

# New studio association formed

Fort Lauderdale, FL...The Industry Workshop held by MCI, Inc. June 13-16 in Fort Lauderdale was hailed by attendees as "the first time anyone had invited us to get together and asked us what we want—this workshop has been the most exciting interchange of information we've experienced in 10 years! The Workshop was hosted and chaired by G.C. "Jeep" Harned, owner and founder of MCI, whose guiding influence helped to make this unique meeting a very productive one.

Recording industry representatives at the Workshop were: Don Frey of A&R Recording Studios, New York City; Dave Teig and Jimmy Douglass from Atlantic Studios, New York City; Ross Alexander, Henry Saskowski, Mack Emerman, Steve Klein, and Karl Richardson from Criteria Recording Company, Miami; Norman Schwartz of Filmways Heider Recording, Hollywood; Angel Balestier of Group IV Recording Studios, Hollywood; Charles Conrad from House of Music, New Jersey; Howard Schwartz from Howard M.

Schwartz Recording Inc., New York City; Kent Duncan, Carl Yenchar and Maggie Garabedian from Kendun Recorders Inc., Burbank; Bob Stone of Larrabee Sound, Hollywood; Fred Porter from Media Sound, New York City; Chris Stone and Penn Stevens from Record Plant, Los Angeles; Bob Liftin of Regent Sound Studios, New York City; Joe Tarsia of Sigma Sound Studios, Philadelphia; Harry Hirsch and Lou Whittier from Soundmixers Inc., New York City; and John Stronach.

### Topics covered

The workshop was held in an informal atmosphere with industry representatives discussing their problems and the shortcomings of equipment now available. MCI's engineering staff explained some of the solutions and alternatives possible within the limits of current technology. These interchanges provided a balance between desired features, required capabilities, technical possibility and economic feasibility. The studio owners went home with a better

understanding of manufacturers' problems, and MCI with a better understanding of users' needs.

The studio owners also spent several hours in a closed meeting by themselves which resulted in the formation of an association of studio owners—the Society of Professional Audio Recording Studios. MCI felt that the formation of this Society could have far reaching implications, all for the good of the professional recording industry.

Lutz H. Meyer, Vice President of Marketing for MCI, noted that "the intent of this meeting was not for sales action, but solely to provide a forum for discussion. If this meeting achieves nothing else but the forma-

tion of an association of recording professionals (to which we may never be invited again) the efforts were more than worthwhile. It is mind-boggling to see the understanding which can be achieved when leading professionals come together in a neutral forum. At the conclusion of the workshop the consensus of opinion was that 'nobody left saying I accomplished this,' the feeling was 'collectively, WE accomplished this!'

MCI felt that the audio recording industry as a whole—both studio owners and equipments manufacturers—will benefit as the results of the open dialogue and active exchange of ideas at this Workshop are realized in the future.

## Shure enters professional condenser microphone market

Evanston IL...Shure Brothers has announced its long-awaited entry into the professional condenser microphone market with the Shure

Model SM81, a cardioid condenser unit designed for mechanical and environmental ruggedness and reliability, as well as state-of-the-art electroacoustical performance.

The Model SM81 is a product of years of research and operational testing in a wide range of studio and field situation involving extremes in temperature, humidity, and physical punishment. As a result, the SM81 is capable of withstanding extensive use and abuse, while at the same time maintaining the high quality performance expected of the very best studio condenser microphones, not only in the studio, but in virtually any professional application.

Similarly, the electroacoustical performance characteristics of the Shure SM81 are the result of an extensive development effort. The outstanding signal-to-noise ratio and

(Continued on page 6)

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Noise: Program audition -120 dBm, Monitor -110 dBm  
Power Source: 117 or 230 Vac 50-60 Hz single phase

**OUTPUT CHARACTERISTICS**

Output (Depends on modules used) 1 Stereo program, 1 Stereo audition, 1 Monophonic program,  
2 Monitor amplifiers, 2 Headphone amplifiers, 1 Cue amplifier  
Impedances: Program audition 600 ohm balanced or unbalanced — 10K ohm balanced or unbalanced, Monitor 4-16 ohm unbalanced, cue 4-16 ohm unbalanced  
Levels: Program audition or mono +8 dBm nominal — +24 dBm maximum, Monitor — 15 watts  
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# New approach to modulation control

by Charles S. Wright  
Delta Electronics

Springfield Va... In recent years great emphasis has been placed on sustaining high modulation levels in AM broadcasting. A great variety of compression amplifiers, limiting amplifiers, and asymmetrical audio processing equipment has been developed and is presently in use to accomplish this end. While most of these devices are remarkably successful, they process the audio material only and do not directly make use of the modulation characteristics of the final transmitted signal. They alter, at least to some degree, the dynamic range and other qualities of the program material. It has been found by many broadcast engineers that when adjustments are made to obtain a very high modulation level with these devices, variations in the transmitter characteristics can cause overmodulation. If the adjustments are made to avoid overmodulation in the worst case, reduced modulation levels must be tolerated on the average. The equipment to be described here is intended to close the control loop around the transmitter in order to correct for these variations so that high modulation levels can be maintained for all operating conditions.

We call this device an Amplitude Modulation Controller. Basically, it samples the RF leaving the transmitter, makes measurements of the modulation characteristics, and by a digital logic process adjusts the audio level to the transmitter. It can be used in conjunction with all of the existing program processing equipment, and field tests have shown that under normal conditions a further enhancement of the modulation characteristics can be obtained. The audio control on this modulation controller is strictly linear so that no real time compression or asymmetry is added to the program.

### Description of Equipment

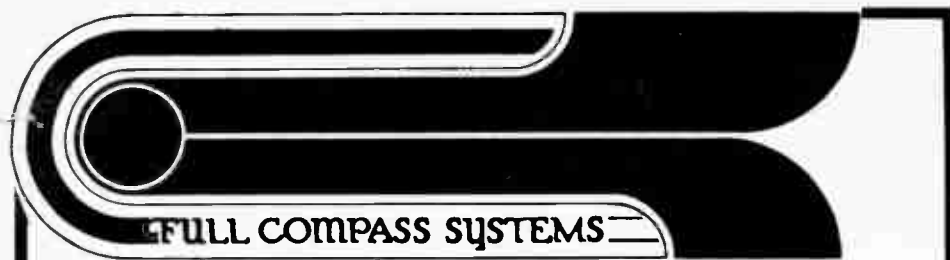
The simplified block diagram in Figure 1 will illustrate the operating principles of the Amplitude Modulation Controller. A sample of the transmitter output is taken, typically with a toroidal current transformer, and supplied to the device. This sample is first demodulated by an envelope detector. The output of this detector contains a dc level proportional to the unmodulated carrier and a superimposed audio component. This total envelope output signal is identified as EM in the figure. The second

signal, EC, is derived with a unity-gain, low-pass filter. The result is a dc voltage proportional to the carrier level. From the ratio of these two signals, real time modulation characteristics are determined. Typically, one of the signals is attenuated by a variable resistance divider and compared to the other with a digital comparator circuit. For example, the comparison marked "Threshold" on the figure is derived by taking 75% of  $E_c$  and comparing it to  $E_m$ . When  $E_m$  goes lower than the attenuated carrier sample, the comparator output goes high and indicates that a modulation in the negative direction exceeds 25%. A total of seven such comparisons are made simultaneously. In addition to the threshold comparison just described, negative low modulation and positive low modulation comparisons are made. These levels are typically minus 85% and plus 100%. The plus and minus high modulation comparisons are typically at minus 95% and plus 112%. The plus and minus over modulation comparisons are set by the FCC limits, minus 100% and plus 125%. The figures just given are typical only and the station operator is at liberty to set all of these levels at any desired value. I will use these typical values throughout to simplify the discussion. The comparator output signals are TTL logic level, that is, they are at a TTL low level when the condition for which they are set is not

satisfied and at a TTL high level when the condition has been satisfied.

The threshold signal is used to determine when modulation is present. No corrections of the audio level are made when the modulation is below the threshold. This prevents the circuit from "pumping" as is common with most gain control amplifiers. The circuit works as follows. The threshold signal is used to gate an increment clock. This is a clock in the logic sense rather than in the normal time keeping sense. It is simply a pulse generator and its frequency is called the increment rate. The gated clock pulses drive a "low period" counter. A typical count period is 5 seconds. (This parameter is also available for adjustment by the operating engineer.) If this counter is not reset within five seconds of modulation time, the increment pulses will go to an up-down counter and cause it to count upwards. If either of these low modulation thresholds are satisfied within the five second period, the counter will be reset to zero and a new period will begin. Thus, if the transmitter has not had at least one modulation burst exceeding 85% negative modulation or 100% positive modulation within 5 seconds of modulation time, the counter will increment and increase the program level driving the transmitter. This gain increase will continue until the

(Continued on page 22)



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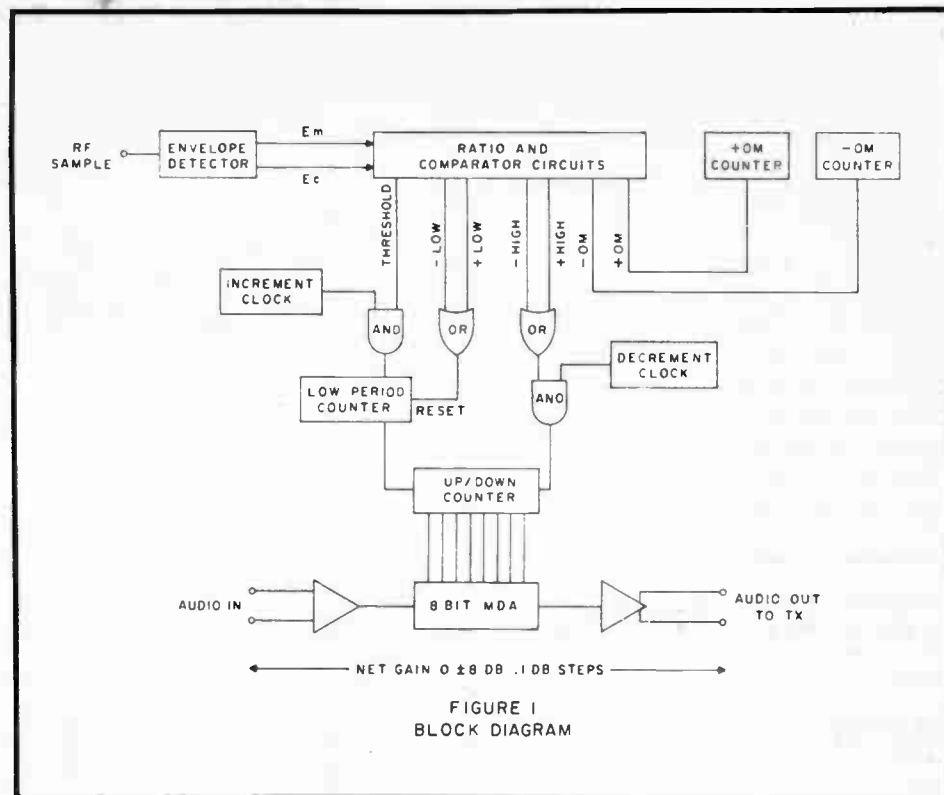


FIGURE 1  
BLOCK DIAGRAM

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## Recorder care from Nortronics:

# Cartridge recorder maintenance

Minneapolis MN... Virtually every professional or consumer tape recorder requires regular preventive maintenance if long-term, optimum performance is to be maintained. This is particularly vital for broadcast cartridge machines, since they are subject to long hours of continuous operation along with frequent service and calibration.

The enemies, of course, are dust, dirt and oxide deposits; excessive humidity and, although less obvious, residual magnetism. Individually and collectively, these factors can sneak up to gradually degrade reproduction quality and even damage pre-recorded tapes.

### How It Happens

A spacing loss (separation between magnetic tape and tape head) approximating just 1/20th the diameter of a human hair can cause a noticeable loss in high-frequency response. As spacing becomes greater, so does the loss. Reproduction quality is noticeably lacking in highs...sound is, at best, dull and mushy.

