feedback problems were anticipated and it was immediately apparent that careful planning in choice and location of speakers would be of primary importance.

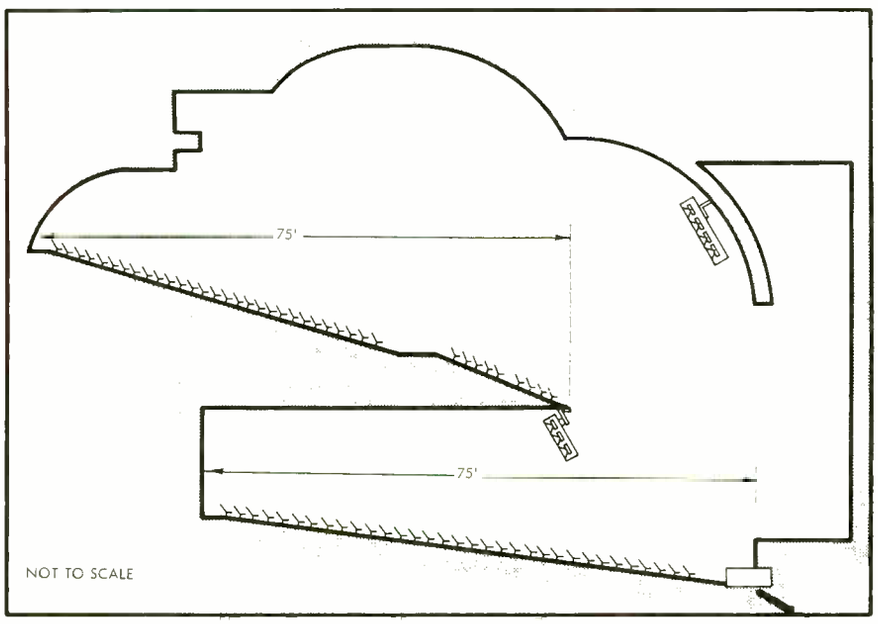


Fig. 1. Side view of the Ziegfeld theater showing location of the column speakers. Only one under-balcony speaker is shown although there are actually two, one at each side. The drawing is not to scale.

Speaker Selection

A low-level multi-speaker system was first considered and then rejected for a number of reasons. Among these were higher costs, valuable time sacrificed in running the additional speaker lines, and the difficulty in installing a large number of speakers in a manner which would be least harmful to the decor.

Consideration was then given to high level speakers in the area above the proscenium arch. Two locations, one at each side, at a height considerably above the balcony rail, had in former years, contained horns. Speakers or horns mounted here, it was felt, might present a feedback hazard. The arch curves horizontally inward above the stage while the stage itself curves outward. Portions of it, therefore, would be exposed to substantial amounts of sound.

Further inspection of the curved area immediately above the proscenium arch revealed a square opening high above the arch, exactly in line with the center of the theater, and several feet forward of the stage. A line-source array or column suspended here was expected to cover most, if not all, of the balcony plus the first few rows of orchestra. No more than two additional speakers might be needed for the rear of the balcony, and two small columns for the under-balcony area of the orchestra would certainly be adequate. Further, the reduced vertical dispersion, which is characteristic of columns, would substantially attenuate the amount of unwanted sound reaching the stage below, and the ceiling dome above, thereby minimizing feedback to the stage and reflections from the dome.

Investigating these possibilities further, it became apparent that the under-balcony and balcony rear auxiliary speakers would present a two part problem. First, sound reaching the rear of the balcony from the proscenium speaker

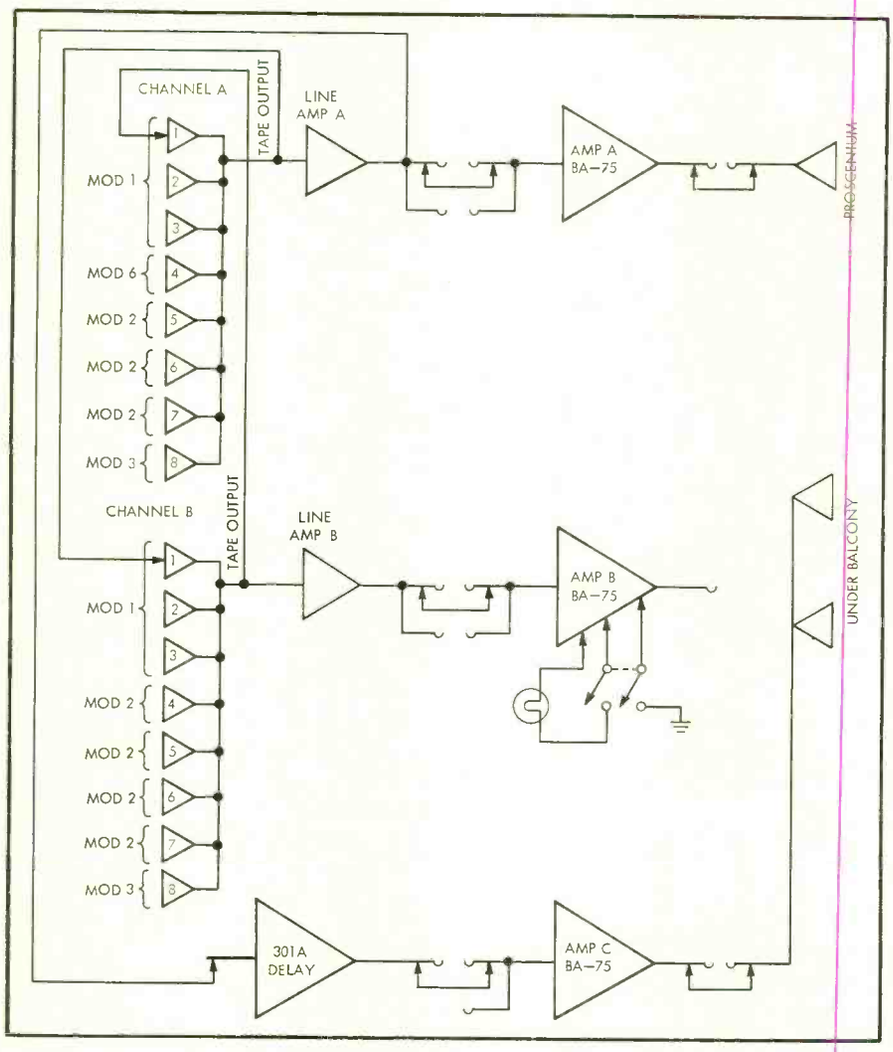


Fig. 2. Block diagram of the system.

more than 100-feet away would take almost a tenth of a second to arrive. The same sound from the speakers mounted in the balcony would reach the listener with no delay. This time difference would be more than enough to cause an area of severe confusion and echo with consequent loss in intelligibility. This would, of course, also be true for the under-balcony area where the distance difference of about 65 feet would cause a time difference of about 50 milliseconds.

The second part of the problem would be the distraction caused by the auxiliary speakers to the listener sitting nearby, since the sound which appears to originate on stage actually comes from the rear or sides. This effect can cause extreme annoyance and was expected to be as severe for the area under the balcony as for the rear rows of the balcony.

The same solution would be used for both problems. Intelligibility would be restored by delaying the sound to the auxiliary speakers an appropriate amount of time, and the illusion that the sound source is at the front would be achieved by an additional time delay.

The instrument for achieving the time delay was a rack-mounted endless-loop tape recorder which has two playback heads mounted on a track so that the distance between record and playback heads can be adjusted. This provides two adjustable and separate time delays from 25 to 180 milliseconds, equivalent to 28 to 200 feet. Loop speed is 30 ips, frequency response 60 to 15,000 cps within 2 db and signal-to-noise ratio 50 db. This time delay instrument is made by Audio Instrument Co., their Model 301A.

The choice of a speaker column was the next problem. In order to secure coverage for the first few rows of orchestra and the rear of the balcony as well as the main balcony area, an untapered column turned out to be best. Tapering in columns reduces lobe effects, which reduces vertical beam width. In most cases minimum vertical angle is highly desirable as an effective control against feedback. However, a certain amount of vertical coverage was needed for the first few rows of the orchestra in this case. It was also hoped that expanded vertical dispersion would eliminate the need for auxiliary speakers to cover the topmost section of the balcony.

A subsequent attempt to reduce vertical beam width through tapering to correct an echo from the dome indicates these assumptions are valid. The echo was eliminated by tilting the column down about 10 degrees. This is not meant as an argument against tapering. It merely points up a single instance

Fig. 3. Operator Karl Harz at console in sound room at side of stage.

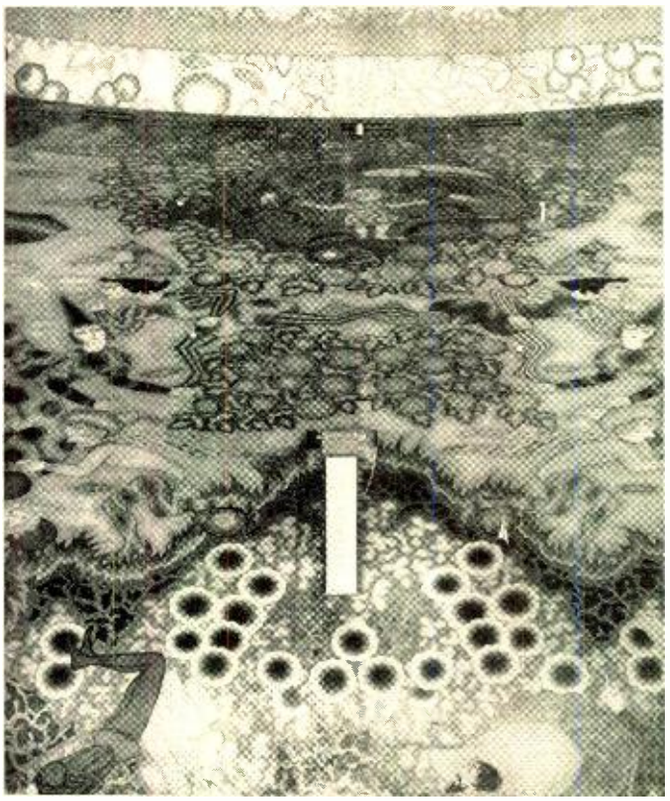


Fig. 4. Sound column suspended from ceiling through square cutout. Lighter-colored portion at top is smaller dome.

where normally undesirable lobes can be utilized to advantage.

The column selected for above the proscenium is the Sound Columns Inc. Model AS 20 (*Fig.* 4). It is a line array of six 8-in. permanent magnet direct radiators, 9 inches from center to center. It is enclosed in a ¾-in. plywood case measuring 52 × 11 × 8 inches. The manufacturer rates dispersion at 20-deg. vertical and 120-deg. horizontal. This single AS 20 provided adequate coverage with good quality for the entire balcony and the first few rows of orchestra, thus serving a total of about 1000 people. No auxiliary speakers were needed for the rear of the balcony.

Two Model AS 15 sound columns were used for under-balcony coverage (*Fig.* 5). These are arrays of four 8-in. speakers. Vertical distribution is rated at 30-deg., horizontal at 150-deg. The Enclosure is 36 × 11 × 8-in. These were installed on swivel mounts at either side of the orchestra, just below the point where the balcony meets the wall Fed from the time delay, they also have been very satisfactory. The total delay (about 60 milliseconds) was determined by trial and error.

The Electronics

A major stumbling block in planning installations of this type is a lack of specific knowledge as to eventual requirements. This one proved no exception. I was advised that the Chevalier show would most likely require no more than three microphones, but no one knew for sure. It wasn't known what, or how much, accompaniment Mr. Chevalier would bring with him. Naturally, under these circumstances, a very flexible system was called for. I found this flexibility in the Harman-Kardon Modular Galaxy system. In these units I found a preplanned flexibility made to order for just this kind of situation. Through the use of plug-in modular units, just about every conceivable eventuality had been anticipated. To illustrate, beginning with the knowledge that at least three microphone inputs would be required, and that duplication for insurance against equipment failure would be desirable, I rack mounted two PR-1 mixers. These units contain the basic module No. 1 which provides two high-level and one low-level input channels. Plug-in transformers are available for 600-ohm and 50- or 250-ohm balanced input. The chassis also contains a line amplifier with a choice of 600-ohm balanced or unbalanced, or 150-ohm unbalanced outputs, and a solid-state regulated power supply. Included on the panel are bass, treble, low-frequency cutoff, and master-volume controls. There is an illuminated VU meter, and a headset monitor jack. A recording output is located at the rear of the module No. 1 chassis. Space is provided for five additional modular plug-ins, making this unit expandable to a total of eight individually controlled channels.

Six different modules are available. Module No. 1 is basic and is supplied as part of the mixer. Module No. 2 is a multiple-input unit. It provides control and preamplification for either high- or low-impedance microphone, tape head, or magnetic phono. Plug-in RIAA or NAB equalization is available for records or tape (at either 3.75 or 7.5/15 ips). An anti-feedback filter switch is mounted below the pot on the front panel. Module No. 3 is identical to No. 2 except that phono and tape equalization are built in, and a switch permits selection between phono, tape, and microphone from the front panel. This one is called the switched-input module. Module No. 4 is a variable compressor/limiter for one channel with input facilities identical to module No. 2, plus a high level input. Module No. 5 is a precedence unit, permitting the introduction of emergency messages, time signals, and so on, which may override or completely interrupt program. It has input and control facilities identical to module No. 2. Relative level can be set between override and program. Module No. 6 is an all-channel limiter providing up to 40 db of limiting and has input and control facilities identical to module No. 4. Each module has locking 3-pin receptacles at the rear of its chassis for microphone input. The locking feature is valuable protection against accidental disconnect of the microphone cable. Plug-in for remote gain control of up to six low-level microphone channels, and a.c. power or plate voltage "standby" is also provided.

In this installation (see *Fig.* 2) two No. 2 modules and one No. 3 were first added to each of the two mixers. 600-ohm balanced outputs and multiples were wired to a jack strip, rack mounted below. This further expanded the flexibility so that the components might be used for duplicate standby or to cascade available facilities. In conjunction with phones, the jack strip is also available for rapid location and isolation of trouble.

Three Harman-Kardon BA-75 booster/power amplifiers were installed at the

(*Continued on page 42*)

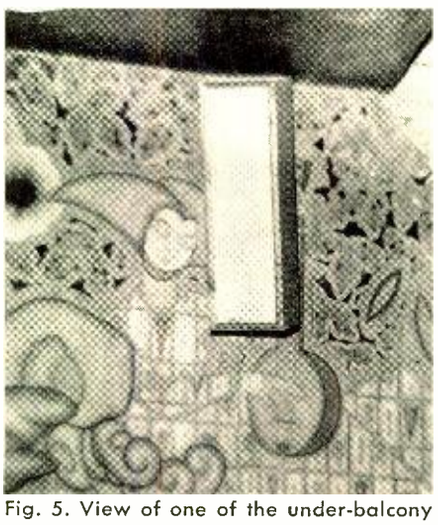


Fig. 5. View of one of the under-balcony speakers.

Class D Amplifiers

GEORGE FLETCHER COOPER

A closer look

IN TWO PARTS—PART I

LAST MONTH I gave a quick survey of some ideas of the use of pulse modulation which have been discussed in the British Journal *Wireless World*. The readers of that journal are of the bulldog breed and will probably be chewing away at these ideas in the letters column for months. Letters to the Editor are a great British institution and even Queen Victoria once wrote to *The Times*, anonymously, to defend herself. I have never understood why they are less popular in America: they are easy to write, because they are short, and they are free copy. What has one got to lose? I expect to see some more interesting circuits pop up as letters during the next few months.

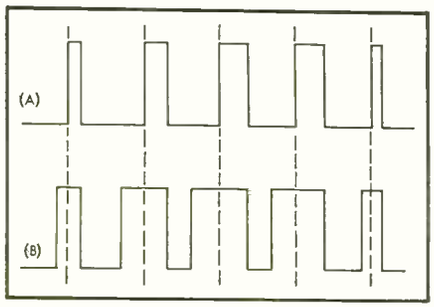


Fig. 1. Single- and double-edge modulation.

