FM Radio Station Operations Handbook

SECOND EDITION

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FM RADIO STATION OPERATIONS HANDBOOK

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By The Editors of BM/E Magazine

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SECOND EDITION

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Preface

After struggling for a decade or more as the stepchild of AM radio, FM radio has become a profitable commercial entity. During the past seven years, the successful independent FM operation is something more than an exceptional case. And with the increasing sales of FM receivers—including those in autos—the situation can only improve in the years ahead.

FM's growing success is evidenced by the increase in the number of commercial stations in operation. In 1966, when the first edition of this book was published, there were approximately 1500 commercial FM stations. Now, there are more than 2500!

Along with this growth in station numbers, stereo broadcasting has become the accepted mode of operation. And some stations are even presenting quadrasonic program offerings using encoding and decoding techniques. The number in the latter category will certainly increase in the years immediately ahead.

The material in this volume, which originally appeared in BM/E magazine, reflects the true FM "state of the art." Virtually every aspect of FM broadcasting is covered—planning, engineering, automation, production, stereo and quad techniques, promotion, and management. It is written by a host of people—the "experts," really—those who are contributing daily to the advancement of the art. Anyone looking for "answers" in any of the above categories, whether you are a student or a novice, or a veteran seasoned by years in AM or TV, this anthology should thoroughly acquaint you with modern FM broadcasting. Hopefully, too, it will provide the solutions to many problems "bugging" those presently involved in any facet of the FM medium.

Much of the material contained in the first edition appears in this revised second edition. Since some of the original material was written, economic inflation and natural growth factors have caused prices and other figures to go above those quoted in some cases. Otherwise, the information is just as valid as when originally presented. We hope this new, expanded version will serve you even better!

The Editors

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WJFM—Nation's Most Powerful FM Station

Bruce M. Glycadgis

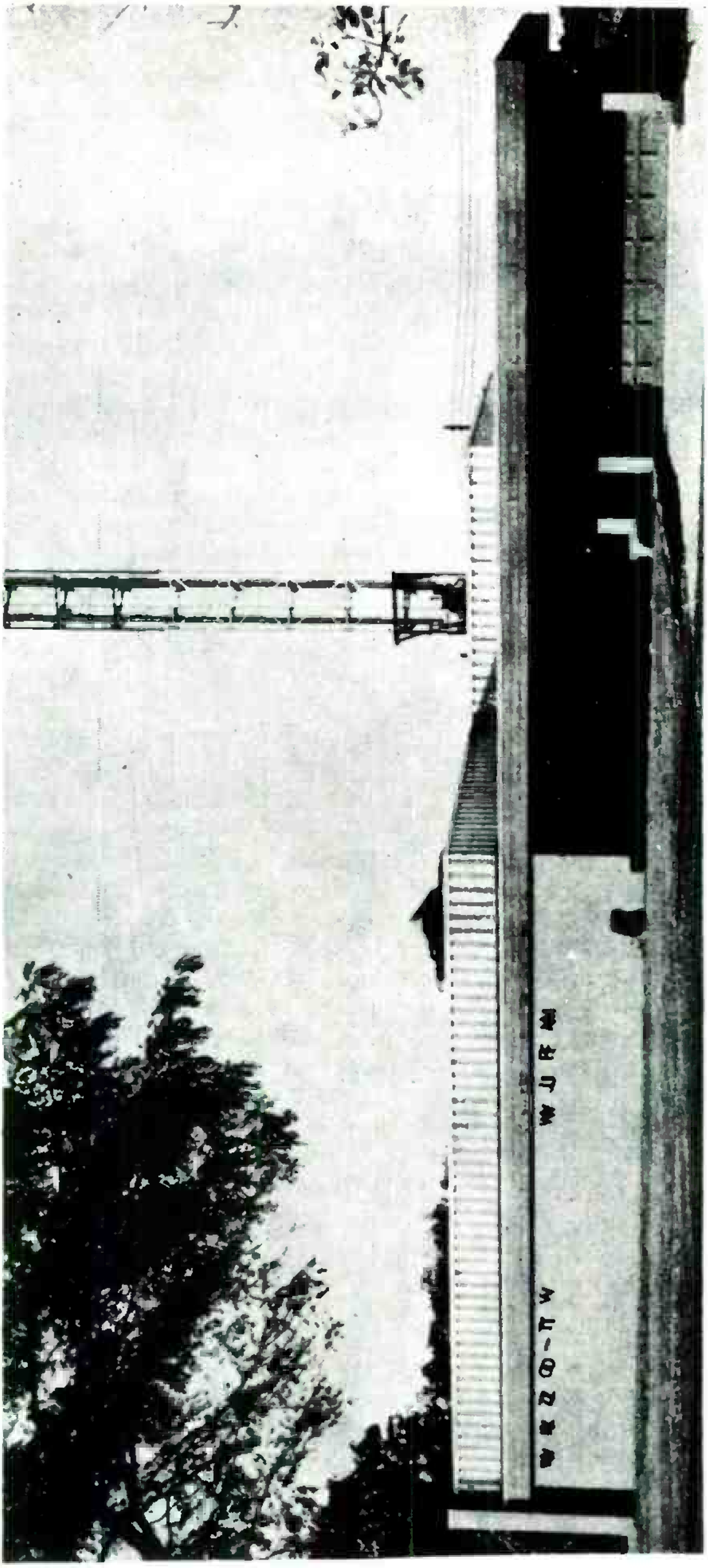
93.7 on the FM dial has become a household term to more than 150,000 families in Western Michigan. For 21 hours each day, WJFM radiates its powerful voice of ½ million watts (ERP) over some 30 counties and dozens of communities. WJFM began broadcasting with this tremendous power (the next highest FM station power is about 260 kw) on November 15, 1961, a significant date for FM listeners in about a third of the state because it meant they could receive noise-free radio programs whether their receivers were small, large, cheap or expensive. It brought on a resurgence in the purchase of FM receivers within the area, especially in localities which had never before received FM. November 15, however, represented not the beginning, but, rather, the climax of a continuing effort to provide FM to the vast listening public of Western Michigan.

The Beginnings of WJFM

The birth of WJFM goes back to 1946, the year Fetzer Broadcasting obtained its first construction permit for the facility. This CP was for the unheard-of (in those days) power of 500,000 watts. The company was confronted with many complications: Equipment capable of producing 500,000 watts was not readily obtainable; also, there was the problem of a suitable antenna site with adequate ac power available for such a powerful transmitting plant. (Over 150 kilowatts, 21 hours a day, are needed to provide the 50-kw transmitter output used today.)

In 1950, Fetzer constructed WKZO-TV, and it was determined that the TV tower would also be suitable for an FM antenna transmitting at reduced power. Thus, on June 25, 1951, WJFM took to the airwaves with an effective radiated power of 115 kilowatts. For the next 10 years WJFM's income was not large enough to pay the power bill, but Fetzer had great faith in the future potential of FM and felt it was in the interest of the radio public to keep the facility on the air.

To realize some income from the operation, a Muzak franchise was purchased, and the first multiplexed operation in Southwestern Michigan went on the air .The anticipated increase in power would eventually produce even greater multiplex potentials, a factor supporting the initial decision to purchase the Muzak franchise. All this, remember, took place during



WJFM/WKZO-TV transmitter building at Sun Lake.

the years when many FM stations were going off the air.

WKZO Moves to Gun Lake

During 1960. Fetzer management decided it was time for a modernization program. Their conclusion: to locate the WKZO-TV transmitter and antenna at a point midway between Kalamazoo and Grand Rapids, to serve both communities. Management further reasoned that the new antenna tower would be an excellent location for WJFM's antenna.

To keep WKZO-TV's signal on the air during the move from Kalamazoo to Gun Lake, management purchased a new TV transmitter. The two 25-kilowatt TV-power amplifiers at Kalamazoo were designated for the FM operation. These were Type TT-25AL amplifiers, and it was a relatively simple task to raise their operating frequency to 93.7 mc, diplex the amplifiers, and raise the 10-kw output of the new RCA Type GTF-10D driver transmitter to 50 kilowatts.

Amplifier Conversion

The power amplifiers use the well-known cluster of seven 5762 triodes operating in a parallel, grounded-grid configuration. This cluster design, owing to the physics of VHF frequencies and the mechanics involved, lends itself excellently to frequency conversions. The modifications resulted in the first BTF-50B transmitter, and system performance has proved very satisfactory.

Side-Mounted Antenna System

WJFM uses a 12-section, gapped-ring antenna to one leg of the TV tower at the 800-foot level. Center-fed, this array provides a power gain of 12.5 and raises the 50-kw transmitter output to 500-kw ERP. Mounted on one leg of the triangular cross-section tower, the antenna provides substantially circular coverage over a 25,000 square-mile area (90-mile radius). This area includes Kalamazoo, Battle Creek, Grand Rapids, and Lansing, plus dozens of smaller municipalities at all points of the compass. In addition, the signal covers a large rural area that would not otherwise receive FM service.

Building Features

Both the TV and FM transmitters are housed in a modern, well-engineered building of prestressed concrete. The 1100-ft antenna tower stands immediately outside to minimize outdoor horizontal runs of transmission lines. Locating the tower so close to the building presents a falling ice problem during Michigan winters; this was overcome through a specially-designed roof that withstands potential damage.

All the electronic gear associated with the transmitters is located on the basement level with the power transformers and blower equipment. This setup keeps the transmitter room on the floor above extremely quiet. Further, this arrangement considerably reduces blower vibration in addition to increasing accessibility to the equipment. All of the air is filtered prior to its entry, eliminating the need for individual air filters for the blowers. Outdoor air is first filtered through spun-glass filters, then passed through electrostatic filters to axial fans which "pressurize" the basement room and thus make it a massive plenum chamber.

The blowers, mounted on concrete piers, push the filtered air upward through the basement ceiling and into the bases of the transmitter equipment. Ducting, at the top of the transmitter cabines, is thermostatically controlled so that the warmed air from the equipment goes directly outdoors in summer, or indoors in winter to heat the transmitter room. This loop system, using outdoor air, reduces the BTU requirement of the air-conditioning equipment in summer and delivers fresh, warm air in winter.

In addition to providing a dustless atmosphere in the transmitter room, another advantage in prefiltering the air is the elimination of a settled-dust problem in the basement. This, of course, simplifies maintenance.

WJFM Programming

When the station went to the half-megawatt power, management decided it should be an entity in itself and should therefore generate its own programming. The staff spent many months making audience surveys to devise the programming that is now a part of everyday operation. As a result, WJFM programs its educational and informational shows throughout the day instead of just during the early hours of the morning. The surveys also indicated that listeners desired large blocks of time set aside for each musical category. As a result, WJFM maintains a considerable disc and tape library which provides an excellent range of musical selections.

FM Stereo Programming

From 8:00 A.M. to Midnight each day, WJFM transmits multiplex stereo, using a stereo subcarrier generator mounted in the center cabinet of the FM transmitter. Since introducing stereo programming. WJFM has built up a separate stereo-record library of nearly 2,000 albums.

Commercial stereo tapes are run through a four-track playback head. The recorder is also equipped with separate erase, record and play heads for two-track stereo tapes. The machine plays virtually all quarter-inch tape recordings —full track, half-track, half-track stereo and four-track stereo tapes.

The dual-channel consolette is in the center of a horseshoe arrangement, with turntables on both sides of the announcer's station. Each turntable contains two preamps for stereo reproduction. Cueing is incorporated within the consolette. An RT-37A cartridge-tape machine serves ideally for spot announcements, permitting greater use of the turntables for program material. The cartridge-tape facility serves for both stereo or monophonic announcements.

Muzak Programming

The SCA subchannel programming comes from two long-play tape machines located in the main control center adjacent to Studio 1. These two machines operate almost completely unattended, using Muzak tapes pre-programmed for such operation. The signal from these machines travels via multiplexed microwave to the transmitter site. Here it modulates a 67-kc subcarrier of a Type BTX-1A multiplex generator which, in turn, modulates the BTE-10B Exciter in the FM transmitter.

Building an FM Station—from CP to Sign-On

Carl B. Haeberle & James W. Davis

In March 1964, WAJR management requested production and engineering to (1) develop a new concept in FM programming; (2) build a maximum power stereo station within the confines of the present staff and physical plant; (3) produce the end result in a minimum time; (4) continue present duties; (5) sign-on with minimum expenditure but maximum flexibility.

Less than 8 months later, WAJR-FM signed-on with complete stereo facilities including locally recorded events—anything from a basketball game to a tiddly-winks tournament. Three million people now have quality music and news programming 17 hours a day, 7 days a week. One million of the potential listeners had never been able to receive quality FM without more noise than music. The budget to build these facilities, although sizable, was squeezed in every possible way. Over $10,000 was saved by local design and construction.

When you set out to build an FM station, you soon learn that there is not an abundance of available basic information to guide you, and there are few sources of paternal counsel to steer you in selecting equipment and efficiently operating a stereo facility. In spite of these conditions, we were on the air in just a little over seven months after our CP was granted.

We felt there was a definite need for WAJR-FM. Adjacent counties were not being reached by local radio, and the statewide Mountaineer Sports Network needed a feed signal. Then, too, it was felt that many people were not completely satisfied by a middle-of-the-road AM outlet and the other local station.

WAJR-FM came into being in 1947. By 1962 the old transmitter was outmoded—antique, in fact—and was taken off the air due to instability. The operation had befitted the term "experimental"—a poorly programmed and staffed AM stepchild. Programming was provided via an automatic record changer or by simulcasting with AM. To replace and improve the facility, the station applied for, and was granted, a new channel and a power increase to 25 kw ERP. A new transmitter was ordered and shipped just in time for the FCC

Here's what it takes—

An **unofficial** cost list taken from sales estimates and purchase orders. Additional costs in administrative supplies, engineering and legal fees, transportation, wages, etc., increase the total cost figure. Comparatively minor items, such as bulk tape erasers, which cost in the neighborhood of $15, are not included in this break-down. Figures on labor and locally constructed electronic and mechanical units are not included in the estimates.

Electronic Equipment
Transmitter and antenna equipment: Collins 830H-1A 20-kw transmitter, 8-bay antenna and 8-bay vertical antenna, 26 U-2 limiter, 900 C-1 modulation monitor; McMartin TBM-3000 frequency monitor **$55,000**

Transmitter Studio: Gates Stereo Yard-Wide console; two Empire Troubadour turntables with Shure M3D cartridges and Audio-Empire Dynalift arms; RCA RT-37A cartridge playback unit; Ampex 354 playback tape deck; locally-constructed console table and storage shelf unit; standard equipment rack **$7,000**

Production Studio: Gates stereo "Executive" console; two Gates CB-77A cartridges; Ampex 354 record tape deck and PR-10-2 record tape deck and portable case; RCA RT-37A record playback unit; locally-constructed console table and cartridge storage rack; two standard equipment racks **$10,250**

Construction
Transmitter studio and building modification .... **$ 1,500**
Production studio and office .... **$ 800**

Office Equipment & Furniture**
Transmitter studio: desk .... **$ 100**
Office: typewriter, file cabinet, table, card index, three desks .. **$ 850**
Records .... **$ 800**
Reel tapes .... **$ 200**
Cartridge tapes*** .... **$ 350**

Advertising: newspaper and mail .... **$ 500**
Estimated Total **$77,350**

*Does not include labor.
**New furniture was purchased for other offices where needed. Older furniture was released for FM use; however, costs show new furniture purchases.
***Since all air announcements are pre-recorded, more tape cartridges and reel tapes are required.

freeze in 1963. The transmitter made an about face and went back to the factory.

The matter rested for over a year while allocation procedures were ironed out. Finally, in March 1964, WAJR was assigned a frequency of 101.9 mc and granted a CP for a 50-kw FM station. Then, with the advent of vertical polarization, management felt that the mountainous terrain would be best served by vertical as well as horizontal polarization. FCC approval was then obtained for 50-kw dual polarized transmission.

As of March 15th, 1964, the station was a paper tiger! It had received thought as to means and methods of programming, but concrete construction plans were non-existent, even though an on-air date of September 1st had been arbitrarily set.

On March 22nd, 1964, a member of the AM staff was designated as FM Production Director and assigned the responsibilities of developing the physical plant, the basic administrative structure, and the programming. The Production Director was also charged with the promotional aspects of the FM station. The AM Chief Engineer received the additional duties of FM engineering. His duties were expanded to the development of technical details, including wiring, equipment selection, construction procedures, and the problem of how to set up a "new concept in radio."

In these opening stages, we established that a "quality" sound—from both engineering and programming standpoints—was a basic prerequisite. The music policy was tentatively set—good music with an upper middle-of-the-road approach, stressing instrumental music, with all, or as much as possible, programmed in stereo. As the market was reasonably open there was no reason to specialize in any one area of music. To allow ample room for error, all steps taken prior to sign-on were made carefully, with the idea of a complete middle-of-the-road format at sign-on. As comments are voiced on likes and dislikes, the station expects to move into new fields. Down to the initial order of records, we developed only a framework program schedule. We ordered only "standards"; i.e., music which would definitely be used regardless of possible variations in the final program structure.

Advantages of a Transmitter-Site Studio

From cost, to overall sound, to proficiency, we feel that having production facilities and offices downtown, and the on-air studio at the transmitter offers more advantages than disadvantages. The biggest problem is providing the engineer with enough information to ensure proper insertion of prerecorded announcements and intros, but with practice and training the problem resolves itself. Had we used a downtown location for the on-air studio, we would have had to hire three new announcers or used a packaged program unit, not to mention that there just wasn't enough space for the studio. Then, too, our transmitter engineers' time is put to better use.

The dual balanced 15-kc phone lines required by stereo presented some problems; the telephone company has the equipment, but is short on staff. They didn't appear overjoyed at the thought of installing and maintaining the facility. Also, we received a report that one station was having phase shift problems on their phone lines, resulting in a signal loss by the time it got to the transmitter. A 15-kc line is fine for AM, but the high audio frequency fall-off reduces FM quality considerably. We have discovered that our transmission has more "presence," more consistent audible levels of music and talk.

Transmitter and Studio Locations

Since the station already had an FM transmitter site, the logical thing was to locate the new FM transmitter there. The old FM had been operated by remote control on a hill within the city limits. The AM transmitter location—5 miles out of town with directional 5,000-watt daytime. 500-watt nighttime pattern—could also serve as an FM transmitter location, complete with an engineering staff.

We learned during our initial research that stereo stations encounter difficulty sending the two audio channels through two pairs of telephone lines without some phase and separation loss. Therefore, we concluded the best studio transmitter location would be on Bethel Hill with the AM transmitter. With this setup the AM transmitter engineers—then only reading meters—could run the FM programming from logged music sheets, using prerecorded commercials, show openings etc.

Since Bethel Hill is some 5 road miles from the downtown offices and AM studios, we decided to build a production studio at the downtown studio site to reduce the administrative and announcer problem. Here we would "build" the programming material for FM—record the commercials, show openings, etc. The engineer at the

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Sales—

We were lucky in as much as we did not have the requirement of "profit within 'x' number of days." The ownership and the highly successful AM side of our operation gave the FM time to work out its major programming ills and to establish itself within the community before it had to start a sales campaign in earnest.

Concentrated sales efforts were begun this past July. We designed and ordered several printed sales aids and salesmen were on the street with the new packages by the first of September.

The primary printed aid is a brochure-cover unit which contains brief statements concerning the station's services to the community and aimed at the local sponsor, his agency, and as an aid to the station representative working on national business. Printed on tan glossy stock in brown and black, it exudes a "quality" station image. It includes coverage maps of both the AM and the FM signals, SRDS information on the coverage area, and additional sales information.* (Total cost for 1.000 was less than $100.)

A second unit is a style-matched rate card. The AM and FM use separate cards; however, they are designed to complement each other and are cross-referenced for combined time-buying. The rate cards are also printed on tan stock. By use of a single ink (black) and half-toning, a quality appearance was produced at a minimum cost.

The third unit is a simple presentation folder—a legal-size sheet with the bottom third folded up. It holds any material the salesman wishes to give the client (including the contract) and is pre-printed with the station call letters and address. The client's name is imprinted at the appropriate place. The personalized presentation for the client gives the salesman somewhat of a head start.

Additionally, we utilize an individual presentation for each sponsor. When the salesman arrives at the client's door he has in his hand the complete package including his conception of what his client should transmitter studio would play the records, according to the music sheet, and insert announcements. For news, we would merely simulcast with AM.

Studio Design

After establishing the concept on paper, the next step was to formulate the studio design and operations guide. As of that date, a very limited amount of information was available as to the "best way" to do anything in stereo broadcasting or programming. Thus, all old patterns were basically scrapped. A design for the production studio was set up by a three-man group, the production director, the chief engineer, and the station manager. These ideals were established: The studio must serve as a show room and part-time sales-demonstration room. A demonstration of equipment and prerecorded sample spots seems to aid sales. The room must present a relaxed atmosphere, uncluttered with equipment, an advantage to both operation and sales The operation has to be flexible and semi-moveable in case of a location change in the future. Any operation has to be efficient. If all recording is to be done from one location, and done inexpensively, a limited amount of wasted time is of prime importance. With these mandates in mind, we arrived at our studio design.

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of Course!

have on the air. The order is all pre-written and ready for signature.

To introduce the FM station to a new client, and to soften up sales resistance, we used an idea from CHUM-FM in Toronto, Canada, and adapted it to our use. This classical music station used a 6-minute tape presentation which they call an "Emotional Approach to FM Sales." It must be effective—the Canadian station was almost sold out at sign-on!

To allow maximum sales, we set up our programming to accommodate virtually anything from one-minute spots to a 2-hour show package. Spots are available (in 60-second time length only) adjacent to the hourly news and on weekends. The remainder of our weekday commercial time is devoted to 25-30 minute and 55-minute blocks. If a sponsor buys, say, a 55-minute package, he receives 25 fifty-five minute shows per year; approximately one-third are programmed in the morning, a third in the afternoon, and the remainder at night. This rotation gives the sponsor maximum audience saturation at a minimum cost and gives us a minimum of production problems. Rates were set, for these packages, by the use of a relatively simple formula. The cost of operation (all payments, wages, etc., included) is divided by the number of commercial-hour availabilities per week-day per year. The less than one-hour shows are priced according to the cost per hour figure.

To provide a "profit margin" for the station, and to offer clients a show which they can "call their own" we also set up three production shows and have developed three holiday shows. These packages are not sold at the lower rotation show rates but are included at the regular rates.

Two daily national newscasts, several local newscasts daily and the annual West Virginia University football and basketball shows, are sold at the standard "card-rate" or combined with the AM sales.

Assuming all rotating blocks were sold, the remaining sales would be profit. Even with only about ¾ of our total availabilities sold we are in a slight "profit" position.

*Mark Data Associates, Albuquerque, N.M.

Broadcast Studio (Bethel Hill)

1 Gates Stereo Yard-wide console
2 Empire Troubador turntables with Shure M3D cartridges and Audio-Empire Dynalift arms
1 Ampex 354 tape deck (playback only)
1 RCA RT-37A cartridge playback Unit
1 Locally-constructed console table
1 Locally-constructed storage shelf unit
3 Standard equipment racks

Production Studio (Downtown)

1 Gates Stereo Executive console
2 Gates CB 77A turntables with Audio-Empire Dynalift arms and Stanton 481-AA cartridges
1 Ampex 354 record tape deck
1 Ampex PR-10-2 record tape deck (plus portable case)
1 RCA RT-37A cartridge record playback unit
1 Locally-constructed console table
1 Locally-constructed cartridge storage rack
2 Standard equipment racks.

Other normal studio equipment, including patch panels, microphones, etc., were also listed, debated, and purchased.

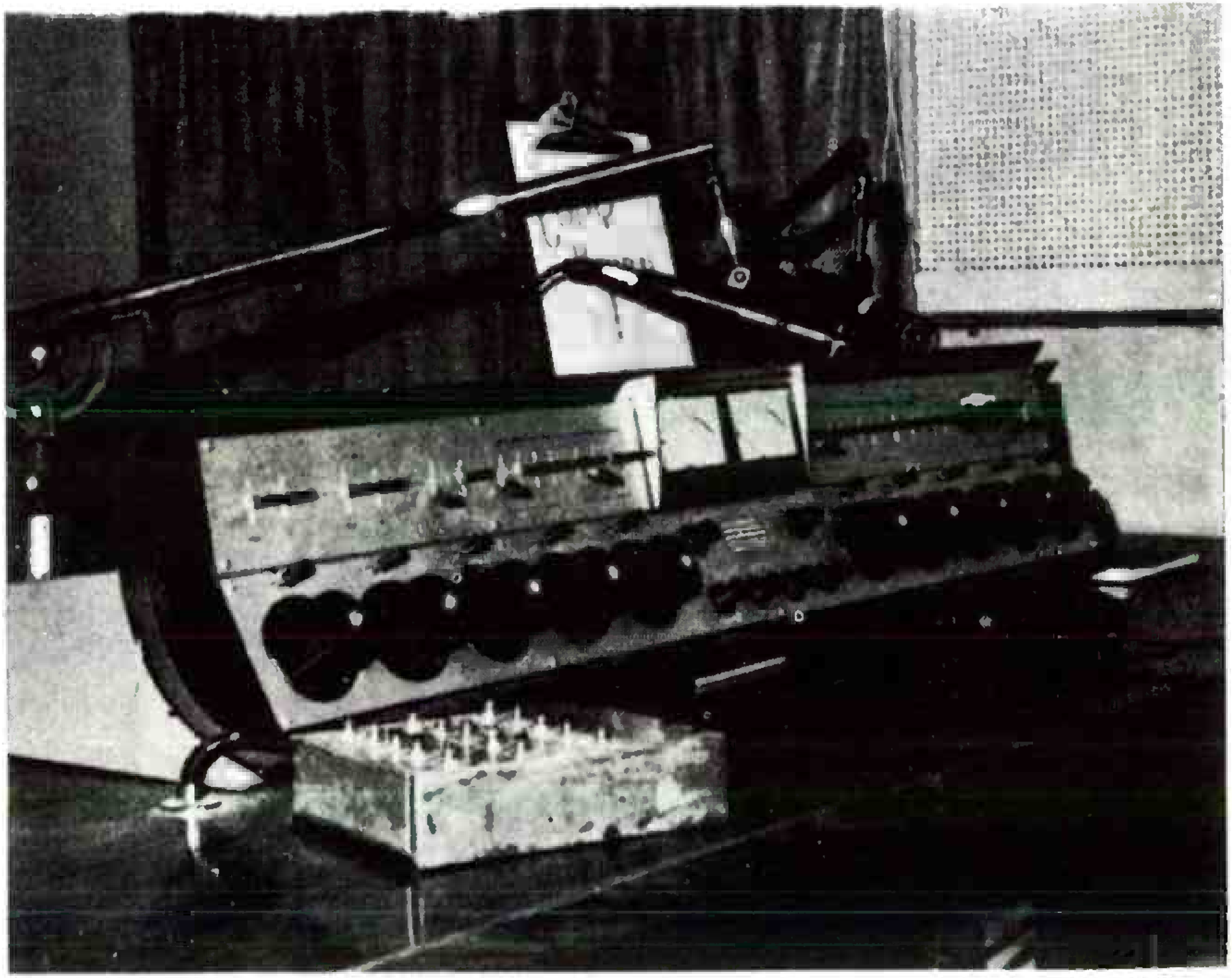
We found that no reasonably priced commercial turntables have (or did not at that time) sufficiently low rumble and wow characteristics needed for stereo "quality" programming.

A rumble or wow, undetectable in AM or in monaural FM, can sound like a wind-storm in stereo. Thus, the two belt-driven "home use" machines were purchased. These are critical to the extent that even tightening the drive belt beyond recommended specifications can induce rumble. A heavier drive belt may also cause audible rumble. The lack of close cue, due to the extremely slow starting characteristics inherent in a belt-driven unit, creates something of a problem in programming until the operating engineer becomes accustomed to the mechanical operation. Critical to broadcasting also is the fact that back cueing is impossible due to a required rubber turntable pad. Actually, with less than two duty shifts using the turntables, the engineers develop their timing sufficiently to provide the desired programming.

We have found, too, that a tape recorder instead of just a playback unit should have been installed at the transmitter studio. With a recorder unit, we could record "on-air" material for later use. Comprehensive air checks could also be made in this manner.

Ordering Equipment

As the operational plans were completed, equipment procurement began. Again, expense came into focus as equipment was checked. The "mail-order" system of obtaining multi-thousand dollar equipment units was employed. This proved, at best, a poor means of spending company money. Too late, the value of attending one of the yearly NAB conferences and equipment displays was discovered. In our particular case, however, all equipment obtained *did* perform as hoped, or nearly enough so, that with local changes by the Chief Engineer, the station could operate efficiently. Had we attended a display, though, some of the equipment purchased



Even announcements are in stereo at WAJR-FM; one of two boom-mounted mics feed each stereo channel. This is WAJR-FM's downtown production facility using a dual channel console, where all voice program portions are recorded. The "box" lying in front of the console is a remote control panel for tape recorders, cartridge machines, and turntables.

would have been overshadowed by other available units.

An "optimum" list was developed, including everything possible for a "perfect" station. The use and importance of each item was then discussed and debated. If the unit was a luxury item, or one which could be omitted and still maintain the programming concept, it was crossed off the list. By this means no extraneous equipment was purchased, but there was no last minute rush to buy something that had been forgotten.

STUDIO LAYOUT AND CONSTRUCTION

In many ways, our new FM facility was looked upon as an AM stepchild, so we were left to our own devious means of building the facilities with a fixed budget. Thus, we did much of the work ourselves, and resorted to many special innovations.

Construction labor was drawn from local resources—from building the production studio's raised platform, to painting the ceilings. As a result, we saved about \$6,000—6% of our anticipated \$100,000 total investment. This saving is mostly in labor; we found it possible to construct many items not available in prebuilt form. As an example, an estimate of \$600 was given by one lumber company to construct the production room console table. The cost, after minor modification, was less than \$150. The finished unit serves better than the one originally planned, since the wiring was installed during construction and modifications were made when "hitches" arose.

Construction of our studios was initiated as soon as the equipment was on order. At that time all dimensions and terminal points of the equipment were known. The transmitter building had to be completely remodeled prior to arrival of the new FM transmitter; thus, it took precedence over the production studio in most instances. Design and construction, however, were inaugurated for the two areas concurrently, so that similar construction phases could be tackled simultaneously.

As the transmitter studio is engineer-operated, the engineers were consulted. Everything had to be put into a compact, efficient cube which would allow maximum use of necessary equipment with as many time saving innovations as possible. Due to our almost exclusive use of "student" engineers (students at the University), shifts are often long to accommodate class schedules. In spite of the fact that they are part-time students, they are outstanding and willing workers.

It was decided that a "U" shaped work area would best suit the needs of the operators. Three racks form the left leg of the "U" while the turntables form the right leg. The console is mounted facing the transmitters; a double-paned window allows all meters and warning lights to be viewed. In the racks we mounted transmitter monitoring equipment for both AM and FM, the tape deck, and the cartridge playback unit. The room is also provided with a specially built shelf

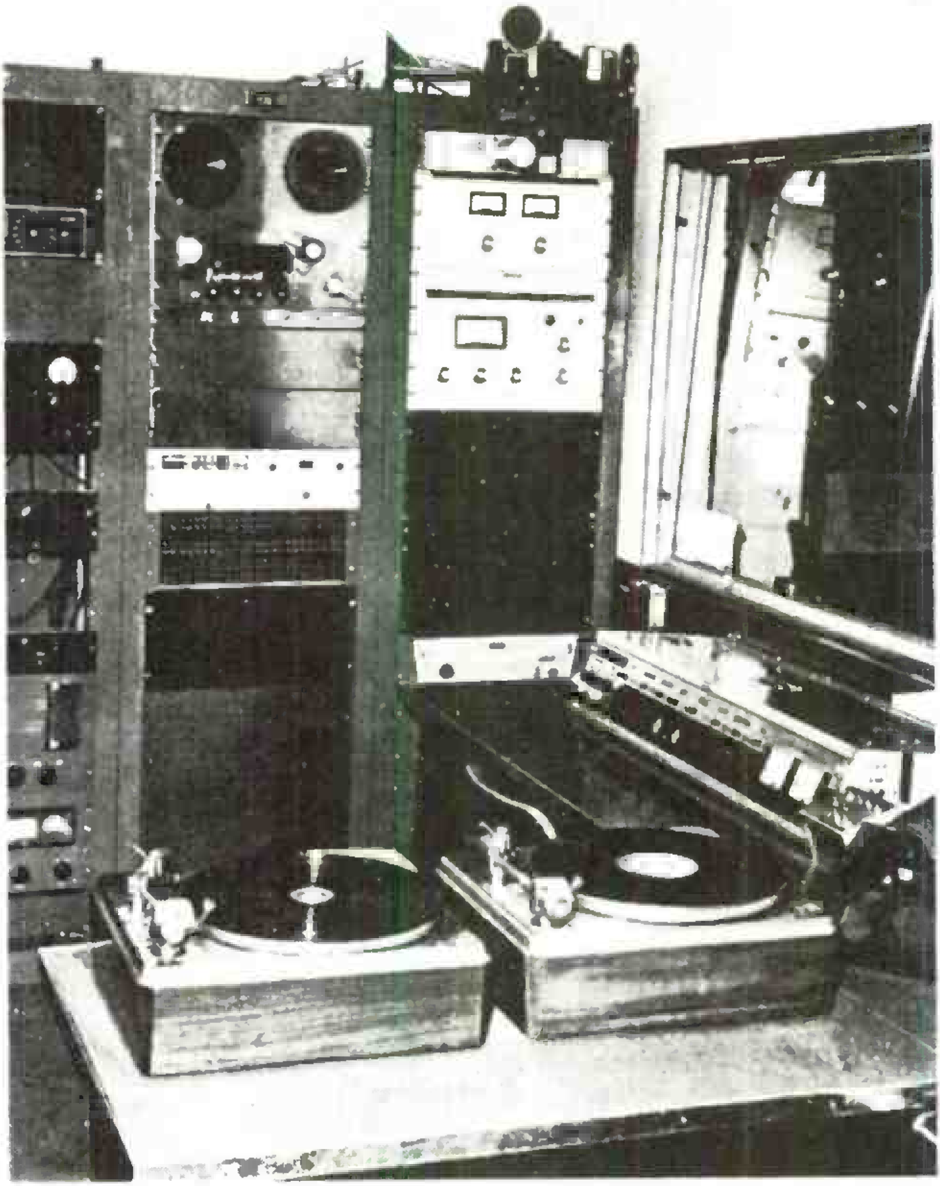


Fig. 1. View of transmitting studio, showing console, turntables, and rack equipment.

unit immediately behind the "U" to hold logs, records for the day, and necessary programming tapes. An air-conditioning unit was installed to replace two windows. (The windows were considered a detriment to silence, plus, with a beautiful view of "those West Virginia Hills," something of a work deterent. The window areas were sealed inside and out with exterior grade 3/8" plywood sheeting, then treated as regular wall areas.)

We foresaw one major problem: By locating the studio near the 5-kw AM transmitter, a 50-kw FM transmitter, the associated antenna system, and the required cooling fans, we would undoubtedly swamp the audio equipment with RF and the studio with noise. At the outset, the studio area was stripped to bare floors, joists, and rafters, and a "quadruple" wall system was designed and constructed.

First, a rock wool insulation material was stapled between all joists and rafters and stuffed between door jams and joists. Next, a copper screen cage (using window screen type material) was built to completely enclose the area. It was stapled to all joists and rafters and laid on the floor. All seams and joints were then soldered and the system was connected at appropriate points to the station ground system. An industrial grade floor covering was installed over the screening on double felt mats. All of these were bonded together and to the concrete floor through the screen with mastic. Panels of Celotex were rough nailed over upper wall and ceiling screening. Finally, acoustic tiles were installed on the upper wall areas and the ceiling. Pegboard was used up to the 4-foot wall level to provide a more durable surface.

The room turned out to be "studio quiet," yet still live enough for quality air work if an emergency arose and the announcers were forced to work "live" at the transmitter studio.

Production Studio Construction

Concurrent with construction of the transmitter-site studio, the production studio at the downtown offices began to take shape. Every effort was made to make the 15 x 11′ studio appear large and unobstructed. The room was painted in light tan tones with a white ceiling. The production area was raised seven inches by use of 2 x 6's and a double 3/4″ plywood floor. The reason for the heavy construction was the stability required for lightweight tone arms. Other stations we visited during our research study had used 2 x 4 beams on 2 x 6 sill plates. These had developed—over a period of months—a bounce which had to be eliminated with structural reinforcement. The flooring was both nailed and contact-cemented to produce as near a perfect bond as possible. Raising the floor allowed the racks to be placed away from the work area while still electronically accessible to the console.

Six 1″ conduit pipes were run between the joists from the rack position to the console location. Four 1″ conduit pipes were run from the rack position directly through the studio wall into the AM studio to interconnect the two. After completion of the floor area, a wall-to-wall carpet was installed in the interest of appearances and acoustics.

Studio Console Table

The console table was constructed almost entirely with 3/4″ birch plywood and cost less than $150. A hollow leg design proved structurally sound and ideal for wiring. In construction of the base legs, the major leg (larger of the two) was built with two removable sides. The fixed sides are doubled 3/4″ plywood. These were bonded with contact cement and nailed from the inside, thus preserving the surface areas. These two fixed sides provide inside surface space for terminal points and wiring mounts. An auxiliary AC circuit provides light and power for maintenance work on the console or other equipment.

The top surface was constructed of two shaped 3/4″ plywood panels. Prior to cementing the top panels together, a 2 x 4 the length of the top was fastened by a series of stove bolts to the bottom of the underside panel to help support the heavy console. After the 2 x 4 unit was in place, the project was handled with professional results.

The two turntables were placed at the side of the table 6″ below the 30″ table height. This level was found to be ideal after ex-

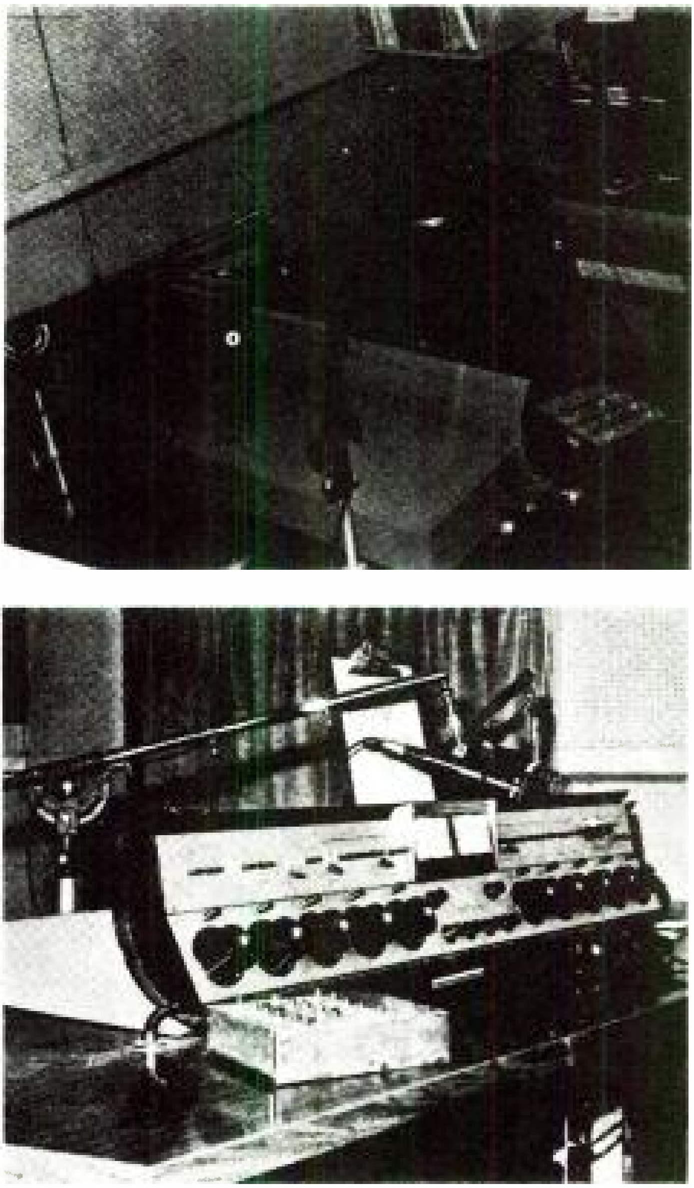


Fig. 2. Two views of the WAJR-FM production area. Rack equipment is in close proximity.

the two panels were contact-cemented and nail-locked together. The formica top was also installed by our own "carpenters," neither of whom had ever used a router. However, with five minutes briefing at the lumber yard, perimentation for visibility and cueing ease. Since that time we have discovered that NAB has adopted this height as a standard!

Boom mics were attached directly to the table top. Commercial stands allow adequate flexibility; however, they give the appearance of giant storks. Thus, the boom, swivel unit, and the arm of two mic stands were mounted on vertical aluminum tubes (do-it-yourself 1″ tubes) which are attached to the table by means of a flange mount. Microphone chassis connectors were sunk into the formica top to provide termination for the mic cables. A second mic termination point, at the base of the major console table leg, allows minimum cable run to the open recording area in front of the platform.

In the interest of convenience and better production, we deemed it necessary to devise a means of starting and stopping tape machines and turntables from a central panel at the operator's finger tips. After pricing several individual units which are commercially available, we decided that the combined cost was prohibitive, plus the fact that the individual units would take too much space on the console table. With a little thought and an expenditure of less than $20, plus 6 hours construction time, a customized control center was built to handle all physical functions of tape recorders, cartridge machines, and turntables. The unit was first placed in an aluminum chassis box so the ideal location could be determined by experimentation before permanent mounting. (After a 4-month period of actual use, we have decided to mount the unit *in* the console table at the left of the operator, at approximately a 30° angle from the console front.) The unit is a simple 6″ rack plate lettered to indicate functions, and a series of *spst*, normally closed, momentary contact switches. The turntables are operated by power relays which activate the 100v AC motors. Thus, with one hand all the functions can be controlled in whatever order desired. Adapting the remote control to the equipment was simple since all wiring ran through terminal blocks located at the rear of all units except the turntables; a simple wiring change interrupting the line ahead of the mercury switches took care of the latter. To facilitate later modification, sub-terminal blocks were installed in the console table base leg and in the racks. A similar unit was built for the transmitter studio and mounted in a portable chassis box for ease of operation.

Finishing Touches

In the near future, a foot-actuated time clock will be added to the production studio complex so that we can time longer-than-one-part recordings more accurately. The present wall-mounted clock, positioned so that it is visible directly over the portable copy board, is adequate to time a single spot or uninterrupted recording. However, to record a longer-than-one-part time segment, a stop clock is needed. The foot actuated unit will free the operator's hands for controlling equipment.

An ideal copy board should not block the operator's vision, and obstruct the open-aired, relaxed feeling desired. Thus, no copy board was installed at the time of construction. Instead, we contrived a simple clip board with two legs which gives the announcer a means of holding copy if required. The legs are leftover mounts from the thin speakers used in the control room. (The speakers were wall-mounted—thus four spare legs.) Another clip board serves as a portable news table with a means of holding script. The console table copy board fits on the console and immediately behind the double microphone array.

As the construction phased from structural to electrical and then to electronic, the staff engineers were called into service more and more. Many items—such as patch-panel wiring harnesses and pre-wired units—were built at the transmitter site while the engineer had only meters to read. These were then installed by the Chief Engineer.

By the fifth month of construction, meeting the original deadline of September 1st was an obvious impossibility. Added to this, the cartridge machines we had were reported "in construction" but experiencing technical difficulties beyond the control of the manufacturer. Due to time limitations involved, other units were ordered by telephone. Within 48 hours, the two machines were at the station, which permitted equipment installation to follow an orderly procedure. As the two studios began to look like functional facilities, we faced the next major phase—installing the transmitter and antenna system.

EQUIPMENT INSTALLATION

At this point, let us delve a bit into the "whys" of our transmitter selection. Since we planned to run 50 kw into an 8-bay antenna, the smallest unit we could use was 20 kw. For one reason or another, some of the available equipment was not quite suited to our situation. We had to have a transmitter which would fit into the space we had, and naturally, we wanted high quality equipment with good stereo separation. From past experience with our AM transmitter and based on reports from other stations, we finally chose Collins. It comprises two separate 10-kw amplifiers fed by a common exciter unit. In our case, the two 10-kw amplifiers had to be diplexed into a single transmission line.

Transmission Plant Installation

Timing was vitally important at this phase of our schedule. All equipment had to be on location before any installation could actually begin, since one AM tower had to be replaced with one strong enough to support the FM antenna. This involved disrupting the night-time AM directional pattern; therefore, all work had to be completed within a limited time.

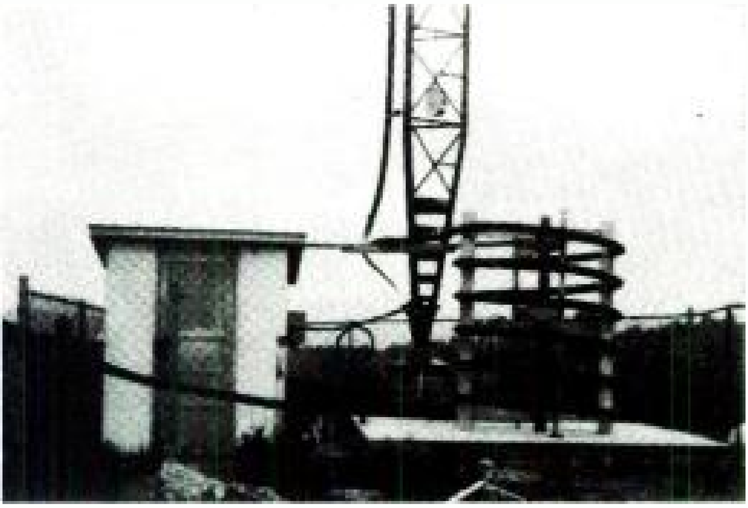
Permission was obtained from the FCC to operate the AM with a non-directional night pattern at reduced power, and to determine operating power by the indirect method. The non-directional pattern was arranged by feeding only the No. 2 tower with 250 watts.

In two days, the old tower was pulled down and the heavier tower, with FM antennas attached, was erected. Before the new tower could take its place in the AM operation, the FM transmission line installation had to be completed. To match the antennas to the FM transmitter, and to isolate the AM signal from the FM, we wound a coil of 3 1/8" Heliax line on a homemade 5 x 5' wood coil form. A variable vacuum capacitor, connected in parallel with the coil, provided the required tuning. With this major phase of the installation out of the way, we were able to breathe a bit easier. After re-proofing our AM pattern, night-time operation was restored to normal.

With the basic transmission system complete, and preliminary transmitter tests out of the way, we had to install a dummy load in order to fire up the transmitter RF amplifiers. Our dummy requires a constant supply of water to cool it. Fortunately, we had a nearby cistern with an ample water reserve. The dummy was mounted across the room from the transmitter and the specified lines were connected. The frequency and modulation monitors and the limiter were installed; at the same time, all AM monitoring equipment was moved into the broadcast studio, within easy reach of the operator.

Studio Equipment Installation

Studio equipment installation, while a less monumental task, still harbored its share of bugs. During the construction, all audio wiring had been pulled into conduits, and each cable pair numbered to avoid the confusion inherent in the duplicity of audio circuits required in a stereo installation. All console inputs and outputs were fed through a patch panel, thus providing more flexible use of turntables, tape machines, and microphones. Left and right channel mics at each of the two locations (console and studio positions) are fed to a pair of jacks, and the lines to the console inputs are fed from another pair of jacks directly above the mic termination jacks. Each pair is normaled so that the mics feed directly into the console when patch cords are not in use.

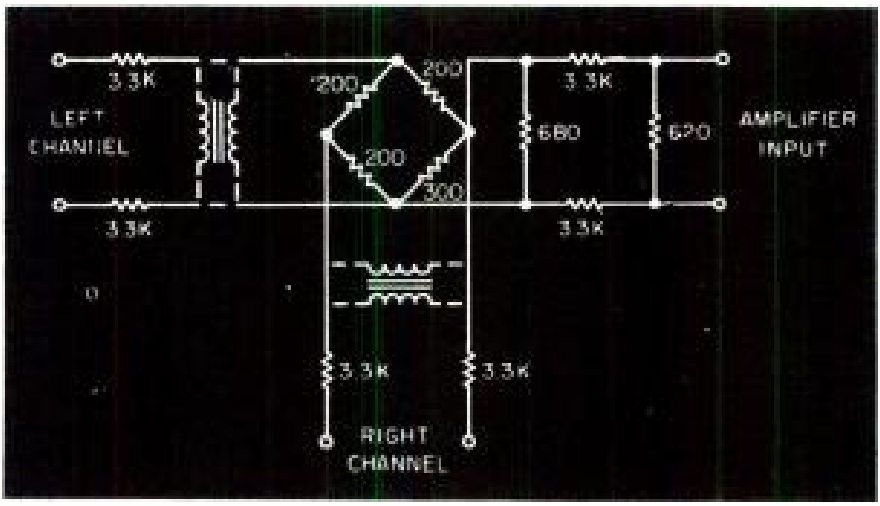


Construction of the antenna coupling coil. The form is attached to the base on bolts planted in the concrete pad.

With this arrangement, any or all mics may be fed into any console input or brought out and connected to any other equipment. By the same token, other mics, or any other equipment, may be fed into the console mic channels. Each channel of the two stereo reel-to-reel tape machines and a stereo cartridge tape machine is terminated in two pairs of input and two pairs of output jacks. This arrangement affords widest possible use of each individual machine: console studio equipment phasing. With as little equipment as we are using, four patch panels were required. (Telephone lines and associated monaural lines were terminated on two patch panels.)

Feed AM to FM and FM to AM?

In a stereo operation, feeding AM to FM, and vice versa, involves more than merely running a couple of wires. A means of



Matrix used to combine the two stereo channels into a single channel to feed the AM transmitter.

output may be fed into each machine, a tape may be played back through the console for mixing purposes from any machine, or a tape may be dubbed from one machine to the other, independent of the console, merely by inserting patch cords in the appropriate jacks.

Of course, program lines terminate at the patch panel, and a feed *to* the AM studio and a feed *from* the AM studio, as well as a network termination, appear on the panel. A series of "multiple" jacks add to the system flexibility by providing the capacity for feeding several sources from a single output. Also, these facilities have proved valuable in polarity determination and in doing it had to be developed, since sports feeds and network news are fed from AM. In addition, we wanted to be able to feed both AM and FM from the transmitter studio when the occasion arose.

To feed AM to FM, signal is tapped off the AM transmitter line, bridged into an amplifier and fed through a splitting network into a spare pot on the FM console. To feed FM to AM, both FM channels are bridged off the FM console output and fed into a matrix, which in turn feeds an amplifier that can be switched into a limiter. Our engineering department came up with the circuit shown in the drawing.

Testing

With our target sign-on date rapidly approaching, all systems appeared to be in a "go" state. However, when the FM transmitter was turned on, the turntables in the transmitter studio produced a jungle of noise if touched or moved, indicating that RF was being picked up by the turntable circuitry. To correct the problem, RF chokes were installed on the power lines entering the room, all ground shields were checked, and as a final step, the external transistorized preamps were eliminated from the turntables and the pickups connected through equalizers into microphone console inputs. Fortunately, this turned out to be the most serious bug—in the studio, at least.

Transmitter-site studio. The racks contain both AM and FM monitoring equipment and other necessary terminal gear. The operator faces the transmitters through the large double-paned window.

Complaints From TV Viewers

Although our transmitter is located a mile and a half from any major population concentrations, equipment and program testing started a flurry of complaints from TV viewers. At first we suspected second harmonic problems, since most complaints were about interference on Channel 11. Channel 11 audio is on a frequency which is approximately the second harmonic of 101.9 mc. Thus, even though our second harmonic level met and bettered all specifications, we went a step further and installed a second harmonic filter on the

Methods of Eliminating FM Interference

A quarter-wave open-ended stub, constructed of 300-ohm lead-in wire, is attached to the back of the offended TV set at the antenna terminals, or at the antenna itself. The back-of-set location is simpler, of course, but if a booster is used on the antenna, the stub must be connected ahead of the booster. The formula for computing stub length is:

$$\text{(length in feet)} = \frac{246\,V}{f}$$

All boosters had to be equipped with a built-in trap or a trap installed ahead of the booster, such as an absorption-type made from a length of 300-ohm lead-in wire and taped to the TV antenna lead-in.

transmission line. The complaints persisted. Finally, we discovered the interference was the result of severe receiver overloading, which produced a second harmonic component within the mixer of the receiver itself. Most of the sets suffering from the interference were within seven or eight miles of our tower, and the TV antennas, oriented toward Pittsburgh, were aimed right at our tower. This, obviously, furnished them with a healthy supply of our RF.

In spite of the fact that we were in the right, the station wasn't making any friends, and it was imperative that we solve the problem before we could begin regular operation. Correction involved installing traps, tuned to our carrier, at each offended TV receiver (see box). In most cases, each set owner either had a trap installed or devised his own trap, at a nominal cost in either case.

Not content to let the matter rest there, we made a tour of all radio and TV sales and service establishments, told them of the problem and its cause and cure. As a service to ourselves, and to the CATV and TV service companies in the area, we personally worked with them to correct the problem. We also discovered since that our case was by no means isolated; most high power FM stations have had this TV set overload problem.

Program Tests

Two weeks of program tests were allowed in our revised schedule, and by mid-October it appeared that we were at least partially ready to take on a broadcast schedule. On November 1, 1964, with appropriate fanfare and last minute sign-on jitters, we were a member of the growing minority of stereo broadcasters!

DETAILS OF TRANSMISSION SYSTEM

THE DESIGN and installation of our FM antenna and transmission line called for a series of necessarily well-timed, coordinated operations — the night-time AM DA had to be taken apart, the FM antennas added, and then the system put back together again.

We had our moments of mixed emotions in trying to time the arrival of all equipment and supplies, but when construction finally started Dame Luck was pretty much on our side.

Tower Replacement

Our plan was to mount the FM antenna on our #3 AM tower, chosen because it is used only on the night-time pattern. Disturbing the daytime pattern would have been more upsetting to the station economy. The weight of the new antenna, approximately a ton, was much too heavy for the existing tower; therefore, a stronger tower had to be installed. To replace the tower, we obtained permission to operate with reduced night-time power, using a single tower.

Installing a heavier tower meant starting from scratch—new guys, new base, new insulator. A very important consideration in tower structure is the relationship between tower strength and the number of essential guys. Stronger towers, of course, require fewer guys, and additional guys up the cost—cable, insulators, earth anchors, etc. Then, too, the presence of guying cables will disrupt the electrostatic field around the antenna unless they are properly broken up with insulators so that each continuous length is a submultiple of a wavelength.

The original 12″ face triangular cross-section tower had to be replaced with one 24″ wide on each side. The heavier tower required heavier guys; the original ⅜″ cable was replaced with ½″, but we eliminated one set of guys. The suitably larger base insulator and heavier tower required a new concrete tower base. By exercising a bit of care, we were able to use the existing ground system. A new beacon and side lights required by the larger tower cross-section were installed, but we didn't have to replace the lighting choke since no additional power was necessary. The FM antenna de-icers called for a separate circuit (their use may be necessary when the lights are off). Since the de-icers consume about 1400w, we used a 1600w

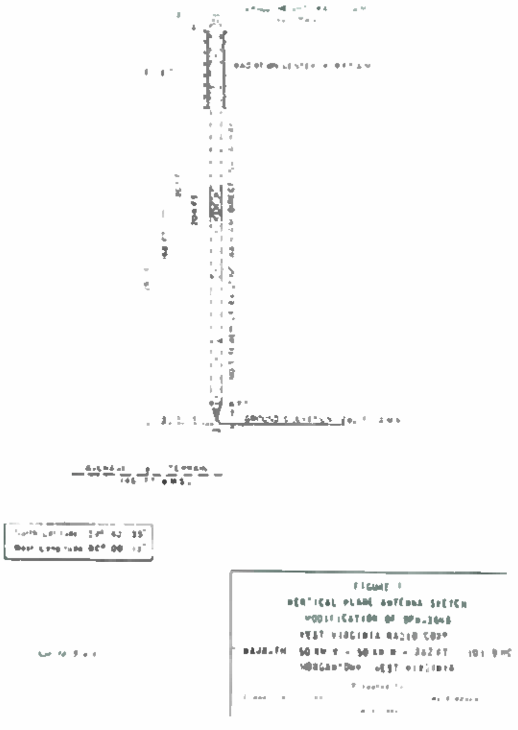


Fig. 1. FM antenna tower mounting configuration.

choke to get the AC across the tower base.

FM Antenna Mounting

After the new tower was erected, we mounted the FM antenna. The 8-bay ring type horizontal section, including de-icers (Collins 37M-8), was mounted on a tower face and the 8-bay vertical dipole section (Collins 300-8) was mounted on the opposite leg. This configuration was used to minimize interaction between the antennas and to more evenly balance their weight. The power divider was mounted on the tower at the base of the antenna assembly. The antenna radiation center is 18 feet from the top of the tower and the antennas occupy 36 feet of vertical tower length (space between antennas is approximately 5 feet, Fig. 1).

Transmission Line

After the new tower was erected, a 130-foot length of 3 1/8" diameter coax transmission line (Andrew HJ8-50A) was attached to the tower, the outer conductor bonded to the tower just beneath the FM antennas and two feet above the tower base. This length runs from the power divider to the isolation coil at the base. Another 100-foot length was used to wind the isolation coil and an additional 100-foot length runs from the isolation coil to the transmitter, supported on the AM transmission line carriers. The outer conductor of the transmitter run is grounded at both ends with a 2½-inch copper strap running to the antenna ground system and common station ground. The coax shield of the isolation coil is also grounded at the bottom end by virtue of the transmitter line ground.

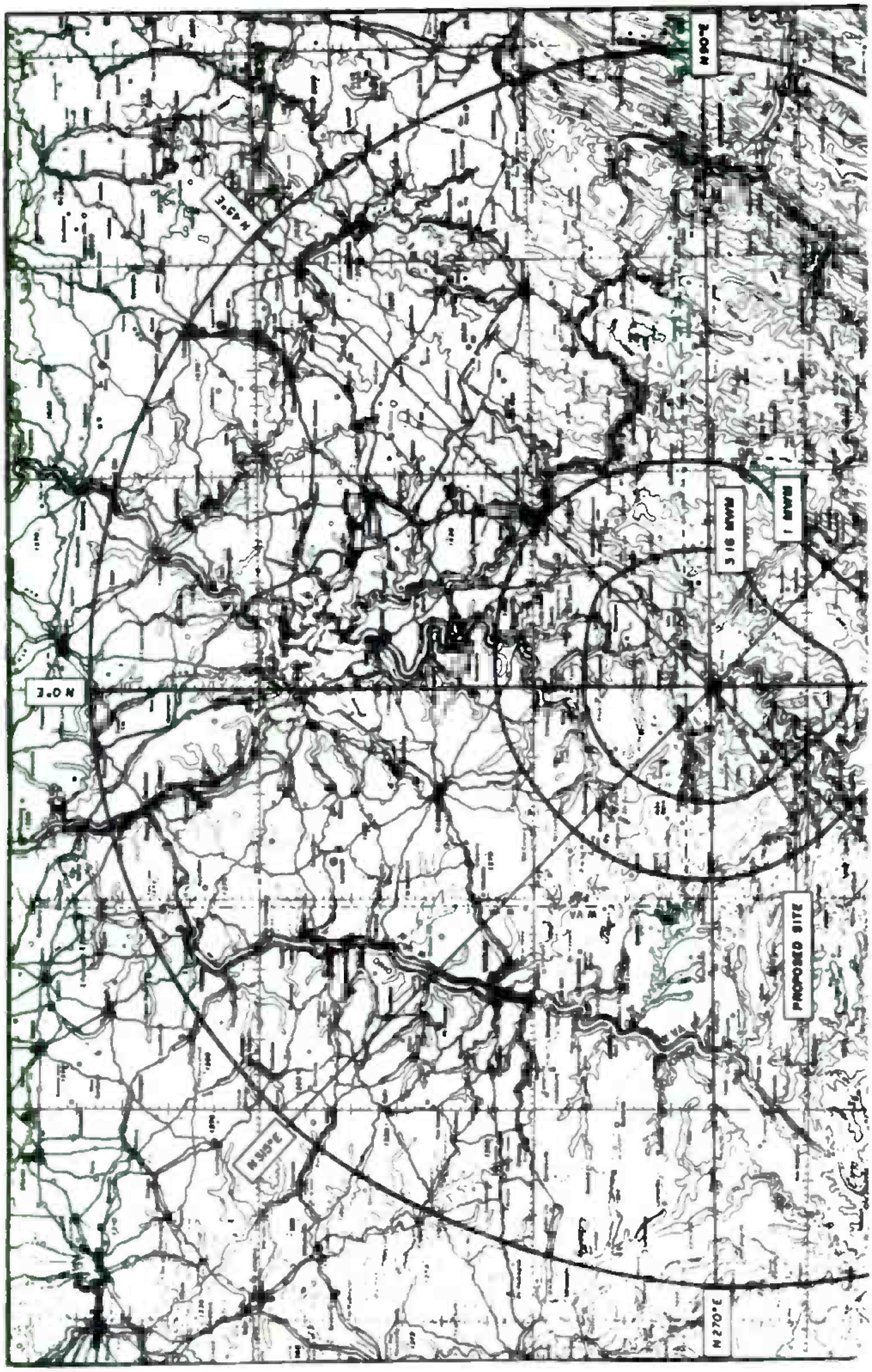
Two coax splices were necessary, one at each end of the isolation coil. This procedure is tricky. We used the recommended connectors and followed the manufacturer's instructions to the letter. If the outer and inner conductors of the coax aren't solidly attached to the connectors, many problems (fortunately none for us) may crop up.

The air dielectric transmission line is pressurized with 5 lbs. of dry nitrogen. We've had some leakage problems at the antenna junction, but even so, a 2,000-lb. tank of nitrogen lasts about 30 days. The line pressurization fitting and gas tank are located inside the transmitter building where operators periodically

Table I. Elevation & Contour Data-WAJR-FM

Radial and Bearing (Degrees)		Average Elevation 2-10 Miles (Feet AMSL)	Effective Antenna Height (Feet)	Effective Radiated Power (kw)	Distance to Predicted Contour 1 mv/m (Miles)	0.05 mv/m (Miles)
A	0	1117	291	50	26.5	76.5
B	45	1040	368	50	29.5	78.0
C	90	1089	319	50	27.5	77.0
D	135	1254	154	50	20.5	70.0
E	180	1079	329	50	27.5	77.0
F	225	1215	193	50	22.5	72.0
G	270	1195	213	50	23.5	73.0
H	315	1183	225	50	24.0	74.0

Height of radiation center above mean sea level, 1408 feet.
Height of average terrain above mean sea level, 1146 feet.
Height of radiation center above average terrain, 262 feet.


N 0°E
N 45°E
N 90°E
N 135°E
N 270°E
3.16 MVM
1 MVM
PROPOSED SITE

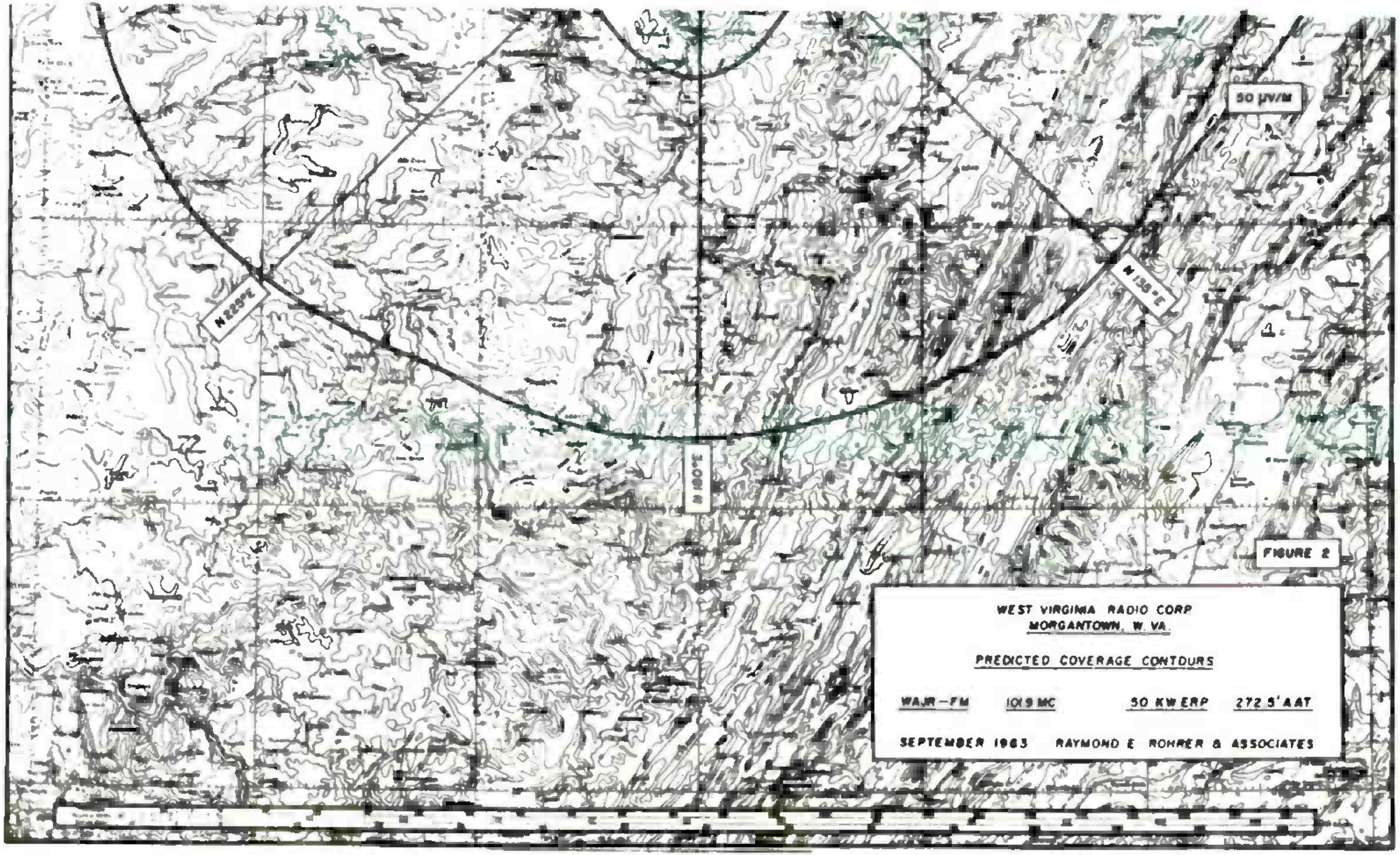


Fig. 3. WAJR-FM coverage contours.

check the pressure and gas supply. Since the RF diplexer, combining the output of the 10-kw amplifiers, is not pressurized, a gas barrier was inserted between it and the transmission line.

Tower Base Isolation

Obviously, the tower must be insulated from ground at the AM carrier frequency. To maintain this condition and at the same time get the grounded outer conductor of the transmission line across the tower base, we constructed a coil to form a parallel resonant circuit with the base capacity of the tower (base capacity and the inductance of the coil formed by the outer coax shield). The resonant circuit offers a high impedance to the AM carrier when tuned to the carrier frequency, 1440 kc. A 20-180 mmf vacuum capacitor, connected in parallel with the coil, serves as a trimmer to tune the circuit precisely (Fig. 2).

Winding the 3" diameter coax on the coil form required a bit of patience and improvisation. The form had been prepared in advance, with notches (12" on center) cut deep enough into the form members to receive the coax. The minimum bending radius of the coax was 30 inches (according to manufacturer's data); therefore, the coil had to be 5 feet in diameter. Calculations indicated that we would need 6 turns on 12" centers to give us the 40-uh inductance, requiring a form 5 feet long. To wind the coax on the form, we stretched out the 100-foot length of cable on a clean area, then placed the coil form on the cable at the point where winding was to start. Slowly, we rolled the form, carefully placing the cable in each notch, until the end of the transmission line was reached. As the cable was placed in each notch, a 3/4-inch wide stainless steel strap was fastened across the notch to hold the cable. As it may sound, this was a slow process, but with the almost unwieldy stiffness of the cable, it was impossible to hurry. The

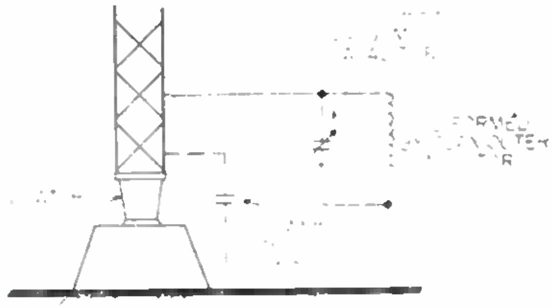


Fig. 2. Schematic of tower base isolating circuit.

vacuum capacitor was attached to the inside of a coil form member and connected to each end of the coil by 2 ½" copper straps. It is tuned by reaching through the coil turns.

Operating Parameters

Each antenna section, horizontal and vertical, has a gain factor of 8.3. This required 6.03-kw input to each antenna for the licensed radiation of 50 kw, and an input at the power divider of 12.06 kw. The manufacturer's specifications indicate a transmission line efficiency of 91%; therefore, the transmitter output was adjusted to 13.26 kw to overcome the transmission line loss of 1.20 kw. The design and pretuning of the system was such that our vswr was nil when it was put into operation. Had we not been extremely careful during construction, including transmission line splices, the situation may have been different.

Effect On AM Pattern

The new tower and associated circuitry changed the base impedances of all three towers used in the night-time pattern, necessitating recomputation of all parameters. Upon completion, the new engineering data was submitted to the FCC and permission granted to resume operation after reproofing the entire system.

PROGRAMMING

WHILE IT WAS NOT our intention to program for specific ethnic groups, we felt that there was a need for more European-style music, at least during some time periods. Also, in conjunction with our "foreground" music concept, we wanted to establish a distinctive sound, so that when a listener tuned across the dial he would immediately recognize WAJR-FM without hearing the call letters. Music preferences were made known to us as soon as the intention to build the station was announced. Through letters and personal contact, many people were quite generous with advice. Then, too, we had an accumulation of comments on music tastes in our AM file. With these guideposts, plus the manager's 20 years experience in the market, we developed our program structure.

Programming Techniques

To prepare programs initially, a trained musician and two temporary programmers were hired, each schooled in certain types of music. The intention was to set up a 6-month schedule, after which the permanent programmer could handle the job by merely inserting new material with the best of the previously used music. Before planning a daily schedule, the programmer checks the preceding week's list to avoid duplication of feature material, thereby guaranteeing a 2-week separation of featured artists and music.

A feature artist is selected for each 45-minute time block. Two cuts by the featured artist, then a cut from a blending orchestra or group, then back to the featured artist for another one or

Prefix

The Orchestra section is filed under the prefix "OR" and albums coded with an orange magic marker. Dinner music is listed under DM and labeled with blue magic marker. The Male Vocal selections have the prefix MV and are marked with red. The Female Vocal discs are filed under FV with a green marker; Vocal Groups are headed VG and indicated with yellow magic marker. The double coding system insures correct filing.

Numerical System

Each separate group is individually numbered —from one to infinity. To keep individual artists together we estimated the additional disc probability of major known artists, then left holes throughout the file to allow for additional releases, artists, and music types.

The new discs are checked against order forms and logged in, and assigned a prefix, and if a Promotional Issue or received from a Music Service, checked. If not usable within our programming concepts, it is removed from circulation and held for future promotional use. Usable discs go to the librarian and are assigned a number. We maintain a long sheet with all music on hand and the number availabilities. The librarian "builds" the file cards, inserts them into the card file, and releases the disc for air use. By holding out new discs until they are completely filed, the card file is up to date at all times.

File Cards

Pre-printed legal length spirit stencils are imprinted with the card file headings of ALBUM TITLE, COMPOSER, ALBUM NUMBER (ours and the publishers), ARTIST, and SONG TITLES. By use of a letterpress process, we are able to apply enough pressure to not only mark the headings on the master but to force an imprint from the transfer sheet, thus providing headings on all duplicated material. Three-up cards are cut to the proper width, and serated every 4" to provide the desired 4 x 6 card size. These are not split apart until after run-off. Both BROADWAY and CLASSICAL records are color coded black. BROADWAY discs are prefixed SM (show music), as we include movie themes, and orchestral records featuring one show. In numbering new SM discs, a cast album is given the next consecutive number in the file (no holes left for additions) and all adaptations from the original are assigned its number and a letter. The classical file is handled by the publishing company number only. All RCA Classical discs are filed in one group, all Columbia in another.

two cuts, make up a typical segment. A third element adds another blending or contrasting group, then a switch back to the featured artist. The "featured artist" policy permits a complete day's programming with a minimum of duplication, even though different programmers work on separate blocks. These are distributed so that the programmers' style does not get stale to a constant listener.

In stereo programming the lack of music in some categories becomes a critical factor. Due to a shortage of records and a strict music policy, the programmers were virtually forced to follow a set format in major daily programming blocks.

Initially, we figured a programmer would need only 15 minutes to program each hour; this, however was a 50% error. We quickly discovered that it takes approximately 30 minutes to program an hour of music, if the desired quality is to be maintained. Five normal cuts are programmed per quarter hour. The transmitter studio operator justifies the program list at the close of the hour by deleting unnecessary cuts. To properly close the hour, the last indicated disc is back-timed. If it appears that he will run short, the operator inserts additional music listed on a standby disc prior to the last scheduled cut. The standby records are chosen so that, although the given selection may not be ideal in that given position, it will not be entirely out of place.

A music slot for each day has a folder for program data sheets prepared in advance. Programs are planned 8 weeks in advance to allow for printing time.

Program Concepts of WAJR-FM

7:00-9:00 A.M. "Daybreak," a light, airy, "Doris Day Movie" approach designed to lift the listener at the beginning of his day.
9:30-11:30 A.M. Caters to an audience segment of mixed nationalities without sounding like a foreign language station.
11:30-1:30 (Noon break for 15 minutes of news and sports): "Cafe Internationale" relies heavily on light European themes, music found at any street cafe. This show has required more work than any other to stay within our concept, due to the limited amount of available stereo music.
1:30-4:30 P.M. "Contempore" features instrumental American movie themes, with a tempo slightly faster than the mid-morning show. Music from the swing era, sprinkled in periodically, serves as an accent element.
4:30-6:00 P.M. "Club Rendezvous" features combos and quiet group—a drive-time show with a different approach to relax and soothe the listener after a day's work.
6:30-8:00 P.M. (following half-hour news break): "International House" produces a restaurant format music block with a sound more suited to the family dining room than to a commercial establishment. The foreign element is again injected to enhance the program image.
8:00-11:00 P.M. "Jetstream" swings from classical to subtle jazz to broadway and back again—music with a bigger, more dynamic sound—Mancini, Leroy Anderson, Percy Faith types. Provides feature music in direct competition with TV's major time block. (TV reception is poor in several portions of WAJR-FM service area.)
11:00-Midnight: The final hour, "Quiet Village," provides a typical late show musical fare in a lush relaxing vein.

Throughout the day individual vocal artists are limited to the 7-9 A.M. block and the 11-12 midnight show. Group vocals are used from sign-on until 11:30 A.M. All other music is instrumental except "Passport to Broadway" on Saturday afternoon and one hour of "Jetstream," two times a week. Other areas of tight control include the use of brass, used only during "Contempore" and "Jetstream." In both cases, wailing or screaming material is prohibited. As a standing rule, modern two-beat music is used with extreme caution—if at all—even though performed by name orchestras. Show themes were chosen to maintain sound continuity with the basic program concept. The underlying or overall goal was to develop an individual sound without resorting to jingles and other identification builders.

Production Liaison

Program openings and closings and half-hour announcements and breaks are recorded on reel-to-reel tape; promos and commercials are recorded on cartridges. The operator at the transmitter studio need only start the reel-to-reel tape for beginning, half-hour break, and closing. The music sheet prepared by the programmer tells him which cuts to play on each album. Since the operator works a 9-hour shift, as many breaks as possible are figured in the program schedule, even though they may be only 3 or 4 minutes. Most featured material for each program is selected from the same album, thus, the operator has to change only the accent disc. Records and tapes are transported between the program department on a daily basis, except for the week-end material, which must all be packaged on Friday. Announcement and intro tapes are recorded by an AM announcer who devotes about two hours a day to provide control and direction.

We had hoped to operate with one part-time secretary-librarian. This turned out to be a 50% time study error. With traffic, posting programmed music to the log, and the rather extensive work of handling record ordering, the job definitely requires a full-time girl.

Program Control

To maintain quality programming, air checks are made by almost all section leaders. The Chief Engineer makes a daily trip to the transmitter if for no other reason than to inspect the area and to check on operator problems. Programmers air-check their program blocks against the music file list to insure continual attention to the log, and management listens for proper program concept. To maintain a logical means of control, engineering problems—including sloppy board work—are referred to the Chief Engineer; administrative problems are taken to the Production Director, and music errors are referred to the Chief Musicologist. All concept questions are settled by the Production Director. Due to the limited contact between operators and programmers, if an indicated record cut is bad, the operator notes the fact on a Daily Problem Sheet which is returned to the program department.

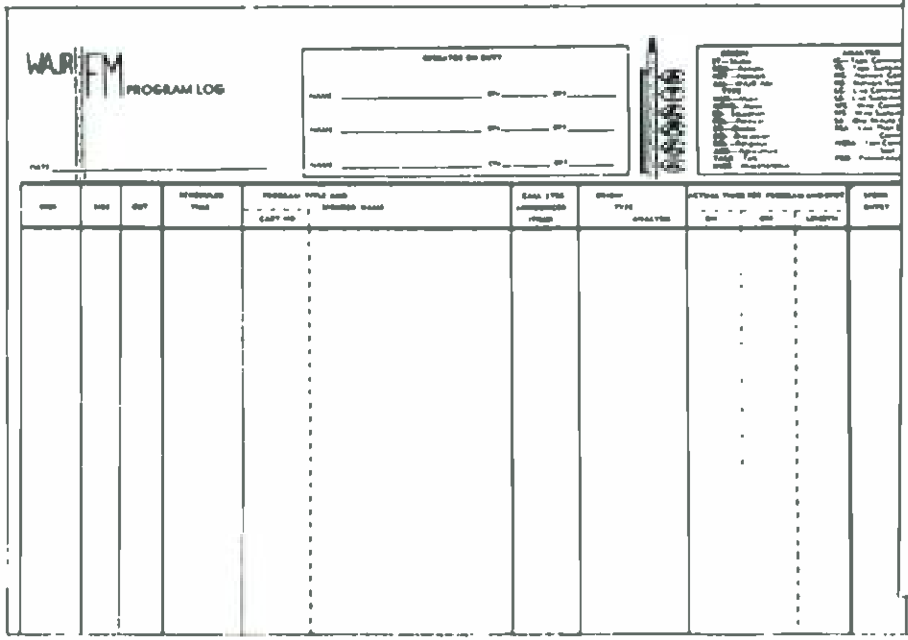


Fig. 1. The log form serves as both music sheet and official program log.

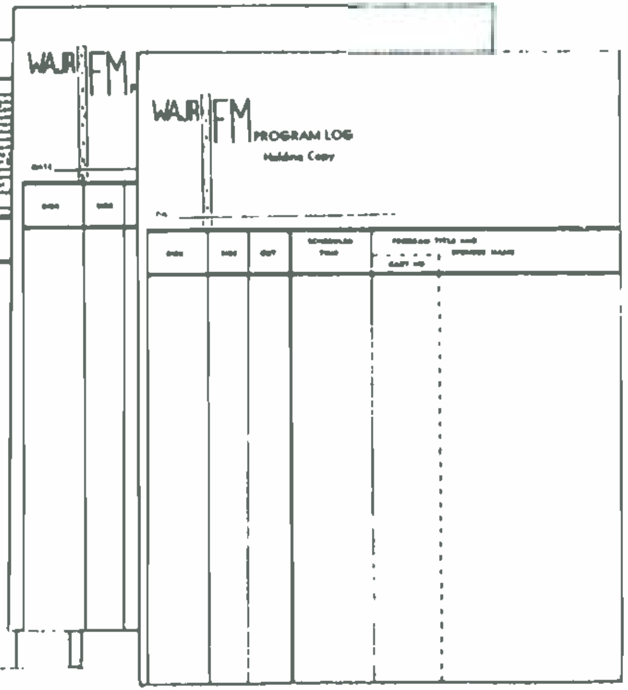


Fig. 2. The second and third copy of the NCR log form are used to prepare future programs, and do not include the official log information.

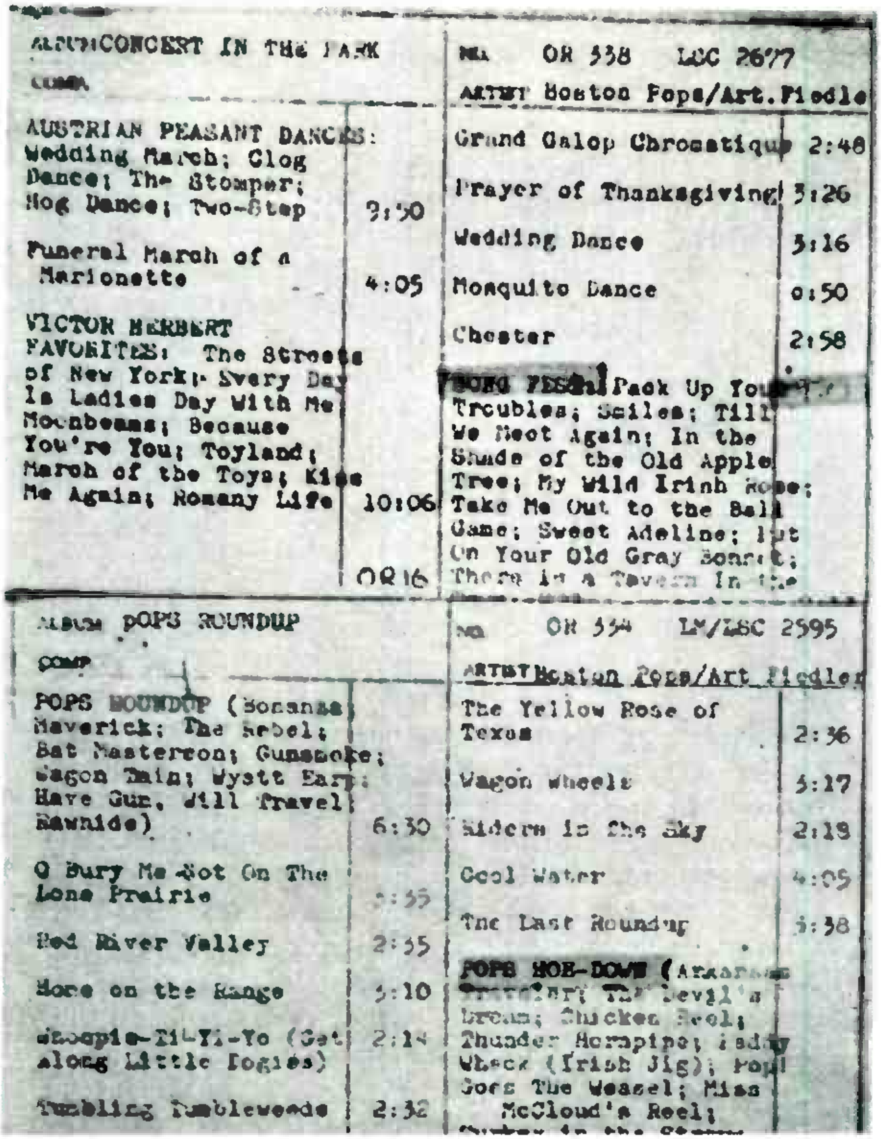
Program Log Forms

Program logs presented a challenge at the outset. Since the station was to operate on a tight budget after the initial expenditure, it was decided to repeat some program segments to a limited extent. To do this, the log had to provide a usable copy for re-logging in the future. Also, the program and music logs had to be combined for the operator. After due consideration, we had the log printed on NCR stock (No Carbon Required), bound in units of three. These forms cost nearly three times as much as any other; however, considering the time required to load three sheets of paper in a typewriter and set up the carbons, the cost of the NCR forms is justified.