Spacing losses result from the buildup of contaminants on heads, guides, capstans and rollers. These deposits are generally a combination of airborne dust, dirt, pollutants and tape oxide which breaks off recording tape. They can be of a gummy consistency or extremely hard, ragged and abrasive.

The solution is to prevent accumulations by regularly cleaning contaminants off recording heads and other tape path parts. Fortunately, there are a number of excellent products specifically formulated to dissolve and remove contaminant deposits without any possibility of damage to delicate machine parts. They are equally effective with broadcast cartridge recorders or any format of consumer recorder.

The best way to ensure freedom from contamination is to institute a

regular preventive maintenance program that includes inspecting and cleaning each broadcast cartridge machine you use. The key word, here, is *regular* which translates down to preventing contaminant buildup and spacing losses *before* they become a problem.

### Residual Magnetism

While you can see dirt and oxide accumulations, you won't see residual magnetism that builds up in metal tape path components. Nevertheless, this residual magnetism will inherently induce a higher system noise level which will degrade the overall signal-to-noise level. Here, too, there

is also a loss in high-frequency response along with the possibility that residual magnetism will partially erase pre-recorded tapes.

Residual magnetism occurs for a number of reasons. First, the use of a partially magnetized screwdriver or other tool used in service and calibration might be the source. In addition, the normal ON-OFF surges in recorder electronics can induce permanent magnetism due to undesirable retentivity characteristics of the metals used in head construction.

The degree of retentivity varies for different tape head materials. Nevertheless, *all* materials have his property to some degree and can retain residual magnetism that will severely

degrade the quality of broadcast cartridge recorders and pre-recorded tapes.

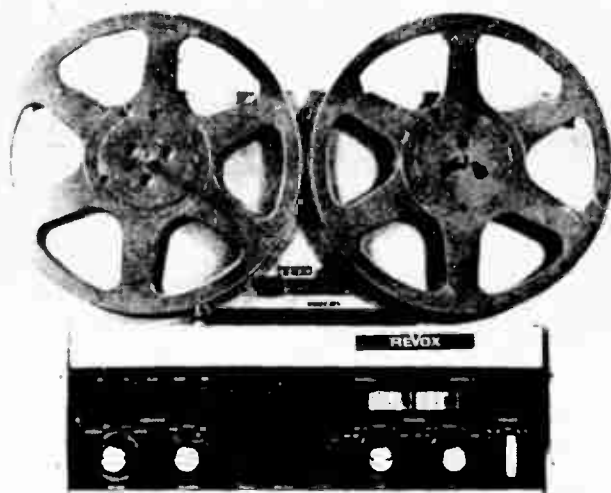
The solution comes down to removing any traces of residual magnetism with a degausser or demagnetizer. This device generates a power flux density to completely remove unwanted magnetic fields.

The Model QM-380 Broadcast Cartridge Head Degausser manufactured by the Recorder Care Division of Nortronics Company, Inc., is an example of a product specifically designed to do away with residual magnetism in broadcast cartridge machines. This unit generates a powerful 400 Gauss A.C. field which is

(Continued on page 5)

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# Solutions to problems by the gold-plated ear

by John Price  
Radio Arts

Part II of 3 parts.

Nothing printed herein should be construed as a replacement for basic engineering knowledge and a well-worn instruction manual. But, just as any set of ears should hear the faults within our product, so any allotment of grey matter should contain some idea of the cures.

First, forget the magic phrase "proof of performance." Time after time, the classical "proof" required by FCC regulations can be run with Abe Lincoln honesty, and time after time it will completely bypass major problems. It's not that the "proof" is no good, it's just that, like most regulations, it is hopelessly out of date.

For starters, both AM and FM proofs still require that measurements be made starting with the input for the "main studio microphone." So that Fibber McGee will have adequate frequency response, distortion and signal-to-noise specs. But we don't originate Fibber any more. We originate from tapes and discs and carts and cassettes, and our

"main microphone" is on the air may be one per cent of the time.

Secondly, most of the equipment that causes audio problems on a daily basis must be switched *out* of the chain when a proof is made. Not only do we bypass all of our source machines, but compressors, limiters and other audio processing gear is bypassed.

So use a proof for that which it will proof: the basic audio chain of console(s), STLs, phone lines and transmitter(s). But go beyond that, and check out all the other possible sources of bad sound.

## Here are some hints.

**Distortion:** Today's crop of solid-state equipment can be both a blessing and a burden when used to create clean sound. Never has distortion been so low—and never has it been so audible! Thus, a new unit with distortion specs that can't be measured will sometimes *sound* worse than its retiring tube predecessor.

So take a hard stance on new, solid-state equipment. Make sure it contains circuits that are well-designed, and try to get an A-B demonstration

against your older unit, if possible.

**Hint:** Most of the continuous distortion heard on the air today comes from over-limiting. As I mentioned earlier, limiting can only be accomplished by distorting the audio. The more tactfully your limiter chops off peaks, the more of it you can do without bending ears. Money spent on a good limiter is an excellent investment. Not just a new one; a new, *good* one.

As with all problems, isolation is the better part of valor. Find the problem's source, then you know where to start troubleshooting. With distortion, you may find several sources. While harmonic distortion doesn't seem to add algebraically (or you'd never understand your network news), it may take several repair jobs to get it all out of an audio system.

**Noise:** Again, isolate and conquer. An immediate improvement may be noticed if unused pots on the console are closed. One station, faced with cart machines featuring an inbuilt hiss, wired the remote start function for each to the program key on the appropriate console channel. Since the machines started with a pop, this killed two birds with one key. Throwing it to "program" started the machine, then connected audio a millisecond later, after the pop.

When possible, the click-pop-humbugs from starting buttons should be properly squelched with capacitors or diodes. The level at which audio is switched should also be investigated. Often, raising console pots and lowering the console master will instantly reduce pops, since the audio is hotter at the switching point.

Ground loops and long unbalanced lines aside, most continuous noise in today's station consists of hiss. Hiss can become hisstory if you:

- \* Check the bias waveform of a tape machine that makes hissy recordings. If it, or the erase current, does not show as a nice smooth sine wave on a scope, that is probably your culprit.

- \* Check high-frequency adjustments on pre-amps and tape record and play sections. Adjust to correct setting, and lock them away from those who think that high fi means high highs.

- \* Reduce compression/limiting, especially in production studios and on network lines. An open compressor can ladle out lots of noise.

## Watch your limiter

**Compression/limiting:** Maybe it was Mike Dorrough who first quoted the "dial full of sounds trying to get out" line, but it applies over and over again when compression/limiting

becomes the point of a critical listening test.

Today's AM demands a narrow dynamic range, it is true. Although Jack Benny made it to the top even though every step down into his vault may not have modulated a full 125% positive. But noise levels from man-made sources were lower, and the horsepower race had not yet started.

For reasons stated earlier, today's rock music, especially disco discs, are best processed with a multi-band limiter, which looks at bass, mid-range and highs separately. Even rock FM can benefit immensely from this technique, though the limiter should not work nearly as hard.

Where hard limiting is desired, the separate actions of each section tend to mask each other. And the bass notes won't punch holes in the rest of the orchestra. Multi-band limiting also acts as a dynamic equalizer: air a muddy tape and the high section will open up; follow with a squawky agency spot and the mid-range section will pull down the presence hump.

I have worked miracles with the Dorrough DAP units, and am getting nothing for this plug. Correctly used (and that means no adjustments without Mike Dorrough on the phone), it can turn a kilowatt into a 5kw, and make a Class IV reach the manager's house at night.

Asymmetrical AM limiting always upsets the music mix to some degree, since normally asymmetrical instruments (or voices) get attacked differently than symmetrical ones. But if you have 500 watts at 1580, you will probably want that extra db or two that 125% positive modulation will give you. Assuming that your transmitter will stand for it (and some absolutely will not), do it, but don't make me listen to it.

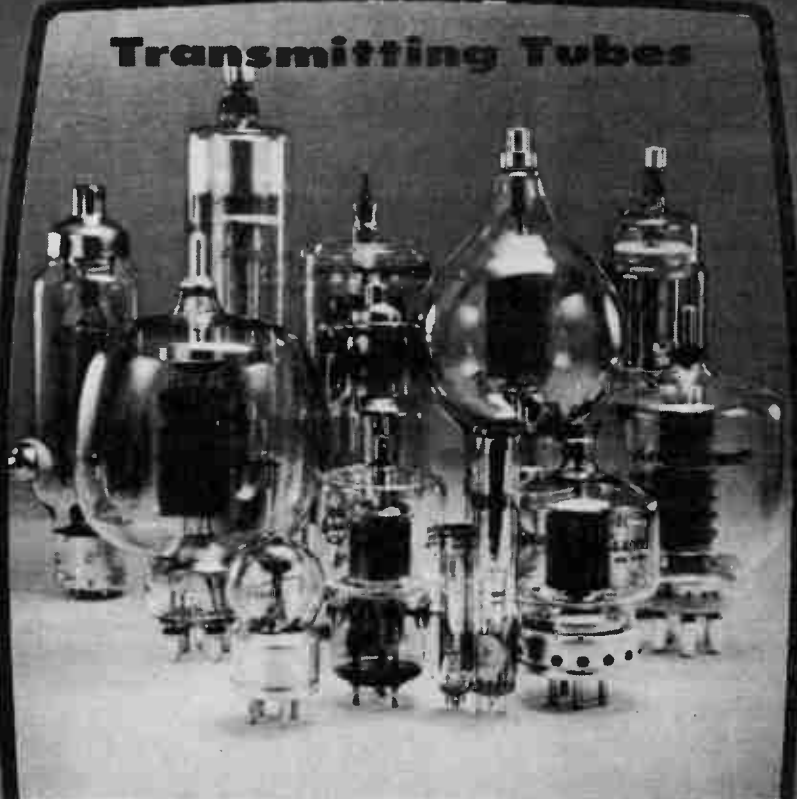
On FM, all this goes away. Amplitude modulation means the better the amplitude is modulated, the better they'll hear you over the static in Dismal Seepage. The best reason for the AM style compression/limiting that is heard on FM throughout the land may be that turgid meters are easier to set and quicker to read—by the engineer with a tin ear.

(Just checked with my favorite L. A. FM station, and they are banging away tonight. If the music pauses, the turntable rumble modulates 100%. The deejay took a breath on the air and his heartbeats hit full level.)

First, solve the far-ranging levels from your control room that your compressor is making like a roller-coaster over. Then take it out. If you can't do that, turn down the input control so that it is in full expansion most of the time.

(Continued on page 8)

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# 3M: Those dropouts

New York NY...Improvement in helical video tape imposes increased demands on studio engineers for proper equipment maintenance. This is because any momentary loss of signal when using today's tapes affects a greater signal area.

Higher density magnetic oxides on thinner, stronger backing materials have made it possible to squeeze more information onto a smaller piece of tape. Signal packing density has been compressed to 24 square inches per minute for today's Beta II helical recorders. That's 75 times more signal per square inch than the quadruplex type of 20 years ago, and nearly a ten-fold increase since 1970.

As a result, any dropout today is proportionately more noticeable. It appears to viewers as a burst of snow that flashes across the screen from left to right.

What can engineers do to guard against such signal interruptions? First, learn the potential sources of the problem. Dropouts can be caused by equipment faults or by magnetic tape itself. Among the most common causes is dirt that builds up on recorder heads. Regularly scheduled cleaning will eliminate this source of the problem.

Proper machine adjustment is essential to preventing dropouts. A separation of tape from the head of less than 1/10th the thickness of a human hair will cause a loss of signal.

## What To Do?

To prevent such dropouts, proper head-tip projection, tape tension and tape alignment must combine to maintain constant pressure of the tape against the head. Any increase or decrease in head-tip projection affects tape-to-head pressure. An optimum setting is more easily achieved with new than with old and worn heads.

Although video recorder heads are made of extremely hard materials such as ferrite, friction produced by tape passing across them will cause them to wear. This reduces head-tip penetration, lowers tape-to-head pressure and consequently results in increased dropouts.

Proper adjustment of hold-back tension is critical to the elimination of dropouts. As hold-back tension decreases, the pressure of the tape against the head declines. If hold-

back tension is reduced too far, dropouts will occur. Be sure to follow the tape manufacturer's specifications for proper hold-back tension.

