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STEREO
EQUIPMENT
& RECORD
REVIEWS

AUDIO

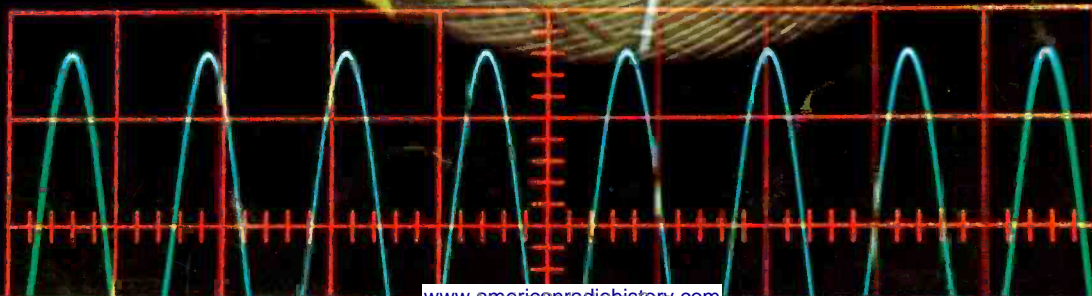
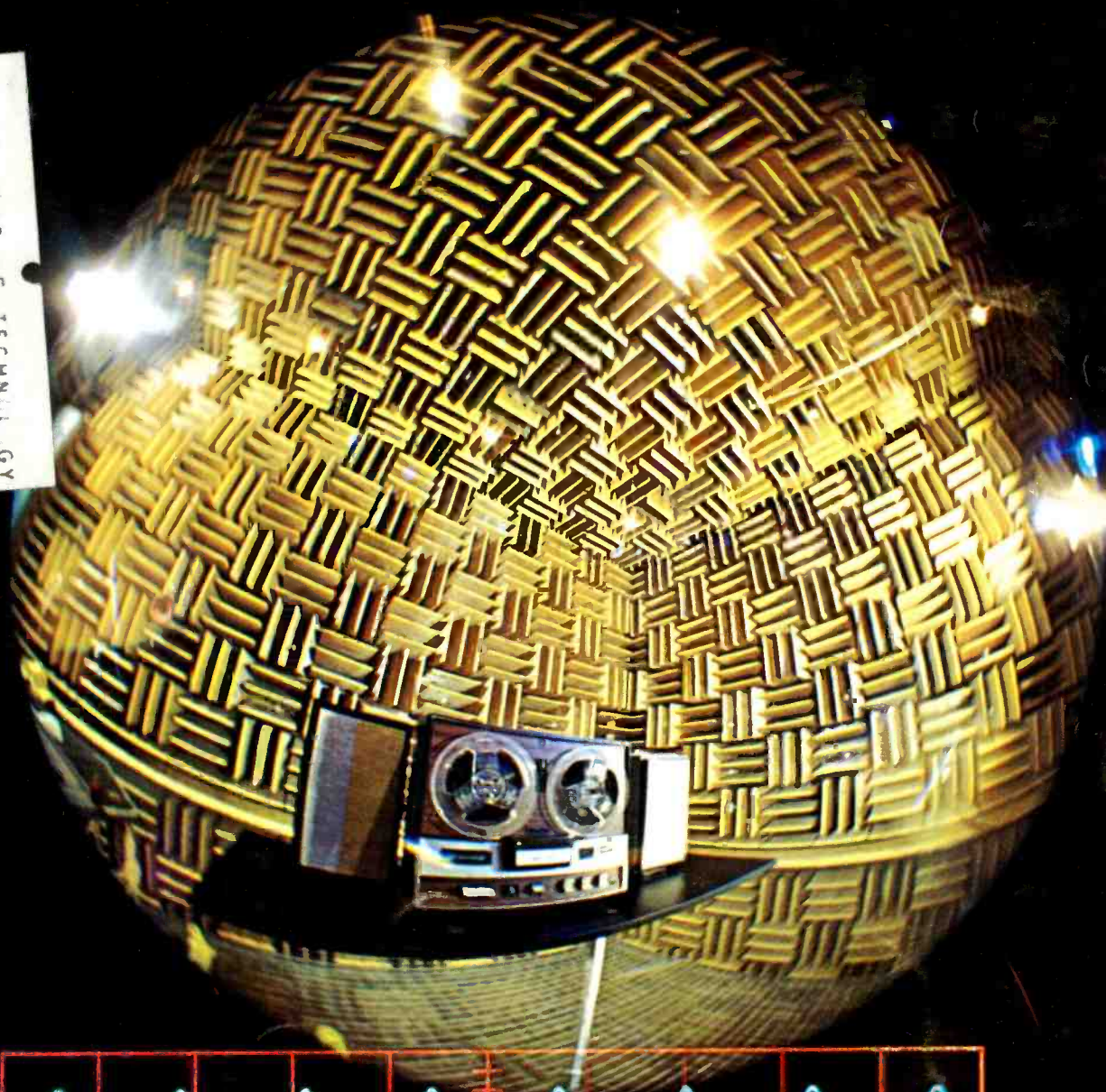
SEPTEMBER
1968 60¢

Cassette Tape:
Pros & Cons

Private FM
Music Channels

How Electronic
Organs Work

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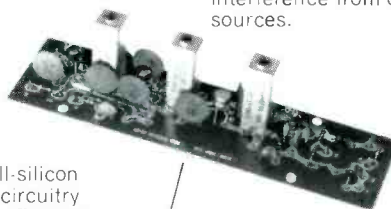
Scott Field Effect Transistor tone control circuitry gives you a wider range of control.



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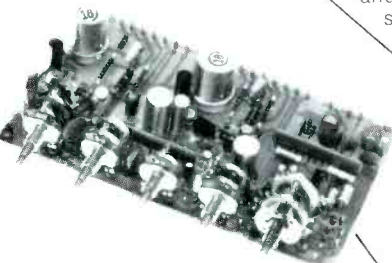
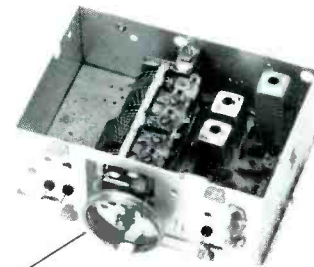
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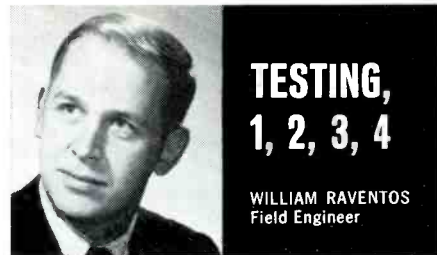
AUDIO (title registered U. S. Pat. Off.) is published monthly by North American Publishing Co., I. J. Borowsky, President; Roger Damio, Frank Nemeyer, C. G. McProud, and Arthur Sitzer, Vice Presidents. Subscription rates—U. S. Possessions, Canada, and Mexico, \$6.00 for one year; \$11.00 for two years; all other countries, \$7.00 per year. Printed in U.S.A. at Philadelphia, Pa. All rights reserved. Entire contents copyrighted 1968 by North American Publishing Co. Second class postage paid at Phila., Pa.

REGIONAL SALES OFFICES: Sanford L. Cahn, 663 Fifth Ave., New York, N. Y. 10022; (212) 753-8824. Louis Weber, 5201 N. Harlem Ave., Chicago, Ill. 60656; (312) 775-0755. Jay Martin, 9350 Wilshire Blvd., Beverly Hills, Calif.; (213) 273-1495.

REPRESENTATIVE: Warren Birkenhead, Inc., No. 25, 2-chome, Shiba Hamamatsu-cho, Minato-ku, Tokyo, Japan.

AUDIO Editorial and Publishing Offices, 134 N. 13th St., Philadelphia, Pa. 19107
Postmaster: Send Form 3579 to the above address.

Number 60 in a series of discussions
by Electro-Voice engineers

**TESTING,
1, 2, 3, 4**WILLIAM RAVENTOS
Field Engineer

Testing of microphones ordinarily takes two distinct forms: laboratory tests and field tests. The former is basically objective in nature and results in performance specifications, while the latter provides a subjective evaluation of the microphone under actual use conditions. Both forms of testing are valuable, but on occasion the field results do not seem to fully support the laboratory tests.

The difference, of course, lies in the "idealized" conditions that consistently form the basis for laboratory tests. No such uniformity exists in the field, yet the need for correlation between specifications and actual performance is increasingly felt.

In order to more thoroughly explore the causes for deviation from laboratory response, Electro-Voice has undergone a series of tests of varying types of microphones using its large anechoic chamber as a research tool. To date the investigation has concentrated on effective polar response, effects of distance on frequency response, and the results of multiple in-phase and out-of-phase microphone pickups. While the studies have just begun, causes of several common problems have been pinpointed.

Polar response was investigated by rotating the microphone in the anechoic chamber, while speaking at constant volume. This test pointed up the necessity for uniform response off-axis as well as on-axis. With microphones such as the Model RE15, level changed with rotation of the microphone, but voice quality (hence frequency response) remained constant. However with directional microphones that did not offer uniform off-axis response, sound quality quickly became unacceptable. Using such a microphone to reduce unwanted pickup to reasonable levels can alter the tonal character of the unwanted sound, as well as distort the apparent acoustical characteristics of the studio or hall.

It was also noted that many omni-directional microphones exhibited directional characteristics that were quite audible at an angle as small as 80° off axis. This proved to result from interference of the microphone case, and was directly related to increasing case diameter.

In another series of tests, the effect of distance on frequency response and articulation was investigated. A male voice was recorded at distances from 2' to 25' in the anechoic chamber. Levels were then equalized, and tonal quality and articulation was compared. No significant difference could be noted as distance increased. It is evident that the "loss" of highs with distance is not due to reduction in actual intensity. Rather the changing phase relationships determined by environment acoustics has an increasing effect with rising frequency. This is interpreted subjectively as a loss of intensity.

Further tests of this type will be discussed in future columns, and suggestions for other areas of investigation are welcome.

For reprints of other discussions in this series,
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Special Hi-Fi Show Issue

The '69 HOT ONES—Audio's special "New York High Fidelity Music Show Issue" covers the outstanding, new stereo/hi-fi components and systems to be presented to the public (September 19 through 22, Statler Hilton Hotel, New York City).

Readers will get a preview of what can be expected to line local hi-fi dealers' shelves in late 1968 and the following year.

Among other feature articles will be:

SMALL ROOMS FOR STEREO MUSIC — Michael Rettinger discusses how music reproduction is affected by a room's dimensions and furnishings.

AN AUDIO ENGINEER LOOKS AT RUSSIAN RECORDING TECHNIQUES — Dr. Ray Dolby's professional recording experiences at Melodiya Studios and the Russian Radio and Television Studios.

EQUIPMENT PROFILES: AR-3a speaker system, Sansui Model 2000 AM/FM Stereo Receiver, Benjamin Model 1050 Compact Stereo System, and more.

PLUS: Regular departments and recorded music reviews.

ABOUT THE COVER: Here's a view (photographed with a "fish-eye" lens) of 3M's anechoic chamber, an echo-free environment for acoustical testing of loudspeakers and microphones. The chamber is built from 12-in. poured concrete, is r.f. shielded, and has about 3000 34-in. glass wool wedges on all six surfaces to absorb more than 99 per cent of the sound.

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If you have a problem or question on audio, write to Mr. Joseph Giovanelli at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.

Electronic Crossover Systems

Q. I have seen several stereo systems which use separate amplifiers for high and low frequencies.

I would like to know what the advantages and disadvantages of this type of arrangement are.—Thomas Hitt III, Chanute AFB, Ill.

A. The obvious disadvantage of having the speaker system divided so that each speaker within is driven by its own separate power amplifier, fed from an electronic crossover, is that the arrangement is both costly and space-consuming. However, in most of the tests that I have observed, this system does provide superior sound over that which you can normally obtain by a conventional LC network. Apparently the LC (inductance-capacitance) arrangement in a network "rings" at the crossover frequency, imparting a roughness to the sound which is hard to eliminate without degrading the slope of the crossover curve.

There is something else which might play at least a small part in contributing to what I think is better sound produced by an electronic crossover arrangement. Each amplifier does not have to handle material covering a wide frequency range. Because each amplifier handles less of the overall program than is true of a more conventional setup, the number of IM distortion products will be reduced. Therefore, a lot of this "soup" will not be passed on to the loudspeakers.

This about sums up the two arguments. I have thought of one more against the electronic scheme, however. If something should happen to the high-frequency amplifier which could result in the production of a high-power transient, this transient will be transmitted into the tweeter as an impulse having a wide frequency distribution. A tweeter should not be exposed to such a pulse, of course. Such exposure will probably damage it. But tweeters do not require real power to drive them, as is the case with low-frequency speakers. Most of the power is concentrated in the low frequencies. Therefore, I would think that the am-

plifier feeding the high frequency speaker can be less powerful. This will overcome the possible damage to a tweeter; at least to some degree.

I can think of some experimental approaches which might be worth investigating further. How about putting a capacitor in series with the tweeter whose value is such that its reactance would be out of the picture at or just below the crossover frequency, but which would be appreciable at lower frequencies. I don't know how much coloration it might add to the sound, but it should not be too bad. Of course, in the case of a tube amplifier, the amplifier would not be loaded very much at lower frequencies. This might cause some damage to the amplifier when a transient occurs. You probably would need to use some kind of extra load in the form of a resistor whose value is perhaps twice the impedance of the speaker being used. Some power would be wasted, but this is not too important inasmuch as the tweeter does not require much power anyway.

I rather doubt that any kind of fusing could be fast enough to prevent damage. I would imagine that the ultimate in protection can be provided by a Zener diode, two of them connected "back-to-back," or perhaps some kind of bridge arrangement.

While I recognize that we are drifting somewhat away from the main idea of the question, I think the idea of protecting our tweeters is a real issue here.

Some observers have wondered about the phase relationship between lows and highs with this kind of electronic crossover system. Personally, I believe that matter is relatively unimportant, so long as the phase relationship between channels is maintained. I can expect considerable disagreement on this, and will welcome comments.

In the days before stereo, electronic crossover systems were rather popular. However, they went out of favor when stereo came along, presumably because the amount of equipment required was doubled. With solid-state equipment becoming more and more compact, this gives rise to a renewed interest in electronic crossover systems.

Damping

Q. My questions concern the "damping factor" specifications given for amplifiers: (1) What is the definition of damping factor? (2) How is the optimum value of damping factor determined? (3) What is the procedure for altering an amplifier's damping factor? (4) Is an amplifier's damping factor a function of frequency?—Robert J. De Jonge, Sodus, N. Y.

(Continued on page 4)

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Feature by feature, the SL 95 is today's most advanced automatic turntable

An investment of \$129.50 in an automatic turntable cannot be taken lightly. When you're ready to buy, compare carefully—feature by feature. You will find that Garrard's SL 95 meets your every requirement since it offers all the innovations that distinguish a superlative instrument plus the assurance of years of flawless performance. Here's why:

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Convenient, gentle, cueing control: The SL 95 features single action cueing—one control is used to start the motor and lift and lower the tonearm. Its location at the

front of the unit plate facilitates the safeguarding of your records in manual and automatic play.

Accurate audible/visible stylus force adjustment: The SL 95 combines accurately calibrated visual positions with detents for positive ¼ gram settings.

Two-point support for automatic play: It has been found vital to have positive support of records at center and edge. The SL 95's center spindle dropping mechanism guarantees perfect operation at all times, regardless of the condition of center hole or size or thickness of records. A unique support platform telescopes into the unit plate when the SL 95 is used as a manual player. Patented automatic spindle handles up to six records safely; manual spindle rotates with record, has durable, friction-free Delrin® tip.

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A. Before we define damping factor, it might be appropriate to dwell for a bit on the nature of damping.

If you tap a speaker cone you will get a characteristic tone. This sound will depend upon the stiffness and mass of the cone and the nature of its inner and outer suspensions. Two things are determined by these conditions: the frequency of the sound produced by your tapping the cone, and the duration of the cone's vibratory motion.

The latter consideration is of interest to this discussion. Naturally, if we have a moving speaker and we suddenly stop feeding signal into it, we would want the speaker to stop moving immediately. Otherwise, it is producing sounds not fed to it by the amplifier.

Now short the two input terminals of the speaker together. Tap the cone again. Notice that the speaker no longer produces much of its characteristic sound, or free-air resonant frequency. We say that under these conditions the speaker is damped. Why did shorting the input terminals help? It works this way because the moving-coil speaker is a generator. When it is tapped, the movement of the voice coil through its magnetic field produces a voltage. Shorting the speaker terminals means that this voltage is shorted. This is the same as saying that our generator has a heavy load on it. This is translated to the speaker's moving mass as work. It takes work to supply this voltage under these short-circuit conditions, and the force available to accomplish this work can be derived only from the motion of the cone imparted to it when you tapped it. Because of the extra work now placed on the moving system, the speaker stops moving sooner. I guess we could say that it's similar to adding friction to the moving system. It is a case of the energy being dissipated more quickly now that a load has been added to the moving system.

Even when there is no load placed on the speaker by shorting the voice-coil leads, the speaker's motion won't continue forever. There is still work involved in overcoming air resistance and frictional components in the suspension. In other words, no matter what you do or don't do, the oscillations of the speaker cone are always damped to some extent. Of course, this action is less than ideal when the voice coil is not well loaded.

Naturally, if the magnetic fields acting on the voice coil are weak the damping factor with the voice-coil terminals shorted will not be as dramatic as would otherwise be the case.

The suspension systems of the better speakers are designed to have the ability to damp out unwanted cone motion mechanically. Notice that when the

speaker is well damped, it ceases motion more in accordance with the motion imparted to it by the driving amplifier.

If we compare the connection of the speaker to an amplifier with a direct voice-coil short circuit, we find that the damping is not quite as good with the amplifier connected as it is under short-circuit conditions, though the difference is slight. This is reasonable when you consider that the speaker, when connected to the amplifier, is not a "dead" short. The amplifier acts as a very low resistance, but not so low as a direct short. All this leads to the damping factor of an amplifier. This is simply the impedance of the speaker divided by the output impedance of the amplifier.

Unfortunately, this gets us into another subject. When you connect an eight-ohm speaker to an amplifier rated as having an impedance of eight ohms, you would have to conclude from my last statement that the damping factor of the amplifier is 1. This is likely not to be the case at all. We are all brain-washed into worrying about impedance matching. Actually, all you really know about an amplifier's output impedance is that when a load having a given impedance is connected to an amplifier specified as having that same impedance, you will get the power indicated by the designer of the amplifier. You probably don't have anything even close to a match. The true output impedance is quite a bit lower than the impedance of the load to which it is connected. The greater this ratio, the higher will be the damping factor. We can increase the ability of the amplifier to perform this damping function as much as we like. Beyond a certain point, however, we just do not register much improvement.

The way I see it, by the time the resistance of the interconnecting cable is figured into the problem, it becomes the dominant factor once the output impedance of the amplifier has fallen below that resistance. This is why I have always advocated very heavy wire between the speaker and the amplifier: No. 16 or even No. 14 lamp cord.

(2) The optimum amount of damping will depend upon the total speaker design, including the effect of the enclosure. It is often best to have a speaker damped below the maximum value which can be achieved. The sound obtained by changes in damping is rather subtle in most cases. Therefore, I have never felt it necessary to have an amplifier with variable damping. As far as I am concerned, there is no really optimum amount of damping. There are too many variables, and the difference between optimum and somewhat removed from optimum is not great

enough for me to worry about.

(3) We can alter the damping factor in two ways. We can increase the amount of negative feedback around the output stage of the amplifier, thereby increasing the damping factor. This is reasonable because increasing the amount of feedback effectively lowers the impedance of the output stage. We can decrease the negative feedback, bringing about the opposite result. We can reduce the damping factor in a much better way, and that is by introducing current feedback. This is achieved by placing a small resistance between the low side of the output transformer of a tube-type amplifier and ground. Perhaps someone will write in and show us how this might be accomplished with a solid-state amplifier. It is the voltage drop across this resistor which is added to the feedback circuit of the amplifier and is in such a direction as to decrease the damping factor.

(4) Assuming that the amplifier is properly designed, the damping of the amplifier should not be determined by frequency of the signal being fed to it. However, the requirement of the load will change with frequency. At the fundamental resonance of the speaker, damping will be most needed, and it is there, ready and waiting.

Note: This whole area of discussion is loaded with controversy. I hope some of you will rise to the occasion and submit your thoughts. I will try to include at least some of them.

Choosing an Amplifier

Q. I bought a pair of AR3 speaker systems. I would like to know which of the following amplifiers is the best to match the AR3.

*JBL Model SA600,
40 W/ch rms at 8 ohms
McIntosh Model MA230,
30 W/ch rms at 8 ohms
Scott Model 260 B,
40 W/ch rms at 8 ohms*

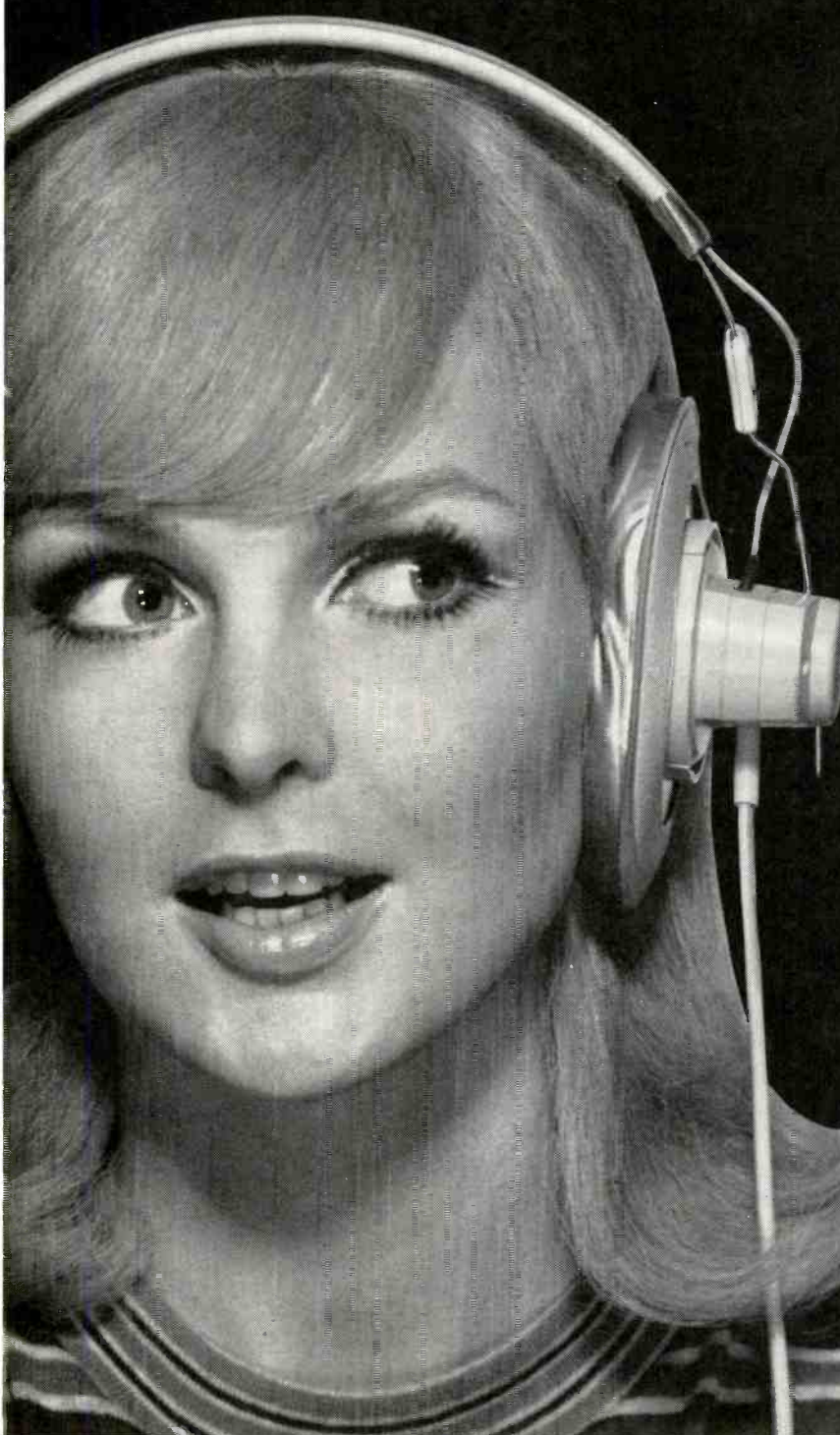
The AR3 requires an amplifier of at least 25 W/ch rms.—H. M. Chan, Hong Kong.

A. I would say that any of the amplifiers you have listed should work well with the AR3.

To my way of thinking, if an amplifier is basically good, and if it meets the power requirements of the load, then that is all there is to it. All you need to do is choose the amplifier that you like best.

You cannot judge a speaker or an amplifier by written specifications alone, of course, you must hear it. This is especially true of transducers, but it does also hold for amplifiers. So listen to your AR3 driven by the amplifiers you're interested in, playing familiar source material.

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What's New In Audio

New York was a summer festival for the electronics trade. Two industry shows—the NEW show and the Consumer Electronics Show—gave dealers and distributors an eyeful of what's coming up during the '68-'69 buying season.

A substantial number of hi-fi component equipment manufacturers participated in both shows, joining parts manufacturers at the NEW Show and packaged equipment manufacturers at the CES Show.

Some products will undoubtedly not be available to the public for some time (and some not at all should marketing plans change, sales to dealers and distributors turn sour, and so on). Nevertheless, many *will* be available in the near future. So let's take a look at some of the highlights.

Tape recorders were hot items. Seems like everybody is on the bandwagon. Aside from the myriad types and models displayed, there were a few recorders that impressed us due to apparent high quality and/or appealing innovations. For example, *Roberts* introduced a combination video and stereo (audio) tape recorder that uses standard 1/4-in. recording tape. It's expected to be priced at under \$1000. *KLH* entered its first tape unit, a stereo, open-reel tape deck that incorporates an audio noise-reduction system) for use with the recorder's 3 3/4-ips speed) under an agreement with *Dolby Laboratories*. A 7 1/2-ips speed is also provided. Expected price is about \$600. *Sony Superscope* topped its new reel-to-reel recorders with a professional portable stereo tape recorder, the model 770. It operates on a.c. or d.c. (includes a rechargeable nickel-cadmium battery pack) and boasts four

tape heads. Priced at \$750. Among *Sony's* new cassette machines, the model 125, an a.c.-powered stereo cassette deck, provides an end-of-cassette alarm system, actually a light that starts to blink on and off as the cassette approaches the end of each side. If you've ever squinted through a cassette machine's window to determine if you're near the end of the tape, you would appreciate such a useful facility. *TEAC* demonstrated a cleverly designed tape deck which had seven-inch reels positioned diagonally instead of in a straight line, thereby reducing the width of the machine.

Top to bottom: Roberts Model 1000 video/audio tape recorder. KLH tape deck with Dolby audio-noise-reduction system. Sony/Superscope Model 770 professional portable stereo tape recorder.



Its new A-7030 tape deck features 10 1/2-in. reel capacity (\$749.50). *Uher's* new Royal Deluxe model 10,000, at \$550, features two- and four-track head assembly modules that may be interchanged quickly. *Harman-Kardon* showed its receiver/tape deck combination, model TDC-33, which retails for less than \$489.50. *3M's Wolensak* unveiled new open-reel tape machines. A new tape transport system is said to provide more rapid forward and rewind operations, and gentler braking. Model 6100, a tape deck, is priced at \$159.95. Also introduced by *3M* was a new stereo cassette recorder, model 4800, that features heavy-duty components to improve wow-and-flutter performance (less than 0.3% at 1 7/8 ips). With separate speaker systems, it will be priced under \$200. *Ampex's* new compact tape deck, model 1450, features automatic reversing and replay, sound-with-sound, and tape monitoring, at a \$299.95 price. *Bell & Howell* exhibited its full line of reel-to-reel tape recorders and cassette tape units. Two new reel-to-reel machines feature automatic threading and automatic reversing for playback. *Revox*, in a location near the CES Show, demonstrated its new model 77A 3-motor deck. *Sterling* showed off its Nordmende stereo recorder/deck with built-in slide-type mixers, as did *Dynaco* with its B&O recorder. *Panasonic* had a broad, complete line of tape recorders, in addition to TV receivers (including a 1 1/2"-screen pocket portable) and a component 90-watt AM/FM stereo receiver (\$349.95). *BASF* magnetic recording tape, both PVC and polyester backed, were shown, as well as two editing kits.

Speaker systems were given a big play by a number of companies. *Jensen Manufacturing* and *University Sound* both displayed speaker systems for music instrument applications, as well as those for use with stereo hi-fi systems. *University Sound's* new Alhambra III 4-way, 3-speaker floor-standing speaker system includes a two-position switch for electrically adjusting the system's bass-response characteristics over a range of 5 dB. *Marantz* introduced a speaker system for the first time. It's a three-way design with five speakers, available in two enclosure styles. The Imperial I, a walnut cabinet with hand-rubbed French lacquer finish is expected to retail for about \$299; Imperial II, with a distressed antique finish, will be priced at about \$369. *Yamaha* presented el-

(Continued on page 54)

The new Sansui 5000 is now available at Sansui Franchised Audio Centers across the country

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Audio Techniques

Got any hints or aids to enhance equipment performance? Simplify operation? Construction shortcuts? Audio invites readers to send them in to Mr. Joseph Giovanelli at AUDIO, 134 North Thirteenth St., Philadelphia, Pa. 19107. Please enclose a stamped, self-addressed envelope.

