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the technical journal of the broadcast-communications industry

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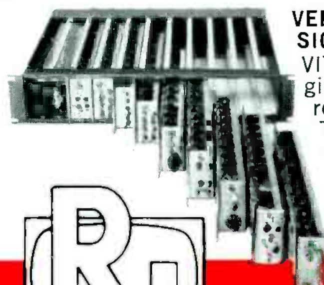

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Volume 7, No. 7 **July, 1965**

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Five of the six 235' towers in the complex array being readied for service at the new 50-kw facility of WIBC, Indianapolis, Indiana show in our cover photo. Additional information on the installation appears on page 52.

BROADCAST ENGINEERING is published monthly by Technical Publications, Inc., an affiliate of Howard W. Sams & Co., Inc. Editorial, Circulation, and Advertising headquarters: 4300 West 62nd Street, Indianapolis 6, Indiana. SUBSCRIPTION PRICES: U.S.A. $6.00, one year; $10.00, two years; $13.00, three years. Outside the U.S.A., add $1.00 per year for postage. Single copies are 75 cents, back issues are $1.00.

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LETTERS
to the editor

DEAR EDITOR:

In the "Letters" column of the May issue, Mr. William A. Kingman (CE, KOWL, Lake Tahoe) brought up a point concerning my article "Protective Maintenance at the Studio" which appeared in the November, 1965 issue. Mr. Kingman was concerned about modifying the frequency response of a microphone channel in a broadcast console in the light of whether the equipment would then pass the tests required by the FCC. In answer, the Rules state in Section 73.40(4):

> "The audio - frequency transmitting characteristics of the equipment from the microphone terminals (including microphone amplifier unless microphone frequency correction is included in which event proper allowance shall be made accordingly) to the antenna output does not depart more than 2 decibels from that at 1000 cps between 100 and 5000 cps."

The part overlooked by Mr. Kingman is the parenthesized phrase which allows frequency - response correction to be made in the microphone amplifier (preamplifier). The circuits are supposed to be flat sa far as is practical, but frequency-response correction may also be added. As described in my article, the circuits as modified will have the same response after proper allowance has been made for the effect of the lower-value coupling or cathode-bypass capacitors.

Using an external filter between the microphone output and the preamplifier, as Mr. Kingman suggests, would provide similar results, but you will need to be careful about hum pickup, particularly if the filter includes inductances.

I should reiterate that these circuits were modified, not to make the audio sound "tinny" nor to give the station an unusual sound, but to **improve** the quality of the audio by removing excessive bass response caused by improper use of the microphone.

A series of defeat switches in the modified circuits will allow use with or without altered response, if such versatility is required. Care should be taken to keep leads short and avoid the use of multiple grounding points.

LYNN R. WILLIAMS, CE
WBEJ, Elizabethton, Tennessee

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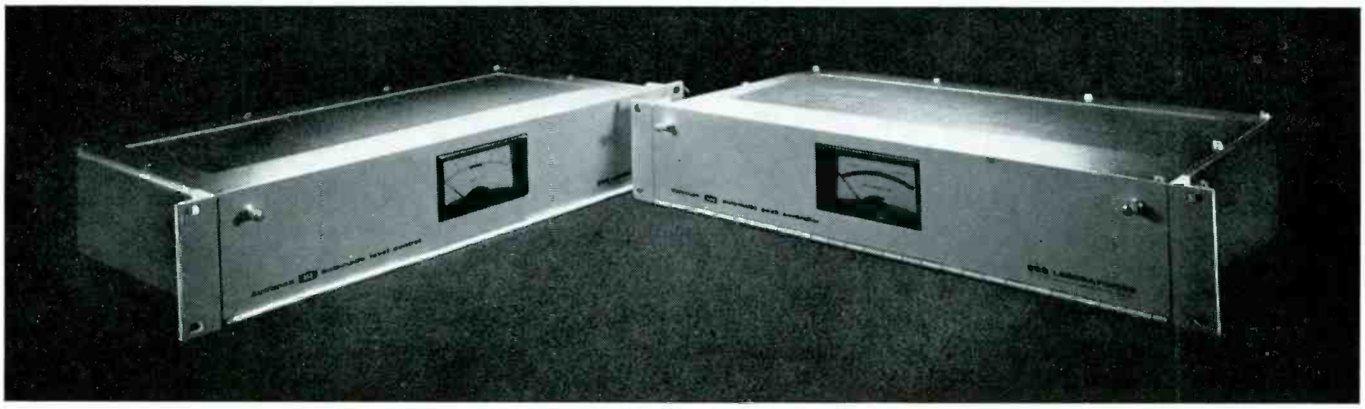

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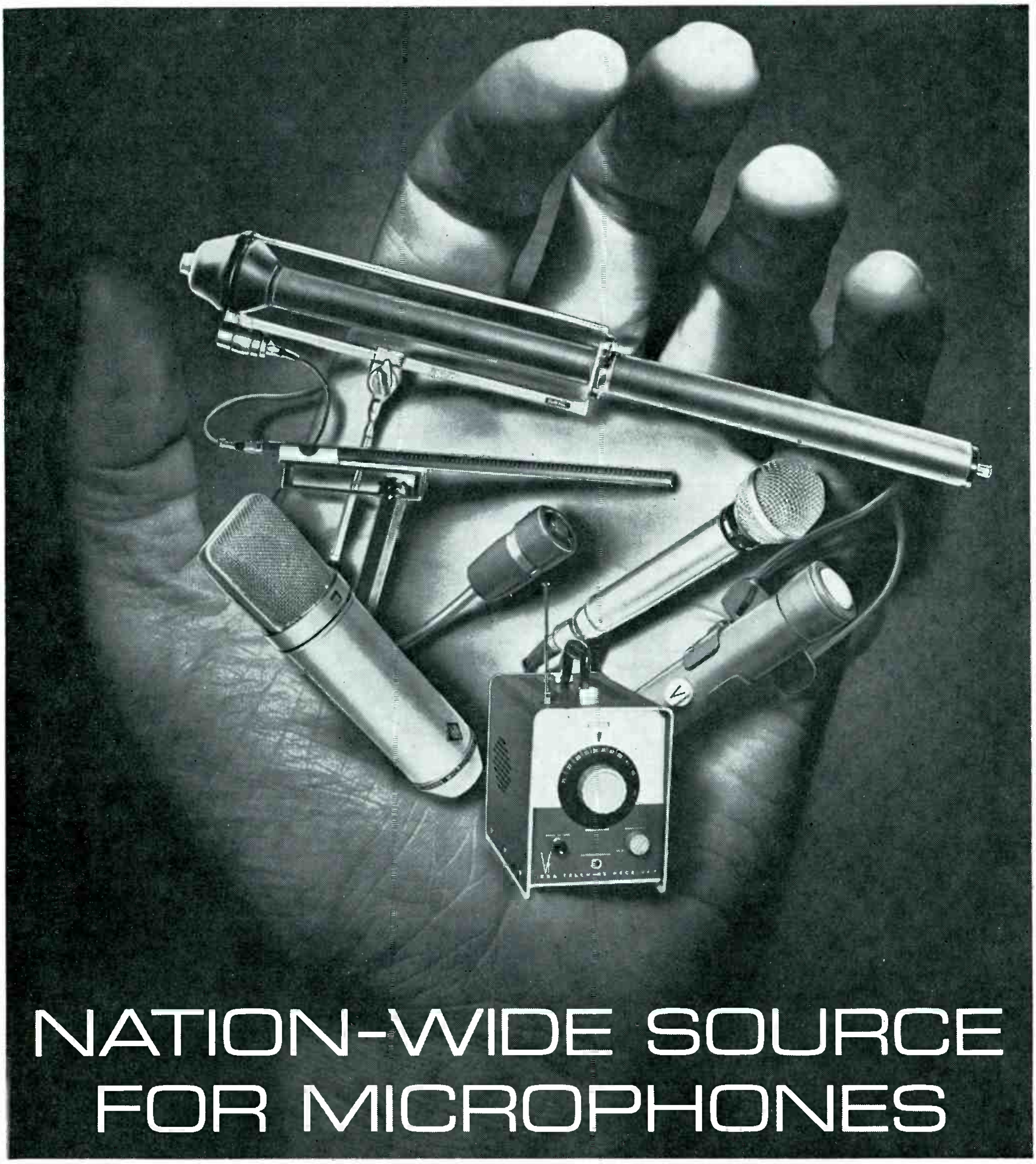

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INCREASING AM TRANSMITTER MODULATION POWER

by George M. Frese, Western Regional Editor and Consulting Engineer, East Wenatchee, Washington—A discussion of various factors which contribute to an improvement in radiated modulation power.

Most broadcasters believe they can improve their service, sound more powerful, and extend their coverage using advanced modulation techniques. What can really be done in this area? If a transmitter is modulated 100% and working properly, what else is there? The technical standards for all United States broadcast stations are given in detail in Part 73 of the FCC Rules and Regulations. The broadcast service area of a given radio station is fixed by the license conditions of the facility as set by frequency, power, antenna system, and local terrain. The .5 mv/m primary service contour cannot be exceeded for any given licensed facility. Rule 73.57 requires station power not to exceed the limits of 5% above or 10% below the licensed value. Rule 73.55 says modulation power is not to be less than 85% on peaks, nor more than 100% on negative peaks. Other audio characteristics are defined in Rule 73.40 as to frequency response, distortion, carrier shift, and noise. All characteristics are to be held within reasonably close tolerances, so it may seem there is very little a broadcaster can do to improve the efficiency of his radiated signal. The most reasonable way to proceed would be to increase modulation power, and even this seems to be pretty well fixed. The purpose of this article is to point out possible methods for increasing modulation power, consistent with improving demodulated audio levels in the receiver, while remaining within the framework of all FCC Rules and Regulations.

A Review of Modulation Basics

What then can be done to achieve increased modulation power on an AM transmitter, and how effective is each procedure? In the course of this discussion, we will cover eight different techniques, all of which are independent of each other and therefore additive. Before these procedures are attempted, the station equipment should be gone through carefully to bring it up to top performance. Electrical characteristics of concern are: frequency response, distortion, noise, carrier shift, and modulation capability. Frequency response should be ±2 db from 50 to 10,000 cycles, distortion as low as possible—preferably below 2%, noise below −50 db, carrier shift below 1%—preferably positive, modulation capability to 100% on negative peaks and over 120% on positive peaks. These are not always easy standards to meet, but basically good station performance is essential if we are to achieve better-than-normal performance.

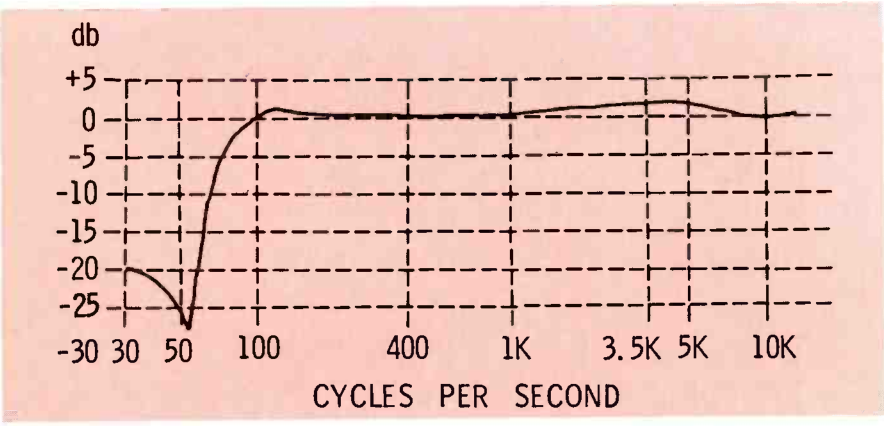

Fig. 1. Sharp-cutoff filter attenuates power-wasting frequencies below 100 cps.

Assuming now that the station equipment meets the standards set by the FCC, in what areas might technical improvement still be made?

1. A frequency response altered from flat might be advantageous.
2. Many limiters and compression devices leave room for improvement.
3. Transmitter carrier shift is almost invariably negative. This presents an area for improvement, as negative carrier shift reduces peak-modulation capability.
4. Control of audio-wave symmetry presents several avenues to further improvement.
5. Antenna-loading compensation can produce improved radiation of modulated sideband power.
6. Instantaneous peak clipping can be used to some advantage to bring up average modulation power.
7. Linearity correction of the audio signal fed to the transmitter sometimes can be used to improve the positive modulation capability of the transmitter and reduce distortion.
8. Reverberation and echo-chamber techniques have been used to give the aural impression of greater volume and "fill in" the lower-level periods.

Frequency Response

A frequency response flat from

30 cps to 15,000 cps is nice to attain, but it can waste valuable amplitude power space. For example, there are practically no radios built today that reproduce audio signals below 100 cps. Even a good hi-fi system suffers only a little when frequencies below 100 cps are removed. If we use amplitude power space to transmit the lower frequencies, we get very little from it, but we do subtract from the much needed midrange-frequency modulation capability. A sharp-cutoff filter which attenuates frequencies below 100 cps can allow for a slight increase in power for the midrange frequencies that better transmit intelligibility.

A slight increase in frequency response in the 3500-cps region will give a slight improvement in the "presence" of the audio—it will sound crisper and more alive. This occurs perhaps for two reasons: The response alteration is compatible to the ear's loudness-response curve, and IF response in selective receivers starts to roll off at about 3500 cps. Fig. 1 shows a response curve, within the limits of the FCC Rules and Regulations, that is tailored to accomplish the roll-off.

Automatic Level Control

Performance of automatic level-control devices varies considerably, and there is generally room for some improvement even in the best of them. The following topics indicate some of the performance errors which reduce their effectiveness: (1) first pulse of audio passes through at too high a level (see Fig. 2), (2) control pulse not balanced out of the audio, (3) attack control function is too violent, which overcompensates the audio level following a sharp rise (see Fig. 3), (4) noise and hum are "pumped up" during quiet periods, (5) gain reduction is triggered by signal elements other than the peak of the audio waveform, (6) full amplitude of the audio used for control, (7) control range too limited, (8) harmonic distortion increases excessively with increased input level, (9) control system is frequency selective, (10) recovery-time rate improper for the nature of the program material, (11) output level rises with increased input level. These characteristics all can be measured or observed and corrected by adjustment or minor circuit changes. For example, apply a sinusoidal tone of any frequency into your limiter and set the negative peak to an exact line on an oscilloscope (connected to the limiter output). Now feed your program material into the limiter. How closely is the negative audio peak held to the line? Not very closely as a rule, but proper adjustment will usually bring it into line.

An ideal automatic level-control system for AM broadcasting should have the following characteristics: (1) the first burst of audio must be controlled quickly to preset value, (2) audio-output signal should be completely free from control-rate voltage, (3) gain changes should be deactivated during quiet periods, (4) output level should be clamped to the peak level of the negative excursion, (5) harmonic distortion must be held to a low value at all levels, (6) the control system should be insensitive to frequency, (7) pulses and "shots" should be controlled by differential circuits so as to give nearly instantaneous control and recovery, (8) average-level changes should be controlled by peak-integrating circuits, (9) output peaks should be kept absolutely constant over the full input range.

Carrier Shift

During the modulation process, the carrier - frequency amplitude should remain constant. In most broadcast transmitters, however, it drops from 1% to 5% under full modulation. This means that the transmitter attains rated carrier power without modulation, but when the carrier is called upon to deliver maximum intelligence, its power has been reduced proportionately to the square of the carrier shift. Negative carrier shift is caused by two factors, the first of which is poor power-supply regulation in high-level-modulated transmitters. Most transmitters use a common power supply for the class-C RF stage and the class-B modulator. During maximum modulation, the class - C B+ voltage falls causing the reduction in carrier power precisely at the time it is most needed. The second cause is a non-linear response of the class-C PA during the modulation process. With new tubes and a properly

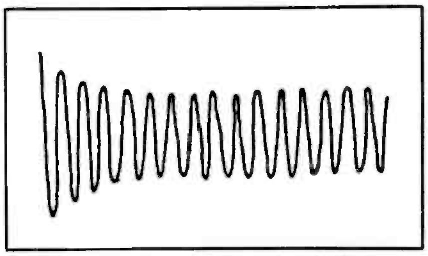

Fig. 2. Faulty limiter action allows first pulse to pass without limiting.

tuned transmitter, this nonlinearity has a positive characteristic, due to the operating conditions of the tubes, which nearly compensates for the negative shift due to poor power-supply regulation. As the PA tubes age, however, they no longer exhibit the positive linearity characteristic because their effective bias angle changes, and a higher value of negative carrier shift sets in for an appreciable part of the usable life of the tube due to a decreased modulation capability.

There are several solutions. The first would be to use two separate power supplies for the two functions. With most existing transmitters, this amounts to major rebuilding and is not too practical. A second solution would be to provide an external system of compensation modulation capable of modulation down to DC. This could be achieved by using a series-cathode modulation system as shown in Fig. 4. The cathode modulator should be capable of supplying around 10% the level of the high-level modulator. The control voltage should be of a DC nature to overcome inadequate power-supply regulation and of a nonlinear positive-pulse nature to correct for the nonlinear response of the PA under modulation. Using this system, carrier shift can be kept in the plus region for a longer period of tube life, so that expensive tubes can be used longer due to increased modulation capability.

Audio-Wave Symmetry

A pure sine wave and a fundamental wave containing only odd harmonics will produce a symmetri-

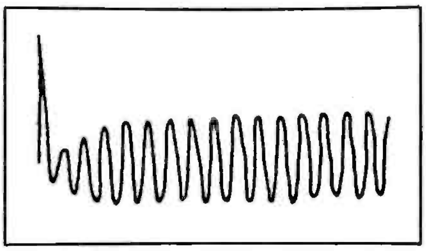

Fig. 3. Excessive attack action creates "holes" in keyed tone fed to limiter.

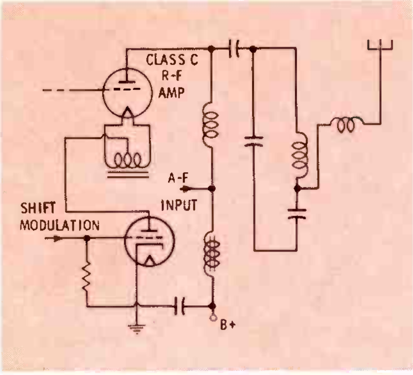

Fig. 4. Series - cathode modulation can be used to compensate for carrier shift.

cal waveform. Any even-harmonic component will introduce an asymmetrical component, therefore almost all broadcast material is asymmetric. Such an imbalance results in heavier limiter action and a reduced modulation capability.

One approach taken to correct this situation is to add a passive device in the system which has an increasing phase-delay characteristic with increasing frequency. In this system, the phase relationship between the even harmonics and the fundamental is appreciably altered. This reduces high-level peaks in the audio waveform because the harmonics do not reinforce one another to produce a transient additive peak as often as in the unaltered material. Passing through phase-delay systems the wave still remains asymmetrical, however, and certain even-harmonic components that originally did not cause excessive peaking may be shifted to do so. If a phase-delay system is used, it should be placed ahead of the limiter.

The second solution to the problem is to keep all transducer leads properly polarized to fit the system. At first this may not seem practical because audio changes its polarity from moment to moment and program to program depending upon its point of origin. (If a transducer consistently produces asymmetry on a wide variety of material, it is probably defective and should be replaced.) An automatic polarity switcher (asymmetrical wave switcher) provides an excellent solution to the problem. This device samples the input polarity and switches the output polarity so that the highest peaks are positive. To achieve maximum performance, this switched audio is fed into a very stiff negative-peak-controlled audio-level device, the output of which is the very maximum that can be used to modulate an AM transmitter. Any other overall control system will always produce something less than this optimum level, or will produce overmodulation on negative peaks. For this system to be effective, the transmitter should be capable of low-distortion modulation up to 100% on negative peaks and as high as possible on positive peaks, as modulation percentage will always be over 100% on positive peaks for any program material transmitted. For a quick and simple explanation of the above practice observe Figs. 5A through 5D.

Antenna-Load Compensation

In order to obtain the maximum possible efficiency from the modulation process, all RF sideband frequencies must be radiated in proper amplitude and phase relative to the carrier. With the modern vertical broadcast towers, these electrical characteristics are usually something less than optimum. A transmitter best delivers its modulated load into a pure resistance. This pure resistance seldom occurs unless special correction circuits are put into the tuning network. Even this is not the whole answer. For example, assume you measure the tower impedance at the carrier frequency and at the two maximum sideband frequencies, then design, build, and insert a network which will make the input to the antenna system look like a pure resistance to the transmitter. Chances are you still may not achieve the results you are expecting. The reason for this situation is that the problem involves two factors, not just one. Assuming sideband radiation resistance is correct and sideband power has a proper amplitude relationship to the carrier, the phase relationship may be altered from optimum by the corrrection network! Therefore, the design of the antenna correction network must consider not only amplitude correction, but also phase correction, so that the radiated sidebands are correct in phase and amplitude.

In the case of a directional antenna system, the corrective networks must be placed at the base of each tower, not at the common-input point. Directional antenna systems with deep nulls often produce excessive null distortion which is caused by a difference in phase between the sidebands and the carrier. This results because the radiation pattern and field vectors are considerably different for the sideband frequencies. It is doubtful that even with perfect network correction this condition could be eliminated, because the directional antenna itself introduces some uncontrollable factors. In some cases, an improvement may be noted since the radiated system and pattern will have less variations with frequency than before.

Instantaneous Peak Clipping

Most engineers usually shudder when peak clipping is mentioned for broadcast use, because it usually results in harmonic and intermodulation distortion. Properly executed, however, noticeable improvement can be had. Using power-bias clipping, if the audio level rises 1 db, distortion will become excessive. Therefore, effective use of clipping dictates that the clip level must be held within close tolerances at all times. If this is done, float clipping, which is more effective and does not get out of adjustment with slight changes of level, can be used. Exact adjustment of the clipping level becomes rather involved. The use of a scope and distortion meter as a starter and finishing up with a subjective response from several

• Please turn to page 29

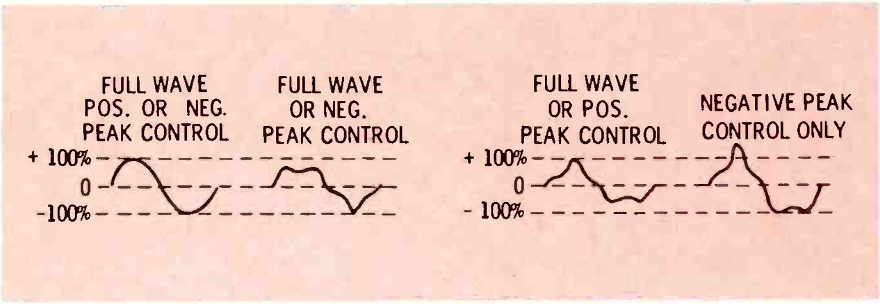

Fig. 5. Waveform symmetry affects limiting action and resultant controlled levels.

CONSIDERATIONS FOR THE MAINTENANCE LOG

by Thomas R. Haskett, Central Regional Editor, Cincinnati, Ohio—
Important requirements dictated by FCC Rules are examined carefully and suggestions made to ensure compliance. Be sure your log contains all necessary entries.

A couple of years ago, the FCC instituted a rule which requires that each AM, FM, and TV broadcast station must keep a maintenance log in addition to the regular program and operating (transmitter) logs. The Commission made no attempt to specify the exact form the maintenance log should take, although they did specify its content. Because several sections of the Rules govern this log, there has been rather general misunderstanding of what should be contained in it; therefore, we have collected sample logs from a number of stations in order to analyze them and determine what an ideal maintenance log should contain.