When optimum tape-to-head pressure has been achieved, record drive may be adjusted. Optimum record drive results when RF drive to the video heads is set for the maximum play-back signal at the heads.

A worn head requires less record drive to produce a given signal level, because the head becomes more efficient. However, this condition also produces an increase in dropouts. Adjustment of record drive should be undertaken only by a qualified service technician.

When spinning heads meet moving tape, pressures equal to hundreds of pounds per square inch are developed. Even in a perfectly adjusted machine, the tape undergoes a rigorous work-out.

The binder system that holds the oxide particles to the plastic backing must combine the toughness to withstand these stresses with the smoothness to protect recorder heads from abrasion. It must not permit particles of the oxide coating to separate. Loose particles will bounce the tape away from the play-back head for an instant, causing a visible dropout.

To determine whether dropouts are caused by machine or tape error, re-record the tape on a machine that is properly aligned. If the dropouts disappear, the tape did not cause them. If the dropouts remain, check for tape damage such as creasing, fraying or crimping. These conditions may indicate that the machine is damaging the tape.

Some video picture irregularities are not caused by dropouts. It's useful to be able to identify them. Random noise generated by devices such as thermostats, electric motors or atmospheric static produces disruptions in the video signal that resemble dropouts.

Sometimes a tape will appear to contain many dropouts when, in fact, it is mistracked. Mistracking can be caused by improper adjustment of the recorder's tracking control, by misalignment of the record or play-back unit, or by physical distortion of the tape.

Proper machine maintenance and tape care will continue to gain importance in preventing dropouts as magnetic recording tapes continue to improve. Also, experts expect basic oxide and particle research, and new coating and slitting techniques that permit closer tolerances, to enable broadcasters to get still more information per square inch of tape in the future, at lower prices per program minute.

## CART MAINT.

continued from page 3

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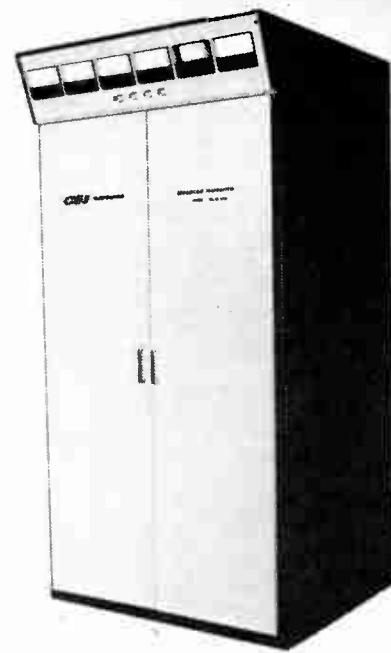
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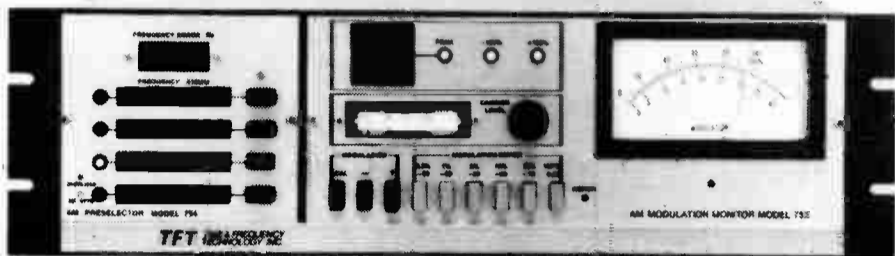
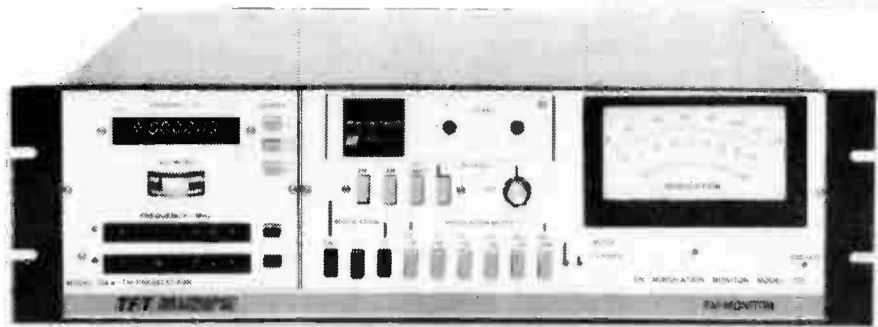
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Circle 134 on Action-gram

## Report on June FCC developments

by B. Jay Baraff  
Baraff, Koerner & Olender, P.C.

Washington DC...In an unprecedented decision, the FCC, in approving the transfer of control of Combined Communications Corporation to Gannett Company, Inc., placed a condition on the acquisition of six AM and FM combinations that they be separated if the FCC adopts rules prohibiting such acquisitions in the future. The FCC is preparing a Notice of Rulemaking to prohibit cross-ownership of an AM and FM in the same market. Any application filed after June 7, 1979, which would result in the creation, assignment or transfer of control of commonly-owned and co-located AM and FM stations would be subject to this condition. However, any applications that were pending as of June 7, will not be subject to this condition unless it is a major media concentration or a request for waiver of the FCC's Rule. Thus, if you are negotiating to purchase or sell such a combination, this new policy should be seriously considered as it may affect the price of the stations.

### FCC Inquiry To Consider More AM Stations.

In a rather significant move, the FCC is now considering reducing the AM channel spacing from 10 kHz to 9kHz in order to permit more channels to meet requests for additional full-time facilities. If you are interested in filing comments, they are due October 1.

### New Composite Week Dates.

The FCC has released its Composite Week for use in the preparation of renewal applications, which have expiration dates in 1980, and assignment of license and transfer of control applications in 1980. The dates are as follows:

Sunday, July 2, 1978  
Monday, April 23, 1979  
Tuesday, September 26, 1978  
Wednesday, February 7, 1979  
Thursday, November 9, 1978  
Friday, January 26, 1979  
Saturday, March 24, 1979

### Deficiency In Public Affairs Results In Conditional Renewal.

FCC renewed the license of WPXY(FM), Rochester NY, but required the station to provide quarterly reports through 1981 of its public affairs programming, including subject matter and topics covered during each reporting period. In 1978, WPXY's public affairs commitment fell 33% below its promise (60 rather than 90 minutes). In 1975, the performance was 85% below the 1972 promise. This combination of facts resulted in their unusually stern conditions.

### FCC Upholds Denial Of Renewal.

The FCC has affirmed an ALJ's decision to deny the renewal of Station WLBB(AM), Carrolton GA, for filing a strike petition against a pending CP in that city. The Commission clarified its definition of a strike petition as that filed for the primary and substantial purpose of delaying a competitor's application.

### Renewal Actions.

The FCC granted the renewal of Station KAIT-TV, Jonesboro, AR, which had been denied because of involvement with network bribing on the basis that the other licensee had all their renewals granted or escaped further scrutiny altogether.

### Expedited Processing For Minorities Challenged.

FCC has denied an appeal by Station WOOK-FM, Washington DC, objecting to the expedited consideration given to the processing of two competing minority applications filed for its facilities. The FCC said this did not affect the comparative aspect of the case but only affected the timing of the case. (Continued on page 9)

### SHURE

continued from page 1

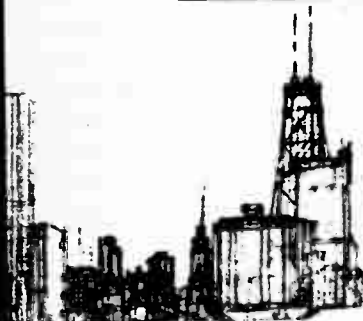
smooth and consistent cardioid pattern at all frequencies provide exceptional off-axis rejection of unwanted sound for improved separation and isolation. In addition to a precise cardioid polar pattern, the electronics section of the SM81 exhibits low total harmonic and intermodulation distortion below its clipping point, significantly lower than that of other professional condenser microphones, with no compromise in performance over an extremely wide range of simplex power operating conditions.

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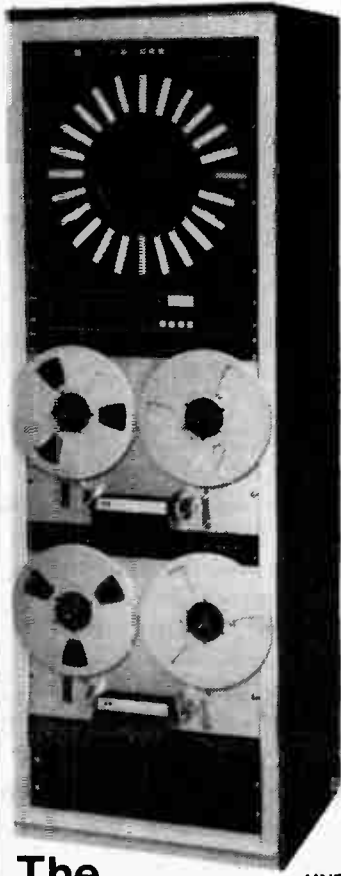
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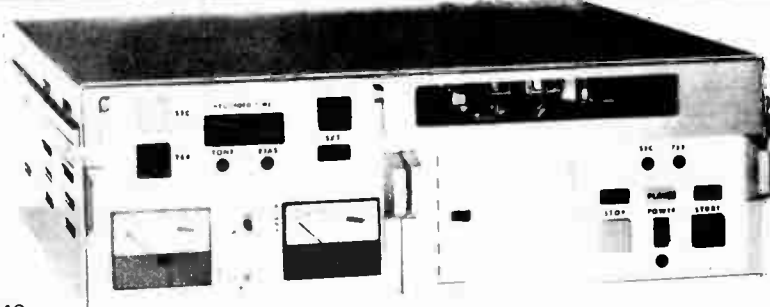
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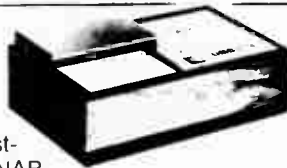


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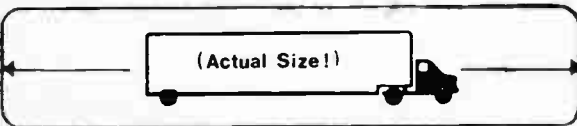


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# TIN EAR

continued from page 4

And let your limiter rest completely, with an occasional, *tiny*, bit of action. It can be very happy acting like a safety valve, chopping just a little peak here...a little peak there.

If you have a production-studio compressor or limiter, consider throwing it away completely, especially if it, like many is a main-line cast-off. At worst, use it on the microphone only. That will be about the only source of un-pre-compressed audio. (Even most cassettes from the

field have been pre-compressed to some degree by the machine's automatic level control.)

Try to avoid any audio chain that puts several compressors in series. Their cumulative effect can be anywhere between comical and disastrous.

And finally, don't assume that any processor will work correctly forever. Put it through the cattle-dip regularly, and above all, *listen* to it critically with your gold-plated ears.

## Response too!

Frequency response: Here is another area open to vast wastelands of abuse. Too often, more highs are equated with better highs. This thinking is now permeating TV audio, too. Often, sibilance is so accentuated that it activates the station's limiter all by itself. Listen to ENG news reports and you will hear one fireman's "s" knock the entire department from audio view.

By contrast, listen to the Person To Person shows now being rerun on PBS. Even the remote audio is usually well-balanced, and the participants, not to mention Ed Murrow, sound like real people and not Artoo-Detoo. And even Ed could take a lesson from the tremendous audio (on location, yet) that is the norm during Masterpiece Theater.

Your basic chain must be flat. As flat as possible. What you will feed it will vary enough. Don't make it worse by adding more to something that is already bad in the source material. At the transmitter, that multi-band limiter is a dandy way to provide a constant, gentle shaping of your response to make up for uncorrectable *minor* flaws in your chain.

Back in your comparative listening room, you'll even hear sound differences from different transmitters and even (on AM) different directional arrays. Here, the dynamic equalization of the multi-band limiter can be of real help.

I can't leave the subject without dancing to the old "make AM sound good on bad radios" song. I've heard that song before, and the "bad radios" usually turns out to be one owned by the chairman of the board.