The left side of the log (Fig. 1) includes a triple column for entry of record number, side, and cut. The official program log requires a minimum of fill-in time. The "cart" column includes numbers of cartridges and tapes to be used at specified times. The white cover sheet becomes the official log with time entries, etc. It is shipped to the transmitter with the daily record stack. The yellow second sheet is filed for a repeat of the music series. Changes will be made in pen and ink, then the new log prepared from it. The pink third copy is used as a dummy for the following week's scheduling, then destroyed. The music list helps identify a listener call-in for a song title. By referring to the list, the record number, side, and cut, the title may be found in the record file.

Music Library File

Building a stereo record library within our requirements has been difficult, due to the unavailability of a vast selection in some categories and further compounded by the fact that some record companies are reluctant to release records to stations for less than the full wholesale price. Several companies offer a music service; however, in our case, as much as 50% of the music received on this basis is not usable because of its content. Even if service costs are low, the cost-per-disc becomes almost the normal wholesale rate. The major companies have been quite helpful with prices and services; one company has established a means whereby unwanted material in their subscription service



ALBUM CONCERT IN THE PARK
COMP.
NO. OR 338 LSC 2677
ARTIST Boston Pops/Art. Fiedler

AUSTRIAN PEASANT DANCES: Wedding March; Clog Dance; The Stomper; Hog Dance; Two-Step	3:50
Funeral March of a Marionette	4:05
VICTOR HERBERT FAVORITES: The Streets of New York; Every Day Is Ladies Day With Me; Moonbeams; Because You're You; Toyland; March of the Toys; Kiss Me Again; Romany Life	10:06
Grand Galop Chromatique	2:48
Prayer of Thanksgiving	3:26
Wedding Dance	3:16
Mosquito Dance	0:50
Chester	2:58
SONG FEST: Pack Up Your Troubles; Smiles; Till We Meet Again; In the Shade of the Old Apple Tree; My Wild Irish Rose; Take Me Out to the Ball Game; Sweet Adeline; Put On Your Old Gray Bonnet; There is a Tavern In the	

OR 16

ALBUM POPS ROUNDUP
COMP.
NO. OR 334 LM/LSC 2595
ARTIST Boston Pops/Art Fiedler

POPS ROUNDUP (Bonanza; Maverick; The Rebel; Bat Masterson; Gunsmoke; Wagon Train; Wyatt Earp; Have Gun, Will Travel; Rawhide)	6:30
O Bury Me Not On The Lone Prairie	3:55
Red River Valley	2:55
Home on the Range	3:10
Whoopie-Ti-Yi-Yo (Get along Little Dogies)	2:14
Tumbling Tumbleweeds	2:32
The Yellow Rose of Texas	2:36
Wagon Wheels	3:17
Riders in the Sky	2:18
Cool Water	4:05
The Last Roundup	3:38
POPS HOE-DOWN (Arkansas Traveler; The Devil's Dream; Chicken Reel; Thunder Hornpipe; Paddy Whack (Irish Jig); Pop! Goes The Weasel; Miss McCloud's Reel;	

The serated, 4 x 6 3-up cards used for record filing list pertinent data on each album to aid program preparation.

may be exchanged, assuming it is in original condition. One company (Somerset) is now providing full albums for 50¢.

To reduce the over-use of music and to allow ample separation between days of use, the orchestra file was split into 7 stacks. Each stack contains about 60 discs comprising a variety of music. One stack is used for each day of the week, then we go back to the top. Other classifications are maintained in normal file sequence.

Of course, we are constantly adding to our library; we feel justified in purchasing an album if it has at least two cuts we can use. Our initial record order, composed of less than

200 albums, was selected on a general basis, music we were sure to use, even if it became necessary to make format changes. By the on-air date, we had increased our library, since our format had become more finalized.

IN RETROSPECT

MUCH WATER has gone over the dam since November 1, 1964, and many kilowatts of FM stereo music have been radiated from our antennas. In some respects, it seems as though it all began just yesterday, but in others the beginning seems like ancient history. As one might expect, every single plan hasn't been fulfilled, and we still have goals to reach, but generally we have accomplished much of what we set out to do.

WAJR-FM is now a byword in many homes and a target for letters from a few others. More importantly, however, the station has become a fixture within the multiple communities in our coverage area. We have gloried in our first stacks of congratulations and weathered the opening blasts of criticism. During the first few weeks, we could have done nothing wrong; praises of the "new medium" were many. But once the newness wore off, we were just like the boys up the street. Everybody had his opinion. Our concept of joining classical, folk, and jazz into a single format suited to these varied tastes was not easily "sold." It took many personal letters, speeches to community groups, and some community-minded advertising.

Station Promotion

How do you tell people over a 17,150-square mile area that you are on the air without spending a fortune? Logically, you start at home. We utilized advertising media we felt we could afford; obviously, promos on our sister AM were used extensively, plus several ads in local papers. Beyond this, we worked hard to gain favorable editorial coverage. Since the FM investment was expected to be in excess of $100,000 it ranked with almost any new big business, and we planned our news releases accordingly. Every week or two for a period of three months before sign-on, multicolor ditto news releases were sent to each newspaper within a 40-mile radius. We also included mats in occasional releases (as inexpensive as photos, but give more assurance of publication). As we approached sign-on, a complete information package, including photos and mats, technical information and news releases, was sent to each paper, As a result, our sign-on got front page coverage in many area publications.

Shortly after sign-on, we wanted to measure the size of our audience as well as reactions toward our programming. With our quality approach, the typical AM radio contest with lots of ballyhoo and prizes seemed unfitting. Accordingly, we developed a simple contest with FM radios as prizes; the only entry requirement was that the listener send his name, address and if he so desired, the name of his favorite program. Contest promotion copy was slanted toward the humorous. We did not imply that the prizes were anything to be desired—just something nice to have. One promo per hour and short station break promos were the only means by which the contest was publicized; no other medium was used. Until the final week of the contest, we didn't describe second and third prizes by product—just that they would be awarded.

In conjunction with the contest, we conducted a poll of those people we knew listened and those who had written earlier, or were met on the street. From this we discovered that only one in 25 or 30 would bother to enter the contest. This compares to one in 10 to 15 who enter similar contests we had conducted on AM. As we had hoped, we received many comments indicating likes and dislikes, enabling us to better analyze our position and determine what changes were needed. Total cost of the promotion was less than $400, which was traded out in advertising.

Programming

Our initial program format remained basically unchanged; only minor adjustments in some segments were required. As we progressed, the overall music tempo seemed to drag; much of the available music for a quality format is naturally slow-paced and the rut is easily widened. Only through careful selection were we able to keep the tempo up in some blocks. We also discovered that many of the people who scream for more classical music don't recognize it when they hear it unless it is announced as such. The original vocal-instrumental ratio has not been increased, since the audience hasn't indicated a preference for it. The early morning program dragged almost from the beginning; therefore, we included more brass than we had originally intended had to use. The mid-morning Bon Jour has taken on, almost without a noticeable push, a distinct European sound, complete with foreign orchestras and a distinctive Mediterranean beat.

The hardest blocks to program turned out to be the quietest and least noticeable—the lunch and dinner hour periods. Since most suitable music has a tendency to sound like background material, we felt it necessary to give each block a distinct sound. We gave each show a different outlook; the noontime show has a light Vienna and sidewalk cafe touch, while the evening block has a quality supper club theme.

Our prime time period was found to be during the evening hours. The Jetstream feature is heavy with the big orchestral sound. We have edged some well-known classical music into this block; it is not announced as classical, so that the classical music hater is not scared away.

Specials and Remotes

No blocks of specialized programming were inserted until the end of the first 6 months, thus giving us time to size up what the audience might want. So far, we have added only three programs—a 2-hour classical show on Sunday afternoon, a 1-hour Broadway show on Saturday afternoon, and a 1-hour Saturday night jazz show.

We have not done as many stereo remotes as we originally planned, primarily because of the manpower and time required. To set up and record a stereo program takes at least two well-trained men and three times as long as a monaural remote. Under current staff conditions, two men sent from the station requires a virtual shut-down of some other operation (and there are 23 on the staff). Response to the two test programs which we did produce was overwhelming, and sharp increase in audience commentary was noticed after each program. This pretty well establishes the fact that if a fairly consistent number of remote programs from several of the major cities in our area were used, it would markedly strengthen our rating.

Music Library

A large basic music library is vital to a program format such as ours, and our initial image could have been improved had we purchased more records at the outset. Also, our plan to reprogram music blocks was curtailed; we had to wait until we had enough music on hand to build our basic blocks for repeat programming. At the end of 6 months, we had hoped to reuse the previous program schedules and start over again, changing only necessary selections. We finally had to settle for a 4-month program package which began in late March. By that time, we had enough material to build without padding. Changes are made only in the case of a record deletion or to insert some new material.

Record procurement was a major problem. After about 6 months, we had obtained records from all but two desired labels. Prices ranged from $.50 to an almost prohibitive $2.50 per album. Before we spent $2.50, though, we made certain that at least 6 cuts would be suitable to our format, and on the $.50 albums we made sure that two cuts were suitable.

Subscription buying can be expensive, even though the cost is only a dollar for each disc. By the time half or more of a proffered album selection is discarded, you quickly have the $2.00 investment per album again. So far, we have found only one company which will trade back unwanted discs. In view of this, we try to make quarterly record orders serve our purpose, except in the cases where we trade unwanted discs. We have also considered trading advertising for records, locally, on a dollar for dollar basis. This method has worked well in larger markets; however, few local agents want to spend that much money in advertising.

Our filing system works well, that is, if all available music is *filed.* In the beginning, we got behind in our filing, and it has only been in recent months that the mass of cards has become a usable fixture. Upon arrival of a new disc, we now mark each musical number according to program block. This immediately separates the selections and keeps the shows sounding as we think they should, as well as reducing programming time considerably. At the same time. discs are assigned to a particular day of the week; all orchestral records are separated into 7 groups, thereby keeping any repeats at least 7 days apart. All incoming music is carefully auditioned to determine its exact sound and how it will fit into a contemplated program.

Records have held up well; some have been used for more than a year, and with the limited number of discs at sign-on, some have had repeated use. Only nominal care is taken of records—no special gloves, cloths, etc. In fact, in all but seldom used albums, the paper liners were discarded shortly after the record went into use. At the suggestion of a California BM/E reader, we are using spray Windex to clean finger prints and other dirt from the record surface. The aerosol spray is used sparingly, then the residue is wiped off with a felt cloth dampened with water. In cases of deep-seated dirt, the chief programmer uses a mild detergent and warm water.

Personnel

We quickly learned that a first class license holder was not necessarily capable of handling the programming part of his duties. During the first year, we lost three engineers and every student operator (full-time university students). Thus, we had to replace the full-timers and add another full-time man. In each case, a salary increase was necessary due to the additional ability required. We had allowed for a certain personnel turnover, but not for an increase in salaries. At sign-on, we had men working 9-hour shifts; this had to be reduced to 6-hour shifts to maintain program efficiency.

In programming, our luck was better. Two part-time programmers were phased out, although some months after we had originally planned. We did have to add a part-time recording engineer to handle necessary taping. Our programmer is an ex-musician who, although he had no radio background, had sufficient musical knowledge to set up basic programming and assume many duties formerly handled by other staff members.

Engineering

When our equipment was purchased, it was what we considered the best available for the money. At that time, however, there was only one recognized stereo console. Availability of professional stereo equipment for studio use was limited; in fact, much of it was still in experimental stages and not yet time-proven.

Our biggest problem has been with our turntables; the production turntables are noisy and the on-air turntables are extremely slow-starting. In addition, they cannot be used for backcueing. Currently, we are considering several new models as replacement units.

Pickup cartridges have been changed three times in an attempt to obtain the response and gain required. It appears that the Shure M44-7 cartridges now in use give us better service and greater life expectancy.

The size of our physical plant is proving to be inadequate; both the downtown production studio-office complex and the on-air studio-

The Management Viewpoint: Sales Success
After 14 months of operation, General Manager L. W. Fleming, Jr. reports that he is quite happy with overall operation of WAJR-FM, particularly with the success of their recent sales efforts. And well he might be! An AM-oriented sales staff has taken the bull by the horns and developed enough accounts to just about "turn the corner." Mr. Fleming indicates that they have attained 25% of their desired commercialization. To accomplish and maintain this, each of the three salesmen must make a satisfactory number of FM sales presentations each week. It's the traditional sales approach; if you see enough people, you're bound to make sales.

The WAJR-FM salesman does not have to rely solely on his wits, however; he has access to a variety of prepared sales presentations, developed by the staff, which point out the salient features of each program segment. From this information, the salesman can tailor his presentation to each specific potential client. Also, a 6-minute recorded sales aid, detailing WAJR-FM's foreground sound ideals, is available for sales use. Thus, armed with the proper sales preparation and enthusiasm (which Mr. Fleming appears to be quite capable of instilling), transmitter location are just about half the size they should be. The programmer and his secretary should have a separate office, as should the FM director. The production studio should be sound-sealed from the office area. Presently, a partial (8′) dividing wall is all that separates the studio from the office which houses all FM employees. Originally, we felt that the production studio would be used only for short periods; however, the FM studio is used as much for AM production work as the regular AM production studio. Consequently, there are many hours when FM office work must be confined to pen and pencil and "silent running."

It is hoped that others contemplating an operation such as ours will profit by our mistakes. It's very seldom that anyone ever started anything of this stature and scope and not wished he had made a few changes in his original plans. Fortunately, most of ours are of a comparatively minor nature.

the salesman can show his prospect how to put advertising dollar to good use.

The WAJR-FM commercial schedule allows a maximum of five spots per hour—before and after the hourly news summary and on each quarter-hour. Major news programs (7-8-12N-4-6), while simulcast with the sister AM, are sold separately. West Virginia Sports Network programs, originated by WAJR, are sold separately on AM and FM.

WAJR-FM's active client list includes two banks, a limestone company, numerous color TV and stereo equipment dealers, two of Morgantown's leading jewelers, and a Cadillac dealer. During the past holiday season, one dealer alone sold 43 stereo combination consoles, which is some sort of record in a town that size. Prior to the existence of WAJR-FM, the area had been at least partially indoctrinated with FM and there were quite a number of sets in operation. Since the advent of WAJR-FM, set penetration has increased markedly and is still growing, according to reports from receiver dealers.

As a further indication of WAJR-FM's growing success, several listeners have complained about commercials, a "brickbat" more FMers would be delighted to get!

Modern Stereo FM Plant

A PROGRAM FORMAT DESCRIBED BY DOUGLAS V. LANE, president of WWDL-FM, in Scranton, Pennsylvania, as "wide middle-of-the-road music" has paid off for the stereo station which covers a good part of the northeast section of the state. The station started quite small in 1964, with a studio and office building of only 800 square feet. Original studio list included only a Gates stereo yard control board, one E-V microphone, two Gates Cartri-Tape II cartridge units. WWDL was 100% in stereo from its first day on the air, the first stereo station in Scranton.

Each year thereafter WWDL added to its programming facilities. And last year the station got a building to house it all properly, with room for any future expansion needed. Designed by Mr. Lane, in collaboration with an architect, the new studio-office plant has 4000 square feet of space with just about everything a "music" FM stereo station needs for effective operation.

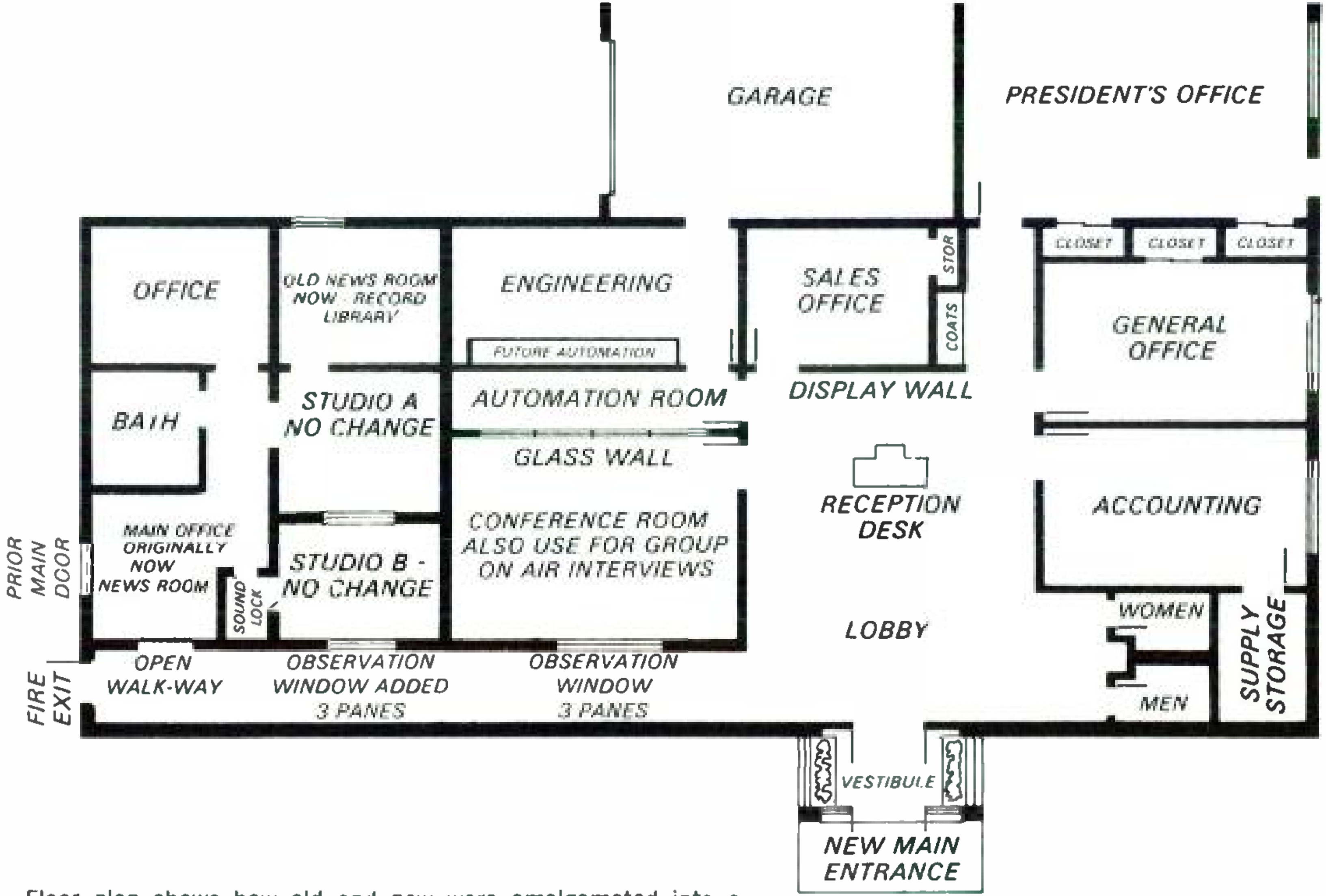
With construction going on around the active studio, WWDL kept construction noise out of the programming by shifting announcers and DJs back and forth to put distance between them and the work crews. Additional "on-air" red signals were put up so that carpenters could avoid hammering or sawing when on top of live mike positions. These precautions succeeded so well that no listener called in to ask what a power saw or active hammer was doing in the music.

The studio line-up now gives high efficiency for WWDL's program format, with most music played from discs, but some current hits on tape cartridges, and some older material on open-reel tape. Gates Stereo Yard console and Stereo Statesman console feed an Audimax 111 AGC amplifier, which feeds telco lines to the transmitter (about two miles away). Gates Criterion stereo record/playback units are in each of the two studios, along with four ITC compact stereo playback units, selected because of low mechanical noise when starting and stopping.

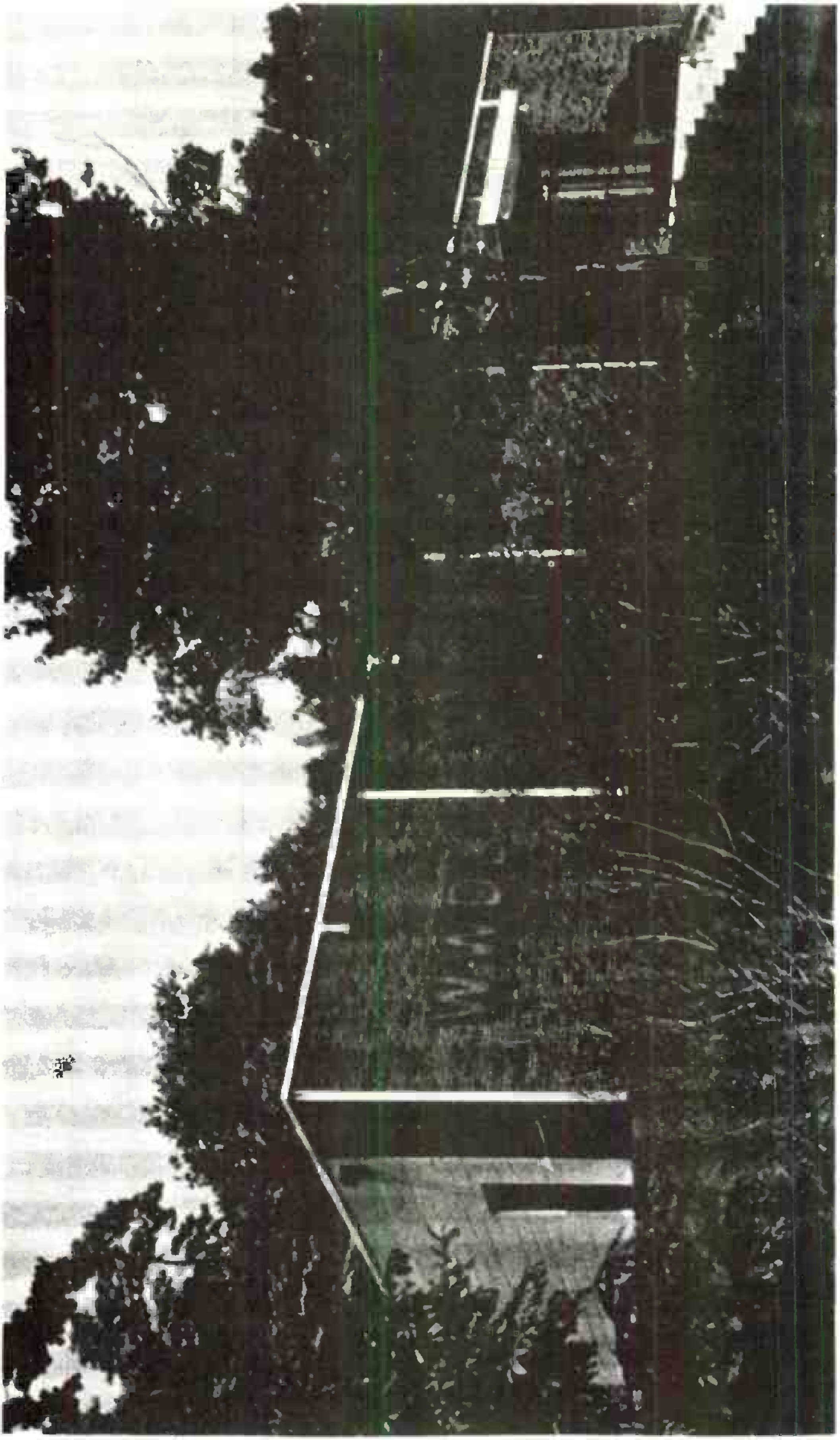
QRK turntables were chosen for flexibility in shifting between 45 and 33-⅓ rpm. Micro-Trak tone arms have Stanton 681-SE cartridges, which have proven to be rugged and easy to cue back. The six open-reel machines include Ampex and Teac models.

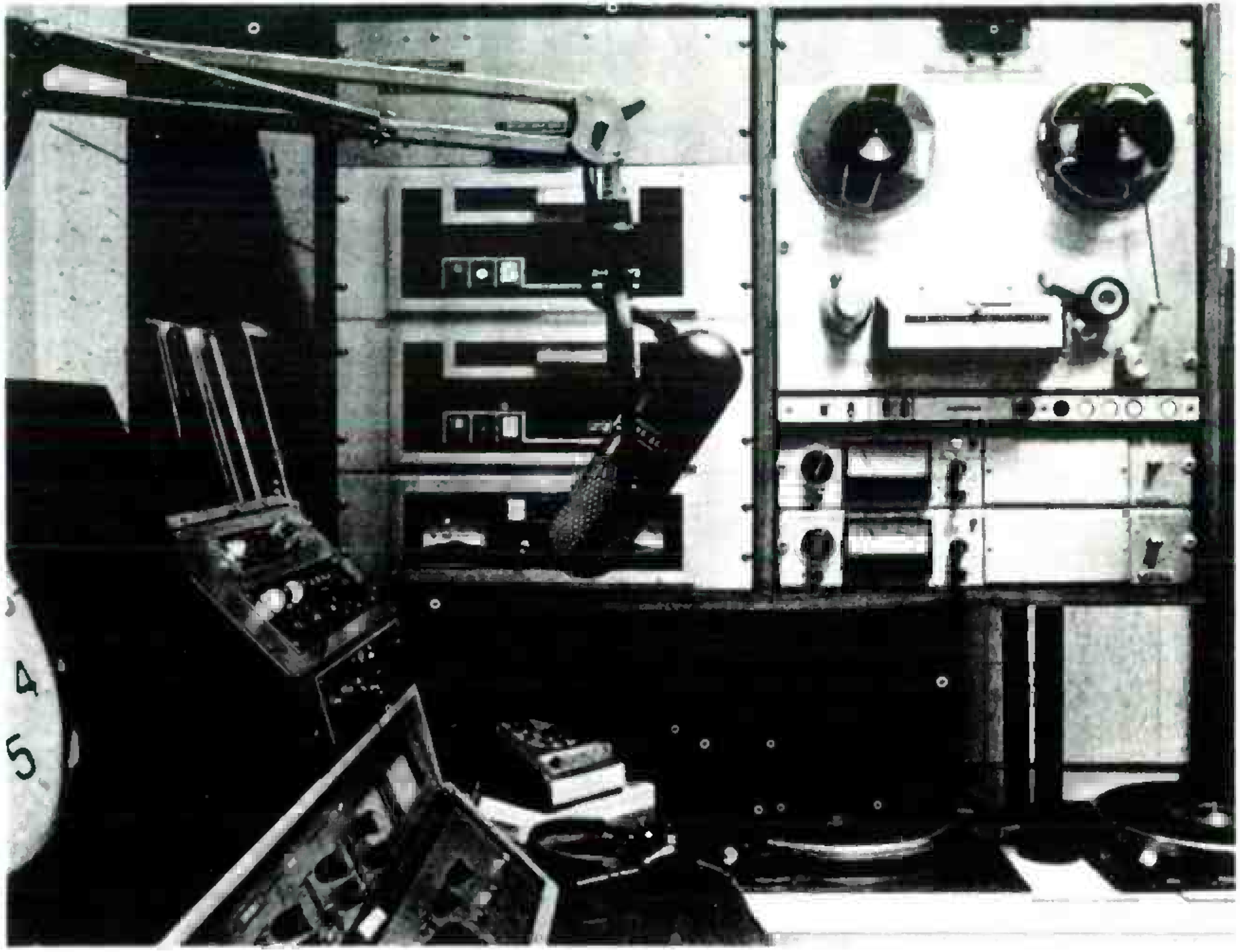
"The announcing staff does not crowd the microphones, and a soft-sell approach is used," says Mr. Lane, "and we have found RCA 770X microphones effective for this approach." McMartin monitors and RF amplifiers are in the main on-the-air studio, to work with a Gates remote control system. UPI audio feeds are handled automatically by the tone-activated control amplifier. Martin book-shelf speakers are used as monitors throughout. An automatic hourly time tone unit was home-brewed from two Singer timers.

WWDL's old building, with 800 square feet of floor space, before the expansion program that incorporated it into the new building.

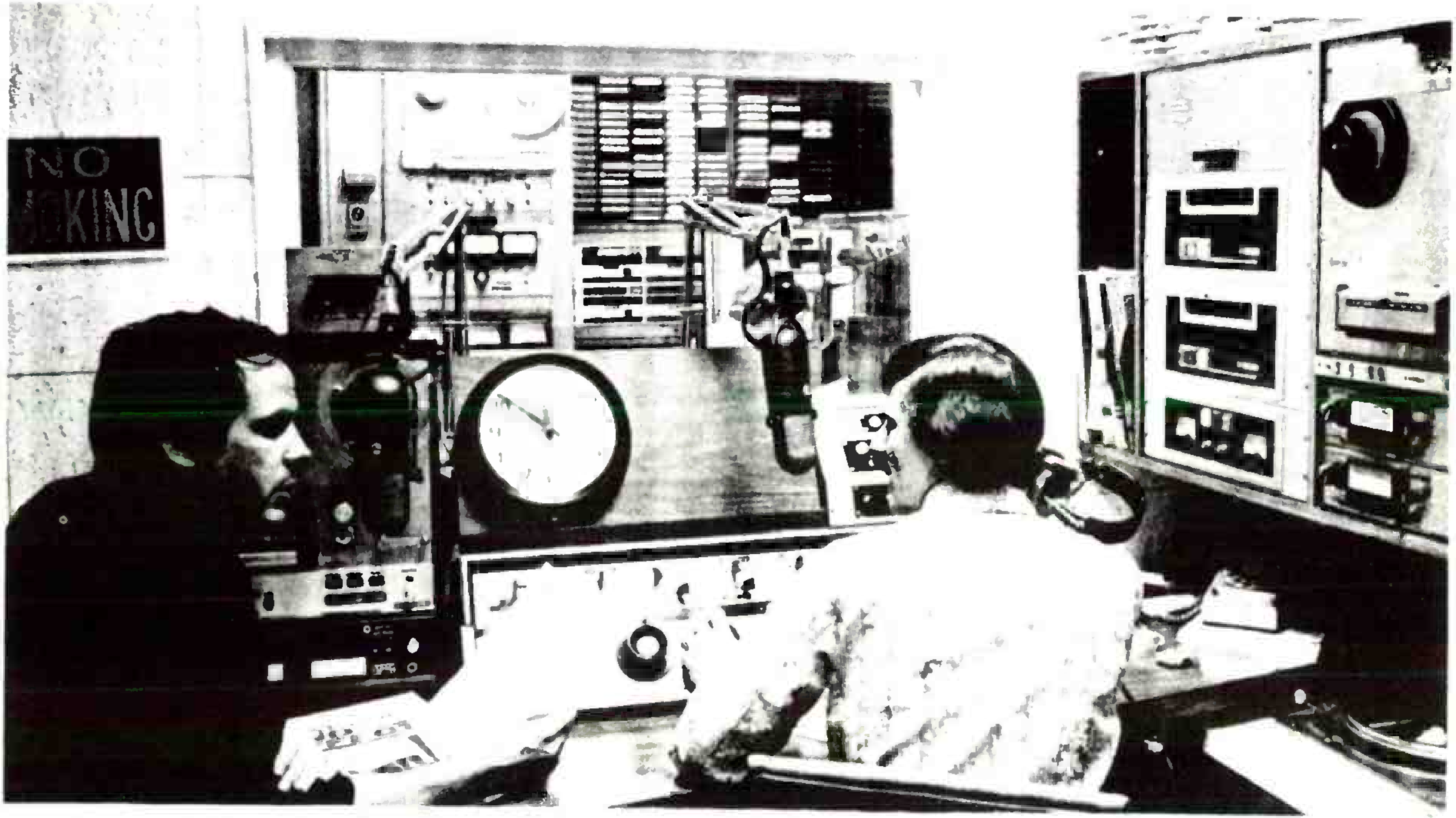


Floor plan shows how old and new were amalgamated into a greatly enlarged stereo FM plant which has everything needed for a successful "wide MOR" music operation on stereo FM.





Close-up shot at disc jockey-announcer position in one studio shows how program origination equipment is all within reach: Gates cart machines, Ampex open-reel tape player, QRK turntables with Stanton 681EE phono pickups, RCA microphones.



Looking over control desk with Gates console, the second studio can be seen through window, with a variety of origination and control units.

Closer shot of second studio shows Gates console, on control desk at right, open-reel and cart tape machines on rear wall. Door to news room is at left rear.

With the studio arrangements (see photos) an announcer or DJ can do just about everything in the programming line without leaving his control chair.

Also in the building are all the offices, the record library, a conference room which is control-board equipped for recording interviews, and a room intended to hold automation and computer equipment in the future, as well as the present engineering office and maintenance area. The building is heated by electricity and has zoned air conditioning.

The transmitter plant, on top of West Mountain, includes a 350-foot tower with single-bay circularly polarized antenna, and an auxiliary antenna on the building. Gates FM-IH3 is the main transmitter, and Gates ISC the auxiliary, which is kept in stand-by at all times and can be put on the air from the studio in about one second.

Emergency transmitter power comes from a Kohler 15 kW unit with propane-fueled generator. A modified stereo Volumax at the transmitter gives adequate peak control. There is also a small emergency studio in the transmitter building.

Concludes Doug Lane: "A well-equipped facility is a vital necessity if an FM station is to serve itself

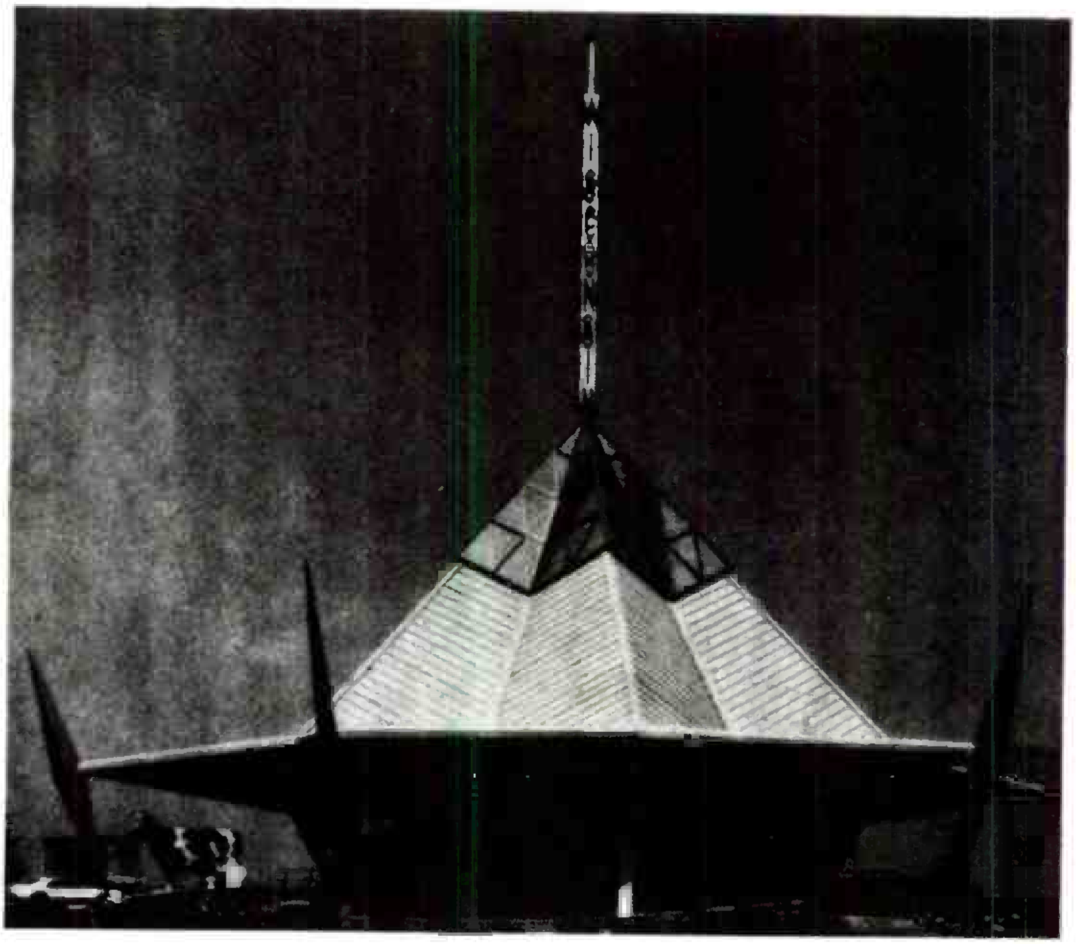
Above is the original equipment set-up at the main control position, shown in its present state in the pictures on the preceding pages. New studio is behind wall at announcer's rear.

and the community well. We have been highly gratified by our recent showing, with ARB surveys putting us frequently number one in the Scranton/Wilkes Barre area, in a number of the demographic quarter-hour shares. Our plant efficiency is an essential part of this showing."

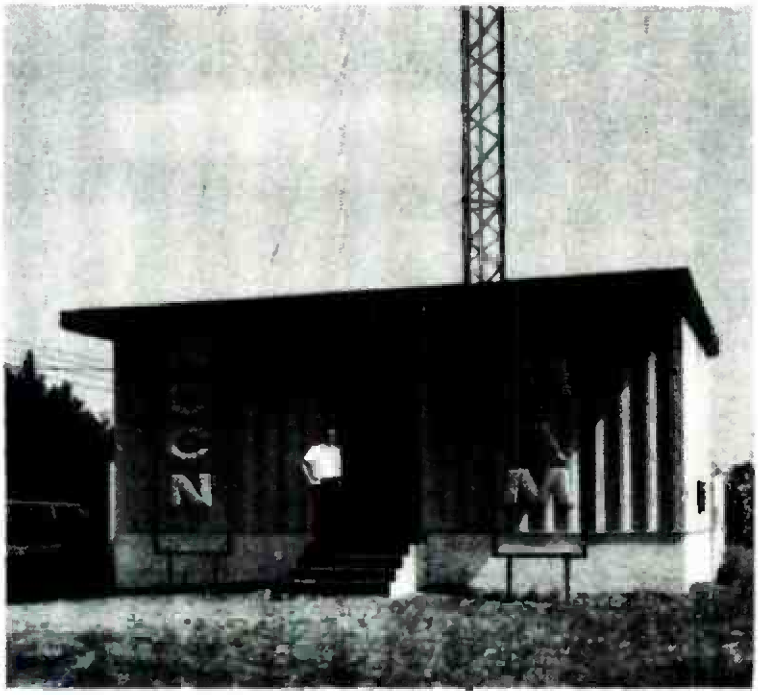
Planning with a Flair

WHAT NEWSPAPERS and newswire services are calling "The Jazziest Looking Radio Station" in Wisconsin, is the building pictured here. The Wisconsin pavilion of the New York World's Fair is now the permanent home of radio stations WCCN-FM-AM in the central Wisconsin community of Neillsville.

Neillsville, a city of only 2750 population, got its first radio stations back in 1957 when WCCN received a construction permit as a 1000-W day-



View of 326-ft Collins 37M-11 a-m tower with isolation coupler in foreground. The 11 bays of fm antenna are mounted at the extreme top of the tower.



Building on Neillsville's north side, made of Bethlehem steel with copper screen under entire floor structure. Arc lamps on roof light tower structure at night.

timer on 1370 kHz, following an enthusiastic free-for-all over the frequency. WCCN settled itself in main floor studios on highway 10 in downtown Neillsville.

Two years after WCCN's beginning, in 1959, they traded their only slightly used Gates 1-kW transmitter back in when a construction permit enabled them to increase power to 5 kW. In 1962, WCCN applied for and got permission to increase their antenna height to 326 feet, which helped considerably to increase the range of the a-m station

In 1963, WCCN lost their 6 A.M. sign-on because of interference on the channel assigned to a Toledo, Ohio station. "We were broken hearted," President Sturtz said, "because we serve a rural area, and when it snows here, you know it!" Bent on doing something about it, WCCN waited for the freeze to lift on fm channels. Neillsville was not included in the FCC assignment of fm channels but immediately petitioned and was granted a Class A channel 288. WCCN-FM went on the air with 3000 W in 1965. The 1-kW Gates fm transmitter was squeezed into the building originally built only for the Gates BC-5-P-2 transmitter.

Without waiting, WCCN then set out to get a Class C channel with 100,000 W of power on fm. An engineering exhibit was submitted through Charles Brennan and Associates, Consultant Engineers in Milwaukee. The exhibit called for moving 9 channels in 5 states, which would in the end give all assignments a similar or same frequency channel and yet WCCN would get channel 298. The FCC accepted the change in assignments and WCCN immediately built on the channel. The new transmitter selected for use was the Collins Model 830-F-2A 10-kW transmitter fully transistorized and with provision for stereo. Much more was done than that at the time, however. Two Gates cartridge recorders were also installed.

A new transmitter building, a most elaborate structure which features an 8-foot concrete base to avoid flooding under any circumstances, was built. The building is bomb resistant, has all under floor wiring channels, features electric heat, and automatic electrically operated ventilators, and is finished with limed oak paneling. Outside, an ela-

The Move in 13½ Hours

On Saturday, April 1st, WCCN-FM & WCCN-AM signed off the air (early) at 7 P.M. instead of the usual 10:30 P.M. Three first-class engineers were on hand: Charles E. Marvin, WCCN chief engineer, Richard Hanneman, chief engineer at WDLB, Marshfield, Wisconsin, and Ray Deitzler from WEAU-TV, Eau Claire, Wisconsin. By 9:30 P.M. the old studio was stripped and the engineers were busy reinstalling it all at the Wisconsin Pavilion. (Already installed was a new McMartin amplifier and speaker system and the new Gates custom built console.) In addition to the three engineers, WCCN had a carpenter, an electrician, and at least a dozen other men who worked at least part of the evening and morning doing the nontechnical chores like lifting, and replacing screws, etc. The entire WCCN staff helped as well as many advertisers.

By 8 A.M. the following morning, WCCN-FM and WCCN-AM were fully operative and ready to go on the air with such accessories as 3 turntables and 2 Ampex 601's already hooked up. The console was completely in operation, and both cartridge tape recorders were working. Some remote lines were not ready, some switching was lacking, and the building monitors, which are a separate circuit, were not in operation until 2 days later.

There was a severe rain storm that night about 1 to 5 A.M., and unfortunately the station couldn't get any audio to the transmitters. Careful checking revealed that lightning had interrupted the telephone loops from the studios to the transmitter. It must have been an unusual circumstance. It has never happened since. But by 8:30 A.M., April 2, WCCN was on the air, 13½ hours after it signed off from the old location. Wire services were available instantly.

borate set of neon-filled call letters that operate by time clock during the evening hours, greet motorists along highway 73, 250 feet away. The fm antenna consists of 11 bays of rings (see pictures). At night, the tower is attractive to motorists passing by and citizens who look north from the city. The tower is flood lighted with two powerful arc lamps that completely illuminate the red and white structure from top to bottom. Cartridge recorders were added to the studio at that time.

Enter the World's Fair

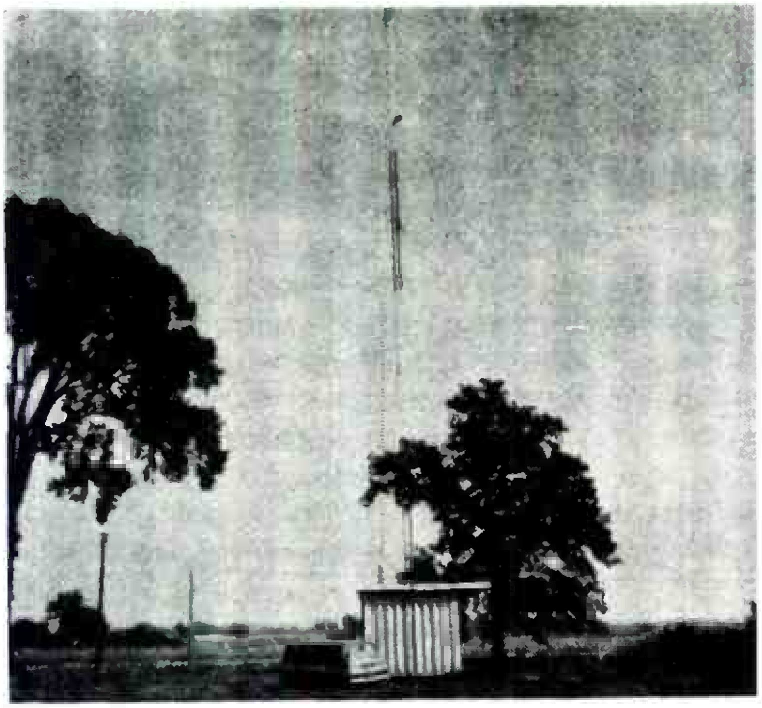
Only months after putting the 100,000 W of fm on the air, WCCN went into another expansion program. President Howie Sturtz II, who explains, "I always get nervous when things quiet down," discovered that the Wisconsin Pavilion of the N.Y. World's Fair had been salvaged by a Boscobel, Wisconsin, blacksmith, Ivan Wilcox. After trucking it back to Wisconsin in 5 semi trucks, Wilcox found that there was no support to reconstruct the building in his home town, so he put it up for sale.

Bidding against 30 other Wisconsin corporations and individuals, WCCN was successful, and on November 15, 1965, they became owners of the one of a kind building of national and international fame. The eye-catching structure was reconstructed on station-owned land and foundation. The reconstructed pavilion has a full basement with the building mounted on 12 concrete piers 18 feet high. The building is approached at the main floor level by bridges over a beautiful rock garden that contains a flagstone walk, pools, three electrically lighted fountains, and wishing wells. The purchase price was $41,000.

There are 5 offices in the finished basement and an engineering room which contains broadcast equipment not necessary to the main floor. Also on this lower level are display cases leased to various advertisers.

Underground out back is the heating and air conditioning plant. The four gas fired furnaces each have their own control zone in the building and each has its own Carrier air conditioning unit. Also in the heating room are the remotely operated dairy display cases, refrigerated compressors, a 400-A electrical service entrance for the building, and 19 time clocks that regulate the maze of lights inside and out automatically. There are 57 spotlights outside alone.

On the main floor, WCCN has two broadcast studios, a main lobby which contains a cheese



Separate 150-ft fm receiving tower has side-mounted Marti and top-mounted type for receiving Farmer's Union On The Air fm network from WEAU, Eau Claire.

In addition to standard studio equipment, WCCN's lineup of gear includes: weather instruments, frequency and modulation monitors, remote control, fm receiver, etc.

house and gift shop and plenty of room for expansion. The main Studio B in which 90 percent of the broadcasting originates features a new custom built walnut finish console with three Gates turntables. The Gatesway console facilitates 3 mics, 3 turntables, 5 recorders, and a patching panel enables many other loops to be brought up to the board. The console also has switches for Mutual Network, the Marti remote broadcast equipment, and fm programs from other stations. A UPI news machine is located on the main floor behind a wrought iron railing. A mezzanine is located above the broadcast studios and contains three administrative offices, with red carpet, and walnut paneling.

The more than 30,000 visitors who have viewed the pavilion since early May enjoy watching the station in action through huge soundproof windows. The walls are 12 inches thick and completely soundproof. Both broadcast studios feature red carpeting as does most of the building. Floor channeling will enable the station to install most any kind of future equipment with never a wire showing. Announcers face the No. 5 fairway of the Neillsville Country Club which borders the station property on two sides.

Another substantial investment by WCCN includes a Marti mobile unit. To make the Marti extremely useful, WCCN purchased a boat trailer and then added a crank up telescoping tower that extends to 50 feet mounted on it. They simply pull into a ball park, or other community function, place the antenna on the tower, extend a pipe to 15 feet, then raise the tower upright and crank it into the air. Back at Neillsville, the signal from the Marti is received by a special antenna atop a 150-foot tower, erected for this purpose. The signal is remarkably clear, and has enabled WCCN to send basketball games back to the station for a distance of 50 miles. Also atop the 150 foot tower is an fm antenna that receives the Farmers Union on-the-air network program at 12:45 noon weekdays. This fixed tuned receiver picks up the signal from WEAU-FM, which is rebroadcast to other stations on the network across the state. A special relay installed by Chief Engi-

Trailer-mounted crank-up antenna facilitates remote operation. Last 20-ft section isn't extended till distance from antenna exceeds 25 miles.

This is WCCN's original Cheesemobile that carried world's largest cheese to the N.Y. World's Fair, and kept the 17¼-ton golden giant refrigerated there for two years.

Financing the Expansion:
President Howard Strutz II's answer:

Our radio stations are located in Neillsville which is the county seat of Clark County. Clark County is an agricultural county, with cows outnumbering people 4 to 1. Nevertheless, we have 32,000 people in Clark County and this is their only daily advertising medium and their only radio station. WCCN-FM-AM did $127,000 volume in billing last year. We do not trade out anything at anytime with anybody, so there is no time trade to add to this.

Financing a project of this size in a city as small as Neillsville is never easy. We were at it for 6 months, all the while the building was under construction (1 year). The final arrangement involved bank-participating loans with 5 banks in the local area each taking a piece of it. The largest participant was Neillsville Bank, and the loans ranged from $70,000 down to $10,000 per bank.

Our loans are for 6 percent simple interest and the financing called for every bit of collateral that was available, even personal holdings, such as home, insurance, cars, etc.

WCCN is owned by Central Wisconsin Broadcasting, Inc., and I, as president, hold 90 percent of the stock. Wayne Grap, secretary and sales manager, owns the other 10 percent. I am 37 now and Wayne is 29 years of age.

We believe (at least I do) that the Wisconsin Pavilion, having been viewed by 13 million visitors who went inside the Wisconsin Exhibit at the fair, is an emblem of the Dairy Industry. We have formed still another corporation called the World's Fairest Cheese and Gifts, Inc. This corporation is branching into the gift cheese business. We started 5 months ago with a cheese and gift shop on the main floor of the pavilion opposite the broadcast studios. We have now completed the design of 21 different gift packages of Wisconsin cheese all under our own label. I should add that jellies and honey and maple syrup are included. We are mailing 25,000 brochures on our World's Fairest Cheese to selected names from more than 40,000 fine people who have visited us these past 5 months.

Financing continues to be our most difficult problem. I would think that we're probably trying to go too far too fast, and we have to forego many projects that we feel are good or important. We hope that through the cheese business we will be able to boast one of Neillsville's largest industries 5 years from now: As industry grows so will radio and we expect to be able to add to our own facilities as we have in the past.

neer Chuck Marvin at the receiver kicks out the fm receiver when the Marti is turned on (which is not, of course, when the network is on the air). WCCN has one car equipped to operate the Marti on battery.

WCCN attributes much of its success in this small community to its complete dedication to serving the local needs of the area. WCCN is at most every worthwhile local event. This year alone, it did extensive remote broadcasting of 4 hours or more from the community celebrations at Withee, Greenwood, Loyal, Alma Center, Granton, Merrillan and, of course, Neillsville. WCCN carries almost 100 local ball games on fm each season—all sponsored.

WCCN broadcasts from 6 A.M. to 10:30 P.M. 7 days a week. The a-m programming duplicates the fm programming during those hours the station is allowed to operate a-m. Sturtz says the future is in the fm. The station has worked hard to get an over 90 percent fm set penetration in this rural market. Farmers have fm radios in their barns, fm radios in cars, and fm portables. The fm set penetration is largely the result of a relentless 2-year campaign of radio spots selling fm sets through local dealers. A participation package was sold to the local dealer, all the fm set sales going to him. At one time as many as 54 dealers on the air were advertising fm sets for sale. The campaign helped get fm listeners and at the same time more than $5,000 in spot radio business was realized from the dealers.

WCCN has a staff of eight, plus maintenance people dedicated to doing what they can for the listeners. Sturtz says. "We carry the 'live from N.Y.' programs (Mutual) on WCCN but we also hunt for lost puppies, cows and rare blood types."

WCCN is a showplace that is proud of its name, the World's Fairest Radio Stations. Sturtz adds, "radio people are always especially welcome here."

Successful FMer Wears Many Hats

Oliver Berliner

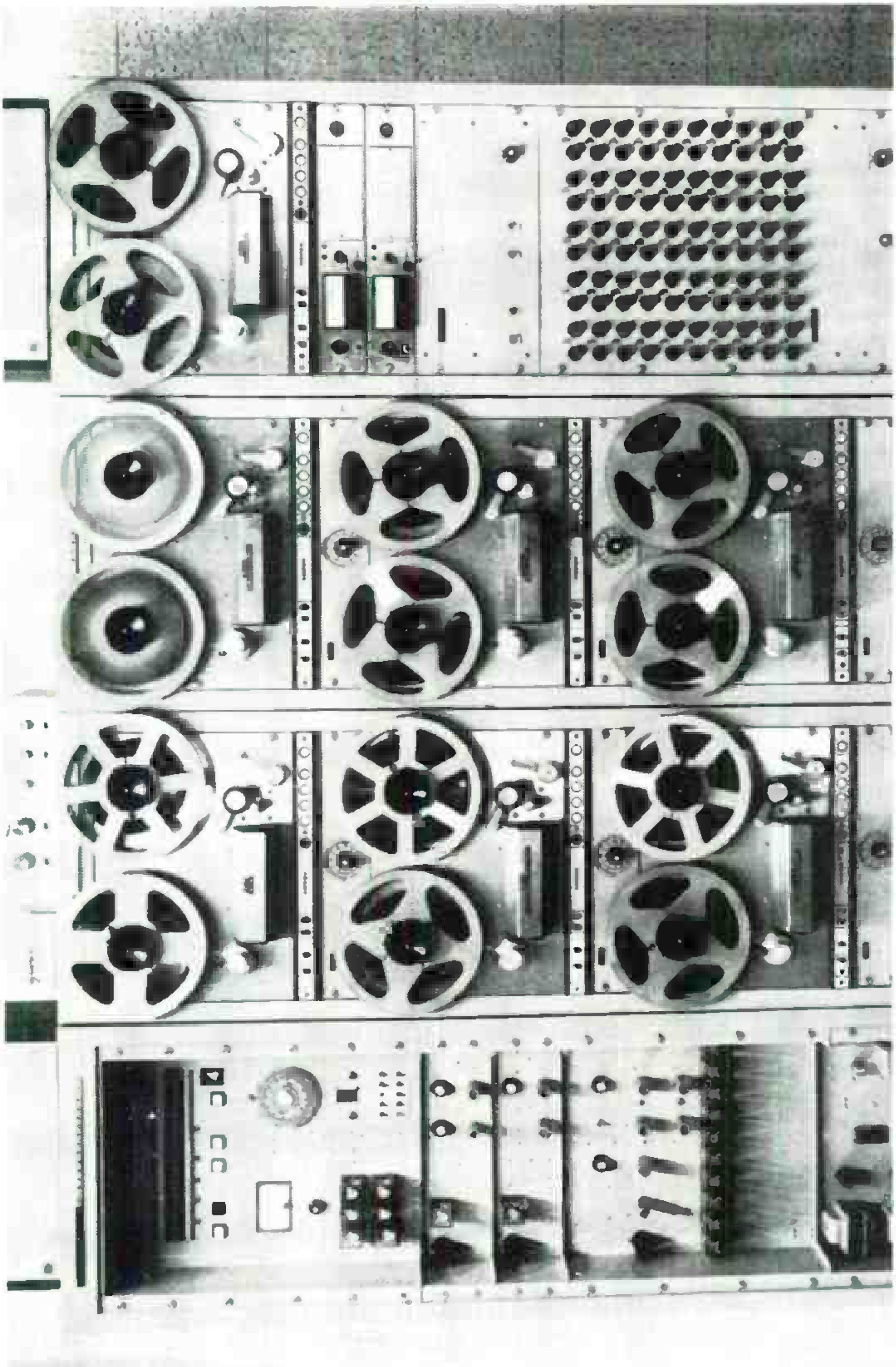
THE MAGIC SUCCESS FORMULA for the fm-only broadcaster can be summed up in two words: imagination and diversification. Sometimes this diversification can go rather far afield from the traditional fm station's boundaries, as in the case of Garden Grove, California's KTBT. A combined business operation, KTBT/Telaudio Centre calls a shopping center its home, and its main transmitting antenna sits in front of the building in a parking lot.

Located five minutes from Disneyland and forty minutes from Hollywood, KTBT/Telaudio Centre complex is actually five separate, allied operations functioning under two distinct companies.

One of the firms is Audio International, Inc., which operates Radio KTBT, a 2-kilowatt fm'er, transmitting 24 hours a day in stereo. In the less than two years that Audio International has owned this station, it has risen from last place among the county's broadcasters to become the pace-setting, most watched and most copied broadcaster in the area. KTBT was the first in the county with dual-polarized antenna for both automobile and home reception, the first to automate, the first to use the latest style fm antenna, the first with a female station manager.

The manager is a glamorous creature named Michelle Danielle, who's garnered more national and local industry and public attention for KTBT than has been given to any other radio station in the country, regardless of size or age.

KTBT was also first in the area to run the famous old *Green Hornet*, *The Shadow*, *The Third Man* and *Lone Ranger* dramas. The station further



Custom-made automation rack covers control room wall.

pioneered with the introduction of the group sales concept for Orange County, permitting an advertiser to make one buy with just one contract for saturation advertising in the entire county. This has simultaneously served to awaken national advertisers to the fact that the chauvinistic million-and-a-quarter Orange County folk prefer local radio to the nearby Los Angeles County stations.

Shared Facilities

Sharing the same location is sister Telaudio Centre, whose four areas of endeavor form a rare but very logical adjunct to the broadcaster. These include: a commercial and consumer audio and video products distributorship; the county's newest and most advanced recording studio; an elaborate mobile television unit available for rental; a television air check service—audio only or audio and video.

The high esteem in which Telaudio is held is illustrated by the fact that it has furnished equipment to keep one of KTBT's competitors on the air; its studios prepare commercials broadcast by all

Well-tanned deejay pretapes his show using Ampex four-track recorder. Show will be aired from automation rack.

Sophisticated custom-built recording console gives KTBT flexibility plus facilities for extra-income recording.

the county's stations; and one of its engineers has more than once provided emergency service for various KTBT competitors.

The building is located in the Orange County Plaza Shopping Center. In addition to KTBT's antenna, the parking-lot tower supports a radiophone antenna and also various uhf and vhf receiving antennas for Los Angeles and San Diego TV stations. The building's physical layout and the responsibility for all facilities design and equipment specification, were handled by SounDesign Engineers.

Just inside the main door is the audio-video products distributorship. The display area is small, but adequate for the limited number of lines handled by Telaudio. The areas of activity are: home, industrial and broadcast video products; hi-fi tuners, amplifiers, turntables and tape recorders; broadcast audio tape recorders; commercial sound systems; accessories and tape for all of these departments. KTBT's Studio A, now used only for production work and some special shows, is also in this area. This permits visitors to get an easy look at the radio equipment from the hallway. The considerable glass area also makes it possible for those in Studio A and in the Telaudio sales office to see any visitors who enter unannounced.

Next down the hall is Studio B control room. Here, a window provides a view of the recording studio mixing console and the KTBT automation equipment. One of the automation racks is located in Studio A for production convenience. The remainder sit on a dolly in Studio B control, which permits the entire assembly to be rolled away from the wall for servicing.

One unusual innovation is the wall of glass between the control room and the studio. It extends from the floor to approximately six feet above floor level. A saloon-type foot rail prevents visitors from leaning or putting their feet on the window-wall.

A small window lets visitors see from the hallway into the studio, but curtains can prevent this if necessary for "closed" recording sessions. These hallway windows give visitors an eyefull while reducing unauthorized and unnecessary interruptions of studio and control-room activity.

A receptionist sits at the end of the hall and has a clear view of the main entrance and the entire hallway.

Near the rear of the building and away from unneccessary traffic is Studio C—the disc-cutting room—where tapes and discs are edited, equalized and dubbed, as needed. In addition, television air checks for clients are made here, which is also possible in the showroom and Telaudio office. Equipment repair is also done in Studio C, where extensive test equipment is available.

Studio B itself measures approximately 18× 32 feet. Its control room is disproportionately large to accommodate the automation system and to allow VIPs to watch sessions from floor level between the window-wall and the operating platform. There are tape and microphone storage cabinets along most of two of the studio's walls. A duct at platform surface level runs all the way from the microphone plug-in panel, past the automation system to the console, console rack and transmitter room and terminates in Studio A. All audio and video lines are easily accessible here.

A conduit links Studio C with Studio B. Very high current ac power lines are provided in Studios

C and B and in the Telaudio display and office areas to accommodate a large number of video tape recorders. Extra ac wiring is provided in Studio B for lights for small television productions. Special ports into the hallway are located in the walls of Studio B and its control room for running camera cables down the hall and out the front of the building for hookup to the Video Tape Mobile.

Video Tape Mobile

This latter service is one of the most exciting of the many facilities offered by Telaudio Centre. The van is a compact, complete mobile video tape recording unit providing broadcast quality at modest rental rates for custom clients such as schools, low-budget TV stations, the military, independent television producers, advertising agencies and industrial accounts. The van, which uses a director and basic crew of three, plus up to three cameramen depending on client requirements, houses a 3-camera video system with all necessary monitoring and processing equipment, broadcast-grade video tape recorder, plus full audio and interphone equipment. In spite of its elaborate nature, the walk-in van is one of the smallest of its type made. Three men (director, video, audio) operate comfortably inside, and it also functions as a mobile unit for Radio KTBT's remote broadcasts. The van is normally parked next to KTBT's tower, where ac power is available for equipment testing and to charge batteries. Since all of the audio and video equipment in the van draws less than a kilowatt, its equipment can be run on a battery/inverter combination.

Planning a 100 KW FM Plant

L. D. Ewy

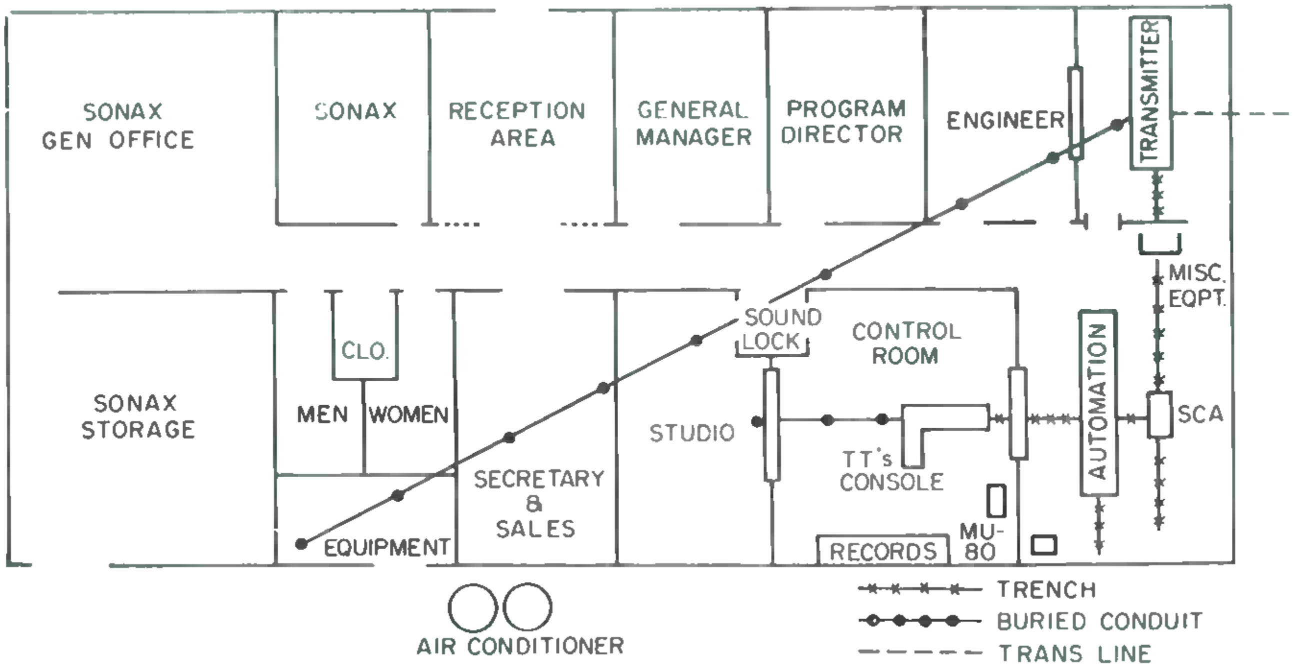
On October 4, 1965, KOFM radio began equipment installation in a new modern building, housing offices, studio and transmitter. Proof - of - performance measurements were completed 40 days later. On November 15, 1965, the station received program test authorization and began regularly scheduled programming. Responsibility for the relative speed in which the 20-kw transmitter, 32-bay antenna (1425' high on TV tower) 10-channel stereo console, SCA background music service and program automation system was installed must be attributed to careful planning.

Planning Motives

The building, designed to encompass the entire KOFM broadcast operation plus space for the Sonax Corp. (background music leasee), is constructed of insulated concrete blocks, poured concrete floors and a flat insulated tar paper roof. During the initial planning stage, tentative equipment locations were blocked-in on a floor plan layout, thereby allowing each individual to visualize the working relationship of each integral part of the operation. In so doing, possible layout errors were eliminated on paper and a flexible and efficient overall installation was achieved.

Offices, control room, and studio are carpeted and remaining areas are tiled. The rather large proportion of partition window area simplifies routine operation and saves a lot of steps. The studio area is visible from the control room, enabling close operator-talent contact. The studio is equipped with mike outlets, monitor speakers, intercom, and a large table and chairs.

The transmitter is visible from the engineer's office/working area, allowing transmitter obser-



Floor plan provides step-saving efficiency and room-to-room equipment visibility.

vation during the time this office is occupied. The automation system, transmitter, and rack equipment are visible from the audio console position. Because we wanted to create a good impression with a visiting client or a casual visitor, the reception area received special attention with lounges, floral decor, and contemporary lighting.

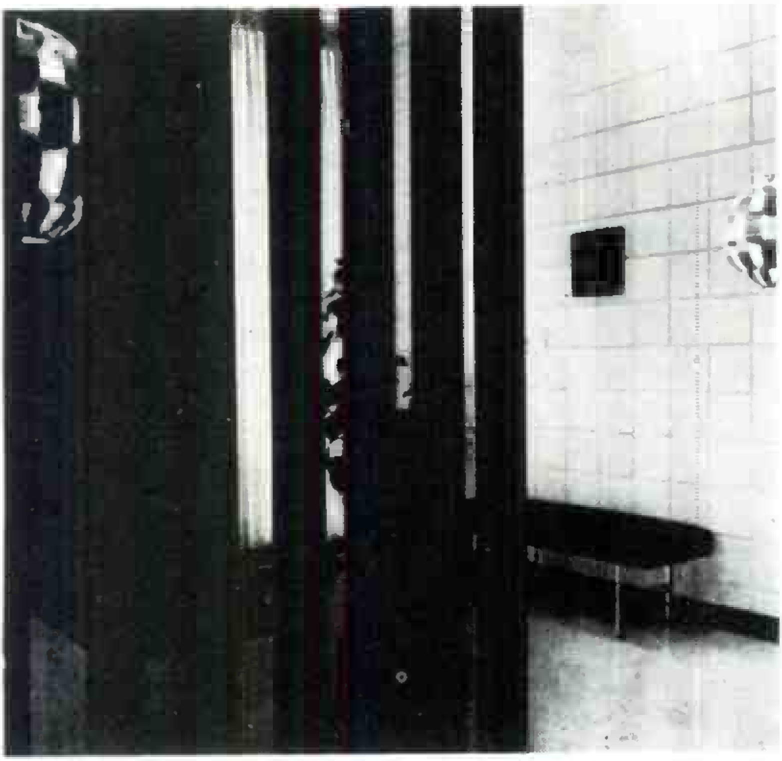
Construction Procedure

Work on the control room was started first. The audio console and recording facilities had to be completed so music tape library production could be started. All audio wires and RF cables were labeled and logged as to origin and termination as work progressed. Needless to say, left and right audio channels must be distinguished and polarities observed. Also, high, low and medium level audio circuits were carefully isolated.

We decided to eliminate the typical studio patch panel and tie all audio inputs directly to the console. This was done to minimize operational errors. However, all major equipment inputs and outputs and those convenient for proof-of-performance measurements are normalled through a patch panel. Before rack installation, the patch panel and associated terminal block was assembled on a jig. This method proved very convenient and error-free.

Due to the cost of running primary cable, AC power to the transmitter runs through a 3" conduit buried beneath the floor and terminates in the trench beneath the transmitter (see floor plan). A ¾" conduit is imbedded in the floor between the control room and studio to allow for further expansion. A ¾" conduit also runs from the trench near the console to the control room ceiling and is used for audio distribution to monitors, cue speakers, intercoms and on-air lights. Conventional trenching accommodates cabling between the transmitter, automation system, subcarrier operator and console.

The automation system with its accompanying pre-cut and labeled audio and control cables was easily assembled. It was squared away over the trench, and AC was run to complete this portion of the installation. The transmitter is also installed over the wiring trench and is cooled by filtered air brought in through a 24" inlet cut in the outside wall to the rear of the



Modernistic reception area greets the KOFM visitor.

Uncluttered control room environment advocates efficient production from record and tape sources as well as live pickup from the adjacent studio.

transmitter. A metal hood, with an exhaust fan, was fabricated and placed over the transmitter. A ground buss, terminated at the water well, provides a common ground for equipment.

Antenna Mounting

It was decided to sidemount the KOFM antenna on KOCO-TV's tower with the very top of the antenna at or near the top of the supporting structure. However, design analysis by the tower manufacturer showed that excessive loading would result unless the added torque was eliminated. Consulting Engineer Robert Silliman came to the rescue with a solution of mounting the antenna in a manner creating 0 torque.

We anticipated some trouble in mounting the power divider to these specifications, due to the existing elevator cables, transmission lines and tower members. By careful measurements and plotting at ground level we determined the least trouble-free method of mounting the power divider and routing the feed line. The top of the horizontal antenna is mounted at 1425′. The transmission line is 3″ heliax, wrap-locked to a tower leg every 6 feet. The VSWR is down to a low 1.02, due to the absence of sharp bends in the line and a short 30-ft. horizontal run with a sweeping 90° turn up the tower.

The antenna's 16 horizontal and 16 vertical bays are interspaced and modified for 6° beam tilt and null fill. 100 kw ERP is radiated in both horizontal and vertical polar planes. We have not yet completed field strength measurements, but we have had consistent omnidirectional reports from 120 to 180 miles. Skips to Calgary (Canada), Omaha, and Sioux City have been reported.

Programming & Operation

Upon completion of the installation of control room equipment, the program director began recording music for our tape library so that a sufficient number of tapes would be on hand at sign-on. The MU 80 portion of the Automator was utilized for this purpose. On tapes intended to program the bulk of our day, various musical styles are blended in accordance with our format. Highlighting our program schedule are specialized programs catering to the tastes of classical, folk, and jazz devotees.

KOFM Equipment

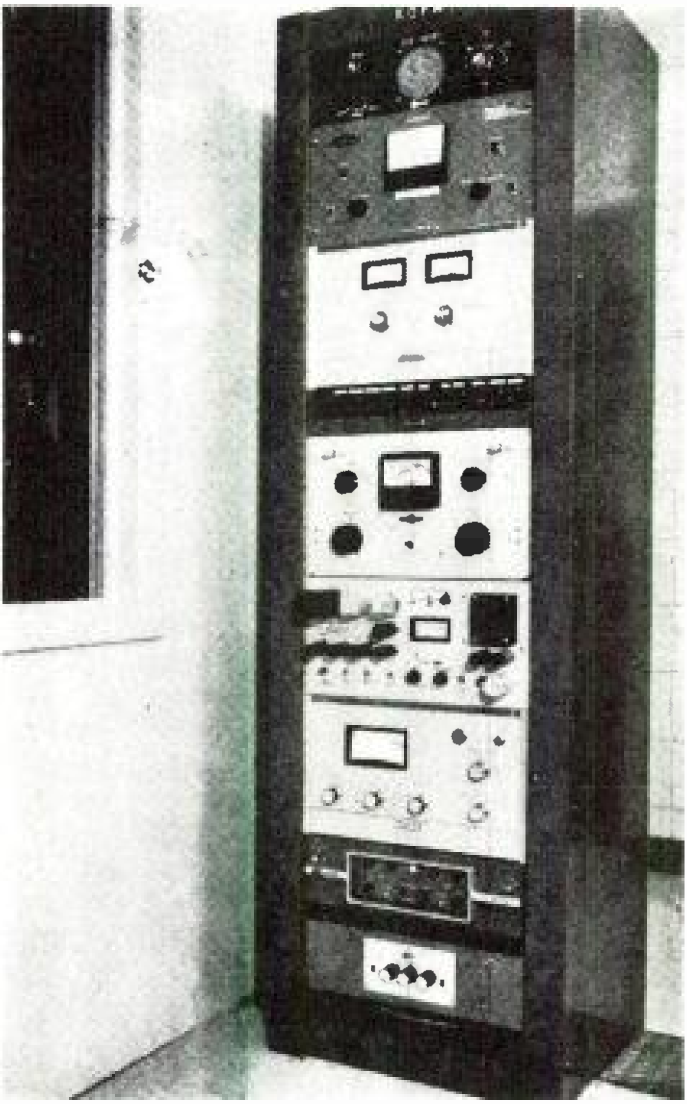
Collins 830 H 1A 20-kw transmitter
LTV multideck tape transport
Collins antennas
Schafer automation system including:
—Schafer CU-8S control unit with remote control
—6 Ampex PB-351-2 decks
—Audio clock and 2 Ampex PB-351 (time announcer)
—SA 100 commercial spotter with M-50 memory unit, remote controls and Ampex 354 deck.
—MU 80 make-up unit with remote controls and Ampex 351-2 decks.
—2 Crown Series SS 800 program recorders with monitor alarm unit.
Moseley Model SCG-4 SCA generator
Gates Executive audio console mounted on 36" by 84" desk top with double and single turntable pedestals.
2 Gates turntables equipped with Shure SME Series 11 pickup arms.
Shure M 44-7 cartridges
McIntosh C22 preamps
Gates Playback Cartritape
Gates Playback and Record Cartritape with remote controls
Sony Model 77-4 tape deck with remote controls
Sony Model C-37A condenser microphone
Neumann U-67 condenser microphone
Gates Top Level limiter
Collins 26U1 limiter
Collins 26U2 limiter
McMartin TBM 3000 frequency meter
Collins 900 C-1 modulation monitor
Miratel E.B.S. monitor
Horizontal—37M-16 with .6° beam tilt and null fill
Vertical—300-16 with .6° beam tilt and null fill

Several innovations, designed to increase operational flexibility, were incorporated into our installation. A high impedance audio bridge was installed at the audio output of the Automator and fed to a separate pot on the console. This enables us to fade and integrate certain program elements from the Automator during live periods. A bridge was placed on the remote-controlled spotter, allowing any announcement on the spotter tape to be played back through the console during live operation. Also, spots recorded from the console can be auditioned. The same bridging technique was applied to the MU

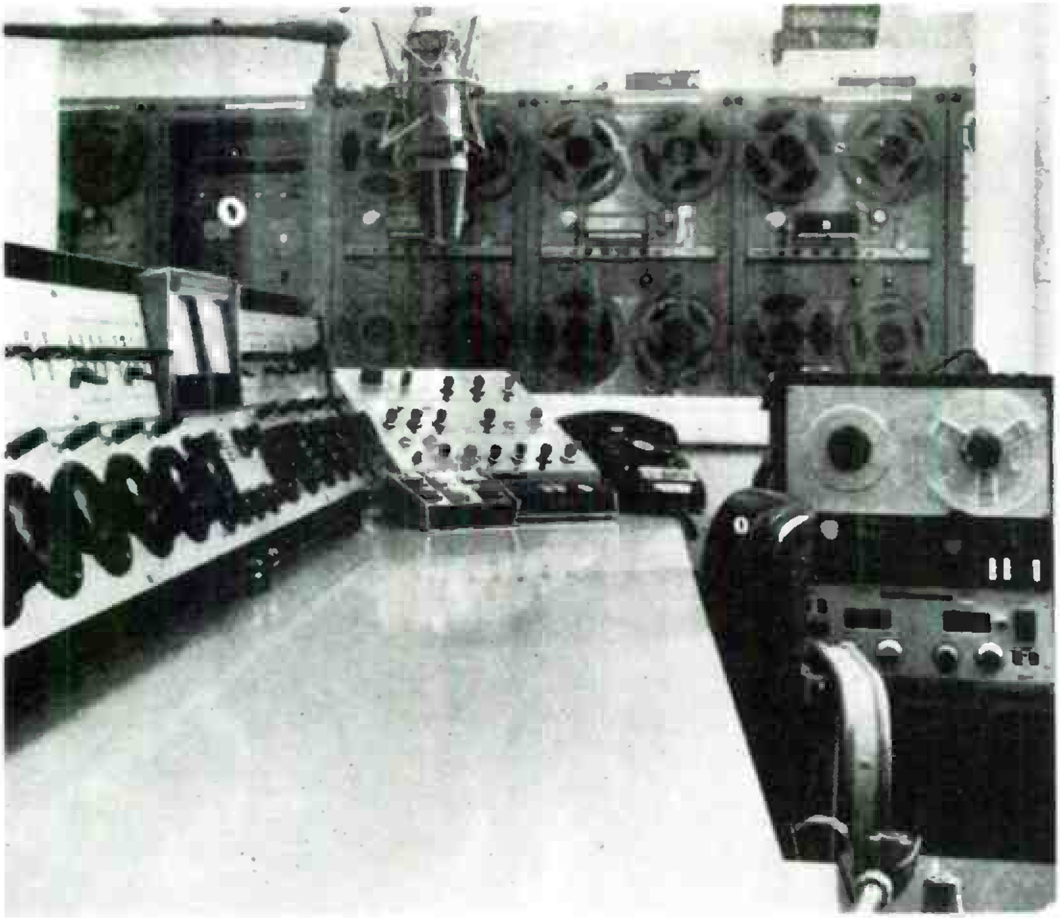
80 make-up unit and #5 playback deck to assist in dubbing.

Since we wanted to be able to go live from the console at a moment's notice, an audio relay was installed to interrupt the Automator's normal feed to the transmitter. By the simple flip of a switch at the console position, live or automated feeds can be selected. The audio console and automator were both adjusted for equal output of 8 VU. The spotter containing commercials and promos, the complete Automator, the MU 8, are all remote controlled with audio appearing at console inputs, and can be used during live operation.

To provide a positive off-the-air alarm, a system utilizing the modulation monitor, program



Audio processing, monitoring, and accessory equipment rack is located adjacent to transmitter room door over wiring trench.



Convenient automation system, turntable, and tape recorder remote controls on the operator's right simplify periods of live programming as well as production.

logger, and the monitor alarm was designed. The program logger is fed a mono signal from the modulation monitor. The audio output of the program logger controls the monitor alarm. In this manner any audio interruption of 40 seconds duration anywhere in the entire system will activate the alarm.

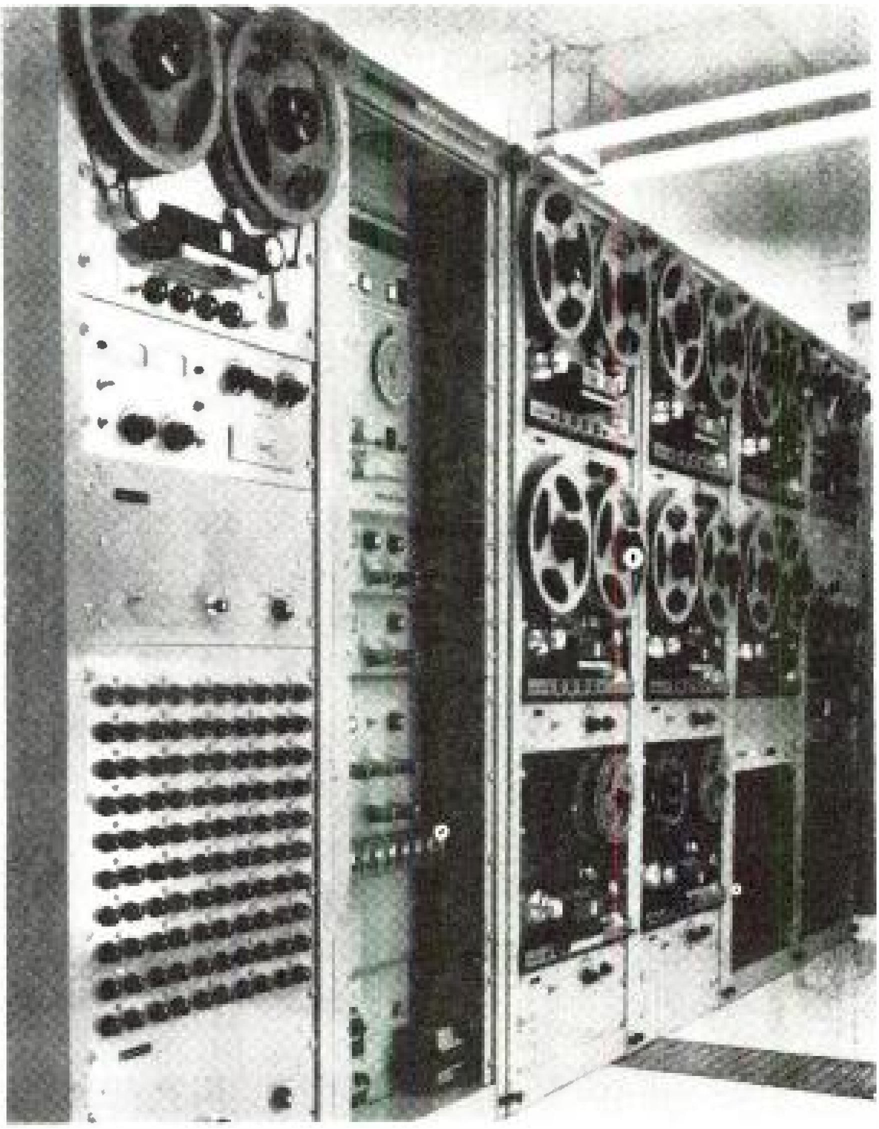
Turntable start and stop functions are remote controlled from the console by a momentary contact switch which energizes a latching relay. Our operators like this convenience.