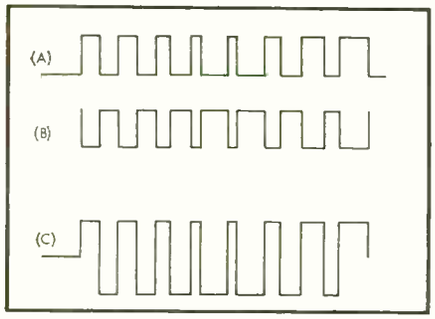


Fig. 2. Two half-waves and the push-pull output.

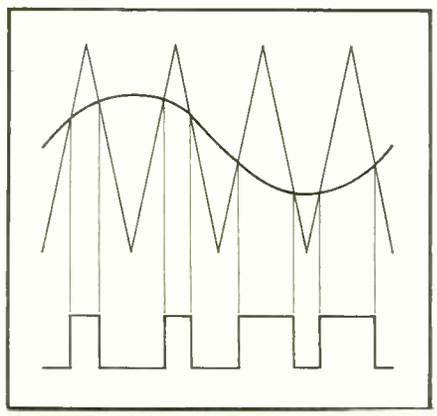


Fig. 3. Use of a symmetrical sawtooth for double-edge modulation.

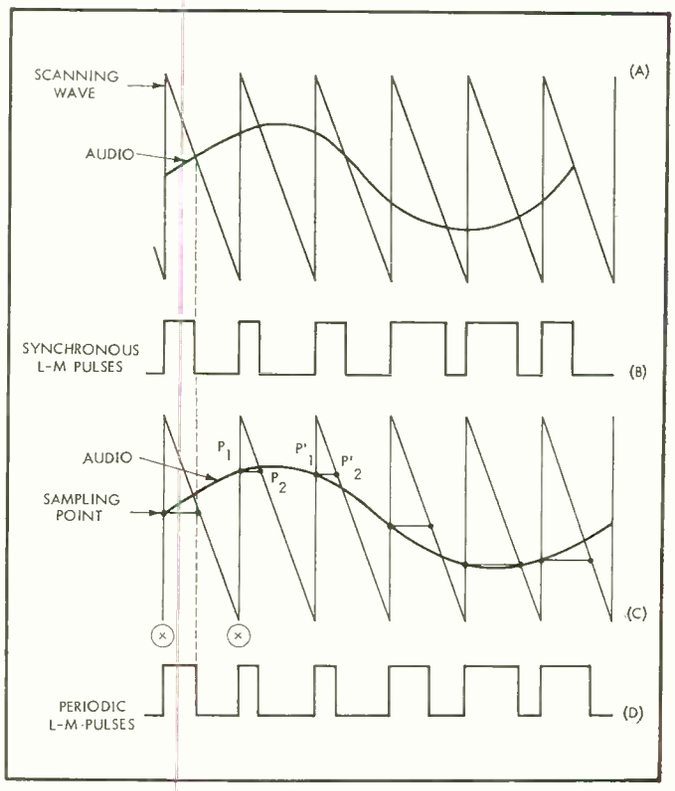


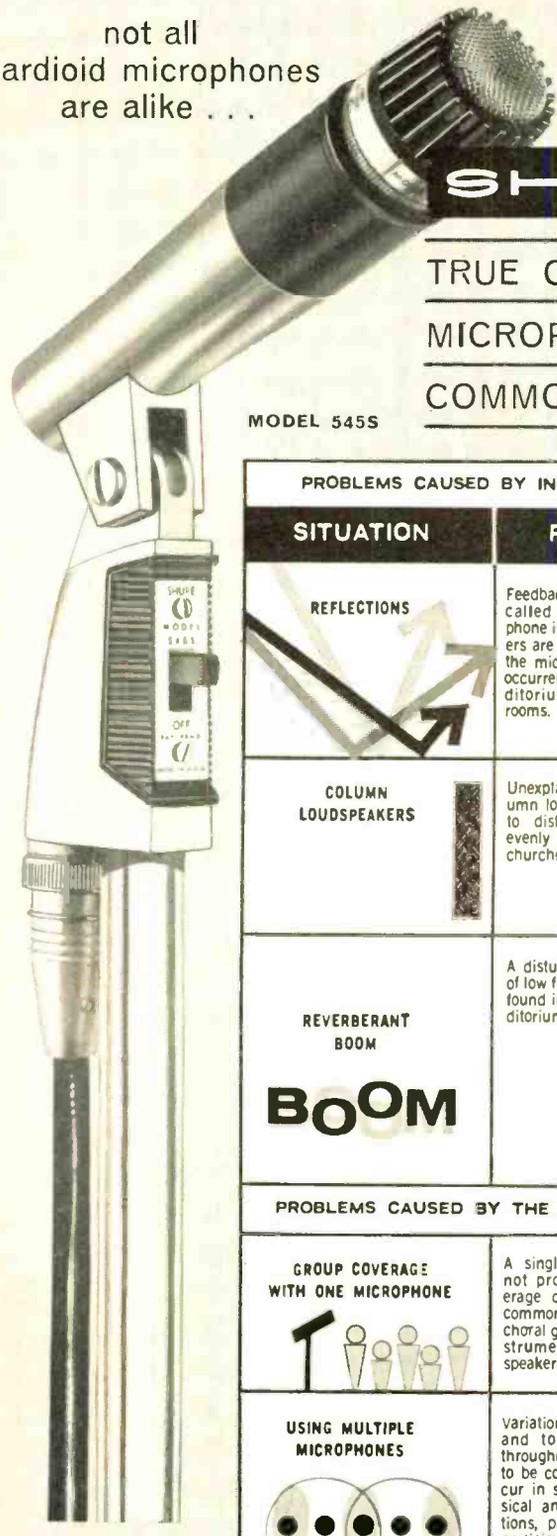
Fig. 4. Two methods for signal scanning.

Meanwhile I want to go back over the ground and fill in the details which I left alone last month. Although I was brought up on a diet of Pearl White I do not think that this journal is a place for cliff-hangers and I rushed past a lot of vital material in order to introduce Mr. Johnson's practical circuit.

The method of handling the signal, as we have seen, is to convert it into a pulse-length-modulated signal, so that it has constant amplitude and can be amplified by switches instead of by linear devices. There are, however, several different ways in which we can produce our pulse-length modulation and although the differences are small you may remember what the Frenchman said about the difference between man and woman. Here we are concerned with two kinds of difference and we must consider them quite independently.

The first point is that we may modulate either one edge of the pulse or both. In *Fig.* 1 these two kinds of modulation are shown, with only the trailing edge of the pulse in (A) modulated, while both edges are modulated in (B). If the single-edge modulated pulses are inverted and clamped at the bottom we shall have the leading edge modulated. Now this is not just an academic point, put in to show you how clever I am. There is a very real difference between these two methods of modulation. The lower sidebands of the first modulation group in the spectrum (see *Fig.* 3 of last month's article) are very much smaller. You will remember that these sidebands occupy more bandwidth than the simple sum and difference range of amplitude modulation and that if they extend down into the audio band they will produce distortion. Without doing a great deal of mathematics for particular cases it isn't easy to give a firm figure for the difference, but it would appear, from some

not all
cardioid microphones
are alike . . .



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MODEL 545S

SITUATION	PROBLEM	CAUSES	SOLUTION
PROBLEMS CAUSED BY INEFFICIENT REJECTION OF UNWANTED SOUNDS BY THE MICROPHONE			
REFLECTIONS	Feedback occurs where a so-called "cardioid" microphone is used and the speakers are placed to the rear of the microphone. A common occurrence in churches, auditoriums, and meeting rooms.	Sound bounces off hard surfaces on the walls, floor and ceiling, in and around the audience area and the microphone used is not effective in rejecting these sounds at all frequencies, and in all planes about its axis.	The Unidyne III eliminates this problem because of effective rejection of sound at the rear of the microphone with uniformity at all frequencies. Sounds bouncing off the floor or other reflective surfaces that reach the rear of the Unidyne III are rejected.
COLUMN LOUDSPEAKERS	Unexplained feedback. Column loudspeakers are used to distribute sound more evenly to the audience in churches and auditoriums.	While column speakers direct the sound toward the audience, they also have side and rear sound lobes which may reach the microphone. Feedback occurs when the rear and side sound lobes of the speakers coincide with the rear and side lobes of a so-called "cardioid" microphone.	The Unidyne III solves this problem because it has no rear or side lobes. Thus it rejects the side and rear lobes of the sound column speakers.
REVERBERANT BOOM BOOM	A disturbing, echoing effect of low frequency sound often found in churches, large auditoriums, and arenas.	The particular "cardioid" microphone used fails to retain its unidirectional characteristics with low frequencies. In addition, its front response tends to accent low frequencies of the desired sounds. These factors result in pickup and reinforcement of the low frequency reverberation and boominess characteristic of many halls.	Using the Unidyne III Microphone will solve the problem because it maintains a uniform pattern of sound rejection in all frequencies, even as low as 70 cps. The frequency response also has a controlled roll-off of the low end. This prevents reinforcement of the low frequency reverberation and diminishes the effect of a boomy hall.
PROBLEMS CAUSED BY THE MICROPHONE'S INEFFECTIVENESS IN PICKING UP THE DESIRED SOUND			
GROUP COVERAGE WITH ONE MICROPHONE	A single microphone does not provide uniform coverage of a group. This is commonly experienced with choral groups, quartettes, instrumental combos, and speaker panels.	The particular "cardioid" microphone used lacks a uniform pickup pattern, so that persons in different positions within the general pickup area of the microphone are heard with varying tonal quality and volume.	The Unidyne III affords uniform pickup of the group with a resulting consistency in volume and sound quality among the members of the group.
USING MULTIPLE MICROPHONES	Variation in the pickup level and tonal quality exists throughout the broad area to be covered. This may occur in stage pickup of musical and dramatic productions, panels and audience participation events.	The pickup pattern of the microphones used is too narrow, causing "holes" and "hot spots". The off-axis frequency response of the microphones also varies.	The Unidyne III permits a smoothness in pickup as the true cardioid pattern gives broad coverage with uniformity throughout the coverage area. This eliminates "holes", "hot spots", and the variations in sound quality and permits blending many microphones with ease.
DISTANT PICKUP	Too much background noise or feedback results when working with microphone at desired distance from sound source.	So-called "cardioid" and particularly long range microphones being used are less directional with lower frequencies. In addition, they have lobes or hot spots that pick up sound at the rear, resulting in the background noise or feedback problem.	Use the Unidyne III to gain relatively long range with effective rejection of sound at all frequencies at the rear of the microphone.

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Evanston, Illinois

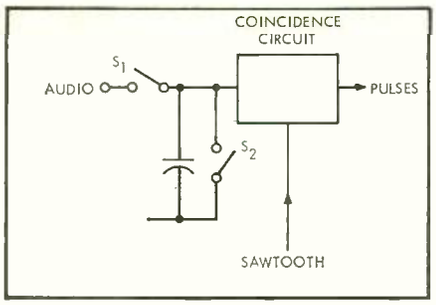


Fig. 5. Block diagram of circuit for producing periodic length-modulated pulses.

graphs which have been published, to be in the region of 20 db.

The waveforms obtained in a push-pull system are shown in *Fig.* 2. and so far as I can see we have not escaped from our single-edge modulation. I must confess that my guess was that in push-pull the symmetry of the system would have led to a balancing out of these terms, but it looks as though this judgment was wrong. We shall need to attend to this earlier in the circuit. Let us see how we can do this.

You will remember that the modulator we discussed used a sawtooth wave with a fast flyback, the pulse edges being defined by the coincidence of the sawtooth and the audio signal. We could use instead a symmetrical sawtooth, in the form shown in *Fig.* 3, and this will give us the modulation of both edges which we require. The sawtooth waveform is most easily obtained by the accurate integration of a square wave, which leads us at once to the Miller integrator used by Mr. Johnson.

We have not yet finished with the problems of modulation, however. Ideally we should sample the audio wave at regular intervals, but both the modulations systems we have considered sample the signal at an instant which depends on the instantaneons amplitude of the signal. This action is shown in (A) and (B) of *Fig.* 4, and it is called synchronous scanning. An alternative method is to sample the size of the audio wave at absolutely regular intervals and to convert this sample to a steady voltage which is then scanned. In (C) and (D) of *Fig.* 4 we see this action. At P_1 the audio voltage is measured and the pulse end is produced at P_2, when the sample voltage equals the scanning voltage. This method of pulse modulation, called periodic length-modulation, was described by Parks and Moss, who point out that each carrier-frequency component only has one pair of sidebands, so that the pulse repetition frequency can be just a little more than twice the maximum audio frequency. This is tremendously important, because Birt quotes figures to suggest that only a small modulation index may be used and, for example, if the maximum pulse ratio is 60:40 the term $(f_{pulse} - 3f_{audio})$ will be only 36-db down. With periodic pulse-length modulation this term just does not exist. I would expect this to be particularly important when transistors are used, because if we take our maximum audio frequency as 15 kc, the term $(f_p - 3f_a)$ will also be 15 kc when the pulse frequency is 60 kc. Notice again that these are not harmonics: a 15.1 kc input will produce a 14.7 kc unwanted term.

It is easy enough to draw a block diagram of the circuit we need to produce periodic length-modulated pulses. We have a sawtooth generator, and a coincidence circuit, such as a long-tailed pair. At the critical instant of the sawtooth, marked X in (D) of *Fig.* 4, we operate the switches shown in *Fig.* 5 in a special order. First we close S_2 to discharge the capacitor, although we can

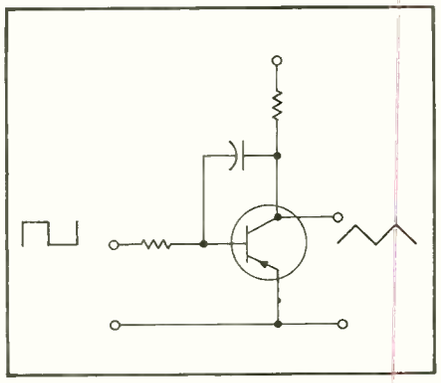


Fig. 6. Miller integrator

omit S_2 althogether if the signal source is suitable. Once the capacitor is cleared out, we close S_1 for a short time, so that the voltage across it becomes the audio input voltage. We now open S_1, leaving the capacitor to remember the voltage P_1. Two transistor gates can be used, of course, and we could probably operate the switch S_2 from the pulse trailing edge to give us more time for maneuver.

A practical circuit is by no means so easy to produce. We need fast gates, and we need a coincidence circuit with a very high input impedance in order that the capacitor may not, as it were, have a failing memory. This part of the circuit is beginning to turn itself into a small computer. I just cannot decide whether the extra complication is worthwhile, but that seems to be a matter which each designer must decide for himself.

The sawtooth generator is obviously a very important part of the circuit, for if the slope is not linear we shall lose our over-all linearity. For a triangular waveform we may, as I have said, integrate a square wave. Any symmetrical inverter circuit may be used as the square wave generator and the well-known Miller integrator is shown in its basic form in *Fig.* 6. For an asymmetrical sawtooth we may use a transistor as a constant-current source to charge a capacitor or we may use the Miller integrator with the feedback disconnected on the flyback. Instead of the negative feedback of the Miller effect we provide positive feedback by means of an extra transistor. One typical circuit is shown in *Fig.* 7 and this is described in detail in "The Junction Transistor" (Wolfendale, Heywood and Co., 1958). I do not propose to go through the mode of operation in detail, for I imagine that a quick look through the literature of cathode-ray oscillograph circuits will show you a number of variations on this theme. The way in which V_2 and V_3 form a positive feedback pair, while C,R and V_1 act as a Miller integrator for the linear run up is easily followed, but the detail of the catching operations at the ends is rather tedious. Blocking oscillators are not likely to be linear enough and will place a heavy demand on the over-all negative feedback. It is very tempting to start out by just tapping a fraction off the X-deflection voltage in a cathode-ray oscillograph.

