A HOWARD W. SAMS PUBLICATION

DECEMBER 1963 75c

SPECIAL FM STEREO ISSUE

Five feature articles on stereo broadcasting subjects: Installation, Monitoring, Antennas, Phase Checking, and State-of-Art

Plus — Subject Reference Index, 1963

Broadcast Engineering

the technical journal of the broadcast-communications industry

TOTAL PACKAGE CONCEPT ASSURES MAXIMUM STEREO PERFORMANCE

A complete FM stereo broadcast package – specially engineered to deliver the greatest stereo realism possible — is now available from the Gates Radio Company.

This exclusive system features a full power range of stereo transmitters from 10 watts to 20,000 watts, the new Cycloid antenna with one through sixteen bays, a dual peak limiter, stereo Cartritape, the choice of two stereo audio consoles and two professional stereo turntables (12 or 16-inch)—plus other important accessories that add realistic depth and separation to broadcast sound.

All equipment in the package was researched, designed and manufactured after the FCC rules and regulations concerning FM stereo were finalized — yet each product has been extensively field tested.

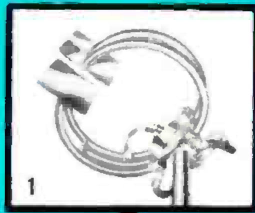
To assure maximum stereo performance, the new FM station will want a fully integrated system designed specifically for stereo—and Gates is the only manufacturer in the broadcast industry to offer such a complete equipment plan. This total package concept solves the broadcaster's problem of purchasing equipment from several different sources — which could result in an incompatible stereo broadcast system.

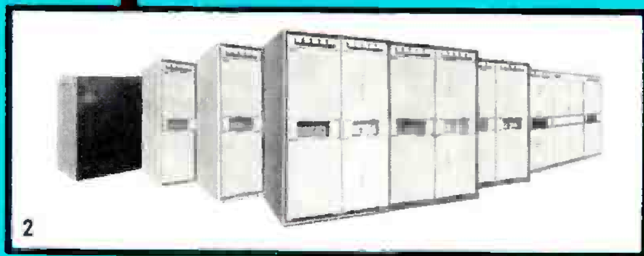
Many FM stereo stations already on the air may find that they are not getting full stereo performance due to an incomplete system. By reviewing the package diagram on the right, they can determine the equipment needed to assure true stereo transmission. And the monaural station should investigate to see how relatively simple and inexpensive it is to convert to the "wonderful world of stereo" with the complete Gates package.

Full technical information on this special FM stereo package is now available. Write Gates Radio Company, Quincy, Ill., for the FM Stereo Fact File.

(Advertisement)

GATES OFFERS MOST COMPLETE FM STEREO PACKAGE IN INDUSTRY


1

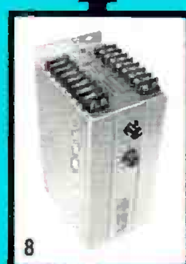

2


4


3


5
6


7


8


9

1 Gates Cycloid FM Antenna — Designed for Stereo

2 Complete Line of FM Stereo Transmitters — from 10 Watts to 20,000 Watts

3 Gates M-6146 Stereo Generator

Gates M-6160 Subcarrier Generator 67 KC or 41 KC. Switching Kit Optional

4 Gates M-6144 Stereo Dual Limiter

5 Gates M-6158 Executive transistor console—10-channel stereo

6 Gates M-6188 Stereo Yard

7 Gates Stereo Cartritape II

8 Gates M-6169 Stereo Transistor Preamplifier

9 Gates CB-500 16-inch & CB-77 12-inch, with GE VR-1000 Gray 208S Stereo Cartridge Arm & Rest

Gates is the only manufacturer in the broadcast industry to offer such a complete stereo system. For complete information, write for the FM Stereo Fact File – yours for the asking.

GATES

GATES RADIO COMPANY
Subsidiary of Harris-Intertype Corporation
QUINCY, ILLINOIS

HARRIS INTERTYPE CORPORATION

Offices in: HOUSTON, NEW YORK, LOS ANGELES, WASHINGTON, D.C.
In Canada: CANADIAN MARCONI COMPANY
Export Sales: ROCKE INTERNATIONAL CORP. • 13 EAST 40th ST. • NEW YORK CITY

Circle Item 1 on Tech Data Card

Every TV Station Doesn't Use Belden Wire and Cable . . . but most of them do!

like WBAL-TV

BALTIMORE

In their new $2,000,000 studio building, Belden Audio, Camera, and Control Cables were used exclusively.

WGN-TV

CHICAGO

In this mammoth new Mid-America TV and radio broadcasting center, 90% of all Camera, Microphone, and Audio Cables are Belden.

KTRK-TV

HOUSTON

The exclusive use of Belden Camera, Audio, and Control Cables by this ABC affiliate helps them to maintain their continuous, highly efficient programing.

The extensive use of Belden wire and cable by radio and television stations reflects the engineered quality of all Belden wire and cable. It offers lighter weight, lower coefficient of friction, greater flexibility, easier termination, and exclusive Beldfoil* insulations for elimination of crosstalk.

Belden manufacturers a complete line of wire and cable for all TV and radio broadcasting, recording studios, remote control circuits, and similar applications. Call your Belden electronic distributor, or write for catalog.

*Belden Trademark—Reg. U.S. Pat. Off. 8-6-3

power supply cords • cord sets and portable cordage • magnet wire • lead wire • automotive wire and cable • aircraft wires • welding cable

Better Built—Better Buy—Belden

Belden WIREMAKER FOR INDUSTRY SINCE 1902—CHICAGO

BELDEN MANUFACTURING COMPANY • 415 South Kilpatrick • Chicago, Illinois 60644

Circle Item 2 on Tech Data Card

the technical journal of the broadcast-communications industry

®Broadcast Engineering

Volume 5, No. 12 **December, 1963**

CONTENTS

FEATURES

DEPARTMENTS

PUBLISHER: Howard W. Sams **GENERAL MANAGER:** Mal Parks, Jr.

EDITORIAL: Exec. Editor, Verne M. Ray; Editor, Forest H. Belt; Managing Editor, Stuart N. Soll; Consulting Editor, John H. Battison.

CIRCULATION: Manager, J. A. Vitt; Fulfillment: Manager, Pat Tidd; Assistants, Katherine Krise and Cora LaVon Willard.

PRODUCTION: Manager, Robert N. Rippy.

ADVERTISING: Sales Manager, Dave L. Milling; EAST: Howard W. Sams & Company, Incorporated, 3 West 57th Street, New York, N. Y., Phone—MU 8-6350; MIDWEST—Hugh Wallace, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis 6, Ind., Phone AX 1-3100; SOUTHWEST—C. H. Stockwell Co., 4916 West 64th Street, Mission, Kansas, Phone—RA 2-4417; LOS ANGELES 57, CALIF., Maurice A. Kimball Co., Inc., 2550 Beverly Blvd., Phone—DU-8-6178; SAN FRANCISCO, Maurice A. Kimball Co., Inc., 580 Market Street, Phone—EX 2-3365; PARIS 5, FRANCE, John Ashcraft, 9 Rue Lagrange, Phone—ODeon 20-87; LONDON W.C. 2, ENGLAND, John Ashcraft, 12 Bear Street, Leicester Square, Phone—WHitehall 0525; TOKYO, JAPAN, International Media Representatives, Ltd., Kisha Kurabu 14, 2-chome Marunouchi, Phone—(502) 0656.

SUBSCRIPTION PRICE: U.S. $6.00, one year; $10.00, two years; $13.00, three years. Outside U.S.A. add $1.00 per year for postage. Single copies, 75 cents, Back issues, $1.00.

BROADCAST ENGINEERING is published monthly by Technical Publications, Inc., an affiliate of Howard W. Sams & Company, Inc. Editorial, Circulation, and Advertising headquarters: 4300 West 62nd Street, Indianapolis 6, Ind.

A HOWARD W. SAMS PUBLICATION

BPA

ABOUT THE COVER

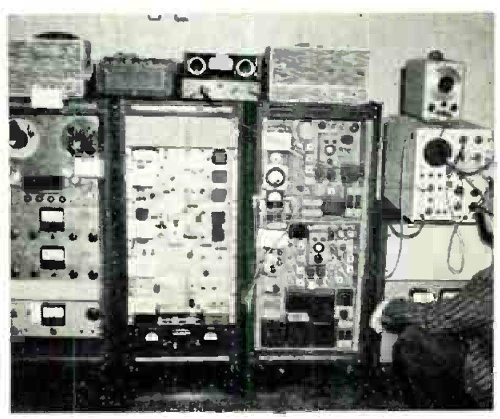
At 12:00 o'clock A.M., on the morning of June 1, 1961. (the earliest time authorized by the FCC), Zenith Radio Corporation's FM Station, WEFM, Chicago, transmitted the first stereophonic FM broadcast using the new FCC standards. WEFM's stereo transmitting installation is shown on the cover.

Since that broadcast, well over 200 FM stations have begun stereo operation. Meanwhile. in a constant effort to improve stereophonic broadcasting, manufacturers. stations, professional organizations. and other interested groups continue intensive research and experimentation programs. (See FM Stereo — Past, Present, and Future. page 20.)

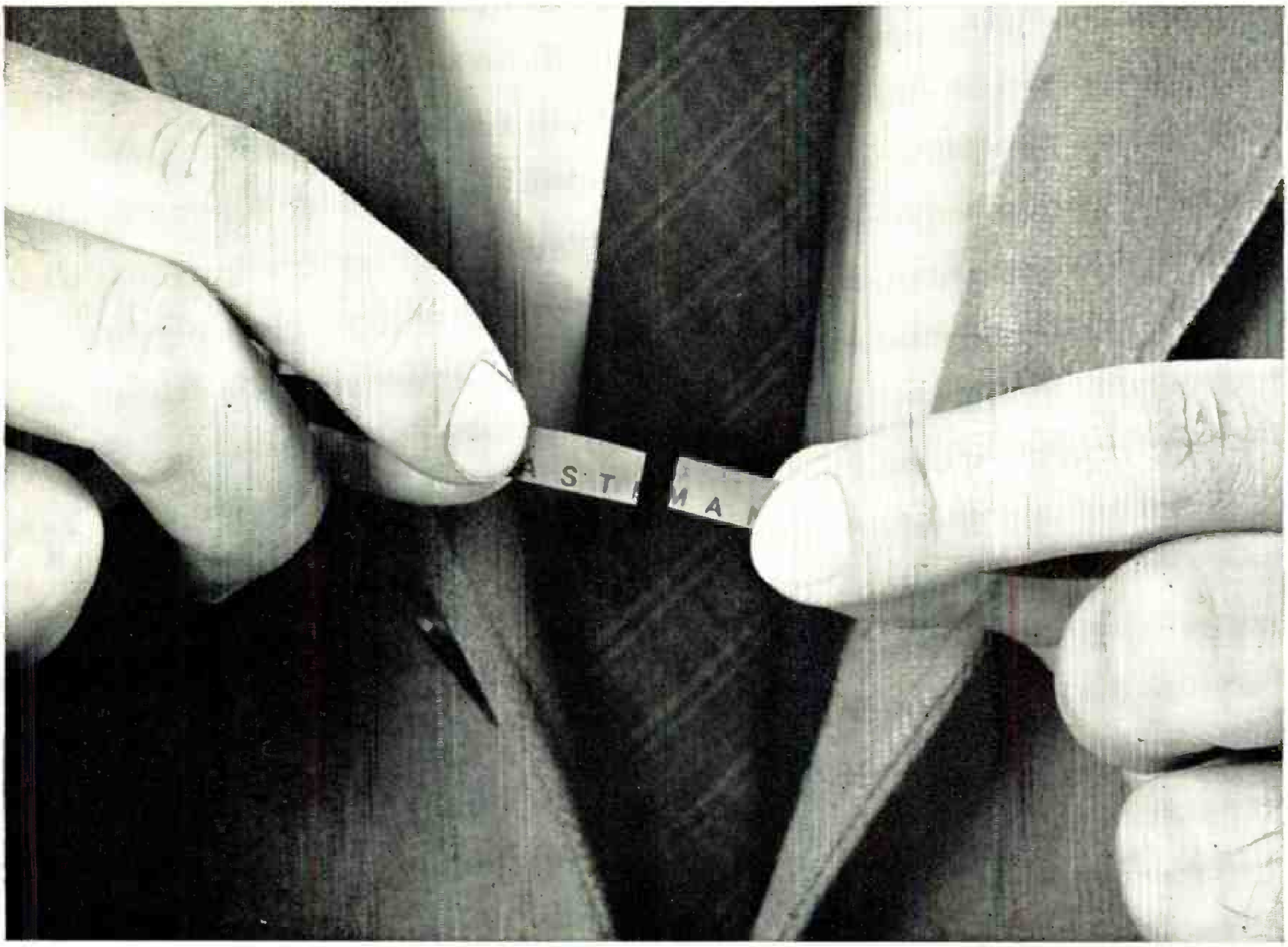
The FM stereophonic broadcasting system tested by Zenith Radio Corp. during 1959 and 1960, and later proposed by Zenith and General Electric Co., was adopted officially by the FCC on April 20, 1961. It has since been proven to be an effective and workable technique.

In the lower accompanying photo is the equipment used by Zenith to demonstrate stereo transmission at the first industry showing. This took place May, 1961, in Washington, D.C.. during the National Association of Broadcasters convention.

The new stereophonic service has made steady progress since its introduction less than three years ago. In the words of Zenith president Joseph S. Wright, it is ". . . a new dimension in FM broadcasting, and a new era for the enjoyment of FM radio listening."



Now...a new EASTMAN Sound Recording Tape!



Take a piece of the new Eastman tape. See how tough it is . . . how clean it breaks under stress.

Look! No stretch...when it breaks—it breaks clean!

NEW! Support material for EASTMAN Sound Recording Tapes is DUROL Base. A specially prepared form of cellulose triacetate—smooth, tough, durable, highly flexible—provides high strength with low elongation. When equipment accidents happen, it breaks clean. Splices are made easily, quickly—with minimum program loss.

Another important feature: "Lifetime Coding," your assurance of highest quality. Printed on the back of all EASTMAN Sound Recording Tapes is a continuously repeated, permanent legend. This identifies Eastman Kodak Company as the manufacturer and provides a convenient means of indexing these tapes.

New "R-type" binder. This gives a smoother, tougher surface, thereby reducing tape noise and distortion. In addition, it provides extreme abrasion resistance, preventing oxide build-up at the head. Even more important, however, are the amazing magnetic properties of coatings of "R-type" binder which make possible two superlative tapes—both available now . . .

At leading electronic supply houses: Type A303, a vastly superior low-print tape with output comparable to a fine general-purpose tape . . also Type A304, a high-output tape with remarkably low print-through.

Unique ultra-handy Thread-Easy Reel with indexing scale and built-in splicing jig.

For information, see your electronic supplier or write

Magnetic Products Sales

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Circle Item 6 on Tech Data Card

PLANNING THE FM STEREO INSTALLATION

*by George W. Yazell** — Some considerations in the selection of stereo equipment for new installations.

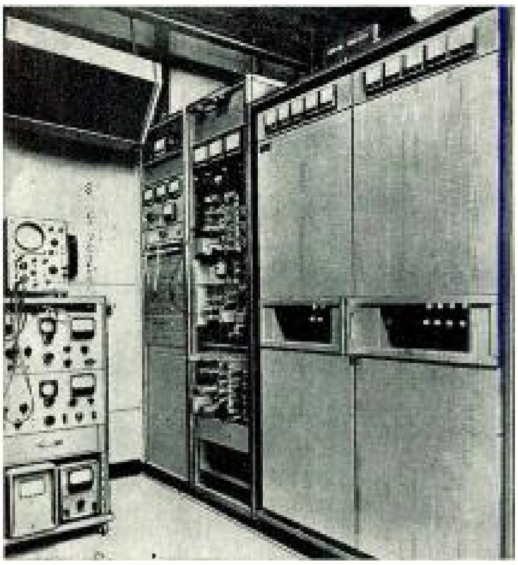


Fig. 1. Typical transmitter installation.

In planning a new installation, the broadcast station engineer will be called upon to evaluate the products of various manufacturers before an order is placed for new FM stereo station equipment (Figs. 1 and 2). In preparing his recommendation, the engineer will review descriptive literature, advertisements, and instruction books. He will seek information and advice from his consultant, other station engineers with stereo experience, and sales representatives of broadcast equipment manufacturers. His thinking may also be influenced by magazine articles and advertisements.