A left- and right-channel audio feed is taken from the modulation monitor and fed to a spare position on the audio console monitor. This enables the operator to monitor the off-air signal. Stereo audio feed for building monitors is provided by an inexpensive stereo amplifier with an added isolation transformer bridged at the modulation monitor output. Three pilot lights, mounted in a small "mini box" near the console, notify the operator of an EBS alert, overmodulation and an off-the-air condition.

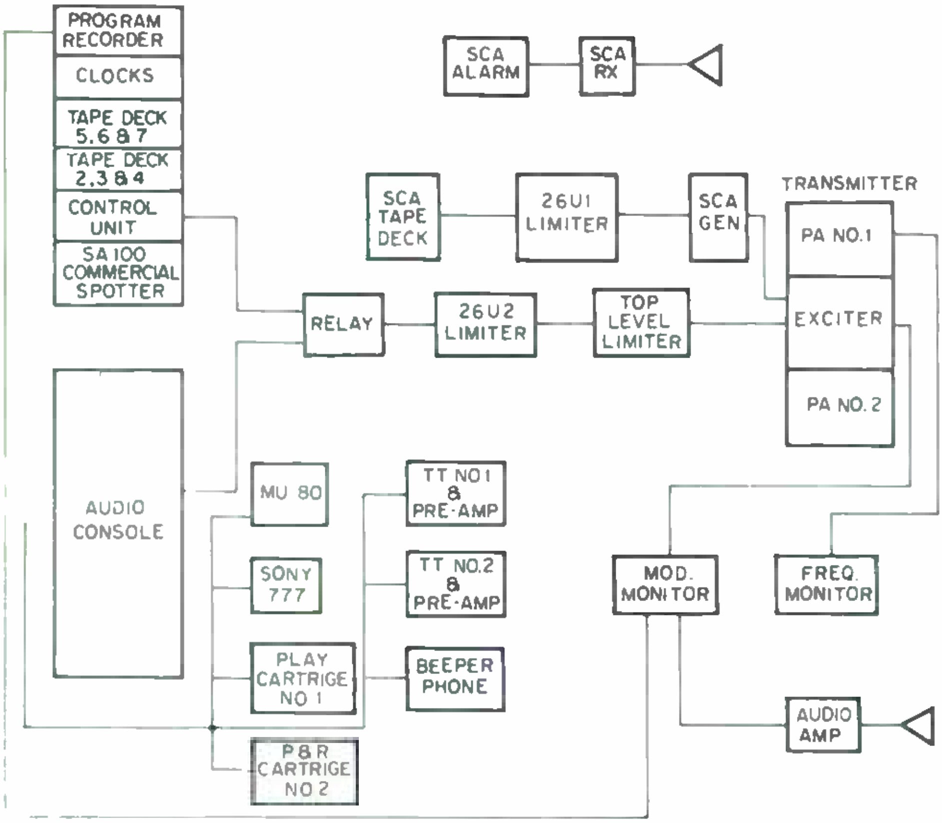
Eliminating the "Bugs"

There was the usual run of equipment malfunctions: noisy resistors, temperature-sensitive tape transport capstan speed, two transposed black wires, loose and unsoldered connections and miscellaneous problems. A prompt call to the equipment manufacturer proved to be a great asset with unfamiliar equipment. Often, they have had the complaint before and the cure is on the tip of their tongue.

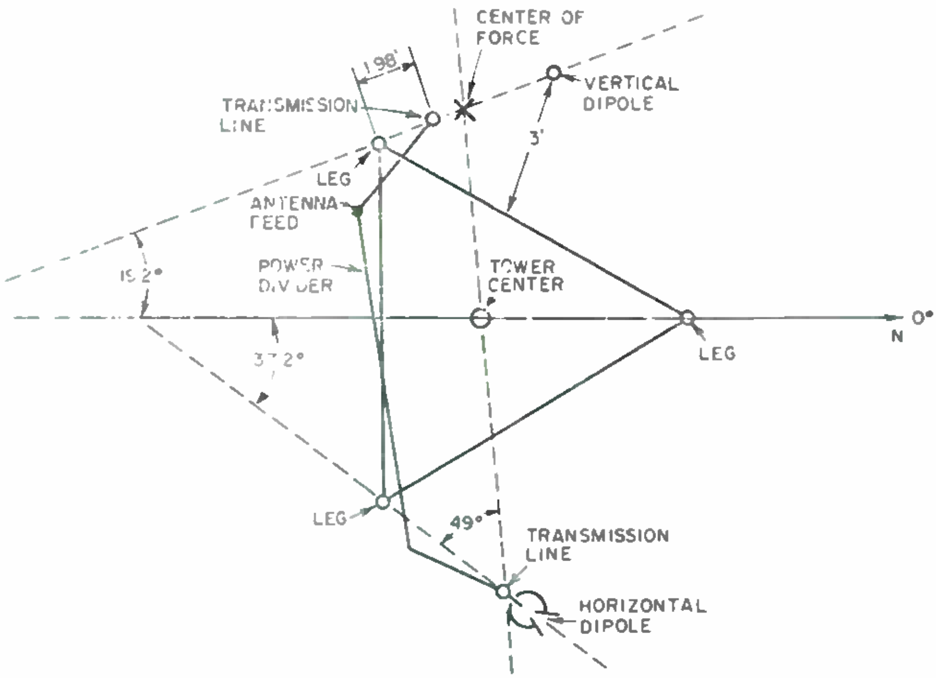
Main-channel modulation was a source of trouble initially. Due to FCC required 75 usec pre-emphasis in the transmitter the high audio frequency content created objectionable cross-



The Schafer automation system is used for major program segments but may be immediately interrupted for live operation. SCA generator is located directly behind the automation gear.



Block diagram shows inter-equipment wiring.



TV tower cross-section shows FM antenna and feed line mounting.

talk at high modulation levels. This was remedied by lowering the main channel modulation. Later, in order to raise the modulation level, a frequency sensitive 2-channel limiter was installed ahead of the transmitter at the output of the conventional stereo limiter. This minimized our crosstalk problems and normal modulation levels were obtained. However, since variable equalized turntable preamps were used, we have to be very careful to not add any excess treble boost during live recording (our decks are flat within 2 db to 15 kc) or the purpose of the frequency-sensitive limiter is defeated.

To achieve the "best in town" audio fidelity in the SCA system, we encountered and solved numerous problems. There is an audio pause of approximately 10 to 15 seconds between music selections on the SCA music tape. It was decided to mute the subcarrier generator during these pauses to completely eliminate all traces of crosstalk. Muting the SCA system created two more problems:

1. If the squelch control on client receivers was advanced too far, a very objectionable "splat" occurred as the RF carrier was cut off. To correct the problem, the squelch was adjusted to the very edge of carrier reception and then advanced about 10°. This eliminated the splat and carrier cutoff can not be detected.

2. The line feeding the generator must be absolutely quiet. The preamps in the tape deck must be hum-free and correspondingly quiet, otherwise the SCA generator muting circuit would interpret this as audio, resulting in erratic muting.

After a few SCA equipment failures an alarm was constructed and installed. It is bridged across the output of the SCA receiver normally used for monitor feed, and is designed so that it takes about a 6-minute loss of audio before it rings. This delay was necessitated by the long leader tape at the beginning and end of each reel and the accompanying loss of audio.

The pre-emphasis circuit in the generator was clipped out for better modulation control. This did not lower the fidelity and supresses out-of-band emission. These steps remedied our SCA problems, and as a result, many customers are now enjoying a low cost background music service.

The construction of KOFM reaffirmed the importance of careful planning. We not only completed the job in a minimum of time, but continue to benefit in daily operating efficiency and convenience. By adhering to the manufacturer's recommendations, our program automation system produces the "live" sound we desire and also affords an instantaneous live operation capability.

Improve FM Coverage with Dual Polarization

Harry A. Etkin

FM stations radiating a horizontally polarized signal experience a definite loss in transmission effectiveness because of the vertically polarized whip or line cord receiving antennas used with many modern FM sets. Transmission of a vertically polarized signal, in combination with a horizontal signal, will considerably improve coverage of the authorized service area. The advantages of a dual polarized FM antenna system are:

1. Increased signal pickup by vertical car whip antennas.
2. More signal into home FM receivers with line cord and built-in antennas. (These antennas are widely used in console FM combination radios.)
3. More signal into transistor portable FM receivers with whip antennas.
4. Increased signal level in the null areas of the horizontal antenna.
5. Improved reception in multipath areas; more listeners in hilly terrain.
6. Improved reception of monaural, stereo, and SCA signals.

This article will provide the FM broadcaster with detailed electrical and performance characteristics for the proper installations of a dual polarized antenna system.

Technical Considerations

The addition of vertical polarization is not a cure-all in providing increased coverage. In some cases the addition of vertical antennas will not increase signal in a deadspot for the horizontal system. Vertical radiation will

Fig. 1. Basic folded dipole.

not cure the multipath effect, but used in conjunction with the horizontal system, improved reception in areas with multipath problems often results. The dual system also does not increase signal pickup of a horizontally polarized receiving antenna.

Broadcast engineers should note that operation of both types of antenna systems does not degrade the horizontally polarized ERP when the vertically polarized antenna is installed. Existing FCC Rules authorize radiation of the same amount of power in the vertical mode. For example, a Class B station having a 10-kw transmitter and a 4-bay horizontally polarized antenna with a gain of 4 will radiate a horizontal ERP of approximately 30 kw. A vertical antenna system could therefore radiate an equal 30 kw in the vertical mode.

Horizontally polarized vee, ring, and circular shaped radiating antenna elements have earned an excellent reputation, and their technical characteristics are well known. The vertically polarized antenna is basically a folded dipole, usually constructed of copper tubing or transmission line copper (see Fig. 1).

These dipole elements, or bays, are spaced approximately one wave-length apart. The bays in some makes of antenna are then fed in phase along a transmission line that will support from one to sixteen elements connected in parallel. The impedance of each dipole is made greater than the transmission line impedance by the number of elements. Thus, the input impedance of the antenna must be 50 ohms to match the transmission line impedance following the standard Ohms Law formula for parallel impedance ($1/Zin = 1/Z_1 + 1/Z_2 + \ldots\ldots 1/Z_n$).

The standard FM antenna is a modified half-wave horizontal dipole. Fig. 2 shows the horizontal radiation pattern, the typical figure 8. According to the position of the antenna it is possible to radiate a signal which is either vertically or horizontally polarized. When the dipole is horizontal, the signal is horizontally polarized; when the dipole is in a vertical plane the radiated signal is vertically polarized.

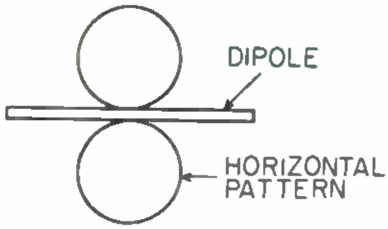


Fig. 2. Pattern for a half-wave horizontal dipole.

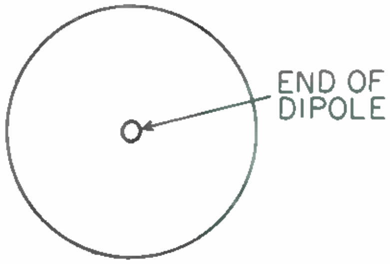


Fig. 3. End view pattern of a half-wave horizontal dipole.

To produce a circular horizontal radiation pattern, the most common antennas in use today are the circular ring and vee type. These antennas will radiate a uniform omnidirectional circular horizontal polarized pattern. The circular dipole is usually end-loaded to provide a more uniform current along its length. The appearance of the radiation pattern, when viewed from an end of the dipole, is shown in Fig. 3. The circular or ring antenna is simply a folded dipole bent in a circular shape, which gives a circular horizontal field pattern. The vee antenna is a folded dipole formed into a truncated vee shape. As the number of horizontal bays is increased, the vertical radiation beamwidth is decreased or "squeezed down." To step up the vertical radiation pattern, vertical antenna elements

FCC RULES ON DUAL POLARIZATION

The FCC Rules and Regulations, Volume III—January, 1964, Part 73—Radio Broadcast Services, designates in Paragraph 73. 310 FM technical standards that the definition for effective radiated power is as follows:

> The term "Effective Radiated Power" means the product of the antenna power (transmitter output power less transmission line loss) times (1) the antenna power gain, or (2) the antenna field gain squared. When circular or elliptical polarization is employed, the term "effective radiated power" is applied separately in the horizontal and vertical components of radiation. For allocation purposes, the effective radiated power authorized is the horizontally polarized component of radiation only.

It should also be noted that Paragraph 73. 316, Antenna Systems, sub-paragraph (a) specifies that:

> It shall be standard to employ horizontal polarization; however, circular or elliptical polarization may be employed if desired. Clockwise or counterclockwise rotation may be used. The supplemental vertically polarized effective radiated power required for circular or elliptical polarization shall in no event exceed the effective radiated power authorized. The rules therefore provide that the amount of power authorized for horizontally polarized radiation may also be radiated in the vertical mode. Under Paragraph 73. 257, FM broadcast stations are required to apply to the FCC for a construction permit, requesting authority to install a vertically polarized antenna as addition to the existing horizontally polarized system.

must be used in combination with the horizontal elements.

Using a half-wave dipole in the vertical mode, the horizontal becomes the vertical and the radiation pattern is circular, like the doughnut pattern in Fig. 4.

Installation Details

There are three basic configurations to be considered in the installation of dual polarized antenna systems. The first, shown in Fig. 5, is the stacked arrangement, with the horizontal elements mounted above the vertical elements. Notice that the center of vertical radiation is lower than the center of horizontal radiation. A large tower section must be used for mounting the complete antenna system.

The second method, shown in Fig. 6, is the "back to back" mounting, which distributes the weight of the dipoles equally. The vertical antenna elements are mounted on one side of the tower and the horizontal elements on the opposite side, at the same height above ground.

The third method is interposing or interlacing. This system of mounting places the vertical antenna in the same plane as the horizontal antenna with the verti-

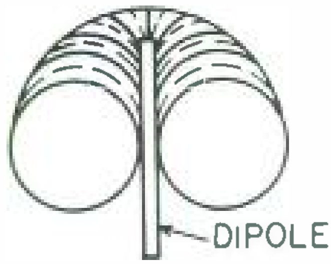


Fig. 4. Pictorial radiation pattern for a vertical dipole (doughnut pattern).

cal elements between the horizontal antenna sections (see Fig. 7). Notice that less tower mounting space is required than for the stacked system in Fig. 5.

Interlaced or Interposed System

Of the three described mounting methods, the interlaced or interposed system is the most effective in improving the station's coverage area. In this system the pole mounted antenna does not affect the pattern circularity.

Back-to-Back System

Some engineers prefer the "back to back" system, since this arrangement tends to balance the pole or tower load distribution. However, because the vertical and horizontal elements are facing in opposite directions, the horizontal pattern distribution of their respective signals may be affected.

Stacked System

Many recent installations are of the stacked antenna type. These are popular because advantage is taken of the existing FM horizontal antenna. The vertical antenna bays are usually installed directly below the horizontal bays.

The difference in height of the antenna elements in the stacked configuration may affect the line of sight distance to the horizon. When tower-side or tower-leg mounted, the antenna pattern will be somewhat affected by the supporting structure. The extent of deviation from a circular pattern will vary with the type and size of the structure.

Power Distribution

Since normally one transmitter feeds both antennas, the recommended type of installation is a single transmission line from the transmitter output to the antenna. Therefore, to operate with the same horizontal and vertical ERP, a power divider or splitting "tee" with a power division ratio of 50/50, 60/40, or 70/30 can be used to feed both the horizontal and vertical assemblies (see Fig. 8). An adjustable transformer may be used between the power splitter and the antenna elements to adjust for proper matching and power distribution.

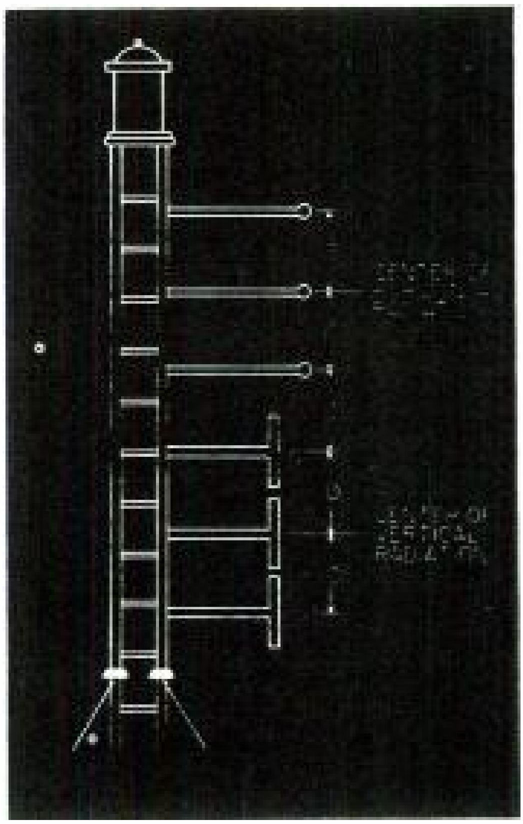


Fig. 5. Drawing of stacked dual polarized antenna system.

As noted previously, the maximum allowable ERP of vertical polarized radiation is limited to the licensed horizontal radiated ERP power. The power available to the antenna can be determined by multiplying the transmitter power output by the transmission line loss (efficiency). For example, the total available power of a 10-kw transmitter is equal to 10 kw (transmitter output) multiplied by the transmission line efficiency of 90%, the result is 9 kw of available power. If the horizontal polarized antenna is a 3-stacked array with a gain of 3.0, and the station's licensed ERP is 24 kw, then the transmitter will be operating at less than full power output of approximately 8.0 kw.

Since the total available power is 9 kw and we want to operate with same horizontal and vertical power, using one transmission line, we must use a 50/50 power split to feed 4.5 kw to each antenna. A 6-bay horizontal polarized antenna with a power gain of 6.3 would be required to obtain the licensed ERP of 24 kw with a power input of 3.8 kw for each antenna feed line.

If a 6-bay horizontal polarized antenna is used, a 5-bay vertical polarized antenna should be interlaced between the horizontal elements. One manufacturer's vertically polarized antenna has the same gain as their horizontally polarized elements; thus, an equal number of horizontal and vertical bays may be used. The vertical polarized ERP for this combina-

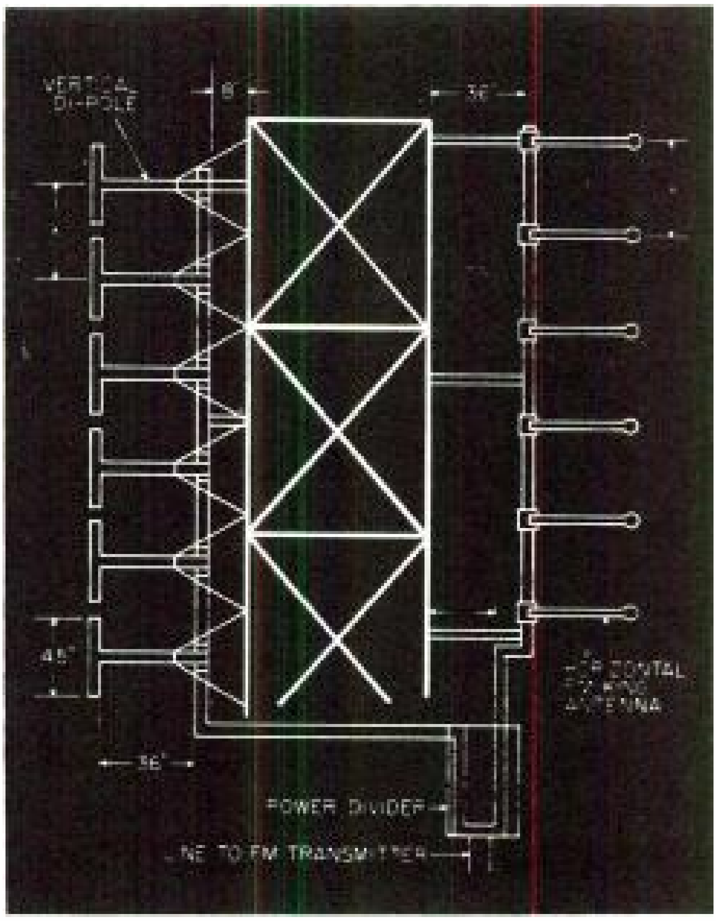


Fig. 6. "Back-to-back" dual polarized antenna system.

HORIZONTAL					VERTICAL				
No. Of Dipoles	Gain Power	Gain DB.	Input Power Rating KW	Input Power Rating DBK	No. Of Dipoles	Gain Power	Gain DB.	Input Power Rating KW	Input Power Rating DBK
1	0.9	0.5	3	4.8	1	.95	.002	3	4.8
2	1.0	2.8	6	7.8	2	1.97	2.942	6	7.8
3	3.0	4.8	9	9.5	3	3.12	4.942	9	9.5
4	4.0	6.0	12	10.8	4	4.2	6.230	12	10.8
5	5.1	7.1	15	11.8	5	5.31	7.251	15	11.8
6	6.3	8.0	18	12.6	6	6.39	8.057	18	12.6
7	7.3	8.6	21	13.2	7	7.5	8.751	21	13.2
8	8.4	9.2	24	13.8	8	8.57	9.330	24	13.8
10	10.5	10.2	30	14.8	10	10.96	10.398	30	14.8
12	12.5	11.0	36	15.6	12	13.19	11.204	36	15.6
14	14.5	11.62	42	16.4	14	15.3	11.844	36	15.6
16	16.5	12.18	48	17.2	16	17.48	12.426	36	15.6

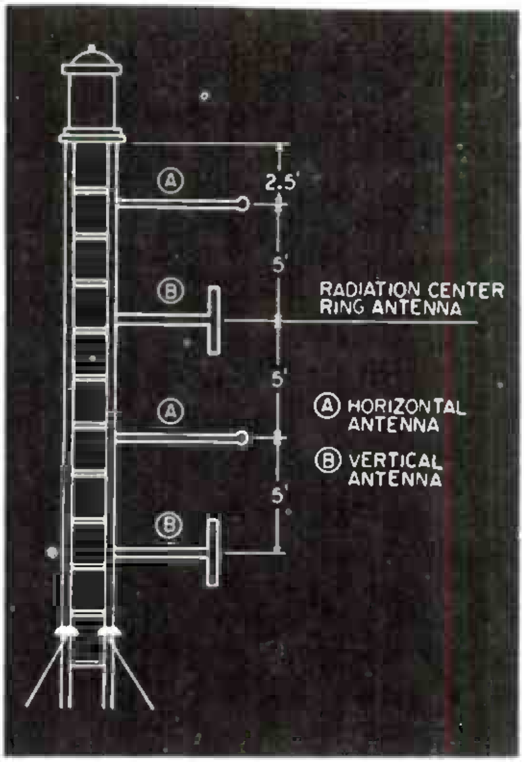


Fig. 7. Intermingled or interlaced dual polarized antenna system.

tion would be 20.2 kw. (5.31 power gain × 3.8 kw power input = 20.2 kw ERP). Thus the dual polarized FM antenna combination would therefore comply with the FCC regulations. The gain of the horizontal and vertical antennas increases with the number of stacked bays used; Table I contains the figures for determining the appropriate number of horizontal and vertical antenna elements.

Vertical Pattern

The vertical pattern shows how the radiated energy is distributed and its proper choice is an important factor in good coverage. The vertical pattern is a plot of the relative field strength versus the vertical angle transmitted in a given vertical plane. Fig. 9 illustrates typical patterns for low, medium, and high gain antennas.

Choice of System

In the examples given here, only vertical and horizontal plane radiation has been discussed. Elliptically polarized radiation results from a dipole whose axis is 45 degrees to the earth. Unfortunately, this condition holds true in two general directions only. Circularly polarized radiation occurs from a combination of vertically and horizontally polarized radiators with the same center of radiation and with power 90 electrical degrees displaced. Circularly polarized FM antennas are practical in interposed arrays if the power to the vertical (or horizontal) elements are delayed 90 degrees. There appears to be no particular advantage of circular polarization over straight horizontal and vertical polarization.

Selecting the desired dual polarized antenna system can only

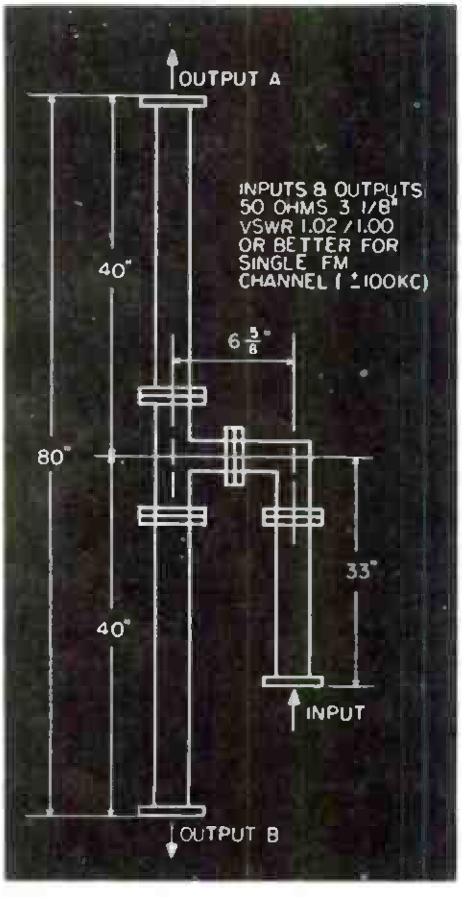


Fig. 8. A typical FM power dividing tee.

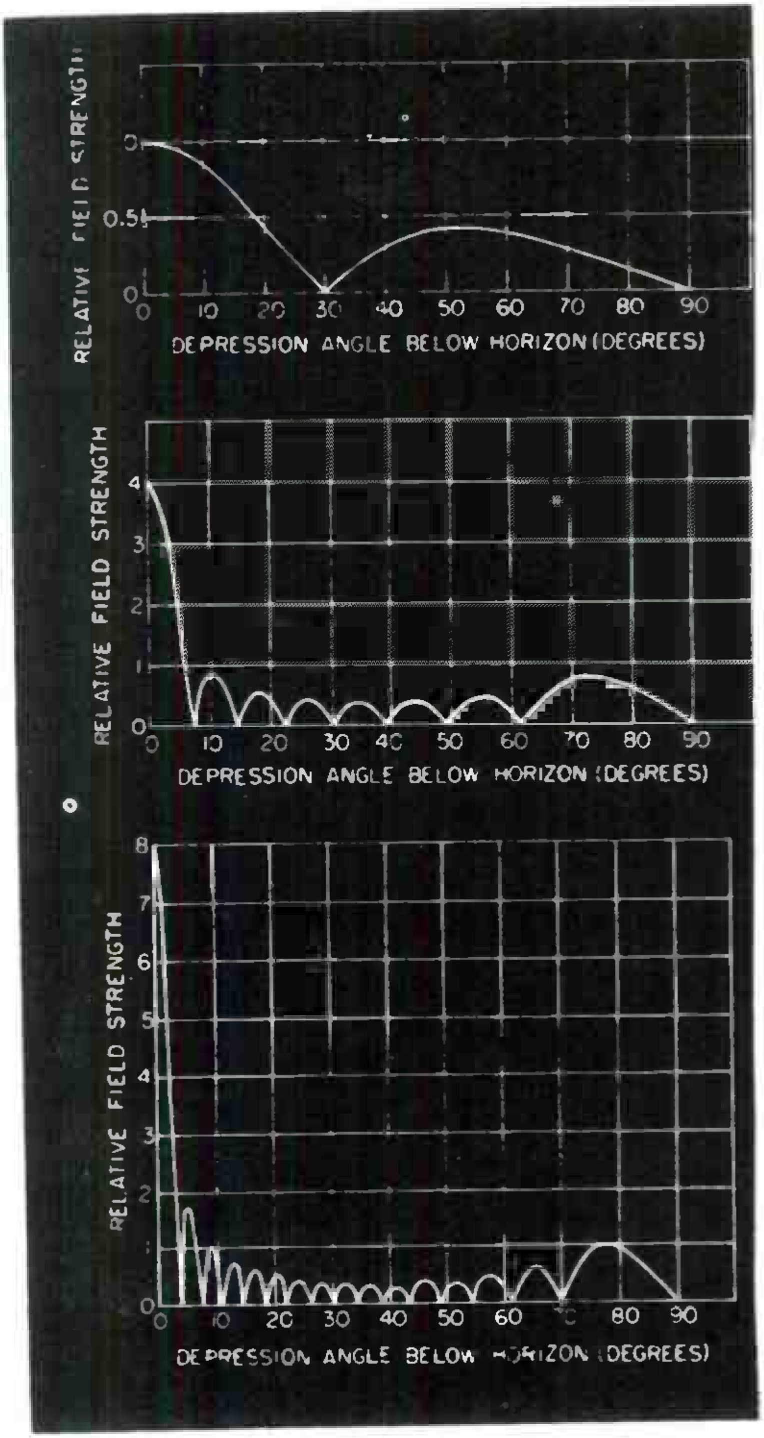


Fig. 9. (top) 2-bay vertically polarized antenna. Power gain: 1.969, db gain: 2.942. (center) 8-bay vertically polarized antenna. Power gain: 8.571, db gain: 9.330. (bottom) 16-bay vertically polarized antenna. Power gain: 17.483, db gain: 12.426.

be made by evaluating a particular station's requirements. Consideration must be made of the inter-effects of these factors:

1. Available transmitter power.
2. Transmission line losses.
3. Existing antenna and tower structure.
4. Terrain of area coverage.
5. FCC rules.

The proper choice will result in vastly improved service to an existing FM audience.

Dual Polarization Tests

During the past decade there has been a great deal of interest directed toward achieving more uniform coverage from FM broadcast stations through the use of dual polarized antennas. Tests conducted using facilities at WNHC-FM, New Haven, Conn. were reported in CCIR Study Group X, Document USPC-BC 22, dated Dec. 15, 1964. The antenna feed system was modified to provide for radiation of horizontally polarized signals only, vertically polarized signals only, or a combination of the two. Extensive measurements were made in both Hartford and New Haven to determine the effects of dual polarization on reception in the service area, and also upon the interference potential of dual polarized transmissions.

Transmitting Equipment Used

The transmitting antenna consisted of a Jampro 8-bay horizontally polarized section mounted on one leg of a 100-meter self-supporting tower and an 8-bay vertically polarized section mounted on an adjacent leg. The two sections

TABLE I—Vertically Polarized Component Transmitted From The Horizontally Polarized Antenna

Measurement No.	Horizontal Field (mv m)	Vertical Field (mv/m)	DB Difference
1	83.0	2.5	32.0
2	79.0	2.8	29.0
3	72.0	2.2	30.3
4	84.0	3.8	26.9
5	78.0	14.0	14.9
6	90.0	12.0	17.5
7	120.0	11.5	20.3
8	38.5	5.0	17.8
9	37.5	2.7	22.9
10	47.0	4.0	21.4
11	54.0	7.0	17.8

TABLE II—Horizontally Polarized Component Transmitted From The Vertically Polarized Antenna

Measurement No.	Horizontal Field (mv/m)	Vertical Field (mv/m)	DB Difference
1	4.3	60.0	32.1
2	3.5	59.0	36.6
3	7.4	53.0	17.2
4	3.5	54.0	34.6
5	8.6	43.0	14.0
6	4.0	38.0	19.6
7	2.3	43.0	38.8
8	6.2	52.0	18.4
9	3.0	39.0	29.6
10	5.8	40.0	16.8
11	7.2	34.0	13.8
12	8.8	48.0	14.6

were separated by approximately 4 meters, and fed through a 50/50 power splitter with individual feed lines originating from separate junction boxes. A coaxial switch was installed between the power splitter and the vertically polarized antenna junction box so that power could be switched into a dummy load. It was therefore possible to make field intensity measurements with horizontally polarized antenna excitation only or both horizontally and vertically polarized antenna excitation. The effective radiated power in the horizontal plane was 10 kw, and in the vertical plane 9.5 kw. (The gain of the vertically polarized antenna was slightly lower, thus accounting for the difference.) The VSWR of the system was 1.15, and remained the same for all modes of operations.

During the latter portion of the tests, the coaxial switch was moved to permit power to be switched from the horizontally polarized antenna to a dummy load. Thus, it was possible to make measurements resulting from vertically polarized radiation alone.

TABLE III—Far Field Measurements

		DUAL ANTENNA		HORIZONTAL ANT.		VERTICAL ANT.	
Point No.	Distance (miles)	Horizontal Field (mv/m)	Vertical Field (mv/m)	Horizontal Field (mv/m)	Vertical Field (mv/m)	Horizontal Field (mv/m)	Vertical Field (mv/m)
1	27.0	.980	.750	.940	.110	.120	.860
2	33.4	.850	.300	.820	.110	.045	.360
3	42.3	.320	.170	.350	.065	.032	.185
4	46.9	.260	.090	.270	.030	.024	.100
5	52.3	.310	.150	.280	.040	.018	.180
6	55.6	.070	.038	.080	.028	.007	.031
7	57.4	.080	.034	.080	.012	.010	.036
8	61.5	.070	.030	.070	.010	.008	.030

Receiving Equipment Used

To assure accuracy of the measured fields, it was necessary to design a dual polarized receiving antenna that would measure the horizontal and vertical fields simultaneously. The design of this antenna consisted of a horizontal balanced dipole mounted on the bottom skirt of a coaxial vertical dipole. It was necessary to bring the coaxial cables from the dipole down through the bottom skirt of the vertical antenna to eliminate radiation from currents flowing in the coaxial sheath. Tests on this antenna indicated 37 db decoupling between the horizontal and vertical sections.

Simultaneous horizontal and vertical fields were recorded by using two VHF field intensity meters to feed two chart recorders. The antenna was raised to a height of 10 meters during all measurements. To assure a homogeneous field, measurements were recorded by making runs varying in length from 30 to 150 meters, depending upon available clearances.

Measurements of the service area field were made with the same equipment, except that four spot measurements were made at each location, instead of a continuous chart recording, because of limited clearances in populated areas.

Close-in Measurements

A number of close-in measurements (2 to 5 miles) were made to determine the extent of vertical component radiation from the horizontally polarized antenna. Line-of-sight locations, which had Fresnel clearance, were chosen for these measurements. The vertically polarized component measured from 14.9 to 32.0 db below the horizontally polarized component. The average of these locations showed the vertical field to be 22.2 db below the horizontal field. (See Table I).

A second set of measurements was made at these same points to determine the extent of horizontal component radiation from the vertically polarized antenna. It is interesting to note that the horizontally polarized component measured from 13.8 to 38.8 db below the vertically polarized component, and the average of these locations showed the horizontal field to be 23.0 db below the vertical field. (See Table II.)

Far Field Measurements

Far field measurements were made starting at the 1-mv/m contour to determine the effect on the horizontal field when equal amounts of power were fed to the horizontally and vertically polarized sections. At each of the eight locations chosen, chart recordings were made of the horizontally and vertically polarized fields being radiated from the dually polarized antenna, from the horizontally polarized antenna only, and from the vertically polarized antenna only. The fields were recorded while the receiving vehicle was moved over a distance of from 50 to 150 meters with the receiving antenna at a height of 10 meters. The most distant recordings were made at a location where the horizontal field measured approximately 70 microvolts. (See Table III.)

Service Field Measurements

To determine the effect of the addition of the vertically polarized field in the service areas of WNHC-FM, a number of measurements were made in the Hartford and New Haven areas. The

TABLE IV—Hartford Area Measurements

Point No.	DUAL ANTENNA Horizontal Field (mv/m)	DUAL ANTENNA Vertical Field (mv/m)	HORIZ. ANTENNA Horizontal Field (mv/m)	HORIZ. ANTENNA Vertical Field (mv/m)	VERT. ANTENNA Horizontal Field (mv/m)	VERT. ANTENNA Vertical Field (mv/m)
A1	.360	.720	.330	.095	.079	.740
B1	.960	.995	.935	.140	.290	1.100
D1	.260	.245	.235	.038	.032	.235
F1	.370	.190	.280	.034	.070	.210
G1	.730	.360	.650	.090	.086	.340
B2	.580	.370	.510	.060	.130	.300
E2	.750	.890	.780	.190	.280	.770
A3	.280	.190	.240	.040	.064	.110
B3	.250	.240	.220	.050	.090	.180
C3	.960	.720	.900	.140	.130	.455
D3	.260	.089	.170	.038	.090	.120
E3	.740	.530	.670	.112	.180	.490
G3	.295	.215	.240	.029	.070	.250
A4	.560	.420	.560	.104	.057	.340
B4	.120	.160	.138	.036	.044	.120
C4	.160	.130	.150	.026	.032	.100
D4	.210	.190	.190	.022	.064	.160
E4	.500	.400	.490	.120	.150	.330
G4	.745	.320	.650	.093	.120	.230
A5	.350	.300	.300	.078	.045	.180
B5	.490	.590	.480	.080	.083	.525
F5	.360	.335	.330	.073	.045	.298
G5	.395	.420	.350	.047	.110	.370
C6	.350	.610	.370	.057	.095	.570
D6	.430	.390	.400	.065	.080	.355
A7	1.640	1.100	1.630	.050	.140	1.240
B7	.820	.510	.850	.150	.093	.360
F7	.380	.400	.420	.065	.100	.340
G7	.200	.205	.180	.018	.056	.210

Hartford area is approximately 25 miles from the transmitting site. The transmission path is over terrain which produces varying degrees of shadowing starting with practically line-of-sight in West Hartford to moderate shadowing in East Hartford. The dual polarized antenna is mounted on the north face of the tower, toward the city of Hartford.

A grid system was laid over a city map of the Hartford area so that most of the 49 grid points fell in the populated area shown on Map No. 1. Measurements were recorded at 29 of these grid points, with the greatest concentration in the downtown area. The locations were chosen by going to the grid point and then finding the nearest site where the measuring antenna could be raised to 10 meters with sufficient clearance to move the vehicle approximately 20 meters. At each of these locations, four spot measurements were recorded with the vehicle being moved about 5 meters between spots. Measurements were recorded while transmitting with the horizontal and vertical antenna, the horizontal antenna only, and vertical antenna only. The four spot measurements at each location were averaged and tabulated in Table IV.

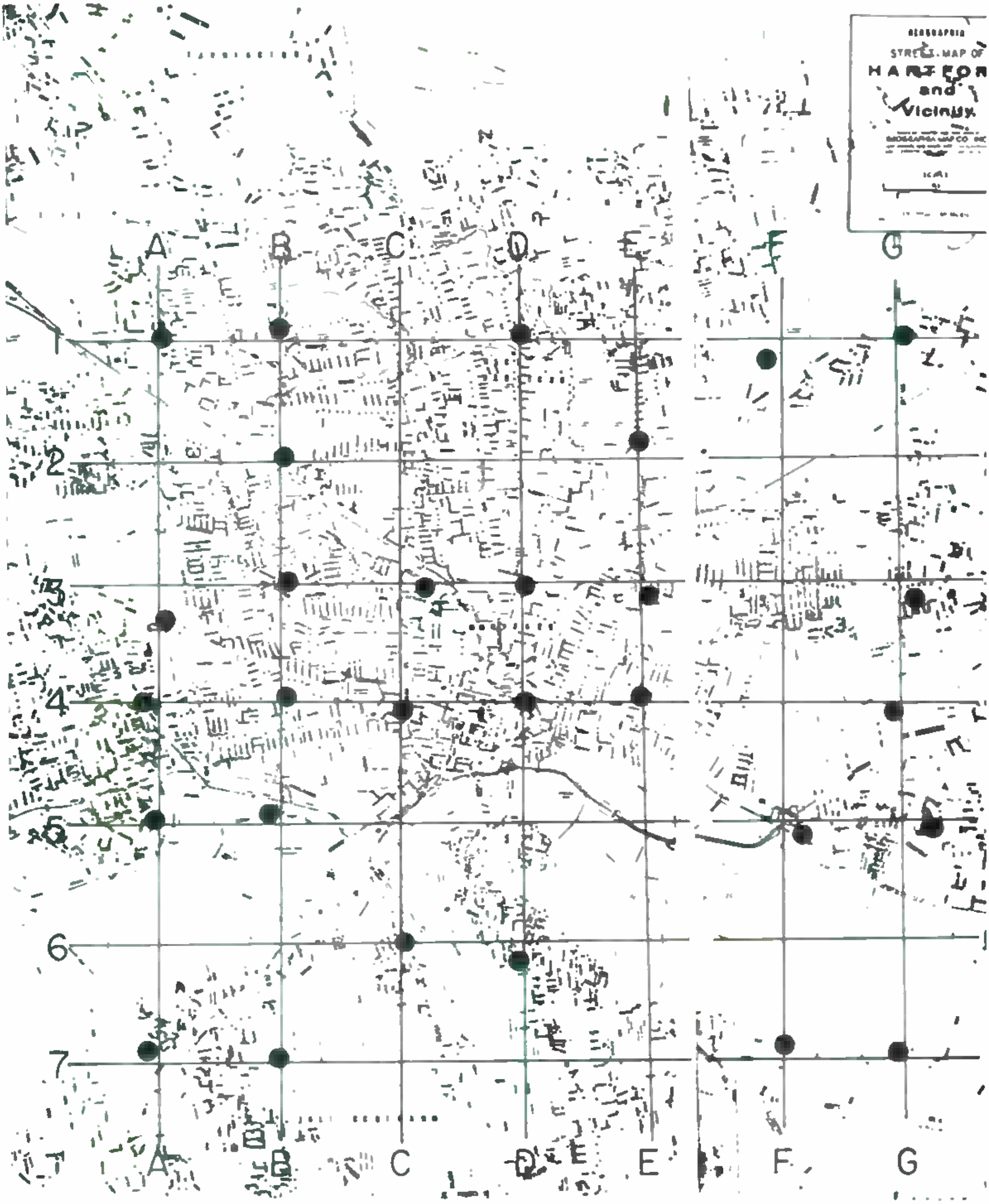
Similar measurements were made in the New Haven area, approximately 9 miles from the transmitting site, as shown on Map No. 2. New Haven is located at the base of a number of mountains which end abruptly and almost immediately before entering Long Island Sound; thus, the transmission path from WNHC is over very rough terrain. Severe shadowing is evident in some areas, while in some parts of the city farther south, line-of-sight paths were obtained. The transmitting antenna, however, is mounted on the opposite side of the tower from New Haven. A map system with 30 grid points was used. Measurements recorded at 20 points in populated areas appear in Table V.

Summary of Results

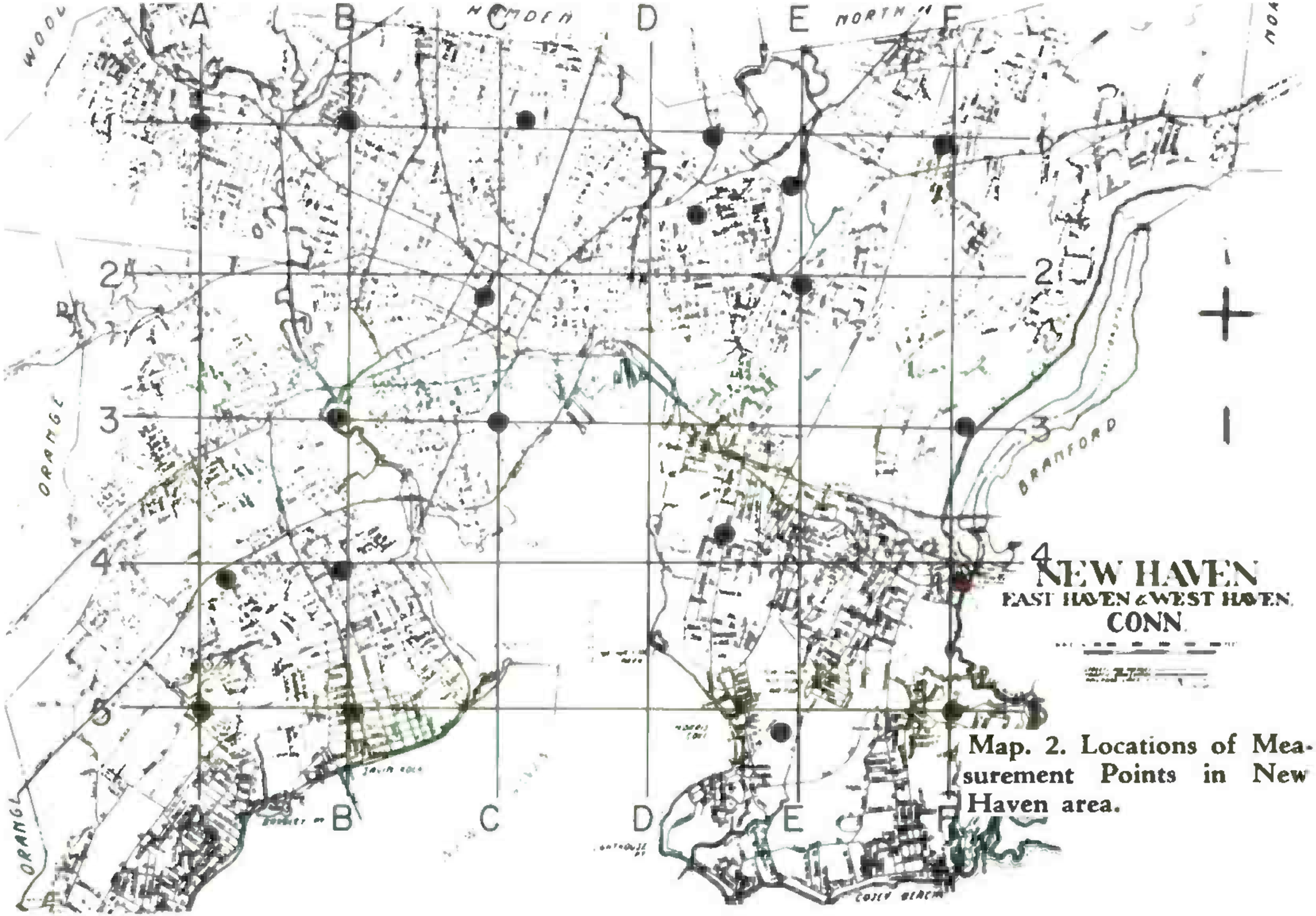
As shown in Table III, measurements made at distances from 27 to 61.5 miles from the transmitter, using alternately dual polarization and horizontal polarization, show very little improvement in the horizontally polarized component received at the eight monitoring points. At distances greater than 55 miles, very little change is observed. Up to 50 miles, on the other hand, a vertically polarized component on the order of 100 microvolts or better is established. This signal would be of considerable advantage to listeners employing automobile FM receivers with a whip antenna.

TABLE V—New Haven Area Measurements

	DUAL ANTENNA		HORIZ. ANTENNA		VERT. ANTENNA	
Point No.	Horizontal Field (mv/m)	Vertical Field (mv/m)	Horizontal Field (mv/m)	Vertical Field (mv/m)	Vertical Field (mv/m)	Horizontal Field (mv/m)
A1	1.950	3.100	2.500	0.210	1.360	2.900
B1	3.100	5.250	2.375	0.420	1.160	5.200
C1	2.650	10.900	1.900	0.450	1.310	8.400
D1	0.960	0.890	0.415	0.110	0.810	1.230
E1	6.600	20.250	6.100	0.460	5.600	20.750
F1	1.600	6.180	0.865	0.103	1.500	6.230
C2	3.100	11.300	1.640	0.320	2.180	10.750
D2	1.250	3.500	0.680	0.135	0.790	4.500
E2	2.560	8.750	1.425	0.265	1.850	10.200
B3	4.450	6.600	4.300	0.480	1.880	10.100
C3	1.650	4.480	0.850	0.131	0.990	5.730
F3	1.100	5.100	0.280	0.056	1.000	5.650
A4	1.950	1.950	1.900	0.150	0.360	2.350
B4	1.100	4.330	0.805	0.110	0.695	4.880
E4	6.150	13.500	5.500	0.580	0.800	15.100
F4	2.080	5.300	0.640	0.070	1.650	5.620
A5	6.430	4.280	4.850	0.370	1.230	3.730
B5	4.180	4.150	1.100	0.080	2.350	4.130
E5	1.060	7.930	1.710	0.130	0.980	7.930
F5	2.100	15.480	1.450	0.115	2.200	17.150



Map. 1. Locations of Measurement Points in Hartford area.



Map. 2. Locations of Measurement Points in New Haven area.

The measurements given in Table IV, while not made in areas which are line of sight from the transmitter, were not substantially affected by shadowing. Consequently, the plane of polarization of the received signal should be substantially the same as transmitted. This, apparently, is the case. Although the relative magnitudes of the dually transmitted vertical and horizontal components appear to be about equal, there was little increase in the horizontally polarized field over that measured when the horizontal antenna alone was in use. This, of course, would be the case if no rotation of the plane of polarization were to occur. At the same time, there is a substantial vertically polarized field throughout the Hartford area, which would indicate that car radios employing whip antennas or home radios that employ so-called "rabbit ear" antennas, should receive a substantially better signal due to the presence of the vertical component.

Conclusions Drawn From Tests

1. In the absence of shadowing or diffraction effects, transmission of a vertically polarized component adds very little to the signal received on a horizontally polarized receiving antenna.
2. When receiving antennas having a substantial vertical component are employed, a correspondingly substantial improvement in overall service can be expected.
3. The vertical component appears to have substantial value for users of automobile FM radios, both in town and at distances up to 50 miles from the transmitter.
4. In the presence of shadowing or diffraction effects (see New Haven measurements), shadowed areas which have very low signal strength during horizontally polarized transmissions receive substantially improved horizontally polarized components when dual polarization is employed.

Table III presents a different picture, however. The measurements, in general, were made in areas shaded to a greater or lesser degree by the rocky formations which lie between the transmitting antenna and New Haven.

In 90% of the locations the dual antenna provides a horizontally polarized field measurably improved over that received when using the horizontal transmitting antenna alone. This improvement is most noticeable in those areas where the magnitude of the fields indicates substantial shadowing—for example, points D2, D1 and C2 on map No. 2.

Reference to the New Haven measurements shows that at 18 out of the 20 locations measured, the *horizontal* component of the field *increased* when vertical polarization was added. At 7 of the 20 locations, the *vertical* field *increased* with the addition of horizontally polarized radiation. It should also be noted that at 10 of the 20 locations, the horizontally polarized field measured with only the vertical transmitting antenna operating, was of higher intensity than the horizontally polarized field measured when only the horizontal antenna was excited. At 16 of the 20 locations, the vertical component of the measured field was of higher intensity than the horizontal component when radiating with both vertical and horizontal antenna sections. In New Haven, as in Hartford, the presence of the strong vertically polarized field would substantially improve the service rendered to FM receivers with indoor, or "rabbit ear," antennas.

Directional Antenna Systems for FM

John H. Battison

THE FCC has long permitted AM broadcasters to use directional antennas, but prior to the FM freeze a few years ago, very few FM stations were allowed this privilege. FM directional antennas were beginning to appear in applications for new FM stations and improved FM facilities just as the freeze was imposed. Today, there is a resurgence of interest in FM directional antennas.

As activities in FM construction become more settled, the FCC is stabilizing its outlook on directional FM antennas and spelling out their requirements more clearly. The major purpose of the directional system is to enable short-spaced FM stations to increase power to the maximum now allowed their classification under new FCC Rules. Directional antennas *may not* be used, however, as a means of reducing minimum mileage separation requirements in order to fit in a new station.

Before a station manager decides to use a directional antenna, he should become familiar with the pertinent parts of the FCC Rules. Two deal specifically with such antennas and their uses (see box). A typical application under the classification of improving service might be a situation where the proposed principal city is close to a mountain or similar shadowed area and there is no advantage in radiating toward the blank mountain side. The other approved application is for the purpose of using a specific antenna site. If an applicant owns an existing tower or high building, or even another class of broadcast station, and wishes to use this as the supporting structure, a directional antenna might be required in order to limit the combination of height and power in a specific direction to conform with the Rule regarding power and height combinations.

Technical Requirements

Technical requirements are spelled out in detail in FCC Rule 73.316(c),(d) subparagraphs 1 through 3. Certain portions are particularly noteworthy.

In most cases where a directional FM antenna is used, the engineering portion of FCC Form 301 will be completed by the applicant's consulting engineer. However, sometimes a well qualified chief engineer can handle this work. (See Fig. 1.) If this is the case, these points should be observed. The application must completely describe the antenna and explain the method of obtaining directivity. You must provide a radiation pattern showing free space field intensity at one mile in mv/m for the horizontal plane[1] and data on vertical radiation between plus

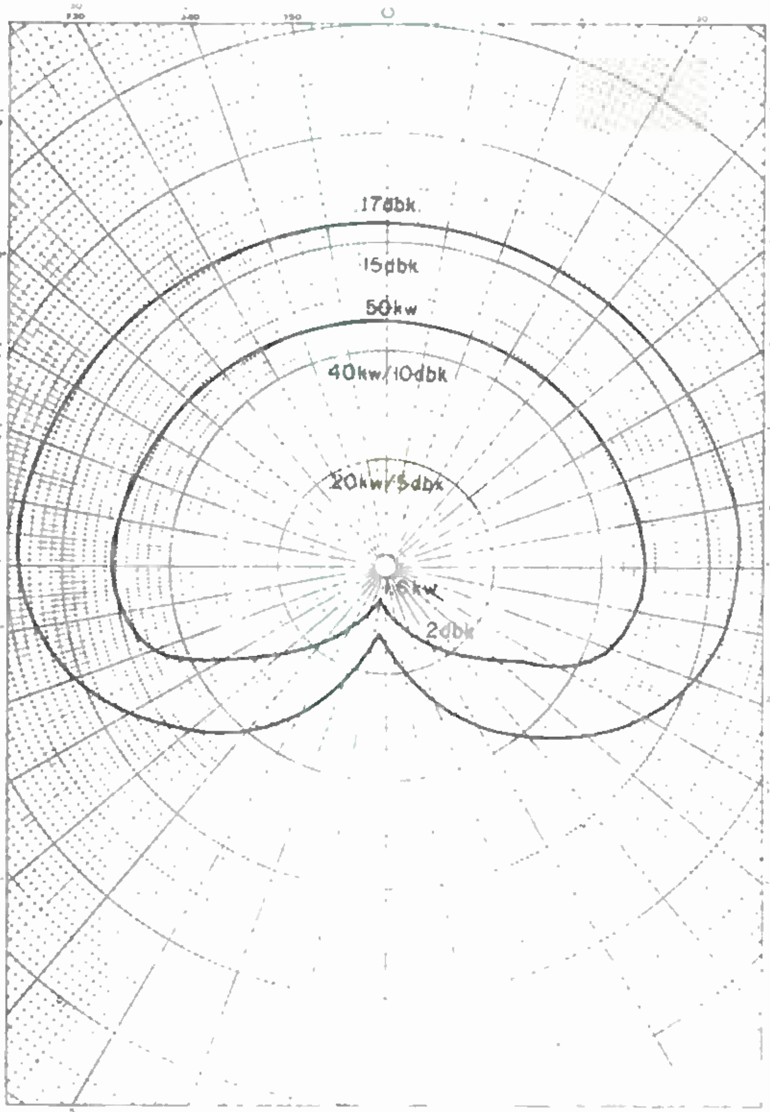


Fig. 1. An illustration of the relationship between power in kw and dbk for a given pattern.

[1] The FCC prefers to have all data in dbk, rather than kw. See Fig. 5.

and minus 10° above the horizontal plane. This data must not show any undesirable radiation in the vertical plane between these limits. Finally, the name, address and qualifications of the engineer making the calculations must be given. The antenna information required above may be computed or measured, but you must include a full description of your computations and methods of measurement.

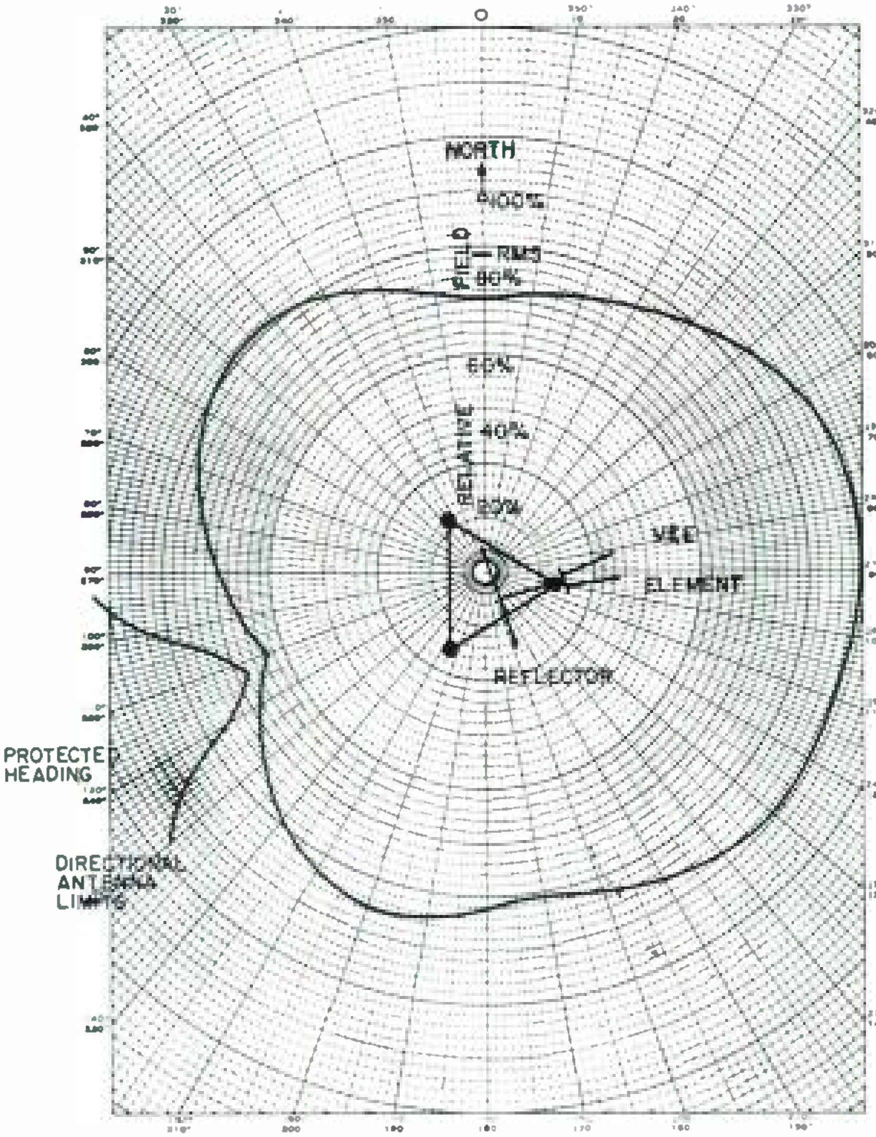


Fig. 2. Predicted antenna horizontal field plot for WJZZ, Bridgeport, Conn.

Station managers with experience in AM directional antennas will notice a big difference—a consulting engineer must provide the technical data supporting the directional antenna system. This is because there are so many variations in AM DA patterns that every installation is different. The limits of radiation are very rigid in FM DA systems; therefore, it is possible for a manufacturer to have FCC required technical data for his whole line of FM antennas. There may be the exception, of course, where an exotic pattern is required—and can be justified—but this will be rare. The manufacturer will furnish complete engineering data for paragraph (d) of this Rule.

Operating Directional Antennas Systems

The horizontal field patterns for three operating FM DA systems are shown in Figs. 2, 3, and 4.

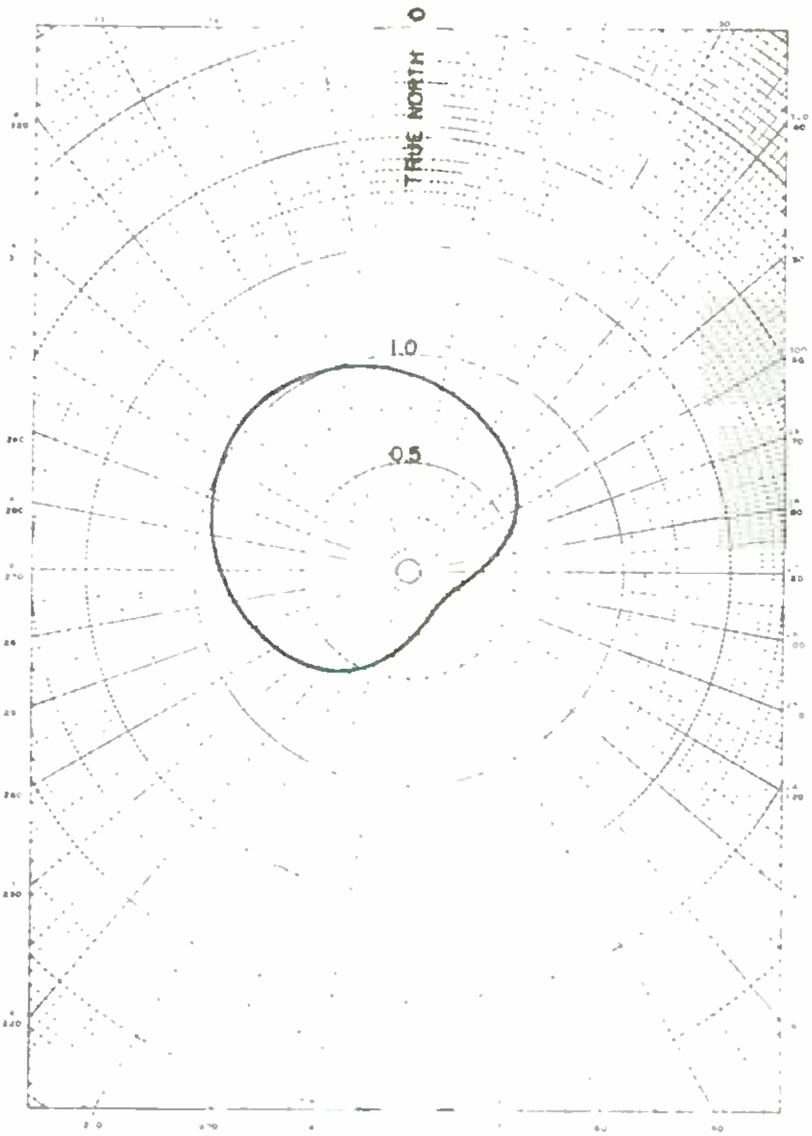


Fig. 3. DA horizontal pattern for WGIR-FM, Manchester.

WJZZ, Bridgeport, Conn., Fig. 2 uses a Jampro J 6b/6V/DA; WGIR-FM, Manchester, N. H., Fig 3, plans to use a Collins 37M-DA and WTFM, Lake Success, N. Y., Fig. 4, will use an Alford 7615.

These DA's are shown because they represent a cross section of new stations; there are many older operations, but they were installed before the present DA regulations went into effect, and as a result do not have to conform with the new Rules.

Engineering Considerations

The application procedure for an FM directional antenna system is far simpler than that for an AM directional. This is due to the difference in physical

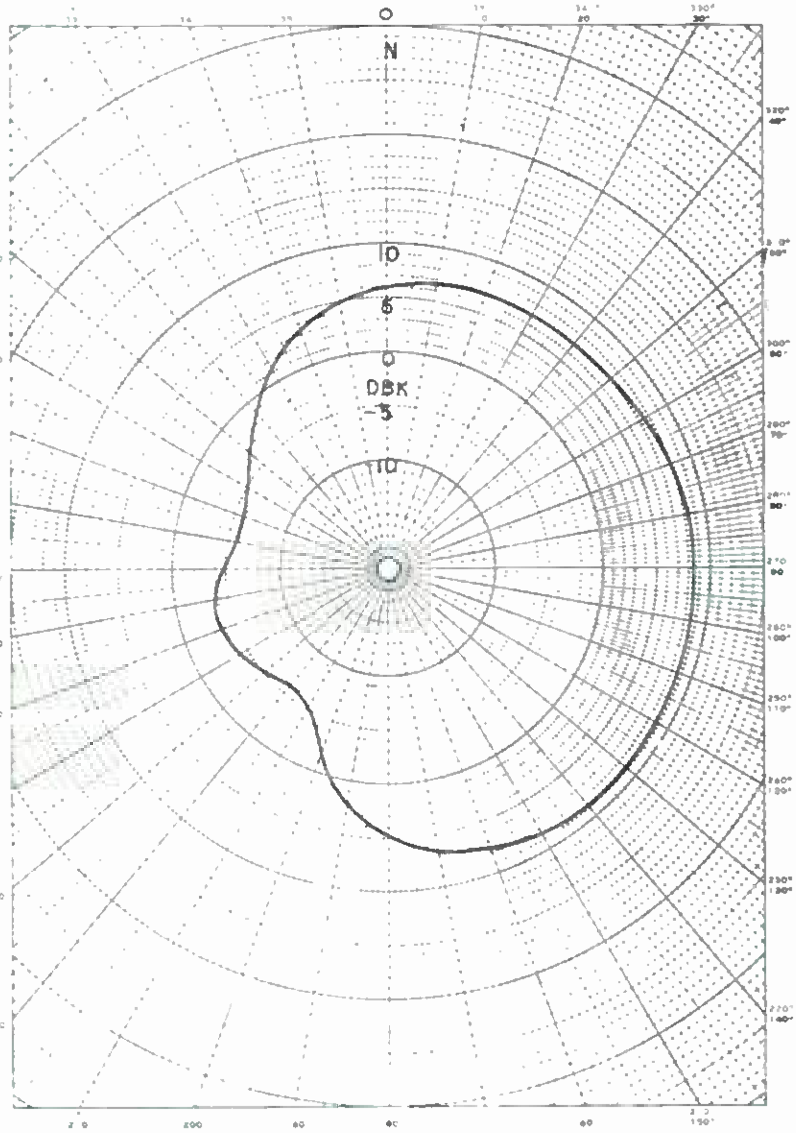


Fig. 4. DA horizontal pattern for WTFM, Lake Success.

arrangement. Because of the small size and often one-piece construction of an FM antenna, it can be adjusted and tuned at the factory for its desired directional pattern, and installed in the field with reasonable certainty that the pattern will be correct—provided that the antenna is properly oriented.

The FCC has inserted into the Rules a provision that might go unnoticed by many readers. It says "a submission must be made by a qualified surveyor that the antenna has been properly oriented at the time of installation." This means that a surveyor must measure the azimuth of the antenna when it is installed, probably by means of a mark on the base of the antenna as it is being mounted on the tower, or in a manner which will assure the Commission that the antenna is properly oriented.

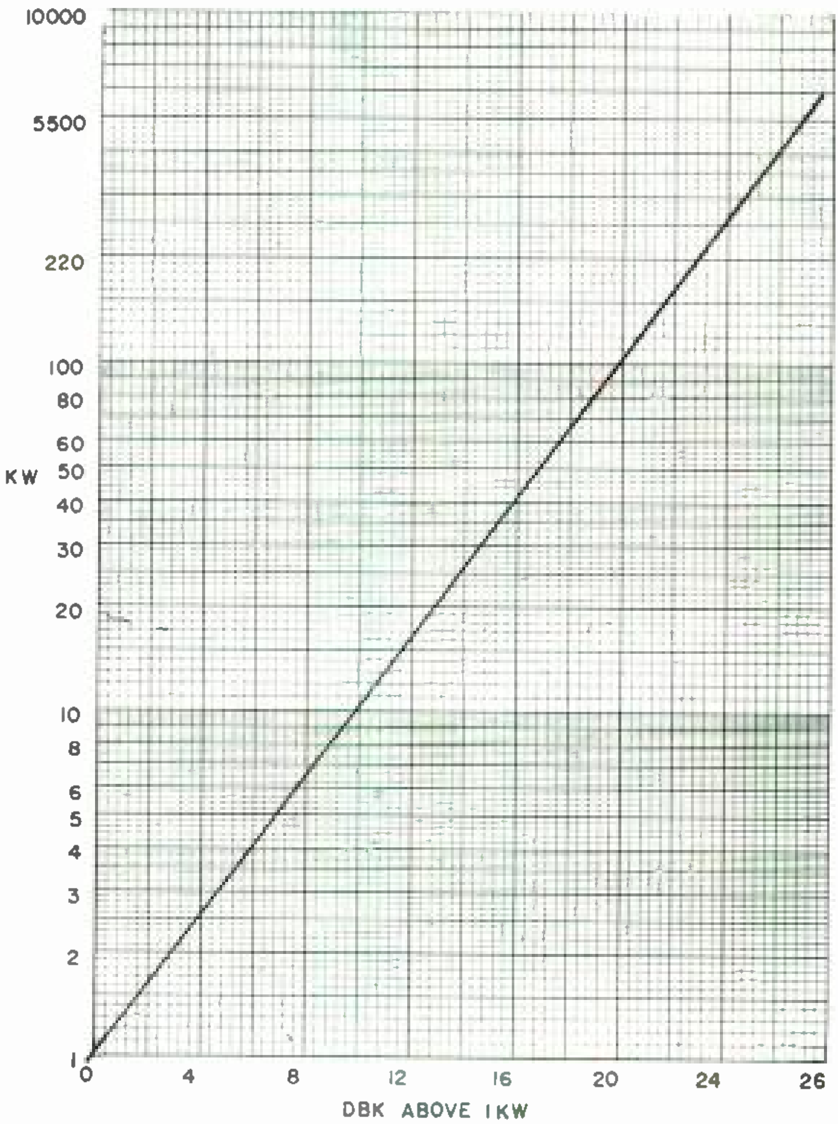


Fig. 5. Graph showing relationship between power and dbk above 1 kw.

Proof of Performance

Measurements are required in the horizontal as well as the vertical plane. The 360° horizontal radiation pattern must be shown. There is no formal way in which the FCC requires the proof to be measured or submitted, provided the material is there and is correct.

Condensation of FCC Rules Governing FM DAs

Rule 72.213 (c): In the case of short-spaced stations, maximum radiation may be used—provided that the maximum power radiated in the short-spaced direction is not in excess of the amount allowed non-directionally. No more than the maximum permissible power for the class of station concerned may be radiated in any direction, and the power increase off the radial separating the two stations must not be greater than 2 db for every 10° of change in azimuth. (See Fig. 1.)

Rule 73.316 (c): A directional antenna is considered to be any antenna that obtains a deliberate non-circular pattern for the purpose of improving coverage or using a particular site. It may not be used to circumvent the minimum mileage separation requirements. A ratio of 15 db maximum to minimum radiation will not be accepted. The hypothetical patterns in Fig. 1 comply with this rule.

The Rules call for a proof to be made in the field, or by the manufacturer. The latter is far easier and less expensive for the applicant, although such activities do tend to remove the bread from the mouths of consulting engineers. However, the Commission requires that the manufacturer make his measurements with the antenna mounted on the actual tower, or a replica thereof, together with all lines, ladders, lights, etc., that will be used in the final installation. The reasoning behind this is obvious. However, the word *tower* should not be taken to mean the 300-foot high mounting structure, but to a section of tower or pole on which the antenna is secured prior to mounting on the actual tall tower. The old rule which required measurements along eight radials with a pen recorder is out! Today, directional antennas for FM use are as simple to specify and use as non-directional antennas.

Management Considerations

FM directional antenna costs should not be more than 10% of general equipment costs. Their construction is simple and, in many cases, undetectable from non-directional antennas. DA arrays are as simple to install as non-directionals, except for proper orientation. Unlike AM DAs only one tower or supporting structure is needed.

The average FM station now operating at full power, will not have to consider directional operation. One application of the FM directional is in the case of a short-spaced station which wants to increase power. Then it may be necessary to use a directional antenna to control radiation in the short-spaced direction. Occasionally an operating FM station will discover that coverage in a given direction is not what it might be for various reasons such as terrain. In this case a directional antenna will achieve the desired coverage. FCC Rules governing the proposed operation must be adhered to. Often an existing FM antenna can be modified, depending on the design, to give a directional pattern by means of fairly simple phasing alternations. When this is done, field pattern measurements will have to be made with the antenna mounted on the station's tower, and this can run into several thousand dollars, depending on the complexity of the measurements. Generally, if the antenna in use has been amortized, and the station is about ready for a new one it would be better and cost less in the long run to install a new one that has been factory-tuned, adjusted, and furnished with a proof of performance.

Care & Design of FM Antenna Systems

Lewis D. Wetzel

THE ANTENNA SYSTEM is ofen the part of the station's equipment which receives the least attention, even though it is left to weather everything Mother Nature can dream up. The initial cost of the antenna system is usually a quarter to half the cost of the transmitter which receives daily attention. Some simple guidelines may be useful in maintaining an existing antenna system or choosing a new one.

A key meter in the transmitter system which can give the operator some indication of how the antenna is performing is the reflectometer, or VSWR meter. Unfortunately, this measuring device is 1) often installed at the wrong place; 2) not designed to give the needed accuracy; or 3) not supplied with the transmitter.

Let's take a look at the reflectometer which should really be considered a part of the antenna system. It is a device which should be inserted into the transmission line after the harmonic filter. It should have a directivity of about 35 dB and a coupling factor which is proper for the associated meter. The reflected or reverse power probe should preferably have 6 to 10 dB more coupling, but this again must be coordinated with the meter scale. The proper adjustment of these probes is made at the factory. No attempt to alter the adjustment in the field should be made unless fairly elaborate test equipment is available to assure knowledge of results.

Calibration of the reflectometer, however, is a function which the engineer must perform at the station whenever a proof-of-performance is made. To assure accuracy, the transmitter should be operated into a dummy load and the reflectometer adjusted to indicate the operating power level. By reversing the leads from the directional coupler and switching the reflectometer to the reflected position, the calibration in this position may be checked taking into consideration the reflected coupling factor.

VSWR should be below 1.3

If the VSWR on your antenna system is above 1.3 under normal conditions, an effort should be made to determine the reason. Some of the things to check are: the accuracy of the reflectometer; the correct placement of the reflectometer in the system; uniform temperature along the transmission line; no presence of moisture in the system; good contact of all connectors; and proper antenna installation.

Let's take a look at some of these trouble indicators in addition to the aforementioned problems concerning the reflectometer. A discontinuity will cause hot spots every half wavelength along the transmission line—until the reflected energy has been dissipated. It is, therefore, necessary to get within a few wavelengths of the trouble or the hot spots will not be apparent.

Moisture in the system is difficult to determine, so the easiest remedy is to purge the system periodically with dry air or dry nitrogen. Be sure the dehydrator is delivering dry air. For convenience in purging the system, an eight to ten pound pop-off valve can be installed in place of the bleeder plug on the antenna.

A periodic resistance measurement of the transmission system using a bridge is a good way to detect or anticipate connector problems in the transmission line. The value of this reading will, of course, depend upon the length of line in the system but it should be in the 50 to 500 milliohm region. If a high resistance reading is obtained, a time domain reflectometer or pulse measuring equipment can be used to locate the fault.

Refer to the installation instructions and drawings to assure yourself that the ground straps are in place and that the antenna radiating elements are intact. Falling ice and careless riggers can cause troublesome damage.

If the antenna transmission system does not hold pressure, find the leak. A system without pressure invites moisture to accumulate and the voltage breakdown point of the system decreases drastically. To check each element of the antenna, have your antenna man hold a 15-watt flourescent tube at a similar position from each element to check for equal radiation. Bad connectors or mistuned elements within the antenna may be located in this manner.

Use the right antenna size

When an antenna system is being designed for a new station, or an existing system is being replaced, several factors should govern the type and size of antenna and transmission line. Conservative ratings for a transmission line which allow for a rise in VSWR without damage to the line are as follows: 8 kw for 1⅝ in. line, 30 kw for 3⅛ in. line, 60 kw for 4⅜ in. line, and 120 kw for 6⅛ in. line. Bear in mind that the ratings given in the catalogs are for unity VSWR with dry air in the line. Laboratory conditions are seldom met in the field.

How much gain should the antenna have? The FCC limits the Effective Radiated Power of FM stations by class of station. The ERP for a station can be achieved by a high-power transmitter and a low-gain antenna or, conversely, by a low-power transmitter and high-gain antenna—or something in between. With any combination, the maximum radiation in the main beam has to be the same. How high the antenna is mounted, how near the antenna is to the desired coverage area, and how rugged the terrain is in the coverage area are some of the factors which should be considered in selecting the power/gain combination. Null fill and/or beam tilt can be built into the antenna to tailor the radiation pattern to provide the desired coverage. With about a 15% reduction in gain, a high-gain antenna can be designed to give close-in coverage similar to a low gain antenna.

Pick a broadband antenna

Broadbanding of an antenna system is something not well understood by non-technical people. An analogy is the garage door built with only an inch to spare on either side of the automobile. One would have difficulty driving through the door. If, however, the garage door is built with two feet to spare on either side of the automobile, there should be no difficulty in passing through the door. With all the extras riding on the FM carrier today, i.e., stereo and SCA, it is important to have a broadband antenna to insure undistorted stereo and SCA service. Normally the measure of broadbanding is the VSWR of the antenna over the FM channel. This does not present the total picture since the VSWR could be flat across the channel while the impedence varied across the channel. A better measure of broadbanding would be to specify the percentage change of impedance over the channel.

A word of caution on circularly-polarized antennas

Circularity of an antenna can only be specified for free space. Unfortunately a supporting structure must be used to mount the antenna. The size of the supporting structure will determine the circularity of the radiation pattern. For large towers, the radiation pattern becomes rather directional. If coverage in all directions is important and the supporting structure is large, special attention should be paid to the antenna supports and their effect on the pattern. Possibly a special antenna which surrounds the tower should be used.

True circular polarization is rarely achieved except in a free space measurement. As soon as the antenna is mounted on the supporting structure, the amplitude and/or phase of the horizontal and vertical fields will change, producing elliptical polarization. This change in polarization is not important, however, since nearly all receiving antennas are other than circularly polarized.

Because each station's coverage area presents unique propagation problems, the best results from your station can be obtained when the transmitting system is designed for your market.

Preparing Engineering Data for FCC Form 301

Harry A. Etkin

The most significant factor in assuring a successful filing of Form 301 is to supply all the specific data in complete detail. Thus, in planning a new station or changes in an existing station, a broadcaster should be familiar with the engineering know-how required. Familiarity with the FCC Rules will aid in making the necessary decisions regarding site location, equipment requirements, and antenna location and construction.

Section V-A of the form applies to standard broadcast (AM) engineering data, Section V-B to FM data, and Section V-C to TV engineering data. Section V-G of the application specifically pertains to antenna and site information.

Application Considerations

Applications lacking complete answers, or supplementary documents and engineering data, may be returned for additional information or corrections. While the application may be resubmitted, and no additional fee is required, approval for construction and operation will obviously be delayed, possibly resulting in unplanned financial loss. To minimize the possibility of such a delay, a cardinal rule is to become familiar with the instructions on the cover page of Form 301 and the applicable sections of Part 73 of the FCC Rules.

Cost Considerations

One of the first points to be considered about costs is whether the chief engineer or a consulting engineer should make the calculations and perform the tests to obtain the necessary data. While many chief engineers may be capable of preparing much of the data required, it is generally advisable to use the services of an engineering consultant, especially if the antenna system is complex (such as a directional array). Also, present-day regulations make it almost mandatory to enlist the aid of a consultant in making an allocations study and report for proposed facilities. In an operating station, engineering time is too valuable to perform the technical determinations. For a new station, however, it is most practical and economical for the chief engineer to work with a consulting engineer.

Engineering personnel assigned to the project should be advised of the necessity for keeping within the budget. Total cost for the engineering data will vary widely from station to station and area to area. As required tower heights and power outputs increase, costs will increase proportionately.

Selecting a Frequency

Available frequencies for FM broadcasting are listed in Par. 73.201: Numerical Designation of FM Broadcast Channels, Subpart B—FM Broadcast Stations (Vol. III of the Rules). The channel you request must be one assigned to your community (Table of Assignments, Par. 73.202). If your community has no channel assigned, or is not within 25 miles of

Table I—Typical Horizontal FM Antenna Data

NO OF SECTIONS	GAIN POWER KW	GAIN DB	GAIN FIELD
1	0.9	0.5	0.95
2	2.0	3.0	1.41
3	3.0	4.8	1.73
4	4.1	6.1	2.02
5	5.2	7.15	2.28
6	6.3	8.0	2.51
7	7.3	8.63	2.70
8	8.4	9.25	2.90
10	10.5	10.2	3.25
12	12.5	11.0	3.55
14	14.[illegible]	11.65	3.83
16	16.6	12.20	4.07
20	21.0	13.22	4.59

Table II—Typical Vertical FM Antenna Data

NO OF SECTIONS	GAIN POWER KW	GAIN DB	GAIN FIELD
1	.95	.22	.97
2	1.97	2.94	1.40
3	3.12	4.94	1.79
4	4.20	6.23	2.05
5	5.31	7.25	2.30
6	6.39	8.06	2.53
7	7.50	8.75	2.74
8	8.57	9.33	2.93
9	9.76	9.89	3.12
10	10.97	10.40	3.31
11	11.87	10.74	3.45
12	13.20	11.20	[illegible]
13	14.03	11.47	3.75
14	15.29	11.84	3.91
15	16.30	12.12	4.04
1[illegible]	17.[illegible]8	12.43	4.1[illegible]

the assignment, or if there are stations already on the channels in your area, a petition must be filed with the FCC to change the Table of Assignments as required by Par. 73.203.

Antenna Site Considerations

Applicants who propose to operate an FM antenna in the immediate vicinity (200 ft. or less) of another FM antenna, or TV antenna with frequencies adjacent to the FM band, must describe the effect the two systems will have upon each other.[1]

If an FM antenna is to be mounted on a nondirectional standard broadcast antenna tower, new resistance measurements must be made after the FM antenna is installed and tested. During the installation, and until the new resistance measurements are approved, the AM license should apply for authority (informal application) to use the indirect method of measuring power. The FM application will not be considered until the new resistance measurements are filed for the AM station. If the FM antenna is to be mounted on an element of an AM directional array, or on a tower in the vicinity of a directional array, a full engineering study of the effect on the performance of the AM array must be filed with application. In some cases, the FCC may require readjustment and certain field intensity measurements of the AM system when the FM antenna is in operation.

