AUDIO LEVEL DEVICES

*by Thomas R. Haskett** — Part One. Peak Limiters: operating principles, theory, features, and a survey of currently available models.

The automatic control of audio level is a very specialized and sophisticated art today. The operating engineer is faced with a sometimes confusing array of devices: peak limiter, compressor, AGC amplifier, threshold, platform and gate amplifiers, etc. What is each used for? Should there be more than one per station? What are their advantages and disadvantages? We shall attempt to answer these questions in the following survey of devices on the market today.

Level-controlling devices can be grouped into three general categories, by function: (1) **Peak limiters,** or limiting amplifiers, tend to establish a ceiling or barrier, beyond which audio peaks cannot increase; (2) **Compressors,** or averaging devices, compress peaks and expand low passages, and such action is neither as fast nor as drastic as that of a limiter; (3) **Specialized devices** overcome disadvantages of limiters and compressors. We shall now examine each of the three groups in some detail.

*Michigan City, Ind.

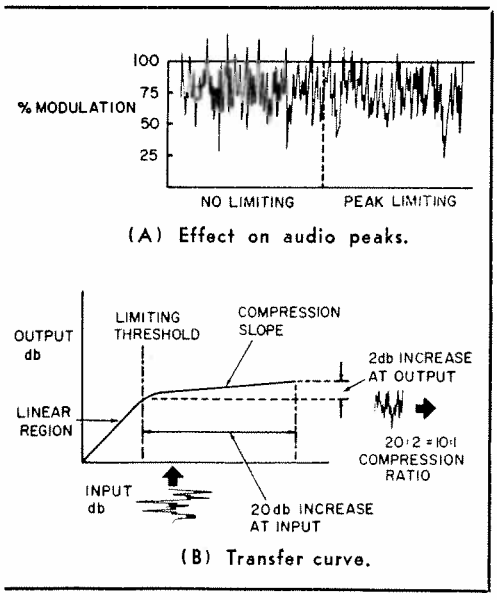


Fig. 1. Basic limiter-circuit action.

Limiters

As most audio operators know, normal program material contains short, but high-amplitude peaks, which can overmodulate the transmitter. The FCC prohibits overmodulation, since it causes severe distortion at the receiver, adjacent-channel splatter or hash, and possibly even transmitter damage. In earlier days, the peak limiter was invented to avoid this trouble. It puts an approximate ceiling on audio peaks, as illustrated in Fig. 1a.

But the limiter not only prevents overmodulation; with the transmitter protected against instantaneous peaks, the average modulation can be raised somewhat. Since the result is to put more audio in the listener's receiver for the same carrier power, it means a louder signal. Note, however, that there are still low passages which the limiter doesn't affect.

What a Limiter Does

When signal peaks are below a certain level, called the **limiting threshold**, a limiter acts like a linear amplifier; output is directly proportional to input, as shown in Fig. 1b. When a peak exceeds this threshold, amplifier gain is reduced. Ideally, no matter how high the input peak, the output would remain at the threshold level. Actually, no limiter is perfect; there is always a slight variation in output level caused by a change in input level. The relation between input and output variation is called the **compression ratio** (or slope). If the input increases by 20 db and the output by 2 db, as shown, this ratio is 10:1. The time it takes for limiting to begin is called the **attack time,** and since this is a few milliseconds or less, hardly any of the signal peak gets through to the transmitter. When the signal level drops below

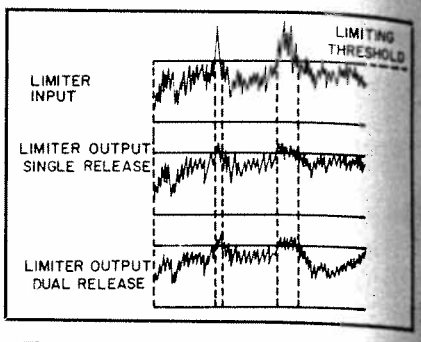


Fig. 2. Single and dual release times.

threshold again, there is a slight lag before amplifier gain returns to its former value. This period is known as the **release** or **recovery time.** In practice, half a second to several seconds of release is used, depending on the type of program material and the effect desired. Fig. 2 illustrates the two types of release commonly available on limiters. For most voice work, jazz and popular music, single release is preferred—gain returns to normal rapidly regardless of the peak duration. Dual recovery is used for other material, such as classical and religious music; following a short peak the gain returns to normal rapidly, but after a series of peaks, gain is held low for a longer period.

How It Works

Fig. 3 is a block diagram of the conventional limiter. Each stage is push-pull; the first (V1-V2) is a variable-gain, controlled stage. The intermediate stage (V3-V4) and the output stage (V5-V6) employ fixed gain. A portion of the output is rectified by control diode V7, which is usually a full-wave rectifier, providing limiting action even on assymetrical waveforms. The resulting DC is applied to a grid of the controlled stage; hence, input gain depends on output level. However, to establish the limiting threshold, diode V7 receives a fixed DC bias so it won't conduct until signal

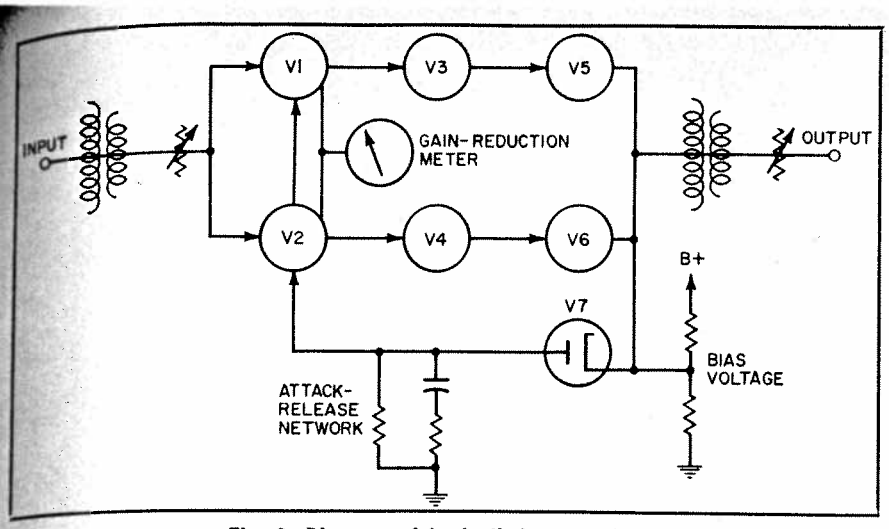


Fig. 3. Diagram of basic limiter circuit.

level exceeds this bias. This means that any signal which produces an output **lower** than the diode's bias will be amplified linearly. The attack and release time constants are set by RC networks in the line between the diode and the controlled stage.