In my early days in the radar world, more than 20 years ago, we could not get oscilloscopes with really fast triggered time-bases. It was the smart thing to do to build your own and to make it a really personal circuit. This kind of pulse-modulation for audio is still fluid enough to enable you to put a personal touch into each block of the over-all system.

Coincidence detectors leave a wide field for the imagination. The long-tailed pair has already been mentioned, as has its conversion into a Schmitt trigger by the addition of a signal path from one collector to the other base. There are, indeed, many negative resistance circuits which may be used. One of the simplest is the npn-pnp combination shown in

(*Continued on page 38*)

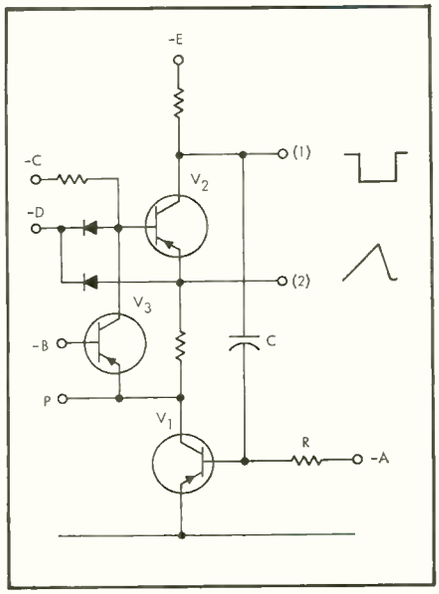
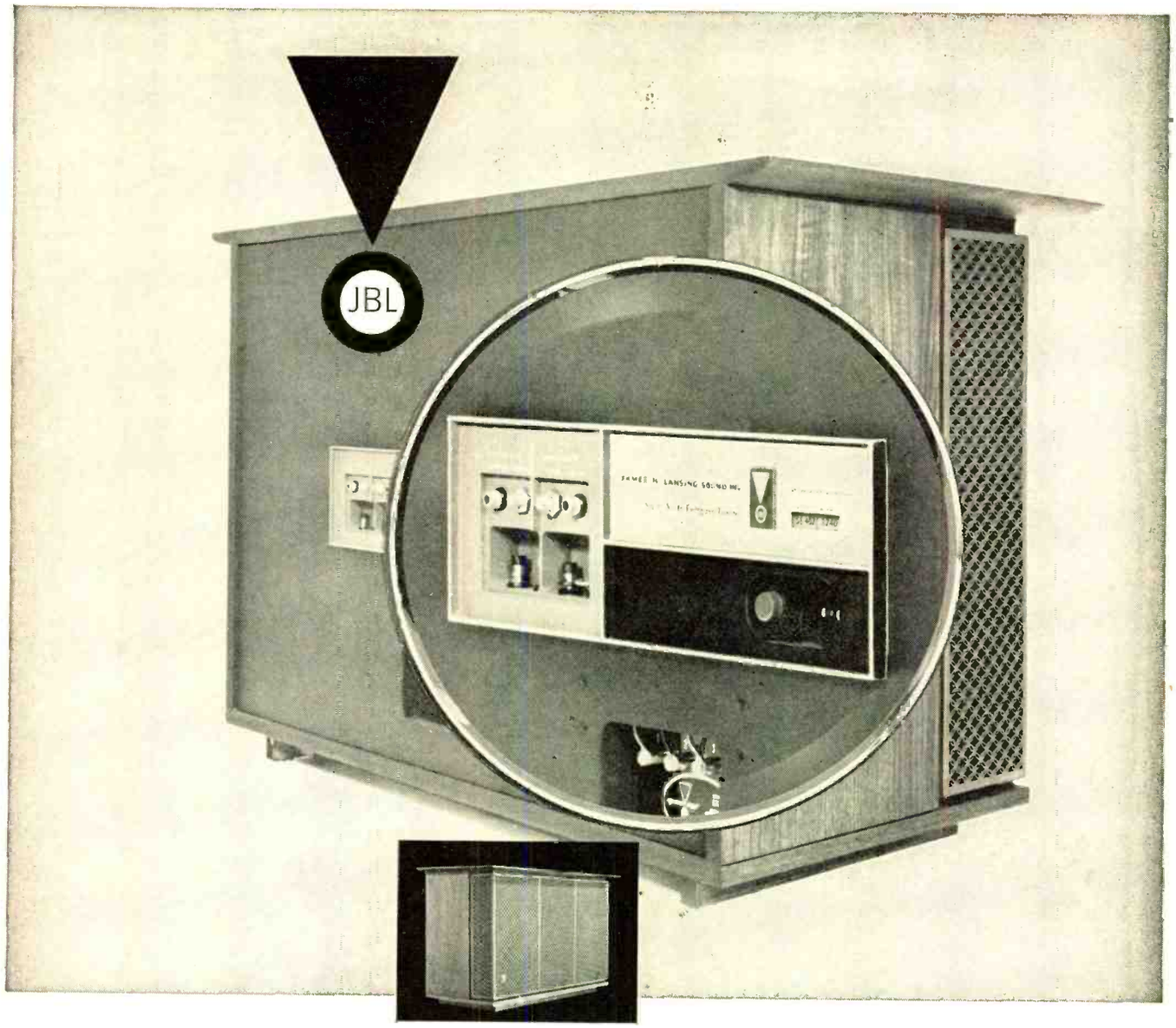


Fig. 7. Typical circuit for producing asymmetrical sawtooth waves.



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HERMAN BURSTEIN*

(Note: To facilitate a prompt reply, please enclose a stamped, self-addressed envelope with your question.)

4-Track Mono

*Q. I recently purchased the * * * tape recorder, which is a stereo quarter-track machine. However, I find that I am unable to record 4-track mono; I can only record on two tracks. I can't understand why this is so. Since I am interested in tape economy, I would greatly appreciate knowing if and how my machine can be adapted so that it will record and play 4-track mono as well as stereo.*

A. For stereo, the left and right channels of your tape recorder are probably ganged. That is, when the left track is being recorded, so is the right track; similarly for playback. But for 4-track mono you want to be able to record only one track at a time; if a second channel is also in the record mode, any material on the second track would be erased. Thus the record and erase heads must be disabled on one of the channels. When the load on the tape oscillator is lightened by disconnecting one channel, more current will flow into the heads on the active chanel. The increase in bias current through the active record head will produce a serious loss of high-frequency response. Therefore when one pair of heads is disconnected, a substitute load must be connected to the tape oscillator so that the active heads will continue to receive normal amounts of oscillator current.

In sum, 4-track mono recording requires switching facilities that do two things: 1. Disconnect the record and erase heads of one of the channels; 2. substitute an equivalent load on the tape oscillator in place of the disconnected heads. *These switching facilities should permit either the left or the right channel to be used alone, as desired.*

The above may explain why you cannot record 4-track mono with your tape recorder. So far as adapting it to 4-track operation is concerned, I think you should consult the manufacturer or one of his authorized service stations.

Even if you succeed in adapting the machine, you may not be satisfied with the results if there is crosstalk between the two sections of the record or playback head. That is, the signal intended for one channel may appear, to an objectionable extent, on the other channel as well. This may be one of the prime reasons why the manufacturer of your machine did not provide for 4-track mono operation. On stereo, such crosstalk is hardly likely to be objectionable because, after all, the signals on both channels are related to each other.

* *280 Twin Lane E., Wantagh, N. Y.*

NAB Curves

Q. I am engaged in the design of a transistorized professional-quality record-playback electronics package. The record amplifier is to be entirely separate from the playback amplifier. I have, however, had difficulty in finding the NAB characteristic for record and playback. I would very much appreciate it if you could supply this. The recorder will operate at 15 and 7.5 ips. However, I have noticed that different playback equalization is used for 7.5 ips and for 3.75 ips. Since I may modify my tape transport for multi-speed operation, I would appreciate information concerning varying playback curves for different tape speeds.

A. The NAB playback curve, official only for 15 ips but commonly accepted for 7.5 ips as well, is as follows. Bass boost starts (up 3 db) at 3180 cps, continues to rise with decreasing frequency at 6-db-per-octave, and levels off (3-db below maximum) at 50 cps. Total bass boost is 36 db. If the playback head deviates from ideal response —a steady rise of 6-db-per-octave as frequency increases—the playback curve should be modified accordingly. Thus if the head produces augmented response at the very low end, as some do, less than 36 db bass boost is needed. If the head exhibits treble losses, a corresponding amount of treble boost has to be added to the playback curve. With a playback head having a gap of about 0.0001 in., it is unlikely that you will have appreciable treble losses *in playback* until you decrease speed below 3.75 ips.

There is no NAB recording curve as such. The NAB requirement is simply that over-all record-playback response shall fall within certain limits: within 1 db between 100 and 7500 cps; no more than 4 db down at 50 and 15,000 cps. However, at 3.75 ips it is difficult to maintain response fully to 15,000 cps without running into appreciable distortion because of the large amount of treble boost required in recording.

Thus, after NAB equalization has been introduced in playback (allowing for head deviations from ideal response), you must tailor the record equalization to produce relatively flat response. In arriving at the proper record equalization, you must allow for the interplay among distortion, signal-to-noise ratio, and frequency response. These three factors are affected not only by equalization but also by the amount of bias current employed. If distortion were the only consideration, you would set bias current at 7.5 ips for minimum distortion. But this usually involves treble losses so great that the compensating treble boost would produce excessive distortion, unless you are willing to reduce the recording level and thereby reduce the signal-to-noise ratio. It is generally accepted that you don't want treble boost to go much above 20 db; about 23-db boost at 15,000 cps is typical in a number of high-quality home machines operating at 7.5 ips. At 15 ips, you can probably indulge in the luxury of setting bias for minimum distortion, yet not have to use more than around 15 db treble boost.

In order not to exceed 20 to 23 db treble boost at 7.5 ips, bias current will probably have to be set below the value for minimum distortion.

A typical record equalization curve for 7.5 ips in a high-quality home tape machine has about 3 db boost at 2000 cps about 10 db at 5000 cps, about 15 db at 10,000 cps, and about 23 db at 15,000 cps. This steeply rising curve requires either a combination of several RC circuits or an LC resonant circuit.

If you desire flat response down to 50 cps or lower, some bass boost may be required in recording. This should, in theory, reach 3 db at 50 cps and continue to increase with declining frequency at the rate of 6-db-per-octave. Such bass boost can of course be achieved with a simple RC circuit. I say "in theory" because the augmented response of some heads at low frequencies may obviate the need for bass boost in recording.

At 3.75 ips, some tape machine manufacturers employ bass boost with a turnover frequency of 795 cps, while others use the turnover of 1326 cps suggested by MRIA (Magnetic Recording Industry Association). Again, bass boost levels off (within 3 db of maximum) at 50 cps. And, as before, recording equalization must be tailored to achieve flat response or a reasonably close approximation to it. My own feeling is that it is unwise to strive for much beyond 10,000 cps, or possibly 12,000 cps, at 3.75 ips. To do so requires what I consider an unwise sacrifice in terms of distortion and/or signal-to-noise ratio.

Summing up, the same playback curve, having turnover frequencies of 3180 and 50 cps, is employed at 15 and 7.5 ips. Another playback curve, having one turnover frequency of either 795 or 1326 cps and a second turnover of 50 cps, is employed at 3.75 ips. Each speed will require different recording equalization in order to achieve flat over-all response. Upper limits of 15,000 cps are practical at 15 and 7.5 ips; about 10,000 or 12,000 at 3.75 ips.

Line Output Top Point

*Q. I am considering the purchase of a * * * tape recorder. It seems to have desirable specifications in every respect but one. That is, it has a line output that is taken off the secondary of the power amplifier stage; this is a 600-ohm winding that also feeds the VU meter. I would like to know if having a line output as described above is undesirable. You state in one of your articles that "the output should be at a point prior to the tape machine's power amplifier and speaker, thereby assuring best frequency response and lowest distortion." Is the * * * machine an exception to the rule?*

A. In the average tape recorder incorporating a speaker and therefore a power amplifier stage, the output transformer in this stage is of moderate or poor quality, so that frequency response and distortion are worse at a point after the transformer than prior to it. That is why the line output should ordinarily be taken prior to the transformer. In your tape recorder, however, the 600-ohm winding is on a transformer of sufficiently good quality so that there is no significant degradation of the signal with respect to frequency response and distortion. In other words, this *is* an exception to the rule. Æ

You push the button down, the music goes round and round

and it comes out great!

headset by KOSS / tuner and preamp from DYNACO

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The magn ficent Concord 880 (as do all professional tape recorders) has **three separate heads**—one record, one playback and one erase. To make professional quality stereo tape recordings from F.M. multiplex, stereo records, or live performances, your tape recorder must have **three heads!**

Operational conveniences include all push button controls, three speeds, two VU meters, and two professional full range dynamic microphones. The Concord 880 records 4-track mono or stereo, sound on sound, and sound with sound. *Priced less than $400!*

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CONCORD 550—transistorized 4-track stereo record and playback: push button operation, three speeds, Trans-A-Track, sound-on-sound, dual amplifiers, two VU meters, separated 6" speakers for full stereo effect. *Priced less than $320!*

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CONCORD 880

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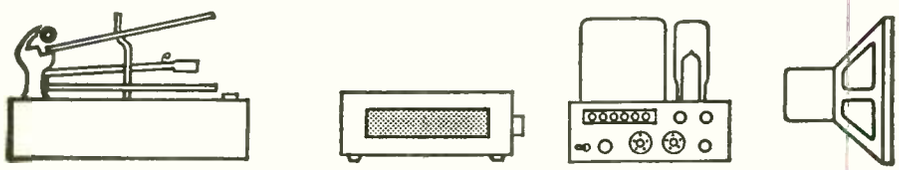
EQUIPMENT PROFILE



H. H. SCOTT FM-STEREO TUNER, MODEL 350B

We had forgotten how comfortable it feels to twirl that distinctive circular tuning knob, it's like visiting an old friend. We first became acquainted with the 350 series years before, with the advent of FM stereo; it was one of the first stereo tuners with a built-in multiplex adapter. At that time, it filled a special niche in the hierarchy of FM tuners; moderate price with performance level just a smidgin below the most elaborate units. The 350 was a good value way back then, and has remainded in that niche during the intervening years. The 350B carries on that tradition.

The 350 series reflects the small amount of technological improvement that has been necessary since FM stereo; sensitivity has been improved by about 10 per cent and a method of determining the presence of a stereo broadcast has been incorporated. In other words, the improvements are primarily refinements. This speaks rather well for the original Scott multiplex design; it was the first of its type to become hardware and still works well with only minor refinements.

The stereo broadcast indicator is certainly one of the simplest available. All one does is switch to the "monitor" position and dial across the band; a tone will be heard if a stereo broadcast is being transmitted. Simple. Scott calls it the "Sonic Monitor."

Another convenience feature of the 350B is the tape output jack on the front panel. This jack permits one to record "off the air" using a portable recorder, or one that is not built in without pulling out the tuner to get at the jacks on the rear panel. This is an especially valuable feature for those who use a built-in deck for playback, keeping their best "recorder" out of the system and available for remote recording. We think it is a good idea—good enough to be incorporated in the control center.

Circuit

The circuit of the 350B is time-tested. It features the well known Scott front end, three i.f.'s, and a wideband ratio detector. The multiplex circuit utilizes the time-division approach and was described by the engineer who developed it, Daniel R. von Recklinghausen, in our June, 1961, issue. We recommend that you read his description, if you haven't done so already. In any case, the circuit he described in that article is virtually the same as the one in the 350B. We must commend Scott for the daring and ingenuity (they were the only manufacturer to use this approach at the outset) exemplified by this circuit.

As we noted before, the rest of the circuit is time tested; Scott has used virtually the same configuration in the mono 314 tuner. The 350 is different, however, in that it must handle stereo. That means dual audio sections and special filters to take care of the special noise problems involved with multiplex reception. Now, two years after the introduction of the 350, the entire circuit is time tested.

