AUDIO

JUNE, 1963

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AUDIO

JUNE, 1963 VOL. 47, NO. 6

Successor to RADIO, Est. 1917

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AUDIO Profiles

AUDIO in General

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Coming NEXT Month

Construction

Professional Condenser Microphone by R. Williamson
Design and construction of a professional quality condenser microphone.

Sound Reinforcement

Sound Reinforcement at the Ziegfield Theater by George Schimmel
The problem was to put together an inexpensive system for the personal appearance of Maurice Chevalier, and in a theater which is an unusually hard problem to solve.

Design

Class-D Amplifiers—A Second Look by G. C. Cooper
A more searching analysis of this intriguing idea introduced last month by Mr. Cooper.

And

Equipment Profiles

1. H. H. Scott 350B FM-Stereo Tuner
2. Benjamin-ELAC Stereo Cartridge, Model 322
3. Revere Stereo Tape Cartridge System

In the July Issue—

On the newsstands or in your own mailbox

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
Joseph Giovanelli
2819 Newkirk Ave.
Brooklyn 26, N. Y.
Include stamped. self-addressed envelope.

Note:

Please observe that from now on, letters addressed to "Audioclinic" should be addressed to me at my new address: 2819 Newkirk Avenue, Brooklyn 26, New York.

Many of you do not put your address in your letter, only on the envelope in which the letter is contained. I do not keep the envelopes. Sometimes, therefore, when a letter requires an answer in two parts, the second part cannot be sent because I do not have the address. I try to avoid losing the address, but sometimes I goof. The result is that I have a few letters which cannot be sent, even though the answers to the questions posed are worked out. If any of you have not received a complete answer to your question, a missing address is probably the reason. Therefore, please—pretty please—put your address in your letter proper!

Last, I wish to thank you for enclosing stamped self-addressed envelopes with your questions. This is helping me to help more of you more quickly. J. G.

Disc Recording

Q. A subject that I have not seen covered in your column is concerned with the cutting of acetate phonograph records with semi-professional equipment—that is, equipment that a small studio or an audiofan is able to purchase and connect—to obtain good results.

We are driving our cutting head with a 25-watt power amplifier. The impedance of our cutting head is 8 ohms. We wish to cut the RIAA curve on our records. The manufacturer of the head claims that it has a built-in RIAA curve from 1000 cps down to 30 cps. But would we get this by connecting the head directly to the 8-ohm tap on the power amplifier? One authority states that a capacitor and resistor network must be inserted in series with the head to keep it from loading down the power amplifier as the frequency decreases and the impedance of the head drops lower.

To get the full RIAA curve I would have to tip the curve up above 1000 cps. I understand this is done ahead of the power amplifier assuming the power ampliefir is flat. I know that some manufacturers make networks to insert ahead of the power amplifier but all are 500 ohms out and in. My power amplifier has a 100,000-ohm input. I drive this power amplifier from the output of a tape recorder. Is there a practical way of constructing a unit to give me the tip-up with my high impedance input?

In obtaining power amplifiers for driving cutters such as mine, what are the chief characteristics to be concerned with outside of frequency response, distortion, and power output? I understand that top quality heads require at least a 40-watt amplifier to obtain clean bass transfer.

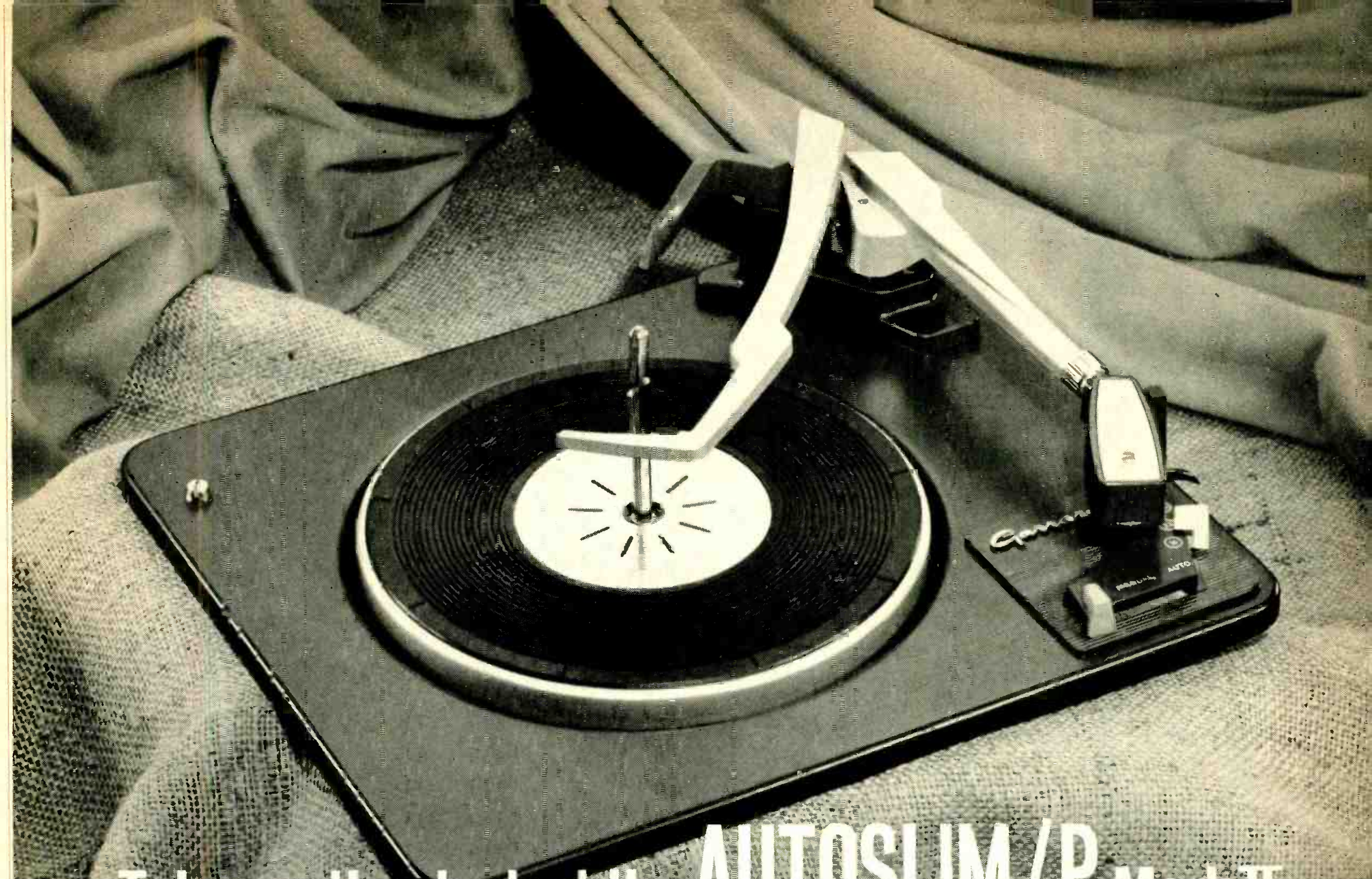
Is it possible to connect a 600-ohm cathode follower output to the input of a device which has a transformer input of 500 or 600 ohms? Will the transformer look at the cathode follower as if it were just another transformer with a 500- or 600-ohm secondary—a perfect match? Allerton H. Hawkes, Westbrook, Maine.

A. With your 8-ohm cutter head, you will probably need a 15-ohm resistor in series with it to give you the constant current effect you need. The actual value of the resistor is something you will have to determine by trial and error. I made measurements on two different cutting heads and with a current limiter in series. I found it is possible to obtain a curve similar to the RIAA bass curve by feeding a flat signal into the power amplifier. The high end did not respond in the same manner, which was not unexpected. Some of the tip-up can be achieved at the record head itself. If you want the input to the head to be 3 db up at 1000 cps, why not use a capacitor whose value is equal in reactance to the resistance of the current limiting resistor at 1000 cps. This capacitor is placed in parallel with the resistor. A slight boost is necessary between 50 and 30 cps. This boost can be created by means of a choke, across the resistor, whose reactance is equal to the value of the constant-current resistor at 50 cps.

The amount of correction this provides depends upon the impedance of the head at these various frequencies. You will have to measure the head first to find out. (The entire theory behind the use of this series resistor is based on the fact that the impedance of the head decreases below the nominal with decreasing frequency below 1000 cps. In addition, the series resistor provides a more or less constant load to the power amplifier. Were it not present, the impedance of the cutting head at very low frequencies would be sufficiently low that it would virtually short circuit the output of the power amplifier. Thus, this resistor could be termed a "constant-impedance" resistor. The choke placed across the resistor is of such reactance that it gradually shorts out the resistor as the frequency drops below 50 cps, thereby providing a boost. The capacitor acts to short out the resistor at the high frequencies, providing a boost there.)

You will have to plot the over-all impedance of this network before determining the best amplifier tap to be used with it. However, I have found that the impedance of the tap should approximately equal the value of the constant-impedance resistor.

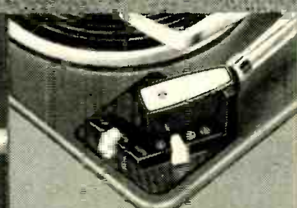
Any additional tipping must be done



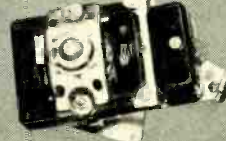
Take another look at the AUTOSLIM/P Mark II

Autoslim/P is the most compact of multi-speed record changers. Only 6½" in height overall, it will fit where other automatic units may not. Sparkling in grey, charcoal and brushed aluminum, the Autoslim/P will grace any music system. It is the ideal replacement changer.

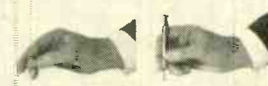
The graceful tonearm is cast aluminum, for non-resonance and rigidity. A bayonet fitting holds the plug-in shell, which accommodates the widest personal choice of cartridges. An extra-sensitive stylus pressure control insures correct tracking force, according to the cartridge manufacturers' specifications.



The unified control panel has separated positions for playing records automatically or individually. Operation is exceptionally quiet. The Garrard 4-pole shaded "Induction Surge" motor, with dynamically balanced rotor, is shielded from hum. Constant speed is assured, free from vibration.

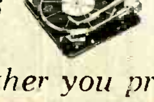


In automatic position, the Autoslim/P intermixes records of any size or sequence. Two spindles are provided. A convenient short single play spindle is interchangeable with the center drop automatic spindle which pulls out for safety in handling records.



Installation is simple. Autoslim/P is fully wired for stereo, with a 4-pin/5-wire system utilizing separate connection for ground, to eliminate hum. Leads connect to the changer with a built-in Amplok plug (for AC) and a female twin phono socket mounted on the unit plate (for audio). Simply plug-in at the player!

Price $39.50 less cartridge

The new Autoslim is a pure-bred Garrard. Built in the same tradition as Garrard's automatic turntables, the immensely successful Type A  *and AT6*  *it reflects the same dedicated engineering and quality control techniques. Whether you prefer the Autoslim, AT6 or Type A, your pride of ownership resides in the name . . .*

Garrard
world's finest

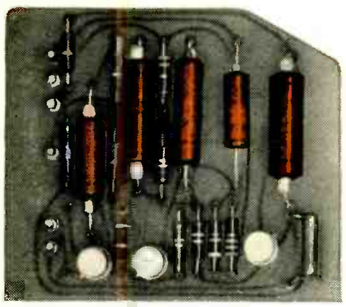
There is a Garrard for every high fidelity system. Type A $79.50, AT6 $54.50, Autoslim $39.50.
For Comparator Guide, write Dept. GF-1 3, Garrard Sales Corporation, Port Washington, N. Y.

Canadian inquiries to Chas. W. Pointon Ltd., 66 Racine Road, Rexdale, Ontario. Territories other than U. S. A. and Canada to Garrard Engineering and Mfg. Co., Ltd., Swindon, Wilts., England ahead of the power amplifier. This system has the advantage that some of the tipping is done at the cutter and that the amplifier does not have to supply as much power. The loss provided by the constant-current resistor is made up for on the high end by the capacitor.

The commercially available networks are fine up to a point. If you use the tipping scheme I have just outlined, however, and use one of these networks, I believe that the network will introduce too great a rise at 1000 cps. Let us assume that we want to be up 3 db at 1000 cps. This can be done in our original network via the capacitor. If the commercial network is designed to give you the same boost at 1000 cps you will be 6 db up rather than the 3 db you should be at this point. The extra 3 db can be removed by removing the capacitor. This would mean, however, that the amplifier must deliver twice as much power for that 3-db boost than it would with the capacitor in place. Remember that a 25-watt amplifier is being used. It is easy to drive a cutter in the mid frequencies, but more and more power is needed to do this as the frequency rises, assuming that you follow the RIAA curve. Let us assume that you require 5 watts to drive the cutter at 1000 cps. Perhaps 10 watts will be lost across the current limiting resistor. The amplifier is already delivering 15 watts. If we correct for the 1000-cps loss with the capacitor, the amplifier need not deliver much more power at 1000 cps than it does at 500 cps. If you do not use the capacitor across the current-limiting resistor you must feed more power to the amplifier to get the required 3-db boost. The amplifier will then have to deliver 30 watts. This is just beyond the capabilities of the amplifier. Let us hope that your cutter requires considerably less than this 5 watts to drive it at mid frequencies, or you will have to use a monster amplifier in order to correct as frequencies go even higher. While it is obvious from the foregoing that the amplifier cannot be used for such a cutting head, the illustration does show that the use of the capacitor reduced the amount of power required from the amplifier.

There are authorities who say that the energy distribution of music and speech is such that most of the power is concentrated in the low and middle frequencies, with little power in the high frequencies. This leads to the assumption that, when recording music and speech, an amplifier having less power capabilities is required than would be if an audio oscillator was used as a sound source. There are exceptions to this assumption. Take for instance a cymbal crash which contains intense high frequency energy. The amplifier must be capable of handling large amounts of high frequency power at such times.

There is another drawback to a commercial network. It does not take into account the peculiarities of a particular recording head. Suppose the network is designed to give a correction to 15,000 cps on the assumption that the head with which the network is to be used is flat to that frequency. Suppose, however, that the head is flat only to 10,000 cps and is down 6 db at 15,000 cps. The network will function perfectly to 10,000 cps but at 15,000 cps the response will be 6 db down. It will be necessary to build a separate network to produce a rise of 6 db between 10,000 and 15,000 cps. Assuming that you do not use a commercial network, the network you do use can be so designed as to give you this extra boost. Before building this type of network make sure that the amplifier is capable of supplying the extra power and



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. . . a 'straight wire with gain'."

EQUIPMENT REPORT — HIGH FIDELITY MAGAZINE

For the full text of the High Fidelity report, write Dept. A-6, Citation Division, Harman-Kardon, Inc., Plainview, N. Y.

harman kardon

that the coils in the recording head are capable of withstanding the extra strain. If your equipment cannot handle the extra boost, you may have to be content with less correction at the extreme top end than you would like. In that event the best thing you can do is to correct as perfectly as possible as high as you can go and leave it there, even if the response is only good to 10,000 cps.

Commercial networks are usually 600 ohms in and 600 ohms out. Such networks can be fed with a cathode follower but a fairly large coupling capacitor, about 10 to 15 μf, will be needed. Because of the leakage in an electrolytic capacitor of this size, the use of a few 4 μf paper units or oil-filled units is preferable. The output of the network can be terminated in a 600-ohm resistor and fed to the input of the power amplifier. If more gain is required than this arrangement will provide, a line-to-grid transformer of good quality must be used. Further, you cannot ground the input and output terminals of the amplifier if these circuits are balanced. In the output circuit, a line-to-grid transformer is mandatory. The input must be fed from a transformer whose secondary impedance is 600 ohms and whose primary impedance is that of the source supplying the signal. If this signal source is a professional tape recorder, it is more than likely equipped with a transformer which can feed the equalization network directly.

Concerning the matter of what to look for when selecting a power amplifier for disc recording work, outside of the points you have mentioned, be certain that it has good voltage regulation. Don't rely on a music power rating of power. Be sure that the amplifier does not sag under heavy, sustained, loads. Also, the amplifier must have the best possible transient response even at its maximum power capabilities. This means that the frequency response should extend well above audibility, preferably to five times the highest frequency to be recorded. You may very well have to make some compromise here, but make as little as possible. Æ

THIS MONTH'S COVER

Proving again the adaptability of audio components to decorative needs, this music wall in the home of Murray Landsberg of Maywood, N. J. is an unusually attractive example of what can happen when the technical man meets the immovable force—his wife. Actually, Mr. Landsberg says that he and his wife worked together to design the wall.

The wall is 12-ft. wide and 8-ft. high. There are two speakers, one at each end of the wall (Janzsen-400's) behind closed doors. An H. H. Scott 350-B tuner brings in stereo FM signals, the Scott LC-21 preamp is the control center, and a Scott LK-150 power amplifier drives the speakers. Records are played on a Weathers single-speed turntable and picked up by either a Weathers professional tone arm or an ADC "Pritchard" tone arm system. All equipment is removable from the front.

Above the record player *from left to right* are the speaker selector switch, the Fairchild Compander (to increase the dynamic range of the music) and an Alliance U-98 antenna rotator (for the Finco FM-4 yagi antenna on the roof of his home). The antenna also has a Jerrold transistor booster for distant stations. This booster can be turned off for reception of strong local stations by a pushbutton under the tuner dial.

LIGHT LISTENING

Chester Santon

Marty Gold: Soundpower!
RCA Victor Dynagroove LSP 2620

With the unveiling of its Dynagroove process, RCA Victor joins the small group of record companies fighting for top honors in sound on table phonographs and cheap consoles. This Marty Gold release, his first in the Dynagroove series, surpasses all other labels in bolstering the response of the playback unit the Electronic Industries Association had in mind some six months ago when it outlined its "high fidelity" standards to the Federal Trade Commission. Once you sample this record on a decent component rig, you'll immediately understand the instantaneous success of this new RCA process on home machines that deliver less than five watts and a response curve that is down 3 db at 100 cps and 6 db down at 8000 cps. It's going to take more than one decade of explanation by RCA Victor to convince me that the company responsible for the design of this "Soundpower" album had nothing to do with the formulation of the original EIA "high fidelity" definition. It is true that the trend that has been leading us away from the bona fide sound once generally available on stereo records was not started by RCA Victor. Some elements of the Dynagroove process have been concocted in self defense following the sales inroads made in recent years by other labels. Enoch Light's Command label, in its pop recordings, demonstrated some time ago that a fortune could be made these days with a stereo disc of compressed dynamic range and drastically altered frequency response. There the matter might have rested if Columbia had not brought out a modified version of the Command process in the Columbia "360 Sound" series. RCA could afford to ignore Command's popularity on the changer of the typical console. Columbia's boosted signal and "fuller" sound with the "360 Sound" disc on the same console was a threat that could not be disregarded and the Dynagroove idea was hastily pressed into service. It seems hard to believe in the light of what has been perpetrated in the Dynagroove series that only a few months ago this column was congratulating RCA Victor on its refusal to join Columbia in the trend toward restricted dynamic range and excessive peaking of bass and treble in recordings of light music.

What are the salient features of a Dynagroove record? It is alleged in RCA's statement on the Dynagroove process that the speed of the master tape is 30 ips. If such is the case, the benefits of that speed are nowhere in evidence on most of the ten initial Dynagroove releases I've heard. As some of the more obvious bugs are eliminated (the second half of the new Ravel "Bolero" is the most distorted stereo record ever produced by the American disc industry) some of that 30 ips sound may get a chance to come through. At the moment, the process itself eliminates so much of the response RCA has always had on its 15 ips master tapes, most Dynagroove releases could just as well start with a master tape of 7.5 ips and no one would be the wiser. Response at both ends of the frequency spectrum has been drastically curtailed. What bass and treble is left on the record now sounds like the mismatch you get when a loudness compensator of the Fletcher-Munson type is set too high for the volume being used. In the most astounding aspect of the whole process, a monitoring device governs the action of the cutting stylus. In this final step of the Dynagroove process, any groove wiggles that RCA considers might cause tracing difficulty on even the lowest-price equipment are simply not allowed to appear on the record. The result? Usable high-end response on most of the new discs doesn't go much beyond 8 or 9000 cps. Whatever the nature of favors bestowed by this process on the owner of poor equipment, I miss in this Marty Gold release all the familiar features that used to make his albums a sonic delight. Suppressed dynamics hobble the fluent instrumentalists of his orchestra almost as much as they curb the piano style of Peter Nero in a companion Dynagroove record (Hail the Conquering Nero—LSP 2638). If the Dynagroove process fails to improve in future releases, I, for one, am prepared to plead with RCA Victor that at least an occasional outstanding recording be released under the regular, "old-fashioned" process that could be enjoyed on even the most critical sound system.

Edmundo Ros: Broadway Goes Latin
London Tape LPM 70059

As more record labels show signs of abandoning the audiophile disc market, tape releases are bound to assume more importance in the component field. Four-track tapes such as this brand new London release sound mighty good after a listening session with some of the new stereo discs. Although the latest tapes still do not deliver the range of true highs that I get on an undoctored stereo disc (particularly those taken from masters made on 35 MM magnetic film) any decent four-track tape will give you a freedom in the sound of instrumental music that is unobtainable in the new discs aimed at table phonos. Shadings of expression within the orchestra of Edmundo Ros are relatively unharmed in the transfer to four-track tape as England's most famous dispenser of Latin tempos tackles a group of Broadway show tunes. These range in age from George M. Cohan's venerable classic *Give My Regards to Broadway* (done here in the cross rhythms of the baion and the bolero) to the brand new scores of "Oliver" and "Stop the World." Ros himself is heard in the vocals of several tunes but the main attraction of this outfit is still the crisp sound of its Latin beat so familiar to record fans on both sides of the Atlantic.

Al White Orchestra: Station J
Capitol ST 1832

This is an amazing recording. You can search the stereo disc catalog from end to end and find few, if any, recordings that possess the natural liveness in room acoustics Capitol has captured in the San Francisco nightclub called Station J. Since the unorthodox is but one of the many factors that underlie the charm of that cosmopolitan city, local citizens felt no shock when three young men-about-town decided to open a nightclub in a fortress-like structure that once had housed a substation of the Pacific Gas and Electric Company. Station J is situated on no-wider-than-an-alley Commercial Street in San Francisco's financial district. Opened in September of 1961, the interior of the club is an extraordinary locale for recording purposes—particularly if the music being miked consists of the bright fare popular during the '20s. Imagine working a batch of stereo microphones in a large room whose walls rise 60 feet to the ceiling. Some 500 guests can be accommodated on the main floor and the high balcony that extends from two adjoining walls. Al White's 14-piece orchestra occupies an elevated bandstand in one corner of the room. Every snappy morsel of its Twenties dance music frolics its way to that 60-foot ceiling with a saucy delay that no reverberation unit could ever match. Orchestra leader White is an established fixture in the Bay area, having played viola in the San Francisco Symphony Orchestra and served as musical director of the local CBS and NBC radio stations back in the days when they maintained staff orchestras. *Milenbury Joys, Tiger Rag* and *Yes Sir, That's My Baby* are but a few of the sinewy songs revived here. Trombonist Reid Tanner typifies the casual good humor of the orchestra's work as he nonchalantly wields a coffee can for a mute in *Wabash Blues*.

The Cascading Voices of Hugo and Luigi Chorus
RCA Victor LSP 2641

The Dynagroove process seems to have less adverse effect on singer's voices than it has on the sound of instruments. Of all the pop releases in the first shipment of RCA's Dynagroove discs, this vocal album is the least artificial in sound. Presence is uniformly excellent in the pickup of male and female voices heard with a minimum of instrumental accompaniment. The bass fiddle taking care of the rhythm has been provided with a frequency characteristic all its own. It thumps along with a boosted thud that would have gladdened the hearts of the men who designed the first jukebox. As the chorus works its way through a program of ripe ballads (*Moonlight and Roses, Marcheta* and *When Day is Done*) the dynamics of the arrangements remain pretty much on the same level. In such circumstances, the elaborate gear of the Dynagroove process has relatively little to do in the way of peak suppression and the listener gets an opportunity to evaluate some of the other features of the new process. In this album, alone among the first batch of Dynagroove discs, is there any suggestion that a speed of 30 inches per second was used in making the master tape.

Doris Day and Robert Goulet: Annie Get Your Gun
Columbia OS 2360

Here are forty-six minutes of a vintage Berlin musical comedy score in up-to-date sound and performances just about as good as those on the now ancient original cast album. Columbia continues to earn the gratitude of dyed-in-the-wool show fans with its revivals of the great Broadway hits of the past, this time with Doris Day and Robert Goulet re-enacting the vocal dueling matches first made famous by Ethel Merman and Ray Middleton when "Annie Get Your Gun" opened on the Main Stem back in 1946. Miss Day is far too winsome an Annie Oakley to convey all the withering fire that was an important part of the Merman interpretation. She is not too far behind in the songs that stress the tomboy aspects of Annie's nature and definitely ahead of Ethel Merman in the ballads that require a judicious application of vocal syrup. Robert Goulet easily matches the out-of-doors masculinity Ray Middleton brought to the role of Frank Butler with no trace of the latter's woodenness in the acting department. In plotting the action for records, Columbia producers Jim Foglesong and Irving Townsend have stressed closeups of the principal players at the expense of the theater illusion found in many stereo original cast albums. The added crispness in the delivery of the lyrics made possible by Columbia's approach comes in handy during seldom heard items in the score such as *Moonshine Lullaby* and *I'm an Indian Too*.

Georgia Brown Sings Kurt Weill
London Tape LPM 70061

With this tape release, Georgia Brown moves up from a featured role in the original cast recording of "Oliver" to star billing in an album of her own on the London label. Plans for this Kurt Weill program began to jell while Miss Brown was playing in the London run of "Oliver." Appearances in "The Threepenny Opera" had given Georgia Brown an inside track when London decided to produce an album of Weill songs featuring a singer currently in the spotlight. In this fairly exhaustive collection of Kurt Weill tunes, arranged and conducted by Ian Fraser, Miss Brown is fully convincing only in the songs that have a distinctively foreign flavor. She captures most of the decadent atmosphere of the early Weill scores such as *Threepenny, Happy End* and *Mahagonny*. Her approach in *Mack the Knife, Alabama Song* and *Surabaya Johnny* amounts to a heady mixture of the

(*Continued on page 51*)

There are only three finer control amplifiers than this $169.50* Fisher X-100-B.

(The three below.)

There are only two finer control amplifiers than this $199.50* Fisher X-101-C.

(The two below.)

There is only one finer control amplifier than this $249.50* Fisher X-202-B.

(The one below.)

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AUDIO ETC.

Edward Tatnall Canby

PHONES—THE "CROWNED" CURVE

Don't let the headphone boom pass you by just yet.

Since last year, and because of a very considerable restudying of the whole problem of hi-fi phone listening, there has been a healthy development of new and modified phones offered for home stereo music listening. I have two sets of them on hand, successors or supplements to earlier types, and I must say at once that I find both really excellent. Try the E. J. Sharpe HA-8, or the Telex Stereo-Twin model ST-10, if you want at last to hear really natural and musical stereo sound via phones. (With Bauer circuit cross-feed, by all means.)

What has happened in this year's headphone soul-searching has been fundamental. The older idea was simply to extend response, as flat and as far as possible, in both directions. Hi-fi, after all, *requires* flat response, doesn't it? The trouble was, though, that however valiant the attempt, every wide-range phone ended up with plenty of highs and much too little bass. Fair bass, sometimes—if you glued the phones to your head, or applied excruciating pressure. Practically no bass at all, most of the time, thanks to leaks and lack of sealing, on top of small-transducer problems of dismal magnitude. After all, it isn't easy to get big bass out of a half-size tweeter, seal or no seal.

The result of these earnest attempts was remarkably the same, as one listened to many conscientiously designed quality phones: a gross unbalance, unpleasant to the ears and to the musical mind and hence producing a seemingly strident, distorted effect.

The answer was already understood, however, by some of the phone makers. They cannily put aside ideas of flat response and went to work on assorted contrived curves, to please the ear. Rig the bass (like the old bass reflex cabinets) to get maximum semblance of bass effect out of what was available. Then *droop the treble*. (Or just let it droop of its own accord, instead of working hard to bring it up to flat.) Whether you also indulged in assorted peaks for presence was in a way irrelevant. The important thing was the high-to-bass balance, which makes or breaks stereo listening via phones. And the thing to do, over all, was to achieve what can nicely be called a "crowned" response curve. Not flat, but balanced and symmetrical to the ear.

Now, this year, the conscientious makers, who once carefully made their quality phones as flat in the highs as they could, have revised their thinking and they, too, have come to the greater truth. *It isn't a flat, linear response that is wanted (and can't be achieved); it is a balanced curve.* Balance is the basic requirement for realism and nturalness. So—roll down that fine treble response, if need be. Deliberately.

The Sharpe HA-8 phone set is a smaller version, easier to manage on the head, of the basic Sharpe design that includes the distinctive Sharpe internal sound absorbers to insulate from outside noise, plus the very comfortable liquid-filled ear-surround, providing an easy seal with very light pressure on the ears. Self-contouring. I am enthusiastic about these new Sharpes, after several evenings of stereo listening (via Jensen "Space Perspective"). I find them for music in every way superior to the larger (and "flatter") phones of the original model; and if I am right, they are cheaper, too. If you are still shopping in your mind for the ideal private listening method, shop right here for a splendid beginning.

The early Telex phones, on which I reported well over a year ago, had excellent soft foam-rubber surrounds, were light and easy to wear, but lacked bass. Their good highs were, accordingly, of little avail; the sound came through thin and somewhat strident. The new model, very similar in outward appearance, is the result of some careful thinking on the company's part, influenced by this department's assorted discussions of the problem, they tell me. What has come forth is a modification similar to that in the new Sharpe phones. Much less strident highs (as the ear hears them) and a good over-all balance between available highs and lows. That is the essential, and again, these phones are far more satisfactory for music listening than the early type. I find the Telex curve perhaps a bit too severe on the highs; the sound is slightly muffled alongside of the Sharpes. Not much. Not enough to spoil an immediately natural musical sound.