It is unfortunate, but true, that during the engineer's survey he will encounter many conflicting opinions and claims. Some "advisors" may go so far as to imply that their system of stereo signal generation is the only one worthy of consideration, and all the rest have so many shortcomings as to be impractical or even unworkable.

The simple truth is that any manufacturer offering a transmitter or associated device for sale to broadcast stations must obtain FCC type acceptance. In doing so, complete and authentic test data is submitted for the Commission's review and approval. Type acceptance by the FCC is your assurance that the equipment will meet certain specifications.

Thus you can either draw straws, or accept the views of the "advisor" with the most forceful opinion — and still feel safe that the equipment you recommend will work. A more practical solution would be to prepare a list of equipment and features you require, with careful attention to needs peculiar to your own station; then select the equipment which most nearly matches your requirements.

*Gates Radio Co., Quincy, Ill.

Fig. 2. Modern control room equipped for stereo broadcasting.

List What You Have

The first step is to list and evaluate any equipment, facilities, and assets already available for the proposed installation—even if it is only a construction permit, a bank account, and a plan of operations. Some items to consider include:

1. Ask management for a budget. This is probably the most significant factor in your recommendation. You should set both a practical budget and an absolute top limit. If you find it impossible to do the job within the budget limitations, do not hesitate to say so. Point out that stereo is a two channel system and that in addition to special transmitting equipment, the studio installation will require **two** of each amplifier, loudspeaker, telephone line, etc. Therefore, a stereo installation will cost considerably more than monophonic facilities.
2. Review the program plans for the station. The quantity, complexity, and flexibility of the

audio equipment selected must adequately meet these needs, with some reserve facilities for future expansion.

3. You may presently have an FM, AM, or TV station—or a combination of these. In this case you can probably count on using existing studio facilities, some of the technical equipment, the tower, remote control facilities, and technical manpower.
4. Consider the abilities of your technical staff. You may be the only engineer, or may have available a large staff of technical personnel. In any event, select equipment having circuits and components your technicians can install and maintain.
5 Survey the supply situation. Determine the location and stock capabilities of electronic supply houses in your area. Keep in mind that **any** electronic component must eventually fail; and an inexpensive component can cost hundreds of dollars if you are "off the air" several days while a replacement is being flown in from a distant source of supply. If the supply picture is discouraging, you can best protect yourself by selecting practical equipment employing readily available components—and ordering an adequate supply of spares for parts you cannot obtain locally.

List Your Needs

Your next step is to prepare as complete a list as possible of the total equipment requirements. Sketch a block diagram of your proposed layout (Fig. 3). Then prepare a chart of **all** the equipment you will need with space provided for prices, data, and notes on each device (Fig. 4). As you prepare these charts several things will become evident:

1. You will probably discover more equipment is needed than you originally anticipated.
2. In determining what must be purchased, you must carefully integrate your needs with equipment now on hand.
3. Your ultimate decision will depend on many interacting factors rather than on one outstanding feature of a particular device.

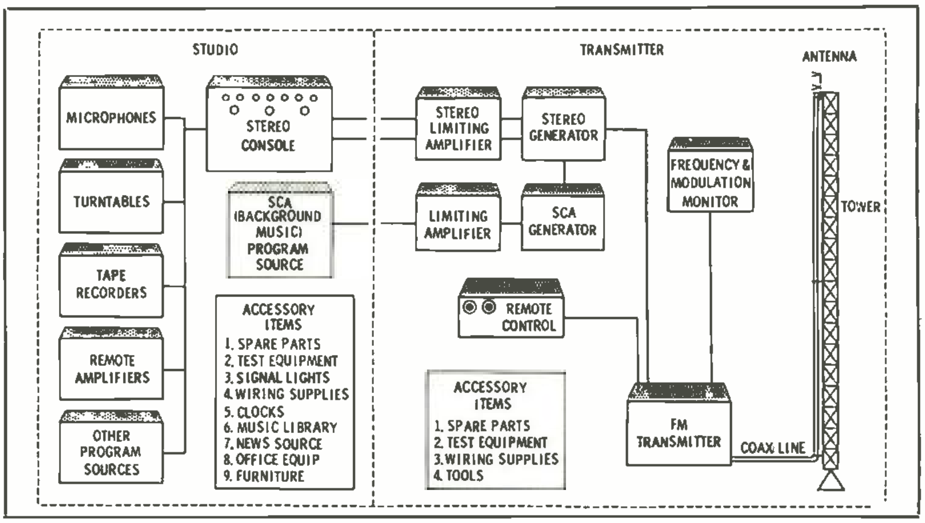


Fig. 3. Block diagram of typical stereo station equipment layout.

4. It will be wise to purchase as many items as possible from a single source to take advantage of: compatability of equipment that is designed to work together as a system, coordinated shipments and service, possible lower cost because of quantity purchase, and — if required — simpler financing arrangements.

Making A Decision

After considering the points outlined above, and making the lists, you are ready to select equipment.

If the budget is limited you may investigate the possibility of some used equipment. However, since today's FCC Stereo Specifications were only established as recently as 1961, there will be little used equipment available. In the majority of cases, converting old monophonic equipment will be difficult, costly, and the end result may be less than satisfactory. Old "dual-channel" audio consoles have been successfully converted, but in the process usually require almost complete rebuilding. It is necessary to install dual faders, correct phase differences, and balance gain between channels.

Used FM transmitters are frequently advertised, but many are left over from the early days of FM. Some transmitter manufacturers of the late '40s are no longer in business. Replacement tubes and parts are difficult, if not impossible, to get. Some older transmitters lack stability and some contribute to degradation of stereo separation, because they do not maintain the proper phase relationship between upper and lower sidebands. If such a transmitter is to be used, it prob-

• Please turn to page 35

COMPARISON CHART

ITEM	MFR. "A"	MFR. "B"	MFR. "C"
5KW FM TRANSMITTER			
8BAY FM ANTENNA			
STEREO CONSOLE			
STEREO LIMITER			
STEREO ...			

Fig. 4. Simple product comparison chart.

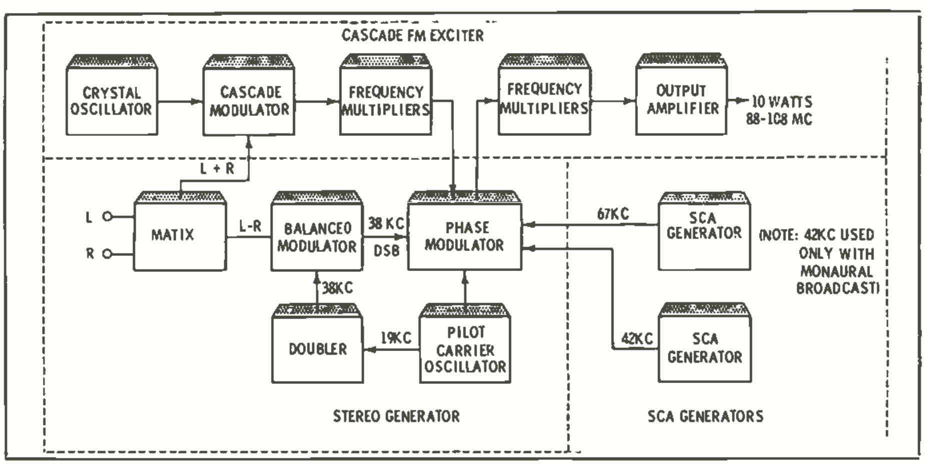


Fig. 5. Functional block diagram of a stereo/SCA generator.

MONITORING AND MEASURING THE FM STEREO BROADCAST

by D. Ridgely Bolgiano* — Three methods of oscilloscopically monitoring and measuring the FCC-approved FM stereo signal.

Monitoring of compatible stereophonic FM broadcast signals has not as yet been standardized to any particular accepted method or instrument.

The FCC has clearly specified criteria for meeting monophonic FM broadcasting standards. There are already methods of meeting these criteria, which are known to any station operator who completes a proof of performance. There now exists the problem of monitoring the stereo FM signal. This problem may be solved by examining three composite-signal characteristics which the stereo FM operator must keep within limits if he is to transmit a good and consistent stereophonic signal. These three characteristics can meet FCC standards when:

1. The ratio of main channel modulation to subchannel modulation for a left-only or right-only signal is close to unity.
2. The same ratio is maintained for all audio input frequencies from 50 to 15,000 cps.
3. The 38-kc sidebands are in phase with the 19-kc pilot subcarrier.

The first condition determines whether there is adequate cancellation in matrix-type receivers, or whether residual signal remains in the "off" channel in time-division receivers.

The second simply says that good separation is desirable at all audio frequencies and not at just one. Thus, a monitoring method should show separation at all audio frequencies. The FCC requires 29.7 db separation as a minimum at all audio frequencies transmitted.

The first two conditions are basic,

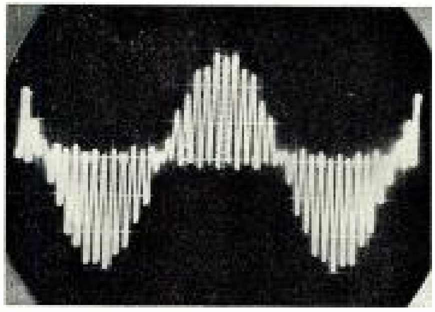


Fig. 1. Monitoring composite signal with internal sweep synchronized on the audio.

since sound can be received stereophonically if they are established — even if the third criterion is not. However, it is desirable that a properly phased receiver be capable of receiving separate channels when tuned to any station transmitting FM stereo. For this to be true, it is necessary that all stations maintain the same phase relationship between their 38-kc sidebands and the 19-kc pilot (synchronizing) subcarrier; this meets the third specification. The FCC has stipulated that the stereophonic subcarrier, its sidebands, and the pilot subcarrier shall cross the time axis simultaneously — and in the same direction — when a positive-going cycle of left signal is applied to the transmitter. This determines that alternate time-axis crossings of both the subcarrier and the 38-kc sidebands (the stereophonic subcarrier sidebands) should coincide with each other. Also, the FCC specifies that the left channel information will

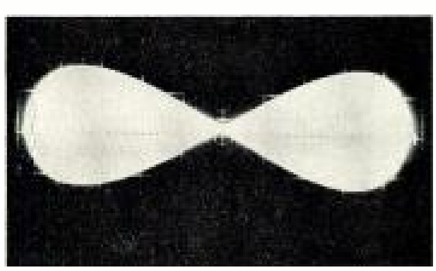


Fig. 2. Bow-tie monitoring with 19-kc sine wave (pilot subcarrier) on shown X-axis.

appear during the first 90° of pilot subcarrier deviation after the subcarrier crosses the time axis.

One way to monitor these conditions might be with meters. Two meters could be connected to monitor the sum and difference audio. If both meters show identical indications during program transmission of right or left signals only, then the first two characteristics would be established. A third meter could measure phase differentials between the pilot subcarrier and the stereophonic subcarrier sidebands. Once calibrated, such meters would provide reasonable day-to-day indications of operation. However, no such instruments are commercially avialable.

Oscillographic Monitoring

The oscilloscope can provide all the means for stereo measurements and in a fashion that can be used for regular control room monitoring operations. There are three methods that have come to my attention in the use of the oscilloscope for monitoring the composite stereo signal.

Using Audio Waveforms

The familiar pattern in Fig. 1 may be formed by connecting the composite discriminator output to the oscilloscope vertical input; the horizontal sweep is synchronized with the audio to display one or two audio cycles. If a left or right signal is supplied to the transmitter, lack of separation may be easily seen. The upward modulation envelope should not extend below the time axis and vice-versa. The pilot subcarrier may be seen as alternate tips extending below or above the time axis, as the case may be. This

*Bionic Instruments, Inc., Bala-Cynwyd, Pa.

Editor's Note: This paper — which was presented at the 1963 Audio Engineering Society Annual Meeting — is based on work performed at Drexel Hill Associates, Inc., Dover, N. J.

method of looking at the composite signal is useful primarily when sine waves are transmitted, since the oscilloscope must maintain synchronism with the audio signal — for complex program material, the audio frequency is constantly changing. As long as the trace on the oscilloscope screen can be made to "stand still," this waveform is "absolute"; it is dependent only upon receiver and oscilloscope amplifier linearity. This method is also useful for determining whether lack of a unity ratio (characteristic 1) is caused by phase delay or by amplitude differences between the subchannel and main channel modulation; this is the only method that shows the actual audio waveform.

Bow-Tie Method

A second method (the bow-tie) gets its name from the pattern produced (Fig. 2). This system of monitoring can be used during program transmission. The pattern is obtained by connecting the composite signal to the x-axis amplifier and the 19-kc pilot (in its unmodulated form) to the y-axis amplifier. The pattern is, however, subject to phase shift. The 19-kc and the composite may not arrive at the oscilloscope deflection plates in phase with each other. One should not use this method for monitoring the phase of a stereo transmitter unless the phase is known to be correct initially.

A very clear distinction between the left and right channels can be obtained if the pilot carrier is doubled to 38 kc before application to the y-axis input. With proper phasing, the pattern on the oscilloscope screen will form a triangle pointing leftward for left signals and rightward for right signals. Just reversing the x-axis oscilloscope leads will reverse left and right on the pattern.

Pilot-Sync Technique

The third method of oscilloscopically monitoring the FM stereophonic signal does not depend upon any external signal phasing. It will show clearly and immediately whether the conditions (unity amplitude ratio at all frequencies and phasing between the stereophonic subcarrier and the pilot subcarrier) are met. The composite signal is connected to the y-axis and the oscilloscope sweep is used as in the first method, but with one slight difference. This time the sweep should be synchronized with the pilot subcarrier and, for easy viewing, may best be adjusted so that about two cycles of the pilot subcarrier can be seen on the screen.

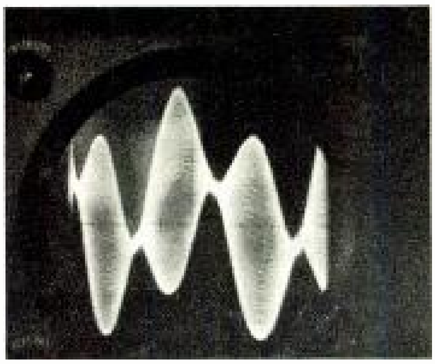


Fig. 3. Left signal modulation; employing pilot-synchronized method of monitoring.

I have found this pilot-synchronized method of monitoring to be excellent. The only variables involved are the linearity of the receiver and the linearity of the oscilloscope vertical amplifier. With this method you will see patterns such as those shown in Figs. 3 through 8, which show immediately which channel is left and which is right.

In Fig. 3 notice that the audio signal appears to modulate the pilot subcarrier principally after the subcarrier crosses the time axis and before it reaches its peak (either upward or downward). This agrees with the FCC specification for a **left** signal. The upward swing is created by the positive left signal and the downward swing by the negative left signal. Notice that, if you reverse the x-axis input leads, the signals remain in the same quadrants of the pilot subcarrier — thus still indicating a left signal. Making the same swap with either of the other oscilloscope monitoring methods would reverse left and right. Thus, the left signal appears in the odd-numbered quadrants of the pilot subcarrier. The right signal appears during the even-numbered quadrants of the pilot subcarrier, as may be seen in Fig. 4.

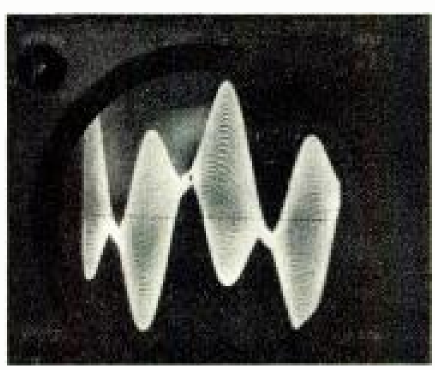


Fig. 4. Right signal modulation; using pilot-synchronized method of monitoring.

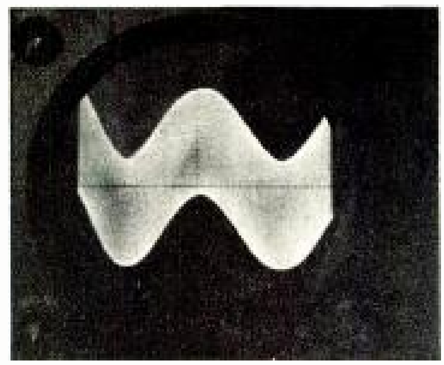


Fig. 5. Main channel, or monophonic modulation; pilot-synchronized monitoring.