Performance

We must admit at the outset that we have never tested an H. H. Scott product that did not meet its published specifications. We point this out to explain why we don't bother to provide a lengthy list of performance figures (also of what use are those figures to the consumer if the unit he buys isn't guaranteed by the manufacturer to perform at least as well as he says it will?).

Instead, we will focus our attention the relative performance of this unit; that is, we will place it in the scheme of things. For instance, it is clear that this tuner is intended to be up next to the top in performance, but towards the middle in price. This is done by economizing more on luxury features than on performance features. Thus, the 350B has a simple tuning meter rather than a super-sensitive unit, pots to control output level instead of calibrated attenuators and VU meters, and so forth. On the other hand, sensitivity might be improved 10 per cent but that's pretty much all. In other words, the H. H. Scott 350B is an excellent stereo tuner. It pulled in a large number of stations—without distortion and with excellent signal-to-noise. Also, it did not drift even though it does not have a.f.c.

In sum, the 350B is intended for the music lover with a medium budget. It is a good value. **G-18**

Fig. 1. H. H. Scott Model 350B FM-Stereo tuner.

REVERE/3M STEREO TAPE CARTRIDGE SYSTEM

Some three years ago—in May, 1960—we carried an article by Dr. Peter Goldmark and others of CBS Labs describing a 1⅞-ips tape cartridge system which had been developed by the Labs for the 3M Company. Having heard some of the original demonstrations and listened to the data on the machine, we were constrained to register our comments in the EDITOR'S REVIEW. These comments indicated considerable skepticism as to the attainable quality of reproduction relative to both frequency response and to flutter, and as to the practicability and reliability of such a system.

How wrong we were!

We still feel that information about new devices should not be given to the public until they are on the market or very nearly so, and accordingly we have not even mentioned this unit heretofore, even though it was released in one U. S. market late last fall. Since it will be in general distribution throughout the country within a month or so, we now feel that we should publicly "eat crow" with respect to the performance we had expected. The unit compares well with many a 7½-ips reel-to-reel machine.

Description

The Revere Stereo Tape Cartridge System is contained in an attractive metal and plastic case 14¼ in. wide, 16 in. deep over the plugs at the rear, and 7½ in. high with two cartridges in place. It contains two 5×8 in. speakers, one on each side, and is entirely self contained.

The tape cartridge itself is 3¾ in. square and 9/16 in. thick, and is of molded plastic with projections and slots for stacking. Each cartridge plays for a maximum of 48 minutes. The tape, 0.146 in. wide and 1.5 mils thick, is carried on a plastic reel. Attached to the starting end of the tape is a relatively heavy (10-mil) leader tape, ¼ in. wide, which rides on the flanges of the tape reel so it can be driven by a rubber idler from the outside of the reel. Up to 20 cartridges may be loaded onto the left platform.

With a cartridge in place, one presses the PLAY button. The operating cycle then commences with the left platform lowering the cartridge to the playing position; an idler drives the reel, pushing the leader outward until it engages with the take-up reel; notches in the leader actuate the mechanism so that when the tape is in front of the heads a guide moves and contacts

the tape across the heads, without pressure pads, and the playing begins. Each step of the cycle is indicated by a disc which is visible through a window in the top of the case, so that cartridges should be placed on or taken off the left platform only when the disc indicates LOAD. At the end of the tape, the cycling continues with the idler again contacting the edge of the reel and rewinding the tape, after which the two platforms incline together and the cartridge slides to the right platform, underneath any other cartridges which are held up by spring pawls. The platforms return, raising the completed cartridge onto the pawls on the right, and, at the left, releasing the bottom cartridge from its pawls and lowering it to the playing position. The entire change operation takes 60 seconds from trip to the first note from the next cartridge. Cartridges may be placed onto the left stack or removed from the right stack anytime, so that the machine can play continuously. A reject lever starts the change cycle at any desired time, and a CHANGE-REPEAT lever permits continuous playing of the same cartridge, or simply to start a selection over at the beginning.

The operating controls at the front of the unit are the ON-OFF switch, PLAY, STOP, and RECORD keys (the latter with an interlock); at the left is a digital counter which resets itself to zero at the beginning of each new tape. A lever at the left front of the unit permits fast tape movement, either forward or backward, and operation of this lever automatically releases the PLAY or RECORD key. Separate concentric volume and tone controls are provided for each channel, with the volume controls having numbered scales for reference. The tone controls have four markings—TREBLE, HI-FI, BASS, and BALANCED TONE—giving a continuously variable control with curves as shown in *Fig.* 3. In the HI-FI position, response is within ±2 db from 50 to 17,500 cps, remarkable enough for 1⅞ ips; BASS gives a rolloff of the highs, and TREBLE boosts the highs, with the low end remaining the same; BALANCED TONE boosts both lows and highs, giving a fairly passable sound quality from the built-in loudspeakers. Switches on the volume controls disconnect the bias and erase heads and short out the recording heads of their respective channels for mono recording.

Input and output connections, as well as the a.c. line plug, are mounted on the rear apron. In addition, there is a speaker switch which can be used to monitor the signal being recorded or to permit the use of the amplifier for p.a. applications. The speakers are normally off when recording to prevent acoustic feedback. The input jacks, one for each channel, accept standard phone plugs for high-level signals and

Fig. 2. The Revere Stereo Tape Cartridge System.

shorter-than-normal plugs for microphone. When the standard plug is inserted, the sleeve shorts out the long spring of the jack and feeds the input through a voltage divider to the first amplifier stage. The short plug connects directly to the input through a 22k series resistor. One pair of jacks connects directly to the output transformer for external speakers, disconnecting the internal ones. The other pair of jacks feeds an external amplifier from a voltage divider from the output-tube plate to ground. For recording, the heads are fed from a similar divider from the output-tube plates, with the required equalization in the divider circuit. Neon lamps serve as level indicators for recording; d.c. bias on the lamps, together with the a.c. signal, cause one plate to glow at normal recording level, and both to glow at overload level.

Each channel employs two 6EU7's (dual high-mu triodes) feeding single-ended 7591's. Three triode stages are used for recording, with a fourth stage used as a preamp for playback. Feedback is applied around the last two stages in all modes, and playback equalization is provided by feedback around the first two. Low-noise resistors are employed in the plate circuits of the first two stages, resulting in an overall low noise level for a home-type machine.

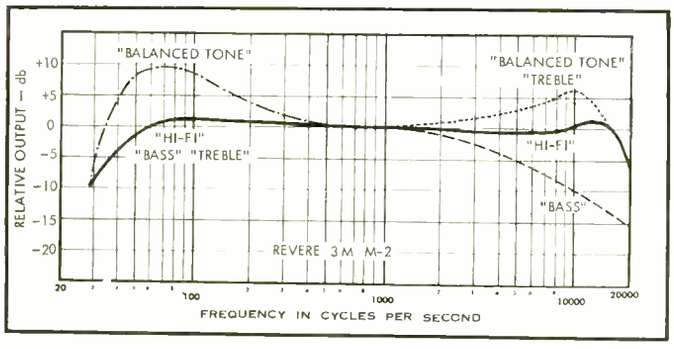
The tape used is of a new type not yet available in conventional packaging. This tape is slightly less sensitive—about 2 to 3 db—than standard tape, but has a signal-to-noise ratio about 6 db better than usual. This is one of the reasons for the performance of the over-all system, another being the 50-micro-inch head gap. Because of the low tape noise, much of the high-frequency equalization is accomplished in the playback mode, as seen in *Fig.* 4, where the solid line indicates the playback curve compared to the standard 7½-ips NAB curve. One of the faults of normal 3¾-ips machines is the large amount of equalization used in recording, with a considerable chance of overloading on the high end. The recording equalization is also shown in *Fig.* 4, and it is seen to be only 8 db at the top end. The erase/bias frequency is in the vicinity of 72 kc.

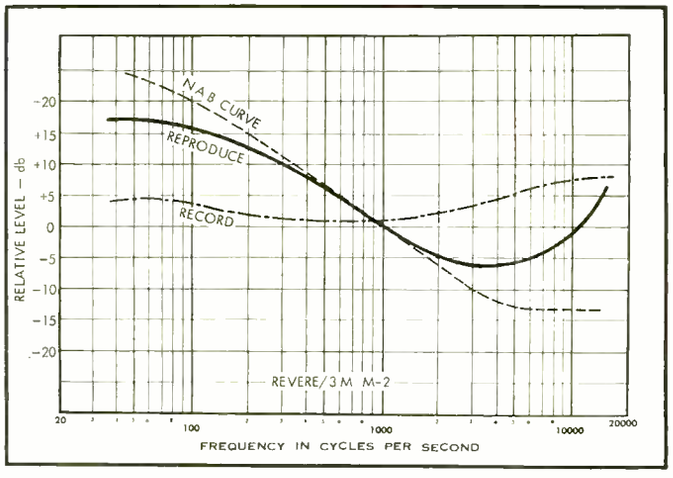
Performance

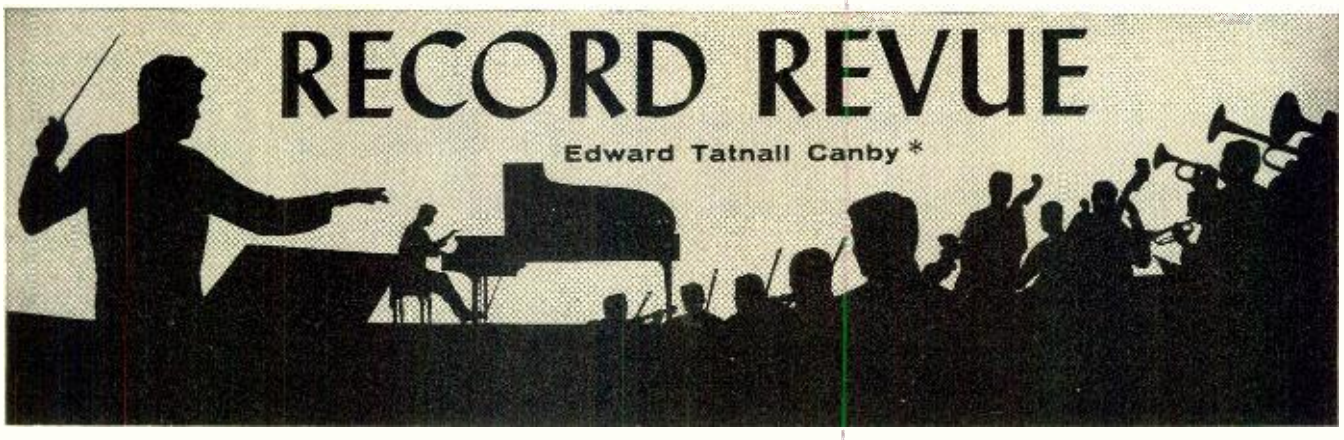
Our first listening with an external amplifier and good loudspeakers was a real eye-opener. From previous experience with performance from 1⅞-ips machines, we had not expected too much, but the frequency response of the Revere Stereo Tape Cartridge System was judged to be at least as good as the average 7½-ips machine. Before making any measurements, we actually dubbed a new LP onto the tape and played it back in synchronism with the record and *we could hardly tell the difference.* Measurements confirmed the opinion we made on listening—that frequency response is essentially flat to over 15,000 cps. Signal-to-noise ratio measured 52 db on one channel and 47 on the other, with the noise consisting largely of 60-cps hum. Distortion was measured by recording through the amplifier onto the tape, and then playing back through the amplifier, and at the normal recording level was less than 2 per cent. So far, no standard frequency tape is available for the machine, so frequency meas-

(*Continued on page* 42)

Fig. 3 (below). Record/play response of the Revere at four settings of the tone control. Fig. 4 (right). Playback equalization curve (heavy line) compared to the NAB curve for 7½-ips recording. The dot-dash line shows the recording equalization.







ESSENCE OF DYNAGROOVE

Debussy: Afternoon of a Faun; Nuages; Fetes; Printemps. Boston Symphony, Munch.

RCA Victor LSC 2668 stereo

The Boston Symphony is famed for its French music. So is Charles Munch. Not even the massive pail of RCA's Dynagroove publicity can spoil the warm, sensuous freshness of these performances—including a seldom-heard very early Debussy work, the "Printemps" suite.

My thoughts on Dynagroove in this connection are pointed. (a) Nearly everybody who is Anybody in recording wants a catchy brand name for the local hi-fi. Full-Dimensional Sound, 360-Degree Sound, Living Presence, Phase 4, Natural Balance, all are as benignly meaningless as they are inspiring—and thus easily cover whatever the company is inclined to turn out on its discs. Now, add Dynagroove.

(b) Behind these fronts, and everywhere else, practically everybody dickers with recorded sound in one way or another. Sometimes more, sometimes less. Sometimes with taste, somtimes without. Mostly, though, the companies have the sense to shut up about it and let the results speak for themselves in the final product. Not RCA. RCA has made the tactical mistake of *advertising* its dickering, down to the last gory detail.

(c) All recording equipment, plain or fancy, has knobs. Dynagroove, it is clear, also has knobs. They turn. *Ergo:* Dynagroove is variable, to taste (or lack of taste). You may just as well take it for granted, then, that every Dynagroove disc is going to be a law unto itself. Even unto Dynagroove inaudibility, at times. It all depends whose itchy fingers are on those knobs, and when. The fingers were quite intelligently tasteful in these Boston Symphony recordings. But cross yours about other Dynagrooved products. RCA is a fickle giant.

Dello Joio: Fantasy and Variations. Ravel: Concerto in G. Lorin Hollander, piano; Boston Symphony, Leinsdorf.

RCA Victor LSC 2667 stereo

This, too, is a very acceptable disc, recorded with considerable tastefulness and care, Dynagroove or no. The piano, to be sure, is close and loud; but then RCA has always liked that effect in its concerto recordings. There may be the often-described alterations of frequency range and compression of dynamics; if so, the effects are not overt here and will scarcely bother music listeners. They may even contribute moderately to the over-all musical impact.

Young Hollander's playing of the eclectic-modern Dello Joio work is intelligent and effective. The music itself will outrage few ears and please a good many, for it is modern but never obscure, hard, yet graceful in the playing. Dello Joio is a realistic musical craftsman. As for the Ravel, a piece taken right out of Gershwin and the early 'Thirties, Hollander is miscast and so, I say, is Leinsdorf. They both play it like so much Chopin. The cool, elegant jazz-blats of the Ravel masterpiece are made too sentimental, lack the cat-like intensity that should dominate this urbane musical exterior. I guess Hollander is too young to feel like 1930. And Leinsdorf is too European.

MELLO DORATI

Mozart: Symphony No. 40 in G Minor.

Haydn: Symphony No. 45 ("Farewell"). London Symphony, Dorati.

Mercury SR 90280 stereo

I've decided there's just no accounting for Antol Dorati. In many an earlier Minneapolis recording, and in some of his European work of more recent date as well, he shows a hard hand, a stony rhythm and a very unpoetic lack of a sense of phrasing. His music more often pounds than flows.

Not here! This is one of the "other" Dorati jobs, and it might be a wholly different conductor. I don't remember hearing a more satisfactory Mozart G Minor (except perhaps for the Minuet, which is somewhat jabbed and jerky). And I am sure there has been no more sympathetic recording of the "Farewell" of Haydn, one of the loveliest testaments to that master's utter genius in his earlier period. Splendid! The Mercury plain-ordinary-tape stereo recording is exactly right for both works, just intimate enough to bring out the small-orchestra clarity of the scores yet with enough liveness to lend a mellow realism Highly recommended.

Finlandia. Music of Sibelius. Morton Gould and His Orchestra.

RCA Victor LSC 2666 stereo

Fate ordained that this should be the first Dynagroove record to hit my turntable. I wish it hadn't. This one is not a handsome advertisement for the product.

