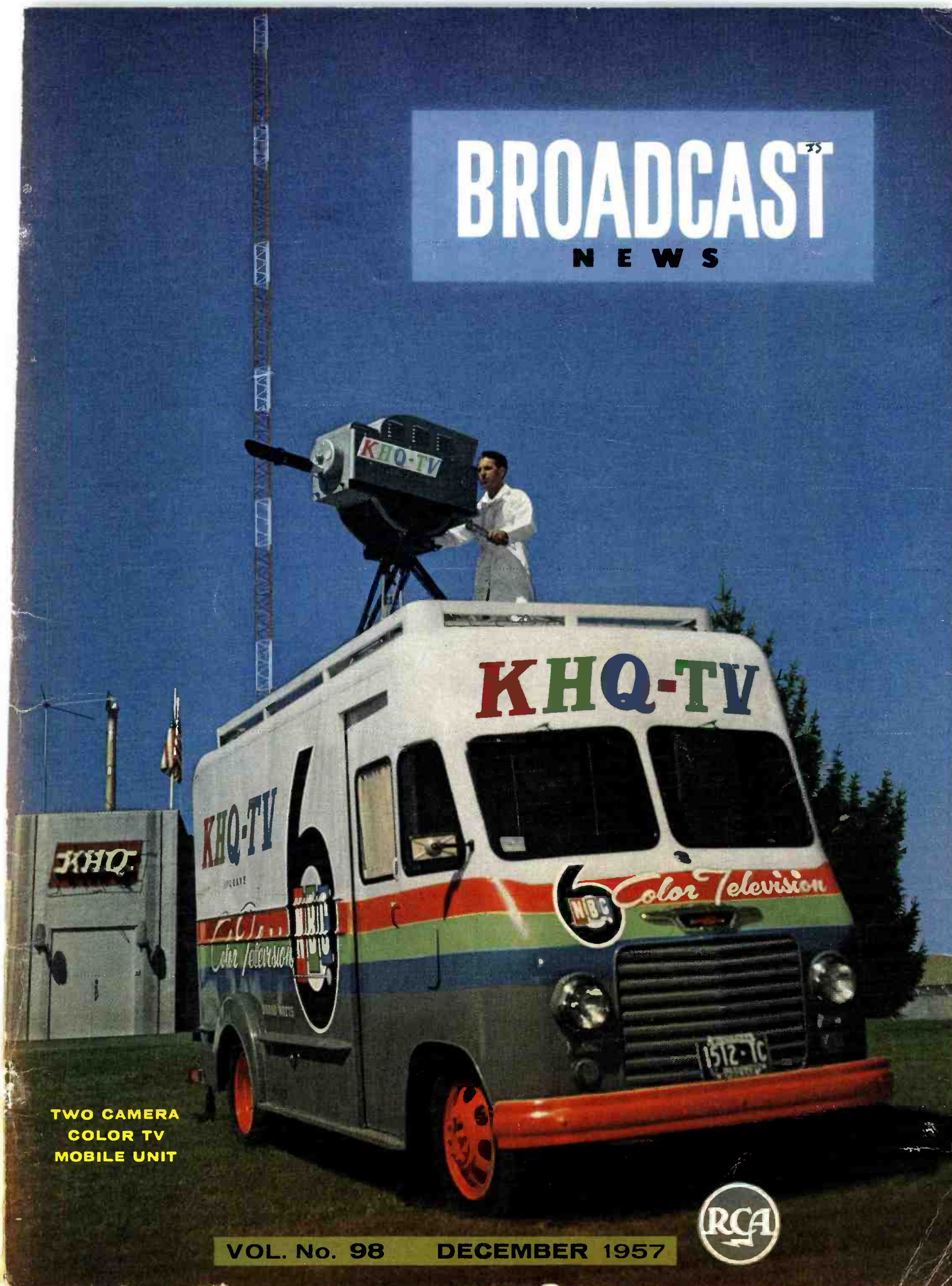
BROADCAST NEWS



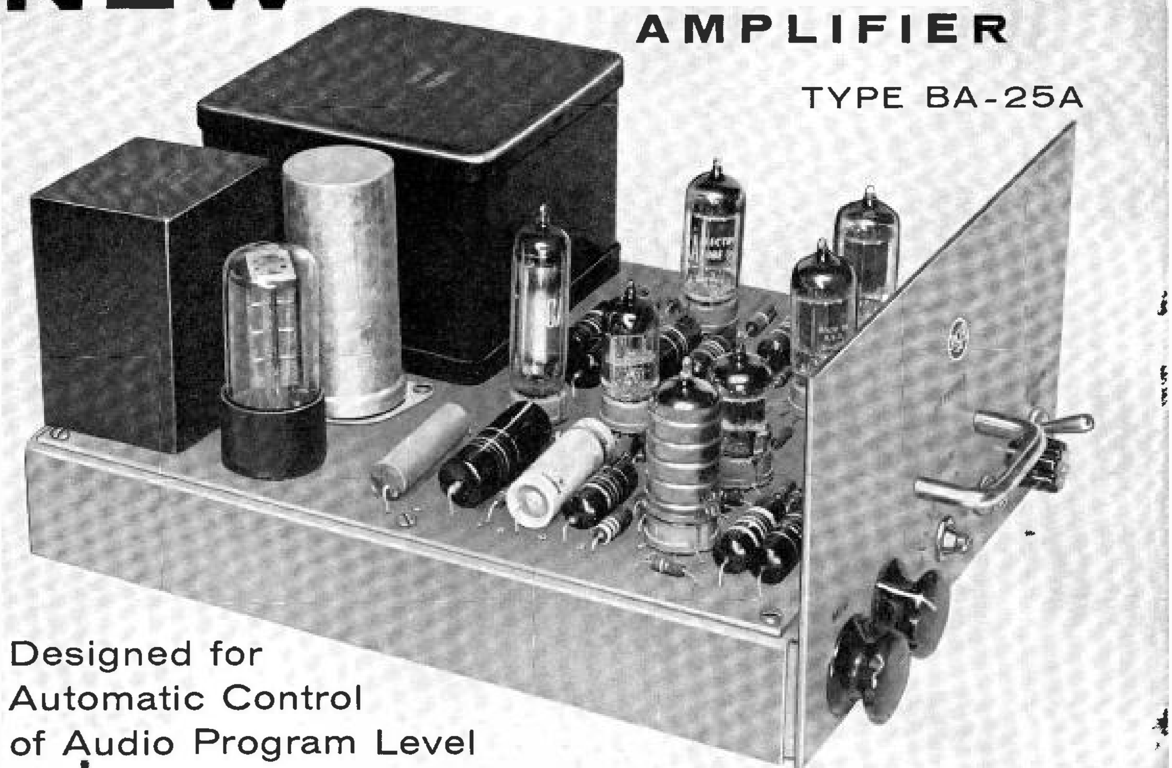
TWO CAMERA
COLOR TV
MOBILE UNIT

VOL. No. 98 DECEMBER 1957

RCA

NEW AGC PROGRAM AMPLIFIER

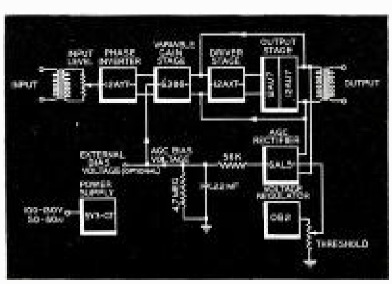
TYPE BA-25A



Designed for Automatic Control of Audio Program Level

Features:

- Small, compact, plug-in construction.
- Feedback circuits assure excellent frequency response—low harmonic distortion at any degree of gain reduction.
- Provides automatic fading or remote gain control.
- Self-contained power supply.
- Metering switch provides quick tube check.
- Convenient front panel controls.
- Stabilized bias voltage.



Now you can improve your station coverage. This new RCA Program Amplifier with automatic gain control can maintain a nearly constant average output level over wide variations of average input level, thereby assuring maximum performance of your limiting amplifier.