The audio purists may still insist on phones with utterly flat highs—and they can have them, too, more or less. But most listeners will find the new "crowned" response curve, equally down at both ends and gracefully balanced, by far the most satisfactory solution to the hi-fi phone problem. I think we've found the right answer this time. That is, until somebody comes up with a pair of featherweight phones with flat bass from 20 cps right up to mid-range and no pressure on the ears at all.

Given more bass, you can push up your highs. Make a shallower curve, not so crowned. Maybe even a straight line, more or less. That leaves hypothetical room for improvement—if and when. Meanwhile, it's crown, or nothing.

P. S.—Koss announced a new higher-fi model last year to supplement its standard and popular model—which has always had a "crowned curve" (plus a few well chosen presence peaks and mellow bass-booms) since the phone idea first hit. I have not heard the new more expensive Koss but if, by any chance, it has "progressed" from curved-down highs to flat highs, I prophesy the worst. More likely, though, Koss has found means to build a "flatter," i.e. smoother, crowned curve into the new phones, and thus a higher quality, without sacrificing the basic balance. Try them yourself and see.

JUST ME, TALKING

I wouldn't know whether the two Schoeps condenser mikes I've had on hand for quite awhile are actually "audibly superior," as their ads put it, since that is a dangling comparative and I don't go for such things, m'self. Dangle or no, I can say, much more concretely, that they are audibly very pleasant to hear—if indeed you can hear them at all.

For the function of a quality mike, like that of a superior amplifier (whoops . . . there I go), is to be transparent to sound. The most obvious thing about the sound I've so far recorded through this mike is exactly that. It is very hard to figure out what the mike is doing in the circuit—you're not even conscious that it's there.

For instance, aside from fine response in a general way, this is one mike with a variable pattern that includes a boomless cardioid pickup. Others no doubt feature this negative virtue, but this was my first experience with it. On the old-type cardioid, such as my sedate and highly respectable (also highly durable) Western Electric job of many years' usefulness, I can't talk close-up in the cardioid position. The ribbon element won't let me. The cardioid pattern in those older mikes was achieved, as all professionals remember, via a dual element, a dynamic and a ribbon mike combined. The dynamic by itself was omnidirectional, the ribbon bi-directional. Together, they added up and subtracted down, so to speak, to produce a cardioid pickup, wide open in front and down to a muffled deadness at the rear. But the dual combo did things to the combined signal, inevitably. And the ribbon, like most ribbons, could not tolerate close-up sound without booming out a tubby false bass.

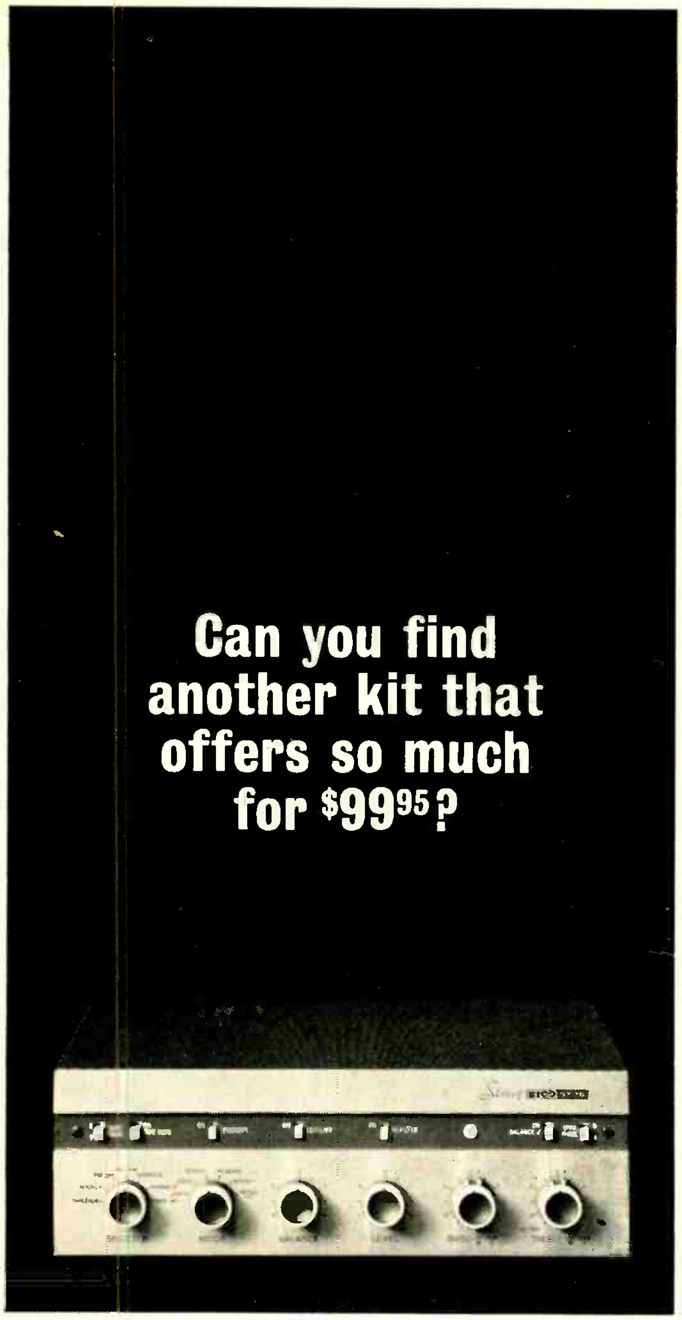
Schoeps gets its cardioid most ingeniously from a single mike diaphragm via acoustic chambers around the element, alterable to make the familiar three patterns—cardioid, bi-directional, and omni. No phasing and cancellation problems—or none that I could hear. No ribbon boom at close range on cardioid, and a better front-to-back cardioid ratio, too, than with the older mikes. That's why this mike remains transparent to any old sound even at very close range, whatever the pattern you may choose, including cardioid.

I'm tossing forth this description on account, pending further explorations, since I am still looking for greener recording fields—the very greenest—upon which to give the pair of mikes a really adequate field-test, along with that big gray inspiration for their loan to me, the Crown 800 tape recorder. Sure, I've fed stuff in and out of the machine via one and via two Schoeps—but somehow, such casual doodling as I've been able to do so far doesn't really satisfy me; I need a bigger, more serious occasion, a real tough job to do, and I find it hard to locate one within hauling distance for all this fancy equipment!

We recorded some hours of professional stereo with my Canby Singers recently—via somebody else's Ampex and Sony combo. Mine wasn't within reach of the recording site. Now, my latest idea—if I can hang onto my fabulous equipment long enough—is to import the Canby Singers, all 17 of them, for a Schoeps-Crown recording session in my country place, to complement the New York session we recently completed. That'll bring out the best, if not the worst! Anything may happen.

The Schoeps, in cardioid and mounted handily in its clever little elastic cage suspension, has, however, produced all my broadcasts over WNYC for several months. What can I say about the results? They are

(*Continued on page 41*)



EICO ST70, 70-WATT STEREO AMPLIFIER

EICO ST97 FM STEREO TUNER

Beyond the performance level of these two units, possible improvement is merely marginal and very expensive. That's why with EICO's ST97 and ST70 you strike the optimum balance of cost and performance—each costs less than $100 as a kit. You can also get the ST70 and ST97 factory-wired for $149.95 each—and you couldn't find comparable wired units at the price.

If high power isn't your primary need, you can get superb sound for even less with EICO's ST40, the 40-watt counterpart of EICO's outstanding ST70. The ST40, essentially equal to the ST70 in all but power, costs $79.95 as a kit, $129.95 factory-wired.

ST70 DATA: As the center of your stereo system, the ST70 accommodates all program sources. It even has separate inputs for both turntable and record changer, preamplified tape signals and tape head with correct equalization for both fast and slow tape speeds. A center channel output feeds directly on a center channel speaker or, where desired, extension speakers throughout your house without any additional amplifier. Critical parts—filter capacitors, rectifiers, output tubes—all operate well below their ratings to assure long, trouble-free life. Oversize output transformers deliver full rated power all the way down to 30 cps. . . . And as a kit builder, you'll like the spacious layout. We got rid of all those tight places. Kit $99.95. Wired $149.95 (includes metal cover).

SPECIFICATIONS ST70 *Output Power:* 70 watts (continuous sine wave 35-watts per channel) *IM Distortion:* 1% at 70 watts. *Harmonic Distortion:* less than 1%. *Frequency Response:* ±½ db 10-50,000 cps. *Inverse Feedback:* 17 db. *Stability Margin:* 10 db. *Hum and Noise Level:** mag. phono —63 db; tape head —54 db; tuners, auxiliaries —78 db. (all measurements according to IHFM standards.)

ST97 DATA: Building the ST97 FM stereo tuner requires no instruments, no critical adjustments. The front end and IF stages are fully pre-wired and prealigned. The tunable coils of the stereo demodulator are factory-adjusted. With four IF stages plus a stable, sensitive front end, the ST97 pulls in clear stereo even under fringe conditions, and EICO's filterless zero-phase shift stereo detector (patents pending) maintains reliable channel separation. EICO's unique traveling tuning eye makes tuning simple and precise. Stereo stations are automatically identified by a pilot light. Semi-kit **$99.95.** Wired **$149.95.** (Includes metal cover and FET.)

SPECIFICATIONS ST97. *Sensitivity:* 3μv (30 db quieting), Sensitivity for phase-locking (synchronization) in stereo: 2.5μv. *Full limiting sensitivity:* 10μv. *Detector Bandwidth:* 1 megacycle. *Signal-to-Noise Ratio:* −55 db. *Harmonic Distortion:* 0.6%. *Stereo Harmonic Distortion:* less than 1.5%*. *IM Distortion:* 0.1%. *Frequency Response:* ±1 db 20 cps-15 kc. *Capture Ratio:* 3 db. *Channel Separation:* 30 db. *Controls.* Power, Separation, FM Tuning, Stereo-Mono, AFC-Defeat (all measurements to IHFM standards).

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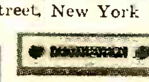

HFT 90 FM TUNER kit $39.95 wired $65.95

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LETTERS

Transistors Sound Better?

SIR:

Recent publicity for transistorized audio equipment has put much emphasis on claims that "transistors sound better than tubes." Frequently these claims are offered merely as subjective opinions; sometimes there are attempts to rationalize them with references to extended bandwidth, transient capabilities, and similar attributes. Often it has been said that "transistors sound better even though they don't measure as well."

One thing that has generally been overlooked when making comparisons between transistors and tubes is whether transistors *sound better* or whether they merely *sound different*. This is a rather important distinction, and a distinction which should be made. I would like to suggest a way by which it is practical to judge whether a difference in sound with transistorized (or any other equipment) may be a result of better sound or whether something may have been added which gives the impression of better sound.

All that has to be done is to *add* the transistorized equipment to an existing audio chain: A preamplifier can be injected into the high-level input of another preamplifier; an amplifier can have the attenuated output of another amplifier fed to its input. Then the comparison can be made of sound quality *with and without* the transistorized equipment in the chain. If this is done with due regard to impedance matching and operating levels, then I contend that any difference observed when the transistor unit is in the circuit represents some form of distortion (since it is generally accepted that any change in characteristics when a signal is passed through equipment *is* distortion). If the added equipment does not change the overall sound, then its distortion level is very low, at least lower than the other equipment with which it is being tested.

In a specific test of this type, I have observed that the transistor unit made a substantial difference in the sound. Unexpectedly, many of the listeners *preferred* this added component of sound even though it represented distortion. Obviously, these listeners misuse the term "better" in describing sound since most people agree that the "best" sound has no characteristics of its own.

Tests made by inserting high-quality tube amplifiers and preamplifiers into an existing audio chain indicate that differences can be exceedingly small, inaudible to most people. This seems to prove that the equipment involved is practically free from all forms of distortion, transient and otherwise, relative to the equipment with which it is tested. Until the insertion of transistorized equipment can be equally inaudible, listening tests which show that transistors contribute to different type of sound cannot be interpreted as indicating that this is better sound.

At the present state of the art, tube equipment, as evaluated by the above procedure, adds practically no audible distortion (its shortcomings are probably masked by the program sources and transducers involved). The goal of the transistor circuit designer should be to do at least as well—not just to achieve a difference in sound.

DAVID HAFLER
Dynaco Inc.,
3912 Powelton Ave.
Philadelphia 4, Pa.

Measurement of Vertical Recorded Angle

SIR:

Observations of the Sarcophagus pattern, described in my article in the February issue of AUDIO, had led to the discovery of modulation springback and subsequent compensation thereof by cutter tilt. We have found, however, that calculation based on the geometry of this pattern, favored by Mr. Alexandrovich (LETTERS, April 1963) is not a reliable method for determining the effective vertical recording angle. That is why this calculation is not used in my article.

Four different ways for determining the effective vertical recorded angle are given in a paper distributed widely to the industry which I presented before the Electronics Industry Association, at a meeting held on February 6, 1963, at the IEEE headquarters in New York. I review them here briefly to help others avoid barren ground that we had already covered:

1. *Geometry of the Sarcophagus pattern.* This is the simplest, but the least reliable method, despite its manifest appeal, because the intersection between the groove wall and the record surface does not portray exactly the geometry of the groove in stereophonic recording. What one sees is the groove edge; but the pickup plays the inside of the groove, not the edge. The reaction of the lacquer surface is different during the up-and-down strokes of the cutting stylus; horns of varying dimensions are generated at the interface making it difficult to ascertain with precision where the groove ends and the surface begins. Moreover, a recorded squarewave is rarely "square." At 1000-cps repetition rate the 20th harmonic is 20,000 cps and most ordinary cutters fall off above 15,000 cps; even a small amount of phase shift alters the "square" shape. Thus the wave tends to have rounded walls and corners making it difficult to determine exactly the limits of either the down or the up stroke.

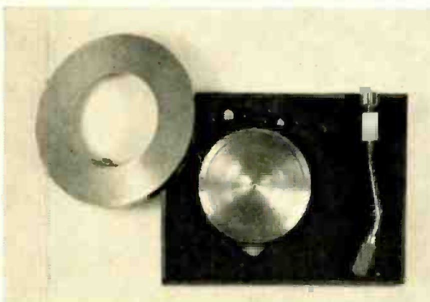
The geometric method, therefore, while useful for qualitative observations, is not recommended for accurate measurements.

2. *Shift of the optical pattern.* It may be shown that when the effective vertical recorded angle, C, is not zero the reflected pattern from a vertically modulated groove is shifted by a distance $d = b^2 \tan C/4r$. Here b is pattern width and r is the groove radius. The optical pattern shift method has the advantage of originating by reflection of light from the groove wall itself (rather than from the intersection between the wall and the groove surface), but it has the disadvantage of depending upon small differences of two large quantities. On the other hand, optical pattern shifts are usable with sine-wave as well as the square-wave modulation. With the former, interference or diffraction patterns may be used to enhance the accuracy.[1] (Square-wave light patterns also exhibit diffraction effects, but I have not had a chance to study how these effects may be applied to calibration procedures.) Despite their theoretical attractiveness, light patterns require considerable photographic instrumentation and skill; moreover, with light patterns we *look* at the modulation, not actually *measure* it with a pickup, which, after all, is the final purpose of a record.

(Continued on page 54)

[1] B. B. Bauer, "Calibration of test records by interference patterns," *J.Acous. Soc.Am.*, Vol. 27, pp. 586–594, May, 1955.

AR INC. *turntable* (33⅓ & 45 RPM)



PROFESSIONAL quality. The AR turntable meets NAB specifications for broadcast equipment on wow, flutter, rumble, and speed accuracy. It is belt-driven from synchronous motors.

complete with arm, oiled walnut base, and dust cover, but less cartridge.

STABLE performance. The suspension design makes it insensitive to mechanical shocks from the floor or to acoustic feedback.

FOR BUTTERFINGERS. This is a picture of the tone arm a second after it has been "accidentally" dropped. It floats down, but when the needle is in the groove the arm is free of restraint.

quoted from **HiFi/Stereo review** *(Julian Hirsch)*

"The wow and flutter were the lowest I have ever measured on a turntable . . . The speed was exact . . . the only rumble that can be heard with the AR turntable, even with the tone controls set for heavy bass boost, is the rumble from the record itself.

"I found that records played on the AR turntable had an unusually clean, clear quality. The complete freedom from acoustic feedback (which can muddy the sound long before audible oscillations occur) was responsible for this."

quoted from **MODERN HI-FI & STEREO GUIDE** *(John Milder)*

". . . the best answer so far to the interrelated problems of rumble and acoustic feedback . . . the only time rumble is audible is when it has previously been engraved on a record by a noisy cutting lathe. Nor is feedback audible—even when the turntable, against customary warnings, is placed directly on top of a wide-range speaker system. There is simply silence."

quoted from **INDUSTRIAL DESIGN**

". . . noteworthy for elegant simplicity." (The AR turntable was included in an exhibit staged by **Industrial Design** Magazine, as an example of functional beauty in product design.)

Literature on AR speakers and turntables, including reprints of the complete AR turntable reports from **HiFi/Stereo Review** and **Modern Hi-Fi**, will be sent on request.

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EDITOR'S REVIEW

A FABLE FOR OUR TIME

A LONG LONG TIME AGO there lived a little old engineer in a place that is far far away from the hustle and bustle of the big city. This old engineer worked away in his old well-equipped laboratory and developed new audio circuits every day from 8 in the morning until late at night. He really liked his job very much except for one thing—he had a "thing" about transistors.

He worked with the pesky little devils for many years, but he would get furious every time a transistor destroyed itself because it got too hot, or because of a surge in the line, or because of a short in the load. He worked, and he worked, and he worked. And he fumed, and he raged, and he swore. He designed special circuits to prevent that little devil from getting too hot. He designed special circuits to prevent line surges from getting through to the "working" transistors. He also designed special circuits to prevent a short from "taking the world" with it. My! how he invented special circuits.

He used to dream about a device which would solve all those problems and still do its basic business of amplifiying; it would laugh at high temperatures, and at line surges, and at temporary overloads, and at all those clever little annoyances that his nemesis could devise. He thought about it when he was awake too.

Then, one day, he heard an engineer talking about a device that could do all those wonderful things he had dreamed about. Of course, he couldn't get one of them right away because the government had it all tied up as a military secret. He could understand that, national security first.

But he could hardly wait, and neither could everyone else. It seems that the wonders of these magical new devices had spread like wildfire. Everyone knew that they would make the best audio amplifiers ever. After all didn't the military use them for the most exotic purposes?

Finally, when they did become available, he rushed into his little old lab and built his very first "tubeized" amplifier (up to now he had just called an amplifier an amplifier). He was ecstatic, and the sound—he swore that it sounded infinitely better. "Don't confuse me with numbers," he would say when some scoffer would point at the much higher distortion he had measured "there's a certain indefinable something about tubes which makes them sound better. Maybe its the way they handle overloads."

Well, our little old engineer lived happily ever after with his tubeized equipment. He had found a whole new world. And it cost him only 50 per cent more.

(This fable—or fairy tale, if you will—was suggested by an idle question, "What if transistors had come first?" We aren't sure that events would happen the way our tale suggests, but after all it is a fable).

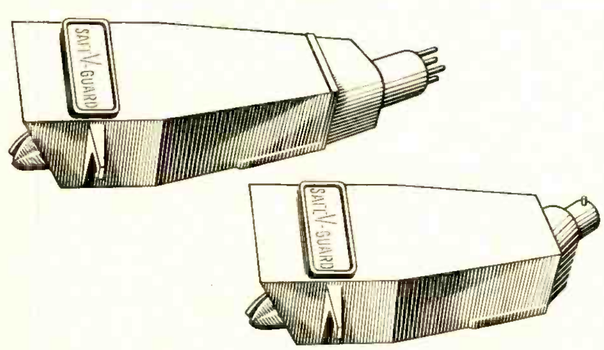
SERVICE, SERVICE, SERVICE

In a recent column, our own Ed Canby took aim at a very touchy problem, the generally inadequate service available for high quality equipment. We know it must be touchy because of the many letters we received. Many of the writers agreed with him, and some disagreed—but all were very strong, one way or the other.

We do sympathize with the many fine servicemen who feel maligned by Mr. Canby's remarks, but we must agree with him in the over-all. There just aren't enough servicemen who know what's up when it comes to high-quality equipment, nor do they have the test equipment to prove up isn't down. Most are at least able to troubleshoot, but there are very few that can adjust a set for minimum distortion.

Instead of calling Canby names, why don't you outraged and (presumably legitimate) souls band together and set up the standards of service necessary for this type of equipment. And form an association to police them.

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.

GA/38ATG — for Garrard Type A LIST **$52.50**
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Includes U/38 Stereo Fluxvalve Cartridge (premounted) with D3807ATG **SAFE V-GUARD**® "Floating Stylus"

STANDARD OPERATION — for use where environmental conditions require a nominal tracking force of 4 grams or more.

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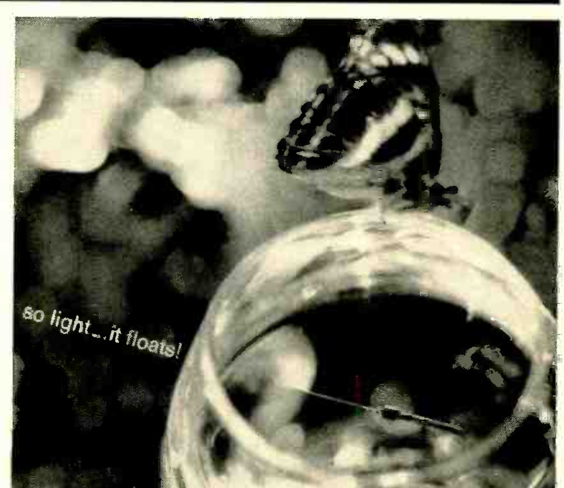

Featuring Pickering's exclusive "floating stylus" ...so little mass that it actually floats on water... so light it "floats" over the surface of your records. The Pickering "floating stylus" action protects the diamond and the life of the record while it plays.

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.
- **Wide-band 3-mc. Gated-Beam Limiter and 1-mc. Balanced Ratio Detector:** combine to suppress background noise introduced by stereo FM and create the pace setting capture effect of 2.4 db.
- **FM Interchannel Hush:** eliminates the "rushing" noise between stations.
- **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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D.c.-coupling the electrostatic loudspeaker to the amplifier, and including the speaker in the feedback path, takes full advantage of the unique capabilities of this type of loudspeaker. You can build both the speaker and the amplifier by following the instructions carefully.

THE DYNAMIC SPEAKER has been developed to a high degree of perfection, some say to the point where it can no longer be improved considerably. Although dynamic speakers can be designed to have a frequency coverage well above and below the audible frequency spectrum, phase differences between the inner and outer radiating part of the cone tends to make good transient response difficult to achieve. However, good transient response seems to be an exceedingly important factor for naturalness in sound reproduction. Also, crossover networks used with the multiple-way systems necessary with most dynamic speakers introduce some phase error, at least near the crossover frequency.

The well-constructed electrostatic speaker is able to overcome most of these difficulties, and in the past it had only one drawback: it needed rather high audio feed voltage, which, for full-range units, usually had to be supplied by a step-up transformer. As the secondary of that transformer couldn't be included in the feedback loop, the result was the same old harmonic and phase distortion. The present speaker-amplifier combination solves these difficulties by d.c.-coupling the speaker to the amplifier and including the speaker in the negative feedback loop.

In the construction data you will find dimensions for the speaker. They should all be closely observed, except for the length. For reasons which would lead us too far afield, it is desirable to make the speaker as long as possible for maximum low-frequency response. As this unit is only about 6-in. wide and 1½-in. deep (including its protective envelope), it can be hung a few inches off the wall, thus taking much less space than even a "compact." This means that the speaker should be one narrow strip, beginning at the floor and extending from three to nine feet in height.

The author's speaker is composed of three sections, each three-feet long, mounted one over the other. They are light and suspended like a picture, or curtain, five inches off the wall.

The audio voltage from the amplifier is applied in push-pull to the electrodes, e_1 and e_2 (the copper layer on a printed-circuit board). For better isolation and linearity, the electrodes are on the outside of the electrode-supports, E_1 and E_2. As the efficiency rises geometrically with the applied bias voltage, the membrane gets a high negative bias (minus 3500 volts) which is produced, at rather low cost, by a doubler using diodes. The use of such high voltage is made possible because of a special insulating lacquer on the copper electrodes. Lower bias will result in lower efficiency. If all values are observed, the efficiency of the speaker-amplifier is many times better than that of a good dynamic cone speaker. The membrane is made of very thin (0.25 mil) metalized elastic polyester foil. The foil itself is glued to spacer S_1 and on the opposite side, to spacer S_{11}. By slightly pulling spacer S_{11} out, the membrane is stretched and then fast-

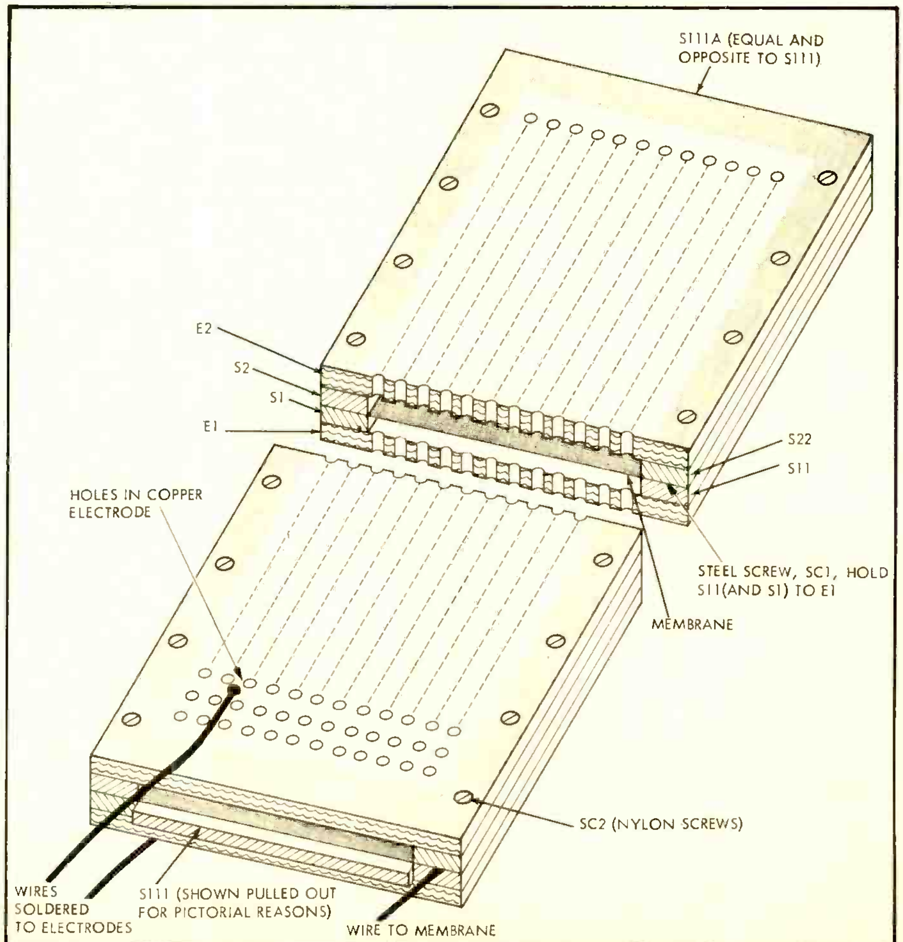

Fig. 1. Pictorial representation of assembled speaker unit. Note that the drawing is not to exact scale in order to show the parts more clearly.

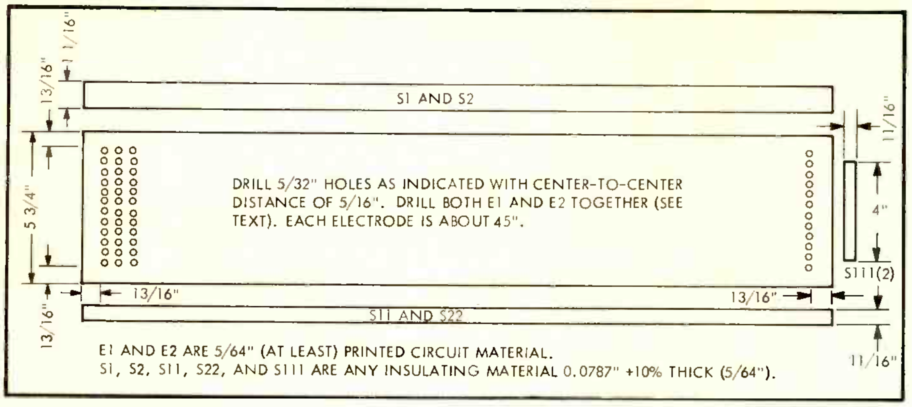

Fig. 2. Dimensions and hole pattern of both electrodes and dimensions of the spacers. Only one each of the electrodes and spacers are shown; two are required.

ened in place by screws Sc_1. The spacers $S_{1,2,22}$ are glued upon their respective electrodes E_1 and E_2 and the whole unit screwed together with nylon screws Sc_2, which also serve to fasten the speaker to its frame or support. The screws, Sc_2, must be made of an insulating material

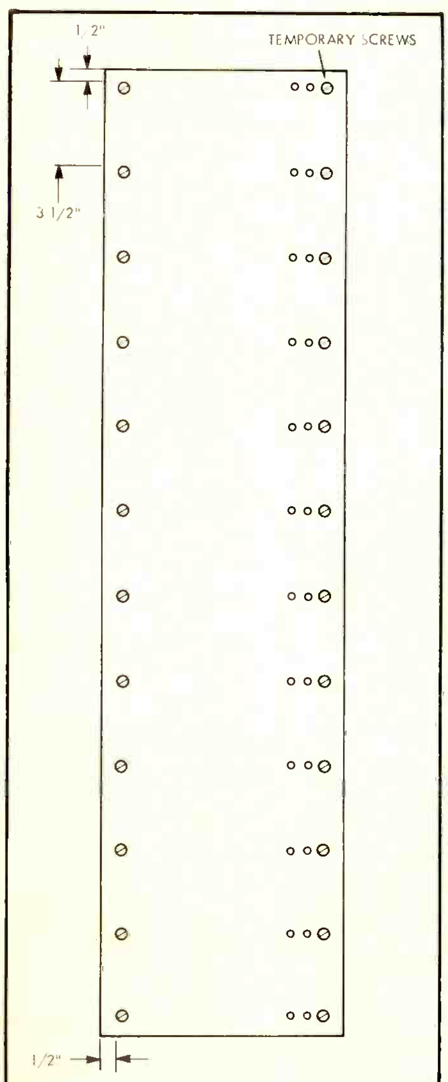

Fig. 3. Layout of mounting holes. Drill holes through electrodes two rows at a time and then use temporary screws to hold new row down.