Convenient Multiple Load Panel

At one time or another, every experimenter needs a Load Resistor. And in this day of stereo amplifiers, he needs *two* load resistors. And furthermore, he needs a number of values to make comparative tests of solid-state amplifiers, which are usually rated at what is their best value—such as 8 or 4 ohms. Requiring these resistors on almost a day-to-day basis, and tiring of adding up an assortment of power

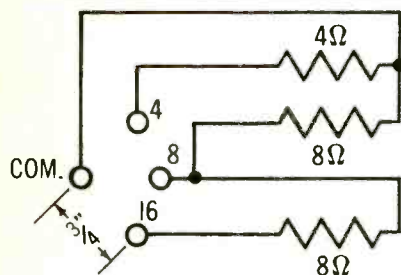


Fig. 1—Wiring diagram for the three-value load resistor panel described. Both channels are identical.

resistors every time a load resistor was needed, the unit shown herein was put together and given a convenient location on our test bench where it would be readily accessible to an amplifier under test, and readily patchable to output and distortion meters.

The unit consists of six 50-watt, 3% power resistors—two of 4 ohms each, and four of 8 ohms each. These are

mounted on a 1/16-in. bracket, along with eight binding posts in the schematic of Fig. 1.

Since the use of double banana plugs is standard in our lab, the four posts for each channel were mounted as shown in Fig. 2. The ground post is at the center of a 3/4-in. arc, and the remaining three posts are mounted on the arc, one directly above the common ground post, and the others 45 deg. to the right and left of it. Labeled 4, 8, and 16, they permit immediate choice of termination. Stackable double banana plugs permit extensions to the remaining equipment—distortion meters, output meters, and an oscilloscope.

The ground post is connected direct to the chassis, which is grounded. It could have been insulated, and perhaps would have been had it been made two years ago, when some stereo amplifiers had outputs which could not be connected together. However, practically all amplifiers at present now have a common ground for both channels, so no problem has arisen. In the present form, the load unit can accommodate 50 watts at both 4 and 8 ohms, and 100 watts at 16 ohms in each channel. Note that the wiring is with #14 solid copper wire. Since each of these resistors can accommodate a 100% overload for a short time, this choice has proved ideal. The 3% resistors were obtained from surplus stocks—only 1% resistors are listed in current mail-order catalogs, and they cost considerably more. Figure 3 shows the rear of the unit.

Fig. 2 (Left)—Panel view of the load resistor unit. This is permanently mounted under the test equipment panel. Fig. 3 (Right)—Rear view of the author's load panel.

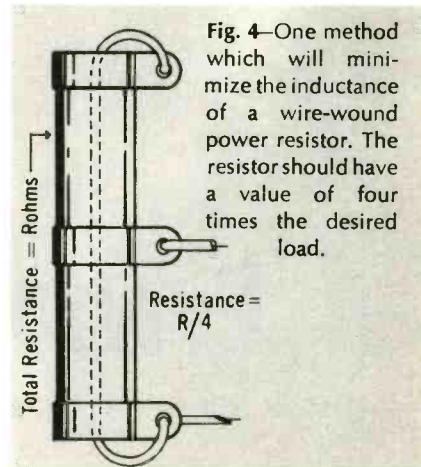
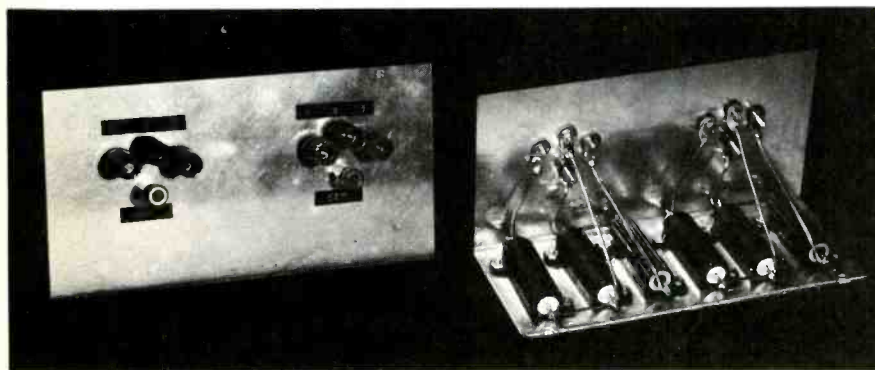


Fig. 4—One method which will minimize the inductance of a wire-wound power resistor. The resistor should have a value of four times the desired load.

Inductive load resistors

The purist may argue that these resistors, being spiral wound, have some inductance, and should not therefore be used for crucial terminations. However, non-inductive load resistors are hard to find in high-wattage values. In the past we have used a single wire-wound adjustable type 50-watt resistor by tying the two ends together for one terminal, and using a center-tapping band for the other terminal. The lead connecting the two ends together passes through the tube. In this arrangement, shown in Fig. 4, the two halves are thus connected in opposition, and the inductance cancels out—well, almost. In a 75-ohm, 50-watt resistor, with the two halves connected in parallel as shown to provide approximately 16 ohms, we measured an inductance of less than 10 microhenries, which is an improvement over the series inductance of the untapped and unparallelled resistor which measured 125 microhenries. The only problem which exists is that there are no 16, 32, and 64-ohm resistors in the catalogs, so it is difficult to get 4, 8, and 16 ohms. It can be done with an extra clip band on each resistor, but that's a lot of trouble.

At the time of writing this, no problem has been encountered with the small inductance which is inherent in the 50-watt Dalohm resistors used in the unit described, and no rebuilding is contemplated. Æ

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BEHIND THE SCENES

BERT WHYTE



The Cassette Tape Format: Pros & Cons

At the recent Consumer Electronics Show (an industry trade show) in New York it was well nigh impossible to walk into a manufacturer's exhibit that did not feature some form of cassette recorder. The proliferation of new units, especially from the Japanese companies, was of amazing proportions. It was very obvious that the cassette format had "arrived." There were tiny battery-operated portable mono and even stereo cassette recorders; recorders combined with AM and FM radios; recorders built into elaborate "entertainment" consoles; integrated stereo cassette recorders with amplifiers and speakers. There were stereo cassette playback decks, even stereo cassette changers from Norelco and Aiwa which automatically played back up to six cassettes. Every manufacturer I talked with outlined his extensive and elaborate marketing plans for maximum exploitation of the cassette concept.

While the 8-track cartridge is generally regarded as a playback medium, the cassette has been touted for its recording capabilities as much as for its function for playback of pre-recorded music. In fact, I would say that at the Show, the emphasis was on the "hardware" and the recording aspects of the cassette. The attitude of many people I talked with was that the "plus" of the recording facility in the cassette system had a great attraction for the con-

sumer, even if his primary interest was in pre-recorded cassettes. It was also felt that this was the reason why the cassette system would eventually prevail over the 8-track cartridge. This of course, remains to be seen. With the accelerated pace of developments in magnetic recording technology over the past few years, prognostication is a very precarious pursuit.

Admitting the values of the recording function, it is also apparent from the ever-mounting sales figures that the pre-recorded stereo cassette is a resounding success. Let's take a look at this plastic phenomenon and discuss some of its positive and negative qualities.

Advantages and disadvantages

The stereo cassette is indisputably small, light, easy to handle and easy to store. It is rugged and, unless grossly abused, should last almost indefinitely. Its tiny size stimulates miniaturization of drive mechanisms and electronics. The narrow 150-mil tape can be had in an ultra-thin configuration which will afford 120 minutes of playing time at its $1\frac{7}{8}$ -ips speed. The cassette permits the use of fast-forward and rewind, which allows a certain degree of program selectivity when combined with a footage counter. The two pairs of stereo tracks are well separated so there is no crosstalk problem. There is crosstalk between the tracks in each stereo pair, but since the tracks both run in the same direction, the crosstalk isn't audible. Under labo-

ratory conditions the frequency range of a stereo cassette can be 40 to 12,000 Hz with a signal-to-noise ratio (S/N) of 45 to 48 dB (unweighted). Under optimum playback conditions in the home, regular production-run cassettes afford 60 to 9000 Hz with S/N ratios of 40 to 45 dB (unweighted). It should be noted here that this S/N ratio is better than the levels of many cassette playback units!

Needless to say, like any other developing technology, the cassette has various problems. Some of these problems are in the cassette itself, others are in the playback units. For example, in the standard cassette there is a mu-metal shield to reduce stray hum fields. In practice it has been found that with certain drive mechanisms the shielding is inadequate and, try as you might, you just can't ground out the hum. In new cassettes which should be on the market very soon, the mu-metal shield has been extended in a "wrap-around" style; with a very slight additional cost to the pre-recorded cassette manufacturer, this has reduced hum significantly. There are also some new playback units which use synchronous motors. Unfortunately, the narrow width of cassette tape contributes to playback noise on a ratio of almost 2 to 1 compared to standard $\frac{1}{4}$ -in. tape. The cassette tape has a 0.5-mil base and a 0.2-mil coating of magnetic oxide. Standard $\frac{1}{4}$ -in. tape has a 0.4-mil coating. This difference in oxide thickness produces about a 5 dB loss in the cassette tape because of the very short wavelengths at the $1\frac{7}{8}$ -ips speed. The cassette tape must have the thin base and coating to ensure a supple tape which permits good head "wrap" and contact to maintain good frequency response. It is also a matter of sheer space and playing time, an important factor in the tiny confines of the cassette. One bright spot is the production of a new oxide which is reported to gain back about 3 to 4 dB of the loss attributed to the thin coating on cassette tapes. As far as the "Cronar" chromium oxide tape is concerned, it is not available at present. In any case, it is too thick, is somewhat abrasive, and could cause accelerated wear in the type of heads furnished with cassette playback units. Further, it would require the bias frequency to be almost doubled. In the considered opinion of some engineers, there has been and there is such rapid progress in the development of iron oxides that they doubt chromium oxide would be much of an advantage

The cartridge looms large for a simple reason:

It is the point of contact between the entire hi-fi system and the recording. What happens at the tip of its tiny stylus determines what will happen in all those big and impressive components that are so obvious to the eye and, in the aggregate, so apparent to the pocketbook. Worldwide, experts and critics have hailed the discovery of Trackability as *the* definitive measurement of cartridge performance. When evaluated against this measurement, the superb **Shure V-15 Type II Super Track** stands alone. Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Illinois 60204

The analog-computer-designed Shure V-15 Type II Super-Trackability cartridge maintains contact between the stylus and record groove at tracking forces from $\frac{3}{4}$ to $1\frac{1}{2}$ grams throughout and beyond the audible spectrum (20-25,000 Hz). Independent critics say it will make all of your records, stereo and mono, sound better and last longer. Tracks 18 cm/sec. and up at 400 Hz; tracks 26 cm/sec. and up at 5,000 Hz; tracks 18 cm/sec. and up at 10,000 Hz. This minimum trackability is well above the theoretical limits of cutting velocities found in quality records. \$67.50.



... at least not in the area of home audio.

Another thing that plagues the duplicators of pre-recorded stereo cassettes is the variation in the width of their duplicating tape. The standard calls for 150 mils with a tolerance of plus zero and minus 2 thousandths. If the tape is slightly narrower, it cuts into the edge track (which is the left channel) and may cause a loss of 3 to 4 dB in signal. There is an appreciable number of pre-recorded stereo cassettes which are down in level on the left channel. It is usually not your machine which is out of kilter, but this tape variation . . . so you will have to use your balance control. You will also encounter dropouts in pre-recorded cassettes. Much of this is caused by fingerprint residues on the thin coating, but this is expected to be eliminated by the use of automatic machinery instead of the hand assembly of cassettes.

The wow-and-flutter content of most pre-recorded stereo cassettes is usually quite a bit less than the wow-and-flutter of the various playback units. This is one of the penalties of the 1 $\frac{7}{8}$ -ips speed and is likely to remain a problem until the development of an inexpensive servo-control drive. It should be noted that there are two new cassette recorders made by 3M/Wollensak and Harman-Kardon which use full-sized drive components, large fly-wheel, etc., and are in general built to "professional" standards, and for which excellent figures are quoted for

wow and flutter. I saw and heard both units at the Consumer Electronics Show and they seem to hold much promise. I hope to obtain sample units and give them the "lived with for awhile" treatment.

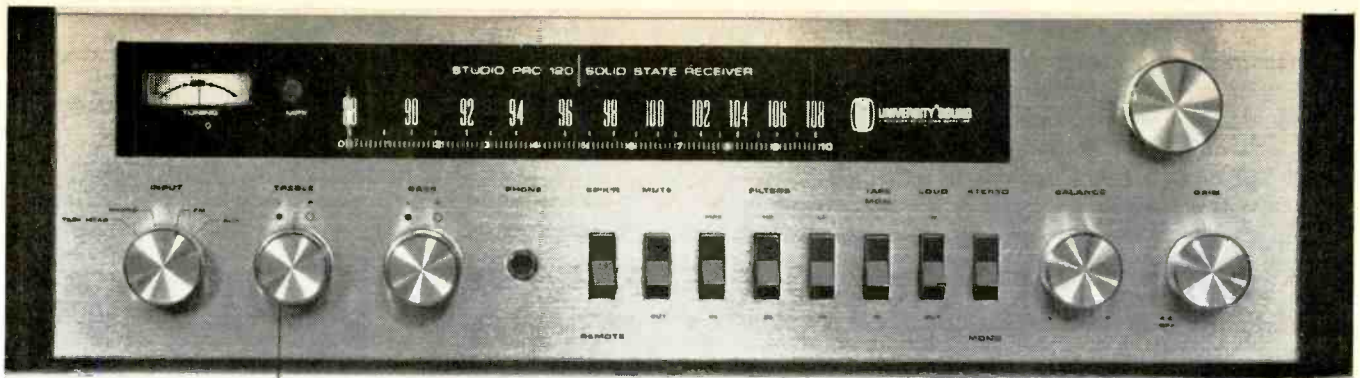
There seem to be two schools of thought regarding the duplication of stereo cassette tapes. One method is the Ampex-style use of multiple-slave tape machines. The other is what is known as the "common mandrel" system. The mandrel is the equivalent of a large-diameter, massively heavy axle on which are mounted many large take-up reels which pull the tape over a recording head . . . one to each reel. Since the reels are all driven by the same mandrel or "axle," it is claimed there is very little difference in wow-and-flutter content between the tapes on each reel, and a low overall figure for wow and flutter. The Dubbings Co. of Copiague, New York uses the common mandrel system; I am indebted to Chief Engineer Trevor Campbell for a most fascinating and instructive tour of his plant. Mr. Campbell says that, under optimum conditions, wow and flutter are about equal between the multiple-slave tape-machine system and the common-mandrel system, but he feels the latter system is easier to maintain to specifications. He also feels that scrape flutter is easier to control, especially since he is using dubbing ratios of 16 to one and is currently experimenting with ratios of 24 to one. This drops the scrape-flutter frequency much further into the bass range, with subsequently less effect on transient response. Mr. Campbell uses the Ferrite heads which wear very little and thus avoids "lipping" and tape skew which could cause track misalignment.

At the present time, any evaluation of the pre-recorded stereo cassette must be considered in the light of several different kinds of listeners. For the mass market—those with integrated or "compact" systems with small limited-range speakers, who audition mainly "pop" type material, at relatively low playback levels in small apartments or homes—the stereo cassette affords them a quality of sound equal if not superior to what can be obtained from a disc system in the same price range. With the added advantages of longevity and non-"scratchability" of their recorded material and the recording capability of their cassette unit, the appeal of the cassette system is readily apparent and the burgeoning sales not surprising. For the serious audio buff, especially those oriented to classical music, the

stereo cassette leaves much to be desired. For one thing, the number of classical cassettes is comparatively limited. Ampex, for example, issues but one classical cassette to every 15 or 20 pop productions. It is true that D.G.G. and a few other companies are trying to build up fairly extensive catalogs of classical cassettes, but this still makes for scant classical representation. Far more serious than the lack of material is the quality of sound to be found on classical stereo cassettes. To put it bluntly, it is not remotely competitive with the high-quality stereo disc or 7 $\frac{1}{2}$ -ips stereo tape, and only marginally and occasionally equal to 3 $\frac{3}{4}$ -ips material. The restriction of frequency response, especially in the bass range, the dropouts and the all-too-frequent distortions of various type, and above all, the almost traumatic hiss caused by the poor S/N ratio, simply negates its virtues of size and handling. When "pop" cassettes are played over a high-quality system the results are somewhat better, but the hiss still is too high. I must admit that the present cassette playback units add their increments of noise, and some of the newer units may help the overall noise picture. I will also admit I heard some remarkably quiet stereo cassettes of generally good quality under laboratory conditions, and presumably this kind of quality will be forthcoming in the not-too-distant future. As things stand now, with the currently available quality of sound on stereo cassettes, the audio buff will most likely use them for background music.

Over the past months we have discussed various formats of slow-speed tape. The quality picture with all of them is not particularly bright, at least as far as the devotee of high-quality sound is concerned. A friend of mine, one of the most respected engineers in the tape field, who chooses to remain anonymous, sums up the slow speed tape situation thusly: . . . there are many avenues of approach to upgrade the slow-speed tape where it can eventually begin to compare with top-quality disc and tape. But all of the effort expended in doing this will prove that reaching this goal will be very expensive and that, except for certain convenience factors, it will not be as good as a 7 $\frac{1}{2}$ -ips tape. The factors needed to improve 7 $\frac{1}{2}$ -ips tape are far easier of accomplishment and far less costly. The extra tape required on a 7 $\frac{1}{2}$ -ips tape is cheap and is getting cheaper all the time." A radical view in this age? Unquestionably, and only time will tell. Æ





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And if that isn't enough, how about asking your dealer for a re-print of the three-page article on the Studio Pro-120 from the January, 1968, issue of *Audio Magazine*.

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AMPLIFIER SECTION: IHF Power Output: 120 watts total, IHF Standard at 0.8% THD, 4 ohms (60 watts per channel). RMS Power Output: 8 ohms: 30 watts per channel at 0.3% THD. Frequency Response: +0, -3 dB from 10 Hz to 100 kHz. Power Bandwidth: 10 Hz to 40 kHz, IHF Standard. Intermodulation Distortion: Less than 0.5% at any combination of frequencies up to rated output. Tone Control Range: ± 18 dB at 20 Hz and 20 kHz. Damping Factor: 50 to 1. Noise Level: (Below rated output) Tape monitor: -83 dB—Auxiliary: -80 dB—Phono: -60 dB—Tape Head: -63 dB. Input Sensitivity: (For rated output) Tape Monitor: 0.4 Volts—Auxiliary: 0.4 Volts—Tape Head: 1 mV at 500 Hz—Phono: 4 mV at 1 kHz. Input Impedance: Phono and Tape Head: 47,000 ohms—Tape Monitor: 250,000 ohms—Auxiliary: 10,000 ohms. Load Impedance: 4 to 16 ohms. **FM TUNER SECTION:** Sensitivity: 1.6 μ V for 20 dB of quieting, 2.3 μ V for 30 dB of quieting, IHF. Frequency Response: $\pm \frac{1}{2}$ dB from 20 to 20,000 Hz. Capture Ratio: Less than 1 dB. Image Rejection: Greater than 90 dB. IF Rejection: Greater than 90 dB. Separation: 40 dB at 1 kHz. Selectivity, Alternate Channel: 55 dB. Drift: .01%. Distortion: Less than 0.5% at 100% modulation ± 75 kHz deviation. Multiplex Switching: Fully automatic logic circuit. **GENERAL:** Dimensions: 4 $\frac{1}{2}$ " H x 16 $\frac{3}{8}$ " W x 12" D (including knobs). Weight: 17 lbs. Amplifier Protection: Three 1-ampere circuit breakers. Complement: 31 Silicon & MOSFET transistors, 21 Diodes, 2 Integrated circuits (each containing 10 transistors, 7 diodes, 11 resistors).

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Letters

Stylus Size

• We read with some interest the advice given to Mr. Paul E. Scraggs on the subject of Styli and Records in your April 1968 issue; and while agreeing with most of the recommendations made, we feel that the question of stylus-tip size needs clarification.

In accordance with the International Standard for Processed Disk Records and Reproducing Equipment (IEC Publication 98 Second Edition 1964, Clause E.1.1.2, including amendment No. 1 of August 1967), the frontal tip radius of reproducing styli for stereophonic records must be between 0.5 and 0.7 mil. The lower limit is set by the bottom radius of the groove while the upper limit is set by the instantaneous minimum groove width on stereophonic records. In accordance with "Dimensional Standards, Disc Phonograph

Records for Home Use, Bulletin E4" published by the Record Industry Association of America, the instantaneous minimum groove width on stereophonic records is 1 mil.

Simple geometric considerations show that a stylus of frontal tip radius greater than 0.7 mil will not fit into a groove having a minimum width of 1 mil, and will therefore be subject to severe mistracking or groove jumping. For these reasons we consider it essential that the frontal tip radius of styli for stereophonic records should be strictly limited to between 0.5 and 0.7 mil.

Finally, we should like to draw your attention to the fact that it is the tip *radius*, not the diameter, which must lie between 0.5 and 0.7 mil for stereo.

G. M. NATHAN

The Decca Record Co., Ltd.
W. Hampstead, England

"Pro-Recorded" Tape

• If you must have a prefix on the word tape to indicate one recorded with music, why not use the term "Pro" Recorded, meaning, of course, Professionally Recorded.

LEWIS DICKENSHEETS
Wichita Falls, Texas

A Shocker

• I read your article on TV sound in the Audioclinic section of AUDIO, July 1968, with considerable concern. I have added cathode-follower circuits to several TV sets in the past. There are many TV sets around that do not have an isolation power transformer between the chassis (audio ground) and the power line. Installing a cathode follower between the TV audio and an external hi-fi system via shielded cable could result in the metal parts of the hi-fi system, phonograph, tuner, tape recorder, etc., all being connected directly to the hot side of the power line. If a component in the hi-fi system is grounded, smoke and sparks may appear in TV or in the grounded component. If a component is not grounded, a deadly trap awaits someone who touches the system and a ground at the same time.

Don't be fooled by sets with a power transformer in them. I have a set with a 6.3 V power transformer, but it is only for the tube filaments. The power line goes directly to the chassis and selenium rectifiers are used in a voltage-doubler circuit for the B+. The TV is safe for normal use because the chassis is insulated from the cabinet, knobs, etc.

These sets offer you a 50-50 chance of getting a shock depending on how the plug is oriented in the wall. If you are lucky, the chassis could be connected to the ground side of the power line instead of the hot side. Reverse the plug and you won't be so lucky.

Try using a 1:1 line isolation transformer and avoid this hazard; that's what I do.

ROGER H. RUSSELL
Binghamton, N. Y.

• The technical information submitted with AKG K-60 headphones (reviewed in the July issue) when introduced late last year did not include details on the unusual efficiency of the mylar diaphragm driver unit. The headphones require only one milliwatt to reproduce a sound pressure level of 112 dB. This high sensitivity provides ample reserve output for versatile, direct connection to virtually any source—from amplifier speaker circuits to the high-impedance outlets provided on many transistorized tape decks for monitoring. Also, both K-60 and the budget-priced K-20 version may be used on any impedance from four ohms to 10,000 ohms without a transformer.

R. W. MILLER
AKG Microphones-Headphones
New York, N. Y.



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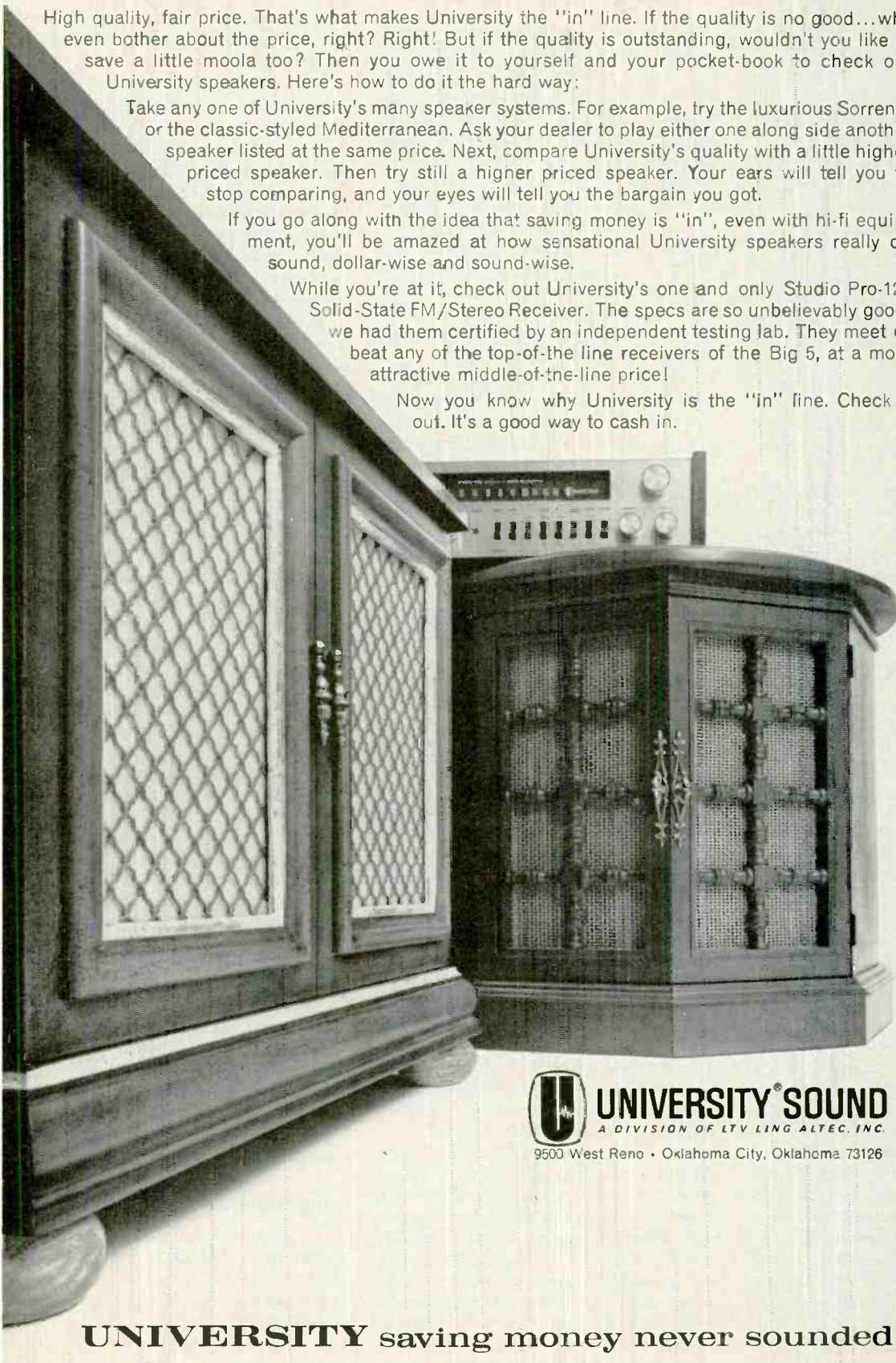
High quality, fair price. That's what makes University the "in" line. If the quality is no good... why even bother about the price, right? Right! But if the quality is outstanding, wouldn't you like to save a little moola too? Then you owe it to yourself and your pocket-book to check out University speakers. Here's how to do it the hard way:

Take any one of University's many speaker systems. For example, try the luxurious Sorrento or the classic-styled Mediterranean. Ask your dealer to play either one along side another speaker listed at the same price. Next, compare University's quality with a little higher priced speaker. Then try still a higher priced speaker. Your ears will tell you to stop comparing, and your eyes will tell you the bargain you got.

If you go along with the idea that saving money is "in", even with hi-fi equipment, you'll be amazed at how sensational University speakers really do sound, dollar-wise and sound-wise.

While you're at it, check out University's one and only Studio Pro-120 Solid-State FM/Stereo Receiver. The specs are so unbelievably good, we had them certified by an independent testing lab. They meet or beat any of the top-of-the line receivers of the Big 5, at a most attractive middle-of-the-line price!

Now you know why University is the "in" line. Check it out. It's a good way to cash in.



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Tape Guide

HERMAN BURSTEIN

If you have a problem or question on tape recording write to Mr. Herman Burstein at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. Please enclose a stamped, self-addressed envelope.

Tape Electronics

Q. I am considering the purchase of a used tape transport. How should I go about building it into a deck? Would another make tape preamp be good to use with this transport? What heads would you suggest? About what would the transport be worth?—Hal Weinberger, Ithaca, N. Y.

A. I can make the general statement that I am prejudiced against the idea of trying to hook up a tape transport with separate record electronics not matched for it. Even separate playback electronics under this circumstance is not highly recommended.

Separate electronics present a variety of problems to those not technically qualified and equipped. These problems include proper adjustment of bias current, adjustment of recording current, adjustment of recording-level indication, matching the circuit impedance to the head impedances, and proper equalization, including compensation for frequency irregularities of the record and playback heads (or of the record/playback head). As witness that these problems cannot be lightly taken, there are extremely few tape preamplifiers today offered for sale as separate items for matching with transports in general.

High-Speed Duplication

Q. When duplicating a prerecorded 3.75-ips tape, and doing so at 15 ips, thereby cutting recording time to minimum, should the new recording be distorted when played back at normal speed? If so, is it due to misadjustment of the line and mike volume controls, or is it due to the very high frequencies? I notice while duplicating that the VU meter registers above 0 VU a great deal of the time. When I decrease the record volume control to diminish distortion, the playback level is not loud enough. When recording, is it best to

just monitor the recording to obtain the best volume and balance, or should one use the VU meter indications as well?—B. S. Powell, APO San Francisco, Calif.

A. In multiplying playback speed and therefore all recorded frequencies by a factor of four, you are increasing the output of high-frequency energy. Thereby you may be overtaxing the capabilities of the playback head, the playback electronics, the record electronics, and the record head. For cleaner tape duplication, record at a level that keeps the pointer of the VU meter in the proper range—presumably below 0 VU. Although this will reduce the recorded signal level, what counts is the eventual signal-to-noise ratio. If S/N becomes unsatisfactory, try dropping to a lower duplication speed.

Ordinarily one relies heavily on the VU meter in order to record at proper level. But you should also monitor the tape to make sure that, whatever the VU meter indicates, the recording level is not so high as to produce noticeable distortion, nor excessively low so as to cause an inferior S/N ratio.