Now you can prepare for unattended AM programming system. The amplifier is also used in conjunction with an external bias source for remote gain control or automatic fading permitting remote audio operation.

Other uses include its application as a master gain control for program line, microwave input audio control, automatic fader control, or straight program amplifier without level control (by removing tube disabling the automatic level control circuit).

Premium performance and ease of operation will assure years of successful application.

Ask your RCA Broadcast Sales Representative for complete information. In Canada: write RCA VICTOR Company Limited, Montreal.

Tmk(s) ®

RADIO CORPORATION of AMERICA

BROADCAST AND TELEVISION EQUIPMENT

CAMDEN, N. J.

Vol. No. 98 | December, 1957

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CAMDEN, NEW JERSEY

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CONTENTS

A new standard of performance for color television systems... The **RCA TM-21** Color Monitor

This new color control monitor is a reference standard for evaluating the quality of color television pictures from any source. Providing the most precise and brilliant color picture available . . . this new monitor accurately reproduces the scene *as the camera sees it*.

QUALITY CONTROL OF COLOR PROGRAMMING—The TM-21 is used in Color Camera Chains, Switching Systems, Master Control and Transmitting Control for monitoring color picture quality. It is the basic instrument for checking registration, shading and deflection linearity . . . color fidelity of the entire TV system . . . chroma to monochrome ratio . . . color phase or hue adjustments.

BEST POSSIBLE COLOR—When used to display color pictures in clients' rooms and executive offices, the TM-21 lets the station put its "best color foot forward." Clients will be impressed by the bright, high definition picture.

COLOR ACCURACY AIDS PROGRAM PRODUCTION—Production departments can use the new monitor for accurate continuity control of color programming. Producers and directors will get a true color picture of what's happening on the set. Costume and background colors can be seen in proper relationship. Lighting can be accurately evaluated, production aided.

SIMPLIFIED MONITOR ALIGNMENT—Initial adjustment is extremely simple. Built-in test switch reduces set-up time to minutes. Screen grid selector switch provides quick viewing of primary colors.

LONG-TIME STABILITY—Once set up, monitor adjustments "hold." Extra stability has been designed into brightness, contrast, decoder, convergence, and linearity circuits.

Get maximum return from your color TV investment! Ask your RCA Broadcast and Television representative for further information on the new TM-21 Color Monitor. In Canada: Write RCA VICTOR Company Limited, Montreal.

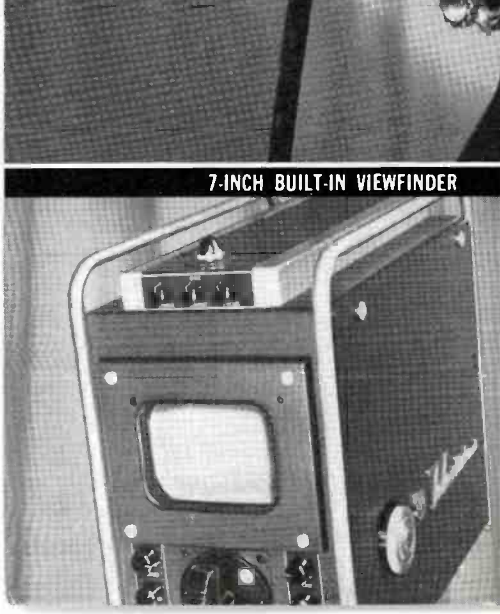
Check these additional technical features:

- Feedback techniques and precision components provide long-term stability.
- Automatic brightness tracking for color balance.
- Convergence circuits designed for rapid setup.
- DC restoration at black level, stabilized by feedback.
- Stabilized diode demodulators.
- All components and tubes easily accessible.
- Automatic wide-band operation during monochrome picture intervals.
- Stabilized black level shows effects of pedestal adjustments, aids close control of color in picture low-lights.