Trouble is, the NAB has never issued specifications for Bad Radios. Is a Bad Radio the beach portable with

with a two-inch speaker, or the bass car set in a dashboard cavity that booms away at 100Hz? Think about this: No matter how cheap the set is the FM side of an AM-FM always sounds best. So make your station sound as much like FM as possible. It will sound better on *all* radios.

There are two types of creative frequency response distortion that you may want to consider, but only after your plating job is complete and you trust your hearing to direct slightly bad from slightly better.

1. Stations at the low end of the AM dial spread out over more dial space than those at the high end, and many radios, when tuned dead center, receive very little sideband information (which contains the highs) from these stations. So if you're at 570, you may want to tip the highs up a bit to compensate for this. A bit. A quarter-bit at a time. Followed by another listening test.

2. In this country we operate from the same source material as that used for phonographs in homes. Cheap phonographs in homes. While we consider records to be cut with correct sound. "Defective product" often means "my needle jumps out of the groove," and the solution is to cut the low end. Barring special full-range records for radio stations, and assuming a turntable almost entirely free from rumble, you can effect a tremendous improvement by replacing some of the sub-bass missing on discs.

I'm being very careful not to say anything that translates as "Price says boost the bass." We're not going to *boost* anything, just replace what has been subtracted. And it's not bass, but that critical range below bass that contains all sorts of delicious concussion, fundamentals and warmth.

It must be done with a very good equalizer that can treat frequencies below 60-80Hz in octave (about 20Hz) ranges. It must also be done with a good set of speakers and ears. It can almost never be done "live"—this is an act to be consummated in the production room.

Learn to "learn" bass lines on a VU meter. Watch for bass notes that occur during pauses in the rest of the instrumentation. You'll find many discs that have no bass higher than -10VU compared to the rest of the audio. Raise it to -50VU...never higher...working only the range below 80Hz...and listen to the sound that results.

I was amazed to find recently that many final-mix masters, headed for the disc cutting room, have no test tones below 100Hz. Since all fundamentals of a bass viol's music occur below 96Hz, you have just given some bass players their jobs back.

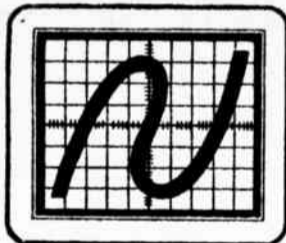
As long as you're this far into creative equalization, check the record-play response of your cartridge recorder. You will often find a hump in the 100Hz range. It's caused by

(Continued on page 23)

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# JUNE FCC

continued from page 6

## FCC To Clarify Impact Of Minority Ownership.

The FCC is requiring further proceedings in a hearing for a new FM station in Media PA, in which a grant was made to an applicant on the basis that 5% of its stock was owned by a black woman who would serve full-time as business manager. The outcome of this decision will determine whether it is advisable to modify your structure to include minority ownership for purposes of a comparative preference.

## Commercial Time Standards.

The FCC has now made its commercial policy into a rule allowing up to 24 minutes of commercial time over the 18 minute ceiling for political broadcasting provided it is no more than 10% of the station's total operating hours in the applicable period when lowest unit charges are in effect.

## FCC Sets Policy On Part-Time Integration.

The FCC stated in an application for a new FM in Springfield IL, that a proposal to intergrate a person for less than 20 hours per week would be given no consideration in the Commission's comparative evaluation. Although this was dissented to by Commissioner Washburn, it now

appears to be the policy to give no credit for part-time integration of management and ownership if this is less than 20 hours per week.

## Further Reregulation.

A. The FCC has amended 32 rule sections to eliminate conflicting provisions and deleting various technical engineering sections. Examples include deletion of the requirement for annual skeleton proof of AM directional antennas used with remote control operation for all stations having approved antenna sampling systems; permitting AM stations to use the indirect method when there is a temporary malfunction of a remote reading, remote control or extension meter indication of antenna or common point current.

B. The General Accounting Office has presented to Congress a study which makes numerous recommendations affecting many changes in the FCC's operation. Some highlights are indefinite licenses; public right to petition for revocation at any time; elimination of comparative hearings; substitute lottery; exemption of stations from ascertainment requirements.

C. Effective June 15, stations will no longer be required to keep for 60 days audio recordings of public affairs program in which issues of public importance were discussed. This is the result of the U.S. Court of Appeals holding that the Communi-

cations Act was unconstitutional in making this requirement.

## FCC Site Policy Challenged.

The FCC denied a challenge to its policy which creates a conclusive presumption that a renewal applicant's transmitter site will be available to a successful challenger. The issue was raised by one of the applicants who had agreed to purchase the facilities of WFAB, Miami against the remaining 6 applicants. The FCC found that their reliance upon this site was in good faith since the towers, transmitting facilities and equipment were already there.

## FCC Approves Citizens Group Reimbursement

The FCC has permitted reimbursement to a public interest law firm on behalf of a citizens group that had filed a petition against Stations WFVR-TV, AM and FM, Richmond VA. An agreement had been entered into with the citizens group warranting the dismissal of the complaint. Approval was specifically required for reimbursement because of the tax exempt status of the public interest law firm.

## Reporting Of Trade-Outs.

Please be reminded that your Annual Financial Reports should include all trade-out transactions which, although not prohibited, must be considered as income.

## EEO Reports.

The FCC has directed 14 broadcast stations to submit periodic Equal

Employment Opportunity progress reports because their minority/female employment was less than 50% of the available work force and 25% in the upper four job categories.

## Pre-Sunrise Authority Denied.

The FCC denied a request for waiver of its clear-channel rules for Station WHLO, Akron OH, to permit pre-sunrise authority since this would affect the nighttime exclusivity protection given to clear channel KFI, Los Angeles.

## TV Translator Station Authorized To Rebroadcast Programs In Spanish.

The FCC has allowed the unprecedented use of a TV translator station to import broadcast signals into urban markets containing a large number of broadcast stations for the purpose of fulfilling an unmet need for Spanish programming. Normally a translator is only used to reach rural areas and strengthen week coverage areas of regular broadcast stations.

## Environmental Challenges.

The FCC is allowing parties to file a petition to deny challenging environmental consequences of an FCC action, provided that they can show that they have a legitimate interest in the environmental impact of that action.

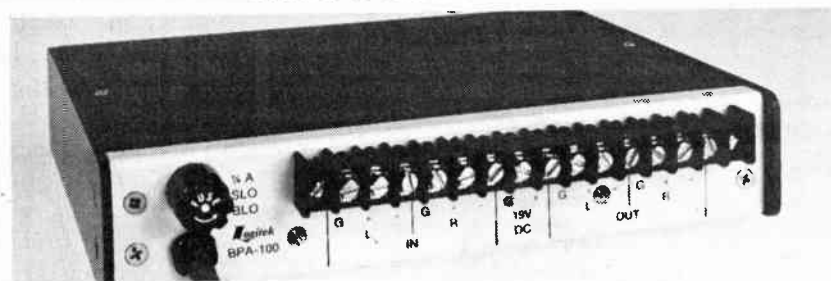
## Assignment Of Call Letters Denied.

The FCC denied the assignment of call letters KWK-FM for a station in Granite City, IL, because Granite City was east of the Mississippi.

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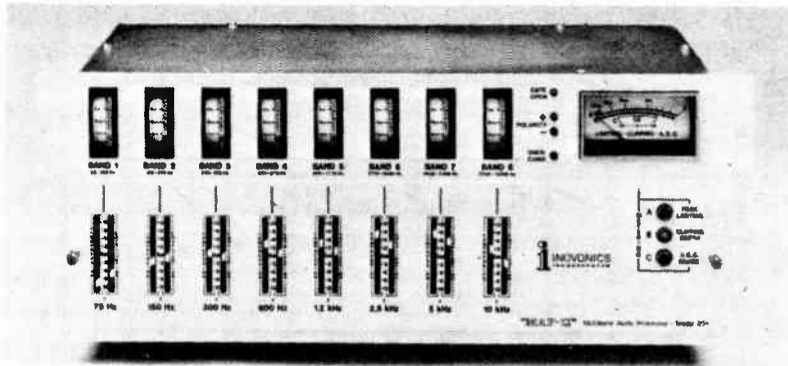
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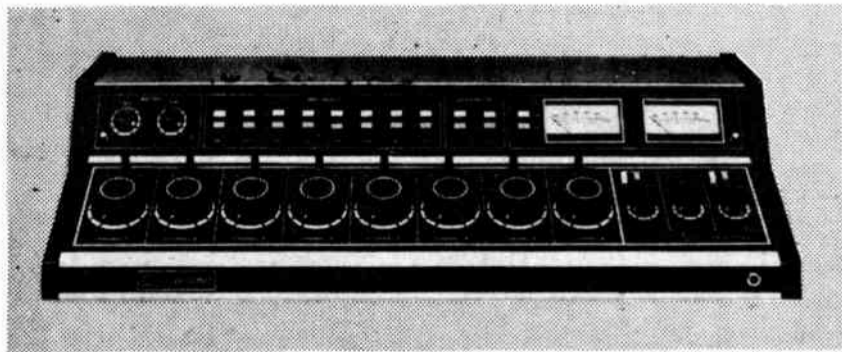
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Circle 133 on Action-gram

## Clint Free on VTR's:

# More on headwheel servos

Knoxville TN...This article continues a discussion on headwheel servos. Methods used to control the speed and phase of headwheels vary, as most things do. Some of the more complicated methods have been steps backward from earlier, more simple ways, however, most newer methods improve either performance, reliability, or both. I will attempt to describe a velocity detector which in addition to having no adjustments, also performs as a phase detector when velocity is achieved.

Velocity detection is an essential component in a headwheel servo if fast locking and tight phase control are desirable or necessary. A phase detector will attempt to lock each time a multiple of the reference frequency is approached.

Reference vertical is 60Hz and reference 15,750 does not divide to 240 (tach frequency). The most popular method is to multiply 15,750 (15,734) to 126,000 (8x), and then divide this signal to 240Hz. This produces a more stable 240Hz reference than multiplying 60Hz vertical to 240Hz, and the divider to develop 240Hz from 126,000Hz (believe it or not) is 7, 5, 5, 3. Just a little nostalgia for us old-timers!

Figure 1 is an overspeed detector. When the velocity of tach exceeds the reference, MV#2 output is gated to a trapezoid generator for phase detection, and until velocity is achieved, the trapezoid output is a level which when sampled causes maximum power to be applied to the headwheel.

The leading edge of MV#2 is refer-

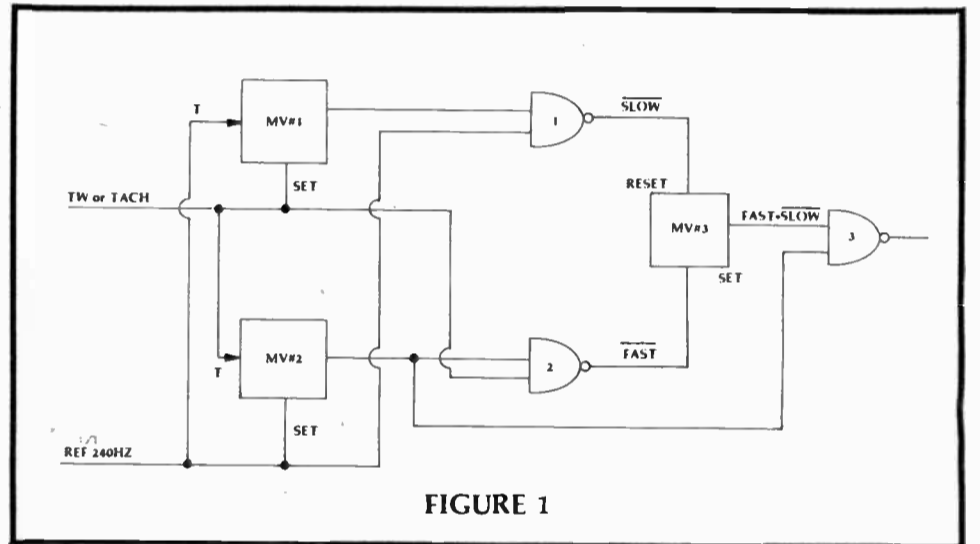


FIGURE 1

Last month I described an early method of velocity control and although the method is fairly stable, adjustments need to be made as temperatures vary, components age to new values, etc.