Disadvantages

Limiter bugaboos are **thump** and **pumping,** or **breathing.** Thump is a low-frequency transient caused by a rapid change in grid voltage to the input stage, or by poor B+ regulation, or unbalance in any stage. The usual design employs a VR tube to establish a fixed supply voltage for controlled-stage plate and screen, and for grid bias. Arrangements are also normally made for balancing the push-pull stages where needed. Both of these measures reduce thump to a minimum. Pumping, on the other hand, isn't so easy to minimize. It's the effect noticed at a ball game, where the crowd noise rises and falls with the announcer's voice, at almost a syllabic rate. It's caused by a single, short release time constant, and the dual recovery circuit at least partially overcomes it.

Operating Practice

The usual place for the limiter is working into the audio input of the transmitter. Before the compressor was developed, many operators preferred to drive the limiter hard—10 db on average program material, and more on peaks. While this effectively increased the loudness at the receiver, it also increased distortion. For increasing the effective range of an AM transmitter this practice is unnecessary today, if a compressor is used ahead of the limiter; the limiter is then only employed as peak protection. This is desirable, since most units today won't limit over 10 or 15 db without a considerable increase in distortion. (For an excellent treatment of this subject, see "Audio Limiting and AGC Action," in the June, 1962, issue.)

When a limiter drives an FM transmitter, the 75-microsecond pre-emphasis curve produces a problem. If the limiter is used solely to guard against overmodulation, it must be located **after** pre-emphasis; then, no matter what the frequency, no peaks can overmodulate the transmitter. But with such a hookup, there will be times when high-amplitude, high-frequency signals will cause limiting; and this limiting will decrease the gain for **all** frequencies, including the loudness-controlling middle frequencies. Hence, the limiter following pre-emphasis cannot be used in an effort to increase average modulation by heavy limiting. However, more about this in a later installment.

Features of Limiters in Current Use

Each of the limiters mentioned below is supplied with front-panel input and output attenuators, will match 600 ohms in and out, has a panel meter which reads limiting in db, and mounts in a 19-inch rack (although RCA needs an adaptor). Specifications are given in Table I; individual features follow here.

Collins 26U-1 — The conventional circuit is used, with Daven step-type attenuators. Since the push-pull stages are self-balancing, they require no adjustment. Both attack and release times are continuously variable, so the operator can choose the exact time constants he wants. With a view to dependability, the power supply employs silicon rectifiers and extended-life capacitors. And there's a front-panel VU multiplier with a range of +4 to +24, as well as a five-function meter-selector switch.

Collins 26U-1

Fairchild 660 and 670—The 660 (a single-channel unit), although nominally a limiter, can function either as a limiter or a compressor, depending on user preference. A six-position switch is used to vary the time constants of both attack and release, and a continuously-variable threshold control permits

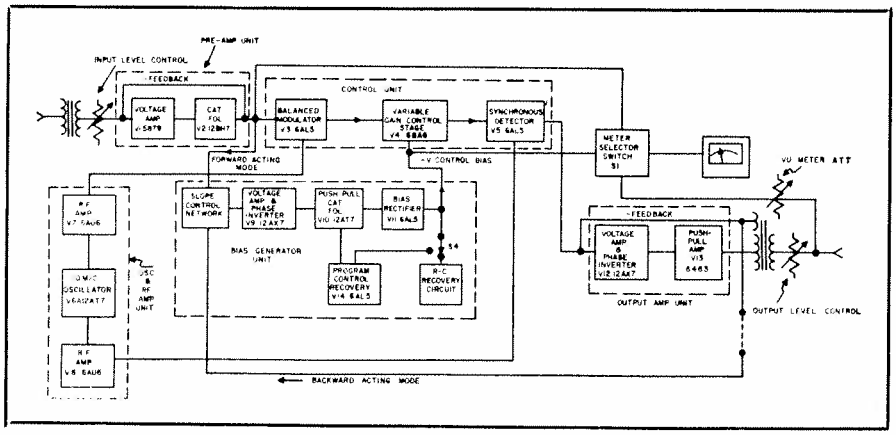


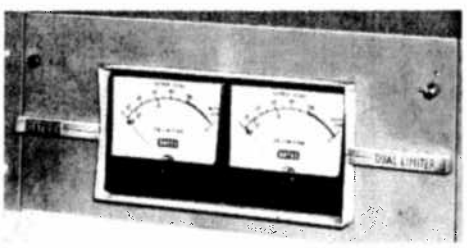
Fig. 4. Block diagram of General Electric BA-7-A.

Fairchild 670

varying the limiting point and compression ratio. Thus, gain control can be fast and extreme, like a peak limiter, or slow and moderate, like a compressor or averaging device. With both speed and degree of level control almost continuously variable, the action can be set up to match a wide variety of individual preferences.

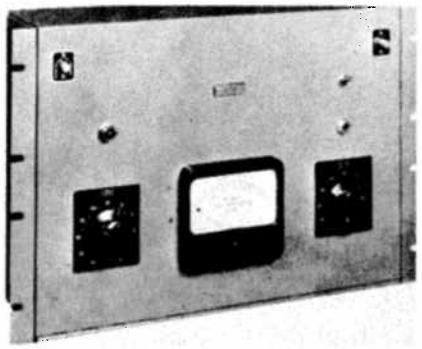
The 670 (a dual-channel unit) consists of two 660's in parallel, fed by a single power supply. Except for a slight difference in gain and input level (see Table 1) there are no variations between the two. The 670 can be operated in either of two modes: In the first, the left and right channels are handled separately; in the second, the two signals are matrixed to furnish sum and difference components, which then determine the amount of limiting. However, the outputs remain L and R. Hence, when used for stereo, limiting action occurs as a result of the combined effect of both channels. In the separate mode, channel separation is 70 db; in the combined mode, it's 40 db.

Gates SA-39B and M-6144—The SA-39B (a single-channel unit) uses the traditional circuit with one exception: A rather elaborate, electronically-regulated power supply furnishes a closely-regulated B+ for everything but the output tube plates. This reduces thump and instability to a very low value. The input attenuator is a grid-circuit potentiometer, permitting precise adjustment of input level and operating point. The input matches 500/600, 150/250, or 30/50 ohms, and there is a front-panel phone jack for output monitoring.