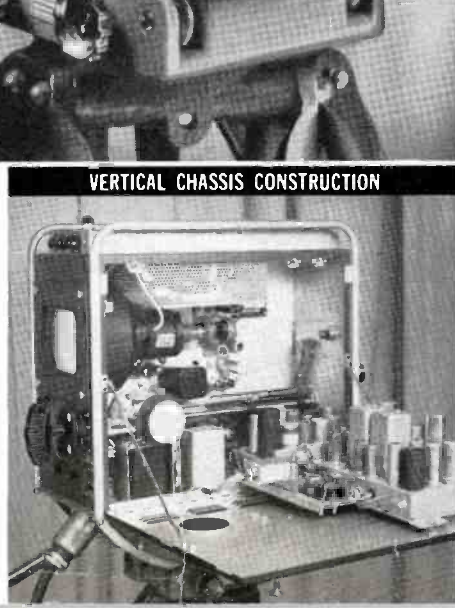
RCA Vidicon

TYPE TK-15 VIDICON CAMERA

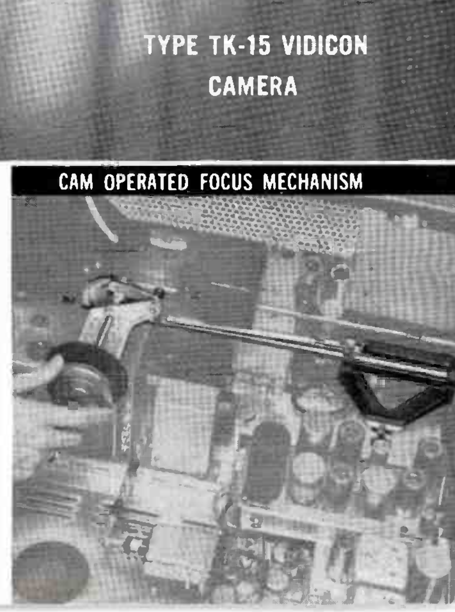
7-INCH BUILT-IN VIEWFINDER



VERTICAL CHASSIS CONSTRUCTION

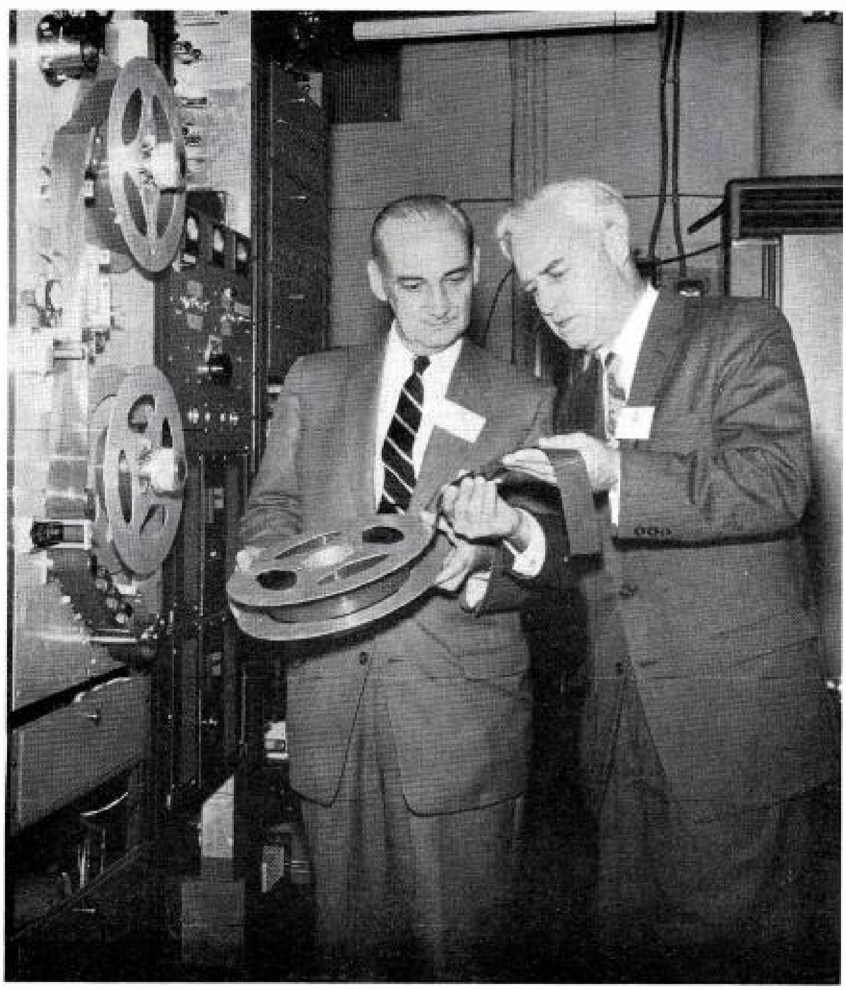


CAM OPERATED FOCUS MECHANISM



color VIDEO TAPE RECORDER

NEW EQUIPMENT CAN HANDLE BOTH MONOCHROME AND COLOR FOR ALL BROADCAST AND CLOSED-CIRCUIT TV REQUIREMENTS



Video tape recording equipment for both color and monochrome operation has been announced by the Broadcast and Television Equipment Department of RCA. The color tape