In some radio services, a maintenance log has been required for many years. The licensee of a shipboard radar or taxicab radio station, for example, must keep a log in which are noted all repairs and service adjustments performed on all equipment covered by the license. When most broadcast stations employed several First-Class transmitter men, there was little need for a maintenance log, except as a convenience for the station staff. But with the expanding use of remote-control devices, and with many stations employing only a single First-Class operator or a "contract chief" (part-time First-Class licensee), it was quite natural for the Commission to require that certain inspections be made at specified intervals, and that notations be made concerning these inspections and the maintenance performed as a result of them.

General FCC Logging Rules

There are certain general requirements that apply to the maintenance log (as well as to the operating and program logs). These rules are found in Sections 73.111 (AM), 73.281 (commercial FM), 73.581 (noncommercial FM), and 73.669 (TV). All versions are substantially identical and, briefly, here is what is required: Each station must keep program, operating, and maintenance logs. Each log shall be kept by the person who has actual knowledge of required facts, and this person shall sign the log when starting his shift and when he goes off duty. Each log shall be kept in an orderly and legible manner, so that all data are readily comprehensible. Key letters or abbreviations may be used if proper meaning or explanation is shown on the log. Each sheet must be numbered and dated. Time entries shall be either in local standard or daylight-saving time and times must be so indicated. No portion of a log may be erased, obliterated, or willfully destroyed, and all logs must be retained for at least two years (longer if specifically requested by the Commission). Any necessary correction may be made only by the person originating the entry, who shall strike out the erroneous portion, initial the correction made, and indicate the date of correction. You can keep a rough log and later transcribe it into a more formal appearance, but you must keep the original memoranda as part of the complete log.

The above provides us with a starting point for our ideal maintenance log. Certain items are obvious:

Title—Maintenance Log.

Station call and city of license.

Date—This should include both the day of the week and the day of the month, as "Monday, May 10, 1965." If the maintenance log is intended to cover an entire week, this should be stated with beginning and ending dates given. Individual entries must then also be dated.

Page number—Blank log forms should contain no numbers; these should be added as logs are filled out and filed. Some stations bind logs in a ledger or loose-leaf book for retention, and they often place dates and page numbers at the bottom of the page for ease in referring back to a particular log.

Time zone—To prevent confusion, it's a good idea for the log to contain a printed statement of the time reference, for example: "All times entered herein are EST."

Operator on/off signature—A basic requirement of all logs, this provision is expanded below and may contain additional items.

Abbreviation code—You may use any code you wish to save space, but you must explain it. Examples: ANT—antenna; BUF—buffer; DRI—driver; Ep—plate voltage; Ip—plate current; K—1000. Note that you aren't required to use abbreviations; some stations don't use any and spell out every word.

Specific Maintenance-Log Rules

The exact language prescribing the maintenance log is contained in the following Sections: 73.114 (AM), 73.284 (commercial FM), 73.584 (noncommercial FM), and 73.672 (TV). In most respects, these requirements are similar. We shall note the differences below:

Tower base - current ammeters(s) (AM only)—a weekly reading and entry must be made.

Remote antenna ammeter(s) (AM only)—A weekly reading and entry must be made of each meter, **before** it is recalibrated against the actual base ammeter.

Remote antenna ammeter(s) (AM only)—A weekly reading and entry must be made of the same meter(s), **after** each has been recalibrated against the actual base ammeter.

Auxiliary transmitter (AM, FM, and TV)—Sections 73.63, 73.255, 73.555, and 73.638 require that an auxiliary transmitter be tested at least once a week (unless it has been used upon failure of the main transmitter). The maintenance log must contain a weekly entry of the time and the result of this test—

STANDARD AM/FM MAINTENANCE LOG

DAILY EQUIPMENT INSPECTION

Date	Time On	Time Off	Maintenance accomplished: note repairs pending, if any.	Signature

EQUIPMENT STATUS

Defective Equipment	Removed from Service		Restored to Service		Signature
	Date	Time	Date	Time	
Frequency Monitor					
Modulation Monitor					
Final-Plate Ammeter					
Final-Plate Voltmeter					
Base-Current Ammeter					
Common-Point Ammeter					

WEEKLY CALIBRATION ADJUSTMENTS

OPERATOR:	LICENSE NUMBER:

Date	Time	Meter Funct.	Main Mtr. Before Cal.	Rem. Mtr. Before Cal.	Main Mtr. After Cal.	Rem. Mtr. After Cal.
		Ip-Pa				
		Ep-Pa				
		% Mod.				
		Freq.				
		Tower 1				
		Tower 2				

MONTHLY FREQUENCY MEASUREMENT AND MONITOR CALIBRATION

	Independent Measurement Result	Frequency Monitor Reading
AM		
FM		

EXPERIMENTAL OPERATION & AUXILIARY TRANSMITTER TESTS

TIME	Description and Results	
		Signature:

TOWER LIGHTS

Inspection of tower lights made in accordance with Section 3.65 17.37 & 17.38 of FCC Rules.	
Any adjustments, replacements or repairs made to insure compliance are noted here:	
	Signature: Date:

Week of ____________ to ____________, 19__.

whether or not the transmitter operates properly. Note that an AM transmitter must be tested only between midnight and 9 AM local time, and a commercial FM transmitter must be tested only between midnight and 6 AM local time. No time period is specified for testing noncommercial FM or any television transmitter.

Frequency measurement (AM, FM, and TV)—Time interval is not specified for this entry, and will depend on your station's practice or license requirements. This entry must show frequency measurement by means other than the frequency monitor. It's a good idea to give the name of the company making the check. Measured deviation must be shown, the time of the measurement, a reading of the station monitor at that time, and a note indicating what adjustments (if any) were made to make the monitor agree with the independently measured frequency.

Calibration of automatic logging equipment (AM, FM, and TV)—Sections 73.113, 73.283, 73.583, and 73.671 permit all stations to use automatic devices to record entries in the operating log. These same rules require that such automatic devices be calibrated once each week and a notation to this effect made in the maintenance log.

Instrument failure—Whenever any of the following instruments become defective and are removed from service, an entry must be made; when repaired and returned to service, another entry must be made. Some stations also provide an entry showing date of occurrence and the location of the FCC district office to which failure notification was sent as required by the rules. Instruments covered and class of station involved are as follows:

- Modulation monitor (AM, FM, TV)
- Frequency monitor (AM, FM, TV)
- Final-stage plate voltmeter (AM, FM, TV)
- Final-stage plate ammeter (AM, FM, TV)
- Base-current ammeter(s) (AM only)
- Common-point ammeter (AM only)
- Transmission-line RF voltage, current, or power meter (FM and TV only)

(Note: For TV stations, each item above applies to both the visual and the aural transmitter.)

Tower lighting inspection and failure (AM, FM, and TV)—Tower light inspections must be logged as required by FCC rules or by the station's current instrument of authorization. Section 17.38 states that you must make a daily check for proper operation of the tower lights. Entries referring to these daily checks are made in the operating log by some stations and in the maintenance log by others; Section 17.38 doesn't specify which is preferred.

Section 17.38 also states that once every three months a complete inspection shall be made of all tower lights and associated tower lighting control devices, indicators, and alarm systems. An entry must then be made—although not specified, it's probably best to include it in the maintenance log—which must give the date of the inspection and the condition of the equipment. Details must be noted of any adjustments, replacements, or repairs made to insure compliance with the lighting requirements, and the date such adjustments, replacements, or repairs were made.

Section 17.38 also covers tower light failure. Entries must be made showing the nature of such failure, the date and time the failure was observed or noted, the date, time, and nature of the adjustments, repairs, or replacements made. You must also give the location of the Flight Service Station of the Federal Aviation Agency which you notified of the lighting failure, and the date and time of such notification. When the light is replaced and normal operation is resumed, you must notify the FAA again and make a further entry of this, together with date and time. It's a good idea also to record the name of the operator on duty at the FAA center to whom the report was given.

Experimental operation (AM, FM, and TV)—Complete details (date, time, purpose, result, whether carrier was modulated or not), time(s) of station identification, power, mode of operation) must be given for all operation during the experimental period, **unless** such operation consists of regular programming as for stations licensed for unlimited operation.

Daily inspection (AM and FM only)—Sections 73.93, 73.265, and 73.565 require that a complete inspection of all transmitting equipment in use shall be made by an operator holding a valid Radiotelephone First-Class operator license at least once each day, five days each week, with an interval of no less than 12 hours between successive inspections. The operator must sign a statement that this inspection has been made, noting in detail the tests, adjustments, and repairs which were accomplished in order to insure operation in accordance with FCC rules and the station's current instrument of authorization. The statement shall also specify the amount of time, exclusive of travel time to and from the transmitter, which was devoted to such inspection duties. If complete repair could not be effected, the statement shall set forth in detail the items of equipment concerned, the manner and degree in which they are defective, and the reasons for failure to make satisfactory repairs. Some stations list the items to be inspected (tower, transmitter, console, limiter, patch board, frequency monitor, etc.) so that the condition of each may be noted individually. It's obvious that the maintenance log must be kept only by a First-Class operator. Some stations provide a space for the operator's signature which is preceded by a statement like: "I certify that I hold a currently-valid Radiotelephone First-Class license and that I have this date made the above required inspection." Some stations also provide a space for the operator to list his license number.

Other entries (AM, FM, and TV)—The rule says you must include any other entries required either by FCC Rules or by the station's current instrument of authorization.

Nonrequired Entries

In addition to the above items, which are required by FCC Rules, we found that many stations voluntarily include entries in the maintenance log that aren't required, but which may be helpful. A note of the instrument of authorization

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A NEW LOOK AT NEGATIVE RESISTANCE

by C. G. Cunningham, Professional Engineer, Taos, New Mexico—Part 1: A report on one family of semiconductors and the electrical phenomenon which makes them useful in myriad applications.

Negative resistance has been around, as a plague and a blessing, from almost the beginning of electronics. For most electronics people, negative resistance was a plague: it interfered with the operation of high frequency amplifiers; it couldn't be seen or touched since it appeared only in mathematical formulas and in the errant operation of circuits; and, it was ignored since it usually could be analyzed as feedback. As a result, the idea of negative resistance has been surrounded by confusion.

Most of the alibis for not accepting the idea of negative resistance are no longer true. Modern electronics has produced devices that can be analyzed no other way. Negative resistance exists across the terminals of devices, independent of external circuitry, as an observable and measurable characteristic. Because it sounds impossible it may give one a sinking feeling in the pit of the stomach, but it's time to see just what negative resistance really is.

It is natural for people working with electronic devices, to think in terms of the object that exhibits certain electronic properties. So, when one thinks of resistance he thinks of a resistor; when he thinks of inductance, coils come to mind. Usually, people think of objects with weight and shape; this has increased confusion about negative resistance. People keep wanting to think of a "negative resistor."

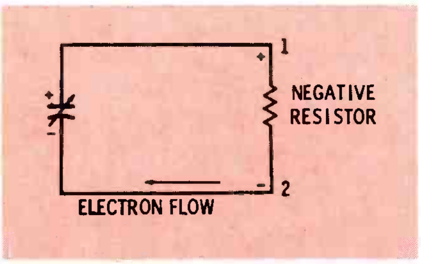

Fig. 1. Voltage-stable negative resistor.

If there were a "negative resistor" how would it behave? The answer to that question is quite surprising; it depends on what kind of "negative resistor" is used—a current type or a voltage type. Negative resistance occurs when either the current or the voltage in the familiar Ohm's law behaves directly opposite to the usual case:

$$\text{Negative R} = \frac{E}{-I}$$

$$\text{Negative R} = \frac{-E}{I}$$

The first equation describes the "negative resistor" in Fig. 1. As battery voltage is increased electrons start to flow from the negative resistor to the negative terminal of the battery. Furthermore, as the voltage increases, this backward current increases. This is known as a voltage-stable negative resistance; since it is against the laws of nature, such a device has never existed.

The second equation describes the "negative resistor" in Fig. 2. In this circuit, the variable resistor is large enough to control the current in the circuit regardless of what the negative resistance does. This is what happens: As the switch is closed, electrons start to flow from the negative terminal of the battery; but, voltage at terminal 2 of the "negative resistor" becomes more positive than terminal 1. As the current is increased, this voltage difference increases. This is the behavior of a current-stable negative resistance. Once again, however, there is no such device.

Since there is no such thing as a "negative resistor," what causes the excitement? Today, there are devices and circuits that display negative resistance over certain regions of conduction or under certain conditions. Since there is no other word, we must call it just that—negative resistance; it is a characteristic, not an object. In order to make this clear, some people use the term "negative-resistance region" or "dynamic negative resistance" to indicate that special conditions are necessary to obtain negative resistance.

Now let's look at negative resistance as it really is, a negative-resistance region in the volt-ampere curve of some device. In Fig. 1, assume this new device instead of the "negative resistor" is connected between terminals 1 and 2. Also assume that there is a means of controlling precisely the voltage across those terminals. As the voltage increases, current starts to flow as in any ordinary resistor. As Fig. 3 shows, as the voltage increases, the current increases until we reach 10 volts with a 100-ma current flow; this is point 1 in Fig. 3. The ratio of voltage to current shows that, so far, this is a 100-ohm resistance. As the voltage increases past point 1, we observe that the current *decreases* until at 20 volts, point 2, a current of only 50 ma is flowing. From point 1 to point 2, there was a 10-volt change with a 50-ma decrease in current, or an apparent negative resistance of 200 ohms.

In this circuit there is apparently a 100-ohm resistor in series with a 200-ohm negative resistance. This is not a short circuit, however; the total resistance has actually *in-*

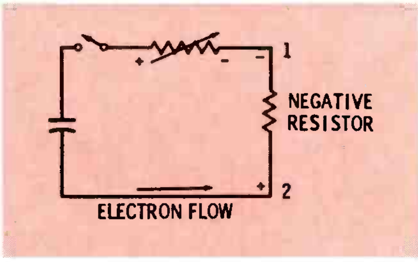

Fig. 2. Current-stable negative resistor.

creased! There is now a difference of 20 volts at 50 ma for a total resistance of 400 ohms across the terminals. This is the voltage-stable negative resistance that was described in Fig. 1. One way of looking at it is to assume that after point 1, current from the negative resistance started to buck the current that was flowing in the circuit. If nothing else changed in the circuit and the voltage was increased to 30 volts, there would be zero current flowing—an apparent open circuit. Of course no practical device works this way; at some point the slope changes again, and the current increases with increasing voltage. This is shown in Fig. 3 by the dashed line from point 3 to point 4.

If we replace the current-stable "negative resistor" of Fig. 2 with a practical device having a current-stable negative-resistance region, we get the results shown in Fig. 4. In this case, the current must be controlled to examine the characteristics. As the current through the unit rises to 100 ma, as shown by point 1 in Fig. 4, the voltage rises to 10 volts. Again, so far, the unit looks like an ordinary 100-ohm resistor. As the current is increased to 125 ma, as shown by point 5, the voltage *drops* to 5 volts. This is a 5-volt decrease with a 25-ma increase, an apparent negative resistance of 200 ohms.

Once again, there is a resistance of 100 ohms in series with a negative 200 ohms. In this case it appears to be more awesome, since the current increases as the voltage drops. This time, the net resistance decreases as we move further into the negative-resistance region. If nothing changed, the voltage would be zero when a current of 150 ma was flowing. Of course a short circuit with no voltage across it is not alarming; but this is a short circuit only when a 150-ma current flows. Furthermore, if the current decreases, the voltage increases; this is another fundamental characteristic of negative-resistance devices. The slope of an actual device would change at some point and the voltage would start to increase as shown by the dashed line from point 6 to point 7.

The relative magnitudes of the negative and positive resistances in these devices cannot be taken at face value. The negative-going elements are always dependent upon the real voltage and current. Devices having negative-resistance regions, as shown in the simple circuits of Figs. 1 and 2, always have a net positive resistance. They also continue to draw real current, show real voltage across their terminals, and dissipate real power.

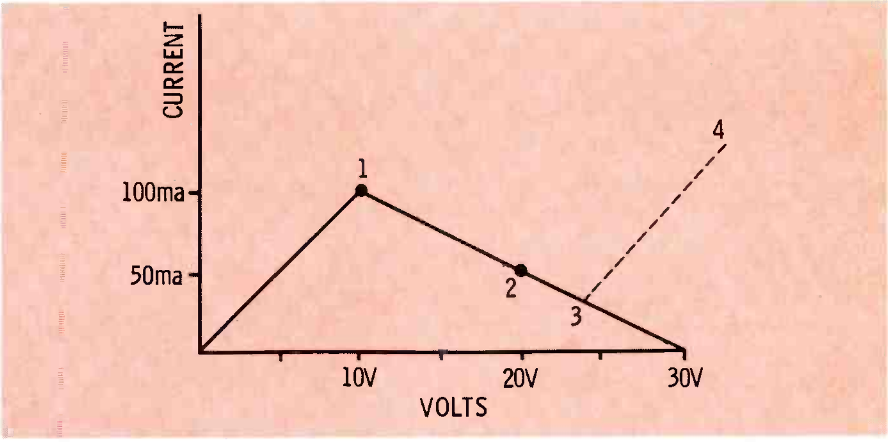

Fig. 3. Practical voltage-stable curve showing negative-resistance character.

In an ordinary resistor, the current is proportional to the voltage; for the negative-resistance regions, however, the proportion is opposite to that in the positive-resistance regions. This phenomenon is used in negative-resistance devices that are biased in or near this negative-resistance region with DC current or voltage. Signals are then AC-coupled to operate the circuit in the negative-resistance region. Under these conditions, the device can be used as an oscillator, amplifier, switch, or multivibrator. The useful energy delivered by such circuits comes, of course, from the bias source indirectly through energy stored in capacitors or inductors.

Before the advent of semiconductors, negative resistance in electronic circuits appeared primarily as a nuisance. High-gain amplifiers with stray feedback appeared to have a negative input resistance at certain frequencies and would oscillate unless care was taken to prevent it. However, early manifestations of negative resistance were not all liabilities; the dynatron oscillator utilized the negative-resistance characteristics of the tetrode. Some types of multivibrators and flip-flops using vacuum tubes were considered negative-resistance devices. Relaxation oscillators using gas-discharge tubes and neon bulbs are current-stable negative-resistance devices similar to Fig. 4 except that their negative-resistance region is much sharper.

Most vacuum-tube circuits which were operated as negative resistance devices depended on feedback to achieve the desired characteristics. It was not an intrinsic property of the components used. More recent developments included were video amplifiers, active filtering elements, and operational amplifiers for analog computers. These circuits could be arranged to present a pair of terminals that exhibited a negative-resistance characteristic. This region of negative resistance, though, was usually limited as to range of volt-

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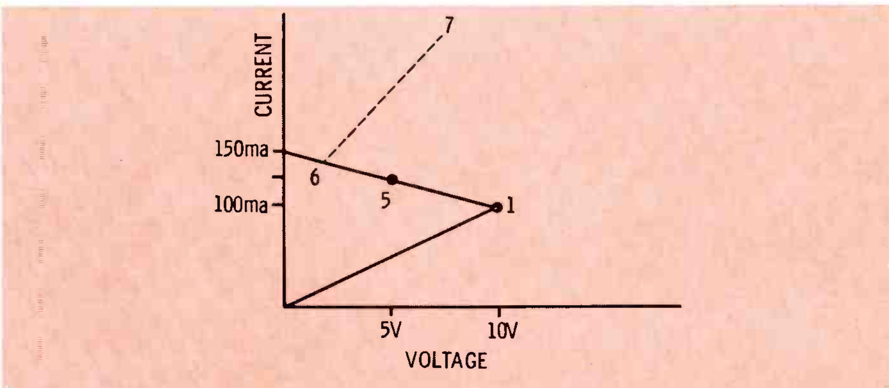

Fig. 4. Practical current-stable curve showing negative-resistance character.

CHOOSING CABLE FOR CATV

by Lon Cantor, Philadelphia, Pa.—The highly critical component in a CATV system comes under closer scrutiny.

Continuous expansion of multichannel CATV service requires low-loss cables to allow operation at the high-channel frequencies and to minimize losses in systems covering large geographical areas. Since all cables cause signal losses that increase as the frequency of the signals fed through the cable increases, these losses determine trunkline-amplifier spacing. Because signal attenuation also varies with temperature, AGC units and thermal equalizers are required to maintain constant signal levels. In choosing cable for a CATV system, there are three basic factors to consider: attenuation; return loss; and moisture resistance. Of these, signal attenuation is the most significant parameter.

Automation Factors

Table 1 shows the loss characteristics of several commonly used CATV cables. Cable loss is primarily a function of the resistance of the center conductor. The larger the center conductor, the lower the attenuation figure. Increasing the size of the center conductor, however, necessitates an increase in the outside diameter of the cable. This is true because all CATV cables have an impedance of 75 ohms, a characteristic determined by three factors: the size of the conductors, the spacing between the conductors, and the dielectric used. Thus, when the diameter of the center conductor is increased, the spacing between conductors must also be increased to maintain the 75-ohm impedance (unless a different dielectric is used). Naturally, larger cables are harder to handle and more expensive. In spite of these factors, however, more complex systems require cables that exhibit lower losses, so most CATV engineers lean to the physically larger and more rigid cables.

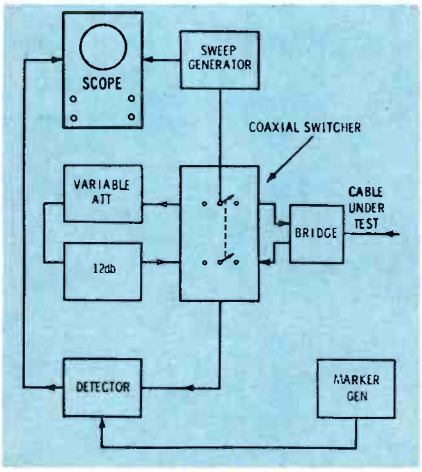

Fig. 1. Test setup for return-loss measurement provides evaluation of CATV cable.

Notice that the attenuation figures shown in the table increase with frequency. Attenuation at channel 13 is almost double that at channel 6. For this reason, cable limitations restricted early CATV systems to the low band where the maximum number of channels is five. Many modern CATV systems, however, provide as many as 12 channels, using the entire VHF spectrum. This increased service has become possible through development of cables exhibiting extremely low losses.

Another cable attenuation factor is the increased loss as the ambient temperature rises. The loss figures shown in Table 1 were determined at 70°F. Each 1° ambient temperature rise causes an increase of .1% in attenuation.

Return-Loss Characteristic

Perhaps the best overall indicator of cable quality is its return-loss characteristic. Until a few years ago, coaxial cable simply was "swept" to determine its uniformity, or lack of it. The output of a sweep generator covering the required band of frequencies was sent through the cable, and the output level at each frequency was measured. Any significant notches, or "suck-outs," indicated impedance variations at some frequencies. A marker generator and a calibrated attenuator could then be used to measure the amplitude of the notch and, using a nomograph such as that shown in Table 2, it was possible to determine the voltage standing wave ratio (VSWR) at any specific frequency.

The sweep-frequency evaluation method is not too accurate, however. Since attenuation readings more accurate than ±.2 db are seldom obtainable, the best possible VSWR measurement attainable was about 1.5 to 1. While this VSWR is sufficient for many applications, it is not good enough to evaluate a high-quality CATV system. Thus, a more accurate measurement is required.