Running Correspondence

The series of questions and answers below resulted from correspondence with an overseas reader, Domingo Riego, Jr., Manila, Philippines.

Q. The manufacturer of my tape recorder says that the cause of clicks recorded on the tape may be removed at the factory. How can this be done at home or in a radio shop?

A. There are various possible causes of recorded clicks. The click may be due to a power switch, and placing a capacitor in parallel with the switch contacts might be the remedy. In another case, a high-value resistor, say, 10 megohms, between a switch contact and ground may be the answer.

Q. Almost all better quality speakers on the market are rated at 8 ohms impedance. My tape recorder has a 3.2 ohm output, and I find it difficult to obtain good quality 4-ohm speakers to match the recorder's output impedance. How may my recorder's output impedance be changed to 8 ohms?

A. I think you will find that 8-ohm speakers will generally work satisfactorily when fed from your machine's 3.2-ohm output. An upward mismatch (amplifier impedance lower than the speaker impedance) is not apt to result in perceptible losses, provided you do not attempt to drive the speakers to very high volume. If you do operate at high volume, choose speakers of

relatively high efficiency. A number of high-quality 8-ohm speakers have rather low efficiency.

Q. Will lowering the bias voltage in my tape recorder, say from 55 volts to 45 volts, lower the volume in recording or playback?

A. Lowering the bias voltage (as measured at a prescribed point designated by the tape recorder manufacturer), which really means reducing the bias current through the record head, will result in reduced magnitude of the signal recorded on the tape. Of course you will therefore also have a lower signal in playback. Reduced bias will also result in exaggerated treble response.

Q. My tape recorder is properly fused for operation on 117 volts a.c. However, if plugged accidentally into a 220-volt line, the voltage used in the Philippines, the fuse blows only after a length of time, almost always after at least one tube has been damaged beyond use. I would like to have a fuse or mini-breaker installed in the circuit which will instantaneously blow or break the instant 220 volts is applied. In what part of the recorder's circuit may it be installed, if applicable? What should be the rating of the fuse or mini-breaker, in amperes (my recorder is rated at 100 watts). Will the addition of a mini-breaker affect volume and frequency response?

A. I would suggest trying a fuse with slightly lower amperage rating than the one you are now using. And install it in the same place as the present one. Presumably the manufacturer of your tape machine has already chosen the best fuse location. I would guess that the proper fuse value is about 1 ampere or slightly less. If by any chance your present fuse is of the slow-blow type, replace it with a conventional fast-acting fuse. I don't see how the mini-breaker could affect volume or frequency response.

Q. My tape recorder is rated at 117 volts a.c. Can it be modified for use with 220 volts merely by changing the power transformer and solenoid shunt, without disturbing the other components?

A. To convert to 220 volts you also need to change the transport motor.

Duplication

Q. Is the Cross Field head of any value in recording or copying at 7.5 ips? Which is the more important to someone like me, who does a lot of copying: a Cross Field head with good accuracy and wow-and-flutter specifi-

How to recognize a stacked deck.

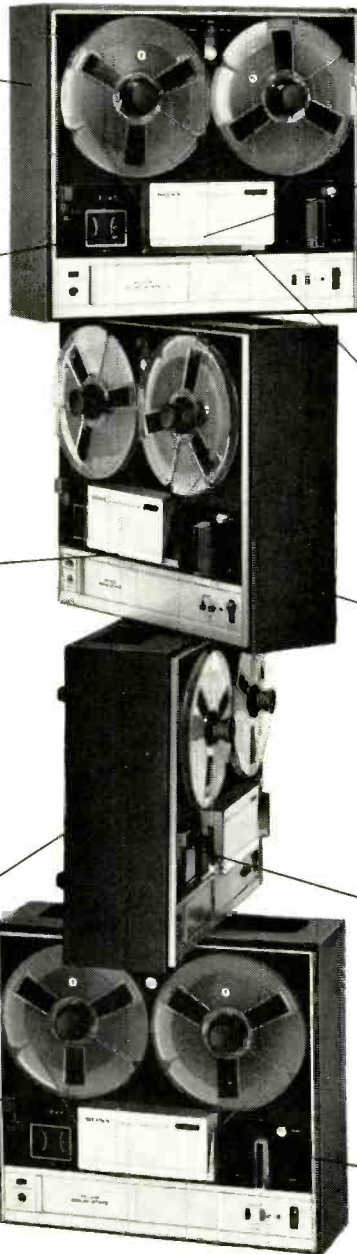
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fications, or the very best in these specifications without the Cross Field head?

When you do a lot of copying, is it important to stay with machines of the same model and make, or can I still get the best results even though I buy two different machines, both of high quality? One day I took music recorded at 3.75 ips and played it at 7.5 ips, and copied it at 7.5 ips on my second recorder. The result when replayed at 3.75 ips wasn't too good. To speed up the copying process, could music recorded at 7.5 ips be copied using two machines designed to operate at 15 ips? Would it come out sounding all right on the 7.5 ips replay?—M. Glen Bair, Idaho Falls, Idaho

A. The Cross Field head claims to permit better treble response at low speeds. While this is of course desirable, nevertheless I feel it is a secondary consideration compared with low wow and flutter, low noise, and low distortion.

In copying tapes you can get good results with two machines of different makes and/or models if they are both of high quality and conform to the same equalization practices.

A 7.5 ips tape can be copied at 15 ips (that is, played at 15 ips, recorded at 15 ips, and eventually played at 7.5 ips) with good results if the tape amplifiers have frequency response to at least 30,000 Hz and if the bias frequency of the copying machines is satisfactorily high, say about 150,000 Hz.

Amplitude Fluctuation & Warble

Q. In the recording mode, with a very constant voltage input from a frequency generator, the monitor output of my tape recorder fluctuates as indicated by its VU meters. A VTVM confirms this random fluctuation. Various audio frequencies give the same erratic output. So do various tapes. Heads were cleaned and demagnetized, and springs controlling tape tension were adjusted per the instruction book. The pressure roller seems reasonably round and smooth. All tracks give similar results. An oscilloscope shows about 5% fluctuation in amplitude. Using earphones, a warble tone is heard. Your interpretation of the difficulty and suggestions to correct the trouble would be appreciated.—William E. Shenk, Philadelphia, Pennsylvania

A. All tape machines exhibit amplitude fluctuations, due in part or all to the tape and to varying contact between the head and the tape. A 5% fluctuation in amplitude is less than 1 dB and rather moderate. The warble

tone may be due to excessive recording level, particularly at high frequencies. At upper frequencies the VU meter should indicate at least -10 dB when recording a steady tone.

Using Two Recorders in Tandem

Q. I own two tape recorders, both stereo. I am using them with a packaged set. Both recorders have a pre-amplifier, but the packaged set does not. I would like to hook both recorders into my audio system in tandem, so that I can tape long broadcasts without reel change interruptions, and also so that I can duplicate tapes. I have tried a Y-adaptor to each channel's tape recorder output jack, but this does not work. The signal cuts out completely. Yet both recorders work well when hooked up individually.

Another problem is that there is no left-right mode switch on my audio set, so that when using one of my tape machines and playing back a 4-track mono tape, I have to unhook one of the output leads from the tape machine. Can a switching arrangement be made to eliminate this problem?—William J. Zinn, Hanover, Ontario

A. In the absence of schematics of your audio set and your tape machines, it is difficult to suggest with certainty how to feed the two tape recorders simultaneously from your audio set outputs. Seemingly one of the tape machines loads down the other, shorting out the input signal to them. Perhaps the following might work to isolate the machines from each other: Connect isolating resistors between the Y-adaptors' hot leads and the inputs of the tape recorders. Use the lowest value that produces acceptable results. Start with about 10,000 ohms, but try to avoid going above 100,000 ohms. Instead of using two isolating resistors, one for each machine, a single resistor to one machine or the other might do. Perhaps you can mount these resistors inside the tape recorders, at their input jacks.

As for cutting out one of your channels in playback, does either of your tape machines have separate playback volume controls for its two channels? If yes, just turn down the volume for the undesired channel. If no, does either of your tape recorders have a left-right mode switch? If yes, use it. If both answers are no, you or a technician can install in the tape machine a simple toggle or slide switch to short out the playback signal of the undesired channel. The shorting can be done at the site of the playback volume control. AE

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EDITOR'S REVIEW

For the Birds

Recording bird songs is not an uncommon avocation, though our British cousins have a greater affinity for this hobby. Any tape recordists interested in taking a turn at this would do well to get Dover Publications' recent record release, *Common Bird Songs* (\$2.50), which makes it possible to identify songs and calls of 60 different and widely distributed birds of Eastern and Central United States, and Canada. An accompanying 32-page booklet contains a picture of each bird, together with comments on its sounds. The Company's address is 180 Varick St., New York, N.Y.

Statistics

For the first time since 1949, sales of musical instruments showed a decline compared to the previous year. Whereas 1966 retail sales were \$954 million, 1967 sales dropped to \$924 million. However, its per cent of personal consumption, 0.187 per cent, was exceeded only in 1965 and 1966.

According to a report by *The American Music Conference*, the number of music-making adults and students continued to rise in 1967 from over 41 million to almost 44 million persons. Not surprising, the piano was the leading instrument, with 23½ million people playing the instrument (ten years ago it was nearly 20 million). This was followed by the guitar, which numbered 11 million players (ten years ago it was close to 3 million). Both leaders exhibited a decline in unit sales in 1967.

Guitar unit sales, in particular, slumped from 1.43-million unit sales in 1966 to 1.04 million, a loss of almost 400 thousand guitar sales. On top of a 70-thousand loss in unit sales in 1966 compared to

1965, could this mean that the interest in "rock" music and/or "folk" music, the prime stimuli of guitar sales, has leveled off and is now in decline? Or does it simply point to a trend toward more listening and less instrument playing?

For the fourteenth consecutive year, the number of stations broadcasting FM has grown. As of February 28, 1968, there are 1804 FM broadcast stations, according to the *Electronic Industries 1968 Yearbook*. This is an increase of 173 stations over 1966 (at year end). In contrast, commercial AM broadcast stations evidenced a continuous increase every year since 1949 (2006 stations at mid-year) to its present (as of February 28, 1968) 4180 stations. This is an increase of 65 stations over year-end 1966.

Coming Up

The New York High Fidelity Music Show is coming up fast. It will be held at the Statler Hilton Hotel, Seventh Ave., 32nd to 33rd Streets, in New York City. Admission charges are \$2.00 for adults, 50¢ for children under twelve years of age. Mark these show dates on your calendar:

GENERAL PUBLIC

Thursday, Sept. 19 4:00 P.M. to 10:30 P.M.
Friday, Sept. 20 4:00 P.M. to 10:30 P.M.
Saturday, Sept. 21 1:00 P.M. to 10:30 P.M.
Sunday, Sept. 22 1:00 P.M. to 9:00 P.M.

DEALERS

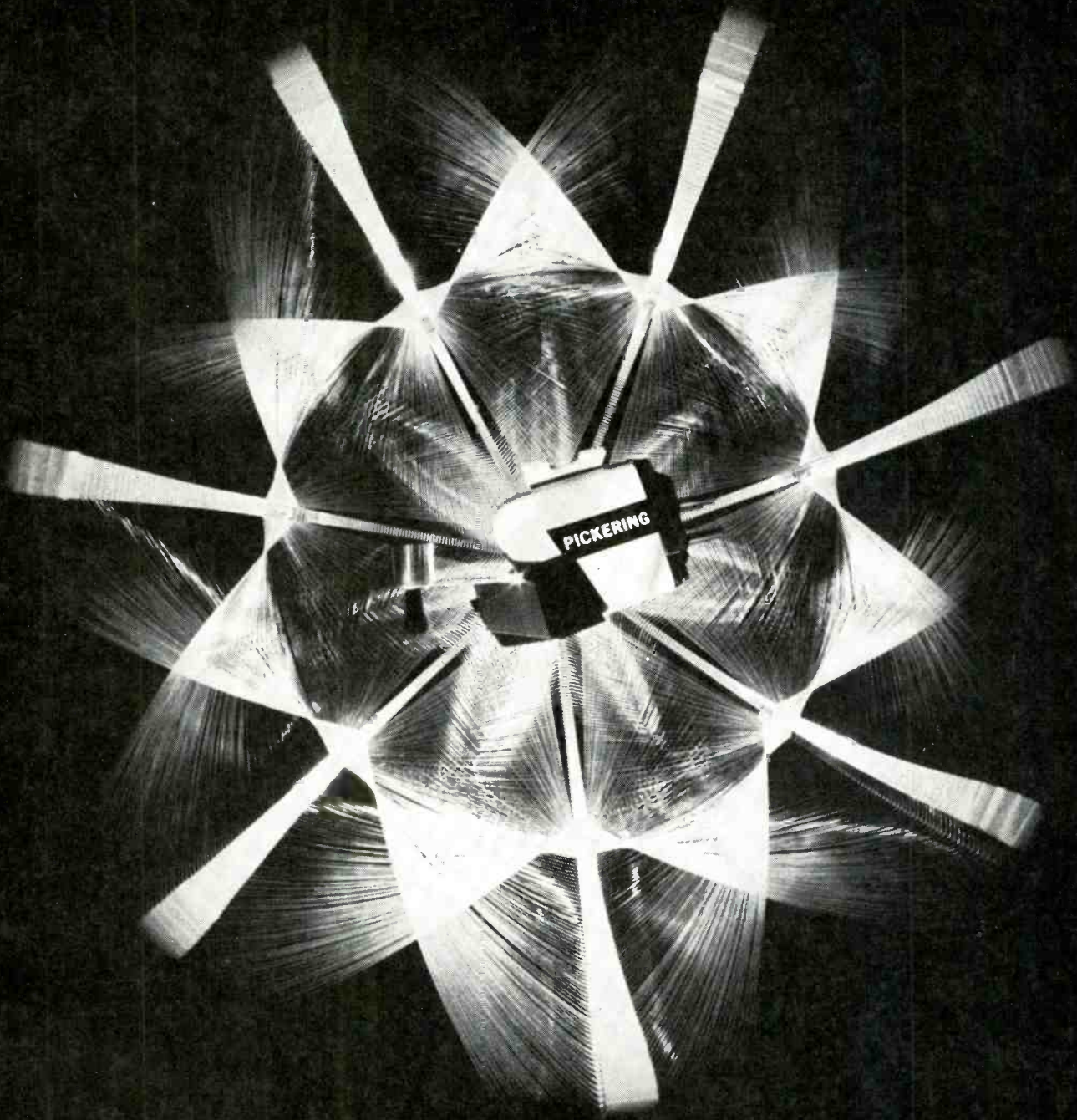
Wednesday, Sept. 18 5:00 P.M. to 9:00 P.M.
Thursday, Sept. 19 1:00 P.M. to 4:00 P.M.
Friday, Sept. 20 1:00 P.M. to 4:00 P.M.

George Dubé was named to the newly created post of Executive Director of the Institute of High Fidelity. He joins the IHF directly from the Consumer Products Division of the Electronic Industries Association.

Address Unknown

On occasion, readers forget to enclose a stamped, self-addressed envelope with their inquiries to AUDIO columnists. Every letter directed to them for assistance on a hi-fi problem is answered. If you do not receive a reply within a reasonable time (1 to 2 months?), please send a duplicate of your letter with another stamped, self-addressed envelope. (Some readers omit their address on the letter itself, making it impossible for columnists to respond.) Thanks. A.P.S.

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The X in the new Pickering XV-15 stands for the numerical solution for correct "Engineered Application." We call it the Dynamic Coupling Factor (DCF).SM

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the egg, the end result can be presented quite simply. So can the superior performance of the XV-15 series. Its linear response assures 100% music power at all frequencies.

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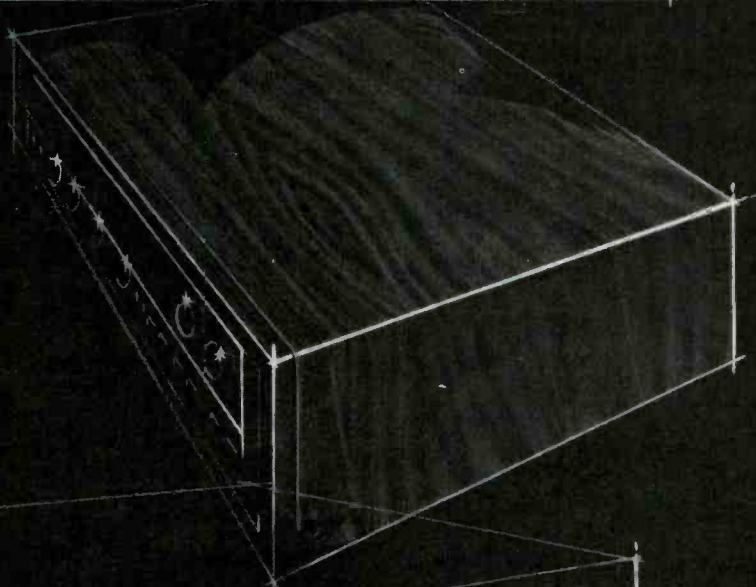
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Sherwood

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AUDIO • SEPTEMBER 1968

SCA

Private Music Channels on FM Stereo

LEONARD FELDMAN

How background music broadcasts are hidden on public FM stereo broadcasts

IT WILL COME as no surprise to many owners of stereo FM receiving equipment that there exists, within the public FM frequency band, a service which is anything *but* public, known as SCA (Subsidiary Communications Authorization). Manufacturers of stereo FM receiving equipment are even more aware of the existence of this ancillary service, for they must painstakingly filter out this additional sub-carrier by adding circuitry to their receivers' stereo FM decoders. Earlier in the brief history of stereo FM, many manufacturers learned the hard way that failure to provide adequate SCA rejection filters resulted in a combination "swishing-whistle" on certain stereo FM stations which rendered some just about un-listenable.

Additional sub-carriers (other than the suppressed double-sideband, audio modulated one used for transmitting the L – R information of a stereo program) are used by some broadcast stations to transmit "background music"—the music you so often hear in restaurants, bowling alleys, factories, and many other public places. In most instances, the station owner merely "leases" this additional facility to another entrepreneur who is engaged solely in the sale of this innocuous, commercial-free music. Actually, that's all that is sold. The necessary FM receiver and decoder are seldom, if ever, sold to the user. Rather, equipment is leased to the customer, installed by the background music firm, and serviced by that firm as well. Usually, the receivers so leased are fix-tuned units (crystals are usually used to tune the main r.f. frequency)

capable of receiving *only* the background music service, to the exclusion of main channel programming of the given station or any other station.

SCA Standards

Figure 1 details the spectrum distribution of the various services authorized by the FCC to be transmitted over a single FM transmitter. Note that the horizontal axis represents frequency, while the vertical axis represents percentage of modulation or deviation of the main carrier. The band of frequencies from 50 Hz to 15,000 Hz represents "main channel" or L + R monophonic public programming. This is followed by the well-known 19-kHz "pilot" carrier, needed to establish a 38-kHz reference carrier in the stereo decoder section of the receiver. Next come the upper and lower sidebands of the suppressed 38-kHz subcarrier which constitute the L – R stereo information. These extend from a low of 23 kHz to a top frequency of 53 kHz. If the station is not engaged in SCA service, the sum of all these modulations will equal 100% (or 75 kHz) deviation of the main carrier. (Note that both L + R and L – R information are shown to cause a maximum modulation of 90%, while the pilot signal provides the other 10%. Actually, because of the so-called "interleaving" action associated with the FCC-approved FM stereo system, L + R and L – R never reach 90% deviation at the same instant, so that the instantaneous sum of the two never exceeds the 90% deviation figure.)

In the event that a station is to transmit SCA service as well, L + R

and L – R modulations are "backed off" to 80%, the "pilot" remaining at 10%. This leaves an additional 10% available for the SCA service, which, as can be seen in the diagram of Fig. 1, is nestled in at 67 kHz, extending upward to approximately 72 kHz and downward to about 62 kHz when modulating information is applied. Note that unlike the L – R stereo subcarrier, this additional subcarrier is *frequency* modulated. Thus, if you think of this subcarrier as a sort of FM station all over again, its "r.f. center frequency" is 67 kHz. Its amplitude remains constant at all times, but its frequency is caused to vary in accordance with the desired program material. This entire subcarrier then modulates the main r.f. carrier. Since this subcarrier is quite different in makeup from any part of the stereo composite signal, the programming imparted to it by FM modulation of its center frequency (67 kHz) is not audible on a standard FM receiver nor on a standard stereo FM receiver. About all a stereo FM receiver can do is reproduce the annoying whistling sound described earlier if SCA rejection filters have not been adequately designed.

Several months ago, Mr. Murray G. Crosby (the noted inventor in the FM field, and one of the pioneers in the development of stereo FM broadcasting) suggested a novel way to demodulate this frequency-modulated 67-kHz subcarrier, once it has been recovered intact at the output of the detector of a conventional FM tuner. In order to appreciate the sophistication of his approach, it is necessary to first consider how this decoding job is generally accomplished by most manufacturers of

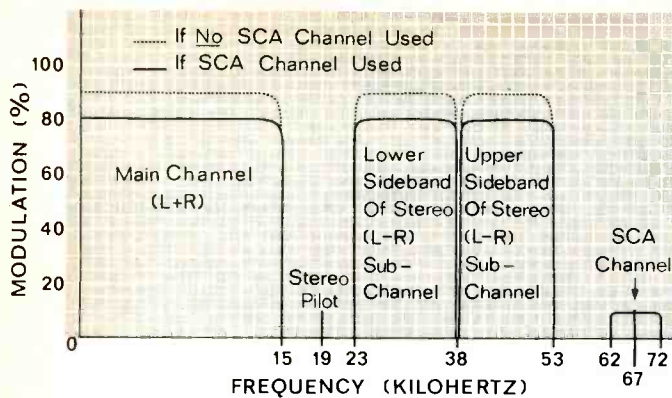


Fig. 1—Spectral distribution of information on FM channel.

SCA decoding equipment. Perhaps the most-often-used approach is illustrated in the block diagram of Fig. 2.

The small amount of 67 kHz subcarrier recovered at the detector (either a discriminator or a ratio detector type) of the standard FM tuner is first passed through a 67 kHz resonant circuit of moderate selectivity which rejects some (but not all) of the other material present. A stage of isolation usually follows (such as an emitter follower), to prevent circuit loading of the main FM detector (not shown). A local oscillator (often, but not always crystal controlled) produces a frequency which is 455 kHz above that of the incoming subcarrier. Thus, for a 67-kHz subcarrier, the local oscillator would be tuned to 522 kHz. The two signals are heterodyned in much the same way as is done in any AM radio, producing an "i.f." frequency of 455 kHz. This choice enables the use of very ordinary "AM i.f." transformers, and a sufficient number of stages of gain employing such interstage transformers are used to both reject anything other than 455 kHz and to build up the signal to a well-limited one.

Finally, since we are dealing with FM (despite the use of a familiar "AM" frequency), detection is accomplished by a discriminator tuned to a center frequency of 455 kHz. Ratio of deviation to total frequency is not unlike that associated with regular FM. Here we have a deviation of approximately 4 kHz about a new center frequency of 455 kHz, as opposed to the more familiar 75 kHz about a frequency of 10.7 mHz.

Audio recovery is fair, usually running about 0.1 volts rms for 4-kHz deviation. Cost, however, is quite high, since several stages of 455-kHz amplification are required, not to mention crystal control of local oscillator, and a converter stage, "i.f." transformers, a rather expensive, specially made discriminator, and so on.

Back in October 1958, in the AUDIO edition of that month, I described an alternate method of FM subcarrier demodulation, a

block diagram of which is shown in Fig. 3. In this approach (still used, by the way), the 67-kHz subcarrier is processed "as is."

The first stage is for isolation, followed by a band-pass filter that is employed to remove everything but the desired 67 kHz. Amplified further, the 67-kHz signal is used to key a "Schmitt Trigger" type of multivibrator which produces square waves of large constant amplitude, the frequency of which follows the frequencies of the incoming 67 kHz subcarrier as it is modulated, ± 4 kHz based upon program audio. The square waves are then differentiated to form narrow width pulses, which are then "counted" or integrated by a form of counter detector. In this form of detector, the more closely spaced pulses will cause a greater output (instantaneous d.c. level) while more widely spaced pulses (corresponding to the downward deviation away from 67 kHz) will cause reduced d.c. level. The movement above and below a nominal

Fig. 2—One approach to 67-kHz decoder circuit utilizes heterodyning and an AM-type i.f. strip.

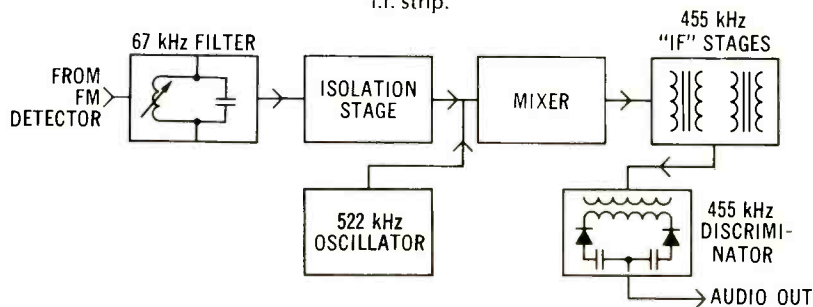


Fig. 3—An early SCA decoder described by the author (AUDIO, October 1958).

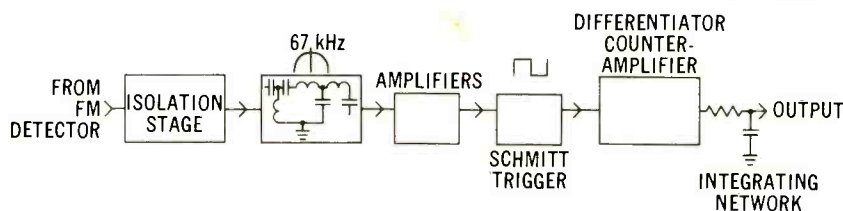
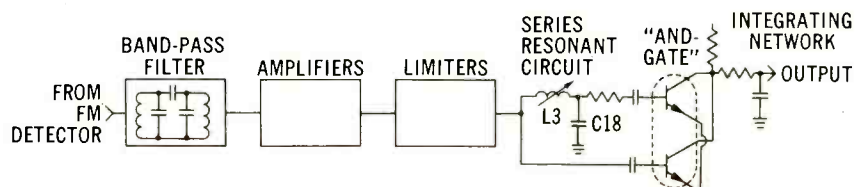


Fig. 4—Block diagram of new SCA decoding system.



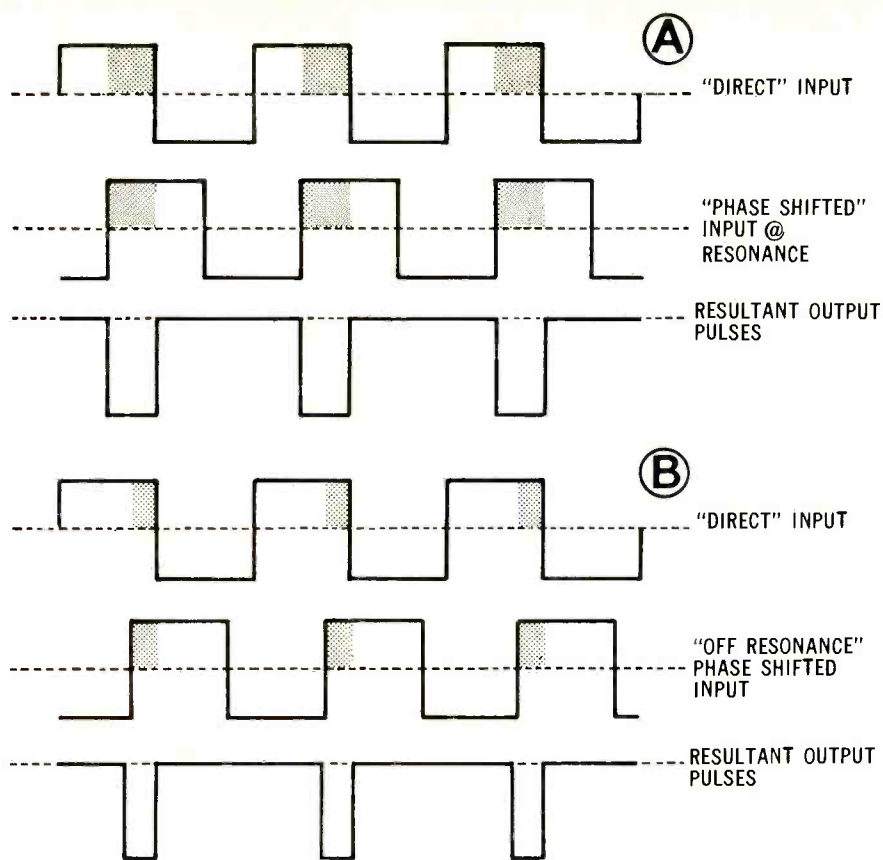


Fig. 5—Principle of "Gate" FM detector. Output pulses at (A) are for unmodulated condition of sub-carrier, while those in (B) represent departure of sub-carrier from center frequency.

d.c. center point, with changing frequency above and below the nominal 67 kHz, represents the detected audio output of the system. Extremely linear output is a known characteristic of such counter-detectors. In this instance, because of the relatively small difference in "integrated area" of pulses as one goes from 63 kHz to 71 kHz, the actual audio output using this system is *extremely* low, measuring much less than 0.1 volt for the parameters involved in SCA transmission. Though the circuit is less costly than the 455 kHz type already described, the very low output more than offsets this advantage since extra stages of gain must follow detection and these, unfortunately, can do nothing to improve signal-to-noise factor.