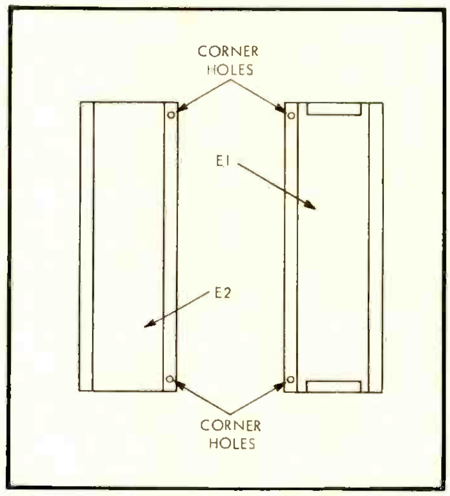

Fig. 4. Use corner holes to bolt electrodes together.

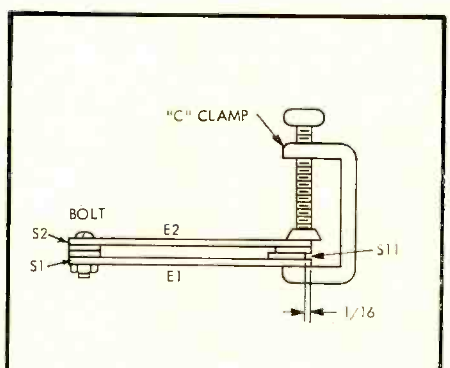

Fig. 5. Bolt E_1 to E_2 with S_1 facing S_2 and clamp S_{11} in position indented 1/16 in. as shown.

because they go through the membrane and would inevitably short-circuit the bias voltage to the metal frame of the speaker-envelope.

Construction

Cut electrodes E_1 and E_2 with a circular or compass saw. Use printed-circuit board material with a copper layer at least 3 mils thick. Then cut spacers S_1, S_{11}, S_2, S_{22}, and S_{111}. Drill the holes in E_1 and E_2 if you are not in a position to get them punched. Of course you can drill up to ten layers of electrodes at a time. This will be sufficient for more than four yards of speaker length (twice two yards for stereo). See *Fig.* 2.

To drill the holes, proceed as follows: Hold the electrodes together with clamps and drill the mounting holes (5/32"). (See *Fig.* 3.) Then screw all the electrodes on to a wooden panel of the size of E_1 and a thickness of about ¾ to 1 inch. You now can drill the first two rows of holes (*Fig.* 3). Before drilling the next row, press the electrodes together by screwing some screws about four inches apart through the holes of the second row. If you do not, the holes will not have clean edges and will not allow high bias voltage on the speaker because of corona effects. Continue to drill two rows at a time and screw the 4th, 6th, 8th, and 10th rows until all 1800 holes are drilled.

To remove the copper layer from the margins of the electrodes measure 1 1/16-in. in from one long edge and 11/16-in.

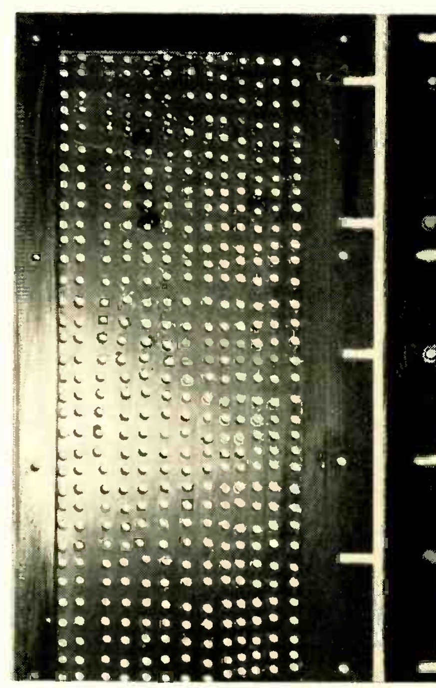

Fig. 6. View of E_1 and S_{11}. Note slots for stretching membrane.

in from the other three edges. Cut deeply into the copper layer along these lines with a sharp knife, then pull off the copper margins with flat nose pliers.

Smooth all edges of E_1, E_2, and the spacers with emery paper, but do not round off the inner edges of S_1 and S_{11}. These edges must be very sharp so that you can glue the membrane precisely onto the edge.

Place E_1 and E_2 on a table (copper layer down) and glue spacers S_1, S_{111}, and S_{111a} on E_1 and S_2, S_{22} on E_2 (see *Fig.* 1.) Drill through the four holes on

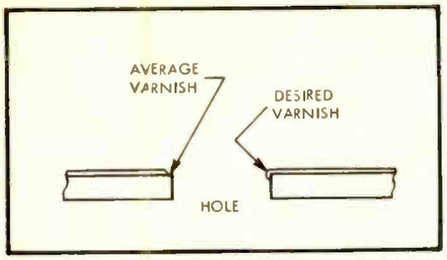

Fig. 7. Varnish should cover edge of hole as shown at right.

the corners of E_1 and E_2 as shown in *Fig.* 4. Bolt E_1 and E_2 together as shown in *Fig.* 5. Then insert S_{11} so that it is indented 1/16-in. and clamp (*Fig.* 5). Now drill all the mounting holes through the spacers. Unscrew and remove all parts and bolt S_{11} to E_1 with 3 or 4 bolts still making sure that S_{11} is indented 1/16-in. Drill the holes for the stretching bolts (*Fig.* 6). These bolts will be used to help stretch the membrane when it is glued on S_1 and S_{11}. Take S_{11} off E_1 and countersink stretching holes for the bolts Sc_1. The bolts Sc_1 must not protrude over the surface of S_{11}. Spacer S_{11}, once the membrane is glued, will be pulled outwards in order to stretch the membrane. To be able to do this, saw slots into E_1 under the stretching holes and into S_{11} above the mounting holes as shown in *Fig.* 6. Before varnishing, take off S_{11} and solder a copper wire to a convenient spot on the copper layers of E_1 and E_2. Make sure that no solder flows into any of the holes.

Varnishing

The copper layers on E_1 and E_2 carry very high voltage. The insulation of the electrodes of course prevents the membrane from touching the conducting copper layer. But the high voltage applied would inevitably arc over from the membrane to the edges of the holes, especially during loud music peaks. To prevent this, a sealing lacquer had to be found for application to the copper surface. This sounds very simple, but in reality was quite troublesome. The problem is that nearly all insulating lacquers on the market have some surface tension. This means that if you apply the lacquer or varnish to a surface with sharp edges such as our holes, it tends to withdraw from these edges. (See *Fig.* 7.) This, of course, would not be a solution to our problem, because it is those edges which cause corona (i.e. ionize the air around it) and thus encourage arcing over from the membrane. Clearly you can not overestimate the importance of this fact. After many failures with brands on the (German) market, the author found a friend who developed a lacquer which does not withdraw, i.e., has no surface-tension. However, there might be something comparable in the United States. The procedure after you have the lacquer is to first clean the copper layers with a soft cloth impregnated with a cleansing solution (or a dilute solution of the lacquer). The best coat will be obtained if you use a spray gun. Proceed as follows: 1. Spray the first layer very fast from all four sides (A,B,C,D, in *Fig.* 8), not directly from above, so that the little drops will hit the edges of the holes from all sides and go inside a bit too. The first spray should not exceed 5 seconds, all four sides included. Thus, some drops will stay on the edges of the holes. 2. same as 1, but a bit more intense spraying. Repeat step 1 five to seven times, letting the coat dry between sprays. Examine the coating with a magnifying glass to determine its effectiveness. The author always tests the insulation with 5000 volts rms, in series with a 5-megohm resistor, a procedure which should only be followed by the very experienced (and super-cautious) constructor.

Now fasten S_{11} to E_1 with the Sc_1 bolts. Make sure the S_{11} is set in about 1/16-in. from the edge of E_1; later you

Fig. 9. Testing tension of membrane. A weight of one ounce (or up to 15 per cent more), in this case a screwdriver, is placed at the center of the stretched membrane. The tension must be such that the weight presses the membrane down so that it nearly touches the inside surface of E_1. The gap should be between 5 and 10 mils. Correct the tension by loosening bolts Sc_1 and moving the spacer. Repeat test at several points along the long axis of the membrane.

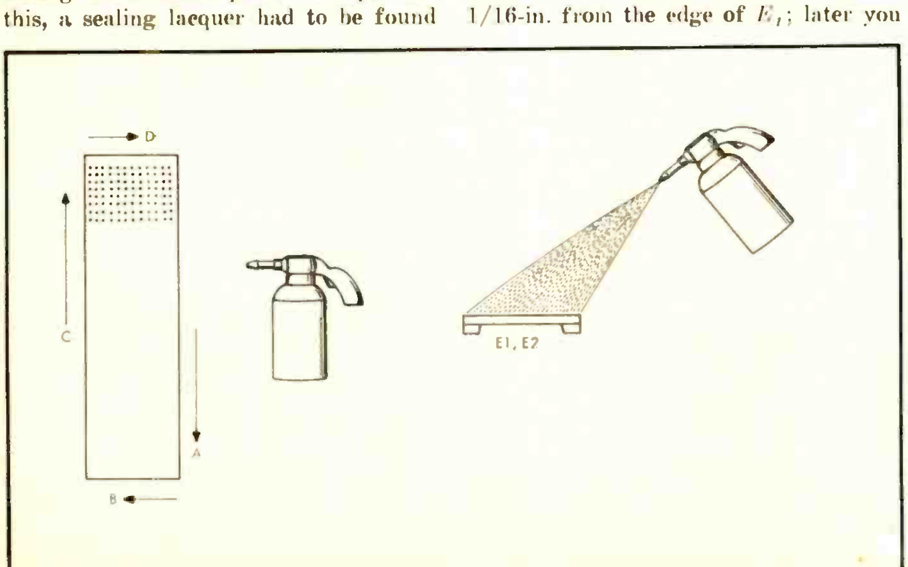

Fig. 8. Method of spraying varnish.

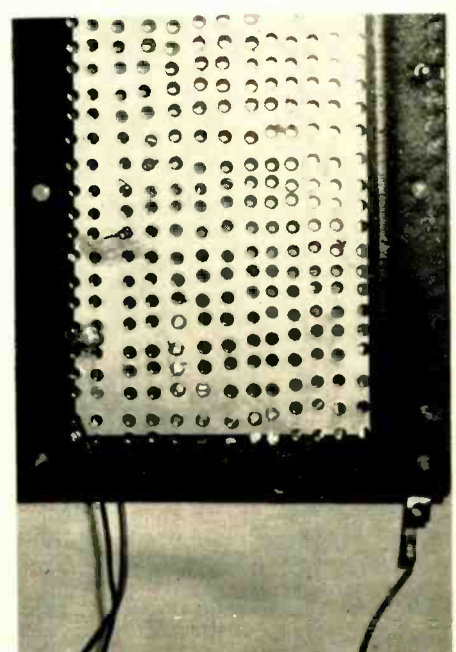

Fig. 10. The electrical connections to the speaker.

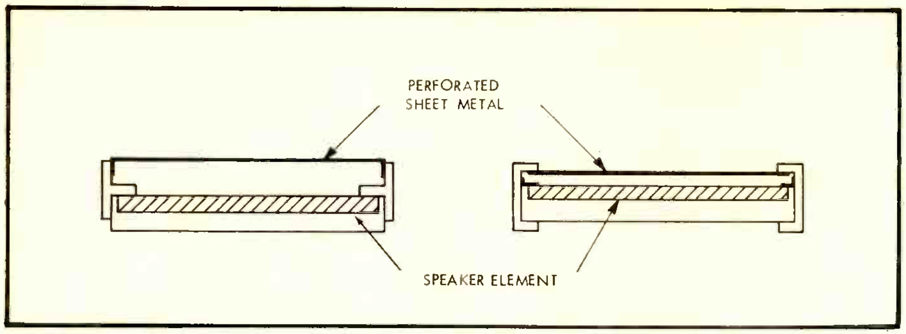

Fig. 11. Completed speaker element must be mounted in a protective enclosure.

will pull the spacer outward by this amount to stretch the membrane. Glue the membrane on spacers S_1 and S_{11} with polyester glue. The conductive layer of this membrane must be up (test with ohmmeter). Make sure the membrane is fastened well up to the very edge of S_1 and S_{11}, otherwise the membrane will rattle at the low frequencies (at or below 50 cps). Apply conductive pure silver paint on S_{22}. This will connect the entire length of the membrane to the negative bias. When the glue under the membrane is dried, loosen bolts Sc_1 a bit, pull spacer S_{11} outward to stretch the membrane, and then tighten the bolts. The loose ends of the membrane over S_{111} and S_{111a} are held with Scotch tape. The tension of the membrane is easily checked with a one-ounce weight as shown in *Fig.* 9. The system is now bolted together with the nylon or other insulating bolts. For electrical connection of the membrane to the negative bias, solder a wire to a soldering lug and insert the lug at a convenient place near one of the ends of the speaker, so that it is pressed against, and held by, one of the mounting bolts between the membrane and the silver paint on S_{22} (see *Fig.* 10). The elements are usually mounted on metal T or U channels as shown in *Fig.* 11.

Use of the protective enclosure is imperative with the high voltage employed. All possibility of physical contact with the speaker elements and associated wiring must be avoided. THE MOUNTING FRAME MUST BE WELL GROUNDED, AS WELL AS THE PERFORATED SHEET METAL AROUND IT. The leads from E_1 and E_2 to the amplifier are best made of 300-ohm TV lead-in (twin lead) wire through high-voltage insulating tubing. The negative bias and ground wire can also be in the tubing. The wires between the amplifier and the speakers may be up to 10 feet long or so with the 300-ohm twin lead.

The speaker is used without further

(*Conitnued on page 53*)

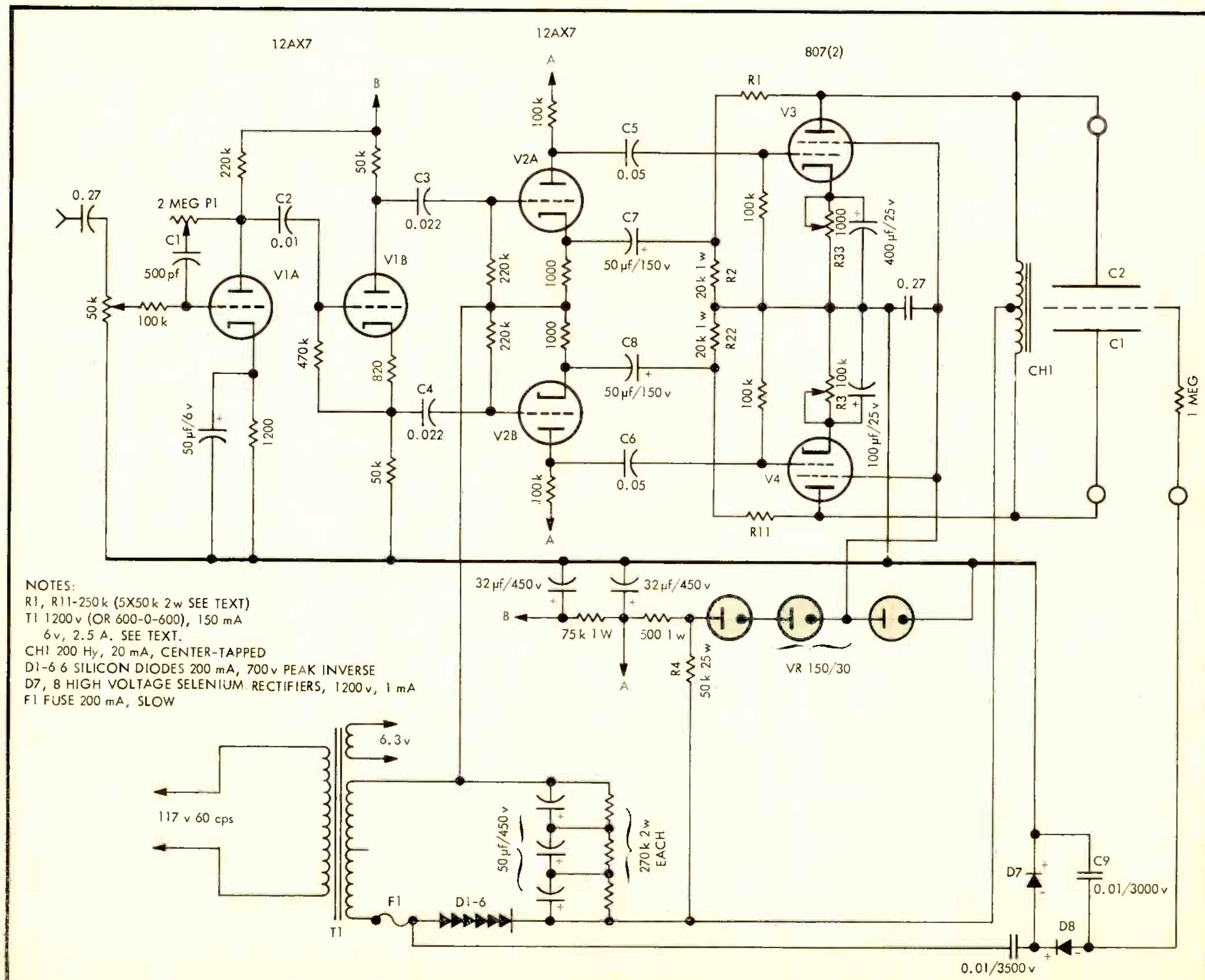

Fig. 12. Schematic of amplifier.

Electronic Simulation of Organ Sounds

NORMAN C. PICKERING*

Multiplicity and variety in tone generation, loudspeakers, and production of artificial reverberation are the keys to the simulation of organ sounds, according to this author.

IT HAS BEEN ASSUMED by many workers in the field of musical acoustics, and even by many musicians, that electronic organs will eventually replace the atavistic wind machines which are still being made. The feeling seems to be that it is only prejudice on the part of organists and composers which resists the advances of modern electronics in this field. Advantages pointed out for the new instruments are, usually:

1. They cost less.
2. They occupy less space.
3. They consume less electrical power.
4. They are more easily tuned and voiced.
5. They stay in tune much better with time and temeprature.

All of the *objections* to electronic organs are subjective reactions by musicians and listeners—to the effect that the instruments lack "character," "warmth," "quality," "verisimilitude," and the like—which are difficult to compare with practical and tangible advantages like the ones listed above. Nevertheless, most well-informed listeners agree that it is more than "snob appeal" which causes wind organs to be specified for most large churches and concert halls.

This paper is an attempt to explain the peculiar and unique sound of the organ in terms which relate to electronic simulation, in the hope that designers and builders of electronic instruments will find herein an idea or two to stimulate imagination.

Some History

The organ has been used by serious composers for over five hundred years. Actually, though, it has been a different instrument in different places at the same time, and has varied in the same place at different times. Therefore we have the separate traditions of the Spanish, Italian, French, German, and Dutch organs of the fifteenth and sixteenth centuries; the magnificent and vastly different ent French and German instruments of the seventeenth and eighteenth centuries; the lush and romantic French, English, German, and American creations of the nineteenth and early twentieth centuries; and of an organ which successfully combines the essentials of all the great periods.

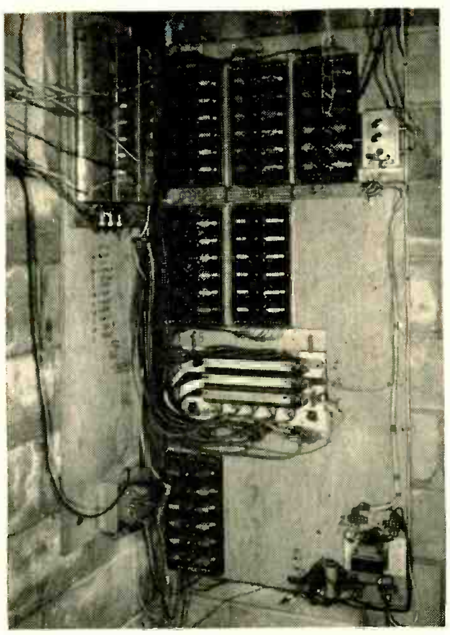

Fig. 1. A bank of oscillators for one set of mixture stops. There are six such banks required for the whole organ comprising two manuals and pedals. At the upper left are three reverberation generators associated with this group of oscillators. In the lower center are a stack of coupler switches. The power supply is in the lower right hand corner. The small chassis are preamplifiers and mixers.

The organ in some ways resembles the hippopotamus; everyone is impressed by it, but very few develop a genuine affection for it. Most of those who adore serious orchestral music are bored or even annoyed by equally serious organ music. This is particularly true of recorded music, where even the best phonographs are less adequate for recreating organ music than they are for orchestral music.

When coming to grips with the problem of developing an electronic organ which is to be a competent and beautiful musical instrument, we must therefore base our work on the traditions of the past and the best wind-organ practice of today. It is a sobering experience for the musical engineer to spend a few hours with a fine Aeolian-Skinner, for example, while imagining the oscillator circuits, keying systems, and loudspeakers necessary to duplicate the sounds he hears.

The organ, paradoxically enough, is one of the most limited of all musical instruments. The player has no control of an individual note, once registration has been selected, other than to turn it on and off. To be sure, certain enclosed divisions permit a limited amount of "expression" through swell-shutter manipulation, but all notes played on that division must go together. This limitation was clearly recognized by the early great composers for organ, and is responsible for the impersonal and rather severe character of much of their music. It is also significant that, during the early nineteenth century, none of the budding romantic movement in music was applied to the organ. That came later, with a vengeance, and was abortive.

The application of electric power to the instrument paved the way for mechanical monsters and one-man orchestras, which led the art of organ building into a blind alley from which it has emerged only recently. The experience did, however, afford students of the instrument and its music with plenty of material on which to base a "theory" of organ sound.

A "Theory" of Organ Sound

Since there are likely to be as many "theories" as observers, I feel free to advance my own. It has two parts:

1. Organ ensemble sound consists of a planned synthesis of complex tones, simultaneously sounded, having pitch relationships based on the harmonic series. (In the use of the word "ensemble," I am, of course, referring to the sound produced for each key of the instrument.)

2. Organ solo voices obtain "character" and "interest" by production of unpredictable transient sounds and by

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variations of harmonic structure and attack time throughout the scale.

It is the manner in which these characteristics are combined in an instrument which determines its musical success or failure.

Pipes divide into two classes—flues and reeds. The true organ sound is built upon flues, which further subdivide into diapasons, flutes, and strings. It is generally understood that diapasons are *sui generis,* but is assumed by some that the excellence of an organ flute or string stop depends on how well it imitates orchestral instruments of the same name. The same assumption is often made with respect to reeds, and is just as unwarranted. Although imitative stops do have a place in organ building, they are not indispensable in the tonal structure.

Each division of the organ is a complete instrument in itself, and the same principles of tonal structure apply to all. There are usually as many complete and independent divisions as there are keyboards (counting the pedal keyboard), and often one or more "floating" divisions which can be coupled, at will, to any keyboard. In a good instrument each division has its own special character, which is achieved by the type of pipes on which it is based, and by the number of solo stops relative to ensemble or "chorus" stops.

The sound-building begins, on the manuals, with eight-foot tone, to which is added four-foot, two-and-two-thirds, two-foot, one-and-two-thirds, and so on. These are pipes pitched to sound fundamentals at the principal harmonics of the eight-foot pipe. Two things are crucial to the success of this process:

1. Each of the complex tones which is part of the mixture must have an appropriate harmonic content (to be discussed later);

2. Each of the constituent tones must bear the correct loudness ratio to all others, over the complete five octaves of the keyboard (2½ in the case of pedals).

Note that these tones are produced by individual pipes, which cannot possibly be phase-locked to the fundamental. This seems to be of vital importance in achieving a satisfactory organ sound. Note also that the individual pipes produce complex waves, so that the harmonics of the lower voices beat with the fundamentals of the upper ones. This would imply that dead-beat tuning of the intervals other than octaves is necessary. Let us examine that point:

The fewest frequency ratios adequate to produce the organ mixture sounds are, for each note, the sounding fundamental (in the tempered scale) and 2, 3, 4, 5, 6, and 8 times these frequencies. Obviously the powers of two will be dead in tune. The twelfths, at 3-times fundamental, can be taken from the tempered scale with an error of only two cents. The same goes for the octave of the twelfth, which is the nineteenth. In the case of the "tierce," or seventeenth, at 1⅗-foot pitch, the mistuning amounts to nearly 13 cents, which is intolerable. This calls for a separate set of oscillators to supply the seventeenth. Two or three octaves will suffice, since the pitch can be allowed to "break back" as the scale ascends.

The constituent tones of an organ chorus must have a meagre harmonic development to blend well. The tones which combine best have a steadily decreasing overtone content as the order increases. Furthermore, the lower pipes of a rank are likely to have a better-developed harmonic series than the upper ones. Flutes, diapasons and strings, being essentially of the same pipe configuration, differ in this respect only in the rate at which the harmonic fall off with order. Most open flutes show a strong fundamental with a rapid drop-off, and rarely any significant harmonics above the fifth. Diapasons can be "flutey" or "stringy" (the terms being self-explanatory) but they are characterized by a strong fundamental and second harmonic with a steady drop-off in the higher harmonics. The highest harmonic of significance will be between the tenth and sixteenth. String pipes show a relatively weak fundamental with a very extended harmonic series, dropping off quite gradually.

The major point of interest here is that the best full organ choruses are made up of diapasons which are on the "flutey" side. Dull flutes are unacceptable, giving rise, in the extreme, to the Hammond-organ sound. Bright flutes in

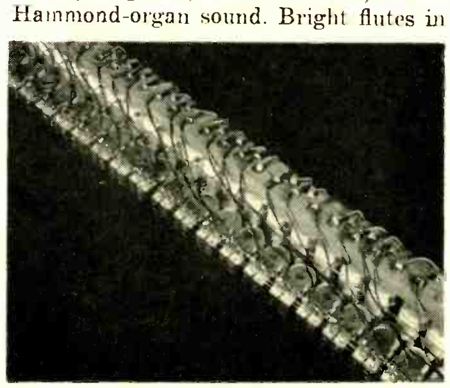


Fig. 2. Part of a bank of relays used to produce the time-sequenced key closures. Adjustment of the contacts can produce any desired timing in the sounding order of the mixture.

combination form the "baroque" sound, which is preserved in the many fine "positive" divisions now being built. The majestic quality of the full great chorus can only be achieved by properly voiced, large-scale diapasons. This brings us to the question of relative loudness of these constituent tones.

An eight-foot rank of foundation quality should be voiced with nearly equal loudness over the entire scale. If this is not done, it is found that moving passages in the upper part of the keyboard are lost when chords are sustained in the lower part. When the process of tone-building begins, it is quickly discovered that the higher-pitched voices must be appreciably less loud (and increasingly so with ascending order) in order to blend acceptably. When adjusting the level of each upper voice, there is a point above which the note seems to "scream" and below which the tone sounds dull. It is amazing to discover that the range between a bright organ sound and a dull one can be traversed with only a 3-db change in the relative level of the upper-work to the eight-foot tone.

It is common practice today to obtain the upper tones for an electronic organ by connecting the requisite oscillators from the same rank that provides the eight-foot tone, extending the upper end for an octave or two. An instrument of this sort cannot achieve an acceptable tonal balance unless the switching provides for level adjustment on each key for each component of the ensemble. This is not easy.

There is now the question of attack characteristics. In musical judgments of organ-stop qualities, the speech idiosyncracies seem to dominate the steady-state sound. Again, we have the happy middle ground with ugliness on either side. A cleanly-switched onset of tone, so easily done with electronics, is apallingly offensive to most serious musicians. On the other hand, pipes which wheeze and gulp before settling down to business are admired only by the faddists who are generally not listening to the music.

Charm and beauty seem to lie with pipes which make unpredictable small noises (generally harmonic) before speaking, and those whose pitch wanders slightly around the correct one for a short time after starting. There is also a vast difference in the rate at which tones reach full loudness. Naturally, low notes speak slowly and high ones of the same type more quickly. Some reeds start every tone with an explosion. This is an admirable quality for piercing through the full organ with a single melody. Some of the more majestic diapasons require a few tenths of a second to reach full voice. One of the more publicized speech characteristics of flue pipes is the "chiff." Some strenuous efforts have been made to imitate this sound which, like all mannerisms, is charming only when unanticipated. Electronic simulators which do not produce the random effect of the constantly-varying wind pressure on pipes quickly become boring and then distasteful.

Simulating the Organ Characteristics

To simulate some of these characteristics, I have arranged harmonically-related multiple oscillators on key contacts so that the upper tones sound before the lowest one. With no attempt to have the same contact delay on every key the effect is excellent, since the speed of depressing the key determines the nature of the transient sound. In rapid pieces the speech is crisp; in slow melodies, a delightful "chiff" can be heard, which is hardly ever twice the same.

So far, the principal point of emphasis is the rather obvious one that the more tone-generators the better if realism is to be achieved. At the very least, each manual division needs two eight-foot ranks (one having a fast attack, the other being slow), a sixteen-foot rank and two or three higher-pitched ranks from which to build the mixtures and some solo stops. This makes about 350 tone-generators per division if the electronic organ is to approach the marvelously complex sound of the wind organ. At least twice as many pipes would be required to cover the same tonal range.

Although (except for every low pitches) an oscillator costs about as much as a pipe, the saving in cost expected of an electronic organ can be realized by providing circuitry to produce several types of tone from each rank of oscillators. These oscillators would rarely be used alone, except for the simplest open flute stops.