recorder was introduced in demonstrations to the trade press, television editors and broadcasters. In each case, reports were very favorable, the picture quality and color fidelity of the taped program very closely rivaling live presentations.

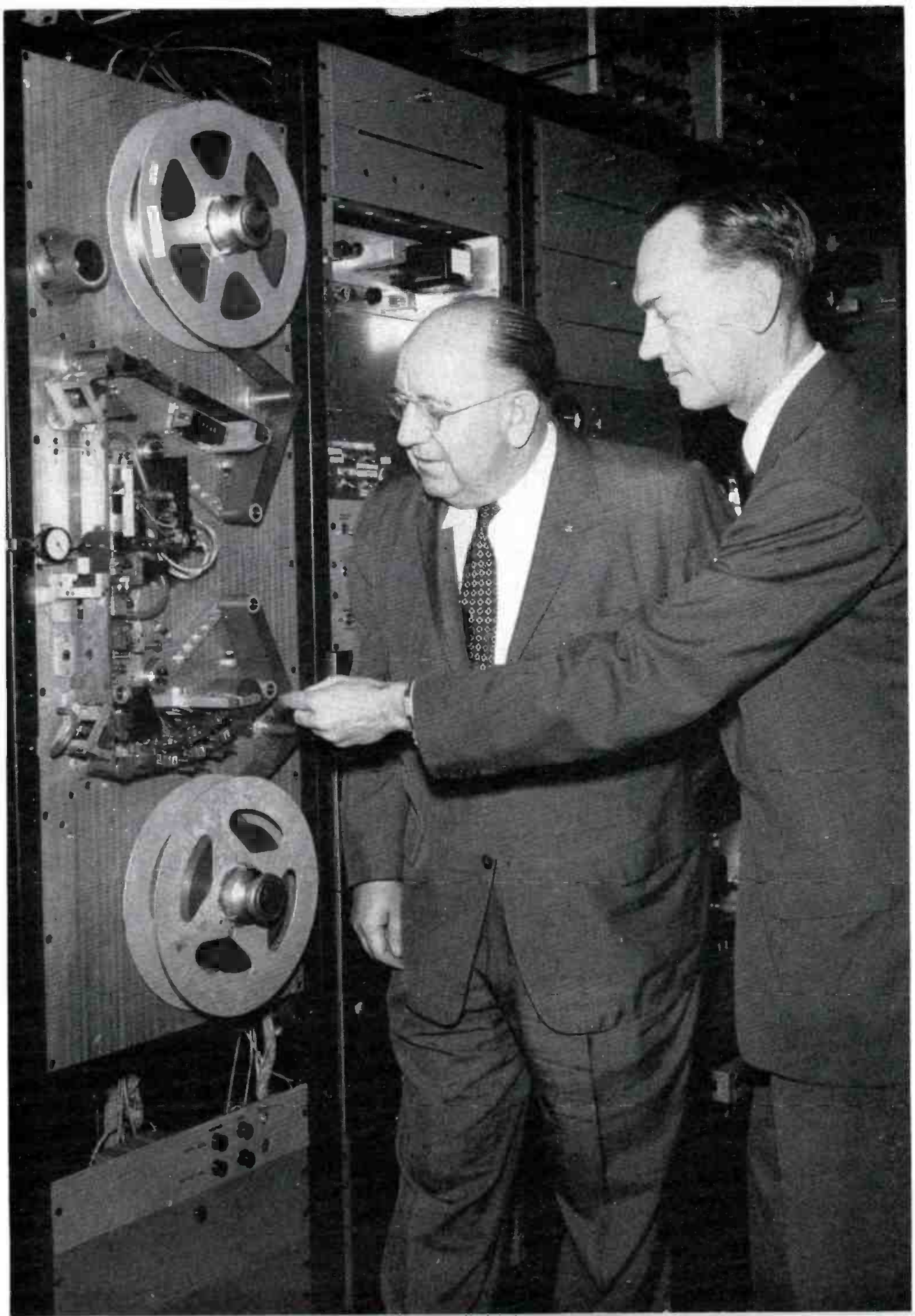
In New York City more than 30 representatives of the trade press and metropolitan newspapers viewed a special presentation in the RCA Exhibition Hall. The taped program originated in Camden and was sent via microwave to Philadelphia then via network cable to New York.