Gates M-6144

The M-6144 Dual Limiter has been designed specifically for stereo. The identical limiting channels share a common power supply, which uses solid-state components, and all low-level filaments



Gates SA-39B

are fed filtered DC. Each channel has its own continuously-adjustable input and output potentiometers, balancing and meter-zeroing controls, and meter-selector switches. Operation is possible either in separate (twin mono) or combined (single stereo) modes. In the separate configuration, the two separate limiters can be used on different programs with no interaction—channel separation is 70 db. In the combined or stereo arrangement, the limiting circuits of each channel are connected together so that the greatest peaks control both channels, thus preserving the stereo effect.

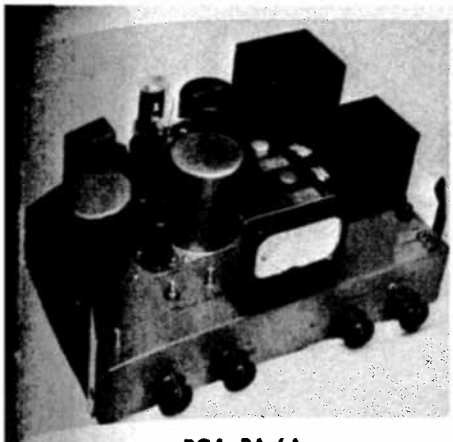
ITA LA-1A—ITA employs the conventional circuit, but adds a push-pull isolation amplifier between the output stage and the control-voltage rectifier diode. This isolation prevents clipping in the output stage, and by using a push-pull stage from both sides of the output, limiting still takes place on assymetrical waveforms. The output attenuator is a Daven step type; the input control is a continuously-variable potentiometer. Standard,

ITA LA-1A

easily-avail
throughout
RCA B
traditional
receiving-t
controls f
stage. To
balancing,
amplitude
extra featu
to read
variable-g
current of
The signal
26 db w

Model	Attack Time μsec	Release Time sec	Compr. Ratio	Input Level dbm	Output Level dbm	Gain db	Noise Level dbm	Frequency Response	Harmonic Distortion
Collins 26U-1	0.5 to 3.0	2.2 to 5.2	12:1	−20 to +20	−20 to +20	32	−50	±1.5 db 50 to 15,000 cps	1.5%
Fairchild 660 / Fairchild 670 (Dual)	0.2 or 0.4	0.2 to 25	2:1 to 30:1	+4 or +16 / 0 to +16	+4 or +8	16 / 7	−66	±1.0 db 20 to 15,000 cps	below (10 db) 1.0% (limiting)
Gates SA-39B	3.0	0.2 to 1.2	10:1	−20 to +20	0 to +19	50	−46	±1.5 db 30 to 15,000 cps	1.5% (15 db) 0 to (limiting) 5,000 cps
Gates M-6144 (Dual)	Up to 0.6	2.0 to 4.0	10:1	−45 to +24	0 to +16	63	−54	±1.0 db 30 to 15,000 cps	1.0% (25 db) 0 to (limiting) 5,000 cps
GE BA-7-A	0.07	0.5 to 1.5	20:1	−30 to +20	+12 to +27	57	−65	±1.0 db 50 to 15,000 cps	2.5% (20 db) 0 to (limiting) 5,000 cps
ITA LA-1A	1.0	0.2 to 5.0	6.7:1	−25 to +10	0 to +20	65	−45	±1.0 db 50 to 15,000 cps (20	1.5% (20 db) 0 to (limiting) 20,000 cps
RCA BA-6A	0.6 or 900	0.33 or 2.0	10:1	−24 to +14	+9.5 to +38.5	54	−54	+1.0 to −2.0 db 30 to 15,000 cps (20	below 1.0% 00 to (15 db) 5,000 cps (limit)
Universal Audio 175-B	0.3 to 1.0	0.027 to 0.527	12:1	−24 to +13	−24 to +13	37	−67	±0.5 db 20 to 20,000 cps (15	below 1.0% 0 to 5,000 cps

Table 1.

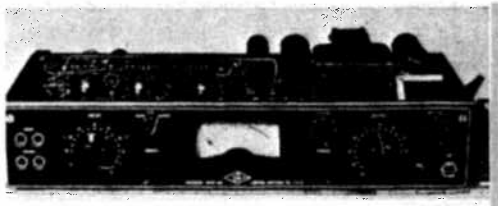


RCA BA-6A

easily-available parts are used throughout.

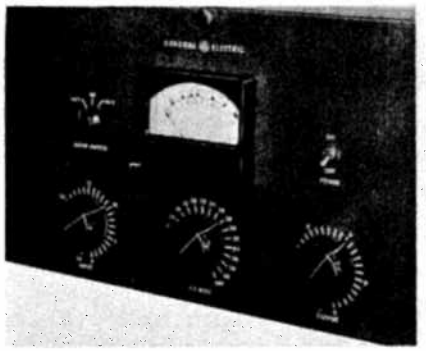
RCA BA-6A—RCA uses the traditional circuit, with ordinary, receiving-type tubes and balance controls for setting up the input stage. To facilitate such dynamic balancing, an internal constant-amplitude signal is provided. An extra feature is the use of the meter to read heater voltage on the variable-gain stage, and cathode current of all signal-channel tubes. The signal-to-thump ratio averages 26 db with non-selected tubes, measured under 10 db of limiting. The input will match 150 as well as 600 ohms, the input tube has DC on its heater, and the power supply can furnish plate and filament power for an external preamplifier. The BA-6A is designed for plug-in mounting on an RCA type MI-11599 shelf, which mounts in a 19″ rack.

Universal Audio 175-B—This is the smallest limiter available. By using miniature tubes, military type printed circuitry, and careful parts placement, it requires only 3½ inches of rack space. The conventional circuit has been followed, except that triodes are used instead of the usual pentodes. There are Daven 2-db-per-step attenuators at both input and output, and a vernier adjustment is provided alongside each, which covers the intervening 2-db range. Front-panel patch jacks for input and output are provided, in addition to a rear-panel terminal strip. Not only are tube-balance controls furnished, but an internal balance signal is available, making external test gear unnecessary. Continuously-variable attack and release controls are mounted on the front panel.