The fault is by no means entirely with Dynagroove. Morton Gould contributes his share. Maybe the Dynagroove and Gould philosophies resonate; I don't know. In any case, I found this a gratingly unpleasant disc from start to finish. Coarse is the best word. Overdone, gross, tasteless, both musically and technically. These Sibelius "best-loved" war horses still can offer many musical subtleties when played with feeling and consideration, and recorded the same way. Here, Gould pulls out all the stops of orchestral commercialism and obvious appeal. RCA's engineers cooperate with a gross display of crude, untasteful microphoning and a positively cathartic dose of Dynagroove. Ugh!

The mikes turn this orchestra inside out in a spaceless and unimaginative vacuum. The inner workings of the music, which should blend gracefully into an unconscious background, here churn away senselessly a few feet from your nose—as though the musicians were busy practicing some entirely different piece while their colleagues flail away at the Sibelius. It is possible, with judgment, to bring out interesting things with modern mike technique—but this job brings out all the banalities. Finally, Dynagroove manages to blow up the mysterious soft passages almost as loud as the loudest parts, out of all semblance of believability. They growl and roar like a cageful of drunken zoo lions. And in the climaxes the brass is merely strident instead of triumphant—I dare even suggest that the sound is just plain distorted. Reminds me of RCA's old pre-war "high fidelity" 78's.

Plenty of other companies, remember, share RCA's ability to turn out corny, crass, crude, coarse, best-selling commercialism. But you won't find a more striking example than this one. It'll probably sell millions.

SOMETHING NEW, SOMETHING OLD . . .

Shostakovitch: Symphony No. 4 (1935–6). Phila. Orch., Ormandy.

Columbia MS 6459 stereo

It is hard to say just what impact this scare-headlined "new" symphony will have upon you but one thing is very sure—you won't find out in a hurry. The piece is long, like so many later works of this composer, unconscionably so. Takes a whole hour, give or take a bit, and all of that is on this one disc.

The Fourth symphony was not heard publicly until 1961, its 25th anniversary. Stalin didn't like the trend of Shostakovitch's music in 1936 and this work was prudently withdrawn in advance of an inevitable axe. The Fifth, a justly popular work, was written as a "reply to just criticism" (its subtitle)—and succeeding symphonies have burgeoned forth, louder and noisier for the most part, right through No. 11, which had its premiere on records in 1958. The Seventh and Eighth you'll remember, caused sensations during the war period, with great conductors scrambling unceremoniously to grab the first-performance laurels in our fair country.

Well, here we are again. Remember the famous Seventh? Probably not. It isn't exactly popular today, for all the sensation. The Fourth is sterner stuff and may well stick for musical reasons, publicity aside; but it is clearly not as "catchy" as the Fifth, and its public will be those who are more interested in inner strengths. After a once-over, I'm not prepared to praise or damn—but the music is, as we hear it, neither radical nor difficult except in sheer length. Though perhaps derived in part from Mahler (as the album notes suggest), it is more signficant to us for its forecasting of much that came later in Shostakovitch and, through him, the whole gamut of recent Russian music, from the air-hammer drive of the "Gayne" suite to the rattling military salvos of the later Shostakovitch march movements.

As usual, the work that was condemned is the very one that comes closest to what much later was to achieve maximum official approval! In this respect, alas, official state criticism isn't so very different from the private variety.

I suggest you ignore the scare headlines, then, and avoid this disc unless you just happen to want to hear some more Shosta-

kovitch, from his strongest period. Just because Stalin threatened the official axe doesn't mean that you are going to be thrilled and titillated.

Liszt, Brahms, Schubert (Liszt: Hung. Rhaps. No. 2; Brahms: 6 Hung. Dances; Schubert: Symphony No. 4). Austrian, Vienna Symph. Orchs., Hagen, Sacher.
Everest 3102 stereo (?)

There's nothing musically wrong with this pleasing pot-pourri of well-played music from Vienna. But if Everest, the new Everest, expects me (and you) to think that these are brand new Everest recordings, perhaps on 35 mm, then they'd better think again.

If Everest had simply said that these were worthwhile reissues of older material no longer available, nobody could object. Reissues of this sort, treated to a dose of useful modernization, are always welcome. Many labels offer them, including the biggest.

Moreover, I'm the first to say that a good job of "electronic reprocessing for two channels," as Columbia puts it, is very worthwhile in rendering an irreplaceable mono recording acceptable for playing on two-channel equipment. Some fine things have been done in this fashion.

But Everest says nothing of all this. And so, left to themselves, my long ears and persistent memory must go to work on their own. They tell me, like a hound sniffing a warm scent, that this is apparently a mono tape (normal width), probably dating from prestereo days, acquired from somebody else and re-processed for this release. (I can guess the source but won't). The stereo re-processing is not subtle. It appears to be simply a general roll-off of lows in one channel and highs in the other, rather extreme when you listen to the two channels separately. No other channel differences exist that I can hear. No stereo "room sound." If all this is so, the information belongs on the record cover.

Hindemith: Requiem "For Those We Love." Hongen, Braun, Vienna Symphony (Vienna State Opera Cho.), Hindemith.
Everest 3100 stereo (?)

I can be very specific about this disc. It is a re-processing of Vox album PNL 1760, two ten-inch mono discs. The Vox album was copyrighted in 1950. I have it before me. The Everest disc, similarly labeled to the above, was sent me for review but, I hear, has since been withdrawn; the composer is said to have objected.

Again—if you will grant that the original performance is a good one, then this reissue would have been well worthwhile. I compared the two, AB. Definitely, the Everest is cleaner, quieter-surfaced, re-equalized (to RIAA) and even re-pitched—the two versions are different by a quarter tone or so and I'd guess that Everest's is nearer right. The synthetic two-channeling is again unsubtle, the same heavy roll-off in the bass on one side and the treble on the other; but even so, it does allow this big, complex music for solos, chorus and large orchestra to spread out between stereo speakers. Without the slightest doubt the Everest reissue is a technical improvement over the original Vox release of some thirteen years ago.

It seems to me that the sooner the new Everest company begins to tell us exactly what it is offering, the better it will be for all. We can use what they have to give, new *or* old.

Schubert: Quartet No. 15 in G (1826). Juilliard String Quartet.
Epic BC 1260 stereo

It is a memorable time for any music lover when he first begins to respond to the profundity of late Schubert, the music composed in the middle Twenties until his death in 1828. Much of it was never heard at the time, including the great C Major Symphony, now one of his best known pieces, and the "Unfinished," entirely lost until the 1860s. The Schubert songs, in their hundreds, were what

(*Continued on page 41*)

ABOUT MUSIC

Harold Lawrence

Chance Music, Or What's (a) Happening?

"Serious music is a dead art." So charged Henry Pleasants in "The Agony of Modern Music," a book that created quite a stir in musical circles eight years ago. To Pleasants, Richard Wagner was the "last really serious modern composer"; after him came only the "reaction, refinement . . . and desperate experimentation" of such "triflers" as Debussy, Bartók, Strauss, Mahler, Berg, and Prokofiev. "Jazz is modern music," the author concluded, "and nothing else is!"

The moment the first copies rolled from the presses of Simon & Schuster, serious modern composers declared war. In an article for the *New York Times Magazine,* Aaron Copland described "The Agony" as "the most confused book on music ever issued in America." Many of the points raised by Pleasants provided a legitimate basis for discussion of the state of modern music, but his buckshot approach turned the book into something of a tabloid editorial, replete with sweeping generalization and wholesale dismissal of composers and musical periods.

And like a newspaper editorial writer, Pleasants invoked *vox populi* to support his position. A musical product, he maintained, is culturally valid only because of "popular guidance"; without it, the composer labors in a vacuum. The trouble with the modern composer is that he has become indifferent to popular taste. Furthermore, Pleasants argued, the creation of his music lacks the vital element of improvisation.

"Even as late as Beethoven," wrote Pleasants, "improvisation was fashionable among composers . . . Certainly many of their compositions should be thought of as the written record of an improvisation, refined by critical afterthought." Jazz, the author pointed out, has taken over both traditions; hence its cultural validity.

In the years that followed the publication of "The Agony," many non-jazz composers wholeheartedly embraced improvisation and audience involvement. Although Pleasants would unhesitatingly lump their works under the heading: "desperate experimentation," these new directions are already part of the cultural fabric of our time.

Roughly speaking, composers today are divided into two camps: those who pre-compose and those who improvise. The former set down their ideas using formal notation and traditional instruments; the latter roam over hitherto unexplored sonic territory.

Like Pleasants, John Cage (dean of the chance composers) believes that serious music, as presented in the formal setting of the concert hall, has estranged itself from the public. His music is designed to make the spectators part of the composition. A case in point is his *4 Minutes and 33 Seconds,* in which the performer sits quietly at a piano, holding a stopwatch for 4:33. The "music" is provided by the audience as people yawn, cough, sneeze, giggle, or squirm in their seats. In his more recent *Music Walk with Dancer,* Cage has scored his work for electric blender, speakers nonsense syllables, shortwave radio, and piano. Apart from a few directions scribbled on slips of paper, the performers were on their own, restricted only by the sonic means at their disposal.

Chance music may not be what makes the world go round, but it is turning the heads of composers throughout the West, and even behind the Iron Curtain. In Germany, Karlheinz Stockhausen, who employs both traditional and "indeterminate" techniques, composed a work which gives the performer the freedom to play any part of the music his eyes first fall on. Toshi Ichiyanagi, a Japanese disciple of John Cage, has a special fondness for the insides of a grand piano, and uses metal rollers, fingernails, and fists to produce the unusual timbres in his chance works. In England, Cornelius Cardew notified the performers of his *Octet '61* that his piece is cyclic, and may be started anywhere, "joining the end to the beginning, or the beginning to the end if you are reading backwards, and may be played for any length of time. End anywhere."

Knock On Any Object

The chance composer differs from the pre-composer in another fundamental way. The latter creates his music out of the memory of familiar pitches and timbres, often works without an instru-

mental aid, and meticulously writes down every note, expression mark and tempo indication. Apart from choosing his instruments and occasionally setting a timing schedule, the chance composer plans only the vague outlines of a new work. It is at the concert that the music is really "composed," as when the performer twiddles the dial of a shortwave receiver and comes up with Radio Moscow while a drain pipe (recording) gurgles a chance obbligato.

The electronic composer is closer to his traditional counterpart in that his work is completed *before* the concert. Nevertheless, chance is an essential element in his music. "The compositional process of creating electronic music is almost the reverse of the conventional procedure," said Remi Gassman, who composed the electronic score for Alfred Hitchcock's film, *The Birds*, "The (electronic) instrument itself is constantly creative. To start with the predetermined concepts of what you want to create musically is against the new medium."

In a larger sense, chance music is part of a cultural movement that includes Happenings, Pop Art, and sound sculpture. The pure electronic composer to one side, these artists and musicians utilize everyday objects and sounds. Last April, an exhibition of Pop Art at the Washington Gallery of Modern Art included the following *objets de non-art*; coal shovel, window (complete with sill, sash, frame, and glass), pliers, can opener, egg beater, carving knife, license plate, and bedspring.

Newspapers are a favorite feature of the Happening, a sort of surrealist theatre-in-the-round which combines elements of Dada, the circus, mime, and chance music. At recent Happenings in New York, performers sprinkled torn-up newspapers over audiences and props and tacked full pages on the walls. In a Chambers Street loft studio, Yoko Ono (painter and poetess) wrapped parts of an afternoon edition around her head.

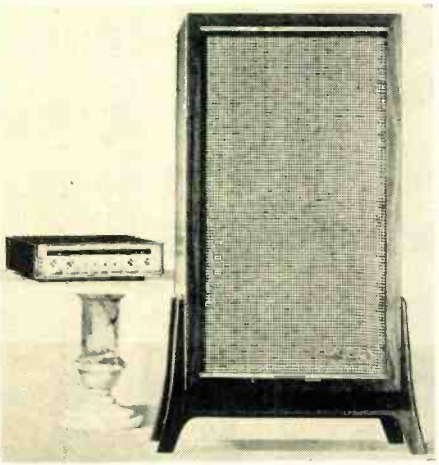
Wired for Sound

Not content with the visual element alone, some sculptors and painters add sound to their work. Robert Rauschenberg attached a small radio to the back of one of his canvases; Marisol, a sculptor, installed a record player in a horse; and Jean Tinguely produces radio sculpture. Tinguely's creations consist of radio parts (tuners, speakers, tubes and cables) "all elegantly arranged with an eye for their esthetic or poetic qualities," reported John Gruen in the *New York Herald Tribune* last December. "When a switch . . . is turned on, things begin to move either in frantic speed or in slow motion, and sound begins to emanate from the speakers."

(*Continued on page 38*)

NEW PRODUCTS

● **Three-Way Speaker System.** The Berkshire speaker system, with eight features critical to optimum high-fidelity reproduction, has been introduced by Sherwood Electronic Laboratories, Inc. The Berkshire incorporates a high-compliance, ten-inch woofer. It features a single-roll suspension which provides 21-cps free-air resonance. In addition, the woofer voice coil has a four layer winding which boosts efficiency, and a "throw" of one inch to minimize distortion. A three-inch shallow-ring radiator tweeter reproduces high frequencies. The eight-inch midrange speaker is specially fabricated. Over-all system



response is 35 cps to 17,500 cps ± 2½ db. Another of the features critical to high-fidelity performance is the 600-cps crossover network. A second crossover is effected at 3500 cps. The entire speaker system, including a bass-port, is mounted on a one-inch thick baffle. The enclosure is made ¾-inch solid-core walnut-veneered plywood. Size of the enclosure is 24 × 13 × 9½-inches deep. Matching pedestal bases and Consolette legs are available. The Berkshire handles 50-watts of program material. Minimum drive requirement is 10-watts. Sherwood Electronic Labs, Inc., 4300 North California Ave., Chicago 18, Ill. **G-1**

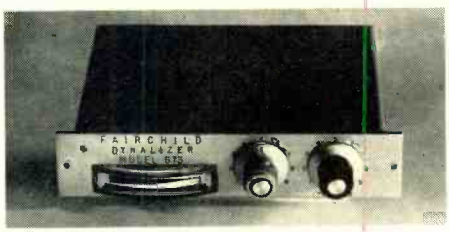
● **New Tape.** A "triple length" sound recording tape, providing maximum continuous recording time at an economical per foot cost, has been introduced by the 3M Company, maker of "Scotch" brand magnetic tapes. The tape, designated "Scotch" brand No. 290–36, comes in 3600-foot lengths on 7-in. reels to provide 50

per cent more recording time than has been available on 7-in. reels. The longest standard length previously available on 7-in. reels was 2400 feet. The tape is list priced at $11.95 per roll. It also is available in 600-foot lengths on 3¼-in. reels for miniature recorders. The small reels are list priced at $2.95 per roll. Minnesota Mining and Manufacturing Company, 2501 Hudson Road, St. Paul 19, Minn. **G-2**

● **New Stereo Tape Recorder.** The new Norelco Continental '301' (Model EL3549) transistorized 4-track, 4-speed tape recorder features two preamps for stereo playback through any hi-fi system. The '301' also features the new fourth speed of 15/16 ips for up to 32 hours of recording on a standard 7-in. reel. Fully capable of stereo playback and monophonic record/playback, the Continental '301' includes two preamplifiers, power amplifier and speaker and comes furnished with a dynamic cardioid-pattern microphone. It has inputs for recording from microphone,

tuner and phono with facilities for mixing and a special input jack for a foot control. Monitoring is possible by means of the internal speaker or with headphones. A unique parallel operation feature permits tracks 1 and 3 or 2 and 4 to be played back simultaneously so that prerecorded stereo tapes can be played back monophonically through the built-in speaker. The '301' utilizes all-transistor electronics. The manufacturer's suggested list price for the Norelco Continental '301' (Model EL 3549) is $299.50. North American Philips Company, Inc., High Fidelity Products Division, 230 Duffy Avenue, Hicksville, Long Island, New York. **G-3**

● **Dynamic Equalizer.** This newest product from Fairchild is designed specifically for the recording, motion picture, and broadcast industry. The Fairchild "Dynalizer" provides dynamic equalization of the audio-frequency spectrum to accomplish "true apparent loudness." The "Dynalizer" is the only device that accomplishes apparent loudness without conventional amplitude limiting or compression and its often constricted sound, but produces apparent loudness through automatic distribution of the frequency spectrum to compensate for human hearing limitations particularly at lower listening and program levels. It automatically compensates for scale distortion, the dynamic and re-



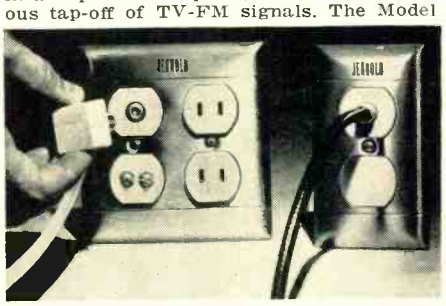
sponse value distortion that results when record makers and broadcasters have to squeeze the dynamic range of an orchestra to the confines of the recording or broadcast medium. The "Dynalizer" can also be effectively used in broadcasting to maintain true effective loudness of signals without a compressed sound, thereby increasing the apparent loudness and range of the station. The device can also be utilized to help stations maintain a more pleasing balance between regular program material and the highly compressed loud commercials that have proven to be distractions to listeners and have recently come under governmental scrutiny and comment. Fairchild Recording Equipment Corp., 10–40 45th Avenue, Long Island City 1, N. Y. **G-4**

● **New Speaker System.** The W90, a 6-speaker "Achromatic" system, has been designed in the spirit of the much larger Wharfedale system used by G. A. Briggs in his demonstrations at Carnegie Hall, and other great concert stages. It is neither a compact nor large system—but a new size in between; measuring 32¼ × 27¾ × 13⅛.