By using bistable multivibrators and gates to compare reference and tach or tonewheel pulses, a detector with no adjustments can be made. One of the problems with this type of detection is that both reference and tach pulses must be at the same fre-

quency and the trailing edge is tach. The trailing edge is sloped for sampling.

The headwheel motor must be driven by a voltage which will not allow the motor to overspeed to a multiple of the reference for this detector to work properly. It works best using a fixed frequency of 260-280Hz. Power removal by pulse width modulation of the motor drive voltage allows the head to run at 240 rps.

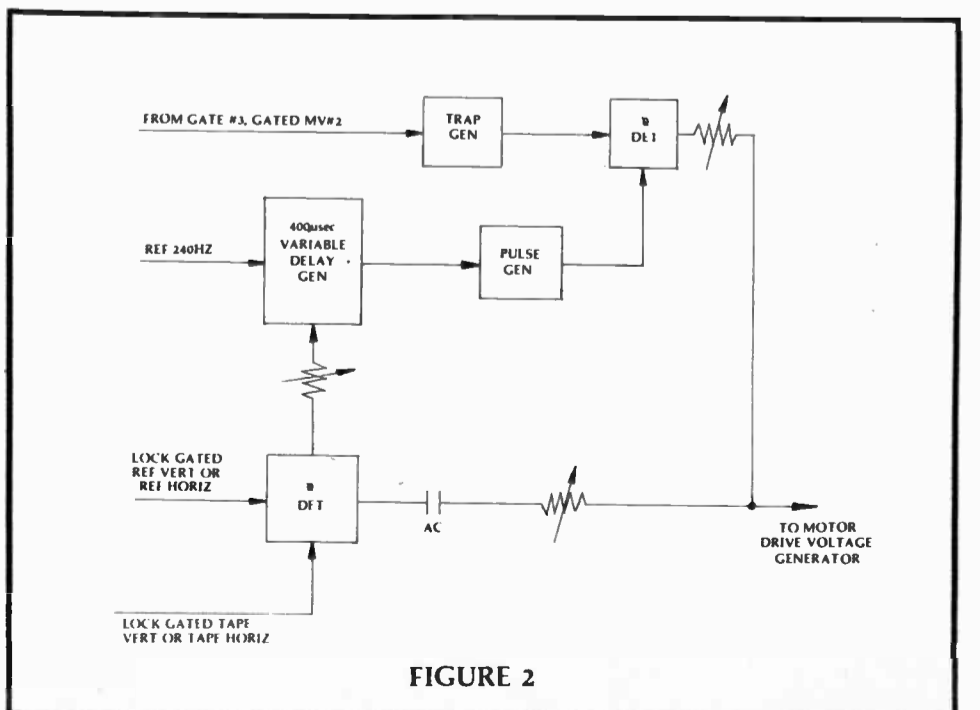


FIGURE 2

# audiotechniques mixdown

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## National Public Radio Chooses MCI Recorders

Audiotechniques is pleased to announce the receipt of a contract for 21 MCI JH110-A quarter inch recorders from National Public Radio, Washington, D.C. The contract for the MCI units was placed after an extensive, year-long evaluation of professional tape recorders by NPR.

Contract negotiations for Audiotechniques were conducted by VP Mike Faulkner, whose previous experience in successfully negotiating a similar contract between NPR and Scully nearly 12 years ago, held him in good stead. The new MCI recorders, slated for a late summer delivery, will have custom stainless steel deck covers and engraving.

Faulkner and Bob Cavanaugh attended a three day seminar of National Public Radio's affiliates in late May and there demonstrated the MCI products to more than 500 public radio station representatives.

## SUMMERTIME IS RENTAL TIME!

A/T Rentals Manager Kurt Fleischer reports early bookings for summer rentals are heavier than ever. If you're going to need equipment for a remote gig or whatever, give Kurt enough advance warning to take care of your needs. A deposit (10%) works wonders.

## Prime Times in stock for immediate delivery!

They're hard to get, but we got 'em! Lexicon's Prime Time special effects delay units are on the shelf at Audiotechniques and waiting for your call. Price is \$1660 with the Memory Extension Option (and that's the only way we stock PT's). Give Bob Cavanaugh or Lou Greto a call today.

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## Sid Zimet joins Audiotechniques in New York City

Sid Zimet, well-known Metro area hi-fi and semi-pro equipment specialist, has joined Audiotechniques' sales engineering staff. Zimet, who was the founder and owner of Audio By Zimet, pioneer Long Island audio outlet, has disposed of his interests in that company, and in Sound Workshop, which he also co-founded. Sid's initial assignment will be in the NYC offices of Audiotechniques Leasing and Rentals. We're pleased to have Sid Zimet with us, and feel that his years of experience will be a welcome addition to a growing Audiotechniques.

## And speaking of staff additions...

Tom Laughlin has joined Audiotechniques' technical service staff and can be found at our New York office. Tom comes to us with a good technical background and is specializing in MCI tape recorder installation and service.

Lou Greto, Greenwich, CT, has joined the Audiotechniques' sales department in Stamford. Lou, in addition to experience in hi-fi, is a brown belt karate guy (so better not argue about the price with Lou!).

Jamie Howarth, with a wealth of experience as a "Roadie" and studio engineer, is another new addition to Greg Hanks' technical services crew. Jamie is usually on the road, but he hangs his hat in our 1619 Broadway office.

## MCI Hosts Industry Leaders Parley

# TARSIA HEADS NEW RECORDING STUDIO GROUP

## SHORT TAKES

### Tom-Toms for Schwartz!

Tom Jung, President, Sound 80, Minneapolis, and Tom Cahill, Chief Engineer, Atlantic Recording Studios, NYC, have joined Howard Schwartz Recording in New York City.

Jung, who was a co-founder of Sound 80 and has been with the nationally-known Midwest firm for more than 10 years, will join the fast-growing New York studio complex shortly after Labor Day. Tom Cahill joined the Schwartz organization in mid-June as the Chief Engineer. With two nationally-known engineers already on the roster, look for Howard to land another industry biggie as he staffs for a shot at the top.

### Fist-O-Funk Studios!

Kevin Misevics' studio of the above name opened July 2 with a new, automated MCI 500 console, MCI 24 tracker, and all the associated gear, including a Lexicon Digital Reverb.

Kevin's taken over the Blood, Sweat and Tears complex that was formerly owned by Bobby Colomby in New City, N.Y. (just on the other side of the Tappan Zee Bridge). Our MCI installation crew, headed by Greg Hanks, put it all together, with sessions booked as the final solder joint cooled.

### PCI goes 24

Another 16 tracker bites the bullet as Ted Hummel's PCI Recording (Rochester, NY) goes 24 with a new MCI installed by our usually-on-the-go technical crew. Keep your eyes and ears, too, on PCI... they've got it together!

### More new stuff at Blank

Rapidly becoming one of the NY area's hottest studios, Blank Tape Recording took delivery of another new MCI JH 24 recorder, automation for their MCI console, and another MCI 2 tracker. These guys (Bob and Lou) are booked solid well into the fall with name acts!

### More MCI for Blind Foundation

Nice to see American Foundation for the Blind's Peter Hanke and his two young sons at our recent Lexicon demo gig. And thanks to Peter and the foundation for their order of 5 more MCI recorders. We get a particular thrill out of playing a small part in the great work this group does every day.

Joe Tarsia, president of Sigma Sound Studios, Philadelphia and NYC, was elected temporary head of the Society of Professional Audio Recording Studios (SPARS) at the organization's founding meeting on June 13-15 in Ft. Lauderdale, Florida.

Other directors of the group, which is dedicated to achieving technical excellence in the recording studio industry, are: Bob Liftin, Regent Sound, NYC; Mack Emerman, Criteria, Miami; Glenn Snoddy, Woodland, Nashville; and Chris Stone, Record Plant, LA.

The more than 30 recording studio executives who founded the group were in Ft. Lauderdale as guests of MCI for a working seminar on technical directions for recording console design and manufacture. The formation of SPARS came at the suggestion of Don Frey of A & R Recording, NYC, who pointed out the continuing need for studio owners and managers to meet, exchange ideas, discuss problems and recommend technical standards.

### Studios represented at the MCI meeting were:

A & R Recording Studios, NYC; Atlantic Studios, NYC; Criteria Recording Co., Miami; House of Music, NJ; Filmways Heider Recording, Hollywood; Group IV Recording Studios, Hollywood; Howard M. Schwartz Recording Inc., NYC; Kendun Recorders, Inc., Burbank; Larrabee Sound, Hollywood; Media Sound, NYC; Record Plant, LA; Regent Sound Studios, LA; Soundmixers, Inc., NYC; Sigma Sound Studios, Philadelphia; Studio 55, LA.

### Guest list and visitor's log

Our recent visitors include Bruce Bluestein, Sigma; Malcolm Addey; Jim Czeck, Nola; Mark Free, Chelsea; George Markunis; Jack Anthony; Tony Kalmen, Leasewell, NYC; Kevin Misevics; Charles Conrad; Jeff Kawalick; Stephan Glafas; Gary Rosen, House of Music, West Orange, NJ; Eddy Kramer; Bob Troeller and Tim Bomba, Sound Mixers; Gene Catani, RCA; Ray Weiss, NBC; Ace Frehley.

### And a tip of the hat to...

MCI's Jeep Harned for the PR coup of the decade and possibly the classiest industry meeting that's ever been held! The SPARS formation (covered elsewhere in "Mixdown") was only a small part of the accomplishments, as console concepts for the 80's were hammered out by a blue ribbon group of studio executives from across the country... and MCI picked up the whole tab. Which only goes to prove what we've been saying for seven years... MCI's on top of the heap when it comes to giving the recording industry what it wants... and in helping the industry decide what it needs. Well done, MCI!

## SCAMP DEMOS

Our Bob Cavanaugh is now demonstrating A&D's remarkable SCAMP rack of special effects devices to unbelieving ears in northeast studios. From the same people who give us the Complex Limiter, its an incredible array of auto panners, filters, limiters, eq and lots more. Call Bob and get your check book ready.

## BUILDING A RECORDING STUDIO?

Make us your first call.

**Audiotechniques**  
**(203) 359-2312**

We're not only the biggest, we think we're the best, by far! We've been building studios for nearly eight years and have more years of combined professional audio engineering experience than we like to admit. Initial planning, financing, designing, equipment installation, maintenance... they're all our business. If your business is recording, you should be talking to us.

# New linkup for MCI/EMI

Fort Lauderdale FL...MCI, Inc. and EMI, Ltd. have entered into a licensing agreement under which MCI will manufacture digital recording equipment, based on technology developed by EMI.

A prototype of the first machine to be developed under the agreement, the MCI JH-220 two channel stereo tape recorder, went on show at the Association of Professional Recording Studios Exhibition in London on 20 June.

Production models of the JH-220 will be available by the end of this year. The first of these will go into EMI recording studios and be immediately available to artists using those studios.

Future joint projects under the licensing agreement will include development of an editing system as well as multichannel digital tape recorders.

Development work on both these projects is nearing completion at EMI's central research laboratories at Hages in Middlesex, England, and prototypes of both will be completed by MCI by the end of this year, and will go into production early in 1980.

EMI's central research laboratories have developed a digital system which makes the EMI/MCI machines competitive with any digital recording systems in the world.

"In fact," says Bhaskar Menon, chairman and chief executive of EMI Music Worldwide Operations, "we have no doubt that the EMI/MCI system is the very best in the world."

"Our central research laboratory has been involved in digital technology research for as long as anybody in the world, but in addition to having achieved a tremendous level of technical excellence we have also researched the requirements of our

industry.

"We are confident that the technology that the EMI/MCI venture will offer the music industry will dovetail very precisely with their requirements.

"Ours has the unique advantage of being an affiliation between the equipment manufacturer, MCI, and an equipment user, EMI. Clearly, this fact alone gives us a head start in what is becoming a very hotly con-

tested technological race."