Fig. 1 shows the type of test setup currently used by many CATV operators to measure cable quality. What actually is measured is "return loss"—the difference (in decibels) between a signal applied to a cable and the signal that is reflected back out of the same end of the cable. As shown in the illustration, one end of the cable is properly terminated, and the other end is connected to a sensitive impedance bridge. The cable is swept from 50 to 220 mc. A switcher provides simultaneous comparison of the signal fed into the cable and the signal reflected back. A bridge such as that shown can measure VSWR values as low as 1.01 using this technique. The marker generator enables you to determine the frequency of any notches which are observed. Return-loss figures are closely related to picture quality; the higher the return-loss figure in db, the fewer will be the reflected signals generated within the cable—and reflections cause ghosts.

It is difficult to determine just how much reflected signal is tolerable within a CATV cable. For one thing, reflections may be caused by system components other than the cable. Every connector, for example, introduces a discontinuity that may cause reflections. Also, the location of the "lump" (impedance change) is important. A reflected signal that travels only a short distance will create a ghost which is very close to the picture formed by the direct signal. Many of these reflection images are so close to the primary image that they appear as smears rather than distinct double images. Finally, a viewer's tolerance to ghosts is a subjective thing. What one viewer finds very annoying, another hardly notices.

In spite of these difficulties, equipment manufacturers have established workable standards. Careful experimentation has shown that cable with a return loss of 26 db at 54 to 60 mc (channel 2) will transmit very good pictures to CATV subscribers, if used with high-quality video amplifiers and tapoffs. Faint ghost images are present, but most subscribers ignore them. A return loss of 30 db (4 db improvement) insures CATV pictures of excellent quality, with ghost images just barely perceptible to the most keen-eyed viewers.

CATV system standards are steadily rising. When CATV systems were installed only in extreme shadow or fringe areas, subscribers were delighted to receive a viewable picture of any quality. Now, in competition with live TV in many locations, cable systems must deliver pictures equal to or better than those obtained on any channel by the best home receiving equipment.

Moisture Resistance

Since CATV cable is run outdoors, it must be able to withstand a variety of weather conditions. However, CATV systems have a problem not common to any other communication field. In CATV systems, frequencies as high as 220 mc must be sent through miles of cable, a practice which requires cascaded amplifiers. To design an adequate system and to space the amplifiers properly, the engineer must be able to predict the losses exhibited by a length of cable—that means knowing all factors which contribute to the total cable loss. As discussed previously, center-conductor resistance and temperature variation are significant factors. An often overlooked contributor to loss, however, is cable moisture content.

Polyethylene Jackets

Since most cables are jacketed in polyethylene, nobody worried much about moisture until a few years ago. It was thought that polyethylene was completely waterproof, and waterproof it is; but polyethylene jackets are not vapor proof. Water vapor easily penetrates the cable jacket and accumulates at a low point in the cable, usually at the bottom of a downhill run. Why didn't this accumulated vapor cause trouble in the early days of CATV? The answer is that it did, but nobody really noticed its effect until all-channel VHF systems became common; Fig. 2 shows why. To obtain the data for the graphs shown, a 2400′ reel of foam-dielectric cable was sprayed with water

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Table 1. Common CATV Cables

MANUFACTURER	NUMBER	TYPE	ATTENUATION (db/100 ft) Ch 6	Ch 13
Times Wire & Cable Company	JT-11625	Solid Aluminum Sheathed	.32	.60
	JT-116255	Solid Aluminum Sheath w/Jacket	.32	.60
	JT-1750	Solid Aluminum Sheath	.60	1.03
	JT-17505	Solid Aluminum Sheath w/Jacket	.60	1.03
	JT-1500	Solid Aluminum Sheath	.84	1.40
	JT-1500J	Solid Aluminum Sheath w/Jacket	.84	1.40
	JT-1412	Solid Aluminum Sheath	1.05	1.65
	JT-1412J	Solid Aluminum Sheath w/Jacket	1.05	1.65
Phelps Dodge	FXA 41-75	Solid Aluminum Sheath	.99	1.55
	FXA 12-75	"	.74	1.27
	FXA 34-25	"	.52	.92
	FXA 158-25	"	.30	.52
Plastoid Corporation	CT-48	Corrugated Copper	.84	1.40
	TA4	Welded Aluminum Sheath	1.04	1.60
	TA4J	Welded Aluminum Sheath w/Jacket	1.04	1.60
	TA5	Welded Aluminum Sheath	.73	1.26
	TA5J	Welded Aluminum Sheath w/Jacket	.73	1.26
Rome Cable	R075-038-1	Solid Aluminum Sheath	1.05	1.68
	R075-412-1	"	.99	1.54
	R075-012-1	"	.72	1.25
	R075-034-1	"	.50	.88
	R075-078-1U	"	.44	.75
	R075-078-1J	Solid Aluminum Sheath w/Jacket	.44	.75
Superior Cable Corporation	4910	Corrugated Copper Sheath w/Jacket	.86	1.85
	4920	Sheath w/Jacket	.98	1.5
	4930	Sheath w/Jacket	.65	1.15
	6030	Sheath w/Jacket	.64	1.13
Viking	VK1412	Solid Aluminum Sheath	1.05	1.65
	VK1412J	Solid Aluminum Sheath w/Jacket	1.05	1.65
	VK1750	Solid Aluminum Sheath	.57	1.00
	VK1750J	Solid Aluminum Sheath w/Jacket	.57	1.00
	CF480	Corrugated Copper Sheath	1.01	1.65

CHECKING THE PATTERN

by Elton B. Chick, Consulting Author, General Manager, WLOU, Louisville, Kentucky — A series of quick checks for use in establishing maintenance procedures for directional antennas.

Editor's Note

An earlier article by the author described a method for making a field-intensity survey. ("Running the Radial," BROADCAST ENGINEERING, June 1965). Here Mr. Chick discusses an important use of the field-intensity data collected from such surveys, specifically as applied to directional antennas. This information provides a quick-check method for evaluating antenna performance.

A typical field-intensity survey provides tabulated data which gives signal strength in millivolts/meter, the distance from the station at which the reading was taken, and the radial azimuth angle in degrees. Table 1 shows a typical tabulation. To provide meaningful information for evaluating antenna performance, the data for each radial are plotted on log-log graph paper (K & E No. 182 or equivalent). The distance of the measurement point from the transmitter is plotted as the abscissa, and the measured field intensity is used as the ordinate (see Fig. 1). The graph paper mentioned allows the measured data to be compared to the ground-wave field-intensity charts contained in Part 73 of the FCC Rules. Field-strength measurements taken on each radial are plotted on separate sheets of graph paper, and each sheet is labeled with the azimuth angle of the radial. It is customary also to list transmitter power output and other operating parameters directly on each graph.

Table 1. Field Intensity, 120° Radial

Point	mv/m	Distance (miles)
1	400.0	.50
2	300.0	.60
3	275.0	.70
4	235.0	.80
5	190.0	1.00
6	150.0	1.25
7	116.0	1.48
8	88.0	2.00
9	72.0	1.47
10	55.0	3.00
11	42.0	3.45
12	39.0	3.95
13	29.0	5.00
14	26.5	5.50
15	20.0	6.50
16	15.0	8.00
17	11.5	9.00
18	10.5	10.00
19	7.7	12.00
20	7.0	13.00
21	5.3	15.00
22	4.2	16.00
23	3.7	18.00

Analyzing the Measurements

Analysis of the plotted data can be only as valid as the accuracy of each point; that is, how nearly the point represents the actual conditions. Equally important is the matter of engineering judgment or experience. Because of this subjective influence, some variation can be expected in the results obtained by various engineers in evaluating the measured data. However, if all factors are considered carefully, there should be no unreasonable differences.

Data analysis is begun by comparing the curve indicated by the plotted points to the FCC standard curves by laying the plotted data over the appropriate set of FCC ground-wave field-intensity curves and moving the sheet of plotted data up or down over the FCC curves to find the best match of curve to plotted points. The left and right graph margins must remain aligned while this is being done. When the closest match of points on any curve is found, the curve is traced on the graph containing the points. Next, the inverse-distance curve is drawn on the graph by tracing the FCC curve marked 5000. The point at which the curve crosses the graph's one-mile distance line gives the inverse-distance field (at 1 mile) for the radial being analyzed. The inverse-distance and

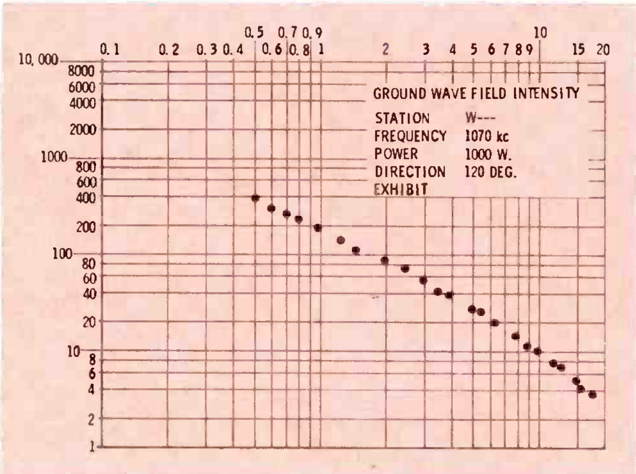

Fig. 1. Field-intensity measurements along 120° radial.

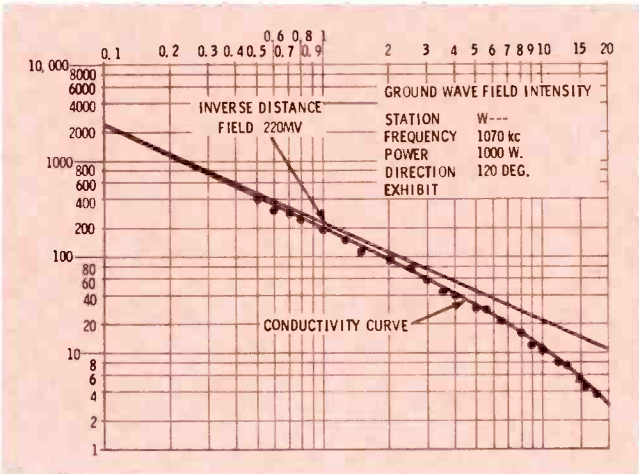

Fig. 2. Curves drawn using FCC field-intensity charts.

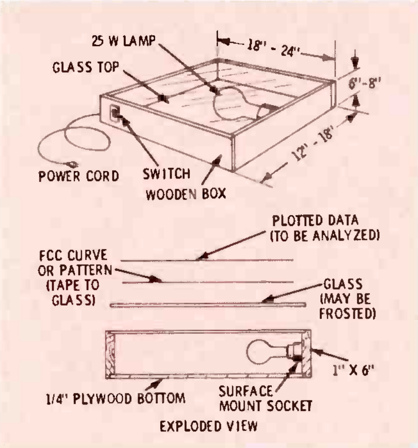

Fig. 3. Light box suitable for tracing FCC standard curves and other information.

ground-conductivity curves must be drawn to meet at a common point at the left-hand margin of the graph.

In some cases, the plotted data will not follow a single standard curve. If the points seem to follow one curve and then jump to another curve and follow it, a change in conductivity is indicated. In this case, the first curve is traced out only as far as it follows the standard, and the second line is traced from there on. If more than one change occurs, portions of several curves may need to be traced. This situation occurs frequently because of ground-conductivity changes and should be taken into consideration when difficulty is experienced in obtaining a good match between a single FCC curve and the plotted data.

As each radial is compared to the standard curves, a tabulation of inverse-distance fields is compiled. This data represents the unattenuated field intensity at a distance of one mile from the station along each radial and will be used later to determine the radiation pattern. Fig. 2 shows the two curves for the data listed in Table I and shown plotted in Fig. 1. A convenient method for making the comparisons is to use a light box like that shown in Fig.3 .

Plotting the Pattern

To determine the actual performance of an antenna system and to compare its performance with the original design or with earlier measured patterns, it is necessary to plot the series of inverse-distance fields obtained for each radial. This is done by plotting the inverse-field values on polar graph paper. Table 2 shows a typical tabulation of inverse-distance fields, and Fig. 4 shows them plotted on the polar paper.

The unattenuated pattern shown is the theoretically perfect one which would result if the ground conductivity were constant over the entire field area; the actual attenuated pattern may show a considerably different shape. If no ground losses or other detrimental effects upset the pattern, its shape could be obtained simply by measuring the field intensity along a circular series of points equidistant from the station. Unfortunately, this condition seldom, if ever, exists.

The RMS Value

Once a pattern has been determined, its rms value can be found and used to evaluate the overall horizontal-radiation efficiency of the array. The rms voltage magnitude of a radiation pattern is equivalent to the radius of a circle (expressed in mv/m), the area of which is equal to the total area enclosed by the inverse-distance-field pattern.

Table 2. Inverse Distance Fields

Radial Azimuth (degrees)	Inverse Field (mv/m)
0°	88.0
30	119.5
60	88.0
90	5.0
120	120.0
150	220.0
180	280.0
210	295.0
240	280.0
270	222.0
300	120.0
330	6.0

There are several precise methods used to determine the rms figure: A polar planimeter can be used, if available, or the value can be computed by squaring the inverse-field values for each radial and taking the square root of their average. This latter method works best if the inverse-field values are taken for radials every 5 or 10 degrees around the pattern. Another method, of reasonable accuracy and usable to check performance periodically, is to estimate the pattern area by tracing the pattern on linear graph paper and counting squares inside the pattern as indicated in Fig. 5. When this area is known, the rms value is computed as follows:

To check the pattern, this value is compared to the original design value or to any previously determined value deemed acceptable. Any substantial change in rms value will suggest a fault in the antenna system. A smaller figure would in-

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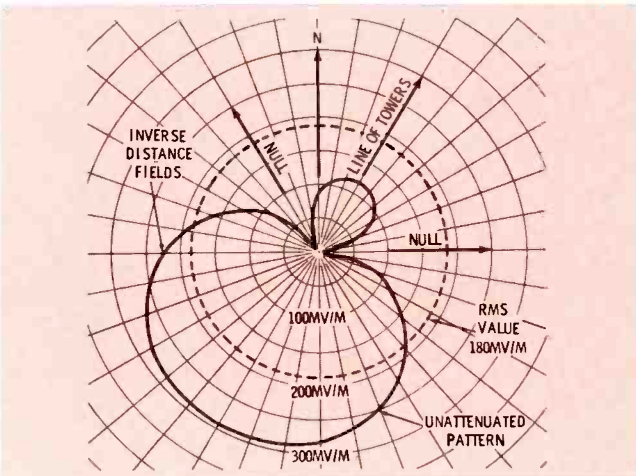


Fig. 4. A polar plot of inverse-distance-field pattern.

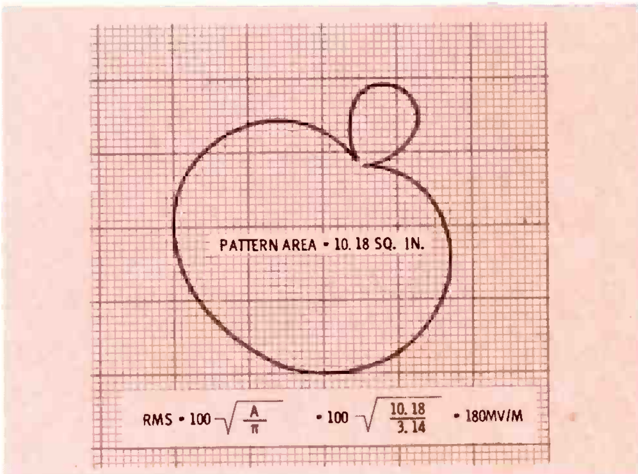


Fig. 5. Counting squares gives area to find rms value.

CARTRIDGE RECORDER PLAYBACK WITH AUTOMATIC CUEING

*by **Joseph D. Coons,*** President and General Manager, WOHI, East Liverpool, Ohio — A simple and versatile control system to coordinate use of commercially constructed cartridge-tape equipment.

This article describes the construction, from new parts, of a cartridge-tape control system capable of recording and playback of NAB standard cartridges with 1-kc cue tone. The machine is not intended to be the sole recording facility for any station; however, in the WOHI newsroom, it is in use as an everyday machine for recording "beeper" telephone reports, network spot-news releases, and story reports by WOHI announcers. It performs all these functions reliably.

In planning the function of this unit, there were three basic requirements which had to be met: The system had to be reliable and easy to operate, compatible with the other machines in the station, and constructed of new parts for as little money as possible. Our machine has met these requirements admirably, and the following paragraphs will explain the machine in detail in case you might be interested in one for your station.

Theory of Operation

A wiring diagram, complete with inputs and outputs, is shown in Fig. 1. The physical positions of all switches and indicators located on the front panel are shown in Fig. 2. The machine will accept any one of three line-level signals, plus a standard low-impedance type microphone. Switch S1, an eight-pole double-throw rotary, switches the input from LINE to MIKE, substituting a different primary winding of transformer UTC 0-1 and changing the connection on the Viking record playback preamp (RP-62C) from the low-level input to the high-level input. Utilizing the switch in this way eliminates the need for extensive mixing, padding, or the use of other switching equipment. Switch S2 selects which line is in use when switch S1 is in the LINE position.

For cartridge playback, a standard Viking tape deck, Model 36-R, is used. The power supply (Fig. 3) is modified to handle the additional load of the three relays and pilot lamp PL-R. The erase head on the left top of the deck is removed, and the new program head is moved into this position. A second program head is installed (to detect cues) in the right-hand location adjacent to the capstan. We used a worn program head from our stock for the cue head. The program head records on the upper track, the cue head on the lower track.

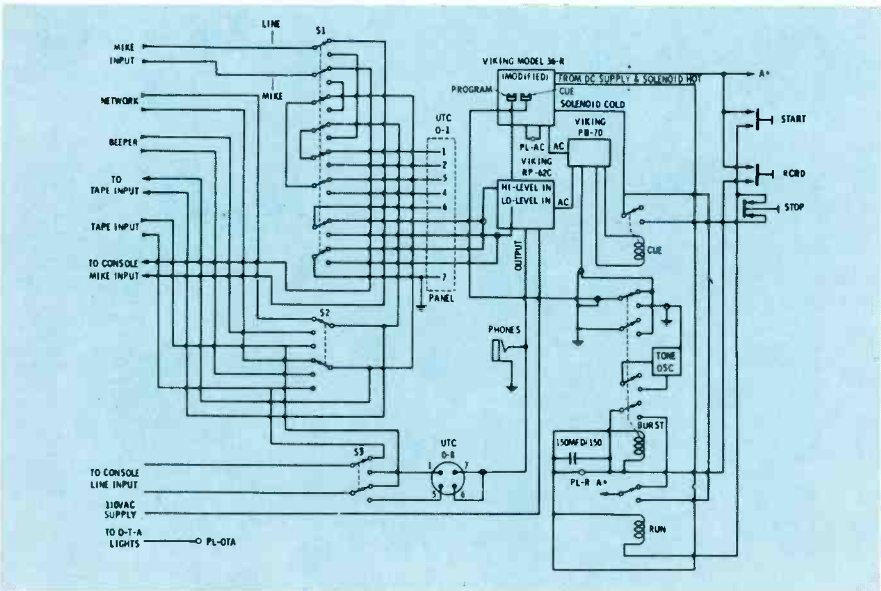


Fig. 1. Wiring diagram of the recording and playback control system.

Table I — Parts List

Panel

S1—Eight-pole, two-position rotary switch

S2—Two-pole, three-position rotary switch

S3—Two-pole, two-position rotary switch

PL-AC, PL-R Neon-type pilot light assemblies

Cough button

On-the-air-light assembly to suit

Phone jack

Audio and AC connectors to suit

Transformers—UTC 0-1—Input
UTC 0-8—Output

Fuseholder for 2A fuse

Deck

Viking Model 36-R

250-ohm, 10-W wirewound resistor

Cue record playback head (use worn head)

Record Playback Amplifier

Viking Model RP62-C (erase lead not connected)

Cue Preamplifier and Relay

Cue relay—10,000-ohm coil, 1-ma sensitivity (3-ma pull-in, 2-ma dropout), SPDT contacts

Viking Model PB-70 Preamplifier

.05/150 capacitor

.01/450 capacitor

8/450 capacitor

1-meg, ½-watt resistor

40-K, ½-watt resistor

1N34 or equivalent diode

10-K, ½-watt resistor

Control Circuits

Burst relay—110VDC coil, 4SPDT contacts

Run relay—110VDC coil, SPDT contacts

150 MFD—150WVDC delay capacitor

2—Normally open SPST pushbuttons

1—Normally closed SPST pushbutton

Tone Oscillator

Transistor module with 1-kc output (mercury cell operated) capable of delivering 3 volts audio (on VTVM) into head-load impedance (available in most radio parts stores for about $5). Minibox to suit.

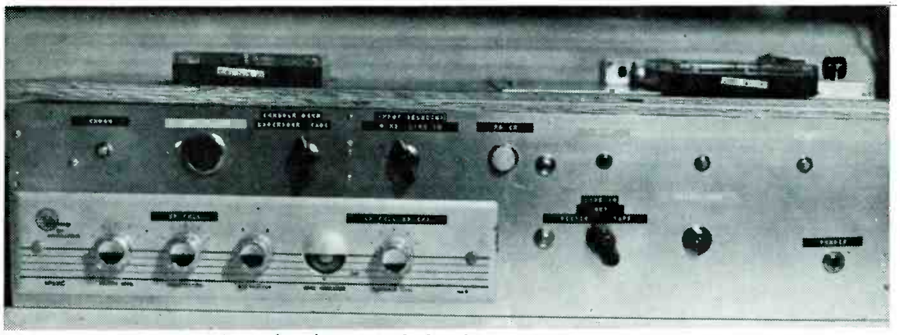


Fig. 2. Front view showing panel detail and arrangement of all controls.

Trip cue is detected by a modified Viking playback preamplifier, Model PB-70. This model was chosen because of the price of the unit and to avoid power-supply and other construction problems. The output stage was modified (as shown in Fig. 4) to provide a load on the plate which in turn is across a sensitive relay coil. Other modifications involved removing the equalization control and adding a 10K resistor ground to the junction of the .047 capacitor and 10K resistor in the grid circuit of the first amplifier stage.

The relay in the plate of V2B is energized when the cartridge is running, with deenergization causing the cue relay to trip, stopping the machine. Use of the regular preamplifier gain control provides for adjustment of cue threshold. The signal from the cue head comes to the preamplifier from the normally-closed contacts of the burst relay. To understand how a cue-tone burst is impressed upon the tape, it is important to follow the relay wiring shown in Fig. 1. The RECORD button is depressed and, providing the run relay is not engaged, the burst relay is energized, latching through its own contacts and those on the run relay. Thus, when the burst relay is closed, the cue head is disconnected from the cue preamplifier and connected, instead, to a 1-kc tone generator. The tone generator is turned on by the relay action, and the input to the cue preamplifier is grounded.

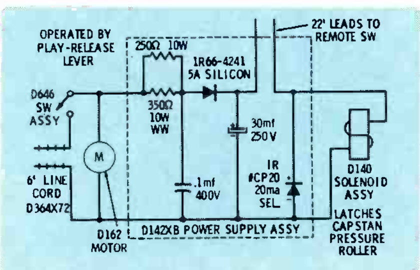


Fig. 3. Added resistor increases output.