At its color studios in Burbank, California, NBC demonstrated to more than 100 television editors the kind of color pictures produced by the video tape recorder. Excerpts from some of the network's major shows, which had been recorded in Camden, were fed via network lines to color receivers at Burbank for the demonstration. Although these excerpts included portions of programs that origi-

FIG. 1. Tom Howard of WBTV, Charlotte, discusses color tape recorder operation with E. C. Tracy, Manager, Broadcast and Television Equipment Department. A pre-production equipment has been ordered by WBTV.

FIG. 2. Theodore A. Smith (right), Executive Vice-President, Industrial Electronic Products and Dr. George H. Brown, Chief Engineer of Industrial Electronics, examine the color tape recorder used in the demonstrations.

ANNOUNCED BY RCA



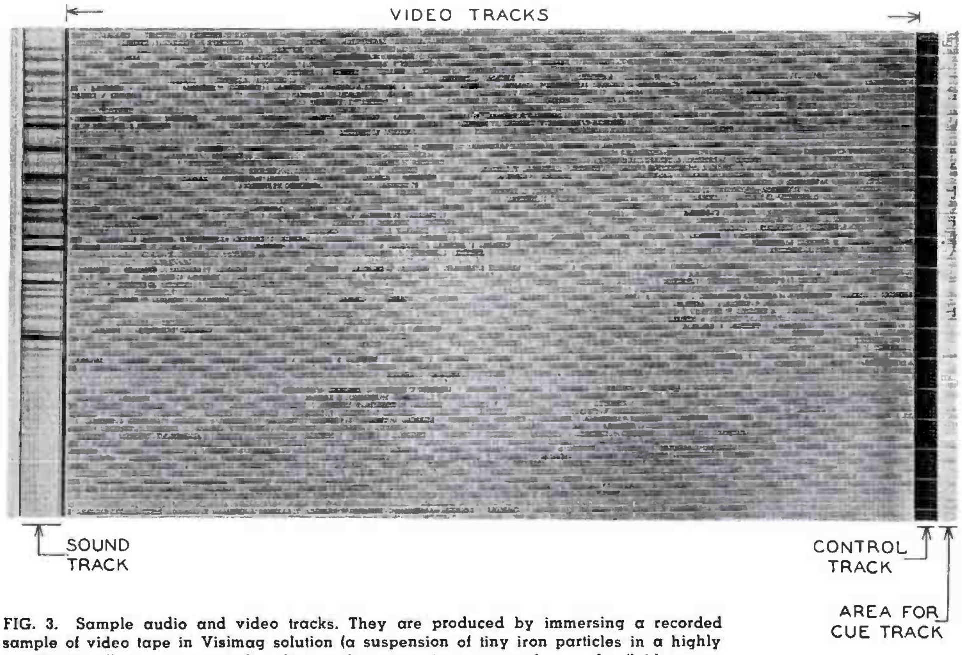


FIG. 3. Sample audio and video tracks. They are produced by immersing a recorded sample of video tape in Visimag solution (a suspension of tiny iron particles in a highly volatile liquid). The iron particles cling to the magnetic areas, and once the fluid evaporates, the magnetic pattern becomes visible. The pattern shown here was picked off the video tape onto a strip of transparent adhesive tape, then photographed and engraved.