Universal Audio 175-B

GE BA-7-A—The design of GE's "Audiomatic" differs radically from the standard outlined earlier, and merits a close look. As Fig. 4 illustrates, there are five sections: oscillator-RF, bias generator,



General Electric BA-7-A

control, output, and preamp. The input signal is first amplified by the preamplifier, then split and fed to both the control and bias generator units. The oscillator-RF unit furnishes a constant-amplitude 10-mc RF carrier to the control unit's balanced modulator (V3). The incoming audio amplitude-modulates the RF; the carrier is then suppressed and only the modulated sidebands are passed to the variable-gain control stage (V4). Meanwhile, audio from the preamp is also fed to the bias generator unit. It goes through the slope control, which adjusts the compression ratio, and is further split and fed through a cathode-follower to the bias rectifier (V11), and the program-controlled recovery circuit (V14). (The low impedance of the bias generator permits fast attack time, 70 microseconds.) The bias diode furnishes operating bias for variable-gain control stage V4, and thus the modulated sideband amplitudes are controlled. Note that since control voltage is derived from input, rather than output, motor-boating cannot occur. Also, since no carrier is present at this point, any thump components

• Please turn to page 40

Harmonic Distortion	Meter Reads	19″ Rack Space Height	Depth	Price	Model
5%	Limit db Input vu Output vu Ext. Limit db Ext. vu	10½″	9″	$ 425.00	Collins 26U-1
low (10 db) % (limiting)	Limit db Tube bal.	14″	11″	970.00 1495.00	Fairchild 660 Fairchild 670 (Dual
5% (15 db) to (limiting) ,000 cps	Limit db	14″	9½″	445.00	Gates SA-39B
% (25 db) to (limiting) ,000 cps	Limit db Output vu Tube bal.	7″	16″	867.50	Gates M-6144 (Dual)
5% (20 db) to (limiting) ,000 cps	Limit db Input vu Output vu Tube bal.	10½″	9½″	1000.00	GE BA-7-A
5% (20 db) to (limiting) ,000 cps	Limit db Tube bal.	8¾″	10⅝″	425.00	ITA LA-1A
low 1.0% to (15 db) ,000 cps (limit)	Limit db Tube bal.	8¾″ requires	14″ adapter	582.75	RCA BA-6A
low 1.0% to ,000 cps	Limit db Input vu Output vu	3½″	9¼″	425.00	Universal Audio 175-B

Limiter Specifications.

Audio Level Devices

(Continued from page 13)

introduced by control-stage bias shifts can't be passed on. Hence, thump is very low—45 db below signal. The sidebands go to synchronous detector V5, which also receives the 10-mc carrier from the RF section; sidebands and carrier are recombined and the audio detected. Finally, the signal goes to the output amplifier.

Two recovery circuits are used. The first is the conventional dual RC network mentioned before. The other is called program-controlled recovery. It establishes a 6-db limiting platform, below which recovery time is long, thus minimizing pumping. Above the 6-db platform, recovery is much faster for short-duration, rapid-sequence peaks. However, if a high-amplitude, short-duration peak is followed by an absence of program material, the recovery rate is again long. Recovery is thus controlled by program material, making it possible to use a large compression ratio (20:1) with negligible pumping effect.

Normally the "Audiomatic" works **forward**—that is, input level controls output level. It's possible, however, to use it working back-

Collins Radio Co.
Cedar Rapids, Iowa

Fairchild Recording Equip. Corp.
10-40 45th Ave.
Long Island City, N. Y.

Gates Radio Co.
Quincy, Ill.

General Electric Co.
Defense Electronics Div.
Technical Products Operation
Syracuse, N. Y.

ITA Electronics Corp.
Broadcast Div.
130 East Baltimore Ave.
Lansdowne, Penn.

Radio Corporation of America
Broadcast and Communications Products Div.
Camden 2, N. J.

Universal Audio, Inc.
6000 Sunset Blvd.
Hollywood 28, Calif.

Table 2. Manufacturers' Addresses

About the Cover

The cover scene this month is the golf course at the Indianapolis Motor Speedway. Shown is some of the equipment employed by WFBM-TV in covering the 1963 500 Festival Golf Tournament. The van in the background houses a a complete mobile television studio, including the equipment shown in the lower photo. A second mobile unit, at the other end of the course, was linked to the main remote truck via microwave relay (the "dish" antenna can be seen on the van roof). Zoom lens equipped cameras, built by the WFBM engineering department, were located at three positions around the course. The upper photo shows one of the camera equipment installations.

ward, with output controlling input (the conventional limiting arrangement). The backward compression ratio, however, is only 2:1, which makes it more of an averaging device than a limiter. Additional features: 600 or 150 ohms in and out, and a front-panel VU multiplier with a range of 40 db.

Part 2 of this series will discuss the operating principles, advantages, disadvantages, and features of compressors and averaging devices. Compressors currently in use will be described and illustrated. ▲

AUDIO LEVEL DEVICES

*by Thomas R. Haskett** — Part Two. A discussion of compressors and averaging devices, their principles and features.

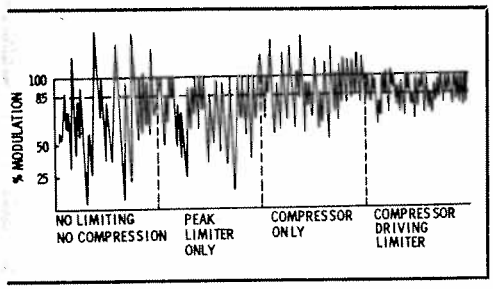


Fig. 1. Compressor and limiter effects.

Although a limiter can protect a transmitter against audio peaks, too much limiting (say, 20 to 30 db) can increase distortion to 3 or 4%. The limiter can't do anything about low passages, below its limiting threshold. During many programs low passages would be lost to some listeners if only a limiter were employed. To overcome such difficulties, the compressor was developed. The names are different—compressor, compressor - expander, AGC amplifier, averaging device, etc.—but the function is about the same in each case. Dynamic range is lessened by compressing peaks and expanding low passages.