When the operator presses the START button to begin recording, the run relay pulls in, breaking the latching circuit and opening the burst relay after a delay determined by the capacitor across it. This delay provides for a tone of about one second duration. After the delay, the relay opens, and the cue head is again connected to the cue preamplifier; thus, the preamplifier will fire the cue relay when a tone is detected (indicating that the machine has run around to the beginning of the recorded cartridge). When the START button is depressed, the capstan is engaged and the run relay is latched electrically, remaining in an energized state until either the cue relay opens (because of a cue-head signal amplified by the cue-head preamplifier) or because the operator has depressed the STOP button.

Physical Construction

Our unit was constructed to fit into space available on our news desk. It had also to provide a cough button, on-the-air light, and connections for a reel-type recorder also used in the newsroom. It isn't necessary for the cabinet to be either as long or as deep as ours; we suggest you work out the layout to suit your own requirements. The switches, relays, and transformers are all mounted on an aluminum panel for easy grounding of components. By hinging the cover, we have quick access for adjustments or checks. On our unit, we provided phone-jack connectors, mike connectors, and AC plugs for each connection to the console, etc., in order to provide for easy servicing. The parts list in Table 1 lists all components necessary to construct this equipment.

Maintenance

Initial adjustments of the cue threshold and of the spring tension on the cue relay are quite touchy, and should be performed patiently by the builder. Following this, an occasional touchup of the threshold control will be all that is required, aside from periodic head cleaning. Check head alignment both for frequency response and compatibility with other machines.

Operation

Before making a recording, the operator should select the source from which the recording is to be made, switch the recording amplifier selector to R and adjust the RECORD GAIN control for maximum closure without overlap of the "V" on the eye tube. Having adjusted the levels, the cartridge should then be inserted, the capstan brought into ready position, the RECORD CUE button depressed, and the START button depressed as the program material is started. (When pressed, the start button should always be held in for about two seconds to avoid a false actuation of the cue relay as the burst relay drops out during recording or as the tail end of the cue tone on the tape is detected during playback.) When the machine starts during recording, the operator can hear a soft click—as the burst relay drops out—about a second after the start button is pressed. This click indicates proper operation of the cue-burst recording apparatus.

When the recording is completed, the STOP button should be pressed, the recording amplifier switched to P, and the START button pressed to allow the cartridge to run until it gets back to the cue at the beginning of the recording, at which time it will automatically stop. Pressing the START button again will cause the recording to be played back.

This efficient, inexpensive machine has served its intended purpose well and has helped us to provide our listeners with improved programming through increased versatility at a low cost. ▲

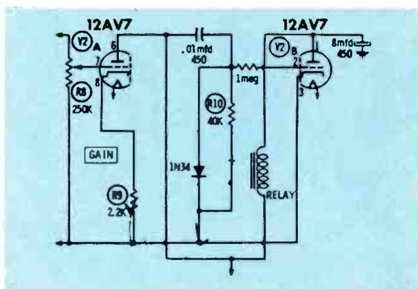


Fig. 4. Modified preamplifier output.

ANTENNA AND TRANSMISSION-LINE MEASUREMENTS

by William H. Artzberger,
Transmitter Engineer, KDKA-TV, Pittsburgh, Pennsylvania — Two well-proved techniques for keeping track of the condition of the television station's transmission line and radiating system.

Antennas and transmission lines are usually on the "neglected maintenance" list at television-transmitter plants. This is comprehensible, since there is very little that the broadcast engineer can do with reference to adjustments on these items. Nevertheless, good engineering practice requires station personnel to keep a regular check on this final link in the broadcast system.

This article describes two methods for checking the antenna system which have been used regularly at KDKA-TV and found to be very practical maintenance procedures. The first is the resistance-bridge method, and the second is the sweep-frequency method that can also be used to compute actual values of voltage standing-wave ratio (VSWR).

The Resistance-Bridge Measurement

This method is a rather basic one for troubleshooting, but when performed on a regular schedule for maintenance records, it can provide valuable reference information. The transmission line(s) should be disconnected from the transmitter at a convenient location; the resistance bridge is then connected to read the combined resistance of the transmission line and antenna. The impedance measurements thus obtained can be checked against readings made at the time of installation or compared with manufacturers specifications. (See Table 1 for typical resistance values.)

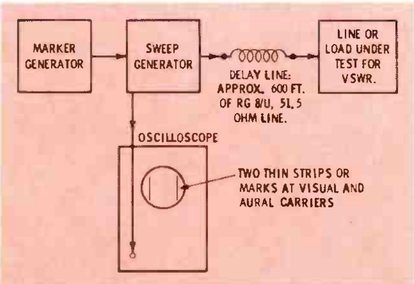


Fig. 1. Test setup used to determine condition of the transmission line and antenna.

Table 1. Typical Bridge Readings

	Original Resistance	Present Resistance
MAIN TRANSMISSION LINES		
Line 1	.0430	.0460
Line 2	.0495	.0495
AUX TRANSMISSION LINES		
Line 3	.0460	.0475
Line 4	.0350	.0350

Any change in resistance values indicates either corroded or burned transmission-line joints or poor connections at the antenna-feed straps. The consequences of these irregularities would be an increase in VSWR, overheating at the resistive spot, and loss of radiated power. The most serious indication would appear in the visual transmitter in the form of reflections or ghosts in the picture. Any one of these effects, of course, is undesirable.

Sweep-Frequency Measurement

The second method is more elaborate and more interesting, as the VSWR actually can be observed and measured by means of an oscilloscope. Fig. 1 shows the equipment setup for making this measurement. The sweep frequency should be adjustable to approximately 5 mc and should sweep from about 250 kc below the visual carrier frequency of the channel to be checked and continue to about 250 kc above the aural carrier.

At this point, let's stop and review some transmission-line theory. For maximum transfer of power from the transmitter final amplifier to the antenna, it is necessary to have the impedances of all signal-handling components perfectly matched. This is most important in the case of television antenna systems, as explained in an earlier paragraph. Therefore, the VSWR ultimately must approach one to one. To help explain this, look at the formula

$$\text{VSWR} = \frac{Zo}{Zr}$$

where,

Zo = the characteristic impedance of the line, and

Zr = the impedance of the load.

In the setup, you will notice a length of 51.5-ohm transmission line (RG 8/U). For need of better nomenclature, we call this test line a "delay line." (The characteristic impedance of this line must match exactly the characteristic impedance of the transmission line under test.) To insure getting a good comparison between the delay line and the system under test, the length of the line should exceed one-half the total length of the antenna-feed system. In the setup used at KDKA-TV, the transmission line was over 1000′ long, and the delay line was approximately 600′ long.

When a signal voltage is fed from the sweep generator into the delay line (with the delay line unterminated), the reflected and direct signals combine to produce a display on the oscilloscope as shown in Fig. 2 (the high-amplitude sine

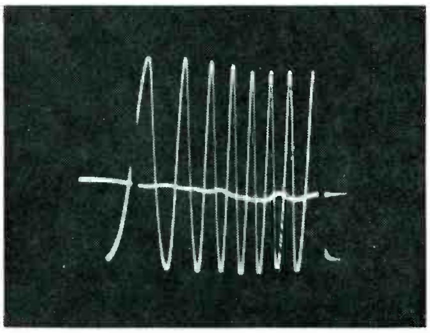


Fig. 2. Superimposed traces from the unterminated and terminated delay lines.

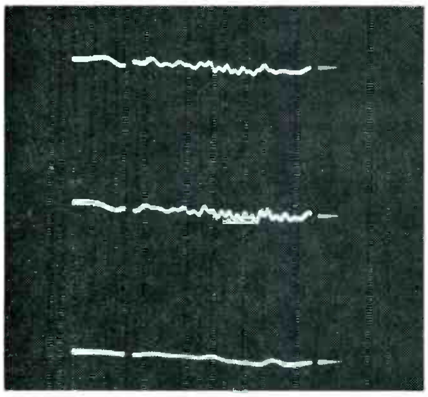


Fig. 3. Top two traces reveal impedance irregularities in two transmission lines.

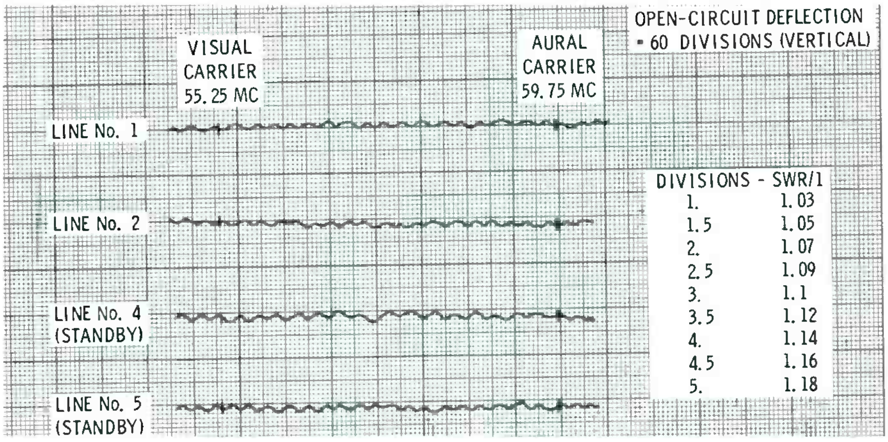


Fig. 5. Using graph paper, actual VSWR readings can be obtained from the traces.

wave). When the same signal voltage is fed into the delay line with the line terminated in a pure resistance of 51.5 ohms, there is no reflected voltage; this also can be seen in the illustration (the almost flat horizontal trace). The open-line and terminated-line traces were superimposed photographically by double exposure for comparison. It can now be seen that our system under test must look like a 1.5-ohm resistor to the end of our delay line!

The next step in the measurement is to insert a marker from the marker generator first at the aural carrier frequency and then at the visual carrier frequency. The limits set by these markers can be marked on the scope face with either a china marker or thin strips of black tape. (These appear as voids in the trace in Figs. 2, 3, and 4.)

Without changing any of the scope or generator controls, the sweep generator is fed to the antenna and transmission line under test through the delay line. Fig. 3 is a multiple exposure of three traces and displays a reference trace and the sweep patterns of two independent lines feeding a six-bay channel 2 antenna. A is for line 1 (E-W), B is for line 2 (N-S), and the remaining trace C is for the 51.5-ohm dummy-load resistor used for comparison.

Fig. 4 is another multiple exposure which exhibits a slight difference in configuration, as these traces were obtained at the diplexer input. It is interesting to study the photos very closely. Much information can be observed from them. It can be seen that the diplexer unit causes a slight VSWR in addition to that created by the antenna and transmission line.

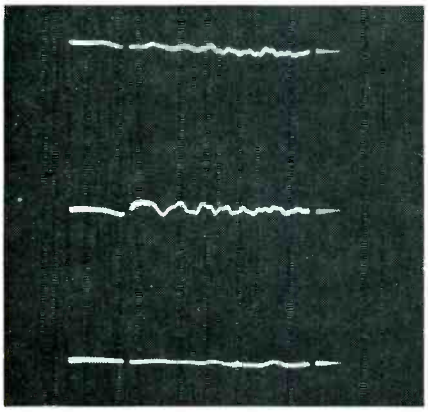


Fig. 4. Traces obtained at diplexer differ from those taken at transmitter end.

The VSWR Measurement

The preceding tests may be conclusive enough to satisfy the station engineer that his antenna system is or is not in acceptable condition, but the USWR figure may be needed. It can be found by using the following procedure: Adjust the scope vertical-gain control so the maximum deflection for the open-ended delay line is exactly 3″. Then, with the delay line connected to the transmission line in question, trace the scope display on a sheet of graph paper. (K & E 20 x 20 to the

• Please turn to page 39

Maintenance Logs

(Continued from page 15)

could show that the station is operating on a construction permit, equipment test, program test, telegram, license, or post card. A listing of the mode of operation employed at the station is sometimes included—authorized frequency, power(s) DA or NDA pattern (for AM), ERP, antenna-power gain, line and transmitter efficiency (for FM or TV)—and the particular transmitter involved where more than one is licensed.

Some stations include readings of transmitter meters which aren't required on the operating log—oscillator plate, buffer plate, grid drive, etc. Another item found is a list of tube replacements in the transmitter, showing tube type, serial number, position or stage, and reading of time meter, if any. Calibration of remote control and failure, removal from service, and restoration to service of a phase monitor may be required by station license, but other stations add them to the log.

Regular daily inspection of the following items is logged by some stations: Antenna-tuning unit, color and condition of PA and modulator tubes, all indicator and pilot lamps, spare and standby crystals, spare tubes, fuses, and parts stock, building-ventilating fan, air-conditioning and heating equipment, fire extinguisher, burglar-alarm system, frequency-monitor crystal-oven temperature, recording equipment (disc or tape), NDEA or EBS receivers, and the general condition inside and outside the building. An audio check is used by some stations—notes of input and output audio levels, distortion, noise, and transmitter-carrier shift.

Some stations may be required to take monitor-point readings with a field meter, and these are often entered in the maintenance log. FM stations with SCA or stereo subcarriers sometimes have these frequencies checked by an independent measuring service and enter the results in the log. Latitude and longitude of the transmitter site are listed by some stations.

We found that some stations simply use longhand notes on the back of the operating log to describe maintenance work. While this may be acceptable from a legal standpoint, it ignores human nature and leaves too much to the duty man's memory. It's much better to have a printed form as a reminder of the various tasks to be performed. A few stations use large sheets (16" x 13") with the operating log printed on one side and the maintenance log on the other. There is space for an entire 24 hours' operation and for daily and weekly maintenance-log entries.

After examining many logs, two deficiencies were most often noticed—lack of space for remarks, and a tendency to encourage checkmarking items. If there's space for only an "OK" after a listing, how can you expect the duty man to describe trouble? Many stations maintain completely inadequate records of previous service, which means that new employees or consultants have to troubleshoot equipment blind. Remember, your job can be made much easier if you and your coworkers describe fully any and all repairs, adjustments, and service in the maintenance log. ▲

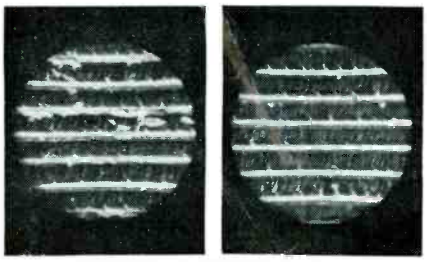
Some plain talk from Kodak about tape:

Slitting accuracy and skew angle

Tape is made in wide rolls which are slit to width—¼″ for most audio tapes. There are three main considerations in this process: cleanliness, dimensional accuracy and trueness of cut. Cleanliness cannot be given too much consideration. When the tape is slit, particles of the oxide and the base can flake off. This condition arises from poor oxide adhesion and poor quality-control standards on slitters. Slitting dirt is virtually nonexistent in Kodak tapes because of our "R-type" binder and our unique slitting techniques.

Tape dirt clogs the recording gap and prevents the tape from making intimate contact with the head, thus causing dropouts and high-frequency losses. Oxide dirt can also cause a phenomenon known as re-deposit. During a normal tape transport operation, gummy oxide dirt can actually re-deposit on the magnetic layer and fuse in position. Just imagine Main Street strewn with giant boulders. Well, that's the way re-deposits appear to your recorder heads. Pleasant thought, isn't it?

To get some idea about how Kodak tape slitting compares to ordinary slitting, take a look at these two photomicrographs. The dirt you see between the turns on the left is oxide dirt. Compare it to the virtually spotless edges of KODAK Sound Recording Tape on the right.

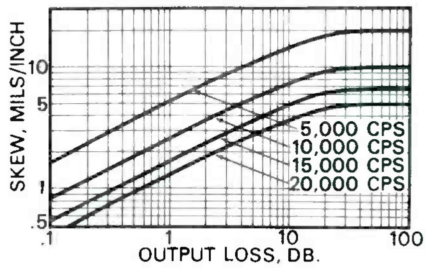


It's like splitting hairs, only more critical

From our 42-inch-wide master web, we have to cut 160 quarter-inch ribbons of tape — each almost two miles long. That's a lot of total mileage, especially when you think how straight and true those edges must be to assure optimum tracking on your recorder. In terms of slitting accuracy, the standard specs call for a tolerance on width of ±.0020 inches. We decided that that was just about double what it really should be, so we hold ours to ±.0010 inches.

But the really critical part of slitting is a bad guy known as weave. When a tape weaves, it passes the head at a continuously changing skew angle. Look at the graph.

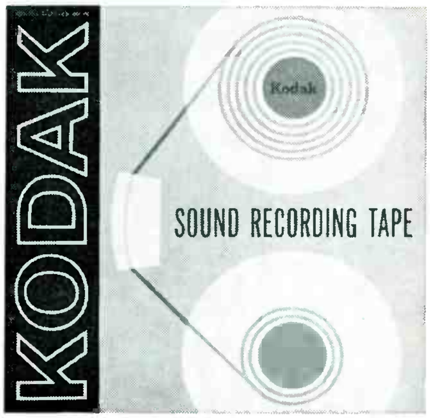
TRACK WIDTH: 75 MILS (½ track)
RECORDING SPEED: 7½ IPS



Note how losses pile up as skew angle increases. And as you would guess, the losses are in proportion to the frequency. Higher frequencies, higher losses. Same principle, really, as an azimuth loss.

The patterns of tension set up within the roll when the tape is wound are quite interesting. Normally, the tension at the outside of the roll will decrease until it reaches a point of zero tension about ⅓ of the way from the core. Beyond this point the tension increases, but the direction of that force is reversed. Near the core the tape is in a state of compression. It's just the opposite with the outer layers. They're clocksprınged.

Proper tape tension is also important if you want to prevent "stepping." Stepping usually takes place at the point of zero tension. You can visualize it as a lateral shearing of a roadway during an earthquake. Shades of old San Francisco. This sets up stresses which cause fluted edges and prevent proper head contact. From winding billions of feet of motion picture film, Kodak has developed some pretty specialized tension-control techniques. The end result, of course, is that when you get Kodak tape on a roll, you know it's wound properly: not too loose, not too tight. Just right. Our Thread-Easy Reel is part of the story, too. Because it is dynamically balanced, we get a good wind right off the bat, and you get a good rewind, too, when you run it on your tape deck.



KODAK Sound Recording Tape in a complete variety of lengths and types is available at most tape outlets: electronic supply stores, specialty shops, department stores, camera stores . . . everywhere.

FREE! New comprehensive booklet covers the entire field of tape technology. Entitled "Some Plain Talk from Kodak about Sound Recording Tape," it's yours on request when you write Department 8, Eastman Kodak Company, Rochester, N.Y. 14650.

EASTMAN KODAK COMPANY, Rochester, N.Y.

Circle Item 12 on Tech Data Card

Checking the Pattern

(Continued from page 21)

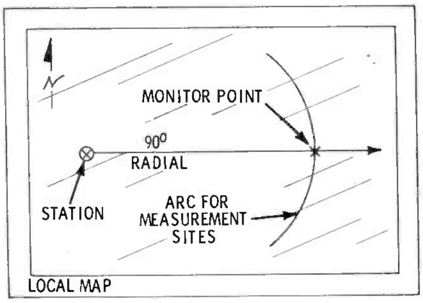


Fig. 6. Method used to establish measurement points for determining ratio points.

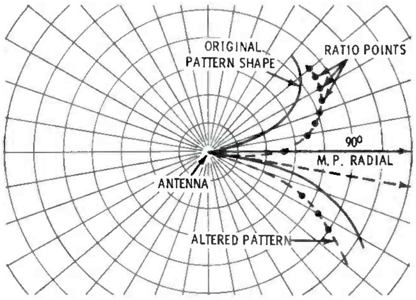


Fig. 7. Use of ratio points provides the means for determining shifts in minima.

dicate greater losses or a lower power, whereas a higher figure would indicate the converse. In either case some change has taken place, and a check of the transmitter input power and common-point current values against the original values would be in order.

Ratio Points

Frequently, the shape and position of pattern minima or nulls should be checked. There are several methods of doing this, including the techniques justde scribed; however, a quick, simple method is often needed. A null can be checked by making a series of measurements, under both directional and nondirectional conditions of operation, along an arc in the area of the null. As an example of this technique, assume that you wish to check a null which lies on a monitor-point radial of 90°. Using a map of the area under study, an arc which extends 20° to 30° each side of thee radial is drawn through the monitor point. The station is the pivotal point as shown in Fig. 6. Under nondirectional operation, measurements are made at as many points along this arc as is practical. Next, the same points are measured under directional operating conditions. To obtain the ratio for each point, divide the directional field strength by the nondirectional field strength and plot the resulting ratios on polar graph paper after determining the azimuth angle of each ratio point. Fig. 7 shows the result of such a determination. The original shape is shown by the continuous line; the modified shape by the broken line. This investigation shows that the null has shifted away fromm the 90° line to a higher azimuth angle of approximately 100°. Because of seasonal effects, it is desirable that ratio measurements, both directional and nondirectional, be made during the same season in the same day, if possible.

Conclusion

Whatever the purpose in checking a pattern, it is important to keep careful records so that information is on hand for investigating any future problems. Remember, too, that information presented in this article is designed primarily to provide several points of reference for setting up and maintaining performance records. With a means foor running several quick checks, the station engineer will better be able to detect variation from established criteria. ▲

This is L.A.'s Mt. Wilson, where 6 out of 10* TV stations transmit sharper images with General Electric antennas.

Los Angeles has the greatest concentration of TV antennas in the world—and the majority of them are General Electric. These are the stations and their G-E equipment: KABC-TV, Channel 7, 6 Bay Batwing; KCET, Channel 28, 8 Panel Zig-Zag; KMEX-TV, Channel 34, 5 Bay Helical (4 Panel Zig-Zag on order); KPOL-TV, Channel 22, 2 Bay Helical; KTLA, Channel 5, 3 Bay Batwing; KTTV, Channel 11, 6 Bay Batwing.

G.E. can help you improve your image. Contact your G-E Broadcast Equipment Representative, or, General Electric Company, Visual Communications Products, 7-315 Electronics Park, Syracuse, New York 13201. GE-14

Visual Communications Products

GENERAL ELECTRIC

Electronics Park, Syracuse, New York

*Soon to be 7 out of 11... by the end of the year a new station, KMTW (TV), Channel 52, also will be on the air (subject to FCC approval) with a G-E Helical Antenna.

Negative Resistance

(Continued from page 17)

age, current, and frequency. There were few devices that displayed negative-resistance characteristics naturally; the phenomenon was achieved by means of feedback, and circuit operation could be analyzed validly either as negative resistance or as feedback.

The point-contact transistor was the first semiconductor device that had negative-resistance characteristics. The alpha of the point-contact transistor is greater than one over part of its range, which leads to a negative-resistance region that is either current-stable or voltage-stable, depending on the connection of the unit. Point-contact transistors rapidly went into use as miniature oscillators and switching units for early digital computers.

In the span of a very few years, many semiconductor devices displaying an intrinsic negative-resistance characteristic were invented. The variety of units with different characteristics now permits broad latitude in the use of negative resistance as a circuit element. The true scope of this new circuit tool is better noted by listing recently developed devices that display a stable negative - resistance characteristic. Among them are the point-contact transistor, the four-layer diode, the hook transistor, the silicon-controlled switch, the silicon-controlled rectifier, packaged negative-resistance elements, the unijunction transistor, and—the most promising device of all—the tunnel diode.

Next month, in Part 2 of this article, we'll examine this device and others in detail and investigate their operation and function in simple circuits. The entire electronics industry stands to profit enormously from this new generation of semiconductors in widely diverse applications. Even though broadcasting, so far at least, uses only a few such devices, the time rapidly approaches when they will become as commonly employed as simple vacuum tubes and relays are today. ▲

Modulation Power

(Continued from page 12)

critical listeners may provide the best results. Always use a very high quality demodulator, amplifier, and speaker system.