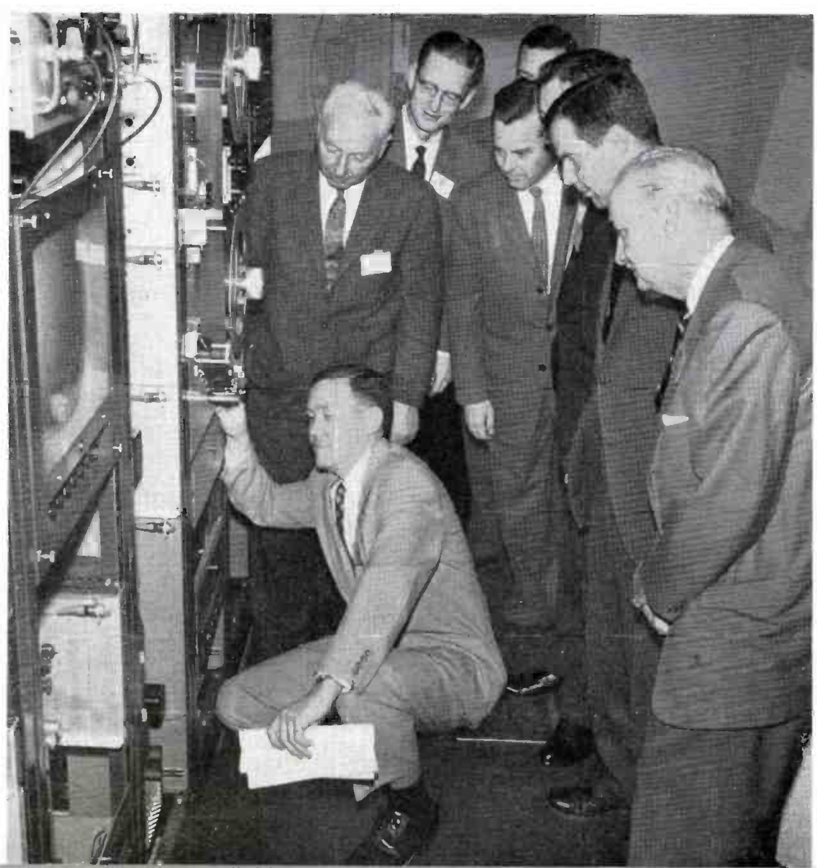


FIG. 4. RCA Project Engineer, Jerry Grever, explains to visiting broadcasters the operating principles of the tape transport panel of the recorder.