A single oscillator cannot possibly provide a plausible reproduction of the solo voices most prized by organists. The flue organ pipe is a coupled oscillator-resonator system with, in some cases, many possible modes of vibration. During the voicing of pipes, the geometry of the "whistle" and the length of the resonator are adjusted. The length-to-bore ratio (or scale) has already been determined at the time of manufacture. Sometimes caps or small extension tubes are fastened to the ends of the pipes. Each of these devices affects the harmonic content of the tone. There are open pipes whose normal modes are 1, 2, 3, 4, and so on; closed or stopped pipes, whose normal modes are 1, 3, 5, and so on; and pipes in between which are almost stopped, but not quite. There are pipes with small secondary resonators, double-length pipes vented at the half-length point to sound the octave, and reed pipes with resonators tuned to the second, third, fourth, or higher harmonics.

An electronic system to provide all of these controls on the frequency spectrum of an individual pipe would be prohibitively expensive. It is in this area that even the best electronic organs usually compare rather badly with the pipe organs. The simple tone generators used do not have the variety, the complexity and the randomness in response to fulfill the requirements for interesting musical tones. Here again, I feel the solution lies in the use of multiple oscillators with randomly-variable time responses. A beautiful stopped flute, gedackt, or bourdon can be synthesized by permitting a very soft twelfth to sound just prior to the onset of the fundamental. The usual practice of squaring a sine wave with diodes gives rise to a hard tone, without the charm of the anticipatory third mode of speech. Solo diapasons can be improved by similarly injecting the octave, quite softly, a little in advance of the fundamental. This technique is unlimited in its possibilities, and opens the way for producing truly "live" sounds.

We have so far slighted the reeds, which occupy a special place in organ tonal architecture. All good organs have at least one full reed chorus of sixteen-, eight-, and four-foot pitch, usually on the swell division. The pedal organ must also be equipped with one or more sixteen-foot reeds which can be extended to eight- and four-foot pitch. Since reeds have the most extended development of upper harmonics, it is not common to have ranks above four-foot pitch. They jangle enough as it is, but when used sparingly in choruses, are truly magnificent.

Pulse generators are usually used as tone sources for reed simulation, although sawtooth forms are often better. Each note requires a resonant filter to give the characteristic tone color. Attack time must be fast, and in the more powerful reeds, should have a raspy beginning to the tone. This is not difficult to achieve, by the multiple contact approach. The common practice of using a single tone-color filter for a whole rank of reeds does not produce a good organ reed. It is true that an orchestral reed or brass instrument has a single formant for all the tones produced by it. The organ reed pipes, however, each have their own formant—another example of the complexity of the tone-generator system we are trying to simulate. By the way, some very convincing reed sounds can be made up of flue pipes alone, mixed with proper emphasis on the higher partials. There is a "cornet" mixture in common use on large organs which is made up, in this manner, of quick-speaking flue pipes.

Expression on the organ is achieved by swell shutters which cover the opening from a box containing the pipes for the division. In ancient organs, all pipes were in the open. It wasn't until the late seventeenth century that parts of some organs began to be enclosed in swell boxes. Later on, many organs were built in which all pipes were enclosed. Nowadays, it is becoming standard practice to have the swell and choir organs enclosed, with the great and positive standing open.

All commercial electronic organs I know have expression controls on all divisions. Because it is so easy to obtain a wide dynamic range electronically, loudness control is usually very much overdone. A good organ obtains its loudness by building up a tonal structure rich in the higher pitches. Powerful low-pitched pure sounds belong only to theatre organs, where they appeal directly to the viscera of the audience.

Control of the higher harmonics gives most effective control of the total loudness of the organ. The usual swell shutters have a range of about 6 db in the lower register and upward of 20 db at the higher frequencies. The range of 30 db or more usually provided on electronic organs can give rise to grotesque effects which are most offensive, musically. Advantage can be taken properly of the huge dynamic range of electronics by providing one or two fixed attenuators for major level setting and then using the swell pedal only over a discrete and limited range. In all cases, the effect on high frequencies relative to lows should be very much greater than is current practice.

Fig. 3. Here is a typical trumpet loudspeaker. The driver is a University ID-40T with the back removed. The bell in this particular unit is from a tenor trombone and is approximately 24-in. long. Other sizes are used to complete the scale.

Loudspeaker Systems

Finally we come to the most important

(*Continued on page 50*)

Class D Amplifiers

GEORGE FLETCHER COOPER

Efficiency, at a price

EVERYONE WHO HAS DESIGNED a transistor amplifier to operate at any sort of power level above a hundred milliwatts will have had to deal with the problem of heat dissipation. It is not uncommon to find that this can be a problem even down in the tens of milliwatts. Audio output stages, which operate at power levels of tens of watts, usually lead to fairly critical thermal conditions. Since the heat dissipated in the transistor is the difference between the heat supplied (the power) by the battery and the heat taken by the load, there is a demand for highly efficient circuits. A paper by Mr. D. R. Birt, in the February issue of the British journal *Wireless World*, discusses a system which can have extraordinarily high efficiency.

When the editor asked me to write about this I started out along a pretty conventional track, with some historical background, which I shall introduce later, and the stuff about classes A, AB, and B. I have, however, decided that we must dig a little deeper into circuit philosophy before we go on to discuss one particular path of new development. The kind of amplifier which will be described later is part of a great family and offers almost unlimited scope for the circuit builder.

Let us go back to the beginning and express some basic ideas in rather formal language. A distortionless amplifying device is one which produces a faithful output replica of a smaller input signal. You can probably do better than that, but the point is that the ideal amplifier is a linear device. Here we are, stuck in class A. We know that linear circuits are easy to calculate, but we know also that switch circuits are easy to calculate, too. We shall come back to this.

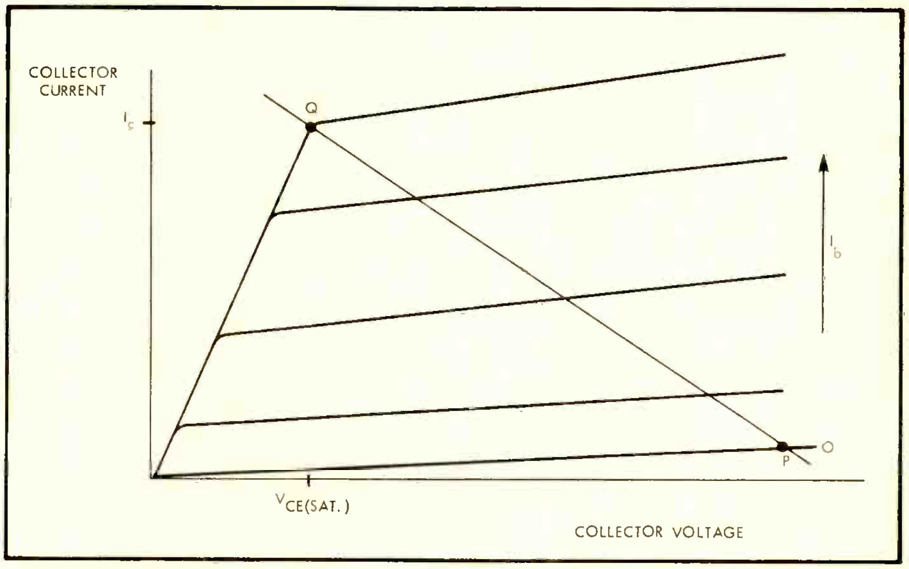


Fig. 2. Transistor characteristics and load line.

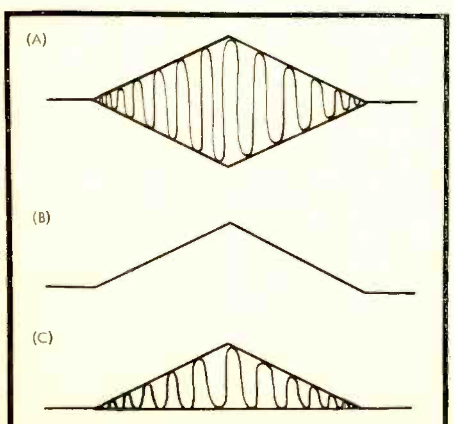


Fig. 1. Combining signal and envelope to produce a composite signal.

Our problem is that class-A operation is not very efficient, even if we are amplifying the largest permitted signal, and it is grossly inefficient when the signal is of varying amplitude. Some time ago I discussed a floating-bias circuit which used the signal envelope to bring the bias of a class-A transistor just far enough up to enable the signal to be amplified without clipping. The scheme, for those of you who did not read the article or who forgot it immediately, is simple. The output is rectified to give us the envelope, which is smoothed to get rid of the audio ripple. A fraction of this envelope is added to the input signal and thus produces a composite signal which has all its wave-tips at the same level on one side. This is indicated in the waveforms of *Fig.* 1, which are extracted from the article in AUDIO, April, 1962. Notice that the excursions of the composite waveform go in one direction only, so that if we had an ideal transistor with a sharp cutoff we could bias it just to cutoff and yet operate it in class A.

The attitude behind the circuit design is that we can improve the efficiency for a program-type signal if we can code our signal in some way. Here we code it by adding the envelope at the input, and then filtering out the envelope at the output. In a class-B amplifier we have another coding system which amounts to the provision of two separate amplifying paths for the two half waves, followed by addition at the output. Here again the envelope signal creeps in, but we use a balancing method to keep it from the load. We produce the envelope by rectification at the input terminal, not the output terminal. Another circuit, rather more elaborate, was described, I think, by R. B. Dorne, some years ago. In this the working point was moved from cut-off to bottoming at high frequency by a subsidiary square wave and a single transistor could be used to give class-B amplification of both halves of the waveform.

All these methods amount to ways of producing amplitude modulation of the supply current. None of them will allow us to obtain an output much in excess of twice the permitted transistor dissipation. Even at this level we have some problems, because we must design for more than thermal safety, we must design for stability of the critical cut-off region, for the absence of crossover distortion when the transistor is hot from a loud passage. Never forget that crossover distortion is worst for low-level signals.

Once you accept the idea that in using class-B operation you are, in fact, using a coding technique or a modulation technique you should find that you have broken through a barrier into a world of new circuits. Usually the new circuits are introduced together with the idea of coding, and so you feel that this is

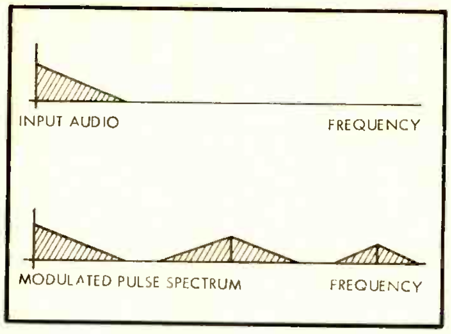


Fig. 3. Modulated pulse spectrum.

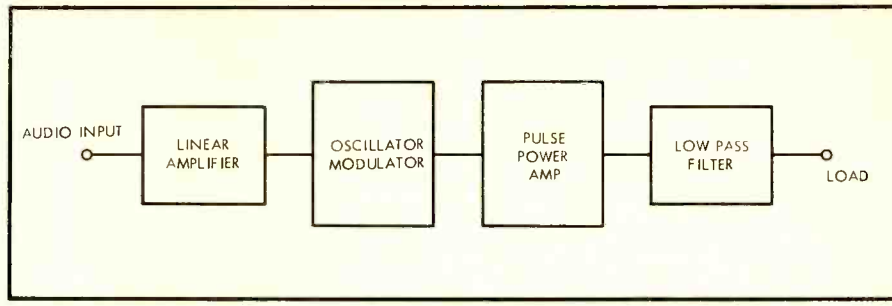


Fig. 5. Block diagram of modulated-pulse audio amplifier.

getting rather complicated: in fact you passed the coding barrier the day you accepted the idea of class B working. Like one of Molière's characters, you have been talking prose all your life.

Already I have hinted at the next step. Ideal active devices may be linear amplifiers, or they may be switches. We have been working away at the linear amplifier side pretty hard for a long time, and class B with frills seems to be pretty nearly our limit. The high-power boys, who want to modulate a 100 kw transmitter, are down to worrying about the odd 1 per cent. You can say that this is a dead end, or that we are all so clever that we have reached perfection.

Once upon a time there was a smith who designed a perfect horseshoe.

That is the attitude of what we may call the new school of audio amplifier designers. They talk about 99 per cent efficiency, about amplifiers delivering 1 kw to a load and yet dissipating only 10 watts in the transistors. There's glory for you, as Humpty-Dumpty said to Alice. The basic idea was patented in 1931 by B. D. Bedford. It was applied to transistor d.c. amplifiers by G. M. Ettinger and B. J. Cooper[1] in the years just before 1960. I understand that it is discussed in a forthcoming book by T. Roddam. Mr. Birt's paper has already been mentioned, and K. C. Johnson has given, in the March, 1963, issue of *Wireless World,* a circuit which he has been using for many months. In fact, a good many people have been talking about this kind of circuit for a good many years, but too many of them, myself included, have talked with a glass or a coffee cup in their hands, not a soldering iron.

The right way to use a transistor is as a switch. If we look at a typical set of output characteristics, shown in *Fig.* 2, we see that when the transistor is biased to either P or Q the dissipation is very small. At *P* the transistor cuts off the supply of current to the load, while at *Q* almost the whole of the supply voltage appears across the load and the load current is nearly *V* (Supply)/*R* (Load). Let us assume that we have a perfect switch. We can use this to amplify the power level of a pulse modulated signal.

We should pause at this point to look back to a room in Paris in the late Thirties, where much of the pioneer work on pulse modulation was done. Let us look at the results. Suppose that we want to transmit an audio signal through a circuit which can only switch on and off. We may vary the time of the signal pulses, by using *pulse frequency modulation;* we may vary the length of the pulses, using *pulse length modulation,* we may vary the phase of the individuals pulses, using *pulse phase modulation* or pulse *position* modulation. Alternatively, we may quantize the signal and send a group of pulses to show the approximate instantaneous signal voltage at regular intervals by *pulse code modulation.* In p.l.m. we may modulate either one edge of the pulse or both, and you will notice that the modulated edge can be turned, by differentiation, into a phase modulated pulse system.

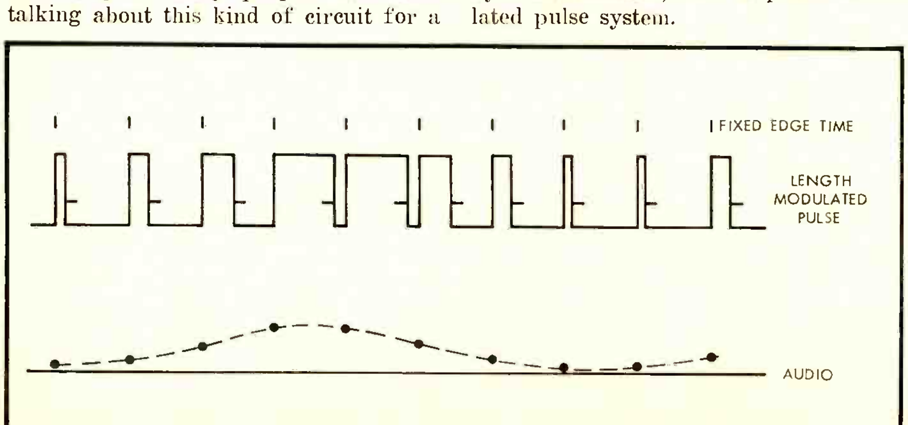


Fig. 4. Modulated pulse with corresponding audio signal.

The frequency spectrum of modulated pulses (excluding p.c.m.) contains an audio component which is free from harmonics and intermodulation terms, but for p.p.m. the audio component is almost proportional to the modulating frequency, while for p.f.m. and p.l.m. it is just a replica of the modulation. The full spectrum contains an infinite series of Bessel function terms which are too horrible to contemplate. The essential feature, however, is that at the average

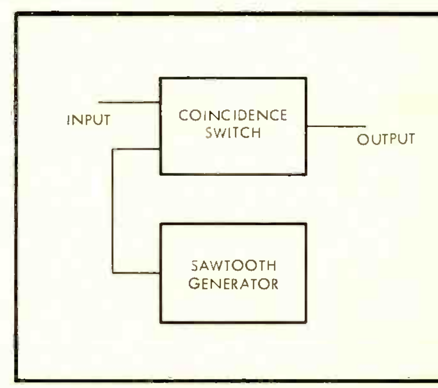


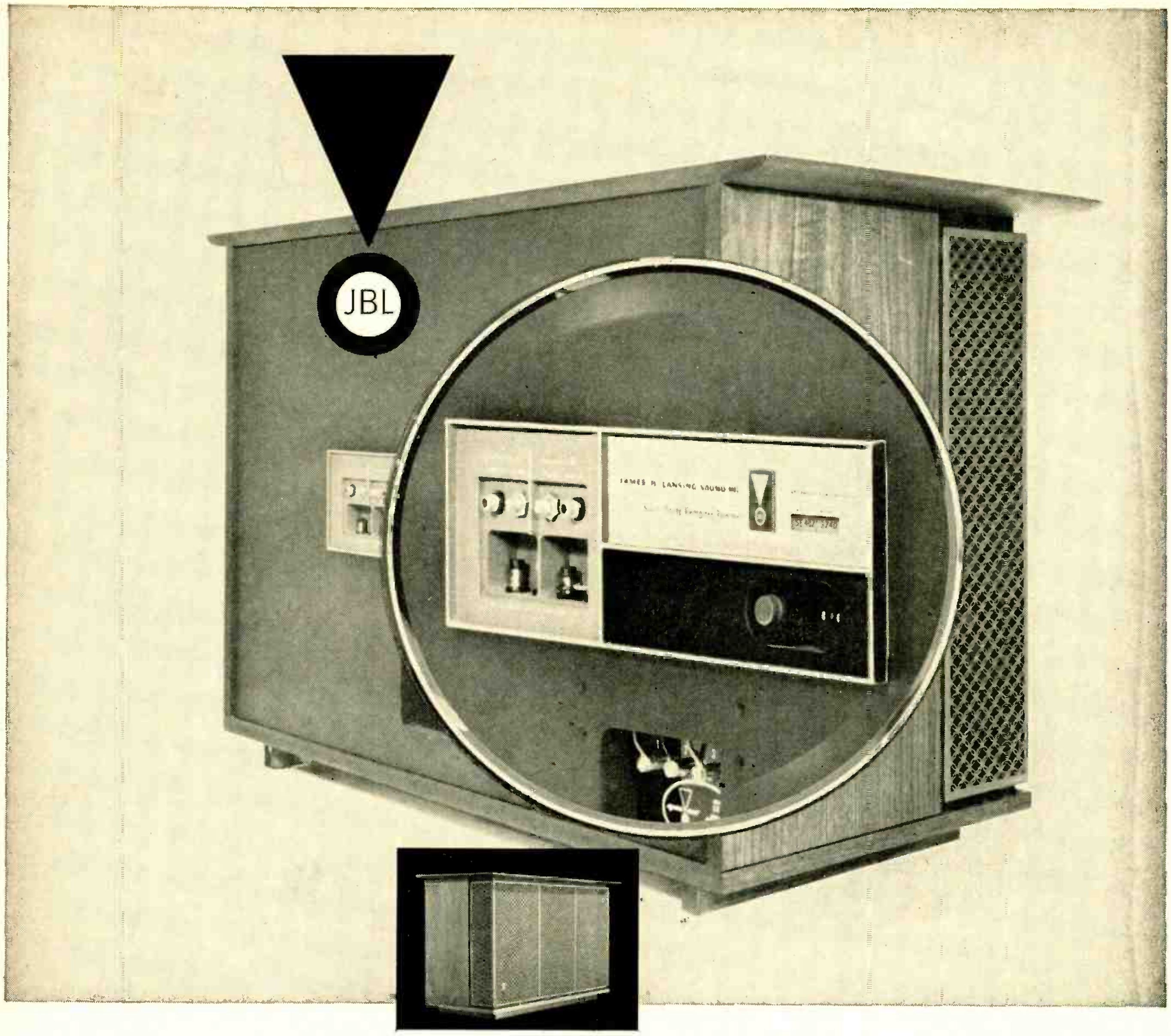
Fig. 6. Oscillator-modulator.

pulse repetition frequency we get a carrier and sidebands and that this group is repeated at all the harmonics of the pulse repetition frequency. This is indicated in *Fig.* 3.

The sidebands are not the simple sidebands we know in amplitude modulation but, like the sidebands of an ideal FM system, extend indefinitely on either side of the carrier. This is just what we should expect, because we are producing the same sort of time modulation as in FM, though we are moving a vertical edge instead of a sloping wave.

I have not introduced this high-brow stuff just to show how clever I am. The point is that when the lower sidebands fall inside the audio band they are distortion terms. The carrier frequency, that is to say the pulse repetition rate, must be well above the highest audio frequency and the amount of modulation must be limited. The use of double-edge length modulation gives much smaller sidebands than single-edge length modulation. The mathematics, and some useful curves, have been given by Fitch.[2]

Let us take a look at the sort of waveforms we are discussing. I shall use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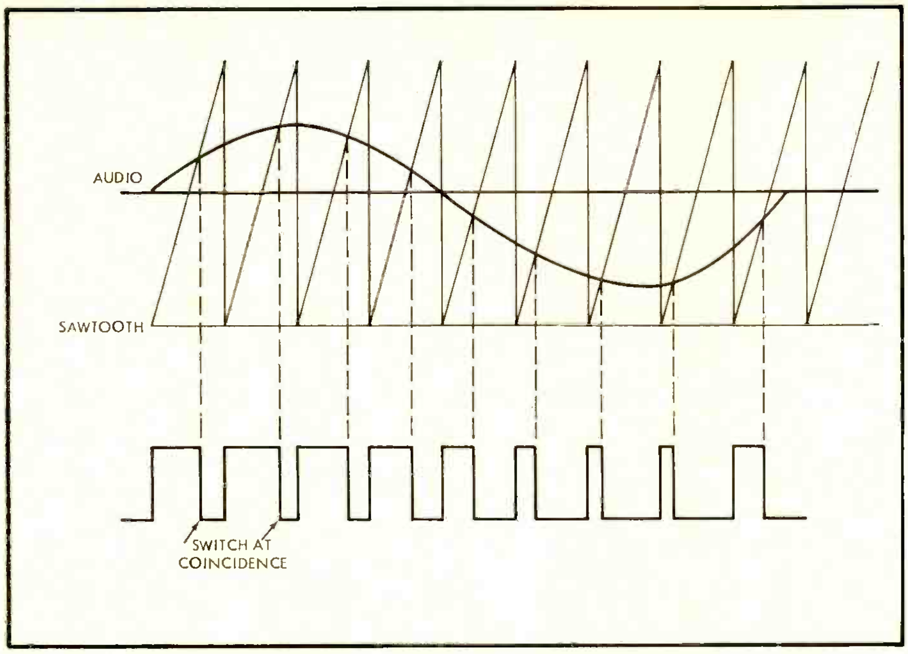


Fig. 7. Waveform produced by oscillator-modulator of type shown in Fig. 6.

p.l.m., with only one edge modulated. In *Fig.* 4 the pulse lengths are 1,3,5,8, 8,5,3,1,1,3 units, and the corresponding graph, the audio wave, is shown below the pulse train. If we assume that the current during a pulse is 1 amp, a unit length of pulse is 1/10th of the inter-pulse time. (This is because I have drawn the pulses to an appropriate scale.) Now 1 amp for 1/10th of the time gives an average load current of 0.1A, and so on, so that the audio waveform is just the smoothed-out charge delivery of the pulse current.

If we leave out the modulation we shall have a familiar square waveform which you will have encountered in transistor inverters. These circuits, widely used for converting d.c. to a.c., which may be transformed to a new voltage and rectified, operate at efficiencies of up to 95 per cent, including the losses in the transformer and the power needed to produce the switching action. There is nothing academic about these high efficiencies: they are obtained with simple everyday circuits.

At this stage we might usefully consider a block diagram. In *Fig.* 5 we see the input signal taken through a linear amplifier, which may be just a buffer stage, to an oscillator-modulator circuit. The output of this is a train of modulated pulses which are amplified to the desired level in the pulse-power amplifier. The audio component passes through the low-pass filter to the load, which we shall usually make a loudspeaker. I am still keeping matters pretty general, but we must now start to go into more detail.

If you look back at *Fig.* 4 you will see that there is a d.c. component equal to one-half the pulse height. The Ettinger and Cooper amplifier for 1 kw is concerned with this single-sided signal and uses two transistors in parallel, connected in series with the load. For our purposes this d.c. term is a nuisance, and so we make use of a push-pull connection. It is theoretically immaterial whether we use a conventional transformer-coupled circuit, or an OTL bridge or half-bridge. The power amplifier must end up looking like a normal amplifier except that we shall be applying the pulse waveform of *Fig.* 4 and driving the transistors from hard-on to hard-off. There is no problem of matching the transistors, for when they are off they are off, and when they are on they should represent resistances of, perhaps, 1/20th ohm, which is small compared with the speaker impedance.

I shall come back and fill in the details later, but first I must say something about the oscillator-modulator. This to-and-fro treatment is planned to give you freedom to take off in a new direction before we get too close to particular circuits. So far the only circuits I have seen described make use of p.l.m. with one edge modulated. This is produced by a system of the kind shown in *Fig.* 6 and the way it works is indicated by the waveforms of *Fig.* 7. The switch tips one way or the other every time the two wave amplitudes coincide, and thus we get a pulse edge at each flyback and the trailing edge, which is the modulated edge, at a time which depends on the size of the audio wave.

The simplest form of sawtooth generator is a blocking oscillator, with a typical circuit shown in (A) of *Fig.* 8. The transformer provides positive feedback and when the transistor starts to conduct it is driven into bottoming. The capacitor C_1 cannot maintain the necessary base current, however, and the current begins to fall, bringing the transistor out of bottoming and driving it to cut-off, with aid from the regeneration. In fact we must use the diode shown across the transformer, in order to prevent the cut-off action producing high peak collector voltages, and this gives us regeneration only for one direction of movement. Even so, the circuit can be taken as providing the switch-RC circuit shown in (B) of *Fig.* 8, in which the switch is self-driven. Provided that the switching period is short compared with the time-constant RC, this circuit will give a linear sawtooth.

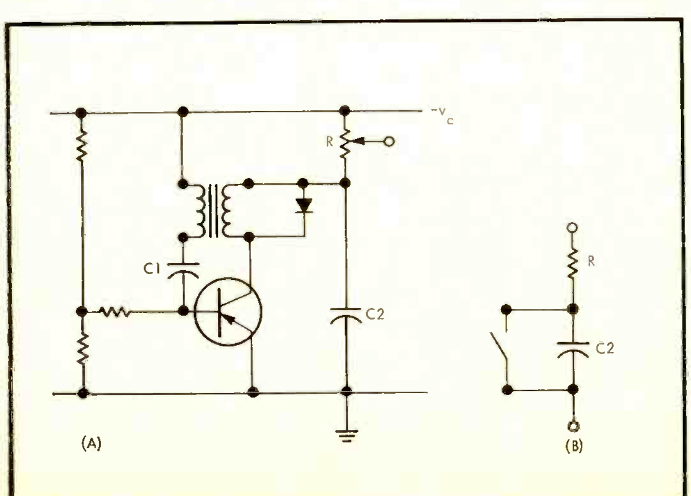
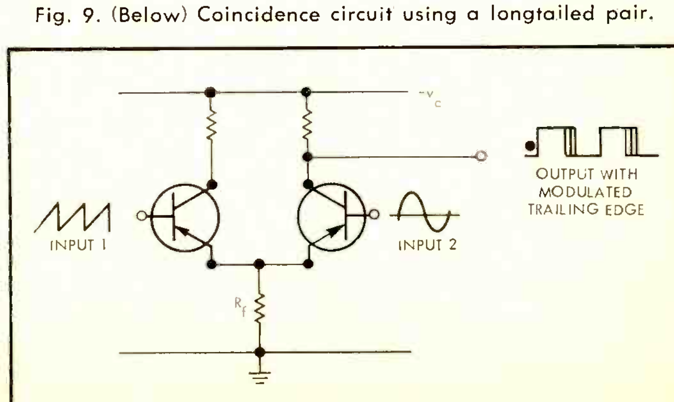


Fig. 8 (left). (A) Blocking oscillator which acts as if it were (B) a switch-RC circuit to produce a linear saw-tooth wave.

Fig. 9. (Below) Coincidence circuit using a longtailed pair.



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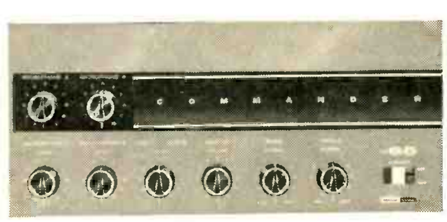

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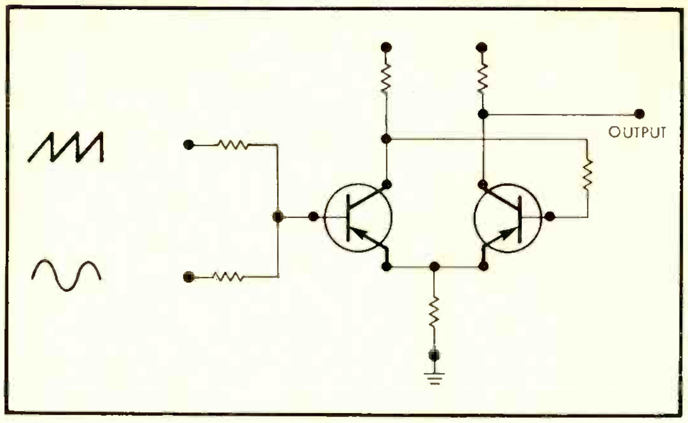

Fig. 10. Schmitt trigger circuit.

A coincidence circuit is easily made by the use of the long-tailed pair. Birt shows the circuit of *Fig.* 9. The first transistor can be regarded as a device for feeding the emitter of the second transistor, so that the base-emitter voltage is the sum of the saw-tooth and the sine wave (signal), with a reversal in the polarity of one of the two signals. Only when they are nearly equal will the second transistor be moving across the transition region between on and off. The two signals can be applied to the same terminal, leaving one base free for the connection of a collector-base path, shown in *Fig.* 10, which gives us the Schmitt circuit, a well-known trigger. You will see here that a buffer stage is needed to prevent the saw-tooth making its way through to the signal source.