The system of decoding suggested by Mr. Crosby is shown as part of the block diagram of Fig. 4. It is based upon one of the most common of "logic" circuits used in computers, but perhaps unfamiliar to

those in the audio and communications field—the "AND" gate. An AND gate is simply a device that produces an output, "C," only when two inputs, "A" and "B," are present. With only input "A" or only input "B" present, no output will be produced. With this idea in mind, let us examine Fig. 4.

The first block represents a simple band-pass filter, which rejects all frequencies other than those at or near the desired 67-kHz center. Two stages of amplification follow, which utilize high-input impedance FET's. The signal is then further amplified and limited by a pair of IC's. The output of the second IC is a fully limited signal which closely resembles a square wave. This signal is passed along two paths. The first, via simple capacitive coupling, applies the signal to one transistor of the pair making up the AND gate. The second path includes a resonant circuit tuned approximately to 67 kHz (L3 and C18 in Fig. 4). The voltage

applied to the alternate transistor of the AND-gate pair is taken from the voltage appearing across the capacitor element of the series resonant circuit. This voltage therefore differs in phase from that directly fed to the other input by approximately 90 degrees.

From the previous explanation of gating action it is obvious that an output will be present for only that period of time in which *both* inputs are positive *and* overlap in time (or, 90 degrees out of a possible 360). Thus, the output will be a series of pulses having a fundamental frequency of 67 kHz and a duty cycle of 90 degrees.

Now suppose we depart from 67 kHz (as would be the case when the signal is modulated with program information). Since we are now feeding frequencies which are on either side of resonance, the phase difference between the directly fed signal and that taken from across the capacitor of the series resonant circuit will no longer be 90 degrees, but will vary above and below that angle. This means that the period during which both inputs are positive and applied to the gate will be shorter when the angular difference increases, and longer when the angular difference decreases. As a result, the *area* or width of the output pulses will vary, too. And variance is considerable compared to the area difference arising merely from the slight change of frequency (as might be the case in a conventional counter-detector). A simple integrating network (in this case, an R-C network which would be needed to provide de-emphasis anyway) is all that is required to translate this changing pulse area into a whopping audio signal.

Fig. 5 illustrates the "gate FM detector principle" just discussed. The "Q" of the series resonant circuit need not be very great to take advantage of this principle. For example, fractional detuning of 4 kHz above or below resonant frequency (67 kHz) results in a phase lag or lead of nearly 50 degrees with a circuit "Q" of only about 10 or so!

A practical SCA adapter, using the above principle, will be examined next month.

Electronic Organs

PART 1 of a series

NORMAN H. CROWHURST

Introduction to how electronic organs work

AN UNDERSTANDING of electronic organs involves a wedding of two kinds of knowledge: musical and electronic.

From the electronic viewpoint, and to some extent in the music department also, organs can be divided according to the way the tones are generated. In grandfather's days, home organs used reeds, driven by air pressure or vacuum which was obtained by foot-operated bellows.

Modern adaptations use electrical power to blow the reeds, relieving the feet of all that work, and they provide electronic amplification of the vibrations to make the sound louder, and allow loudness control. As amplifiers are not electronic tone generators, we'll not consider this group to be true electronic organs for the purposes of this discussion.

In the same category with this kind of organ is the so-called electronic piano, to which we will also give only passing mention. Instead of using the bridge and sound board to radiate sound, this instrument uses neither, but employs pickups and electronic amplification to get the desired volume of sound. With the amplifier off, such a piano is very nearly silent.

Electromechanical Tone Generators

Next we come to two varieties of organ that are truly electronic, although the pitch of the notes is determined mechanically. This type we will call "electromechanical." Best known is the Hammond, which

uses magnetic tone wheels driven at different speeds, using pickups to give the electrical output. As we shall discuss later, the Hammond uses electronics to a far greater extent than the mere use of pickups and amplification from a mechanical-type source.

The other electromechanical type hasn't been seen too much in the U. S. The Compton organ uses it. The pickup is capacitive, and the complete waveforms are etched on tone wheels driven in a manner similar to the Hammond (Fig. 1-1).

The main difference between these two types, apart from the type of pickup used, is that the Hammond synthesizes tone quality electronically, while the Compton has the waveform physically built into the tone wheel.

Individual tones generated on the Hammond are basically close to sinusoidal. They are very nearly perfect sine waves. Overtones or harmonics, to give timbre, are added by electrically adding the outputs from different tone wheels. In the Compton, the composite waveform, complete with all its harmonics, is etched on the tone wheel.

Electronic Generators

Having briefly dispensed, for the time being, with the types that may be considered partially electronic, we now turn to the fully electronic types of oscillator, which have no mechanical moving parts of any kind. These use some kind of elec-

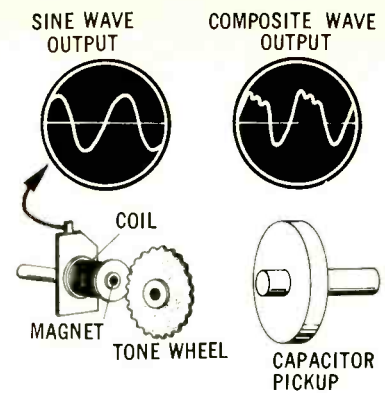


Fig. 1-1—Two types of electromechanical tone generator: (a) The magnetic, used by Hammond, generates a sinusoidal output. Timbre is achieved by mixing the outputs from as many as 9 tone wheels. (b) The electric (sometimes called "electrostatic"), used by Compton. Here, each tone wheel generates a composite wave, with a wave form etched into the original wheel.

tronic oscillator as tone generator.

Two basic kinds can be distinguished, depending on the way the pitch of the tones generated is determined. Some oscillators use a tuned circuit, the waveform of which is basically sinusoidal. If it oscillates too hard, the sine wave goes out of shape, but it is still basically sinusoidal.

When it oscillates too hard, the frequency is less definitely fixed by the circuit L and C values, so frequency stability is more likely to be a problem. But stability is a complicated question, which we will come to in a later installment.

The other type of oscillator works on time intervals, and is exemplified

Fig. 1-2 — Essential difference in basic waveforms generated by two types of generator: (Top) The sine wave, generated by tuned circuit oscillators. (Bottom) The square wave, generated by multivibrator-type oscillators. In each case, the basic, or theoretical waveform is at the extreme left, while the other waveforms are practical variations of it, within the type.

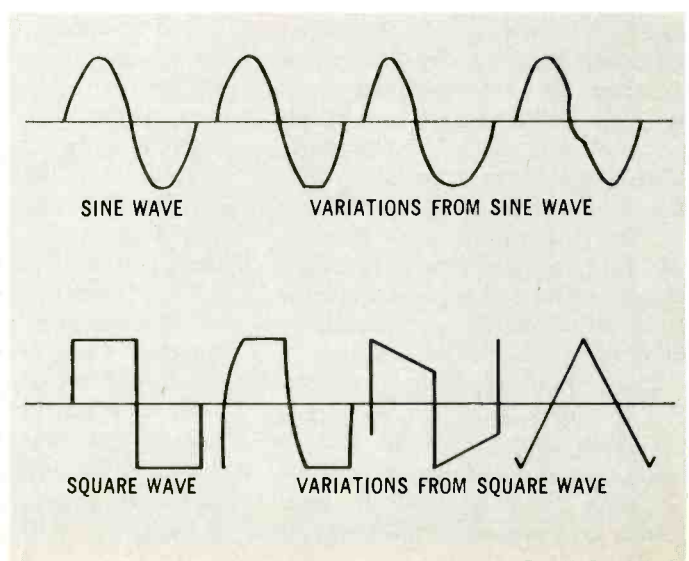


Fig. 1-3—A simple generator circuit for the type of solo organ used as an add-on unit for attaching to a piano.

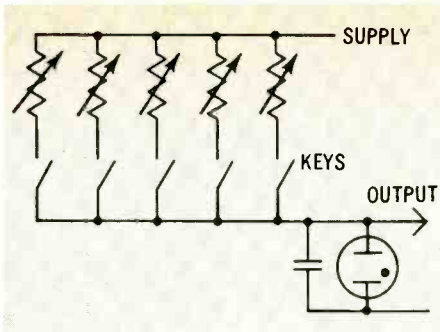
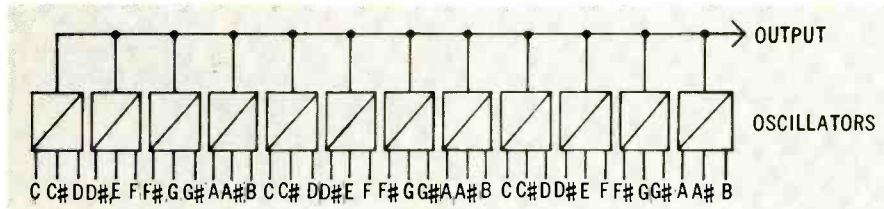


Fig. 1-4—Arrangement of some earlier organs had groups of two or three (the latter shown here) notes sharing each oscillator. Only one note of any group of three could be played at one time. Thus a C minor chord could be played, consisting of C in the first group, D# in the second group, G in the third group, and C in the fifth group.



in the multivibrator. The basic output of a multivibrator is square, although a variety of other waveforms can be "found" around a multivibrator circuit, or easily developed from it.

Fig. 1-2 shows the distinction, together with the essential difference in the waveforms, as generated. Frequency of a sine wave is basically related to a rate of movement, of the harmonic motion type. Period of a square wave is a question of timing between movements, such as switching, whose rate has no essential connection with frequency.

From the musical viewpoint, the quantities of frequency and time interval, or period, are inseparably related, but in considering kinds of generator, this significant difference exists.

Generator Arrangement

Now we have the basic parts from which to build an organ. But still there are different ways of going to work with these parts, of stacking them up, as it were. We can use varying generator arrangements.

The simplest kind of "organ" is sometimes supplied as a solo unit for affixing to the front of a piano keyboard to give extra effects. This uses just one tone generator, which the keyboard switches to a variety of frequencies. It can play only one note at a time. A simple form of generator uses no more than a neon tube, capacitor and different charge resistors for every note (Fig. 1-3).

Some of the earlier organs used this method, possibly with more sophistication for part of the organ, the part intended to be played as solo, one note at a time. Other earlier organs wired one keyboard in a sort of hybrid fashion, where one oscillator serves two or three notes rather than having one for every note (Fig. 1-4).

With these organs, only one of any group of notes using the same oscillator will sound at a time. Not many of these are still in use.

Master Oscillators. The most inexpensive organ capable of playing any combination of notes, as well as being the easiest organ to tune, uses an arrangement with just 12 tone generators or oscillators (Fig. 1-5). Some organs of this type may have more than one master set of 12 oscillators, but the idea is the same. Using more than one set makes the

organ richer in overall tone quality, or it's one way of achieving that effect.

With organs of this type, only the top octave has actual tone generators. Octaves below that are obtained by using frequency dividers. Each octave gets its notes by halving the frequency of the notes in the octave above. When the top octave has been tuned, the whole organ is in tune, automatically.

An essential feature of this kind of organ is that all generators must be oscillating all the time, as are the frequency dividers performing their dividing function. With this type, keying must essentially consist of switching the outputs of the oscillators and dividers that are always running.

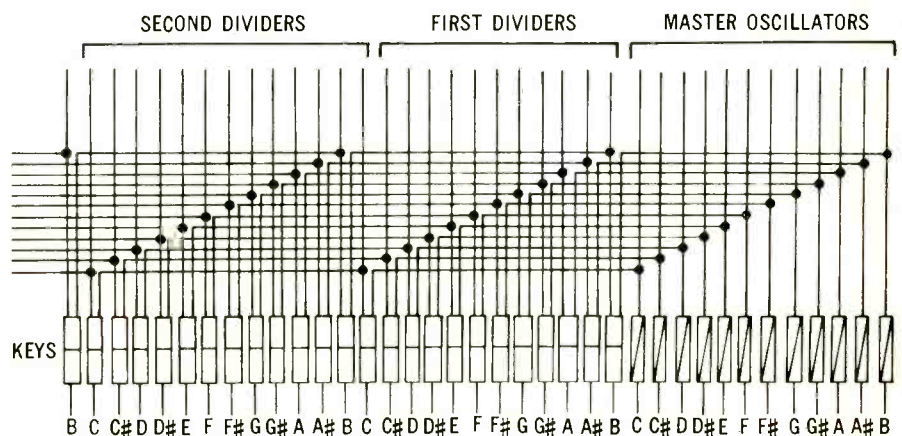
Individual Oscillators. The final type of organ uses a separate oscillator, or more than one, for every note on the keyboards. Only the best organs can afford to include this much electronics and the work involves tuning every one. But when such an organ is tuned, it sounds like a lot more organ.

Timbre or Tone Quality

The next step in designing an organ is to find a way of varying the tone quality or timbre of the notes. An organ may employ one of three different ways to achieve this, although each way is limited, or more readily adaptable, to certain kinds of generator.

Frequency Synthesis. The first type literally puts together the component fundamental and all the har-

Fig. 1-5—The master oscillator system uses only 12 generators (at the right). Lower octaves are obtained by frequency dividers working successively.



monics needed to produce the desired tone quality in each note played (Fig. 1-6). This approach can only be applied to sine-waveform generators.

The only well-known organ employing it today is the Hammond, which uses drawbars to mix harmonics in the desired proportion. Each drawbar works a set of potentiometers in the outputs of the harmonic that the drawbar represents. This approach provides virtually infinite variety to the overtone structures that can be used.

Formants. The remaining types of tone formant work on the output waveform are already produced by whichever type of generator is used. The commonest and simplest is the response formant type. This takes the output from the whole range of oscillators, after they are keyed, and feeds it through a filter that weights lower or higher frequencies. Thus the overall output of the organ is "colored." Different filters can work in parallel to combine effects (Fig. 1-7).

Wave Shaping. The third type of formant works on waveform, rather than on frequency content. It can best be understood by assuming it as used with the multivibrator type of generator, whose waveform is first changed from square wave to triangular (Fig. 1-8). Then the triangular waveform is fed into the waveform-forming networks, which shape it into any desired form. This is much more complicated, but also much more versatile in the kinds of output waveform it can produce.

Integrated circuits have made it feasible for medium-priced organs, where before it would have been prohibitive for any but really high-priced organs. Although we illustrate it applied to the multivibrator form of output, this is not the only type that can use it or an adaptation of it.

Each method of changing tone quality has its merits or range of uses. Some organs use more than one form.

Other Features

That gives us the basic elements of the organ. Now come the trimmings, which may be used in varying quantities, according to how

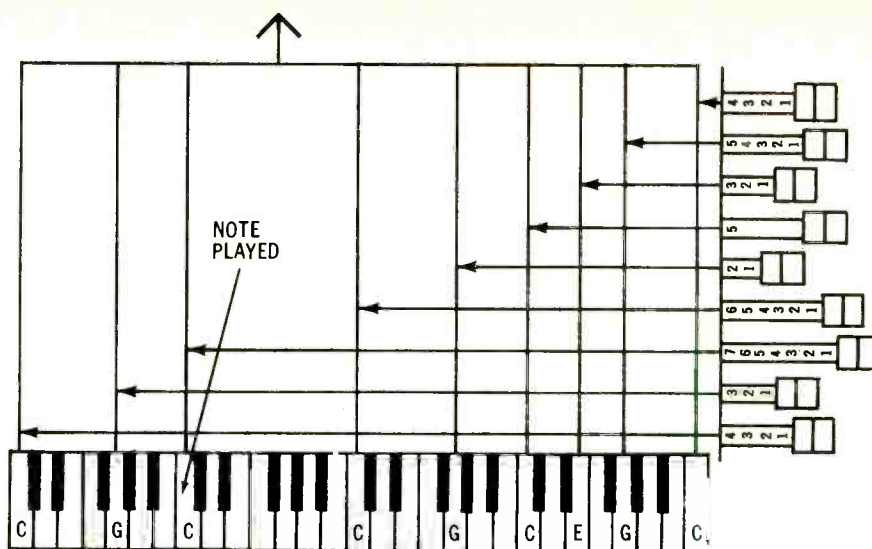


Fig. 1-6—Frequency synthesis as a way of developing timbre. This diagram assumes note C is played. The drawbars (Hammond method) control how much tone is taken from the various other wheels indicated. In ascending order, the bars illustrated represent: sub-harmonic, sub-third, fundamental, second harmonic, third harmonic, fourth harmonic, fifth harmonic, sixth harmonic, and eighth harmonic.

much you want to spend. Organs today include a lot more of them for less money than earlier organs would have cost.

Unless you're interested in church organ music only, with a baroque quality, your organ is certain to have some form of vibrato or tremolo that gives the notes that wavery effect. Many of the better organs have more than one vibrato or tremolo; some a choice and some the possibility of combining effects.

Most modern organs have something in the percussion, sustain and reverberation department. The simplest of these is sustain. The keying is designed so that the tone dies away electronically when the pressure of the finger on a key is released.

The earliest organs to include this feature called it "percussion." Actually it is not. Percussion applies not to the way the note dies away, but to the way it begins. True percussive effects use further electronic means that add something to the beginning of the note when the key is first pressed. A sort of extra attack, rather than just "switching the note on" (Fig. 1-9).

Reverberation has an effect somewhat similar to "sustain." The difference is that it works after all the notes are mixed together; more like a reverberation effect in a large hall. This uses the same kind of reverb units that are used to add that quality to recordings.

Finally come the real "luxury" trimmings, mostly reserved for the

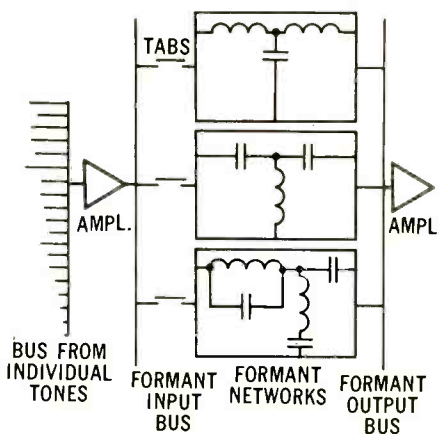
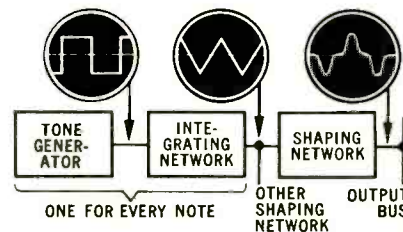


Fig. 1-7—Arrangement of the formant type of timbre control.

Fig. 1-8—The wave-shaping method: The square wave is first made triangular; then electronic shaping controls alter this to any desired shape.



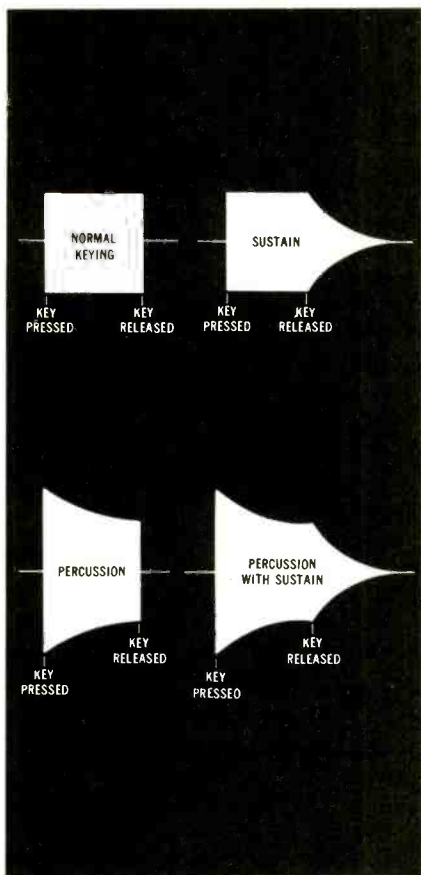


Fig. 1-9—The difference between percussion and sustain. Top left shows the envelope of a wave keyed with no electronic effect added. Top right shows the addition of electronic sustain to the keying. Bottom left shows the addition of one form of electronic percussion to the keying. Bottom right puts the two together.

highest-priced models in the manufacturers' lines, although one of them also comes as an alternative on many of the lower cost organs.

One that only comes as an extra on the best organs is the side-effect department. This has a variety of special names used for promotion purposes, but its effect is to add drums, traps, cymbals and other non-tonal effects.

Some of them take their cue from the player, using electronic means to automatically synchronize the electronic "drummer" with the music you play at the moment. Others can be set to provide a regular beat or rhythm, which they will hold until you change it. With these the organist keeps time with the drummer, rather than vice versa.

Many of the low-cost organs provide some means for automatically

selecting appropriate chords. This is for those who have difficulty reading music well enough to get their fingers in position to pick out the right notes to play the full chords themselves. Not to be confused with this relatively simple chord-making feature, although related to it, is another kind of extra that makes automatic arpeggios, which play the notes in a chord in sequence, like a strum, rather than all at once.

That wraps up most of what goes into the electronics of an organ. We've stayed away from manuals and pedal claviers, the mechanical details associated with playing, for the time being. We'll have to go into that too, when we get down to details. In future installments we'll progress into details, beginning with the next issue, on what goes to make an electronic organ musically satisfying. Æ

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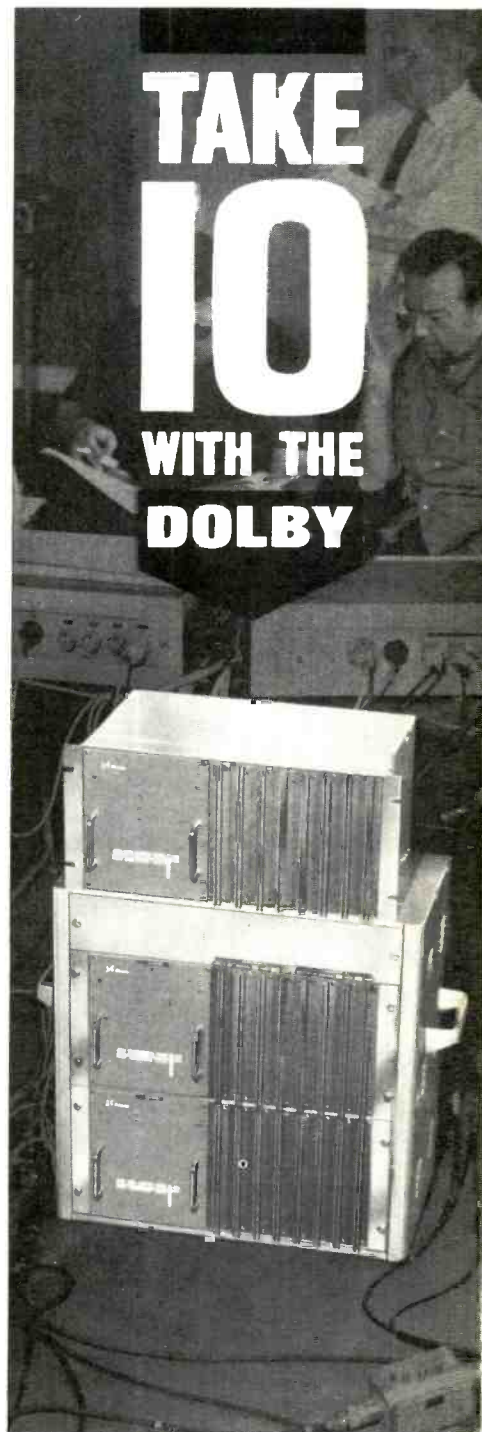
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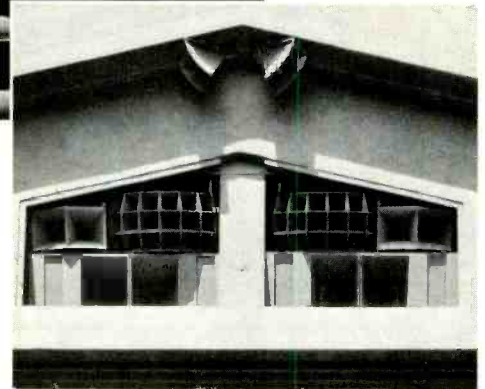
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Fig. 1—View of the seating area and stage of the open-air theater in which the sound system installation described in the text was made. A close-up of the loudspeaker array is shown in the inset photograph.



A Greek Theater (circa 1968)

DON DAVIS*

Sound installation for a modern open-air theater

THE CLASSIC GREEK open-air amphitheater has presented acoustic problems since its inception in antiquity. Witness the works of Vitruvius, the tuned resonant vases found in the risers of the ancient theaters, and the use of the megaphone concept designed into the masks worn by the actors.

Recently, a modern Greek-style theater in Hollywood, California employed up-to-date electro-acoustic techniques to achieve startling results as compared to the ancients, and remarkable results as compared to modern contemporaries.

Five Guidelines

The requirements to fulfill the performance promise inherent in the latest electro-acoustic equipment break down into the following interlocking steps:

1. Correct acoustical design of the loudspeaker enclosure and cluster. This includes time-difference relationships from a cluster to audience vs. performer to audience, acoustic gain potential, and realistic coverage patterns at properly adjusted gain differences that compensate for the inverse-square-law effect of dispersion.
2. Proper electronic system design that provides sufficient *electrical* power to ensure generation of the required *acoustic* power.
3. Correct electronic design to provide full flexibility of source-type and location.
4. Full electro-acoustic equalization to insure optimum acoustic gain and high-quality full-range program reinforcement.
5. A system survey that measures in detail the electrical and acoustical adherence to the design standards set for the system.

This article covers briefly how one professional sound contractor¹ went

about meeting the spirit of these five guidelines in an actual installation.

Site Survey

The first step taken was a site survey of the theater. Tools used were a 100-ft. tape measure, an inclinometer, a sound-level meter, and a Polaroid camera. These tools were used to determine the following data:

(1) Find the height of the proscenium arch. The loudspeaker would be at its optimum, from a placement viewpoint, if this location were used. The listener's tendency to think that the sound was emanating from the stage itself would be at a maximum.

(2) The height also was needed to calculate the acoustic gain achievable from a loudspeaker located at that position relative to the required microphone locations on the stage. Through the use of the tape measure and the inclinometer, highly accurate height readings were achieved by simple triangulation.

(3) Next, the width, length, and rise of the audience area were re-

* Manager, "Acusta Voicing," Altec Lansing, Div. LTV Ling Altec Inc.

¹Hannon Engineering, Inc., Los Angeles, Calif.

corded. This allowed a simple plan and a section view of the theater to be drawn for use in laying out loud-speaker projection angles.

(4) The SLM was then used to read the typical overall ambient noise levels at the site on the "C" and "A" scales.

(5) The Polaroid camera was used to photograph the total site and any of the architectural details that might require further study. Such simple photographs can often save additional trips to the site by showing the detail desired but not recorded in the written data.

All the data gathered on the site survey were taken back to the engineering offices of the sound contractor and translated into a sound system layout. Using the plan view and section view developed from the tape and inclinometer measurements, the number and type of multicellular horns were determined. Consideration of the ambient noise levels and type of program material and audience encountered determined the maximum sound-pressure level goal at the rear of the seating area. This can vary over a 20- to 40-dB range, from reinforcement of poetry readings to providing "enhanced" reinforcement of Rock & Roll bands. Twenty- to 40-dB differences become meaningful when

translated to electrical power required by the sound system.

If the poetry reading can be carried off with a $\frac{1}{10}$ -watt peak electrical power in a high-efficiency system (30% or better), then the Rock & Roll group will require 1,000 peak electrical watts. These are not fanciful figures, but are derived from actual system data. The peak figures naturally reflect an expected average program power of approximately -10 dB or $\frac{1}{10}$ the peak power. In very high quality, conservatively designed sound systems, a 15 to 20 dB peaking ratio can be employed.

Typical System Planning

Obviously, the projected sound-pressure-level (SPL) goal will determine the number of loudspeaker drivers required to handle the power. Thus the necessity of high efficiency in reinforcement work becomes glaringly important. A simple example from this installation can suffice here, as follows:

The Altec 288-C high-frequency driver chosen yields 112 dB-SPL at four ft. with one electrical watt of input power. Its maximum power rating is 40 watts. Therefore, it will give a peak acoustical level at four feet distance of 128 dB-SPL. It is 200 feet from the loudspeaker location to the rear of the seating area

and, being outdoors, the inverse square law dispersion effects are fairly reliable indicators. Therefore, we would expect a peak acoustic SPL of 82 dB, or an average program level of 72 dB. Since the theater handles primarily legitimate stage plays and the site is known for its woody tranquility (confirmed by the very low sound-level-meter (SLM) readings of 45 to 50 dB), these become quite satisfactory figures.

Two Altec 203B twin-cell multicellular horns are used to cover the upper-rear audience seating area with high-quality, low-distortion program levels of 75 dB. (The two horns combine for a 3-dB increase in SPL over the single horn. This information gives us the requirement for one 80-watt power amplifier.)

Looking further into the projection angles of our drawings, we find, due to the width of the house, a need for two 18-cell multicellular horns if good coverage is to be maintained. Due to this area being $\frac{1}{2}$ the distance at its extreme from the loudspeaker array as the rear listening area, these horns require 6 dB less input power than the rear area horns. However, the rear area horns, having a narrower coverage angle, produce a higher SPL per watt. And, the wider horns' greater dispersion

Fig. 2—The power-amplifier rack with complement of four Altec 160-watt power amplifiers. There is sufficient power to allow for moderate expansion of the loudspeaker system.