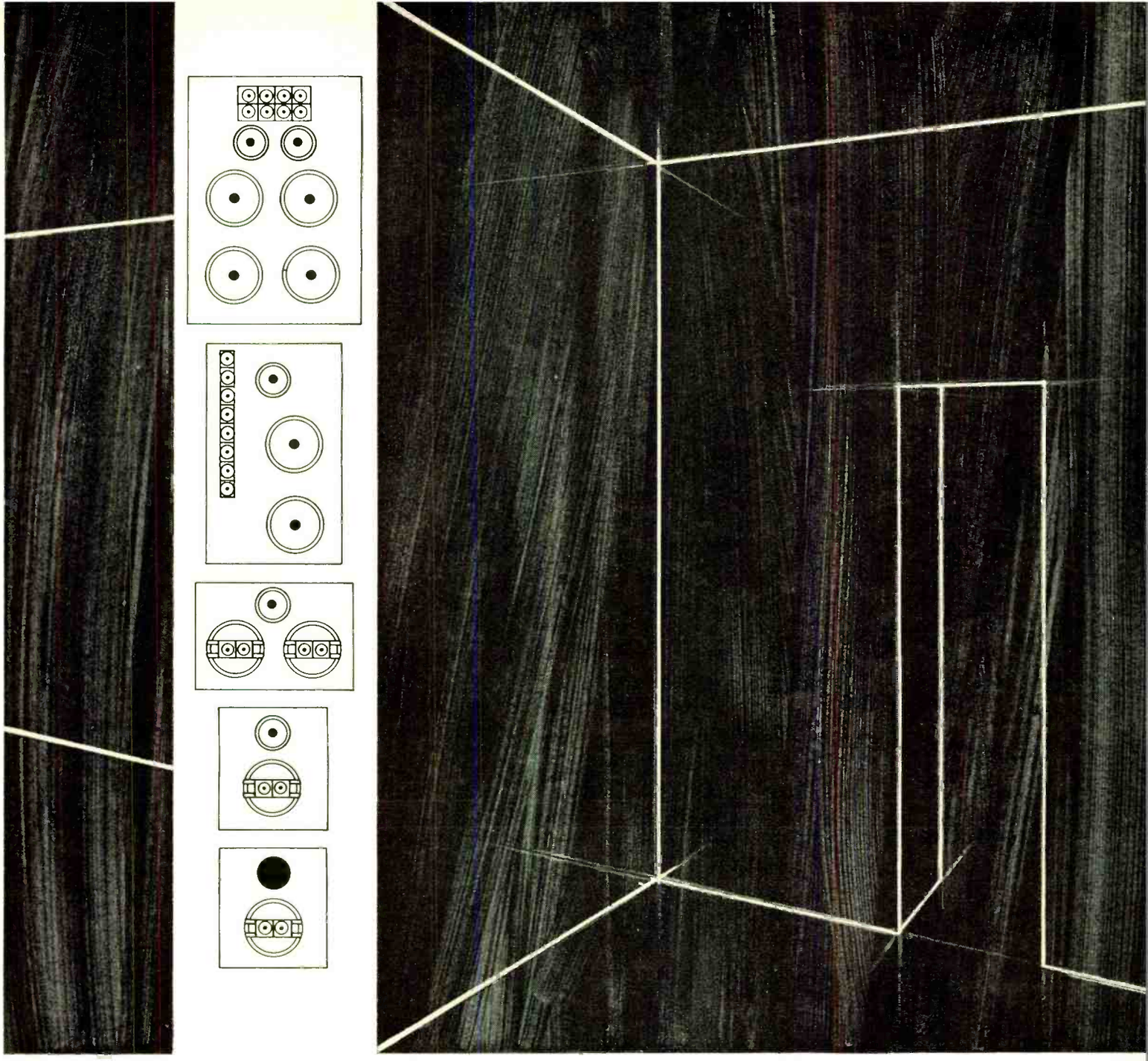
The term "Achromatic," as applied to Wharfedale speaker systems, signifies they are capable of producing "pure" sound.

They incorporate an inert sand-filled panel to damp panel vibrations. Besides the new W90, the Wharfedale Achromatic Series includes the W40 and W60 2-speaker systems; and the W70 3-speaker system. All cabinets are decorator designed in true wood veneers of oiled walnut and polished walnut. Utility models, in unfinished wood, without the curved moldings and dividers, are also available. British Industries Corp., 80 Shore Rd., Port Washington, N. Y. **G-5**

● **TV-FM Tap-Off.** This new wall outlet tap-off offers architects every possible choice of color in richly designed molded plastic cover plates. Either flush (pictured) or surface mounting types are available. The a.c. outlet can be combined with "Ultra-Tap" behind a duplex cover plate. All system fittings are push-on types. The TV and/or FM receivers also connect to the tap-off through push-on connectors. Two connector models are offered—one for use with 300-ohm twin-lead (left), the other for 75-ohm coax cable (right). Either connector will fit any of the three models in the "Ultra-Tap" series. The Ultra-Tap Model UT-33 (shown in a duplex cover plate) is for simultaneous tap-off of TV-FM signals. The Model



UT-22 (shown in the single cover plate) is for tap-off of either TV or FM signals. It also includes an isolation network to prevent a.c. powerline interference. Model UT-12, not shown, is a wall terminal unit for connecting a TV or FM set to a remotely mounted isolation unit. The UT-33, -22, and -12 can be used with either duplex or single cover plates. The isolation networks of the UT-33 and UT-22 can be removed, to change values, and be replaced without disconnecting the distribution system cables. Isolation network values range from 11.5 to 35 db. Feed-thru specifications are from 0.2 to 1.0 db. These wall outlet tap-offs are for use with RG-59 feeder cable systems. Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia, Pa. **G-6**



built-in bozaks solve problems

DECORATIVE / with Bozaks in the wall and
the electronics in a cupboard, your whole floor is free
and an established décor remains as you planned it.
MUSICAL / the overriding concern of the music lover:
no other speakers, no other mounting, provide such deeply
satisfying sound for the critical listener.
STRUCTURAL / no other speakers are so easy to install,
for professional and home craftsman alike.
GROWTH / only with Bozak's Systematic Growth
can you so easily expand a speaker system step by step,
with such superb sound at every stage.

For simplicity, for the ability to enlarge your music system . . .
above all, For The Grandeur of Great Music . . .
build-in Bozaks!

Bozak

DARIEN / CONNECTICUT

ABOUT MUSIC

(*from page 35*)

Pop Artists agree with Henry Pleasants about re-establishing a rapport between the artist and his public. Allen Kapprow, leader of the Pop Art movement, regards comic strips, soup-can labels, magazine ads, and Coke bottles as "works of the human spirit." Why not, therefore, use these and any other commonplace visual and sonic objects in works of art? In discussing Pop Art at a recent symposium, Kapprow referred to "the international charade—it it could be called a mock Happening—involving *Mona Lisa,* and the endless lines of freezing mourners waiting outside to pass by the altar of this departed pin-up girl. We shall possibly never understand the enigma of Leonardo until we face the enigma of our own creation of a Coca-Cola bottle. Pop Art very toughly insists upon the possibility that that bottle, and all that comes with it, may be a lot more mysterious than we ever thought."

In reviewing a recent item of literary Pop Art (*Mobile* by Michel Butor), Truman Capote described its contents: "enigmatic diary-jottings, pop-song lyrics, dreary snippets of almanac-information, bits of unfinished poetry, and long, long laundry-like lists of American merchandise . . ." Sound familiar? Interestingly, the book is dedicated to the memory of Jackson Pollock. "Have we here a clue?" questions Mr. Capote, "Does Butor intend *Mobile* as an experiment in Action Scribbling? an attempt at Drip-Method Prose?"

One can see that the New Cultural Wave—call it Pop Art, Indeterminacy, or Happenings—is not merely closer to our shores; its already broken, and all the arts are spattered with its foam. Æ

CLASS D AMPLIFIERS

(*from page 26*)

Fig. 8. The diode is biased so that regenerative action is caught by the diode before the transistors saturate. This is rather important, because it reduces the hole storage effects in the switching time. You will find that the more advanced circuits are peppered with diodes. I think this circuit and the long-tailed pair are the two easiest to use.

A circuit invented by F. C. Williams and called the Multiar has a very interesting transistor version. The kind of circuit it is can be seen from *Fig.* 9. Basically the circuit is a blocking oscillator, but the base circuit of the transistor through which the feedback is con-

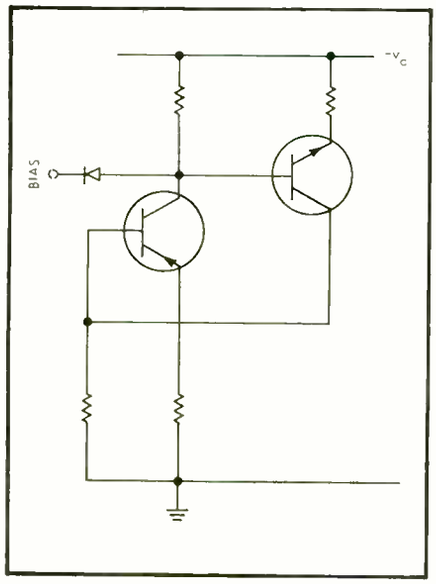


Fig. 8. npn-pnp trigger circuit.

nected closes only when the diode *D* is forward-biased. I have shown the two signals applied at the same point, but they could be applied to opposite sides of the diode. The tube versions of a good many useful circuits of this kind will be found in the "Waveforms" volume of the Radiation Lab. series published by McGraw-Hill. The easiest looking of all the circuits is the one shown in *Fig.* 10. Just three windings on a toroid of square-loop iron. A tiny ferrite ring is used in this mode in computer memories. The basic idea, just to remind you, is that the core is saturated, so that there is virtually no coupling from the inputs to the output except when the total input ampere-turns reverse through zero and the flux snaps across from one direction to the other. This will give us short pulses in opposite senses for the leading and trailing edges of our length-modulated pulses and must be used in combination with an integrator or a toggle circuit.

The critical feature in the design of the coincidence circuit is that it should be fast and that it should not have any memory which could affect the operation, either the level or the speed of switching, according to the length of the previous

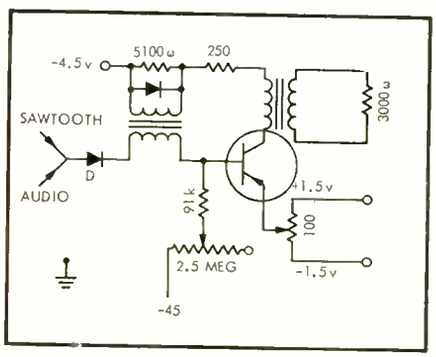


Fig. 9. "Multiar" trigger.

pulse. It is here that the complexity begins to creep in and it is considerations of this kind which make it desirable to stick to either the Schmitt circuit or the closely related npn-pnp switch and to add fast diodes which will catch both ends of the switching operation. Quite a detailed study of the kinds of circuits which may be used is given in IRE *Trans. C.T.*, Vol CT-4, No. 3 Sept 1957, p241–261.

An amplifier of the toggle type may be used after the coincidence circuit to increase the amount of pulse power available for driving the output stage. I do not think we need discuss this in much detail, except to note that it is probably essential to keep the drive impedances equal in order to be sure that we do not disturb the timing of the switch operation. This will become clearer when we consider the output stage.

To Be Concluded

AUDIO ETC

(*from page 12*)

arm meets standards which are compromised or just plain ignored in most of the arms we get? You have to expect a bit more trouble in the installation—.

My friend snorted. He's a practical handy man if there ever was one and a very neat and rapid worker, too. Give him a regular phono arm, just an arm, and he'll mount it up for you with dispatch and invariably right on the nose as to measurements. (I usually manage to bore the holes offside or mis-figure the configuration one way or another.) Never mind the side-pull and the over-pressure, don't worry about mis-tracking or bearing drag. If the thing can be made to work, he'll have it working, splendidly, But an Arm X . . . !

Turned out it was the instruction book that really bugged him. So imperturbably precise, so oblivious of human failing. I could not quote you all that got under his skin but there was, for instance, that cardboard mounting template. Among other directions, it demanded the drilling of four small holes. Those small holes, the instructions said ever so clearly, were to be drilled out at three-sixty-fourths of an inch.

3/64ths! *Three sixty-fourths??* said my man, his steam pressure rising. How in Anybody's name was I supposed to find a drill like that? and how are you going to sight down maybe an inch through that cardboard template from turntable level to the base and locate any point within an eighth of an inch—let alone 3/64! He was practically sputtering.

He had gone out to his tool shed and fetched in an old ice pick. Did a perfect job.

* * *

He had a last fillip of scorn to toss in my direction. Seems somebody had walked into his shop while this Arm X affair was laid out on his bench. The visitor took one long look, remarked with finality, "It'll never fly", and departed.

He was dead wrong, of course. That arm will fly all right. It installed all right, too. It plays just fine. It's an engineer's dream, in fact. Æ

NEW LITERATURE

• **Silicon Planar/Epitaxial Transistor Catalog.** Amperex Electronic Corp. announces publication of a condensed catalog specifically devoted to the company's broad line of Silicon Planar/Epitaxial transistors. Included in the catalog are full listings and basic specifications of the entire line, which consists of: high-voltage universal amplifiers, low-level and small-signal amplifiers, universal amplifiers and switches, low-storage saturating switches, UHF and VHF amplifiers and non-saturating switches, industrial types, and low-level choppers. The transistors listed in the catalog are production-run types, available in quantity as well as sample orders. Free copies of the condensed Amperex Silicon Planar/Epitaxial Transistor Catalog may be obtained by writing on company stationery to: Amperex Electronic Corp., Advertising Department, 230 Duffy Avenue, Hicksville, N. Y. **G-7**

• **TV-FM Distribution Equipment Literature.** Literature covering a completely new line of television distribution equipment for homes, motels, apartment buildings, and hospitals, is available from the Distributor Sales Division, Jerrold Electronics Corporation, 15th and Lehigh Ave., Philadelphia 32, Pa. The information, including photographs, charts, block diagrams and specifications, covers a wide range of newly developed systems and components. Data (DS-CS-004.2, – 017.1, – 018.1, – 019.2 and – 502.1) are provided on: master antenna system yagis; high-output, broadband amplifiers; and the new Ultra-Tap, an all-purpose tap-off unit meeting all architect and installer design requirements. Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa. **G-8**

• **Automatic Broadcast Level Control Bulletin.** A new four-page bulletin, No. 443, issued by CBS Laboratories, a division of Columbia Broadcasting System, Inc., describes its new Audimax II RZ, automatic level control. Applicable to all broadcast and other audio media, Audimax II RZ automatic level control is totally different in concept from ordinary compressors, limiters and AGC's. The bulletin describes automatic gain riding, the gain platform, gated gain stabilization, return-to-zero function, FM-multiplex operation, increased modulation and market coverage, and gives specifications. The bulletin is illustrated with block diagrams, photographs and charts. CBS Laboratories, High Ridge Road, Stamford, Conn. **G-9**

• **Electronic Organ Brochure.** Fourteen models of organs ranging from one to three manuals and available in either kit form or custom built are described in a new 2-page illustrated brochure. Only the basic catalog information is included. Complete stop lists, specifications and detailed literature on the individual organs can be ordered separately and free of charge. Artisan Organs, 2476 No. Lake Ave., Altadena, Calif. **G-10**

• **Book on High Fidelity.** What's high fidelity? Is it the same as stereo? What's a woofer? What about extension speakers? The answers to these questions and many more are contained in a new book published by Allied Radio Corp., Chicago. Using non-technical language, Allied's new book explains the basics of high fidelity and monophonic and stereo sound. Program sources—records, tape, broadcasts—are discussed, as are tape recorders, kit construction, new transistor designs, and other items of interest in high fidelity. The book provides data on planning a "built-in" system and use of extension speakers. A glossary gives clear definitions of hi-fi terms. A number of illustrations help the text material. The publishers say, "The information supplied should help anyone to understand, select, and enjoy a high fidelity system." This 96-page book is available from Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. for 50 cents.