The circuits so far, that is, the blocking oscillator and the long-tailed pair, will draw only the odd few milliamps from the supply. This is important, because we do not wish to produce a highly efficient output stage only to use vast amounts of power in the preceding stages. The output of the modulator is a pulse length modulated signal, and it is large enough to drive a following transistor fully on and off. We are well on our way. Mr. Birt and Mr. Johnson agree in choosing 50 kc as their switching frequency, which means that the conventional moderately fast switching transistors may be used.

I want to go back to a more detailed study of circuit details in a second article and so I shall turn to a rather important point in connection with the output stage. In *Fig.* 11 we have the circuit given by Baxandall for a voltage-switching oscillator.[3] The transistors are driven hard, so that they are either on or off, and the sinewave across the load is produced by the action of the band-pass filter. It is in the Baxandall paper that the name class D is introduced, with the suggestion that a class-D amplifier or oscillator is one in which the angle of current flow in each active device is 180 deg. but in which there is no voltage, except the saturation voltage, across the active device which is conducting. We are supplying a separate drive to the windings B and C, and we are using a low-pass filter, but undoubtedly this is just the type of circuit to which the description "class D" should apply. There is a rather important point which we must bear in mind, however. In the oscillator circuit the filter will reduce the current to a small value at the switching interval, since the drive to the bases is associated with the behavior of the filter. The current in each transistor is, indeed, a half sine-wave. We are not so fortunate, and the inductor of our low-pass filter will try to keep the current flowing in one direction when the transistors switch and try to reverse it. Some sort of protection is needed.

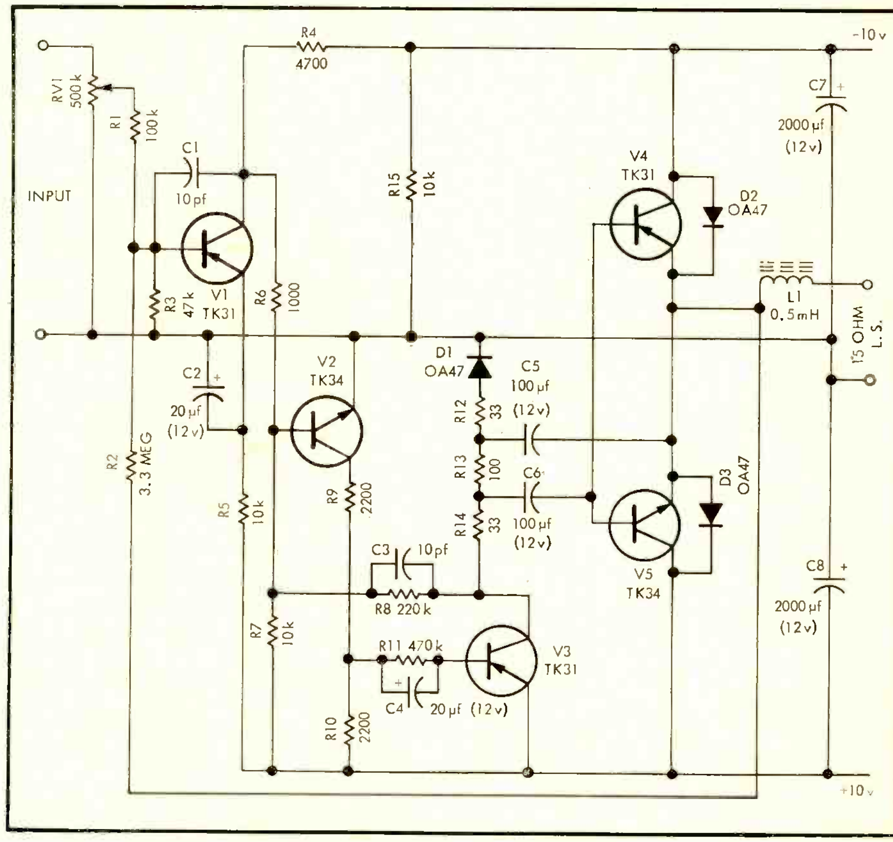

Fig. 12. K. C. Johnson's circuit.

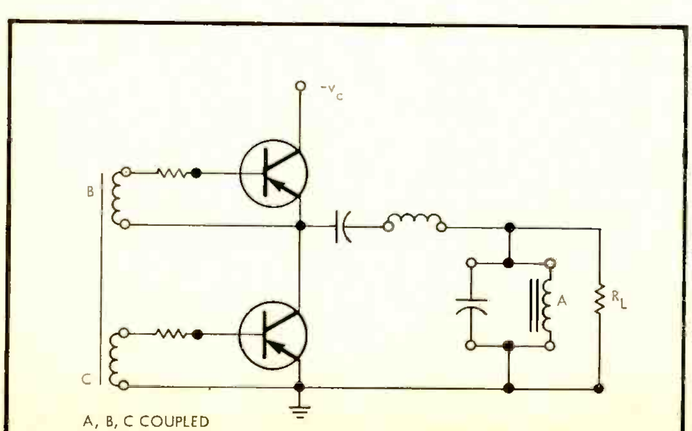

Fig. 11. Baxandall voltage-switching oscillator.

A Circuit to Build

I have a good deal more to say about this general class of circuit, and much of it is material to the questions of distortion and efficiency. At the same time I feel sure that there are many readers who would like to build something for themselves and so I propose to finish

(*Continued on page 49*)

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

Life of a Tape Head

Q. What is the useful life expectancy for high fidelity performance of a tape head mounted on a transport using pressure pads? One manufacturer rates his heads at 1000 hours, but says that pressure pads will cut this figure drastically. Does the use of a head lubricant extend the life of the heads to a worthwhile degree?

A. It is as difficult to state the useful life of a tape head as it is to state the useful life of a diamond stylus. A figure of 1000 hours seems reasonable for a high-quality laminated head, although conceivably this could be diminished by a factor of 2 or 3, depending on conditions of use. If you can reduce friction between the tape and the playback head, this augments life, because the head gap widens with wear, which reduces treble response. Therefore it appears worth using a tape-head lubricant. Use of tapes of good quality, containing a suitable lubricant, is important. Construction and material of the head are factors in longevity; it is generally considered that a laminated head has a longer life than a single-piece head. Tape speed counts. A modern head with a gap initially about 0.0001-in. wide theoretically permits playback response to about 30,000 cps at 7.5 ips. When the gap width has doubled due to wear, response is still good to 15,000 cps at 7.5 ips. But if you operate at 3.75 ips, response which was initially good to 15,000 cps has fallen to 7500 cps. The importance of acquiring a transport with a tape lifter, or using other means to space the tape away from the heads during rewind or rapid forward, cannot be overstressed.

It seems doubtful that the careful, demanding recordist can determine when a tape head must be replaced on the basis of hours of use. The recommended procedure is to check high-frequency response from time to time by means of a test tape and a meter.

How to Judge Specifications

Q. I am interested in buying a tape recorder at a cost of about $400. I know that you cannot recommend tape machines by name. Therefore I would like to phrase my query differently. I understand that a machine with an advertised frequency response of 30–20,000 cps ±3 db might not have as good response as one advertised at 50–15,000 cps ±2 db. Also I can understand that a signal-to-noise ratio of 50 db or better is desirable. Now the thing that is puzzling me is how to be able to choose the best equipment from given specifications when there is little or no chance to test several machines at the same time. For instance, I have folders on several recorders in this price range with the following published performance figures:

Machine A: head gap 0.00012 in.; 50–18,000 cps at 7.5 ips; signal-to-noise 55 db; wow and flutter less than 0.15 per cent.
Machine B: no head gap information; 25–16,000 cps ±3 db at 7.5 ips; signal-to-noise 55 db or better; wow and flutter less than 0.2 per cent.
Machine C: no head gap information; 18–16,500 cps ±3 db at 7.5 ips; signal-to-noise 50 db.
Machine D: no head gap information; 30–20,000 cps ±3 db at 7.5 ips; signal-to-noise better than 60 db; wow and flutter less than 0.15 per cent.
Machine E: head gap 0.00017 in.; 40–15,000 cps ±2 db at 7.5 ips; signal-to-noise 42 db; wow and flutter less than 0.18 per cent.

All these machines are about the same price and as far as mechanical features are concerned, I am not critical because I want the very last ounce of sound quality rather than operating convenience. On the basis of what I understand about these specifications I would choose machine D or E, but all of them seem to compare very favorably with machines of twice the price.

A. I must assume that each of the five machines you describe actually lives up to its specifications. And I must point out that none of the specifications states at what distortion level the signal-to-noise ratio is measured. For home tape machines of good quality, the accepted thing is to rate the signal-to-noise ratio on the basis of the recorded level that produces 3 per cent harmonic distortion on the tape at 400 cps. Some machines base the ratio upon the 5 per cent distortion level, which is about 6 db higher and therefore enables the manufacturer to claim a 6 db greater ratio. In some instances the S/N ratio is based upon "average" recorded level, presumably 10 db less than that which produces 3 per cent harmonic distortion; accordingly, the rated S/N ratio is decreased 10 db. I have to assume that each of the machines you describe bases its S/N ratio upon the recorded level resulting in 3 per cent distortion, although this may not be the case.

Accordingly, I would give first place to Machine D, not because it goes to 20,000 cps instead of 15,000 cps but because: 1. The S/N ratio is better than 60 db, ordinarily true only in a top professional machine; 2. wow and flutter are less than 0.15 per cent, which meets professional standards.

Second place appears deserved by Machine B, because of its high S/N ratio of 55 db (just meeting professional standards) and its very good wow and flutter specification. (I am surprised that you consider Machine E for second or possibly first place, in view of its very poor S/N ratio of 42 db. However, if this ratio is based upon a recorded level 10 db below that producing 3 per cent distortion, the true S/N ratio is 52 db, which is quite good.)

Machine A rates just behind Machine B for two reasons: 1. The response of A is not as good as that of B at the low end; this is more important than the fact that A goes to 18,000 cps while B goes only to 16,000 cps; 2. the departure of Machine A from flat response is not specified. For all we know, its response might be down 6 db at 50 cps and at 15,000 cps.

The specification as to gap width of the playback head is not of too much importance; performance is what counts. The narrower the gap, the better is the *playback* treble response. Therefore most playback heads made today are between about 0.0001 and 0.0002 in. However, this is not the whole story. Linearity of the gap counts a great deal. Thus it is possible that a linear gap of 0.00015 in. will give better treble response than a less linear gap of 0.0001 in. Moreover, if the same head is used for both recording and playback, it may not be advisable to have too narrow a gap because of recording losses; that is, recording flux lines generated by the head tend to jump across an excessively narrow gap instead of flowing through the tape.

READERS' COMMENTS

VU Meters vs. Eye Tubes—Again

I have just read Mr. Allen's remarks about VU meters in April AUDIO. What he says may be correct, but I have a * * * with a VU meter and two * * * with magic-eye indicators, and I find that I consistently make better recordings with the machines with the eye-tube indicators. People undoubtedly vary, but when I add my own reaction time to the lag time of the VU meter, I seldom am able to decrease the gain to prevent series distortion from showing up on the tapes during sudden peaks. With the eye-tubes, I usually can back off the gain before distortion has lasted long enough to be audible in playback. I have been using tape recorders since 1956, so I know by now that I must get as strong a signal as possible on the tape (short of distortion, of course), if I am to avoid the tape hiss that bothers me so much in playback. B. D. BURKS.

End-of-Reel Flutter

I would like to comment on your column of February 1963. The reader (fourth question) states that he has objectionable flutter beyond 900–1000 feet on one reel. The truth of the matter is, that all machines produce more flutter and wow when recording or playing back, during the last few hundred feet of *normal* tape reels. This includes even the studio machines. The solution is a partial compromise but involves using professional *large* hub reels. Some of these are conveniently illustrated in an advertisement opposite your February column. (See reels 3, 6, 8, 10, and so on.) There is another solution depending on the machine involved. The hold-back tension on most supply motors is too great for playing small-hub reel tapes. On one machine, by changing a resistor in the supply-motor assembly, the hold-back tension can be reduced so that there is less tension at the critical footage of the reel. Of course there is also less tension when this reel is completely full but this is usually not a critical factor. GUSTAV CIAMAGA. Æ

headset by KOSS / tuner and preamp from DYNACO

CAPTURED BY CONCORD: SOUNDS FOR CONNOISSEURS

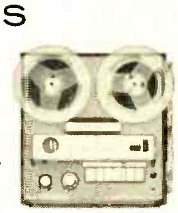
The magnificent Concord 880 (as do all professional tape recorders) has **three separate heads**—one record, one playback and one erase. To make professional quality stereo tape recordings from F.M. multiplex, stereo records, or live performances, your tape recorder must have **three heads!**

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!*

Other outstanding features • Trans-A-Track for sing-a-long or music and language instruction • Exclusive computerized channel indicator • 10 watt dual amplifiers • Separated full range 7" speakers for perfect stereo • Dual cathode follower outputs • Flutter-free salient pole drive motor • Built-in monitoring and P.A. facilities.

CONCORD 880

OTHER CONCORD MODELS



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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Testing Amplifier Response with an Oscilloscope

HERBERT MALAMUD*

Use this simple method with your 'scope to make observations quickly and effectively, even if you do not have a shelfful of laboratory instruments. Or even if you do, when you are in a hurry.

In measuring amplifier frequency reponse, we usually use an oscillator to act as a signal source over the range of frequencies in which we are interested, and a voltmeter to check the output of the amplifier. If the oscillator is not known to be flat in output over its frequency range, either continuous switching or another voltmeter is needed to monitor the oscillator output (the amplifier input) to a constant value.

A simple alternative to this system is to use an oscilloscope in a novel manner to replace both voltmeters. The trick lies in feeding the amplifier input to the horizontal deflection plates of the 'scope, and the amplifier output to the vertical deflection plates. Of course, the amplifier is also terminated in its proper load, as usual. The connections may be seen in *Fig.* 1. The coupling capacitors are large enough to have an impedance that is small compared to the 'scope input impedance over the whole frequency range of interest. The input of most 'scopes is at least a megohm, so for audio amplifiers a capacitor value of 0.1 μf or larger is ample down to the lowest audible frequencies.

* *30 Wedgewood Dr., Westbury, N.Y.*

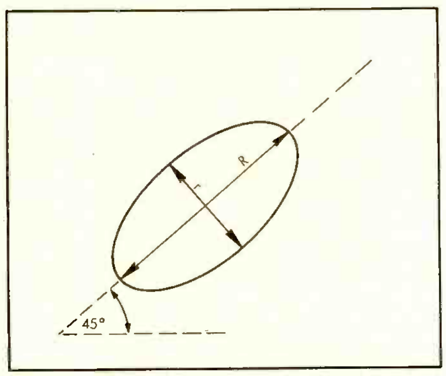


Fig. 2. Phase shift can be determined roughly by measuring the two axes of the ellipse and comparing with the table in the text.

The oscillator is set near midfrequency, the amplitude to the desired value, and the scope controls are adjusted to show a line of reasonable length (say ⅔ to ¾ of the scope screen diameter) at an angle of exactly 45 deg. with the horizontal.

Varying the frequency setting of the oscillator will show no effect at all on the scope screen. If the oscillator output is not flat as the frequency is varied, or if the oscillator amplitude is varied, the length of the scope trace will vary *but not the angle.* 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. With the signal set again to a value within the capability of the amplifier, the frequency of the oscillator is varied. At the frequency where the amplifier response begins to drop off, the trace angle will do likewise. In the absence of a rotatable grid on the scope, a piece of cellophane tape may be used as an angle reference for qualitative checks, while for quantitative measurements, a celluloid protractor may be fastened to the scope screen.

The method is fairly sensitive, since you can easily see the change in angle when one end of a three-inch line is, say, 1/16 of an inch lower than its reference position. For a three inch line, this means an output to input voltage ratio of 2.9375/3 or about 0.98, which is a response drop of 0.2 db. With a protractor, the angle is measured as 44.5

(*Continued on page 49*)

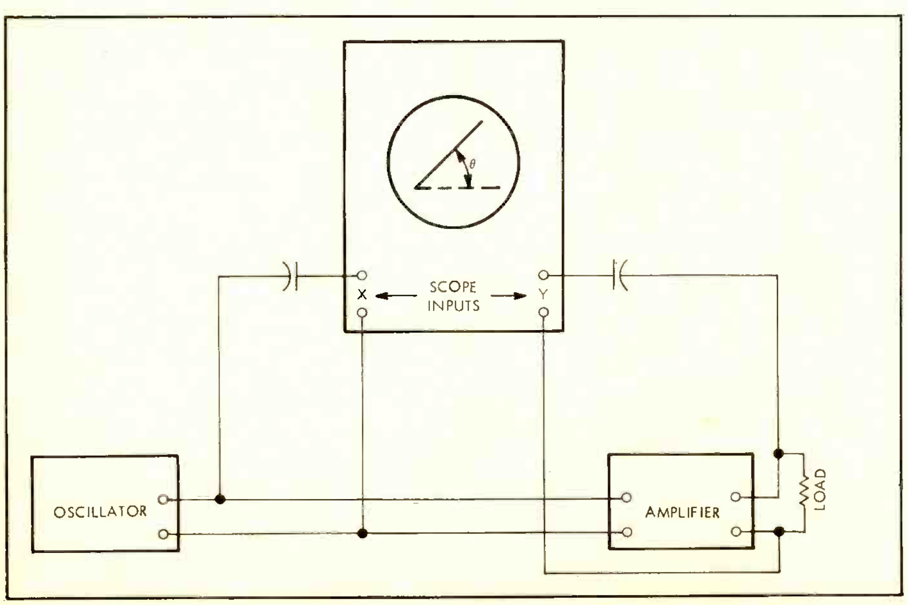


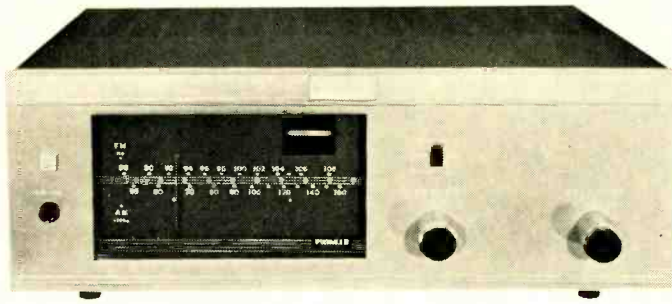
Fig. 1. Typical connections to 'scope from output and input of amplifier to make the observations described in this article.

TABLE I

AMPLIFIER RESPONSE DROP

Angle θ	Voltage Ratio	Loss, db
45.0 deg.	1.0	0.0
44	.96	0.4
43	.93	0.6
42	.90	0.9
40	.84	1.5
38	.79	2.0
36	.73	2.7
34	.67	3.5
32	.61	4.3
30	.55	5.2
28	.49	6.2
26	.43	7.3
24	.37	8.6
22	.31	10.2
20	.25	12.0

Note that the output/input voltage ratio is the tangent of the angle θ.



MODEL AFT-14
AM/FM/FM MPX
STEREOPHONIC
TUNER

A NEW WORLD OF LIVING SOUND . . . By PIONEER

MODEL SM-500
STEREOPHONIC
AMPLIFIER

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 provided 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; $15\frac{11}{32}$ (W) x $5\frac{29}{32}$ (H) x $13\frac{19}{32}$ (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; $15\frac{11}{32}$ (W) x $5\frac{29}{32}$ (H) x $13\frac{19}{32}$ (D) inch, Weight; 28.7 lbs.

PIONEER

PIONEER ELECTRONIC CORPORATION

5 Otowacho 6-chome, Bunkyo-ku, Tokyo, Japan

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ABOUT MUSIC

Harold Lawrence

Rafael Puyana—Enthusiast for the Plucked String

When Wanda Landowska made her debut as a harpsichordist in Paris in 1903, she dared to play only one work on this instrument, devoting the rest of her program to the piano. The sound of the harpsichord was still strange and exotic to audiences of the turn of the century, and it was a risky business for an artist to play it at all in public.

Thanks to Landowska's pioneering and subsequent triumphs, harpsichord recitals are today a permanent feature of our musical life. Naturally, any discussion of harpsichord performances begins with Landowska, but it need not end with her. In her later years, people called Landowska the "grand priestess" of the harpsichord. Along with the title went the implication that she could do no musical wrong, and that she had a direct line to the masters of the Baroque period. There is the famous story of how a pianist visited Landowska backstage after one of the latter's recitals, congratulated her, and said diffidently: "I hope you don't hold it against me for playing Bach on the piano." Landowska is said to have replied in utter seriousness, "Of course not, my dear. You play Bach your way, and I play Bach *his* way."

Musicians from all over the world came to study with Landowska, to sit at her feet. Like Casals and Toscanini, she became a legendary artist. Not that everyone accepted blindly all her musical statements; to some, her phrasing in slow movements was often jerky and episodic, her rubato mannered, and her choice of ornaments intrusive. But no one will deny that, more than any other performer of her day, Landowska set lasting performance standards, and brought the harpsichord out of the obscurity of the 19th century.

When Landowska died, many harpsichordists were active in the concert hall: Ralph Kirkpatrick, Ruggiero Gerlin, Fernando Valenti, George Malcolm, and Sylvia Marlowe, to mention a few. The youngest in the field, and probably the most brilliant harpsichord virtuoso of his generation, is a 31-year-old South American named Rafael Puyana. Landowska's last pupil, Puyana is today a seasoned concert artist. A bachelor, he lives with several harpsichords in New York and Paris, but is on the road most of the time, usually accompanied by one of his Pleyel harpsichords in the back of a Buick station wagon. He concertizes on several continents and spends his summers in Spain teaching. From Landowska, he acquired a taste for tracking down rare harpsichords and unearthing neglected Baroque masterworks. Recently, Puyana made the first recording of what Grove's *Dictionary of Music and Musicians* called "one of the . . . monuments of early Italian harpsichord music"—Giovanni Picchi's *Balli d'arpicordo* (Dances for Harpsichord).

In the early years of his career (Puyana began to concertize in the mid-Fifties), he could not get out from under the "mantle of Landowska," with which critics were constantly draping him. However, the press and the public soon recognized that he had a style and personality of his own. Nevertheless, Landowska made a profound and lasting impression upon him, personally and as an artist.

"She taught me the most precious thing a teacher can give a student," he said recently, in his harpsichord-filled apartment off New York's Central Park. "That was to be able to find your own individuality, your own way in building an interpretation."

The circumstances of Puyana's first meeting with Landowska were dramatic. It was in 1950, a year after Puyana had come to the United States from Bogotà to enroll in the New England Conservatory. A friend of his father had set up an audition for him at Landowska's home in Lakeville, Connecticut. About to play for the greatest harpsichordist of the age was this 17-year-old musician, who had had no guidance on the harpsichord, and had practiced only on an inferior instrument evenings, after classes were dismissed. "I was so nervous when I arrived," Puyana related. "The idea that I

Fig. 1. Rafael Puyana at one of his harpsichords.

was at last going to play for Landowska hit me with a sudden impact. It all felt somehow unreal . . . improbable. I had many preconceptions about how she would look, but they were all shattered when I saw her for the first time. I had pictured her as a shy, reserved old lady, and, of course, I thought she would be dressed in black. But when she made her entrance—and what an entrance that was!—she was dressed in a bright red gown, with white scarves around her neck. She was a very short woman, with penetrating eyes and striking features. She gave the room a special atmosphere."

How did you manage to play? I asked. "I think I acquitted myself very well, in spite of her overwhelming presence. Probably because I had prepared for this audition with every ounce of energy I possessed . . . as if it were a matter of life and death. After I had finished playing, she praised me, said I was very sensitive and that I had a real feeling for Baroque music. Soon after I began to work with her, I learned that I had a long, long way to go, having absorbed all I knew about the harpsichord only from books and recordings.

"As a matter of fact, it was hearing a Landowska record when I was eleven or twelve that changed my life, so to speak. Through my Italian piano teacher in Bogotà, I had previously come into contact with Baroque composers. I came to realize that the true instrument for their music was not the piano, but the harpsichord. And when I heard the sound of the plucked strings on that recording, I was completely bewitched. Then and there, I decided that I would become a harpsichordist."

For eight years, Puyana spent virtually every day with Landowska, studying with her and accompanying her on walks over the Connecticut countryside while they talked about music for hours at a time. He sharpened his rhythmic sense, gained a deep understanding of ornamentation, and developed a remarkable feeling for improvisation.

Playing the harpsichord is a complicated affair. A concert harpsichord at close range gives the impression of a piano in multiple image. On Puyana's instrument, for example, there are seven pedals, four sets of strings, and two keyboards. The layman easily recognizes its metallic twang, but what does he really know about the harpsichord, beyond the fact that its strings are plucked by quills rather than struck by hammers. Take the word "stop" . . . this has one meaning for the organ and another for the harpsichord.

Turning to his harpsichord, which occupied nearly a third of his small living room, Puyana explained: "The term, 'stop,' was simply borrowed from the organ. The 16-foot stop, for instance, is tuned an octave lower than the normal 8-foot stop, and the 4-foot stop an octave higher. The stops on concert harpsichords are operated by means of pedals.

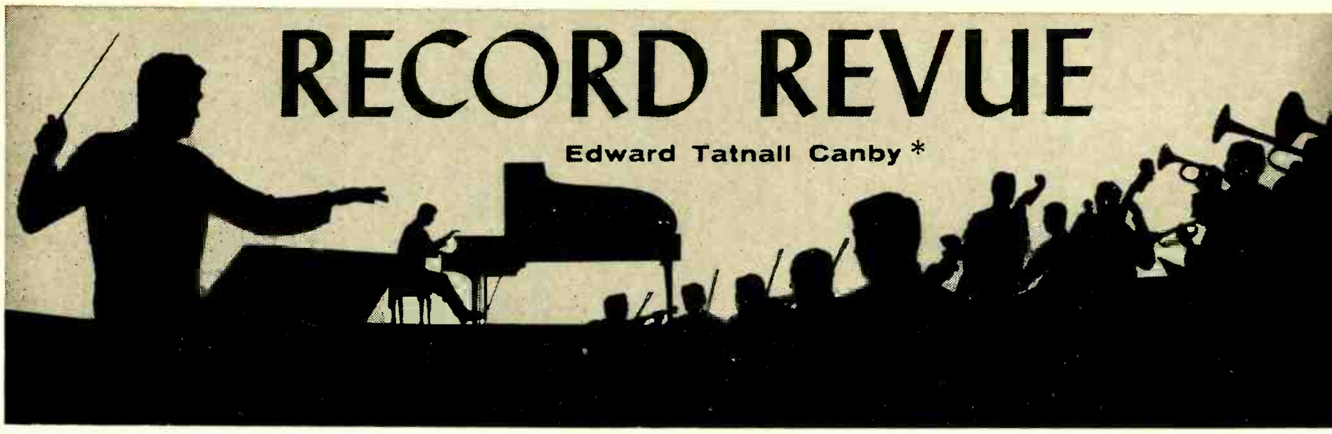
"Now how does all this work? My instrument, a Pleyel, contains four sets of strings. In the upper manual, one set is plucked at two different points by two separate rows of jacks." (The jack on a harpsichord is a wooden upright bearing a pivoted wooden tongue which contains a leather quill. When a note on the keyboard is depressed, the jack rises, the quill plucks the string, then slips back into its slot.) "Two sounds are produced by the jacks plucking the first set of strings," Puyana continued. "One is the normal 8-foot register, the other the *nasal* (pronounced with the accent on the second syllable). A third set of jacks creates the *lute* register by approaching the strings and damping them slightly.

"The lower manual has three sets of strings: 8-foot, 4-foot, and 16-foot registers. Now that takes care of six of my pedals. The seventh is a coupler; that is, it combines the various registers to produce marvellous sonorities."

With all these color possibilities at his disposal, the harpsichordist must, in a sense, "orchestrate" every piece he plays. But there's more to it than that. Baroque composers merely supplied us with the bare notes . . . a sort of musical shorthand. Not only was no registration indicated, but the phrasing, tempo, dynamics, and ornamentation were also missing. In short, the harpsichordist must put the flesh on the bones of Baroque music.

"They didn't always play the way they wrote," Puyana said, referring to the Baroque masters, "either because notation was not developed enough to express certain refinements to which they were accustomed in performance, or because certain habits were passed on from musician to musician."

Small wonder that Puyana spends so much time in libraries, studying treatises on ornamentation and general performance practices of the 17th and 18th centuries. But he is no dry-as-dust scholar. "It takes imagination and technique to bring this repertoire to life," Puyana said. And these are qualities which this dynamic young musician possesses in great abundance. Æ



IN BRIEF . . .

Torroba: Concierto de Castilla; asstd. guitar solo works. Renata Tarrago, guitar, Concert Orch. of Madrid, Arambarri.
Columbia MS 6322 stereo

Handsome picture of a handsome lady guitarist will sell this to you—and she is as good as her picture. Dreamy, not-too-important Spanish music but sensuously played and a pleasure to hear.

Sunday Only (Steam Excursion trains on the Burlington Route).
Mobile Fidelity MF 9 stereo

Steam is petering out. Now, there's only those little branch line affairs in the coal mining regions and, of course, the Sunday special fan excursions, to feed the flames in hi-fi. That's where Mobile Fidelity is operating here, with the Burlington's obviously enthusiastic co-operation. Sounds fine, but I'm glad I wasn't on board. Such clouds of black smoke I never saw, in the accompanying photos! There once was a time when we didn't like all that grime and dirt. Not any more. The fans practically roll in it.

General (Sounds of Steam Railroading Vol. 5).
O. Winston Link (7" 45 mono)

This little disc is an impressive documentary, in sound, pictures and text, for all its shortness. Here is the famous "General," Civil War engine of the great train chase movies, built in 1855, dynamited in the retreat from Atlanta in 1864, restored and immobilized in the Chattanooga station for many years, now put back into actual operation—surely the oldest going locomotive of all. Fascinating sounds, and a climax of sheer joy when the little engine steams back into the Georgia town from which it was stolen on April 12, 1862, for the famous wild 87-mile chase Northwards. Cheers, yells, brass bands. Cheers to O. Winston from us!

The Vienna Choir Boys sing Madrigals.
Philips PHS 900-011 stereo

Whatever they sing, it is the extraordinary musicality—musicianship is the grown-up word for it—that these ever-changing boys offer which astonishes, over the years. It results, certainly, from a combination of careful selection (combing the whole of Austria for fine musical ears) and superb musical training. At such a tender age, too!