This pattern also shows immediately whether there is a unity ratio between the main channel and subchannel modulations. Separation capability may be measured as the amplitude ratio between the modulated channel and the unmodulated channel.

If the right and left signals — in phase with each other and of the same amplitude (R=L) — are applied to the stereophonic transmitter, the pattern shown in Fig. 5 is produced. This is the same as that produced by a monophonic (L+R) transmission with the pilot subcarrier on.

If right and left signals of exactly opposite polarity, but the same amplitude (R=L), are applied to the stereophonic transmitter, the pattern shown in Fig. 6 is produced. Notice now that the pilot subcarrier can be seen only at its peaks and time-axis crossings, and that identical modulation is readily apparent in each of the pilot subcarrier quadrants. Alternate nulls in the signal appear in a straight line along the time axis. This shows that the pilot subcarrier is in phase with the

• Please turn to page 28

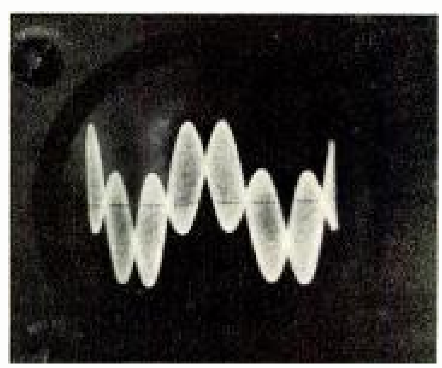


Fig. 6. Subchannel only, or reversed polarity modulation; pilot-sync method.

WHEN THE PROOF-OF-PERFORMANCE FAILS

*by Ed Murdoch** — Part Four. Continuing the discussion of troubleshooting techniques; this month, distortion and balance in push-pull stages.

Part Three of this series discussed techniques for tracing noise sources in the power supply, and on through the audio modulation portions of the transmitter. Procedures for balancing the modulator tubes were also described. This month, the discussion will continue with relationships of distortion to balance in push-pull stages, and other amplifier considerations.

After balancing the transmitter modulator tubes, it may be found that total distortion still exceeds (or approaches) the limits — even though the transmitter is within bounds when measured separately. It is then time to check the balance of the other push-pull tubes in the audio chain. (NOTE: For purpose of discussion continuity, the balancing of the transmitter audio drivers was not treated in its proper place. Actually, the audio drivers should be checked **before** balancing the modulators — and in accordance with the following discussion.

Tube Balance

In any amplifier consisting of several push-pull stages, the high-level or output stages will be the major sources of distortion caused by tube mismatch. The console output stage should be checked first, before the limiter or line amplifiers. The static (no signal) balance can be checked by measuring DC voltage between the push-pull tube plates with a VOM (do not use a VTVM). If the tubes are in perfect static balance there will be no voltage indication. However, this is seldom the case. Generally, there will be some indication of voltage, ranging from a mere "flicker" to several volts. All spare tubes of that type should be substituted until a pair is found that produces minimum DC voltage between the plates.

*Chief Engineer, WMMB, Melbourne, Fla.

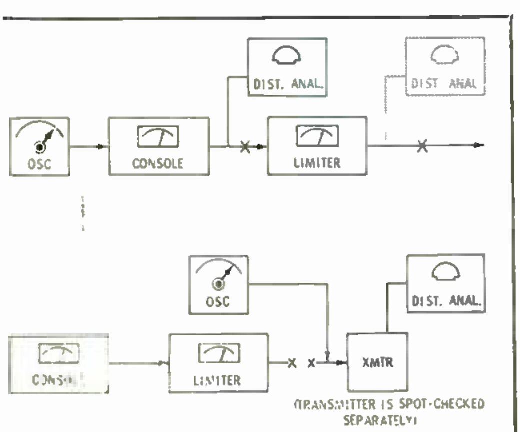


Fig. 1. Spot checks for isolating trouble.

Console Output Amplifier

Before beginning the balancing procedure, the console should be given a separate distortion and response check for reference (Fig. 1). Then as the tube pairs are alternated, a spot-check of distortion and a comparison of response should be made at 25% and 100% of normal output level (generally measured on the output VU meter). The pair which shows up second best on the minimum DC voltage test should also be given a spot-check.

Amplifier stages which have a single balancing resistor shared by two push-pull tubes should be "zeroed in" with a VOM, while the amplifier is inoperative, before attempting to balance the tubes by intrinsic match. That is, the balancing control should be adjusted so it presents **equal** resistance to both tubes. Then, after the best "naturally-matched" tubes are found, a slight readjustment may be made to achieve zero voltage between the plates — but the results should be verified by distortion measurement.

Other Amplifiers

Next, the line amplifiers and limiter should be treated in the same manner. It is advisable to check balance in all push-pull stages, although the output stages will still be the most likely source of mismatch distortion. The bias tube of the limiter should be out of the circuit, as during the full proof.

It might be thought that an easier alternative would be to balance the stage by measuring frequency response with different pairs of tubes and choosing the best pair; minimum distortion would thus be attained automatically without all the trouble of distortion measurements. This system, however, would result in only an **approximation** of minimum distortion. It is possible for two pairs of tubes to be very close in frequency response, yet one pair might produce less distortion. If the tubes are paired according to distortion measurement, the response will generally take care of itself. However, as previously stated, the response should be verified via the output VU meter as the tubes are alternated for minimum distortion checks.

When making the spot distortion checks, be very careful to maintain the same amplifier output level (25% or 100%, whichever the case may be) for all three spot frequencies.

Component Failure—DC Checks

So far, the discussion has concerned only distortion caused by tube unbalance, and mainly with respect to achieving a series of minor improvements in stages which may already be operating within tolerance when considered separately. But what if the console or limiter should show rather high distortion — and after you become groggy swapping tubes around, it becomes apparent that even the best balance makes no appreciable dent in the distortion? Here's where the fun begins. You might even sell tickets to the performance, because you are now in for a gay, carefree spree of troubleshooting, and surely will want the neighbors there when you start running around the control room yelling for a psychiatrist.

Circuit Voltages

While distortion due to tube unbalance generally occurs in the output stage, that caused by a faulty component can occur anywhere in the sequence. As a preliminary step, it is advisable to measure all DC plate, screen, and cathode voltages, and compare them to the voltage charts in the amplifier maintenance manual.

If any obvious discrepancies are found, it should be relatively easy to locate the faulty component. But, before you start hauling out any suspected resistors or capacitors, inspect all wiring in the associated circuit. Go over it very carefully to see if there are any minute solder droplets, or wire ends poking through insulation, causing a partial or dead short to chassis, tube socket terminals, or other wires. And if the amplifier is an old one which has had a good deal of sporadic maintenance, go over the circuit carefully to see if any wires have been disconnected and then fastened to the wrong point.

Bias

Measure the voltage between grid and cathode to ascertain that the required bias voltage is actually appearing at the tube grid. By making these DC measurements it should prove fairly easy to locate an open (or changed) resistor, an open transformer winding, or similar fault.

If there is a noticeable discrepancy between the bias voltages at the grids of push-pull tubes, it is possible that a coupling transformer is faulty (Fig. 2A) and a portion of the preceding plate voltage is being applied to one of the grids (the grounded center tap of the secondary would prevent it from appearing at both grids). This can be verified by disconnecting the transformer leads from the grids, leaving the center tap grounded. Touch the positive lead of a VOM to the secondary leads to measure any DC leakage from the transformer primary. This test can also be applied to single-ended stages if the bias deviates from the proper value.

A similar, but more common, situation can occur in resistance-coupled amplifier stages when the coupling capacitors become leaky (Fig. 2B). A portion of the preceding stage's plate voltage is applied to the grid, thereby decreasing the normal negative bias voltage. This condition can be checked in a similar manner — disconnect the grid end of the capacitor and measure with a VOM for the presence of leakage voltage. If any leakage is discovered, the capacitor should be replaced. Similar leakage through defective feedback capacitors can also cause an erroneous bias on the grid.

Plate Voltage

DC unbalance can also be caused by faults in a transformer primary winding. A winding shorted to the core will bypass part of the plate voltage for that side of the stage (if it is push-pull). This can be checked by removing the tube and measuring to see if low voltage still prevails at the tube socket. However, before snatching out the transformer in a paroxysm of glee, make very sure there is no other cause for the condition — such as the aforementioned solder globule or perhaps a leaky screen-grid bypass capacitor connected to another tap along the same winding. With the equipment turned off, measure the DC resistance from the suspected tap to the core. To avoid confusion, this should be measured first with all primary taps connected and then with all primary taps disconnected — especially if the first reading seems to indicate a short to the core. In the latter case, an ohmmeter should show infinite resistance from the primary tap to the core. When a short exists, the resistance will range from a few to several thousand ohms.

Transformer windings do not always short to the core. Sometimes one side of a primary winding of a push-pull unit will break down to the other side, or one part of a winding may short to another layer of the same winding (Fig. 2C). Either of these conditions will result in very little or no change in DC voltage at either tube. The condition cannot be corroborated by pulling tubes out and checking plate voltage — there is no short to ground to draw current through the winding resistance when the tubes are out. If this condition is suspected, the quickest check is to measure the resistance of each half of the winding. Any serious discrepancy indicates a shorted winding. With a single-ended stage, in which this comparison is not possible, the instruction manual should be consulted for the normal DC primary resistance. If not, the tube-socket resistance chart will be a possible aid. However, these helps will not definitely put a conclusive finger on a defective primary. Unless the normal primary resistance is given in the manual, the quickest way of pinpointing a shorted primary in the transformer of a single-ended stage is by comparing its resistance with that of a replace-

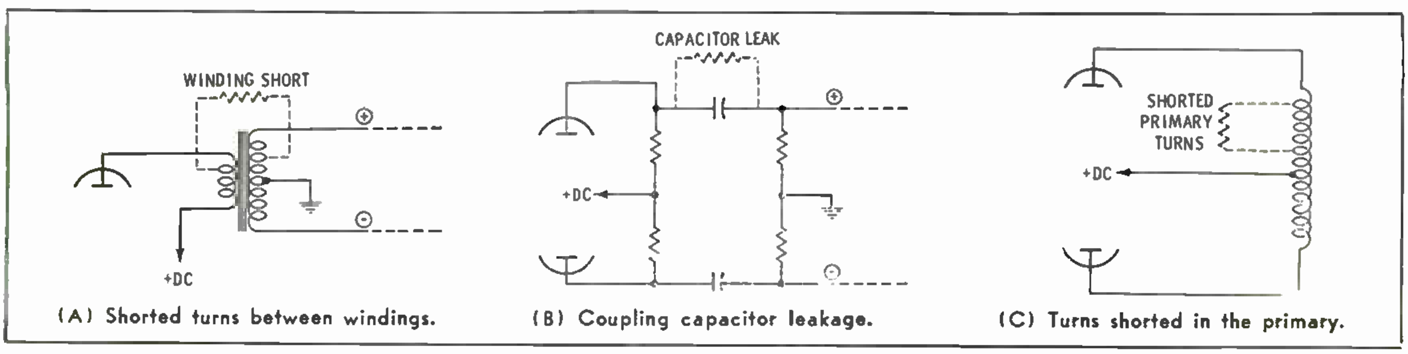


Fig. 2. Some causes of DC unbalance in push-pull amplifier stages.

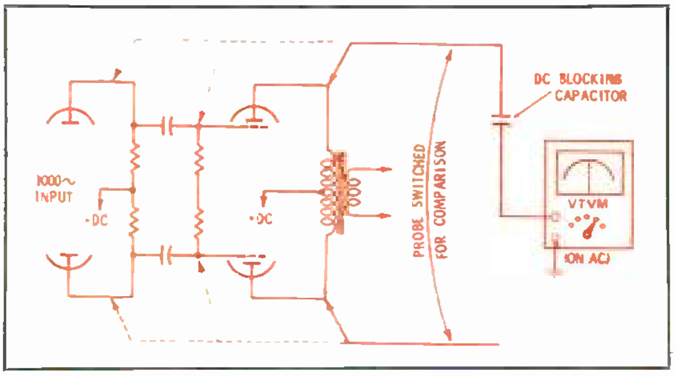


Fig. 3. Checking for audio frequency symmetry.

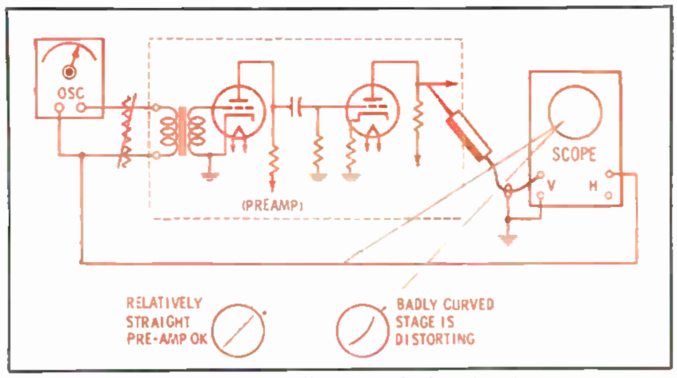


Fig. 4. Check for distortion in low-level stage.

ment unit. In most broadcast equipment, the only single-ended stages are in low-level sections (i.e., preamplifier units); hence there will generally be one or more similar transformers available for comparison. Sometimes, substitution of a new unit is the only practical solution.

Dynamic Checks

(Editor's Note — Watch for an article soon showing a dynamic method of testing transformer windings for single- or few-turn shorts.)

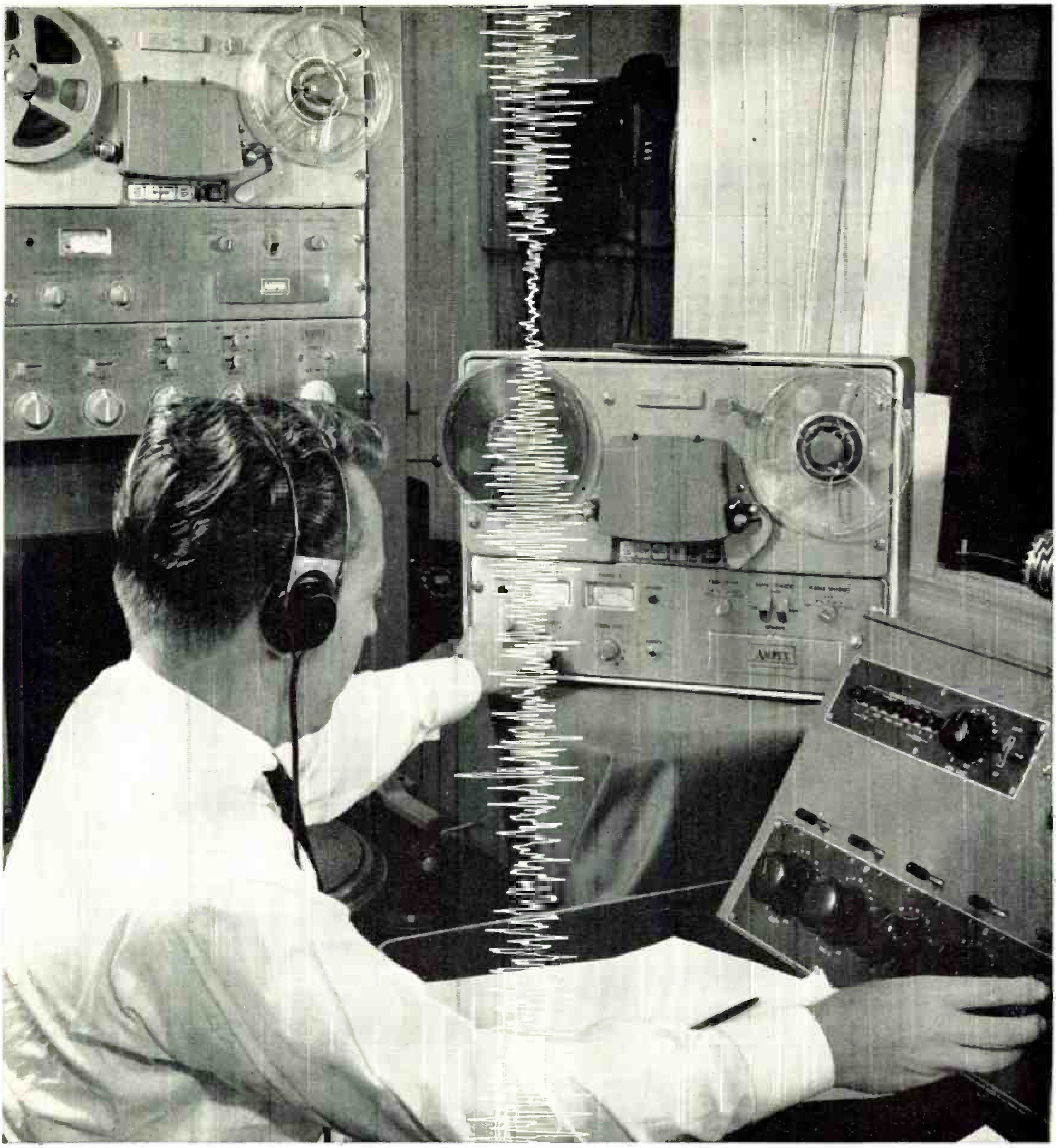
These DC measurements will usually turn up the faulty component; but occasionally everything seems just jim-dandy from a DC viewpoint, yet distortion is there anyway. The trouble could be due to a faulty coupling or bypass capacitor, or perhaps it is one of those contankerous cases in which a component deviates only under actual dynamic operation. So, if DC checks do not indicate the trouble, the next step is to feed a signal from an oscillator into the amplifier, and make AC measurements. Although an oscilloscope may eventually be required, it is best to start with a VOM or VTVM adjusted for "output" measurements (a DC blocking capacitor may have to be added if the meter does not have one). Adjust the oscillator for a medium audio frequency (400 to 1000 cps) and check the amplitude symmetry (Fig. 3) of corresponding points in all the push-pull stages, beginning with the output stage. First, disconnect feedback networks at the point where they connect into the first stage in the loop; readjust the preamp attenuator for normal output level of the output stage. With the negative (common) meter lead grounded, use the positive lead to measure signal voltage at the plates of the output tubes, comparing the relative signal levels. Continue this process at the grids; and so on back through the preceding push-pull stages. If a point is reached where there is a noticeable difference in AC signal between the two sides, the defective component (or condition) should be in that section.