Linearity Correction

A linearity-correction amplifier inserted just following the limiter can correct for the nonlinearities that occur in the transmitter audio system. The amplifier produces precisely controlled distortion which is equal in amplitude but opposite in phase to the distortion produced in the transmitter. Amplifier adjustment is made by inserting a tone at a level equivalent to 100% modulation and adjusting the amplifier for minimum system distortion. In typical cases, distortions of 5% to 7% can be brought down to the 2% range; 3% systems can be corrected to below 1%. Some advantages are as follows: large transmitting tubes (modulators, modulator drivers, and PA tubes, etc.) can be used longer with satisfactory results; positive-peak linearity can be increased for older transmitters, thus allowing for additional modulation increases by other processes; distortions produced by carrier shift can be corrected—if a 5% positive carrier shift is introduced by the correction amplifier, a negative 5% carrier-shift distortion could be corrected, leaving the desired stable carrier.

Reverberation and Echo Chambers

To provide a "fuller" sound, audio is delayed by various processes: tape machine, delay line, echo chamber, or mechanical spring delay; the tape machine probably offers the most practical approach. The original audio is delayed using a second head and mixed back into the original signal. This produces a slight echo effect which, to some ears, makes the music sound more alive. It's doubtful that additional modulation power is attained by this process, but some of the low-level portions of the program material are filled in, giving the subjective impression of "more sound."

Conclusions

Increases in modulation power obtainable from the various techniques discussed are listed below,

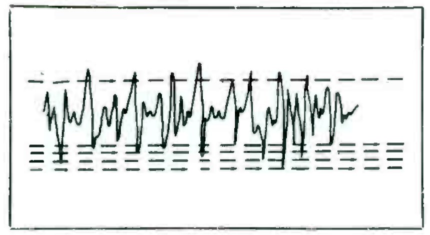


Fig. 6. Depending on negative-peak excursions, clipping level varies widely.

and minimum, maximum, and average expected db increases are also given:

1. Frequency response alteration: .25db to 1db, average .5db.
2. Automatic level control: 4db to 10db, average 6db.
3. Carrier-shift correction: .25db to 1db, average .5db.
4. Control of audio - wave symmetry: .5db to 4db 50% of the time, average 1.5db.
5. Antenna-loading compensation: .25db to 1.25db, average .5db.
6. Instantaneous peak clipping: 1db.
7. Linearity - amplifier correction: 0db to 1.5 db, average .5db.
8. Reverberation systems: 0db.

The total average for all possible systems is 10.5db. What is the effect of this increase? Is it as effective as if the carrier power has been increased the same amount, say 10db—ten times? Yes, it is and usually better. Another question arises: Will the increased power modulation techniques upset present interference conditions? First of all, these techniques do not violate interference rules because interference rules are all based upon field-strength ratios, and nothing is being done to increase field strength (with the slight exception of increasing carrier shift in the plus direction). This is not to dodge the practical side of the interference question. Co-channel interference is determined mostly by carrier beating. Increased modulation will help some to extend the coverage signal beyond the 20:1 interference point, but will have almost no effect to giving increased interference to other co-channel stations.

Adjacent-channel interference is considered to be at a 1/1 field ratio, but in practice it may be influenced by modulation power. Today, most radios are sensitive enough so that objectionable interference is seldom experienced at the 1/1 ratio area. ▲

Modulation Power

(Continued from page 12)

critical listeners may provide the best results. Always use a very high quality demodulator, amplifier, and speaker system.

Linearity Correction

A linearity-correction amplifier inserted just following the limiter can correct for the nonlinearities that occur in the transmitter audio system. The amplifier produces precisely controlled distortion which is equal in amplitude but opposite in phase to the distortion produced in the transmitter. Amplifier adjustment is made by inserting a tone at a level equivalent to 100% modulation and adjusting the amplifier for minimum system distortion. In typical cases, distortions of 5% to 7% can be brought down to the 2% range; 3% systems can be corrected to below 1%. Some advantages are as follows: large transmitting tubes (modulators, modulator drivers, and PA tubes, etc.) can be used longer with satisfactory results; positive-peak linearity can be increased for older transmitters, thus allowing for additional modulation increases by other processes; distortions produced by carrier shift can be corrected—if a 5% positive carrier shift is introduced by the correction amplifier, a negative 5% carrier-shift distortion could be corrected, leaving the desired stable carrier.

Reverberation and Echo Chambers

To provide a "fuller" sound, audio is delayed by various processes: tape machine, delay line, echo chamber, or mechanical spring delay; the tape machine probably offers the most practical approach. The original audio is delayed using a second head and mixed back into the original signal. This produces a slight echo effect which, to some ears, makes the music sound more alive. It's doubtful that additional modulation power is attained by this process, but some of the low-level portions of the program material are filled in, giving the subjective impression of "more sound."

Conclusions

Increases in modulation power obtainable from the various techniques discussed are listed below,

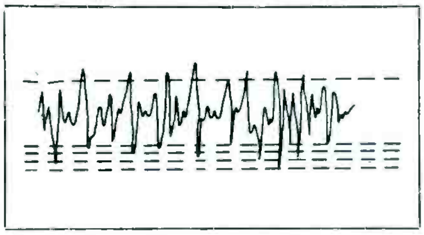


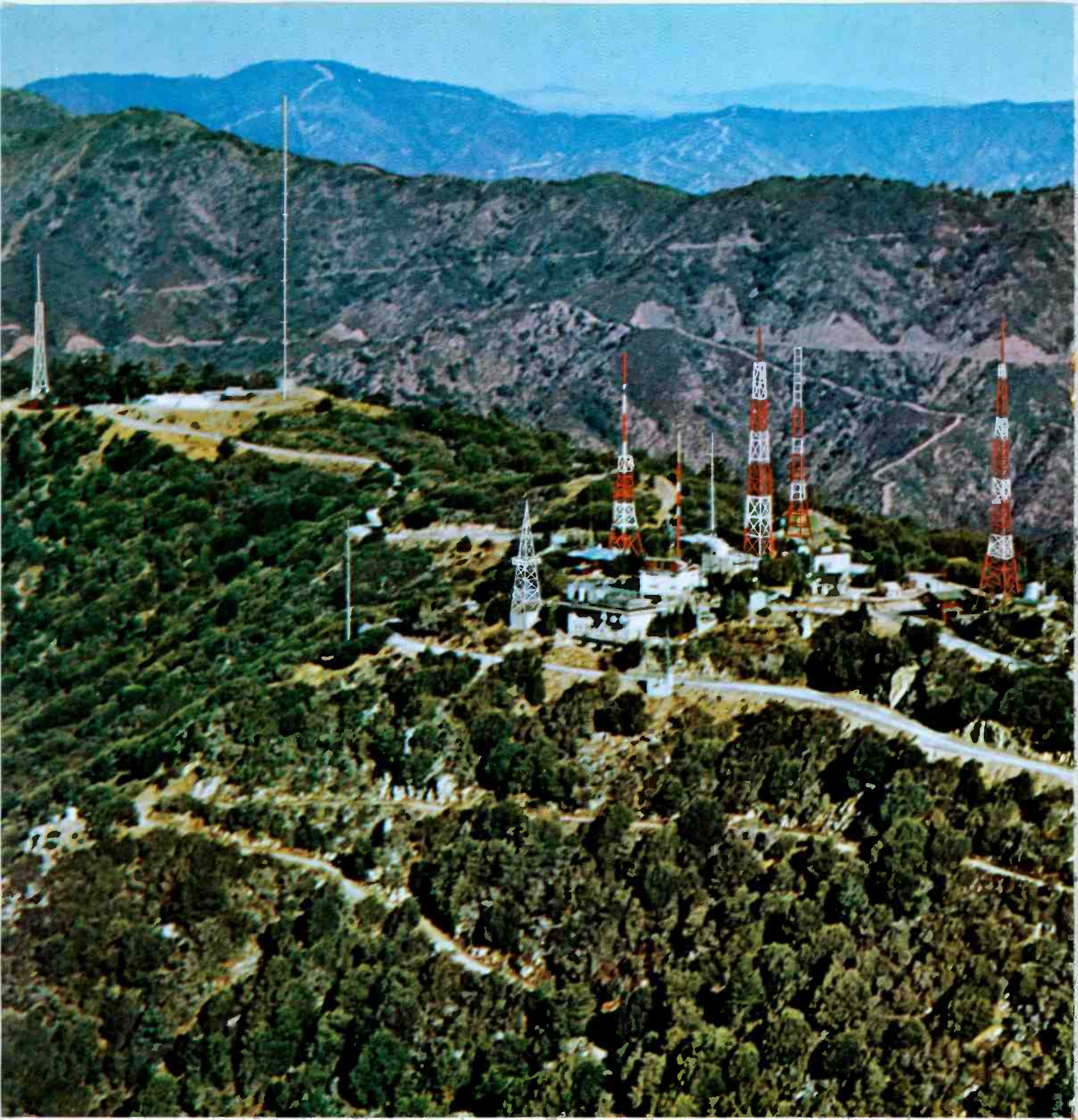
Fig. 6. Depending on negative-peak excursions, clipping level varies widely.

and minimum, maximum, and average expected db increases are also given:

1. Frequency response alteration: .25db to 1db, average .5db.
2. Automatic level control: 4db to 10db, average 6db.
3. Carrier-shift correction: .25db to 1db, average .5db.
4. Control of audio - wave symmetry: .5db to 4db 50% of the time, average 1.5db.
5. Antenna-loading compensation: .25db to 1.25db, average .5db.
6. Instantaneous peak clipping: 1db.
7. Linearity - amplifier correction: 0db to 1.5 db, average .5db.
8. Reverberation systems: 0db.

The total average for all possible systems is 10.5db. What is the effect of this increase? Is it as effective as if the carrier power has been increased the same amount, say 10db—ten times? Yes, it is and usually better. Another question arises: Will the increased power modulation techniques upset present interference conditions? First of all, these techniques do not violate interference rules because interference rules are all based upon field-strength ratios, and nothing is being done to increase field strength (with the slight exception of increasing carrier shift in the plus direction). This is not to dodge the practical side of the interference question. Co-channel interference is determined mostly by carrier beating. Increased modulation will help some to extend the coverage signal beyond the 20:1 interference point, but will have almost no effect to giving increased interference to other co-channel stations.

Adjacent-channel interference is considered to be at a 1/1 field ratio, but in practice it may be influenced by modulation power. Today, most radios are sensitive enough so that objectionable interference is seldom experienced at the 1/1 ratio area. ▲



This is L.A.'s Mt. Wilson, where 6 out of 10* TV stations

*Soon to be 7 out of 11...by the end of the year a new station, KMTW (TV), Channel 52, also will be on the air (subject to FCC approval) with a G-E Helical Antenna.

Negative Resistance

(Continued from page 17)

age, current, and frequency. There were few devices that displayed negative-resistance characteristics naturally; the phenomenon was achieved by means of feedback, and circuit operation could be analyzed validly either as negative resistance or as feedback.

The point-contact transistor was the first semiconductor device that had negative-resistance characteristics. The alpha of the point-contact transistor is greater than one over part of its range, which leads to a negative-resistance region that is either current-stable or voltage-stable, depending on the connection of the unit. Point-contact transistors rapidly went into use as miniature oscillators and switching units for early digital computers.

In the span of a very few years, many semiconductor devices displaying an intrinsic negative-resistance characteristic were invented. The variety of units with different characteristics now permits broad latitude in the use of negative resistance as a circuit element. The true scope of this new circuit tool is better noted by listing recently developed devices that display a stable negative - resistance characteristic. Among them are the point-contact transistor, the four-layer diode, the hook transistor, the silicon-controlled switch, the silicon-controlled rectifier, packaged negative-resistance elements, the unijunction transistor, and—the most promising device of all—the tunnel diode.

Next month, in Part 2 of this article, we'll examine this device and others in detail and investigate their operation and function in simple circuits. The entire electronics industry stands to profit enormously from this new generation of semiconductors in widely diverse applications. Even though broadcasting, so far at least, uses only a few such devices, the time rapidly approaches when they will become as commonly employed as simple vacuum tubes and relays are today. ▲

CATV Cable

(Continued from page 19)

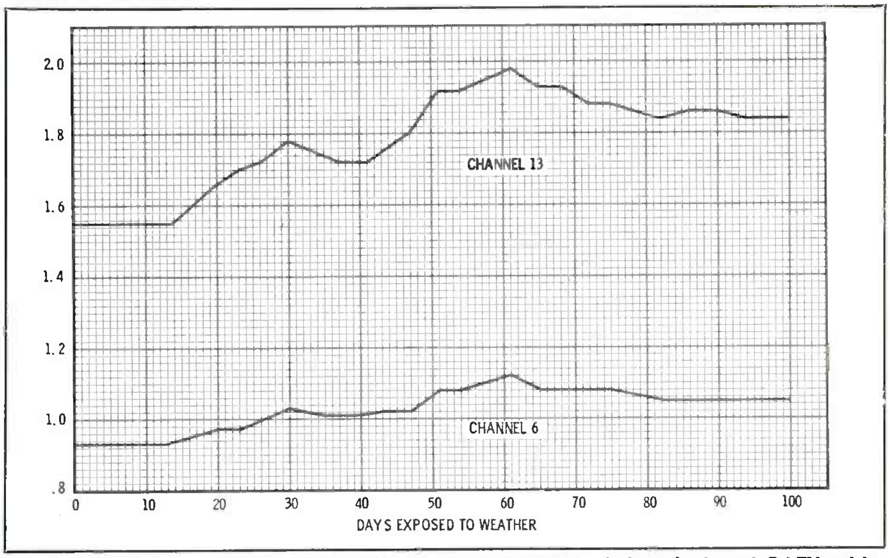


Fig. 2. Graphs show loss effects of moisture sprayed on polyethylene-jacketed CATV cable.

each day for 50 days, then allowed to dry for 50 days. Attenuation increased as long as wetting continued and then dropped slightly under dry weather conditions. An important factor is the difference in attenuation between channel 6 and channel 13. A CATV system employing effective AGC amplifiers can handle the increase in attenuation at channel 6, but not the increase at channel 13, which can be as much as 28%.

Aluminum-Sheathed Cables

The problem of moisture, however, has an answer—semiflexible aluminum-sheathed cable (see Fig. 3A). For effective moisture prevention, the jacket is a seamless aluminum tube. The aluminum jacket is swedged down to the point that the foamed - polyethylene dielectric is compressed between the sheath and the center conductor. This compression prevents water and water vapor from traveling longitudinally along the cable. No cable—not even aluminum-sheathed types—can be permanently free from all pin holes along its entire length, but compressing the dielectric ensures that moisture cannot travel within the cable, thus eliminating moisture accumulation.

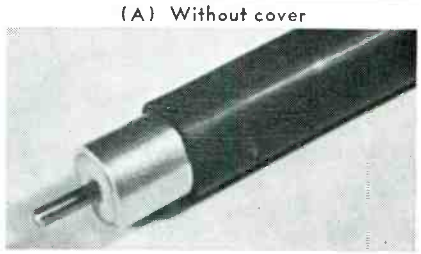
Because they are durable and moisture proof, aluminum-sheathed cables are now used almost universally in modern CATV systems. In most systems, the aluminum tube serves both as outer conductor and outer jacket. However, in some locations a polyethylene jacket is required (see Fig. 3B). Polyethylene-jacketed aluminum cable is used under the following circumstances:

1. Where cable is to be buried for an underground system.
2. Where the atmosphere contains a high percentage of salt (sea-shore systems) or other chemical pollutants that attack aluminum.
3. Where the area abounds with squirrels. Certain species of squirrels will sharpen their teeth on aluminum cable, sometimes damaging it. They don't, however, like the taste of polyethylene.

Conclusion

Demands of viewers for increased fidelity of the TV signal provided by CATV systems has made necessary new cable-evaluation criteria and techniques. Methods for determining attenuation characteristics outlined in this article will assist operators in evaluating cables for various systems. ▲

(A) Without cover



(B) With cover

Fig. 3. Aluminum-jacketed cables with or without outer cover resist moisture well.

July 1965

We interrupt this magazine to bring you...

Late Bulletin from Washington

by Howard T. Head

New Table of UHF TV Assignments

The Commission has adopted a new Table of UHF Television Channel Assignments and has proposed a new class of lower-power, lower-height UHF station (April 1965 Bulletin) to be assigned on a demand basis on channels 70-83, inclusive. The new table provides for a total of 1080 assignments below channel 70, of which 508 are reserved for noncommercial educational television stations.

Under the new allocation table, no regular commercial assignments are made to cities with population less than 25,000, but channels 70-83 will be reserved for "community-type television stations" for these cities. Maximum permitted ERP would be 10 kw with an effective antenna height of 300'. Cochannel mileage separations of 50 miles, and adjacent-channel separations of 20 miles, would be established for the new low-power stations.

Television translators already operating on channels 70-83 will be permitted to continue, and new translators on these channels will be authorized on the same basis as previously. Translators will continue to be assigned on a secondary basis, however; that is, their assignments may be pre-empted by application for one of the new low-power stations.

AT&T To Delete Beep Requirement

The National Association of Broadcasters (NAB) has notified the Commission that it is withdrawing a complaint filed against AT&T relating to the present requirement for the insertion of a "beep" signal in material taken from telephone circuits and recorded for broadcast. In withdrawing the complaint, NAB informed the Commission that AT&T has agreed to voluntarily modify its tariffs to eliminate the requirement.

Field Strength/Distance Curves; Antenna Farms

In related actions, the Commission has proposed new field-strength-vs-distance curves for television use and has invited comments on a proposal to establish antenna farm areas for tall FM and television towers (March 1965 Bulletin). The new field-strength curves consist of new F(50,50) curves for television channels 2-6, 7-13, and 14-83 to replace the F(50,50) curves now in the Commission's Technical Standards.

Also proposed for the first time are F(50,10) curves for determining "equivalent protection" to existing FM and television stations. The provision for "equivalent protection" is made necessary by the proposed antenna farm areas, since they may in many instances be located where not all stations using them will be able to comply with usual minimum mileage separation requirements. The Commission's proposal does not, however, include details of how "equivalent protection" will be established; this is expected to be a troublesome problem, particularly at UHF where the "taboo" requirements cannot readily be met by reducing height and power, nor by employing directional antennas.

New Multiple-Ownership Rules Affirmed

In a recent case involving two AM stations in North Carolina, the Commission has made clear its intention to adhere strictly to the letter of the new multiple-ownership Rules which forbid the licensing of two stations under common ownership in cases where there would be any overlap of the 1 mv/m groundwave contours. In the North Carolina case, the applicant had expressed his willingness to directionalize or reduce power of one of the stations to eliminate the overlap. The Commission refused to consider this proposal, however, stating that such a reduction in service would not appear to be in the public interest.

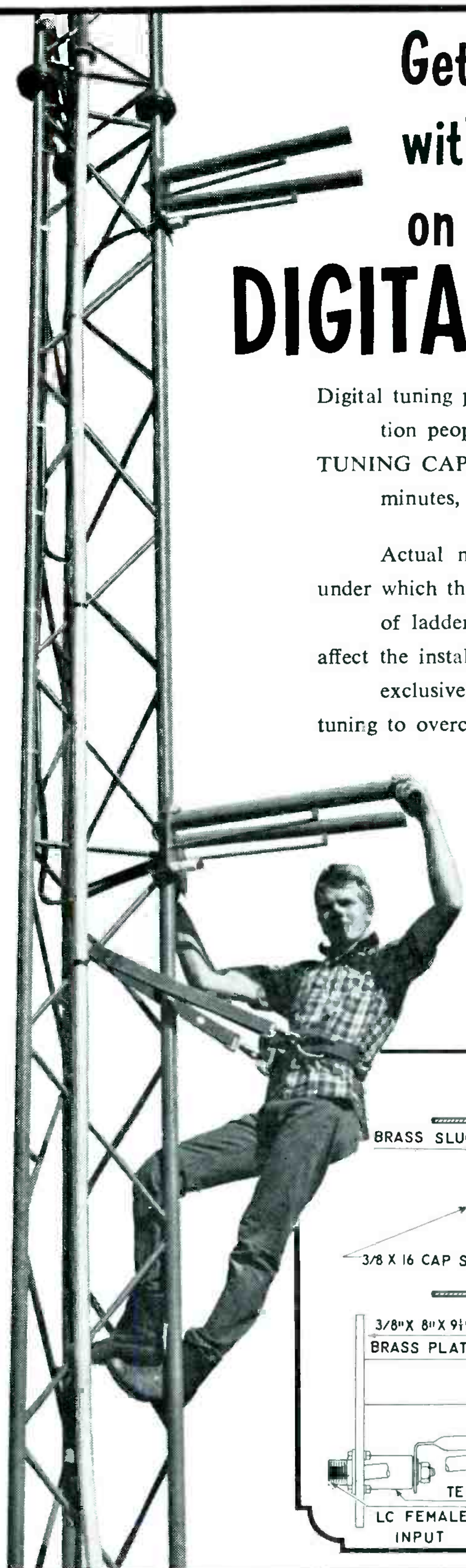
Interim Policy on Translator Grants

In a recent action granting new UHF television translators in Florida, the Commission announced its intention to formulate a definitive policy in the matter of licensing any television translator whose service would duplicate that of a television broadcast station (see February 1965 Bulletin). Under an interim policy, the Commission will require that a translator, upon request of a television broadcast station whose calculated Grade A contour includes the translator, not duplicate -- either simultaneously or 15 days before or after -- any program carried by the station. This interim policy is essentially the same as that now followed by the Commission in imposing restrictions on CATV systems that employ microwave relays.

Howard T. Head...in Washington

Get improved antenna VSWR with a simple field adjustment on JAMPRO's new

DIGITAL FM ANTENNA



Digital tuning permits JAMPRO antennas to be field tuned by installation people in a matter of minutes by EXCLUSIVE END TUNING CAPS*. The average 8 bay installation requires less than 30 minutes, using the transmitter reflectometer.

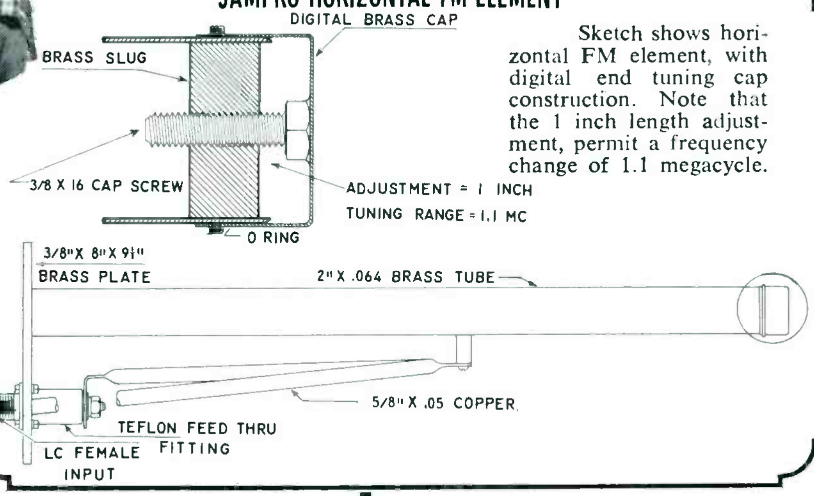
Actual mounting conditions may be different than those under which the antenna was tested. Tower lighting conduits, placement of ladders, tower construction and co-axial cable runs, all affect the installed VSWR of leg and face mounted FM antennas. The exclusive JAMPRO digital tuning feature permits fine field tuning to overcome these problems.