Compressor Operation

While a limiter establishes a ceiling for peaks, as seen in Fig. 1, it doesn't affect low-level signals. The compressor pulls up these lows, but its peak limiting isn't too good. Fig. 2 shows why. The limiter's operating point (average signal level at input) is at or slightly above threshold, seldom higher. But the compressor normally works in the middle of its slope; since this slope often covers 30 db of input variation, greater-than-average signals are compressed more, and lesser-than-average signals are compressed less. The result is shown in Fig. 1, and it's precisely this latter action that gives the compressor an advantage over the limiter. However, this feature has a disadvantage, too. The compression ratio is low—roughly 3:1 for a compressor, compared with 10:1 or more for a limiter. Thus, a compressor's output is much more variable than a limiter's. Also, the attack and release times of a compressor determine its action. If the limiter-type dual-recovery circuit is used, gain reduction and return are functions of the program material, and the action is essentially that of a limiter. But if long time constants are used, the unit is essentially an average-level device, since short peaks don't affect the gain. Where time-constant switching is provided, its positions are usually marked **dual** and **average.**

Circuit Action

The basic circuit is shown in Fig. 3; note the similarity to the limiter circuit. V1-V2 is a variable-gain stage, generally a 6386 twin triode operated in push-pull. V3-V4 constitute a fixed-gain, push-

*Consulting Engineer, Michigan City, Indiana

Table of compressor

Model	Attack Time msec	Release Time sec	Compr. Ratio	Input Level dbm	Output Level dbm	Gain db	Noise Level dbm	Frequency Response	Harmonic Distortion
Collins 26J-1 Auto-Level	11 or 62	0.9 or 5.2	1.6:1 to 5:1	−26 to +30	−24 to +30	41	−50	±1.0 db 50 to 15,000 cps	2.0% (30 db) 50 to (compr.) 15,000 cps
Collins 356E-1				−54 to +6	0 to +36	54			
Fairchild 666	30	0.3 to 30	2.8:1	−5 to +15	+13 to +25	30	−65	±1.0 db (40 20 to (compr. 15,000 cps	0.4% (40 db) 25 to (compr.) 15,000 cps
Fairchild 666A									
Fairchild 663	40	0.3 to 7.0	3:1	−35 to +25	+22	None	None*	±0.5 db 20 to 30,000 cps	Below 0.3%
Gates M-5167 Sta-Level	25	1.0 to 12	3.3:1	−44 to +24	+8 to +24	62	−45	±1.0 db (30 30 to (compr. 15,000 cps	1.0% (30 db) 50 to (compr.) 15,000 cps
GE BA-9-A Uni-Level	11 or 62	0.9 or 5.3	1.6:1 to 5:1	−54 to +6	0 to +36	54	−50	±1.0 db (30 50 to (compr. 15,000 cps	2.0% (30 db) 50 to (compr.) 15,000 cps
GE BA-9-B Uni-Level									
ITA AGC-1A	25	5.0	7:1	−37 to +13	+20 to +34	57	−50	±1.0 db (50 20 to (compr. 20,000 cps	1.0% (25 db) 35 to (compr.) 20,000 cps
Langevin AM-5301 Leveline	0.1 to 11	0.5 to 3.0	1.6:1 to 5:1	−70 to −6	+26 or +37	53	−57	±0.5 db 20 to 20,000 cps	Below (25 db) 1.0% (compr.
Quindar QCA-2	250	....	10:1	−52 to −18	−10	40	....	±3.0 db 250 to 4000 cps	10.0% (10 db 150 to (compr. 2500 cps
RCA BA-25A	12.5	1.0	2.1:1 to 6.2:1	−80 to −25	−10 to +30	70	−46	±1.0 db 30 to 15,000 cps	Below 1.0% 30 to (30 db) 15,000 (compr.

*Passive circuit—no generated noise.

pull output stage, from which a portion of the signal is rectified by V4, the AGC diode. The resulting DC furnishes operating bias for the input stage. Unlike the limiter, which has a **fixed** threshold, the compressor threshold is usually **variable.** A pot across the B+ allows selection of various delay voltages to be applied to the diode cathode. No control voltage can be generated until the output signal exceeds this threshold voltage, of course. By changing the threshold, the input tube operating point is altered, and this, in turn, produces a different compression ratio. Hence, the range commonly found is 2:1 to 6:1. And this action must not be confused with the **signal** operating point; the latter is obtained by setting the signal-input level to the first stage. Between the diode and the signal-input an RC network provides attack and release times. As we've mentioned, this is often variable. Because the compression ratio is low, circuitry is less elaborate than for a limiter. Since compressors are always used **ahead** of limiters, and frequently at the console output, or even at an earlier point where levels are low, size is generally small compared with limiters. All compressors listed in Table 1 will match 600 ohms in and out.

Disadvantage

While the compressor overcomes one difficulty associated with the limiter, it introduces another. If a loud passage is followed by a very soft one, or a pause of several seconds duration, the compressor raises the gain. Only there's nothing to amplify but room noise, air-conditioner noise, and perhaps even tube noise! And if an old ET is being played, or a dusty LP, the surface noise gets expanded and listeners hear needle scratch in all its glory. This can be partially overcome by using less compression,

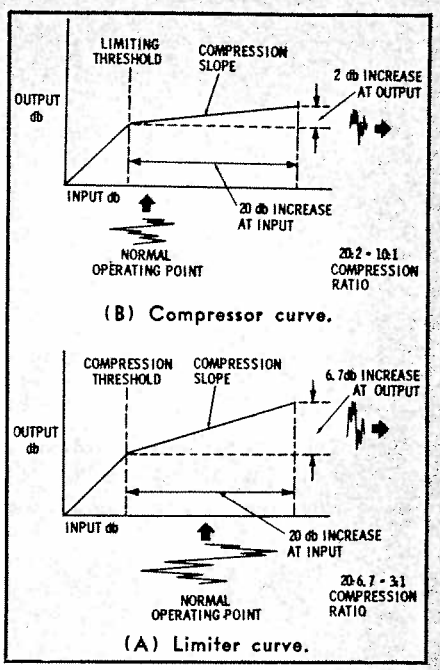


Fig. 2. Limiter and compressor curves.

but it defeats the purpose of employing an averaging device. (The solution to this problem will be covered in Part IV.)

Operating Practice

Operating practice today is to locate the compressor between the main console and the limiter, the limiter then driving the transmitter, as in Fig. 4A. What happens is that the gross variations in level by announcer-operators are corrected somewhat, and the limiter then only has to protect against peaks, and smooth out few of those. This hookup is especially desirable if a telephone line separates the studio and transmitter, since the compressor can then deliver a less erratic signal to that line, maintaining a better signal-to-noise ratio. Also, harmonic distortion divides between the compressor and the limiter; you get less with both than either alone.