If no discrepancy is found in the push-pull stages when tested in this manner, the feedback loops should be reconnected; and the previous measurements repeated for all stages. If an error in symmetry should now be found, one of the feedback ladders must contain a faulty component. In this event, the same comparison tests applied to corresponding points along both ladders will assist in locating the feedback trouble.

Normally, objectionable distortion will occur only in the higher level stages. However, if the measurements taken so far indicate nothing amiss in the last stages of the amplifier, the next obvious step (other than hara-kiri) is to see if the waveform is distorted somewhere before it reaches the push-pull sections. Although the distortion analyzer may be "gimmicked" into low-level circuits (for special application which may at times be advantageous in such difficulty as we are now considering), the procedure requires a special knowledge of many factors and isn't of practical value to the 'occasional' trouble-shooter.

It is at this point that the oscilloscope may again be brought into play, although in not quite the same fashion as before. Since it is difficult to ascertain distortion levels lower than 5% in the oscilloscope reproduction of a waveform, the scope will be used to display amplitude linearity at the various points of measurement. The internal sweep generator of the scope is not used; the "Horizontal" switch is changed to "Horizontal Input" and the signal is furnished by the audio oscillator. To avoid inherent distortion of the waveform, especially when checking at a grid, a low-capacitance probe should be employed (such a probe is not recommended for noise hunting because it has a rather high attenuation factor). If the low level stages are distortion free, the resultant scope trace should be a straight line canted at 45° (as shown in Fig. 4, denoting an in-phase condition). If nonlinearity is present (resulting in distortion) this straight trace will "bend" — the amount depending on the degree of nonlinearity. The source of the nonlinearity may be isolated by probing at various points. Other than capacitors and resistors operating erratically under signal conditions, the input transformer may be defective.

Because of a certain amount of nonlinearity within the oscilloscope, a comparison of conditions should be made in another preamp stage before reaching a final decision concerning the stage in question. NOTE: The 45° cant of the trace, mentioned above, is not automatic. This angle is chosen because it is convenient for observation; the scope amplitude controls must be adjusted to produce an approximate 45° (in phase) trace. Also, the production of a "closed" line assumes that the amplifier signal at the test point is exactly 90° out of phase with the scope's horizontal input — which is not always the case. Depending on circuit conditions at the point of measurement, the line may tend to open into an ellipse; if so, it should be a **symmetrical** ellipse if the stage is not distorting. ▲



What compact can do everything a console recorder can? AMPEX PR-10

The Ampex PR-10 gives you all the features, all the performance of a console recorder. Even remote control. And it's all wrapped up in a suitcase-sized package. That means you can take a complete recording studio out into the field, into the school, the church, industry—anywhere you need it. The PR-10 features positive push-button controls; record-safe switch; and separate erase, record and playback heads. And there's room for an optional 4-track stereo or additional playback head. There's also a new electro-dynamic clutch system to give you fast, gentle starts and lower braking tension. If you want to monitor on-the-spot, the PR-10 has A-B switches, VU meters, phone jacks, output circuits. Moreover, electrical alignment controls are accessible through the front panel. You get all this plus a new Ampex "Four Star" one year warranty. For data write the only company with recorders, tape & memory devices for every application: Ampex Corp., 934 Charter St., Redwood City, Calif. Worldwide sales, service.

AMPEX

Circle Item 7 on Tech Data Card

ANTENNAS FOR FM STEREO

Technical Talks* **— Requirements for stereo transmitting antennas with methods for achieving desired results.**

This month we are going to talk about antenna systems for stereo FM. In general, this is not an especially deep subject. The requirements for best operation of any FM station call for broadband antennas and adequate power capability. Stereo FM calls for an antenna with the ability to transmit the subcarrier sideband pairs as well as the FM fundamental without frequency discrimination or phase distortion.

Other Side of the Coin

Perhaps a quick look at requirements from the receiving end might be helpful. The average FM set that uses the power line for an antenna does not seem to have the same sensitivity as an AM receiver. For ordinary monophonic FM these antennas and receivers are pretty good, and often provide better response than a similarly priced AM receiver; and, they are relatively free from noise. But as soon as stereo is added to the signal, the addition of a stereo FM adapter to the receiver often reveals a poor state of affairs in signal reception.

Maybe the sound is good on nearby stations. But so often there is a peculiar sound — like waves on a beach or a roaring that comes and goes. It is caused by a troublesome acquaintance of ours, phase shift. As the FM signal travels from the transmitter to the receiving antenna, there is generally a slight change in phase. In the case of monophonic transmission this is not important; the ear cannot detect phase shift in a single channel. But as soon as stereo is added, the changes produced by multipath reflections or variations in the relative amplitude and phase of the sideband pairs cause a change in the reinsertion oscillator, with a subsequent variation in separation between the left and right channels. This shifting causes the "seashore" roar. A properly oriented receiving antenna of good design will generally take care of such propagation problems, although there are locations where it seems impossible to get good stereo from certain stations. The situation is similar to that of television where a particularly bad multipath situation produced ghosts so bad that reception was ruined. In TV, the eye perceives the reflections; in stereo, the ear hears the results.

Transmitter Responsibilities

Unfortunately, you at the transmitter end cannot do much about the equipment used by your listeners. So the best approach for the station engineer is to ensure that he puts out the best possible stereo signal. If he knows his transmission is clean, he at least has **right** on his side!

Crosstalk

Once the FM signal has left the antenna, there is not much that can be done to keep it pure. But, until it actually leaves the antenna, you must take good care of it. This means you should avoid crosstalk and poor VSWR in the antenna system. This is merely an extension of good engineering practice, but it is decidedly more important in stereo. Therefore, let's run over very briefly the principles of the FCC-approved stereo FM system. The Commission did not say that any particular maker's system has to be followed, any more than they did in the case of color television. In that case, the NTSC system was specified; the method of achieving it was left to the imagination of the various manufacturers. So it is with stereo FM.

In the FCC-approved system, the main FM carrier is modulated by the **sum** of the left- and right-channel information; so a listener

● Please turn to page 27

*by John H. Battison, Consulting Editor, Washington, D. C.

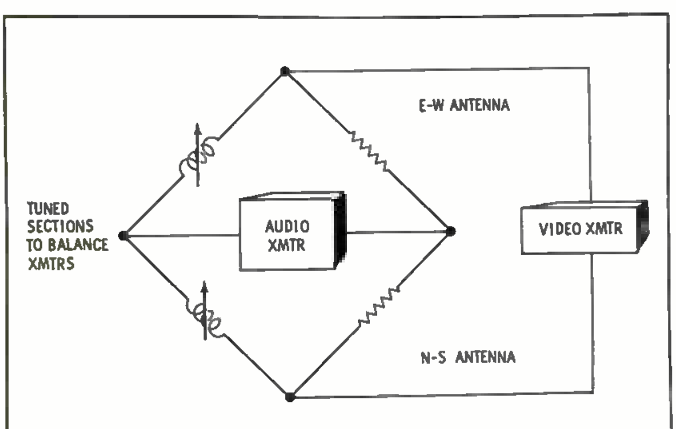


Fig. 1. Diagram of common bridge diplexer.

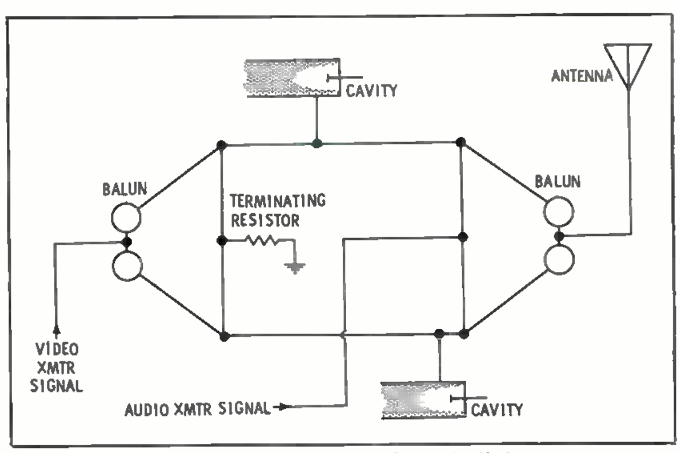
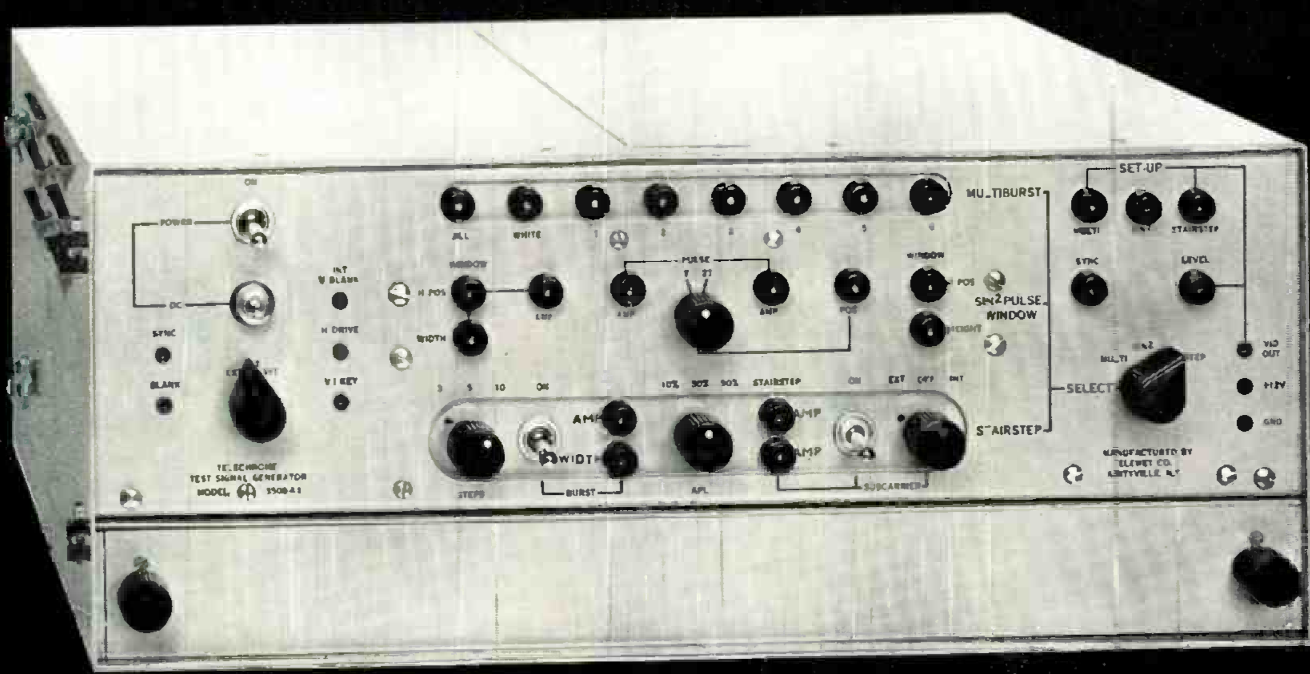


Fig. 2. Basic schematic of notch diplexer.

KEEP STATION PERFORMANCE UP...MAINTENANCE COSTS DOWN
with Telechrome† Transistorized Video Broadcast and Test Equipment



Model 3508A1 Video Transmission Test Set, now with 1/2 T pulse*

†Brand name

FEATURES:

- Rack mount or portable.
- Carrying case contains 1¾" utility drawer which can be removed for installation of an EIA Sync Generator (Model 3507A1), is pre-wired for sync generator.
- All controls conveniently located on front panel.
- Operates from self contained non-interlaced sync, plug-in EIA Sync Generator, or external EIA Sync and Blanking.
- VIT Operation—when used with external VIT Keyer, provides vertical interval test signals through a high impedance (line bridging) output.
- Low distortion multiburst—plug-in oscillators permit optional selection of frequencies to 12 MC.
- Preset 3, 5 and 10-step stairsteps with variable APL and 3.58 MC sub-carrier on all modes.
- * 2T, T and 1/2T (.250, .125 and .062 μsec) Sine squared pulses. Window signal also sine-square filtered.

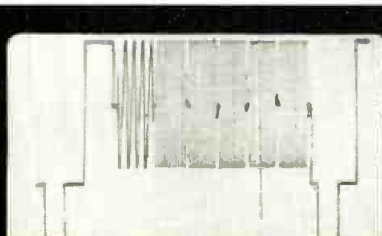
TELEMET COMPANY

A Giannini Scientific Co.

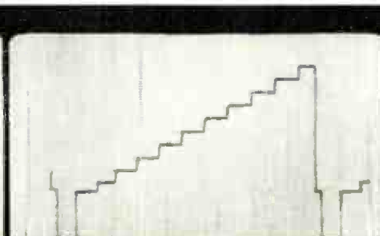
AMITYVILLE, NEW YORK: 185 DIXON AVENUE, (516) 541-3600
SANTA ANA, CALIF: 2509 SOUTH BROADWAY, (714) 546-2881

NOW — condensed into one small lightweight portable unit — fully transistorized.

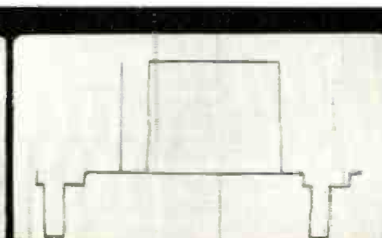
- Multiburst
- Stairstep
- Sine Squared Pulse & Window
- Optional EIA Sync Generator



Multiburst Signal-Line Rate-Internal Sync



10-Step Signal-Line Rate-Internal Sync



Sin² & Window Signal-Line Rate-Internal Sync

Circle Item 40 on Tech Data Card

PHASE CHECKING OF STEREO CHANNELS

*by Harry A. Etkin** — Practical means for determining the relative phase of channels in a stereo system.

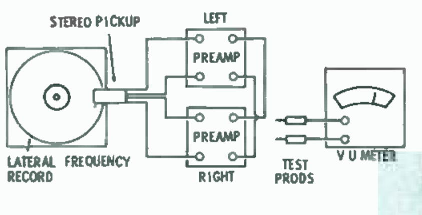


Fig. 1. Checking phase with a VU meter.

In stereo FM broadcasting, it is of utmost importance that proper phase relationship be maintained in the audio channels to produce pleasant music with tonal balance, and sound perspective with depth and "spaciousness." When audio signals are out of phase, music reproduction suffers from cancellation and loss in the low frequency ranges, and undesirable high frequency products. Consequently, the broadcaster must realize the importance of checking and maintaining proper phase between the two channels. Either of two test methods may be employed.