Table III—Authorized Power and Antenna Requirements

Minimum Effective Radiated Power

CLASS A	.100 watts	(−10 dbk)
CLASS B	5 kw	(7 dbk)
CLASS C	25 kw	(14 dbk)

Maximum Erp And Antenna Height

CLASS	MAXIMUM POWER	MAXIMUM ANTENNA HEIGHT (feet above average terrain)
A	3 kw (4.8 dbk)	300
B	50 kw (17.0 dbk)	500
C	100 kw (20.0 dbk)	2000

Table IV—Operational Formulas

1. ERP in KW = Transmitter power in KW — Transmission Line loss in KW + Antenna Power Gain in KW
   The transmission line loss includes the loss in harmonic filter and power divider when dual polarization is used
2. ERP in DBK = Transmitter Power in DBK — Transmission line loss in db + Antenna power gain in db.
3. $\text{Power in dbk} = 10 \log_{10} \dfrac{\text{Power in KW}}{1.0}$
4. $\text{Power in KW} = \text{Antilog}_{10} \dfrac{\text{Power in dbk}}{10}$

Section V-B

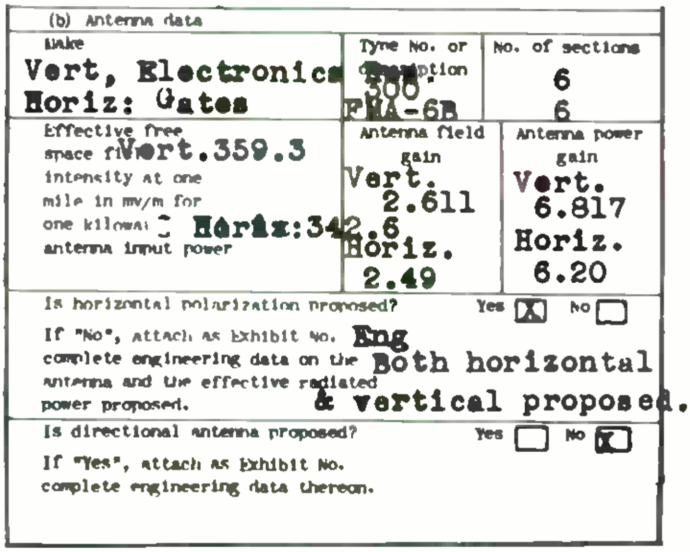
If you plan to use a dual polarized antenna, Tables I and II list data for horizontal and vertical polarization. Fig. 1 shows how data for dual polarization is entered on the form.

The mathematical expressions for antenna field gain and power gain are:

Field gain = field intensity in mv/m for multielement antenna / 137.6

Power gain = (Antenna field gain)^2

Authorized power and antenna requirements are illustrated in Table III. No minimum antenna height above average terrain is specified. Heights exceeding those listed in Table III may be used if ERP is reduced by the amount in-



(b) Antenna data		
Make: Vert, Electronics Eng. / Horiz: Gates	Type No. or description: 300 / FMA-6B	No. of sections: 6 / 6
Effective free space field intensity at one mile in mv/m for one kilowatt antenna input power: Vert. 359.3 / Horiz: 342.6	Antenna field gain: Vert. 2.611 / Horiz. 2.49	Antenna power gain: Vert. 6.817 / Horiz. 6.20

Is horizontal polarization proposed? Yes [X] No [ ]

If "No", attach as Exhibit No. Eng complete engineering data on the antenna and the effective radiated power proposed. Both horizontal & vertical proposed.

Is directional antenna proposed? Yes [ ] No [X]

If "Yes", attach as Exhibit No. complete engineering data thereon.

Fig. 1. Sample antenna data entries on Form 301.

dicated by the appropriate curve in Fig. 2.

The height of the radiation center is the physical center of the radiating elements if uniform power distribution is used. If a split-feed or power divider system and nonuniform power distribution are employed, the height of the radiation center is not the same as the physical center (the manufacturer will furnish this data).

A directional antenna may not be used solely for the purpose of reducing minimum mileage separation requirements; it is permissible if it will improve service, or permit the use of a particular site, and is designed for a noncircular radiation pattern. Directional antennas with a ratio of 15 db maximum to minimum radiation in the horizontal plane are not allowed.

Applications proposing the use of a directional antenna must be accompanied by:

1. A complete description of the proposed antenna system.
   (a). A description of how directivity will be obtained.
   (b). A means of determining the operational pattern and maintaining allowable tolerances, such as a rotatable reference antenna.
2. Horizontal and vertical plane radiation patterns showing the free space field strength in mv m at 1 mile and ERP in dbk for each direction; a complete description of how the measurements were

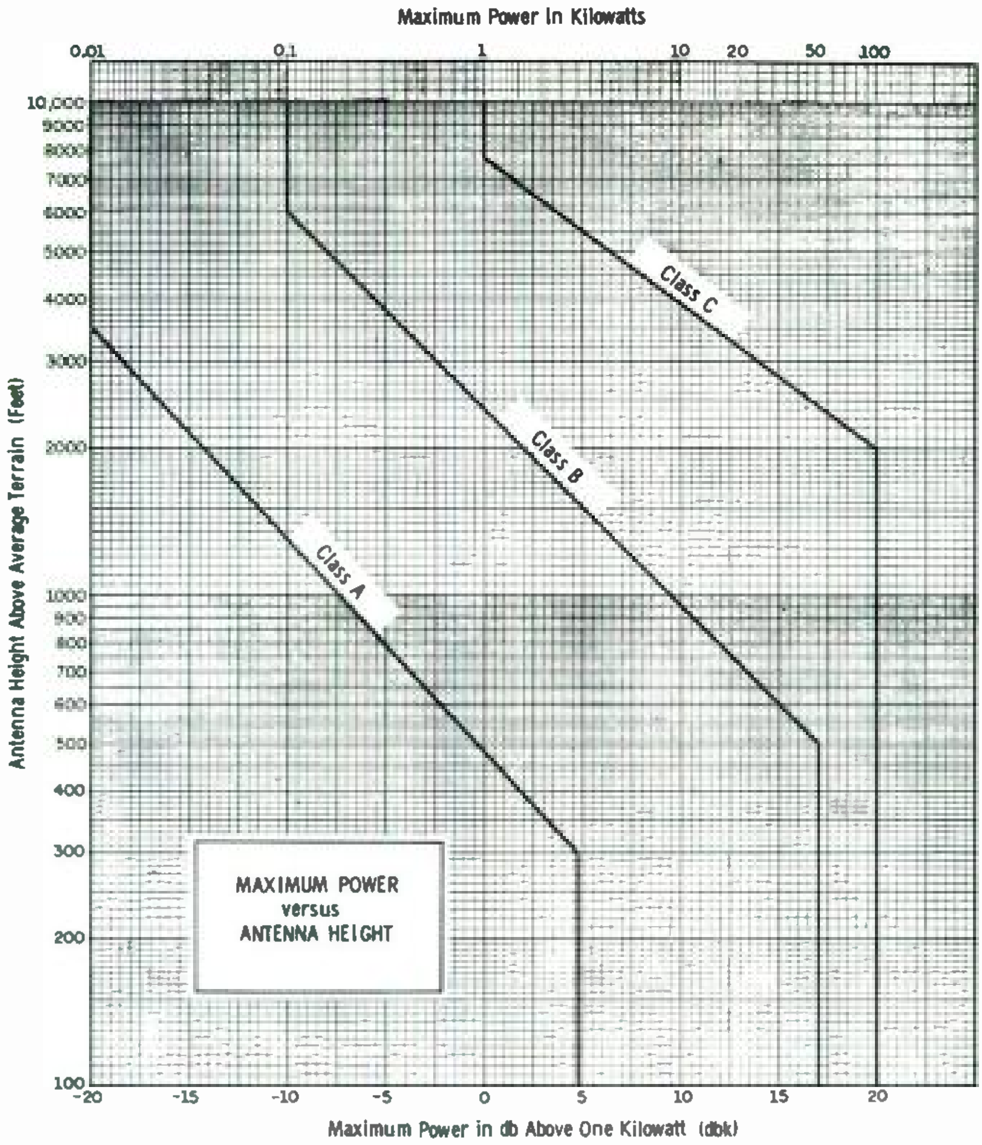


Fig. 2. Relationship between antenna height and power.

made, including the type equipment used and a tabulation of the measured data. If you compute directivity, methods used, formulae, sample calculations[2] and tabulations of the data must accompany the application.

3. Radiation characteristics above and below the horizontal plane illustrated by vertical patterns. Complete information and patterns for angles of ±10° from the horizontal plane, and the portion lying between +10° and the zenith of −10° and the nadir, to conclusively demonstrate the absence of undesirable lobes in these areas.

4. The horizontal plane pattern must be plotted on polar coordinate paper with reference to true north. The vertical plane must be plotted on rectangular coordinate paper with reference to the horizontal plane.

Transmission Lines

Fig. 3 shows entries for the required information on the transmission line. These characteristics vary with frequency: size in inches, coaxial or waveguide, efficiency to produce the desired ERP and, of course, cost considerations. The total length in feet includes the horizontal run from the harmonic filter to the base of the antenna tower and the length up the tower to the antenna terminal point where the gain is rated. Power loss for this length may be determined from the manufacturer's specifications. (See Table IV.)

Expected Coverage Information

Profile graphs of the terrain, from 2 to 10 miles for 8 or more radials from the transmitter location, must accompany the application. One or more radials must extend through the principal city. All radials should be plotted on a topographic map.[3]

The graph for each radial should be plotted by contour intervals of from 40 to 100 feet and, where the data permits, at least 50 points of elevation should be used for each radial. The graphs should indicate the topography accurately and should be plotted with the distances in miles as the abscissa, and the elevation in feet above the mean sea level as the ordinate. The elevation of the antenna radiation center and the source of the topographic data should be indicated on each graph.

The F(50,50) field strength chart, Fig. 4, is used to predict field strength of the contours (Fig. 1 of Par. 73.33 may also be used). The chart is based on an effective power of 1 kw radiated from a half-wave dipole in free space, which produces an attenuated field strength at 1 mile of 103-db above 1 μv/m (137.6 mv/m).

The chart may be used for other powers; the sliding scale associated with the chart serves as the ordinate. Par. 73.313: Prediction of Coverage, explains its use.

If the terrain departs widely from the average elevation of the 2 to 10 mile sector, in one or more directions from the antenna site, the prediction method may indicate distances that are different from what may be expected in practice. For example, a mountain ridge may indicate the practical limit of service, while the

11. Transmission line proposed to supply power to the antenna from the transmitter

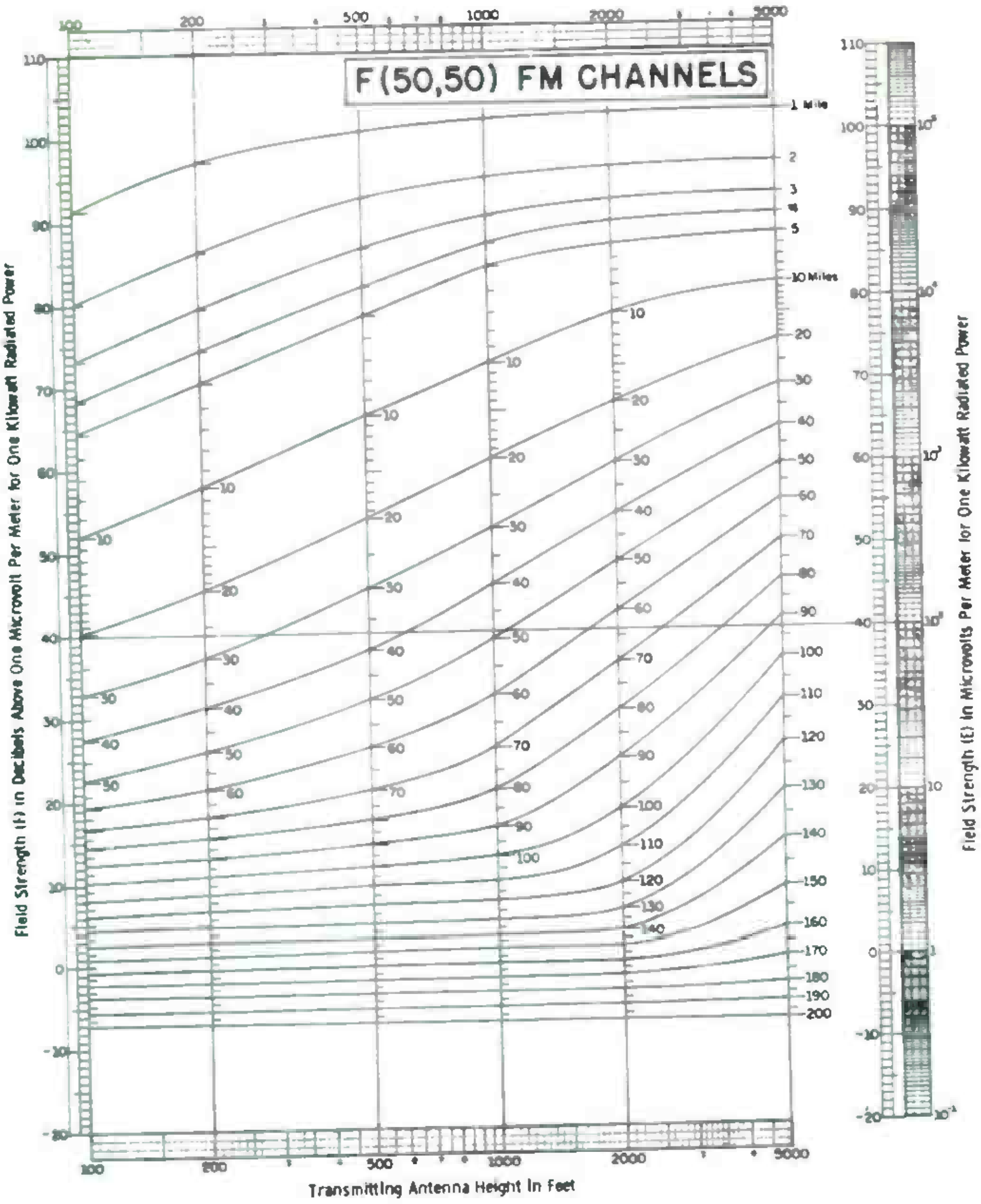
Make	Type No.	Description
Andrew	452 562 A	Coaxial

Size (nominal transverse dimension) in inches	Length in feet	Rated efficiency in percent for this length
3-1/8 3-1/8	280 320	90.6 92.3 83.6

12. Proposed operation

Transmitter power output in kilowatts	Power dissipation within transmission line in kilowatts
7.36	1.20
Antenna input power in kilowatts	**Effective radiated power in kilowatts (Must be same as shown in Para. 2)**
Vert. 2.93 Horiz. 3.23	Vert. 20 Horiz. 20

Fig. 3. Sample entries for transmission and proposed operation data.



FM CHANNELS
ESTIMATED FIELD STRENGTH EXCEEDED AT 50 PERCENT OF THE POTENTIAL RECEIVER LOCATIONS FOR AT LEAST 50 PERCENT OF THE TIME AT A RECEIVING ANTENNA HEIGHT OF 30 FEET

Fig. 4. Chart for predicting field strength.

prediction method indicates otherwise; the prediction method should be followed, accompanied by a supplemental exhibit concerning the contour distances as determined by a method based on actual conditions. The exhibit should describe the procedure employed and include sample calculations. Maps of predicted coverage should include both methods of prediction.

When measurements are required, these should include the area obtained by the regular method and area obtained by the supplemental method. In directions where the terrain is such that negative antenna heights or heights below 100 feet for the 2 to 10 mile sector are encountered, a supplemental showing of expected coverage must be included with a description of the method used in predicting the coverage. The Commission may require additional information about terrain and coverage in such cases.

1. FCC Rules, Par. 73.316: Antenna Systems—Part e.

2. Ground level elevations may be obtained from the U. S. Geological Survey, Dept. of the Int., Wash., D. C. 20240. West of the Mississippi: U.S.G.S., Denver 15, Colo. Sectional aeronautical charts are available from the U. S. Coast and Geodetic Survey, Dept. of Commerce, Wash., D. C. 20235.

3. Topographical maps for most areas are available at a nominal cost from U.S.G.S. If none is published for your area, use the information in Par. 73.312, subparagraph (a) FCC R&R.

Costs for FM Engineering Data

The average cost for engineering, design work, test and measurements, calculations, computations, compiling of data, and filing of Form 301 would be $500 to $1,000 for a nondirectional antenna. There is usually an additional charge of $100 for personnel expenses and the cost of obtaining and entering the data for:

a. Geographic coordinates
b. Topographical maps
c. Sectional aeronautical maps
d. Profile graphs
e. Aerial photography
f. Predicted field strength patterns and contours
g. Instrument approach or landing charts
h. Other incidental materials

Charges for an existing FM station, such as addition of vertical polarization, transmitter power increase, and directional antenna, would cost about $500.

Facts About FM Antenna Structures

An antenna located at a height above the service area, such as a mountain top, may have a pattern null falling in the vicinity of a heavily populated section of the principal city.

If a populated section lies within the area, the broadcaster should have the antenna manufacturer apply electrical beam tilt or null fill or a combination of both.

Polarization patterns, standing wave ratio, and gain may be affected by side mounting an antenna. A performance check should be made before deciding on a final location.

Additional Methods of Determining Topographical Data

Topographical data may be obtained on roads which are along radials from the transmitter site by using a sensitive altimeter.

The average elevation of each radial from 2 to 10 miles may be determined by averaging the mean values of mile or half mile segments.

The height of the antenna radiation center above the average elevation of the radial is: Height of radiation center above sea level minus the 2 to 10 mile average radial elevation.

The free space field intensity in mv/m at 1 mile is measured 1 mile from the antenna with 1-kw input in the half-wave dipole. At this 1-mile point, the field intensity for the half-wave dipole is equal to 137.6 mv/m. This measurement is made under conditions of free space field intensity; i.e., the signal is free from reflections from earth or other objects.

Facts About Form 301

FCC Form 301 is an all-in-one application for authority to construct a new broadcast station, or to make changes in an existing broadcast facility. The various sections include:

- **I. General, Facilities Requested**
- **II. Legal Qualifications**
- **III. Financial Qualifications**
- **IV. Statement of Program Service**
- **V-A. Standard Broadcast Engineering Data**
- **V-B. FM Broadcast Engineering Data**
- **V-C. TV Broadcast Engineering Data**
- **V-G. Antenna and Site Information**

Each Section alone, although requesting a considerable amount of detailed information, is no more difficult to prepare than a Federal Income Tax form. Considered as a whole, however, a broadcaster may wonder if he has the tenacity to see an application through to its acceptance. Obviously, however, applications are continually being accepted, and approved. The reason is that much of the data is prepared by experts—a procedure known to be sound and economical. However, it is also a sound policy for *every* broadcaster to know what is involved, if for no other reason than to realize he should seek qualified help.

Sections II, III, and IV of the form are used to determine an applicant's qualifications for operating a broadcast station. Thus, assuming the other sections, which deal with engineering aspects, are in order, the information these three sections contain weigh heavily in the Commission's judgment of an application. Normally, the information requested in these sections is available, and although they should be completed with the aid of legal counsel, their preparation requires no undue expense. Section V, however, is another matter, especially if a new station is being sought. Depending on the facilities requested, a great deal of time and expense may be involved in making tests, measurements, and calculations for the necessary supporting data. In fact, because of the complications involved in preparing this information, it is the rule, rather than the exception, to enlist the services of a consulting engineer.

Automatic Program Control: Theory & Operation

Charlie Buffington

SINCE THE days when radio programming comprised mostly live studio and network originations, control room equipment requirements have grown from simple console-mic-turntable installations to a plethora of reproducing and switching equipment intended to combine the large variety of program elements prevalent with modern radio. Few stations seem to have escaped the effects of the evolution. Whether AM or FM, top 40 or classical, tightly formated or the more relaxed, all talk and/or news format, there has been a gradual increase in the number of studio sources which must be mixed to produce the desired program output.

Some formats require that material (some of only a few seconds duration) from several sources be played in rapid sequence; other formats may demand only the occasional push of a button due to the added efficiency of tape cartridge decks, etc. In both cases there appears to be inequitable use of personnel—the almost super-human demands of the former or the periods of stark boredom in the latter case. Very probably, more than one station manager has asked himself if there isn't a better way to make more efficient use of a man's time.

Streamlining Program Control

In attempts to better coordinate the overall operation of the ever-increasing number of control room components, many stations have either tried to develop a variety of tone- or silence-sensing, or some sort of simplified switching circuits, or have let things coast along as they will, hoping for the evolvement of better methods. For some years now, actually since the introduction of the tape cartridge, equipment designers have been searching for better ways to control and operate radio program apparatus. Multiple cartridge tape decks with end cue tones to start another tape deck or other unit, or to alert the announcer, have more or less blazed the trail in automatic equipment development, with the intent of lessening the operator burden and improving production and on-air sound. This partial control room automation has helped smooth out some of the rough spots, but all too often such measures eventually turn out to be just a stop-gap and not wholly efficient.

Piece-meal efforts to overhaul control operation places responsibility on the engineering staff to concoct a workable combination of available units. Based on specifications and the stated capability of each unit, the engineering department must assemble a raft of equipment which will perform the desired functions. Quite often, through misinterpretation of equipment specifications or format requirements, the "combination" is over- or under-designed, either falling short of expected performance or possessing capabilities far beyond those required. Then, too, as experience might suggest, when a series of dissimilar units is combined into a single entity, many new problems arise to replace those which were supposed to be cured.

The alternative to developing a homespun rig is to install a complete audio control system customized to the station's format. The mated components of a commercially designed system will perform all switching and mixing functions with automatic precision, requiring only that the operator set up the order he wants. With most systems, extended periods of unattended operation can be programmed in advance, freeing personnel for other constructive duties. With a commercially designed system, there is outside help in gearing the operation to your format; you're not alone in the world with a monster you created.

Automatic Equipment

The first step in selecting any automatic equipment is to develop, *on paper*, a thorough step-by-step analysis of your format. This necessitates bringing all departments into the act, since any automatic operation can ultimately affect sales, traffic, scheduling, and news, as well as programming and engineering. After the miniscule details of minute-to-minute operation have been hammered out, engineering and programming people can sit down with available equipment specifications, and later with manufacturer's reps, and determine which system will precisely fit a specific format.

Unless you can find a system which will do *exactly* what you want it to do, it's foolish to buy it. (No manufacturer will try to sell you one unless he feels it will do the job you want, either.) Any manufacturer will gladly offer all possible assistance in determining the compatibility of his equipment and your format requirements, and many help install the equipment and train your personnel in its operation.

What Can Automation Do

If your format requires that a live disc jockey or personality be on duty at all times, then you want only equipment that will eliminate routine human operations. All recorded material can be programmed in advance and the on-air man merely interrupts when he so desires. Then, at the conclusion of his dissertation, he simply re-initiates the automatic system. With some systems the "live" mic can be automatically turned on at predetermined intervals—after each musical selection, for example—then switched back to automatic operation for the next sequence. After a brief shakedown period, such programming would be distinguishable only by its improved sound, preserving all attributes of so-called "live" operation. The automatic system in this type of operation is used only for cartridge and/or reel-to-reel tape handling; music is either on cartridges or several reel-to-reel tapes. Commercials are similarly handled, on separate tapes, naturally. By adding automatic logging, the operator may devote his entire effort to his on-air work with, perhaps, some extra-curricular activities such as following up news tips by phone, etc. Some stations use a combination of live and unattended operation even with strong personality formats. In this way, entire segments (late morning, early afternoon, late night) can be pre-programmed using a talk tape with record intros and other conversation. Should emergency news or any situation demanding immediate audience contact occur, the automatic system is simply interrupted.

Any system can be designed to provide unattended operation throughout the entire broadcast day with only periodic feeding. With time announcement and network switching equipment, a totally automatic operation will duplicate the sound of live operation desired with some formats. Actually, in some stations, the term "live" is becoming somewhat of a misnomer. Most of the talk is on tape anyway, reducing the primary function of the on-air man to that of a button pusher.

The urge to rush into the installation of any automatic programming equipment can waste large sums of money and result in partial or total disenchantment. With many formats, adapting automatic programming equipment is quite complicated, but there are scarcely any formats which cannot utilize at least some of the benefits. There are instances where less than satisfactory results have been attained with automatic programing equipment. This is due, in virtually every case, to a lack of understanding of equipment capability. Therefore, it cannot be over-emphasized that format requirements be precisely matched to a programming system. For many, this may mean installation by degrees—first the basic unit, then the more sophisticated units, allowing more time for personnel to adapt to preparing daily on-air material and integrating it with reusable material.

Available Systems

Beginning with a simple background type operation, there are systems available for the most complicated format. These can be broken down into three basic types:

Sequential systems simply switch back and forth between two channels at the command, usually, of a tone. However, due to its simplicity, this type of system is used in only the most basic applications. To increase flexibility and provide the use of more than two channels, a series of switches or a matrix board is used to integrate the desired channels. The program element mixing sequence is fixed by specific switch settings or matrix board pin positions and remains so until manually changed. (By using a drum, at least one system offers automatic switching of several formats.) When a preset sequence is completed, a timer is usually employed to reset the sequence so that station breaks and other fixed time features occur at their proper times. More sophisticated clocks have faders which provide an override for material which must be aired at exact times. With a sequential system, it is possible to use several music sources and a single source for talk and commercials.

Insertion systems generally operate with a single music source; non-musical material is inserted between selections on a time basis. Clocks are used to switch in talk or non-music features; insertion times may be changed by changing clock setting. There are systems which offer a combination of the sequential and insertion methods where music sources are controlled sequentially and non-music sources are inserted by clock control.

Random select systems are usually much more sophisticated than other types and, of course, more costly. However, random select systems offer unlimited flexibility. Methods of program control include a series of tones on a tape, a prepared program log, a punched paper tape, or punched IBM-type cards. Program elements are mixed in any manner dictated by the control method and may be changed by altering the information on the control medium. Systems of this type offer an additional function in that they may be tied-in with traffic, logging, accounting, and billing.

Economy of Automatic Programming

Equipment costs vary from several thousand dollars and up, depending, of course, on what is demanded of it. Broken down on a weekly basis, costs range from $60 to $120. Unfortunately, some stations expect that the biggest bonus of automatic operation will be an immediate staff reduction. While this may be true in some cases, it is not the rule; systems purchased with this as the major pretext usually have disgruntled owners in a short period of time and the programming system becomes a stepchild with poorly organized programming and maintenance. The real economy is based on more efficient personnel deployment in news gathering and production, overall production, and participation in community affairs. In other words, instead of devoting a large part of their time to live operation, staff members have more time to spend at or away from the station in sales, news, and public relations activities; the same number of people do more work which will ultimately result in a higher income without a payroll increase. Where it is necessary to maintain a live announcer, either part- or full-time, the real benefits lie in an improved (and more salable) sound with fewer sponsor irritating goofs.

Of course, we must face the fact that not every staff member will, in every case, be capable of swinging into production, news, sales, etc. Therefore, some juggling may be necessary until a workable group is acquired, but most staff members will, after proper indoctrination where appropriate (and some apprehensive grumbling), rapidly visualize the possible merits of a more efficient operation. If not, it's likely they would not have ever been a star employee, anyway, and will leave under their own volition, thereby eliminating the distasteful task of discharging anyone. There is no cause for any industrious individual to fear for his job or value in broadcasting because of automatic programming equipment; he should rather look upon it as a challenge, since any equipment takes people to operate it. Quite the reverse of the expected is true, since any management with enough vision to purchase any amount of automatic equipment generally wants to get the most out of it.

Automatic programming equipment allows AM-FM operations to offer their audience separate programming — two distinct program services—at far less than twice the cost. With only an additional one or two people, or the same staff in many cases, the FM operation can be programmed separately, with the likely exception of news and public affairs programming.

A very religious and thorough preventive maintenance program is absolutely vital to continued flawless operation of automatic programming equipment. If sufficient engineering personnel isn't available for regular cleaning and a series of operative checks, frequent breakdowns or malfunctions may cause heavy revenue losses. The manufacturers' recommendations should be followed to the letter if the equipment is to perform as expected.

Pre-Programmed Music

Several manufacturers offer taped music services covering everything from top 40 to classical, including country music. Many strides in this field have been made in recent years and music for virtually any format is available. Taped music with prerecorded introductions adds to the distinctiveness of a station's sound by adding another voice or two to the on-air staff—a decided advantage to smaller stations. Of course, any station can prepare its own music tapes, on either reel-to-reel or cartridges, by recording promising new releases and selected album cuts; this method is often used where a limited play list is employed.

Conclusion

The only product a radio station can market is its programming or "sound," and the better the sound and audience acceptance, the more marketable the product is. If the present format is successful, it would be foolish to change it simply to meet unyielding automatic equipment. Therefore, a wise manager will make every effort to inform himself, devouring all available information on existing equipment and by visiting stations using such equipment. By observing the equipment in actual operation, it is much easier to visualize how it can be made to fit a particular format and to gain some knowledge of the experience accumulated by other stations.

Well used, automatic programming equipment can produce good results as a production aid or part- or full-time operation. As is the case with any tool, you get out of it exactly what you put into it.

The Cost of Automation

Donald R. Nichols & Keith R. Greiner

IF YOU LISTEN TO A LOT OF STATION OWNERS TALK (as we did through a survey), you will discover that (a) automation is a snare and a delusion that will never work and costs more than it gains; and (b) automation is the only thing keeping the station in business. This contradiction in views arises to some extent because the situation of different stations does differ; automation will not be as effective for some as for others.

How can you figure what automation will do for you? It is usually a fairly simple problem in financial projecting. We give a hypothetical example here which we hope will provide the station operator with a technique he can apply to his own situation.

The approach utilized in our example is a standard technique for analyzing long term equipment purchase or replacement decisions called "capital budgeting." Additional information on the technique may be found in most good corporate finance or managerial accounting books. The basic task in the analysis is to determine the increases or decreases in various costs (incremental cash flows) that would result from automation, and to compare the total with the cost of equipment.

The first step is to identify which costs would be affected by the installation of new equipment. Some of the more important costs usually are: cost of new equipment, taxes, announcers' salaries, engineers' salaries, other production salaries, annual cost of records, annual cost of blank tapes, annual cost of tape cartridges, annual cost of announced or unannounced music tapes for the automation machine, and salvage of present equipment that can be eliminated (control board, tape recorders, cartridge machines, turntables, etc.).

An estimate must be made of the amount of change in each cost that will occur if automation is installed. Quite often useful information about these amounts can be obtained from other stations that have automated or that have considered automation.

The items to be included are:

1) Estimations of reductions of costs.

2) Estimations of increases of costs.

3) Salvage values of the equipment which can be eliminated.

4) An estimation of the cost and depreciation of the entire unit.

5) The tax effects on all the items listed above.

The effects of the costs found above are totaled for each year of the life of the investment. In our example, we have assumed a $50,000 value for the original cost of the automation equipment. The net cash outflow to acquire the automated equipment is then found as follows:

Cost of equipment	$50,000
Net Salvage Value of Equipment Replaced (after taxes)	6,547
Net cash outflows for the Initial Investment	$43,453

We have chosen $50,000 as a kind of mean value for automation equipment which might typically fall in a $25-70,000 range; lower cost equipment would allow a minimum of programming variety and for many stations might result in a lower quality of broadcast. Higher cost equipment gives more flexibility and special items.

The decision on quality and variety of programming is not amenable to quantification; each station owner must make it to match his objectives and programming format.

The salvage value of equipment replaced ($6547) represents the estimated sales value of equipment currently owned by the station that can be sold upon the installation of automation equipment. The difference of $43,453 represents the net cash expenditure necessary to acquire the automation equipment.*

Savings may result from reductions in announcer, technician, and other production salaries; savings on records, blank tapes, etc. Additional expenditures may be required to purchase automated programming tapes, as well as special items (time, temperature, news, etc.). Again, the specific savings and expenditures will depend to a large degree on the type and format of programming that is desired.

This calculation may be accomplished by considering: 1) determination of the incremental net cash flows before tax; 2) determination of the incremental net income after tax; and 3) determination of the incremental net cash flows after tax.

The determination of the annual incremental net cash flows before tax in our example is as follows:

Reduction in recurring costs (salaries, etc.)	$24,700
Increase in recurring costs (program tapes etc.)	−13,600
Reduction in net yearly cash outflows before tax	$11,100

This represents an increase in annual profits. But net income before taxes includes other items that may be deducted for tax purposes, that do not require cash outlays. A major item would be the depreciation on the new equipment. If depreciation is taken on a straight line basis, the annual depreciation may be computed as follows:

Initial Investment	$50,000
Estimated Salvage in Ten Years	7,750
Depreciable Amount	$42,250

If the $42,250 is depreciated over a ten-year life, the depreciation per year is $42,250 ÷ 10 years, or $4225 each year. Finally, net income before and after taxes may be calculated as follows:

Reduction in yearly cash outflows	$11,100
Less: Depreciation	4,225
Additional income subject to taxes	$ 6,875
Less: 30% (assumed) for taxes	2,063
Additional net income after taxes	$ 4,812

* There are some tax implications that must be considered here, but they cannot be generalized. They consist primarily of tax savings (or expenditures) from losses (gains) or sale of equipment and investment credit on purchases of equipment. They will be ignored in the example, but should be considered in a specific decision.

The additional annual net cash flows after taxes, resulting from purchase of the equipment, may then be determined by subtracting the amount of taxes from the increase in cash inflows before tax as follows:

Additional cash flows before tax	$11,100
Less: Additional taxes	2,063
Annual incremental cash flows after taxes	$ 9,037

The $9037 is the amount of increase in cash flows each year as a result of the investment in automation in our example.

Thus far, we have quantified the cost of the investment in automation and the annual savings resulting from that automation. The question then becomes: *Are the savings large enough to justify the cost necessary to obtain them?* If so, our analysis would indicate that we should automate. If not, the analysis would indicate that we should not automate.

The annual cash savings of this example are $9037 for ten years or a total of $90.370. An additional investment of $43,453 was necessary to achieve these savings. Therefore, it appears that the purchase of automation equipment in the example returns roughly twice its cost in savings. This represents a return on investment of roughly 22 percent. However, at least one other factor should be considered before making a final decision: the time value of money. All businessmen know money is not a free commodity, and that it has a time cost (or value). Stated very simply, a dollar held today has more value than a dollar to be received in the future. Even if there were no inflation (which we are assuming in our example), there is a time value of money. We may see this from two rather simple illustrations. Assume you must borrow $40.000 to pay for an investment. For simplicity, we will repay the loan at the end of one year and pay 10 percent interest.

Borrow	$40,000		Discounting		Present	
Interest	4,000		Factor (10%)		Value	
Total cash payments	$44,000	×	.9091	=	$40,000	

Another example of the time value of money can be illustrated by assuming that the cash for the

Table I. Cash Flows for the Investment Decision

Year	Net Cash Flows After Tax	Present Value of a Dollar at 15%	Present Value of Cash Flows After Tax (to the nearest dollar)
1	$ 9,037	.8696	$7,858
2	9,037	.7561	6,833
3	9,037	.6575	5,942
4	9,037	.5718	5,167
5	9,037	.4972	4,493
6	9,037	.4323	3,907
7	9,037	.3759	3,397
8	9,037	.3269	2,954
9	9,037	.2843	2,569
10	16,787*	.2472	4,149
	Present Value of Annual Cash Savings		$47,269
	Less: Cost of Investment		43,453
	Net Present Value (excess of savings over cost of investment)		$ 3,816

* Includes salvage value of equipment in the final year.

investment is available, but that you have alternate investments that can earn 10 percent per year. The cash proceeds from the alternative investment after one year are as follows:

Investment	$40,000		Discounting		Present
Earnings	4,400		Factor (10%)		Value
Total earning plus investment	$44,000	×	.9091	=	$40,000

Both of the above illustrations are examples of the time value of money, demonstrating that the time value can be a very important element in the analysis.

One approach that considers the time value of money is the net present value method. This technique involves "discounting" the cash flows to be affected in the future to compensate for the time value. The rate used would depend on the cost of money and the earnings rate on alternative investments. Essentially, the future flows must be adjusted by multiplying the flow by a discounting factor. This results in the flows being stated at the "present value" after allowance of the time value of money. After this adjustment, the "present value" of the future cash savings may be compared with the cost of the investment. If the savings are greater than the cost, the investment is considered to be profitable; if not, the investment would be undesirable. Table 1 shows the computations at an assumed discounting rate of 15 percent.

If 15 percent were the required rate of return on investments, our hypothetical investment would show a positive net present value of $3816 as shown in Table 1. This would indicate that the savings from automation exceeded the cost.

Finally we re-emphasize that the calculations are unique to this example. Another station in another situation would have different incremental cash flows. The general approach is valid, but the actual figures on cost and savings must be determined from a study of the specific station involved.

Live/Automated Programming

Roderic R. Matthews

THE TREMENDOUS FLEXIBILITY demanded by the programming operations at KRLD AM-and-FM led us to a special approach to automation. Our AM facility is a clear-channel 50 kilowatter served by CBS and ABC. It is heavy on news and sports and uses many network features on a delayed basis. KRLD-FM is a 100 kilowatt, Class C station programming progressive rock, with both live and automated entertainment during the broadcast day.

When KRLD's new studios were constructed about one year ago, we planned for a system that would yield an ever-consistent sound and foremost consideration was given to operator convenience, efficient operation, and flexibililty. This called for automating programming and other operational steps where possible, while retaining all of the flexibility and versatility of instant program changes afforded by fully live operations. The result is a combination of live and automated features, which gains the best of both worlds, and might be best described as "human-automation."

This approach utilizes the human brain (modularly mounted within the head of the announcer) as the main programmer of the overall system. Control pulses (in the form of index-finger motion on control buttons) activate a series of non-human subprogrammers to carry out complex programming operations.

All of the automated support technology—automatic cueing, EOM segues, next event preset programming—are utilized throughout the broadcast day on both stations—whether or not the facililty is fully automated or in a mode combining live and automated operations.

The array of technical equipment involved in the KRLD automated facility includes six custom "Program Logic" consoles provided by the Concept 70 division of Dyma Engineering; two separate program automation systems incorporating nine reel-to-reel transports, four Carousels,® two Gates-55 cartridge handlers, ten single cart playbacks, and Gates SP-14, SC-48, and RA-5 programmers; and virtually all of the individual studio sources—tapes, carts, turntables etc., in the six program logic equipped control rooms.

While the above equipment is used primarily in on-the-air operations, much other automated and semi-automated gear is assigned to off-the-air and production work. Many network programs for broadcast are DB'd, re-cued, and eventually programmed by automation. Other net feeds such as closed circuits are separately recorded and held for the appropriate uses, also automatically.

A separate, centralized delegation system provides instant input selection to 14 reel-to-reel and eight cartridge recorders throughout the plant from 26 stereo sources. The entire plant has been designed as a stereo operation, even to the degree that both AM and FM STL systems are stereo. This compatible concept provides ultimate flexibility in that any studio or either of the automation systems may be utilized for AM or FM programming or both.

To gain a better insight into the overall "human-automated" concept, it is easiest to look at the individual components in the system.

Consoles with a pre-set future

The custom Dyma consoles utilize single push-button control to mechanically start the desired source and place that source's audio on the air. The trailing edge of its end of message, then, will release that source's audio from the program channel. The consoles also incorporate a "preset" feature, where the announcer may select additional sources in advance (as in a conventional automation system), and the console will provide over-lapping segues, cued by the leading and trailing edges of the end-of-message tones.

The six consoles range in size from eight to 15 stereo mixing channels, each with dual inputs per

Master control center handles two stations. The overhead monitor and control assembly raises or lowers to operator's preference.

channel. The input selectors not only switch audio, but also select between the start, stop, and EOM pulse of the two inputs, maintaining automated control of all of the console sources. Full tape motion and other remote controls for sources within the studio and elsewhere in the plant are in-built into the console for ease of operation.

KRLD may be the only station in the country with "automated" turntables since, through the console, automatic segues from a commercial on a cart to music on record are possible and common.

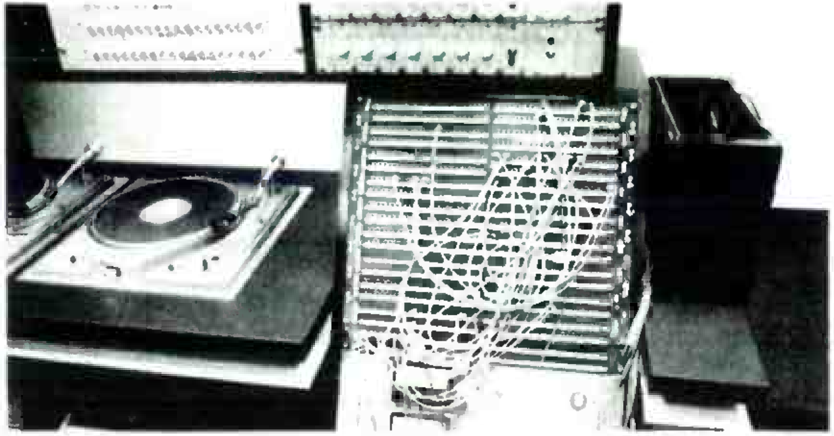
The consoles are interfaced with the automation programmers described below to allow them to work in conjunction with one another during the combination live/automated segments.

A custom Concept 70 automation control console houses the three Gates programmers, carrousels, time pulse generator, network news DB unit, silence sensors, and digital clock and time correction units. The SP-14 programmer utilizes data magnetically recorded on cartridge to program the FM, along with the RA-5 random access and carrousels for spots; and the sequential SC-48 unit is used for the bulk of AM music throughout the day, and full AM operation at night. Two Gates-55 units and two carrousels handle the AM spot load at night, along with several single cart players for jingles, themes, and voice tracks; daytime spots are semi-automated through the announce control room console and cartridge equipment.

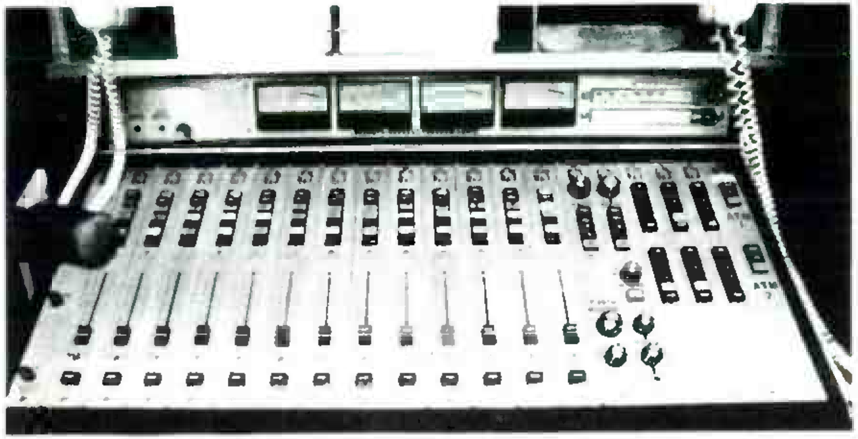
The balance of the automation equipment is housed in nine racks, along with two slow-speed loggers, and two air-check recorders, which automatically operate whenever the FM or AM announce microphones are on-the-air.

An elaborate patch bay, utilizing 24 pin Blue-Ribbon type connectors adds tremendous versatility to the system by allowing virtually all tape and cart sources (in the automation complex and six studios) to be patched into either automation or any of the consoles. In addition to audio, this patching system switches all control, cue, and tally circuitry.

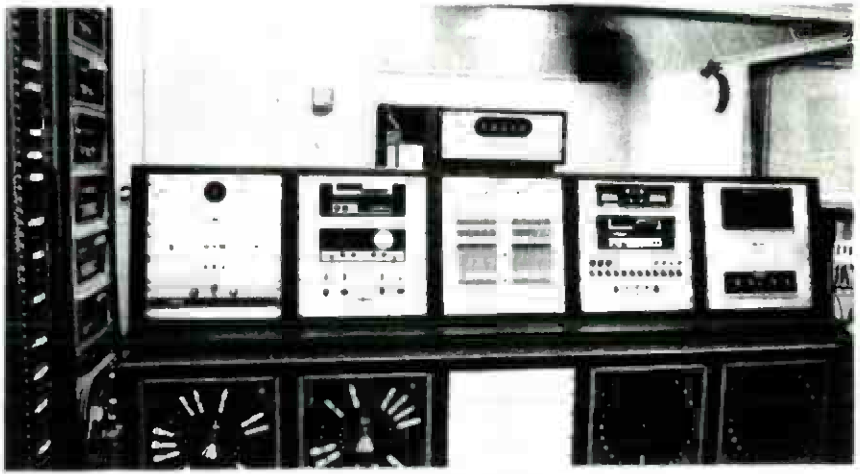
The output of a Gates digital real-time clock is utilized by both programmers, and also feeds time information to the several automatic network delay/record/playback units. A second identical



Master audio patch bay (in master control).



Master control console. Program controls are to right of VU meter.



Automation sources, loggers, net delay machine (left), two separate main programmers including random access for Carousels (right).

clock is operated on a stand-by basis in the event of failure of the primary unit.

In addition to the numerous primary sources available through the three programmers, two separate "sub-source" systems are in operation.

During fully automated periods on AM, commercials are run in a double-spot cluster. To accomplish this, and occupy only one source on the programmer, the two Gates-55 units are set up on a source/sub-source basis. The step pulse from the SC-48 programmer starts machine number one rolling the first commercial. The EOM pulse from that cart (which would normally be fed back to the programmer) is routed directly to the second 55, starting the second spot. The cue tone from this cartridge then advances the programmer to the next source.

Music on KRLD-AM is presented in sweeps of several selections, back-announced over a special instrumental theme bed. During live segments, the music programmer EOM pulse enters the Program Logic console in Announce Control and fires the preset theme cart. The "live" announcer then back-announces the selections. The EOM on the theme music cart rolls the first preset commercial. The rest of the break is automatic from preset cartridges, except for live spots. (We're working on a way to

One of three essential identical "Announcer" control setups.

automate the announcer, but haven't yet found a way to electrically cue him which is both reliable and safe.)

At the end of the commercial break, depressing a single button on the console re-starts the music programmer and returns it to the air. (If the last event of the break is recorded, return to music may also be done automatically, using the preset circuitry in the console.)

During fully-automated segments, this same sequence is accomplished as follows: The theme cart (in the automation rather than control room) rolls at the end of the music sequence. A tertiary tone on the theme cart directly fires a sub-source cart loaded with a daily synchronized voice track, running the back announce over the theme. The theme EOM (via the programmer) then fires the two 55s. The second 55 EOM reenters the programmer and starts a theme/return cart which overlaps back to music on four reel-to-reel decks.

In other segments on both AM and FM, the tertiary tone on a logo/jingle cart will roll time checks (via automation time announcer) over the trailing edge of the jingle bed.

Eight different music sequences are available through the index points on the SC-48 programmer, which has been modified so the arm/skip and index select functions may be remoted from the Announce Control Room. The announcer may, by push-button control, select any music sequence in any order, and may instruct the programmer to the beginning of a new segment when required.

KRLD masters its own music tapes on a ½-inch Scully 282-4 four-track recorder, with track assignments as follows: tracks one and two, program material (stereo); track three, cue tones; track four, voice tracks.

This mastering concept results in KRLD's extremely tight and well-produced music tapes since both major and slight errors in tone placement or voice tracks may be easily corrected without disturbing other aspects of the tape. The four-track masters are eventually dubbed to quarter-track stereo on quarter inch tape through an Ampex M-10 mixdown unit on a Scully 280-4 SP-14.

In the ten months since the new facilities have been installed, several sizeable changes in both AM and FM formats have occurred, and the adaptation of the automated and semi-automated facilities have been instant.

In addition to the automation concepts utilized in the entertainment areas of programming, many of the routine news operations are also automated.

Two tape machines constantly monitor the CBS and ABC net lines. Timer units slaved off of the automation real-time unit are set up to take specific feeds—selected features and closed circuits—and to skip items not to be programmed or used. All recording is done automatically.

A cart recorder, and similar delay broadcast unit, monitors the ABC net to record news for the FM automated operation. The DB unit uses the ten-second advance cue tone from ABC and timers operating on a real-time basis to record the feed, bail-out from the net, and record the secondary tone on the cart to advance the automation following the news. Normally, news is carried on FM only during certain hours. Switches on the DB unit select which network newscasts are to be DB'd and schedule the duration of the recorded feed. Local and state news is produced slightly ahead of air time and loaded into an automatic cart player remote-mounted in the newsroom. When broadcast, the local news cart rolls, cues the delayed network news (operating as a sub-source) which, upon completion, cues the programmer to rejoin automated FM entertainment.

During feeds of actualities or voicers, a back-up tape in master control automatically rolls as protection to the manual selected-dubbing operation accomplished in one of the two news studios.

Program logic consoles are also used in both of the news studios for ease in handling local voicers from beeper and two-way, and field-recorded cassettes. All of these consoles feature human-engineered layouts, and are similar in function to enable easy personnel transition from studio to studio.

It's all visible in master control

Master control, which is really three studios in one, includes a central control center, with tape and cart recorders, net DB and alert units, remote line equalizers, turntables, and dual stereo logic equipped console which is used for routine production and programming. One of the more impressive features to visiting "firemen" of the master control area is the overhead suspended monitor unit, housing all RF monitors, transmitter remote controls, and microwave control and monitoring panels for both the AM and FM transmitters. The unit is winch-suspended, and may be electrically raised or lowered from the console tc convenient operator height, and for maintenance of the equipment it houses.

In its normal position. clear visibility of all monitors and meters is afforded while not interfering with line-of-sight into the five other programming and production studios in the main operations core.

Other areas of MCR include a tape production area for dubbing and automation tape make-up; and the automation control center and numerous racks of automation and support equipment.

Controls in announce, production and news are similar

Three identical control centers have been designed for the AM and FM announce control rooms and production. Flexibility has been added by a delegate switcher system which allows instant selection of any of these studios to feed either or both transmitters or operate independently for production. Two additional similarly laid out control centers are provided for news control (where multi-newsman news blocks are presented in morning and afternoon drive-times) and news production. A separate production and tape editing facility is located in the news "bull-pen" itself, and a smaller production studio is provided within the operations core area for music dubbing and tape make-up.

More coming

KRLD, even with these elaborate facilities, is still in the growing stage. and automation. both in the conventional sense and in the many other ways we have put it to use here, has made many programming and operational concepts not only possible, but easy to achieve.

The key to the successful use of automated concepts, as well as the success of any broadcast studio or transmitter facility, is careful and detailed advance system planning, and programmed preventive maintenance. The engineering staff at KRLD examined carefully the total operational area which calls for visual contact in six studios from master control and demanded of Dyma Engineering specifications to insure complete presence of all types of programming. This approach by KRLD has provided smooth adaptation and switchover from the former conventionally-equipped location. Efficient implementation of technology was insured by using advanced engineering know-how.

Automated Transmitter Logging

Charlie Buffington

FOR YEARS, broadcasters have been faced with the FCC "bugaboo" of logging semi-hourly transmitter readings. Everyone knows what a pain in the neck it is to have to make these readings by the clock. In this day and age, and especially where modern and reliable transmitter gear is used, tedious meter reading and logging often seem a waste of time. Yet, one cannot deny the validity of the Rules, nor the value of properly logged data in preventive maintenance. Thus, it is only natural that more and more stations are resorting to automatic logging equipment as the logical solution.

From a survey of many users of such equipment, logging accuracy is immeasurably better, and a constant, continuous, permanent log of transmitter parameters is provided. It is very easy for a busy operator to overlook regular half-hour reading times. When a chief engineer inspects a manual log, he can't be positive of its accuracy. An automatic log chart, on the other hand, gives him truer and continuous operational readings. Slight changes in operating constants, indicative of impending trouble, can easily go unnoticed in half-hour readings, whereas a continuous recording will readily show intermittent momentary variations.

Effects on Manpower

Aside from the engineering values of having an automatic "watchdog," and a continuous record of transmitter performance, are there any other advantages to be gained? Very definitely! Numerous stations using automatic logging equipment are unanimous on this point.

Automatic logging has freed transmitter engineers and operators from long, boring transmitter watches to handle other important jobs in the control room, in production work and in maintenance. A multitude of financial gains have been derived from more useful deployment of personnel in various phases of operation. Some stations have reported cutting transmitter staffs in half, thereby providing much needed manpower for maintenance and production. In many cases, where nondirectional stations are operating remote, a technician need spend only an hour or so a day at the transmitter site.

One station reduced its transmitter staff from four to two men. Two were reassigned to studio work and the remaining two maintain the equipment and manually log entries during nighttime operation. Another station reassigned three of four men to studio control, leaving transmitter supervision to a resident operator. At still another station, one man has enough time to maintain visual and aural transmitters, two microwave receiving stations, an FM transmitter with two SCA operations, and an FM standby transmitter. Previously, a large part of his time was spent merely logging transmitter readings. Although it's not required (as long as licensed operators are available in emergencies), many stations keep one man at the transmitter, charged with maintenance responsibilities and an occasional check on overall operation.

Equipment Performance

Automatic loggers are meeting and exceeding the expectations of the chief engineers we talked to. Initially, though, some didn't find everything so rosy. Some problems were encountered in matching sampling voltages to logger requirements, and a bit of experimentation was necessary to produce the required levels. While most logging equipment will accept a fairly wide range (10v or so) of input sampling voltage, high plate voltages and currents are tricky to reduce to acceptable levels. Engineers who have worked with remote control gear will find their experience quite useful. If you are installing a remote logger, the sampling voltage problem may not be so complicated since you already have data coming in from the transmitter at levels suitable to most loggers (if yours is a DC system). However, in a few cases, line noises interfering with logger accuracy were reported. This presents a particularly knotty problem since phone company line quality is involved, and the only solution is to improve line quality. Transmitter RF on phone or sampling lines, especially if it's intermittent, gives erroneous readings until it's tracked down and eliminated.

Components used in sampling and alarm circuits, and in the logger itself, must be of the highest quality; at least comparable to broadcast equipment standards. To sacrifice quality is to invite all sorts of problems: repeated failure, difficult calibration maintenance, and the risk of inaccurate readings.

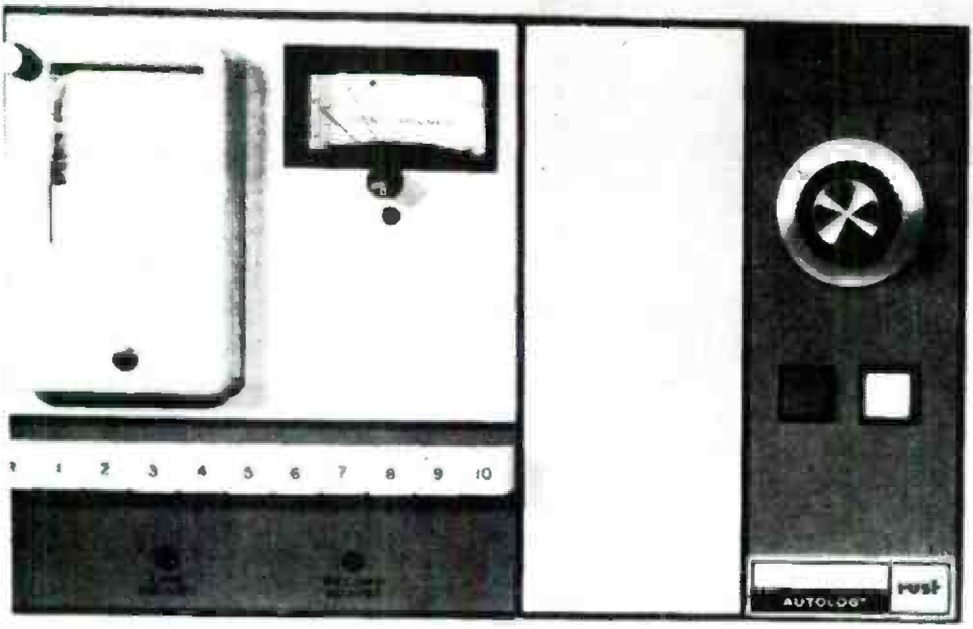
Also, personnel must become familiar with the equipment, which is unlike most other broadcast gear. Adequate installation time serves as a "get acquainted" period and allows for accuracy and stability checks, and "debugging." One chief expressed, as his only regret, allowing insufficient installation time.

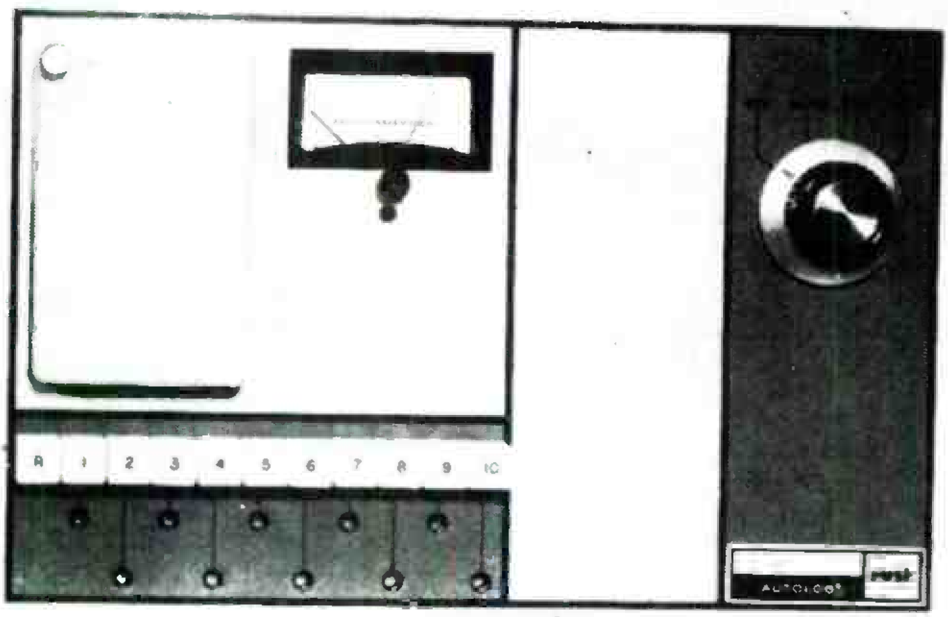
Importance of Maintenance

An automatic logger without a properly moving recorder chart is less than useless. When a new roll of paper is installed, special care must be taken to insure that it is inserted properly and moving at its proper pace. If carelessness in setting up the recorder is permitted you may discover later that you have no operating log for an entire day! Chart paper quality is of utmost importance; use of cheap, off-brand paper may result in sprocket hole tearing, as it did in one station, which wound up with no operating log for several hours.

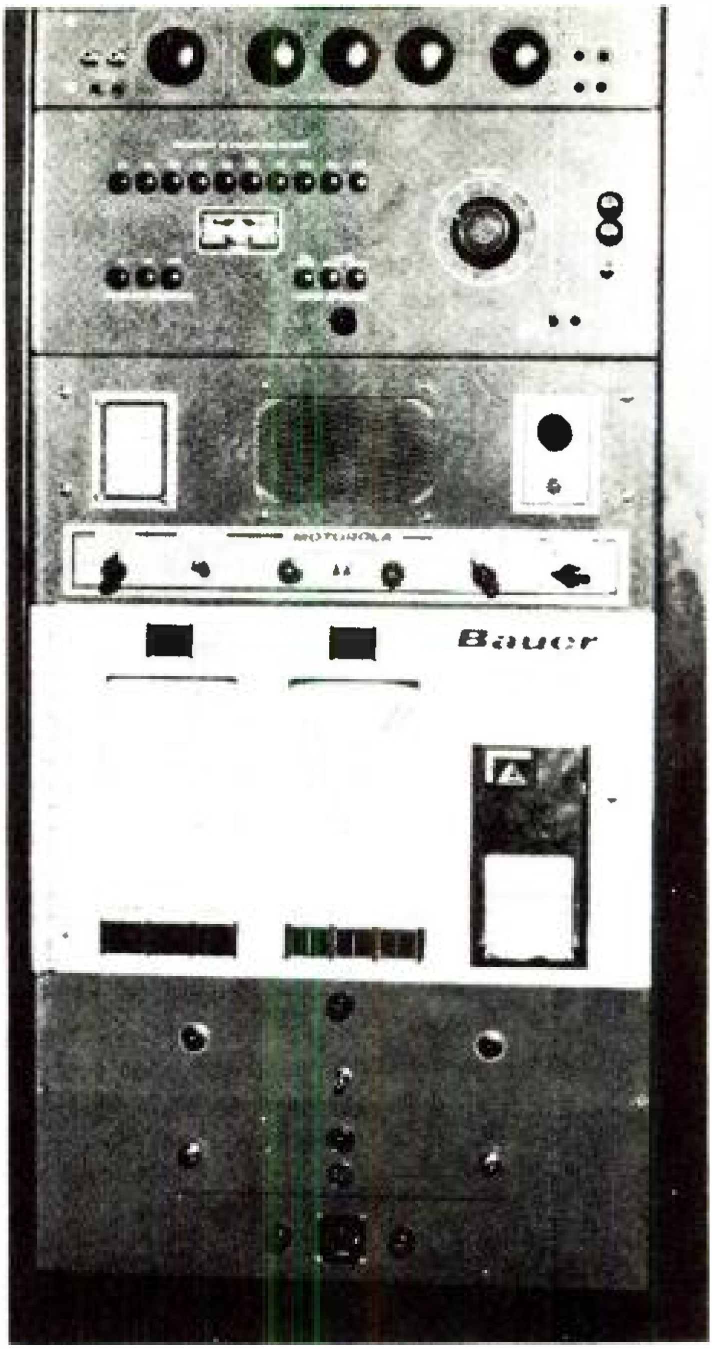
Logging Procedures

Some stations remove the length of chart at the end of each broadcast day and attach it to a daily log sheet containing carrier on and off times, tower light records,





Rust AUTOLOG equipment is designed for local or remote logging. Requiring a single pair of metallic phone lines, the AL-100R is compatible with DC remote control systems and will use the same pair of phone lines. Sampling voltages are fed through one of the remote metering positions. Sampling voltages of 10mv to 10v, usually derived by sharing remote control samples, may be fed into any of the 10 inputs. Readings displayed on the chart recorder appear as continuous lines which vary in direct proportion to any parameter variation. Each parameter is also displayed on the panel meter beside the chart. The system provides continuous alarming of desired parameters, and when a pre-set upper or lower limit is exceeded, it stops sequencing on the defective position and indicates which parameter has varied. Contacts for aural alarms are incorporated for instant alerting. Rust Model AL-100, designed for local logging, has identical basic features.

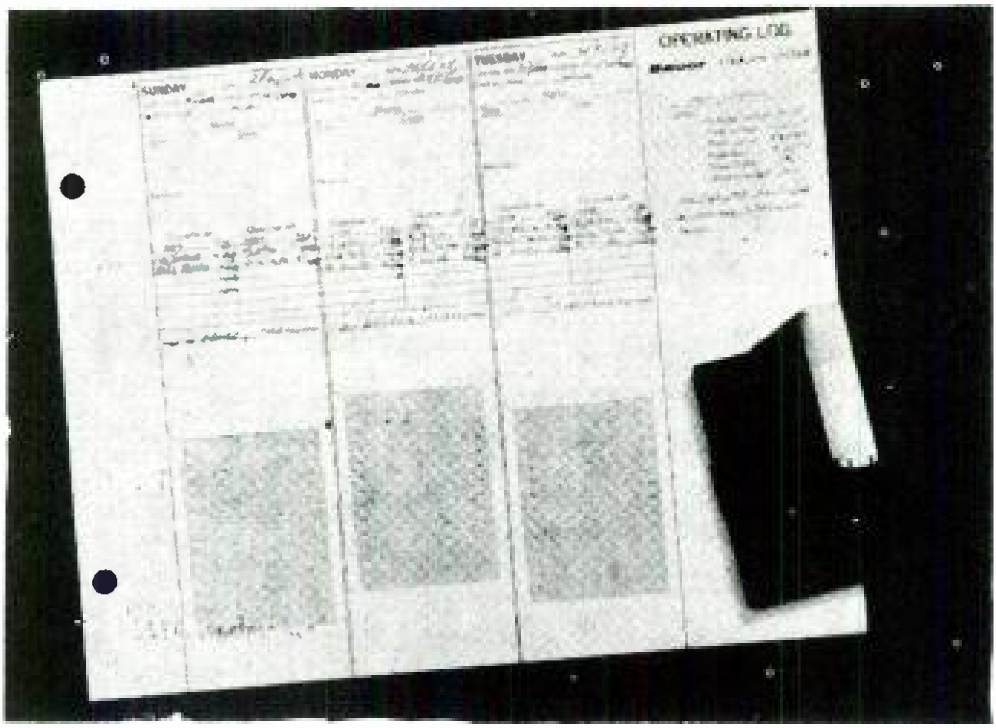


Bauer Log-Alarm equipment records necessary parameters 7 times each hour on a 1" per hour strip chart. If transmitter frequency or power output varies beyond preset limits, the unit sounds an internal alarm, plus external alarms at any desired location, until the condition is corrected.

DA phase readings, etc. Others leave the roll chart in place until used up before filing it in the records. In the latter case, the date is stamped on the chart at the beginning of each day.

What About Costs?

Surprisingly, automatic logging equipment is fairly reasonable, ranging from a minimum of \$2,000 to as high as \$5,000 where



Automatic logging charts become a part of the daily operating log. This form provides a complete permanent record of transmitter operation.

a more complex installation is involved. TV and AM-FM stations will need two loggers to accommodate both transmitters.

Automated logging installations in remotely controlled stations require phone lines capable of carrying DC. If existing lines fulfill the requirements, without disrupting remote control and fail-safe functions, installation costs will be that much lower. If transmitter sampling circuits do not exist, they will have to be installed. If the transmitter was designed for remote control, at least some of these sampling circuits can be adapted to feed the logger. Manufacturers' recommendations should obviously be closely followed. Sampling voltage *levels* are critical; if they are not at recommended values, logger calibration will be difficult to adjust and maintain.

Most logging equipment uses internal relays to operate external parameter tolerance alarms, but it's up to the station to devise necessary alarm apparatus. Bells, buzzers, flashing lights, or any combination of devices which will attract attention will do the job. Intermittently ringing bells and buzzers and flashing lights have been found to attract attention more readily than a steady ringing or buzzing, or a constantly glowing light.

Is Automatic Logging For You?

While it may be possible to do so, it usually isn't practical to discharge transmitter staff personnel whose jobs are eliminated because of automated logging equipment. Most stations have found that they have a need for technical personnel in other phases of their operations. On the other hand, after a period of stabilization, an employee who resigns may not always be replaced.

From a manager's viewpoint, automated logging makes it possible to accomplish more with the same number of people, and to enhance better technical operation. There are many ways to use an engineering staff's additional time to advantage — more thorough maintenance, for example. Better maintenance is almost like money in the bank!

Your situation must, of course, dictate whether or not automatic logging will be advantageous to you. Stations using it say it's a wise investment.

Remote Transmitter Control

Leo G. Sands

SHOULD YOU lease wire circuits or install your own radio link? Or, is it wise to even consider going remote at all. Much depends upon economics, and the quality and reliability of available leased circuits. Where circuits of adequate quality are available or can be made available without paying excessive construction costs, leased circuits are usually less costly.

A radio link installation, on the other hand, requires a substantial initial investment, but recurring costs are generally lower. It provides considerable flexibility; it can reach into areas where link services are not available; and it enables expansion of remote control facilities without increasing the cost of the transmission medium.

Circuit Requirements

Four or five circuits are usually required from the transmitter site to the remote control point. As shown in Fig. 1, these include (1) a *control* channel, (2) a *telemetering* channel, (3) an order wire, (4) a program circuit, and, if stereo facilities are required, (5) a second program circuit.

The program circuits already exist if the studio and transmitter are at different locations. Don't forget to include the present cost of leasing one or more program circuits when you consider the total cost of a radio link against the total cost of leasing all of the required circuits.

Control Channel

The control channel may be a so-called 0-15 cycle circuit which may be a true metallic hookup capable of passing DC, or a derived circuit which does not pass DC but provides a relay at the transmitter site with control contacts at the remote point. These two types of circuits are illustrated in Fig. 2.

Or, a *voice grade* telephone circuit may be used to provide the equivalent of up to 32 circuits of the type shown in Fig. 3, by employing *tone multiplexing.*

Telemetering Channel

The true metallic circuit in Fig. 2 can be used for direct analog measurement. A derived 0-15 cycle circuit, which does not provide a

DC path, can be used for remote measurements of transmitter currents and voltages by converting them into coded pulses. A single circuit of either type can be used for both control and telemetering. The cost of leasing such a line is usually around $1.50 per mile per month. A voice grade telephone circuit, costing around $3 to $5 per mile per month, can be used to provide up to 32 telemetering channels by employing tone multiplexing.

Order Wire

The order wire may simply be a common carrier telephone hookup between the transmitter site and studio. Or, a separate voice grade telephone circuit may be leased, terminated at each end in a local battery, magneto telephone, or intercom unit of the type ordinarily

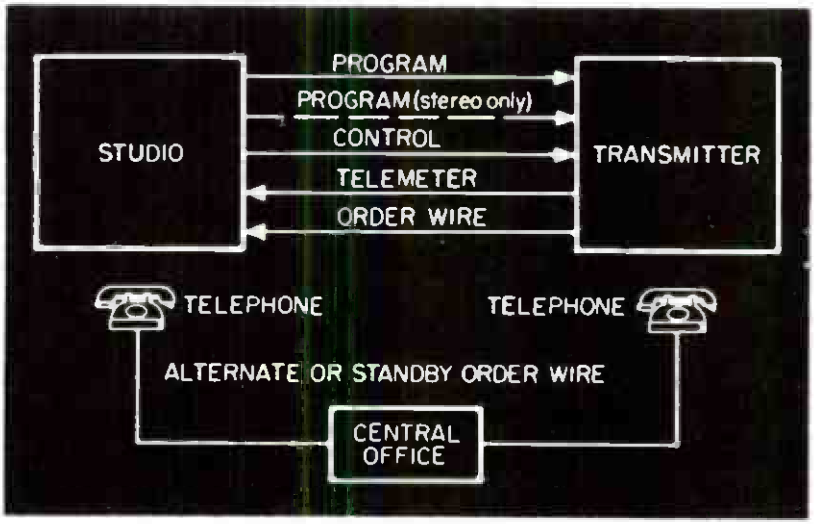


Fig. 1. Remote Control Circuit Requirements.

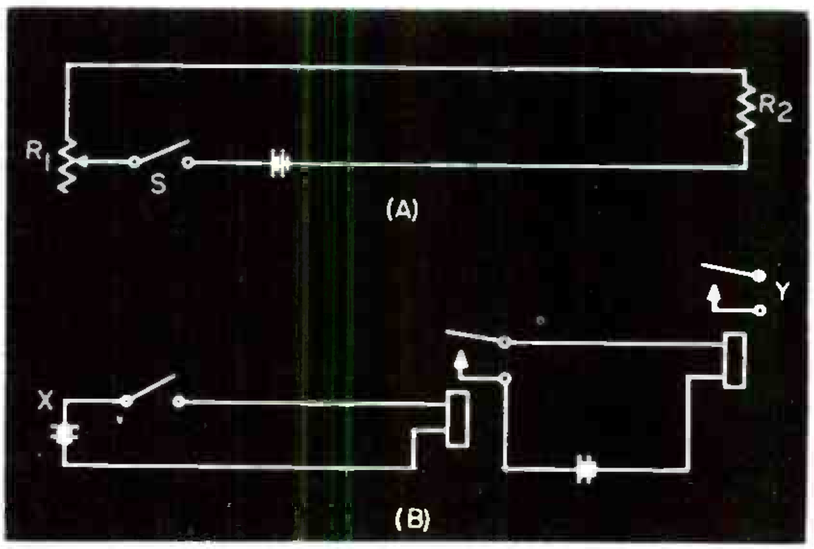


Fig. 2. Two Types of Metallic Circuits. (a) Metallic DC Circuit can be used for transmission of quantitative information. (b) A signaling circuit may not necessarily provide a direct DC path from X to Y.

used for remote control of mobile radio system base stations, as illustrated in Fig. 4. On the other hand, the order wire may consist

Broadcasters are eligible for station licenses in the Business Radio Service and Citizens Radio Service for other than program

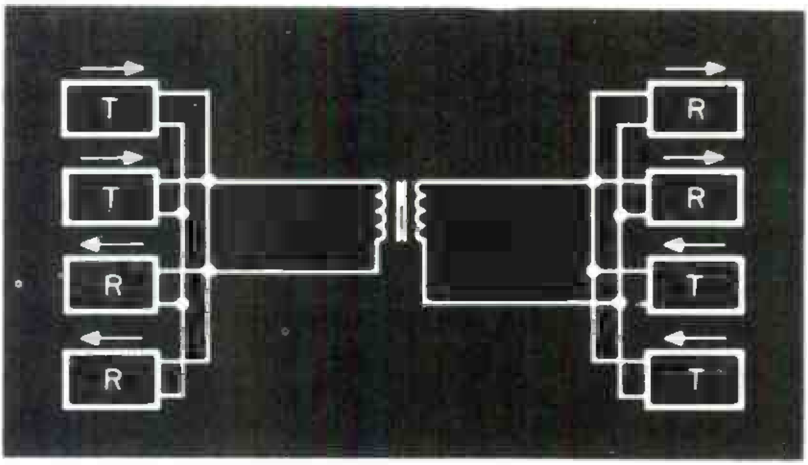


Fig. 3. Up to 32 tone channels can be accommodated by a voice grade circuit. Transformer illustrates that DC path is not required.

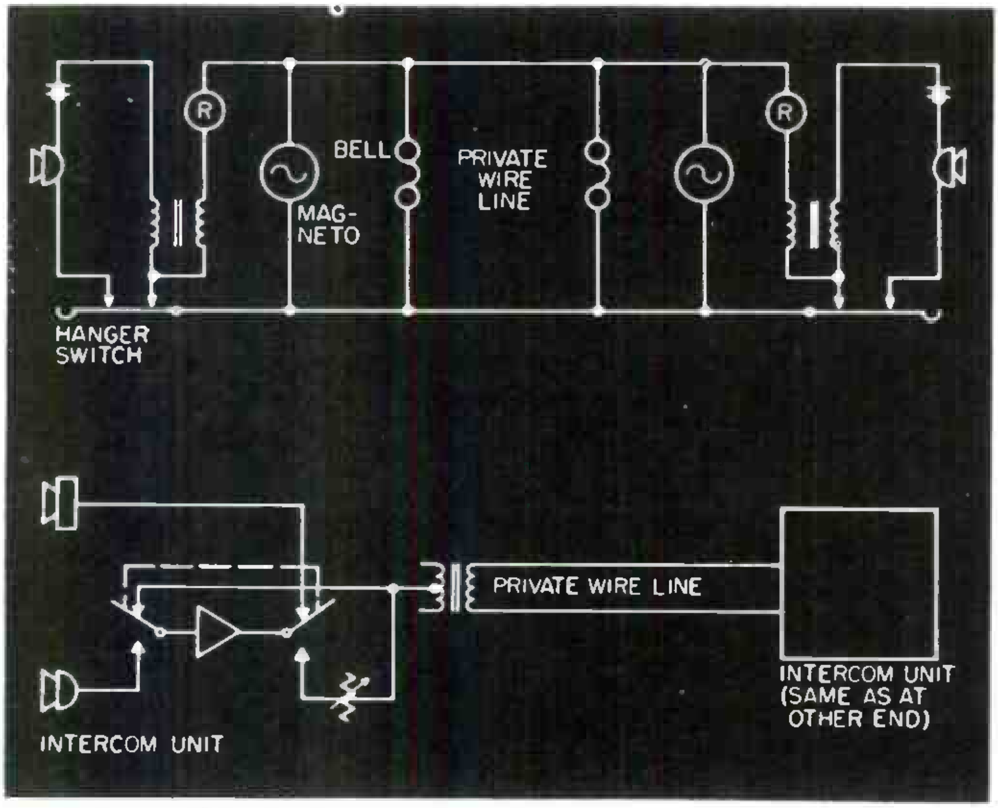


Fig. 4. Private Line Order Wire Circuit.

of a single-channel, reversible two-way radio link, as illustrated in Fig. 5, preferably equipped with tone squelch to mute the receivers except for desired signals.

transmission. Thus, the radio transmitter-receiver at each location may be a Class-D Citizens radio unit, or a 5-30 watt AM unit operated on one of the 27-mc business channels. A 3-watt (or lower power) unit may be operated on one of the low-power business channels in the 5-50 mc, 150-173 mc, or 450-470 mc mobile radio bands, on which fixed communications are permitted. Or, a UHF/FM unit may be operated on any one of the 48 Class-A Citizens channels in the 450-470 mc band with input power up to 60 watts.

Program Channel

The program channel (two for stereo) must meet the frequency range requirements stipulated by the FCC for the type of broadcast station. A leased program circuit generally consists of an *equalized* telephone circuit. Rates are higher than for voice grade circuits, even if it's simply an ordinary telephone circuit with one or more equalizers.

An 890-960 mc band radio link, licensed under Part 4 of the Rules, may be used to provide one or more program channels.

Combined Circuits

A single broadband circuit, if available, can be used to provide one or two program channels plus the control, telemeter, and order wire circuits by employing frequency division multiplexing. The broadband circuit must have adequate frequency bandwidth to accommodate all of the channels, as provided under telpak tariffs.

When the broadcaster has a right of way where he can install a suspended or buried coaxial cable, all of the channels can be accommodated by a single cable, as shown in Fig. 6.

If such a transmission medium is not available, the program channel(s) may be independent and one voice grade telephone circuit may be employed for control, telemetering, and order wire purposes.

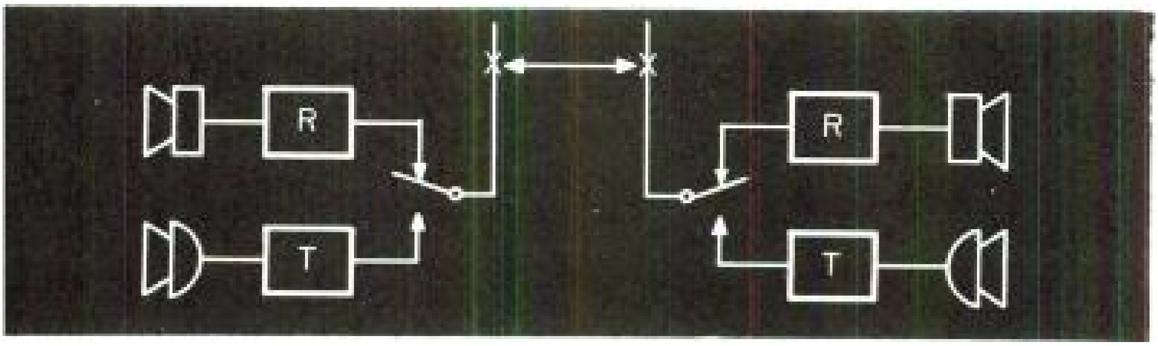


Fig. 5. Radio Link Order Wire.

DC or 15-Cycle Circuits

When a DC or 0-15 cycle circuit is used, remote control is achieved by dialing specific numbers to perform various control functions, such as turning on transmitter filaments and transmitter plate voltages, reducing power, increasing or decreasing plate and filament voltages in discrete steps, switching over from the main transmitter to standby, etc.

The same circuit can also be used to observe power line, filament, and plate voltages, plate and antenna current, frequency and modulation monitor readings, and for determining if the tower lights and flashers are functioning properly. Each circuit to be monitored is dialed. Selectors at the transmitter site connect the remote

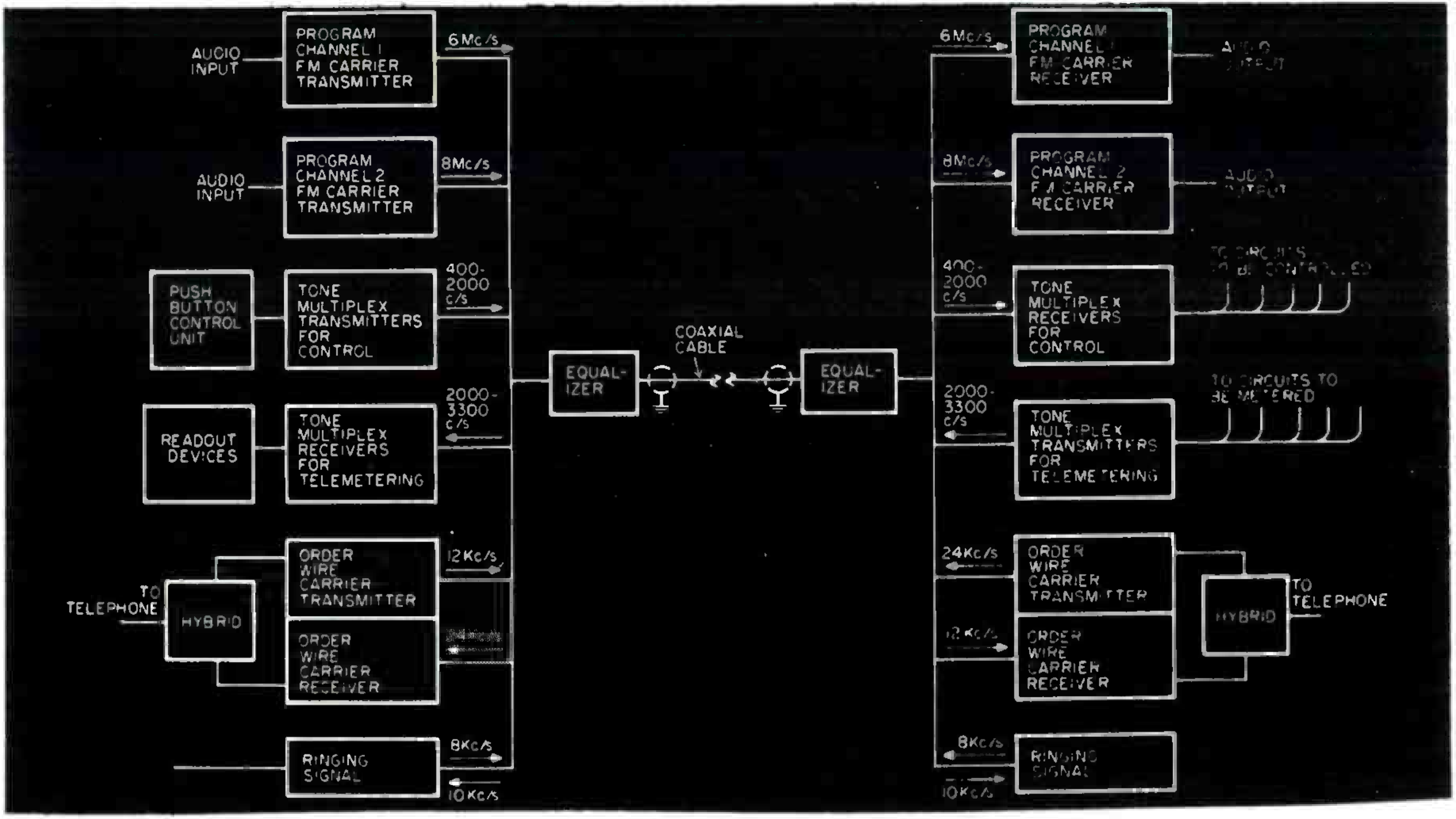


Fig. 6. Short-haul coaxial cable system for programs, order wire and simultaneous remote control and telemetering.

nel frequency is transmitted when S is in its center position. When S closes one contact pair, the tone is shifted up; when in the opposite position, tone decreases in frequency.