• Please turn to page 36

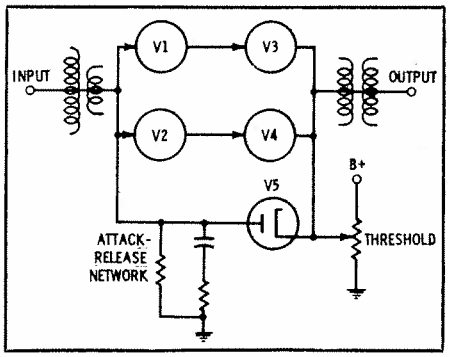


Fig. 3. Basic compressor circuit.

eraging device specifications.

Harmonic Distortion	Compr. Meter	Dimensions Width	Height	Depth	Price	Model
2.0% (30 db) 30 to (compr.) 15,000 cps	Yes	19"	5¼"	9"	$275.00	Collins 26J-1 Auto-Level
	No	3"	5⅜"	9"	130.00	Collins 356E-1
0.4% (40 db) 25 to (compr.) 15,000 cps	Yes	19"	3½"	6"	495.00	Fairchild 666
					399.00	Fairchild 666A
Below 0.3%	Yes	1½"	7"	4½"	158.00	Fairchild 663
1.0% (30 db) 30 to (compr.) 15,000 cps	Yes	19"	5¼"	7"	249.00	Gates M-5167 Sta-Level
2.0% (30 db) 30 to (compr.) 15,000 cps	No	3½"	5¾"	10¾"	140.00	GE BA-9-A Uni-Level
		19"	3½"	7½"	200.00	GE BA-9-B Uni-Level
1.0% (25 db) 25 to (compr.) 20,000 cps	Yes	19"	5¼"	7¾"	225.00	ITA AGC-1A
Below 1.0% (25 db) (compr.)	No	2⅜"	3"	10¼"	225.75	Langevin AM-5301 Leveline
0.0% (10 db) 50 to (compr.) 1500 cps	No	1¾"	1¾"	6"	90.00	Quindar QCA-2
Below 1.0% 0 to (30 db) 5,000 (compr.)	No	8⅜"	4$\frac{31}{32}$"	12½"	225.75	RCA BA-25A

Audio Level Devices

(Continued from page 13)

Another attractive job for the compressor is shown in Fig. 4B, in series with a permanent, unattended remote line, and preferably **at** the remote location. The wide variations in level at the scene will be converted into a more easily-managed signal before being put on the TelCo line.

The **ducker,** or **automatic fader,** is a favorite at stations with semi-automated operation. The turntable or tape output is mixed with the announce mike preamp output, setting the announce mike gain from 10 to 15 db higher than the turntable; this combined signal is then fed to the compressor. (This can be done at the console.) When it's desired to announce over music, the announcer simply opens his mike—the compressor will pull down the combined signal, the music being 10 or 15 db below voice.

Some stations use a mixerless studio operation for announcers, wherein it's only necessary to start and stop turntables and tape machines and open the mike switch. All gain-riding is done by the averaging device, and the motor-start switches trigger relays which open and close the signal channels from the turntables. As illustrated in Fig. 4C, no console is actually needed, since the preamp outputs can be tied together by fixed pads and the common leg fed to the compressor. For a simple setup involving only two turntables (or an automatic disc player) and one or two cartridge machines, such an arrangement simplifies controls for nontechnical announcers. Some stations even go so far as to dub all music on tape; then three cartridge machines and a mike are all the announcer needs to operate.

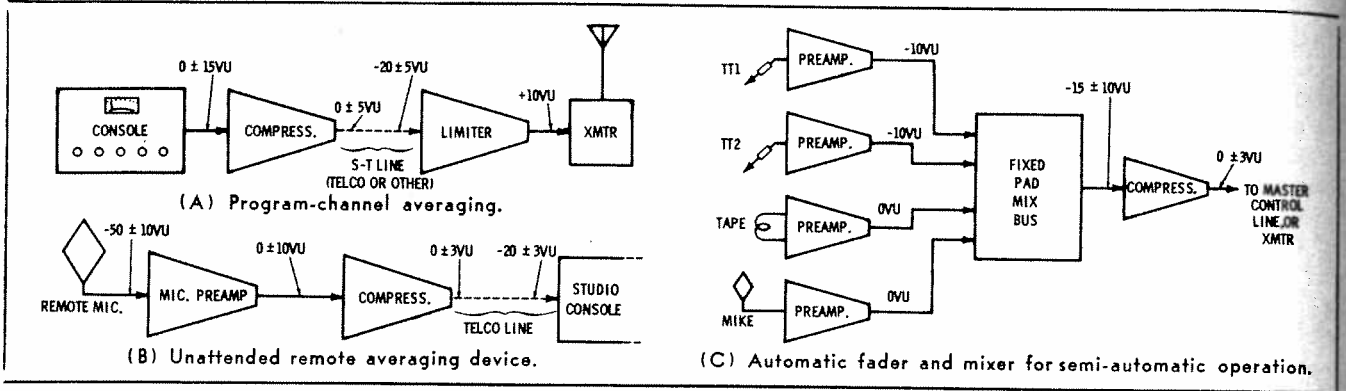


Fig. 4. Compressor application block diagrams.

AUDIO LEVEL DEVICES

*by Thomas R. Haskett** — Part Three. A listing and discussion of available compressors, concluding Part Two, plus an addendum to Part One.

Some Available Compressors

Altec-Lansing 436C and 438C Compressors—The only difference between these two units is that while both provide bridging inputs, the 438C additionally contains a 12AY7 low-noise mike preamp. This feature is of particular value in such things as semi-permanent remotes (churches, baseball, etc.), since a 438C, a mike, and a pair of headphones are all the equipment needed. Also, the bridging input on the 438C can be used simultaneously with the mike, making it possible to do a music remote using one mike and a turntable (or tape).

The circuit is conventional, using a 6BC8 in the controlled stage. The output will match either 150 or 600 ohms, and the front panel contains an nput attenuator as well as threshold and release-time controls (which have shaft locks for security). The power supply is self-contained and uses solid-state components. A remote compression meter is available as an accessory.

Gates M-5167 "Sta-Level" — Gates employs the standard circuit, with the addition of a buffer amplifier, running fixed-gain, between input and output stages. Also, a VR tube holds operating voltages constant for the critical input tube, which is the familiar 6386. Input and output attenuators are furnished, and there's a front-panel switch (marked **double-single**) for changing the attack-release time constant from compression to averaging action. Additionally, a resistor kit is supplied so the release time can be lengthened or shortened to suit station preference.