One Way-VU Meter

The first method for phase checking is to patch together the outputs of the left and right channels either at the pre-amplifier or line amplifier stage, and connect a single VU meter to indicate the combined outputs. Play a good lateral frequency record and observe the VU meter reading for each channel, separately. The readings, if the channels are properly balanced, should be equal. If the phase relationship is incorrect, the VU meter will indicate a reduced reading when the channels are connected together. Fig. 1 shows the equipment arrangement.

Another System-Scope

The second method for making the phase check of the stereo audio chain is detailed in Fig. 2. The essential equipment to perform this test are an audio oscillator and an oscilloscope. The oscillator is connected to the scope; the audio signal connected to the vertical and horizontal inputs of the scope. When you feed a 400-cps sine wave to both inputs of the scope, a straight line — sloping upward to the right — will appear. Its angle on the screen should be adjusted to 45° by manipulating the scope's gain controls. This step calibrates the scope for subsequent phase checks. This linear waveform corresponds to an in-phase condition.

Signals of equal amplitude and the same frequency, but 180° out of phase with each other, would result in a straight line sloping 45° upward towards the **left.** A perfect circle appearing on the screen would indicate a 90° phase difference.

Making the Test

After setting up the audio oscillator and oscilloscope as described, the broadcaster can readily determine the phase relationships between stereo amplifier channels, microphone setups, and loudspeakers. Fig. 2 shows the equipment setup for checking stereo amplifier channels. Fig. 3 indicates the system used for testing microphones.

An effective method of testing speaker phase is shown in Fig. 4. Both microphones are placed in front of the left speaker, and a 200 cps tone is fed to it. The right microphone is then placed in front of the right speaker and the same signal fed to both speakers. An identical figure should appear on the oscilloscope.

Conclusion

The test methods and techniques described and illustrated in this article will contribute to high quality reproduction of both music and voice program material for both monophonic and stereophonic transmission and reception. ▲

*Staff Engineer, WQAL-FM, Philadelphia, Penn.

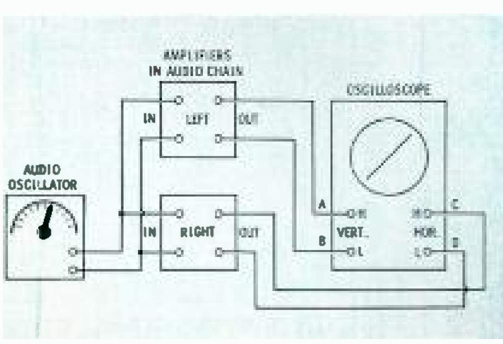


Fig. 2. Setup for checking amplifier phase with audio oscillator and oscilloscope.

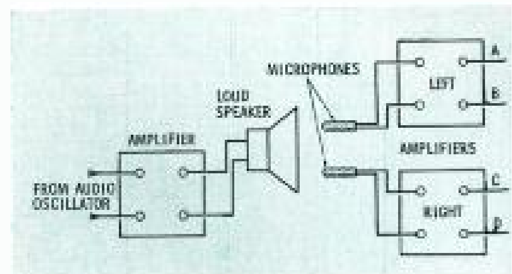


Fig. 3. Setup for checking microphone phase with an audio oscillator and scope.

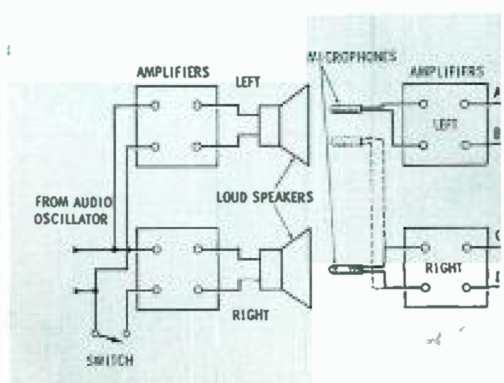


Fig. 4. Setup for checking speaker phase with audio oscillator and oscilloscope.

SARKES TARZIAN

Tube Replacement Silicon Rectifiers

BIG

in broadcasting...

More and more broadcasting stations of all kinds are proving that the reliability and long, *long* life ✱ of these units pay off in station on-time. Send for free replacement chart covering 95% of the vacuum tube rectifiers now in common use, price information, and case history data.

✱ *Not to mention instant warm-up, no appreciable heat radiation, no filament supply, compact size, ruggedness, and dc current ratings up to three times as high as the tubes they replace.*

SARKES TARZIAN Inc.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

Canadian Licensee: Marsland Engineering Limited • 350 Weber Street North, Waterloo, Ontario

Circle Item 8 on Tech Data Card

FM STEREO—PAST, PRESENT, AND FUTURE

*by Harold W. Kassens** — A brief history, summary of current conditions, and a look into the future of stereophonic broadcasting.

Fortunately for all of us, the FM band was, in the beginning, over-allocated. If each FM station were permitted a maximum deviation of only 25 kilocycles (plus and minus) for its aural signal, as a television station is, the multiplexed stereo and subsidiary services by FM stations would not have been possible.

The first important experiments in FM multiplexing began in 1948. In 1955 the Commission adopted rules to permit FM stations to engage in subsidiary services — such as storecasting and background music — as an adjunct to main channel programming. Subsequently, in 1958 proceedings were instituted by the Commission to determine other possible uses of FM multiplex.

At this stage, the Electronic Industries Association organized the National Stereophonic Radio Committee consisting of six panels membered by outstanding technical personnel in the industry. This group was devoted to the purpose of developing, and recommending to the Commission, a set of standards for stereophonic radio broadcasting. As a result of the Committee's studies, six systems were rigorously field tested at Uniontown, Pennsylvania, using the transmission facilities of Station KDKA-FM in Pittsburgh.

*Broadcast Bureau, FCC, Washington, D.C.

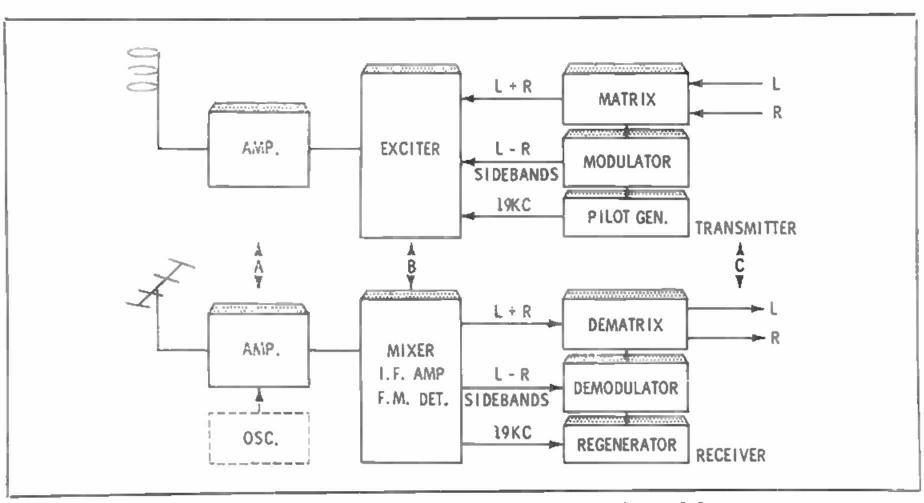
After a careful evaluation of the findings of the Stereo Committee, the Commission, in April 1961, announced its decision selecting a system — proposed by both the General Electric Company and the Zenith Radio Corporation — as a basis for national standards for FM stereophonic radio. This system was determined to be capable of providing, among other characteristics, essentially a flat frequency response from 50 to 15,000 cps in each channel and providing a separation of 30 db between channels over this entire audio range.

The first stations to begin stereophonic programming, on June 1, 1961, under the new rules were, quite appropriately, the General Electric Station WGHM in Schenectady, New York, and the Zenith Station WEFM in Chicago, Illinois. Since that time there has been a steady increase in the number of stations transmitting FM stereo, and today 218 stations have entered this exciting field of endeavor. The amount of time devoted to stereo programming varies from station to station, with some transmitting as little as one hour a day, and others as much as twenty-four hours.

What do we learn from these stations? In general, there is contentment with the system. It has proven its ability by providing a wonderful new world of public entertainment. In addition to acceptance by the broadcasting industry, the general public is also accepting stereophonic radio. The Electronic Industries Association indicates that in 1962, almost one-half of all radio-television and radio-phonograph combinations produced were capable of receiving FM stereo.

This stereo world, however, is not entirely one of milk and honey. The system is complicated and critical, and engineers that are quite able are required to keep the equipment operating properly. During these intervening 30 months since June 1, 1961 there has been an increasing demand for suitable monitoring equipment to permit the operator to measure performance of the technical equipment. Several papers have been offered that demonstrate this need and the steps the industry is taking to satisfy it. The Commission must now establish standards for type-approval of the monitoring equipment.

While progress has continued in the United States, other countries have also been busy in the FM stereo field. Canada has adopted the United States standards for use in that country, and several stereo stations are operating. Japan is expected to follow within the near future. The International Radio Consultative Committee, a subdivision of the United Nations, has been studying the question of FM stereo broadcasting with a view toward establishing international



Basic block diagram of FM stereo transmitting and receiving systems.

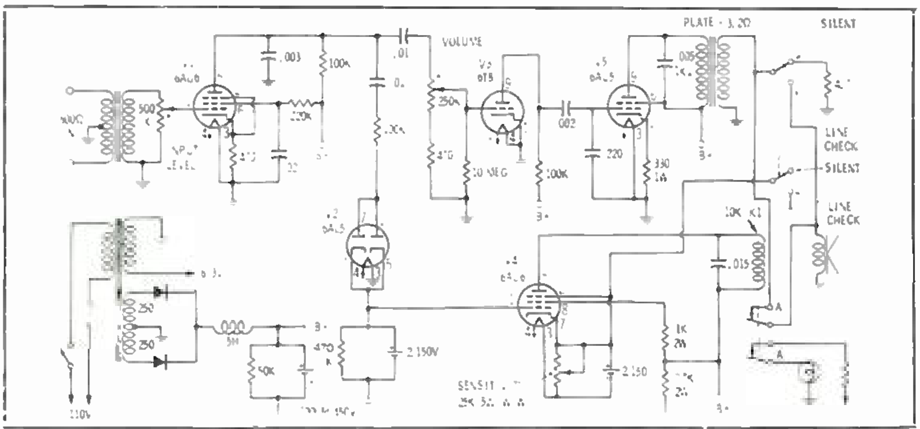
Editor's Note: This article is from a paper delivered by the author at the Fifteenth Annual Convention of the Audio Engineering Society.

standards. At preliminary meetings in Germany last summer, the United States delegation and the European Broadcasting Union succeeded in obtaining an interim agreement for international standardization using the U. S. standards. However, at the Plenary Assembly in Geneva, Switzerland, last winter we were unsuccessful in finalizing the standardization of this system. It was apparent, however, that several countries in Western Europe were satisfied with the capabilities of the Pilot Tone system — as it is known in Europe — and intend to institute stereophonic broadcasting before the question again arises, probably at the next meetings in Vienna in 1965.

What does the future hold for stereo? It appears quite obvious as most new FM stations begin operation, they will do so in stereo. A big difficulty for existing stations — in addition to the extensive technical rearrangement — is the need for a costly conversion from a monaural to a stereo transcription library. While a brief view over the horizon indicates additional stations being provided, it does not appear that any major changes in transmitting or receiving equipment will occur. The view does foretell, however, that demand for high quality components will increase as the public becomes more aware of what is available in stereo programming.

One new development which has occurred is three-channel stereo. Here, the normal two-channel FM multiplex signal is supplemented by a low-quality third channel provided by an AM broadcast station. The question which arises is whether the minimal benefits obtained justify the added spectrum space.

Another new development is "off the air" relay of stereophonic programming. The desire and the need for monophonic FM networks has been well established in the past. That desire and need now extend themselves to stereophonic FM networks, but it is considerably more difficult to receive and re-transmit a stereo signal than a monophonic one. Examination of the basic transmitting and receiving equipment will indicate that there are several possible solutions to the problem. But it will require considerable mental exertion on the part of many engineers to arrive at the best solution. ▲



NIAC Receiver

by Lawrence I. Presler
WERT, Van Wert, Ohio.

In converting our present CONELRAD receiver — a Karr "Conelert" — to receive and display the NIAC signal, the accompanying circuit was developed. It can be built from "scratch" or adapted to existing receivers.

The 600-ohm line transformer is connected to the NIAC line coming into the control board. As a tone signal is received, V1 amplifies the signal to a sufficient level before it is applied to V3, the relay rectifier control tube. A 500K potentiometer is connected across the input transformer secondary to adjust the signal to the proper operating level.

The positive voltage developed through the 6AL5 is applied to the control grid of relay control tube V4 causing plate current to flow. This, in turn, pulls in alarm relay K1.

The relay control tube sensitivity can be adjusted by the 25K 5-watt wire-wound rheostat. The 2-mfd 150-volt electrolytic capacitor across the sensitivity control gives the circuit excellent hold-in characteristics. The screen resistor (1K 2 watts) can be made from a 5K 5-watt wire-wound pot to provide an additional sensitivity adjustment. These two sensitivity controls should be adjusted simultaneously to achieve the best relay action.

The audio voltage is split at the output of V1, being used to both control alarm relay K1 and drive the control room speaker. The audio circuit uses a 6T8 (V3) driving a 6AQ5 (V5).

As alarm relay K1 is activated, the speaker is connected to the audio output transformer, replacing the 4.7-ohm standby load. At the same time another set of contacts activates the alarm light (6.3V - No. 47) by connecting the 10-ohm limiting resistor and pilot bulb combination to the filament supply. If additional control circuits are desired, 6.3V AC relays can be connected across the supply end of the alarm light system. However, the circuit should be arranged so the coil current **does not** flow through the 10-ohm 1-watt resistor.

Operating Instructions

To operate the units, turn the volume control to 8 or 9 (almost full rotation). When the unit has had ample time to warm up, depress the line check button to hear the input (normal operation is indicated by a few weak "signals" in the background). The unit does not have to be reset (as was the case with most conelrad receivers) when it is first turned on. When an alarm is received, listen, take note of what is going on, and after the alert, depress the check button to return to normal condition. Normal volume level is about half rotation.

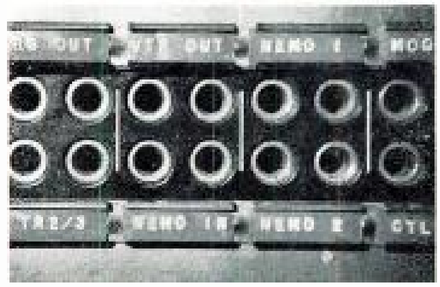
High Line Voltage

by Peter H. Van Milligan, Maintenance Supervisor, WMBI, Chicago, Ill.

Over a period of years, the line voltage throughout the country has been on the increase. Equipment designed for 115 volts now may have as much as 125 volts applied.

We have noticed that trouble in equipment which has developed shorted or noisy tubes was traced to resulting high heater voltage. Reducing this voltage by moving the tap on the power transformer primary resulted in a marked improvement in reducing noise.

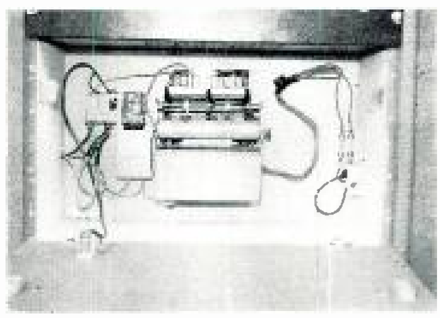
On equipment which does not have adjusting taps, installing a line dropping resistor, either in the primary or in the heater string, gave the same results. The size and value of this resistor can be determined by simple Ohms-Law calculations.



Jack Field Labels

by Dale Taylor, Chief Engineer,
KZTV, Corpus Christi, Texas

We have found that the little embossed tape labels (Dymo-M5, or equivalent) fit perfectly into our video and audio jack strips, making a very neat and readable jack field. They are easily changed if the adhesive backing is left covered. Colors can be used for a complete coding system. Eight characters will fit each double plug.