The output relay (K) may be a three-position differential or polar relay, which is normally in its center position and is pulled one direction or the other, depending on whether the frequency shifts up or down.

Or, separate output relays may be provided for all three tone frequencies, as shown in Fig. 8D. When S1 is closed, relay K1 pulls in; K2 pulls in when S2 is closed. Both switches should not be closed at the same time. Relay K3 operates whenever the tone frequency is shifted.

Since each tone channel operates on a different frequency, several tone channels may operate simultaneously on the same circuit. Up to 32 tones can be transmitted, in either or both directions, over a voice grade circuit.

Speech Plus Tones

Three or more tones may be transmitted along with speech over a voice grade circuit without mutual interference by using filters as shown in Fig. 9. The filters may cut a slot in the voice band at around 2000 cps or attenuate frequencies above 2600 cps or higher, allowing room for tones at the top of the voice band.

ON-OFF and FSK tone equipment is available from several manufacturers. Any combination of ON-OFF and FSK tone transmitters and receivers and common power supply may be stacked in a 19-inch relay rack to accommodate the desired number of modules. In lieu of the power supply module, or as its standby, a 12-volt battery may be used as the power source.

An ON-OFF or two-state FSK tone channel can be used to transmit GO-NO/GO intelligence (mark and space signals). A three-state FSK tone channel can be used to transmit such commands as forward-reverse, up-down, fast-slow, increase-decrease, etc. A combination of these systems can be used to transmit more complex intelligence, including quantitative information, by coding the tone pulses or varying their duration, repetition rate or relationship.

In addition to keyed tones, there are tone systems which convey quantitative information by stepless variation of the tone frequency. As shown in Fig. 10, the tone frequency is varied by changing the voltage applied to the tone transmitter. The output of the tone receiver is a DC voltage which is proportional to frequency. For telemetering, the DC voltage to be measured (reduced if necessary) is applied to the tone transmitter and the value of the voltage is read on a meter connected to the output of the tone receiver.

Current is measured in the same manner by connecting the tone transmitter input to a series resistance in the circuit being monitored. RF and AC can be measured by rectifying it.

A variable frequency tone channel occupies more space than a keyed tone, and thus fewer can be accommodated within the same transmission band.

Radio Links

An 890-960 mc band radio link can accommodate all of the required circuits. An FM radio link licensed under Part 4 of the Rules may employ up to ±200 kc FM

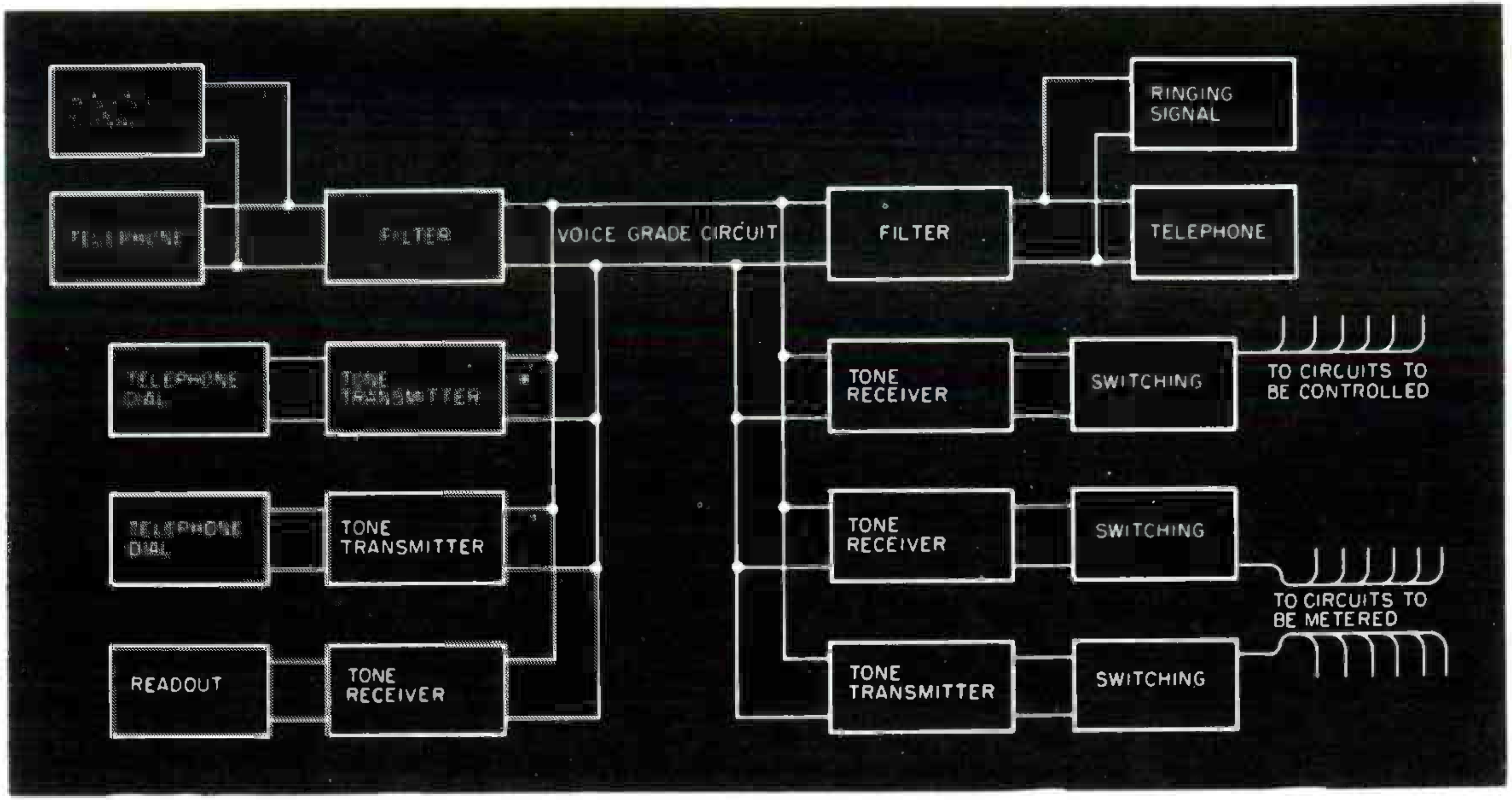


Fig. 9. Combined order wire and sequential remote control and telemetering system.

frequency deviation and, when employing a 4:1 deviation ratio, can accommodate up to 50 kc of intelligence.

A two-way link (Fig. 11) provides the same amount of band space in both directions. When broadband transmission is required in only one direction, the transmitter-to-studio artery may be a DC, 15-cycle, or voice grade wire line, or a narrow band radio link.

The narrow band radio link could operate in the 72-76 mc band, except when close to a TV station operating on TV channel 4 or 5. Or, it could operate on one of the 26-mc channels on which 30 watts input power and any kind of emission can be employed as long as band occupancy does not exceed 8 kc. The transmitters may be remotely actuated. Licensing would be in the Business Radio Service on a shared basis with other services, with no guarantees against interference.

Special narrow bands of frequencies are also available in the 25-50 mc and 150-174 mc bands to business radio applicants on a developmental basis. Any kind of intelligence may be transmitted within the specified frequency limits.

Or, the return link could operate on one of the 48 Class-A Citizens channels in the 450-470 mc band using up to 60 watts input. Class-A stations may be remotely controlled. For example, a tone could be transmitted from the studio via the broadband link, which would turn on the narrow band transmitter when a meter reading is made or control function is verified.

Ordinarily, Class-A stations are authorized for AM or FM radio-telephoning only, but the FCC may authorize use of other emissions upon adequate showing of need. While the point being made is that the operation of the return radio link on business or Citizens channels is technically feasible, such use, from the standpoint of acceptability for broadcast transmitter telemetering, must be approved by the FCC.

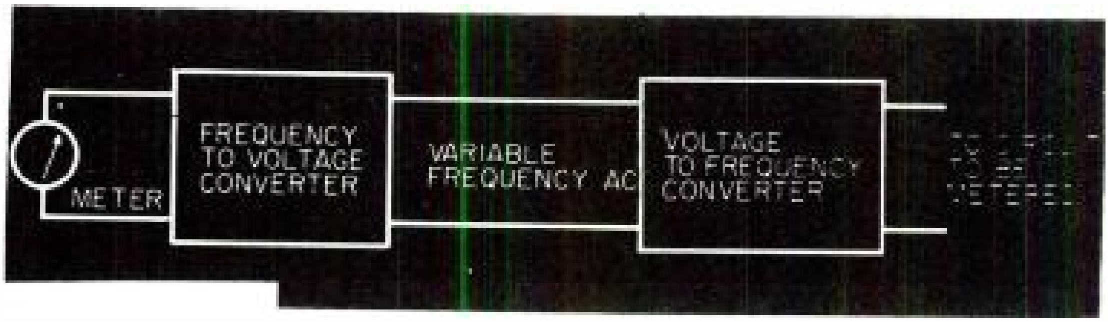


Fig. 10. Analog telemetering system.

While more expensive, a 12,000-mc band microwave link could be used to transmit telemetering signals from the transmitter to the studio. There is ample bandwidth for transmitting video signals from a closed circuit TV camera to a monitor at the remote control point. One or more remotely selected TV cameras could be used for direct viewing of the transmitter's meters as well as the tower lights.

Telemetering

The simplest method of transmitter telemetering employs direct selective connection to the

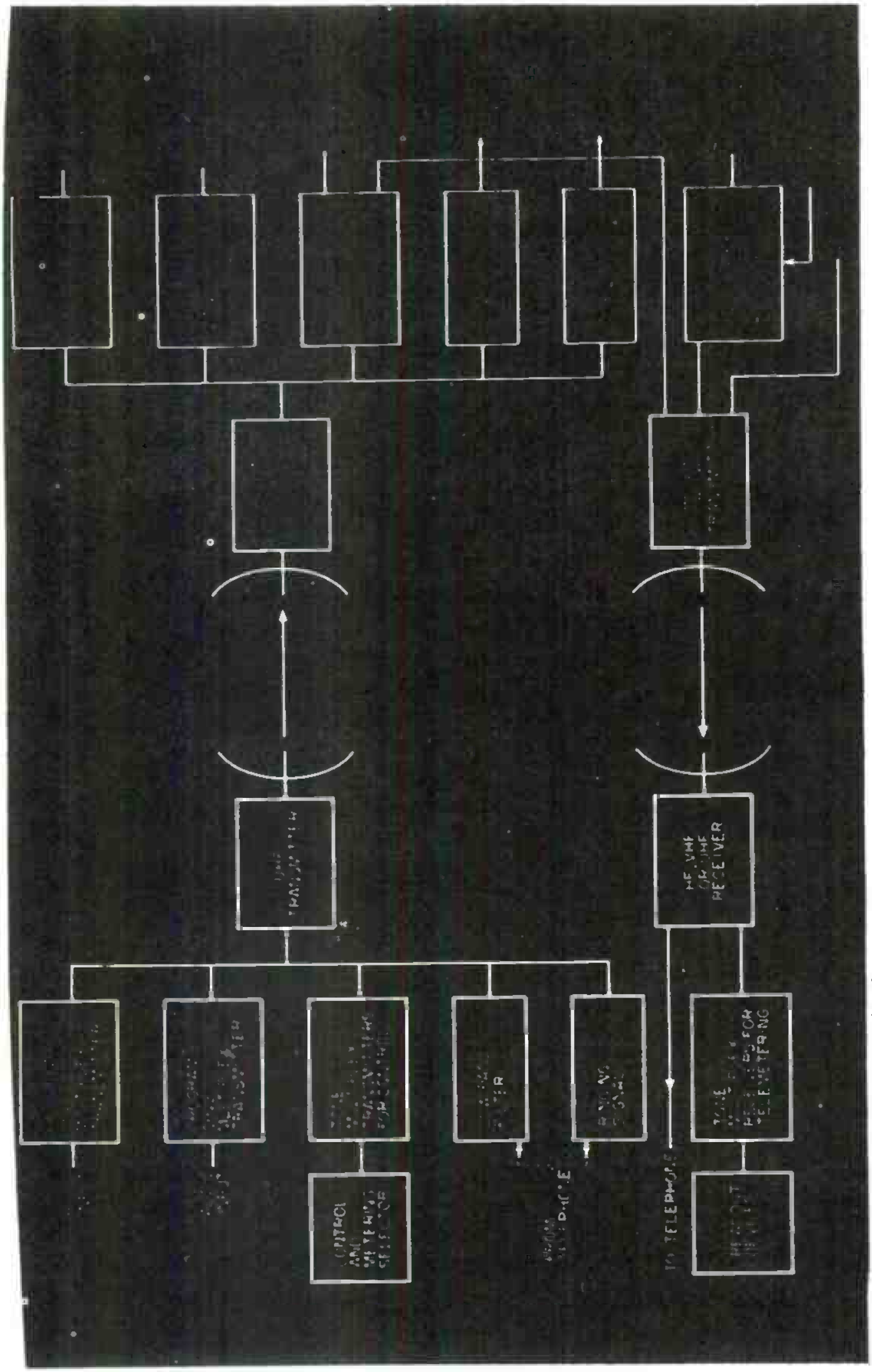
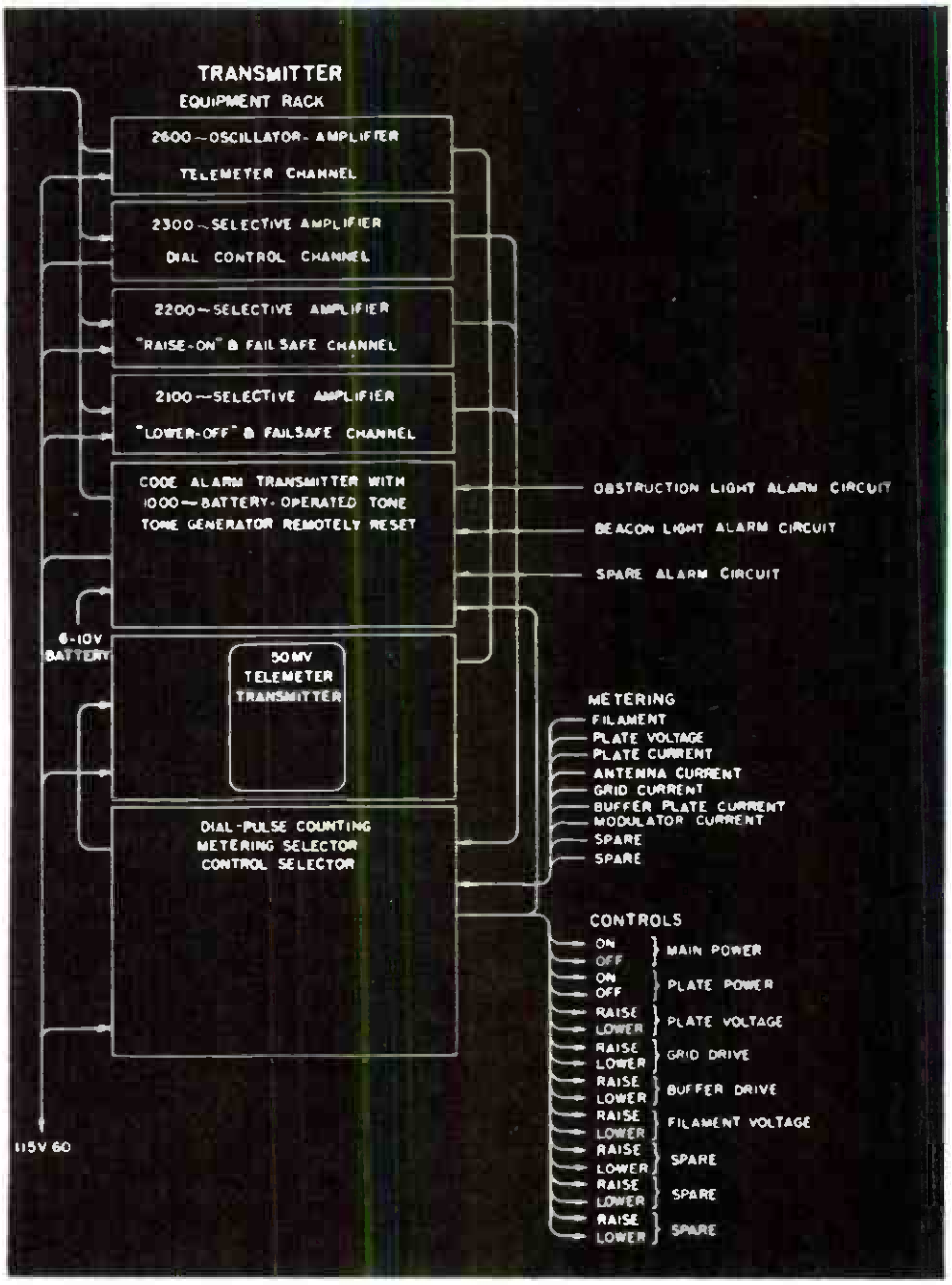


Fig. 11. Radio link block diagram.



compatible with wire line or radio link.

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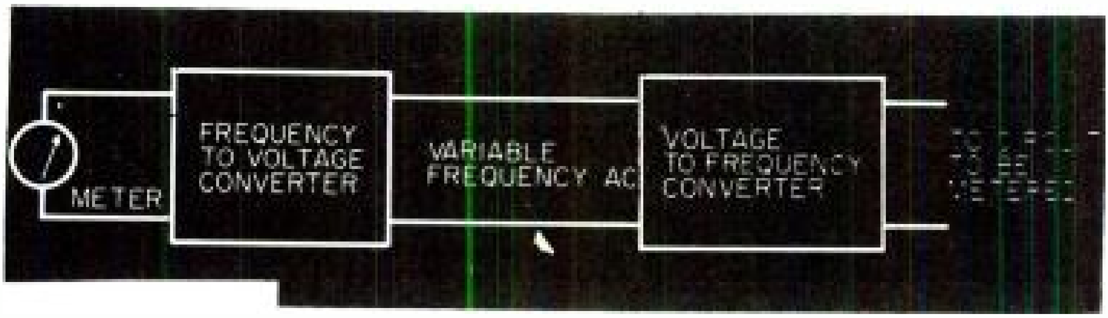

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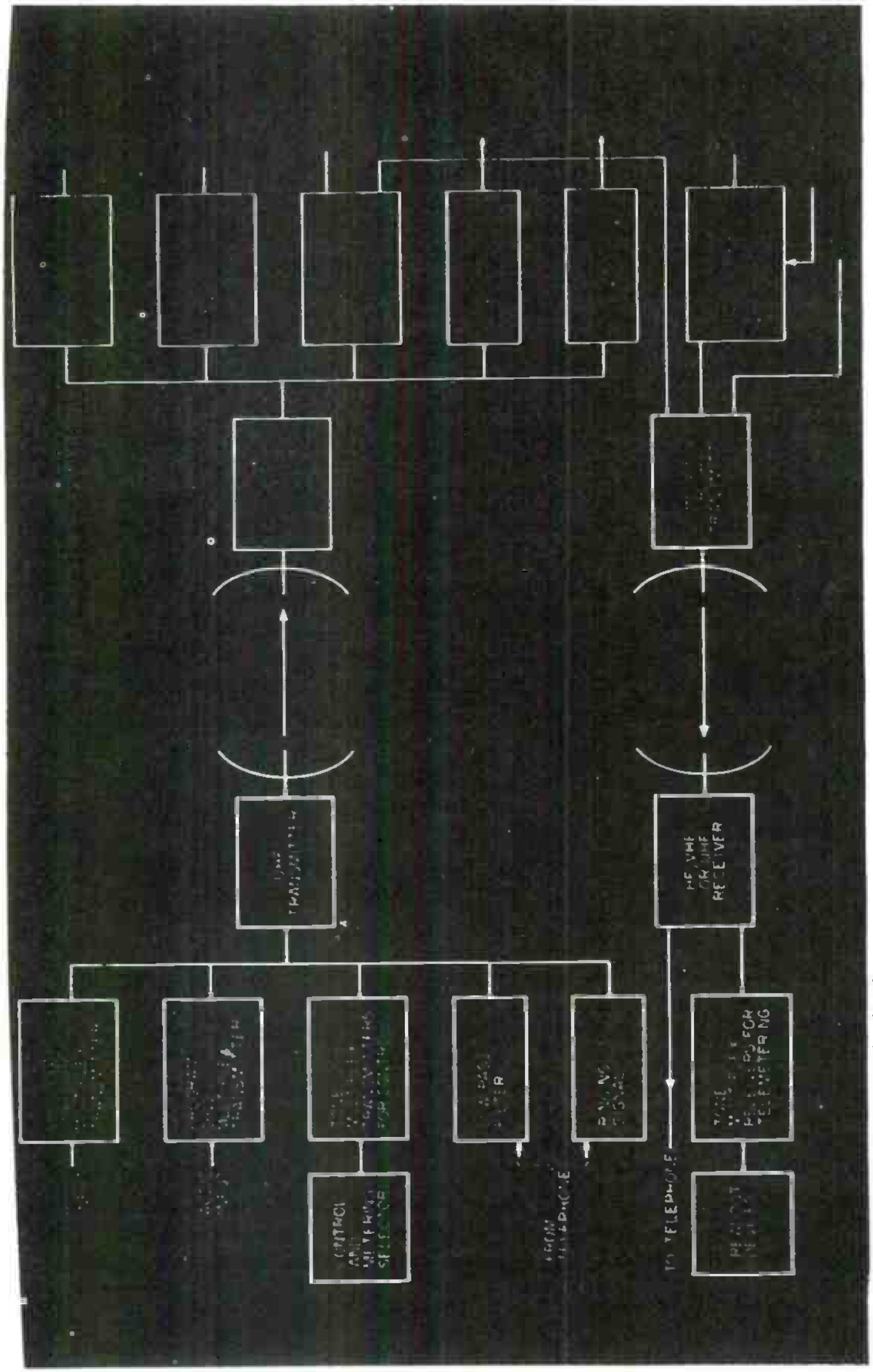

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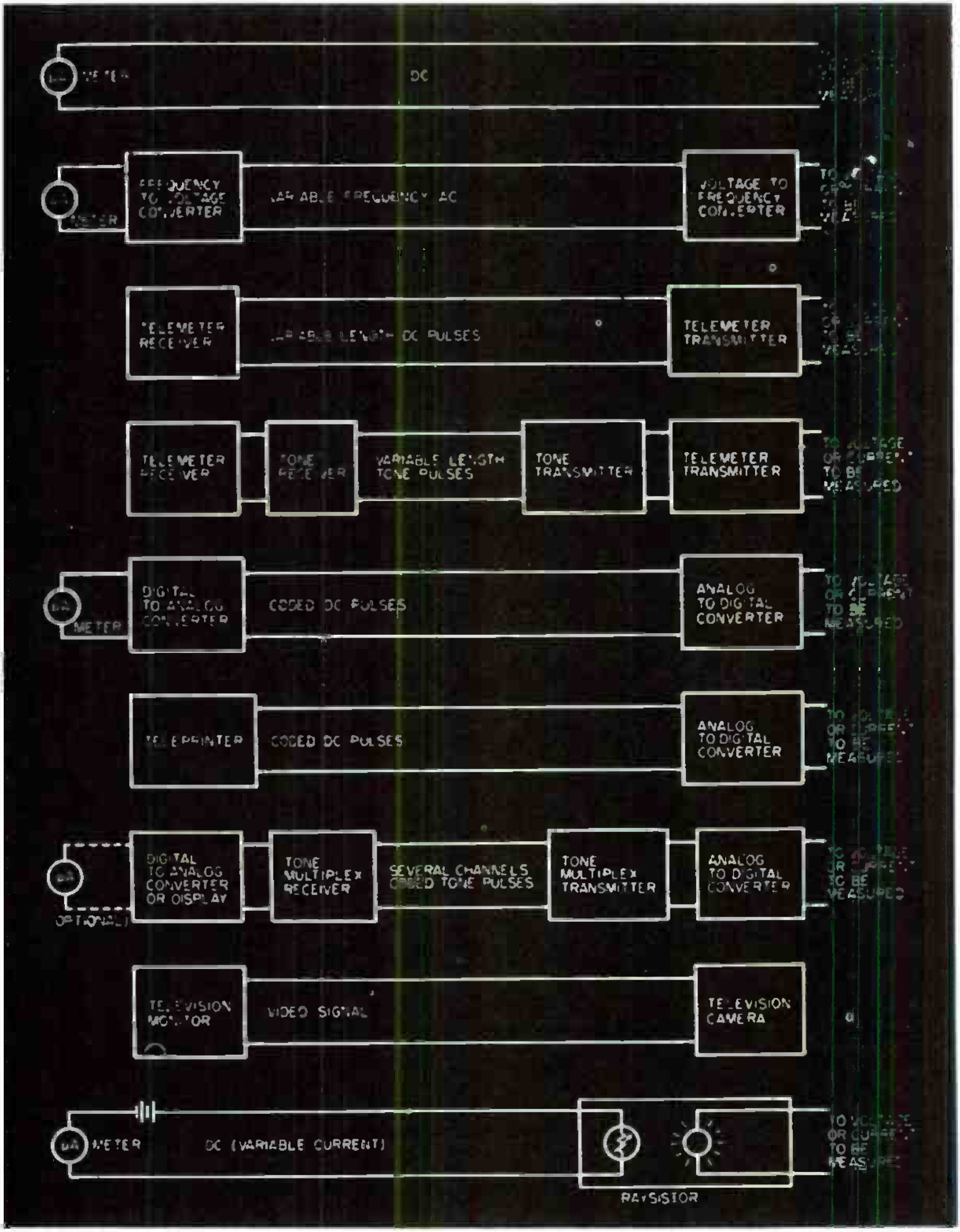


Fig. 12. Block diagrams of various telemetering circuits.

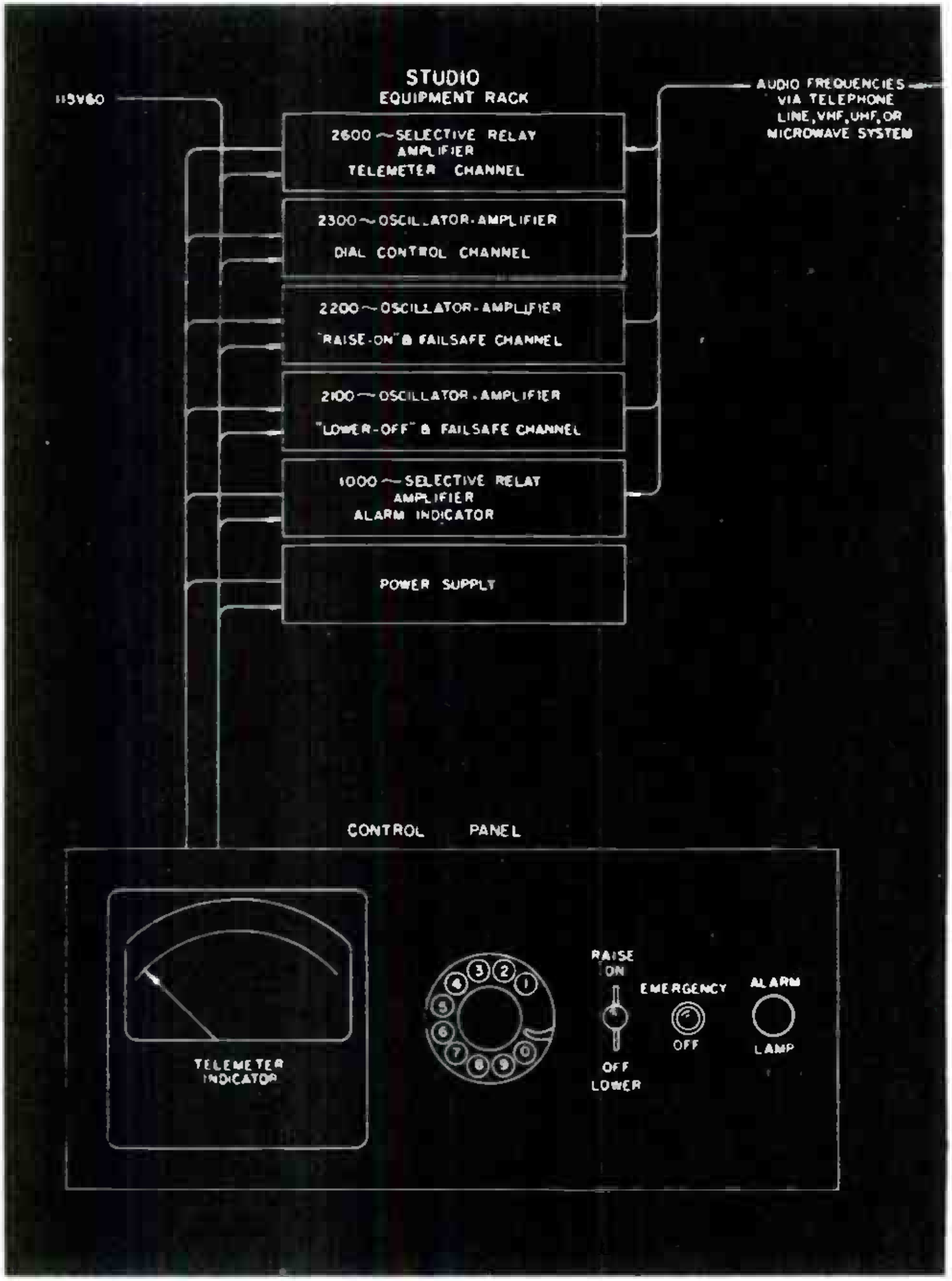
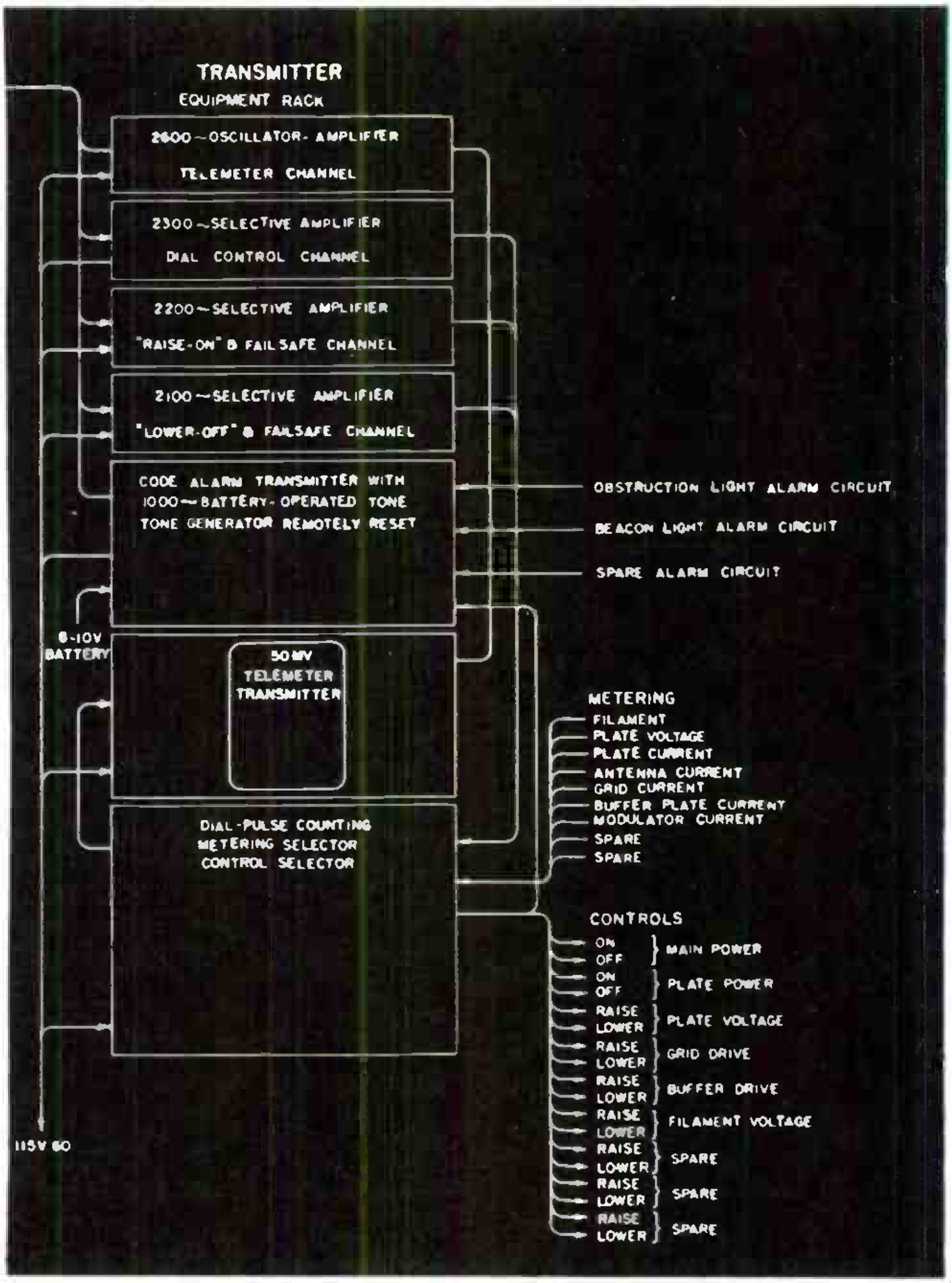


Fig. 13. Block diagram of control and telemetering system



compatible with wire line or radio link.

transmitter metering circuits and the frequency and modulation monitors, and a meter at the other end.

Many telemetering techniques, developed to meet the requirements of water works, process machines, aerospace and the military, can be used for broadcast station telemetering.

A pulse duration telemeter transmitter, for example, can be connected to the circuit to be measured through a voltage divider and/or rectifier. The telemeter transmitter keys a DC or 15-cycle circuit, or a tone transmitter. The duration of the key closure time with respect to the total metering cycle time causes the remote telemeter receiver to indicate volts or amperes in values related to pulse duration.

More direct is a voltage-to-frequency conversion/frequency-to-voltage reconversion system, in which the measured voltage or current (DC, AC, or RF) is applied as a small DC voltage to the variable frequency tone transmitter, and measured at the other end with a meter connected to the output of the frequency-to-voltage converter.

Another possible technique is the use of Raysistors to convert voltage or current (DC, AC, or RF) directly into resistance.

Other techniques include the use of magnetic amplifiers and transistors for sensing voltage or current and providing a DC or AC output signal that can be measured at the remote central point.

Digital Systems

Voltage and current can be converted into digital data by an analog-to-digital converter which transmits quantitative information as DC or tone pulses. At the remote control point the digital data may be fed to a numerical display or a teletypewriter for printout. Or the data may be fed into a digital-to-analog converter for readout on a meter or electronic counter. The digital data may be transmitted serially over a single tone channel, or several tone channels may be employed for parallel transmission of data. Digital techniques, using push buttons or a teletypewriter, can be used.

Choice of Systems

Complete broadcast station remote control systems are available. A block diagram of a commercial system is shown in Fig. 12. This one can be used over any two-way voice grade transmission path. Since it employs audio tones, a metallic DC path is not required.

A broadcast station's engineering staff can design its own remote control system employing available components. Using modern technology, it is possible to design automated broadcast station remote control systems which require no human commands, but which can be monitored by the operator in charge, who can take over control when and if necessary.

FM Overmodulation: Cause & Cure

Harry A. Etkin

With the continued improvement in recording and FM broadcasting equipment, the increased use of special equalization effects by recording artists and studios, the differences in microphone equalization and response, and the use of close microphone techniques, the high frequencies fed into FM broadcast transmitters are often of sufficient amplitude (after pre-emphasis) to cause serious overmodulation problems. The increasing number of incidents of FM overmodulation, and the resultant FCC citations, indicate a real need for corrective actions.

Why Does the Problem Exist?

Normally the lower frequency component of an audio signal is amplified more than the higher frequencies. This occurs at every step between the input equipment and the transmitter, unavoidably adding a high frequency noise to the desired audio signal. As a result, the signal-to-noise ratio is low at the high frequencies. Where the audio spectrum from 50 to 15,000 cps is utilized, a situation such as this cannot be tolerated.

To improve signal-to-noise ratios, various methods of equalization and pre-emphasis are employed. Pre-emphasis—increasing the amplitude of high frequency audio signals before they are fed to the transmitter — reduces the unfavorable relationship between high frequency audio and high frequency noise. High frequency program signal is increased, while the high frequency noise level remains the same, improving the high frequency signal-to-noise ratio.

However, as signal-to-noise ratios increase, equalization or pre-emphasis can actually result in signal degradation due to distortion brought about by the excessive high frequency signal levels that are forced through the various amplifiers. The main reason for the equalization and pre-emphasis network is to make sure that high frequencies are not blocked out by the inherent noise characteristics.

Since there is less energy in the upper section of the 50 to 15,000 cps region than there is in the portion below 1,000 cps, a 75-microsecond pre-emphasis curve was adopted by the FCC to take advantage of this distribution. Fig. 1 illustrates the standard pre-emphasis characteristic curve. The solid curve shows a flat response below 200 cps; at 1,000 cps the gain rises to +0.9 db, to +8.3 db at 5,000 cps, to +13.8 db at 10,000 cps, and at 15,000 cps the gain increases to +17 db. In gen-

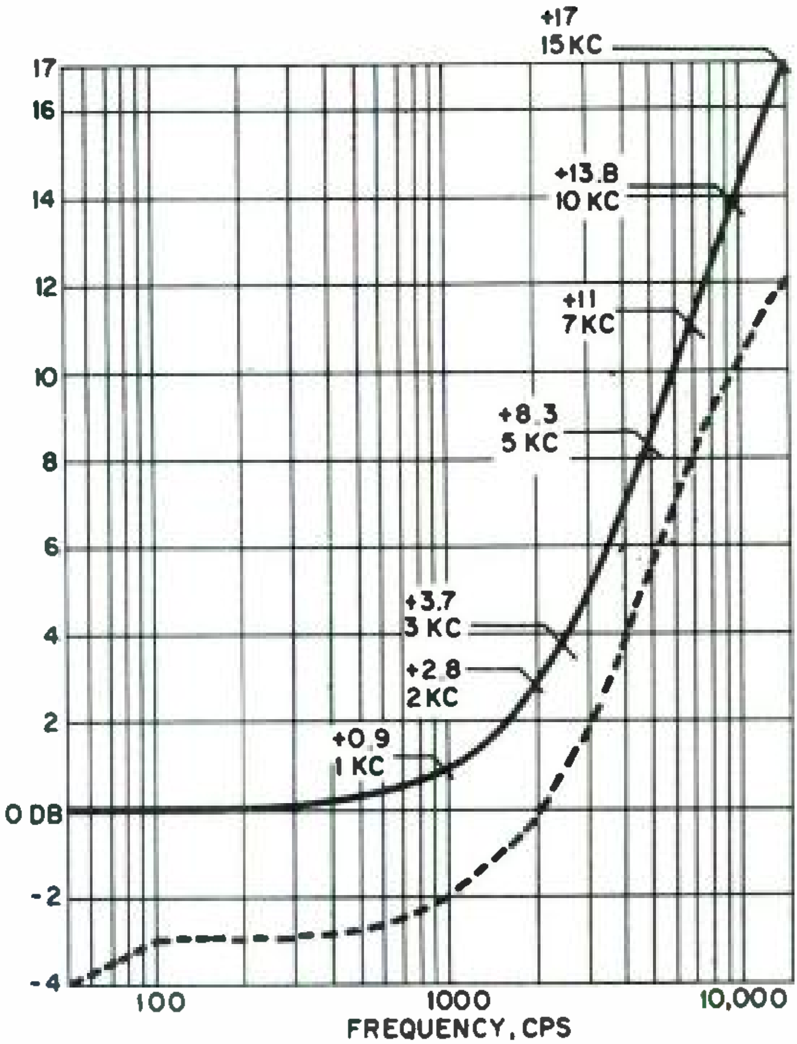


Fig. 1. Standard pre-emphasis curve. Frequency response limits are shown by solid and dashed lines.

eral, a 75-microsecond pre-emphasis curve means that amplifiers all along the audio line will be handling a 15,000 cycle signal 17 db higher than the 1,000 cps signal. If the transmission at 1,000 cycles is to be maintained at an adequate level, there is a definite probability of overloading the amplifiers at 15,000 cycles when using the 75-microsecond pre-emphasis.

What are the Causes?

The FCC standard pre-emphasis curve is quite severe. When this curve was adopted, FM programming was not too competitive and the FM broadcaster usually operated the transmitter with low values of modulation to allow the transmission of the full dynamic range of recordings. The standard practice for FM broadcasters was to operate at a low modulation level without the use of peak limiting amplifiers. Although limiters are being used today, more FM stations are still being given citations for overmodulation. This has led many engineers to the conclusion that limiters were not operating correctly. However, tests showed that they were operating on a flat response curve, and the high frequency signal fell below the threshold of limiting. Overmodulation is caused by pre-em-

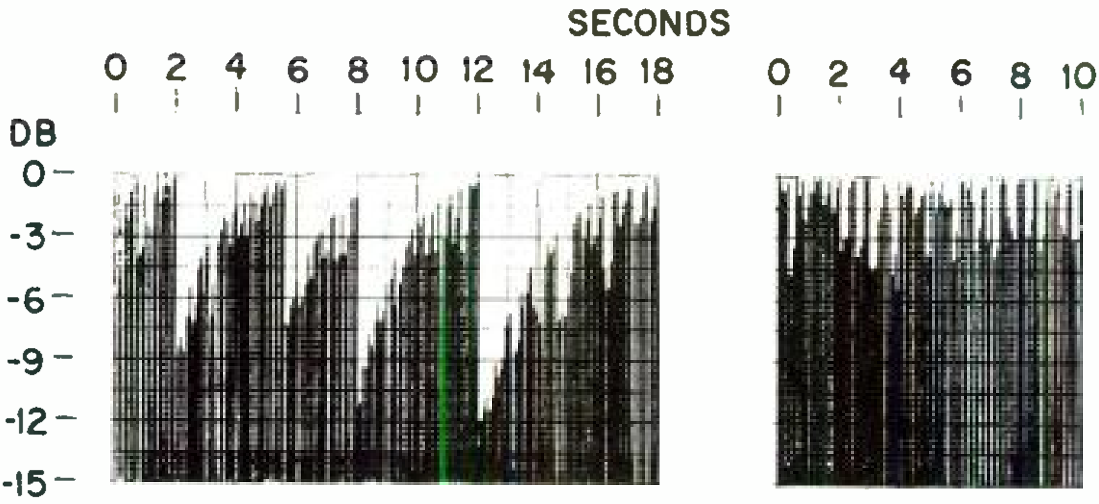


Fig. 2. Typical limiter operation with pre-emphasis ahead of the limiter. The same signal without pre-emphasis is on the right.

phasis of the audio signal *after* it passes through the limiter.

A limiter cannot always handle the complete job of loudness and level control. High-amplitude, high-frequency signals can trigger the limiter and cause a drop in overall program level, balance, and loudness. Where the limiter is inserted *after* pre-emphasis, it will be particularly susceptible to this triggering with a reduction instead of an increase in signal strength. This method of operation can limit the high frequencies as well as the mid-range and low frequencies. If the program level is maintained well below the threshold of limiting, acceptable program levels will be produced. However, some programs will cause unnatural effects, as shown in Fig. 2. The results shown are for a limiter with an attack time of approximately one millisecond and a 90% recovery time of about two seconds. When the pre-emphasized high-frequency peaks exceed the threshold of limiting, gain at mid-frequencies is reduced. Thus, the de-emphasized signal sounds like the limiter is undergoing a blocking-type of oscillation; the gain suddenly drops, then recovers on the normal RC slope. This type of programming will produce a large group of complaining listeners. The right side of Fig. 2 shows the same signal without pre-emphasis.

If the limiter is placed before pre-emphasis, and if it is not triggered by high frequency peaks, the pre-emphasis can cause transmitter overmodulation with all its distortion and problems. Live studio programs, music, and other recorded sounds containing applause, percussion noises, finger-snapping, clinking and tinkling of glasses and keys, tap dancing, and other peaked high frequency sounds (when combined with program music or speech) will cause transients that will trigger the limiter and actually cause an attendent gain reduction. If the high-frequency content of music and other recorded sounds never exceeded the curve in Fig. 3, the limiter signal could be fed into the FM transmitter pre-emphasis network without causing overmodulation. However, present day microphone techniques and orchestration, combined with RIAA treble pre-emphasis, often create quite impossible levels at the highest audio frequencies. Fig 3 is complementary to the standard pre-emphasis curve and can be used in the FM receiver to de-emphasize the signal to restore the original frequency response. It can be seen that overmodulation will result if the high frequencies exceed the limits of the curve shown by the shaded area in Fig. 3.

FM transmitters are designed to tolerate extensive overmodulation with a minimum of distortion. However, considerable overloads can swing the carrier beyond the maximum ±75 kc limit. A 6 db peak power measured from many types of programs broadcast from a typical FM station. During these measurements, the limiter was set up for a constant mid-range level. The very high and very low frequency peaks occurred much less frequently than the intermediate high and low frequency peaks. Yet, these peaks show why broadcast stations are being given citations for overmodulation. From this study the broadcaster can assume that every FM broadcast station, without preventive overmodulation systems, will produce a peak power distribution

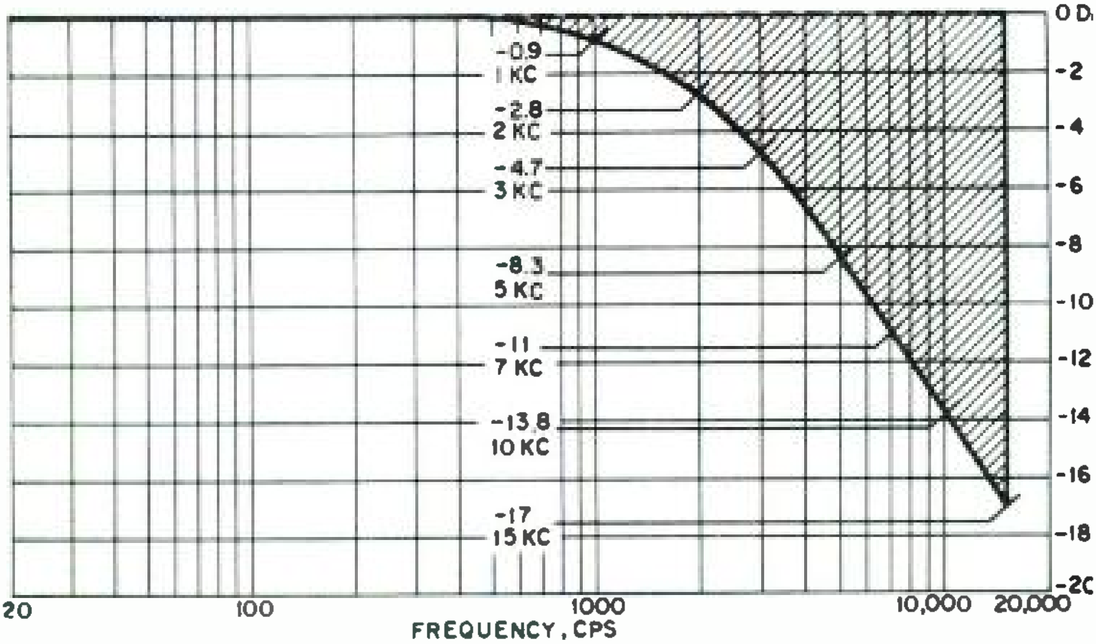


Fig. 3. Standard FM receiver de-emphasis curve.

program peak with low percentages of modulation will produce a carrier swing to ±150 kc, which is well beyond the allowable limit. Numerous measurement studies, using spectrum and wave analyzers, have been made.* The data provides a typical peak power distribution curve, as shown in Fig. 4. This is a composite curve of the curve that will equal or exceed Fig. 4.

To reduce the excessive accelerations which occur at high frequencies, many FM stations simply reduce the modulation level to an average of 50%. This practice reduces the average program power output to one-quarter of the maximum allowed (Fig. 5.) The curve indicates that no overmodulation occurs below 5,000 cycles, but it is possible to overmodulate the transmitter as high

*Study measurement data developed and compiled by Gates Radio Co., Advanced Development Engineering Dept., Quincy, Illinois.

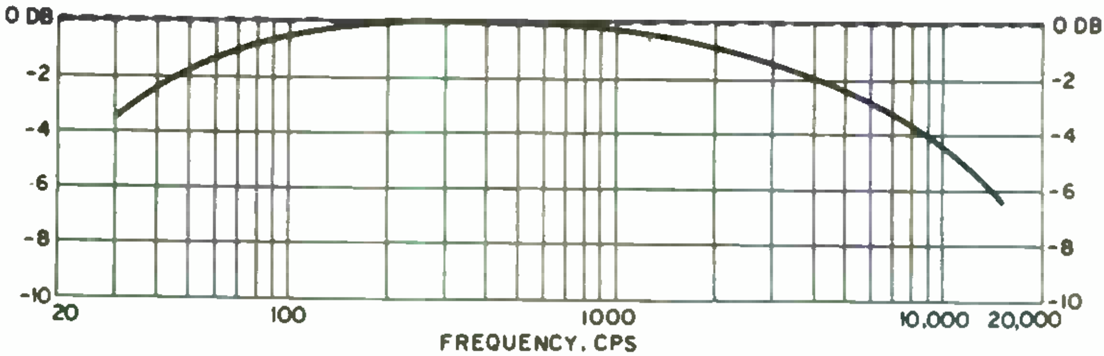


Fig. 4. Typical peak power distribution curve at limiter output.

as 70% at 15 kc. The 10-kc portion of the curve shows that overmodulation can exist up to 150%. Thus, even though the mid-frequencies are controlled by the limiter, the transmitter should be operated at a lower level of mid-frequency modulation to prevent high frequency overmodulation.

Even with 30% modulation, signals containing sharp transients could still cause more than 100% modulation at high frequencies. With 30% average modulation, the program power output of the FM station is approximately one-tenth of the maximum power allowed. In general, operation with very low modulation levels is not very practical because many of the peaks which cause the reduction in modulation are so great that many FM receivers will not pass the signal and listeners are usually incapable of hearing it.

What Are the Cures?

The most logical approach would be to eliminate the necessity of pre-emphasizing FM signals in the transmitter. The great hardship in achieving this objective is to have the set manufacturers modify receiver circuitry.

Since this isn't immediately practical, corrective measures must be employed. One method is to install a low pass filter which will cut off all signals that fall on the slope of the filter curve (Fig. 6). This actually results in signal degradation just to protect the station from a relatively few overmodulation peaks. Thus, the

FCC Pre-emphasis Regulations

Paragraph 73.317 of Vol. III of the Rules states:

1. The transmitter shall operate satisfactorily in the operating power range with a frequency swing of ±75 kc at 100% modulation.

2. The system shall be capable of transmitting a band of frequencies from 50 to 15,000 cps. Pre-emphasis shall be employed in accordance with the impedance-frequency characteristic of a series inductance resistance network having a time constant of 75 microseconds. The deviation of the system response from the standard pre-emphasis curve shall lie between the two limits as shown in Fig. 1. The upper of these limits shall be uniform (no deviation) from 50 to 15,000 cps. The lower limits shall be uniform from 100 to 7500 cps, 3 db below the upper limit; from 100 to 50 cps the lower limit shall fall from the 3 db limit at a uniform rate of 1 db per octave (4 db at 50 cps); from 7,500 to 15,000 cps, the lower limit shall fall from the 3 db limit at a uniform rate of 2 db per octave (5 db at 15,000 cps).

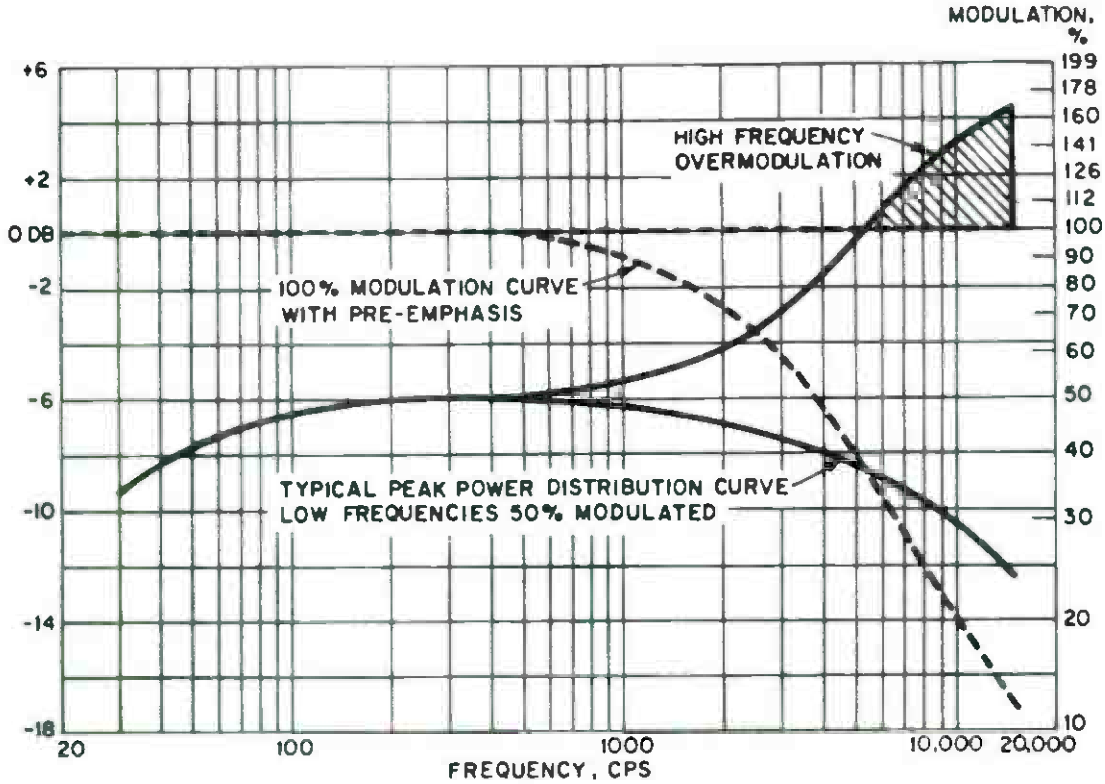


Fig. 5. Typical peak power distribution curve at 50% modulation.

low pass filter is not the cure for the overload problems.

Another method of controlling the high frequency peaks, developed primarily for the disc recording industry, pre-emphasizes the program material, acts upon the troublesome high frequency signals, and de-emphasizes in a complementary manner to give an overall flat output. Although this type of operation can eliminate overmodulation in most cases, it can cause gain reduction at all frequencies above 600 to 900 cycles with some resultant signal degradation.

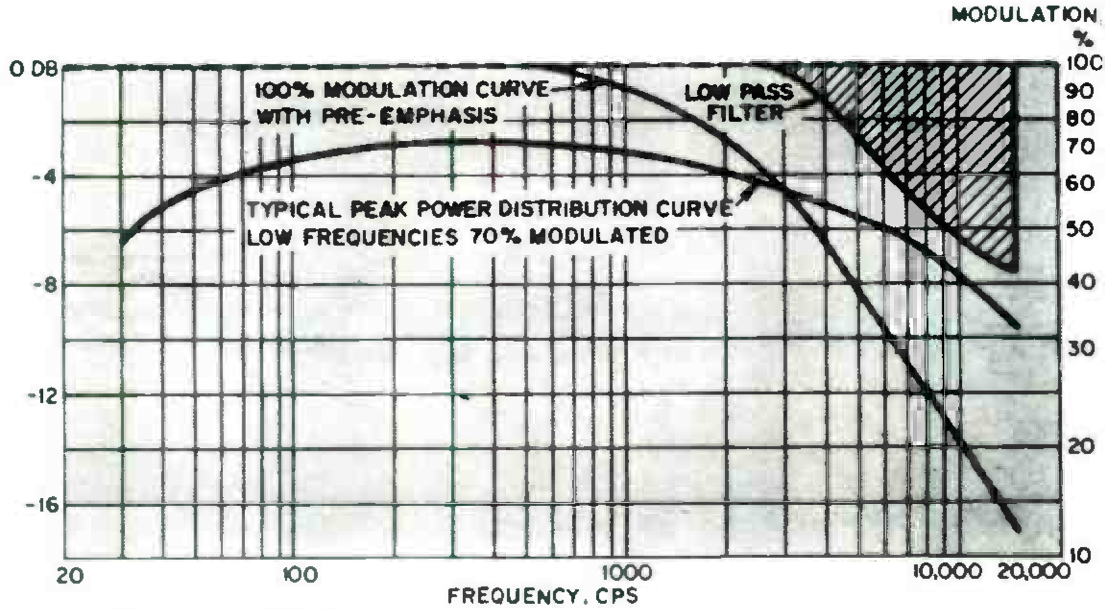


Fig. 6. Performance of low-pass filter.

When a limiter is installed in the system ahead of this unit (with low frequencies controlled to approximately 90% modulation), the resultant signal will contain a small amount of overmodulation in the 1100 to 1200 cycle area. There will also be one another ideally, permitting a higher average level of program material and preventing overmodulation on sudden program peaks (Fig. 8).

The program material fed from the limiter into the automatic level control unit is pre-empha-

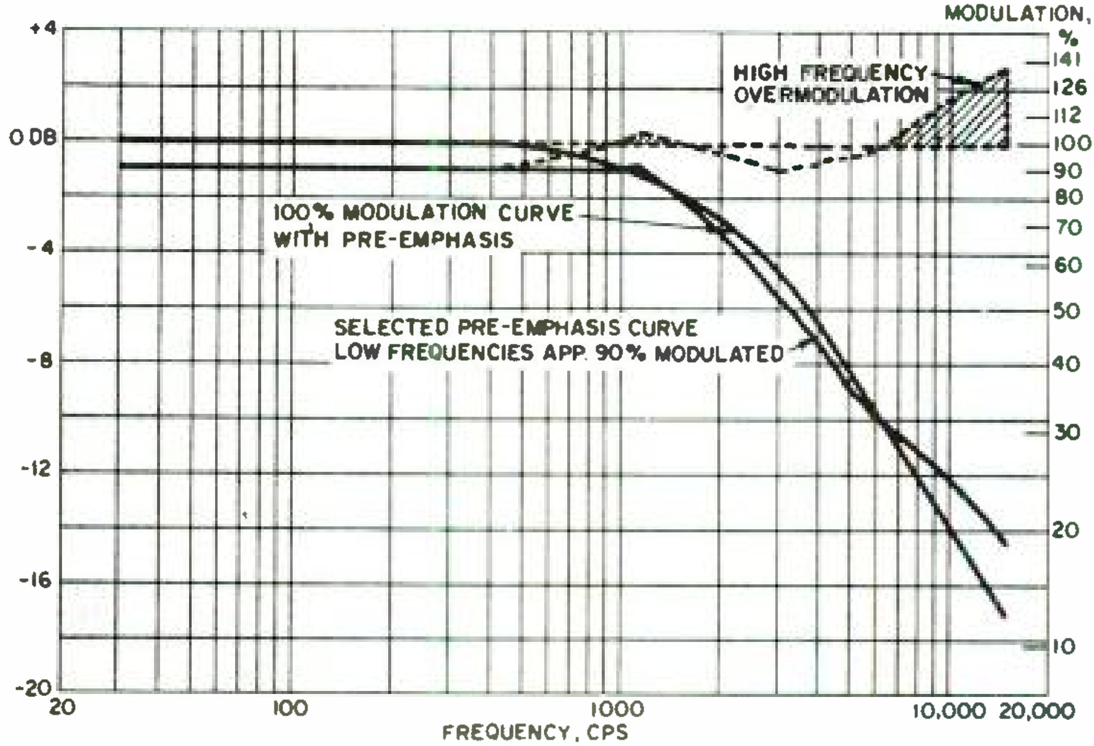


Fig. 7. Results of a typical selected pre-emphasis curve.

overmodulation peaks above 6500 cycles which may rise to 130% at 15 kc. Peaks are also produced in the 2 to 5 kc region (Fig. 7).

The most economical approach is to use a device that is most advantageous from a coverage standpoint—a unit which automatically controls the audio levels. The automatic level control is intended for use between the limiter and the FM transmitter. It is designed for both stereo and monaural service and can maintain a relatively constant output, much in the same manner that an operator might, by carefully and constantly riding gain on the program. The automatic level control unit and the limiter supplement sized with a standard 75-microsecond curve; the sudden program peaks that exceed this curve are clipped off. The signal is then fed through a standard 75-microsecond de-emphasis curve to give an overall flat response. The overall response, shown in Fig. 8, is +0.2 db at 10 kc, −0.2 db at 15 kc, and essentially flat below these frequencies. Average modulation as high as 98% can be obtained without overmodulation. In operation, only those peaks which would cause overmodulation are affected, and they are generally the higher audio frequencies. The attack and release time is instantaneous for immediate and continuous protection.

and there is no deterioration of the dynamic range in program material.

Costs

Since stereo is becoming a standard practice with FM broadcasters, limiter and automatic level control units should serve both purposes. A dual peak limiting amplifier costs from $900 to $1,000 and the automatic level control unit runs between $500 and $600 (not including installation costs). The combined use of these units will improve program and commercial production, cut costs, and boost power output at least eight times. More importantly, better control of program quality is maintained. By expanding effective range and improving reception, it should bring in extra advertising revenue.

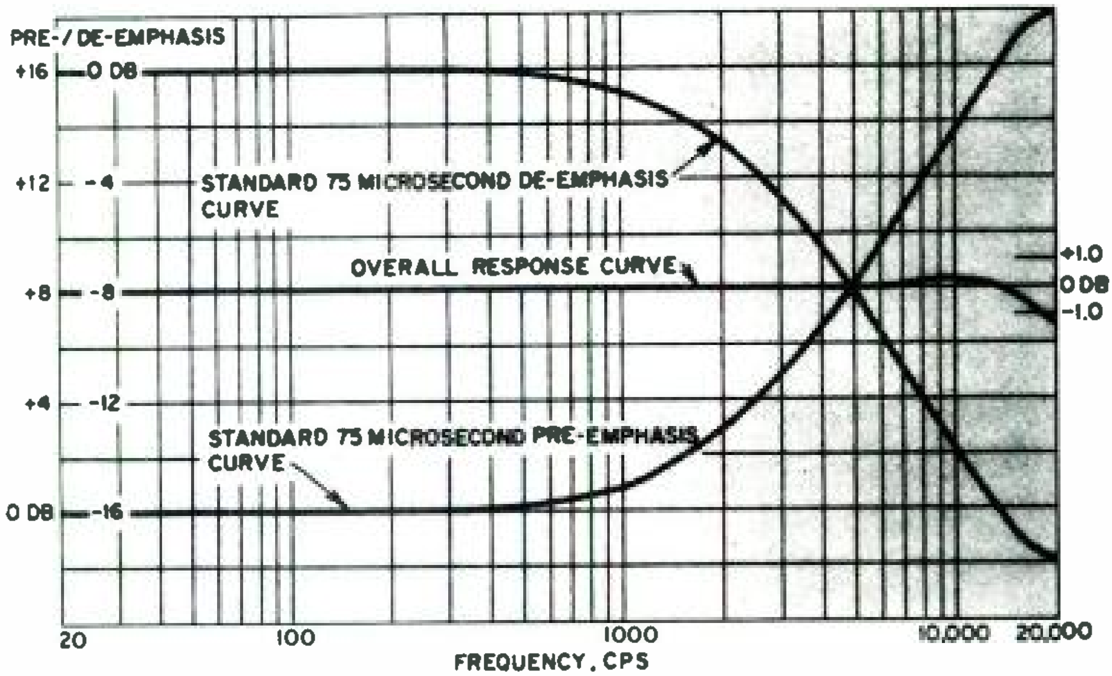


Fig. 8. Test data curves from an automatic level control unit.

The use of a peak limiting amplifier and automatic level control unit inserted between the audio system and the FM transmitter is the ideal approach for putting a ceiling on the high frequency peaks. Whether used for stereo or monaural, FM listeners will enjoy full range reproduction at a pleasant level.

Making Use of Limiters & Compressors

Philip C. Erhorn

ARE YOU interested in improving your market coverage, perhaps at low cost? Are line feed levels apt to be most unpredictable? Do you still get some of those complaints about loud commercials? Do you know the main differences between compressors and peak limiters, and how to use them to best advantage?

There are undisputably many useful applications for audio compression, but there is also a great deal of confusion. To learn how audio compressors and limiters can be best applied to your own operations, read on.

Limiters vs. Compressors

Certainly in any discussion of this sort, the first consideration is to point up the basic differences between compressors and limiters. This one area has been the cause for many cases of misapplication, to the detriment of the broadcast signal, with accompanying disappointment to both

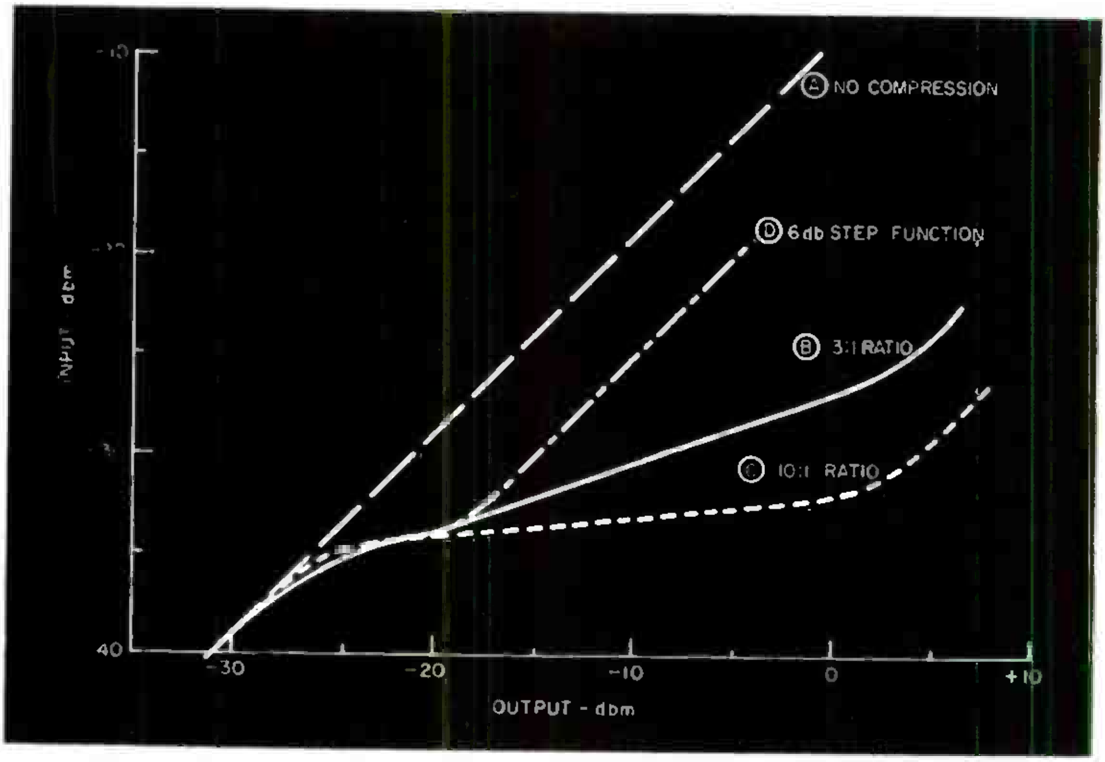


Fig. 1. Gain curves illustrating typical compression characteristics.

engineering and management. In Fig. 1 Curve A illustrates a linear input/output relationship, or no compression, whereas Curve C shows the shelving-type compression achieved with typical peak limiting devices. While the compression ratio shown is 10:1, which means that for a 10 db increase in input signal the output increases but 1 db, compression ratios of 30:1 are not unusual for peak limiters.

Peak limiters offer a very fast attack time, typically on the order of a few hundred *micro*seconds, some even faster. Abrupt loud program passages and steep wavefront transients of high amplitude will be caught quite effectively by the peak limiter, and held to a level which, while perhaps briefly audible, does prevent overmodulation and splatter. Thus, there is no doubt about the value of the peak limiter at the transmitter site.

However, the use of such a fast-attack, severely-shelved compression characteristic, as a method for increasing modulation density, would be highly objectionable to the listener. The dynamic volume range of music would sound squelched to an unnatural degree. A brass or tympani forte would be completely frustrated by the shelving action of the limiter curve.

Curve B of Fig. 1 illustrates a compression curve which, from a listening standpoint, is much less objectionable than Curve C. Note that the knee is less abrupt, and the compression ratio of 3:1 is more gentle in action. As a matter of practical fact, 20 db or more of compression of this type can be used without the listener being aware that considerable compression is in use. Moreover, average modulation level would be increased considerably, with an accompanying increase in effec-

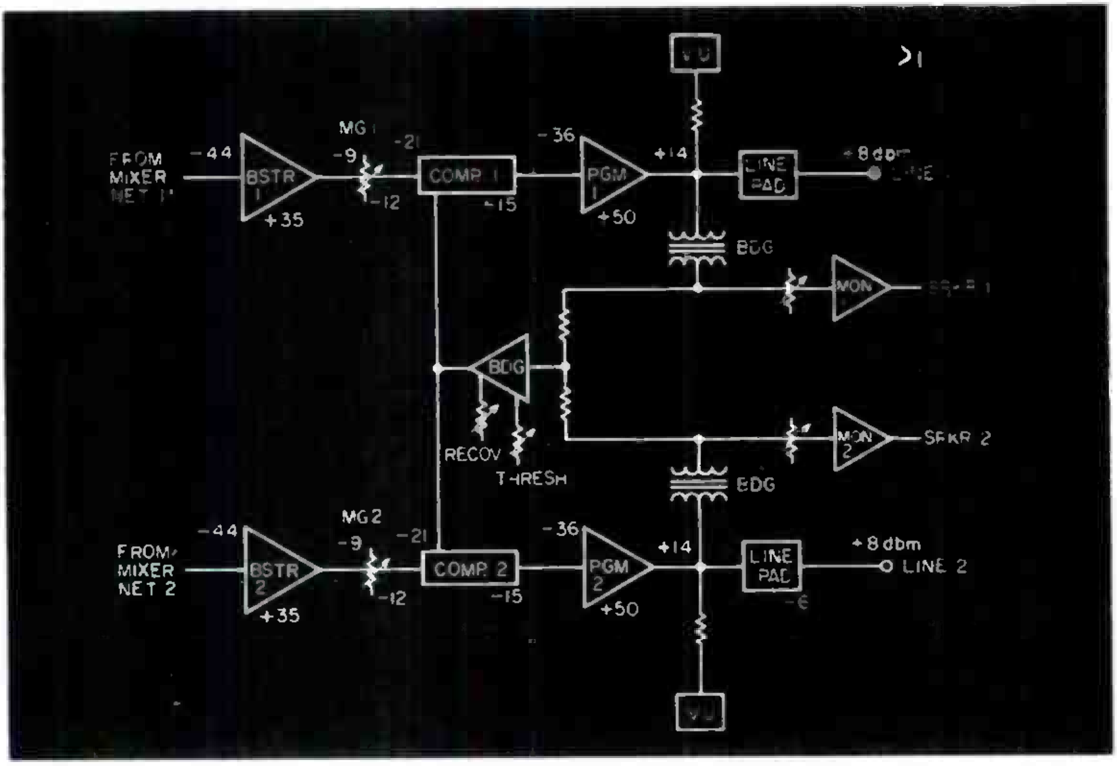


Fig. 2. Typical stereo mixing console detail showing insertion of LDR compressor with single control amplifier.

tive radiated power on AM and in apparent loudness on FM.

The shape of the compression curve is most important in differentiating a compressor from a peak limiter. To impose the shelved curve on your studio program levels would be onerous; to apply the more gentle compression curve as a means for catching the troublesome program peaks which cause overmodulation would be inadequate. Let us continue a bit further in this vein.

There is another aspect of compressors and peak limiters which is quite important, and this is the release time, or the finite time it takes for the device to recover from a considerable degree of compression. If the device recovers too rapidly, the abrupt up-and-down variations in program level produce the familiar "pumping effect," quite objectionable to the ear. When coupled with a fast attack time and adjusted for plenty of compression, a slow release time will chop distinct holes in the audio if triggered by severe level changes such as pistol shots, audience reaction, or an excited announcer. The recovery time of either a peak limiter or a compressor should be adjusted to the nature of the program. But remember that despite fancy names, the recovery circuit is basically a capacitor discharge curve, and the charging voltage is a direct function of program level and degree of compression used. While this obviously offers some degree of program-controlled recovery, there is no optimum release time setting for all program types.

Compressors—Basic Considerations

It is true that many compressors, unlike peak limiters, have a slow attack time. "Slow" may be catalogued in the range of a few *milli*seconds to 30 milliseconds or so. There is no denying that a fast attack time is desirable, to catch virtually any kind of level peaks, whereas a slow attack time will let the initial part of the peak through before the compressor takes over. However, the point to remember is that once into compression, attack time is relatively immaterial. Indeed, a slow attack time at this point prevents the device from instantly responding to a greater transient peak which would obviously drive it into further compression. Thus, the slow attack provides a "gain platform," and avoids rapid response to instantaneous large program peaks once a reasonable degree of compression is achieved.

It can be stated with some authority that a fast attack time is generally accomplished with sophisticated circuitry, which will cost more than a lesser complicated slow-attack circuit. The so-called "zero return" feature is basically a function of the R/C time constant in the release, or recovery, circuit. Depending on the setting of the release time control, partial recovery can be rapid, with complete recovery to full gain dependent upon the degree of compression used and the nature of the program material, as well as the time constant.

Compressor Amplifiers

Many of the available compressors include an amplifier in the package. Thus, in addition to method of mounting and power supply requirements, you must also consider how to cope with the amplifier gain.

Some of the compressor units are designed for plug-in console or rack-shelf mounting, and require an external power source, such as the console supply. Obviously, these units can be readily substituted for the console program amplifier with little problem. If they do not already match the mounting system of the console amplifiers, it is not difficult to accommodate them within the confines of the console shell. Their gain and input level requirements have been made compatible for direct substitution with regular program amplifiers, and they do an adequate job of compression at reasonably low cost. Unfortunately, these units do not lend themselves to stereo use, as they are not normally supplied with a means for ganging compression and time constant characteristics. If identical but isolated units are placed in each stereo program channel, the one which is driven hardest by a program peak will compress more than the other (and will take longer to recover). This tends to degrade the stereo effect at the listening end.

LDR Compression Devices

It is difficult to state the case for the new LDR (light-dependent resistor) compressors without sounding prejudiced in their favor. They have many practical advantages over more conventional compressor amplifiers, and only one significant disadvantage. An LDR is a type of cadmium sulfide or cadmium selenide photocell that greatly varies in resistance depending upon the amount of light which reaches it. This simple component therefore lends itself admirably to applications for controlling gain in an amplifier or in a system. It is easily adapted for remote control.

The LDR cell, if properly manufactured, contributes no noise to the circuit in which it is inserted, assuming that its net output level after compression is not so low as to be below the system input noise. Distortion is a function of the nonlinear resistance characteristics of the cells. Typical measurements show 0.5% THD or less at +4 dbm output after 20 db of compression. The distortion is below 0.1%THD when the LDR is inserted at typical internal system points, such as those shown in the block diagram of Fig. 2. Insertion loss is no more than 3 db when looking into a 600-ohm load, and less than 1 db when looking into the non-loading input of some amplifiers.

The single fault with LDR's lies primarily in the light source. An incandescent light has a very definite thermal characteristic which delays activation of the cell. This means that for compression (gain reduction) use it must be classed as a slow-attack device when driven by a conventional lamp. If the lamp is powered by AC, ripple voltages will be superimposed on the audio circuit which the LDR is controlling.

Applications

In the block diagram of Fig. 2, a typical portion of an FM stereo mixing console is depicted. The two LDR's (labelled Comp. 1 and Comp. 2) are inserted between the master gain controls and the program amplifiers. System levels are indicated, including 15 db of gain reduction due to compression. The common light amplifier is bridged off the output of the program amplifiers through a resistance network to insure proper stereo isolation; at the same time it allows sufficient driving level to accomplish compression.

As the two LDR's are included in one compressor module (as many as 4 are possible), each channel will be compressed the same amount, regardless of which has the higher program level, and the common light amplifier provides the same time constant and controls. Because the threshold adjustment is a panel control, we can take advantage of a feature not normally available in many other units. Without disturbing the system levels existing at the point of insertion, the threshold can be adjusted so as to start compressing below this level. If we assume that we are only interested in compressing levels above normal, there will be little need to adjust for compression loss.

LDR compressors act upon average program content rather than peak program energy. They may be set for some degree of compression at all times. During periods of prolonged levels which fall below the compression threshold, expansion back to normal system gain will take place, depending on the setting of the release time adjustment, a panel control. However, background noise will never be any higher than normal system noise, as there is no extra gain supplied. Adjusting the units to deliver a specified curve is simply a matter of strapping terminals or changing a resistor. The step-function curve of D in Fig. 1 is possible for those applications where compression is wanted only over a 6 db range, with return thereafter to a linear gain characteristic.

By raising the gain of the announce mic channel and adjusting the compression threshold appropriately, the program can be made to fade down under the announcer (sometimes called "ducking"). It will automatically fade back up again after he stops talking. The

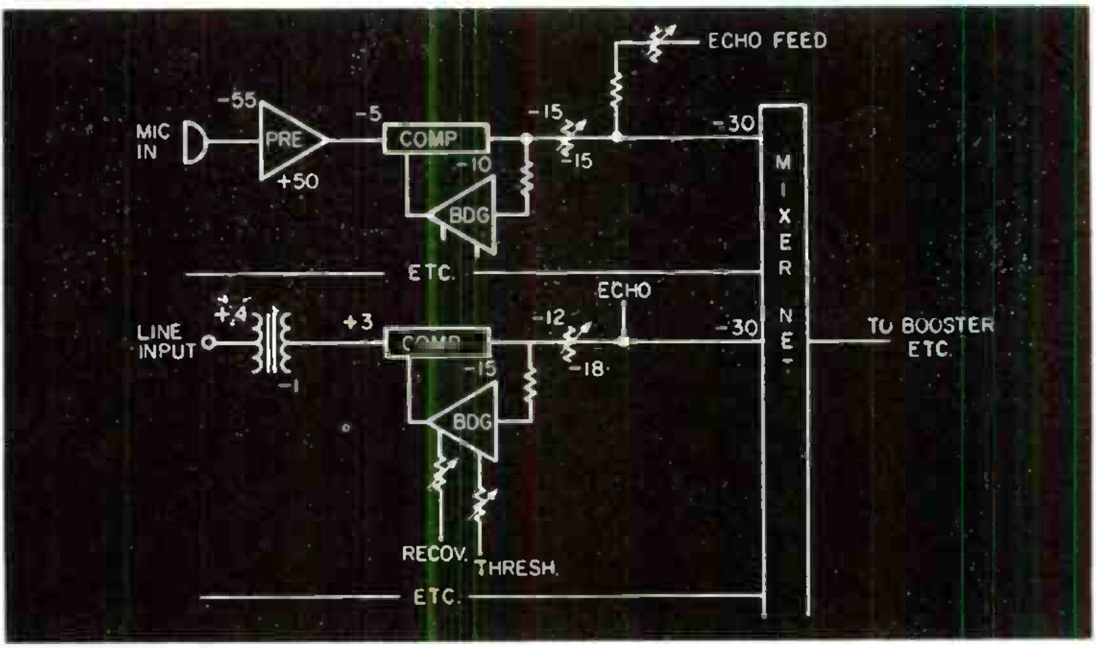


Fig. 3. Abbreviated system showing LDR compressors inserted in input circuits.

fade-up time is set by means of the release time control.

Input Channel Uses

There are many compressor applications where it is undesirable to have the entire program essentially controlled by the level from one troublesome source. Because of its small size and low relative cost, the LDR compressor is logically adaptable to permanent insertion in several microphone or high level console inputs. Or several can be set up on jacks and patched in as needed. In this way any input with controversial levels may be individually compressed, and the compression characteristics adjusted to suit each one.

The abbreviated block diagram of Fig. 3 shows a typical system with a compressor inserted following a mic preamplifier, directly in a high level input line from another studio, a VTR, turntable or tape machine. Typical levels are indicated. Some compression at all times will relieve the engineer from tedious gain riding, and program levels will be definitely improved. Note that the input for the bridging light amplifier is always taken from the output side of the LDR. This forms a closed loop system, providing adequate stability and predictable compression curves.

Special Devices

There are a few other available devices which are intended to solve or alleviate certain annoying audio problems.

Some are designed to control splatter and overmodulation in FM transmitters caused by HF pre-emphasis. They logically are inserted between the peak limiter and the transmitter, where the 75 microsecond pre-emphasis network is in the transmitter. Considering the great amount of high frequency energy present in today's live and recorded (and equalized) program sources, these units will help to provide an increase in apparent loudness of the FM signal.

By combining compression in the studio console with peak limiting at the transmitter, many annoying problems can be thoroughly alleviated. As increased market coverage is achieved at the same time, this is certainly a desirable mode of operation.

The Wasteland of Stereo FM

Carl E. Roliff

IN ALL TOO MANY INSTANCES, stereo fm is a technical wasteland of distortion, hum, noise and poor separation. Apparently some fm broadcasters assume that stereo programming is simply a matter of installing a stereo generator, then sitting back to wait for the new accounts to roll in. Good fm multiplex stereo, however, requires conscientious attention to every aspect of the total system. Seldom is the problem one of the equipment itself; design and engineering has been accomplished by various equipment manufacturers. The problem is proper installation, adjustment and maintenance. The overall stereo system is capable of a better performance than many stations are achieving.