Teletronix LA-2 Leveling Amplifier—The circuit is unconventional, as the accompanying illustration shows. Incoming audio is passed through P1, a photoresistor, and R1, the manual gain control. Signal then goes to the two amplifier stages V1-V2 and the ouput transformer. The ouput signal is further amplified by V3 and V4 and fed to lamp L1, which is physically situated near P1. As output signal increases, so does the intensity of L1, causing the resistance of P1 to decrease. Since P1 is shunted across the incoming signal, this signal is attenuated. Gain reduction occurs without measurable distortion and without thump, as only a resistive circuit performs the compression. Degree of compression is set by R2.

Other notable features of the LA-2 are: High negative feedback of 19 db produces less distortion and greater operating stability. The output stage is a piggy-back cathode follower, another unusual circuit, which is coupled to the load through a transformer for a combination of very low phase distortion and excellent high-frequency response. Input and output match 50, 150, 250, and 600 ohms, and gain and peak reduction are adjustable from the front panel. Two LA-2's may be paralleled for stereo; an interconnection between attenuators insures that compression occurs simultaneously in both channels.

GE BA-9-A/B "Uni-Level" — The BA-9-A is a plug-in model (four such units can be mounted in 7″ of rack height) which requires an external power supply, while the BA-9-B is self-powered and mounts directly in a 19″ rack; otherwise the two are identical. The traditional circuit is used here, in a very simple but effective configuration. A two-position dual-average switch is provided for changing attack and release times; the

Teletronix LA-2 Leveling Amplifier

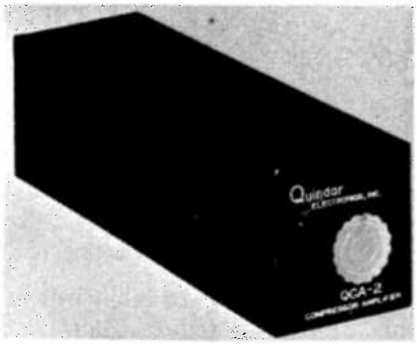
Altec-Lansing 436C Compressor

Model	Attack Time msec	Release Time sec	Compr. Ratio	Input Level dbm	Output Level dbm	Gain db	Noise Level dbm	Frequency Response / Harmonic Distortion
Ampl. Corp. of America 740-C	10 to 50	0.5 to 2.0	20:1	— 35 to — 5	+ 8	35	— 52	± 1.0 db 20 to 20,000 cps (Low 5.0 % compression)
Altec-Lansing 436C	50	0.3 to 1.3	2:1 to 4:1	— 40 to + 10 / — 90 to — 40	0 to + 24	40 / 90	— 50	± 1.5 db 30 to 15,000 cps (Low 1.5 % to 3 db compression)
Altec-Lansing 438C								
Teletronix LA-2	Inst	0.06 to 5.0	4:1	— 40 to + 16	+ 10	40	— 60	± 0.5 % 50 to 15,000

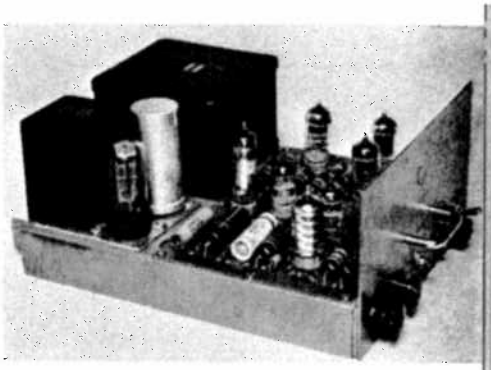
Specifications of some available aud

*Broadcast Consultant, Michigan City, Ind.

GE BA-9-B "Uni-level"



Quindar QCA-2 Compressor



RCA BA-25A AGC Amplifier

threshold and compression ratio can be varied with an internal control; and the input and output will match either 150 or 600 ohms.

Quindar QCA-2 Compressor — This unit has been designed primarily for speech, and due to its restricted frequency response (4000 cps) it probably isn't suitable as a main-channel controller. However, it can be used where high frequencies aren't important, as in portable, transistorized tape machines or remote-pickup transmitters for news and special events, or order-wire circuits. A compact, plug-in, transistorized module, it requires an external power supply delivering 45 ma @ 12 VDC, regulated. Input and output are 600 ohms.

Langevin AM-5301 "Leveline" — The three-stage circuit is used here, with a 6ES8 used as the variable-gain input amplifier; the tube's transfer characteristic has a two-fold feature, compressing just above threshold and peak-limiting at higher levels. Negative feedback is used around the last two stages of the "Leveline," minimizing supply-voltage-produced gain changes. Semiconductors are used in the full-wave control-voltage rectifier circuit, the threshold and compression ratio are continuously variable, and the usual dual-average time-constant switch is provided. If desired, the "Leveline" can be used as a monitor amplifier — it delivers 6 watts output. No power supply is included, the unit having been designed for plug-in operation in an integrated system. The requirements are 6.3 VAC or DC @ 90 ma (+37 dbm output) or 50 ma (+26 dbm output). Input and output will match either 150 or 600 ohms.

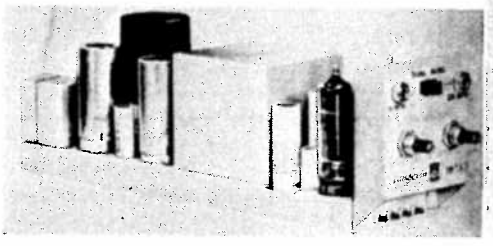
RCA BA-25A AGC Program Amplifier — RCA has adopted an elaborate circuit: A 12AY7 low-noise input stage is followed by a 6386 variable-gain controlled stage, a 12AX7 driver, and a pair of 12AU7's as output. Negative feedback is used around the driver and output stages, and a VR tube is placed across the 6386 plate supply. Because of the 12AY7, this unit will work at very low level points — compression can start as low as —60 dbm. There is an input potentiometer, a threshold control, and a metering switch on the front panel. When used with an external meter, the user can monitor gain reduction or measure cathode current of signal-channel tubes. The threshold control adjusts both the compression ratio and the threshold. Since the fixed time constants are relatively slow, the BA-25A is an averaging device. An external source of bias may be utilized for remote-gain-control application. Input and output will match either 150 or 600 ohms. The assembly does not come ready for direct 19″ rack mounting, having been made for installation in the MI-11597 Mounting Shelf, which requires 5¼″ of rack space. Two BA-25A's can be mounted side-by-side on such a shelf.