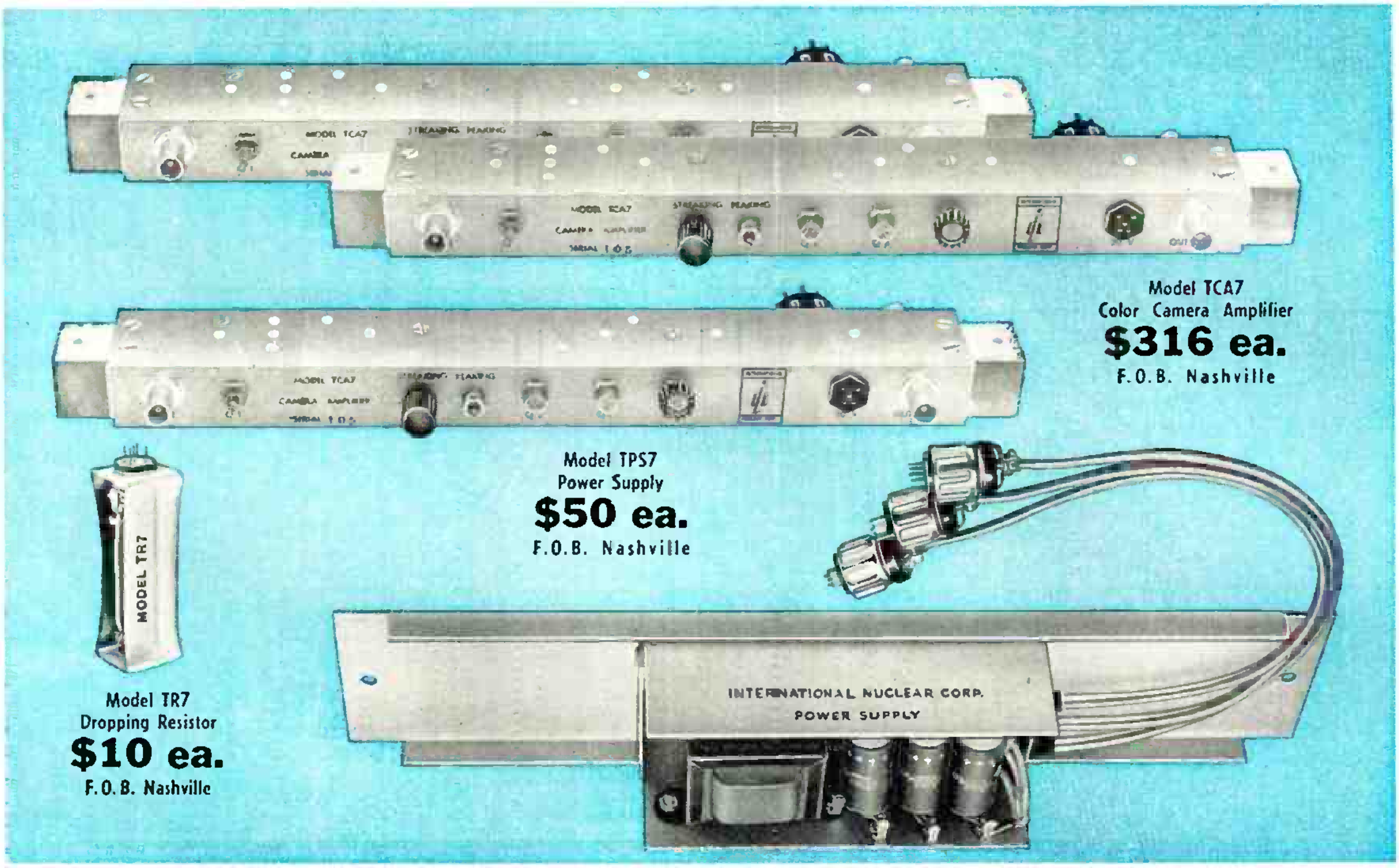


Preset Recording Clock

by Vernon E. Snider, Technical Supervisor
Radio Station KXXX, Colby, Kansas.

Many radio stations have an announcer running his own board, maintaining the program log as well as the transmitter log, and along with other duties, he is expected to turn on a tape machine to record a network program for delayed broadcast. One way to eliminate part of his problems is to install a clock to automatically turn on the recorder at the proper time.

Most clocks listed in radio catalogs are synchronous, constant speed units. A source of more accurate clocks is a school systems supplier



REPLACE TUBE-TYPE AMPLIFIERS IN YOUR COLOR CAMERA WITH INTERNATIONAL NUCLEAR ALL-TRANSISTORIZED PREAMPS

MODEL TCA7 is designed specifically for the RCA TK-41 color camera chain and replaces mechanically and electrically tube-type preamplifiers.

- **ELIMINATE MICROPHONICS**
- **REDUCE NOISE**
- **REDUCE HEAT**
- **GET HIGH GAIN-BANDWIDTH PRODUCT**
- **GAIN STABILITY**

Model TCA7 can be installed in about thirty minutes. Mounting dimensions and hardware identical to replaced tube amplifier. Can be powered by TPS7 solid state power supply or directly from the 280 volt camera supply by using a model TR7 dropping resistor with each TCA7.

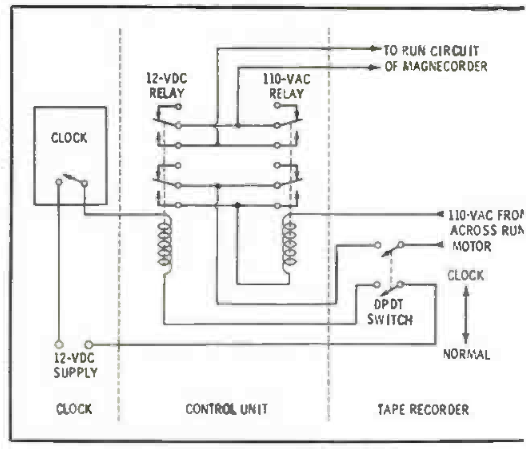
INTERNATIONAL NUCLEAR CORP.

Write for complete information and specifications to Dept. T-7

INTERNATIONAL NUCLEAR CORPORATION

608 Norris Ave. Nashville, Tenn. Phone 254-3366

Circle Item 10 on Tech Data Card



who handles the devices which ring the bells for class changes.

At KXXX we located a used IBM school clock which operates on an impulse each minute. Excess relays, clock face, gears, and power supplies were removed and only the inner working parts were installed in the control room.

This clock employs "time combs." The appropriate "tooth" is removed for operation on the desired day of the week, and time. In the working mechanism of the clock is a set of fingers (which you can read) that determines the day—whether morning or afternoon—and the time in hours, tens of minutes, and minutes. It has six switching contacts. Each minute, the time drum ratches and tries to move forward. If the time fingers do not match the broken out teeth of the time comb, the time wheel will not advance. At the time when they do match, the clock wheel moves past the fingers and closes all six contacts for approximately 30 seconds. We use Magnacorder PT 6's for recording. When the clock "fires," a 12-volt relay is closed, as shown in the diagram. If the recorder is in the record mode and forward position it will start, causing voltage picked up across the run motor to be applied to a 110-volt relay which locks the machine in run position.

At the end of the 30-second impulse from the clock, the 12-volt relay will open. However, the 110-volt relay maintains the recorder running until the forward switch is moved to "stop." The clock is so arranged that it can be set up to control a complete week's recording schedule.

At KXXX, we have the clock set to start the recorders about 40 seconds ahead of time — and it has been holding very steady. ▲

SUBJECT REFERENCE INDEX-1963

Antennas for Stereo

(Continued from page 16)

hearing only this channel would hear a full and complete transmission consisting of both audio channels. The 38-kc subcarrier is modulated with the **difference** between the left and right signals. It is interesting to note that the **sum** signals are allowed a maximum of 45% modulation, as are the difference signals. The pilot tone, which is transmitted to synchronize the receiver detector, may have 10% modulation. Cross modulation refers to modulation products in the transmitted signal caused by unwanted signals and coupling in the transmitter, and by reflections in the transmission line and antenna. In other words, this crosstalk can be caused by the L+R main channel modulation somehow phase modulating the 38-kc L—R subcarrier.

VSWR

The August, 1961 issue of BROADCAST ENGINEERING carried an article on measuring VSWR in stereo FM transmitters. Some of the results are of great importance and are worth restating here. The author's main conclusions are that crosstalk increases as antenna and transmission line mismatch becomes greater. If this condition occurs, the listener can retune and improve his reception slightly.

This means that receiver tuning will mask the results of VSWR changes—even fairly great changes. Since the natural tendency of the listener would be to change the tuning of his receiver to maintain acceptable quality and level, it would seem that antenna and transmission line stability are not of very great importance. This is far from true; because, as the VSWR rises, the problems of maintaining proper control of the signal become very great.

The SWR for satisfactory operation of stereo FM should not exceed 1.1:1, over the nominal bandwidth of 200 kc. This requirement is far more stringent than for monophonic FM, which often works with a VSWR as high as 1.5:1 or 2:1.

Most FM antennas will come from the manufacturer carefully matched to the center frequency, so that the operating bandwidth will be satisfactory for stereo. Provided such antennas are top mounted and properly matched to the transmission line, the VSWR and multiplex characteristics will be as specified.

However, there is a growing tendency among broadcasters to mount FM antennas on the side of existing towers, rather than on a pole at the top. Basically, this practice is sound from an engineering point of view, and has much to commend it. But, one very important point must be considered when a side-mounted antenna is used for stereo: The presence of a tower near the antenna will distort its pattern, and cause deterioration of the VSWR. This could increase VSWR to 1.5:1 or even more!

Considering the effects of unstable VSWR further, let us consider the signals that we are transmitting. The basic FM emission has many sidebands, but they have this in common — they are above and below the carrier frequency and 90° out of phase with each other. If the phase relationship among these sidebands changes, or if they are attenuated or amplified unequally, the result will be crosstalk—through amplitude modulation of the FM signal. For satisfactory freedom from crosstalk, spurious modulation components should be at least 40 db below the signal level.

Other Troublemakers

One last item that can cause trouble in stereo FM is the device that couples more than one transmitter to the same antenna system. A few combination FM-TV installations use equipment in which a third signal (FM) is added to the two TV signals (audio and video) for transmission via the same antenna. This is accomplished by adding another arm to the diplexer, thus making it into a **triplexer.** This can be done only if the TV signal is in the low band — channels 2 through 6. Such a system offers a considerable savings, but it can also lead to troubles if stereo FM is involved. There is the risk of changes in VSWR, or uneven attenuation of upper or lower sidebands in their passage through the diplexer or triplexer. If you are responsible for the operation and maintenance of such an installation, take particular care to check impedance match of the line and antenna to the FM system. ▲

Monitoring and Measuring

(Continued from page 11)

stereophonic subcarrier sidebands. A 45° shift along the pilot wave would completely destroy separation in a properly aligned receiver (Fig. 7). If you continue to shift the 38-kc sidebands another 45° along the pilot wave, you again see the signal in Fig. 6, except the right and left channels are reversed. Physically, of course, the right and left audio lines from the studio have not been changed in any way. The pilot synchronized method of monitoring will tell immediately if such a reversal has occurred, whether the oscilloscope connections are reversed or not.

Operational Considerations

We have examined methods for monitoring and measuring the FM stereophonic signal with meters and with an oscilloscope. I would like to draw a distinction between monitoring during operation and during testing. When you are checking the stereo signal (presumably during the experimental period), you can use sine-wave audio signals and take your time to examine each signal separately; you are primarily interested in measuring exactly how the transmitting equipment is working. That is, you can take the time to properly measure phase and amplitude excursions. However, during regular program transmission you are more interested simply in whether the system is working properly. Indications of modulation and balance must be easily observable by the control room operator, who usually has many other responsibilities to carry out simultaneously.

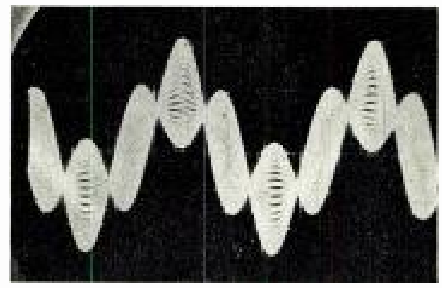


Fig. 7. Subchannel only, 45° out of phase: pilot synchronized method of monitoring.

As yet there is no commercially produced equipment suitable for control room monitoring. The oscilloscope bow-tie and pilot-synchronized methods may be used in the control room as a stopgap, and should be understandable even to combination operators. Stereophonic broadcasting is moving out of the purely technical "Now I'm on the left, now I'm on the right" stage and into the more artistic stage. It is rapidly becoming necessary that a good operating monitor — employing meters — be developed to aid stereo in becoming an integrated tool within the station's programming framework.

Desirable Features

Let's re-examine, in the light of another year's experience, what should be included in an operational monitor. For quantitative alignment or proof-of-performance purposes, we should be able to monitor the following, as a minimum: (1) right channel amplitude, (2) left channel amplitude, (3) main channel amplitude, (4) subchannel amplitude, (5) total composite amplitude, (6) pilot subcarrier amplitude, (7) crosstalk into the subchannel, (8) crosstalk into the main channel, (9) phasing between the pilot subcarrier and the stereophonic subcarrier sidebands, and (10) pilot subcarrier frequency. A monitor should be capable of indicating as many of these characteristics as possible during normal program transmission.

Now, let's look at what the control room operator should observe during operation. Since there are — in effect — two separately controlled and modulated channels, there should be at least **two meters.** The two meters may indicate either left and right channels or main and subcarrier channels, although the former may be easier for most operators to compare readily with actual programming. A third meter should be included to measure the total composite signal — whether it be a peak indicating, absolute reading, or an algebraic summing meter — to eliminate mental arithmetic.

Mention of SCA transmissions has been left out, not because they are unimportant to some FM operators, but because they should rightfully be measured with separate equipment.

Conclusion

I have tried to provide a few methods by which the stereo FM broadcast may be monitored during program transmission (or measured during the experimental period) in the hope that more stereo FM station operators will be able to provide a good signal to the listener. I have also pointed out a few considerations that the designer of FM stereo monitoring equipment should take into consideration. The instruments that result will help the station operator provide the best FM stereo signal feasible—so that now, after over two years of broadcasting in the new medium, we can devote more effort on presenting the artistic values that are available to us. ▲

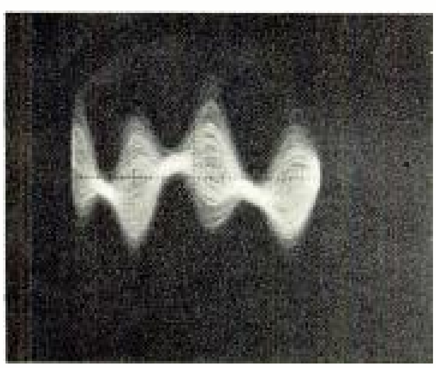
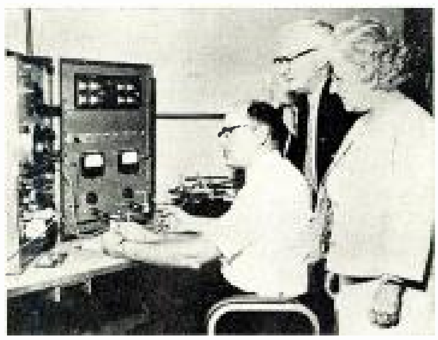


Fig. 8. Broadcast of recorded right channel signal with the pilot sync method.

NEWS OF THE INDUSTRY

AM and FM Operator Rules Amended

The FCC has issued Memorandum Opinion and Order (Docket 14746), reaffirming and modifying its decision of July 15 regarding operator requirements for AM broadcast stations with power of 10 kw or less which use nondirectional antennas, and FM broadcast stations with transmitter power output of 25 kw or less. The action results from petitions for reconsideration and oral argument filed by the National Association of Broadcast Employees and Technicians. The rules require stations to employ, for routine transmitter operation, persons holding at least radiotelephone 3rd-class operator permits endorsed for employment at broadcast stations. Stations using these operators may employ, under certain conditions, a supervisory engineer holding a radiotelephone 1st-class license on a contract part-time basis. The new operator rules become effective Jan. 1, 1964. A transitional period from that date to April 19 during which stations may utilize the services of restricted radiotelephone operator permittees for routine transmitter operation. After April 19, 1964, the operation must be handled by persons holding at least radiotelephone 3rd-class operator permits endorsed for employment at broadcast stations. During the transitional period, stations may not hire radiotelephone 1st-class operators on a contract part-time basis unless at least radiotelephone 3rd-class operators with broadcast endorsement are employed for routine transmitter operation. To obtain a broadcast endorsement for the radidotelephone 3rd-class operator permit, it will be necessary to pass a written examination. Information concerning the new examination will be contained in a Public Notice.



Audio Expert Visits U. S.