Stereo/Monaural Compatibility

The first consideration is compatibility with existing fm equipment. Therefore, the first FCC requirement (Rule 73.322a) is that the main fm channel be modulated with the sum of the left and right signals. The addition of the two signals is accomplished in the stereo generator. Due to the transmission method, a 19-kHz pilot subcarrier (produced by the stereo generator) at 8- to 10-percent modulation is required (73.-322b). The FCC rule of December 1, 1966, requires daily measurement of the 19-kHz pilot subcarrier frequency. (Perhaps if broadcasters had met their responsibility of maintaining an accurate 19-kHz pilot subcarrier frequency, the rule would have been avoided.) The stability of currently available and operating equipment is excellent, and repeated weekly or monthly measurements have shown negligible frequency change. The station that was 1.3-Hz low last week is still 1.3-Hz low this week. The 67-kHz SCA subcarrier also requires frequency measurement. On a recent service call I noticed a log entry of "SCA subcarrier frequency measured at +200 cycles." Measurement of the SCA subcarrier with a recently-calibrated electronic counter indicated a frequency of 68,118 Hz, or +1118 Hz from the desired 67 kHz. A quick look at the unit revealed that the calibration crystal was not even in the socket; therefore, all previous measurements were inaccurate.

Subcarrier Phasing

One of the major stereo problems involves phasing the 19-kHz pilot subcarrier in relation to the 38-kHz subcarrier. Rule 73.322c states: "The stereophonic subcarrier shall be the second harmonic of the pilot subcarrier frequency and shall cross the time axis with positive slope simultaneously". Error here causes a definte axis by the pilot subcarrier." Notice that the rule says "cross the time axis with positive slope simultaneously." Error here causes a definite separation problem. To measure the relative phase of the 19-kHz and 38-kHz subcarriers, many stations try to use inexpensive kit-type oscilloscopes which are prone to have internal phase shift at 38 kHz; therefore, even if the scope indication is correct, the equipment is still improperly adjusted. The 19-kHz phasing adjustment must be made with a good wide-band professional oscilloscope, using a low-capacity probe.

Once properly adjusted, most stereo generators are very stable and do not need frequent readjustment. The instruction book provided with the stereo generator contains adequate alignment instructions and the waveforms which should be obtained. The stereo subchannel is an amplitude-modulated, double-sideband suppressed-carrier signal. The suppression of the 38-kHz carrier is accomplished in the stereo generator (73.322e). The modulating signal for the stereophonic subcarrier must be equal to the difference of the left and right signals (73.322g).

For both the main and subchannels, the audio frequency response should be a minimum of 50 to 15,000 Hz, with standard 75 μs pre-emphasis characteristics (73.322h). I have found pre-emphasis networks installed that had different attenuation characteristics and case grounds missing. Check the pre-emphasis network. If the station converted from mono to stereo and purchased an additional pre-emphasis network, there may be considerable difference in signal phase and amplitude at the output of the two networks. It is very simple to install a matched pair.

Audio Response and Phase

The prime objective of stereo is to transmit two separate channels with a minimum of cross-talk. The FCC requirement is a channel separation of 29.7 dB at all frequencies between 50 and 15,000 Hz. This is a major problem and many stations do not meet this specification. Amplitude and phase differences anywhere in the audio system can cause trouble.

Rule 73.322m specifies maximum phase difference of $\pm 3°$ for modulating frequencies from 50 to 15,000 Hz. Unless the left and right channels are identical in all respects throughout the audio system, up to and including the input of the stereo generator, phase differences will result. I found one station using a peak limiter as a line amplifier on one channel, and a constant-level amplifier of another make on the other channel. Equipment in the two channels was not identical; therefore, the two audio signals could not be equal in amplitude and phase. A pair of matched line amplifiers eliminated that particular problem. The instantaneous addition and subtraction (L + R) (L − R) of the right and left channels can only be accomplished if both channels are identical. Some stereo consoles introduce phase differences at 15,000 Hz. Equalized telephone program lines will also produce phase differences between higher audio frequencies. Phase and amplitude must be matched (within 3°) at all audio frequencies from 50 to 15,000 Hz. Each installation is different and no one phase correction system is a cure-all, but using the best

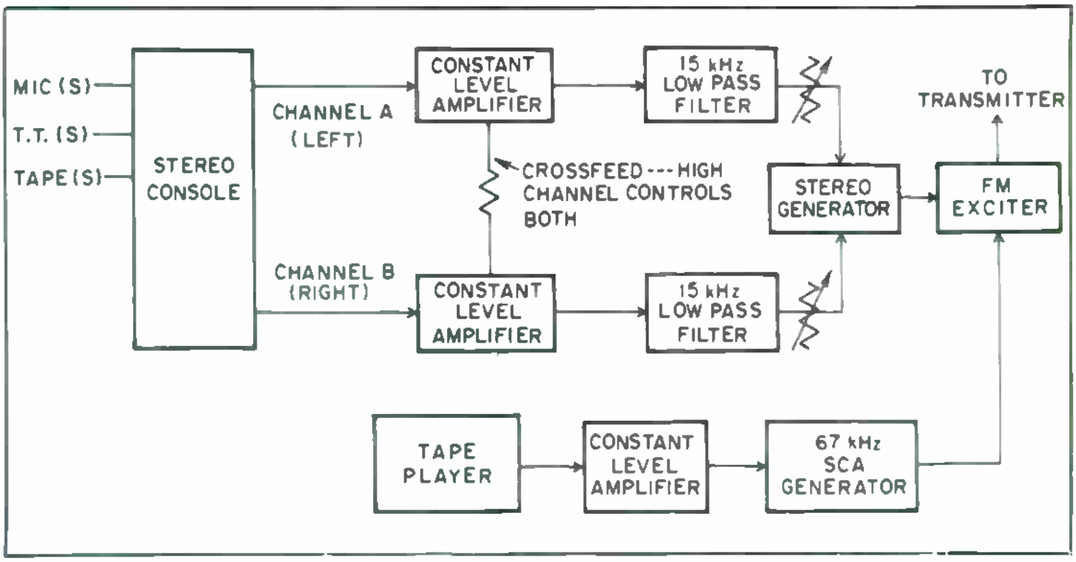


FIG. 1. BLOCK DIAGRAM OF A TYPICAL STEREO AND SCA AUDIO SYSTEM

quality components with a minimum of phase shift throughout the audio range may eliminate the need for phase correction.

The use of a 15-kHz low-pass filter is recommended on each channel at the stereo generator input (see Fig. 1). The filters sharply attenuate any program energy above 15 kHz; 40 dB attenuation at 19 kHz can easily be obtained. The graph in Fig. 2 shows the response characteristics of the 15-kHz filters installed at KSRN. The filters prevent any program energy from

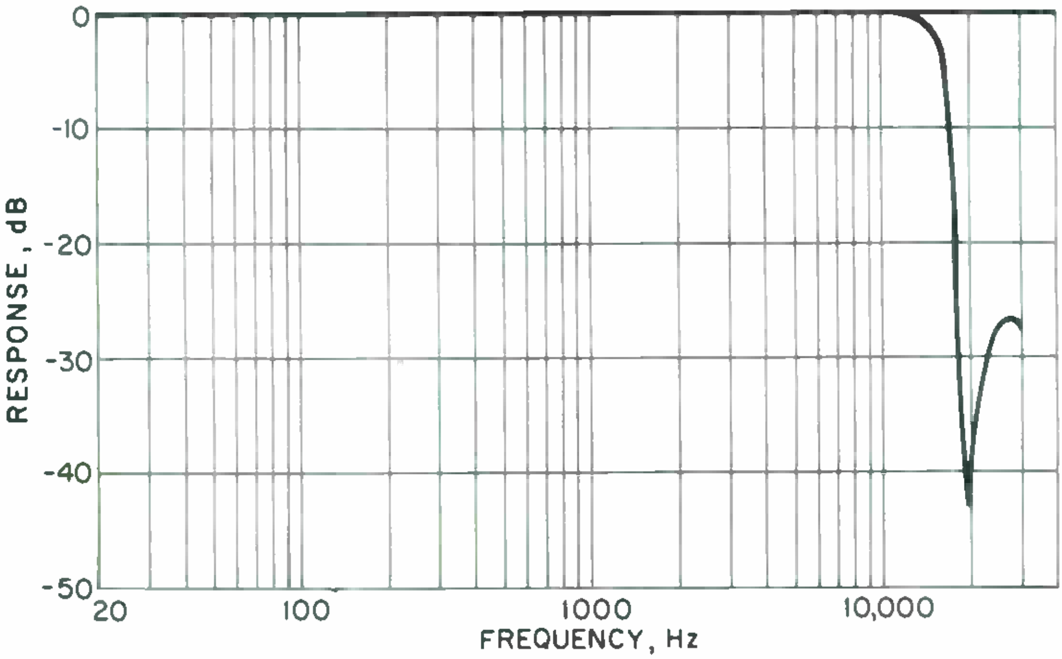


FIG. 2. OVERALL RESPONSE OF A TYPICAL 15-kHz LOW-PASS AUDIO FILTER

interfering with the 19-kHz pilot subcarrier. Unless properly installed, though, they can do more harm than good; considerable phase shift can be introduced at higher frequencies. If such filters are being used, they should be balanced for phase and amplitude throughout the 50 to 15,000 Hz frequency range. A good oscilloscope (with add-algebraic feature of A-B) provides a simple means of checking the entire audio system for phase and amplitude characteristics.

Channel Separation and Crosstalk

In Fig. 3, the 400-Hz modulation on both left and right channels is shown at equal amplitude and phase. When the two signals are combined (L + R), instantaneous addition or subtraction (L — R) is complete. In Fig. 4, the modulating frequency is 15,000 Hz. At this frequency, however, considerable phase shift is present. During instantaneous addition and subtraction of the two channels, it is impossible to obtain the required separation with this excessive phase difference. The stereo transmission system requires that the two channels be combined L + R and L — R. In the receiver, the signals must be recovered and separated to left and right channels. Addition and subtraction of the

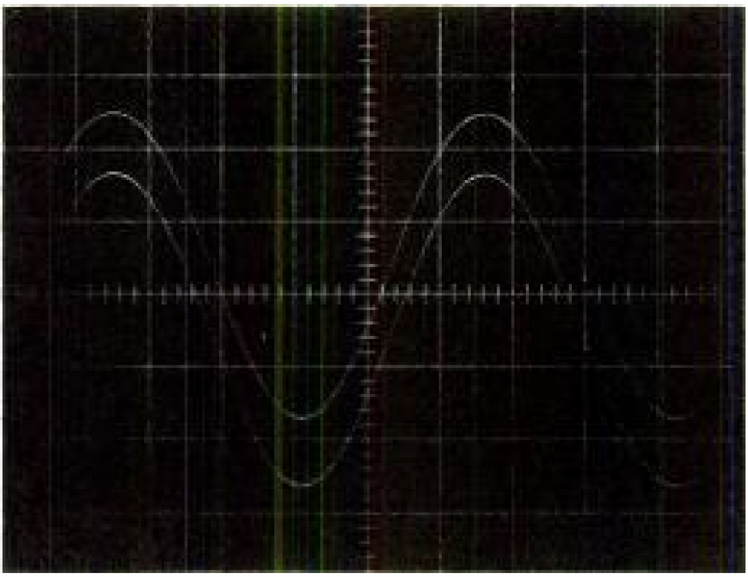


Fig. 3. Scope photograph shows equal amplitude and phase between stereo channels with 400-Hz modulation.

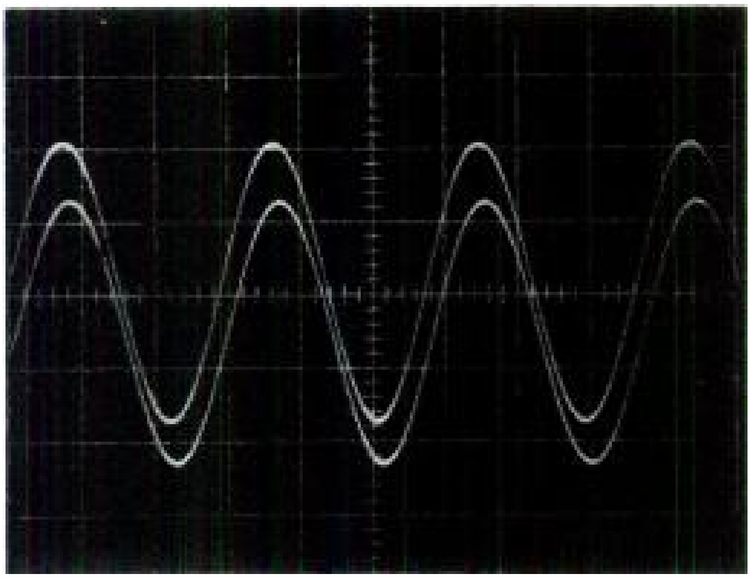


Fig. 4. At 15,000-Hz modulation (Fig. 3) amplitudes are equal, but appreciable phase difference is occurring.

composite signals in the receiver may result in cancellation of one channel. For example:

$$\begin{array}{rr} & L + R \\ (+) & \underline{L - R} \\ & 2L \end{array}$$

The right channels cancel. Now, invert the L — R signal and subtract.

$$\begin{array}{rr} & L + R \\ (-) & \underline{L - R} \\ & 2R \end{array}$$

If the right channel signal was produced by a piano, this mathematical result does not mean that we would have the sound of two pianos, but the same piano signal with twice the amplitude FCC Rule 73.322(n) (o) specifies that crosstalk between main and stereo subchannel shall be down at least 40 dB. Figs. 5 and 6 compare a monaural fm signal with a stereo signal. The original mono system had a modulation capability of 100 percent. Now with stereo (73.322i) modulation levels are 45-percent main carrier, 45-percent stereo channel and 10-percent pilot subcarrier. Overdriving the system to the point where one channel deviates into the other will cause crosstalk and distortion. If the equipment is properly adjusted and modulation levels are correct, crosstalk is not a problem. With stereophonic broadcasting there is a definite decrease in modulation levels; don't worry about it, the listener will set the volume control on his amplifier to the desired level.

Positive and negative main-carrier deviations should be equal (73.322k). If there are push-pull modulators in the exciter, check for equal input signal voltages. I have found only one station with this problem, and in this case the positive input was 5 times greater than the negative signal. Routine servicing and troubleshooting solved the problem.

Equipment performance is a matter of frequency response, inherent noise and distortion, and with stereo, channel separation. With today's modern audio consoles, frequency response of 20 to 20,000 Hz is easily obtained. This, of course, exceeds the 15,000-Hz upper limit. Good frequency response is also obtained from quality tape machines and phono cartridges. Therefore, overall frequency response should never be a problem. However, phono preamp equalization is often incorrect. Hum and noise reduction is a matter of equipment design, proper shielding of cables and placement of parts. (Don't run a high-voltage primary wire next to an audio input transformer.) Distortion should never be greater

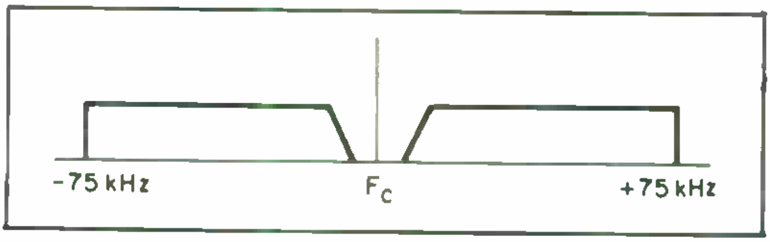


Fig. 5. Diagram of a monaural fm channel with 100-percent modulation.

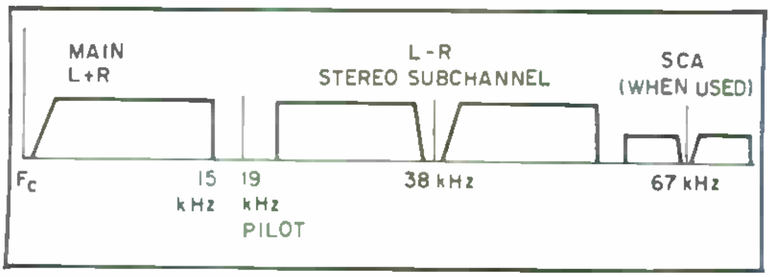


Fig. 6. Subcarriers are shown in this diagram of a stereo upper sideband.

than 1 percent from 50 to 15,000 Hz. Any increase in distortion means defective components. Start troubleshooting and beat that distortion down to where it belongs. It takes a low-distortion audio oscillator, a good distortion meter and a good engineer. Getting all three together is sometimes difficult.

Stereo Receiver Problems

No discussion of stereo is complete without reviewing the problems which may occur in the receiver. A good receiver must have wide-band i-f and detector response in order to recover the composite stereo signal without phase shift or loss of the higher frequencies. The multiplex adapter should be mounted on the main chassis. The use of long high-capacity cables in high-impedance circuits between the multiplex output and the adapter will attenuate part of the stereo signal and degrade the final sound system.

Since the stereo signal is a double-sideband suppressed-carrier signal, the 38-kHz subcarrier must be reinserted at the receiver in order to recover the modulation. The receiver phase adjustment, which controls the phase of the reinserted carrier, seldom matches the phase adjustments at any of the stations in the receiving area; 90 percent of the stereo tuners in the field over one year old are not properly adjusted. If the tuner is aligned correctly on one station, just tune to another station and the phasing on that station is sure to be different. For tuner alignment

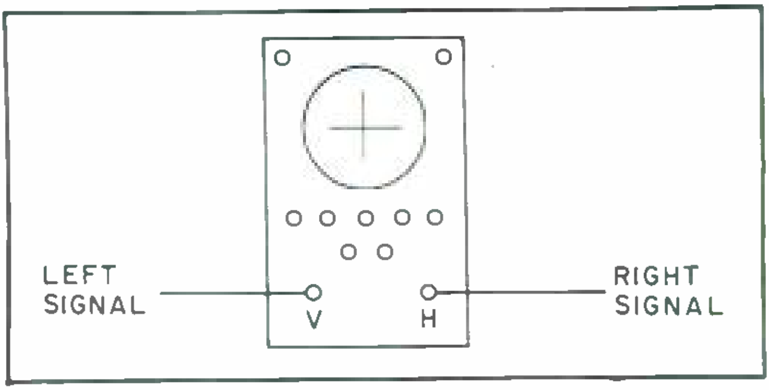


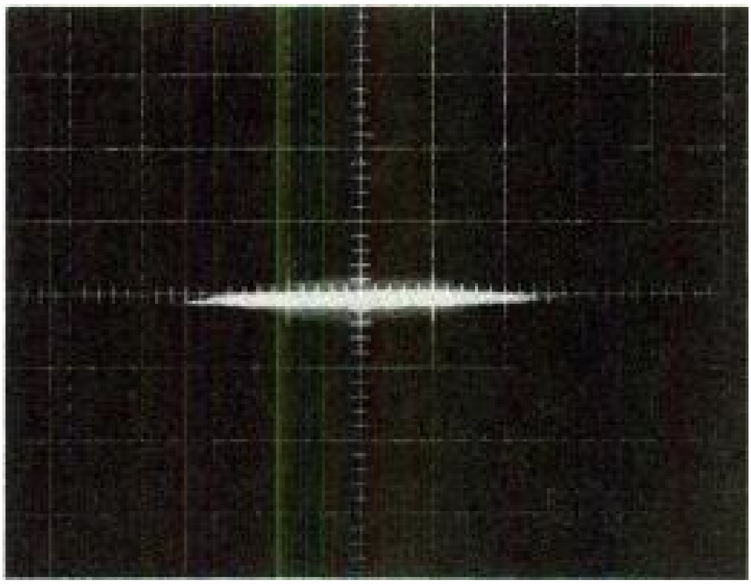
Fig. 7. Connected in the manner shown here, a scope may be used as a stereo monitor.

the service technician should ask the listener which station he listens to most and complete the alignment on that station's signal. Since few service shops have the necessary calibrated professional instruments properly to align test equipment, a method I have used is to align the multiplex adapter on an off-air signal using the oscilloscope as a stereo monitor.

Oscilloscope Stereo Monitor

Connect the left channel to the vertical input and the right channel to the horizontal input of the oscilloscope, as shown in Fig. 7. Adjust

8a



8b

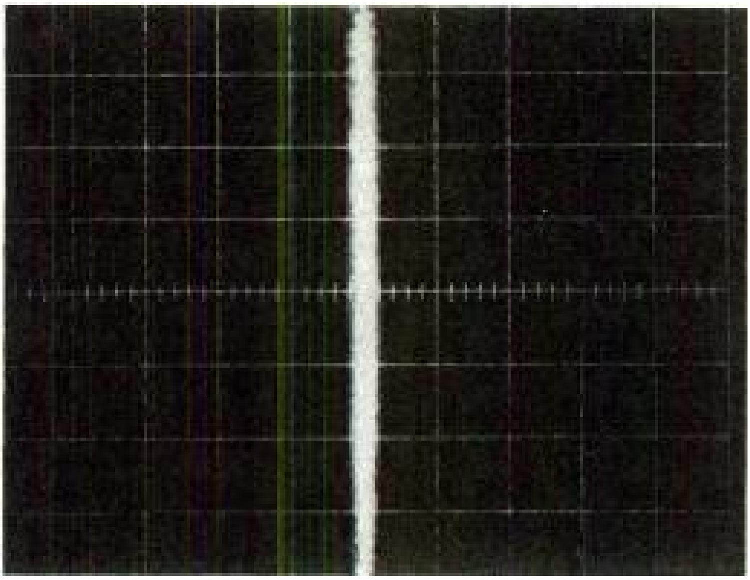


Fig. 8. Scope photographs (a) and (b) show channels with no modulation.

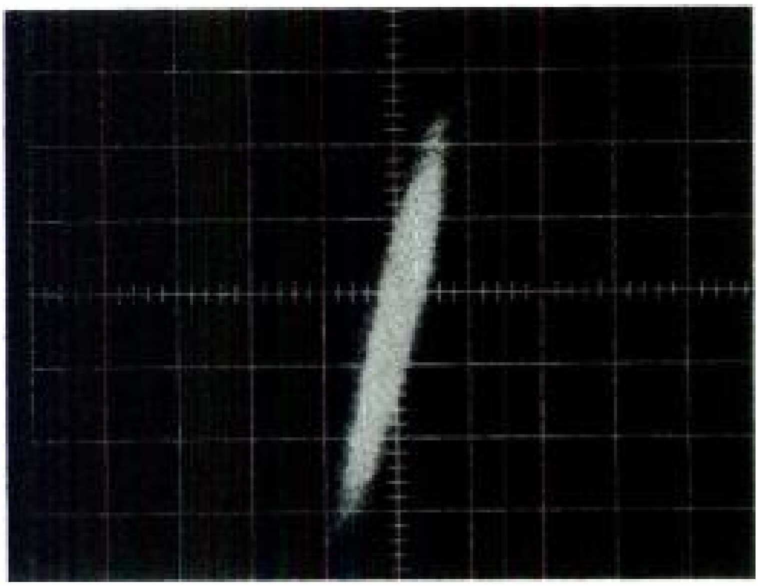


Fig. 9. An off-vertical (or horizontal) scope trace is an indication of poor channel separation, as shown by this waveform.

vertical and horizontal gain controls for equal deflection with equal input to both channels. When only the left or right channel signal is on the air, the scope should show a straight line (vertical or horizontal, depending upon which channel is being broadcast). A high quality, properly aligned system will give excellent results. Any tilting or curvature of the line indicates poor separation and trouble somewhere in the total system. (See oscilloscope photographs, Figs. 8

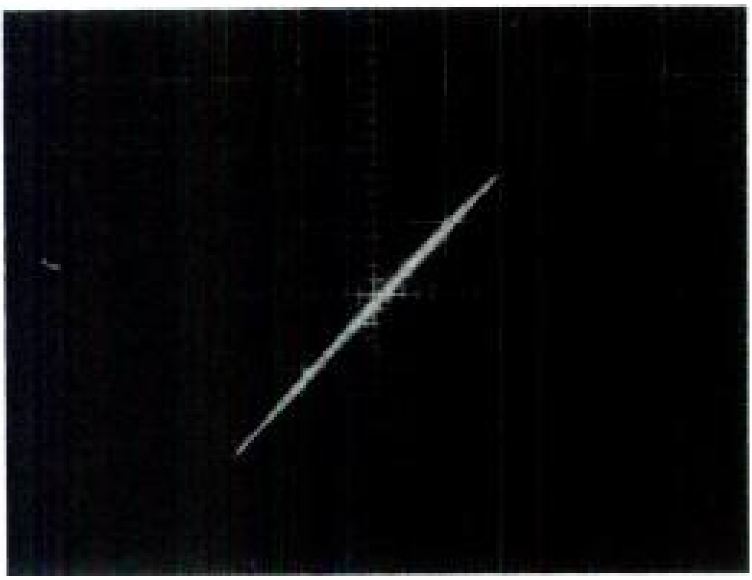


Fig. 10. A monaural signal at the input of the scope stereo monitor will produce a diagonal line.

through 11.) A monaural signal will show a straight line at 45°. With good stereo music, the scope pattern looks much like a ball of steel wool. The best stereo performance may be obtained by adjusting separation and balance controls for the best straight line while one channel is silent.

FCC rules require annual proof-of-performance measurements. Some stations conduct the tests grudgingly and only for the purpose of satisfying the rules. They should be conducted with the objective of providing listeners with the best possible fidelity. Professor William Thomson (Lord Kelvin) said: "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it. But when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science, whatever the matter may be." His exact words summarize as follows: If you cannot measure and express it in numbers, you do not know what you are doing.

In the case of stereo sound, the proof is in the listening. There are many people who claim that measurements are meaningless, and that there is that undefined quality of transient response which gives a sound system that extra

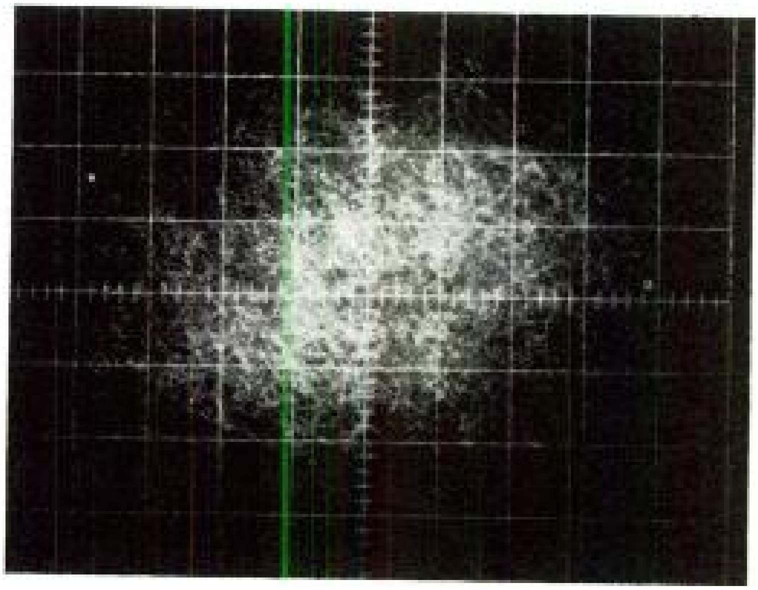


Fig. 11 Full stereo modulation produces a scope display similar to that shown here.

quality. Nonsense! I have never measured a system that sounds bad and obtained good measurements, and any system that measures good has always sounded good. With a good oscilloscope and square-wave generator, transient response and rise time can easily be measured.

It is the responsibility of every broadcaster to comply with all applicable requirements of the FCC rules and regulations. For those systems that already comply, the engineering job is simply one of system maintenance. For others, the only solution is to put a good competent engineer on the job with a coordinated effort to accomplish the best possible stereo. It is doubtful that even an FCC inspection will cure the complacent broadcaster who disregards both the technical standards and his responsibility to the listeners.

Keeping Stereo Phased

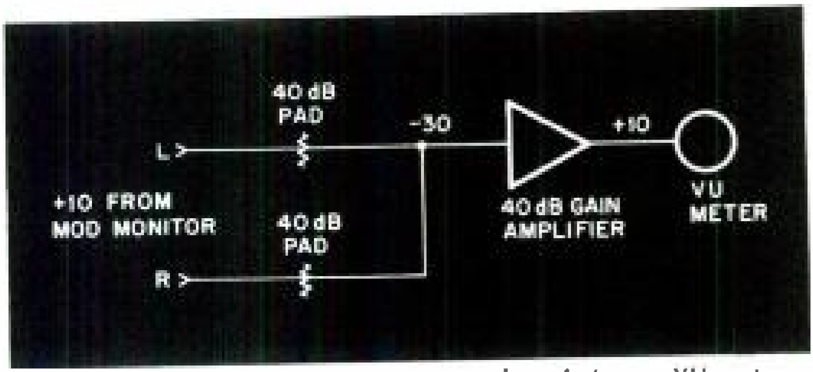
THE STEREO FM BROADCASTER is constantly plagued by the vagaries of proper phasing. Even bigger than this problem is the fact many fm-ers are completely unaware that the problem exists. So says Robert Richer, vice president and general manager of Quality Media, Inc., a supplier of packaged programs to broadcast stations.

There are phase difficulties in varying degrees—from five degrees to as much as 180 degrees. If your station's signal should go as far as 180° out of phase, the result is murder for monophonic listeners—by far the biggest segment of today's fm audience. The received mono signal in such cases is not a full L+R program, but in fact is missing key elements that have been cancelled out. The effect is the same as if your transmitter power had suddenly dropped. There's also distortion, the music sounds thin and unappealing and announcers sound as if they have a speech impediment.

No Time for Phasing

Richer caught a very prominent phasing problem while listening recently to a station in a major market. He called the station owner to tell him about it, and was told, "Yes, I know. The station's been out of phase for about a week now, but I've just been so darned busy, I haven't had a chance to get to it." Richer wonders how much of its audience that station has held onto. We're wondering, too.

Actually, correcting a serious phase outage can be quick, simple and painless, if the outage



One possible way to read out stereo phase is to use VU meter summing L + R from off-the-air monitor.

is 180°. Simply reverse the patch plug (if you're using standard dual-prong audio plugs) in either the left or right channel. That's a quick and dirty method that helps preserve your mono audience. Getting at the root of the phase problem can be a much more complicated matter.

There are several possible causes of phase outages:

- Tape head misalignment.
- Out-of-phase tapes or records.
- Out-of-phase elements in the control console and other station equipment in the circuit.
- Telco line problems between the studio and transmitter.

Richer believes that the extreme case of 180° is no longer the major difficulty today. His contention is backed up by many stereo broadcasters who have this problem pretty well under control. It's the slight phase differences that are the most acute ones, since they produce an annoyance rather an obviously bad or attenuated signal. Given enough of these petty annoyances, or a steady diet of phase outage, and your audience can dwindle very rapidly. First thing they'll do is twirl the dial looking for a station that sounds good to them and fits their taste. If there just isn't any such station, the next step in the listener revolt is to turn the radio off.

Engineers Must Care

Too many stations suffer from lackadaisical engineering practices. You can install a phase meter—a simple matter of hooking a bridge across the stereo monitor's output to feed an outboard VU meter. But if that meter's going to do any good, someone has to look at it. Will your combo night man simply ignore the meter, walk out of the control room when a 15-minute tape is on, and just forget about good practice in general? Attitude is at least as important as technical capability.

If you suspect a chronic phase problem, by all means hook up the circuit and VU meter shown in the schematic. At least your desk man will have an opportunity to know what's going on. If you find that 180° phase outage is a continuing problem with records and tapes, then install a phase-reversing switch on the board to be flipped when the meter does not deflect upward with modulation.

Another check is an oscilloscope fed by both stereo channels. The scope will show phase changes instantly with a high degree of precision. At least one station, Chicago's WFMT, uses Marantz 10B stereo tuners for monitoring in the station and in the homes of key station personnel. This tuner features a one-inch oscilloscope screen used as a tuning and stereo indicator. It will also let you know if the station is out of phase and how the stereo balance and separation are.

Some engineers prefer to monitor the board rather than off the air; it sounds better, they say. This can be suicide! First, you must know whether or not you're on the air. Second, there could be some phase shift in the telco line between your studio and the transmitter. Off-the-air monitoring would certainly show up telco line problems right away, and you might be able to compensate for them at the studio temporarily until the trouble is cleared up.

Mono (L+R) off-the-air monitors feed speakers in the office areas of many stereo stations. During the day, at least, the station's clerical personnel make an excellent monitoring crew with instructions to yell for the engineer the minute they hear anything strange. But this only works for eight hours of the broadcasting day. The rest of the time, it's up to that man riding the board.

Previewing Averts Disasters

The most common culprits in phase criminology continue to be records and tapes. New York's WTFM previews all records, not only in stereo but in mono as well. This way, the previewer knows instantly if a disc has a phase problem and can label it as such. Records that fail the phase test go right into the garbage pail at this station.

According to WTFM's chief engineer, Ed Karl, careful engineering of the studio and its equipment will eliminate at least 99 percent of all phase problems. One continuing possible source of trouble, he says, is the dual-prong audio patch cord. At his station, they're color-coded with red on the right side. But there's always that chance that a plug will be put in reversed. "If I were re-doing the station from scratch," says Karl, "I'd use three-conductor, single-prong plugs for patching. This way there would be absolutely no opportunity for patching to cause phase problems."

A useful trick is to listen carefully when you cue up a record or tape. In the cue position on most stereo consoles, the cue speaker gives you a full L+R signal. If there's a phase problem, and the desk man is interested, he'll spot it instantly. Stereo carts can be another problem. At New York's WRFM, commercials in stereo tend to have serious phasing errors—often going in and out of phase. As a rule of thumb, that station uses only mono spots on carts, especially if there's a jingle or any kind of music on it.

WTFM on the other hand, emphasizes stereo all the way, including its commercials. But it too, has had trouble with stereo carts. Major problem here was the three-channel head. Ed Karl simply couldn't find a mass-produced three-channel cart head that worked to his satisfaction. He found that production-line heads are not only frequently out of phase track-to-track, but alignment within the head has also tended to be a problem. As a result, the station has had its stereo cart heads made to order. Karl says the extra cost amounted to only $15 per head over the price of the mass-produced items.

Ideas for gimmicking up the stereo lines come fast and furious, once you start attacking the phase problem. But all that's really needed is some careful engineering in studio design, and a man on the board who cares. You can have all the fancy indicators you want, but if that night man doesn't eyeball them, your station will lose listeners. One last thought: if you want to ride herd on a carefree night man and have personnel problems (and who doesn't?), you might hook up a repeater for the VU phase meter. The repeater can be a low-cost strip-chart recorder in a locked cabinet. Next morning, you can tell at a glance if the playboy has been doing his job or not.

Solving the Cart Phase Problem

Grady Moats

By now, nearly everyone in the technical end of broadcasting has at least heard about inter-channel phase error in stereo tape cartridges, and many of us have had lots of headaches trying to minimize its unwanted side effects of partial program cancellation in the mono mix, and poor frequency response.

The solution to the problem is beginning to come along in some new, better-made carts, but a lot of stations won't be replacing all their carts right away —that's a tremendous expense. They need a simple, inexpensive way to minimize the problem now—and here it is:

To understand it study first Fig. 1, an idealized drawing of the standard NAB tape cartridge:

A) Tape pack

B) Two twists the tape makes out of the ideal plane of travel

C) Corner guide post

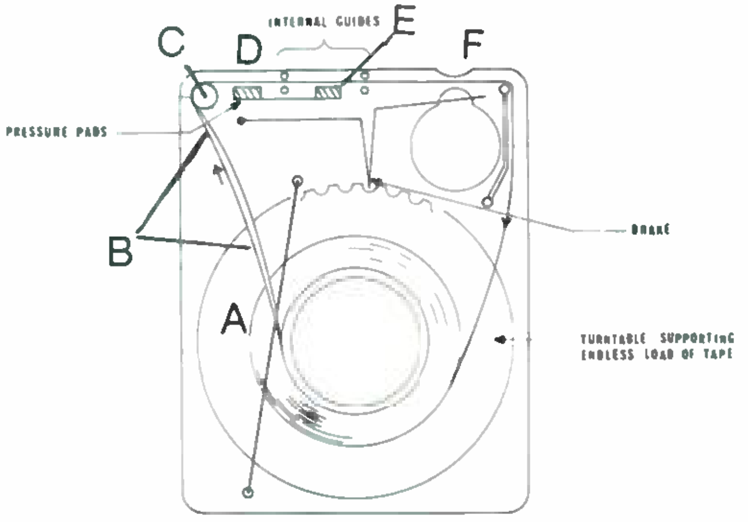


Fig. 1. Drawing of standard NAB cart

D) Record head position
E) Playback position
F) Capstan position

A quick comparison of this cartridge tape system with its ancestor, the reel-to-reel system, shows several weaknesses in the cart design. Chief among them is the fact that the corner guide post, "C," must perform three functions: it must *straighten* the tape out after its travel out of the optimum plane, *standardize tension* of the tape across the heads to eliminate flutter and tape skew due to an uneven tape tension on each side of the capstan, and it must *guide* the tape over the record head's face, at the proper height above the deck plate, to standardize tracking and azimuth adjustments.

If you have had a few years' experience with the common broadcast cartridge, you know that it does none of these things well. In the old model Fidelipacs, for instance, corner post "C" is secured in a small hole with glue. After several months of handling, this post invariably begins to slide up out of its proper position, thereby guiding the tape into the head area higher than intended. The old Audiopak cartridge actually guides the tape with the plastic top of the cartridge. If that is warped, or the top screw is loose, you get a larger variation in tape height with the Audiopak than with the Fidelipac.

Before we go any further, it should be made clear that this is not faulty design work on the part of the cartridge manufacturers, it's our fault!! Manufactur-

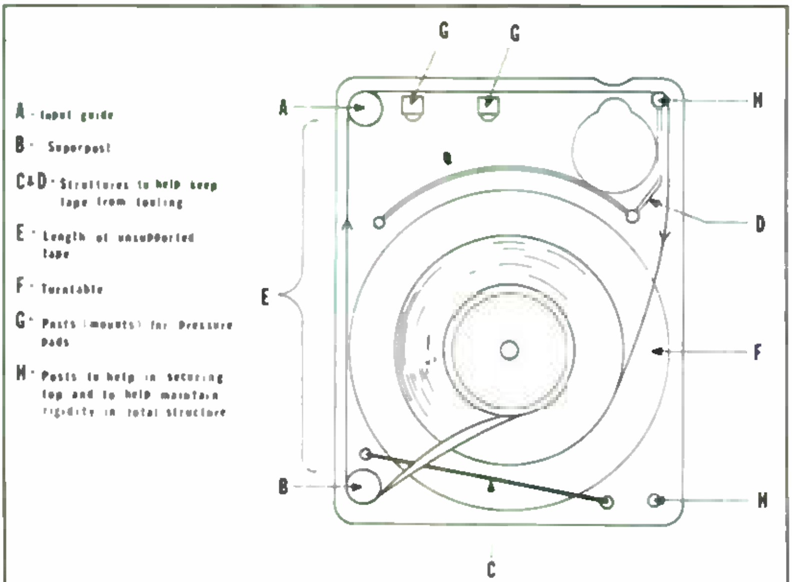


Fig. 2. Drawing of I G M Aristocart

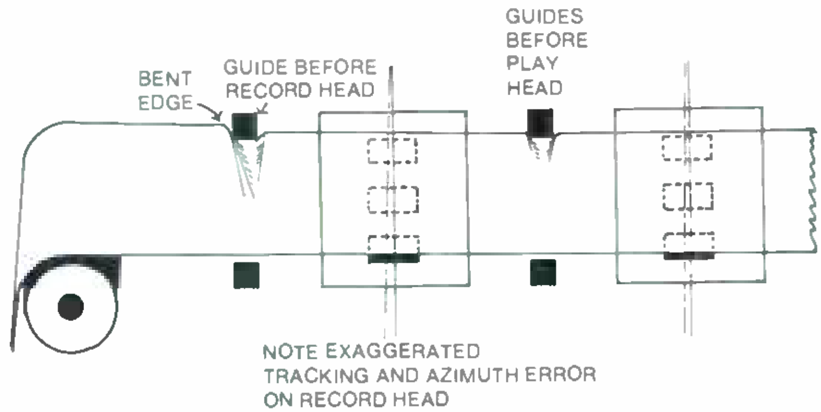


Fig. 3. When tape edge is bent, azimuth errors occur.

ers of tape cartridges, and any equipment or product in the world for that matter, are in the business of supplying us with what we want. When the original design for these carts was drawn, nobody said "phase error lower than 30°." And when we discovered the problem, we took years communicating it in detail to the manufacturers. So that's why the solution is just beginning to appear commercially. Now every manufacturer has a version to beat the problem.

Nearly all early designs of tape cartridges have problems with tape guide "C." Thus the biggest improvement the new designs have come up with is the adjustable guide or, in the case of the IGM Aristocart (Fig. 2), another guide added at the rear of the cart which isolates the out-of-plane tape travel from the front guide. It makes the front guide and the entire front of the cart, for that matter, rigid and accurately positioned to optimize tape height and azimuth without individual cartridge adjustment. A welcome side-effect of this added post is a length of free-running tape between the tape turntable and the heads which acts to minimize fluctuation in tape tension, thereby cutting flutter and tension-associated tape skew to a minimum.

Another aspect of the guidance problem is that addition of a machine-mounted guide between guide post "C" and the record head at "D" is generally ineffective. Reason? The tape has just made a 120° bend around tape guide "C." This fact, coupled with the high tape tension normally encountered in a tape cartridge, means that the position of the tape as it comes off guide "C" is very "firm." Another guide in a different position vertically, located between guide

"C" and the record head, usually just bends the edge of the tape that is out of line, rather than guiding the whole tape longitudinally down the face of the record head. Fig. 3. Occasionally a slack tape loop will allow an additional guide to perform its function properly but the lack of proper tension causes even worse problems—response and phase error that constantly vary because of tape skew!

Examination of the above would lead you to believe that most of the problem lies in the record part of the system, rather than in the playback portion. Experiment verifies this hypothesis: simply record on a reel-to-reel machine a ten-minute length of tape with a 10 kHz tone, and then wind sections of it onto several carts. You will find very little phase error on the carts after you align the playback head to match the first cart.

It is easy to see why this is so; the tape guide before the playback head simply cannot overcome misalignment which is encountered before the record head. Therefore the tape is moved into the proper path *after* it has passed the record head.

Some new carts, of course, solve this problem, but the new carts, as already noted, cost money. Now if you could solve the problem inexpensively, even if it meant adding a little extra routine to your production work, you could slowly phase out the old carts, buying 50 or so new ones a month. Wouldn't that be nice?

You can. Since phase error is a direct product of improper azimuth alignment in recording, you can compensate for the improper entry angle on the record head by re-aligning the head each time you record a cart!

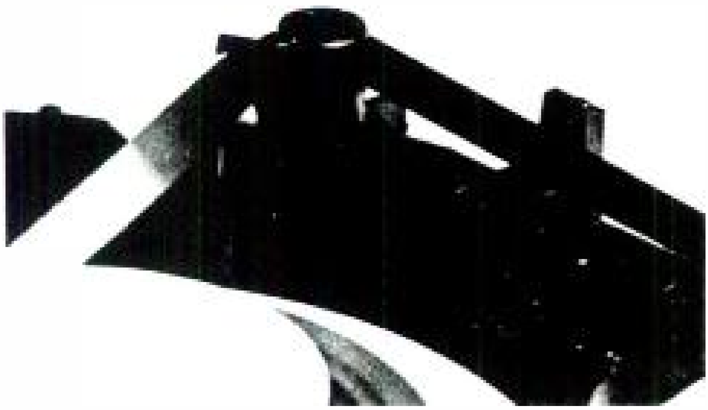
"Good grief!!," you say, "that would take hours to set up!" Not for the operator, if you took all the work out of it for him with a small built-in 10-kHz oscillator, with level and frequency controls, and an In/Out switch. It takes about an hour to build up, out of junk-box parts, another hour to install, and another hour to teach the operator how to use it. Then it takes between 15 and 30 seconds additionally every time a cart is recorded. It's worth it for many small stations who want quality sound, but don't have network-sized pocketbooks. Figure the cost of the proposed solution at a maximum of $15 for new parts.

The New Audiopak Cart Design

The IGM Aristocart relies on accurate molding of tape guides rather than an adjustable guide. IGM says contrary to general opinion plastic mold accuracies of ± .001 inches can be maintained. Another company to take a similar tack is Audio Devices, Inc. Robert L. Manierre described the Audio Devices approach at the AES Convention.

Manierre says the NAB cartridge standard calling for .562 in. ± .002 in. for the upper left tape guide is not easy to maintain if one guide is in the cover and another in the base-plate. Typical molding tolerances of .002 in. for both cover and base adds to .004 in. Warp, poor fit, nicks and dents could increase this.

Inserting a guide by press fit into the base alone avoids the cover warp problem but there are still two pieces to create an out-of-tolerance situation. Cemented inserts can be adjusted to meet tolerances, but they are subject to assembly errors and adhesive failure. Drawing from experience in producing automobile 8-track carts, Audio Devices



Note angled surface prior to corner post.

Fig. 4 is a diagram for a simple, twin-T oscillator, using any audio transistor with sufficient gain to oscillate in a circuit. The first one you pick up will probably work, biased properly. Don't worry about the low price tag. The only reason an H-P or B&K oscillator costs so much is the low distortion and stability. These factors don't matter in this application. The only drawback to this approach is the

Completed Audiopak cartridge.

claims the entire guide can be molded as part of the base to ± .001 in. *if the guide surfaces are formed by solid steel in the mold.* It has adopted this approach in its new cart.

In most carts, guides are positioned after the corner post to push the tape down to the correct height for heads (usually tape climbs up the guide post). Audio Devices has introduced its precision guide prior to the corner post and incorporates an angled surface calculated to position the tape to the correct height by the time it reaches the corner post. Furthermore this guide bears on the entire surface of the tape and not just the top edge (which causes edge wear).

The Audiopak A-2 design has a few other innovations. A lower right hand corner post is used to prevent the loose tape problem and the hub brake has been eliminated. Brakes really do not hold tape —only hubs. Since the objective is to hold the tape for accurate cueing, Audio Devices does this by clamping the loose tape against the sidewall of the cartridge.

change in tracking. Within the limits of guide tolerances, this tracking error makes little or no difference. On a few carts, the noise level may rise a few dB, but that's better than losing half of your mono signal!!

The oscillator can be built on a small seven-terminal bakelite strip, and installed wherever there is free space. Current requirements for a small tran-

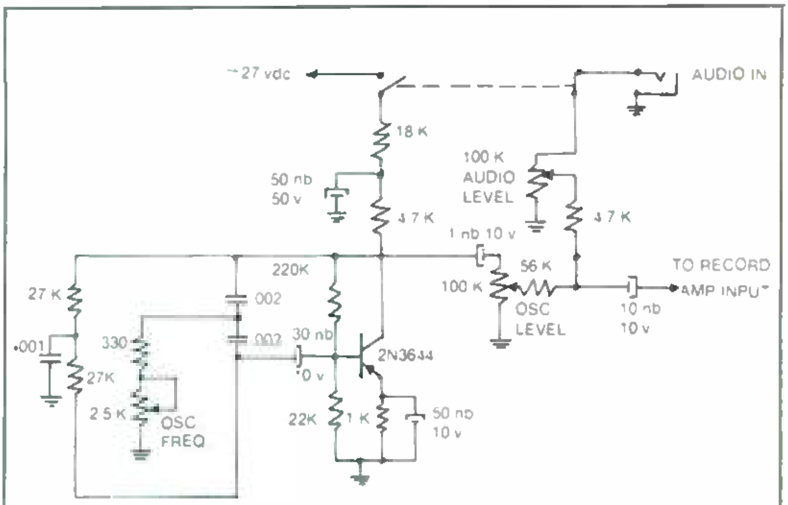
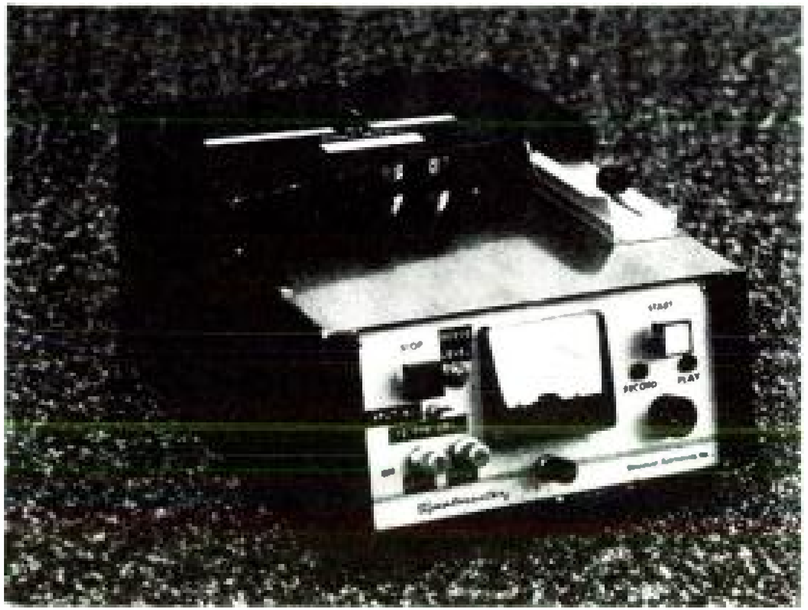


Fig. 4. Schematic diagram of twin-T oscillator.

sistor in this type of service are so small that you can just resistively drop from even a tube plate voltage supply to the 20 or 30 volts you need.

I show a pnp transistor type in the schematic but, if you have only a positive supply available, just use an npn. The easiest way to switch from program input to oscillator is with a dpst two-circuit toggle switch. Use one set of spst contacts to disconnect the program input, and the other to apply voltage to the oscillator circuit. In this manner, the oscillator is switched off when the program input is being used, which is a good idea, as 10 kHz will bleed across a toggle switch like a duck swims across water. It's best to have the decoupling capacitor on the oscillator side of the switch, with a time constant (decoupling capacitor and supply dropping resistor) of less than a second. Otherwise it will take a few seconds for the oscillator to reach full level.

Installation is simple. Align the playback head on the recorder as nearly perfectly as you can. Dope the adjustments, or tighten the lockscrew if your head mount is so equipped. Align all *cart machine* playback heads in the station to this standard. Then, install a long bolt in the adjustment hole for record-head azimuth, to which you attach some kind of makeshift shaft that a knob will fit on. I used the bolt out of a core from a tunable coil, a nut that fit it, and a small round terminal with the terminal broken off which also matched the threads. If the top of the machine is not accessible when in operation, a 90° gear arrangement or a flexible shaft



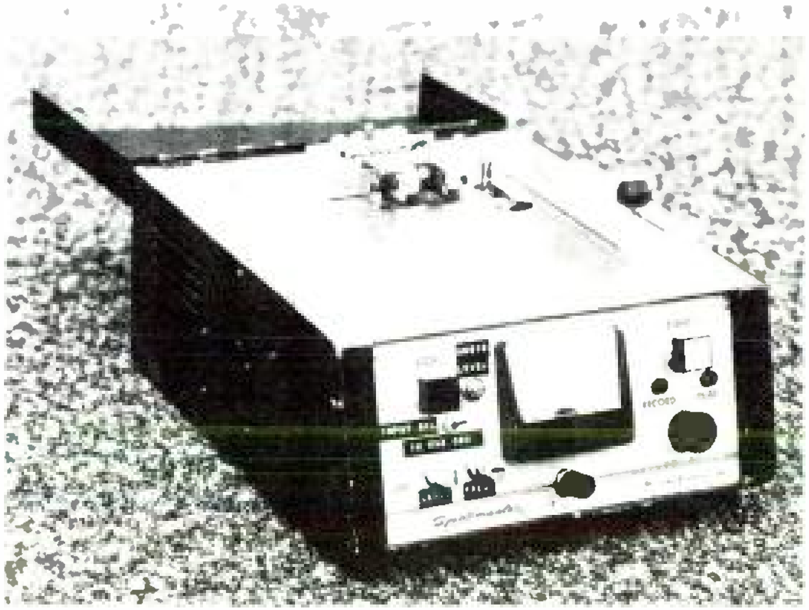
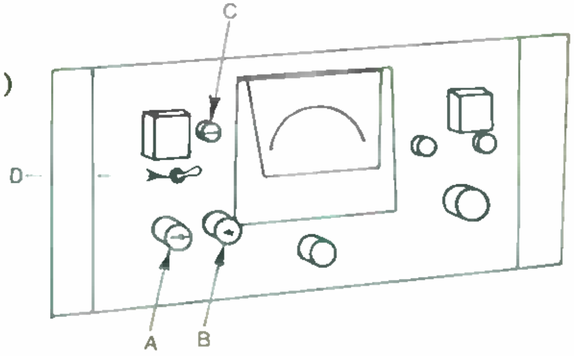


Fig. 5. Modified Spotmaster 500C, with parts added labeled.



A—Level (osc.)
B—Frequency (osc.)
C—Audio level
D—Oscillator sw.

will allow you to bring the record azimuth adjustment out the front panel of the machine. Backlash isn't much of a problem, since you are simply adjusting for a peak response at 10 kHz. You just pass peak once, note the level, and then come back to that level.

Fig. 5 is a photograph of a Spotmaster 5000C modified in this manner, with (a) oscillator level, (b) oscillator frequency, (c) program input level (screwdriver adjustment), and (d) oscillator program switch.

Operation of the recorder as modified above is really easy. Don't erase the cart first. Simply select the cart you wish to use, insert it in the recorder, press the record button, flip the input switch to oscillator, and start the machine. While monitoring the machine's output on the board, adjust the azimuth knob for maximum indication on the production board's meter. If you're way off, you will notice several minor peaks on either side of the optimum position. Don't accidentally hit one of these. Normally, if you are that far off, you should check the corner guide post to see that it is firmly seated in its hole, or that the top isn't warped and is firmly screwed to the base of the cartridge. After adjusting for peak, stop the machine, flip the input switch back to program, erase the cart, and proceed as you would normally through the rest of the recording process.

It is interesting to note that this idea stemmed not from a phase problem, but from a frequency response problem that I was having at another station when dubbing a new jingle pack. I noticed a wide difference in the quality obtained with different carts, and set out to find a solution. Since correct azimuth means correct phasing (within 5 or 10 degrees) this cures that too. And a 30 degree error isn't that noticeable on the air, after all.

As a final note, let me emphasize again that this is an interim measure, designed to give the small budget radio station time to buy the new carts a few at a time, while not sacrificing quality until all carts have been replaced. New carts are the final answer to the phase error problem.

Production & Recording: Key to Station Image

Charlie Buffington

PRODUCTION, to most local stations in the early days of radio, meant the painstaking assemblage of various program constituents, such as orchestras, announcers, actors, etc., and combining their talents into a flawless musical, dramatic, or informational showcase designed to invigorate the listener's imagination and demand his rapt attention.

Back in those days, most stations depended heavily on a network for the bulk of their programming; the local staff had only to cut an occasional acetate disc and produce local news and sports programs. The overall sound of a station was pretty much determined by its network affiliation, and to a lesser degree, by a handful of local personalities.

As dependence on network programming diminished, and as the number of stations on the air increased, the evolution of the present music-news format began, thus requiring stations to produce their *own* sound. It has been, to be sure, a slow tedious process, but during the past few years many stations have developed, or *produced*, a sound which is at least comparable to that of early network production – a sound which emanates excitement and drama in an amalgamation of music, commercials, news, and other features.

The techniques of producing commercials and other announcements, recording music, and producing news and sports programs, require the unfaltering effort and limitless imagination of a station's staff. The only alternative sound is that of an overgrown juke box with an announcer disinterestedly repeating record titles and artists names and *reading* commercials and news—a sound which does little to the listener's imagination and demands little of his attention!

Where Do You Begin?

A fertile production department must be comprised of competent people and good equipment. Let us hasten to add, before anyone says, "I can't afford it," that this does not mean buying a "package" of new people and new equipment. It would indeed be a rare case where there aren't any talented staffers with some imagination, and where there isn't any equipment other than that used for actual on-air programming. (Daytimers can even use equipment at night.)

In most cases, the only *full time* production people are copywriters and, perhaps, a production director. In most smaller stations, particularly, the production director and announcers double on the air. Therefore, the personnel cost of a good production department is within easy reach of any station.

Equipment requirements vary widely, from the bare essentials of a turntable, a small console (a remote amplifier, for example), a mic, and a tape recorder, to elaborate facilities with multiple turntables, multichannel consoles, mics, reel-to-reel tape machines, cartridge tape machines, and even sound-effects machines.

Production aids add to the quality and versatility of a production department. You can get by with music from the record library, or you can subscribe to a jingle service complete with logos, sigs, etc. However, the best jingle service is worthless if the staff and equipment are inferior or inadequate.

The old admonition "Start small" can surely be adopted by the beginner; he can start with the bare essentials and build as time and money permit. There is one certainty; dollars wisely invested in good production (people, equipment, aids, etc.) will pay off handsomely.

Staff Enthusiasm

There is another vital and often elusive element required of an efficient production department—*staff enthusiasm!* Deep within most radio people, there is some ham. Some have latent creative abilities which, when properly nurtured, can be evolved into original concepts of presentation. Thus, the potential of a good production department already may exist. The problem is bringing it out!

An experienced manager must tap the creativity within his people, using any means at his disposal—encouragement, suggestion, remuneration for above average effort, any strategem which will "fire up" the staff.

This is not a job for a taskmaster; quite the opposite. The wise manager will create within his staff the will and the overwhelming desire to do the job right; he will instill in them the very real fact that their security, whether they own any of the station or not, depends directly on how well they do their work. In other words, the manager must give his people an incentive to go the extra step, to try a little harder— a goal taskmaster tactics will never achieve. By the same token, a manager who doesn't seem to care can hardly expect his staff to care.

Therefore, the first step for any station, wallowing in the mire of half-hearted "Well, I may as well get the job out of the way" attitudes, is to determine, or find someone who can determine, a basic concept of how the station should sound. Then, this image can be developed by the joint effort of even a small staff.

Developing a "Sound"

In modern radio, developing a sound is tantamount to developing station individuality. Primarily, station sound is decided by its *approach* and by its *format*—a *hard-sell* or a *soft-sell* approach within a music-news or talk format.

The hard-sell approach, of course, is the rapid, machine-gun style, exuding a constant, almost frenzied, "edge-of-your-seat" state of excitement. This approach places certain demands on air personnel; in addition to maintaining a "tight" sequence of various format elements (records, announcements, etc.), they themselves must sound excited, almost as if they were attempting to squeeze two minutes worth of material into one. Consequently, the hard-sell approach requires a staff capable of developing and holding high-spirited fervor.

The soft-sell approach, on the other hand, is any operational pace other than hard-sell, and isn't easily defined or categorized. It is, however, in no way less demanding (although perhaps less strenuous, physically); it does not suggest, and cannot tolerate, sloppy attention to sustaining a tight sequence of events. Air delivery can be more relaxed; general production material can be lower key, less frantic. But, the more relaxed approach requires just as much care in program element preparation as the hard-sell approach. Therefore, adopting a soft-sell sound is no easy way out of establishing good production standards; either approach is, in essence, equally demanding.

Production Concepts

Once the hard- or soft-sell decision has been made, a basic tailoring-to-format job must be undertaken. No matter what the format—rock and roll, top 40, pop-standard, country - western, concert or classical music, or all talk and news—a general production concept or set of standards must be established for newscast and sportscast production, special events production, special feature or "gimmick" production, and, of course, commercial production. The concept must fit the format (obviously, production standards would differ between classical and country-western formats).

Production concept development requires intimate cooperation of the copy staff; all material must fit the overall production aim, whether hard- or soft-sell. Copy written for rapid delivery requires different treatment than that written for a more relaxed delivery; if nothing else, more words are needed for the rapid delivery. By the same token, if the copy people are to prepare suitable material, they must have complete cooperation from the sales department, such as adequate, accurate information for the message as well as advertiser preference of background music, jingles, etc. Of course, in smaller stations, fewer people are involved in these various inter-departmental relationships; the salesman may be the copywriter and may even assist with production, which may be better in some respects.

Production Aids

The life-blood of any production department is a variety of production aids. At no additional cost, a station can accumulate, by careful listening and screening of all incoming records and albums, a vast selection of musical interludes, bridges, logos, sigs, and background music. Production aids must be carefully indexed; otherwise, the very piece wanted for a specific use will be lost in a myriad of records and albums. If the specific record or album can't be kept in a special production filing area, the desired segment can be dubbed onto tape and filed with production materials.

An alert staff can uncover many unusual and unique production aids from many sources other than records—public service and commercial ETs, tapes, etc., or even from candid tape recordings (permission to use material may be required). Aside from do-it-yourself production aids, a good jingle service, including instrumental jingle logos, is a good investment, particularly where a more uniform sound is desired. However, with or without a jingle service, the resourcefulness of production people determines, to a large degree, the success of a consistent, individual sound.

A word of caution: The tendency to over-produce is quite natural with a staff just going into, or enlarging, an organized effort. Therefore, the need for careful planning can't be stressed too much. As Bud Clain, PD of WSPR (Springfield, Mass.) so aptly states, "Production makes the copy, but creative copy makes the production. Your biggest effort should go into the copy, for it's the copy that sells the product. If you can add some frosting-to-the-cake emphasis with production gimmicks, well and good; if not, let the copy go live."

Production Equipment

It is in the area of equipment that most disagreements between management and production arise. Naturally, an aggressive, anxious staff will want good, versatile equipment. Clumsy patching arrangements and equipment combinations severely hamper good clean production. If, for example, a man can't conveniently reach all necessary controls, flawless production may be very difficult to achieve. A good, flexible recording facility comprising available equipment, used properly, may result in better material than one where the best available equipment is arranged poorly and used improperly.

A wise manager will authorize the best equipment his budget will allow, and continue to improve the recording equipment as economic conditions permit. If this intent is known by the staff, they will willingly extend themselves to do a good job; they will exert the little extra effort needed to make do with the available equipment. The feeling to be avoided is that management wants superior performance with antiquated and hazardly arranged equipment.

Also, a wise manager will insist that equipment be properly maintained to ensure best possible quality production. A rather rigid preventive maintenance schedule is vital to proper performance and long useful equipment life.

In conclusion, let us simply state that it behooves the manager of any radio station to initiate and strive for the best possible production facility, in line with the desired station image and in accordance with its economic potential. Cutting corners unnecessarily is comparable to a prizefighter with one hand tied behind him; you can't deliver the Sunday punch that may mean the difference between just barely getting by or being the decisive winnah!

ENGINEERING AND MAINTENANCE

Dramatic engineering adds a vital element to recorded announcements. Long, slow fades are useless, since they are mostly offset by limiters and compressors. Sharp fades and "stings" (quickly bringing up music or jingle) are much more effective.

Consistent recording levels can't be stressed too strongly; if the level is too low, background noise begins creeping up; if it's too high, the result is distortion due to equipment overload. Then, too, a standard recording level for all production results in more reliable on-air levels.

Thorough tape erasing is essential; otherwise, you run the risk of airing an occasional blip or unerased sound. When using bulk tape erasers, adequate erasing time should be allowed for each tape (15 to 30 seconds). The eraser should be passed over the tape or cartridge in a brisk, circular, or elliptical motion, so as to cut the maximum lines of force.

Maintenance is important, particularly for tape machines. Many stations have thousands of dollars invested in tape machines, logically necessitating a religious maintenance schedule. Test tapes for head alignment, any special wrenches needed to adjust heads, and a head demagnitizer should be provided and used. Wiring harnesses for out-of-rack operation of rack-mounted machines greatly facilitates service and ajustment procedures.

Maintenance records, including notes showing normal operating and performance parameters, will aid in spotting trouble before it actually happens. For example, data might include pinchwheel tension, lever position adjustments, solenoid voltages, control voltages, B-plus voltages, etc. Armed with this data, anyone on the staff can ascertain when any piece of equipment is not operating properly.

A spare parts stock, at least for cartridge machines, may eliminate long periods of down time. Items to consider include spare motors, capstan idlers, replacement heads, power supply diodes, cartridge positioning springs, and a spare set of tubes.

A tone test tape, with 50 to 15,000 cps tones recorded on a new machine, or one known to be operating properly, periodically played on all equipment and compared with previous readings, will give advance notice of deteriorating quality.

Tape heads should be cleaned often, especially those on regularly-used machines; the best time to do this is after sign-off, at least for on-air machines.

Each tape transport mechanism should be disassembled periodically (except sealed bearings and press-fit assemblies). and thoroughly cleaned and lightly lubricated. This procedure should include inspections for worn parts and other potential trouble spots. Vital working parts should be sparingly lubricated when required (over-lubrication brings on unnecessary troubles). A spray can of silicone lubricant is suitable for some cartridge machine brake assemblies, particularly older types. Vaseline is ideal for cartridge hub bearing lubrication.

A stereo reel-to-reel recorder can be used in some cases for master tape recording, especially where frequent copy changes (with the same production) are required. In this manner, only the copy track on the stereo tape need be re-recorded; the two are mixed when dubbing to the cartridge.

NOTE: The NAB Engineering Dept. has published standards for reel-to-reel and cartridge tape recording and reproduction. The data is essential to all broadcast engineering departments. Available from NAB, 1771 N St., N.W., Washington, D.C. 20036.

TAILORING, MUSIC, COPY, AND TECHNIQUES

Copy must fit production music if it is to sound professional. The music must end decisively at the conclusion of the copy, not just fade out. One method of "sectioning" is to select a music cut with a natural ending; then with levels set, record the spot (music and copy) on a reel-to-reel tape. On another tape, record the last few seconds of music and the last few words of copy, making sure the copy ends at the desired place just prior to the end of the music. Next, mark, with a grease pencil, the beginning of any suitable word, preferably a word beginning with a hard sound (like D or G) on each tape. Then, splice, at the grease pencil marks, the end of the spot. On replay, the spot should sound as if the music was tailored for the copy, provided, of course, all levels were constant.

If cartridge tapes are used, the same principle may be applied, only in a much simpler way. First, the spot and music is recorded on a reel-to-reel tape, but the music is faded out just before the copy ends. Then, when dubbing to the cartridge, fade in the musical ending at the proper time (begin fade-in where fade-out begins on the tape.)

In difficult editing jobs, sounds are much easier to identify if they are recorded at 15 ips, then replayed in slow motion at 7½ ips.

Cartridge labeling can be used as an on-air production aid; in addition to cartridge number and client name, its helpful for the airman to know how the spot ends—music or voice—and if voice, the last several words. It prevents the guessing which often results in either dead air or "stepping" on spots.

Where multiple back-to-back spots are necessary, the on-air insertion of an ID jingle, or short logo or interlude, helps break monotony and adds some measure of prestige. Logos may be any variety of lengths—5 or 10 seconds or more—to fit existing time limitations.

Unless a cartridge tape is recorded just following the splice, the danger of a blip or muffled sound will result as the stiff splice passes the head. An easy and quick method of locating the splice is to loop the cartridge tape over the capstan on a reel-to-reel tape machine with an exposed capstan. (The stopper arm must be defeated by holding it in the running position with, for example, a rubber band.) Grasp the cartridge so that your forefinger releases the cartridge brake, then push the fast forward switch on the tape machine. By watching carefully, you can stop the machine as the cartridge splice comes around. Of course, you must have a reel-to-reel machine.

Network affiliates are wise to make use of any promo service offered by the net, such as program promos recorded by net personalities. Most offer this service, tailored to your situation, if you supply the tape. If your network will supply you with copies of their themes, especially news and sports, it's wise to obtain them and use for local news and sports; this gives all news and sports a "universal" sound.

Production Practices Good & Bad

Hal Fisher

WHAT ARE THE CAUSES of bad production? Or more positively, what constitutes good production? As is the case with any serious venture, good production demands preparation and planning—lots of it! Obviously, programs, announcements, etc., can be "thrown" together or just allowed to happen (as they do every day in some operations), but you can bet that that's the way they sound. Production control in broadcasting can be compared with quality control in manufacturing—laxity in either case must result in an inferior product. How can you inject new life—production—into your sound, if yours is a small market station? Here are nine ways:

Preparation

The lack of adequate preparation will ruin any production—and ultimately drive listeners to turn their dials in disgust. This common fault is not a malady of the neophyte; it often accompanies disinterest and overconfidence in seasoned veterans. Lack of preparation often is evidenced by poor cues, stretched themes (open and close), stepped-on or delayed intros and tags or segues, long unscheduled pauses, etc. Of course, each of these bugaboos can occur at times in any station, regardless of the amount of preparation. But when they are common practice, it's glaringly obvious that something is wrong. The only cure is for the program department to encourage and emphasize good broadcast habits such as getting to work on time to prepare for the day's assignments, becoming familiar with any new programming, pulling music in advance of air time, etc., so that the announcer has a chance to "catch his breath" before beginning his trick.

A certain cause of poor production is a lack of reliable communication between the air staff and the program department. Where person-to-person messages are relied upon, the proverbial "weak link" all too often results in a broken chain. Each staff member should have an assignment box where he'll find memos with special instructions, program and production changes, etc. That way, no one can forget to "tell him something." Also, when remotes or taped programs are scheduled, a warning should be typed on the log—in red capitals—well ahead of air time to alert the announcer. These positive methods of communication never leave the individual in doubt, a disconcerting feeling for anyone.

Long unscheduled pauses are often caused by the lack of appropriate material to fill several seconds or more prior to a network join or to round out a program segment. The solution to this problem is to formulate a folder containing a series of cellophane jackets or pockets in which a variety of material is kept within easy reach—emergency announcements, a variety of station breaks, promos, intros, anything to keep announcers from getting out on that limb. Some stations use large easy-to-read wall posters to provide the filler material to maintain continuity and avoid awkward situations.

Distraction

Any factor that tends to divert attention should be strongly discouraged. Visitors, without realizing, can destroy the effectiveness of an entire program. Off-duty staff members should be discouraged from loitering in the studio because they surely will distract the man on duty. Telephone calls should not be forwarded to a man while he is on the air, unless it is a true emergency. A conscientious producer (which is what every announcer is) will not encourage calls not connected directly with his program. Distraction in any form will reflect unfavorably upon production. Encourage concentration by discouraging distraction.

Simplify Equipment Setups

To avoid confusion it is a good practice to identify all controls, switches, etc., in the control room and production studio. This is most easily and simply accomplished by typing the function on an adhesive tab which is attached above or below each control. "Mixer 1, 2, and 3, Mic 1, 2, 3," etc., means little to nontechnical people, but "Turntable 1, Turntable 2, Tape 1, Tape 2" doesn't leave any doubt as to the purpose of each control. By identifying the control and switching for each piece of equipment, even the least technically inclined individual is less apt to commit errors.

Frequently quite confusing, particularly to those with little engineering inclination, is the typical audio patch panel. Those "neat little rows of holes" are bewildering, and unless each pair is clearly identified (by labeling and an accompanying diagram) there are numerous chances for error. Each operator should have at least a rudimentary understanding of the basic functions and purposes of the patch panel, and those often-used arrangements should be diagrammed so that laymen can quickly set up for the operation. Also, detailed instructions for specialized patching needs should be prepared by the engineering department. Complicated patching for dubbing and other routine functions should be avoided by "wiring through" or by the use of switching. It's virtually impossible to get things too simple for some; engineering personnel should keep in mind the confusion caused by what seems simple to them.

Technical Problems

One of the most distracting and irritating elements with which a broadcaster must contend is equipment in need of attention—an obvious contributor to poor production. Most stations, particularly progressive stations, strive to maintain their equipment. But there are cases where equipment is permitted to remain defective in one degree or another—sluggish turntables, intermittent switches, offspeed tape machines, etc.

Clean Environment Helps Clean Production

An untidy control room or studio often results in similar production. The psychological effect of clutter—unused equipment scattered around the control room, wires and cables draped over and around the control room, wires and cables draped over and around the desk and racks—takes its toll in reduced efficiency and enthusiasm. Haphazard equipment installation reflects a disorganized attitude and may cause some individuals to believe that management doesn't really care about its on-air sound—"just as long as it gets on."

Carelessness with used coffee and soft drink containers, sandwich wrappings, paper, tobacco ashes, etc., detracts from a tidy appearance and should not be tolerated. Litter surely results in frustration and is certain to have a negative effect on attitude. Without developing fetishes, management should institute and enforce reasonably strict rules regarding the appearance of the control room, studios, record room, transmitter room, in fact, the entire plant. It will pay off in improved overall performance.

When such conditions are tolerated or ignored, even the most seasoned air man cannot turn out professional production.

It must be emphasized that equipment malfunctions can't always be laid at the door of the engineering department. Sometimes announcers are lax in reporting trouble, and unless the engineering department is aware of trouble it surely can't repair it. Policy should dictate that faulty equipment performance be reported *in writing* as soon as detected. In this way technical problems can be corrected before they reach severe proportions. Also, every staff member should be acquainted with emergency operation procedure so that he will know precisely what to do when the occasion arises.

Inadequate Equipment

Don't expect the ultimate in production unless your staff has adequate equipment with which to work. Unfortunately, some owners choose to economize in the area of equipment, and in so doing they hamstring their operation. If elaborate dj production is desired, a man cannot work with a tape recorder and two turntables; he cannot achieve that snappy production requiring a series of short inserts with a single tape cartridge machine; errors are bound to occur if he has to work with only two turntables on which he must play both music and e.t. spots. There is a limit to what reasonably can be expected from any given control room setup, and if your production demands exceed the technical capabilities, how can you hope to avoid poor production? There is much to be said, also, for the frustrating effect inadequate equipment has on the air man's morale. The very fact that he is expected to produce beyond the capability of the equipment saps his enthusiasm. A teletypewriter, a phone, and a typewriter, for example, is hardly adequate equipment for a news-conscious station. A beeper phone, portable tape equipment, a variety of mics for special circumstances, mobile gear—all are necessary for efficient operation. Certainly it is possible to overestimate equipment needs, but there seems to be a greater tendency to underestimate. The important point is that the control room should not be the first place to cut in an austerity drive—that is, unless production means nothing.

Programming

Stagnant, stale formats and hackneyed productions are powerful audience chasers, not to mention what they do to announcer morale. A sweep of the radio dial in almost any area will reveal bored announcers rattling off intros, etc., with an ill-concealed lack of enthusiasm. If such is the case, you can imagine the effect such programming has on the listener. One way to overcome stagnation is to *personalize* your programming. Give your air staff a chance to produce, let them use their ingenuity; provide them with an incentive. Call a staff meeting to discuss program problems and watch the ideas pour out. Ask for suggestions. You'll get plenty. Weed out the deadwood and put a refreshing new sound on the air. Work for originality. Any man (or woman) worth his keep is waiting for the opportunity to show what he can do. Encourage him!

Tapes and Recordings

Another negative factor that makes for poor production concerns worn-out, brittle tapes and damaged records. Tapes wear and become brittle with use and age; therefore, they should be inspected regularly so as to sort out and replace defective reels and cartridges. Announcers should be required to report damaged records and to mark an X on defective sides or cuts with a marking crayon. That way, the record or album can be returned to the library for use until a replacement is obtained.

Care should be exercised in splicing tapes, using only the type splicing tape recommended for the purpose, and in cleaning parts of tape machines that come into contact with tapes. Heads, pinch rollers, etc., should be cleaned regularly with denatured alcohol to remove the emulsion residue that accumulates from continued use. Magnetic buildup in tape heads will cause crackling noises. Unless your machines have built-in head demagnetizers, a manual demagnetizer should be used periodically to remove the accumulated charge. Also, attach leaders to all reel-to-reel tapes to facilitate threading. To improve production and reduce errors, paste small labels on reels or cartridges to identify them by advertiser or program. It's a good idea, too, to identify clearly commercials or programs recorded on reel-to-reel tapes.

Recordings should be handled very carefully. Fingers smudge the delicate surfaces, and hurried cueing and backtracking can cause untold damage. Fingers should never come into contact with the grooved surface on a record. It's easy to remove a record from its jacket by grasping the uncut edge, then letting the disc slide out in your hand, and support it by the edge and the label (center). A piece of cloth and a cleaning fluid should be available in the control room.

Damaged playback heads certainly do not contribute to good production, therefore, they should be handled very carefully when placing them on or removing them from a record. To protect playback heads and records, it's a good idea to discourage backtracking as a cueing method. This can be done by starting the record at a specific spot (marked with an arrow on the label) and counting the number of dead grooves to the beginning of the recording. To eliminate the necessity of counting each time the record is used, jot the number of dead grooves on the label. Then it is necessary to run the record in a half or quarter turn less than the number on the label.

Poor Timing

In this category we find the overtimed show and the undertimed production, the bad practice of running into a time beep, the extremely fast speaker who is difficult to understand, the annoying opening theme music that stretches out and says, "Sorry, there's no one in this control room." Then there's the dull and monotonous theme filler at the end of a show and, of course, that amateurish giveaway, "Sorry, we're late." There are produced announcements that show an obvious lack of timing, both from the standpoint of content and production.

Unless you have time to rehearse completely an entire show, it is a good idea to allow for fill of some type, but plan it that way. Instead of filling with theme, run down a few program highlights, read a public service announcement, etc. Another trick is to backtime the theme and start it (with closed fader) so that it will run out at precisely the right time. Then it can be brought in under. Another way to allow for short timing is to make the last record an instrumental. Then you can fade, talk over the music and crossfade to the theme. If a show or segment turns out to be overtimed, the next to last record can be deleted and the instrumental substituted. These techniques work well for the dj who has a show several hours long. He must go into and out of each hour on the button, if he is to sound professional.

Produced spots with a music background sound produced if the music ends just after the conclusion of the announcement instead of being faded. There are several ways to do this; of course, the easiest is to use a one-minute cut on special albums which are available. Another method is to tape the music, then edit the tape to the desired length. Extra trouble? Sure, but it sounds professional. Some announcers with years of experience never seem to learn to time their speech. They can talk at but a single pace. Others have the ability to speak slow or fast without losing effectiveness or falling into poor diction and enunciation. Practice is required to develop the ability to time your speech, but it's surprising what 15 minutes practice a day will do.

Poor Copy

Announcers can speak only as effectively as the words put into their mouths by your copy; in fact, even the most experienced announcer will sound amateurish if he is given poor copy. To sound believable, an announcer must feel poised and at ease, but how can he feel poised when his copy is written in an unnatural manner, carelessly phrased, poorly constructed? An announcer is a living producer, and if he must force himself to speak in an affected, assumed manner he will sound artificial.

The highly desired quality of believability, when developed in a broadcaster, attracts listeners and steadily builds audience rating. Here are a few of the elements that should be considered in copywriting to create believability:

- Stick to informal phraseology
- Employ a conversational manner of expression
- Develop the person-to-person approach
- Use simple sentence construction and an everyday vocabulary
- Avoid affectation and flowery terms

Copy should be prepared on a large-character typewriter especially designed for the purpose so that the announcer can read it without eyestrain or error! Sales points and special descriptive words and phrases should be underlined to aid in proper interpretation. Pauses should be written-in to encourage free flowing delivery—some copy writers use a series of three dots instead of a comma.

The copy file should be inspected regularly to weed out stale, outdated continuity. It's surprising how the mere substitution of a new opening line or reversing sentence structure will keep copy fresh and alive, giving old copy a new sound. The announcer must be furnished with copy that he can deliver conversationally, sincerely, and informally. On the other hand, an announcer must be capable of talking a commercial, not merely reading it. After all, it doesn't take much experience or know-how to *read* a commercial. Yes, copy is a very important part of good production, much more so than many realize.

One-Man Operation

Obviously, small-market stations must operate with a smaller staff than those employed in stations in larger markets. But that's no reason why small stations can't produce, no reason why they have to sound small. There are several tricks—in most cases quite simple—which will create the illusion of a larger staff.

Of course, the most obvious way to alleviate the announcer shortage is to hire part-time local talent and train them. In most areas there is talent waiting for such an opportunity—students, newspaper people (might help local news, too), salesmen, who knows? Part-timers can be used to break up those long weekend shifts, a time when most small stations sound their worst.

The advantages of a large staff can be simulated by recording intros, promos, special features, etc. Obviously, this inserts an array of voices into each program segment. Have your morning man record afternoon and evening material, the afternoon man record morning inserts, etc. Cross promotionals are good as audience builders, too, because they give exposure to the morning man in the afternoon, the afternoon man in the morning, etc. Public service announcements can be taped for spotting throughout the day, as well as commercials which do not have a special production. By using these simple devices, your station will sound as though it has a much larger staff than it actually does.

Another good idea is to have chairmen of fund raising campaigns, club officials, etc., record promotionals for their activities. In addition to the voice change, they provide local voices and increase listener interest. The same can be done with commercial accounts. It's often surprising the number of advertisers who like to do their own announcements, and this method is especially useful where an account wants frequent copy changes. Have him record a week's supply at a time and simplify your traffic and production. With all the possibilities, there is no reason why a single announcer's voice should be the only one heard for hours on end. Such refinements as these do not require hours of daily work; an occasional recording session will keep the material sounding fresh.

As is surely obvious to thinking radio people, production is more than a meld of several basic elements into what is called a program. For every basic ingredient there are small details that cement the raw material together. For example, a production might include music and an announcer—the raw ingredients—but to make a real production out of them, good equipment, fresh, lively continuity, and thorough planning are absolutely necessary. To fail in adding the ingredients that bond the entire effort together is to seal the fate of the production—even if it is "just a spot." "Production" doesn't just happen in any station—big or little. It takes planning and effort to get the wheels rolling, but as soon as the staff is caught up in the electrifying results, they'll help in putting the polish on your overall sound.

Production Techniques for Stereo Spots

Arthur C. Matthews

WITH THE STATE OF FM STEREO becoming more secure in the mass communications media, the question arises: "What do I do with it?" As revenues from fm increase and as competition becomes greater, how can fm stereo offer a "unique" service to attract advertisers? One thing that could help win friends and revenue for your station is to use the "stereo" part of fm-stereo in an imaginative way for promo and local spot production. But let's face it, most of us were brought up on standard a-m, and our knowledge of stereo programming and techniques has its limits.

Is it worth all the trouble to make stereo materials, especially since most of us are on monophonic cartridge machines or Ampex mats? I believe so, because if your station *starts* stereo production you may have a competitive advantage in your market. And you, as the engineer, need to know things to begin the process. Don't wait until production gets on your back. Most of the fm stereo I've heard has been very unimaginative. This is partly an engineering problem and partly a sales and continuity problem. There are difficulties also in finding material. But just listen to some of the beautiful sound available on modern LPs and you'll be converted.

Many stations have limited themselves to a single studio mic, switchable so that the signal feeds left, right, or combines to make a center fill. Not very exciting, and probably just as well, because the studio is too small for real effective stereo sound anyhow. Let me hasten to add that the idea of setting up a ping-pong table between the two speakers and bouncing the announcer

The author (1) adjusts an AKG C-12 mic for the actress. Actor is using a Syncron Au7a mic. Patterns are perpendicular.

back and forth between the speakers is rather out now, too. Placement of instruments and voices is not as important as "ambience"—that is, the feeling of being in a room. In fact, I imagine that most of the "broom closets" that pass for studios are entirely too boxy for good stereo. While the

The use of a 2-area mic pattern gives greater separation. The mics shown here are perpendicular to each other.