This program interprets the word "madrigal" quite freely; the songs range from student songs out of Germany through the music of England's Thomas Morley—sung in German (odd effect!). Eight charmingly set German folk songs add lustre to the performance.

The Three Little Pigs, Three Bears, Henny Penny, and Other Fairy Tales. Read by Boris Karloff.
Caedmon TC 1129 mono

". . . So the little pig boiled up the wolf, ate him for dinner and lived happily ever after." Have you forgotten what real, genuine fairly tales were like before Mr. Disney got hold of them? Try this Boris Karloff opus! The three little pigs and the wolf who huffed and puffed 'til he blew the house down aren't even on Side One of the record, which opens with a fine version of Jack and the Beanstalk that goes on and on for a delectably healthy slice of children's bedtime. Then there's something called "Hereafterthis," a sly story about a farmer named Jan whose wife tries to make the cows drink faster and manages to drown them all in the pond, not to mention choking the pigs in their chow—a hefty female, to put it mildly. Slight surprises here and there, for those who know fairy stories mainly via the TV comic world; but these stories, as Caedmon puts it, are "given here just as the facts were originally reported." Karloff is at his usual whimsical best—you'll find him in dozens of other spoken LP's if you enjoy this one.

WALK RIGHT IN

The Rooftop Singers. Erik Darling, Lynn Taylor, Bill Svanhoe.
Vanguard VSD 2136 stereo

This memorable disc must be hailed as the first including an all-out No. 1 Hit ("Walk Right In") that achieves a No. 1 classical rating, too, in the best sense of that term. It contains top music from anyone's viewpoint, hit or no hit.

The thirteen assembled "singles", each commercially tailored, aimed at the jukes and the jockeys, are nevertheless thirteen musical gems of sheer styling and musical content, each a kind of concentration of an aspect of existing folk are—so perfectly worked out, so logical and precise, so intense in the internal structure, that like the classical dances composed by Bach out of popular European dance forms of an earlier time, these attain a classical level of musical expression in their own right.

No—this isn't "pure" American folk. There's an alien bass player, a discrete pops drummer and a taste of straight commercial reverb. Some of the songs, too, fade away at the end, or repeat the last phrase, or make it into a pops ending (anathema to the pure folk!). No—it isn't highbrow classic. Not a trace of a fugue. No Mozart, no Hindemith, not a long hair in sight. It isn't gospel music, though it includes gospel (of which the hit title piece was a 1920s example in its original form). It isn't Lead Belly though the 12-string beat is loud in some of its numbers; it isn't early Appalachian but includes some of the old English heritage; it isn't Work Song nor Western Ballad nor Victorian Saloon though all these contribute to its precise stylings.

Indeed, the music could easily have been a mish-mash of commercialized nothing. Instead, out of all this and more it crystallizes a series of small works of art and contrasts them in a whole that plays with the impact of a symphony, not debasing but elevating the original inspirations, not loosening but tightening the basic discipline. In the presence of such economy of means, such knowing use of the inherited background, the successful commercial element is simply unimportant—if significant.

One song has only five tones; its guitar accompaniment uses just three of these, minus all harmony. Another uses only two guitar notes, throughout. A lush Western badman ballad points its impact by a brief rhythmic break at one chord in each verse—miraculously tightening a loose series of chords into a real musical shape.

What else is classical art but this?

Peg and Bobby Clancy. Songs from Ireland.
Tradition TLP 1045 mono

Imagine a Clancy family without plenty of kin. The singing family of that name has been sending members over here for some time (they manage the business of Tradition Records itself, as a side activity) and importing even more of the musical Clancy product. Here are two younger Clancy siblings. They sing more gently than the older Clancy brothers (and Tommy Makem), their material is of a more neutral sort, just pleasant Irish fare of no great import, not really lusty enough for, say, a New York coffee house or a TV program with a high rating, nor again of a purity to attract the folklore experts. (Even so, Bobby collects in his spare time, around the local country side.) This is merely Irish entertainment, far, far removed from the sentimental corn we hear each St. Patrick's day but hardly taxing upon your intellectual and artistic perceptions even so.

RENAISSANCE TO ROMANTIC

Renaissance Festival Music (Flemish Dances and Venetian Music). New York Pro Musica, Greenberg.
Decca DL 9419 mono

Hard on the heels of the one before, here's another release from the Pro Musica factory in New York. They are practically a monthly event, these fast-flowing discs.

This one is all-instrumental, reflecting the Pro Musica's increasing interest in the systematic revival of *really* old instruments—not just "olde"—and, more significantly, the revival of expert playing techniques to make them sound as they should, and surely did. We can thank this group for an immensely healthy contribution here—serious, virtuoso proficiency on such strangely assorted music-producers as (on this record) cornetts, sackbuts, shawms, krummhorns, regal, schryari, added to the now-conventional recorders, viols, harpsichord and the like.

There are divisions of impact within the enlarged Pro Musica, which has absorbed members of several other New York groups to man its growing collection of instruments. Some of these numbers, notably the first, a familiar dance suite published by the versatile Tielman Susato (based on music by various well known composers) retain the too-familiar Pro Musica hardness of style, riding through the polished musical phrases with the subtlety of a subway express. True—we have outgrown the idea of old music as somehow "quaint" and fragile; but that is no excuse at all for roughshod musical unsubtlety.

On the other hand, many of these players can play with fine expression, given a chance. The recorder ensemble is notably warm and musical on its own. So are the shawms—these being a wonderfully loud and throaty early form of oboe.

Altogether, this is an enlightening record, superbly recorded in a suitably big liveness, particularly splendid in the big multi-group antiphonal works from Saint Mark's cathedral by the Gabrielis and their musical relatives, as featured on Side 2. Decca obstinately sends us mono recordings; I assume that the much-preferable stereo alternative is available.

Vivaldi: L'Estro Armonico (12 concerti), Op. 3. Paris Chamber Orch., Paul Kuentz.
Decca DL 710070 stereo

Complete collections like this are now thriving in the record world, and rightly. Few such monumental assemblages could ever be played straight through in a concert or a concert series, nor were they so intended. The published "collection" coincides exactly in aim with the recorded "collection"—a balanced, well-assembled grouping of similar works presented as a whole but useable in all sorts of flexible arrangements, to taste and according to demand. That's how you'll want to play these discs and many others of the sort. That's how they have been performed throughout their long lives.

This French recording of the concerti (which vary in many details, some for single violin, most for various solo-group combinations including the usual two violins and cello as well as several four violins together) strikes a nice balance somewhere between the heavy approach of German performances, the slightly frothy and nervous Italian style, the chrome-hard American, the genteel British. Not too heavy—not too heady, well thought out, accurate and authoritatively styled. You can get the three discs one at a time if you wish, too.

Mozart: Quintet in E Flat, K. 452; Divertimento No. 8 in F, K. 213; Divertimento No. 14 in B Flat, K. 270. Vienna Symphony Woodwinds.
Westminster WST 17023 stereo

Ah! How this takes me back to the first big batch of Westminster music out of Vienna, back in 1950 and 1951. There is a lovely, unctuous and gravely elegant quality about Viennese playing that is unmistakeable—even when occasionally it hides a less-than-profound approach or even a bit of stodginess. Not so here. The superb Wind Quintet K. 452 has been played with considerably greater intensity; but this suave version is equally valid in its way, and the same with the light-hearted little Divertimenti, "garden music," found here on Side 2.

However, I have one bone to pick. These last two are transcribed from the original pairs of oboes, horns, bassoons to a modern-type woodwind quintet including the clarinet. Now though Mozart later used the clarinet, it has no place in this sound at all and makes me squirm uncomfortably. Moreover, the transcription inadvisably keeps it where Mozart never would have used it, down in the low register as a mere harmony instrument. Better let the clarinet sing out on the high oboe lines (as in his alternative version of the late G Minor Symphony) if you must have it in this music.

Haydn: The Paris Symphonies (Nos. 82–87). L'Orch. de la Suisse Romande, Ansermet.
London CSA2306 (3) stereo

It is a wondrous day, that one upon which any record collector discovers he has an appetite for Haydn Symphonies. It happened to me 'way back in the Thirties. I almost starved, on a sparse diet of expensive 78 rpm creations. The "Oxford", the familiar "Surprise", the last of all, No. 104 in D called the "London", all came from the final group of a dozen. But my favorite, significantly, was the lovely "Farewell", with the cryptic number 45 attached. Cryptic—because I was pestered with curiosity about the dozens and dozens of whole symphonies that must be around *somewhere* to make 45 add up to 104. Only two of them ever got to my ears before the war. Nos. 67 and 80. The rest were blank.

Since then, the Haydn-absorbers have got to hear a good many, though far from all of the total list. Even so, these six works, shortly previous to the "London" series of a dozen, are still mostly unfamiliar. If you're a Haydn-absorber, you will want to eat them up quick and this is a fine recording to sample and to digest. Ansermet's approach is excellent for our times. No more of that once-popular "Papa Haydn" cuteness that Sir Thomas Beecham used to purvey; now, Haydn is big, natural and dignified in his own symphonic right, in spite of Tchaikowsky, Beethoven, Mahler and the rest. The Swiss orchestra plays with imagination and accuracy in these, the London stereo sound is as musically happy as ever.

Dvorak: Symphony No. 4. Brahms: Academic Festival Overture. Columbia Symphony Orch., Bruno Walter.

Columbia MS 6361 stereo

This release is one of the inevitable list of "legacy" recordings that remain outstanding when a top conductor passes away in the midst of his great work. Columbia did its best to get the whole of the Walter repertory into stereo while the old man still was operating on all his musical cylinders—they got an astonishing amount, though perhaps not as much as Angel is now getting out of old Klemperer, nor as sensational as RCA's mixed-bag legacy of tortured Toscanini. This Dvorak is a side-excursion in Walter's catalogue, which centered most clearly upon Beethoven, Brahms, Mahler.

To me it is not a definitive performance. Definitive as to Walter's approach—yes. But though Dvorak was a devoted follower of Brahms and a thorough product of the German Romantic shool, he was no German himself. The Czech in him, in musical terms, is increasingly interesting to us today—the lively folk spirit, the dancing, the crackling tension, the un-Germanic interest in highly colored, high-charge harmonies (almost French in a way), the somewhat absent-minded discipline of form, so contrasted to the Brahms obsession with the same.

Therefore it is vaguely distressing, here, to find that for Bruno Walter, Dvorak is somehow another Brahms. The recording is Germanic, Brahmsian; it purrs but it does not crackle—speaking in emotional terms. I frankly prefer a more modern interpretation which allows this composer the electricity which is so natural to today's musical performance—and was already Dvorak's back in the last century. Say by Epic's Georg Szell, who knows how to crackle very well.

Bruno Walter is long on Amperage, short on voltage.

DUOS

Frida Leider, Lauritz Melchior 1928-31 (Wagner, Beethoven, Gluck, Mozart).

Angel COLH 132 mono

Songs of Debussy. Maggie Teyte, Alfred Cortot. 1936-44.

Angel COLH 134 mono

I hear that some of these priceless "COLH" LP reissues have already gone back into limbo and into the collectors' catalogues. You'd better grab them while they're still extant.

The Leider-Melchior disc is an eye-opener for those of us who had thought Melchior's singing of Wagner began with Lotte Lehmann and went on to his recordings with Flagstad. Here is a younger more flaming Melchior, more accurate, less strained, more ebullient than in the famous later recordings. I had no idea there was such splendid material still available in sound. Nor did I realize what a fine Wagnerian the now semi-forgotten Frida Leider was, around the time I was a schoolboy. She is not as boldly dramatic as Lehmann nor as noble as Flagstad but her Isolde is at the very top, even so. Indeed, the superb understanding of the Wagnerian idiom in these old recordings is immediately evident—this was still the heyday of the Golden Age of Wagner, whereas today Wagner performance is already somewhat a forced art, not easily restored to fluid greatness.

Three quarters of the record is "Tristan," several marvelously long excerpts newly patched together in one piece, as they were never heard before. Whether the conductor is Barbirolli, Heger, Leo Blech, or the indefatigible Albert Coates, the spirit of Wagner shines through all of them. (Short Mozart, Gluck, Beethoven excerpts make up the balance of the record.)

The Maggie Teyte recordings—she was, if I remember, English, and the greatest singer of French songs in her generation—have been super-collectors' items for years. I remember the first ones, back in 1936. Teyte was favored as an artist by Debussy himself; his songs have never been better performed. Anything by the ultra-French Cortot is piano music to be owned and savored, too. He made a fine accompanist in songs like these where the piano is an equal partner.

Dietrich Fischer-Diskau. Schubert: Songs of Greek Antiquity. Joerg Demus, piano.

Deutsche Grammophon SLPM 138 715 stereo

A superb collection of unusual Schubert songs, not composed as a group but assembled out of the hundreds of works by Schubert.

Europe was undergoing yet another Greek revival at this time, early in the 19th century. With Schubert it took the form of more than usually elaborate song writing to contemporary poems on Greek subjects—music that stems clearly from the older Italian concert-style aria on "classical" themes. Gods, heroes, myths and the like.

The poems, in German of course, are of the sort that pick a brief episode out of some Greek tale, or present a hero, or a woman of tragedy or even a god or half-god, discoursing in the first person. Sort of like a miniature piece of historical novel, poetic and mythical. These poems were meat for Schubert's powerful sense of drama, and elicited from him some of his greatest music.

Fischer-D. is surely the greatest, easiest-to-listen-to baritone of his day. Even if you've never cared for baritone solos you'll find these performances compelling. D-G thoughtfully provides not only texts and translations but a glossary "who's who" of the Greeks involved in the poetry.

Prokofieff: Sonata for Two Violins, Op. 56.
Haydn: Duo in B Flat.
Spohr: Duetto II in D.
Honegger: Sonatina. David and Igor Oistrakh, violins.

Monitor MCS 2058 stereo

Four works for two fiddles together—quite an interesting deal. It's amazing how much sonority a good composer can wangle from them, what with constant double-stops, pizzicati and all the rest of the fiddle trickery available (and with a whopping good reverberation to amplify the result).

Of these, the Prokofieff is the most important and the biggest piece musically, the Spohr the most novel. The Prokofieff is as big as a quartet—and his quartets are musically and tonally full-bodied, de luxe models. The Spohr will introduce a "minor" great man of Beethoven's time and a lovely melodist, as is at once evident. Honegger is harsh but not very atonal, as of 1920; Haydn is actually writing an early string quartet here, arranged later for a pair of violins. Like the quartet itself, it is thin, airy, not yet very substantial but beautifully articulated and shaped.

In stereo, the famous Russian father and son are slightly to left and right, well blended. Is it my fantasy, or intentional mike trickery, that makes the father so much more brilliant than the son?

Rachmaninoff: Suites Nos. 1 and 2 for Two Pianos. Vronsky and Babin.

RCA Victor LSC 2648 stereo

These seasoned members of the RCA stable are getting along in years but musically they are still young, perfectly wedded in musical terms after thirty-odd years of performing. Their pianos purr together like synchronized Rolls Royces.

Indeed, this is somewhat of a monument to an era, this record. The players knew Rachmaninoff here in New York, played this music for him back in the late Thirties. They are European, too, pre-war emigrés to America. They project the high post-Romantic style of pianism as faithfully and as musically as Rachmaninoff himself projected it in terms of musical composition.

The First Suite is the best listening—for it is early, naive Rachmaninoff, dedicated to Tchaikowsky (1893). It is so light—there are so many notes in it, and so fast—that I was reminded of one of those giant "Regina" music boxes, with their frilly, gentle, enormously complicated arrangements of familiar music. Freshly Romantic and very youthful. The later Suite, still young (1901), is much nearer the familiar Rachmaninoff, with the big melodies, the whopping piano chords, the thickness and, above all, the length! Rachmaninoff was never a man to be concise when inspiration urged him onward and still onward.

It's wonderful how wonderful two pianos sound on discs, especially in stereo. Now that RCA has recovered its pianistic abilities, as of the days when Rachmaninoff himself recorded for the company, the "Living Stereo" disc is a pleasure to hear, and the more so with a pair of pianos.

Too bad Horowitz went over to Columbia. ... He could use this sort of sound.

SUBTLE SATIRE

Mozart: Symphony No. 29 in A, K. 201; "A Musical Joke," K. 522. Orch. San Pietro, Ruotolo.

Decca DL 710068 stereo

Decca has dug up an excellent small Italian orchestra here, with the typically Italian brightness and eloquence in the strings plus a good deal of that disciplined perfection we know in "I Musici" and the like. Also an understanding of Mozart that, I suggest, is positively Germanic! That's saying a lot.

The Symphony is very nicely styled; but what counts on this disc is the famous "Musical Joke," one of the late-Mozart works and a counterfoil to the ineffable "Little Night Music (Kleine Nachtmusik)."

The "Joke" is a tricky piece. James Lyons, editor of the serious "American Record Guide" has, I regret to see, been led into a familiar fault in his notes describing this piece of musical satire. Only occasionally is it screamingly funny and blatantly obvious—a humorous "travesty" as Mr. Lyons calls it. The satire is more serious than that and a lot more subtle in its jibes at punk composer.

True, the pair of horns plays excruciating wrong notes (making fun of beginners' luck in the well known transposition required when composing for such instruments) and there are, indeed, accompaniments without tunes, counterpoint that gets nowhere, an ending that is a hilarious jumble of dissonance. These are the externals; what is much more subtle is the continuous satire on a thousand technical and professional aspects of composition as it existed in Mozart's day (and in many respects still does). Every page is full. Subtly misplaced rhythms, unbalanced harmony, marvelously sly parallel fifths, hidden fifths and octaves in sixteenth-note passages (as still studied today in advanced strict counterpoint), themes that lack melodic shape; or are redundant, cadences that end where there is no ending or fail to end when an ending is called for, ungainly string writing, clumsy brass, exaggerated style-gadgets (like the then-popular leap upwards of a tenth), obfuscating rhythm patterns—two against three, for instance—and, of course, that nasty little parody of a violin cadenza that ends up in the wrong key, having lost track of where it is *improvising* (that is Mozart's poisonous intent)—all these things make a satire of rapier sharpness and high professionalism, sweet but also extremely biting. Mozart had a violent contempt for inept professional music, as you can read in his letters home to Papa Leopold.

It is a lovely sound, just the same! Mozart could not write bad music—this is only mock-bad. You and I had best take it as Mozart of an oddly clubfooted sound but otherwise songful and rewarding. Even his "mistakes" have character and expression. Nevertheless, for its full value the piece should be studied by an advanced class in harmony and counterpoint over many a long hour, or by experienced composers in need of a check-up on their fundamentals. This version is the best I've heard so far, both for plain listening and for acute musical analysis, at length and with score.

Stravinsky: Quatre Etudes pour Orchestre; Suites Nos. 1 and 2 for Small Orchestra; Divertimento "Baiser de la Fee." L'Orch. de la Suisse Romande, Ansermet.

London CS 6325 stereo

Never be scared by elaborate titles! If you will skip past these French-English handlebar headings, you'll find some delightful and perhaps unexpected music. This is mostly out of a time I like to call the Early Nose-Thumbing Era—*circa* 1915–17. It is deliberately, provocatively low-brow stuff (though masterful in its construction), full of blats and squawks, replete with dizzy little tunes and jazzy "breaks," poking shocking fun at all elegance. Our papas (and some of us, too) were deeply shocked at the time by such dastardly modernism. Now, the music hits us with a lovely nostalgia, as fresh as rag-time or a circus polka. Nose-thumbing indeed! Extremely skillful nose-thumbing, though. Subtler than you think.

The somewhat later Divertimento is a concert suite for string orchestra made out of the ballet "Baiser de la Fée," the music of which was composed around themes of Tchaikowsky. It remains one of the loveliest, most limpid, gentle, ear-catching works of that surprising period the 1920s. Ansermet, as always, manages to bring out the more Romantic elements in the score—in this case, the element of Tchaikowsky—without endangering the security of the mid-Stravinsky style, with its easy, foot-tapping flow of bits of tunes and tune-fragments set against mildly oom-pahish accompaniment figures.

AUDIO ETC

(*from page 10*)

purely negative, i.e., entirely transparent! All that has happened is that a number of mildly noticeable faults audible with the old mike have simply disappeared. Now, you can't hear a darned thing to get your ears on in respect to the microphone performance. Just me, talking.

I should say, for your info, that this little mike comes in two basic models, with many variants. A smaller one with interchangeable capsules of the various types (and a special small tube), is the M221B series. My mikes, slightly larger—still, no bigger than a short, plump cigar can—with all three patterns built in and adjustable simply by turning the top, belong in the CM60 series. You've seen the ads, life-size or larger. The "big" model is remarkably compact, even so, light and easily handled, convenient in its elastic cage mount; the power supply is neat and small, too, and sits easily on the floor or anywhere convenient nearby. Indeed, there is a certain "feel" to this equipment in the handling that has immediately endeared it to me. It feels *right*. It lends itself to your needs, quickly and easily, rather than fighting you off. Not easy to pin this down—you'll need to try for yourself.

Cost? An awful lot. More, I guess, than some of its competitors in the small condenser field. I'm not doing a comparative test here—leave that to the busy all-day recordists in the pro field. Ask them. All I know is that I like *this* mike, even if the others are possibly just as good. Æ

JAZZ and all that

CHARLES A. ROBERTSON

George Shearing: Jazz Moments
Capitol Stereo ST1827

The first batch of releases in Capitol's new "Dimensions in Jazz" series also includes the last recorded performance of Israel Crosby, who will be remembered as one of the great bassists even though his name never topped the list of award winners in any of the annual polls. Crosby was overshadowed early in his career by Pops Foster and later by such advanced technicians as Jimmy Blanton and Ray Brown. In fact, replacing Kirby in the Fletcher Henderson band was Crosby's first important job, and he was picked soon after to play on several recordings made in Chicago for English Parlophone in 1936. Gene Krupa at one session gave the seventeen-year-old youngster a featured role on *Blues Of Israel*, an item long cherished by collectors. Also of the same tender age was one British purchaser, an aspiring pianist named George Shearing whose blindness from birth placed him at the mercy of the blues.

Crosby spent six years lifting the Ahmad Jamal trio to the affluent position it enjoyed prior to disbanding. Shearing jumped at the chance to hire Crosby and drummer Vernel Fournier, the other half of Jamal's rhythm team. The new quintet members complemented Shearing's playing so well that he decided their joint recording debut should take place on his first trio album in some time. Sessions were held last June during an engagement in Manhattan at Basin Street East, and Crosby was dead less than two months later.

The new arrivals on this recording were probably made to feel at home by an invitation to sit down to Jamal imitations off stand, but Shearing frees both from their previous specialized roles and steers clear of set formulas for this introductory get-together. Much of the time is spent comparing notes and testing reflexes, with ample solo space for all, on such standards as *Like Someone In Love, When Sunny Gets Blue*, and *Makin' Whoopee!* If the association had continued, subsequent chapters would undoubtedly feature the novel commercial twists essential to most contemporary success stories. That Shearing also would have received a creative boost is foretold by *Blues In 9/4*, during which the pianist meets the challenge of the blues and an unusual time signature in splendid fashion.

Sal Salvador: You Ain't Heard Nothin' Yet
Dauntless Stereo 6307

Working on the theory that big bands must please all sorts of customers to get by these days, Sal Salvador packs a little bit of everything into his debut album on a new label. Even so, only slight inroads are made into the band's book, as it boasts a good one hundred and fifty numbers and was written to cover any situation.

Sharing credit for this versatile approach to the commercial aspects of the band business is Larry Wilcox, an arranger whose ability to write to order never interferes with his creative capacity as a composer of jazz originals. He can do pretty much what he wants after flattering the leader's solo guitar with imaginative frameworks on *The Song Is You*, and his own *Shade 3*. His backgrounds for the band vocalist are equally ingratiating, however, and Sheryl Easly gives a pleasing lilt to *On The Street Where You Live*, and *Love You Are Here*. Contemporary jazz trends are neatly noted with references to bossa nova, outer space, and Benny Golson's *Blues March*. An instrumentation which includes two mellophones affords mild touches of the Stan Kenton sound on *Colors In Sound*, a bright tribute to the band's ensemble strength and a stunning stereo treat.

While this recording presents a vivid picture of the band's potential, lack of space deprives the many fine soloists of a chance to really stretch out. But if Salvador ever follows Woody Herman onto the same stand, there will be no stopping such stalwarts as Nick Brignola, Andy Marsala, Charlie Mariano, Ray Starling, Jerry Tyree, and Joe Farrell. Some alert promoter should try talking this pair of leaders into a combined concert at Carnegie Hall.

Herbie Mann: At The Village Gate
Atlantic ALC1919 (4-track UST)

Once upon a time, as though to establish the right of the flute to stand in any company, Herbie Mann surrounded himself with a platoon of exotic drummers and wild-eyed percussionists. The flute had little trouble in winning the day, due to the tendency of the accompanying horde to become overly enthusiastic and take pot shots at one another. Mann, having made his point, still enjoys working with percussionists of all nationalities, but the forces are now reduced to a size suitable to the precincts of the Village Gate, where this four-track stereo tape was recorded before a receptive audience. Besides being more manageable, a drum corps of only three members gives each a chance to be heard, something that always sweetens a drummer's disposition. Supporting Rudy Collins on either flank are Chief Bey, African drums, and conga expert Ray Mantilla, all operating with the best intentions toward everyone concerned.

The factor that hoisted album sales above average is Mann's fresh commentary on the virtues of *Summertime*, a subject already treated exhaustively by various jazz greats. Because of the existence of so many superior versions, the Gershwin melody has been neglected of late by players less adventurous than Mann, whose name now can be linked with that of the late Sidney Bechet, in respect to this performance at least. Vibist Hagood Hardy and Ahmad Abdul-Malik, bass, assist admirably, with extra bassist Ben Tucker adding to the stereo dimensions on *Comin' Home Baby*. Nineteen minutes, however, are hardly necessary for a 6/8 treatment of *It Ain't Necessarily So*, even as a showpiece for the paying customers.

Sonny Rollins: Our Man In Jazz
RCA Victor LSP2612

Great Personalities Of Broadway
Camden CAL745

When RCA Victor decided to reactivate its jazz division, Sonny Rollins was offered a healthy guarantee to come under the company banner and record again after a lapse of two years. Despite the sizeable investment, no commercial pressures in the form of added string sections or themes from current movies have appeared as yet to impede the tenor saxist's progress. The content of his first two albums proved uncompromising enough to satisfy his most exacting followers, and this third effort is even more so, as it pursues the strenuous course of collective improvisation throughout an actual performance at Manhattan's Village Gate. More than 25 minutes and the entire first side are required to relay the quartet's most recent thinking on *Oleo*, a Rollins composition of several years ago that has grown into a jazz standard. A companion piece, *Doxy*, consumes only 15 minutes, with a relatively brief change of mood and pace in between being provided on *Dearly Beloved*. Don Cherry, fresh from a year or so of playing trumpet with Ornette Coleman, apparently finds more order in the Rollins domain and reacts accordingly, developing solos of length and purpose. There is nothing methodical about the choice of rhythm patterns though, and only an intuitive sixth sense keeps Bob Cranshaw, bass, and drummer Billy Higgins going in the right direction.

That Rollins returned to the jazz wars with undiminished powers and heightened imagination should be firmly established after this exhibition of strength. Whether the retail and club sale of recordings made purely for a jazz audience meets Victor's expectations or not is another question, but now Rollins can aim a few salvos at a wider market without damaging his reputation in the least. After all much of his earlier acclaim was won with songs from Broadway shows, particularly numbers associated with Al Jolson, and waltzes from the pen of Noel Coward and less sophisticated composers. He has frequently demonstrated a marked affinity for old or forgotten popular tunes, and a few fresh packages of this sort of material should bring many new listeners into the fold.

As the Camden label is a rich repository of odds and ends from the past, Rollins can do quite a bit of research right in the RCA family group. The latest inspirational opus from this source consists of ten performances by such illustrious personalities as George M. Cohan, Beatrice Lillie, Ethel Merman, and Rudy Vallee. Even Rollins never went as far back in Jolson's career as 1913, a year when the voice of the master was recorded acoustically on March 7 singing *My Yellow Jacket Girl*, and *The Spaniard That Blighted My Life*. This last piece of music hall drollery may prove too intractable for the trappings of modern jazz but Rollins has done the impossible before. Climbing atop a piano and joining Helen Morgan on her favorite perch should present no problems during *Bill*, and his tonal grandeur is virile enough to follow Ezio Pinza on *None But The Lonely Heart*. Although jazz claims were staked out long ago to Sir Harry Lauder's version of *Loch Lomond*, Camden also lists a separate reissue volume devoted to the immortal Scotsman as an additional source. Not every shop carries these items, but those specializing in rarities have stocked up on both against the day when supplies are exhausted. Better buy now, before the price goes up again.

Shelly Manne: My Son The Jazz Drummer
Contemporary Stereo S7609
Allan Sherman: My Son The Folk Singer
Warner Bros. WSTC1475 (4-track UST)

A short story in *The New Yorker* some years ago described how a group of prospering Hollywood exiles centered longings for Broadway on the clock atop the Paramount Building. Similar sentences served in the talent mills of Southern California contribute strongly to these purely personal testaments, thus assuring the sentiments expressed on both a small niche in folk annals. With all the foolery and striving for humor, Allan Sherman could hardly have achieved such a success unless the trek westward from his Chicago birthplace included a lengthy detour in New York. Memories of corned beef sandwiches from the Stage and Gaiety delicatessens probably sustained the two performers while at work in the studios, as Shelly Manne was born and raised in Manhattan. Whether either ever sat around the campfire at a Catskill summer resort is not revealed in the notes, but the ethnic spirit of such gatherings abounds.