Percy Wilson, technical editor of **Gramaphone** magazine and Britain's foremost authority on high fidelity, combined a recent personal visit to this country with an inspection tour of several high fidelity manufacturers whose products are marketed overseas. Wilson is shown here looking over the shoulder of Roger Anderson, manager, Research and Development Section of **Shure Brothers, Inc.,** as Anderson runs a tracking capability test on one of Shure's Stereo Dynetic high fidelity cartridges. Also an interested observer is Mrs. Wilson, who accompanied the noted technical expert on the trip.

TV Equipment for World's Fair

International Nuclear Corp. has manufactured, tested, and readied for shipment thirty-eight video/pulse distribution amplifiers for the TV center of the New York World's Fair opening in April of next year. The equipment was ordered by **New York Bell Telephone,** who is charged with all World's Fair communications, including live TV relay for nationwide color broadcasts. According to Raymond Weiland, president, International Nuclear, these special amplifiers will allow the Bell Company to use many more TV circuits simultaneously than would ordinarily be possible. Gene

NEXT MONTH

Annual Antenna Issue —

Radiators for UHF
Design of Directional Antennas
Introduction to Television Translators
Antenna Matching Network Design
Remote Pickup Transmitter
After the Freeze, ?

Plus:
Engineer's Exchange, Book Reviews, News of the Industry, New Products, and many other important items you'll want to read!

Reserve your issues! Fill out and send in the convenient subscription card bound in this issue, and receive the Broadcast Engineers' Maintenance Guide—absolutely FREE!

Mignola, engineer in charge of the installation at the Fair for New York Bell, said that the equipment was chosen because it is transistorized, light and compact, allows multiple circuit usage and meets the performance requirements established by his company.

FM Net to Carry National Programming

QXR recently became the nation's newest interlinked radio network, when it began transmitting live from coast to coast, it was announced by James Sondheim, president. Twenty-one years have elapsed since the youngest of the four other major radio networks, ABC, was established. QXR affiliates in major markets from New York to California will carry five hours a week of topical interview and discussion programming. A program of business news and analysis is expected to be added to the schedule. Stereo FM music and drama series will be distributed to affiliates on tape to maintain the network's reputation for broadcast standards of the highest quality. Interconnection of the QXR network, which is owned by the **Novo Industrial Corp.,** represents a "major step in the evolution of FM as a cultural medium," Sondheim said. He disclosed the network's decision was influenced in part by the results of three nation-wide surveys conducted for QXR by Media Programmers, Inc.

Color Film On Tape Use

A 16mm color film on magnetic recording tape is available from the **3M Company,** maker of "Scotch" brand tapes. The 25-minute sound film, entitled "Magnetic Memory," is available on a free-loan basis for showings to clubs and other organizations. This professionally-produced film is built around the theme that magnetic tape has added a "new dimension" to the memory of man by providing a new method of recording and preserving his knowledge, skills, and creative efforts. Opening with a non-technical description of the theory of sound and recording, the movie advances through the many uses of tape, from capturing a baby's first words to preserving the technical data of a manned space shot.

TV Equipment Ordered

The **General Electric Co.** announced receipt of one of its largest orders for television studio equipment from a single station, in a contract for over $700,000 from WWJ-TV, The Detroit News Station is engaged in an extensive, two-year, $1.2 million expansion and modernization program. The order covers studio and film cameras, control systems, audio systems, and monitoring equipment. In the order are included eight 4½" image-orthicon studio cameras, two new four-vidicon color film camera systems, a remote-control studio vidicon camera, and three special audio systems.

FM Station Increases ERP

The FCC recently granted permission for **KNIK-FM, Northern Television, Inc.,** to increase power to 3,000 watts effective radiated power. The switch of the equipment was made at midnight Sept. 26th, and on the 27th, KNIK-FM began broadcasting with a new Collins transmitter. The actual transmitter power is 1,000 watts as compared to the previous 250 watts. However, the power gain of the antenna gives KNIK-FM an effective radiated power of 3,000 watts. In the past, effective radiated power was 750 watts. The transmitter is transistorized with the exception of the power tubes and is completely equipped for stereo broadcasting.

SMPTE Award

Robert L. Lamberts, research associate with Kodak Research Laboratories, has won the 1963 Journal Award of the **Society of Motion Picture and Television Engineers.** SMPTE Editorial Vice-President **Herbert E. Farmer** announced the award, which recognizes the most outstanding technical paper published in the monthly **Journal of the SMPTE** during the preceding year. Mr. Lamberts's winning paper, "Application of Sine-Wave Techniques to Image Forming Systems," discusses the derivation of spatial frequency—more properly called modulation transfer function—and illustrates uses in evaluating optical and photographic systems.

PERSONALITIES

Clifford Warner has been named manager of the southeastern district sales office of **Eitel-McCullough, Inc., Louis Martin,** director of marketing of the electronic tube manufacturing firm, announced.

P. A. Rasmussen, president of **Viking of Minneapolis, Inc.,** announced the appointment of **Ansel Kleiman** as general manager.

John S. Kane, vice-president and general manager, has announced the appointment of **H. Grignon** as manufacturing supervisor of the **Reeves Soundcraft Div.** of **Reeves Industries, Inc.**

Appointment of **Wendell C. Morrison** as chief engineer, **Radio Corporation of America's Broadcast and Communications Products Div.,** was announced recently by **C. H. Colledge,** division vice-president and general manager. In his new assignment, Mr. Morrison will direct overall engineering activities for the Division and its product line, which includes radio and television broadcast equipment, microwave communications systems, scientific instruments, two-way mobile radio, marine radio equipment, and audio visual products.

GPL Division, General Precision Aerospace, has named **J. Frank Price,** president of the company's Pleasantville Instrument Corp. subsidiary.

The Distributor Products Div. of International Telephone and Telegraph Corp. has appointed **Edward J. Carney** as manager of advertising and sales promotion. He will report directly to the division's president. **Leonard J. Battaglia** and will be responsible for all product advertising and related sales promotion programs.

Vitro Engineering has appointed **Donald F. Ferguson** technical director, responsible for Vitro's operations in India. This was announced by **Dr. Norman A. Spector,** vice-president of **Vitro Corp. of America** in charge of the engineering and services group, who stated that Mr. Ferguson would be headquartered at the Bombay office.

Sylvester L. (Pat) Weaver, Jr. has been appointed president and chief executive officer of **Subscription Television, Inc.**

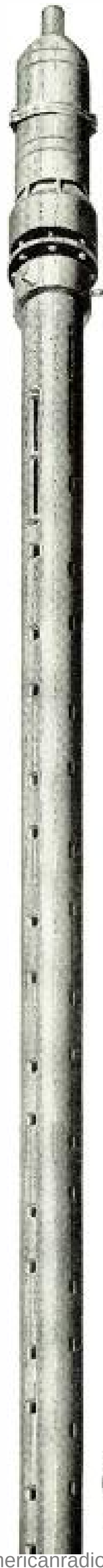
Meredith L. Koerner is now the director of engineering for **Radio Liberty.** The appointment was announced by **Howland H. Sargeant,** president of the American Committee for Liberation, which sponsors Radio Liberty's freedom broadcasts.

Arthur J. Kjontvedt was named vice-president of marketing by the **Houston Fearless Corp.** board of directors, it was announced by **President F. C. Mehner.**

C. J. Tevlin has accepted an assignment as director of the Motion Picture Services Div. for **Superscope, Inc.,** according to **Joseph S. Tushinksy,** president. Tevlin will handle the introduction to the film industry of the new Superscope wide-screen motion picture process.

What Station Men are saying about

THE RCA "*TRAVELING WAVE*" ANTENNA



At WMTW-TV, Poland Springs, Me.
Parker Vincent, Chief Engineer, says:

"We decided on our Travelling Wave TV Antenna for the specific purpose of operation under the severe icing conditions we encounter on Mt. Washington (N.H.). We could not operate without it. Aside from the special properties of strength and ability to operate within a radome, the field of the antenna is very uniform."

At WLOS-TV, Asheville, Greenville, Spartansburg
Mitchell Wolfson, President, says:

"WLOS-TV is extremely well satisfied with the Travelling Wave Antenna installation. Physical and electrical advantages met every promise and the increased signal strength throughout the station's 82-county, 6 state area exceeded all expectations."

At KROC-TV, Rochester, Minn.
Robert W. Cross, Chief Engineer, says:

"During installation and erection of our Travelling Wave Antenna, I was most favorably impressed with the mechanical simplicity and ease of assembly. Subsequent electrical check-out of the antenna and its 1300-ft. transmission line proved it to have the lowest VSWR of any system encountered."

At KGIN-TV, Grand Island, Nebraska
D. Raymond Taylor, Chief Engineer, says:

"Field strength measurements show that the signal far exceeds the predictions of the FCC 50/50 Field Strength Curve. Reports from viewers on the fringe area substantiate these measurements. The standing wave ratio is very good and no ghosting is present."

At KTSM-TV, El Paso, Texas
Karl O. Wyler, President, says:

"I believe that KTSM-TV was one of the first stations to order the RCA Travelling Wave Antenna. It has been in service on Range Peak since December 1959, and we are completely pleased with its performance. We like it because there is practically no maintenance, no bolts to tighten, and fewer inspections. Overall efficiency is very good."

At KOAM-TV, Pittsburg, Kansas
Leo S. Stafford, Chief Engineer, says:

"I have viewed KOAM-TV from some 85 miles away and was amazed at the picture quality. The antenna has increased our area coverage by 63 percent, while at the same time it gives us 316 ERP on less transmitter power. This reduces primary power requirements and increases tube life."

Favorite Antenna of High-Band Stations!

CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13
CJAY	KGHL	KLRN	KROC	CHCH	KCND	CKCO
KCMT	KSWS	KTSM	KXTV	KCBD	KEYC	KMSO
KOAM	WKBT	WAFB	WCBB	KGIN	KFVS	KOVR
WNAC	WMTW	WWTV	WIS	WBAL	KNMT	KSOO
WPBN	WOOD		WLBN	WLWA	KTVH	WGAN
WTRF	WQAD		WPTT		KVAR	WIBW
WXYZ	WXGA				WEAT	WJZ
					WMEB	WLOS
					WPRO	WOKR

If you want more facts about this VHF High-Band Antenna, your RCA Broadcast Representative can help you. Or write RCA Broadcast and Television Equipment, Building 15-5, Camden, New Jersey.

RCA®

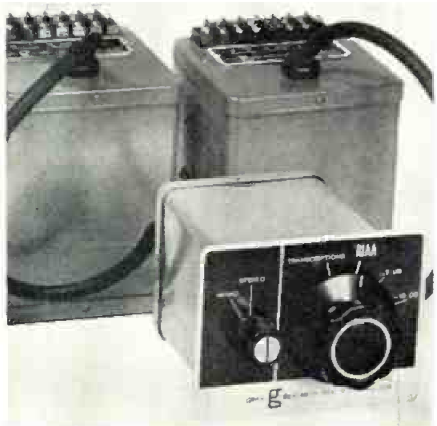
The Most Trusted Name in Television

Circle Item 23 on Tech Data Card

NEW PRODUCTS

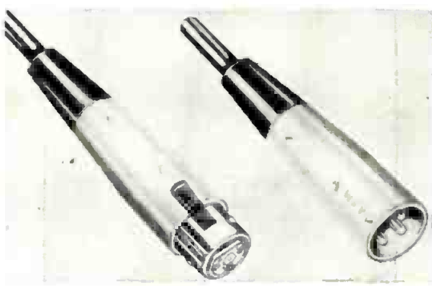
Record Compensator

A passive record equalizer for stereo and monaural discs, flexibly designed to permit broadcast stations to install new stereo facilities, to convert existing monaural facilities to stereo, or simply improve monaural performance only, has been introduced by **Gray Research and Development Co., Inc.** Called the 604-M/S, the unit takes the constant velocity output of either stereo or monaural magnetic cartridges and feeds the signal into low-impedance microphone channels on



a stereo mixing console, automatically compensating for both cartridge output and recording characteristics. The device operates with either high-impedance magnetic stereo cartridges or low-impedance monaural cartridges, and is easily integrated with the present equipment of most stations. Mechanically interchangeable with the Model 602-C Equalizer, widely used by monophonic stations, the control chassis provides smooth switching from mono to stereo discs, as well as to 16" broadcast transcriptions. Two high-frequency rolloff positions are included for noisy records or instantaneous lacquers. Prices are: 604-M/S, $137.50; 604-M (monophonic only) $79.25.

Circle Item 32 on Tech Data Card



Grounded Audio Connectors

A series of audio connectors, featuring a ground terminal with continuity to the connector shell, is now available from **Switchcraft, Inc.** The "Ground Contactor," as it is called, is additional to the three circuit contacts, and automatically grounds the mating connector shells upon engagement. Also, any of the three circuit contacts can be grounded simply by connecting a jumper (provided) to shell or ground. Another new feature of the cord plugs is a "captive" insert screw which cannot be lost during cable installation. Each connector, formed of diecast zinc alloy construction with a satin nickel finish, uses a dielectric insert of thermosetting plastic with high impact resistance. The connectors, series A3F, A3M, B3M, and C3M, are latch-locked to prevent their pulling loose from the cable, and are provided with dual pressure plates for strain relief and a secure cable lock.

Circle Item 33 on Tech Data Card

Sound Tapes Introduced

Two professional-quality sound recording tapes have been announced by **Eastman Kodak Co.** Eastman Sound Recording Tape, Type A303, is basically a low-print tape with a signal-to-print ratio of 54 db. High-frequency sensitivity and undistorted output, however, have been increased 33%. Type A304 is a high-output tape which has more than double the undistorted output capability of conventional tapes. Signal-to-noise ratio of A304, as measured from zero signal to saturated output, is 79 db. Print-through has been held to the general purpose level of 49 db. The tapes use a polyester base and an improved Durol base; the latter is a modified triacetate approximately 40% stronger than conventional triacetate. Lubrication is incorporated both within the coating and on the back of the tape to minimize head wear and to provide quiet tape transport. The tapes will be supplied on Eastman Thread-Easy Reels, which have a built-in splicer.

Circle Item 39 on Tech Data Card

Circle Item 22 on Tech Data Card

Circle Item 30 on Tech Data Card

Stereo Installation

(Continued from page 9)

ably will be necessary to purchase a new exciter and, of course, a stereo generator.

Since stereo listeners are a discriminating and critical audience, audio equipment should be chosen with care. It will be wise to settle for only the finest professional stereo turntable and tape equipment. It is better to have the minimum requirements of excellent equipment than a control room crowded with "make do" items.

Stereo consoles are available with a wide range of prices and facilities. Some offer stereo channels only for record and tape inputs, while the more complete models even make provision for stereo network and remote circuits. Much of today's programming is on records and tapes, but regional "off-the-air relay" stereo networks are springing up. Stereo microphone facilities are a must if you want your locally produced commercials to sound as impressive as your stereophonic music.

Current models of FM transmitters are highly efficient, trouble free, and easily remote controlled. All FM transmitters follow one pattern—a basic exciter and a number of amplifier stages to produce the required power output. The power amplifiers in the various models are somewhat similar, except in high power transmitters (20 kw and up).

A wide variety of FM exciters and stereo generators is offered, and this is one area in which confusion might occur. (Again, it should be pointed out that all these units are subject to FCC type acceptance.)

A typical exciter and stereo/SCA generating system is shown in Fig. 5. The block diagram explains the signal path and function of the various circuits.

Conclusion

The selection, installation, and operation of FM multiplex stereo equipment requires the careful attention of a highly skilled technician. Installation, adjustment, and maintenance should be in exact accordance with the manufacturer's instruction book. Following these instructions, the broadcast engineer can feel confident in planning a stereo installation that will be a pleasure to operate and a source of pride and profit. ▲

ENGINEERS' TECH DATA SECTION

AUDIO & RECORDING EQUIPMENT

52. BROADCAST ELECTRONICS — Packet contains specs and prices for tape cartridge system.
53. CROWN—Magnetic tape recorders and players for professional applications are covered in brochure.
54. 3M—Bulletin "Sound Talk" carries items of interest to engineers and operators concerned with professional quality audio recording and playback.
55. NEWCOMB—Brochure covers line of complete public address systems.
56. RCA—Data sheet gives physical and magnetic properties of magnetic recording tape.
57. REEVES SOUNDCRAFT — Professional products brochure, cross reference chart, and triple-play tape literature give information on magnetic tape.
58. SAXITONE—Catalog covering tape and audio components list full selection of items.
59. SPARTA—Spec sheet on "Fidelipac" tape cartridge service lists tape lengths and prices for both new units and reloading.
60. TURNER — Spec sheet covers 50/200-ohm lavalier microphone giving properties and applications.