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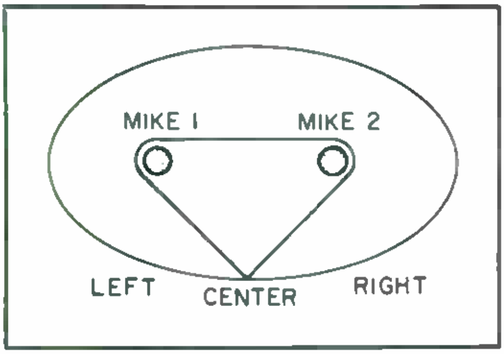

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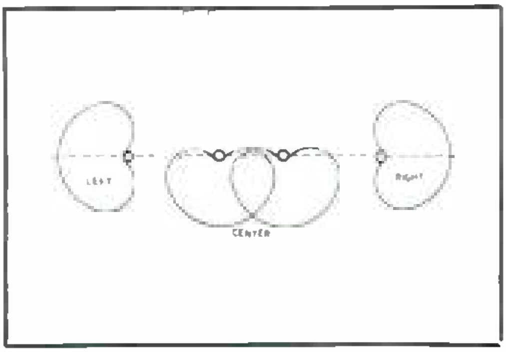

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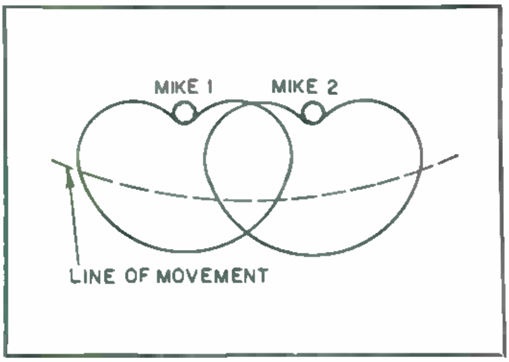

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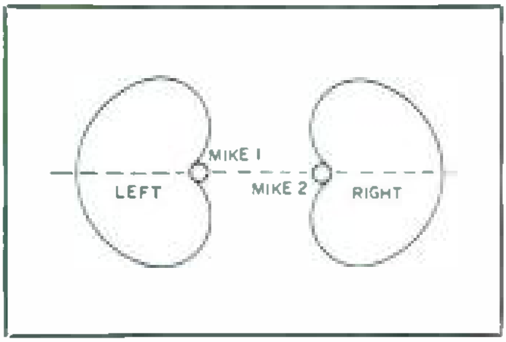

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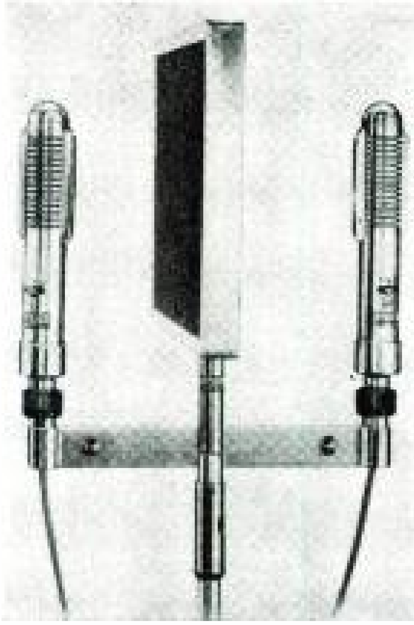

1. Omindirection fusion pattern.

2. Cardioid fusion pattern.

3. Cardioid separation pattern.

4. A 3-area cardioid fusion pattern.

5. B&O Dynaco mics and separator.

idea 30 years ago was deadness, the ideal today is a little more liveness, and I don't mean artificial liveness supplied by a reverberation unit of some kind.

Basic Mic Setups

I've experimented with 5 basic mic setups:

1. Omnidirectional fusion (curtain of sound)
2. Cardioid fusion

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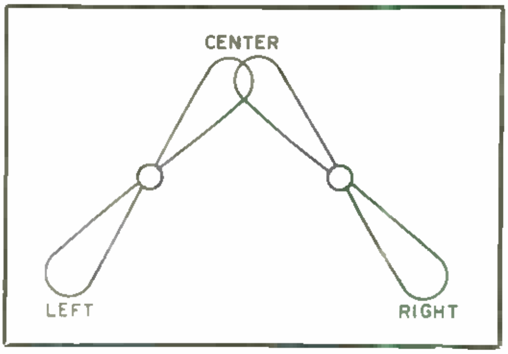

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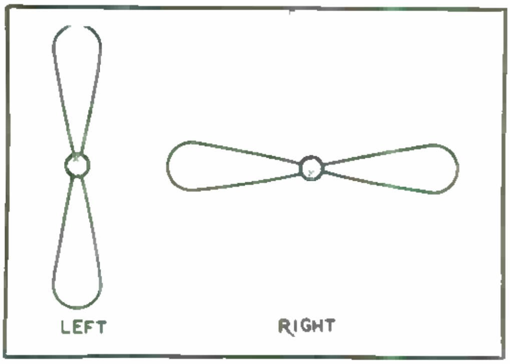

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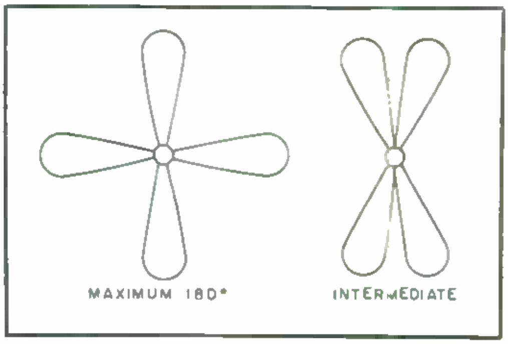

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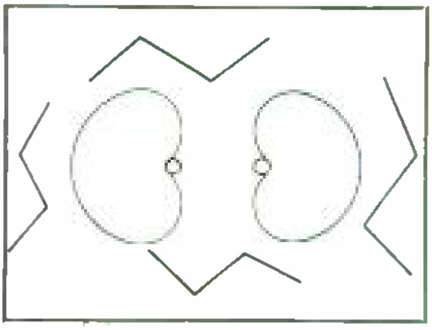


6. Bidirectional separation pattern.

7. Pattern of bidirectional mics set up at a 180° relationship.

8. Bidirectional fusion pattern.

9. Dynaco ribbon mic.

10. Folding screens used for acoustic effect.

3. Cardioid separation (2 area, 3 area)
4. Bidirectional separation (2 area, 3 area)
5. Bidirectional fusion (variable)

By "separation" I mean a more or less ping-pong effect in which the talent appears to be widely separated near the outsides of the listening room. By "fusion" I mean a blending with a true feeling for room acoustics . . . a curtain of sound, if you will. It's difficult to achieve complete separation with omnidirectional mics unless they are widely separated. Let's look at the mic setups individually:

1. Omnidirectional fusion is the most dangerous unless you have an excellent room as described below. Reflections can play absolute havoc with the sound and make listeners wonder just what's going on. You can use two mics or four mics for this curtain of sound and have the talent move across, around, and between the mics for interesting effects. If you have a big studio with lots of air, this kind of sound is quite appealing. I don't like this kind of spread for close talk; it seems more appropriate for "drama of every day life" material. But it has a wonderful openness and sparkle that no other technique can achieve.

First of all, decide on the average distance that the actor must be from the mic. Place the mics that far apart. Use the two mic stands as the foci of an ellipse to assure that, as the actors move across, they maintain their acoustic distance from the mic. To lay out the ellipse, take a piece of string 3 times the distance between the mics (as an experimental starting point anyhow), tie a knot in the end of the string and place the string around the mic stands. Put a piece of chalk inside the loop, pull the string taut and draw an ellipse around the mics (See Fig. 1). A semicircle will be fairly accurate, too. Anyone standing at any point around the ellipse should be just about right for the mics. By following the line, you can create a curtain of sound along which the actor may move with approximately the same perspective. If you have a really big production, use four mics instead of two with the two left and two right mics having interlocking ellipses.

2. The cardioid fusion technique may be used if your room is less than ideal; set up as in Fig. 2 the sound will be picked up only *on* pattern. You may have to do a little adjusting here, too. Is it necessary to warn you about phase at this point? I had a pair of AKG G-12 variable-pattern mics with which a great deal of my work was done. Somehow the shop technician didn't observe polarity or color code and a red and yellow wire got switched. It took me some time to figure out why my center channel never worked properly,

but seemed mushy and slushy. So, it's ideal to check phase before you really run into trouble. A sound wave striking the mic faces should cause them to move electrically in the same direction, not one positive as the other swings negative. I know we always try to maintain phase relationships, but it's especially important for stereo.

3. Cardioid separation (2 and 3 area) requires that you move the mics so that the patterns are back to back on the *same* line, as shown in Fig. 3, rather than perpendicular to it. You also can move the mics farther apart for maximum separation. It's possible to create some rather wierd effects by putting the mics in different rooms—one area may be rather live and one rather dead. It results in quite a startling effect.

I've used University mics and some EV 676 mics with a switch for a reduction of bass frequencies, 5 dB down or 10 dB down at 100 Hz. They work fine in boomy surroundings. With this setup you create a 2-area acoustic pattern—left and right. Using four mics (Fig. 4) you can get 3 acoustic areas— left, right, and center. Using a 2- or 3-area setup, you can have static commercials (no motion) but lots of separation. A little experimentation pays off here. You don't have to keep the talent on the same mics all the time either. If you move them, however, move them *between* lines, because if you move them during a line you'll lose them as they move out of one pattern and into the next.

4. Bidirectional separation. Because the bidirectional mic has a narrow figure-eight pattern, it lends itself rather beautifully to the 2- and 3-area technique. I've used B&O Fentone (Dynaco) ribbon mics with a separator. You can make a separator of your own, but the Dynaco separator maintains proper relationship and provides two mic mounts for one stand (Fig. 5). The only thing you have to be careful about is that you get the *front* of the mics pointing in the same direction, otherwise, you'll have phasing problems again. You can usually tell if phasing is correct by putting three people around the mic array and recording some talk. If the center drops in a mono playback, you're out of phase.

Although author Matthews is a bit skeptical over stereo cartridge machines, current commercial models, Gates unit shown, can often be used effectively. For example, a voice commercial which comes in mono can be made to switch back and forth by panning its separate balance knobs. This technique cannot be used indiscriminately but often it works wonders. A Ford commercial on used cars has a fast talking used car salesman who at one time says ". . . you can't go wrong, right? Right!" Splitting the two rights is very effective. (The unit on top, incidentally, is a timer with a Veeder Root counter which indicates cartridge tape used up in seconds. This permits several commercials to be stacked on same cartridge.)

The bidirectional mic setup offers a choice of 2- or 3-area pickup pattern. With the setup shown in Fig. 6, you have to be careful that actors don't move very much, especially the center actor. It doesn't take much (a turn of the head) to have him zinging across between the speakers. You get excellent separation and good sound. Watch playing actors close to the ribbon mic, too.

They're very sensitive to popping (p, b) and overloads from fricative (s, f) and dental (d, t) sounds. The Model 50 has a T/M (talk-music) switch which might be worth trying. The T position reduces the amount of bass in the output so people don't sound quite so boomy. If you need more separation than the above setup, place the mics on separate stands with the patterns at 180° to each other as shown in Fig. 7.

5. Bidirectional fusion technique. Here you use two mics as shown in Fig. 8, one directly above the other—perhaps one on a floor stand and the other on a boom. Turn the patterns, using 90° as the basic arc around which the actors move. Dynaco has a Model 200 which combines two ribbon mics on one axis (Fig. 9). Mount the mic on a stand and then rotate the upper mic for the kind of separation that sounds best for the recording. Here, of course, use a circle for the pickup area, since the two mics are one above the other. Some people feel you don't get "separation" this way. In a sense they're right, but you do get a lovely picture of the room ambience.

What technique do you use where? That depends on how the material is written by the continuity department; in fact, you probably can let them know what they can do with the equipment you have. The choice will depend also on the room used for recording. That brings us to a major problem—finding a room. I've had to do quite a bit of production "on location." Most studios aren't set up for stereo production anyhow, so I've had to scratch for recording space. If you're using the curtain-of-sound approach, you'll need a big room. And not one with walls, ceiling, *and* floor covered with acoustic material. I've mainly tried stages, gymnasiums, and lounges. A stage draped but open to a large volume of air in the auditorium is a good place for me—handy, too, since I split my time between radio and drama work. I like the stage, too, because by pulling curtains it is possible to expose more or less wall area for more or less reverberation. Gymnasiums are always big, but often too live. For this problem, I've made folding screens covered with acoustic material to make sort of a tent around the performers (Fig. 10). By moving the

Basic Mic Setups
Sample Stereo Spots

Here are three scripts with indications of setup, types of mics, and stereo effects to give you an idea of what happens. (We used the Audio Fidelity series of sound effects.) The first two are spots written for "Harvey" when we did the play at the college, and the third is a promo for WBSC.

Mic setup: Curtain of sound (fusion)
Mics: 4 Syncron Au7a mics, cardioid.
Sound: Lion roaring.
Ambience: Very live, like in a lion house.
Old lady: (left mic, slowly walking across to right) That's right Ollie, we're going to a play tonight. "Harvey," it's called. Hmmmm . . . it's about this invisible rabbit. You see he's got a friend, Elwood P. Dowd. (Sound about half way across, slight growl in background.) Keep away from them lions . . . (with determination). Ollie, I want to see that play tonight. We haven't been anyplace in weeks. At the college theatre . . . only $1.25. I know things haven't been too good this year with the crops and all but (at left mic) Ollie . . . (sound of footsteps on right mic) Ollie? . . . (moving away) I'm going to the play anyhow . . . Harvey, tonight, 8 P.M., college theatre.
(Sound: lion licking chops and belching in right mic.)

screens back and forth and opening them, I can get the air needed for the particular recording. Large rooms of any kind are good to experiment in. Sometimes your TV affiliate might have a studio big enough to be worth a try. You'll have to develop your ear for this kind of thing.

Some tests might be worth the effort. I like to set up equipment and make test tapes before deciding. You can tell a little by clapping your hands and listening for slap-backs. But usually an hour or so "playing" will give you a good idea of how the room might work out. Look around your building or nearby buildings and see what's available. If you're in a noisy area, you may have to settle for a studio, but keep looking. Remember, Les Paul and Mary Ford started out in their bathroom. For the 2- or 3-area sound, the studio isn't quite so critical; still it doesn't hurt to experiment a little.

Since most stations are not now set up for stereo production, you'll have to improvise. I've been using a Crown 822 solid-state portable recorder and four Syncron Au7a condenser mics for my most recent experiments. I try to find a big room which adjoins a medium sized room

Mic setup: 3 area — left, right, center
Mics: 2 Dynaco Model 53 mics with separator
Sound: Cards, center shuffled, then dealt, left, right, center
First Lady: My, there's nothing to do in this town. Just watch the snow.
Second: I need one more. I hear there's a play up at the college. Harvey . . . about a white rabbit.
Third: I saw that on TV once.
Second: It's better as a play . . . real live actors you know.
First: When is that?
Second: All this week, up at the college. Ollie and I are going. You ought to get out a little more.
Third: I bet it's expensive.
Second: Dollar and a quarter.
First: Is it funny or what?
Second: Very comical. My niece saw it last night. She just laughed and laughed.
Third: Up at the college? (card dealing has stopped).
First: Hmmmm. I might get Arthur to go out. 8 P.M. at the college theatre . . . and only a dollar and a quarter?
Second: I'll raise you one (sound of chips, center).

Mic setup: 2-area cardioid
Mics: 2 Shure 565
Music: Happy beat, Duane Eddy (music up and out)
Man: (groans left) Oooooohhh.
Announcer: (right) What's the matter man? Homework got you down? The cares and troubles of college too much for you?
Man: (Groans, yes)
Announcer: Then take a study break and listen to the live sound of WBSC, your campus radio station. Where everything that's happening . . . happens. Not only the now sound but yesterday.
Music: Quartet
Announcer: And tomorrow
Music: Electronic music
Announcer: So get with it, buddy
Man: (heavy breathing, close to mic)
Announcer: WBSC, Bemidji State College on the air with a variety of music and the latest campus news.
Man: (Breathes, then stops)
Voice: (Close to right) No use, nothing will revive him now.

(9 × 12 or larger). The big room becomes the studio and the small room the listening room. I take along a pair of AR2ax speakers and an amplifier for monitoring purposes. Some engineers try to monitor with headphones, but that's dangerous. Using headphones, the idea you get of stereo separation is entirely erroneous. The reason I try to find a medium sized listening room is that I like to approximate a living room. I take along an intercom so I can talk to the talent and a turntable so music or sound effects that must be part of the recording can be added. Music that fades in and out, without voice over it, I put on the tape back at the studio. I record at 7½ in./s, edit, then make the final dub for playback on a studio 2-track recorder. Perhaps you can modify cartridge machines for this use, but audio quality too often deteriorates on these machines, so I prefer to make up a "tape for the day." Not quite so convenient though.

Four-Channel Sound: What It Means to the Broadcaster

Emil L. Torrick

WE ARE ON THE THRESHOLD of a new era in sound broadcasting, an era as momentous as that following the introduction of commercial FM broadcasting in 1941 and the introduction of stereo FM in 1961. The year 1971 will go down in history as the beginning of the four-channel, or quadraphonic, era.

The use of multi-channel sound sources is not a new phenomenon in the music industry. Early experiments by Leopold Stokowski in the film "Fantasia"(1940) led to Cinerama sound and the formulation of four-track film standards by the Society of Motion Picture and Television Engineers. From the days of the earliest composers, similar effects have been used—the double organs of Soler, the brass choirs of Gabrielli, the off-stage operatic effects of Wagner, and the massed choral and instrumental forces of Berlioz. The advent of stereo added a second dimension to the reproduction of such material; quadraphonic recording now permits full three-dimensional recreation of the original sound field.

Quadraphonic music in the home

Efforts toward the development of a four-channel product for home playback have generally followed one of two approaches: a *matrix* format or a *discrete* format. At first consideration, the discrete method seems the better approach. By definition, a discrete format theoretically maintains the full separation achieved on the original four-track master tape. In contrast, a matrix method, with its processed summation of four channels into two before recording, produces some dilution of the original separation, although with the recently-introduced Columbia "SQ" matrix system, this dilution is reduced to an insignificant proportion.

Overriding the consideration of separation alone, however, is the overwhelming importance of what constitutes a practical recording system for home use, and the question of how much separation is really necessary to recreate the desired musical effect. Quadraphonic progress in the American recording industry appears to be going in both directions. The discrete approach is being used for prerecorded tapes. (Available only in the 8-track cartridge so far.) In disc recording the matrix approach has been selected. The announcement of a discrete four-channel Japanese disc notwithstanding, it seems the widely-held opinion of the U.S. technical community that a discrete four-channel disc, with its required high-frequency subcarrier response well into ultrasonic frequencies, does not represent a practical approach to home reproduction of four-channel sound. On the other hand, the recent introduction by Columbia Records of the stereo-quadraphonic "SQ" record, quickly followed by the adoption of the same system by Vanguard, Ampex, and others, guarantees that for some time to come, at least, the major source of program material for four-channel home reproduction will be a matrix-type disc.

Four-channel broadcasting

History repeats itself with the coming of four-channel broadcasting. As in the pre-FM multiplex days when stations joined their AM and FM facilities in the broadcast of a two-channel program, today we hear of experimental broadcasts using two stereo FM stations to transmit a four-channel program. As in the earlier days, we also hear of familiar corporations such as GE and Zenith developing their own multi-channel broadcasting systems. A curious paradox in the development of discrete four-channel broadcasting systems is that the bulk of prerecorded music which will be issued by recording companies will be in a matrix format, thus negating the necessity for a special broadcast system. To broadcast matrix-type records, a stereo broadcaster need not add any special equipment. For the listener, the same

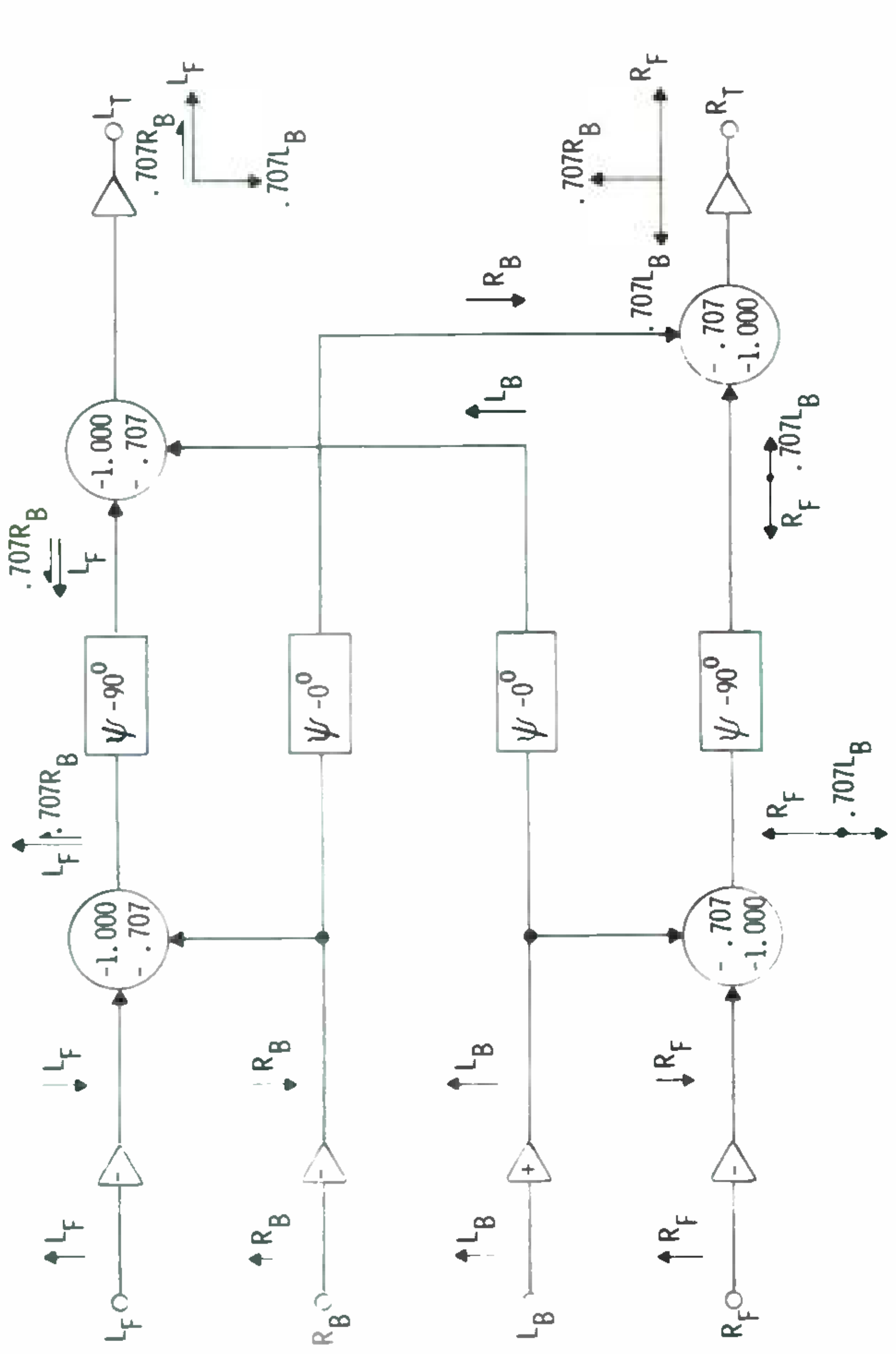


Fig. la. SQ encoder.

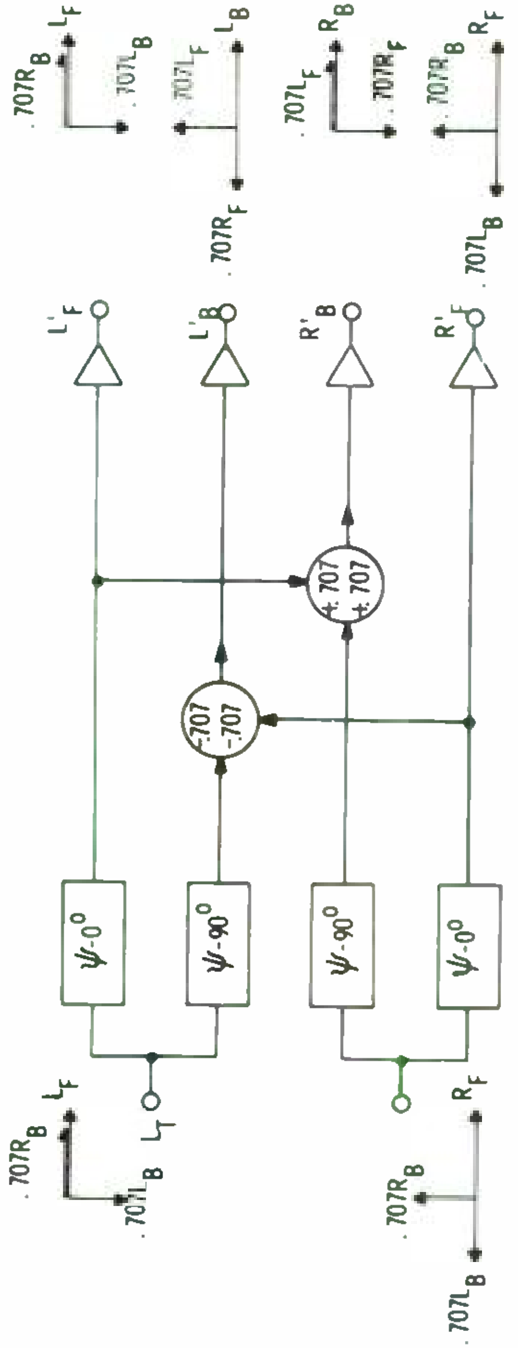


Fig. Ib. SQ matrix decoder.

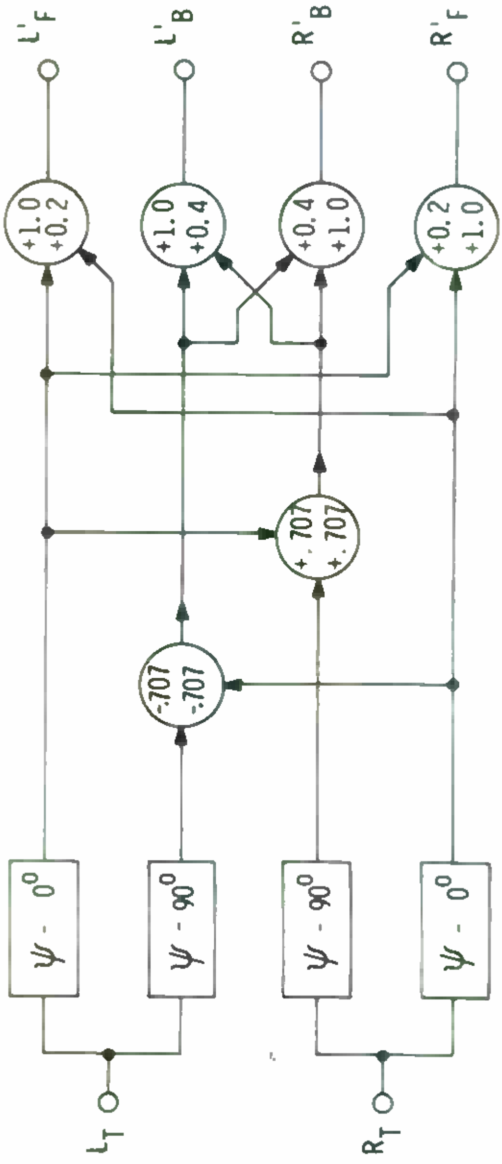


Fig. 1c. SQ matrix blend decoder.

decoder which extracts four channels from quadraphonic disc recordings will similarly work on the stereo-quadraphonic signal from an FM station. The addition of two amplifiers and loudspeakers will complete the listener's required investment.

Columbia Records "SQ" disc

In a technical paper presented at the 41st Convention of the Audio Engineering Society, CBS Laboratories engineers, Benjamin Bauer, Daniel Gravereaux, and Arthur Gust, disclosed the technical details of the new "SQ" disc. While basically a matrix recording system, the CBS system provides an optional "logic" playback mode which electronically enhances the existing matrix separation to be equal to, or better than, that of the original four-track master recording. With this method it is possible to enjoy the benefits of a simple and inexpensive storage medium with a playback characteristic which is psychoacoustically equivalent to the original master tape.

In a matrix disc the four channels must be appropriately encoded and modulated on the left and right groove walls of the disc. The system input signals are characterized as L_F, L_B, R_F and R_B, corresponding to left-front, left-back, right-front, and right-back, respectively. The encoded signals are identified as L_T and R_T, (for left-total, and right-total). In the SQ disc, the channels are encoded as follows:

$$L_T = L_F - j\,0.707\,L_B + 0.707\,R_B$$

$$R_T = R_F - 0.707\,L_B + j\,0.707 R_B$$

The significance of the operator $-j$ and $+j$ terms in the above equations is to shift in phase the signal components pertaining to the back channels. The effect results in an interesting modulation of the record groove wall. By recording sine waves in the back channels, the motion of the playback stylus is a clockwise helix when playing back left-back signals, and a counterclockwise helix when playing back right-back signals. This form of encoding results in separation between the two back channels which is as good as that on a conventional stereo disc and separation between the two front channels which is similarly undiluted.

Fig. 1a is an electrical representation of the encoding process. The phase-shift circuits employed are all-pass networks, which provide the required phase shift to within $\pm 2°$ over the range 20 to 20,000 Hz, with no change in amplitude response. Fig. 1b shows the basic matrix playback circuit, which is complementary to the one in Fig. 1a. Fig. 1c shows an alternate matrix playback circuit identified as the "blend" mode. This, too, is a passive method of decoding, as opposed to the active or "logic" method to be described later. In the blend mode some of the left right (front and back) natural separation is traded off to increase the limited normal 3 dB front:back separation of the SQ disc. Many cross-coupling ratios for blend may be employed, but the popular one shown in Fig. 1c produces left-right:front-channel separation of 14 dB, left-front:back-channel separation of 8 dB, and a center-front:center-back separation of 7 dB.

Compatibility

Compatibility is of special importance to the broadcaster. There are many levels to the compatibility question. One concerns the compatibility with present playback equipment. Another concerns the level of modulation on the disc and whether it can be broadcast without readjustment of console gain settings. The SQ disc scores high in both respects; it can be used as any conventional stereo disc. Equally important is the quality of reception of SQ broadcast by the listener with conventional stereo or monophonic receivers. Unlike systems announced by other experimenters in the field, the "SQ" record is an excellent stereo record as well, as can be seen in Fig. 2.

Fig. 2 is a graphical representation of the image placement a listener would hear when playing an SQ record on conventional stereo equipment. As the drawing shows, images are placed as though the room were folded forward in a mirror representation of the original array. The original left-front, center-front and right-front signals appear in the usual place, *with no dilution of separation*. The center-left and center-right signals are folded in slightly from the two loudspeakers, and the two back signals appear slightly in from the center signals. The total effect of these real and virtual images is to produce

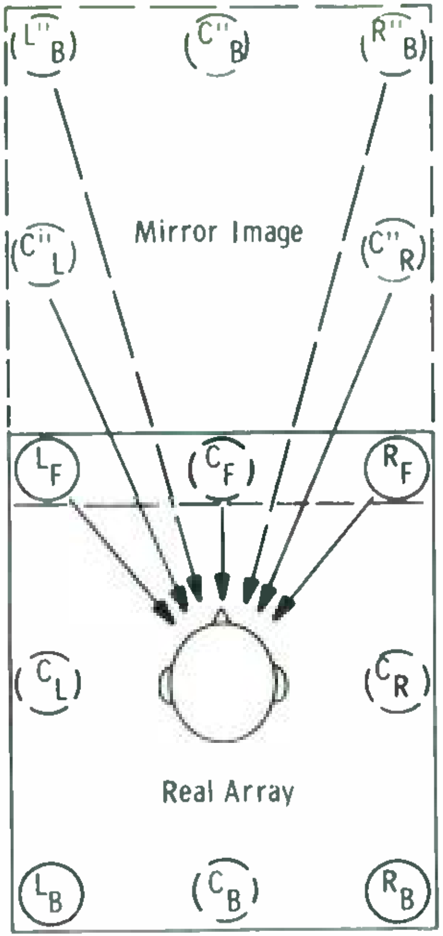


Fig. 2. Display of quadraphonic images in stereo playback.

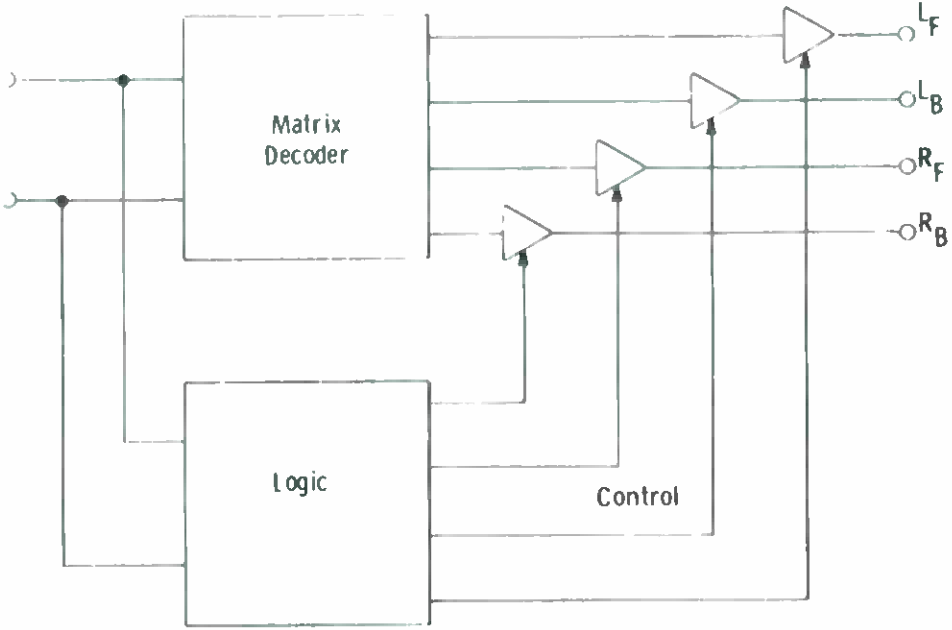


Fig. 3. SQ logic decoder.

a stereo wall of sound with excellent definition and broad distribution of images. One image, the center back, has not been transferred in the above diagram. The exact center back location is not used in the editing of SQ records. A center back image would have to be produced by equal modulation of the left back and right back channels. Since these channels are in opposite phase to each other, the center back image would disappear in a monophonic playback. However, the four principal corner channels are transmitted to monophonic radio receivers with identical strengths.

Logic playback mode

Matrix, or blend, decoders operate passively, i.e., the signal passes through fixed phase shift and combining networks. In contrast, the logic decoder is an active device, whose amplitude response dynamically changes as a function of the modulation on the disc. A simplified diagram of a logic decoder is shown in Fig. 3. One distinguishing feature is a voltage-controlled amplifier in each of the four output channels. The automatic gain variation in each of these amplifiers makes it possible to isolate a signal in any channel with an arbitrary and selectable amount of crosstalk to the other channels. An accompanying electronic logic circuit continuously monitors the incoming signals. By comparing the various amplitude and phase relationships of these signals, certain command functions are derived and appropriate control voltages are fed to the variable gain amplifiers.

Although one might question the tolerance of the human ear to a continuous process of rapidly changing signal amplitudes, this is not a problem. Indeed, as broadcasters themselves long ago realized, the judicious use of high-quality AGC amplifiers and limiters can enhance signal quality significantly, without undesirable audible effect. Regarding the effect on image location when channel gain is changed, we are led back to the early experiments in stereo at Bell Laboratories. Here it was discovered that apparent image location is dependent primarily on the starting transient of a sound, not on what happens following that initial transient.

In a particularly interesting experiment, a signal tone was first presented to one loudspeaker and quickly panned to the other loudspeaker in a stereo pair. Although the signal ultimately resided on the other side of the room, listeners were unanimous in judging the location to be at that loudspeaker where the signal first began. The SQ logic decoder similarly benefits from such a psychoacoustic phenomenon. Since a group of performing musicians is not likely to control its precision to a degree undetectable by millisecond-precise electronic circuits, the logic decoder need only insure that signal starting transients are properly placed, while responding to the separation-gain requirements of this playback mode. The result is highly effective, and it is virtually impossible to distinguish the logic mode playback from an original four-track master during carefully controlled A-B tests.

Conclusions

Quadraphonic sound is an idea whose time has finally arrived. With the adoption by Columbia Records of a completely compatible four-channel disc system, we can look forward to the availability of a large body of new recorded material. The four-channel medium offers exciting playback possibilities for our favorite repertoire of the past. It also provides our composers and producers with a new tool for creativity in the future. The broadcaster is in an exciting position, today, to participate in this new medium.

Getting Into Quad Stereo

Ryousuke Ito

IF YOU HAVEN'T ALREADY TRIED your hand at broadcasting quad stereo, chances are you've at least toyed with the idea. Certainly the entire concept of four-channel broadcasting is so exciting and so promotion-oriented that it has to be considered an important part of any station's future programming. But why the future? Why not right now? You can broadcast quad today, right this minute, with no FCC approval or special equipment needed.

The secret is in the compatible simulated four-channel disc, and there are at this writing three such systems that are relatively compatible with each other. Naturally each manufacturer involved (CBS, Electro-Voice, Sansui) claims that his system is the ideal and the one that should definitely become the industry standard. Each one can cite substantiating evidence for his claims.

With time, each of the three has moved somewhat closer to its rivals with the result that today virtually any of the three encoding systems can be played back on any of the decoders with satisfactory results. This doesn't mean that all such results will be equally satisfying, and may certainly be far from idealized, but satisfactory nonetheless.

Basic encoding

To establish the appropriate encoding methods and phase relationships, let's look at a typical four-channel matrixing relationship. In this and other presentations that follow, LF = left front; RF = right front; LB = left back; RB = right back. In the diagrams, BC = back center and FC = front center.

Fig. 1 shows the basic matrixing used for cutting compatible discs with the Sansui matrixing system.

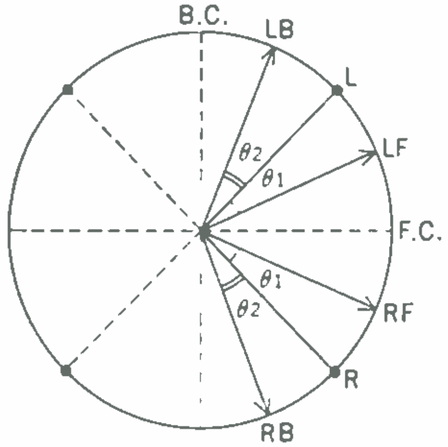


Fig. 1. Basic vectors for cutting matrixed disc.

Based on these vectors:

$$L = (LF + LB)\cos\Theta + (RF - RB)\sin\Theta$$
$$R = (RF + RB)\cos\Theta + (LF - LB)\sin\Theta$$

When $LF = RF = RB = LB = 1$, then

$$L = 2\cos\Theta = 1.84$$
$$R = 2\cos\Theta = 1.84$$

This is the typical output of a four-channel encoder of the generalized type shown in Fig. 2.

The other systems are essentially similar, except that the initial phase relationships may differ, causing an apparent shift in channel location and certain other phase differences. The result: separation and location can differ (and suffer depending on the judgment of the listener) from system to system. Whichever system becomes the industry standard, it must have these features:

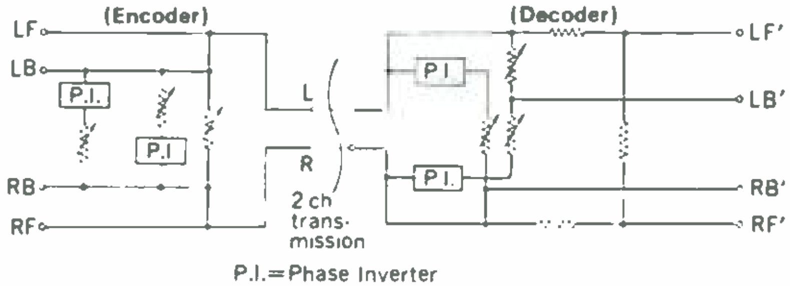


Fig. 2. General approach to encoders-decoders.

• Ability to record sounds occurring at any point in a 360° sound field, reproducing these sounds in the correct location during playback.
• Signal quality should not be degraded in noise, frequency, and non-linear distortion as a result of being matrixed.
• System should be totally compatible with existing playback equipment, using standard components wherever possible.
• The four-channel program should be capable of reproduction on all standard two-channel equipment, with all sonic material from the four-channel program heard in their proper left/right positions.
• Monophonic compatibility should likewise be total with a full program that doesn't lose or alter relative levels of any sounds in the original four-channel program.
• The system should be adaptable to standard software manufacturing practices.
• Any format used should be adaptable to standard software manufacturing practices.
• Any format used should provide full playing time, or the playing time equivalent of stereo recordings.
• The recording matrix should be usable with all major recording media and capable of being broadcast.

The decoder output of a typical matrix is as follows:

$$L = (LF + LB)\cos\Theta + (RF - RB)\sin\Theta$$
$$R = (RF + RB)\cos\Theta + (LF - LB)\sin\Theta \quad (1)$$

The relative decoder output is:

$$LF' = L\cos\Theta + R\sin\Theta = LF + 2R\sin\Theta\cos\Theta + LB\cos2\Theta$$
$$RF' = R\cos\Theta + L\sin\Theta = RF + 2LF\sin\Theta\cos\Theta + RB\cos2\Theta$$
$$RB' = R\cos\Theta - L\sin\Theta = RB - 2LB\sin\Theta\cos\Theta + RF\cos2\Theta$$
$$LB' = L\cos\Theta - R\sin\Theta = LB - 2RB\sin\Theta\cos\Theta + LF\cos2\Theta \quad (2)$$

From these equations, if LB = RB = 1, or when there is a sound source at the back center of the original sound field, these equations can be derived:

$$L = LF\cos\Theta - RF\sin\Theta + (\cos\Theta - \sin\Theta)$$
$$R = RF\cos\Theta + LF\sin\Theta + (\cos\Theta - \sin\Theta) \quad (3)$$

These equations show that out-of-phase components in the left and right back channels cancel each other out. The result is that the encoder output consists only of in-phase sound components.

This loss of audio information and mislocalization of sound sources happens during the encoding process. This also shows that it is practically impossible to encode simultaneous four-channel signals of identical phase and level with this technique; they'll simply cancel each other out.

The equations (2) show that the left and right back are 180° out of phase with each other. Thus, any sound sources in the back in a quad program would sound very unnatural and unclear, and would have little directionality, even when the encoding is properly handled. The same will happen with other types of matrixing based on the vectors shown in Fig. 1.

Most four-channel encoders have not been able to convert true four-channel information into two channels and reconvert them to four because of this phase cancellation during the encoding process. The apparent conclusion is that a simple matrixing system for encoding and decoding quad stereo programs doesn't overcome this defect.

Phase-shifting technique

By introducing a rear-channel phase shift of $\pm 90°$, and by setting the disc-cutting vector angles (Θ) between each adjacent channel at 22.5°, these phase cancellation problems can be solved.

This phase-shift in the Sansui QS encoder—instead of using the usual 180° phase inversion used in other systems—produces the desired phase relationship between the two rear channels. Some other matrix systems introduce a phase shift at the rear channels in playback—and this *artificial* phase shift changes the ambience to produce a sense of spaciousness that is not true quad stereo. In effect, the phase shift is introduced to make up for the system's shortcomings which may have resulted from rear-channel cancellation occurring in the encoding process.

The Sansui system, on the other hand, introduces its $\pm 90°$ phase shift at the encoder to eliminate any problem with cancellation; then reshifts the rear-channel information back to its original phase location in the decoder. The system thus recreates the original sound field, not an imitation of it.

The basic encoding system is shown in the block diagram in Fig. 3, while Fig. 4 shows how the phase shifters are wired into the circuit. The left-rear channel is shifted by $+90°$ and the right rear by $-90°$. Thus, the reverse-phase relationship between the back channels is converted into an in-phase one. Now the encoder outputs will be:

$$L = (LF + jLB)\cos\Theta + (RF + jRB)\sin\Theta$$
$$R = (RF - jRB)\cos\Theta + (LF - jLB)\sin\Theta \quad (4)$$

Where $j = \pm 90°$, these equations show that there is no loss of back-channel information in the encoding process when j-phase shifters are used.

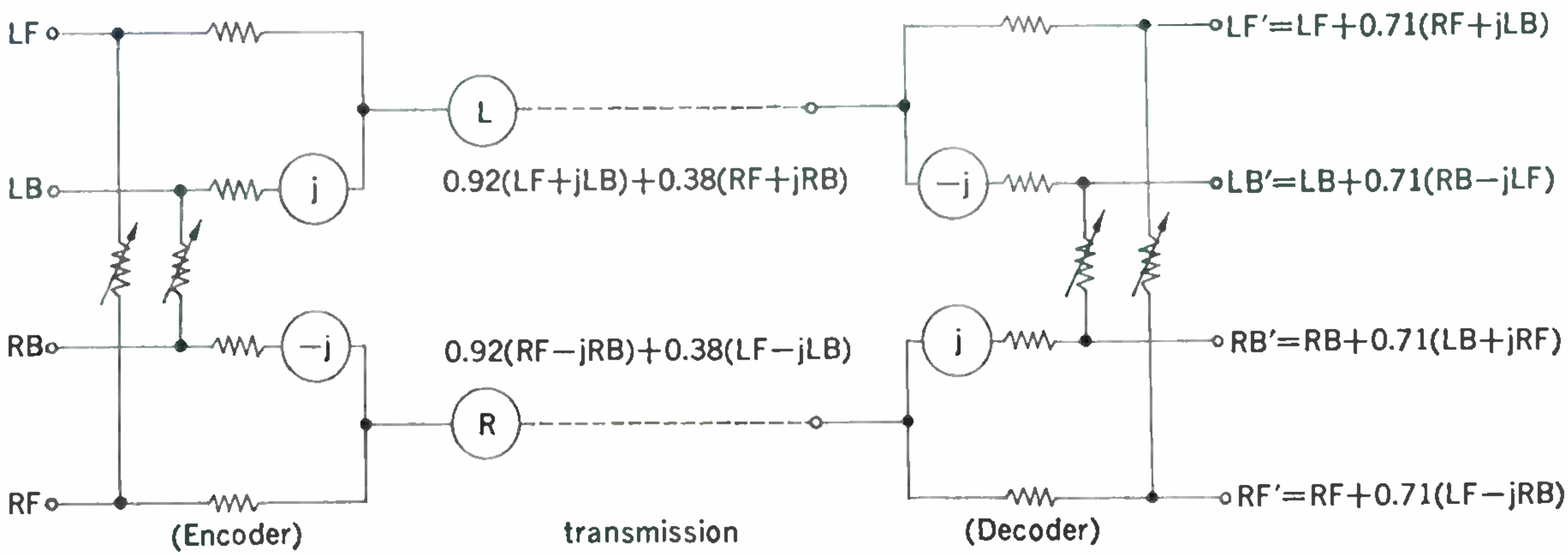
In any four-channel stereo system, the information in each channel must be treated equally. Vector analysis shows that this is true only when the vector angles among the four channels are identical—when they are all $\pi/8$ (because $2\Theta = \pi/4$).

When recordings are made with this angle, adjacent crosstalk is uniformly 3 dB. Thus, the four channels are reproduced equally to provide a square sound field. Equal volume balance is maintained among the four channels, so distinct sound images can be positioned in any location inside the sound field.

Programs encoded by this method can be decoded using a different vector other than 22.5° without losing much of the original four-channel effect. At the same time, a decoder using a 22.5° vector can decode programs encoded at other vector angles without losing a significant amount of the quad effect.

Discrete programs

In the early days of quad broadcast experiments, the only four-channel material available was on tape, and this was, by definition, discrete material. It required simulcasting by two FM stereo stations and early experiments showed a great deal of promise. Certainly the demand was there for FM quadcasting, but using two stations for a simulcast was just as impractical as it had been in the early days of stereo.



$$\theta=\frac{\pi}{8}\quad\begin{cases}\tan\theta=0.414\\ \cos\theta=0.92\\ \sin\theta=0.38\\ 2\sin\theta\cos\theta=\cos 2\theta=0.71\end{cases}$$

Fig. 3. Block diagram of encoder.

Various methods of discrete broadcasting have been proposed, but none has been approved by the FCC except for experimental broadcasts. Besides, any discrete quadcasts would require special receiving equipment for full four-channel reproduction.

While there continues to be a market for discrete quad, most such taped material being sold today is in eight-track cartridges aimed mainly at the highway listener. But more and more record companies are experimenting with encoded discs. The split is fairly even with about half the major labels opting for Columbia/Sony (now partially combined with the Electro-Voice system) and the rest using Sansui encoding. No matter which of the two encoding systems is used, the other system's decoder will provide satisfactory quad playback.

The important feature of quad matrixing is that an encoded record can be played on the air with no modification to any of the station's equipment. The same phono pickup, the same turntable, modulator, and transmitter are used. In all respects, the matrix

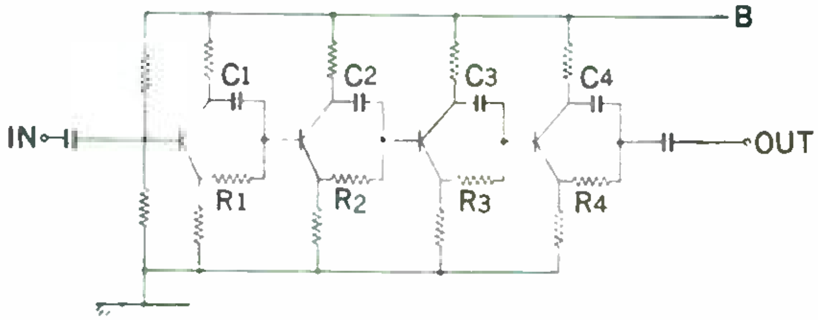
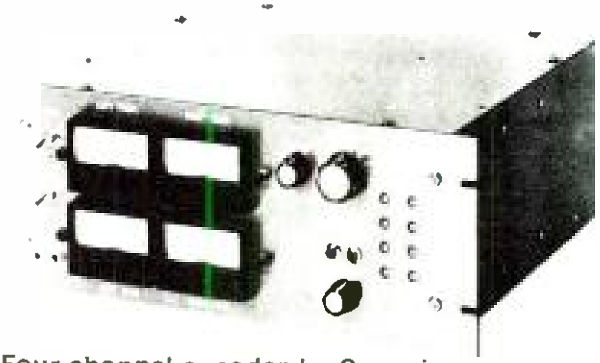


Fig. 4. Phase shifting circuit.



Four-channel encoder by Sansui.

disc is treated like an ordinary stereo recording. The listener who has a quad decoder gets a full four-channel program; those listening with ordinary stereo get a balanced stereo program.

If a broadcaster wants to transmit from discrete sources, such as a tape or a live concert, an encoder must be used between the four-channel source material and the broadcast console. But the encoder's output is an ordinary two channels, so we're back to regular stereo again.

The encoded signal makes absolutely no extra demands on the station's equipment or on its allocated channel space. The encoded program has no additional sideband information impressed on it. Proof of the pudding is in the numerous FM stereo stations around the country that are now transmitting encoded music on a regular basis. The FCC has made no move to interfere with or restrict this activity because the stations aren't sending anything that goes outside their license limitations.

The promotional value of broadcasting quad stereo can be invaluable to an FM station. Just as it paid off to go stereo in the mid-1960's, it may now pay to quadcast on a regular basis. This prospect is especially inviting since there is no equipment investment or extra cost of any kind involved (except perhaps to buy the records) when transmitting four-channel stereo.

Local promotional tie-ins with stereo dealers and national co-op deals with manufacturers of quad equipment is also in the cards. Some stations have started special weekly programs to discuss and demonstrate the latest quad recordings and often include semi-technical discussions of the equipment and how it works. It all adds up to larger and more interested audiences. So why not start broadcasting quad stereo now? It's the cheapest program upgrading you'll ever make.

SCA Applications

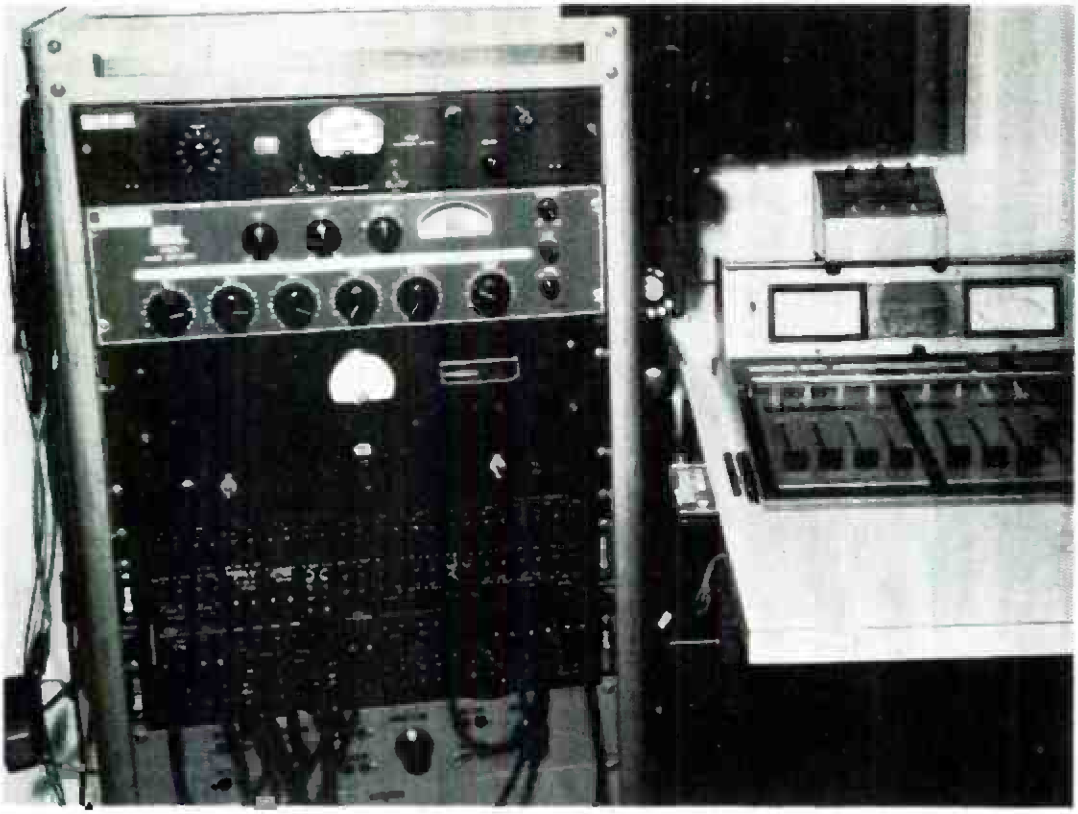
WITH THE EXCEPTION OF UHF television, nearly every segment of the operating communications services has felt the pinch of a lack of spectrum space. In particularly crowded spots on the frequency allocation chart there are as many as seven different services sharing the same channel.

Doing what it can to alleviate the situation, the FCC makes it a standard practice to offset carrier assignments and generally get the most mileage from each kilohertz of available spectrum space. Recently, the Commission whittled down the guard bands on land mobile frequencies—a particularly congested portion of the spectrum. Communications manufacturers too, are developing and/or refining equipment for more efficient spectrum use. Speech compression is increasingly emphasized. Modulation limiters ride the gain for a-m and fm transmitters. Television lower sidebands are attenuated and more squeezing has spurred development and use of such transmission modes as single sideband.

Despite all these efforts by the Commission and manufacturers, there are segments of the market with special requirements that until relatively recently, have been shortchanged because of a lack of spectrum space. This is where SCA can move in and do a job. SCA is attractive to fm'ers where it really counts---the pocketbook.

According to the latest FCC data, there are well over 600 fm stations who have discovered how easy it is to get a subcarrier authorization.

Despite the fact that SCA has been around almost since the time that Major Armstrong invented fm in 1934, it has been a retarded child,



Two views of the University of Wisconsin's SCA control room. Bottom view shows a conference discussion being transmitted via SCA for the Educational Telephone Network. The telephone network permits listeners to ask questions which lecturers answer on the air. The arrangement maximizes the exchange of information and saves on travel time and expense for conference participants.

its development slowed by legal and regulatory difficulties. Only in the past few years has SCA's potential begun to capture broadcasters' imaginations. Lying beyond SCA's traditional role of background music is bright future of specialized communications services. A list of new areas of application would include: medical radio, weather forecasting, news, facsimile and data transmission, aircraft newscasting, programmed learning, broadcasts for the blind and radio paging services.

SCA and Education

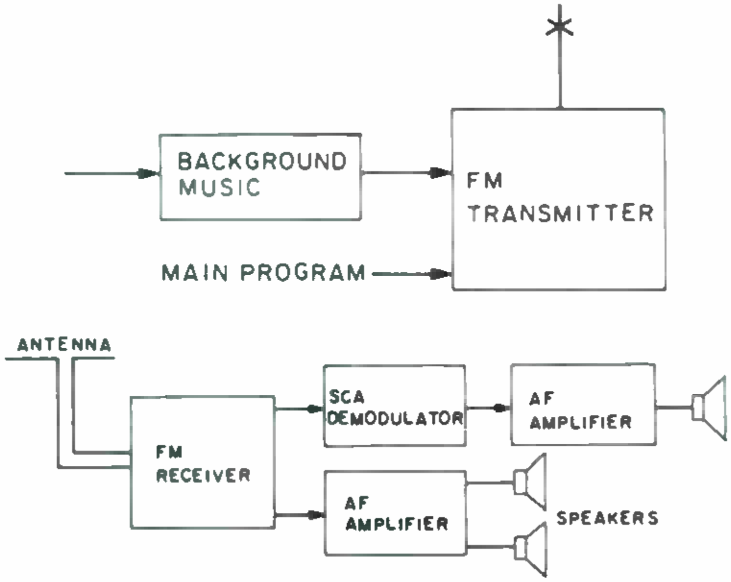
Use of SCA in the educational field is getting a big boost with Triangle Publishing's Educasting system and the efforts of WHA-FM at the University of Wisconsin.

WHA-FM and the Wisconsin fm network—the first educational stations to carry SCA programming on a regularly scheduled basis—are providing unusual educational and community services. The SCA service is the result of a cooperative arrangement between the University of Wisconsin Extension and the State Coordinating Council for Higher Education. Two hours of third- and fourth-year Spanish and an hour of fourth-year French are broadcast each week to high schools where teacher shortages or class enrollment don't permit the usual method of instruction.

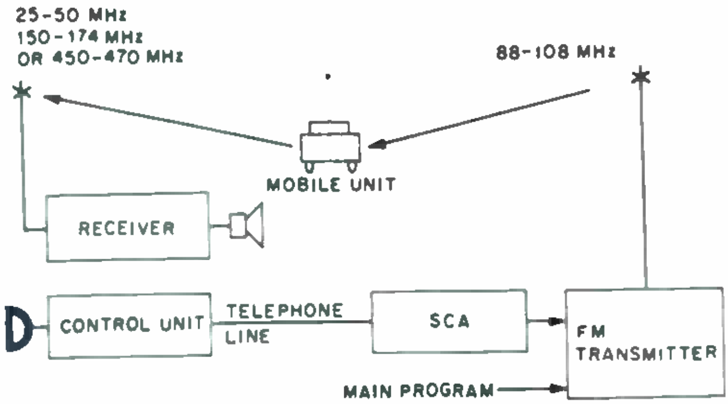
WHA also uses SCA for conferences and special captive audiences of all kinds. Frequently the audience and those in the studio conference are members of specialized government agencies or professional groups. Listeners are able to telephone questions to be answered by the on-air conference participants. WHA, because of its financial position as a part of the University of Wisconsin, is able to provide SCA air time on request at no charge.

SCA Network for Airline Passengers

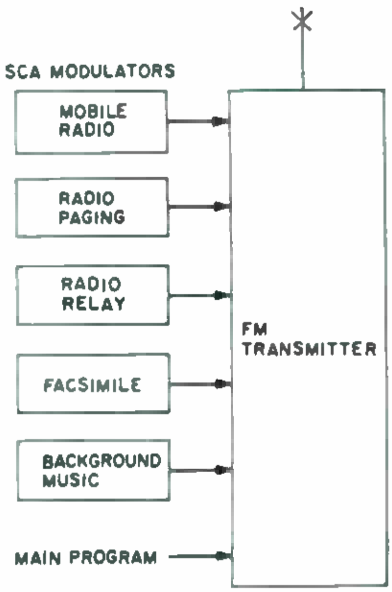
A new and exciting development is an SCA network for airline passengers. Newsrad, the company organizing this new operation, is based in New Rochelle, N.Y. Studios at Newsrad headquarters receive local, national and international



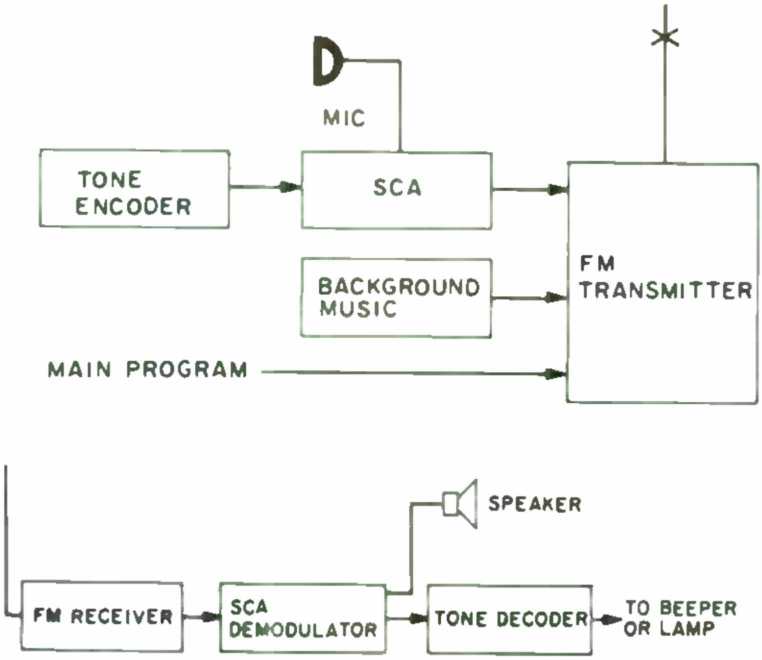
Usual SCA system.



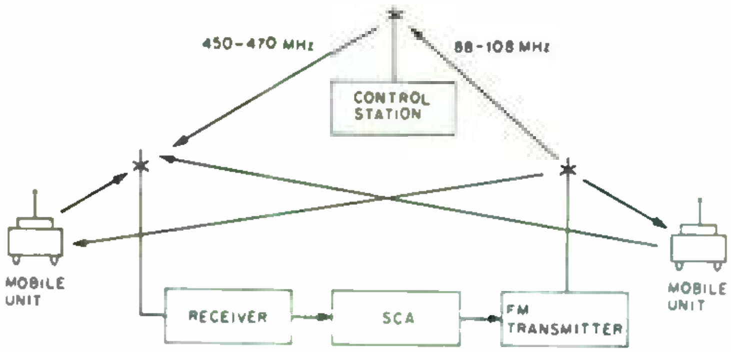
Fm transmitter site serves as base station for communication with mobile units.



Sample of fm station SCA capabilities.



Fm station used as radio paging transmitter.



Fm station used as repeater station in mobile relay system. Mobile units may intercommunicate through repeater, and may also communicate with fixed control station.

SCA and Radio Paging

The first group of diagrams shows SCA channel fed to an fm transmitter simultaneously with the public program, and what is required for SCA reception. Two or more SCA channels are shown in the next group of diagrams. The SCA subcarrier may be a-m, fm or single sideband, preferably with reduced carrier. When broadcasting mono over the main channel, the SCA carrier may operate at frequencies between 2 and 75 kHz. When transmitting stereo, the SCA subcarriers must operate below 53 kHz. Signals from mobile units can be picked up by a receiver at the base station as shown in the third diagram. Mobile relay system for mobile unit intercommunication and a sample of SCA's potential for program diversity are shown in final two diagrams.

Hardware for transmission of visual material via SCA or telephone lines. The Victor Electrowriter Remote Blackboard (VERB) shown above transmits handwritten notations. Sylvania's ECS-100 blackboard-by-wire system (below) has the additional capability of storing visual material for up to one hour.

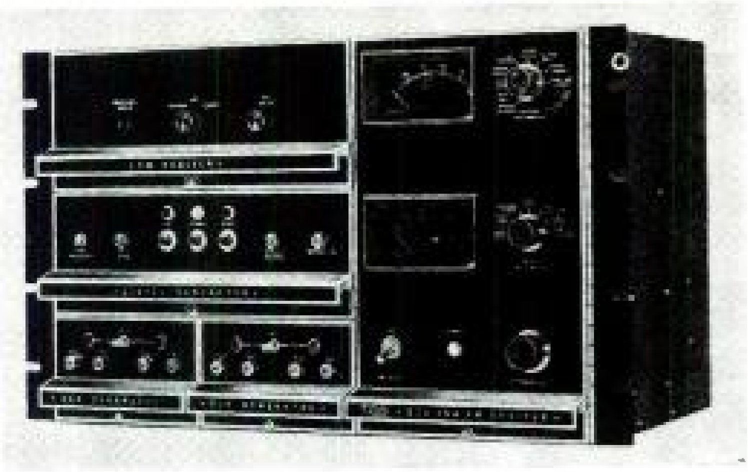
news, sports, stock reports and weather in 3-minute-plus-ten-second capsules, revised hourly by UPI. Newsrad inserts cue tones at the beginning and end of each tape and transmits audio via telephone lines directly to the SCA generators at fm stations near airports, in New York and Chicago.

Aboard the airliner, passengers will hear no commercials. A stewardess will push a button about 10 minutes' flying time from the airport, keying an onboard receiver. The cue tones inserted by Newsrad (77 Hz at the beginning and 67 Hz at the end) will key the aircraft's public address system, preventing passengers from being tuned in on the middle of a newscast. The cue tone at the end of the loop of tape being played at the New Rochelle studio turns off the airplane's PA at the end of the newscast. An override allows the plane's crew to cut in for announcements of transcending importance.

SCA Paging

Leading proponent of SCA radio paging, Leo Sands, a New York-based communications consultant, has labored mightily, though as yet unsuccessfully, to make the FCC see things his way. The problem is that fm'ers are licensed by the broadcast bureau while radio paging is a common-carrier service. The FCC is not currently in favor of licensing one transmitter to perform two different services.

Sands sees SCA as a way out, at least temporarily, of the spectrum squeeze. Land mobilers, who see themselves as probably the most short-changed group of spectrum users, would benefit most if the Commission were to approve SCA paging. As Sands sees it, the paging system would be used by police to contact walkie-talkie-equipped patrolmen on their beats. Talkback would be on land mobile frequencies. Emergency broadcast system alerts could be piped through the system, providing instant civil defense information to police in the field. Despite the fact that a petition was filed in 1951 for rulemaking, no action has been taken by the Commission to allow SCA paging.



RCA's BTX-1B SCA multiplxer mounted in direct fm system offers deluxe features but is typical in its modular construction. The Marti SCG-67 (below) is directly rack mountable.

Closely paralleling musicasting or storecasting, SCA is going into doctors' waiting rooms to entertain patients and provide news to medical personnel on the latest developments in medicine. Developed 9 years ago by the National Broadcasting Co., the system mutes only waiting room speakers as periodic medical news is broadcast to doctors.

An increasing variety of visual media is being transmitted via SCA. Displays of news headlines, time, weather reports, stock market averages and sports information are being conveyed to hotel and motel lobbies, restaurants, and other public locations. Facsimile and blackboard remoting are other modes of transmission suitable for SCA. Victor Comptometer Corp. and General Telephone are both making systems which transmit graphics and audio via phone lines or SCA.

New and more efficient facsimile transmission systems are being developed, and can be used on SCA for sending copy and page makeup to satellite printing plants from editorial offices. The system also can be used to provide home TV set readout to subscribers.

Although SCA multiplexer specs indicate they're all pretty much the same, major SCA manufacturers discourage mixing breeds of SCA multiplexers and main carrier generators. Even where circuits are compatible, modular construction and plug-in units make breed-mixing impractical and inconvenient.

Of the half-dozen leading manufacturers in the field, five modularize their fm equipment. The main idea appears to be to sell customers the modular concept, with components designed from the ground up to work well together. Even if a broadcaster buys only a direct fm generator, that's 90 percent of the battle for an eventual complete system sale.

None of the modularizing manufacturers seems willing to admit that somebody else's multiplexer will work with his fm generator. Besides, it's impossible to fill the holes in a modularized box with anything but a same-family plug-in.

In spite of the basic sameness in SCA circuitry, there is an order of sophistication, taking the form of an active-component pre-emphasis network in some units. In one particular model, pre-emphasis can be set for flat, 50-, 75-, or 150-μs response. Typical crosstalk specifications are on the order of 42- to 45-dB down from main to subchannel or vice versa. Reports from the field indicate that this well may be insufficient, and might be an area where SCA multiplexer and receiver manufacturers could do a little homework.

SCA as a Revenue Producer

According to one source, SCA is an industry with a $15-million potential gross for receiver rental alone. This figure is based on an estimate that the average number of subscribers per town is 400, with actual numbers of SCA receivers varying from 100 in smaller communities to 3000 or 4000 in major cities. Multiplying communities by the average number of subscribers per town produces a figure of nearly 50,000 receivers. Based on an average monthly charge of $25 per receiver for background music, the national rental income per month works out to $1.25 millions.

Educasting receiver has four pushbuttons for selecting answer. Student works with special "Edu-text" provided with the course.

Because of its ability to satisfy the communications requirements of small, select groups, SCA broadcasters are in a good position to request funds from state and federal agencies. Speaking at NAEB's session on ways and means of improving the economic base of educational radio, Albert P. Fredette, manager of WAMC-FM, Albany, N.Y., explained that his station receives one-third its total revenue in the form of a grant. The grant pays for a special subcarrier service for the blind. Fredette feels that station operators often overlook possibilities for such grants by seeking revenue only in the obvious areas of technology and education.

PROGRAMMED EDUCATIONAL INSTRUCTION via the widely available SCA subchannels is on the threshold of becoming a major element in at-home learning. Being offered by Triangle Educational Services, "Educasting" not only makes this highly sophisticated form of instruction available on a widespread basis—it is also a vast potential revenue source for the fm broadcaster.

The system uses four subcarriers, running independently of the main program carrier. A special receiver has four numbered pushbuttons so the student can "answer" questions posed by the radio instructor. The entire program is on 4-track tape, and although only one channel is used the greater part of the time, all four subchannels are in use during the "answer" period.

Subscribing fm stations pay Triangle an annual fee for special transmission equipment to be used with their regular fm transmitters. The main fm carrier is multiplexed with four subcarrier channels that can't be picked up by conventional home fm receivers.

Special Receiver

The small, specialized receivers are made by Sylvania. These are available to participating stations on an annual fee/per 100 units basis. These sets are then provided to students who pay for them with part of the course enrollment fee. The major share of the course fee paid by the student goes directly to the fm station.

The Educasting fm radio not only lets the student listen and answer questions, it provides for an instant response from the instructor every time a question is answered.

In operation, the student tunes in each lesson when it is scheduled. Each lesson is repeated; if it's missed the first time, the student still has another shot at it. Using time-tested and highly effective training fundamentals, a skilled professional instructor teaches his subject using the dramatic potential of fm radio. Each step is covered clearly and completely. At intervals, the instructor will ask a question about the material he has just presented. By using one of the response buttons on the Educasting radio, the appropriate answer to each question is selected. The instructor's voice will then tell the student: whether or not the answer is correct, and why; what the correct answer is; the reasoning behind the correct answer.

In addition to learning by listening and by answering questions, the student works with a combination textbook, notebook and workbook. Called an "Edu-text," this book contains text, pictures and diagrams, where appropriate, and charts, tables and other printed materials—plus plenty of room to take notes. Some Educasting

Modified Ampex recorder plays back four tracks simultaneously for the four concurrent programs going out on SCA channels.

courses consist of 30 one-hour lessons, three weekly for 10 weeks. Many people cannot afford the time or money for conventional classroom instruction, but Educasting is potentially within the reach of all fm station listeners who want it.

Extensive Course Catalog

New courses are constantly being added by Triangle to the Educasting catalog: general knowledge; career improvement; leisure time activities. All of these courses are presented at times convenient to the subscriber, and lessons are repeated for their benefit in case they miss one, or if they want to repeat.

The Educasting transmitting and receiving equipment was product-designed and is being manufactured by the Commercial Electronics Division of Sylvania Electric Products, Inc. The equipment installed at the fm broadcasting station uses a four-track audio tape machine to feed the four subcarrier generators which drive the exciter of the fm transmitter. This permits transmission of four subcarrier audio messages without interfering with the main carrier and its scheduled entertainment program.

The subcarrier frequencies are approximately 25 kHz, 40 kHz, 55 kHz and 70 kHz from the main carrier. The deviation of each subchannel is nominally 3.5 kHz. With a maximum modulating frequency of also 3.5 kHz with 15kHz separation between subcarriers, a guard band of 8 kHz is provided.

FCC regulations limit the modulation baseband to ±75 kHz for broadcast fm service. There are varying specifications outside the U.S.; other countries have different standards or no standards at all, and may assign other frequencies for these subcarriers.

FCC regulations also require that interference by a subcarrier to the main channel must be down at least 60 dB. In the Educasting receiver, the objective for the main-to-subchannel crosstalk is down at least —40 dB.

The Receiver

The fm receiver is pretuned to the main carrier and can be used practically anywhere within listening range of the fm transmitter. It has a sensitivity of approximately 10 μV for 20 dB of quieting on the main channel. In most environments the subcarrier signal is usable when there is 30 μV of signal available at the receiver input.

The compact unit contains a complete transistorized fm receiver chassis plus a four-transistor subcarrier circuit board which "responds" as the student presses the multi-color buttons on the set. The chassis also contains four simple stagger-tuned three-stage filters which are alternately inserted in the circuit when the student makes his selection. In receivers designed for classroom use, the subcarrier filters operate simultaneously, en-

Facsimile machine is easily loaded by secretary. New system could put a fax unit in any office.

abling each of 40 or more students to listen to any one of the outputs he selects by pressing one of four buttons mounted on his chair.

The set may be designed to accommodate a paper tape or computer card punch built into the set. The unit can be time-sequenced to record the student's response to testing. The tape or card could then be fed to a computer to help determine the results of an overall study program. Ancillary units could pump out coins as rewards for correct answers; they could indicate the number of correct answers. Other accessories could advance film in a slide viewer, when triggered by tone signals.

A NATIONWIDE FACSIMILE NETWORK via SCA is beginning to take shape. It may have far-reaching benefits to broadcasters and the public alike—increased revenue for the broadcaster; convenience, financial, medical and other benefits for the public.

Fm subcarriers will be able to carry pages of facsimile newspapers to satellite printing plants at the rate of one page per minute. This can mean income for broadcasters offering this service during periods when the station is not transmitting stereo.

Another possibility will be transmission of home newspapers using the "Sonic Vee" system's narrow bandwidth techniques, operating within the frequencies assigned for subcarrier fax transmission—again, at times in the broadcast day when the subcarriers aren't being used for anything else. The system will establish broadcasters as communications centers, supplementing their income while using existing overhead and facilities.

Fax Systems Already Running

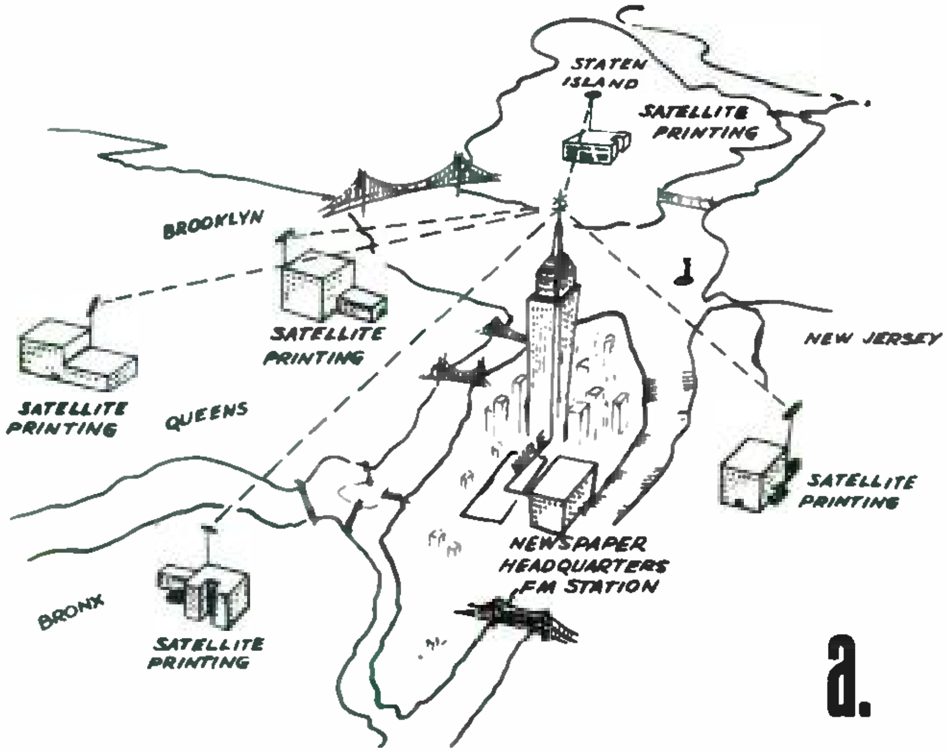
The first graphic transceivers to be used are the compatible Xerox and Magnavox units. Advanced devices using high-speed transmission will be available later from Chromalloy American Corporation, under the brand name of Comfax Communications Corp. Documents to be handled include both handwritten and typed correspondence, printed documents, graphs, maps, reports, charts, contracts, engineering drawings, bank signatures and checks, photographs and security validations such as fingerprints and other identification materials. Transmission time for an 8½ x 11″ document sent over the Xerox or Magnavox equipment will be about six minutes. The Comfax equipment will be faster.

Plans call for Comfax communications centers in all major markets in the U.S., and on the premises of franchised radio and TV broadcasters who may or may not be part of a common network.

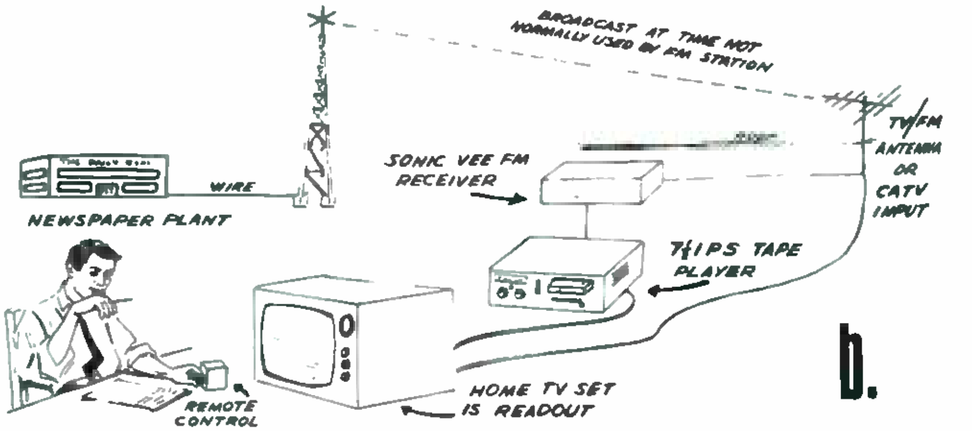
Advantages over the classic telegram are cited as the ability to transmit pictures, drawings and illustrations and messages in non-Roman alphabets such as Japanese and Hebrew. Error-free transmission of copy containing medical logic and price and shipping information, is seen as another important application.

The Cost Factor

Cost savings of facsimile over telegrams can be significant. Lengthy telegrams are transmitted error-free and at low cost. When Comfax's high-



Satellite printing plants (a) can be served simultaneously by a single fax SCA subchannel in a centrally located point, such as the Empire State Building. In home fax newspaper service (b), special receiver would pick out fax signals, putting them on tape for later recall on TV screen.



speed equipment becomes available and telephone charges are further reduced, the average facsimile transmission will cost less than a 50-word telegram.

The broadcaster is considered the best outlet for distributing this vital new communication medium. He has rapport with the community and can offer a profit-making public service.

Medical information, stored in computerized libraries in major cities, will on demand, be fed across the country on the fax system's existing telephone lines. A hospital treating an emergency case for an out-of-town visitor can have his complete medical history available via facsimile in a matter of minutes. This will reduce emergency medical errors, and may well save lives.

Comfax will be used by any nationwide organization which occasionally finds itself needing the ability to put out its own kind of All Points Bulletin. The credit card industry may be an early subscriber. Criminals who steal charge plates generally buy virtually all they want with the cards for up to three days. After that, they feel the word has been put out and the card is hot. Using broadcasters as com centers could cut that down to less than two hours after a credit card theft is discovered. Affiliated fm radio stations will serve as cooperating relay points along the coast-to-coast network. They'll use messenger services and local store facsimile units when needed to make sure major outlets are properly notified of a credit card in wrong hands.

This same technique can apply to pharmaceutical houses which might want to remove medicines from drugstore shelves for safety or marketing reasons, automobile manufacturers who need to recall an entire line of models, and food packaging or distribution firms when a product must be kept out of the public reach. Currently, such tasks are performed by an expensive and often image-damaging combination of hundreds of telegrams and use of the public news media.

Remote Broadcasts Pay Off

WHEN WDDD WENT ON THE AIR in Marion, Illinois, in November 1970, the independent FM station was up against two high-power AMs, a local cable system, and a brace of local newspapers.

Two months later the station was in the black and has stayed there ever since.

One of the main elements of that success, according to Dutch Doelitzsch, president, has been the management's determination to become the "hot" news station, known through the town as the one present at, and aiding with air coverage of, a wide range of important community activities. To get this go-everywhere capability, WDDD invested in a Ford Super Van and equipped it with a Marti remote radio link. Broadcast-quality signals can be fed into the studio from as far as 25 miles away. Important remotes go on the air live, switched in between the country music programming that is the station's staple fare.