ITA AGC-1A AGC Amplifier— ITA uses the conventional circuit, modified slightly to include an intermediate amplifier between input and output stages, for better isolation. Also, a VR tube maintains input-stage supply voltage constant, minimizing dynamic shift. While the unit is normally an averaging device, with fixed attack and release times, instructions are pro-

monic rtion	Meter	19″ Rack Space Height	Depth	Price	Model
w 5.0% db pression)	Yes	7″	8¾″	$245.00	Ampl. Corp. of America 740-C
w 1.5% 00 cps db pression)	Yes	3½″	6″	165.00	Altec-Lansing 436C
				199.00	Altec-Lansing 438C
	Yes	5½″	6¼″	235.00	Teletronix LA-2

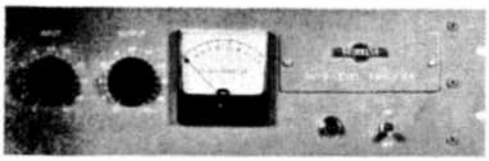
ilable audio level devices.

Gates M-5167 "Sta-level"



Langevin AM-5301 "Leveline"

Fairchild 666 Compressor



Collins 26J-1 "Auto-Level"

vided for altering the RC network to change the time constants and compression speed.

Fairchild 666/666A and 663 Compressors — The 666/666A's compression is not done by shifting bias on the input stage; rather the input signal level is varied by changing the resistance of a semiconductor circuit. The result is no noise and no increase in distortion with increased compression, unlike most compressors. In addition to flat compression, an equalized mode is available which provides increased gain reduction in the 3 to 4 kc range. Input and output level, release time, and degree of compression can all be adjusted on the front panel. The input accepts 150 to 50,000 ohms; the output can be 150, 300, or 600 ohms. Note: The 666A is a compressor only; the standard model is a 666, which is a compressor with an integral 661 "Auto-Ten" unit.

The 663 is a compact unit; completely transistorized, it can be installed on the front panel of a console, as it's about the size of a vertical attenuator. Hence, console inputs can have individual compressors, ahead of mixing. Each channel then has its own compression and release time, to suit various needs. Like its big brother, the 666A, the 663 changes input resistance and compresses the signal before amplification, maintaining low distortion and noise levels. It will accommodate impedances from 150 to 50,000 ohms at input and output, and threshold, release, and meter-adjust controls are provided on the panel. There is no power supply; the 663 requires either 6 VAC or 9 VDC at 150 ma.

Collins 26J-1 "Auto-Level" and 356E-1—Both of these units employ the basic, four-tube circuit outlined above, and both have

ITA AGC-1a AGC Amplifier

dual/average time-constant switches and threshold-setting controls. In addition, the 26J-1 has a panel meter reading compression in db, input and output attenuators, and a defeat switch which disables the gain-reduction circuit and makes it a straight amplifier. Completely self-contained, its power supply uses solid-state components; Input and output are standard 600 ohms.

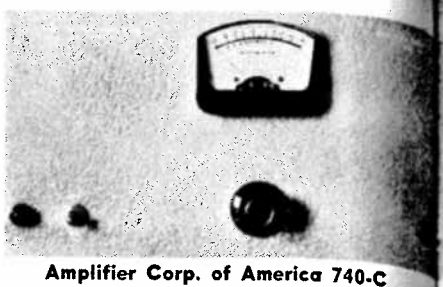
The 356E-1 is a cut-down, plug-in version of the "Auto-Level," having been designed for modular use in the console, where it replaces the program amplifier. It requires an external power supply, and has no attenuators or meter, although jacks are provided for an external gain-reduction meter. Input and output will match either 150 or 600 ohms.

Additional Limiters

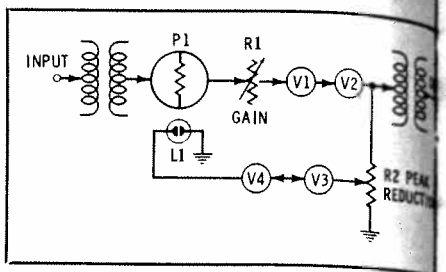
The following manufacturers' products were inadvertently omitted from previous sections of this series. The author regrets this oversight. Comparative specifications are given in the table; individual features are listed below.

Amplifier Corporation of America 740-C—Although termed an AVC Amplifier by the manufacturer, the 740-C is essentially a limiter, considering its circuit and function. It consists of a two-stage, push-pull circuit with 6BD6 pentodes as the variable-gain controlled amplifiers. A bridging input is furnished, and the unit will accommodate either balanced or unbalanced lines. Power, meter transfer, and input attenuator controls are provided on the front panel (the output gain is fixed), and internal adjustments control attack and release time. A self-contained power supply makes the 740-C entirely independent.

ITA LA-1B Limiter—This is the latest model and supersedes the previous model LA-1A. Comparing the two, I find a general tightening of specifications—compression ratio



Amplifier Corp. of America 740-C



Block diagram of Teletronix LA-2.

is now 10:1, instead of 6.7:1. But the major feature of the new unit is a solution to the FM limiter versus pre-emphasis problem. An RC circuit adjusts gain versus frequency at the high end of the program material fed in, rolling off the high end of the limiter output slightly. This prevents the transmitter from being overmodulated when highs are boosted by the standard FM pre-emphasis network. This means a station can maintain a high level of modulation for the low- and mid-range audio, without overmodulation by the highs.

Manufacturers Addresses

Altec-Lansing Corporation
1515 South Manchester Avenue
Anaheim, Calif.

Amplifier Corporation of America
398 Broadway
New York 13, N. Y.

Collins Radio Company
Cedar Rapids, Iowa

Fairchild Recording Equip. Corp.
10-40 45th Avenue
Long Island City 1, N. Y.

Gates Radio Company
Quincy, Illinois

General Electric Company
Defense Electronics Division
Technical Products Operation
Syracuse, N. Y.

ITA Electronics Corporation
Broadcast Division
130 East Baltimore Avenue
Lansdowne, Pennsylvania

Langevin Division of Sonotec, Inc.
503 South Grand Avenue
Santa Ana, Calif.

Quindar Electronics, Inc.
5 Lawrence Street
Bloomfield, N. J.

Radio Corporation of America
Broadcast and Communications
Products Division
Camden 2, N. J.

Teletronix Engineering Company
4688 Eagle Rock Boulevard
Los Angeles 41, Calif.