Jeep Harned, president of MCI, Inc., says, "I think that the cooperation between our two companies has been very fruitful to both parties, in particular because of the way it has brought American technology and British ingenuity together.

"Ours is a partnership that is well equipped to give the music industry the very best in recording equipment."

## Improved outer-rotor cartridge tape machine motors

Elmsford NY...Cartridge tape machines present demanding challenges for the motor drive system. The magnetic tape medium is heat sensitive and life is appreciably shortened if exposed to temperatures exceeding 135 degrees F. Japan Servo motors combine specially designed windings with a high-precision, close-coupled air gap, yielding the high torque required by tape cartridges while providing coolest possible running. These motors actually produce more torque output with only 17 watts input than other designs provide with 24 watts input. Running temperatures, measured under continuous operation, are typically 20° F. cooler than competitive motors.

Japan Servo motors have lower magnetic hum, lower electrical and mechanical noise incorporating dual-plane micro-balanced rotors.

To facilitate repair and service, life-limited parts such as shafts and bearings are interchangeable and easily replaced in the field providing lowest operating costs to the ultimate customers. Standard replacement parts are available from stock.

Hitachi high-cobalt hysteresis

materials, world renowned for their excellent magnetic properties and homogeneity of dispersion are used exclusively and precision shrink-fitted into the die cast rotors. The assembled rotors are then dual plane micro-balanced to eliminate vibration.

Japan Servo motors are guaranteed to meet all of the new NAB cartridge tape motor standards including DIN measured wow/flutter.

Each motor is installed in a cartridge machine actually playing tape, and must meet 24 stringent operating tests before being accepted for shipment.

Advanced design, engineering and construction excellence, combined with rigid quality control are the main reason why virtually all of the world's leading cart machine manufacturers including ITC, Spotmaster, Harris, Sono-Mag, Schafer and Sparta use Japan Servo motors exclusively as original equipment in their highest performing machines.

Japan Servo Company is the largest manufacturer of high precision fractional horsepower motors and gear-motors and is a subsidiary of Hitachi, Ltd.

## BEE Employment Service

### For Help Wanted

Any company or station can run technical Help Wanted ads at the flat rate of \$12 per month, per insert (for each 50 word increment). Payment is preferred with insert, but if invoice is necessary, there will be an extra \$1.00 charge. Blind box numbers can be provided at an extra charge of \$10.00 per insert, and the responses will be forwarded to the listee, unopened, upon receipt.

### For Positions Wanted

Any individual can run a Position Wanted ad, FREE of charge, at any time. Simply send in your listing, 50 words maximum, and it will appear in the following 3 issues of BEE. Contact information will be provided, but if a box number is required, there is a \$10.00 fee which must be paid with the listing (there will be NO invoicing). Responses will be forwarded to the listee, unopened, upon receipt.

Clip out & mail to: BEE, Box 1238, Arlington VA 22210

Name \_\_\_\_\_

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## EMPLOYMENT CLASSIFIED

### POSITIONS WANTED

Sales Manager, 5 years Industrial/Residential Video Sales, Rentals, and Industrial Production. Basic technical understanding all phases of Video Equipment willing to relocate. Resume available upon request. Kenneth Cheek, Personal, Southern Video Systems, Inc., 4019 W. Kennedy Blvd. Tampa, FL 33609. (813) 379-5094.

1st class, 3 yr's TV and Radio, currently chief at backwoods station, desires maintenance or Asst. Chief with quality-conscious AM-FM. Have gold-plated ear; will travel. Can jock. Send replies to Box PW 7-1.

AM, FM or combination owners. Thinking of selling? Upgrading? Experienced broadcast executive seeking first owner/operator venture in medium or small market. Let's talk. No brokers, please. J.U. Steele/Editor, NAB Code Authority, 477 Madison Avenue (#1405), New York, New York 10022, (212) 759-7020.

### POSITIONS WANTED

1st Class. Experience includes: 2 years directional, 6 years with non-commercial stations, fund raising, management, programming, instruction, complete design, operation and installation of 2 stations, CCTV experience. Prefer school station position but will look at others and will re-locate. Box PW 6-1.

Chief Engineer at Midwest AM/FM (stereo) automation station looking for advancement from a small-market facility to medium or large-market station. Love the station/work but I have to eat. Send replies to Box PW 6-2 for mutual exchange of information.

For listings with Box numbers, reply to  
Box \_\_\_\_\_, c/o BEE, PO Box 1238, Arlington VA 22210

# Aviso Importante

## Para Radiodifusores de México!

Usted ahora tiene acceso a la lista de equipo de radiodifusión mas extensa en el mundo.

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Debido a un acuerdo exclusivo con esta publicación, Broadcast Equipment Exchange (BEE). Guarantee Radio se complace en ofrecerle a usted y a los demas radiodifusores de México esta gran oportunidad.

En las siguientes paginas usted encontrará, convenientemente catalogadas, mas de mil referencias de equipo usado de radiodifusión.

Con esta extensa selección, Guarantee Radio le permite comprar equipo de uso con la misma facilidad como si lo comprara nuevo.

Examine nuestra lista y convéncase de que este servicio que le ofrece Guarantee Radio le ahorrara largas horas y dinero en su búsqueda de equipo usado.

Para mas información, incluyendo precios llamenos al telefono:

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El campo de la electrónica dia con dia nos brinda nuevos descubrimientos; descubrimientos de gran utilidad para la industria de la Radiodifusión y el mundo de la Electrónica.

Nosotros aqui en GUARANTEE RADIO nuestro principal objetivo durante más de 50 años ha sido la superacion en servicio y atenciones para nuestros clientes y amigos.

En esta ocasión nos es grato llamar su atención para extenderles la más atenta de las invitaciones a que nos visite y vea como GUARANTEE RADIO tiene siempre a su alcance los últimos adelantos electrónicos tanto en equipos de prueba como en transmisores AM, FM. (nuevos o usados) y lógicamente en partes y refacciones nuestro stock es el más amplio; garantizandole siempre los mejores precios. Asimismo ponemos a sus ordenes nuestro catalogo de equipo usado.

Si en algo podemos servirle nos seria muy grato poner nuestra experiencia a sus ordenes.

Atentamente

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# The Exchange The Exchange The Exchange

## AMPLIFIERS

### WANT TO SELL

**Heathkit AA-111** stereo amp (tube) \$35. SP-2A stereopreamp, \$40. Eric ST-100 solidstate MPX tuner, \$25. Key Code 7-5.

**JBL Model 6233** power amplifier 200 watts per channel 8 ohm, 300 watts per channel 4 ohm, JBL 510 professional mic pre amp, new. Key Code 7-66.

**Western Electric 22D** remote amplifiers (five) (2-suitcase variety). All work. Some less VU meters. Make offer. Key Code 7-35.

**Pioneer 4 channel amplifier.** Best offer. Key Code 7-64.

**RCA BA-12A** Line Amp, 3 units. \$25 each. Key Code 6-20.

**RCA BX-1E** Power supply for BA11 pre-amps, 3 units. \$20 each. Key Code 6-20.

**Sparta stereo preamps TEP-3**, 2 available at \$50 each. Key Code 6-79.

**RCA BA-4C** Line Amp. \$20. Key Code 6-20.

**Altec P518A** power supply. Key Code 6-42.

**Dyna 120** Basic Amplifier, 60 watts per channel, excel. cond. Best offer. Key Code 6-59.

**McMartin LT-80-B**, 4 each \$75. Key Code 6-70.

**Phase-Linear** model 2000 preamp, excellent cond. with manual. \$80. Key Code 6-19.

**RCA BA-13** Line Amp. 6 Units. \$40 each. Key Code 6-20.

**GE Uni-Amp BA9-B**. \$20. Key Code 6-20.

**RCA BA-14** Monitor Amp. 7 units. \$60 each. Key Code 6-20.

**Altec 1569A** amplifier. Key Code 6-36.

**RCA BA-2C** Line Amp. \$20. Key Code 6-20.

**RCA BA11-A** Pre-Amps. 13 units. \$20 each. Key Code 6-20.

**G.E. model 48A10A** utility amp. Key Code 6-42.

**Spotmaster AD-1B** Audio D.A., 1 in, 5 out, excel. cond. \$256. Autodyne, Box 13036, Orlando FL 32809. 305-855-6868.

**McMartin TBM-2500** RF amplifier, good cond. Key Code 5-27.

**Gates M6Z44** pre-amplifier, two available, good cond. Key Code 5-27.

**Spotmaster PLA-20/Marti PGM-20** line amp, mint cond. \$95. Autodyne, Box 13036, Orlando FL 32809. 305-855-6868.

**Gates M6442** pre-amp, two available, good cond. Key Code 5-27.

**Dynair DA-230A** Video D.A., 1 in, 4 out, like new \$175. Autodyne, Box 13036, Orlando FL 32809. 305-855-6868.

**Fairchild/Robins DA-1520**, Audio D.A., 1 in 15 out, good cond. \$195. Autodyne, Box 13036, Orlando FL 32809. 305-855-6868.

**Sony 100 watt** stereo amp in road case. Used by former Beach Boy for instrument amp. \$500 or best offer. Key Code 4-85.

### WANT TO BUY

**McIntosh MC-3500** (need two) working 350 350 watt tube. Key Code 7-7.

**Marantz #9 70 watt tube mono** (need four) working. Key Code 7-7.

**McIntosh MC-275** tube stereo 150 watt working. Key Code 7-7.

**General Electric Model 4BA3A3** transcription amplifier and equalizer rotary switch for same (one). Be reasonable, or no go. Key Code 7-35.

**Harmon Kardon Citation II** stereo 120 watt tube working. Key Code 7-7.

**Dyna Kit Mark III** 60 watt tube mono (need many) working or not working. Key Code 7-7.

**Fisher SA-1000** working. Key Code 7-7.

**RCA type BR-2** or 36-B rack shelves wanted. Key Code 6-19.

**Turntable preamp**, working, reasonable price. Key Code 5-58.

**Marantz Model 5**, any condition (need one). Key Code 5-8.

## ANTENNAS & TOWERS

### WANT TO SELL

**Delta Electronics** transformer (new, never used) coupled antenna ammeter. Model TCA5EX and TCA5EXM3 remote meter. Original price of \$380. Key Code 7-38.

**GE 502** Gravel Bottom Guy Insulators 50¢ ea., volume 20% discount. Key Code 7-65.

**400' or 800' Cablewave** 1-5/8" Foam Low VSWR Transmission Line. Brand New on Reel. Wellflex with Connectors. 400' \$2,000. 800' \$3,990. H.M. Holzberg Associates., P.O. Box 322, Totowa, NJ 07511, 201-256-0455.

**Andrew Heliac** 7/8" transmission line (100 feet). Gates FM-2 Educational Ring Antenna. Make offer. Key Code 7-31.

**Tower sections** (to form 100 to 200 ft. towers), 24" face or larger. Key Code 6-16.

**Crouse-Hinds DCB-24R** rotating beacon. \$100. Key Code 6-83.

**Rotary Joints** 2 each, for 7/8" complete with Andrew fittings \$100 each. Key Code 6-4.

**Tower**, 320 ft. heavy duty, 36 in. triangular, lighted, immediately available. Key Code 6-17.

**Harris FMC-2**, two bay antenna tuned to 100.1 MHz, circular polarized. \$750. Key Code 6-29.

**Self-supporting tower**, 200 ft, 4 leg. Includes base insulators, top light and flasher. Former use-AM and FM on ground. \$6000 f.o.b. Key Code 6-82.

**Jampro 4 bay FM antenna.** Key Code 5-36.

**Collins 4 bay FM antenna.** Key Code 5-36.

**Guyed Tower**, 150 ft, on ground, good condition. \$800. Key Code 5-11.

**Andrew 10.7-13.2 GHz** rigid waveguide type WC-109, (54346-240), new, unused, w/hardware, 190 feet, best offer, plus shipping. Lists at \$2,544. Key Code 5-31.