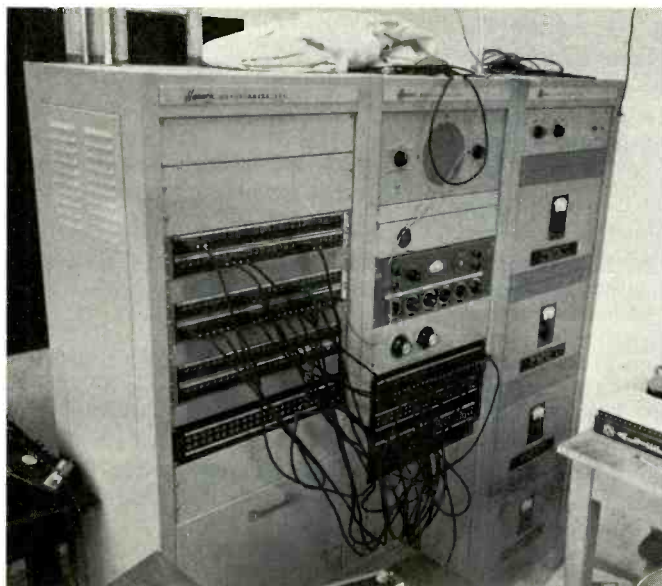


Fig. 3—View of the Altec 9200 console, custom built for the Greek Theatre. Should expansion be required at a later time, different strip modules can be installed.



angle means that slightly less than a 6-dB power differential will be applied. At this point, these four multicellular horns provide full high-frequency coverage for the major part of the seating area. It is now necessary to match enough low-frequency energy to them so that the audience will hear a natural balance of both high and low frequencies.

Using the specified efficiency ratings of the drivers involved plus their enclosures led us to select four 15-in. low-frequency drivers mounted in four large combination-type enclosures. To achieve the proper sound pressure level in this case required 160 watts of power. The four drivers chosen can handle up to 200 watts safely. This leaves only the front side areas uncovered. Two Altec 300-Hz sectoral horns mounted above the main array supply this need. A 40-watt power amplifier safely supplies the necessary electrical power here.

Planning for Power Amplifiers

It can now be seen that, in developing the proper loudspeaker coverage for the audience seating area, we have also accurately determined the maximum electrical power required and how to best divide it among several amplifiers. We have:

Two (2) 80-watt amplifiers for the four (4) multicellular horns . . .	160 watts
One (1) 160-watt amplifier for the four (4) 15-in. woofers	160 watts
One (1) 40-watt amplifier for the two (2) sectoral horns	40 watts
TOTAL	360 watts

If Rock and Roll groups were to be handled in this theater, the magnitude of the problem can be realized by visualizing the size of the loudspeaker array capable of safely handling 3600 watts at the same efficiencies as provided in this array. It should also be apparent why professional sound engineers do not use low-efficiency column speaker systems.

Planning for Speech-Input Equipment

The speech-input equipment is largely determined by the number of mixing positions required, the desired dynamic range, and the amount of total hum, noise and distortion that can be tolerated.

In the case of the system illustrated here, no compromises were to be tolerated; a 24-microphone plus one-phono and one-tape-input Altec 9200A console was constructed. The equivalent input noise level was -128 dBm, $+27$ dBm the maximum output level, and maximum operator comfort with speed and versatility were to be maintained. Slide wire attenuators were chosen because more of them can be mounted within a normal operator's arm span than can equivalent rotary controls, and also because they feature 0.1-dB increments and extremely low noise in use.

When designing complex speech-input systems, the temptation is great to include all the current "cheese keepers." The seasoned professional, however, restricts the controls on his panel to only those actually required at the present time. Note that on the console illustrated here, provision has been made for additional controls *if the need arises later*, but only the actual needed controls *now used* are mounted and connected.

Two forms of equalization are included in this console. The first is individual dialogue equalizers on three of the microphone inputs plus one for the main program channel. In addition to this, a graphic equalizer is used to shape the overall acoustic response of the sound system to as close to uniform amplitude as possible, thus allowing maximum acoustic gain to be developed before dialogue equalization is attempted.

Proofing the System

Once the system was designed, constructed, and carefully shop tested for conformity to its electrical specifications in regard to equivalent input noise, total harmonic distortion, frequency response, maximum power output, proper grounding,

freedom from spurious oscillations, hum, and noise, it was ready for installation on the site.

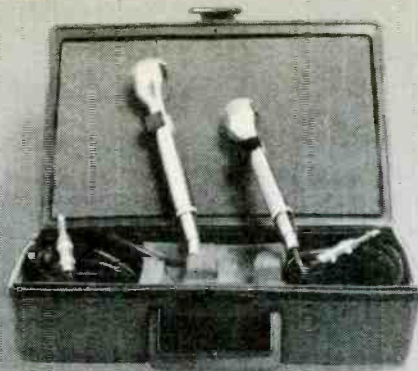
Installed at the site, these same electrical specifications were again confirmed. It is at this point that the *acoustic tests* of the sound system begin, and it is here that many present-day sound contractors are remiss in their duty. To leave the sound system as finished after the electrical tests are completed is about as satisfactory as connecting a magnetic cartridge into a linear preamplifier and expecting good results without the benefit of proper equalization. The interaction of the acoustic with the sound system always requires more complex equalization than any cartridge manufacturer ever contemplated. For example, the following acoustical tests were performed:

1. The measurement of the distribution of the sound system's acoustical energy throughout the audience area, as measured in the 4000-Hz octave band.
2. The measurement of the acoustical frequency response of the sound system taken in the audience area.
3. The equalization of the measured frequency response until maximum acoustical gain is obtained. In this case, 32 dB of acoustic gain was achieved. If there had not been sufficient acoustic gain after the use of the graphic equalizer, then the system would have been Acousta-Voiced² using the 9014A Filter Set. But, achieving adequate acoustic gain outdoors is seldom the problem that it is indoors, thanks to the absence of multiple reflective paths.

Increasingly, the better sound contractors now own sound-level meters, octave-band and $\frac{1}{3}$ -octave-band analyzers, graphic level recorders, random-noise generators, pink-noise filters, tone-burst generators, oscilloscopes, oscilloscope cameras, impedance bridges, and elaborate sound-system equalization facilities—all used or available on the Greek Theater job. Æ

²Trade Mark, Altec Lansing.

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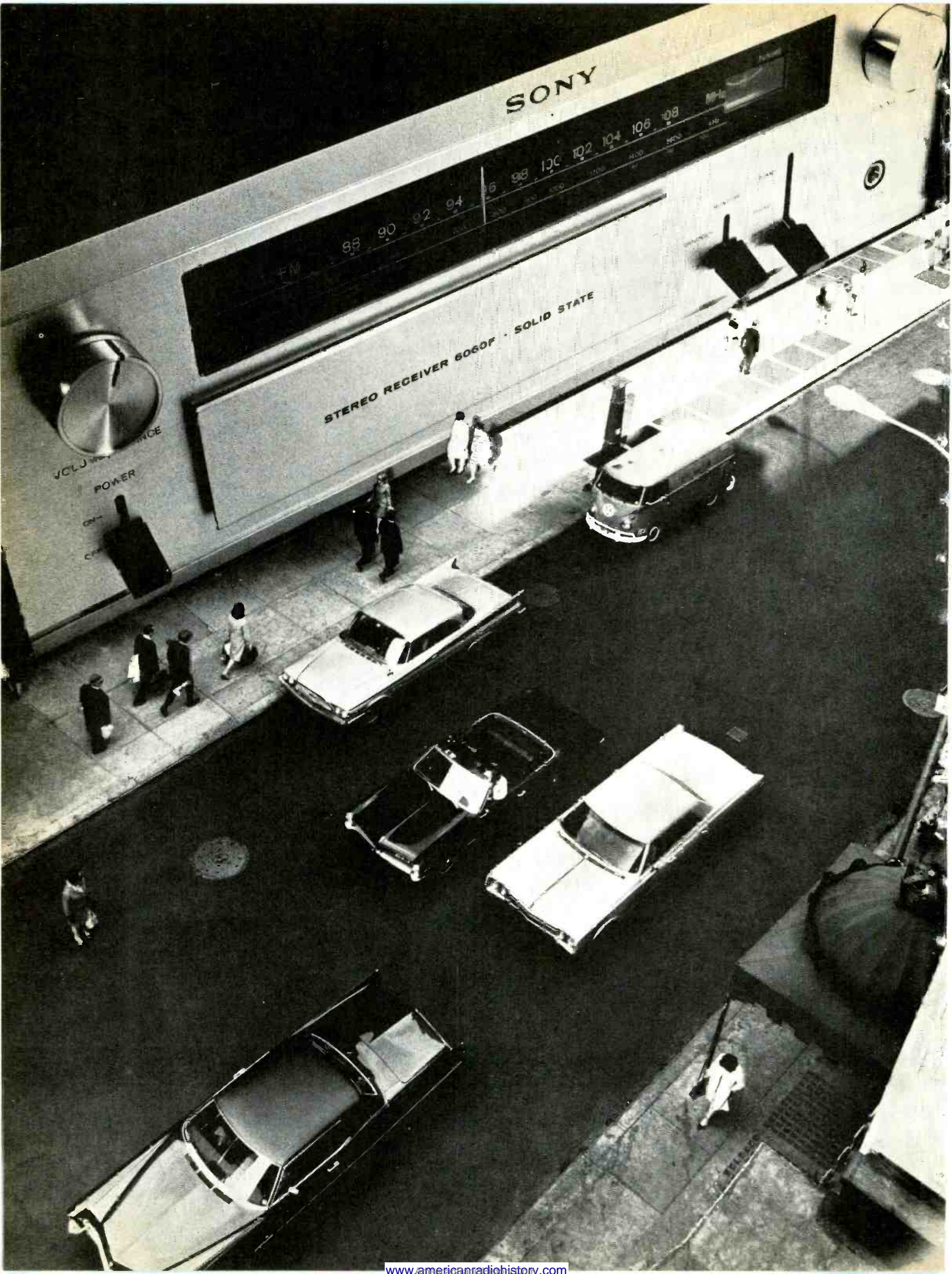
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ALABAMA BIRMINGHAM: Likis Stereo Center, 2018 11th Ave. So.

ARIZONA PHOENIX: Bruce's World of Sound Inc., 2711 E. Indian School Rd.

CALIFORNIA ANAHEIM: Henry Radio, 931 N. Euclid Stereo Mart, 979 S. Anaheim Blvd. AZUSA: Rancho Sound, 18532 E. Alosta Ave. CANOGA PARK: Wallichs Music City, 6600 Topanga Cyn. LAKEWOOD: Wallichs Music City, 5255 Lakewood Blvd. LONG BEACH: Humphrey's Music Co., 135 E. Third St. Wallichs Music City, 1501 N. Vine St. Winstead Cameras, 5015 E. Second LOS ANGELES: Bel-Air Camera & Hi Fi, 927 Westwood Blvd. Crenshaw Hi Fi, 4051 Marlon Ave. Henry Radio, 11240 W. Olympic Blvd. Henry's Camera, 516 W. 8th St. Jonas Miller Stores, 3025 Crenshaw Magnetic Recorders, 7120 Melrose Ave. Schireson Bros. 344 So. Broadway Winstead Cameras, 724 So. Broadway PALM SPRINGS: Palm Springs Music, 360 W. Palm Canyon Dr. Pat Barbara Music, 121 So. Palm Canyon Dr. PALO ALTO: Yamaha Peninsula, 3731 El Camino Real PASADENA: High Fidelity House, 563 S. Fair Oaks Ave. Stereo Mart, 3205 Foothill Blvd. REDONDO BEACH: Bay Elect., 2315 Artesia Blvd. SAN DIEGO: Milo Double "E", 3686 El Cajon Blvd. SAN FRANCISCO: Skinner Hirsch & Kaye, 229 Kearney St. Tokyo Electronics, 1766 Buchanan St. SANTA ANA: Hi Fi Assoc., 2220 No. Main SANTA MONICA: Bob Pilot's Stereo Ctr., 2201 Santa Monica Blvd. SUN VALLEY: Electronics Division, 7562 San Fernando Rd. TARZANA: Stereo Mart, 18410 Ventura Blvd. TORRANCE: Griffey's Elect., 3840 Sepulveda Blvd. Wallichs Music City, 17540 Hawthorne WEST COVINA: Wallichs Music City, 2917 E. Garvey Ave. WHITTIER: Oxbow Elect., 15914 E. Whittier Blvd.

COLORADO BOULDER: Lloyds Hi Fi, 1134-13th St. DENVER: Empire Audio Exchange, 1100 Broadway Lloyds Hi Fi, 1599 S. Colorado Blvd.

CONNECTICUT NEW HAVEN: David Bean Smith, 262 Elm St. NORWALK: Arrow Elect., 18 Isaac St. WESTPORT: Klein's, 44-50 Main St.

WASHINGTON, D.C.: Glen Music & Audio, 1204 "G" St., N.W.

DELAWARE WILMINGTON: High Fidelity House, 3910 Concord Pike

FLORIDA MERRITT ISLAND: Stereo Assoc. (Helene's Int), 545 N. Courtenay Pike MIAMI: Electronic Wholesalers, 9390 N.W. 27th Ave. Hi Fi Associates, 3188 Biscayne Blvd. ORLANDO: Electronic Wholesalers, 345 Graham Ave. TAMPA: Viviano Hi Fi Center, 1538 So. Dale Mabry Hwy. TITUSVILLE: Stereo Assoc. (Helene's

Int), 4549 S. Hopkins Ave.

ILLINOIS CHICAGO: Allied Radio, 111 N. Campbell Ave. Musiccraft, 2035 W. 95th St. Musiccraft, 48 E. Oak St. Schwartz Bros., 8533 S. Cottage Grove

LOUISIANA BATON ROUGE: Kadair's Inc., 226 W. State

MARYLAND BETHESDA: Audio Center, 4962 Fairmont Ave

MASSACHUSETTS CAMBRIDGE: Audio Lab, 16 Eliot St. Minute Man Radio, 30 Boylston St., Harvard Sq. SPRINGFIELD: Consumer Audionics of Springfield, 461 Summer Ave.

MICHIGAN DEARBORN: Alamas Hi Fi Stereo, 15031 Michigan Ave., DETROIT: Pecar Electronics, 11201 Morang Dr. Stereoland, 17131 W. McNicols, 20746 Mack Ave.

MINNESOTA MINNEAPOLIS: Audio King, 7010 France Ave., So.

MISSOURI KANSAS CITY: David Beatty Hi-Fi, 1616 W. 43 St. ST. LOUIS: Hi-Fi West Inc., 8217 Delmar Blvd.

NEW JERSEY CHERRY HILL: High Fidelity House, 244 W. Marleton Pike NEW BRUNSWICK: Hi Fi Haven, 28 Easton Ave. NORTHFIELD: Rainbow Electronics, 318 Tilton Rd. PARAMUS: Sam Goody, Garden St. Shopping Plaza SPRINGFIELD: Federated Purchaser, 155 Rt. 22 TRENTON: House of Hi Fi, 1819 No. Olden Ave., Ext. TOTOWA: Arrow Electronics, 255 Rt. 46

NEW MEXICO ALBUQUERQUE: H. Cook, 308 Central Ave., S.W.

NEW YORK NEW YORK CITY: Arrow Elect., 97 Chambers Audio East, Inc., 310 E. 79 St. Audio Exchange, 1305 Second Ave.; 415 Lex. Ave.; 110 W. 32nd St. Electronic Workshop Sales, 26 W. 8th St. Grand Central Radio, 124 E. 44 St. Harmony House, 197 E. 76 St. Harvey Radio, 2 W. 45 St. Interiors & Sound, 1307 Second Ave. Leonard Radio, Inc., 18 Warren St., 1163 Ave. of the Americas Liberty Music Shop, 450 Madison Ave. Lyric Hi Fi Center, 1221 Lexington Ave. Sam Goody East, 666 3rd Ave. Sam Goody West, 250 W. 49 St. G. Schirmer Inc., 4 E. 49 St. Sonocraft Corp. (Asco Sound), 115 W. 45 St. Wexler & Sporty Inc., 125-127 Lafayette St. BRONX: Arista Camera Specialists, 2194 White Plains Rd. BROOKLYN: Audio Exchange, 1065 Flatbush Ave. Kitcraft (Dyna Tech Labs), 738 Washington Ave. FARMINGDALE: Arrow Elect., 900 Broad Hollow Rd. HUNTINGTON: Sam Goody, Walt Whitman Shopping Ctr. JAMAICA: Audio Exchange, 153-21 Hillside Ave. MINEOLA: Arrow Elect., 525 Jericho Tpke. NANUET: Electronics 59, 346 W.

Rt. 59 ROSLYN: Audio Exchange, 1040 Northern Blvd. SYRACUSE: Audio World Hi Fi, 2910 Erie Blvd. Q-Tronics, 3461 Erie Blvd. E. VALLEY STREAM: Sam Goody, Green Acres Shopping Ctr. WAPPINGER FALLS: Arnee Audio Designs, Nine Mall Rt. #9 WHITE PLAINS: Audio Exchange, 239 Mamaroneck Ave. WOODBURY: Harvey Radio, 60 Crossways Pk. W.

OHIO AKRON: Electronic Eng. Co., Audio Hall, 362 W. Bowery St. CINCINNATI: Hi Fi Audio Co., E. McMillian at Woodburn CLEVELAND: Winteradio, 4432 Mayfield Rd. COLUMBUS: Anderson Hi Fi, 2244 Neil Ave. Custom Stereo Electronics, 1391 So. Hamilton DAYTON: Hauer Music Co., 4421 Salem Ave. KETTERING: Hauer Music Co., 3140 Far Hills Ave. PARMA: Winteradio, 5373 Ridge Rd. SPRINGFIELD: Bradley Kincaid Music, 130 So. Fountain TOLEDO: World of Sound, 3139 W. Central Ave. YOUNGSTOWN: Audio Arts, 4224 Market St.

OKLAHOMA OKLAHOMA CITY: Sonax Co., 1200 E. Britton Rd. TULSA: Sound Unlimited, 3745 So. Peoria

PENNSYLVANIA ARDMORE: Soundex, 45 W. Lancaster Ave. FAIRLESS HILLS: C. A. Rogers Audio Lab, 312 Oxford Valley Rd. PHILADELPHIA: Danby Radio Corp., 19 So. 21 St. Sam Goody, 1125 Chestnut St. PITTSBURGH: House of Audio, Terrace Level, 218 Allegheny Ctr. Radio Parts Co., 6401 Penn. Ave.; 929 Liberty Ave. Solar Elect., 2354 No. Mall POTTS-TOWN: Amity Supply Co., 216 River Rd., So. WAYNE: High Fidelity House, 167 W. Lancaster Ave. YORK: Sol Kessler, 126 So. George St.

RHODE ISLAND WOONSOCKET: Sound Products, 230 West School St.

TENNESSEE MEMPHIS: Opus Two, 404 So. Perkins St. TEXAS AUSTIN: Home Entertainment Ctr. 4803 Burnet Rd. DALLAS: Gramophone Shop, 2800 Routh DENTON: Music City EL PASO: Ayoub & Wardy, 218 S. Stanton HOUSTON: Audio Center, 1424 Westheimer Home Entertainment, 5310 Kirby Dr., Nassau Bay Shopping Ctr. Mall, 18091 Upper Bay Rd. LAREDO: Cowli's Music Center, 1212 Hidalgo St. SAN ANTONIO: Vandergriff, 6740 San Pedro Vision Elect., 1116 E. Houston St.

UTAH SALT LAKE CITY: House of Music, 156 So. Main St.; 4835 Highland Dr.

VERMONT BURLINGTON: Concert Elect., 40 Church St.

WASHINGTON SEATTLE: Standard Records & Hi Fi, 1028 N.E. 65 St.

WISCONSIN MADISON: Specialized Sound, 621 Gammon Rd.; 411 State St. MILWAUKEE: Wack Sales Co., 5722 W. North Ave.

ABZs of FM

LEONARD FELDMAN

I.F. Amplifiers

THERE ARE SO many factors to be considered in discussing FM i.f. performance, design and desired specifications, an entire book might be devoted to this subject alone. All we can hope to do in a quick treatment is to acquaint the reader with some of the high points of design and operation of this most vital section of an FM tuner or receiver.

The need for an i.f. section arises from the use of the superheterodyne principle common to both AM and FM equipment. By reducing all incoming signal frequencies to a single, lower frequency (by the conversion or mixing process discussed last month), subsequent amplification is relatively simpler and more stable, and reliable designs can be produced. Actually, the lower the i.f. frequency, the easier it is to come up with an effective design. Why, then, did the industry choose 10.7 MHz as the universally accepted i.f. frequency for FM, as opposed to, say, 455 kHz (used for AM i.f. stages) or some other low frequency? For one thing, such a small spread between local oscillator frequency and incoming signal frequency might well cause a strong incoming signal to "pull" the frequency of the local oscillator, until both were "locked" at the same frequency. Result: no i.f. output from the converter for the i.f. stages to amplify! Still, an i.f. frequency of a couple of megahertz would eliminate this problem. So why 10.7 MHz?

Well, suppose, for the moment, that we were to choose an i.f. frequency of 4.5 MHz (as is, in fact, done for the sound portion of some TV receivers), and suppose we were tuned to a signal frequency of 95.0 MHz. If our oscillator were designed to operate above incoming frequency, it would be oscillating at 99.5 MHz. Next, assume there were another station (and a strong one at that) in the vicinity, transmitting at a frequency of 104 MHz. Despite the selectivity of the tuned r.f. stage (assuming there is one), this higher frequency would beat with the 99.5 MHz of the local oscillator to produce a second signal, also at 4.5 MHz. Before you

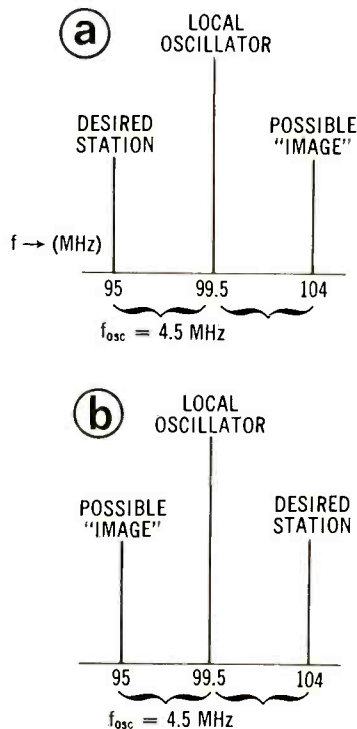
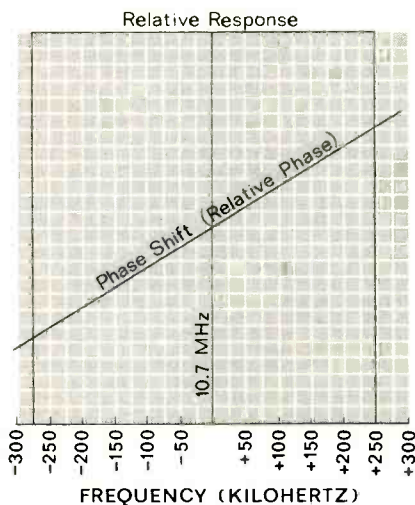


Fig. 1—Examples of "image" frequencies which would occur if local oscillator were (A) 4.5 MHz above desired station frequency or (B) 4.5 MHz below desired station frequency.

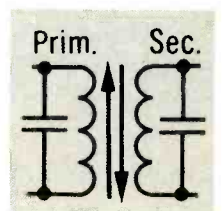
Fig. 2—"Idealized" i.f. response (output and phase shift) for the "perfect" i.f. system.



decide that the local oscillator should have been designed to operate below the incoming signal frequency, take a look at Fig. 1B, which shows that the same thing can happen, only this time with the desired stations at the high end of the dial and the undesired station 9 MHz lower.

It's pretty obvious, therefore, that given an FM band of 20 MHz (from 88 MHz to 108 MHz), the least i.f. frequency necessary to avoid "image responses" would be some frequency greater than 10 MHz. The last major consideration which led, specifically, to the choice of 10.7 MHz has to do with "direct i.f. response." If some station is transmitting at the chosen i.f. frequency itself, such a received signal could easily reach the i.f. circuits either through the usual input channels (which might lack sufficient selectivity to exclude them) or by the appearance

Fig. 3—Schematic representation of i.f. interstage transformer. Arrows indicate "slug" or permeability tuning of both primary and secondary.



of i.f. signal voltage directly at the input of the first i.f. stage when adequate shielding is not provided. To forego this possibility, the chosen frequency (10.7 MHz) is one that is never or seldom used for commercial transmission. This choice does not eliminate every type of spurious response possible, but it seems to be the best compromise choice available.

Having established the frequency of the FM i.f. "strip," we can now consider the additional characteristics which must be considered. They are really surprisingly few in number (though often, a design can be quite difficult to achieve). Gain, of course, is one. Bandwidth is another, phase response a third, and that's really about all there is. Remember, we are excluding limiter stages from the discussion, even though many consider them to be part of the i.f. strip (structurally, they usually are). We shall deal with limiters and their special additional requirements next month.

While you might suppose that a bandwidth of 150 kHz is all that would ever be required of an i.f. stage (based upon the maximum allowable modulation of ± 75 kHz), recall that sidebands may actually exist well beyond these superficial limits. This is especially true now, since the advent of stereo FM (multiplex), which involves higher modulating frequencies. A bandwidth of 6 dB (attenuation) for around 250

press comment *on the*

AR-3a

THE AMERICAN **record guide**

(Larry Zide)

"In choral works and other music of relatively 'heavy' content, the AR-3a simply eliminates any mid-range lack of clarity . . . I find myself repeating what I said in 1959 [about the AR-3]. The AR-3a . . . easily succeeds its prototype as a speaker that I consider 'as close to musical realism in the home . . . as the present state of the art permits.' In a word, it's superb."

HIGH FIDELITY

(Norman Eisenberg)

"Our reaction on first hearing the AR-3a was [an] . . . enthusiastic one which has not diminished after weeks of listening . . . in normal use, predominantly fundamental bass is evident to about 30 Hz . . . Tones in the 13 to 14 kHz region can be heard clearly at least 60 degrees off axis . . . at [high] levels, the speakers sounded magnificent . . . On any material we fed to them, our pair of AR-3a's responded neutrally, lending no coloration of their own to the sound."

Hi Fi/Stereo Review

(Hirsch-Houck Laboratories)

" . . . the best speaker frequency response curve we have ever measured using our present test set-up . . . virtually perfect dispersion at all frequencies — perhaps the most non-directional forward-facing speaker we have ever tested . . . AR speakers set new standards for low-distortion, low-frequency reproduction, and in our view have never been surpassed in this respect."

Chicago's AMERICAN

(Roger Dettmer)

"I have not encountered truer 'fidelity' . . . in three decades of home listening."

The AR-3a is priced from \$225 to \$250, depending on cabinet finish. Literature is available for the asking.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge, Mass. 02141

Check No. 37 on Reader Service Card

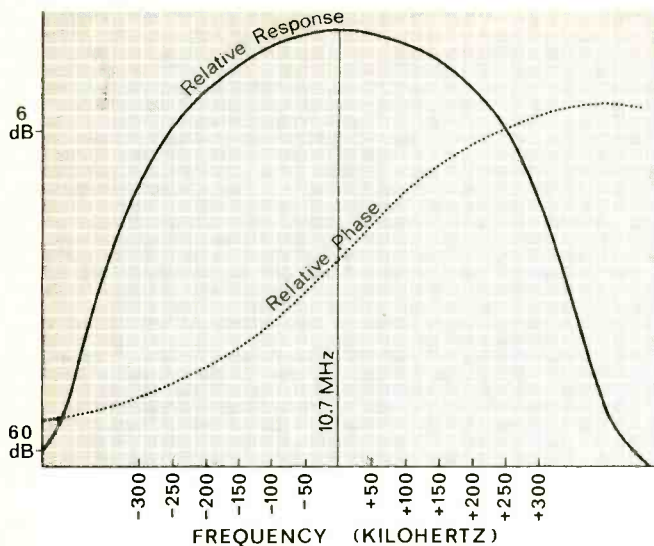


Fig. 4—Typical i.f. response and phase shift achieved by using transformer-coupled circuits.

to 300 kHz is now accepted as being adequate for high quality, stereo FM reception. Ideally, the shape of the "response curve" of the i.f. system should be that shown in Fig. 2. Generally, however, the expense involved in attempting to come close to such perfect response is prohibitive. There is at least one manufacturer we know of who comes mighty close to this ideal by means of complex, multiple-section filter networks. Most manufacturers achieve their response by means of double-tuned, interstage i.f. transformers, as represented in Fig. 3.

Depending upon the number of stages used and the excellence of the particular design, the resultant response curve might be something like that shown in Fig. 4. It should be noted that when we speak of a 6-dB loss for a bandwidth of 250 kHz we mean the total attenuation of the entire i.f. system, not simply to a single stage. Thus, in the example cited, if there were three tuned circuits in the i.f. system, each circuit would contribute 2 dB of attenuation at the "end points," but the total response of the entire system would then be "down" 6 dB at 250 kHz.

Still another method of achieving a desired bandwidth characteristic involves the use of newly devised "crystal filters" between amplifying stages. Still relatively new in FM use, these "mechanical filters" are actually already in use in the i.f. system produced by one well-known receiver manufacturer. Rapid progress in this field is sure to occur in the very near future.

All tuned amplifiers exhibit phase shift between secondary current at resonance and secondary currents at frequencies off-resonance. At resonance, this current is in phase with the i.f. transformer's secondary voltage. Above resonance, secondary current leads the secondary voltage, while below resonance the converse is true. If this phase shift does not vary linearly with changes in frequency within the i.f. pass-band, time-delay errors in the received FM signal can occur. Though not terribly serious in monophonic FM reception, such delays can be disastrous in the case of stereo FM, where so much depends upon phase relationships between main-channel audio, 19 kHz pilot sub-carrier and the stereo sub-carrier information. Proper selection of coefficients of coupling, Q's of the various stages, and required bandwidths help to achieve a proper frequency/phase relationship.

Gain in an i.f. system (as with any amplifying system) is achieved by means of active amplifying devices, (Continued on page 63)

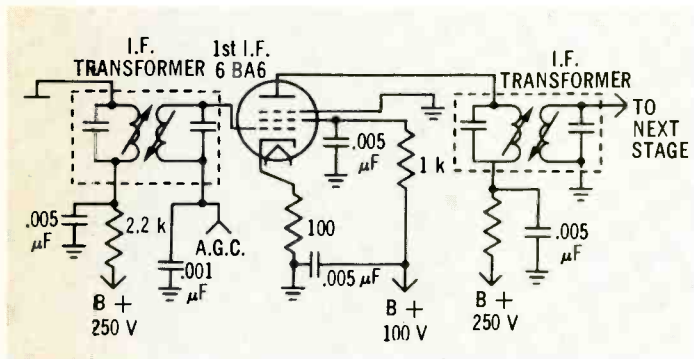


Fig. 5—Typical i.f. stage using a pentode tube amplifier with agc.