RECORD REVUE

(*from page 33*)

people knew and loved. Much of this late music, in contrast, is long, tortured, introspectively complex and profound beyond measure, forecasting—and surpassing—music which would be written at the near-end of the long century.

This Quartet, accordingly, is not often played or heard (though the Scherzo lives a separate life as an isolated quartet movement in many performances). It was practically new to me. The music features those violent, disturbing, unbelievable changes of harmony, virtually atonal except for the strong thread of continuity and the return to the starting point, which anticipated the relatively oily and easy-going language of the later "Tristan." This music is "Tristan" in the raw, hard and biting. The work also features to an amazing extent the ominous, high-speed tremolo, an unearthly trembling of the bow-arm that fairly haunts the quartet in every movement, for chilling effects.

The Juilliard performance, characteristically, is on a very high plane of accuracy and good ensemble but somehow, nevertheless, it is consistently cold. I found it impressive yet, in the end disappointing. It lacks soul—if that means anything to you.

CONDUCTORS

Bernstein Plays and Conducts Beethoven Piano Concerto No. 1 in C. New York Philharmonic.

Columbia MS 6407 stereo

Is it my imagination? Somehow, this performance of the second of Beethoven's concerti (in spite of the published number) sounds uniquely different simply because the pianist and the conductor are one and the same.

The whole spirit is oddly unlike that which prevails when a celebrated soloist is pitted "against" an orchestra and its leader—the usual situation. For here, the composer-conductor arrangement, was the original intention. Beethoven wrote the music for his own use, conducting from the piano. Bernstein, a many-talented innovator, is able to do the same, as few important conductors have managed to do since the days of Liszt and Mendelssohn. (Brahms had somebody else conduct the orchestra when he played.) It works—and works well, even for us "blind" listeners via loudspeakers.

Curiously, too, Bernstein styles the music in the manner of the new, very young performers, playing much of it quite slowly with much romantic fervor. I got the feeling, as I listened, that he tries hard to convey the newness and freshness of the work as it might have been heard in Beethoven's day, playing up the then-novel and striking features of its construction as they could well have been played up for effect by Beethoven himself. Interesting—and fresh.

The last movement goes like a whirlwind, though I'll have to concede that it isn't blurred a bit—not in the piano, anyhow. If there is any evidence of haste, you'll find it in Mr. Bernstein's orchestra, not in his playing. Was there ever before a conductor who could outdistance his own men at their own game? Must command an enormous respect from them.

Beethoven: Symphony No. 7; King Stephan Overture. Concertgebouw Orchestra, Sawallisch.

Philips PHS 900-019

The old conductors tend to play mellowly, richly. The young-middle-age ones, who began work just before or after the war, play hard, fast. But the extremely young once more play mellowly. Neo-Romantic.

Sawallisch first conducted in 1947. He is of the middle generation and no two ways about it.

Accordingly, the comfortable old Concertgebouw, that used to sigh and pant at length under Mengelberg (for fifty years, no less) here trots along at a brisk-to-rapid pace with hardly a bow to Romantic dalliance. This is a good Seventh but an uncompromising one; it is strictly business, strictly over-all in shape, strictly unbending in tempo. The second movement is perhaps twice as fast as it used to be, back a generation, under Stokowski or Koussevitsky. (But not faster than Toscanini. Newer!) The last movement, that incessant dance, positively bares its teeth, more the angry Beethoven than the triumphant.

Wrong? Right? I could not say. But whatever the tempi, this music is not unmusical, never crude or unpolished. The Concertgebouw is too good for that. Probably the same with Sawallisch.

Willem Mengelberg. Brahms Symphony No. 4. Concertgebouw Orch. (Recorded Nov. 30, 1938).

Telefunken TH 97010 mono

Aha! Here's Mengelberg himself, in his later years, and you'll find this a superb Brahms performance, if in many ways strikingly unlike those of today—mainly in the famed Mengelberg *rubato*, expressively uneven speed. He was a master of this, notably with his own great orchestra, as you will understand when you listen. Of course, that sort of thing has long been out of style (though it is trying to come back among the very young). Still, a lot of us remember it with pleasure. Brahms himself probably would approve.

Two bits of technicalia to note. First, for the curious recording engineer and the aware listener, this is a splendid example of the best sort of "dead" recording—dead compared to our present tastes—as perfected during the period of the 1930s. It did not then sound dead to us. It regains its fine qualities after a time, as you listen today. Second, this recording was Dutch, made before the invasion of the Germans—and of German equipment of superior quality—that occurred while Mengelberg was still conducting this orchestra. His last recordings were, unfortunately, made under Occupation auspices, with a war-reduced orchestra. Not so this one.

Otto Klemperer Conducts Kurt Weill's Suite from the "Three Penny Opera," Strauss' "Vienna Life" Waltz, "Emperor" Waltz, Overture "Die Fledermaus" and Klemperer's Own "Merry Waltz." The Philharmonia Orchestra.

Angel S 35927 stereo

I quote you the actual title of this disc—by which you may see the size of our problem today in listing record titles! Next thing you know, they'll be including a capsule "review"—say, "A fabulous Beethoven 6th together with the "Coriolanus' Overture in its Definitive Performance. . . ." At that point I'll draw a line. Opinions in this space are mine not the companies'.

Surprised to find the grand old man mixed up with Kurt Weill? Don't be. Klemperer was the first ever to record this music, in a set of 78's made in the early thirties. I remember it. Thus, in spite of his elegant Beethoven and persuasive Wagner, this rendition is as blatty and brassy as it needs to be to sound right. If there are some signs of flabbiness, I credit them (a) to the British players, who don't lend themselves to such things as easily as ours do and (b) to Weill himself. The music isn't nearly as revolutionary now as it was then.

The other matter here, strictly light classical of the top sort, was never more limpidly set forth. As for Dr. Klemperer's own bit of comedy, it isn't really so very funny, especially next to Weill. A kind of heavy-handed parody of Richard Strauss (not Johann), including an unveiled reference to "Death and Transfiguration" (not mentioned in the liner notes: I heard it all by myself). Supposed to be a dance in a mental sanitarium or something, but the humor isn't exactly modern, nor is the schizophrenic hysteria. AE

EQUIPMENT PROFILE

(from page 31)

urements had to be made on a record and playback basis, as were flutter and distortion measurements. Making flutter measurements by recording and playing back on the same machine gives rise to the possibility of either doubling or cancelling flutter, but enough measurements were made to arrive at a figure of approximately 0.25 per cent, although specifications claim only 0.3 per cent.

The unit comes with two ceramic microphones, two attachment cords with clips, and four with phono plugs to connect into other equipment. In addition, each is furnished with a demonstration cartridge and one of blank tape. At the present time, there are 50 cartridges from Columbia records and ten from Musictapes, Inc., with ten more to come soon from Command Records. It seems likely that many more will be made available when the unit achieves general distribution.

After living with this System for about three months and playing it over 100 hours to see how it would stand up to continuous use, we feel that many a tape user will want to put this machine into his listening system, using conventional reel-to-reel machines for preliminary recording and editing, then dubbing material onto the cartridges for ease of storing and handling. There are so many uses for this type of machine that come to mind—restaurants, hotels, doctor's and dentist's offices, banks, and so on would seem to be first to use this machine, with many other applications in the offing. The unit has performed reliably throughout, and we are certainly very much impressed with this Tape Cartridge System, and we predict a highly successful future for it. G-19

BENJAMIN/ELAC MODEL 322 STEREO CARTRIDGE

The first stereo cartridge we ever had for test was an Elac, 'way back in 1958. We have kept up with all the models since then, and the latest 322 Studio comes close to achieving the ideal in stereo cartridge design. As in previous models, the stylus assembly is replaceable as a complete moving-magnet unit. The stylus diamond has a radius of 0.52 mils, and the cartridge is designed to track at 1.5 to 3 grams, although with top-quality arms it will track

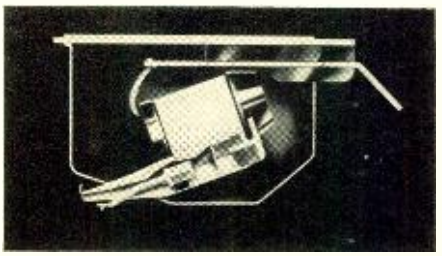


Fig. 5. Cross-section of Elac Model 322.

perfectly at 1 gram. Response extends up to 20,000 cps with less than a 2-db droop, and channel separation measured 32 db at 1000 cps, 25 at 10,000, and 16 at 20,000. IM distortion measured 1.5 per cent, which is satisfactorily low.

Stylus compliance is stated at 14×10^{-6} cm/dyne, which, while exceeded by some other types, gives consistent groove contact and results in a "solid" type of sound which indicates a complete lack of chatter. The unit, bright red in color for identification, comes in an attractive jewelry-type box. The stylus assembly is interchangeable with earlier Elac models to give the same quality of performance. G-20

ZIEGFELD SOUND

(from page 23)

bottom of the rack. One was used to feed the proscenium speaker, a second to feed the under-balcony speakers from the delay, and a third as a spare to serve as standby for the two active amplifiers in the event that either should fail.

The front panel includes a headset jack with its own volume control and has plug in provision for either a VU meter or monitor speaker. Since the amplifier feeding the proscenium speaker was to be monitored by phones, a VU meter was used for the under-balcony amplifier. Thus, simultaneous monitoring for both outputs, one aural and one visual, was provided. 600-ohm balanced inputs to each of the amplifiers were brought out to the jack strip. Both active amplifiers are run at less than half power.

Take-off receptacles are available for remote standby operation and for remote a.c. control. In the present situation advantage was taken of the remote standby takeoff. Standby is achieved through opening the common cathode return of the push-pull 6550's for the control of plate voltage. One side of a dpdt "bat" switch was connected in series with this return in the spare amplifier, so that filaments could be kept hot and no warm-up time lost in an emergency. The other side of this switch was connected in series with 6.3 volt pilot lamp to indicate "plate on." 6.3 volts is available at the VU meter socket.

The installation was ready on Friday, January 25th, when word arrived that Mr. Chevalier would be at the theater early Monday afternoon for a short rehearsal. At the same time it was suddenly learned that he would require four additional footlight microphones. This is where that Galaxy flexibility paid off. I had already installed three additional modules in each mixer, so by cascading the two mixers I would have more than enough inputs. But then the safety of a duplicate mixer would be lost. Furthermore, no matter how good the footlight microphones, their distance from the performer made it very desirable to include a limiter.

The weekend intervened, but a phone call and personal pickup of additional No. 2 modules and a No. 6 all-channel limiter module Monday morning made it possible to have these units installed, tested, and ready for rehearsal by noon.

That evening I sat back, and after a while, I began to enjoy the show. Æ

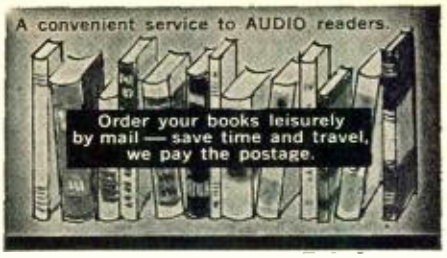
CONDENSER MICROPHONE

(*From page 20*)

needle over two holes on opposite sides of the capsule body. The clamping ring is then placed over the coated surface of the plastic; two screws are inserted through the holes in the ring and the plastic and carefully screwed into the body. This procedure is followed with the remaining six, inserting each screw on opposite sides of the ring. When all are fitted, each is tightened with equal firmness. The whole capsule can now be removed by cutting away from the mounting jig and trimming off the surplus plastic. At no time during this process should either surface of the plastic be touched with the fingers.

The final step is heat treatment of the mounted diaphragm. This has the effect of further shrinkage of the plastic and stabilizes the diaphragm against extremes of temperature change. A hot blast of air from a hair dryer held close to the capsule for 3 or 4 minutes is the recommended method.

Having now completed the "heart" of the microphone, attention can be given to catering to its electrical requirements. A condenser capsule of this type is almost pure capacitance and a typical value is in the region of 100 pf rising a little when the polarizing potential is applied. This is caused by electrostatic attraction between diaphragm and fixed electrode, so reducing the nominal gap. It will be appreciated that one cannot connect the capsule by ordinary cable to the terminal equipment with which it is being used. Even using coax, a substantial part of the signal can be lost due to the shunt capacitance of the cable itself. So the usual practice is a "head amplifier" in close proximity to the capsule and within the body of the microphone casing itself. Actually, the term "head amplifier" is something of a misnomer, since its prime function is to match the very high source impedance of the capsule down to a more manageable low impedance usually the familiar 30 or 600 ohms. *Figures* 7 and 8 indicate the line adopted by the writer, but should not be regarded as definitive. Although a tube of European origin was used since it was ideally suited for this particular application, there are probably a number of American alternatives. A triode with a plate resistance between 10,000 and 20,000 ohms designed for low-noise work should fit the basic requirements, and one section of a 12AY7, or its "preferred" equivalent 6072 would seem a satisfactory substitute. In this particular application, the most important factor to aim at is low noise so that, due to the high impedance in the grid circuit, d.c. "heating" is absolutely essential. It will be noted in the writer's power supply that a common B+ and heater supply is used with the unwanted voltage being dropped down to the required 12 volts at 100 mA by a large preset resistor. This may seem a wasteful way of going about it and there are more conventional methods, but it does use less components than a separate heater supply, and a suitable transformer happened to be available. There is one advantage—the heater supply is from a virtually constant current source and the microphone cable can be extended at will from a short to a very long length without appreciable losses in the cable itself. With the more orthodox low-voltage heater supply, there may be fluctuations in the heater voltage due to variations in cable resistance if the length is altered. The actual polarizing voltage was determined experimentally and is in the region of 80 volts for the capsule shown. Higher potentials have little advantage; the sensitivity does not increase appreciably above a certain voltage level and there is the risk of collapse of the diaphragm from excessive electrostatic force. The choice of values for the polarizing and grid resistors warrant some mention. The recommended value for the polarizing resistor is 150 megohms and it must be a high-stability type, as indeed should all the resistors in the head amplifier. The choice of value for the grid resistor is mildly controversial. First of all, both polarizing and grid resistors are effectively in parallel with the capsule. Since the source impedance is pure capacitance at a certain low frequency, when the source impedance equals the two resistors in parallel, output will fall 3 db and thereafter at 6 db per octave. It is preferable that the polarizing resistor be as high as practicable to minimize accidental leakage currents, therefore the value of the grid resistor can ultimately determine the low-frequency response of the microphone. One school of thought suggests that, aside from low-frequency considerations, the value of the grid resistor should also be as high as practicable, on the grounds that theoretically a low noise figure results. Contrary to this, it has been found even more desirable to use the grid resistor in combination with the capacitance of the capsule as a high-pass filter and to proportion values to attenuate everything below 30 cps. The response of the capsule extends well down into the subsonic region and it is contended that nothing below 30 cps has any musical value. In fact, there is adequate proof that it can be a positive nuisance and any such



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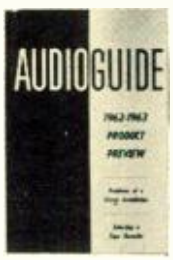

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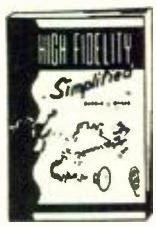

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sounds might even overload the amplifier in extreme cases. The capsule shown has a source capacitance of 120 pf when polarized, so a grid resistor of 60 megohms was chosen. The over-all bandwidth of the completed microphone can be checked by inserting a low value of resistor in the "ground" side of the capsule and injecting an audio signal via a relatively high resistance.