**Utility Tower 200 ft.** guyed Type 2201. Key Code 5-36.

**329 feet Andrew 1 1/2" HJ7-50A** Heliac with connectors. Good condition. Key Code 4-43.

**Windcharger tower**, 300 feet, with 20 ft. pole at top. Lights and wiring for lights and deicers. Tower to be available on the ground April 1, 1979. Key Code 4-43.

**Tower lighting chokes**. 3 Wire, 2000 watts AC. Some new, some used. Some used available in weatherproof metal boxes. 6 available \$25-\$100. Key Code 4-24.

**Parts chassis.** Were part of antenna switching-failsafe system. Many relays, latching relays, small AC contactors, indicators, etc. Well worth \$15 each. Key Code 4-24.

**Crouse-Hinds Tower** light flasher unit. Mercury bulb type. In working condition, but dirty. \$25. Key Code 4-24.

**Shively 6810 CP Antenna.** 8 Bay tuned to 101.1 and 102.1 used for duplexing. Deicers open. Key Code 4-12.

**Harris FMC-2**, Two Bay FM Broadcast antenna with deicers, tuned to 100.9 Mhz. Excellent condition. Station moved to new frequency. Key Code 4-43.

### WANT TO BUY

**Guyed tower** (300'), Base insulator, A-3 lighting & ground system. Key Code 7-40.

**Tower 200** plus ft, 3 leg. Key Code 6-63.

**Heliac 3" Transmission Line**-150 to 250 feet. Will consider longer line. Key Code 6-16.

**TV antenna for Channel 29 or 45.** Key Code 5-50.

**Six bay antenna** or four vertical antenna for 106.1 with power divider. Key Code 5-51.

**Wincharger Type 101** tower or 20ft sections of Type 101. Key Code 5-36.

**Collins 37M-8** antenna tuned to 99.1 MHz with 1-1/2" coax or other horizontally polarized antenna, 6 or 8 bay on 99.1 MHz in good cond. Key Code 5-38.

**FM Circularly polarized** 4 bays tunable 88 to 90 Mhz, that will accept 1KW R.F. Maximum. Key Code 4-38.

## AUDIO PRODUCTION (OTHER)

### WANT TO SELL

**Eventide instant phasor.** Good condition. \$300. Key Code 7-30.

**Dorroughs model 310** Audio Processor, excellent operating condition with full factory overhaul. \$1000, will ship continental USA. Key Code 7-42.

**GLI 3880 Disco Mixer**, \$375. Audio Techniques Inc., 652 Glenbrook Rd., Stamford CT 06906 203-359-2312.

**ROH audio modules**, 1-DA212 1x6 dist amp, 1-AG219-AGC amp. to fit ROH enclosures, about 1 year old, never used. List \$620, asking \$400 or best offer. Key Code 7-34.

**Eventide Clock Works Omnipressor**, two each/both new. Key Code 7-66.

**Ampex hi-speed reel to reel duplicator**. 1 master, 3 slave units: 1, half track and mono, 2, half, quarter, and mono. Key Code 7-22.

**Langevin 251 type program equalizer.** \$250. Brand New. Key Code 7-27.

**DBX 187**, 4 channel; Lexicon 93; Spectrasonics Complimiter. The Audio Group, 1780 B'way, New York, NY 10019, 212-765-7790.

## International Contact Section

For more information on any product listed in BEE contact the following companies:

**In Canada:** United Video Ltd  
1485 Triole Street  
Ottawa, Ontario K1B 3S4 or  
Canada  
613-741-5554

Norbec Video Ltee  
4315 Girouard  
Montreal, Quebec H4A 3E5  
Canada  
514-481-3483

**En Mexico:** Exclusivo, para mas informacion, llamen:

Guarantee Radio Supply Corp  
1314 Iturbide Street  
Laredo TX 78040 E.U.A.  
512-723-6913

**In Australia:** Contact the closest office of Audio Telex Communications,

Sydney (Head Office):  
54 Alfred Street  
Milsons Point 2061  
Tel: 929-9848

Melbourne:  
7 Essex Road  
Mt. Waverley 3149  
Tel: 277-5311

Brisbane:  
394 Montague Road  
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**In Other Countries:**

Broadcast Equipment Exchange  
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Tel: 703-525-0400  
TELEX: IMASINC 64593  
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In the U.S. call 800-336-3045  
For any Key Code Names and Addresses.

# 800-336-3045

New Listings are in *Italics*.

# ACTION-GRAM

JULY 1979  
USE BEFORE  
OCTOBER 1979

**Instructions:** Use this form to take advantage of any of the services provided by *Broadcast Equipment Exchange*. Always fill in the Contact Section below first, then fill in the appropriate service section(s). Remember, BEE provides a FREE listing service for end-users. Listings are printed *without* the listee's name and address... A Key Code is used instead. Paid subscribers receive their issues of BEE with the matching Key Code list. Non-paid subscribers do not; they pay for the Key Code only when they order it (see the Subscription Section below).

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Name \_\_\_\_\_  
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 Company/Station \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_  
 State \_\_\_\_\_ Zip \_\_\_\_\_  
 Telephone \_\_\_\_\_  
*(Verifiable number must be provided)*  
 Signature \_\_\_\_\_

**KEY CODE ORDER SECTION:**

**TOLL FREE KEY CODE HOTLINE**

**800-336-3045**

*In Virginia call 703-525-0400 collect.*

...our Hot Line telephone number. When you call, we will give you any Key Code names and addresses and send you the full list with an invoice for \$5.

**International Readers**  
See International Contact Section  
on page 14

**READER INQUIRY SECTION:**

7-79

If you are interested in receiving literature from any of the advertisers, in this issue of the *Broadcast Equipment Exchange*, then circle the numbers as shown at the bottom of the ads, and we will be happy to forward your request to the appropriate company.

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**1. FIRST CLASS MAIL WITH KEY CODE LIST.** Avoid delay... get in on the action faster! For \$25 per year, you get BEE 1st class WITH the matching Key Code number list. (Enclose your check with your order and get 3 BONUS issues!).

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Bill me \$25 for a 1 year, 1st class mail subscription to BEE including the Key Code list.

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Free without the Key Code list (I'll buy the list for \$5 only when I need it).

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# MOD. CONTROL

continued from page 2

low modulation level criteria have been satisfied. Likewise, if the modulation exceeds minus 95% or plus 112% at any time, a decrement clock will be gated, causing the counter to count downwards reducing the audio level to the transmitter until the high modulation condition has been cleared.

The other two thresholds shown on the figure measure the overmodulation conditions and are connected to two counters whose counts are displayed on the front panel. These counters operate for one minute so that the operator can see how many modulation bursts, both negative and positive, have occurred in the preceding one minute period. They display both the accumulating count in the current minute and the total count in the preceding minute. These counters are necessary and convenient tools for adjusting the variables for the desired degree of control. They also provide the necessary overmodulation count signals for ATS operation.

The actual program control is done by an eight bit multiplying D to A converter. Without resorting to

counter periods adjustable for field evaluation. The production models have all of these adjustments with the exception of the overmodulation counter periods adjustable behind a front panel door. The range of adjustments have been restricted to practical values as determined in our field tests. By setting these adjustments in the desired manner, the unit can be made to operate very slowly as might be desired in a classical music station so that long term variation in transmitter characteristics can be corrected without any change in program material characteristics. It also may be adjusted for fast action so that very high average modulations can be obtained. This would be suitable for stations operating with more contemporary formats.

In the past several months we have made extensive field tests at three different broadcast stations. Generally, we asked the station engineer to adjust his program equipment to obtain modulation characteristics according to his normal operating procedure and to include all of the audio processing equipment normally in the circuit. We then inserted

troller increased the average signal to the transmitter by about 1 to 2 dB during most periods.

It is of interest to point out that these corrections were made even though WMAL was operating with what it considered the best complement of audio processing equipment. The tests at two other stations showed results very similar to these. At one station the gain adjustment was larger because the audio and symmetry level varied considerably between program sources.

An interesting transmitter characteristic was measured at WGH, Hampton Roads, Virginia during these field tests. WGH is equipped with two complete transmitter sites and with diesel backup power. They were kind enough to permit us to operate one of the sites on a dummy load and vary the primary supply voltage to the transmitter using the diesel generator. With an audio oscillator source we adjusted the transmitter for 90% modulation with a 1000 Hz tone. The audio level was maintained constant and the AC supply voltage was varied from 225 to 260 volts. Figure 4 shows the measured percentage of modulation for different supply voltages. It is striking to see how the transmitter characteristics change under these conditions. Mr. Looper, Chief Engineer for WGH, has long recognized this problem and in fact presented a paper at last year's convention on the subject. He has successfully corrected the problem by regulating the modulator bias and the dc supply to the audio amplifiers in the transmitter. It is obvious though, that standard audio processing equipment will not cope with this situation. In fact, Mr. Looper's paper on this subject provided the impetus for our development of the Amplitude Modulation Controller.

I would like to thank Mr. Looper of WGH, Mr. McPherson of WMAL, and Mr. Miller of WFAZ for their great interest in this project, for the use of their facilities for field testing and for the suggestions and guidance they have given us in this program.

(Note: From a paper presented at the 1977 NAB convention.)

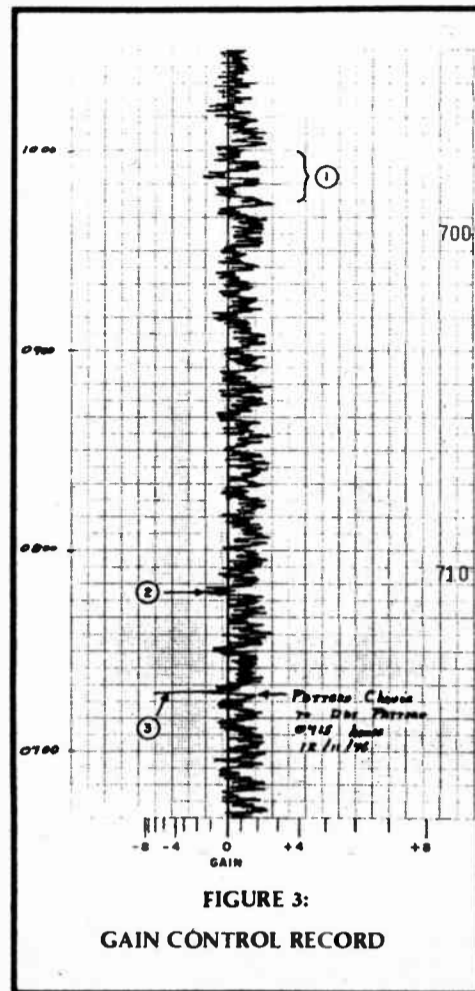


FIGURE 3: GAIN CONTROL RECORD

Several interesting features can be seen on this record. In the area of program source. That is, on a change of live to network, announcer to recorded music, etc. Occasionally the gain is reduced to below zero to prevent overmodulation. A typical example of this is shown in area (2). The large downward spike at (3) shows a malfunction of the equipment on pattern change. When the carrier momentarily went to zero, the logic system appeared to detect a very high modulation and drastically reduced the audio level. Subsequent to this experiment we installed a special circuit to idle the control logic when the carrier dropped below a predetermined level. This malfunction was not detected in further tests.

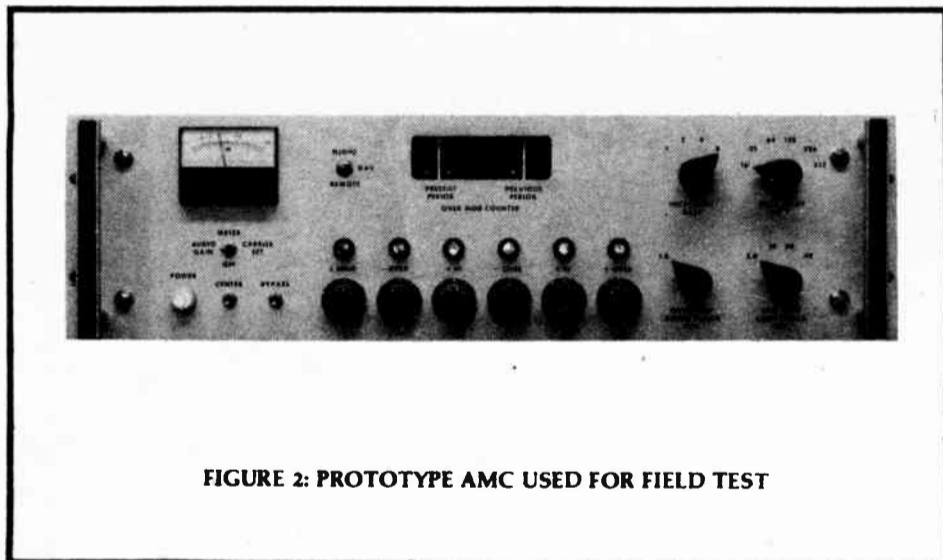


FIGURE 2: PROTOTYPE AMC USED FOR FIELD TEST

unnecessary detail, this device can be described as a linear attenuator, adjustable in approximately 0.1 dB steps by an eight bit word coming from the up-down counter. The total range of adjustment is plus or minus 8 dB. The adjustment steps are so small that gain changes are not discernible in the program material.