Obviously inspired by public reaction to Sherman's parodies, Manne plays modern jazz settings of traditional Jewish and new Israeli songs, along with a few Yiddish stylings from Tin Pan Alley. The drummer treats the material with greater respect, aiming for novel and unexpected effects rather than rib-tickling laughter. Shorty Rogers and Lennie Niehaus also collaborate on the arrangements, using rhythmic approaches which range from ancient hora dances to the contemporary bossa nova. Whenever a folkish touch is needed, Al Viola supplies an appropriate guitar interlude to contrast with jazz solos by Rogers on flugelhorn and trumpet, Teddy Edwards, tenor sax, and Victor Feldman, piano and vibes. The cause of humor is not entirely forgotten, however, and more than one witty remark may be detected on *Bei Mir Bist Du Schöen*, *Tzena*, and *My Yiddish Momme*. Howard Holzer's engineering of the stereo version is superb, and Manne has another volume on the way.

Ella Fitzgerald: Ella Swings Gently With Nelson
Verve C283 (4-track UST)

One requisite of jazz singing is the ability to swing gently, but the meaning of the term itself can fluctuate as widely as certain electronic stocks. The calmer moments of the buxom Dinah Washington are far more turbulent than the serene tones of an unruffled June Christy. While Ella Fitzgerald normally comports herself somewhere in between these two extremes, she has learned by now to judge a song's potential and gauge the amount of pressure to be applied accordingly. Some simply require a bit of coaxing, others respond to the prodding of a compulsive beat, and the dozen on this stereo tape are rounded up without strict regard for the mood level implied in the album title.

When Miss Fitzgerald deigns to observe rules of decorum, she defers to themes capable of making their own way and politely understates the lyrics of *Body And Soul*, and *The Very Thought Of You*. As she sang with the Chick Webb band when other girls that age were busily engaged in Girl Scouting, her idea of a good turn is to channel a little of the same youthful exuberance into revitalizing such old favorites as *I Wished On The Moon*, and *Darn That Dream*. Her affection for weaker tunes is becoming quite parental, a trait which should be noted by those critics who cite Billy Holiday as the lone example of a vocalist gifted enough to transform ordinary popular songs into memorable jazz performances. It prompts to discard all scruples in working wonders for a previously undistinguished ditty called *It's A Pity To Say Goodnight*. Nelson Riddle also packs more variety into his orchestral settings than the title indicates, and the quality of the stereo tape never fluctuates from a pleasingly high level.

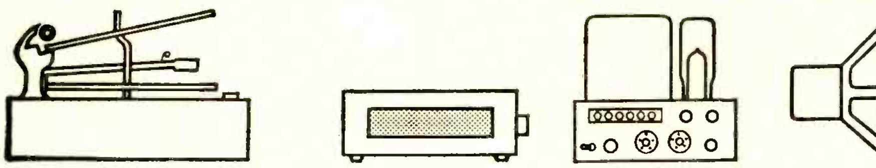
MONO

24 Great Jazz Groups: On Mike!
Pacific Jazz PJ100
26 Artists: The Greatest Names In Jazz
Verve PR2–3

Because these albums combine jazz history and promotional magnanimity, they qualify as excellent gifts for the jazz novice or sure bait for bargain hunters. Paicfic jazz celebrates its Tenth Anniversary with a two-record set, packaging twent-four selections in chronological order and tracing the growth of the company from Gerry Mulligan to the current roster of talent. Nearly every group is heard at about the period when fortune first smiled, playing works which drew praise from critics and fans alike. Richard Bock, president and founder, relates in the liner notes how it all happened and personally introduces such discoveries as Chet Baker, Chico Hamilton, Bud Shank, Les McCann and Clare Fischer. Besides being a tribute to Bock's artistic and business acumen, the compilation attests to his careful attention to audio details from the start. In the interests of promotion, recent additions to the catalog receive a proportionately larger amount of space.

Verve gives the show away with the series number assigned to its boxed set of three records, and the samples are arranged for variety rather than orderly progression. There is a little something for everybody though, and any publicity man will approve that sort of logic. Johnny Hodges, Terry Gibbs, Dizzy Gillespie and Woody Herman lead big bands, while Oscar Peterson and Art Tatum head trios. Groups of sizes in between fill out the balance of twenty-six numbers. Some items go back more than a decade, and the sound varies accordingly. A choice between the two is likely to depend upon a particular dealer's price tag. Æ

EQUIPMENT



PROFILE

HEATHKIT TRANSISTOR STEREO AMPLIFIER, MODEL AA-21

The Heathkit AA-21 is billed as a 70-watt stereo amplifier (35 watts per channel) which achieves this power output (not music power) without benefit of output transformers or vacuum tubes. From experience, even before we tested this unit, we tended to credit Heath with having told the truth. Sure enough, the unit delivers at least 35 watts per channel, into an 8-ohm load, and is completely solid state. Nary a vacuum tube to be found in the whole shebang.

With this excellent start to encourage us, we took a closer look at the Heath AA-21. Hope we don't sound too tongue-in-check, but frankly we have learned, also from experience, to tuck our tongue in when approaching a transistor amplifier from the rear. We've been bitten before. Or something.

Anyhow, the AA-21 is an integrated stereo amplifier and control center with sufficient flexibility to handle all requirements of a modern home system. Thus there are six sets of inputs including tape head, magnetic phono (note that the ceramic input seems to have disappeared from the modern amplifier), tuner, FM stereo, AUX, and tape monitor. Input-level sets are provided, cleverly hidden behind a fold-down panel on the front of the unit. On the front panel, dual-concentric controls are provided for the usual signal-handling functions: bass, treble, and volume. These controls are designed to operate both channels simultaneously by means of a friction clutch, which is overridden to control each channel separately. Of course there are the usual mode and function switches. Hidden behind the fold-down panel with the level sets are the loudness-contour switch, tape-monitor switch, and the speaker-phase switch. The power on-off switch is activated by pressing that section of the front panel bearing the Heathkit logo. Two convenience outlets are provided, one switched and the other unswitched.

The Circuit

Fundamentally the circuitry utilized in a transistor preamp is similar to the circuitry used in a tube preamp, taking into account the essentially different characteristics of these two devices. For example, equalization networks for both the NAB and RIAA characteristics are feedback type around the first two transistors. Then there are the usual tone networks using gain as necessary to compensate for the losses due to the networks. Following this, again, we have the usual driver stages, although the three stages utilized in the AA-21 are somewhat more than the normal number. The driver stages then feed the driver transformer, which in turn feeds the output stage. So far, all is pretty common, excepting of course that transistors are used instead of tubes.

But that output stage is different. First of all there are four, big, powerful, and expensive, transistors used in each channel. These transistors are arranged in a series circuit known as single-ended push-pull. Strangely enough, this circuit is not unique to transistors. We recall a circuit shown by Philips of the Netherlands which was essentially the same but used tubes. Unfortunately, however, the output impedance was in the hundreds of ohms so that one had to use a relatively high impedance speaker. In the Heath circuit, the output impedance of the transistors makes it possible to couple directly to commonly available speakers. Actually the low impedance of transistors is not an unmixed blessing. In the preamp stage, for example, the low impedance offered at the magnetic phono input (30k) may very well attenuate high frequencies for some cartridges.

Anyhow, both current and voltage feedback loops are used around the output stage to reduce distortion and to improve stability.

The power supply uses four diodes in a full-wave bridge to provide the positive and negative d.c. Decoupling and filtering for the driver stages is supplied by an active filter network containing a pair of transistors as well as capacitors and resistors. A similar network is used to further filter and regulate the preamp d.c.

We hope Heath has started a trend in kit design—in our opinion this kit is worth emulating. What they have done is to pre-assemble several of the "sticky" assemblies, dip them in some gunk, and make them as easy to install as a tube. Modules are provided for three networks in each channel, and installing them consists of plugging into the holes in the printed circuit board.

Another device falling into the time- and labor-saving category are the cables which are provided; they do make it a veritable snap to wire up the front end of this kit. The AA-21 was one of the most effortless kits we have built to date; that is, it went together with no strain, fuss, or muss.

Unfortunately, the manual was not fully as excellent as the kit. Don't misunderstand, it is a good manual in its way; instructions are complete and accurate (we found only one or two small errors), and certainly they are clear. Our reservation has to do with the lack of explanation about what is being done in the various sections, and why. Of course this has been mentioned editorially several times in AUDIO, but still we continue to receive manuals which have not made any attempt to relieve the boredom of skatey-eight consecutive steps which one must follow implicitly. Nothing for the mind, everything for the hands. Come now, Mr. Manual Preparer, do you really think *that* of kit builders?

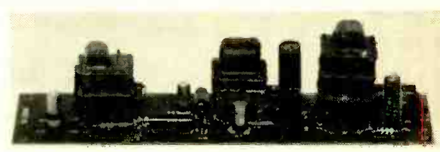


Fig. 2. View of one of the circuit boards showing the encapsulated modules.

Performance

The Heathkit AA-21 is certainly entitled to be billed as a high-fidelity instrument: Distortion never exceeded 2 per cent and throughout most of the frequency spectrum it produced much less. At rated power, the distortion was just under 2 per cent at 20,000 cps; at 20 cps it was just over 1 per cent. Intermodulation was 0.9 per cent at rated power (60 and 6000 cps mixed 4:1).

Although rated at 35 watts per channel, we were able to achieve 40 watts per channel at 1000 cps and with an 8-ohm load; at 16 ohms the AA-21 produced 28 watts, and with a 4-ohm load it produced 21 watts. Hum, as referred to an output of 35 watts, was −65 db for the high-level inputs.

The frequency response, while generally flat and within 1 db from 35–20,000 cps, did fall off somewhat from 35 cps down. At 20 cps it was 4.5 db down.

Over-all, the Heathkit AA-21 stands out as a reliable and unusually well thought out transistor amplifier whose characteristics and performance clearly place it in the high fidelity category. Listening to it confirms the instrument test results. F-18

Fig. 1. Heathkit transistor stereo amplifier, Model AA-21.

Fig. 3. Audio Dynamics ADC-18 speaker system.

AUDIO DYNAMICS MODEL ADC-18 SPEAKER SYSTEM

The name ADC is best known for a transducer which operates at the other end of the audio system—best known until now, that is. There is no question in our mind that the ADC-18 speaker system will earn as many accolades as did ADC cartridges. But we are running a little ahead of ourselves; first let us take a close look at it.

The ADC-18 is a two-way speaker system consisting of a 16 × 12-in. woofer and a Mylar-diaphragm dome-type tweeter which is housed in an extremely handsome walnut cabinet and incorporates several rather novel ideas. Number one is the shape of the woofer cone—it is a rounded-corner rectangle (16 × 12 in.). The reason for this unorthodox shape, as we understand it, is to increase the rigidity of the cone and thus make it act more nearly like the perfect piston than a round cone. According to theory, the more like a perfect piston, the more linear the response. Another reason is the greater radiating area, as compared with a 12-in. woofer (nearly twice).

Number two, also concerning the woofer, is the elimination of most of the speaker basket by mounting the surround directly to the baffleboard. Eliminating a substantial portion of the basket also eliminated reflections and resonances due to this structure, thus contributing substantially to smoothness of response.

Number three, the woofer cone is fabricated from expanded polystyrene foam surfaced by aluminum. The advantage of this plastic as a cone material has been related in the pages of AUDIO in the past, and essentially it boils down to the fact that polystyrene foam is light, rigid, and impervious to water. The aluminum skin adds to rigidity and ability to "push air." It works well.

Obviously, a lot of effort has been expended on the woofer, and it is quite obvious the first time one listens to the ADC-18 in proper context; it has one of the fullest "bottom ends" we have experienced. But that isn't all, the high and low frequencies have been so well balanced that one experiences smooth and effortless reproduction throughout the entire frequency range. This exceptionally fine tonal balance is helped, in part, by carefully matching the efficiencies of the woofer and tweeter. Also, the crossover point has been spread (mechanically and electrically) over the range from 1000–4000 cps.

Now as to the over-all performance of the ADC-18, we can come to the point very quickly; it is an exceptionally fine speaker which belongs in the top rank of available speakers, with accurate response down to 30 cps, and with useful energy available below that. We are not going to burden you with technical chit-chat because we believe it is not meaningful with a speaker of this quality. Instead we advise you to listen to a pair of them, as we did, for as long as circumstance will permit (or as long as the dealer will let you), and let your ears tell you. **F-19**

WEATHERS MODEL MT-66 UNIVERSAL TONE ARM

While the Weathers arm is an integral part of the complete Weathers record-playing system, it cannot be denied that there are some audiofans—the majority, as a matter of fact—who may want to mix things up a bit, using, for example, arm XYZ on the Weathers turntable or the Weathers arm on turntable PQR. For the latter group, the availability of the MT-66 Universal Tone Arm is the answer, providing, as it does, the versatility of accommodating any standard phono pickup.

The arm itself, *Fig.* 4, is made of one piece of oil-finished solid walnut, and together with the satin finish anodized aluminum hardware it is a thing of beauty. The pivot assembly includes full-time damping in both lateral and vertical modes to eliminate resonant bouncing of the arm at sub-audible frequencies. It is statically balanced so that it produces no side thrust even on unlevel turntables.

The pivot system consists of polished metal sleeve bearings rotating against low-

(*Continued on page 51*)

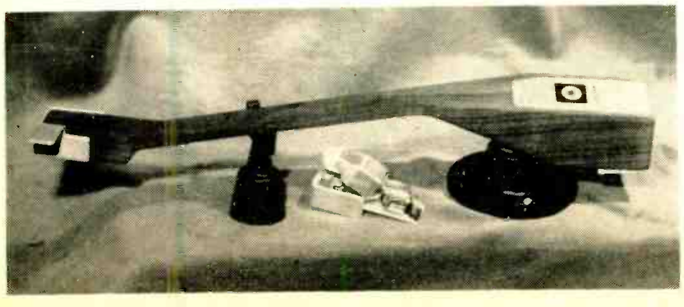
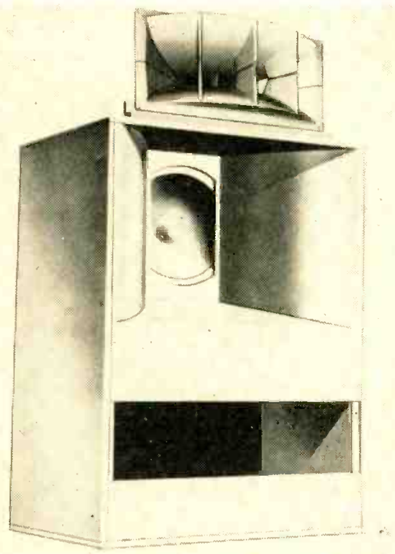


Fig. 4. The Weathers MT-66 Universal Tone Arm.

NEW PRODUCTS

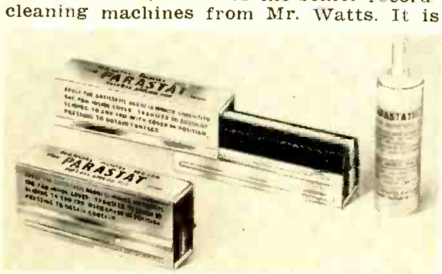
• **Professional Speaker System.** A new two-way loudspeaker system, developed for playback application in recording and broadcast studios, small theatres, and for the serious high-fidelity fan, has been announced by Altec Lansing Corporation, a subsidiary of Ling-Temco-Vought, Inc. Designated the A7-500, the new system is the latest member of Altec's famous "Voice of the Theatre" series.

The A7-500, with a power rating of 30 watts, incorporates the Altec 802D compression driver coupled to the large 511B cast aluminum sectoral horn for propagation of high frequencies. This assembly, complemented by an N500D dividing network, has a crossover point of 500 cps providing the A7-500 system with a smooth effective frequency range from 35



to 22,000 cps. The low crossover frequency plus the long length of the 511B horn allows good control of the beam width in addition to providing smooth reproduction of low mid-frequency signals. The large size of the horn also permits a much greater dominance of direct versus reverberant sound, especially desirable in public-address and sound-reinforcement applications. Low frequencies are reproduced in the new system by the high-compliance Altec 803B loudspeaker mounted on an exponential horn to provide good coupling and efficiency. The rear of the low-frequency driver is loaded by a bass-reflex enclosure, providing optimum performance of each. The cabinet is heavily constructed, fully braced, and has true exponential configuration. The A7-500 weighing 142 pounds is priced at $315.00. Altec Lansing Corp., 1515 S. Manchester Ave., Anaheim, Calif. **F-1**

• **Record Cleaner.** The manual "Parastat" by Cecil E. Watts of England, and distributed in the United States by Elpa Marketing Industries, is one of the senior record-cleaning machines from Mr. Watts. It is

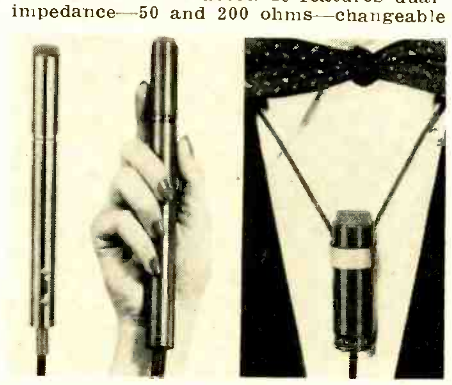


intended to get out the deep-down dust and grit from the record groove. It comes complete with cleaning brush and anti-static fluid. Elpa Marketing Industries, New Hyde Park, N. Y. **F-2**

• **Stereo Tuner-Amplifier.** H. H. Scott, Inc. announces the introduction of their new Model 340B FM-stereo tuner-amplifier. This single compact unit combines the FM performance of Scott's 350 FM stereo tuner with the power and control flexibility of Scott's 299 stereo amplifier. The 340B features new panel styling, slide-rule tuning, convenient front-panel earphone receptacle, and "Auto-Sensor" circuitry which automatically switches to stereophonic or monophonic mode of operation depending on which type of broadcast is

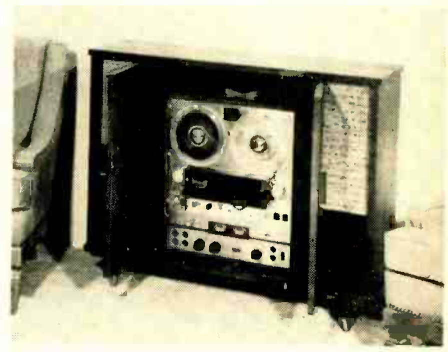
being received. Operating in conjunction with the "Auto-Sensor" is a signal which lights when stereo is being received, and is automatically extinguished when "Auto-Sensor" switches to monophonic mode. Additional features include: Precision illuminated d'Arsonval meter for pinpoint tuning of all signals; powered third channel for direct connection of remote speakers or for a three-channel system; complete tape monitoring facilities. The 340B carries an audiophile net price of $399.95. For further information on the new 340B 70-watt tuner-amplifier, write to H. H. Scott Inc., Dept. P, 111 Powdermill Road, Maynard, Mass. **F-3**

• **Ultra-Slim Probe Microphone.** Three ultra-slim, ¾-in. diameter dynamic microphones have been introduced by Shure Brothers, Inc., Evanston, Illinois. Two of the new ultra-slim dynamics, the Model 576 (center in photo) and Model 570 (right in photo), are specially designed to meet the critical requirements of professional studio and broadcast use. The Model 576 is an omni-directional probe, ideal for television use and wherever an inconspicuous microphone is an asset. It features dual-impedance—50 and 200 ohms—changeable



by moving pinjacks inside the case. Frequency response is 40–20,000 cps and output −60 db. Its case is finished in nonreflecting gray. Its companion entry in the broadcast field is the Model 570, a dynamic lavalier microphone, of small size (only 2½-in. long) and light weight (2 ounces). User net price of the Model 576 is $105.00. The Model 570 lavalier is $57.00 (user net), complete with "Flex-Grip" lavalier assembly and 30 feet of two-conductor shielded cable attached. Rounding off the ultra-slims is the Model 578 "Omnidyne" (left in photo) a top quality, rugged PA model. It is available with choice of 200-ohm or high impedance. Also a feature is an on-off switch and optional cover plate to lock switch in "on" position. User net price of this model is $49.50. Shure Brothers Inc., 222 Hartrey St., Evanston, Ill. **F-4**

• **Professional Stereo Tape Machine.** The Freeman Model 200 stereo tape recorder offers professional equipment in a consumer-sized package. The 200 is transistorized, has three motors, and is a 4-track stereo and mono record play instrument. It has a fully automatic continuous-play deck and preamplifiers with monitor speakers and automatic reverse play. In addition to the hysteresis-synchronous capstan motor, the 200 has two variable speed induction reel drive motors. Other features are: Automatic shutoff in manual



modes; four double-shielded broadcast-quality heads with playback "off-the-tape" monitor while recording; four-channel mixer with four input-level controls; 100 per cent semiconductor military specification electronics; 600-ohm balanced-line cathode-follower outputs plus built-in monitor speakers; stereophone jacks; wave traps for fully professional stereo multiplex recording; two 5-lb. roller bearing flutter filters and 10-lb. flywheel; professional "touch button" function selection. Freeman Electronics, 729 N. Highland Ave., Los Angeles 38, Calif. **F-5**

• **Electronic Organ Kit.** Newest in a line of 14 kit organs, ranging from single to three manuals, the "York" with "theatre" style horseshoe console is designed for the apartment or home where space is limited. Although compact, it has features found only in larger organs—two full-size 61-note manuals, 25-note pedal keyboard, dual expression pedals and 40 multi-colored stop tabs. It can be purchased in a complete kit or in smaller component kits. The component kits consist of tone generators (one octave of generators comprises

one kit), tone changers, pedal keyboard, manuals, and console. There are optional accessory items such as, chimes, Band Box, Glockenspeil, speakers, and amplifiers. The "York" can be played through the customer's mono or stereo audio system or optional audio components are available. Price is $2250. Artisan Organs, Dept. A, 2476 No. Lake Ave., Altadena, Calif. **F-6**

● **Transistorized Stereo Tape Deck.** A new four-track stereo tape deck for use with component high fidelity equipment has been introduced by Concord Electronics Corporation. The new deck features monitor power amplifiers and transistor preamps. The unit is available in two separate packages: 1. The Model 550-D with chrome trim for horizontal mounting in custom cabinets, and 2. The 550-DW self-contained in its own decorator-styled, solid walnut cabinet. The transistor circuitry of the 550-D and 550-DW provides good signal-to-noise ratio. The accessory power amplifiers of the units allow monitoring of recordings directly from the deck through stereo earphones or speakers. They will also drive a pair of accessory

speakers to provide stereo sound in another room of the house, apart from the main component system. A special accessory jack panel permits direct connection of microphones or stereo earphones without the necessity for special adaptors when the jack panel on the side of the deck cannot be conveniently reached in a cabinet mounting. The accessory jack panel may be connected to the deck and mounted conveniently in the same cabinet. The Models 550-D and 550-DW include pushbutton interlocked controls, three speed with automatic equalization, tone control and two VU meters. The 550-DW is priced under $300 and the 550-D is priced under $230. Concord Electronics Corp., 809 N. Cahuenga Blvd., Los Angeles 38, Calif. **F-7**

● **150-Watt Stereo Power Amplifier.** A new laboratory-standard stereophonic power amplifier, with more than enough power to drive any combination of speakers in almost any room under any listening condition, has been made available by the Fisher Radio Corporation. The new power amplifier, the Fisher SA-1000, Offers 150 watts music power (IHF) and 130-watt rms. An interesting design element, the

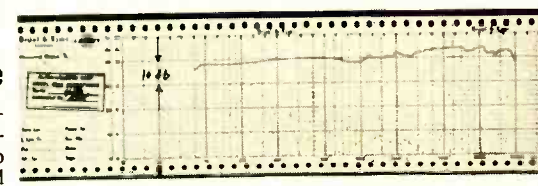
Fisher hinged control cover, has been incorporated to enhance the visual appeal of the SA-1000. In this design, everyday controls—those that must be used to assure operation—are in full view. Occasionally-used controls remain concealed behind the control cover but are instantly accessible when needed. The Fisher SA-1000 stereophonic power amplifier retails for $329.50. Fisher Radio Corp., 21-21 44th Drive, L.I.C. 1, N. Y. **F-8**

This advertisement is reprinted from JOURNAL OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS *and* JOURNAL OF THE AUDIO ENGINEERING SOCIETY *for the benefit of* AUDIO *readers seriously engaged in quality microphone applications.*

The superiority of new Altec Dynamic Microphones is all the more amazing when you discover their moderate price!

There are six dynamic microphones in Altec's new professional studio series. Each sets new standards of performance and durability in its class. Each offers distinctive features of significant value to the professional user, especially since the highest price model is yours for under $100.00! Let's take a look at some of these features:

PROOF of Superior Performance



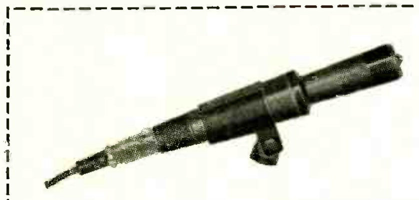
Each Altec 684A Omnidirectional and 685A Cardioid Microphone comes to you with its own certified calibration curve made on a Bruel & Kjaer Graphic Recorder. *In the entire professional field, this practice is unique with Altec.* The one shown here is typical of the 684A. The curve you receive gives visual proof of the remarkably smooth response provided by your Altec Microphone.

BALANCED PAIRS FOR STEREO: For stereo work, any pair of 684A or 685A Microphones is perfectly matched in performance characteristics. The calibration curves offer rapid means of assuring yourself of this balance.

DESIGNED FOR RIGOROUS PROFESSIONAL USAGE: *The exclusive sintered bronze filter* positively bars all foreign matter. These Altec Microphones may be used safely in any situation the professional engineer finds himself; not only in a protected studio, but anywhere – a metals grinding mill if need be. Only Altec offers this absolute protection against the gradual degradation of quality common in ordinary microphones that can't prevent dust, moisture, and minute ferrous particles from restricting diaphragm movement.

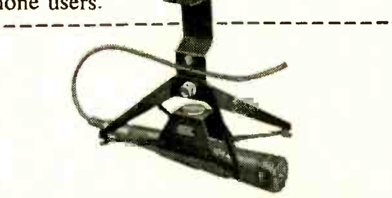
Also featured are *diaphragms of indestructible* polyester that cannot be damaged by blasts, shock, impact – designed specifically for rigorous usage in any professional applications.

EXCLUSIVE ALTEC MICROPHONE EXCHANGE POLICY: After expiration of normal full year guarantee, you may exchange an inoperative microphone for a comparable new unit at a fraction of original cost. This Altec policy is unique in the industry; offered to better serve microphone users.



ALTEC 684A OMNIDIRECTIONAL MICROPHONE

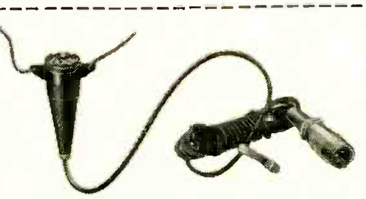
Frequency Response: 35 to 20,000 cycles • Output Impedance: 30/50, 150/250, 20,000 ohms • Output Level: –55 dbm/10 dynes/cm² • Hum: –120 db (Ref.: 10⁻³ Gauss) Price: $78.00 net



ALTEC 685A CARDIOID MICROPHONE

SHOWN IN ALTEC 181A BOOM MOUNT

Frequency Response: 40 to 16,000 cycles • Output Impedance: 30/50, 150/250, 20,000 ohms • Output Level: –54 dbm/10 dynes/cm² • Discrimination: Average front-to-back, 20 db • Hum: –120 db (Ref.: 10⁻³ Gauss) Price $96.00 net



ALTEC 686A LAVALIER MICROPHONE

Frequency Response: 70 to 20,000 cycles • Output Impedance: 30/50, 150/250 ohms • Output Level: –55 dbm/10 dynes/cm² • Hum: –120 db (Ref.: 10⁻³ Gauss) Price: $45.00 net

For specific engineering details, call your nearest Altec Distributor (listed in your Yellow Pages) or write Dept. AM6

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NEW LITERATURE

• **Guide to AM, FM, and TV Broadcasting Stations.** A comprehensive, up-to-date, radio-TV station guide has just been introduced by Howard W. Sams & Co., Inc. Prepared by Vane A. Jones, known for his three previous editions, this new volume contains over 7500 broadcast station listings, including 5000 AM and 1500 FM radio stations by city, state, and frequency; and nearly 1000 TV stations (both UHF and VHF). "North American Radio TV Station Guide," 1963 edition, lists the call letters, frequency, power, and network affiliation for all stations now operating those which are scheduled to begin operation within the year, and those which are temporarily off the air in the U.S. and its possessions, Canada, Cuba, Mexico, and the West Indies. This is the only volume containing a complete alphabetical listing of AM-FM and TV station call letters in one integrated list—invaluable for anyone who wishes to determine whether a certain station in AM, FM, or TV. Also included is the only listing of FM stations by frequency, showing the effective radiated power and antenna height. A special feature of the book, of particular interest to radio engineers, is the 14 two-page maps—one for each of the 12 VHF TV channels, one for all UHF channels, and another showing the location of all FM stations. The books is available from electronic parts distributors and bookstores throughout the country, or from Howard W. Sams & Co., Inc., Indianapolis 6, Indiana. List Price is $1.95.

• **Guide To Custom Stereo.** H. H. Scott announces the 1963 edition of their Guide to Custom Stereo. The new edition is twenty pages in length and includes many illustrations, some in full color, of high fidelity component systems. There is a section describing what high fidelity is and how it works. There are special tips on how to install components and the kind of cabinetry to use. There is a complete section explaining how the new FM-stereo works, a picture guide to wired components and speakers, and a section explaining the meaning of technical specifications. Copies of this new Guide to Custom Stereo are available free by writing to H. H. Scott, Inc., Department P, 111 Powdermill Road, Maynard, Mass. **F-9**

• **Microphone Catalog.** The American Microphone Company 1963 Product Directory is now available. The new catalog contains detailed application and specification information on the complete American line of microphones and accessories, which cover every audio requirement. The six-page brochure is the first catalog published under the company's new ownership. Included are sections on broadcast and professional microphones, units for high quality public address, advanced amateur recording, industrial sound, mobile radio, language laboratory, as well as general purpose microphones. According to George Riley, vice-president and general manager, the catalog is arranged for easy use, so that the user can immediately locate a microphone suitable to his needs and budget. Copies of this 1963 Product Directory are available free on request from American Microphone Company, First and George Sts., Galien, Mich. **F-10**

• **Portable Tape Recorder Booklet.** Freeman Electronics Corporation has prepared a 24-page booklet on portable tape recorders and their uses as well as technical data on the company's Models 550 and 660 high-fidelity portable units and the accessory equipment available for these tape recorders. The booklet details information on microphones and how to select them for specific uses, recording tricks, 25 valuable uses of a portable tape recorder, maintenance and operating hints, and other data pertinent to both prospective and present owners of tape recorders. The booklet is priced at 50 cents and is available from the Freeman Electronics Corp., 729 N. Highland Avenue, Los Angeles 38, Calif.