This exclusive JAMPRO feature permits overall VSWR values as low as 1.02 to 1. With tower leg or face mounted horizontal and vertical FM antennas, it is always possible to achieve 1.1 to 1 or better, 200 KC above and below carrier. JAMPRO antenna VSWR is not affected by fog or rain.

*Patent Applied For.

Write for catalog on Horizontal or Dual Polarized FM Antenna.

JAMPRO HORIZONTAL FM ELEMENT



Sketch shows horizontal FM element, with digital end tuning cap construction. Note that the 1 inch length adjustment, permit a frequency change of 1.1 megacycle.

JAMPRO

ANTENNA COMPANY

6939 POWER INN ROAD SACRAMENTO, CALIFORNIA

Circle Item 18 on Tech Data Card

Antenna and Transmission

(Continued from page 25)

inch.) This graph paper is thin enough to see the scope trace, although it may be helpful to increase the intensity. This step must be performed with extreme accuracy for best results.

When the trace has been transferred to the graph paper, a careful inspection can be made of the excursion of any complete sine wave on any part of the trace. It is reasonable that a broad-band antenna will not be perfectly flat. This sweep method allows the engineer to determine the VSWR not only at the aural and visual carrier frequencies, but at any point in the sweep spectrum.

A VSWR figure can now be computed by using the following formula:

$$VSWR = \frac{60 + X}{60 - X}$$

where,

60 = 60 divisions on the K & E 20 x 20 graph paper or 3″ deflection on the scope, and

X = Number of vertical divisions that any one complete sine wave covers on the graph.

The resultant figure will be the ratio between the open line (maximum deflection of 3″) and the terminated line (minimum scope trace).

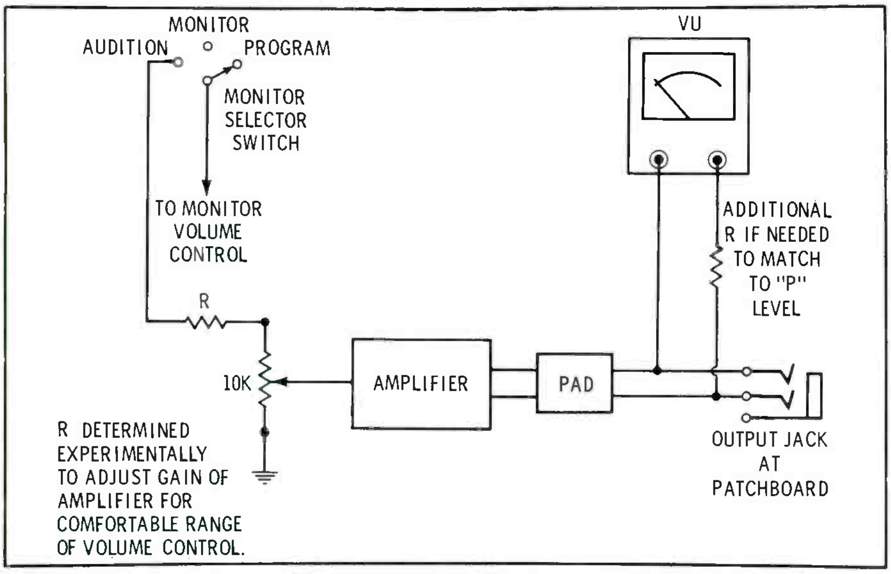
Fig. 5 shows some traces taken from the face of a 5″ scope and transferred to the graph paper. It also shows a chart, obtained by using the above formula, which can be used for a VSWR-reference calculation.

It may be preferable to take pictures of the tests to keep for reference. A Polaroid oscilloscope camera using 3000-speed film set with the lens opening at f1.9 and the speed at 1/25 sec. will produce excellent results.

Conclusion

These measurements should be made on a monthly basis. The results should be recorded and used for comparison with measurements repeated at the end of a one-year period. Any irregularities can be detected and corrected. By using these methods, the broadcast engineer can be confident of the performance of the television-station antenna system. ▲

ENGINEERS' EXCHANGE



Dual-Channel Modification of "Yard"

by Herbert Greenberg, Technical Consultant, and Richard Drake, WALI, Adelphi University, Garden City, N.Y.

A dual console is considerably more useful than one capable of handling only one program. Here at WALI, the Yard console "A," or audition, bus was connected to a spare small amplifier through an isolating resistor and a gain control which becomes the "A" master. Once the master control is set, all "A"-channel gain adjustments are made with the individual mixer pots.

A spare VU meter was wired to read the output, and the audio pair from the added amplifier was terminated at the patch panel. The gain of the amplifier was set to correspond to the "P," or program, side so that a remote line level could be checked in advance before switching for airing.

Good engineering practices indicate the use of an isolating pad at the output. The input impedance of the amplifier should be fairly high (or matched with a transformer), or resistance may be inserted for isolation. Similarly, the output can be terminated in a standard load resistor to maintain VU readings. The resistance can be arranged to lift at the patch terminals or be left in the circuit if bridging inputs only are used with the output. The increased capabilities more than justify the relatively simple modification, which disturbs no other functions of the console.

Dual Recovery Time For Gated Compressor

by Jim Dorsey, Chief Engineer, WLPM, Suffolk, Va.

In trying to boost our average modulation, we found that control-room noises became objectionable long before maximum efficiency was reached in our automatic gain

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The TDA2 is a completely solid state instrument transistorized all the way with a regulated, built-in power supply. The circuit was designed to meet exacting color standards for the TV industry. These TDA2s will accept composite or non-composite video at a bridging type input of as little as 0.25 volt and will deliver four individually isolated 75 ohm outputs of 1.0 volt, peak to peak. They replace all tube type amplifiers without alteration of existing cables. Weighs under four pounds and is only 1¾ x 19 x 7 inches overall.

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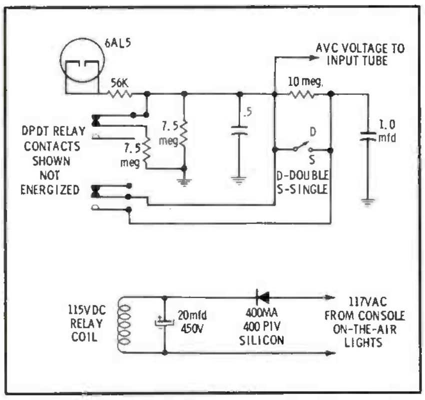
Circle Item 23 on Tech Data Card

amplifier. We sought to slow the recovery time of our unit only when the control-room mike was on. The circuit we developed uses a 115 VDC continuous-duty relay which operates from rectified AC from the on-the-air lights in the console. We used DC to prevent arcs on the key contacts.

This relay connects another resistor to ground from the AVC buss



and also changes the unit from single- to double-recovery operation. Since this relay controls accumulative AVC voltage, it makes no noise and doesn't noticeably change the level when it changes position.

Our unit is a Gates Sta-Level. However, the circuit will work in any gated compressor. Using 25db compression for a reference, our time constants change from 1.65 sec to 11.25 sec recovery time when the relay is energized. The station engineer can change resistance values by consulting the instruction book and performing a little experimentation.

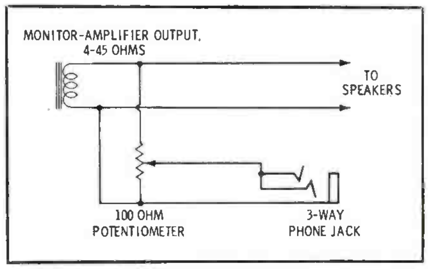
Level Control For Low-Z Headsets

by Ronald Pesha, Chief Engineer, KTHO, Tahoe Valley, California

Our announcers prefer to use the stereo headsets which are widely sold on the high-fidelity market. The innards of these headsets consist of small speakers with typical impedances of 4 to 16 ohms.

When so low an impedance is plugged into the usual headset jack wired across a 600-ohm program line, the line is virtually shorted out. Furthermore, these stereo headsets use three-way phone plugs, with each earpiece wired separately.

As shown in the schematic, a 100-ohm potentiometer is wired across the station's monitor-ampli-

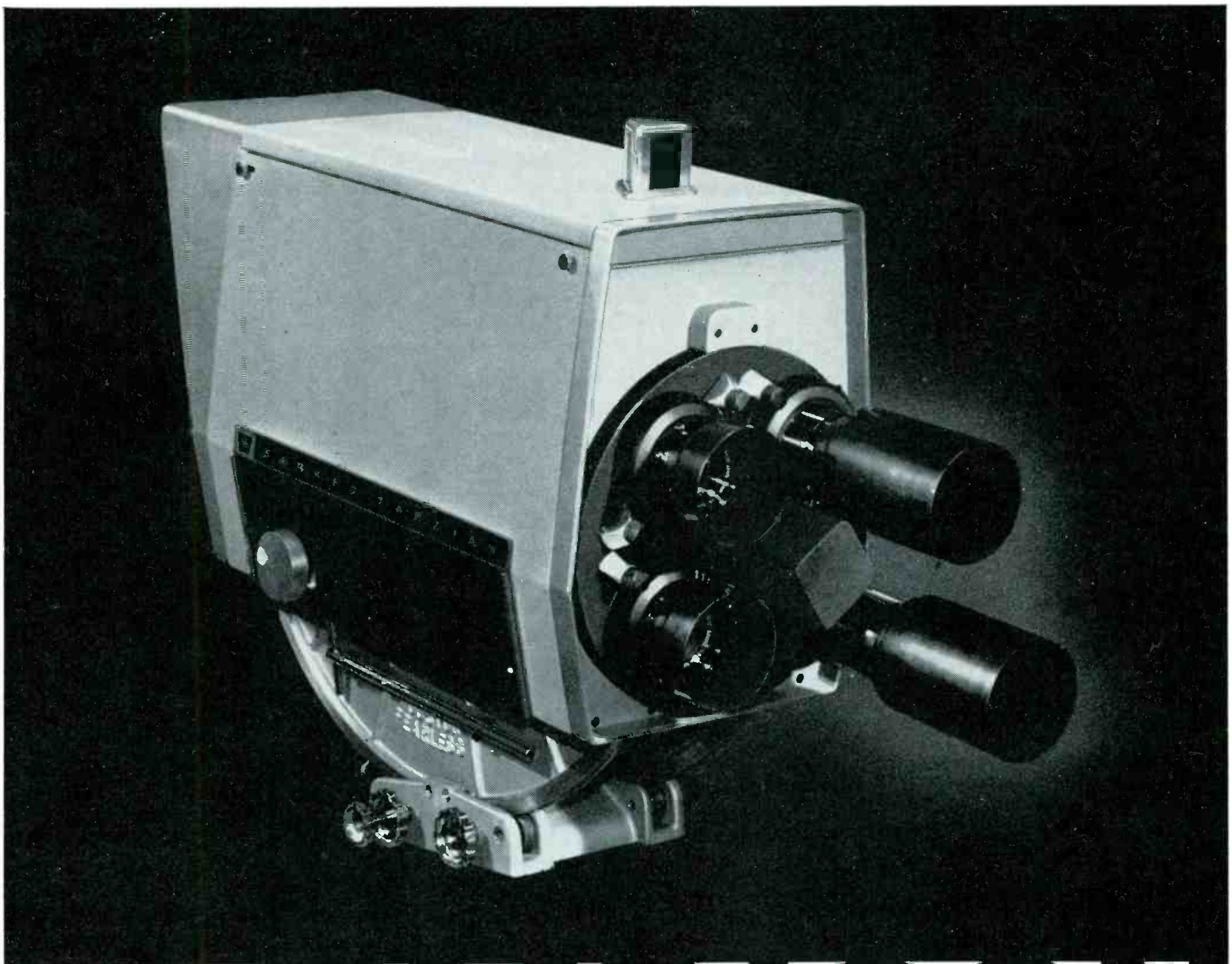


fier output. The potentiometer allows the operator to control the level of his phones. The level is also dependent on the setting of the monitor-amplifier gain control, and the headset impedance is not matched. More sophisticated ap- could eliminate these minor drawbacks, but this circuit is quick and easy.

Warning Operator of Carrier Failure

by 1st Lt. George M. Durenberger, Jr. 269th Signal Comany, APO, N. Y.

A device which will automatically warn the operator of a carrier failure or lack of modulation is a must for every small station. The unit described here is simple and costs just a few dollars to build. It will announce carrier failure or loss of



PLUMBICON

Field proven? Tarzian's is. Tarzian plumbicons are in use today . . . in actual station operation. And, Tarzian's on-the-job experience verifies plumbicon as the first really significant improvement in television camera pickup tubes in years.

Here's a camera with a high sensitivity and the ability to handle wide contrast ratios, like an IO, combined with an exceptionally high S/N ratio (48 db) . . . especially well-suited for taping. The new plumbicon tube is excellent for both color and monochrome use, exhibits no lag, and has an exceptionally long life of several thousand hours.

For your early delivery or additional information on the Tarzian plumbicon, contact your Tarzian regional manager, or call or write direct.

SARKES TARZIAN

BROADCAST EQUIPMENT DIVISION — BLOOMINGTON, INDIANA

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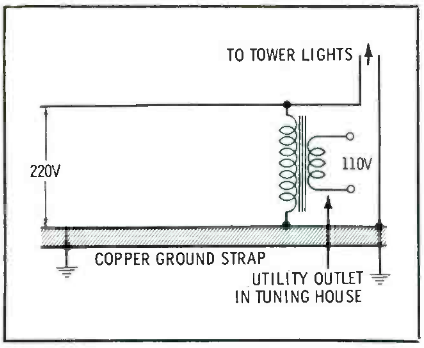
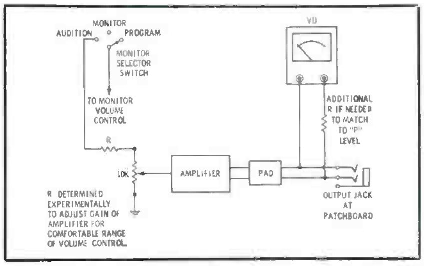


modulation by flashing a light at the operator or by sounding an alarm. Here's how it works: Station carrier signal is rectified by the diode, and audio is applied to the grid of V1a as in an ordinary receiver. The audio output of V1a is rectified and applied as DC bias to the grid of V1b. As long as there is modulated carrier present, V1b is cut off and K1 remains open. Should the modulation drop below a certain level (or fail to appear), the condenser at the grid of V1b will discharge, causing the tube to conduct, closing the relay, and actuating an alarm. The parts values are not critical. Delay in warning can be adjusted by varying the RC combination at the grid of V1b. Operation at reduced voltages results in extended tube life. The unit can be housed in a minibox and mounted near the control console. It draws just a few watts, gives off little heat, and has proved extremely dependable.

Economizing on Tower Lighting Wiring

by Robert A. Jones, Professional Engineer, Lorain, Ill.

In most directional antenna systems I've seen, two wires (sometimes even three) are run between each tower where tower lights are required; actually only one wire is needed. The fact that the copper ground system is an ideal return circuit or common wire (neutral) is often forgotten. In fact, for the



safety of the station operators where two wires are used, the neutral wire is always grounded both at the towers and at the transmitter.

Another method is to use 220 volts instead of 110 volts; this is sometimes done where Austin transformers are required. By employing the higher voltage, conductor size and current demand are both reduced. We installed just such a system at WBBY and added a small 220/110-volt stepdown transformer in each tuning house to use for a light-and-utility outlet. ▲

To what lengths must a cable manufacturer go to prove his product is better?

As long as the distance between your amplifiers—even up to one-half mile continuous lengths.

When Times Wire and Cable decided to build a CATV cable to outdistance any other in length and performance, we really went all the way: We built a cable that can span the entire distance between your amplifiers.

However, it's not just that Times JT-1000 CATV cable is longer that makes it better. It's also continuous. It's seamless for the entire length. And it's aluminum. Put them all together and you have *continuous seamless aluminum tube sheath CATV cable* in lengths up to ½ mile long—a feat nobody else has yet been able to match!

Here's what these new longer lengths mean to your CATV operations:

■ **Easily saves you 10% installation and shipping costs.** Longer lengths mean fewer splices—8% saved. Another example: Only 1 reel needed for 2,500 feet of cable instead of 1 reel for each 1,000 feet—another 2% saved.

■ **Times seamless cable is waterproof.** Puncture it, splice it, apply as many pressure taps as you like. Water vapor and/or water can't travel in Times self-sealing solid sheath cable. Complete dielectric adhesion to center conductor and complete compression seal to outer conductor eliminate longitudinal vapor or water paths.

■ **Times cable gives you minimum return loss guarantee.** Your choice of guaranteed 26 db or 30 db minimum return loss—a must for minimum ghosting, true color reproduction.

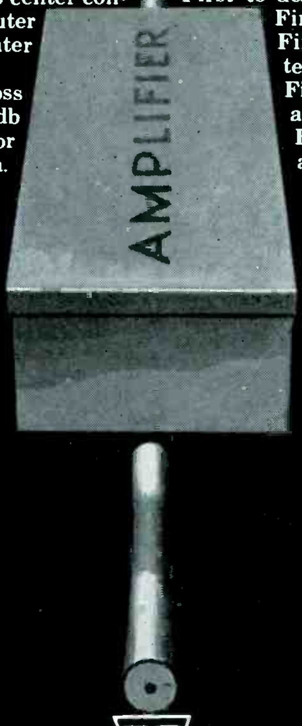
■ **Increases profit by decreasing splices and scrap.** Fewer splices mean less material wasted (fewer tailings), less maintenance needed, too. Less maintenance means less labor cost and more profit.

And don't forget: long after so-called economy cable has been replaced (it starts deteriorating the day you install it), Times continuous seamless aluminum tube sheath CATV cable will still be a top performer, keeping pace with your system's planned potential.

There you have it: the longer the cable, the fewer the splices, the lower the maintenance, the better the performance . . . and the higher the profits. Times did it all, with its new longer CATV cable . . . and we're shipping it right now!

Presenting the Times Family of Firsts— The Standards of the CATV Industry . . .

First to design a long-life cable specifically for CATV.
First with foam dielectric cables for CATV.
First with cable that made all-band CATV systems economically feasible.
First to offer 26 db minimum return loss guarantee for CATV.
First again with ½ mile lengths of seamless aluminum sheath CATV cable.



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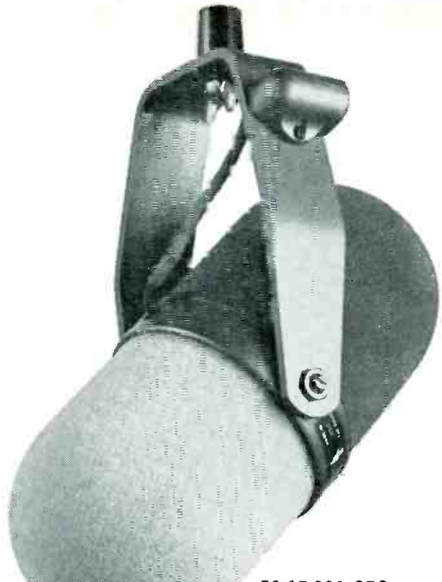
NEW

SHURE SM5

UNIDIRECTIONAL DYNAMIC BOOM MICROPHONE

SOLVES THE AUDIO ENGINEER'S MOST ANNOYING BOOM PROBLEMS

THE PROBLEM	HOW THE SHURE SM5 SOLVES IT
Sound coloration—from stage reflections or off-mike performers.	True Cardioid pickup pattern—symmetrical about the axis and exceptionally uniform with frequency. Excellent background noise rejection.
Wind and Boom noise from fast boom swings.	Two-stage mechanical isolation—two-stage permanent windscreen assembly. Element and isolation completely surrounded by outer wind shell, minimizing wind and mechanical noise in any indoor or outdoor application.
Pickup of electrical hum	No transformers or inductors. May be used in extreme hum fields.
Maneuverability	Perfectly balanced, lightweight — excellent stability, minimum overswing.
Mechanical Damage	Element and isolation assembly protected by outer windscreen and steel reinforcing rods.



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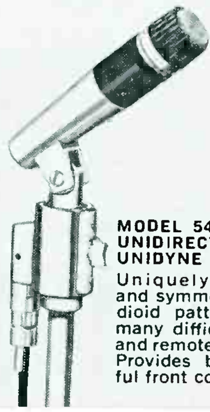
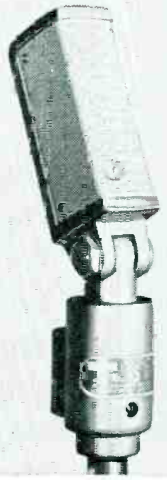
MODEL 576 OMNIDIRECTIONAL DYNAMIC
Only ¾" diameter! 40% smaller diam., 60% smaller area than popular dynamic omnidirectionals. Virtually flat from 40 to 20 Kc. Rugged steel case.

MODEL 570 LAVALIER DYNAMIC
Outstanding on the job. Specially shaped response cuts "chest boom" . . . provides unequalled presence. Non-metallic "Flex-Grip" hanger . . . silent, secure. Only ¾" diam.



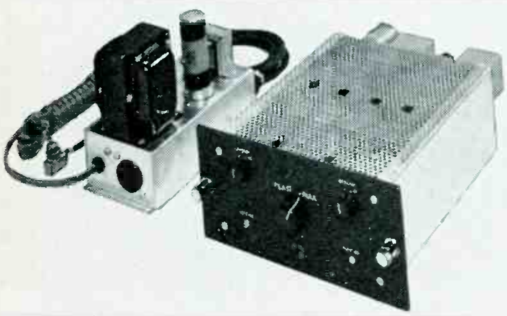
MODEL 546 UNIDIRECTIONAL UNIDYNE III
Uniquely uniform and symmetrical cardioid pattern solves many difficult studio and remote problems. Provides broad useful front coverage.



MODEL 333 UNIDIRECTIONAL RIBBON
Extremely rugged. Exceptionally attractive and compact. Ideal for music (stereo or mono) and general applications on stand or boom. Super cardioid, flat wide-range response.

CIRCUITRY

Shure stereo equalizer and preamplifiers are praised as MAJOR contributions to upgrading station quality by broadcasters.

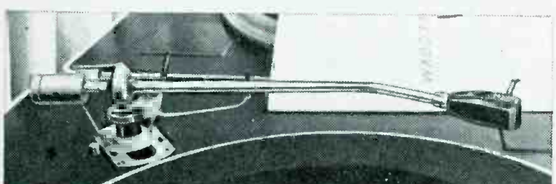


SE-1 STEREO TRANSCRIPTION PREAMPLIFIER
Provides precise RIAA equalization from magnetic phono reproducers at line levels. Separate high and low frequency response trimmers. Lowest distortion, noise level, susceptibility to stray RF fields.

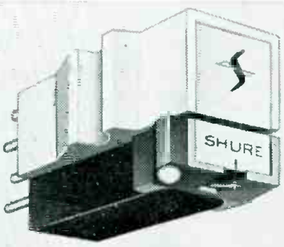
M66 BROADCAST STEREO EQUALIZER
Passive equalizer compensates recorded frequency to three playback characteristics: RIAA, flat, roll-off. Provides precise equalization from magnetic pickup at microphone input level.

TONE ARMS & CARTRIDGES

World standard for quality sound.