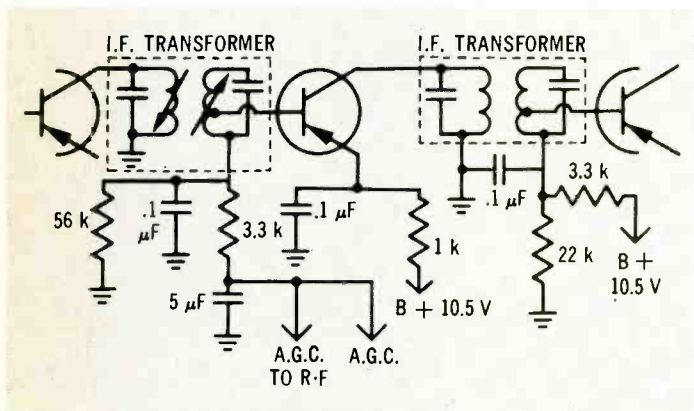


Fig. 6—Typical i.f. stage utilizing discrete, bi-polar transistors.

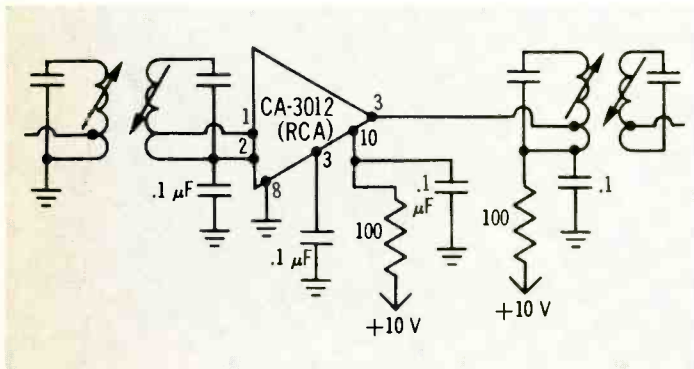


Fig. 7—New integrated circuit (CA-3012) used in i.f. systems of some FM receivers today. High gain with good stability and excellent limiting characteristics are claimed for these new designs. See Fig. 8 for "contents" of the IC.



High Fidelity starts here.

Equipment Profiles

This Month:

- Altec Lansing 711B FM Stereo Receiver
- Electro-Voice Model E-V Five-A Speaker System
- Panasonic RS-761S Stereo Tape Recorder
- Dual Model 1015 Automatic Turntable
- Shure Model SM-60 Dynamic Microphone
- Shure Model 330 Super-Cardioid Ribbon Microphone

Altec Lansing Model 711B FM Stereo Receiver



MANUFACTURER'S SPECIFICATIONS—
 (Tuner Section): IHF Usable Sensitivity: 1.9 μ V. Image Rejection: 80 dB. Frequency Response: 20 to 20,000 Hz \pm 1 dB. Capture Ratio: 2.5 dB. Separation: 35 dB.
 (Amplifier Section) Power Output: 100 watts IHF total music power @ 0.5% THD (4-ohm load); 70 watts (8 ohms); 60 watts (rms) total continuous power (8 ohms). Power Bandwidth: 15 Hz to 25,000 Hz. Frequency Response: 15 to 30,000 Hz \pm 1 dB. Tone Control Range: \pm 15 dB at 20 Hz and 20,000 Hz. Damping Factor: 50. Noise Levels (IHF): Tape Head: -58 dB; Phono: -65 dB; Extra: -88 dB. Dimensions: 5 $\frac{3}{8}$ " H x 16 $\frac{3}{8}$ " W x 12" D. Weight: 19 lbs. Price: \$399.50.

This solid-state entry from Altec Lansing is a medium-priced complete receiver containing virtually all of the facilities needed for a home music center. For its compact size, it delivers a goodly amount of power—a common characteristic of the latest crop of solid-state integrated receivers. For those who favor a quiet, almost aristocratic subdued look, the physical appearance of the Altec 711B will have instant "shelf appeal."

The front panel, with the exception of the heavy gold framing around its

rim and is colored a very soft, matte charcoal grey, which makes the gold-screened control designations extremely legible. Approximately seven inches of frequency spread, with a tuning control that includes a ball-bearing fly-wheel arrangement, makes for one of the smoothest and easiest-to-tune dials we have encountered in some time. The upper half of the panel also contains a peak-reading tuning meter and the usual stereo FM indicator light mounted behind the dial glass.

Functionally arranged controls located at the lower portion of the panel include a five-position selector switch, a dual volume control (simultaneously controlling both channel levels), a balance control, and the usual bass and treble controls. Secondary controls, all activated by means of rocker switches, include a high-frequency filter, the tape monitor switch, a "stereo-mono" mode switch, a loudness in/out switch, speaker switches for "main" and "remote" speaker installations, and the power on/off switch. A stereo telephone jack completes the layout of the front panel, which may be seen in Fig. 1.

The rear connection panel, shown in Fig. 2, offers very widely spaced screw terminals for connection of main and remote sets of speakers, FM antenna screw terminals (for both "local" and "distant" reception), input pairs of jacks for tape head, phono, "extra," and tape monitor and output jacks for recorder output and a center channel, the latter intended to feed a separate monophonic amplifier, not a center-channel speaker directly. One final feature at the rear of this receiver is a little slide switch called "amp gain/lo/hi." This feature is extremely useful in light of the great range of speaker

efficiencies which exist among popular speaker systems. The "amp gain" switch provides two settings of amplifier gain not total power capability, which is the same for either setting). Thus the user who has highly efficient speakers need not limit himself to just "cracking open" the volume control before he is drowned in loud sound. He would set the switch to the "lo" position.

Circuitry

Circuitry layout, viewed from under the set, can also be seen in Fig. 3. The totally shielded "front end" employs one FET as a first r.f. amplifier, followed by a second bi-polar device used as an *additional* r.f. amplifier, and separate transistors for local oscillator and mixer. Thus, the front end has *four* tuned circuits, rather unusual for a unit in this price class. With this fine front end, which could not be overloaded under any signal conditions, we wonder why Altec bothered to include the "local"-*"distant"* terminal arrangement?

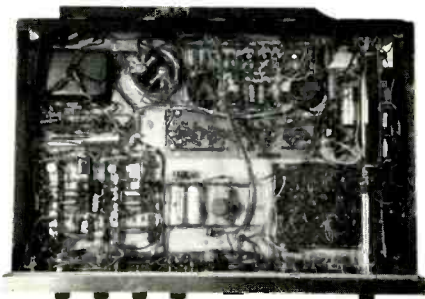
The i.f. circuit module contains two RCA CA-3012 integrated circuits, a balanced ratio detector and a meter-amplifier transistor.

The multiplex demodulator circuit board is of fairly conventional design, containing four active transistors, plus one for indicator light activation, as well as for a balanced-diode-bridge demodulator. Encapsulated bridged-T filters eliminate much of the residual 38 kHz and its harmonics at the output of this module.

Fig. 2—Rear panel connections of the 711B.



Fig. 3—View of the inside, showing combination of circuit board and direct-wiring layout.



Performance

Measured performance agreed very closely with published specifications. IHF FM usable sensitivity measured $2.3 \mu\text{V}$, well within manufacturing tolerances to be expected. Maximum quieting was a very respectable 70 dB, as shown in the curves of Fig. 4. Measured separation of our sample fell somewhat short of the specified 35 dB at 1 kHz by a few decibels, but it was certainly more than adequate at this frequency. Separation at the high end of the spectrum, however, fell off a bit too rapidly to below 20 dB at 10 kHz.

The FM tuning meter is of the peak-reading type, common to many receivers. As mentioned here in the past, this makes it slightly more difficult to tune to center of channel compared with the center-reading types. The meter circuit is not designed to operate truly as a signal-strength indicator of received stations as some peak-reading types are.

As for amplifier measurements, just about every one was better than the published specifications. The 0.5% total-harmonic-distortion (THD) figure was reached at 34 watts per channel with 8-ohm load) against the 30 watts claimed by the manufacturer. A curve of THD is shown in Fig. 5, along with IM distortion, which reaches 2.2% at 36 watts per channel.

Tone-control action is plotted in Fig. 6, along with that of the high-frequency filter. Note that this filter has only a 6-dB-per-octave slope, and really does no more than counter-clockwise rotation of the treble control. Loudness compensation, when switched into the circuit, produces bass boost of +5 dB at 50 Hz at one-half rotation of the volume control and +11 dB at 50 Hz for one-quarter volume control setting. Power bandwidth is shown in Fig. 7, while Fig. 8 illustrates square-wave response at 100 Hz and 10 kHz.

Listening to FM and FM stereo on the Altec 711B, we were able to pick up 35 clear FM stations with just a simple dipole antenna. Just to see if

Fig. 4 - FM quieting characteristics of the 711B.

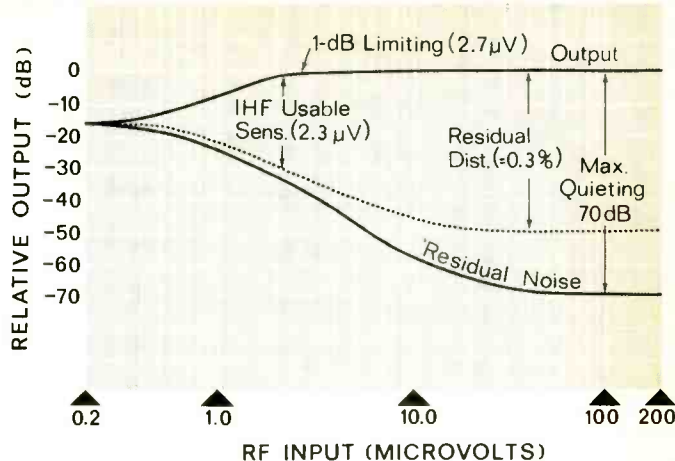
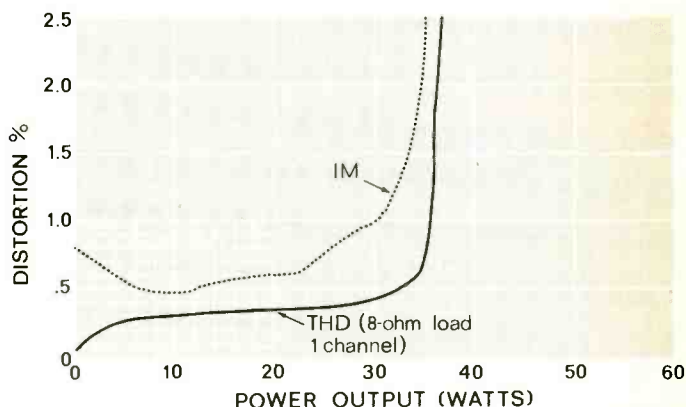


Fig. 5-THD and IM curves with both channels driven.



the local-distant antenna connections meant much, we then connected our antenna to the "local" terminals, only to find that we still picked up the same 35 stations. In fact, one station (a local) exhibited minor interference from an even stronger local adjacent station when the antenna was connected to the distant terminals. This cleared up considerably using the "local" terminals, but aside from this single phenomenon, all other stations seemed about the same regardless of antenna connection.

Of the stations received, eleven were broadcasting in FM stereo. All of these "gated" the circuits into the stereo mode with no popping or noise of any kind, and no erratic illumination of the stereo indicator lamp was noted at any

point on the dial. Operating the receiver with the muting circuits "in" reduced the number of received stations to 31. A few of these were marginal in that high orders of distortion were noted, until the muting switch was turned back to the "off" position.

The sound we heard (using fairly inefficient speaker systems) was full bodied and very pleasing. Settings of about 11 o'clock produced room-filling sound, and as we "pushed harder" there was no evidence of break-up. At a suggested retail price of \$399.50, the Altec 711B has come up with a design that does not scrimp on latest circuit components or quality of parts used, combining this with attractive appearance.

Check No. 40 on Reader Service Card

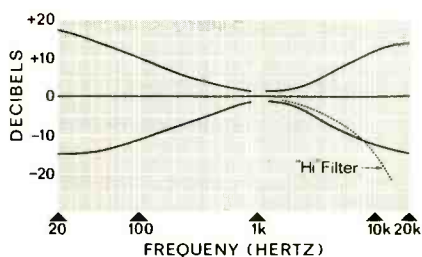
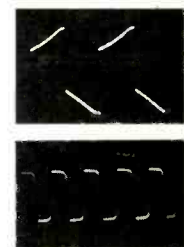
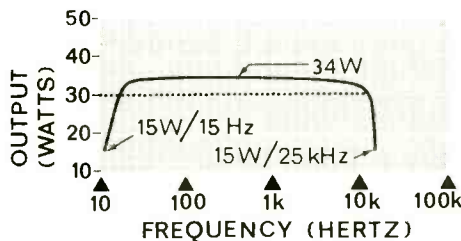


Fig. 6 - (left). Tone-control range. Dotted line shows effect of "HI" filter.

Fig. 7 - (right). Power bandwidth curve.

Fig. 8 - (far right). Square-wave response -upper, 100 Hz; lower, 10 kHz.



Equipment Profiles (continued)

Electro-Voice Model E-V Five-A Speaker System

MANUFACTURER'S SPECIFICATIONS—Frequency Response: 30 to 20,000 Hz. Impedance: 8 ohms. Power-Handling Capacity: Program, 30 watts; Peak, 60 watts. Dimensions: 12¹/₄" H, 21³/₄" W, 10³/₈" D. Finish: Polymer-coated walnut veneer. Weight: 27 pounds. Price: \$88.00.

The new E-V Five-A is a small- to medium-size bookshelf speaker of impressive performance that belies its price. It is a straightforward, well put together two-way system, using a 10 in. acoustic-suspension woofer. An LCR network crosses over at about 1100 Hz



Fig. 1—Electro-Voice E-V Five-A speaker system.

to a 2¹/₂-in. dome tweeter which takes over from that frequency and upwards. Two more layers of wire have been added to the woofer's voice coil, offsetting the inefficiency caused by the greater moving mass of an acoustic suspension design. The result is higher efficiency than is expected from a unit of this construction. This means that a smaller power amplifier will adequately drive these speakers. (We found that a clean 20 watt amplifier does it just fine.)

The tweeter has a dust dome mounted centrally on its cone. In the lower portion of its frequency range the tweeter cone and dome function together. As the frequency increases, a progressively smaller area of the cone radiates sound. The dome is radiating only at the highest frequencies. Since the dome is hemispherical, it radiates widely, thereby aiding dispersion. The resonant frequency of the tweeter is just below the crossover point, no doubt for rapid rolloff. Also, a viscous-damping compound is injected between the voice-coil form and the magnetic structure. The jelly-like stuff dampens cone movement at resonance, with the inten-

tion of eliminating intended spurious responses and breakup. From the lack of these undesirable hobgoblins, we'd saw that the viscous damping is successfully used here.

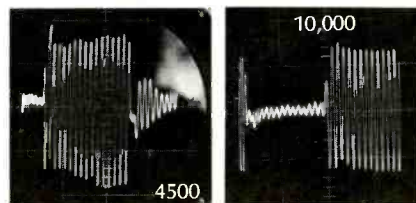
Both the woofer and tweeter are front mounted, the rear of the ³/₄-in. flakeboard cabinet being completely sealed. Fiberglass fills most of the inside, and duckseal is used around the speakers to inhibit air leaks. The light-tan grille cloth is affixed to a thin wooden panel that comes off with a pull and goes back on with a push. (Velcro, again.) The high-frequency control is recessed in back of the cabinet and is adjustable only with a screwdriver—can't be changed accidentally that way. It is a 20-ohm wirewound potentiometer that represents part of a voltage divider of the crossover network. Its range at 10 kHz is about 8 dB. In our listening room we found it best up all the way. A mark atop the control says NORMAL, but there's no corresponding pointer on the shaft of the control. A minor quibble.

A vinyl coating protects the walnut surface so that dust cannot collect in the wood grain to dull the appearance; it also makes it more scuff-resistant. A wax can be applied to get a glossier finish, or fine steel wool can be used to reduce the surface sheen for a duller look. The "as is" surface looks exactly like standard oiled walnut.

Performance

Our averaged measurements of frequency response showed that the E-V Five-A covered 50 to 16,000 Hz within 5 dB. It put out clean bass down to 40 Hz, below which doubling could be induced. E-V's engineering data sheet shows the response right out to 20 kHz, with only a small drop. We don't doubt it. The speaker's tone-burst response, as shown in Fig. 2, is excellent, with only one small ringing node. Dispersion was good all the way up, with the

Fig. 2—Oscilloscope photos of tone bursts at 300, 4500, and 10,000 Hz illustrate the E-V Five-A's excellent transient response.



angle of radiated sound converging slowly above 13 kHz. Distortion was low all the way down.

We were especially pleased, though, when we listened to music reproduced via these speakers. After all, speaker measurement techniques have not yet been sufficiently standardized. Therefore, subjective evaluation still yields the most meaningful data.

The E-V Five-A (a stereo pair) sounded forward, open and big. The highs were crisp and balanced. The bass was very full and resonant—more so than we expected from a unit of this size and price. The speaker system, in fact, was just a pleasure to listen through in both small and large room. Anyone who still thinks he can judge size of speakers by their sound ought to put a couple of EV Five-A's behind an acoustically transparent curtain and then try it.

We agree with E-V when they say: "The Five-A provides performance formerly found only in far more expensive systems." The increased efficiency is a bonus.

Check No. 42 on Reader Service Card

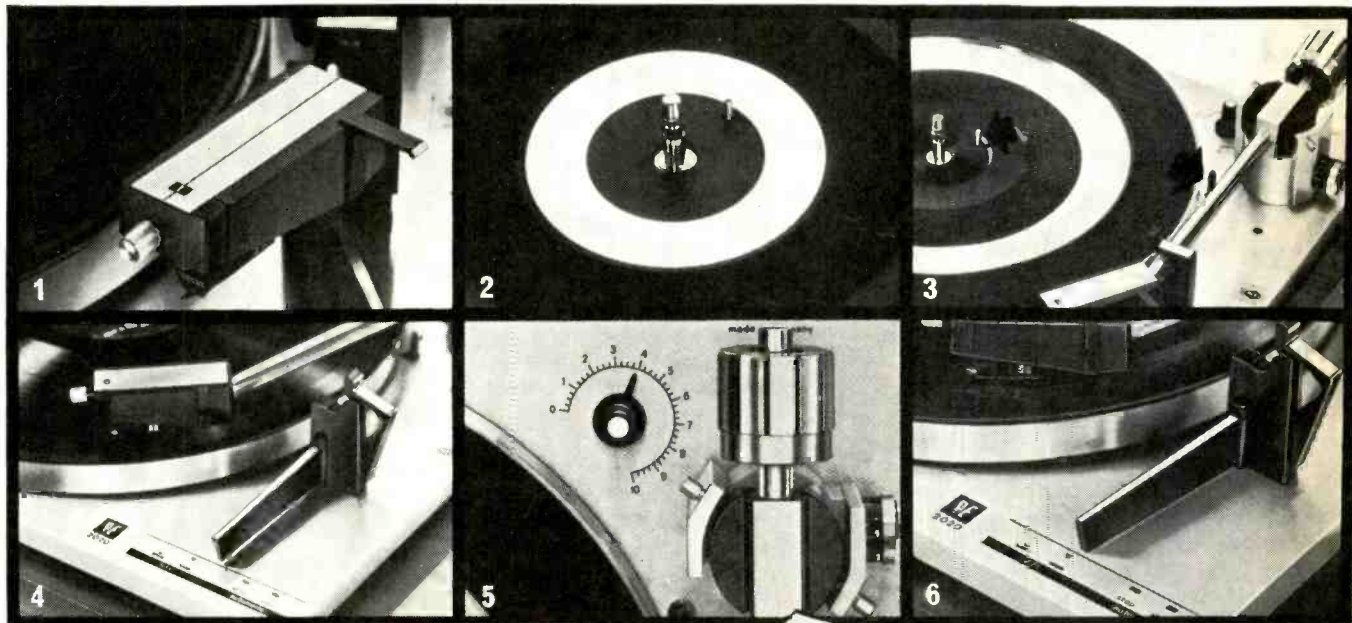
Panasonic Model RS-761S Stereo Tape Recorder

MANUFACTURER'S SPECIFICATIONS—Four-tracks. Record-playback system. Tape speeds: 7¹/₂, 3³/₄, 1⁷/₈ ips. Frequency Response: 30-18,000 Hz at 7¹/₂, 30-13,000 at 3³/₄, 30-16,000 at 1⁷/₈. Signal-to-Noise Ratio: more than 52 dB. A.C. Bias: 50 kHz. Weight: approx. 22 lbs. Dimensions: 17³/₁₆ x 6¹/₂ x 11¹/₄ in. Speakers: Two 8¹/₂ x 5¹/₂ x 11 in. enclosures. Price, with speakers, microphones, connecting cables: \$269.95.

Every time we encounter a new tape recorder, it's like a new ball game—they are similar in many respects, but vastly different in detail. The RS-761S is a tape recording system, in that it includes everything one needs to start recording immediately—microphones, speakers, etc.

The unit is a three-speed, 7-in. reel-to-reel machine, designed for four-track stereo recording, four- or two-track stereo playback, and four tracks of mono recording and playback. The small speaker systems, each of which contains a 6¹/₂-in. woofer and 2³/₈-in. tweeter, have provisions for wall mounting.

the new ELPA PE-2020 Automatic turntable lets you escape from the ordinary



Here's why

(1) The Exclusive 15° Vertical Tracking Angle Adjustment.

For critical listening and perfect sound reproduction, records should be played with the stylus at a 15° vertical tracking angle. The new ELPA PE-2020 is the only automatic turntable that permits the critical listener to do this — for a single record, in single manual play . . . or for any record in a stack in multiple automatic play. This feature gives the ELPA PE-2020 the precision of a fine manual turntable, and a greater precision in multiple play than any other automatic turntable.

(2) Stylus Protection. It is impossible to damage the stylus of the ELPA PE-2020 by lowering the tonearm onto an empty platter. Should the turntable be switched on accidentally, the tonearm will refuse to descend if no record is on the platter.

(3) Automatic Scanning. You don't need to adjust the new ELPA PE-2020 for various size records. The scanning device automatically determines the size of the first record on the platter and automatically adjusts the tonearm to descend in the proper play position.

(4) Simplicity Of Operation. One lever controls all modes of operation: Start, Stop, Repeat, Cueing, Pause, and Lift — making the ELPA PE-2020 the easiest automatic turntable to operate. The single control is located at the front of the turntable and is easily accessible even in confined quarters.

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(6) Motor Driven Cueing. The most advanced form of cueing today. No extra levers, no viscous-damped hand controlled manual devices. Eliminates accidental slips of hand striking the tonearm.

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Equipment Profiles (continued)



Fig. 1—The Panasonic RS-761S Stereo Tape Recorder System.

The panel of the recorder proper—the amplifier panel occupies the 3½-in. at the right of the recorder chassis—has the usual supply and take-up spindles, with the speed selector between them and a 4-digit counter at the lower left. The control section is fitted with two record-level meters which also indicate during playback, and two record-level controls at the left. Below these are two pushbuttons for the record function. These buttons are covered by a plastic slide which helps to prevent unauthorized or inadvertent operation. To the right is the transport and head section, and below this is the pair of microphone jacks, using the miniature phone plugs. A push-on, push-off power switch is next, and farthest right is the control lever. The rest position of the function lever is STOP; one position to the left is REWIND and one position to the right is PLAY. Next to the right is the PAUSE position, and farthest right is the FAST FORWARD position. The pause position between fast forward and play practically eliminates any possibility of breaking the tape in switching from F.F. to PLAY.

The unit employs one motor, with a stepped motor pulley providing the speed changes, and idlers between the motor shaft and the reel-spindle turntables. All of the action is mechanically controlled by a series of levers and wires. The head shields, on which

are mounted the pressure pads, are raised automatically when the control lever is placed at PLAY, hinging outward when the lever is in any other position.

The amplifier section, mounted at the right of the deck, has a three-position slide switch at the top. In the center position, the machine is in the stereo mode, and at either right or left positions feeds the speakers from either right or left channels—desirable when playing monophonically recorded material. Progressing downward are the treble control, bass control, volume control, balance control, and a headphone jack.

On the rear is a panel which offers access to the auxiliary inputs, line-out phono jacks (high impedance), and two miniature phone jacks for the speaker connections. The power cord also enters the unit from this panel.

Circuitry

The Panasonic RS-761S employs a total of 19 germanium pnp transistors and six diodes in its electronic circuitry.

The amplifier consists of the bass boost control, followed by a transistor stage, with its output going to the speaker switch which selects the source channel for the monitor signal. This is followed by the treble control, the driver transistor stage, transformer-coupled to the two-transistor output

stage, which is a single-ended push-pull configuration, with the output being taken from the intermediate point, going first to the headphone jack which cuts off the following speakers when the usual three-circuit plug is inserted. The balance control is a 20k pot connected from the bases of the driver stages, with its arm grounded.

The bias/erase oscillator uses two more transistors in a balanced oscillator which feeds a 50-kHz signal to the erase heads from a tap on the secondary of the oscillator coil, and bias voltage from the entire coil through adjustable trimmers. When only one channel is being recorded, a load resistor is switched into the circuit to simulate the unused head.

D.c. is supplied to the low-level stages through a regulating transistor, while the full rectified output voltage is fed to the audio amplifier sections. A pilot light, which illuminates the record-level meters, is fed from a tap on the secondary of the power transformer.

Switching from play to record is done entirely by the push buttons used to select the channel on which recording is to be done, while separate switches short out the audio signal to the amplifier when the machine is stopped or in either of the fast-wind positions. In addition, the line outputs are shorted out during recording. A tape-sensing switch shuts off the drive motor when the end of the tape passes through the head assembly.

Performance

In operation, the Panasonic gives a good account of itself. Its one-knob function control and vertical stacking of amplifier controls simplifies operation.

It has a comparatively low hum-and-noise figure of 49 dB below the 3% distortion point when measured according to NAB standards at 7½ ips. At 3¾ ips, S/N is 50 dB, and at 1⅞ ips it is 47. Wow and flutter measure 0.13% at 7½, 0.17% at 3¾, and 0.25% at 1⅞.

The record-level meters are calibrated at a zero which is 10 dB below the 3% distortion point, and the output at the overload point is 3 volts at the line output and 1 watt at the speaker jacks—enough for a reasonably loud signal with the speakers furnished. To reach the meter zero in recording, a signal of 0.14 V is required at the line inputs, and only 0.25 mV at the microphone jacks. One great convenience is the fact that the meters operate in the

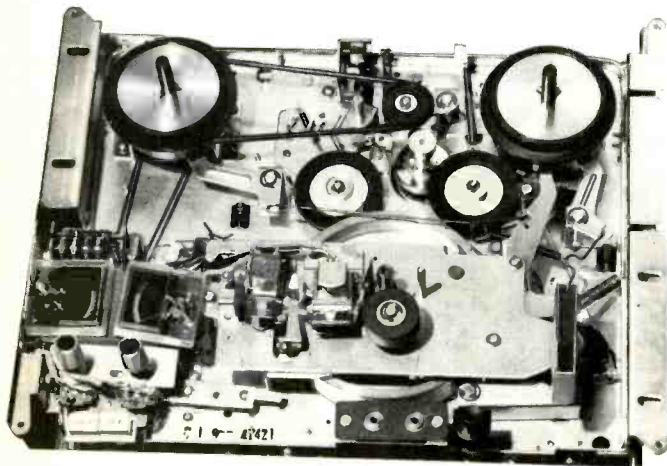


Fig. 2—View of the mechanism of the Panasonic RS-761S with the front panel removed.

Shown here are several good reasons why Altec audio equipment is being used by more and more recording and broadcast studios and auditoriums. And for all sound reinforcement applications.

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Equipment Profiles (continued)

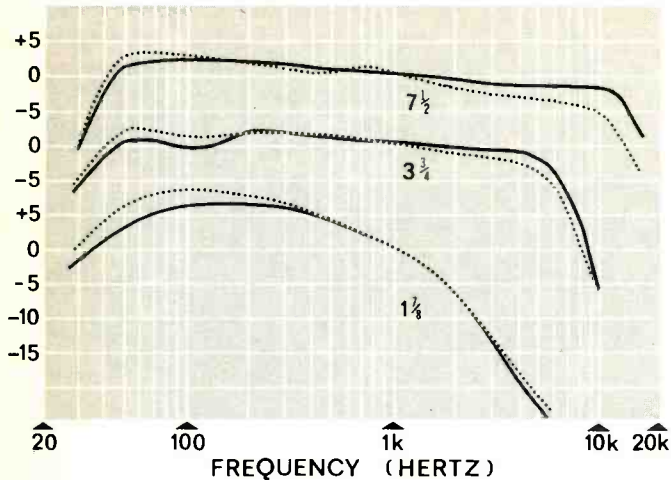


Fig. 3—Record/play curves for the Panasonic RS-761S Tape Recorder.

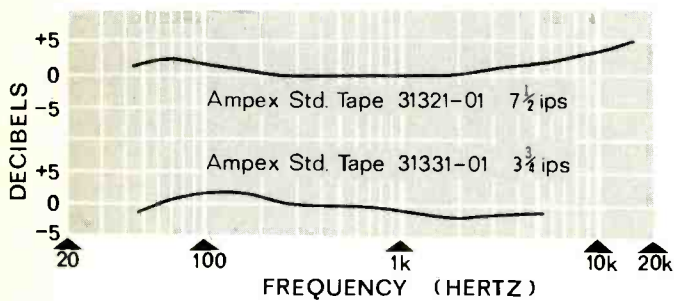


Fig. 4—Playback response from Ampex Standard Tapes.

playback mode as well as when recording.