COMPONENTS & MATERIALS

61. BRADY—Catalog lists line of self-sticking labels and markers for wires, cables, and components.
62. CALVERT — Brochure covers improved vacuum variable capacitors for use in high-voltage RF circuits.
63. FOUR JAY—Brochure lists features and applications for "Twin-lock" terminals and nylon connectors.
64. E. F. JOHNSON—Two catalogs cover electronic components, and heavy-duty RF components.
65. KURMAN—Microminiature relays with high reliability, and shock/vibration resistance are detailed in bulletin.
66. OHIO SEMICONDUCTORS—Data sheet gives characteristics and applications for line of thermo-electric devices.
67. QUAM-NICHOLS — Catalog lists speakers for PA, background music, intercom, mobile and outdoor applications, high-fidelity, and general replacement.
68. TERADO—Bulletin presents miniature relay used in television cameras and other broadcast applications.
69. TUNG-SOL—Base diagram book, interchangeability guide (industrial), and subminiature catalog provide tube information.
70. WALDOM—Buying guide lists electronic and electrical items including solderless terminals, connectors, hardware and tube sockets.
71. WALLACH & ASSOCIATES—Six-page brochure covers cabinets for storage and filing of records, tapes, and filmstrips.

POWER DEVICES

72. CATERPILLAR — Four illustrated booklets describe line of natural gas and diesel engine-generators for prime, standby, and emergency electricity.

RADIO & CONTROL ROOM EQUIPMENT

73. ALTEC LANSING—Brochures cover lines of audio equipment and speech-input devices for recording and broadcast studios.
74. GOTHAM—Spec sheet gives particulars on steel-plate reverberation units available in mono, stereo, and remote control models.
75. LANGEVIN—Catalog shows full line of audio components and equipment for professional recording and broadcasting applications.
76. McMARTIN—Catalog describes transistorized amplifiers for cueing, monitoring, talkback, and utility applications.

STUDIO & CAMERA EQUIPMENT

77. BLONDER TONGUE—Product brochure describes transistorized vidicon camera with 8" viewfinder screen.
78. TELEVISION ZOOMAR—Pocket guide for field coverage of all image orthicon lenses gives scene size at distances from 3 to 1,000 feet.

79. WARD LEONARD—Solid-state lighting control system for small theatres, schools, TV studios, and similar facilities are described in product bulletin.

TELEVISION EQUIPMENT

80. INTERNATIONAL NUCLEAR—Line of transistorized video equipment is described in catalog.
81. JERROLD—Short form catalogs cover three lines: TV/FM distribution systems equipment, Paralog antennas, and Super Powermate amplifiers.
82. RAYTHEON—Data sheet discusses clamper amplifier for microwave radio or cable circuits handling monochrome or color television signals.
83. RIKER—Set of brochures present all-transistor video modules which may be assembled, changed, or expanded at any time.

TEST EQUIPMENT & INSTRUMENTS

84. SPRAGUE—Circular fully describes features and applications of interference locator for determining sources of radio and television interference.

TOOLS

85. HUNTER INDUSTRIES—Brochure and booklet list special tools for electronic components assembly, and describe services of special products dept.

TRANSMITTER & ANTENNA DEVICES

86. BAUER—Brochure describes "Log Alarm" system for automatic transmitter logging and monitoring.
87. CO. EL.—Spec booklets cover broadband dipole TV antennas for VHF and UHF, multiguide UHF slot antennas, directional antennas for 1-kw UHF transmitters, wide band FM antennas, VHF and UHF notch diplexers, and filterplexers.
88. G.E.L.—Data sheet describes local automatic transmitter logging equipment which makes use of a single chart recorder.
89. JAMPRO—Spec sheets provide details on dual-polarized FM antennas.

BOOK REVIEWS

Analysis, Transmission, and Filtering of Signals; Mansour Javid and Egon Brenner; McGraw-Hill Book Co., Inc.; 462 pages, $12.75. This book presents, in unified form, clear treatment of a variety of subjects including frequency analysis, an introduction to modulation theory, and an introduction to noise calculations. The necessary mathematics are developed as needed and examples are presented which demonstrate the application of these concepts to problems involving distributed parameter systems. The problem of wave propagation along a transmission line is treated both in transient and steady state forms, to demonstrate the application of the developed analysis methods. The system theory concept serves as an underlying goal of the development. In this framework the examples treated serve as models for general systems, rather than simple demonstration of the developed techniques. Analysis is treated as a fundamental tool of engineering. Consequently, the approach avoids merely generating a collection of problems and their solutions by presenting them as required to develop the subject. Numerous problems of varying difficulty are presented as well as examples, proofs, and practical system analysis. This book is recommended for the book shelf of the engineer who is familiar with normal engineering mathematics.

Professional Services

VIR N. JAMES
CONSULTING RADIO ENGINEERS
Applications and Field Engineering
345 Colorado Blvd.
Phone: (Area Code 303) 333-5562
DENVER 22, COLORADO
Member AFCCE

- SYNCHRONOUS MAGNETIC FILM RECORDER/REPRODUCER
- MAGNETIC TAPE RECORDERS
- NEW—THE portable MINITAPE synchronous 13 lb., battery operated magnetic tape recorder for field recording.

THE STANCIL-HOFFMAN CORP.
845 N. Highland, Hollywood 38, Calif.
Dept. B HO 4-7461

JOHN H. BATTISON & ASSOCIATES
CONSULTING RADIO ENGINEERS
TV-AM-FM & Microwave Applications and Installations
Specializing in all forms of communications engineering.
422 Washington Bldg. Washington 5, D. C.
Phone ST 3-3484
Established 1954

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

Commercial Crystals and new or replacement crystals for RCA, Gates, W. E., Bliley and J-K holders; regrinding, repair, etc. BC-604 crystals. Also A. M. monitor service. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 96, Temple, Texas. 9-61 tf

PROMPTING EQUIPMENT. Used one, two and three prompter packages. Full one year warranty. Limited quantity. TELESCRIPT CSP, Inc., 155 W. 72nd. St., New York 23, New York. 10-63 2t

REAR SCREEN PROJECTORS. Used No. 7000 3¼x4" R.S.P., 70 slide capacity, ¼ sec. fast slide changer, remote control. Taken in trade on new Dual Head R.S.P. Full one year warranty. Limited quantity. TELESCRIPT CSP, Inc., 155 W. 72nd. St., New York 23, New York. 10-63 2t

GOVERNMENT SURPLUS, NEW 10 CM. WEATHER RADAR SYSTEM—Raytheon, 275 KW peak output S band. Rotating yoke P.P.I. Weather Band 4, 20 and 80 mi. range. Price $975 complete. Has picked up clouds at 50 mi. Wt. 488 lbs. Radio Research Inst. Co., 550 5th Ave., New York, New York. 8-63 6t

MICROWAVE ANTENNAS. Parabolic, 6 foot dia., Andrews, Spun Aluminum. 1700-2400 MCs Complete with mounting bracket, Di-pole, de-icres, etc. Unused - Crated - Cheap. One Hundred Available Sierra-Western Electric 1401 Middle Harbor Road, Oakland, Calif. Tele. 832-3427. 10-62 2t

Ampex Head Assemblies for 300 and 400 series recorders reconditioned. Service includes lapping and polishing all three head stacks, cleaning entire assembly, readjusting and replacement of guides, and realignment of stacks as to azimuth and zenith. Full track assemblies—$60.00. Taber Manufacturing & Engineering Co., 2619 Lincoln Ave., Alameda, California. 8-63 5t

Western Electric 405B1 5 Kilowatt AM transmitter. Condition perfect. Make offer. Write Broadcast Engineering, Dept. 105. 12-63-1t

ENGINEER. Advisory capacity, must know thoroughly all phases of storecast receivers, design, alignment and most of all their installation. Can be presently employed, should have test equipment for same. Write P. O. Box 6731, Cleveland, Ohio. 12-63-2t

LANGEVIN AMPLIFIERS available in excellent condition with tubes, trays and plugs. 13 AM-5115 pre-amplifiers @ $38.75, 4 AM-5117 program amplifiers @ $45.15, 1 PS-5206 power supply @ $70.60. Hugh T. McKenny, R.F.D. No. 1, Milton, Vermont. 12-63 1t

TRANSMITTING TUBES FOR SALE—Immediate Delivery on 6076 Power Tetrodes, at $235 each, 3X2500F3 — $170, 450TL—$35, 4-125A—$22.50, 872A—$5.25, 575A — $15.50. Also SPECIAL HIGH QUALITY ENGLISH ELECTRIC 6166—$840. All tubes are factory new, 1000 hour warranty, from the largest wholesale supplier of broadcast tubes. Inquire about our special quotes for complete spare tube kits. CALVERT ELECTRONICS, INC., Dept. BE-12, 220 E. 23rd St., New York 10, N. Y. (212) OR 9-1340.

STEREO MICROPHONES — Matched pair of Electro-Voice Model 623 Slim Dynamic microphones, unused, in original packaging. Price, complete, $50.00. Write BROADCAST ENGINEERING, Dept. 106.

Advertisers' Index

McMartin

No other FM MONITORS can do so much!

McMartin TBM-4000

FM/SCA MULTIPLEX MONITOR FCC TYPE APPROVED #3-116

This is the most versatile instrument available for monitoring all main channel modulation and SCA Multiplex operating characteristics. Compatible with FM stereo.

Direct meter readings of:

- Total Modulation
- SCA Modulation
- Crosstalk
- SCA Injection
- SCA Frequencies

McMartin TBM-3000

McMartin TBM-3500

FREQUENCY & MODULATION MONITORS FCC TYPE APPROVED #3-113, #3-119

- The TBM-3000 is a completely self-contained frequency monitor and the TBM-3500 is a self-contained modulation monitor.
- The 3000 used in conjunction with either the 3500 or 4000 fulfills the FCC requirement for a station monitor.
- The TBM-3500 is completely compatible with FM stereo.

McMartin TBM-2500

RF AMPLIFIER FOR REMOTE MONITOR OPERATION

The TBM-2500 will drive any combination of two monitors including other brands.

- Isolated high and low level outputs.
- Excellent stability and long tube life.
- 2 watt output with 1000 μv input.
- Complete with yagi antenna and coaxial cable.

McMartin

Originality by

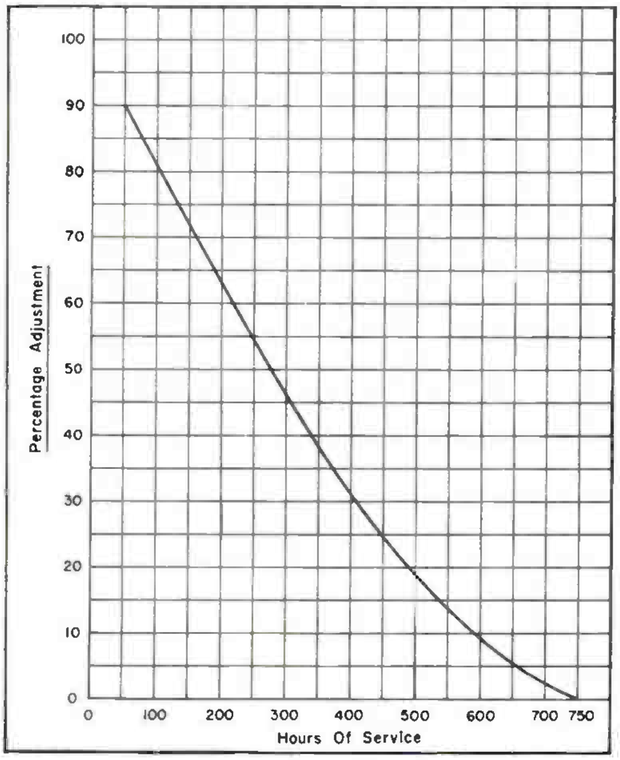
McMartin Industries, Inc.

605 North 13th Street
Omaha, Nebraska
Code 402 — 342-2753

In Canada Sold By: Canadian Marconi Company, Montreal 16, P. Q.

Circle Item 28 on Tech Data Card

New RCA-5820A Partial Adjustment Curve—Extension of the RCA-5820A warranty period from 500 to 750 hours' service provides more generous coverage.



NEW!
50% LONGER WARRANTY COVERAGE
for the popular RCA-5820A image orthicon

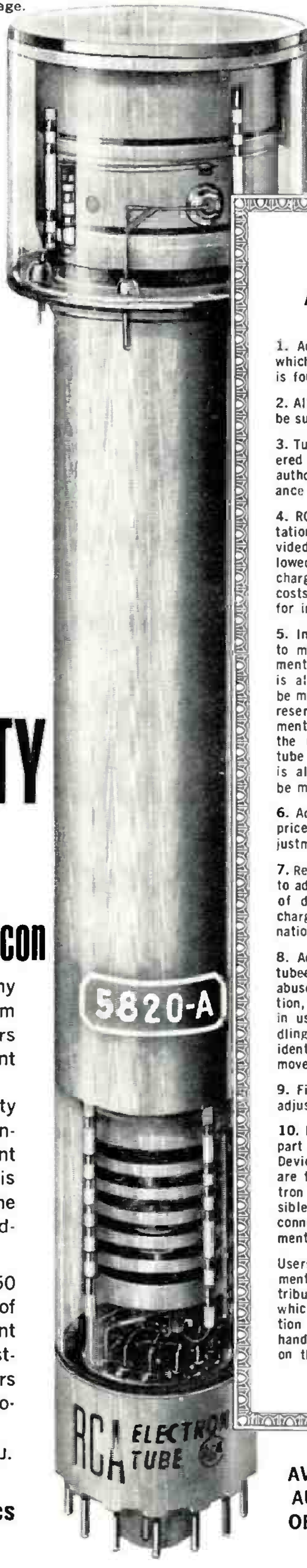
RCA now gives further assurance of reliability and economy by extending the warranty period on the RCA-5820A from 500 to 750 hours of service. Hours of service are total hours of operation, including time that power is applied to filament or heater.

RCA electron tubes are manufactured to high quality standards and are warranted against defects in workmanship, materials and construction. If a defect is of a latent nature, it normally will reveal itself shortly after the tube is placed into service and RCA will allow adjustment for the RCA-5820A, subject to the terms set forth herein, in accordance with the following:

> Full adjustment is allowed for tubes failing within 50 hours of service. Partial adjustment up to 750 hours of service is allowed in accordance with the Adjustment Policy Table which is shown graphically above. Adjustments are limited to claims presented within 1½ years after the tube was shipped by RCA Electronic Components and Devices.

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

The Most Trusted Name in Electronics



WARRANTY ADJUSTMENT TERMS

1. Adjustment will be limited to claims which are presented promptly after tube is found to be defective.

2. All tubes claimed to be defective will be subject to inspection and test by RCA.

3. Tubes returned to RCA will be considered for adjustment only if return was authorized by RCA and made in accordance with instructions issued by RCA.

4. RCA will be responsible for transportation costs on returned shipments provided adjustment is subsequently allowed. RCA, however, cannot accept charges for packing, inspection, or labor costs in connection with tubes returned for inspection or adjustment.

5. In all cases, RCA reserves the right to make adjustment by repair, replacement, or credit. Where full adjustment is allowable, adjustment normally will be made by replacement in kind but RCA reserves the right to limit the adjustment period on the replacement tube to the unexpired portion of the original tube warranty. Where partial adjustment is allowable, adjustment will normally be made by the issuance of credit.

6. Adjustment credits will be based on prices in effect on date of claim for adjustment.

7. Replacements for tubes found subject to adjustment will be shipped F.O.B. city of destination with transportation charges prepaid by RCA to city of destination.

8. Adjustment will not be allowed for tubes which have been subjected to abuse, improper installation or application, alteration, accident or negligence in use, storage, transportation, or handling nor for tubes on which original identification markings have been removed, defaced, or falsified.

9. Final determination as to where any adjustment is allowable rests with RCA.

10. No warranties or obligations on the part of RCA Electronic Components and Devices, other than the aforementioned, are to be implied with respect to electron tubes, and RCA cannot be responsible for labor or any other charges in connection with the failure or replacement of electron tubes.

Users should present claims for adjustment to their RCA special market distributor except that a claim for a tube which had an advance Return Authorization packaged with the tube is to be handled in accordance with instructions on the authorization.

AVAILABLE THROUGH YOUR AUTHORIZED DISTRIBUTOR OF RCA BROADCAST TUBES