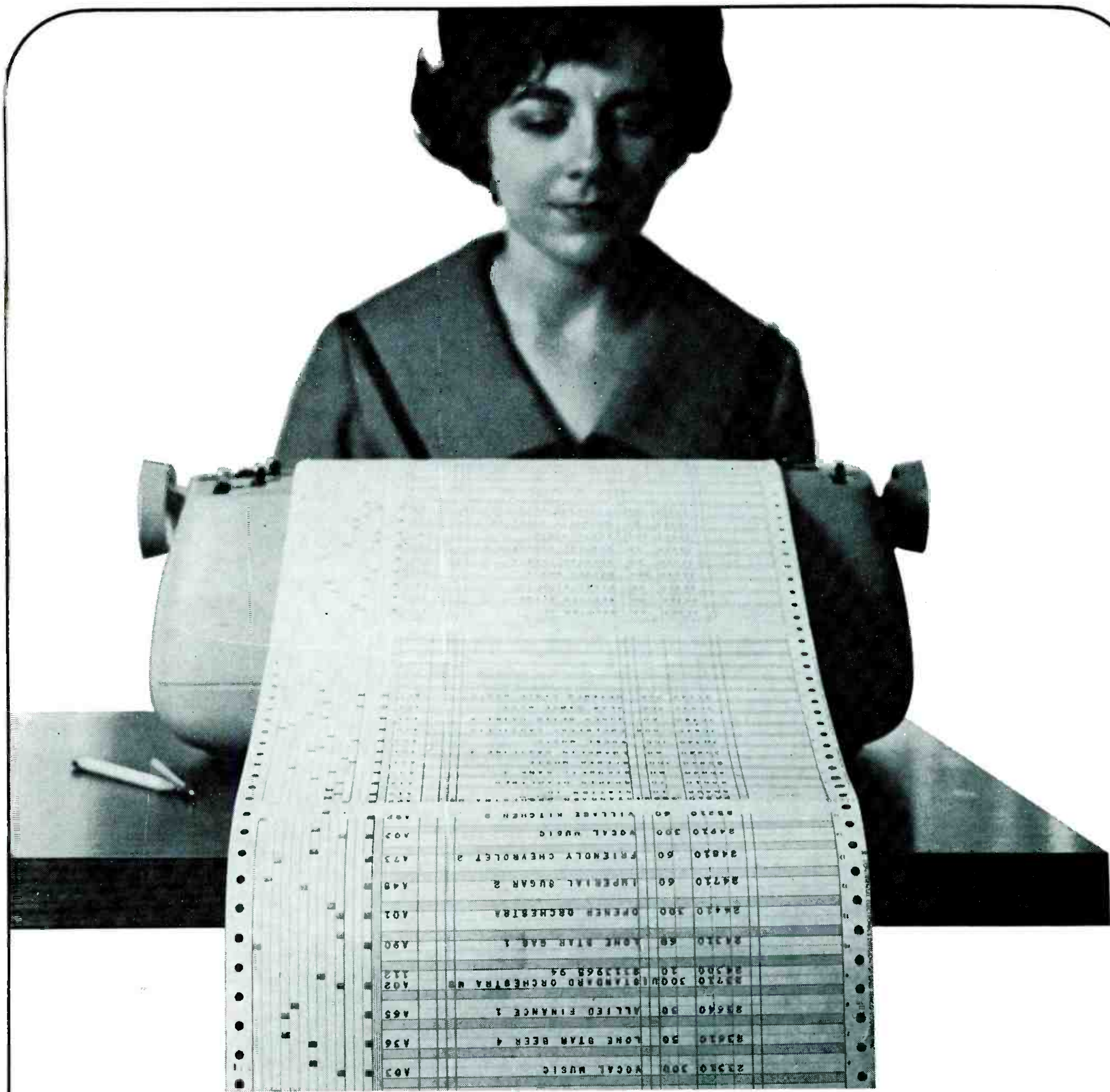


SHURE SME "THE BEST PICK-UP ARM IN THE WORLD"
Utterly beyond comparison. Supremely accurate, proved reliable in quality music stations.



STEREO DYNETIC Phono Cartridges
First choice on every count—standard in the quality music stations.

Write directly to Mr. Robert Carr, Manager of Professional Products Division, for personalized assistance, technical data, samples for testing: Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill.



add 3 ■ s to your Log

and get automatic programming, logging and authenticating (only PROLOG can do it)

PROLOG uses your station log to give you any degree or combination of unattended, automatic, or manual-live operation you desire. PROLOG simply adds 3 squares (■) to the information you normally enter on the log. The entire log can be prepared on any standard typewriter, or you can use any of the auto-typing, Traffaccounting, IBM punch-card, and similar equipment in use today. PROLOG uses your established programming format; nothing changes unless you want to change it. That's PROLOG: simple and flexible!

For a 12-page brochure on PROLOG Systems, write to Commercial Sales Dept./Continental Electronics Mfg. Co./box 17040/Dallas, Texas 75217.

LTV *Continental Electronics*

A DIVISION OF LING-TEMCO-VOUGHT, INC.

Circle Item 31 on Tech Data Card

NEWS OF THE INDUSTRY

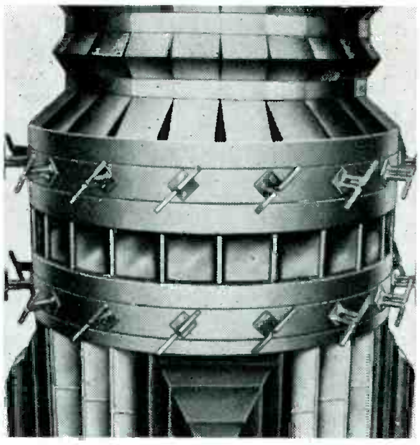
NATIONAL

New Radio System Corrects Garbled Signals

A radio receiving system that would automatically eliminate static, blackouts, and any other atmospheric interference obscuring the signals it receives, was described recently in Houston, Texas, by a Purdue University electrical engineer.

Prof. Paul E. Wintz, of Purdue's Electronics Sciences Research Laboratory, said such a system is now being tested, using a tropo-scatter link between the Purdue Laboratory and the Collins Radio Company, 265 miles away. He reported on this research during a meeting of the National Telemetering Conference in Houston.

Preliminary tests have confirmed the Purdue theoretical work—a mathematical model of the unique receiver; the self-correcting system works, Wintz said, but research is continuing to determine how well it will work under all circumstances. The research project is supported by The National Aeronautics and Space Administration.



Master FM Antenna for Empire State Building

The nation's first master FM antenna, which will permit 17 FM stations to broadcast simultaneously, is to be installed atop the Empire State Building. Three FM stations will use the facilities as soon as they are installed, and leases for that use were signed on the building's 102nd-floor Observatory by representatives of **WQXR** (96.3 mc), **WHOM** (92.3 mc), and **WLIB** (107.5 mc).

Erection of the antenna will culminate more than six years of study by the Empire State Building and its consulting engineers, Dr. Frank Kear of Kear & Kennedy, Washington, D. C., and William Scofield of Edwards & Hjorth, structural engineers.

The antenna will be designed and fabricated by the Alford Manufacturing Company of Boston; installation of the system will be made by Gunnar A. Olsen and Belmont Electric Co., both of New York City. It will require about six months to install and will be erected on the 102nd floor at the 1250′ level of the structure.

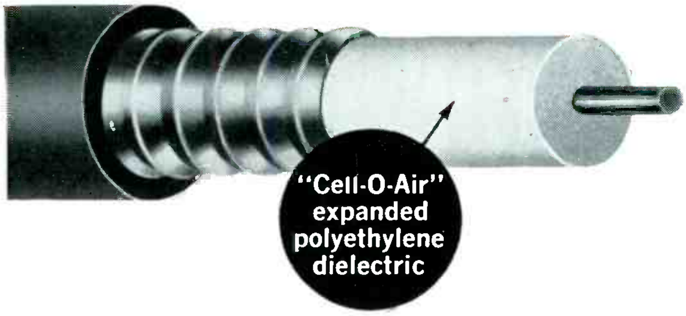
The new antenna will be omnidirectional, providing a substantially circular pattern with both vertical and horizontal polarization. One of the major results will be improved radio reception for automobile FM radios.

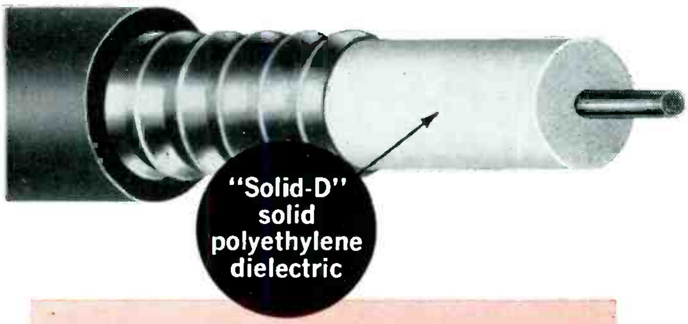
New York's nine television stations are currently utilizing antenna facilities atop the Empire State Building. The VHF stations are: WCBS-TV, Channel 2; WNBC-TV, Channel 4; WNEW-TV, Channel 5; WABC-TV, Channel 7; WOR-TV, Channel 9; WPIX-TV, Channel 11; WNDT-TV, Channel 13. The UHF stations are WNYC-TV, Channel 31, and WNJU-TV, Channel 47 (to be operational end of April).

GAB Grants Membership to CATV Organization

The **Georgia Association of Broadcasters** has approved Clearview of Georgia, Inc., one of the state's largest CATV operators, as an associate member. GAB indicated this is the first time any CATV company has been enrolled as an official member in any broadcaster's organization in the United States.

The CATV Cable that GUARANTEES FULL-SPECTRUM CAPABILITY





SUPERIOR Coaxial Cable

with "Coppergard"

Superior Coaxial Cable with Coppergard guarantees no attenuation discontinuity over the continuous range — through 219 MCS *and beyond!* This means you can *use* all the frequencies available to you. Unlike ordinary cables, which offer only the television band, Superior Coax was specifically designed for CATV to provide for full utilization of the frequency range in aerial and buried plant.

When you buy cable, insist on the brand that gives full-spectrum capability at no extra cost. Install Superior Coaxial Cable with "Coppergard," the cable your system will never outgrow.

See Us at NCTA Show

Booth 47-48

CHOOSE SUPERIOR CELL-O-AIR® COAX FOR AERIAL PLANT

Guaranteed Maximum Attenuation db/100′ at 58° F					
	Ch. 2	Ch. 6	108 mc.	Ch. 7	Ch. 13
4920	0.75	0.93	1.08	1.41	1.57
4930	0.58	0.68	0.80	1.07	1.20

CHOOSE SUPERIOR® SOLID-D COAX FOR BURIED PLANT

Guaranteed Maximum Attenuation db/100′ at 58° F					
	Ch. 2	Ch. 6	108 mc.	Ch. 7	Ch. 13
6020	0.74	0.91	1.05	1.38	1.55
6030	0.56	0.67	0.79	1.05	1.19

For detailed information and prices, write

Every Reel Sweep-Tested Over Its Full Length

SUPERIOR CABLE

SUPERIOR CABLE CORPORATION • HICKORY, NORTH CAROLINA

Circle Item 32 on Tech Data Card

Charles Doss, GAB president from WROM, Rome, said, "We are delighted to open our membership rolls to Clearview, Georgia, one of the largest and most progressive CATV companies in our state. A majority of GAB members are either in CATV or getting into CATV, and we can think of no better way to cooperate to mutual advantage than by having CATV members in the GAB. We will work to enroll any other CATV operator who wishes to take part in our activities."

Audio-Engineering Pioneer Passes

Clarence Joseph (C. J.) LeBel, president of the Audio Instrument Co. and vice-president of Audio Devices, Inc., New York, died in his sleep on April 14, at his home in New York City. He was 59 years old.

Mr. LeBel, a leading specialist in the field of audio and electrical engineering, held many patents during his career of nearly 40 years, including one of the basic patents on the fluorescent lamp (LeBel patent) and one for the surgeon's metal-locator electronic stethoscope (stethetron). Others touched on lacquer recording discs, magnetic recording tape and its applications, hearing-aid design, logarithmic amplifiers, intermodulation meters, and magnetic-tape time-delay units. He also authored two books, "Fundamentals of Magnetic Recording" and "How to Make Good Tape Recordings."

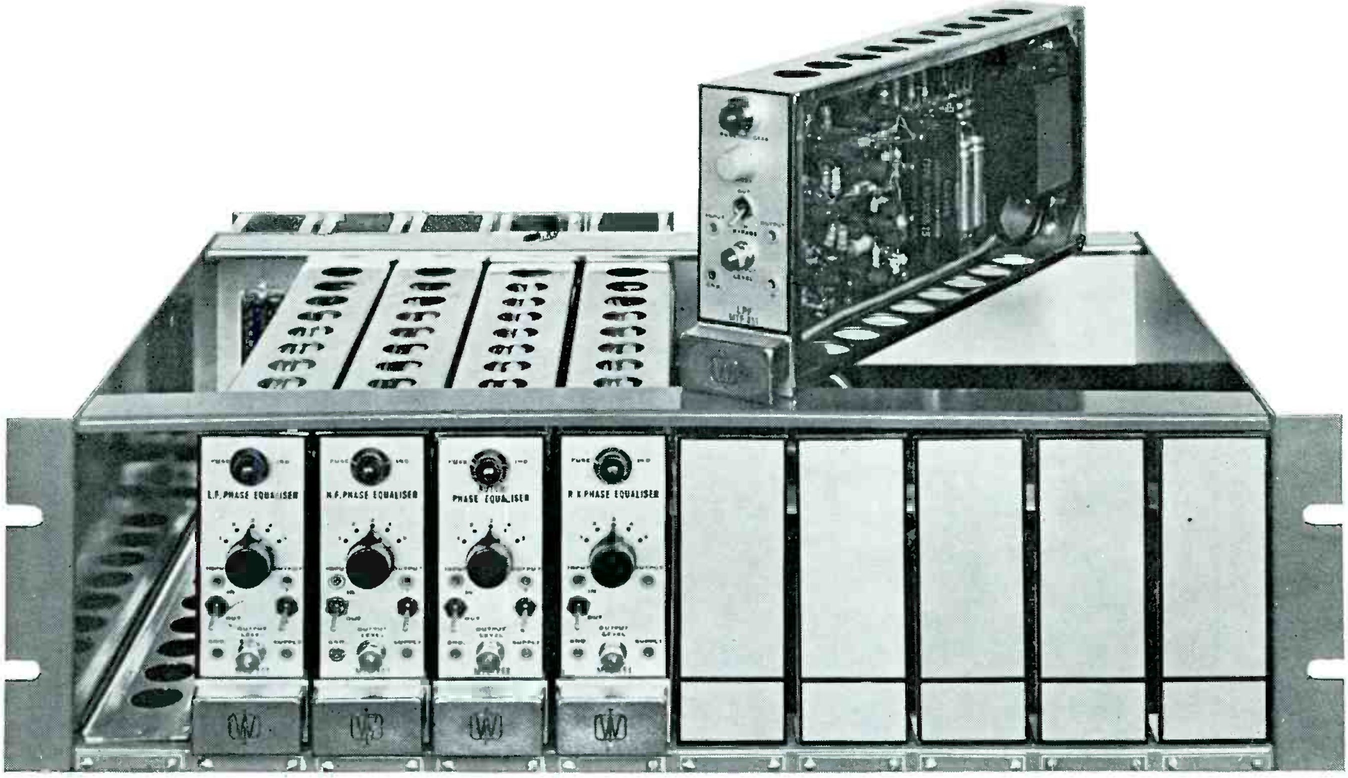
M. L. Koerner, Director of Engineering At Radio Liberty, Dies At 51

Meredith L. Koerner, Director of Engineering for Radio Liberty, died April 23 in Norwalk, Connecticut, at the age of 51. Prior to his assignment with Radio Liberty—the worldwide network which broadcasts to the Soviet Union—Mr. Koerner was project manager of Continental Electronics in Dallas, Texas; Deputy Director of Engineering for Radio Free Europe; Research Director at the Saginaw (Michigan) Broadcasting Co.; and Assistant Chief Engineer for the Office of War Information during World War II. He received his formal training in electronics at Valparaiso Tech, Valparaiso, Indiana.

ANOTHER 1st

A WARD

NEW TRANSMITTER **COLOR** PHASE EQUALIZER AND LOW PASS VIDEO FILTER!



Designed to ensure compliance with FCC color transmission standards, plus optimum video results, the Ward Color Phase Equalizer System precompensates the television transmitter for signal phase errors introduced by the overall transmission system . . . while obtaining better transient response and time coincidence between luminance and chrominance information. The Ward Video Low Pass Filter helps ensure compliance with FCC rules for avoidance of out-of-channel radiation, by restricting the bandwidth in the output of monochrome and color video transmitters.

Other Features Include: Small rack size (5¼" rack frame) • Performance can be optimized on air using Vertical Interval Test Signal • Built-in self-powered input and output isolating amplifiers • Equalizing networks isolated from cables and work between accurate source and terminating impedance • Multiple delay characteristics for optimum color performance • Negligible low frequency bounce • Each equalizing function in individual module • Adjustable for flat frequency response • By-pass switch on each module for test set-up and emergency purposes.

WARD ELECTRONIC INDUSTRIES

1414 EAST ST. GEORGE AVE., LINDEN, N. J. 07036 • (201) 925-4690

Circle Item 34 on Tech Data Card

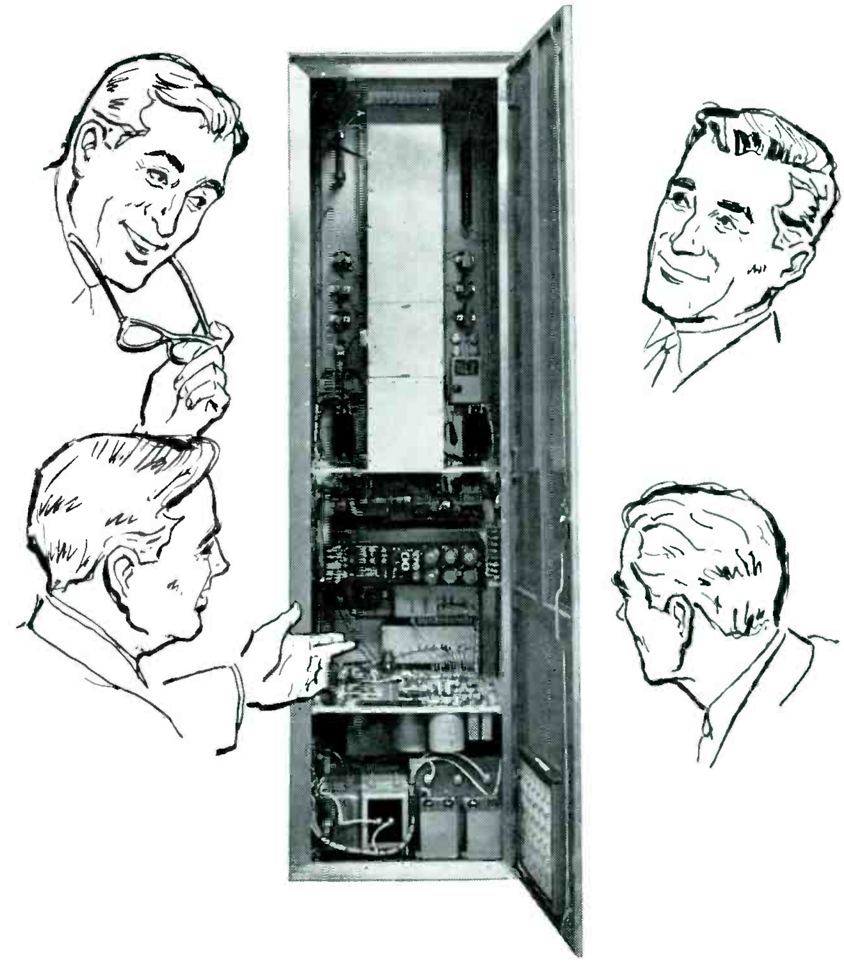
New 50-kw Transmitting Plant for WIBC

You often hear the saying that progress can be painful. In the case of WIBC, Indianapolis, Indiana, and the Interstate highway system, the adage has certain poignancy. When state and federal surveyors laid out a system to speed access to Indianapolis and modernize the highways north of the city, part of the six-tower directional array in use at the present location stood right in the path of the multilane expressway. Since operation with fewer towers than the licensed six is rather frowned upon by the FCC, the only recourse was to relocate in some other area. In spite of the fact that the expressway is not scheduled to be constructed until after 1967, Chief Engineer Clifford Luke and the station management decided to begin work on the new plant immediately so as to have as much time as possible to complete a satisfactory proof and work out the inevitable bugs in the array and in the transmitters.

New transmitting equipment using much solid-state circuitry, especially in the rectifier cabinets, was chosen for the new plant, and plans were laid for construction of the new installation. A new site was surveyed (this time they bought the property!), and Chief Luke worked out the myriad details of the transmitters, phasors, array, and the ancillary equipment that would be required. Power authorization for the licensee is for 50 kw days and 10 kw nights; daytime power uses four towers, and the nighttime pattern requires the entire six-tower antenna system. Two transmitters, therefore, are used to provide an element of redundancy; the main 50-kw rig has a 10-kw reduced-power setting, and its output can be fed into the nighttime phasing equipment. The secondary 10-kw rig can be fed either to the nighttime (normal operation) phasor or to the daytime phasor for emergency operation in case of failure in the main transmitting equipment.

The directional array consists of six guyed towers, each 230′ high mounted on a 5′ reinforced concrete base. A 3′ beacon assembly tops each tower, and a 5′ lightning rod attached to the base of the beacon assembly rises 2′ above the beacon lens element. Chief Luke admits that he doesn't know if the rods will save the beacons during Indiana's frequent severe electrical storms, but he feels they are worth a try. Doghouses at the base of each tower contain phasing and lighting gear. The sampling loops are mounted 20′ up the tower. At each tower, the base and doghouse are enclosed by an octagonal fence which has the ground radials welded to the base of the fence frame. The radials then run up the fence and across the top of the frame to a copper ring encircling the tower base. The radials also are grounded to a copper plate, forming the roof of the doghouse, which is then tied to the phasing-gear ground inside the doghouse. ▲

LET'S LOOK UNDER THE HOOD AT RUST'S NEW 1 KW FM STEREO BROADCAST TRANSMITTER

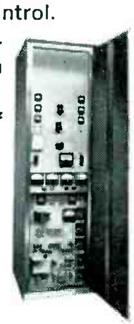


Here's the new 1 KW FM stereo transmitter from Rust. Notice the elbow room? Space galore! (Once, we even found an employee cat-napping there.)

The main channel SWING OUT FME Exciter, plus both subchannel generators are crystal controlled for reliability. As for a stable signal — it locks on like a tiger — never drifts — never lets go. And no more burned knuckles checking tubes. The New Rust power supply is completely solid state and unshirkingly reliable. Incidentally, check the space-saver cabinet — only 24" wide x 28" deep — not to mention the new low price.

The Rust 1 KW, with built-in components, comes ready for remote control.

A very desirable optional feature is our Autolog automatic transmitter logging system. Simply turn it on — and forget it! It frees station personnel for other duties.



For further information, prices, specifications and/or a brochure of the complete Rust line, address your inquiry to:

rust

corporation of america

Eastern Division	Washington, D. C.	Western Division
195 Mass. Avenue	13205 May Court	2921 South 104th St.
Cambridge, Mass.	Silver Spring, Md.	Omaha, Nebraska

RUST FM STEREO TRANSMITTERS • AUTOLOG • RUST REMOTE CONTROL

Circle Item 37 on Tech Data Card

AUDIO & RECORDING EQUIPMENT

45. ATC—"ATC's of Automation," a brochure, illustrates use of automation equipment for broadcast use.

46. AUDIO DEVICES—Technical data sheets on new "Audiotapes;" Formula 10, all purpose and Formula 15, low noise.

47. BROADCAST ELECTRONICS—Packet contains specifications and prices on Spotmaster tape-cartridge equipment including: Portapak I, 400A Series, Ten Spot, and Super "B" series.