The electrical signal output from a standard frequency tape shows the response to be within ± 3 dB from 40 to 15,000 Hz at $7\frac{1}{2}$ ips, and ± 2 dB from 40 to 5000 at $3\frac{3}{4}$ —these frequencies being the limits of our standard tapes.

With signals recorded at a constant input level and played back, the response was within ± 5 dB from 40 to 16,000 Hz at $7\frac{1}{2}$ on the left channel, and within ± 7 dB on the right channel. At $3\frac{3}{4}$ ips, the response measured ± 5 dB from 30 to 8000 Hz, with the two channels differing by not more than 2 dB. At $1\frac{1}{8}$, response was within ± 5 dB from 30 to 2200 Hz. The manufacturer's specs do not indicate any tolerances, unfortunately, so our measurements cannot be compared. These figures are respectable for a complete system in the RS-761S's price category, however.

Tone-control action was relatively gentle, providing very little bass boost and about 8 dB of cut at the low end, and about 3 dB of boost and 10 dB of cut at the high end. While these tone-control figures do not sound very impressive, it is surprising how effective they are with the system's speakers. (Tone-control circuits were modified in early production to meet the follow-

ing specifications, according to the manufacturer: Bass, ± 10 dB at 100 Hz; Treble, $+10$, -15 dB at 10 kHz. —Ed.)

Rewind time clocked 2:58 for a 1200-ft. reel of tape, while fast forward required 3:25 for the same reel. These figures are slower than normal for machines in this general category. The 50-kHz bias frequency is lower than generally used for modern tape recorders; if it appears on the tape it might show up on a stereo recording from a tuner as a 12-kHz squeal.

Crosstalk between channels measured slightly better than 40 dB at 1000 Hz, and about 34 dB at 10 kHz, which is good. Distortion measured below 3% at the speaker jacks up to 1 W output, rising to 5% at 3 W. An output of 1 W provided an adequate listening level with the system's highly efficient speakers.

In summation, the Panasonic RS-761S is a handsome machine, with dark wood, chrome, and black employed tastefully in both the recorder and the loudspeakers. The machine is easy to thread, and easy to operate, with a transport that handles tape gently. Panasonic's RS-761S certainly offers one a nice, complete tape package at \$269.95.

Check No. 44 on Reader Service Card

Dual Model 1015 Automatic Turntable

MANUFACTURER'S SPECIFICATIONS—
Speeds: $16\frac{2}{3}$, $33\frac{1}{3}$, 45, and 78 rpm.
Operation: Manual, auto-single, or auto-changer. Pickup Arm: Dynamically balanced. Tracking Force: 0 to 5 grams.
Price: \$89.50.

Transcription turntable/tone-arm combinations probably received their first real challenge from record changers when changers' tone arms were decoupled during play from the crude springs, levers, and cams of their arm-lifting and record-changing mechanisms. A host of other improvements followed—reduced wow and flutter, lower rumble, less tone-arm pivot friction to permit tracking with newest phono cartridges, anti-skating compensation to further reduce tracking-force requirements, cueing devices, and so on.

Today, there are few practical advantages of the finest manual turntable/tone-arm combinations over the finest automatic changers in the manual playing mode). The former is less complex mechanically, of course, and therefore potentially more reliable. Manual types also remain more flexible in being able to be mated to various tone arms to achieve optimum performance. Additionally manual types are designed for operation with one record only, rather than from one to, say, 10, so that the weight imposed on the turntable platter remains constant, and the tone arm always "rides" parallel to the record. The changer, on the other hand, offers the convenience of automatic start and stop, not to mention the ability to play several record sides in sequence when desired. And catching up in many respects to performance capabilities of the manual types, changers indeed have earned the appellation, "automatic turntables." Depending on applications, then, we need both types.

The Dual automatic turntables, as they are sometimes called, have been in the forefront of the record changer's challenge to manual turntables. The Dual Model 1015 continues this tradition. (A new version of the 1015, the 1015F, is identical to the model examined here with the following exceptions: It has a variable-speed control which permits each speed to be varied over a 6% range, and the $16\frac{2}{3}$ speed is eliminated. The price remains the same.—Ed.)

Similar in appearance and operation to the costlier Dual 1009SK (\$20.00 more), it is a nicely made piece of ma-



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Fifty of the most knowledge and discerning high fidelity salesmen have just completed a thorough testing of the new Elac 444-E cartridge. They tried it with their home systems and compared it with the cartridge they are now using. Here are samples of their findings:

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Elac 444-E

It may be the finest cartridge you ever heard



Equipment Profiles (continued)

chinery that performs exceptionally well by standards for both manual and automatic units. The price differential between it and the 1009SK is due to a single-play spindle that does not revolve with the record; a two-piece vs. one-piece cast platter; a different arm counterweight, and a different motor.

An idler wheel, driven by the stepped pulley on the motor's shaft, connects to the inside rim of a cylindrical sub-platen, riveted to the main one. The 4-lb., cast, non-ferrous turntable platen is not dynamically balanced (at least it shows no signs of balancing holes or slugs) and uses a ball-bearing thrust brace support for the brass sleeve on which it rests. Teeth cast into the outside of the shaft form a gear which drives the record-changing mechanism.



Fig. 1—Dual Model 1015 Automatic turntable.

A ribbed rubber pad with raised "gunwales" to support the record is fixed to the turntable. The "gunwale," together with two other concentric smaller ribs, help in supporting warped records. The turntable itself is 10 $\frac{5}{8}$ -in in diameter.

The tubular tone arm, with a sliding counterweight that is lockable in any position, is supported by hardened steel points, each supported by ball bearings. In the horizontal plane, double ball-bearing races are used. Tracking force is applied at the pivot point by a multiple-coiled mainspring. A calibrated dial sets in the desired tension. This dial was found to be accurate to within 0.1 gram.

The anti-skating compensation is applied by means of a spring which pulls on a finger extended from behind the arm pivot. Though the spring is stretched as the arm moves toward the disc's center, compensation remains essentially constant due to the angle which correspondingly reduces the pull of the spring. The amount of anti-skating compensation is set with a second calibrated dial located in front of the base of the tone-arm pedestal post. One simply turns this dial to the

same number appearing on the stylus force dial. Dual uses about 12% as the ratio of the anti-skating force and stylus force (playing weight). Naturally, the ratio can be changed by altering the anti-skating dial setting relative to the tracking force. We found this anti-skating compensator as effective as any that we have seen thus far. For those who have forgotten, skating force is a term used to describe an undesirable inward force exerted on the stylus (therefore the tone arm).

The arm's cartridge holder accepts all cartridges with the standard half-inch mounting-screw spacing (which includes just about every cartridge). The cartridge holder drops out of the tone arm when the arm's finger lift is pushed to the rear. A plastic gauge,

which snaps over the cartridge holder, allows accurate overhang adjustment by acting as a benchmark for sliding the cartridge forward and backward. A tapered wedge, also supplied, provides optimum 15-deg. tracking angle when one record is on the turntable—in case one plays a single record exclusively or primarily. Dual thought of everything, it seems. The vertical tracking angle of the stylus increases as the stack of records already on the turntable increases, and the object is to remain as close to 15 deg., the current standard, as possible. In order for the stylus to maintain a 15-deg. angle at every disc up to, say, 10 discs, either the arm or the cartridge would somehow have to be raised by increments proportional to the record stack. But many records have been cut not at the standard 15-deg. angle but anywhere between 0 and 25 deg. Furthermore, pickup cartridges vary also, though not as much anymore. Therefore, the 15-deg. requirement is not too critical and could be set up to average out in the record stack—which is what Dual does in the 1015. The difference between the first and the 5th record is just a few degrees. The purist can still set it to

record #1, if he so chooses.

The Dual 1015 can be operated manually, automatically, or anywhere in between. It has a fabulous manual lever-actuated lowering and raising device that gently and *accurately* lowers and raises the tone arm for use when playing a certain portion of a disc, for instance. The control was so true in its lift and drop that, barring an off-center record and other variables, it was possible to lower the arm so that the stylus descended back into the same groove from which it was lifted. (However, a two- or three-groove variation would generally be expected due to eccentricity of grooves, etc.) The anti-skating force doesn't seem to affect the lift here, though it does affect lifts in some other tone arms that we have tried. Aside from the manual cue control, a single lever controls all start, stop, and reject functions of the unit. During changer operation, the large "elevator action" spindle, which holds up to 10 records, lifts the stack except for the bottom disc, which is released to drop to the turntable. A silent cam-operated muting switch shorts the phono output during cycling.

Performance

We tested this unit using two popular phono cartridges. The horizontal and vertical friction of the arm pivot were too low for us to measure, which makes it an exceptionally low friction (Dual claims .04 horizontal and .01 vertical). The sideways arm thrust required to trip the changing mechanism at the run-out grooves measured under half a gram (Dual says it's $\frac{1}{4}$ gram). In any case, the unit is suitable for the most compliant of high-compliance cartridges around these days. A cartridge tracking at just $\frac{1}{2}$ gram trips the mechanism, which is a neat feat.

Rumble, including vertical and lateral components, came out to -33 dB and -38 dB with vertical components cancelled (mono operation). This is unweighted rumble, referred to 3.54 cm/sec 45-deg. velocity at 1000 Hz, the standard NAB reference for rumble measurement. These are excellent figures, surpassed only by the very best manual turntables and Dual's own higher-priced automatic units. Wow and flutter was checked at .07%, which is also a very good figure.

At 33 $\frac{1}{3}$ rpm and one record playing, the turntable of our sample was more than 1% fast. (*The upcoming 1015F has a variable speed control to cor-*

rect for such a deficiency.—Ed.) Speed was constant over line-voltage variations between 95 and 125 volts. We got perfect 33 $\frac{1}{3}$ rpm speed at 85 volts input from a Variac.

Tone arm tracking error, a function of length and offset angle of the cartridge, was very low.

In playing records at a tracking force of 2.5 grams, the Dual 1015 performed flawlessly, though slightly fast. The arm has a smooth feel to it, the motor is quiet, and the changing mechanism is gentle. When using a cart-

ridge that was not well shielded, the changer's motor induced some hum through a wide-range stereo system.

When the changer is mounted on a base, it rests in its three soft, damped springs for isolation from vibrations and acoustic feedback. We found this quite effective. But the main reason for the excellent vibration resistance of the 1015 is its tone-arm design. This was proved by mounting the unit in several different ways while subjecting it to feedback and vibration-inducing conditions. One mounting technique was to

leave it in its starchy styrofoam packing material, which, incidentally, makes an excellent temporary base.

In all, the Dual 1015 is an exceptionally fine medium-priced automatic turntable. Considering the soon-to-be-introduced 1015F's addition of a variable speed control, while eliminating the generally useless 16 $\frac{2}{3}$ -rpm speed, it's worth waiting for. Price of the new version remains the same (\$89.50).

Check No. 46 on Reader Service Card

Shure Model SM60 Dynamic Microphone



MANUFACTURER'S SPECIFICATIONS—
Polar Pattern: Omnidirectional. Impedance: 150 ohms (matches inputs from 50 through 250 ohms). Output level: -59 dB (0 dB = 1 mW with 10 microbars.) EIA Sensitivity Rating: -153 dB. Net weight: 6 oz. (less cable). Dimensions: 1 $\frac{1}{4}$ " diam., 6 $\frac{1}{4}$ " long. Cable: 20-ft. 2-conductor shielded broadcast type, with Cannon XLR-3-11C connector on microphone end. Accessories furnished: Swivel "snap-in" adapter; cloth protective cover. Net Price: \$49.20.

The dynamic microphone has proved itself for applications where rugged, self-contained, and versatile transducers are required. While the condenser microphone has become the standard for measurement purposes, as well as for applications requiring the highest possible quality, it does have the disadvantage of requiring a source of polarizing voltage for the capsule and another source for the heater and

anode current for the cathode follower (in more recent models, a source of current for the FET, which is taking over from the vacuum tube in the latest models).

The ribbon microphone, long the standard in the broadcast industry, is still used for certain applications where its "Figure-8" pattern is desirable, but even that pattern can be duplicated by either dynamic or condenser microphones. The dynamic, however, is the workhorse of radio and TV studios, and it has become the standard for public address uses, and is practically universal in the home recording field. Its simplicity and reliability have earned for it the "workhorse" cognomen.

There are many grades of dynamic microphones, however—some can be purchased for as little as \$7.00, and some cost as much as \$150.00. This one has a practical price at \$49.20 net, but is a quality product, listed by Shure as a professional model. The SM60 is essentially omnidirectional, showing only a slight directionality in the higher frequency range, largely due to its physical construction (the body of the unit provides some shielding against high-frequency sounds coming directly from the rear.)

The microphone body is $\frac{7}{8}$ -in. in diameter, (the same diameter as the Cannon plug) expanding to a maximum of 1 $\frac{1}{4}$ -in., and then tapering down to its 1-in. business end. Its overall length is 6 $\frac{1}{4}$ -in. giving it attractive proportions. The body is a steel tube,

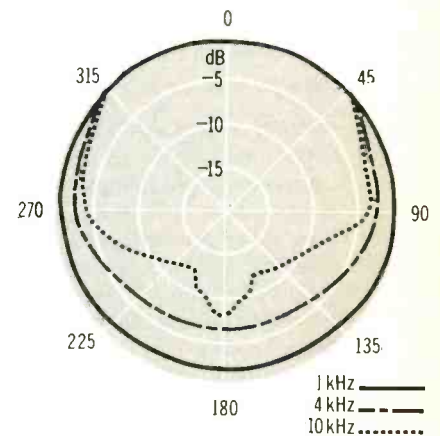
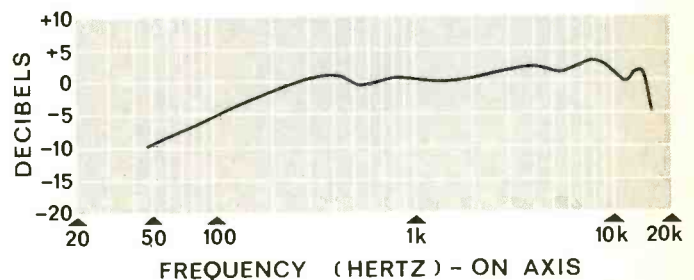


Fig. 3—Polar-response curves for the SM-60 microphone at three different frequencies.

with a non-ferrous tapering section topped by a steel protective grille, which houses the built-in wind and pop filter which eliminates the need for add-on windscreens for outdoor use. Finish is matte chrome. Because of the low impedance, no transformer is required, which eliminates one possible source of distortion. The cartridge ground and case ground are connected to terminal 1 of the Cannon receptacle (the usual professional practice), with the two coil leads appearing on terminals 2 and 3.

The microphone is provided with a plastic snap-in swivel adapter adjustable from vertical to horizontal, and threaded to fit the usual $\frac{5}{8}$ -27 microphone stand.

Fig. 2—Frequency response of Shure SM-60 microphone on axis.



Equipment Profiles (continued)

Performance

The response curve of the microphone is shown in Fig. 2 and its polar response is shown in Fig. 3. Note that there is little departure from omnidirectionality, and that only at 10,000 Hz. These measurements were made in comparison with a calibrated condenser microphone and a suitable speaker source in an outdoor location free from reflections nearer than 50

Model 330 "Uni-Ron" Shure Uni-Directional Super-Cardioid Ribbon Microphone

MANUFACTURER'S SPECIFICATIONS—Frequency Response: 30 to 15,000 Hz $\pm 2\frac{1}{2}$ dB. Impedance: multi-impedance switch furnishes choice of three—50, 150, and 250 ohms. Rated Sensitivity: 50-ohm position, -60 dB; 150-ohm and 250-ohm positions, -58.5 dB: (0 dB = 1 mW with 10 microbars.) EIA Sensitivity: 50- and 150-ohm positions, -152.5 dB; 250 ohms, -150.5 dB. Weight, 1 $\frac{1}{2}$ lbs. (less cable). Dimensions: Height, overall, 7 $\frac{9}{32}$ " ; Width, overall, 1 $\frac{7}{32}$ " ; Depth, 1 $\frac{7}{8}$ " . Cable: 20-foot, broadcast type 2-conductor shielded, with Cannon XL-type cable receptacle. Net Price: \$72.00.

In the previous section, we commented on the usual "Fig. 8" pattern of the ribbon microphone. This pattern results when both sides of the ribbon are exposed to the sound field. Sound originating at 90 deg. from the axis impinges on both sides of the ribbon at the same time and with the same intensity, thereby cancelling out

Fig. 1—Shure Model 330 Super-Cardioid Ribbon Microphone.



feet, and at a level where reflections would not affect the measurements anyhow.

In actual recording use, the smoothness of the unit was evident. The wind filter was particularly effective, although it did not completely filter out breath "pops" when used at 3 to 4 inches. (It was also ineffective in filtering out airplanes flying overhead—one of the disadvantages of outdoor testing, as well as recording.)

any motion of the ribbon and consequently reducing the output to zero, in theory. This is borne out in practice where the microphone is tested in anechoic chambers, but in normal studio use the effect of reverberation modifies this response somewhat. There is sufficient reduction in output from sounds originating at the sides that it was common in the days of radio plays, soap operas, and the like, for two performers to work on opposite faces of the microphone, and the prompter could stand at the side without being heard.

In the 330, however, the back of the ribbon is covered by a phase-shifting enclosure, much as is done with dynamic units to produce the cardioid pattern. In the ribbon, the pattern which results as a combination of the newly designed acoustic phase-shift network and an improved ribbon element is the super-cardioid, which is somewhat sharper than the usual cardioid obtained with dynamic units, and the reduction in rear response is of the order of 26 dB at 9000 Hz, and 15 dB at 4000 Hz. The 300 is claimed to reduce reverberation, reflection, and pick-up of undesired random sound by 73%. Sound enters the microphone through nearly 2500 tiny apertures in the protective housing and impinges on the element through further filtering. The back of the ribbon is connected to the phase-shifting volume, and similarly protected from wind and breath-blast pressures.

The impedance-changing system involves the use of a transformer with three taps on its secondary (a transformer is always necessary with a ribbon microphone because the impedance of the ribbon itself is of the order of $\frac{1}{4}$ ohm) to give the proper output impedance. The transformer is located in the microphone housing, with the four leads brought through a spring-like shield to the switch which is located in the isolation unit, and accessible to a screwdriver blade through a small hole on the front of the unit.

On the whole, we found the SM60 to be a neat, compact unit which is sufficiently versatile for practically any application. Its high-frequency rise is particularly helpful in providing clear, intelligible speech, making it especially useful in recording interviews or for announcing. Its overall smoothness permits boosting the lows for ideal musical recording.

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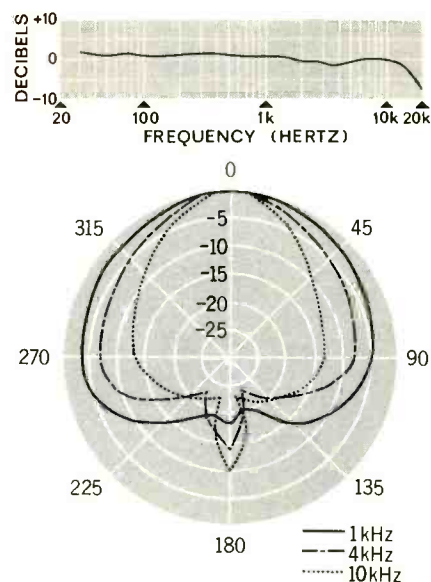


Fig. 2—(upper). Frequency-response curve of the 330.

Fig. 3—(lower). Polar-response curves of the 330 at three different frequencies.

Performance

The response of the microphone is smooth and reasonably flat from 30 to 10,000 Hz, as shown in Fig. 1, and the polar curves exhibit the type of directionality commonly described a "supercardioid." The rejection from the 180-deg. point is slightly less than at the 90- and 135-deg. points, so that the exact rear need not be placed toward the interfering sounds. The unit is remarkably free from breath sounds, and because of its directionality it would not normally be used as close to a sound source as would the usual cardioid or omnidirectional microphone. It is rather too heavy for hand-held use, which is not normally recommended for ribbon microphones anyway. The weight is largely due to the heavy magnets, as well as to the die-cast case, which is sturdy.

For studio use, however, the 330-"Uni-Ron" provides excellent response, and is sufficiently directional to reduce feedback and to eliminate unwanted noises arising from the rear of the unit.

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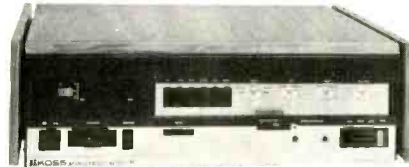
What's New In Audio

(Continued from page 6)

liptical-shaped, flat speaker, (7-in. cabinet depth) with two bookshelf models, NS-15 and NS-10. Benjamin showed off its latest EMI speaker systems, too, which ranged from the small, bookshelf model 55, at \$54.95, to two under-\$350 floor-standing consoles, each of which includes a 15-in. woofer as part of a three-way system.

Both *Koss Electronics* and *Telex* broke out with new headphones. Koss demonstrated its new *electrostatic* headphone, model ESP-6, priced at \$95. Each unit is accompanied by an individually measured response curve. *Telex* announced a new, *low-cost* headphone, the *Encore*, priced at \$9.95.

H. H. Scott and *Fisher Radio* each displayed long, long lines of component equipment, component consoles and modular systems. *Benjamin* displayed its new *Elac* phono cartridges and a new, under-\$200, portable stereo unit. *Koss* entered what is said to be the first of a line of hi-fi component kits, called *KossKits*. The new model 600-K AM/FM stereo features 500 watts total power (IHF) with a 4-ohm

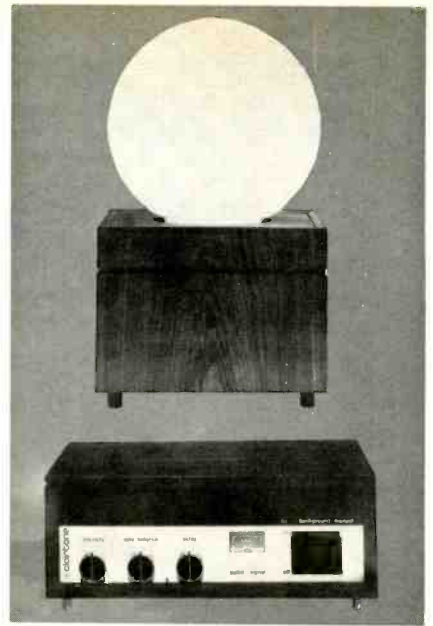


Koss' Model 600-K AM/FM stereo receiver kit.

load. Its digital read-out dials for AM and FM and a "go/no-go" lamp tuning system were among its impressive innovations. *Kenwood* featured its latest addition, a stereo receiver/speaker system, the 30-watt AM/FM KS-33, at \$199.95. *Sansui* showed an electronic crossover. *Nivico* displayed an amplifier with an elaborate tone-control section that uses slider controls.

Packard Bell's "component" color television receiver, the 23-in. model CC9000, caught many eyes. Designed for installation in a flush wall mounting or in a custom cabinet, the new set incorporates cathode followers for audio and a video tape recorder output. \$750. *Panasonic* introduced a novel FM radio—wrist-watch styling. The battery-operated model RF-120

Panasonic FM wrist-watch radio. Model RF-120.



Clairtone psychedelic light and control equipment.

measures only 1 7/8" x 1 13/16" x 2 3/32" and contains five ICs, two transistors and two diodes. Tuning is electrical through use of a "Capistor." *EICO*, *Clairtone*, and *Aztec* demonstrated psychedelic lighting units, with low, medium and high frequencies activating different color lights. *Jerrold* featured its first antenna rotator, an in-line design. *Toujay Designs* had its line of audio cabinets, including its "Sound-X-Pander" cabinet. A Canadian furniture company, *Backhaus*, demonstrated audio cabinets that incorporate power-operated speaker enclosures that can be positioned for optimum sound dispersion. Uses a 24-volt motor and reduction gear box.

Garrard's top model, SL95, with its newly developed synchronous motor, was featured by *British Industries*, along with *Garrard's* Module SLx, which is a complete record playing section with cartridge, base and dust cover. *Garrard* also showed its new, sleek bases and dust covers. *BSR* presented its space-saving "Minichanger" module, SX5H, for compact installations, at the NEW Show. A re-styled line of *BSR McDonald* record playing equipment was shown at the CES Show. *Dual* introduced its new 1212 automatic turntable (\$74.50), which incorporates a variable pitch control. *Seeburg's* "Audiomation" record playing/selecting system, which plays 100 LP-record sides automatically, also included a model with an AM/FM tuner and speakers, as well as a component unit.

More details on the foregoing equipment will be presented here in future issues.

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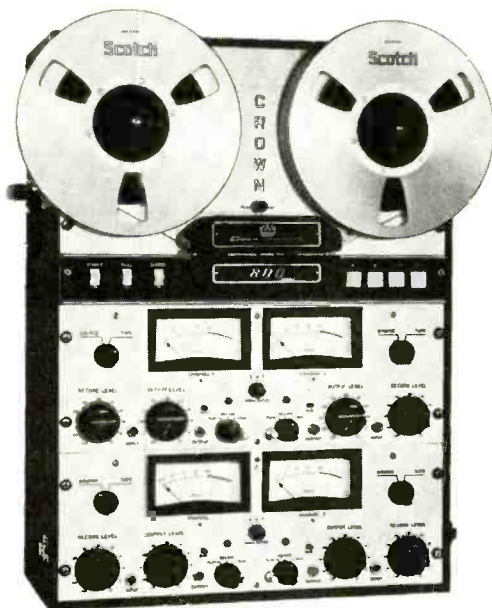


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NEW

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AUDIO MUSIC REVIEW

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Classical Record Reviews

EDWARD TATNALL CANBY

The Nine-Cent Record

I keep trying to remember to put down the prices on my record reviews. I'm reminded; I forget.

My reason for going blank on prices is: I tend to wonder what prices mean. I've wondered even more since a week or so ago, when I got my first nine-cent LP record. I like my nine-cent record! Let's review it right now, and price no consideration.

Handel: Two Italian Cantatas. No. 6, Cecilia, *wolgi un sguardo*. No. 8, *Dalla guerra amorosa*. Dora van Doorn, Leo Larsen David Hollestelle; Orch. Netherlands Handel Society, Loorij. Rarities Collection 304 mono.

Handel, ever versatile, wrote a long chain of beautifully tailored Italian works of the solo cantata type, part of that large body of music which he turned out mainly to show the Italians how easily he could out-perform them at their

own musical games—any game. Nothing deep or profound, but superb music, nevertheless, and deeply enjoyable whenever well performed.

That isn't easy, these days. Handel's singers, Italian or otherwise, were *very* good at the sort of music he wrote for them, full of leaps and jumps and high notes, trills, runs, acrobatics, all to be taken in ever-so-casual stride, vocally speaking. Show any sweat and you're ruined. So we can be grateful when a singer today manages to turn in a reasonably convincing version of this type of music.

These two cantatas are done middling-well—which means pretty good, considering. Three soloists, soprano, tenor, and bass, between the two works. Plus a muscular continuo-type accompaniment and a few strings, basic orchestra. The first cantata features tenor and soprano; the tenor holds forth mightily and he is, alas, both too loud and too close. Lower the volume and he's passable. The soprano is *much* better; and when (flip side) they join in duet the music becomes positively charming. The second work, shorter, is all bass, a good solid one who sings about the War of Love in suitably potent tones. Nice, if not overwhelming. Good modern sound, in mono, but the balance is faulty, the tenor being most at fault, for

singing too loud at close range. This is the only recording of the first of the cantatas.

Performance: B— Sound: B—

Reading that review, could you guess at a proper current price? Wouldn't you say, maybe, \$2.50, the standard list price for imported European Baroque with lesser-league soloists. (And for reissue-type rarities, too.) But *nine cents!*

Of course, that \$2.50 price is subject to certain highly pervasive pressures in the market place. That'd do it. Not all market places. Just a few, though large in their volume of sales. Go to these big-city spots and you'll find the pressures in action. But go to your home town record store, comfortably close and convenient, and you won't find them. List prices, whether high or low.

Even there you have an alternative. Mail order. There, too, pervasive pressure tends to rubberize prices, and mail-order discs are available in every small town merely for the trouble you care to take. *If* you care to. But do you?

Now all this is supposed to be a big, dark secret, at least in print, I'm not letting any secrets out, not *me*. Except for my nine-cent record. I'm just saying that a price is a price, and it all depends. How should I know where *you* do your depending, if you follow me?

It's a Lulu

Alban Berg: Lulu (Hamburg State Opera Production). Rothenberger, Steiner, Meyer, Wohlfahrt, Unger, Borg, Kusche, et. al., Hamburg Philh. State Orch., Ludwig.

Angel SCL 3726 stereo (3)

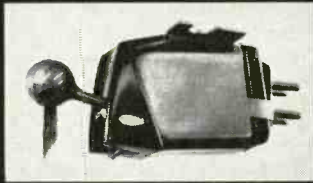
There has been much excitement among the musical cognoscenti over this production of "Lulu," and another new one on records from DGG, supplementing an older Columbia recording. The excitement is real enough. "Lulu" is a twentieth century musical landmark, even though unfinished at Berg's

1927 death. This Hamburg Opera performance has been on tour and hit the Big Time in New York last year at Lincoln Center. Tie-in for public relations, natch.

What strikes the average you-and-me listener in this music, I think, will be not so much its modern idiom—it is "twelve tone" or serial music—as, paradoxically, its old-fashioned quality, straight out of Wagner, and then the German opera of Johann and Richard Strauss which, oddly enough, it remarkably resembles in all but the actual harmonies (if that is a word to use in this case).

Here is the big post-Romantic orchestra, here are the big Romantic opera voices, rich and wobbly and full of dramatic expression. Here, too, is that fast-paced sung "conversation" which is so excellent a feature of Richard Strauss's operas, in contrast to the dead-slow pace of the Wagnerian opera.