This then is a complete description of the operation of the Amplitude Modulation Controller although it is greatly simplified.

### Field Test

Figure 2 is a photograph of a prototype model of this device. As you can see from the numerous knobs and dials on the front panel, we have made all of the parameters, threshold levels, the increment and decrement clock rates, the low modulation period counter time and the display

the Amplitude Modulation Controller into the system and observed the adjustments that were made by the device. The operating gain is displayed on a front panel meter. This is accomplished by running a small fixed dc voltage into the multiplying D to A converter and measuring the voltage delivered at its output. Thus, as the circuit adjusted itself for different gains, the through gain of the audio circuit is displayed on the front panel meter. Figure 3 is a recording chart showing the voltage at the meter terminals over several hours of operating time. These records were made with the chart speed of 6 cm per hour and the real time is shown along the border of the chart. A scale calibrated in system gain is shown at the bottom of the chart. The particular record shown in Figure 3 was made at radio station WMAL here in Washington. The record shows that the Amplitude Modulation Con-

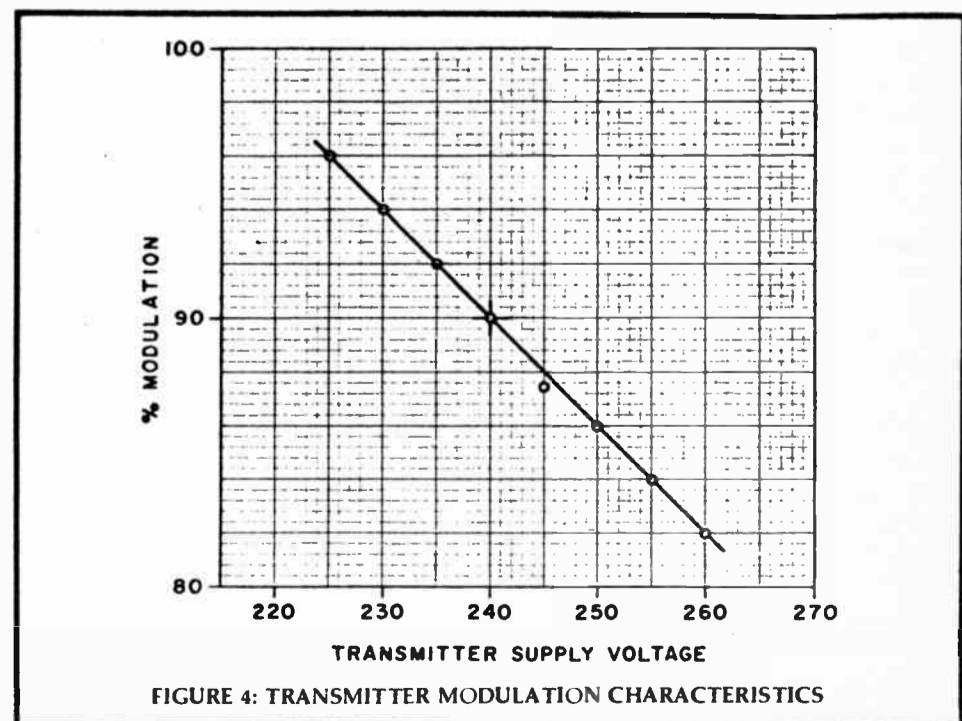


FIGURE 4: TRANSMITTER MODULATION CHARACTERISTICS

**TIN EAR**

continued from page 8

head resonance, and it's right in the middle of the "boom" range that muddies music and lowers speech intelligibility. You may want to operate with a permanent 2-4db dip at 100Hz. Here, your main gain will be better sounding spots...not a bad goal to aim for.

Again, this is a job for a perfectionist with the proper equipment. Better to leave it alone than entrust it to anyone whose ears are less than 24-karat.

Stereo balance: Fortunately this is an easily-measured ailment. Once set correctly, it tends to drift very little.

**What about mono**

Of equal importance is the gremlin caused when mono material is fed at full level in both channels, then mixed or heard as mono. The technical term is "center-channel buildup," and it causes announcers and mono spots to leap at you from your radio. Even in stereo, the centered source will bombard compared to stereo material.

So why do we persist in centering "mono" material? Tradition: maybe laziness. Try placing your deejays 5db to one side of center, your newsmen 5db to the other side. A stereo listener will detect a slight directionality, a mono listener will not miss the Bigmouth Syndrome.

Just make sure that when one channel peaks 0VU, the other is peaking -5VU. You'll be surprised how many stereo shops put you on display because of this natural use of the medium.

Separation: With records as source material, it's none too good to start with. Don't help it get worse. Check the crosstalk of your entire chain while activating all possible patching, switching and routing combinations that are used on the air or in the studio. Just one leak across the channels can destroy all that you have to make you sound spacious.

And keep the ganging cables between sections of your stereo processing equipment in place.

Stereo-mono compatibility: Most of the lack of it comes from carts, and there have been more solutions to this problem than there are people. Mounting the soap-box again, I must express the opinion that a lack of tools, rather than design deficiency or lack of knowledge, is responsible. The broadcast engineer has not had the means to prevent the problem.

In our next installment, we'll outline a simple set of test cartridges. One or two must be purchased; the rest may be made at any station that has an audio generator and a full track recorder.

Using them according to the instructions will result in the best darn cartridge audio you have ever heard. As a bonus, no cartridge will ever miss a cue tone—primary, secondary or tertiary. And you'll know precisely how much headroom

your cue tones have, for a bad cartridge will miscue on your production studio recorder before it will ever goof on the air. No more carts coasting through Paul Harvey.

Tape saturation: I would welcome ideas. Lowering the overall gain when carting is not really acceptable...most cart tape has enough hiss that you don't want to voluntarily increase it by the 3-5db necessary. I suppose an FM-type limiter that attacks highs separately could be the answer, if judiciously used. That the problem exists can be quickly seen if your cart recorder has a "peak record" position for the meter. Dub at normal levels with the meter in this position, and you will

see it the red much of the time.

Armed with the list of faults from your listening session, you may feel a sense of depression. Don't feel like the Lone Ranger. Start with the problems heard most often. A wow-ing before the hum on the phone line for the hog markets, used for three minutes twice daily.




I once ran a proof from a test record through the transmitter of a major-market AMer, and found that it could boast "flat" (plus or minus 3db) response from 100-4,000Hz, with nine per cent distortion and a signal-to-noise of 32db. In short, the sound was approximately equal to that from a tinfoil cylinder. The looks on the faces of staff members as they

arrived for work the next morning, having heard the new sound of music from their station, made the long night almost worth it.

So pick, pare, tweak and troubleshoot. Then, return to those thrilling days at the listening room. Bring your reel of samples from the previous session. Hopefully, you'll find your station blossoming before your very dial. You may also find a competitor slipping down the slimy slope...maybe they didn't read this piece. Keep working on your weak points, and make your own kind of music the best-sounding in your market. Like chicken soup, it can't hurt. At worst, you'll own a pair of gold-plated ears, and gold gets dearer every day.

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|---|--|---|--|----------|-----|-----|-----|--------|------|------|------|--------|------|------|------|---------|------|------|------|---------|------|------|------|---------|------|------|------|---------|------|------|------|---------|------|------|------|---------|------|------|------|----------|------|------|------|---|---|
| <p><b>Colorado Magnetics</b></p> <table border="1"> <thead> <tr> <th rowspan="2">Length</th> <th colspan="2">FIDELIPAC</th> <th>AUDIOPAK</th> </tr> <tr> <th>300</th> <th>380</th> <th>AA3</th> </tr> </thead> <tbody> <tr> <td>40 sec</td> <td>2.16</td> <td>2.21</td> <td>3.20</td> </tr> <tr> <td>70 sec</td> <td>2.19</td> <td>2.25</td> <td>3.27</td> </tr> <tr> <td>100 sec</td> <td>2.25</td> <td>2.32</td> <td>3.38</td> </tr> <tr> <td>2.5 min</td> <td>2.48</td> <td>2.56</td> <td>3.51</td> </tr> <tr> <td>3.5 min</td> <td>2.59</td> <td>2.67</td> <td>3.66</td> </tr> <tr> <td>4.5 min</td> <td>2.72</td> <td>2.75</td> <td>3.81</td> </tr> <tr> <td>5.5 min</td> <td>2.89</td> <td>2.96</td> <td>3.97</td> </tr> <tr> <td>7.5 min</td> <td>3.06</td> <td>3.14</td> <td>4.21</td> </tr> <tr> <td>10.5 min</td> <td>3.48</td> <td>3.56</td> <td>4.61</td> </tr> </tbody> </table> <p>Call or Write for our Competitive Rate Card (Prices based on 100 plus)</p> <p><b>Colorado Magnetics</b>, Box 713, Colorado Springs CO 303-596-0684 80901</p> <p>Circle 120</p> | Length   | FIDELIPAC   |  | AUDIOPAK | 300 | 380 | AA3 | 40 sec | 2.16 | 2.21 | 3.20 | 70 sec | 2.19 | 2.25 | 3.27 | 100 sec | 2.25 | 2.32 | 3.38 | 2.5 min | 2.48 | 2.56 | 3.51 | 3.5 min | 2.59 | 2.67 | 3.66 | 4.5 min | 2.72 | 2.75 | 3.81 | 5.5 min | 2.89 | 2.96 | 3.97 | 7.5 min | 3.06 | 3.14 | 4.21 | 10.5 min | 3.48 | 3.56 | 4.61 | <p><b>BROADCAST EQUIPMENT</b></p> <p>AUTOMATION SYSTEMS<br/>AM-FM TRANSMITTERS<br/>AUDIO EQUIPMENT<br/>ANTENNAS-TOWERS</p> <p> <b>Gene Bidun &amp; Associates</b><br/>10729 Midsummer Lane<br/>Columbia, Maryland 21044<br/>301-992-4444</p> <p>Circle 139</p> | <p><b>SURCOM ASSOCIATES</b></p> <ul style="list-style-type: none"> <li>• CORNELL-DUBILIER MICA CAPACITORS</li> <li>• ITT JENNINGS VACUUM CAPACITORS</li> <li>• AMPEREX VACUUM CAPACITORS</li> <li>• C.S.P. COILS &amp; ACCESSORIES</li> </ul> <p>- MANY VALUES IN STOCK -<br/>305 Wisconsin Ave.<br/>Oceanside, CA 92054<br/>714-722-6162</p> <p>Circle 144</p> |
| Length  |  | FIDELIPAC   |  | AUDIOPAK |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
|   | 300  | 380   | AA3  |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 40 sec  | 2.16   | 2.21  | 3.20   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 70 sec  | 2.19   | 2.25  | 3.27   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 100 sec   | 2.25   | 2.32  | 3.38   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 2.5 min   | 2.48   | 2.56  | 3.51   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 3.5 min   | 2.59   | 2.67  | 3.66   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 4.5 min   | 2.72   | 2.75  | 3.81   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 5.5 min   | 2.89   | 2.96  | 3.97   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 7.5 min   | 3.06   | 3.14  | 4.21   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |
| 10.5 min  | 3.48   | 3.56  | 4.61   |          |     |     |     |        |      |      |      |        |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |         |      |      |      |          |      |      |      |   |   |



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