48. CINE SONIC—Data sheet describes rental service which supplies background music on 7", 10½", and 14" reels, stereo or mono.

49. CINEMA—Catalogs showing line of precision audio equipment including magnetic-tape and film degaussers.

50. CROWN—Specification sheets give data on Model SS700 and Models SS824 and SS825 featuring solid-state modular circuitry.

51. HARVEY—Brochure and price sheet on Ampex Model AG-100-series magnetic mat recorder/reproducer.

52. NORELCO — Product sheets provide technical specifications for microphones, professional tape recorders, transistorized audio modules, and accessories.

53. QUAM—Folder lists replacement speakers for all automobiles from 1954 through 1965 for both front- and rear-seat applications.

54. RCA — Model BK-12A subminiature lavalier microphone illustrated and described technically in product report brochure.

55. VIKING—Series of technical bulletins provides data on Model 38 tape-cartridge handler, Model 96 tape transport, and other tape and audio accessories.

CATV EQUIPMENT

56. BIONIC — Data available describing 12-channel DC momentary-control unit for program switching by remote control between receiving site and control office.

57. ENTRON—Facility brochure describes product line and manufacturing procedures as well as general history of company's participation in CATV.

COMPONENTS & MATERIALS

58. AMPEREX—Condensed form of standard catalog lists available tube types useful in wide range of applications.

59. INTERNATIONAL ELECTRONICS SALES—Letterhead request will bring data on broad line of Mullard tubes for replacement.

MICROWAVE DEVICES

60. MICRO-LINK — Write for planning guide for 2500-mc ITV systems, data on Model 420A portable link, and Model 600 fixed link.

61. SWITCHCRAFT—New product bulletin No. 151 describes Series 3600 coaxial video jacks and plugs designed for microwave use.

POWER DEVICES

62. HEVI-DUTY — Bulletin 7-22 supplies data on line-voltage regulator using saturable-core reactor.

63. TERADO—Folder illustrates and lists specifications of Model 50-160 Trav-Electric power inverter.

RADIO & CONTROL-ROOM EQUIPMENT

64. CONTINENTAL — Twelve-page brochure describes Prolog system of automated programming, with emphasis on the function of the control log.

65. GATES — Transistorized audio-level control instrument especially designed for FM use allows maximum average-modulation level.

66. MOSELEY—New information outlines specifications and uses of Model RPL-1 remote-broadcast pickup for 160-mc service.

REFERENCE MATERIAL & SCHOOLS

67. CLEVELAND INSTITUTE—Booklet outlines courses in electronics, including those for broadcast engineering and FCC-license preparation.

STUDIO & CAMERA EQUIPMENT

68. AMPEX—Three new product sheets available to describe Marconi cameras and video-handling equipment including Mark V I0 camera, master switcher, and waveform generator.

69. BENDIX—Specification sheet gives information on BX-8A broadcast-type image-orthicon camera.

70. CLEVELAND ELECTRONICS — Data concerns modifications using new yoke assembly to update 3" image-orthicon cameras.

TELEVISION EQUIPMENT

71. COLORADO VIDEO — Eight-channel "Bar/Graph" generator is described in illustrated specification sheet.

72. DAGE-BELL—Specification sheets give particulars on Model 520 solid-state broadcast vidicon camera chain useful for commercial or educational broadcasting.

73. DYNAIR—Illustrated mailer describes use of solid-state audio/video modulators to provide inexpensive color-TV monitor using standard color receivers.

74. INTERNATIONAL NUCLEAR — Completely transistorized Model TVA1 stabilizing amplifier (featuring plug-in units for stripped video, white stretch and clip, and monitoring amplifier) described in brochure.

75. VITAL—Data sheets give specifications of Model VI-500 stabilizing amplifier, Model VI-10A video distribution amplifier, and Model VI-20 pulse-distribution amplifier.

TEST EQUIPMENT & INSTRUMENTS

76. ANALAB — Eight-page brochure describes oscilloscope camera system called Rapromatic® used for trace recording. Features use of 35-mm film and has on-camera processing unit.

77. BALLANTINE — Product sheet gives technical description of AC/DC digital voltmeter Model 355.

78. HICKOK—Brochures on industrial tube testers including new Model 580, Model 539C, and Model 752A instruments.

79. MARCONI — Data on Model 1099 video-sweep generator for color video-tape testing and head alignment.

80. SECO—Eight-page tube tester brochure includes specifications and prices.

TRANSMITTER & ANTENNA DEVICES

81. AIR SPACE DEVICES—Brochure describes "Saf-T-Climb" device used to ensure safety during tower erection or maintenance.

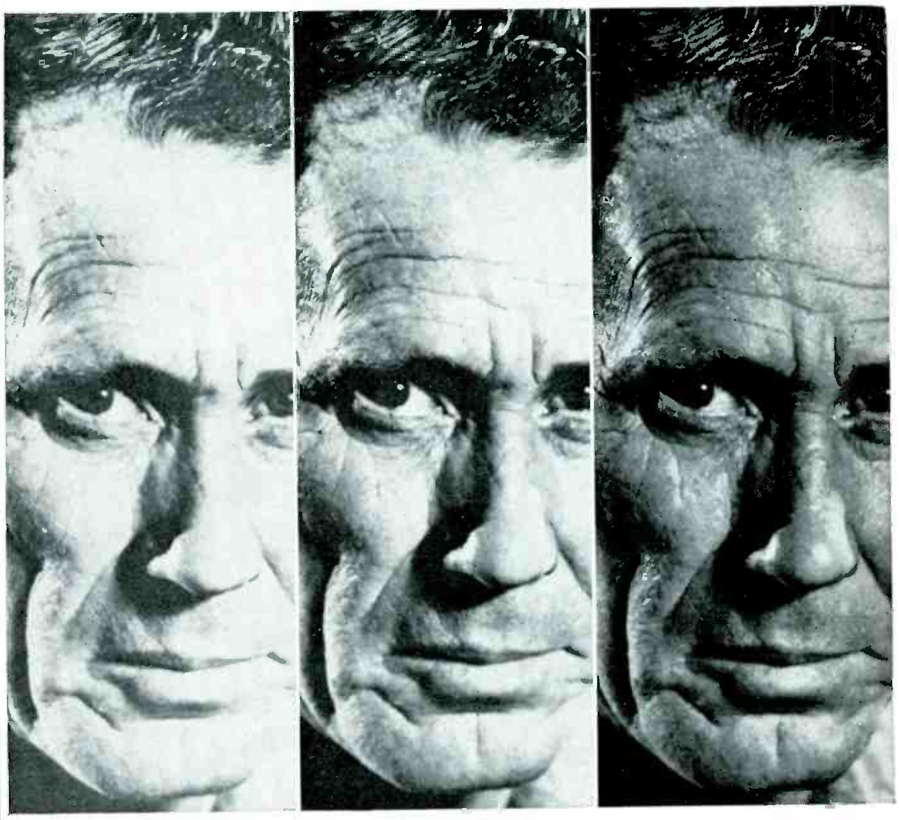
82. CCA—Catalog sheets give specifications and features of several AM transmitters.

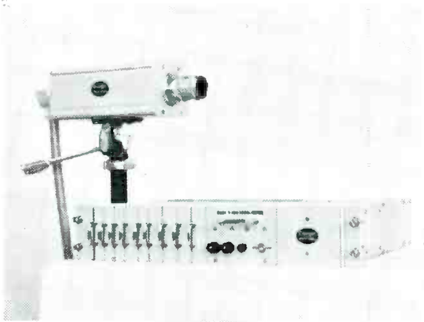
83. COLLINS — Two four-page brochures describe new Model 212 S/M-1 speech-input console and Model 820E/F 5- and 10-kw AM transmitters.

84. GATES — Sixteen page "FM Station Planner" makes equipment recommendations for class A, B, and C stations.

85. JAMPRO—Copy of engineering study titled "A Study into the Effects of Dual Polarization in FM Broadcasting" available on request.

86. RUST — "Base-Current Ratio Alarms" data sheet describes new method for automatic supervision of AM directional antennas.



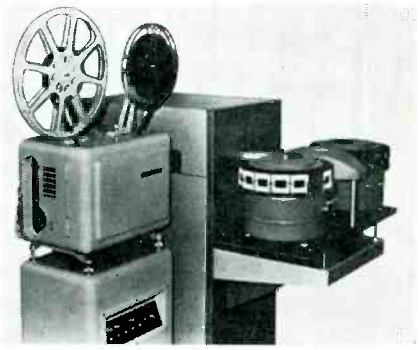


High-Resolution TV System

A compact TV film camera has been introduced by **Granger Associates.** The camera chain has a 30-mc bandwidth, which provides excellent transient response and phase characteristics. A 60-gauss focus field and high G_3 voltage produce a very small scanning spot. Shading content is very low and signal-to-noise ratio is 40 db or better.

The camera and control unit use integrated circuits and silicon transistors for maximum reliability and minimum size. The 9" camera weighs 7 lbs. Two plug-in camera-control units and an EIA sync generator will fit in the 19" wide chassis with 3½" panel height. Price for one camera chain is less than $4000. The optional plug-in EIA sync generator is $920.

Circle Item 87 on Tech Data Card



Vidicon Film Chain

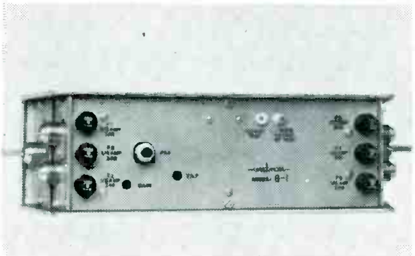
A new vidicon film chain, with optical multiplexer that completely eliminates secondary or "ghost" images, makes the use of expensive field lenses unnecessary. The Model FC-11 developed by **Dage Television Co.** requires less critical setup and adjustment, and has been designed for use by both commercial and educational broadcasters. The new vidicon film chain is housed in a heavy-gauge metal cabinet containing the optical prism multiplexer. Facilities for as many as four input sources are provided to permit any desired combination of film or slide projectors.

All power supplies for the film and slide projectors are contained within the film-chain cabinet. The dust cover is easily removed for maintenance. The cabinet measures 18"x26"x55" and is finished in gray baked enamel. The monochrome camera is compact and uses modular construction throughout. A 10-mc bandwidth guarantees a minimum of 800 lines horizontal resolution. Any standard 16-mm C-mount lenses may be

NEW PRODUCTS

used. Options include installation of an intercom at the cabinet for communication between the cabinet location and the control center. An AC-supply receptacle is provided for test-equipment power.

Circle Item 88 on Tech Data Card



Solid-State Bridging Amplifier

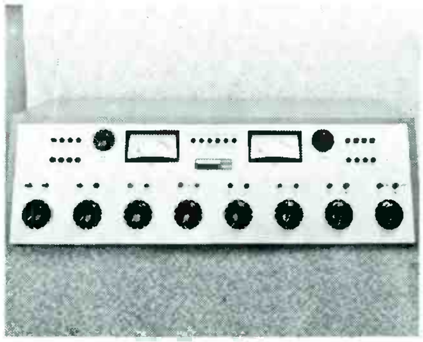
A fully transistorized, remotely powered outdoor bridging amplifier covering the low-through-high VHF band, including FM and intermediate bands, is available from **Entron, Inc.,** CATV equipment manufacturers.

Known as Model B-1, the new Entron unit features 20 db gain to four distribution-line outputs and is designed for strand mounting. It is also weather and atmosphere protected by a cast aluminum housing. Remotely powered through the coaxial cable, it is available with electronically regulated power-supply circuits for 28 volts or 60 volts. From the trunkline, the remote-power voltage can be fed to any or all distribution outlets to feed remotely powered extender amplifiers. Each distribution outlet is individually fused.

The Model B-1 bridging amplifier also features a built-in directional coupler which serves to tap signals off the trunkline with minimum interference to the line's signal. The amplifier section may be removed without interrupting the trunkline. Other features include variable gain and tilt controls.

The Model B-1 is available with a variety of connectors, including UHF and aluminum flare types for 0.412", ½", and ¾" cable.

Circle Item 89 on Tech Data Card



Transistorized Mixer Console

A new solid-state mixer, designed to handle AM, FM, and FM-multiplex channels, will accept up to 24 separate audio sources. The AC8A-2S from **Rust Corp. of America** is compact and features simple operation. The solid-state circuitry in the dual-channel console uses silicon-planar transistors chosen for high reliability and for their ability to withstand damaging transients.

Circle Item 90 on Tech Data Card

New Deflection Assembly

The availability, from **Cleveland Electronics, Inc.,** of a new Plumbicon® deflection assembly designed to operate in conjunction with the new North American Philips Plumbicon® tube, using the basic 30-40 gauss field as design center, was recently announced. Incorporated into this assembly are a deflection yoke, a focus coil, and an alignment coil. The deflection-yoke portion will furnish line resolution in accordance with the tube capabilities with geometric distortions held to less than 1%. The focus/alignment-coil portion of the assembly is covered with a Mumetal shield, thereby reducing normal ambient electrical interferences and attenuating the deflection fields.

Circle Item 91 on Tech Data Card

Advertisers' Index

Professional Services

Classified

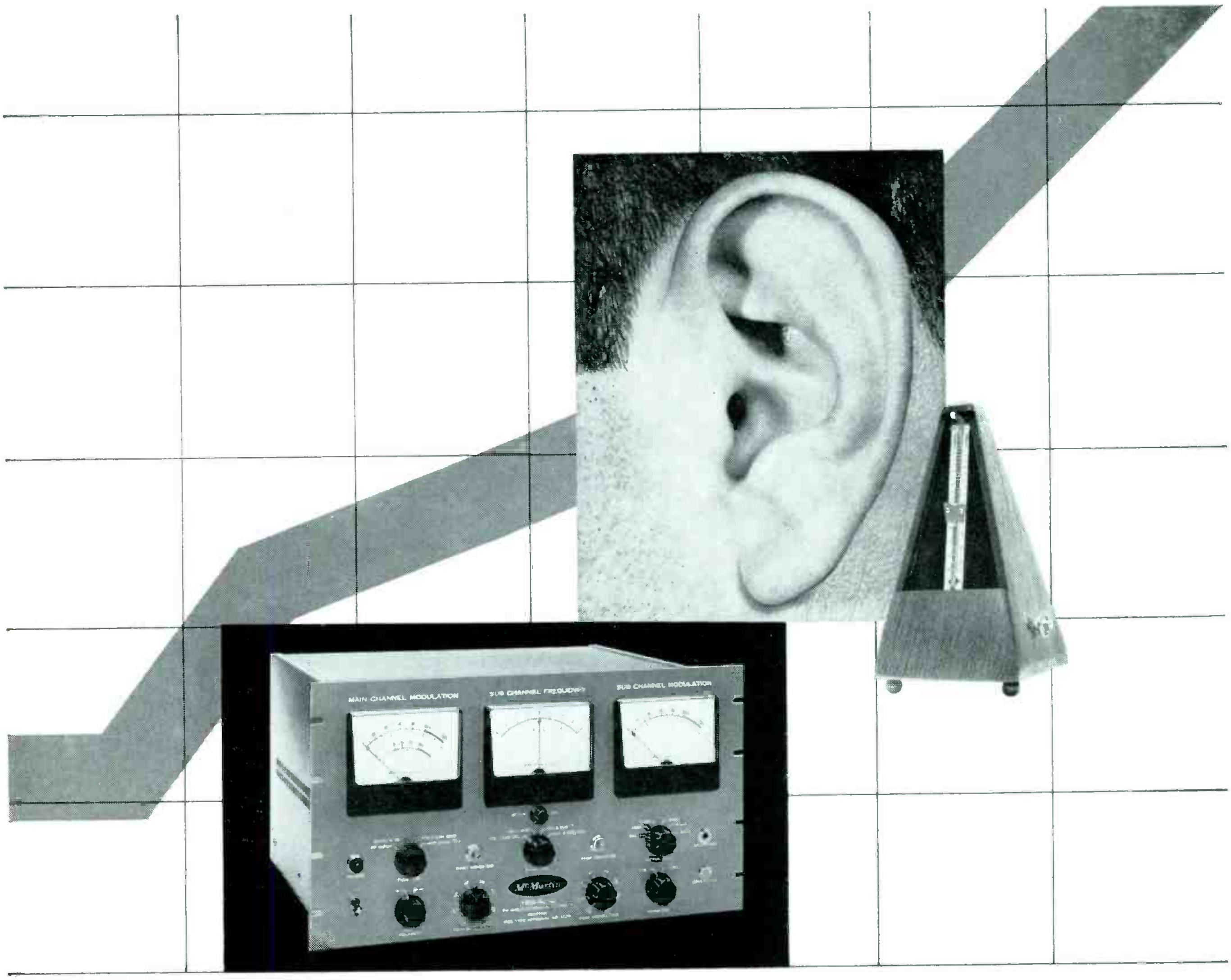
Advertising rates in the Classified Section are ten cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra. Check or money order must be enclosed with ad.

The classified columns are not open to the advertising of any broadcast equipment or supplies regularly produced by manufacturers unless the equipment is used and no longer owned by the manufacturer. Display advertising must be purchased in such cases.

EQUIPMENT FOR SALE

Employment

Business Opportunities



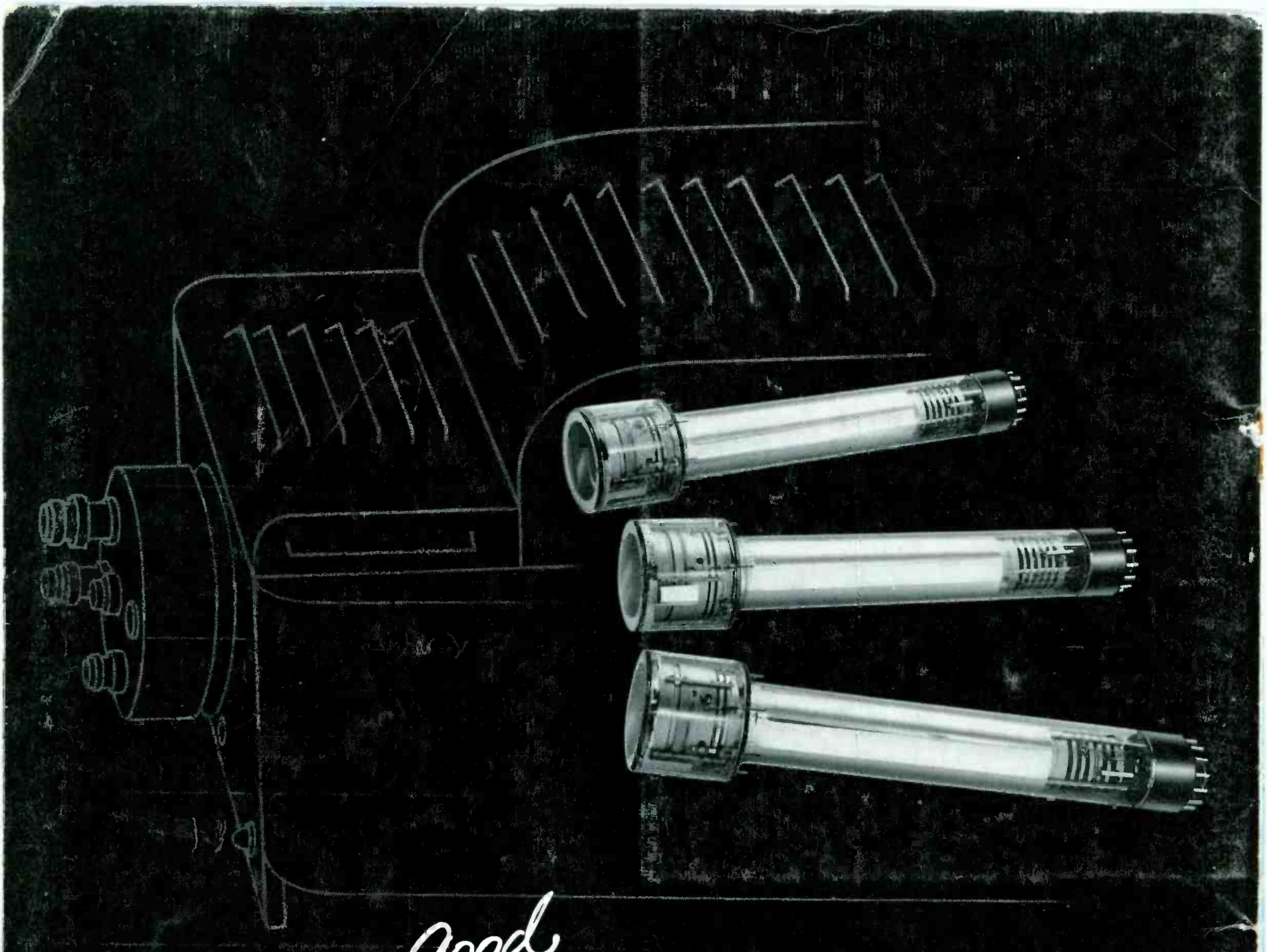
We're Graded on the Curve

A sales curve is generally an indication of Customer Acceptance. That's why we're particularly impressed by the rapid and dramatic growth in our sales during the last year. ■ Each Customer who contributed to that has judged us upon the value that he received versus the money that he spent. We like to believe that he got his money's worth through product excellence. ■ Product excellence is no accident. It results from training the workmen, inspiring the supervisors, and having pride in putting your name on a quality product. ■ There is something new, exciting and different going on at McMartin. It's reflected in the products that we produce for the broadcast, background music and commercial sound industries. If you're now a Customer, look for continued satisfaction; if you're not yet a Customer, why not let us send you our catalog — no obligation, of course; just write to:

McMARTIN INDUSTRIES, INC.
605 North 13th Street
Omaha, Nebraska 68102

McMartin®

Circle Item 40 on Tech Data Card



IT TAKES THREE IMAGE ORTHICONS FOR LIVE COLOR!

Whether you're buying a single Image Orthicon—or a factory-matched set—RCA's tube-to-tube uniformity helps you attain "balanced" color-channel performance. Every major performance characteristic of RCA Image Orthicons for color is quality-controlled by rigid production standards. Precision construction of RCA Image Orthicons for color means that all tube parts are manufactured with precision, spaced with precision, and aligned with precision. Result... you get exceptional tube-to-tube uniformity of:

• Amplitude response • Registration capability • Resolution • Sensitivity • Signal-to-noise ratio.

And, if you're buying matched sets, your tubes are carefully matched for:

• Background • Grey scale • Highlight signal • Sensitivity for each color channel requirement.

AVAILABLE FROM YOUR RCA BROADCAST TUBE DISTRIBUTOR

RCA'S IMAGE ORTHICONS FOR COLOR

Type	Light Levels	Field Mesh	Precision Construction	Matched Sets	Targets
4415 4416	Black and White	Yes	Yes	Yes	Glass
7513	High	Yes	Yes	7513/V1	Glass
7513/L	High	Yes	Yes	Yes	Non-stick
8092A	Low	Yes	Yes		Thin-film

Complete information on the RCA Camera Tube line is available from your local RCA Broadcast Tube distributor ... ask him for booklet CAM-600.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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