But most of all, "Lulu" continues and augments that nightmare-ish atmosphere which one finds in the first Strauss operas, in "Salome" (with the leering head of John the Baptist visible on a platter), in "Elektra"—full of the anguished caterwauling of women



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demented by violence and murder. That grisly tradition goes right on into "Lulu"—somebody dies within the very first moments of the first act, and plenty more to come. Moving, yes! Powerful. But grisly.

"Lulu" then is an early twentieth century opera of the end of the Romantic school, and the fact that its music is serial is both pioneering and, oddly, almost incidental. That's why it is so accessible, of course. That is—if you like deadly serious late-German opera, the Valkyries gone psychotic. Some do—some don't.

Performance: A— Sound: B+

Weill-Brecht: The Three Penny Opera (in German). Stars of the Vienna Opera, F. Charles Adler.

Vanguard Everyman

SRV 273 SD el stereo (\$2.50)

Though not *the* performance—any of several, both in German and English, featuring Kurt Weill's wife the singer Lotte Lenya—this version of the famed popular operetta of the German 1920s has its values. One of those values is not, I would say, the presence of famed and beloved stars of the Vienna opera; instead, the show goes on and is listenable in spite of their slightly unsuitable voices—for this is like, perhaps, a Metropolitan Opera production of "Porgy and Bess," though the gap between popular and "grand" opera, to be sure, is much less in Vienna than in New York.

The performance is good because it is heartfelt, the orchestra (with its unforgettable blatty brasses out of the Twenties) is excellent, if discreet, and above all, the heroine, Polly Peacham, is *not* an opera star, but a Viennese pops artist! Excellent decision on somebody's part, and the other singers generally are able to follow her lead.

An elderly recording, given the synthetic stereo treatment and released at half price (the original was still in the catalogues the month this was released), the new disc has a somewhat dull sound but is otherwise clean and intelligible in the all-important Brecht text (translation provided).

Performance: B+ Sound: C+

Swedish Suite

Music from Sweden. (Blomdahl: Suite from "Sisyphos"; Rosenberg: Voyage to America; Berwald: Sinfonie capricieuse.) Stockholm Philharmonic, Dorati. RCA Victrola VICS 1319 stereo

Two mildly modern items and one

from the earlier nineteenth century—that's the one that would sell this disc to me in a hurry. Berwald.

Nationalism looks good on a cover, of course, and this is, after all, a Swedish performance out of Stockholm. (The newly Swedish Dorati, you'll remember, was not long ago making hi-fi spectaculars for Mercury out in Minneapolis.) But the musical items on this record merely swear at each other's styles. Play 'em separately, I warn you.

Blomdahl, the youngest, is an expertly academic middle-aged contemporary whose grandiose opera about a space trip came out a few years ago. I found it sort of painful. And though I admire the skilled orchestral writing in this "Sisyphos" suite (originally a species of ballet), a lot of swankly sardonic dissonance, very neo-classic, I still find that the Blomdahl technique is 'way ahead of the content. Skillful yet somehow pretentious. As for Rosenberg, the grand old man (b. 1892) of Swedish music, his "Voyage" doesn't cut very much American ice, except that to an experienced ear—it oddly sounds like a good deal of late-Impressionist American music of the pre-World War I era. Loeffler, Chadwick, John Knowles Paine. Probably a coincidence. Slightly nutty, too; Rosenberg's "Voyage" music (from an opera of that name) dates from 1932, a quarter century later.

Ah, but Berwald! A recent discovery for those of us outside Sweden, he turns out to be a fascinatingly real musical personality of the early Romantic era—this little symphony dates from 1842. Such quirky, elfin, high-tension, explosive music, so honestly, so deftly written. Such superbly catchy little ideas, such a wispy sort of thinking, and—for its date—such modernity! The man was a year *older* than Schubert, born 1796, and there is much that reminds us of late Schubert in his work—yet also we hear Berlioz, and Mendelssohn, even a bit of Liszt.

Buy the record for Berwald, decidedly. Throw in the others for curiosity.

Performance: A— Sound: B+

Modern Twists

Microtonal Fantasy. The Music of John Eaton.

Decca DL 710154 stereo (\$5.79)

The determinedly advanced and difficult music of this young man—very much on the classical side—is given a lot of general interest by the Syn-Ket, appearing in a number of works here. It is a live electronic synthesizer,

played on the spot, in performance, and it produces what sounds like and, in fact, *is* electronic music. The gadget is semi-accident, not having originally been intended for live performance, but it works and the idea is very important. Nearest relative is the now well known Moog Synthesizer. But has anyone yet played the Moog machine in a live performance?

Most excruciating music here is that sung by a hard-working Japanese soprano, who practically busts herself screaming out the incredible high notes. Next to her comes the piece for two pianos tuned a quarter tone apart. Oof—*what* a sick sound, for our overly halftone-trained ears. Tough stuff.

New Music in Quarter-tones. (Ives, Hampton, Lybbert, Macero). Chamber Ensemble and Two Quarter-Tone Pianos. Odyssey 32 160162 stereo (\$2.50)

There are ways to break down our half-tone system, including the familiar noises of the all-electronic medium. When the breakdown occurs via live instruments, especially the piano, it is catastrophic on the ears. And yet—go far enough and the sound begins to sound almost OK. This disc will take you over the bumps, from Charles Ives' early and out-of-tune experiment (that's how it sounds) to recent works by thirty-year-olds, who know how to make quarter tones sound persuasive.

Dockstader and Reichert: Omniphony I.

Owl ORLP-11 stereo

(1229 University Ave., Boulder, Colo.)

For a number of years, Tod Dockstader has been a part-time independent creator of electronic music on tape in spare time from his work as a studio sound engineer. Now he has found a "classically trained" musical colleague and the two have combined forces for this enormous operation in 5 movements, and evidently only a beginning, at that. The technique is indeed unusual. The music is largely produced by live instruments—but instead of a performance, the musicians prepared blocks of recorded sound for later treatment, along with other natural sounds and sounds electronically generated. The pieces was organized out of four categories of these—pure instrumental sounds; the same, electronically transmuted; natural sounds, and electronic sounds. Much of the work was done via Moog processing equipment.

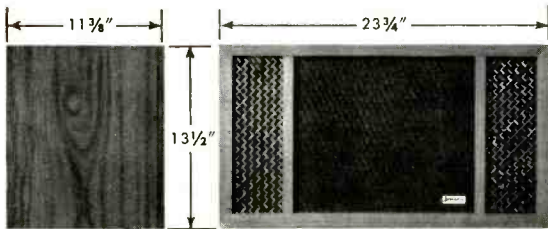
No use trying to "describe" the work! Try it for yourself. A weird cross between recognizably "live music" sounds and now-familiar electronic effects.

(Continued on page 61)

6 reasons why the new Jensen TF-3B should be your next bookshelf speaker

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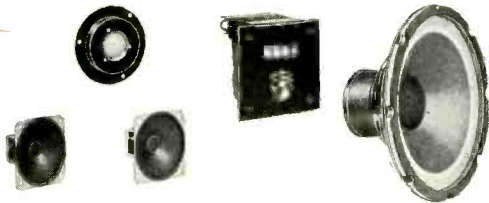
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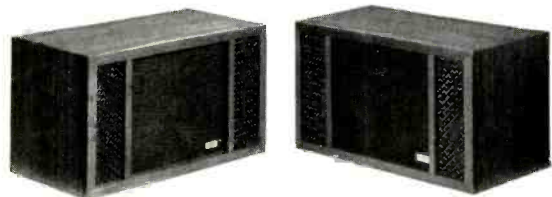
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jensen

Jensen Manufacturing Division, The Muter Company, 5655 West 73rd Street, Chicago, Illinois 60638

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Is There an Eighth Dimension?

BERTRAM STANLEIGH

Early in March, the producers of Command Records herded a collection of record dealers, disc jockeys, and critics into the large studio of Fine Recordings for an advance demonstration of their newest innovation in sound-recording technique. Such demonstrations sometimes precede really monumental strides in recording. Both the long-playing record and the 45-rpm disc were first announced at similar press previews, and curiosity was understandably at a high pitch regarding the new sound method considered so important by its producers that it could only be introduced at a special preview.

First, Loren Becker, co-producer of Command Records, recounted the previous sound triumphs of his label, beginning with the now historic *Persuasive Percussion*, *Stereo 35/MM*, and *Dimension 3*. Then he described the careful planning that he, Bobby Byrne, and engineer Bob Fine had devoted to the development of this new sound. How the tapes of the first sessions, in January 1967, had been discarded as unsatisfactory. How arranger Jack Andrews had been called in to prepare special scoring utilizing new electronic instruments. How the final music tracks had been mixed with effects tracks at the Todd Studios in California, utilizing the world's largest mixing panel, and how by January 1968, Command was confident that it had a worthy product to release. One last modest note crept in as Becker declared, "We hope to do better in six months to a year."

After that, at ear-splitting level, a half dozen of the new disc's eleven selections were played. Unfortu-

nately, the audience contained a high percentage of those strange characters who begin to talk as soon as a recording starts to play. Since the music was loud, they shouted. In the midst of the turmoil, it was quite impossible to reach any conclusions. But I left the conference clutching a copy of *Sound in the Eighth Dimension*, resolved to put this new contender to the test.

A study of the liner notes revealed just what was meant by the *eighth dimension*. Instead of the usual left and right positions, with a center spot between the two, the new Command technique has as its goal the establishment of six firm positions from left to right, plus a solo position in front of the orchestral sound curtain, and a percussion and rhythm position behind the band.

Home listening on my own familiar system immediately made it clear that it was possible to audit this disc at more normal listening levels than had been played at its preview without any diminution of its sonic merits. In fact it was pleasantly surprising to note that in contrast to its very notable loud passages, the disc also had some real pianissimo sections. To this listener, the clarity of sound through this very wide dynamic range is one of the very real virtues of the new technique.

The solidity of "fill" between the speakers was also quite apparent, and there was no question about the stable positions of various sections and solo instruments. Each sound emerged with clarity from its own fixed position, and it was quite possible to detect a half-dozen or more different instrumental locations at the same moment. If one wanted to, one could sit in one's favorite chair and diagram the seating position of the orchestra for each selection. Other records with somewhat smaller instrumental groups have come very close to the clarity and positional stability of this new Command breakthrough, but I can't think of a single recording of a group of forty or more instruments that has succeeded to such a marked extent. The technique really works!

Now, what about the use to which it has been put? The present disc is manifestly a "high fidelity showcase" type of affair. Its selections

have been chosen for their flashy effects and variety of styles. *Limehouse Blues* and *South Rampart Street Parade* are cheek by jowl with *Ebb Tide* and *Blue Hawaii*.

Spanish Eyes and *El Gato Montes* provide the Latin flavor. La belle France is evoked in Michel LeGrand's *This Heart (Paris)*, show biz is represented by *The Sound of Music* and *Get Me to the Church on Time*. The sound of a marching band is provided in *March of the Space Cadets*, and the kiddies get their nod with *Talk to the Animals*. There is, indeed, something for everyone from the *aficionado* to the jazz buff, but the only central theme running through the entire disc is its recording technique. Anyone is bound to find a band or two that he admires—for me *El Gato Montes* is an absolute smasher, a fine performance with marvelous brass sounds and a spine tingling re-creation of the sounds of a bull-fight crowd. But I'm thoroughly uncomfortable with the arrangements that sandwich it in. The only way I can cope with this platter is to sit close to my turntable and pick the bands I enjoy.

Mark you, there's not a thing wrong with any one of the performances, provided you like the style. Robert Byrne, who conducts the first rate studio orchestra, is a thoroughly accomplished professional who can get exactly what he wants from a group. He led one of the spritelier groups back in the "big band" era, and he continues to keep things moving in a bright, youthful manner.

What about the new recording technique? Is it the revolutionary breakthrough it's claimed to be? Well, it's certainly splendid. As good or better than anything I've heard to date. But I wouldn't classify it as more than a particularly well planned, well engineered recording that utilizes all of the familiar present-day techniques. It will take subsequent releases with more substantial musical interest to reveal any startling new dimensions. We'll be waiting to see just how good those new releases are.

Sound in the Eighth Dimension. Command Stereo RS 928 SD

Performance: B

Sound: A

Classical Record Reviews

(Continued from page 58)

Capsule Comments

Boulez Conducts Debussy (*La Mer*; *L'Après-Midi d'un Faune*; *Jeux*). New Philharmonia Orch. CBS 21 11 0055 stereo.

Unusual performances—hailed right and left. I found the familiar music rather *too* different, sounding more modern, less impressionistic, the “insides” oddly showing. Interesting, and the seldom-heard late “*Jeux*” is especially valuable. Definitely a young-generation achievement.

Schumann: Piano Concerto; Novelettes. Artur Rubinstein; Chicago Symphony, Guilini. RCA Victor LSC 2997 stereo.

The sprawling Schumann concerto is tough to interpret—Rubinstein has it in hand as few still do. Guilini is excellent too, but of a younger generation. A fine performance, though there is some noticeable disagreement between the two, not entirely resolved when passages echo, piano vs. orchestra.

Mozart; The Last Six Symphonies. Sir Thomas Beecham, Royal Philharmonic. *Odyssey* 32 3 0009 mono.

True (as *Odyssey* notes)—Beecham was Mozart for years. Now, his resurrected recordings are still meticulously accurate in detail, but the concept seems heavy, often too slow by our standards, the orchestra overweight, the eccentricities of ritard, etc., rather hard to take. Still, these are fine documents of an era now departed.

Music for Maximilian. Rias Ch. Orch., asst. soloists. Angel 36379 stereo.

The Triumph of Maximilian. London Ambrosian Singers, Vienna Renaissance Players. Nonesuch HB-73016 stereo.

Suddenly, the Emperor Maximilian (d. 1519) has been rediscovered—he of the fabulous wood prints, Albrecht Dürer and others, the splendid processions, creator of the Habsburg empire—because his equally important music, once too “early,” is now again coming back for listening. Here are two surveys, Nonesuch's on two records, with such now-revived names as Isaac, Senfl, Des Prez, Finck. Voices, instruments, solo and ensembles of various sorts.

P.D.Q. Bach on the Air. With John Ferrante, counter-tenor, I Virtuosi di Hoopole, Prof. Peter Schickele. Vanguard VSD 79268 stereo.

Prof. Schickele's third spoof-record shows him as persistently seeking the big laugh as ever; he is not noted for extreme musical subtlety. This hysteric take-off of “good music” on the air, nevertheless, will double up anyone who fancies Baroque music. The works, including announcers, commercials, “remotes” all in Baroque-modern! The counter-tenor sings the station breaks and time signals. The P.D.Q. music isn't half bad. As *music*, I mean. I've heard worse.

Haydn: The Six Paris Symphonies, Nos. 82-87. N. Y. Philharmonic, Bernstein. Columbia D3S 769 (3) stereo.

This splendid big album of six superb and formerly little known late Haydn symphonies does not put *Nonesuch's* parallel album (H-73011, Leslie Jones) out of the running—try both. Bernstein's is bigger in sound, more polished, more “symphonic,” and occasionally a bit old fashioned. Jones-Nonesuch gives a surer, more intimate look at these splendid works. Between the two sets, you are set for a year's good listening.

Brahms: Horn Trio, Op. 40; Trio No. 2 for vl., cello and pf., op. 87. Yehudi and Hepsibah Menuhin, Alan Civil, horn, M. Gendron, cello. Angel S-36472 stereo.

Brahms chamber music is so obviously *not* background music—even on records! The Menuhins, violin-brother and piano-sister, steer a leisurely Romantic course through these two works, with a fine horn in one and a fine cello in the other. Excellent if you pay close attention, but a *recorded* performance generally needs more drive and push. Yehudi is getting wobbly and inaccurate, though still musical. Hepsibah's piano is miked too distantly in the horn work, OK in the other one. In sum: not bad, if plenty mellow.

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STUART TRIFF

... The Old

Ethel Waters.

Columbia (mono only) CL-2792 (\$4.79)

Another outstanding reissue in Columbia's "Hall Of Fame Series" is this release devoted to the incomparable Ethel Waters. The selections trace the singer's remarkable career, from 1925 to 1940, in night clubs (Plantation and Cotton Club), movies ("On With the Show"), Broadway revues ("Blackbirds Of 1930," "As Thousands Cheer," "At Home Abroad"), to her memorable starring role in "Cabin In the Sky." The performances are treasures and the songs speak for themselves: "Dinah," "Am I Blue?" "Stormy Weather," "Heat Wave," "Taking a Chance On Love," et al. Once again, engineer George Engfer has achieved remarkably good sound in transferring these faded 78's to LP.

Performance: A

Sound: B+

... And the New

Dawn of a New Day—Margie Day, vocal.; arr. & cond. by Ray Ellis, Chuck Sagle, Jimmy Wisner.

RCA Victor LSP-3899 (\$4.79)

This aptly-titled collection marks the album debut of Margie Day, an exciting young singer from Norfolk, Virginia, who for the past seven years has been serving an apprenticeship warbling in a night spot in her home town. Judging from this disc, I'd say that RCA has a hot property on its hands.

Miss Day's is not a big voice, but it's a flexible one, capable of producing a variety of colors with sensitive and expressive phrasing. She has some strikingly original approaches to her songs, and though not all of them work (as in "Wouldn't It Be Lovely" and "Let's Do It") she's never less than interesting.

Seven of the ten songs are from 1928 to 1968. I especially enjoyed the torchy rendition of "Walk Away," one of the better Elmer Bernstein tunes from "How Now, Dow Jones," and her driving, bongo-punctuated delivery of

"Over the Rainbow." "Am I Blue?" introduced by Ethel Waters in an early film musical, is sung in a style reminiscent, but not imitative of the great Billie Holiday; and Cole Porter's "It's All Right With Me" is given the most electric interpretation I've ever heard, complimented by a fine Ray Ellis setting.

The Burt Bacharach-Hal David song, "In Times Like These," is another highlight of this impressive recital. The three arranger-conductors provide excellent accompaniments. The reproduction is sharp and full, with good stereo effects. Miss Margie Day should have a long and very bright career ahead.

Performance: A

Sound: B+

Fiddlesticks

Fiddle Faddle and Other Leroy Anderson

Favorites: Utah Symphony Orchestra/Maurice Abravanel.

Vanguard VCS-10016 (\$3.50)

Fifteen selections comprise this collection of thrice-familiar Andersoniana, offered by Vanguard in their commendable, low-priced Cardinal Series, in compatible stereo. Employing the new Dolby noise-reduction system, this disc is a joy to listen to. Smooth response over the entire frequency range, noise-free surfaces and a burnished orchestral sound clarify every detail of Leroy Anderson's delightfully imaginative orchestration.

If only the performances were as good as the reproduction of them.

Though the Utah orchestra plays beautifully, the conducting is heavy-handed; almost everything is played too slow, thus robbing these pieces of the necessary snap, sparkle, and verve the composer brings to them in his own infectiously impudent renditions. With Anderson at the reins of his "Sleigh Ride," the journey ends at 2:44, while Abravanel's leisurely trip takes 3:05. In "Song Of the Bells," the composer is finished at 2:58; Abravanel chimes on for 3:44. There's a statement preceding the liner notes, calling attention to the fact that this is the first time a major symphony orchestra has recorded an album of Leroy Anderson. This claim, while technically correct, is hardly reason enough to ignore the 85 virtuosi of the Boston Pops Orchestra, and Arthur Fiedler, for whom many of Anderson's compositions were originally written. The recorded performances by the "Pops" are almost on a par with those by the composer.

Performance: C

Sound: A+

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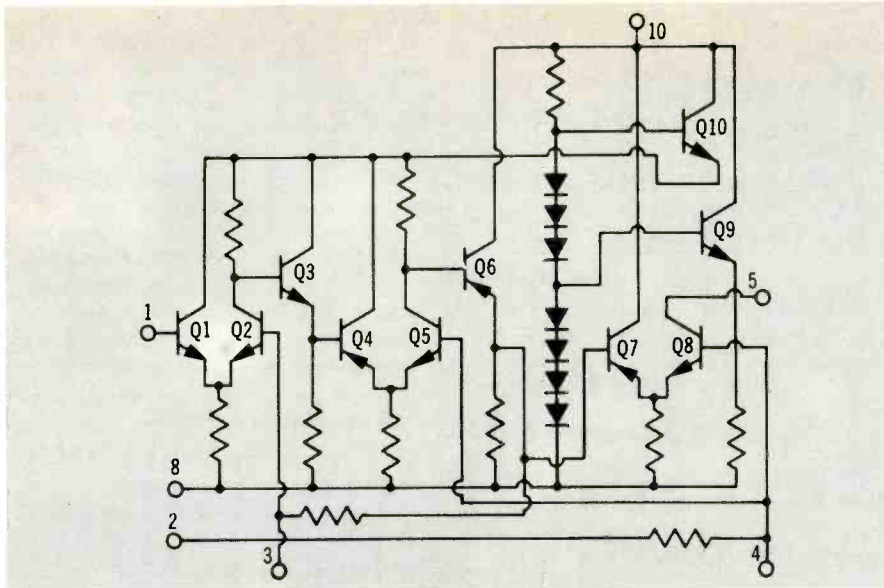


Fig. 8—The CA-3012 "IC" contains all the elements shown here.

ABZ's of FM

(continued from page 38)

whether tubes, transistors, or integrated-circuit linear amplifiers. A typical i.f. stage utilizing a pentode as the "active" amplifying element is shown in Fig. 5. Pentodes were often used because they could be constructed to provide a high transconductance while exhibiting relatively low interelectrode capacitances. In a tuned circuit, a high Q means a high L/C ratio. Thus, if high Q circuits are desired (and they are, for gain and for fashioning desired response curves), we should seek to make L as high as possible. If the "C" in the picture consists not only of a fixed, selected value, but also of the "stray" interelectrode capacitances, we are immediately limited as to how "high" we can choose L to be. The need for a high value of "L" also led, indirectly, to the use of inductive tuning rather than capacitive tuning for interstage i.f. transformers, for with permeability tuning a wider frequency range can be covered without resorting to relatively large variable capacitor values which would again restrict the value of L in the resonant circuit.

The i.f. stage illustrated schematically in Fig. 6 shows the use of a transistor as the active device. Notice, that because of the low input impedance characteristic of "common emitter" stages, it becomes necessary to alter the construction of the secondary of the interstage transformer. A tap is brought out near the "bottom" of the winding to provide a proper impedance match to the transistor base input and to prevent "loading" of the entire secondary with subsequent reduction in Q.

Often (though not in this illustration), even the primary winding is connected to the previous collector by "tapping down" on the coil, for pretty much the same reason — insufficiently high impedance at the collector output of the previous transistor.

Finally, in Fig. 7, we see the use of an integrated circuit in an i.f. stage. The "contents" of this tiny chip stagger the imagination (as shown in Fig. 8), for what we see are ten transistors, eleven resistors and seven diodes. What you don't immediately see is that not all these microscopic devices are contributing directly towards amplification. For example, the "triplets" Q1-Q2-Q3, Q4-Q5-Q6 and Q7-Q8-Q9 each constitute only a single stage of moderate, though highly stable amplification, while Q-10 and all those diodes act as a voltage regulator for the rest of the "innards." These wonderful new devices enable construction with fewer external components and, properly employed, they can and are being used in truly great i.f. designs, but let us not succumb to the overenthusiastic claims which state "... equals ten transistors, nine resistors and umpteen diodes if discrete components were used." At least let's understand what is really meant by such claims. What is not needed is a return to the days when tubes were used (often in profusion) as series dropping resistors, so that advertisers could claim radios having "more tubes than anybody." (In line with this, the FTC recently clamped down on claims made for the number of "transistors" used in radios. Seems that solid-state devices used for other than amplifying or oscillating purposes were numbered as transistors.—Ed.)

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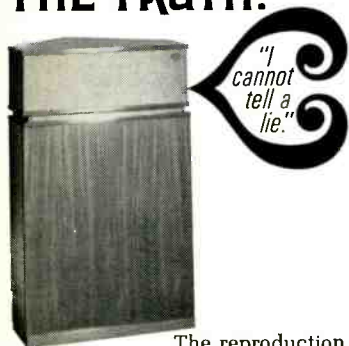
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**Recorded
Tape
Reviews**

BERT WHYTE

Opera in 3¾ ips

Verdi: Ernani (Opera in four acts). Leontyne Price, Carlo Bergonzi, Mario Sereni, Ezio Flagello. Thomas Schippers cond. the RCA Italiana Opera Orch. & Chorus.

RCA Victor TR38004, open reel, 4 tr., 3¾ ips (\$17.95)

The first complete recording in stereo of Verdi's *Ernani* is a resounding success. The cast and their generally superb singing, the conductor, and the splendid sound combine to make this one of the top operatic recordings in recent years. Most certainly it is one of Leontyne Price's most triumphant roles. She is nigh perfect as Elvira, her voice a fantastically responsive instrument, dazzling in its beauty, in its power, and in its sheer eloquence. Such a warm, golden sound coupled with rock-ribbed control is something you have to hear to believe. This stunning performance re-affirms her position of eminence among today's most illustrious prima donnas.

Carlo Bergonzi as Ernani turns in a most convincing portrayal; his rich sumptuous voice and tasteful style are well suited to the role. Ezio Flagello is a richly sonorous Silva, and Mario Sereni serves admirably as Don Carlo, albeit with less emotional involvement than desirable. Even the minor roles are well cast, using artists of more than routine ability. Conductor Schippers, on loan from Columbia, makes an impressive case for his briskly paced, super-charged view of the music. His handling of the chorus and his painstaking care with inner balance is masterful. He gets good support in the excellent playing of the RCA Italiana Opera orchestra, who are old hands in the matter of operatic accompaniment.

This is just about the best-sounding 3¾-ips tape I have heard. It proves that careful processing and rigid quality control can make this slow-speed tape a respectable product, although at

a still considerable remove from the quality of the best 7½-ips tapes. The acoustic perspective is the familiar spaciousness of the RCA Italiana Studio, with microphone placement just about right to ensure a nice blend of direct and reflected sound, affording good presence and fine definition.

Orchestral/choral/vocal balances are good; clever use of the voices for stage movement, not exaggerated, but tasteful and effective. Frequency response extends to at least 9-10 kHz and the dynamic range was unusually wide. Transient response, most always one of the drawbacks of 3¾-ips tape, was surprisingly good, with bright clean



Leontyne Price

Photo courtesy of RCA Records

cymbals and solid weighty tympani. Crosstalk virtually absent, hiss low in level, but pre and post print-through was in evidence. As you have gathered, I am much impressed with the virtues of this recording and I think your ears will confirm my judgment.

A Brahms Winner

Brahms: A German Requiem. Agnes Giebel, soprano; Hermann Prey, baritone; **Alto Rhapsody:** Helen Watts, contralto; **Nanie.** Les Choeurs de la Suisse Romande et Pro Arte de Lausanne. Ernest Ansermet cond. L'Orchestre de la Suisse Romande London/Ampex LOH90135, open-reel, 4 tr., 7 ½ ips (\$12.95)

The "Alto Rhapsody" and the rarely heard "Nanie" are well-performed on this tape and the sound is quite good. It is the "Requiem," afforded a superb performance by Ansermet, that makes this tape worth acquiring. Ansermet sets a leisurely pace, stresses orchestral/choral balances and builds to climaxes of massive power. His reading has great warmth, and many exquisitely lovely moments, yet he carefully avoids any excess of sentiment. It is really a sort of "old-fashioned" performance, best characterized as grandiose, and

the great outpourings from chorus and orchestra are sonically exciting. It is a performance in marked contrast to the high-tensioned von Karajan reading, being closer to the Klemperer recording. Soloists Agnes Giebel and Hermann Prey are excellent; they stand up well in comparison to the illustrious Schwarzkopf and Fischer-Dieskau on Angel and outshine the soloists in the von Karajan recording.

The sound is splendidly embellished with all the stereo attributes. Lateral interplay between voices is very effective. It is possible to easily differentiate the various choirs in the chorus, yet they are a well-blended sonic entity. The acoustics are fairly spacious, mixing medium close. Orchestral definition generally good, chorus quite articulate except for some infrequent blurring and diffusion in the fortés. Orchestral/choral/soloist balances are very good and dynamic range is wide. The important organ pedal in the third movement is big and solid. Overall, a thrilling recording with plenty of presence. Hiss, crosstalk, and print-through are low in level.

Sterling Pop

What The World Needs Now Is Love:

Jack Jones

Kapp/Ampex KTC3551, open reel,
4 tr. 7 1/2 ips (\$7.95)

As you probably know, Jack Jones is now an RCA Victor artist. This tape is presumably the last of his output on Kapp. As with most of his Kapp recordings, this is characterized by top-flight singing and exemplary sound. Jack splits his chores between some aggressive "swingers" and smooth ballads, which I insist is what he does best and which made (and sustains still) his reputation. In addition to the title song Jack sings such familiar numbers as "True Love," "I Only Have Eyes For You," "The One I Love Belongs To Somebody Else," as well as more modern stuff such as "The Eyes Of Love," "Yesterday," and similar material. Some intimate, "singin'-just-for-you" style, dead-on-pitch, cleanly articulate vocalizing and masterful phrasing are the trademarks of this superb entertainer.

First class stereo sound throughout this tape without much of the usual pop exaggeration of direction and reverb. One of the most impressive things is the signal-to-noise ratio . . . this is one of the most noise-free tapes I've ever heard. Almost no hiss, very low pre and post print-through, crosstalk not a factor. Would that all tapes had such sterling qualities!

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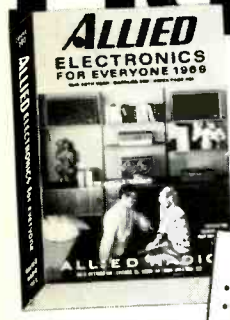


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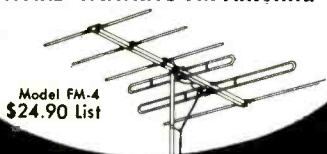
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