So much for the construction of the prototype microphone. *Figures* 9 and 10 show the basic construction technique adopted by the writer, with the whole assembly built turret-fashion on two threaded-metal pillars. Tube base and line transformer are mounted on circular plastic discs, suitably dimensioned to a comfortable fit in the tubular metal body. These discs are drilled and fitted with rivetted soldering lugs and, as shown, the components are wired between the two

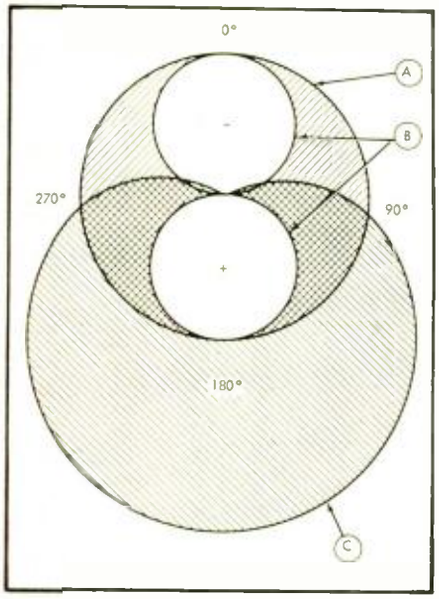

Fig. 11. Various microphone patterns: (A) circular (omnidirectional); (B) cosine (bidirectional); (C) cardioid (unidirectional), or (A) + (B).

discs. The rest is dependent upon the constructor's skill at metal work and there are, no doubt, other ways of solving the construction problems involved. The important factors are avoidance of any open cavities in the microphone structure, negligible sound obstruction around the capsule and above all, very thoroughly shielding because of the exceptionally high impedance of the grid circuit at hum frequencies.

Different Patterns

So far the microphone discussed has been of the omnidirectional type, and when the preliminary field trials confirmed its obvious superiority in fidelity over the others in the writer's microphone armory, it was frequently tempting to use it where its omnidirectional characteristics were wholly unsuitable. So back to theory and experiments with the test capsules. As shown earlier, a plane sound wave has a velocity and a pressure component and the diagram shows that each is displaced in phase from the other by 90 deg. It can be demonstrated that when the output from a pressure-sensitive microphone (e.g., a dynamic) is combined with that of a velocity sensitive microphone (e.g., a ribbon) a cardioid pattern results, assuming both outputs are equal (*Fig.* 11). (This can be proven experimentally with two microphones and a mixer; the two microphones should be very close together.) This is one way of obtaining a cardioid pattern electrically and is, in fact, the basis of at least one commercial design. With condenser microphones, the mixing is carried out acoustically and, in the single-diaphragm type, sound from the back of the capsule is allowed to reach the diaphragm via phase delay networks. These take the form of long, narrow channels through the body of the capsule. With careful proportioning of the length and diameter of the channels, the phase of the velocity component cancels the pressure force for sounds from the rear of the capsule. Thus a cardioid response results. In the capsule illustrated (*Fig.* 10) these "velocity conversion" tubes are shown and unblocked, the capsule has an excellent cardioid response. If on occasion an omnidirectional response is required, it is a simple matter to block these holes with small metal plugs. In the extensive tests since 1960 this basic design has acquitted itself admirably and in fact, quite a number have been constructed successfully. It has been tempting to continue work on the more sophisticated capsules such as the twin-diaphragm, multi-pattern types. However, experimental work is under way to try to solve some of the considerable construction difficulties of a single-diaphragm velocity capsule first. It may be possible to give details of this at a later date.

It might be asked, how does this microphone measure out by the usual objective tests? Anechoic chambers are not for the amateur, so free-field measurements have been conducted in the open air, using as a sound source the most linear tone source available—a full-range electrostatic loudspeaker. Since an accurate calibrated reference microphone was not available, results of this test cannot be regarded as highly accurate because the amplitude nonlinearity of the speaker was included. Nevertheless, the frequency response can be regarded with confidence as substantially flat from 30 cps to 16,000 cps. Total harmonic distortion measured at 200 cps was less than 1 per cent up to an extremely high volume level—in fact, the limit that could be handled by the test speaker. In the cardioid mode, the back to front discrimination was 18 db at 1000 cps and holds

to this figure, or better, over a substantial part of the audio band. Finally, since most microphones are used to record music, how does it sound? In one word—superb—and more than worth the considerable work it has entailed.

In conclusion, an apology. If, in describing some of the highly complex design features of microphones generally, the writer has been guilty of over-simplification, this has been solely in the interest of brevity. Any reader wishing to pursue a more detailed (and possibly accurate!) analysis, is referred to the numerous textbooks on the subject of electroacoustics. Æ

LETTERS

(*from page 6*)

that there are five of order four, 12 of order five, 35 of order six, and 108 of order seven.

If one substitutes certain parameters derived from group theoretical arguments concerning the polyminoes of order four into Aschinger's equation for the a.c. load resistance we obtain a "resistance" of 5 ohms." Similarly, using parameters for the other orders successively in the equations for emitter feedback resistance, low-frequency input resistance and minimum input resistance we obtain values of 12, 35, and 108, respectively! Even more astounding perhaps is the fact that if one puts in the appropriate parameters for order eight into the output resistance equation we obtain the number 370. Heretofore the number of polyminoes of order eight has been unknown but I strongly suspect that 370 is the correct answer. Perhaps some other readers have come to the same conclusions.

M. Bludgeon
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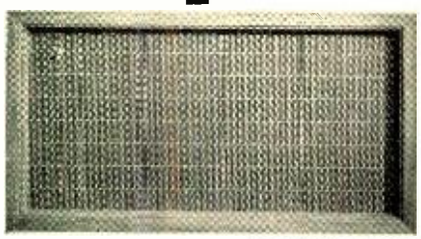
Mr. Dresser was instrumental in the early development of the sound program for Paramount Pictures and later was vice president and chief engineer of Vitarama Corporation, forerunner of Cinerama. During his electronic career he has also been president of Graphic Recorders, Inc., and president of the Audio Tone Oscillator company.

• **Plant Expansion For Concord.** Concord Electronics Corporation of Los Angeles is more than doubling its physical plant capacity by taking over warehouse space adjacent to their current headquarters at 809 Cahuenga Boulevard. The added space, combined with other warehousing facilities in Los Angeles and New York will now provide Concord with more than 30,000 square feet of warehousing, testing, and servicing. Concord will also be expanding office space to more than 1000 square feet to accommodate additional accounting and sales personnel.

• **Reeves Soundcraft Elects Director and Names Vice President. Harry E. Houghton** has been elected a director and **John S. Kane** has been named vice president of Reeves Soundcraft Corp. (AMEX), New York, at a recent Board of Directors meeting, according to **Hazard E. Reeves,** president. Mr. Houghton was formerly president of Encyclopedia Britannica, Inc. He also served as a director and chairman of the executive committee of Encyclopedia Brittannica. Mr. Kane will be general manager of Soundcraft's magnetic tape division located in Danbury, Conn. He replaces Frank B. Rogers, Jr., executive vice president. Mr. Rogers directed Soundcraft's magnetic tape division during its move from Springdale, Conn., to the new and expanding plant operation in Danbury. Mr. Rogers, who has resigned as of March 9, 1963, will continue as a consultant to the company. Prior to joining Reeves Soundcraft, Mr. Kane was assistant director of operations for International Resistence Company of Philadelphia, a manufacturer of resistors, and allied electronic components.



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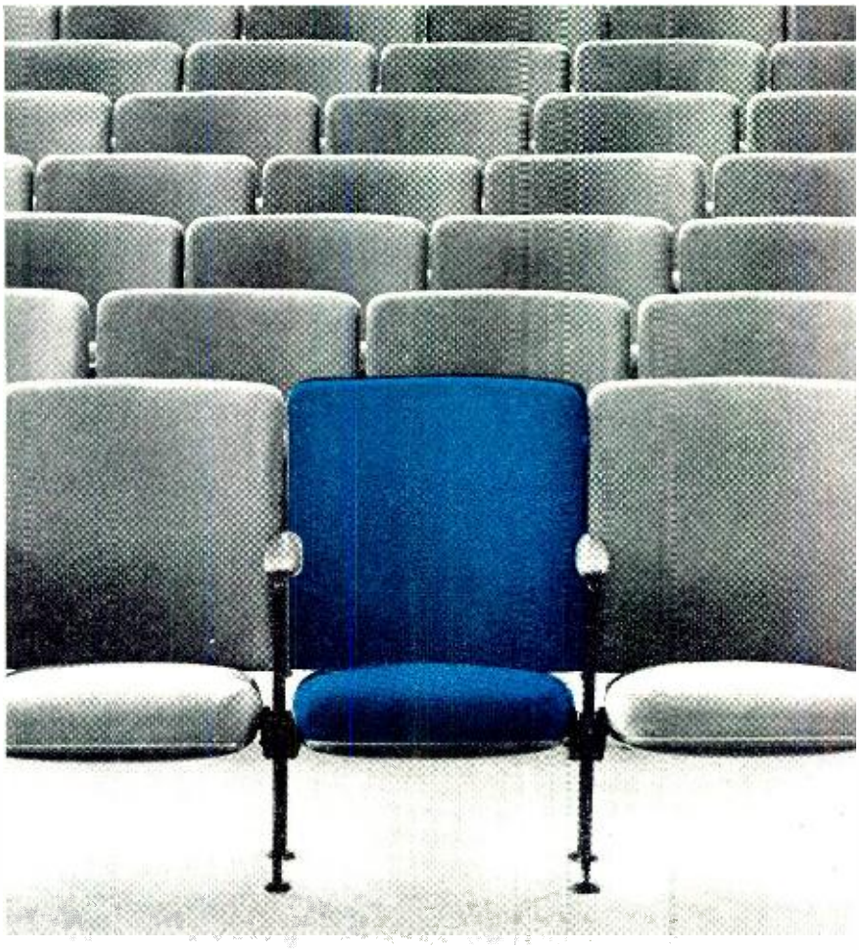

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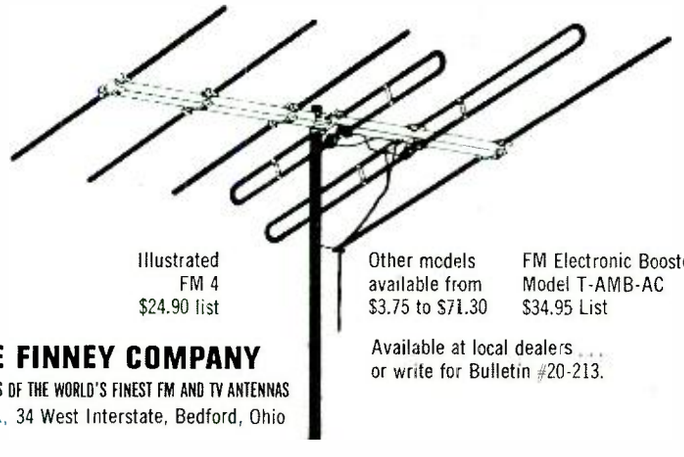

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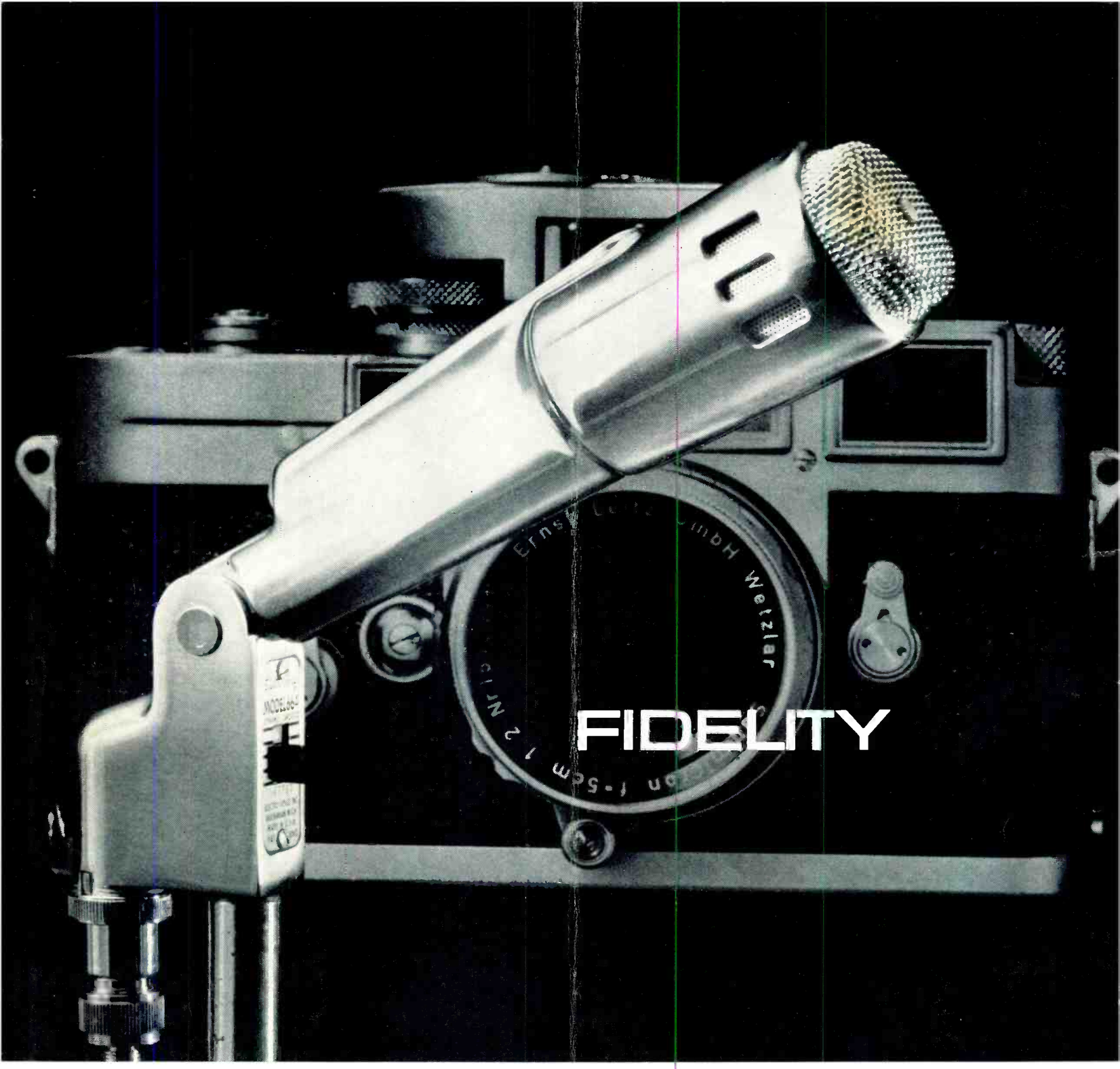

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