FREQUENCY RESPONSE USING OSCILLOSCOPE

(*from page 34*)

deg., since the tangent of 44.5 deg. is close to 0.98. See Table I for some of the most useful values of these relations.

Phase Shift Test

One further very interesting test may be performed with this equipment. This is the test of amplifier phase shift. It is performed as follows: Phase shift in an amplifier often shows up at a frequency near that at which the response begins to drop off, and with the equipment set up as described, phase shift is indicated when the 'scope trace splits from a line to an ellipse. The angle this ellipse makes with the reference is a bit harder to read than that of a line, but with care, it can be done. To check the phase-shift angle quantitatively, the 'scope amplifier controls are readjusted so that the long axis of the ellipse is again at 45 deg. Then the ratio of the short axis of the ellipse to the long axis (see *Fig.* 2) is proportional to the angle of phase shift, the ratio being zero for zero shift (a line rather than an ellipse) and one for 90-deg. phase shift (the ellipse opening out to a circle). Thus the phase shift angle ϕ, may be determined from the simple formula

$$\phi = \frac{r}{R} \times 90 \text{ deg.}$$

This formula is accurate within one degree from zero to 70 deg., and within 5 degrees over the whole range. The complete theory of this method of phase-shift measurement is given in an article by Wischmeyer and Pfeiffer[1], together with a method for making the measurement accurate to one degree over the entire range from zero to 90 deg. Æ

[1] *Review of Scientific Instruments*, Vol. 25, Pg. 41, (Jan. 1954).

CLASS D AMPLIFIERS

(*from page 30*)

off this article with a description of K. C. Johnson's circuit. The circuit itself is shown as *Fig.* 12. Two kinds of transistor are used, a p-n-p and its complementary n-p-n. I have data only on the n-p-n, although they are probably pretty similar, and it has an 8-mc alpha cut-off, a dissipation limit of 150 mW and a minimum beta of 25. The power available from this amplifier is stated to be more than 1 watt and Mr. Johnson drives it from an ordinary crystal pickup.

The inductance at the output, L_1, provides the low-pass filtering effect. The characteristic frequency of $\omega_0 = R/L = 30{,}000$, or 5000 cps, gives compensation for the recording pre-emphasis and also offers about 20 db attenuation to the 50-kc switching frequency. Mr. Johnson has a long loudspeaker cable, which will increase this attenuation, but he does not tell us whether he keeps dogs. You may remember that they can hear some ultrasonic frequencies and I just do not know how a system of this kind will affect them.

The heart of the circuit is the Miller integrator, V_1. This is fed by the audio signal, through R_1, and by the square wave itself through R_2. We must assume that the circuit is already working and that we look at it the moment of switch-over. Current flows into the integrator and the collector moves at a speed which is modified by the audio input current. When it has moved far enough it affects the bias on V_2, which forms, with V_3, a d.c. multivibrator. You can see the cross-couplings from collector to base. When V_2 is urged, the circuit trips over, and the values are such that V_3 is either full on or full off. Through C_5 the output of V_3 can drive the output transistors V_4 and V_5 in a normal complementary half-bridge circuit. The capacitance C_6 and the diode D_1 are used in a bootstrap circuit to generate a floating power supply for V_3 which increases the drive to V_4 and V_5.

The capacitor C_1 settles the frequency and it is recommended that it should be about 50 kc. R_{15} is needed to assist in starting.

When there is no input signal the circuit must set itself to give a 50 : 50 mark/space ratio, because if it does not the capacitors C_7 and C_8 will be charged by the unbalance and will feed back through R_2 to modify the ratio. We must, therefore, have this floating center-point. Since the system is an amplifier we can regard the pair of resistances R_1 and R_2 as the gain defining pair of a negative feedback system, with their junction as a virtual ground. The voltage gain is 33.

I have summarized the description of this circuit in order to help those of you who propose to try it. But this is by no means the same mode of operation as that discussed by Mr. Birt, for both edges of the pulses are modulated. This has some rather important consequences which must be considered next, when the detail of systems of this general kind is reviewed.

Both Mr. Birt and Mr. Johnson convert their audio signals into length-modulated pulses. If we choose to use pulse frequency modulation we have a source of audio signal available in the ordinary FM transmissions. One method for producing a really high quality discriminator is the pulse counter or diode pump circuit. Let us think about this kind of circuit in the language we have just been using: this gives me a chance to remind you how the circuit operates. The incoming signal is handled quite normally except that the intermediate frequency of the receiver is around 150–200 kc. Generally this is, in fact, a second i.f., and much of the i.f. gain is at the usual ten megacycles odd. At this low i.f. we limit really hard, to get a square wave. This is differentiated, and half the resulting wave-form is clipped by a diode. We now have a train of pulses of standard size but variable density.

A conventional discriminator of this kind does its low-pass filtering before the audio amplifier but there is absolutely no reason why we should not standardize the length of the pulses and amplify them as pulses all the way through to the output.

We will discuss this further in the near future. Æ

NOTES

[1] Institute of Elect. Engrs., Paper No. 309 E, Apr. 1960 (106 B, 1285).

[2] Fitch, "The spectrum of modulated pulses," *J. Inst. Elec. Engrs.*, Vol. 94 part IIIA, 1947; pages 556–564.

See also H. S. Black, "Modulation Theory."

[3] P. J. Baxandall, "Transistor sine-wave LC oscillators," Institute of Elec. Engrs., Paper No. 2978 E, Feb. 1960 [106 B 748 (1959)].

ELECTRONIC SIMULATION OF ORGAN SOUNDS

(*from page 23*)

question of suitable loudspeaker systems for the ideal electronic organ.

There is probably more room for improvement in this area of electronic organ technology than any other. In sound reproduction we have worked long and hard to produce loudspeakers which do exactly what they're told by the electrical system. Such well-behaved paragons have little place in the *generation* of musical sound. With tone-generators so limited in versatility compared to pipes, much can be done by selecting and designing loudspeaker systems which enhance the desired effect and introduce color of their own.

One important characteristic of organ sound is its "bigness." This arises from the fact that nowhere in the radiating system, except possibly at the mouth of a high-pressure reed pipe, is there a particularly loud sound. There are just a lot of small ones all at once. Furthermore, there is no intermodulation at all.

There are many inexpensive loudspeakers which cut off rather sharpy at 5000 cps or so, just like large-scale diapasons do. Although a single speaker per note might be overdoing it a bit, I do feel that one speaker per octave or two is most desirable. Furthermore, they should be physically spaced a few feet apart, as octaves of pipes are, to enhance the space distribution needed to break up the artificial nature of the usual loudspeaker tone. The low-fidelity speakers do well for diapasons and flutes, but extended-range speakers should be used for string stops. The slight sizzling usually heard with the less-expensive varieties of wide-range speakers does wonders for recreating such sounds with a high degree of realism.

For the reeds, I feel that the loudspeaker array can suggest the actual conditions which exist in the pipe organ. The most successful such units I have built have made use of metal-diaphragm compression drivers coupled directly to straight exponential horns. The best horns are the bells of brass instruments, which seem to impart a deliciously lifelike quality to the sound. They are required in lengths ranging from eight feet for the sixteen-foot reeds down to one foot or so. Beside sounding best, they look quite spectacular when mounted horizontally (*en chamade*), facing the audience.

In passing it is interesting to note that it is getting more difficult to find speakers with "personality" for organ radiators. The time may come when some of the old "bad" techniques for making loudspeakers may be resurrected for organ use. Let me emphasize that speakers which color the sound are desirable only when there are many of them, of several different types. They should be mounted so as to cover a wide area, but they should be in a coherent group. The practice of mounting speakers for an electronic organ all over an auditorium is no different from providing a PA system for a pipe organ.

All of the foregoing takes a lot of amplifiers, but they can be small ones. A large number of ten-watt power amplifiers operating from a large common power supply need not be much more expensive than the few high-power amplifiers now commonly used. Advantages in balancing the organ are obvious. The pedal loudspeakers and amplifiers must be quite large, but again the load should be distributed among many speakers.

This technique, well carried out, will surpass the usual moving-loudspeaker or other organ-type tone cabinets for realism and beauty of sound. Even so, in buildings which lack reverberation, *any organ* should be provided with artificial reverberation. Music for the instrument has been composed with reverberation very much in the mind of the composer. The sound of any of the great works of Bach with the reverberation removed is quite disappointing.

Happily, much good work is being done today in this area with much promise for the future. Again my approach is to suggest the multiple application of the least expensive coil-spring reverberator. The comb-like frequency response of a single unit can be made quite tolerable if it is combined with the sounds of others having slightly different peak frequencies. Furthermore, artificial reverberation should be used with discretion.

To sum up: The key to organ simulation is multiplicity and variety in tone generation, both as to waveform and attack characteristics; in type, number, and spacing of loudspeakers; and in the production of artificial reverberation. Æ

EQUIPMENT PROFILE

(*from page 45*)

friction viscous-damped Teflon thrust washers—damping being provided by a lifetime fluid. When correctly balanced and adjusted for the proper stylus force, the arm may be dropped from above the record and it will float slowly downward with no sideways drift. The mounting base is molded of solid rubber and mounts with three screws—machine screws on a metal motor board and wood screws on a wooden one. At each screw is a rubber projection which serves as a foot for the base, and being compressible permits leveling of the arm on any turntable surface. The counterweight assembly is under the metal plate at the rear of the arm, and is adjustable by a screw at the rear.

The pickup cartridge is mounted on a shell which plugs into the end of the arm, making the necessary electrical connections with mechanical firmness. Two pairs of threaded holes permit of mounting of any standard cartridge in the proper position. An integral lift is part of the shell. The assembly is completed with a moulded rubber arm rest which mounts with a grommet-like foot into a ⅜-in. hole. For higher than normal turntables, a rubber spacing ring is furnished.

In operation, the MT-66 Universal Arm performed delightfully, and exhibited no resonance down to 10 cps, used with two different types of cartridges interchangeably—easy because two plug-in shells are furnished. The viscous effect is desirable for heavy-fingered users, since it eliminates the risk of record damage from inept handling. Add to the performance the beauty of design, and one ends up with a most attractive and efficient phono arm. **F-20**

SHURE MODEL M99 SERIES "GARD-A-MATIC" CARTRIDGES

The M99 series of cartridges are three in number—M99/A for the Garrard Model A automatic turntable, M99/AT6 for the Garrard AT6 automatic turntable, and more recently, the M99/M10 for use on the Miracord models. All three offer unprecedented record and stylus protection in that it is impossible to bottom the stylus in the cartridge.

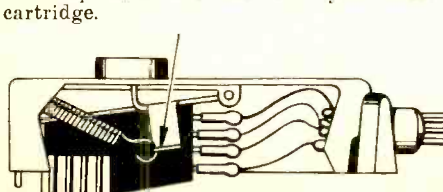


Fig. 5. Cutaway view of the Shure Gard-A-Matic series of cartridges.

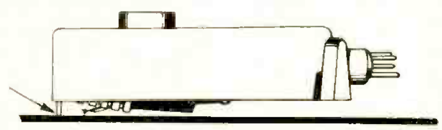


Fig. 6. Retracted position of the cartridge, showing shell protrusion resting on record surface.

Figure 5 shows a cross section of the construction of the Gard-A-Matic unit. The cartridge is mounted on a hinged carrier which is supported by two coil springs, one on either side of the cartridge, the arrow pointing to the connector for the spring. Instead, therefore, of being dependent on the arm springing, the cartridge is entirely dependent on the internal spring which is designed for approximately 3 grams of stylus force. Any force on the arm greater than 3 grams causes the cartridge to retract into the shell so that a protrusion on the front of the shall (shown by the arrow in *Fig.* 6 thus rests on the surface of the record, preventing any damage to the stylus in the first place, and—because of the width of the protrusion and its inherent smoothness—any damage to the record grooves.

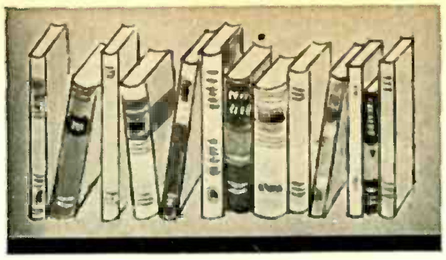
The cartridge itself is a moving-magnet unit of the usual Shure quality. The entire stylus assembly slides in or out for easy and "toolless" replacement. Stylus compliance is claimed to be 20×10^{-6} cm/dyne, and measured output at 1000 cps and a velocity of 3.54 cm/sec was 4.15 and 4.10 mv respectively, well under 0.5 db difference. Response, measured from Columbia STR-100 test record, was essentially flat from 40 to 20,000 cps, with a 2-db rise in the range of 13,000 cps and a gradual falling off after that.

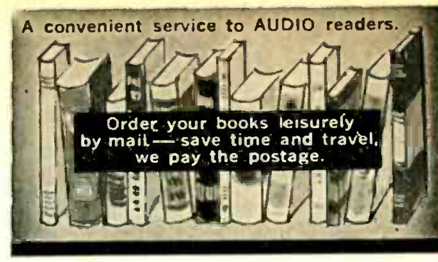
By inspection, it was noted that the stylus actually bottoms in the cartridge with a force of 10 to 12 grams, easily reached by inadvertent downward pressure on the arm. Since the cartridge retracts with any force over 3 grams, it is not possible to bottom the stylus on the record. And the great advantage is not to the record—after all, records are less expensive than cartridges, or even replacement stylus assemblies. But with the recognized acceptance of the Shure cartridges, the additional protection afforded by the Gard-A-Matic series makes it a good investment for the automatic turntable user. **F-21**

LIGHT LISTENING

(*from page 8*)

singing styles of Marlene Dietrich and Lotte Lenya. Miss Brown is on less secure ground the moment she takes on the straight ballads Weill wrote for his famous American productions. *September Song, My Ship* and *Speak Low* could use a far less mannered delivery than they receive here. Æ





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Jeff Markel

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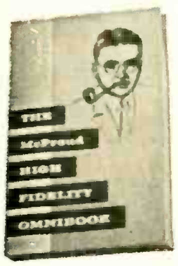

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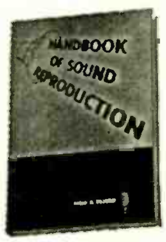

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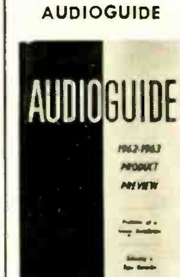

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No. 251 $4.25

FULL-RANGE ELECTROSTATIC SPEAKER

(*from page 20*)

enclosure. Do not place it too near to a wall (no closer than four inches). The sound emanating from it is best when the membrane can move freely.

The Amplifier

The schematic is given in *Fig.* 12. It should be noted that other amplifiers might also do under certain conditions, but the main advantage of this one is that it provides sufficient audio voltage without the use of a step-up transformer. The author has found it impossible to design a step-up transformer capable of producing 2000-volts audio peak voltage over the entire audible frequency band without considerable phase and harmonic distortion, as well as poor transient response. The audio voltage is first amplified by V_{1A}. One-tenth volt is enough to drive it to full output. The negative feedback loop P_1–C_1 serves to boost the output voltage below 130 cps. This loop is necessary only with a speaker length of under two yards. The signal is then split up in the phase inverter, V_{1B}, and fed through the driver, $V_{2A,B}$, into the grids of the final. So far, it is rather conventional. The signal then goes directly into the speakers. The feedback loop actually consists of the voltage dividers, R_1 and R_2, fed through C_7 back into the cathode of the driver, and R_{11}, R_{22} and C_8, respectively. Resistors R_1 and R_{11} each consist of five 50,000-ohm 2-watt units. The author has mounted the entire feedback network R_1, R_2, R_{11}, R_{22}, C_7, and C_8 on one terminal board, above the chassis. The resistors near the plates of the finals do handle very high voltages. Keep them far from the input wiring, and especially far from your fingers!!! The negative feedback is about 26 db. The choke, Ch_1, only serves to supply the finals with d.c., as they operate in pure A1 amplification. It needs only high reactance at low frequencies (200 Hy will give enough). Of course, the insulation must withstand up to 2400 volts peak-to-ground for each half of the winding. For best symmetry it should be wound on two discs. The iron core need not be of highest quality, because, as we mentioned before, the amplifier works class A1, and thus every output tube provides its full half of the cycle.

Some notes on the power amplifier tubes. They are in reality nearly voltage amplifiers, because the electrostatic speakers have such a high efficiency that you need mainly voltage to drive them. For this reason the tubes work with 1200 volts on the plates. New sets of operating conditions had to be designed for the purpose. At the suggested plate voltage (the screens are at 150 volts, regulated), a negative bias of 17 volts is required to measure 20 mA at the cathodes of each 807. As the applied plate voltage varies with different power transformers and rectifiers, it is wise to adjust R_3 and R_{33} at the cathodes to the right value while measuring the cathode current with a milliammeter. Both tubes should draw the same current. The 807, now sometimes called QE 06/50, should be of newer production, because war-surplus types may contain too much gas for such high plate voltage. Newer types work correctly even at more than 2000 volts. In any case the product of plate voltage and cathode current should not exceed 24 watts. The amplifier is designed to feed the impedance of one to three yards of speaker length. It is clear enough that proper phasing between the speaker elements is of importance here, too.

Power Supply

The power transformer secondary may range from 1000 to 1400 volts (for example 500–0–500). Although the amplifier only draws 60 mA altogether, the winding must permit a current of at least double that amount, because in this circuit it must provide all the required power in only one half of the cycle. A full-wave doubler could be used with success, but then one would need a voltage source of about 1200 volts a.c. to feed the voltage doublers, D_7 and D_8, which provide the necessary high negative bias to the membrane. The one-megohm bias resistor should be placed close to the membrane of the individual speaker. Diodes D_1 through D_6 first load up the three electrolytic capacitors in series. This is less expensive than oil-filled capacitors, and smaller, too. The three resistors in parallel to them help to divide the plate voltage equally between them. From here we also take the plate voltage for the preamplifier tubes, through R_4. As soon as the voltage across the loading capacitors exceeds 450 volts, the three voltage regulator tubes, VR 150/30, ignite, and provide the screens of the 807's with the necessary 150 volts, and through the RC ripple filter, the entire preamplifier. If you use other than 1200 volts on the plate of the 807, you should calculate a new value for R_4, in order to keep the current through the VR-tubes near 20 mA.

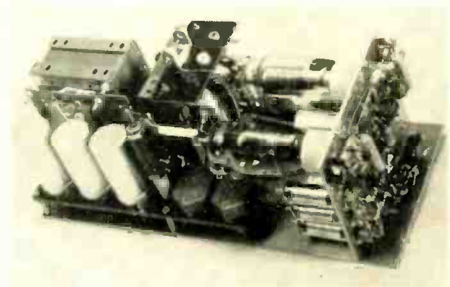

Fig. 13. View of the complete amplifier.

I thank Mr. Fais for much preliminary work and also for the photography. Æ

NOTE

The author obtained the large printed circuit boards, the spacers, and the polyester membrane from Interest, Wilhelmstrasse 4, Heidelberg, Germany.

LETTERS

(*from page 12*)

3. *Measurement of second harmonic distortion.* This is a basic measurement, because with single-frequency waves tracking errors cause mainly a second harmonic distortion. Unfortunately tracing distortion and pickup non-linearities also introduce second harmonic. With pickups having sufficiently low tracking angle we can adjust the vertical orientation with respect to a suitable test record until the second harmonic is at a minimum and this will indicate that the vertical tracking error is zero. At this point we know that the vertical tracking angle of the pickup is equal to the effective vertical recorded angle of the record, but not its actual value, unless the record has been previously calibrated. An absolute determination of the tracking angle is made by plotting distortion, *B*, versus the pickup angle, with the record played in the forward and backward modes whereby the vertical recorded angle is first subtracted and then added to the vertical tracking angle. The resulting curves provides enough information to determine both the angle of the pickup and the record, as described in my AUDIO article, and in more detail in the EIA papers.

4. *Measurement of Intermodulation.* The technique used with second harmonic measurements is applicable to IM measurements. IM measurements have the advantage of being simple to make with an IM meter, while second harmonic measurements require frequent careful retuning of the wave analyzer. Additionally, IM measurements are indicative of interrelationships between high and low frequencies, which is an important consideration.

Summarizing our studies of vertical recorded angle, the measurement of the Sarcophagus pattern provides the least quantitative reliability, and the measurements of intermodulation *versus* angular pickup displacement appears to be the most reliable method. The IM bands of CBS Laboratories STR-111 record were calibrated by all the above methods and determined to have a vertical modulation slant (effective vertical recorded angle) of 15 deg. Thus the STR-111 record is a convenient tool for measuring effective vertical tracking angles of pickups.

While our original work on vertical tracking improvement was carried out with the Westrex 3C recorder, recent study of records produced with three other makes of cutters have convinced us that they too must be suitably tilted to produce a 15 deg. vertical recorded angle.

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FOR SALE: Ampex stereo head assembly for 351-2. Two-track erase, record and playback heads. $275. Condition: like new. J. M. Edelman, M.D., 4550 North Blvd., Baton Rouge, La.

SALE: Two 15CW University woofers. (Sorry, no shipping.) Beling, 4484 30th Street, San Diego 16, California. AT 2-8414.

WANTED: ESL C60 or P60 cartridge. New or excellent condition; reasonable. Write W. E. Irvin, 3477 E. 65th St., Cleveland 27, Ohio.

WANTED: Used Ampex MX 35 mixer. Also audio gear suitable for use in recording studio. Richard Miles, 131 Farrington St., Wollaston 70, Mass.

HARPSICHORD. Same as owned by Philadelphia Orchestra and RCA Victor. In kit form for home workshop assembly, $150. Clavichord kit, $100. Free brochure. Write: Zuckermann Harpsichords, Dept. R, 115 Christopher St., New York 14, N. Y.

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AUDIO from July, 1950, to Dec. 1962; *High Fidelity* from first issue to Feb. 1962. Excellent condition. No reasonable offer refused. Dana, Sagamore Road, Marblehead, Mass.

Industry Notes . . .

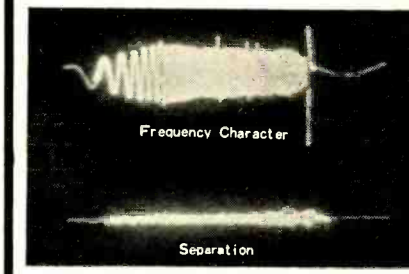
● **University To Move.** Some time before midyear, University will move its entire design, engineering, production, and electronic research operations into a 100,000-square-foot facility being built for it at Oklahoma City, Okla. University's distribution pattern will be improved by the move. An enlarged East Coast warehouse will be established in the New York area, thus enabling the company to continue the servicing of east-of-the-Rockies distribution with maximum speed, while improving its service to the Southwest and Pacific Coast areas via the Oklahoma City plant.

● **Bel Canto Sales Manager. George H. Duarte,** Export Manager for the Sound and Bel Canto Stereo Tape Divisions of Thompson Ramo Wooldridge, Inc., Columbus Ohio, has been appointed National Sales Manager of the Bel Canto Division, according to an announcement made by K. L. Bishop, Divisions General Manager. Duarte will continue to handle the export operations.

● **Audio Exchange Sponsors "Open End" of Hi-Fi Industry.** Audio Exchange, a retail hi-fi chain in the metropolitan New York area, is the sponsor of "The Audio Exchange Hi-Fi Workbench" over WNCN, Concert Network, every Saturday night, from 12–1 a.m. The program began on Jan. 5th, 1963. Each week a panel of guests discusses meaningful and controversial topics relating to the high-fidelity field. Martin Gersten, chief engineer at WNCN, Concert Network, is the moderator and host.

● **Bogen Names Hooper. William Hooper** of Van Nuys, Calif., has been named Regional Manager for Bogen products, it was announced today by **Harold A. Goldsmith,** President of Bogen Communications Division of Lear Siegler, Inc., Paramus, New Jersey. Mr. Hooper, who has 15 years experience in sound sales, was formerly Manager of the Sound Products Division of **Marshank Sales Co., Bogen** field representative for more than two decades. In his new post, he will coordinate with Marshank the sales of all Bogen products including high fidelity components, paging systems, intercoms and school systems.

ADVERTISING INDEX



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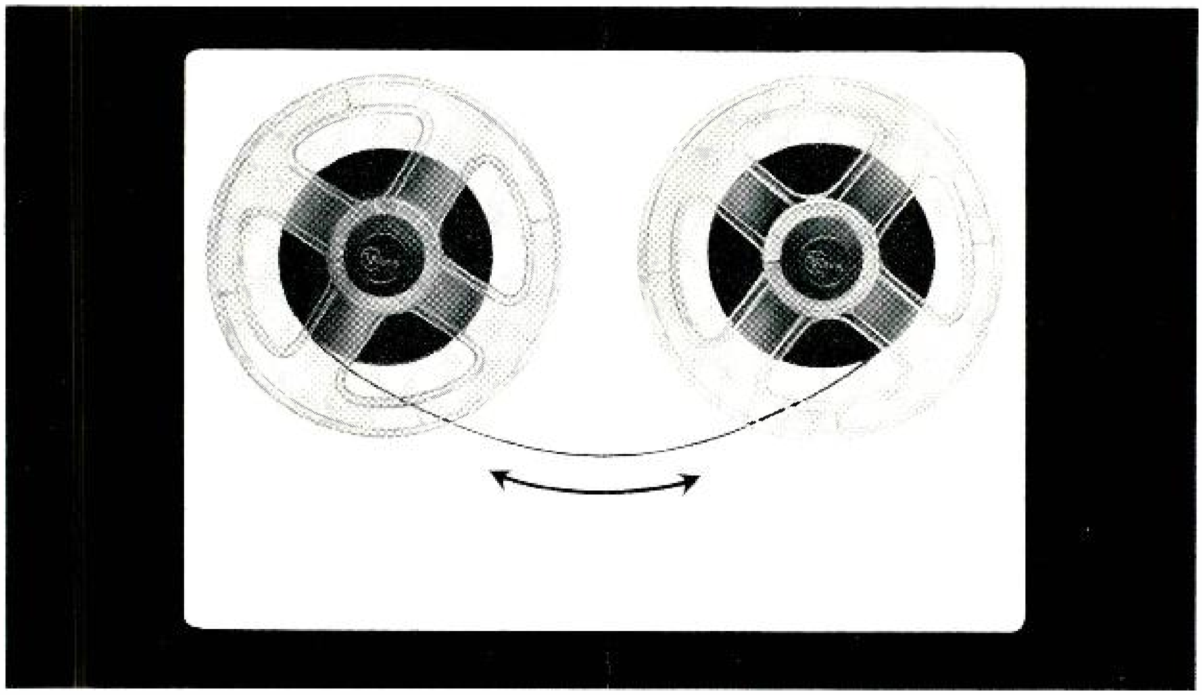

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OUTPUT, MUSIC SYSTEM: 1 volt per channel low impedance.

INPUT SENSITIVITY, LOW LEVEL: 1 MV, 1 megohm impedance.

INPUT SENSITIVITY, HIGH LEVEL: 100 MV for Music System, Tuner, etc.

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CAPSTAN DRIVE: Flutter-filter multiple belt drive. Dynamically balanced flywheel. Oilite bearings.

CAPSTAN DRIVE MOTOR: Hysteresis Synchronous 2 speed precision motor.

FLUTTER AND WOW: Less than 0.2% RMS at 7.5 IPS.

BRAKES: Solenoid-controlled differential braking.

REEL SIZE: 7 Inch maximum.

FAST FORWARD/REWIND TIME: 60 seconds for 1200 foot reel.

COUNTER: 3 digit decimal, resettable.

AC POWER REQUIREMENTS: 200 watt maximum, 110-120 VAC 60 cycles.

Ask your dealer for the Viking Retromatic 220 or write us for information.

Viking OF MINNEAPOLIS, INC.
9600 Aldrich Avenue South, Minneapolis 20, Minnesota

The Electro-Voice Model 642
Cardiline Microphone Earns

THE FIRST ACADEMY AWARD FOR MICROPHONE DESIGN IN 22 YEARS!

Today's movies, radio, TV and recordings sound better, thanks to a microphone design that has revolutionized sound pickup techniques. It is the Electro-Voice Model 642 Cardiline® ultra-directional microphone.

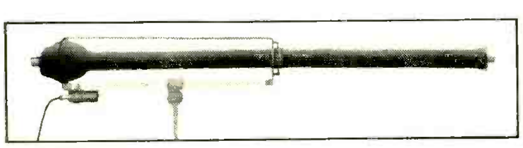
The E-V 642 has contributed so much to motion picture sound that on April 8, 1963 it was presented the coveted Academy Award certificate by the Academy of Motion Picture Arts and Sciences—the first such award to a microphone in 22 years!

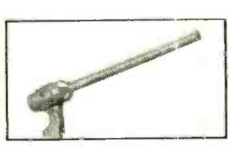
Film sound engineers found the unique 642 Cardiline design sharply reduced effects of noise and distance. They obtained clear, crisp sound under circumstances previously thought impossible.

The 642 is another major achievement by Electro-Voice in the art and science of electro-acoustics. This engineering leadership extends equally to professional and commercial sound, home high-fidelity recording and reproduction—even to phonograph needles and cartridges.

No matter what your interest in sound, look to Electro-Voice for the consistently superior engineering that means award-winning performance for you.

Model 642
$390.00 list





The E-V Cardiline* principle is also found in the famed 7-foot long E-V Model 643 ($1,560.00) and the popular Model 644 for critical commercial sound installations ($110.00.) All prices list, less normal trade discounts.

*T.M. Reg., Patents Applied For

Electro-Voice®

"ACADEMY AWARD-WINNING SOUND"

ELECTRO-VOICE, INC., Dept. 631A, Buchanan, Michigan
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