The latter is nearly 100% automated, but preserves a "live" character with expert announcer and skillful disc jockey talk recorded to surround the music. As in a number of other stations, the resulting air product sounds more "live" than that of many non-automated stations; the quality depends essentially on the personalities of the five disc jockeys, and on the expertise of Program Manager P. D. Schmidt. Getting it all down in advance allows the program department to produce a sound that is smooth and seamless, as well as lively.

Automation, says Mr. Doelitzsch, is one of the keys to the station's success. "The announcer . . . does . . . everything a live announcer does, except that our announcer is doing other things while he is on the air, such as selling, production, news, copy, and so on," said Mr. Doelitzsch. "All this requires about 2½ hours per week for the announcer to prepare his material for automating. . . . Visiting broadcasters can't believe that what they hear is actually automated."

WDDD's emphasis on community involvement goes far beyond the usual alertness to local news. The station, with its remote pickup, becomes a participant in all important local events. The Ford Super Van and the station personnel make the station visible at such events, which reinforces the image of the station as the one to follow for local news. In a recent week, WDDD picked up, live, the following:

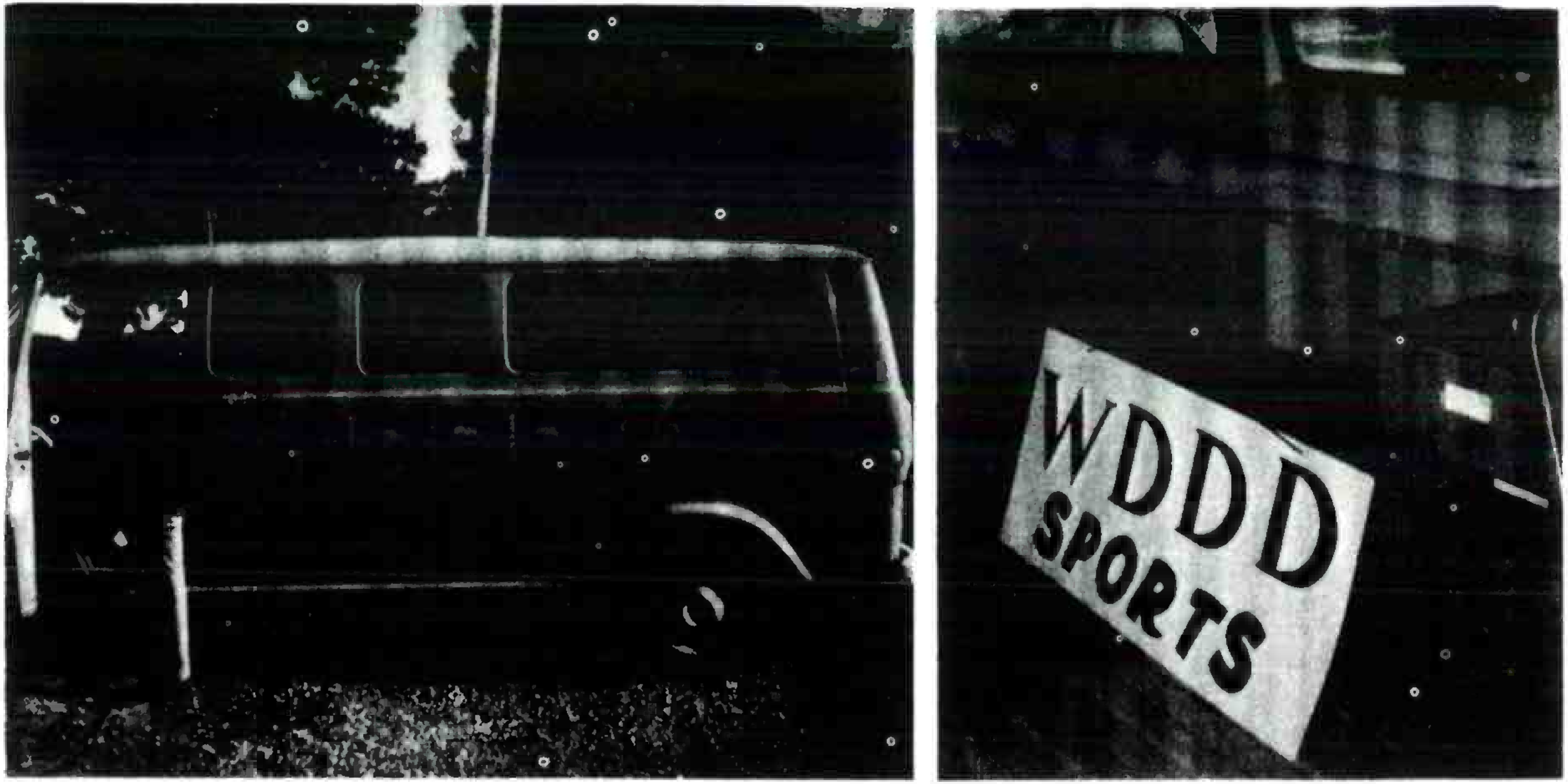
- Three high school baseball games
- High school all-sports banquet
- Senior Citizens Convention keynote address
- A riding lawn mower clinic.

As many as five important remotes have been aired in a single day, but the average is roughly one a day.

This activity has already succeeded in convincing a large number of people that if they want to find out about something that is happening in town, they had better tune in WDDD, Mr. Doelitzsch says. This leadership among the media in the community is ". . . an enormous help in our sales efforts. Wouldn't you want to go with the winner?"

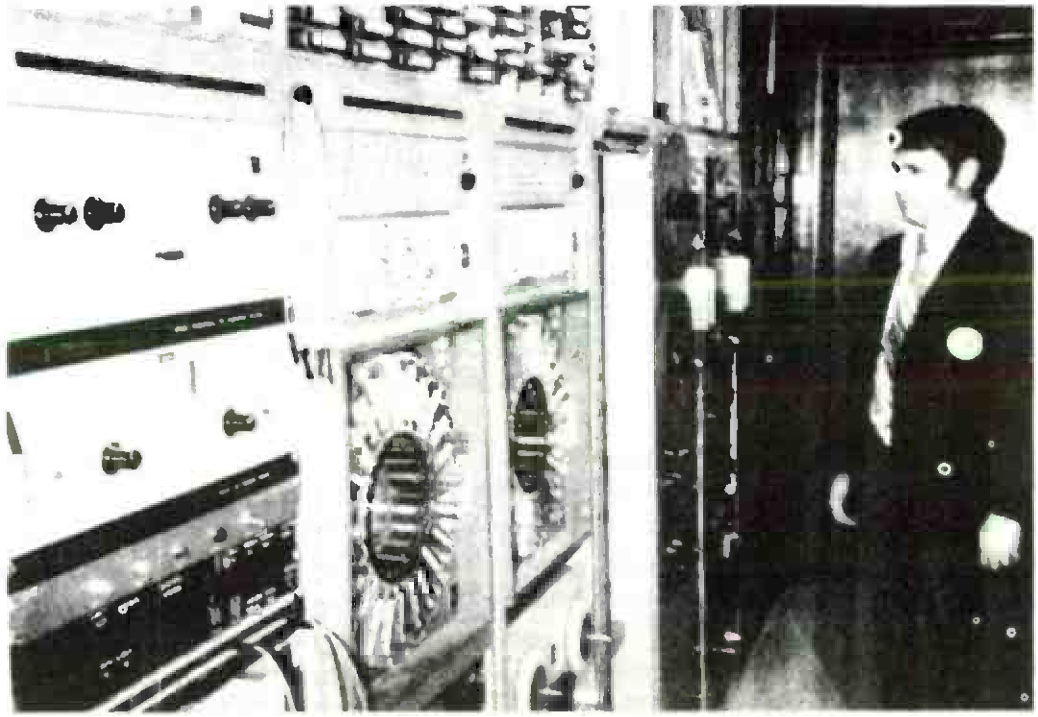
The equipment and personnel costs of the remote operations are both high: a professional broadcaster obviously has to be on hand to handle each assignment. "If our remote coverage were a complete loss, we would still do it for the reasons already mentioned, but at WDDD we make money on our remotes." The method is a sponsorship plan, under which a local businessman can pay $25 each three months, and get mentions—not ads—a specified number of times on remote broadcasts. The plan has proven highly popular with the sponsors and gives WDDD freedom to use remote pickups as needed. "After all," says Mr. Doelitzsch, "who can pass up an advertising package that costs only $8.33 per month? Everybody wins . . ."

A further element of community involvement is the availability of WDDD air personalities as masters of ceremonies for clubs or other organizations.



Inside (right) and outside of the WDDD news van, which can be dispatched in a few minutes to any news location to send back broadcast-quality signals from anywhere up to about 25 miles from the station. The Marti transmitter, visible on shelf at right in interior, is equipped with beam antenna in rear of van (left of picture) for the longer remotes. The attractive van makes the station highiy ''visible'' at town events.

Getting the on-location news: Governor Dan Walker of Illinois (left) is interviewed by WDDD news director Steve Land at the dedication of man-made Rend Lake.



President Dutch Doelitzsch stands next to the Schafer automation gear used to put "seamless" but lively programming on the air.

"They do this as part of their regular duties," says Mr. Doelitzsch. The programming also includes a good number of local "talk" shows, on which personnel of local groups can be interviewed to tell the community about what they are doing.

WDDD put on its first quad broadcast in November 1971, raising considerable local interest. But the station has not yet put much emphasis on this because there is very little country music recorded in quad.

A last note on the special character of WDDD: at the time it went on the air, in November 1970, no member of the management or technical staff was older than 23! Give these youngsters ten years and they will zoom clear out of sight.

"Live" Rock Builds An Audience

LET'S SAY YOU HAVE MADE AN FM STEREO STATION outstanding (and a commercial success) by emphasizing a "stereo rock" format appealing to a large youth audience (heavily in the 18-34 bracket) that is highly sophisticated about sound quality, as well as very hep in its tastes for music.

There have to be two thrusts to your success: the right choice of program material; and the right technology for a clean, sparkling sound.

WLIR-FM, Hempstead, Long Island, about 20 miles east of Manhattan, has made such a success and has a story to tell on both programming and technology. First, "stereo rock" needs an explanation. In the WLIR version it doesn't mean a total diet of hard-beat music In accordance with the demonstrated tastes of a large body of young listeners today, it also includes some jazz, folk music, blues, even a little classical material, in a rather free-form mixture brewed up by Ken Kohl, young program director at WLIR.

Sometimes mixed with the music are public service and political announcements aimed at that same audience, the college-age and next older segment of the 15 million people in the New York City-and-environs megalopolis. That is a huge audience, but it has a correspondingly large number of radio and television stations from which to choose: there are more than 50 radio stations in the area.

WLIR's success, therefore, is a result of the quality of its program mixture, and not of an "easy" market situation: New York's broadcast scene is a battlefield for any station.

An important element of the program mixture are the live rock concerts, the only ones in the east at

At WLIR, Ken Kohl, program director, and Joel Moss, public affairs director, plan a series of information spots for the 18-to-34 audience who are the station's main listeners.

the time this was written. These broadcasts have stirred strong response. with their spontaneity and excitement of a kind largely missing from studio-made recordings. Top recording stars have been glad to take part, sometimes at nominal fees, because of the expected stimulus to sales of their discs. An audience of about 50 "live" listeners is invited to the Ultra-Sonic Recording Studios in Hempstead, where the weekly live show originates. One result demonstrating the pull of the show is the crowd of up to 300 or more who regularly turn up, unbidden, to hear the music at its source.

A number of other concert-style shows picked up remotely are put on tape (more on that in a moment). And WLIR produces a certain number of musical shows in its own studios. In addition, there is a series of disc jockey shows, with each man required only to mix in a certain number of station-specified recordings among his own choices.

The audience that WLIR is reaching with this broadly-interpreted "rock" programming has a strong attraction for a variety of advertisers. For example, Dr Pepper, the soft drink, recently picked up the tab for the weekly live rock concert. John Rieger, president of WLIR, is happy with the number and character of the station's advertisers.

WLIR started in 1959 as a classical music station, and its switch to the present format didn't take place until early 1970. The station's management, which hesitated for some time about giving up the classical format, is now for "stereo rock" 100 percent.

The management agrees on another point: without a top-quality sound, WLIR's impact would be dulled. One center-pin of the sound since mid-summer of 1972 has been the Revox A77 tape

WLIR's chief engineer, George Sullivan, cues up a disc for recording on one of the Revox A77's used for origination of most music programs at the Long Island FM station.

recorder. With the exception of the live concert series, every concert-style show is recorded on one of WLIR's Revox machines, and broadcast from that recording. Included are remotes as well as musical shows produced in the WLIR studios. Mr. Rieger and George Sullivan, chief engineer, both call the sound quality they get from the A77 "superb."

Commercials, too, are produced on the Revox machines, edited there, then dubbed onto carts for broadcast. The quality is just as though the original recording had been made on the cart itself, according to Mr. Sullivan.

The microphones used for music pickup are also obviously essential links in the quality chain. WLIR is satisfied with its Beyer mikes, which include both omnis and cardioids.

Just as important as top equipment, says Mr. Rieger, is an engineering staff thoroughly committed to keeping on the air the top quality of sound the equipment can produce. "We have such a staff," he says, "and I recommend that variety to any radio station that wants its sound to be competitive today."

How To Promote FM

Marlin Raymond Taylor

PROMOTION is the one function in a broadcast station that is most often ignored, put off, or not even thought about. Why? It's the one activity that isn't required for routine station operation. Your engineers must keep the equipment operating, you must put programming on the air and keep it there and you must sell time in order to produce revenue for paying salaries and other expenses. But you aren't required to tell people about your station and its programming, nor is promotion needed to accomplish any of the above functions.

Nevertheless, promotion is related to these various areas of the station. When done properly and effectively, it becomes closely associated with programming, engineering and sales.

What does promotion have to do with engineering? If your equipment is in poor condition, transmitting a signal with low fidelity, poor stereo, or hum and noise, then promoting the station to persons with good stereo systems is a waste of effort and money. You'd be wasting your time just as much if you devoted promotional efforts to reaching listeners beyond your reliable service area, or if you limited your campaign to the center of your metropolitan area when your signal reaches 40-60 miles out.

Recently someone asked about a successful fm station I had been with. Had programming played a role in its growth, or had the station's success been created totally by its extensive promotion? The answer should be obvious. Promotion can be used to "hypo" your audience temporarily, regardless of what you are programming. But new listeners won't stay with you if you are offering inferior programming.

What promotion should do is make the listening public aware of your station and its programming and create enough interest in your product to get a trial tune-in. Therefore, if your programming is poor or isn't designed to interest a reasonably large number of persons in your service area, your promotion will be wasted. A gain in audience is almost impossible under these circumstances. In fact, if your program format does not contain one or more "hooks" your promotion can hang on, it's unlikely that prospective listeners will find anything interesting.

To answer the question more fully, programming is an important factor in the successful promotion of a station. At one station, an analysis of the various rating services surveying the market showed that the audience remained strong during report periods, when promotion was minimal. Promotion was used to attract and interest prospective listeners and to build the image of the station, but it was up to the programming to hold the audience once it was created. The station relied on a well defined and carefully controlled format to achieve a professional sound, avoiding meaningless gab and other rubbish that tends to clutter so many radio stations.

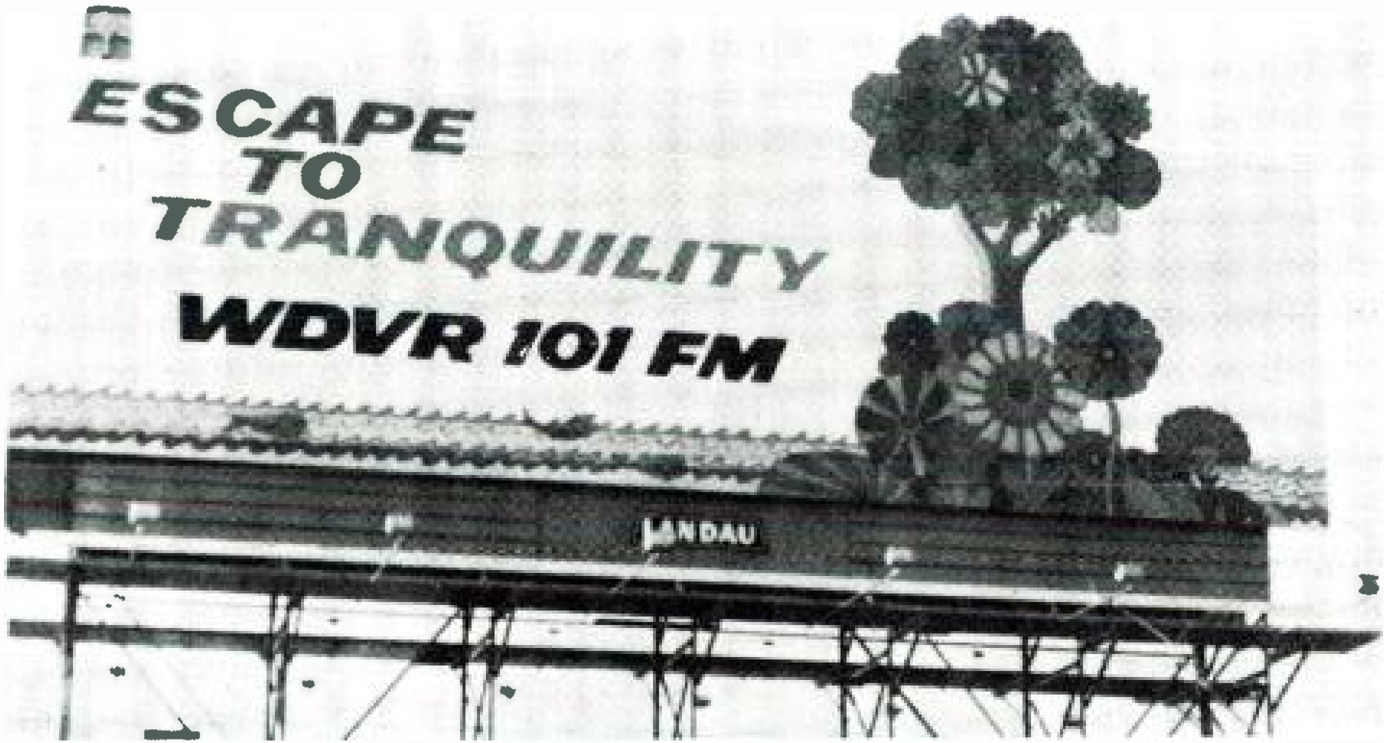
Fm stations have probably put more effort into sales promotion than audience promotion. But a good audience-promotion campaign can reap benefits for your sales department while increasing listeners. After all, aren't the advertising agency personnel, business executives and store owners part of the public you are seeking as listeners? The more these people see your call letters, the more they will readily believe your sales story about audience size and the response to advertiser messages.

When promotion is related to the sales department and to helping increase sales, it must be realized that most successful fm stations have put themselves in competition with *all* radio stations, both a-m and fm. In the advertising community *fm* has come to mean *those stations which promote the least.* It's no longer practical (if it ever was) to try to justify advertising buys on your station with "I'm an fm station." This is supposed to mean that fm listeners are much better than a-m, even if there are only 10 of them out there. In New York it is common to hear agency buyers for large local-regional accounts say "We didn't buy any fm stations this time," or "We had only $300 left over, so bought just one fm." Meanwhile, the specialty a-m stations—black, Spanish-language—are nearly always considered and in most cases bought with fairly substantial budgets. Buyers know the specialty stations reach a segment of the market.

Fm Is Radio

What is the answer for an fm-er? Become a radio station. You already are—it's just that you haven't learned to think that way. Saying you're "an fm station, which isn't being bought this year" is an easy crutch to justify your less-than-beautiful P&L statements. Sure, you're an fm station, just like your sister stations on the other band are a-m. But this chiefly tells potential listeners where to find you on their radio. Technically, you're way ahead. You have stereo, an fm exclusive and superior frequency response. Both are important today when hi-fi store managers tell of the many women bringing their husbands in to buy components and consoles, quite the opposite of the past two decades. With all that interest, you should be ready to give the a-m boys a run for their money. Note that the status symbol even in ghetto homes is no longer the traditional TV set, but rather a stereo system.

If you are not selling successfully, it's probably because you are not communicating with prospective advertisers. They don't know the benefits to be derived from reaching your station's audience. That's where promotion should come in. As said earlier, your programming and what your station has to offer to listeners, such as stereo, are the keys to good audience promotion. At the same time, promotion should impress these points upon prospective advertisers. You are showing that you are a radio station programming to a certain segment of the population. After that, if you are charging a fair price, it shouldn't matter



Billboards are big help in promoting station's image to would-be listeners. Rotating board location also helps.

to your sales prospect what type of radio station you are, unless you make it an issue. But until all fm stations start acting like radio stations, time buyers will continue not to buy "any fm this time." What they're really saying is that your audience isn't large enough to be bothered with, or that you haven't shown them why they need your audience. ("We'll get them anyway by buying the big a-m stations.")

In most cases, the fm station owner or general manager must play the key role in promotion. Very few fm stations are big enough to justify a full-time promotion manager. Therefore, promotion is a part-time job for one or more persons that have other full-time responsibilities. Timing and continuity are important in the effective promotion and continued development of your radio station. It is evident that the manager who is truly concerned with the long-term growth and success of his station is constantly working to improve the image of the station through promotion and community relations activities. This doesn't mean that he plays classical music because the city fathers think better of him for it. Rather he defines what his station stands for to those in his target audience. Plus he insures that his program quality remains high so his listeners remain loyal.

If an award were made to fm's number one promoter, it should go to Jerry Lee, president of WDVR, Philadelphia. Jerry has involved his station in one or more promotional activities on a nearly continuous basis since it began broadcasting in 1963. There aren't too many likely or worthwhile promotional methods that haven't been used in some form by WDVR in the past six-and-a-half years. This was not done out of necessity to keep the station's existing audience, as WDVR's programming has remained at a high level with strict commercial limits—to this day not more than six spots per hour.

Audience Growth Pays Off

While some may consider WDVR's promotional expenditures extravagant, I doubt that more than a couple of promotional efforts could be singled

Clever newspaper ads help get the message across, as with this Boston stereo station.

out as not paying for themselves in audience growth and/or increased business. Considering that the station's 1969 cash billings were well over one million dollars with a healthy percentage of profit, it appears that the station's years of promotion have paid off rather handsomely. To quote Jerry: "Promotion, like a good salesman, is not really an expense, but an asset."

Let's look at some of the various methods open to radio stations for promoting themselves. One of the first ways always thought of is the newspaper. But if you take the Starch reports your sales department uses in selling against newspapers and read them, maybe you'll have second thoughts. If you still want to use newspaper to promote your station (which is not a bad idea if you can get the space on a reciprocal arrangement), develop a concept that allows you to effectively merchandise your ads. During its development years, WDVR used a small number of full-page ads instead of more frequent smaller ads, so that each achieved a far greater impact. Some of the ads were straight audience promotion, with others directed to the business community. It was always assumed that no one read the newspaper. Therefore, a list of several hundred persons the station wanted to read the ad was supplied to the newspaper in advance. The paper mailed a copy of the first edition to each person, so all received the paper on the same morning it was printed. At the same time the station mailed a special announcement to each person inviting him to look at the proper page in the morning paper.

A practice I question is why radio stations place their newspaper ads on the radio-TV page. Who reads that page? TV watchers, that's who! Isn't it more practical to use the pages read most by your target audience? Use the financial pages for promoting a good-music or classical format, especially if you carry stock-market news regularly. Use the food and fashion pages if you're trying to reach women.

A good promotional method, but one where costs add up fast, is direct mail. A similar, lower-cost but somewhat less reliable one is door-to-door distribution. This system is best used in urban, non-apartment areas for things like contest coupons, radio listening questionnaires, or other items of value or interest to the recipient. Another method of getting station material directly into the home is through a bank or department-store charge statement mailing.

Use Billboards

A large category is outdoor. This usually means billboards, which outdoor companies call 24-sheet or 30-sheet posters and painted, rotating bulletins. Posters are the most common in this category and the painted type is largest. Rotating simply means that as part of a long contract, the board will move to a new location every two to three months. There are various sizes and shapes of junior billboards, including those found in bus and railroad stations. These differ from market to market. As part of outdoor I also include bus and taxi posters, which in most markets can be found both inside and outside the vehicles.

In some cities advertising benches can be found at bus stops and in front of supermarkets. Gordon Potter, manager of KWST in Los Angeles, has been making good use of benches throughout his vast, mobile market. Several years ago a station in a medium-sized city began placing its own benches through arrangements with the city government and property owners. The station made its own benches, thanks to a jack-of-all-trades chief engineer who did the construction at the transmitter shack. The station was later sold and the new owners dropped the idea. This method is a perfect vehicle for client merchandising, providing bench signs for advertisers during their air schedules, then using them to promote the station at other times.

If there is one key to the successful, effective use of the various forms of outdoor advertising, it is getting your call letters and message across with an absolute minimum of words and artwork. In this medium a person gets only a brief glimpse of your advertisement, except inside a bus or taxi.

Not to be forgotten in promotion is our sister medium of television, which can be very costly, even on a reciprocal basis. It is unlikely that any a-m station would want to do business with you, although WDVR, which is an adult music station, and KYW, the Westinghouse all-news station in Philadelphia, have aired announcements for each other. Another outlet for your promotion could be the city-wide or regional magazine in your area, and also to be considered are the regional editions of some of the national magazines.

One method of promotion proven effective for an fm station is the dial card. While this idea was first used as far back as 1950, the first large scale printing and distribution of the card (listing all area stations, their frequencies, and noting those broadcasting in stereo) was by WDVR in mid-1963. In the ensuing years the station distributed nearly two million cards. The idea has since been adopted by KWST in Los Angeles and WJIB in Boston, plus a few other stations around the country. Last summer at WRFM, we launched a promotional campaign to support our new maximum adult music, minimum talk format. It included the widest circulation of dial cards to date—more than one million cards were distributed through more than 2000 locations within a 50-mile radius of Manhattan in a five-month period. The card was printed in three editions due to the number of stations in the metropolitan area and the large area over which they were to be distributed.

The WRFM audience more than doubled in the period following the initial dial card distribution and has become one of the top-rated New York City fm stations and a station of major importance for the first time in its 16-year history.

Reaction to and interest in this item that started out as a station promotion piece is now such that it has become an entity unto itself, developing its own popularity, image and word-of-mouth publicity. I estimate that one in four dial cards picked up actually gets to an fm radio and that one in five of these arriving creates a "listening test" tune-in for WRFM.

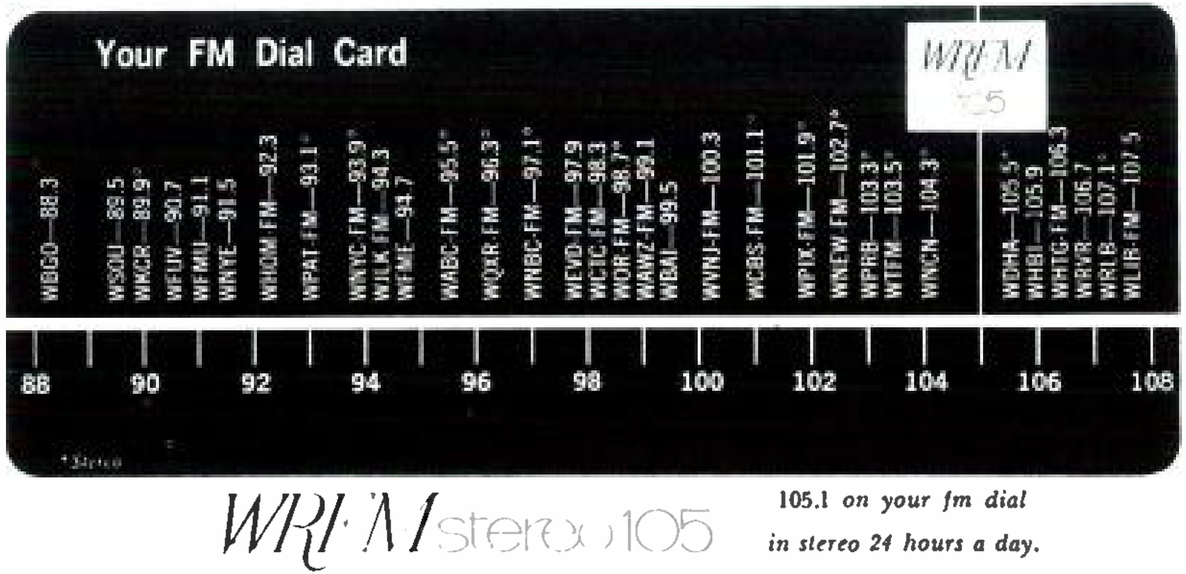
Speaking of word-of-mouth publicity, that's the one promotional method I haven't covered.

Fm dial card widely distributed where fm listeners are likely to shop, are promoted by this bus ad card.

Want your own FM Dial Card?

Pick one up free at your local Hi-Fi radio dealer.

. . . or write to WRFM Stereo 105 New York 10022



105.1 on your fm dial
in stereo 24 hours a day.

It's inexpensive, but unfortunately it's one that no station should rely on. Few stations are lucky enough to get word-of-mouth working for them on any large scale. Yet if it can be motivated, you have a dynamic, potent force going in your behalf. WJIB, owned by Kaiser Broadcasting and the Boston Globe and managed by Peter Taylor, is one of the nation's most successful fm stations, yet just over two years old. The station has never done any extensive promotion, and in fact has done nothing that could be called a true promotional effort. None has seemed necessary. Word-of-mouth went to work for WJIB within a matter of days after its first broadcast and created a spectacular growth.

What message do you want to deliver to the listening public? What is your target audience, or what type of people do you want as listeners? The answers to these questions will determine which medium will be the most effective for you. The next question will be how to use that medium to achieve the maximum benefits.

Stations like WJIB, Phoenix's KRFM, and the old KPEN (now K-101) in San Francisco, have one thing that is missing from many stations: strong rapport with listeners. It's seldom thought as promotion or image building, but rapport can be most beneficial if developed properly. At WJIB, Peter Taylor spends several hours every week writing personal letters to listeners who've written the station. KPEN accomplished it with special programs where co-owner and engineer Jim Gabbert answered listeners' questions about hi-fi equipment. The station also had open house events and once ran a hi-fi components show that was popular.

Successful and effective promotion definitely evolves from a total commitment and effort by management to develop an outstanding radio station in all respects—quality programming, hence large audience/ratings, plus sales revenues and profits. A recent NAB survey found that seven of every 10 fm stations with an a-m sister now present separate programming 50 to 100 percent of the broadcast schedule. The same was true of no more than two out of 10 just five years ago.

With this great proliferation of fm programming, a station must develop a definite identity and image in order to survive and succeed. This is where promotion comes in. Do it well, do it enthusiastically, and compete on an equal footing as a radio station.

How to Select Competent Salesmen

Edward A. Wheeler

THE VALUE OF GOOD SALESMEN to a successful radio operation is incontestable. He's the bread and butter man. Yet, when it comes to seeking out the man to sell time—as often as not—management might as well be back in the crystal set days. It has been my experience that every time you make a mistake in hiring, it costs you about $1,000. This is the average for all station personnel. In the case of salesmen the cost is much higher.

A station that intends to achieve its true sales potential must have well-defined procedures—first, for measuring the potential effectiveness of prospective salesmen, and secondly, for supplying the training program to develop this latent potential. The second step will be wasted motion unless the first is conscientiously implemented.

Measuring Sales Potential

We have found the most successful method of measuring the potential of sales position applicants has been to have them evaluated by an industrial psychologist. Our contact with this specialist is strictly by mail. All applicants (for other positions as well as sales) are required to take a series of psychological tests which takes about three hours. At the outset we lose some applicants simply because they won't spend three hours. We feel that if they aren't interested enough to spend that much time, we don't want them anyway. Thus, without even being administered the tests get rid of some of the chaff. Eventually, you get somewhat familiar with these tests, and many poor risks can be eliminated initially without going to the expense of having the rest evaluated by the psychologist.

This procedure has been remarkably exact in predicting reliably potential sales success as well as failure, except when we have gone ahead and used what we now laughingly call our "judgment" as an overriding factor. Besides avoiding expensive mistakes, on a number of occasions these tests have accurately predicted success from someone who was not too impressive in the employment interview. Some place along the line we may have missed an excellent prospect because he was about to change his whole attitude; but quite frankly it is very difficult for anyone to point to any individual who basically has ever changed his personality traits.

The evaluation of office and operating personnel in the form of a 3-page report costs us $15. A more detailed evaluation of sales applicants—about 15 pages—costs $50. The services of the psychologist include checking the applicant's references. I tremble to think of some of the mistakes we have avoided, thanks to this phase of his services. Ever since being sued for half a million dollars for "blackballing" a former employee, we have been extremely reluctant to give any information on the telephone regarding previously employed personnel. As further protection, every employee who leaves our station, no matter what reason, gets a standard letter of recommendation from the station. When you get a telephone call inquiring about a former employee, chances are you won't really go overboard one way or the other; in fact you may be quite reluctant to report on specific shortcomings. What this psychologist does, when he is calling to check references, is to infer to the former employer that he has uncovered something pretty serious about the applicant in another call. At that point, the former employer commits himself one way or the other—he either says "yes," he stole from us, too" or "yes, he chased the sponsors' wives," or he immediately springs to the man's defense. In any event, you get a worthwhile recommendation, be it good or bad.

In the past, one promising applicant indicated that he had been divorced twice—not necessarily a bar to success in my opinion. But checking his references revealed he had been divorced *nine* times! On another occasion we were advised that a certain applicant was a homosexual. This doesn't necessarily mean he can't sell radio advertising, but it is something management ought to know.

Testing Procedures

There are two basic personal evaluation devices—the aptitude test and the personality survey. Aptitude tests tell us of a man's potential abilities. Personality surveys of the type we use tell us how he can and does use these abilities in a work situation. The surveys measure attitudes, and these, we feel, are the keys to success.

In addition to helping us avoid costly errors in hiring, these tests—on a number of occasions—have prevented errors of omission by accurately predicting success from someone who was not impressive in his employment interview. The tests have pointed out young men who—though they've had no real sales experience—possess sales potential which can be nurtured through training. This potential is demonstrated in such characteristics as enthusiasm, persistence, competitiveness, and non-complacency. Give us a man who has this basic potential and we can develop a winner by following up with the appropriate training. Repeatedly, the tests have saved time and money in picking out the men who profited most from sales training.

Don't assume that these tests are designed to find the so-called "normal" person—the "well-adjusted" individual. If there's anything we do not want in sales, it is the contented type. We want the hungry, dissatisfied type who gets emotional satisfaction from selling.

Sales Training

No matter how accurate your testing procedure is, it will be a waste of time unless you can provide the training necessary to develop a man with the aptitude and the attitude. We are convinced that selling radio time is a special profession, and as such it merits a well-grounded program for developing professionals. If a young man with medical ambitions were to ask a physician for advice, would the doctor hand him a shelf of medical texts, a microscope and slides and tell him to study on his own? That, in a way, is what happens to aspiring young radio salesmen. New men are

Would you please take a minute to assist us in an evaluation of our sales presentations. You have recently been called upon by one of our sales representatives. As a businessman and employer, you realize the importance of intelligent presentation of a service or product. It is not necessary to identify yourself. A stamped return envelope is enclosed for your convenience.

Please check any of the following that apply to your visit by our representative. Thank you.

Should have made appointment	____	Didn't believe in his product	____
Knew our business	____	Didn't interest me	____
Called at a bad time	____	Well prepared	____
I never listen to WEAW	____	Poor approach	____
Don't like programming	____	Rude	____
Don't like programs	____	I don't like radio	____
Discourteous	____	I only need the people newspapers reach	____
Too high pressure	____	Didn't tell me of other retailers' results	____
Idea was poor	____	Didn't present anything specific	____
Didn't ask for my business	____	Didn't understand him	____
Not suitably dressed	____	He wasn't convincing	____
Should have presented a tape	____	Didn't interest me in WEAW	____
Insincere	____	Not as good as newspaper salesman	____
Saw the wrong person	____	Service over-priced	____
Would like to see a different salesman	____	Didn't give me enough reasons to buy	____
Didn't explain advantages of WEAW	____		
Poor personality	____		

Please use reverse side for any additional comments or suggestions you would like to make.

(If you care to identify yourself)

Name ______________________ Business ______________________

(651 0)

After most new sales calls, particularly with new salesmen, this sales evaluation form is mailed to each advertiser he calls on. The advertiser may return it anonymously if he cares to. The advertiser often gives the real reason for not buying, or for buying.

given training; it is not in terms of weeks or months, but years.

During his so-called apprenticeship, the new salesman should undergo re-evaluation constantly. Some of the most perceptive evaluations come from the clients themselves. After most new sales calls, we send out a sales evaluation form to the advertiser. When answering anonymously, the advertiser often acknowledges the real reason for not buying or, as far as that goes, for buying. I might add that we code return envelopes under the flap so that we can identify the source—a helpful factor in upgrading individualized sales techniques.

Probably the biggest problem any station has in searching for salesmen is that they just do not see enough applicants. Believe me, this is a terrific obstacle. If you could interview twenty men and make your choice from the best of that twenty, you would probably come up with a pretty good candidate. But what usually happens in the typical station is that two or three candidates are interviewed, and the employer is forced to choose from these two or three men—not a very good decision-making situation. If you see enough people, then, whether you use tests or not, your batting average is bound to improve. Thus, if there is a formula for building a good sales force, it is simply this: See as many applicants as you can, check out their backgrounds, administer tests, and put them through a comprehensive on-the-job training program.

Psychologist's Analysis of Sales Applicant

(Names have been deleted)

If one were to look at Mr. *Blank's* Profile Form and take it at face value, he would gather that he had considerable potential; certainly, he has had all the experience you want for a salesman. The only question which might arise is that he seems to be leaving (*station B*) rather soon; moreover, he appears to have made fairly good money in the past and seems to have taken a cut to move from (*station A*) to Chicago. Nevertheless, one would have to consider him a good candidate—taking the facts as he gives them. However, we quickly discovered that the facts he presents are not entirely accurate.

We do not know the whole story about his background, but there is no question that Mr. *Blank* has not been frank with you. He states that he worked at (*station A*) from November 1958 until 1962, leaving because the station was sold. The truth is that he left sometime in late 1959 or early 1960, and he left not because the station was sold but because he was fired. From (*station A*), he next turned up in (*city X*), where during a period of five or six months, he worked for three different stations. The sales manager of (*station B*) says that *Blank* was on two payrolls at once. he was drawing a check from (*station C*) and at the same time a check from (*station D*) at the same time. He says that Mr. *Blank* made no serious attempt to do any sort of job for their station; he spent most of his time trying to "con" advances from (*station C*) and the other stations.

Mr. *Blank* disappeared after six months. Where he went no one in (*city X*) seems to know; there is a blank period until he showed up in Chicago. We do not know where Mr. *Blank* was for this period of at least one year. The people in (*city X*) refer to him as a crook, a cheat, a liar.

Talent Factors

Mr. *Blank* had a perfect score in virtually every test. If he took these tests under close-timed supervision, then we would have to conclude that he is a near genius. On the other hand, if he took these tests by himself, timing himself, on his honor, it is quite possible he was very liberal in the time he allotted himself. Certainly it is most unusual to find a man who scores as highly as he does in every test area.

Personality Factors

Mr. *Blank* completed a series of four personality devices designed to evaluate his emotional stability, his patterns of relating to other people, and the manner in which he utilizes his abilities.

Self-Concept and Goals:

One striking theme which runs throughout his material is reflected in the following types of responses to the Sentence Completion Test: "I am afraid of very little" . . . "Other people don't bother me" . . . "I worry very little" . . . "I hate nobody." In effect, he tries to present a rather trouble-free impression. Going one step further, here is his response to the Behind-The-Door test:

"On the other side of the door is the station owner. He is trying to hire a manager so he can devote more time to the expansion of his company. His problem is to make the right decision about the man so he can put his energies to work elsewhere. He hired (*applicant*) and was able to pursue his other goals with confidence. He knew this man would carry out his orders and run his station as well as it was run before."

Again, here is how he describes himself in another test: "a good leader, truthful, an astute business man, makes a good appearance and is respected." In fact, the only negative comment he makes about himself is that he "thinks about the job too much," which after all is not a very negative statement. Whenever you come across a man who seems to be so positive on the surface, and who admits no negative aspects about himself, you cannot help but wonder why he is not being truthful. Certainly we expect the average job applicant to try to create a favorable impression, but the vast majority can admit negative things about themselves. Certainly, when a man says "I worry very little" or "I'm afraid of very little," he is either a fool or a liar.

Work Pattern

Although he tries to create very positive surface impressions, Mr. *Blank's* test materials reveal a propensity for conflict with management. Over and over again, he structures situations as follows: "The salesman got bawled out and called to square things after thinking it over. The salesman got caught loafing by his boss. The salesman was late and got fired. The salesman went to make peace with an irate client. They shook hands and all was forgotten."

The pattern which really characterizes Mr. *Blank's* relationships with other people is one of recurrent conflict. On the surface, he will tell us: "Most supervisors are fair and competent," but, as one man told us, he apparently gets involved in a constant battle of wits with management, seeing himself in one dispute after another. One reason, of which he is unaware, for this recurring conflict is to be found in one aspect of his work pattern—his tendency to cut corners rather impulsively and his apparent reluctance to follow instructions.

Can this man sell? The answer, of course, is that he does have an excellent sales identification; however, so much of his energy goes in two unproductive directions—maintaining what might be called a "phony front," and becoming involved in conflicts with supervisors — that little is left over for consistently productive effort.

Management Cues

Knowing what we do know now about Mr. *Blank*, he would have to be considered an employment risk. He could no doubt be productive with the right control, however. He is the kind of man who will try to take advantage of a situation if he sees the slightest opportunity. In the past, you have had difficulty with men who have falsified contracts, and this man has been in the business long enough to know every trick. He would take close and constant watching.

On the other hand, there is always a possibility that he may be ready to settle down and give someone an honest performance. Perhaps we are being pessimistic, but this is not likely to happen without rather vigilant effort on your part.

Computer Applications for Small & Medium Markets

Gunther S. Meisse

MOST SMALL AND MEDIUM MARKET BROADCASTERS have more or less assumed computers were of relevance only to the large metro-stations who had all the money.

In large measure they were correct in that thinking back in the "60's." Most notable "business-oriented" computer suppliers were busy trying to penetrate the large businesses of this country and didn't even have a product for the small radio station. And those companies that did have the first of the mini-computers were applying the technology to basic accounting tasks and spent little time developing systems for the unique problems of the broadcasters.

Thus, most logs continued to be made out by hand every day, the billing was hand-typed, and simple sales reports were prepared by the front office. Salesmen kept track of their sales goals for the year on the back of a six-inch piece of adding machine tape.

At WVNO we felt that the time had come for us to become more sophisticated in our sales and accounting methodology. Increased sales against a fixed allocation of available time had made traffic more and more difficult and proper scheduling had become more critical in light of the competitive nature of things.

Competition was increasing among the five AM and FM stations in our market, the CATV system was going out on the street looking for radio dollars for their local programming, and the newspaper was becoming increasingly aggressive.

When we first made the decision to become computerized in 1969, we were very discouraged to find that the vendors who were able to deal with the systems necessary for a radio operation were still not producing hardware which was easily adaptable to our problems at a price we could afford. They could systematize our operation but it would cost $1500 per month for the computer hardware.

The second alternative was to join one of the growing networks of "on-line" computers. The problem here, however, was that in most cases the rates for such service were based on the station's inventory, or volume of spots and programs bought and sold and available for sale. In this instance, our numbers were on a par with the big metro-stations, but our rate card wasn't. Thus we were right back to the $1000-per-month figure which could not be justified with a $10 open rate. An additional disadvantage to the "on line" system was the reliance on "Ma Bell" for the link to our purse. Phone lines between our orders and our log just didn't sound very appealing.

The third alternative, which we elected to use, was the leasing of raw computer time on a big computer at a local service center, which gave us the benefit of big computer flexibility at a price we could justify (a couple of hundred dollars a month). With our present system we are on the computer only two hours per month and produce information which would have taken weeks to do by hand, and would have been outdated by the time it was completed. This fact brings me to an important point. The sales pitch of many computer salesmen is, "You'll reduce your expenditure with a computer system." This is generally not the case.

You may go into the system with that thought in mind, but it likely won't work out that way. It isn't the fault of the computer salesman; it is just human nature. You're used to spending a given amount to get the accounting and traffic job done. But when you build your basic data base, and create your original client and station master files, you soon realize there are many valuable reports which can be added to give you a better feel on the pulse of your business for just a little bit more money. Soon you're spending the same dollars you were before, but you are getting a lot more.

Our system was jointly developed by the service bureau and WVNO management. It all starts with the

W V N O

CLIENT CURRENT ACTIVITY HISTORY REPORT

Current Month: AUGUST 1972

Salesman 1 MEISSE

CLIENT NAME	CURRENT UNITS	MONTHLY DOLLARS	CONTRACT EFFECT DATE	CONTRACT END DATE	CONTRACTED UNITS	UNITS USED YTD	SEPT 71 DOLLARS	SEPT 70 DOLLARS	OCT 71 DOLLARS
ACCOUNT TYPE:	APPAREL MALE								
*Goldsmith	65	568.75	09-20-71	09-19-72	1550	1485	521.00	346.00	542.00
Harvey Brothers	42	315.00	05-19-72	05-18-73	900	182	289.00	-0-	364.00
Richman Brothers	80	740.00	01-08-72	01-08-73	1700	1521	820.00	410.00	798.00
	SUB TOTALS:	1623.75					1630.00	756.00	1704.00
ACCOUNT TYPE:	AUTOMOTIVE, NEW AND USED								
Holmes Ford	92	782.00	03-20-72	03-19-73	1500	780	855.00	650.00	755.00
Cheesman Buick	104	884.00	06-14-72	06-13-72	760	350	871.00	726.00	1104.00
*Bigley Chevrolet	136	1156.00	09-06-71	09-05-72	1600	1509	1072.00	1241.00	996.00
	SUB TOTALS:	2822.00					2798.00	2617.00	2855.00

TOTAL CURRENT MONTH: 8625.41

TOTAL HISTORICAL DOLLARS: 9146.00 7251.40 9328.42

* CONTRACT EXPIRES PLEASE TAKE ACTION.......BUDGET PAYMENTS ARE DROPPED THE MONTH FOLLOWING CONTRACT EXPIRATION DATE

sales order. Using a specially designed four-part snap-carbon order form, the salesman prepares his order, keeping a copy for a running record of his "month-to-date" sales. A second copy goes to Continuity, with necessary copy instructions. The remaining two parts go to Traffic and are kept intact for the balance of the month.

Traffic uses these for log building and log auditing and places appropriate marks in the boxes which carbon through to the bottom copy. At the end of the month, they are taken to the "service bureau." There they are key-punched and processed by the NCR Century 100 Computer. The output product of the two-hour computer run includes the following nine items:

1. Client invoicing with day-by-day detail of usage and costs complete with payments, balances, credits, debits, talent charges, agency commissions, and special budget payment amounts (which we offer to our clients as an option).

2. Documentation invoices which are prepared for co-op purposes.

3. A detailed account-aging report showing the distribution of our accounts receivable by Current, 30 Days Due, 60 Days, 90 Days, and 120 and over, together with the date of their last payment.

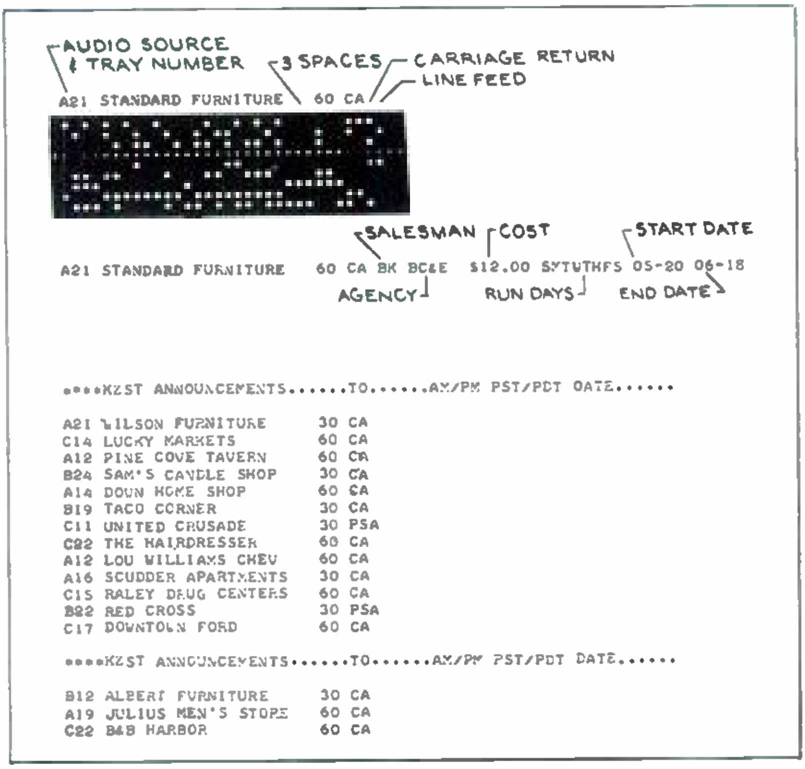
4. ASCAP and BMI Reports.

5. Monthly Usage Summary showing the relative usage of different classes and lengths of time.

6. Masterfile Listing Showing each account in our system and its current contract status, including the start and end date of its contract, the number of spots or programs contracted for and used, contract year-to-date, rate card number, and key or rate card category, such as: 260, 620, 1000 bulk, or package plan number.

7. Salesmen Client History Report, which the Sales Department loves and is a real asset in getting the salesmen to reach their increased yearly sales goal. This report is sorted and printed by salesman, starting with the sales manager. Each salesman's section is then divided into account type and all of his accounts within that type are listed below. Beside each account name is the number of spots or programs which are used during the current month, together with the total dollar amount.

AUTOMATIC LOGGING: How one system works



At top, an actual section of perforated tape as used in the Sparta Automatic Verification System is shown, with a "translation" of the data encoded below it. In the lower part of the picture print-out data is shown in one typical form.

Automatic logging is now an important fact of life for broadcasters with automated programming. If you are using an automated cart system for commercials, IDs, etc., automatic logging will take a comparatively small additional investment.

Also, on this report, the contract "start" and "end" date is listed, together with the number of total spots contracted for and the number used year-to-date. Thirty days prior to the expiration of a client's contract an asterisk is printed in front of the client's name with a footnote indicating that his contract is about to run out and renewal action should be taken.

Additionally, beside each account is that client's gross expenditure for the next two months, a year ago, and two years ago. This shows the salesman, at a glance, what the historical activity of the account is, alerting him to a dramatic change in the client's

The general features of one system, the Sparta Automatic Program Verification System, will show how it works in a fairly typical case. Central data starts with a print-in machine, in this case a Teletype Model 33ASR (send/receive). The logging information is typed into the Teletype machine, producing a perforated paper tape. Electronic unit within the machine produces AFSK (audio-frequency shift-keying) tones from the tape. The tape is run through to record the tones on the cart cue track, either when the cart is originally recorded or at any subsequent time. Tape speed is always the same, no matter what the original typing speed—10 characters per second, for a full 72-character line in 9 seconds, including carriage return time.

When the cart is put on the air, the information on the cue track is fed back through an AFSK electronic module to the print-out, or Verification Teletype; print-out is totally automatic. The signals go through an audio switcher operated from voltages supplied by the program controller, so the logging information reaches print-out only if the cart actually goes on the air.

The system uses the ASAII (American Standards Association Information Interchange) eight-level code.

The logging data can obviously include whatever information the station management wants; the data shown in the illustration is merely suggestive of what can be done. The print-out can be blocked on an hourly basis, or according to other schemes.

Automatic logging seems to provide clear advance in accuracy, as compared with "hand" logging. Its economy probably depends on the size of the operation. It seems likely, though, that virtually any operation that anticipates economic benefits from program automation can gain economically with automated logging.

spending pattern. If a salesman has a 15 percent sales increase goal for the year, he can see account-by-account historical expenditures. He'll know how much he should try to increase that client's buy for the coming months. Each account type is subtotaled, giving the salesman the ability to see the strength, or weakness, of that account type. The end of this report contains grand total dollar figures so he can compare this month with last year and see what gross amount he must top for the next two months.

8. Sales Commission Report divides the gross sales of each salesman into the various sales commission categories including a computation of the

"Clear-Text" Automatic Logging Supplies Instant, Accurate Records for WTMJ-FM

There are a number of approaches to making the logging operation easier, faster, more accurate. Recently the management of WTMJ-FM, the Milwaukee Journal's pioneering FM station, chose the Gates "Clear-Text" logging system, which operates in conjunction with a Gates automation system installed at the same time. WTMJ-FM personnel say the system meets their needs beautifully; they are extremely well satisfied.

In brief, the logger gets its information from information coded on each program cartridge. Whenever a cart is played, the logger simultaneously decodes the logging data and prints it out in clear type. The time is supplied by a digital clock system tied into the logger.

The print-out can use various machines: at WTMJ-FM the printer is a standard teletype machine. The high accuracy of the system lies basically in the facts that if a cart is not played, it is not logged, while if it is played, the data comes from the cart itself. If audio is lost from the air signal, the print-out will be in red, making the system "fail-safe."

The system can be used for automatic preparation of billing invoices. A punched tape prepared simultaneously with the log is fed to a computer, which turns out the invoices.

commission dollars, and deductions of the monthly draw. Total commission dollars due are printed.

9. Station Sales Summary lists for management each salesman and his gross time sales for the month and year-to-date, this year, and last year, the percentage increase or decrease, and a comparison of the station totals for the month and year-to-date. These figures are listed by local, national, and trade-out. This report gives management a running record of the performance of each of his salesmen and the station as a whole.

A back up disc

Since all our financial client records for the last two years are on magnetic disc at the computer center, we decided to lease a spare Disc Pack directly from NCR as added backup. This Disc Pack rents for around $12 per month and is kept in a fireproof file cabinet at the station. When our monthly computer run is complete, we take the disc into the center and they copy the updated information onto it. We then return it to the station. It is not used during regular processing but acts as an insurance policy in case of a failure or catastrophe at the computer center.

Since all our program software and files are on this pack we could always go to any other of the NCR Century 100 computers in our area and process if the "Center" should have a fire, flood, or computer failure. I must point out, that we have yet to use this backup, but we sleep better knowing it's there.

The next phase

While this system does an awful lot for us, it isn't the ultimate answer since we must still build logs at the station by more conventional systematized methods. And we should be able to get instant time availabilities for salemen. With our current system, it may take a girl 15-20 minutes to come up with confirmed information. But since we began, much has happened which shows promise. First, the automation equipment manufacturers are moving into true computer technology making any computerized program log system more directly usable in station program automation. Secondly, the big names of the computer industry are becoming more interested in the smaller businesses since the big business saturation level is close at hand—or oversold and retrenching.

Examples of programmable station automation systems which are compatible with in-house business-oriented computers are Schafer's 8000 system, IGM's new 730 system, and SMC's model 600. In the mini-business computer area, NCR has recently introduced the NCR 399, which will be widely available in the next year. Priced in the $500-per-month range, it can be justified by quite a few small- and medium-market radio broadcasters. The NCR 399, and comparable competitive units, will bring the speed and flexibility of large memory computers down to the price range of nearly all radio broadcasters.

Ultimately, we can expect a computer to do all the business applications of a small station, run the station automation system, and monitor and adjust the transmitter for unattended operation of the station. This is still a few years in the future since the business systems computer suppliers are not yet married to the sensor-based or automation computer suppliers. The two applications are still a world apart in software design.

Don't think it won't happen. Big names in their respective fields, such as IBM and IGM, are thinking and talking about just such systems right now. IBM has gone into the automation or sensor-based computer business in a big way and, of course, has the business systems background. On the other side of the coin, IGM has started using a Central Processor Unit produced by Digital Equipment Corporation, the latter having a good background in specialized applications of the mini-computer. RCA demonstrated a simulated computerized automatic transmitter at the last NAB Convention.

If you are still typing those bills by hand, making those logs out by hand every day, keeping your sales quotas and status on the back of adding machine tape, and assuming that your accounts receivable are good as gold, you better look real hard at your operation. The increasing competition which is springing up and the constantly increasing cost of labor will require you to start planning now for computerization of much of your operation. If you don't, you'll feel the competitive pinch and you'll be able to see it on your profit-and-loss statement.

Uses of the On-Line Computer Networks

IT'S AN OLD, OFT-TOLD STORY on Madison Avenue—usually over a third or fourth Martini in the Biltmore Bar. It's about this agency guy who had to get an important client some key demographic radio and TV spots across the country. But by the time the research department had all the inputs and the budget had been approved and the station reps contacted, the prime time slots the advertiser wanted were all taken or couldn't be definitely promised. Eventually, the client got teed off and went to another agency.

Maybe it didn't happen quite that way just yesterday or to someone you know, but the logistics and paperwork of racio and TV advertising have become so horrendous that today it's a minor miracle if a New York agency can get the time it wants for a client in a small market in the midwest. Oh, they can get it all righ:, provided everyone involved has lots and lots of t.me. But the advertising business just doesn't work that way; everything is last-minute rush and must-do, and the result is lost business for both the agency and the broadcaster.

Opening the communications lines

You'd think that in a modern, technologically advanced business like broadcasting it would be a simple matter to place and confirm the specific advertising time that a client wants. You'd think that the station reps would be Johnny-on-the-spot with open slots in hand, ready to sign. But even if they are, by the time the paperwork gets worked out, the slots may be taken by other advertisers, or the contract is tied up in the Post Office, or the tapes are lost at some other station before they can be bicycled . . . the list is almost endless, and it all spells out poor communications and logistics.

The computer may hold the key—not just any computer and not in-house mini-computers or batch processors. The on-line, real-time computer, in a centralized agency—not even seen by broadcast station personnel—may hold the ultimate answer to the logistics of ad sales and a host of other operational problems. But there have been computers before, you may say, and they still haven't solved the problem. True, but in each case the computer became more of a problem than a solution, and never did everything that everyone thought it could.

Imagine a situation where a station rep walks into an advertising agency, finds out what is wanted, and promises nothing! Instead he says, "Let's see what our availabilities are." He opens an attaché case on the account man's desk, uses the agency's phone to dial the computer center, puts the phone on a cradle in his portable attaché-case computer terminal. The attaché case prints out availabilities and answers queries. The agency man requests certain slots and says the order is final. The rep enters this information on the unit's keyboard and, moments later, the machine prints out a complete, confirmed contract!

Sound like science fiction? No more so than the Apollo Moon shots. It's here right now with a centralized computer system called Compu/Net. Actually, the rep with the attaché-case terminal is an extreme example of the system's capabilities, but just such a unit is offered as an extra option to the Compu/Net customer. Here's how it works.

On-line computers

Unlike past computer operations for broadcasters which would batch-process orders and availabilities overnight or over several nights, the Compu/Net System uses several powerful, on-line computers. When a query or an entry is made from a terminal, the computer is instantly involved and provides instant replies. This is made possible by the system's time-sharing techniques and the fact that such large-scale computers are used. Central to the system are such computers as Control Data 6000 series, Univac 1108s and IBM 360 and 370 series. They are tied together in a network and use CDC's nationwide computer communications network for instant access from any part of the country.

The participating broadcaster subscribes to this service on a monthly rental basis and can have extra terminals and special peripherals at small additional rental fees. Even though the user is sharing a computer simultaneously with possibly hundreds of other users, the system is so sophisticated that the user's information has better security than it would in his own office files. A special password system permits second- and third-level identification before the computer will release various levels of confidential material to anyone.

There is no limit to the number of computer terminals that a Compu/Net broadcast station user may have. Terminals include CRTs— cathode-ray-tube readouts with a typewriter keyboard attached— and can vary widely in size and price. With this system, the broadcaster makes no purchases or long-term commitments, and can cancel at any time with 30-days' notice.

Used with a single in-station terminal, the salesman, after making a sale, gives a handwritten order to the station's traffic manager. He in turn dials the computer and enters the order. He does this by typing the order on the terminal. The computer will query the traffic manager on pertinent information, and is answered in ordinary broadcast-oriented language. The computer checks each of the answers, then makes all the needed dollar calculations, including total cost per week, total contract cost, and total number of spots—both per week and for the entire contract order.

The computer then asks the traffic manager if its calculations agree with his. If they agree, the terminal automatically types out a six-part contract/time order. The contract can be printed on plain paper or standard AAAA contract forms with all the needed legal language on the back. Thus, the Compu/Net System becomes a total, single-document system.

With national orders, the same process can be handled from the national rep's sales office from a terminal located there, or from his attaché-case terminal right in the agency's office. In each case, the traffic manager, salesman, national rep sales office, department heads, and the agency/client each receive identical documents, printed out at the terminal.

Daily logs

The computer, as a result of the information entered, has all the material it needs to keep a daily log. When the traffic manager dials the computer and requests it, the computer prints out the log at the terminal. Any additional information pertinent to the log—late copy instructions, emergency presidential speeches, late-breaking news, special events, sports, and so forth—are entered in the computer by any designated station personnel, and all this is included in the daily log.

Once the computer has finished typing the log, the traffic manager can request a roster which gives a list of all clients appearing on the log that day—along with the number of spots and the precise time each spot was scheduled. The roster can be used by the sales department for clients who want this kind of specific data.

The traffic manager may also request a daily FCC report—designed specifically for the general manager and the program director. It provides a complete breakdown and analysis of each day, letting management keep a day-to-day check on station performance vs station commitments for the FCC. The report shows how many hours included 18 minutes or more of commercials, how many PSAs were run, and a breakdown of program material by various FCC type categories.

Forecasting and reports

The computer can also be queried on projected sales, itemized locally and nationally—on a daily and weekly basis for any period of time in the future. This kind of report, usually requested by general managers, provides an overview of the station's possible sold-out position. These forecasts show instantly what percentage of available time is sold for any given day or week in the future. On request, the computer will even provide reports in graph form—on the cathode-ray-tube display or from the hard-copy terminal.

The sales manager is another key man who can get special material from the computer. He can review the station's inventory and can see up-to-the-second projections of all business written for any month that interests him—itemized by individual local salesmen and national rep sales offices. He can see simulated billing summaries for any future month showing individual salesmen, account or agency, the number of spot announcements, and total billing for the period for each one. In seconds, the sales manager can see weak points in the station's selling efforts and can take corrective action immediately.

Once a day the accounting department can query the computer for posting. This process, which takes about an hour, updates the computer's memory and handles any discrepencies which happened in the previous day's log. After the posting procedure is finished, the terminal prints out, for accounting and for management, the report which shows actual sales month-to-date and year-to-date, compared with the previous year's same period. The report queries about pending make-goods and the computer "remembers" spots which had been missed on previous days. It will inquire daily about make-goods pending at the same time it provides total dollar value of pending make-goods.

Automatic billing

When that time of the month comes along, all the accounting department has to do is dial up the computer and request the billing. The computer has all the data it needs and will spew out completely detailed and accurate bills instantly. The billing can be done on a calendar month or broadcasting month basis. While the station's terminal can print out the bills, rather than tie it up for any period, the usual practice is to have the bills printed out at the computer site and then picked up by or delivered to the station.

Along with this billing, the general manager gets a complete analysis of the billing period, containing vital information on management decisions for programming, rate cards, and sales. The report provides individual hour-by-hour billing breakouts: units of advertising sold by the hour and by the day; revenue received for those same periods; average income per unit of advertising; and totals for each period. It also shows product and service types as part of a maximum of 48 categories.

Attaché case terminal

While the Compu/Net terminal in an attaché case may make for great salesmanship in an impressionable agency executive's office, it has even more potent uses. General managers, sales managers, and traffic directors find the portable terminal a godsend for weekend work at home, out-of-town sales trips and, of course, for those personal sales calls. The portable terminal will work with any telephone anywhere in the country and gives the user all of the computer's capabilities.

The sales manager, on a sales trip, can maintain up-to-date information on local and national sales made by the station in his absence, even after station personnel have gone home. The traffic manager, during hectic peak periods can work in his own home by taking the portable terminal with him. The vice president for a number of group-owned stations can, from anywhere in the country, print out the latest sales projections for any or all of the group's stations.

System costs

According to Compu/Net officials, the computer service can pay for itself in its first 90 days of operation by eliminating dollar losses through ordinary discrepancies. Current reports on sold-out situations let sales personnel pinpoint open slots and they can guide their sales efforts accordingly. Operational efficiency goes way up, further reducing station costs. Base price for the system runs about $600 per month, graded upwards for larger stations with more complex needs. The system works equally well and effectively for both radio and TV time.

Specially trained personnel install the equipment at the station and provide basic instruction for its use. Standard broadcast terminology is used throughout; after all, this is a broadcaster's system, and Compu/Net itself is staffed by ex-broadcasters.

Computer down-time is never a problem. In-station computers that need repairs can put the station's bookkeeping out of business for days or weeks. With the Compu/Net System, if a computer should fail the network diverts its users into other computer centers in the network, with little time loss. The advantages of such an on-line system, as opposed to batch-processing, should be apparent. There have been such batch systems used in broadcasting for the past 15 years, but none of them has been notably successful.

Compu Net has been operational for three years now, and numbers large multi-station companies and network flagships among its top customers. Formats served by the system include good music, rock-and-roll, sports, all-news, and MOR—along with all the variations in between.

Research programs

In May, Compu Net signed a contract with ARB to put new research programs on-line through the system network. This research is an added feature of the network, and the information is available to subscribing stations. Thus, one more powerful sales tool is at the broadcasters' disposal.

This swift transfer of information from agency to national sales rep to the station and back again can completely eliminate the paperwork blizzard that is the broadcast industry's biggest stumbling block today. Presumably it will free up the broadcaster to direct his time and energy to more creative (and sales-producing) areas. By eliminating scheduling and inventory problems, and by forecasting accurately into the future, more station personnel will be able to find the time for those programs they've been meaning to start or plan. It may also be a major factor in helping the broadcaster along the road to offering employees a four-day work week!

Rates and the Rate Card

Joseph D. Coons

At one time or another every commercial broadcaster is faced with a variety of decisions that affect the pricing of his time—his rates. He then moves mentally from the world of decisions based upon tangible data to the world of decisions based upon psychology, ethics, superstition, precedent, and experience. As a station manager, I have gone through such times, and have come to some conclusions that may add new life to some old debates. Reviewing our sales progress, we feel our rate and pricing policies have played a major role in our growth—adding more than 60% to our sales in less than five years. If you feel price is important in your sales, some of our philosophies may help you.

Questions about rates fall into several categories: (1) How many rate cards should there be? (2) What should the cards look like? (3) What discounts should be offered? (4) How many "classes" of time should there be? (5) How many different spot lengths should be offered? (6) What about "Special Rates?" (7) How should rate changes be handled?

Most managers faced with the problem of answering these questions seem to follow either of two paths: They play a hunch, depending on intuition to make the right decision; or, they look up data gathered by NAB, RAB, etc., or SRDS, and see what the other guy is doing. The first course presupposes the manager is right, and the second assumes the other guy is right. But any manager worth his salt knows he can reach the best decisions only after consulting all the other people involved.

We have never made decisions regarding rates without holding meetings with our salesmen, confiding in our most helpful and loyal customers, conferring with our reps, and discussing proposed changes with our community financial prophet, our banker. The resulting comments have often startled us.

How Many Cards?

The old local-vs-national rate controversy is ever present. As for our own experience, we have received may calls from agencies using the old dodge, "This is a local buy, we just set it up." And from our reps, perhaps two out of three memos in the past, emphasized quoting the right rate — the one the rep quoted. These situations were unsettling enough, coupled with the Commission's concern about double billing and other double-rate practices, but there were still other factors to be considered: What of the 15% agency commission? Could we cut our revenues for regional and national sales by 15%? How about the rep's commission?

Perhaps the final blow came in 1961 when an auto firm, well-known for "tough" buying practices, issued the ultimatum: no local rate, no national business. Although this encouraged our subsequent decision to abandon a national card, there were many other arguments in favor of this decision.

The first point in favor of a single rate is elimination of rate-confusion, rate jumping, and double billing. It's amazing how easy it is to say, "Yes, agency, that's our rate, the local rate, the only rate. No one pays less than that, so you must pay it, too." It's a lot easier than trying to explain to a local beer distributor why he must pay national rates through the agency.

> The American Association of Advertising Agencies, 200 Park Ave., N.Y., publishes a standard rate card layout. They will send you a sample card and description of the layout. There are advantages to following a standard form. Once your printer has set up type for your card, he can produce subsequent issues at a lower cost than the original, and by using a different color with the same design, it will be more easily recognized. Your card will maintain a character of its own, and consistency of design will allow you to reissue a card which will be familiar to those who work with it.

Of course, we're getting 15% less for the time when the order comes through the agency. Does the agency earn it? We look at it this way: The agency prepares the copy (otherwise the station must); the agency offers assurance of prompt payment, or at least a record of payment to rely upon (which the station does not always have with non-agency customers); the agency sells the advertising (which is otherwise the station's job); and finally, the agency understands how to buy station time with a minimum of confusion and for maximum benefit (which the station must do for local customers).

Each of these jobs are no longer the station's. Are they worth 15% of the bill? We say *yes*. Agency orders are, we believe, 15% less expensive for us to handle. We see no reason not to subcontract the work for 15% of gross.

Of course, there's still the rep's commission — which cuts out another 15%. But on local sales, we give a 15% commission to our salesmen, so it's all the same. We never think of our rep in any way except as a salesman who calls on out-of-the-area customers. He earns his money; in fact, if we were to replace him, we could not call on his customers for the 15% he gets. We think that 70% of national time, net, is fair. All we have to do is *run* the commercials —no writing, no selling, no talent, no production—just run them. I wish all accounts were like that!

Frequency Discounts

Setting up a discount pattern and the rates for frequency discounts becomes a matter each station must consider on its own. Factors which influence discount rates are:

1. The revenue goals of the station.
2. The current rates being charged.
3. Forestalling use of short spots for economy purposes only; i.e., making it attractive to use minutes rather than thirties or twenties.
4. Making prices and discounts

W O H I 1 4 9 0

Measured .5 MV/M Daytime Contour

Drawn From F.C.C. Performance Proof

W O H I

— 1949 —

P O Box 760
East Liverpool, Ohio
Code 216-385-1490

"where advertisers meet ideas"

Rate Card #10
Effective Jan. 1, 1965
A Single Rate Station

1—PERSONNEL

Joseph D. Coons, General Manager

2—REPRESENTATIVES

Penn State Representatives, Inc., & Ohio Stations Representatives, Inc.,
Regional Representatives

Cront Webb & Company,
National Representatives

3—MAILING INSTRUCTIONS AND CLOSING TIMES

Mail to Box 760, East Liverpool, Ohio. Closing 12 hours prior to broadcast

4—FACILITIES

a - Power - AM - 500 watts Day
250 watts Night

b - Frequency - AM - 1490 KC

c - Hours - 6 00 A.M. - Midnight Mon.-Sat.
7 45 A.M. - Midnight Sunday
Daylight Savings Time Used

d - Transmitter - WOHI View, Shadyside Avenue, East Liverpool, Ohio

5—COMMISSIONS AND DISCOUNTS

a - 15% agency commission on time charges to recognized agencies.

b - 2% discount for cash - ten days, Net 30, end of month billing.

6—RATE POLICIES

a - Rate must be earned within one year from date of first announcement.

b - Advertisers will receive rate protection for 60 days following ending date of schedule or time of increase

7—RATES - ANNOUNCEMENTS

Class A

6:30 A M - 6.29 P.M., Mon - Fri

	Min.	30 Sec.	20 Sec.
1 time	5 00	2 75	2 00
20 times	4 70	x x x	x x x
40 "	4 55	2 60	x x x
60 "	4 45	2 55	1 90
80 "	4 35	2 50	1 85
100 "	4 20	2 40	1 80
200 "	3 70	2 35	1 75
300 "	3 20	2.10	1 70
400 "	2 75	1 80	1 50
500 "	2 60	1 55	1 30
1000 "	2 50	1.45	1 10

6—RATE POLICIES
(Continued)

c - Advertisers who earn new discount rates will receive rebates

7—RATES - ANNOUNCEMENTS
(Continued)

Class B

6 00 - 6 29 A M., 6 30 P M - Midnight
Mon - Fri.

S O - Midnight, Saturday & Sunday

	Min.	30 Sec.	20 Sec.
1 time	3 70	2 05	1 50
20 times	3 50	x x x	x x x
40 "	3 40	1 95	x x x
60 "	3 30	1 90	1 45
80 "	3 20	1 85	1 40
100 "	3 15	1 80	1 35
200 "	2 75	1 70	1 30
300 "	2 40	1 55	1 25
400 "	2 05	1 35	1 10
500 "	1 95	1 15	1 00
1000 "	1 85	1 05	.85

8—RATES - PACKAGE PLANS

A - B COMBINATION, One Spot

Each Class of Time, Same Day

One combination counts two times

	Min.	30 Sec.	20 Sec.
2 times	7.75	4.35	3 20
20 "	7 35	x x x	x x x
40 "	7.15	4.15	x x x
60 "	6 95	4.00	3 05
80 "	6 75	3 90	2.95
100 "	6 55	3 80	2 85
200 "	5 80	3.70	2.75
300 "	5 00	3 25	2.70
400 "	4.25	2 85	2 40
500 "	3 95	2 40	2.10
1000 "	3 85	2 30	1 75

8—RATES - PACKAGE PLANS
(Continued)

"Seven for Six" Plan

a - Seven run of schedule twenty-second spots per week, $6 00 per week.

b - One year, Non-concellable contract

c - Spots ordered under the "Seven for Six" plan cannot be combined for discount purposes

d - Station-supplied copy limited to one change per month.

10—RATES - PROGRAMS & NEWS

News and Program Rates on request.

11—GENERAL

a - Sports - WOHI carries Cleveland Browns, High School Sports, Etc Contact Sales Manager.

b - Contracts - One year from Date of First announcement AAAA Form Accepted

c - Copy and Length - WOHI conforms to the NAB Code

d - Affidavits - On Request Only.

Standard Form of Rate Card recommended by the American Association of Advertising Agencies, Incorporated

W O H I
East Liverpool, Ohio

RATE CARD #10 EFFECTIVE JANUARY 1, 1965

NEWS	20x	40x	60x	80x	100x	200x	300x	400x	500x	BASE
5 min.	6.55	8.65	8.40	8.20	7.95	7.00	6.10	5.15	4.90	9.35
10 min.	12.55	12.20	11.90	11.55	11.20	9.90	8.60	7.25	6.95	13.20
15 min.	16.70	16.30	15.85	15.40	14.30	13.20	11.45	9.70	9.25	17.60

Spots in newscasts are billed at the regular spot earned rate plus 25%. Above prices include commercial continuity of 1:30, 2:10, and 3:00 in 5, 10, and 15 minute programs.

PROGRAMS	20x	40x	60x	80x	100x	200x	300x	400x	500x	BASE
2 Min.	5.45	5.30	5.15	5.00	4.85	4.20	3.72	3.15	3.00	5.70
3 Min.	6.05	5.90	5.75	5.60	5.40	4.80	4.15	3.50	3.35	6.40
4 Min.	6.70	6.50	6.34	6.20	6.00	5.30	4.60	3.85	3.70	7.05
5 Min.	7.30	7.15	6.95	6.75	6.55	5.80	5.00	4.25	4.05	7.70
10 Min.	11.00	10.70	10.40	10.10	9.80	8.65	7.50	6.35	6.05	11.55
15 Min.	14.65	14.25	13.85	13.50	12.10	11.55	10.00	8.45	8.10	15.40
30 Min.	26.15	25.45	24.50	24.05	23.40	20.65	17.90	15.15	14.30	27.50
60 Min.	41.80	40.70	39.60	38.50	37.40	33.00				44.00

Commercial Limits: 2 mins. pgm. : 40" ; 3 mins. pgm. : 60" ; 4 mins. pgm. : 1:15 ; 5 mins. pgm: 1:30 ; 10 mins. pgm: 2:10 ; 15 mins. pgm: 3 mins ; 30 mins. pgm. : 4:15 ; 60 mins. pgm. : 7 mins.

Times shown all programs 5 minutes and up less 30 seconds for station identification.

SPORTS Football	1x	3x	5x	9x	10x	18x
Local ¼	40.00		35.00		30.00	
Local ½	75.00		65.00		57.50	
Browns ¼	20.00				15.00	
Browns ½	37.50				29.00	
Warmups) Wrapups)	17.50	17.00	16.50	16.00	15.00	(Both Basketball & Football)

Basketball

Local ¼	30.00	27.50	25.00	22.50
Local ½	55.00	50.00	45.00	40.00

Engineering Fees: Programs up one hour: $5.00 Other rates on request.

Notre Dame Football: ¼:$15.00 ½: 27.50 No discounts.

WOHI IS A SINGLE RATE CARD STATION.

8 -- RATES -- PACKAGE PLAN -- (Continued)
Effective January 1, 1965

In order to better serve advertisers who are in the habit of purchasing several weeks a year of saturated advertising rather than continuing programs throughout a contract year, WOHI offers the following weekly package plan:

NUMBER OF SPOTS IN THE PACKAGE WEEK

	Min.	30 Sec.	20 Sec.
10 times	-- 42.00	24.00	18.00
15 "	-- 55.50	35.25	26.25
20 "	-- 64.00	42.00	34.00
30 "	-- 82.50	54.00	45.00
40 "	-- 104.00	62.00	52.00
50 "	-- 125.00	72.50	55.00

PACKAGE RATES CAN NOT BE COMBINED WITH CONTRACT SPOTS TO EARN CONTRACT RATES ....

Rate cards, and rates, are a vital part of successful station management. Used constructively and prepared carefully, they will do much to make management easier, public relations better, and efficiency greater. WOHI is a single rate card station; the same rates apply to both national and local spots. Spot announcement and program rate cards are simple, easy-to-understand.

fair to the buyer, without excessively steep or slight discounts.

Each of these factors should be kept in mind as each rate is fixed; in addition, rates should be mathematically simple, rounded off at easily-computed figures. This standardization of figures will save a lot of computation time while the card is in effect. Raising all rates by the same percentage factor makes an increase easier to define to clients. "It's a 10% increase" is much easier to explain than different time and spot increases.

Classes of Rates

The other day I was looking at a card prepared by a major-market high power station. It was complicated by time classifications and bonus plans, concocted, no doubt, with one of two goals—getting more money from the advertiser, or getting the advertiser to use less desirable time. Our "Combination Plan," is designed to give more time at a better rate, rather than get more revenue from our time. The result is better distribution of business around the clock, but little increase in revenue. Unless you are the clear channel station in a top market, you are competing for business. and the best way to compete is to *give the client what he wants at a price that is fair to all.* A bonus plan, for example, offers the client something he doesn't want, and alludes that your time isn't worth the rate-card price. You become a wheeler-and-dealer, instead of a solid seller, just like a car salesman who throws in a radio. (Let's keep the auto dealers throwing in radios, but not throw in our time!)

With our give-him-what-he-wants credo, we use two classes of time—*A* for all daytime, *B* for all nighttime. When we are asked for avails, we guarantee no more than one-half the schedule in traffic times. When we can, we give more; especially if the client can get something out of traffic times. Our salesmen, however, keep selling non-traffic hours because of the specialized audience.

Lengths of Spots

In most markets there are a few huge clients, more large clients, even more middle-sized clients, and a great number of small clients. The rate card, and station policy on announcement length, must be designed to give all potential accounts access to the airwaves at prices they can afford.

We do this by offering three spot lengths—60, 30, and 20 seconds. But, unlike many major-market stations, our price ratios of 100%, 55%, and 40% do not vary in direct proportion to spot length. Thus, the small advertiser can afford to buy a 20 from us at our rate. That's what we feel a 20 is for, basically—a small advertiser. Most big accounts would rather have a 60 and will pay the price when our representative emphasizes the extra time for jingles, etc. If he wants a dense schedule, we use 30's and 60's and give him frequency, always trying to balance spot length to desired frequency, budget limits, and copy demands.

Some stations don't sell anything less than a minute. But wouldn't any manager rather sell two 30's for 110% of the minute rate, or three 20's for 120% of the minute rate? If a client is sold on radio. he will buy not what is cheapest, but what will do the job best.

Of course, all this is a waste of time if spot length is not controlled—running a 30 that has been recorded 36″ long amounts to a 20% rate cut. We say a 60 must be at least 58″, not over 61″; a 30 must be 28″, not over 31″; and a 20 must be 20″ or less. NO EXCEPTIONS! On agency copy that is long we simply inform the agency of the error, and make agreed upon cuts in continuity.

We have found that availability of shorter spots has increased our potential customers. We keep a customer in what we think is his category, and rates and discount schedules to some extent discourage cheaper schedules for the sake of saving money alone.

Special Rates

We have prepared a "program" rate card. It shows rates for news programs, as well as the varying lengths of "prepared" programs. The use of the word "prepared" here is important, for it allows us to surcharge the customer, if necessary, for announcing and engineering talent, line charges, mileage, etc. "Prepared" rates mean the cost of *time* and control room facilities alone, not preparation of program content. If we expend any effort on preparation, or in providing more than our regular staff announcer and engineer, we charge more.

The biggest advantage of a complete rate structure is the elimination of wheeling and dealing. We can always "promo" a show, schedule exceptionally good talent at our expense, or help to merchandise—but brother if a client wants time, the price is set. It's amazing what such a firm rate policy can do to help your sales . . . and your image.

Announcing a Rate Change

We've noticed that many stations announce a rate change as late as possible, sometimes only a day or two before the effective date. What reaction does this cause?

To a businessman in a stable, well-organized business—say a bank—it creates budget problems. It also makes a client wonder about the station's planning. "Why didn't I know of this sooner?" he may think.

Then, a few weeks after the new rates are announced, some customers, usually the ones who yelled the day the increase was announced, get their first hiked bill. They have just cooled off, and they get hot all over again.

The last time we raised rates, we did it differently. We announced the increase *six months* before it was to become effective, with a letter explaining why it was necessary for us and why it was worth it to clients. We got all the usual gripes, but everyone had six months grace to buy at the old rates. Budgets could be planned in at least half the cases. Our friends at the newspaper tried to capitalize on the increase, but their last rate hike increase was already in effect—ours had just been announced.

Then came the date of increase. We rubber-stamped all invoices that month "This invoice reflects rate increase announced July 1, 1964." Everyone knew about it, had stewed about it, and was still on the schedule. If they weren't ready, it wasn't because they hadn't known. We have over 300 good accounts. We lost *one* because of the increase, just one—a 10% across-the-board hike. ●

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