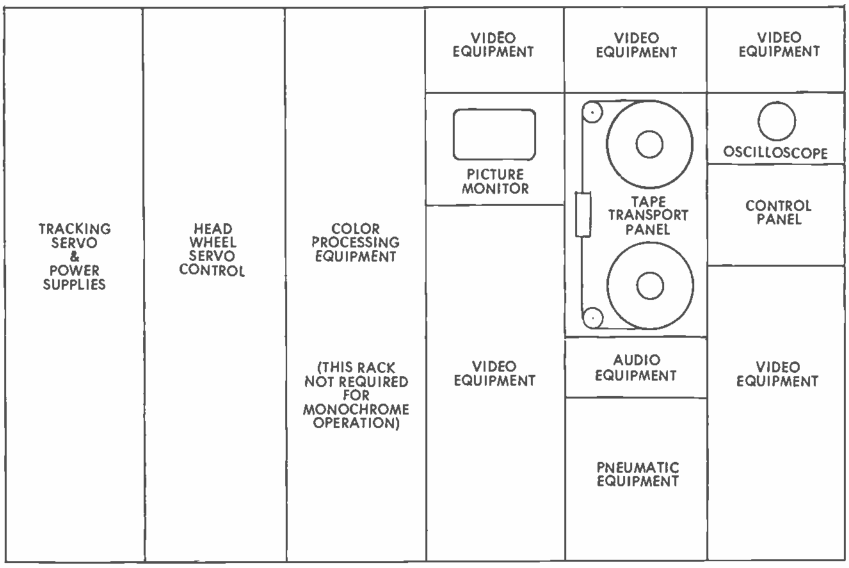


FIG. 5. Rack layout of the Color Video Tape Recorder. Only three racks (shown right) are required at the operating position. Remainder can be remotely located.

nated in Burbank and thus traveled 6,000 miles (from Burbank to Camden and back again), color reproduction excited favorable reactions. At this demonstration, Robert W. Sarnoff announced NBC's order for six pre-production equipments. Mr. Sarnoff said that video tape will open up a "new world for everyone concerned with network broadcasting."

Broadcasters who had the opportunity to visit Camden recently viewed a demonstration with considerable enthusiasm. Station WBTV, Charlotte, North Carolina, has ordered the first pre-production model for use by a TV station. Availability of the first production equipments is scheduled for December of 1958. Price on the color and monochrome equipment, Type TRT-1AC was announced at $63,000. The Type TRT-1A for monochrome only is priced at $49,500.

Tape Recorder Basics

The RCA Video Tape Recorder provides a means of recording and playing back either color or monochrome video signals simultaneously with program sound. It will reproduce both video and audio signals with quality and fidelity that rival closely that of the original program material.

The entire color video tape recorder is contained in six standard cabinet racks. (See Fig. 5.) Although designed specifically for color, it can handle monochrome as well as color. In addition, the equipment can be used for monochrome operation simply by eliminating one rack, containing color processing equipment. Conversely one could start with a monochrome system and advance to color at a later date.

A minimum of three racks of equipment is required at the recording location. The tape transport mechanism with recording and playback heads, supply and take-up reels is vertically mounted in the center. The local control panel, picture monitor and waveform display are located at eye level in the adjacent racks. Also included in the system is a remote control panel which permits handling of all basic operating functions from a remote location.

How it Works

The RCA Video Tape Recorder records both audio and video signals on a single magnetic tape in the form of magnetic patterns. For playback these patterns are, in turn, scanned and processed to reproduce the original signals.

The magnetic patterns on the tape are comprised of "tracks" which are registered as the tape and magnetic recording heads move with respect to each other. The tracks containing picture information are transverse to the tape while the sound track is recorded along one edge. (See Fig. 3.) Along the opposite edge of the tape art two narrow tracks, one for a control signal and the other for an audio cuing signal. The control signal is used in playback to assure that the magnetic heads properly trace the transverse recorded tracks. The audio cuing signal is for the use of recording operators to relay special operative instructions for the information of personnel on playback.

The RCA Video Tape Recorder uses a magnetic tape two inches wide and 0.0015 inches thick. In operation, the tape speed is 15 inches per second. The signal representing one TV frame occupies 0.5 inches of tape length. A 64-minute supply of tape is contained on a standard NARTB 12½-inch reel.

Recording Function

The sequence of functions which take place along the tape path are shown in Fig. 6. Shortly after leaving the supply reel, the tape passes over a master erase head where all previous magnetization is erased. It next passes by a high-speed, rotating wheel which contains four magnetic recording heads equally spaced about its periphery. The rotational axis of the wheel is parallel to the tape; thus, the recording heads slide across the tape in successive "swipes" leaving transversely recorded tracks. The magnetic pattern recorded is a frequency modulated wave having a center frequency of approximately 5.5. megacycles. The instantaneous frequency is determined by the instantaneous amplitude of the input video signal. The speed of the recording head wheel is held constant by a servo control which utilizes a reference signal derived from the station sync generator.

Meanwhile, a short distance along the tape in the direction of the take-up reel, another recording head records a 240 CPS control signal on a longitudinal track along the edge of the tape nearest the tape transport panel. The control signal frequency

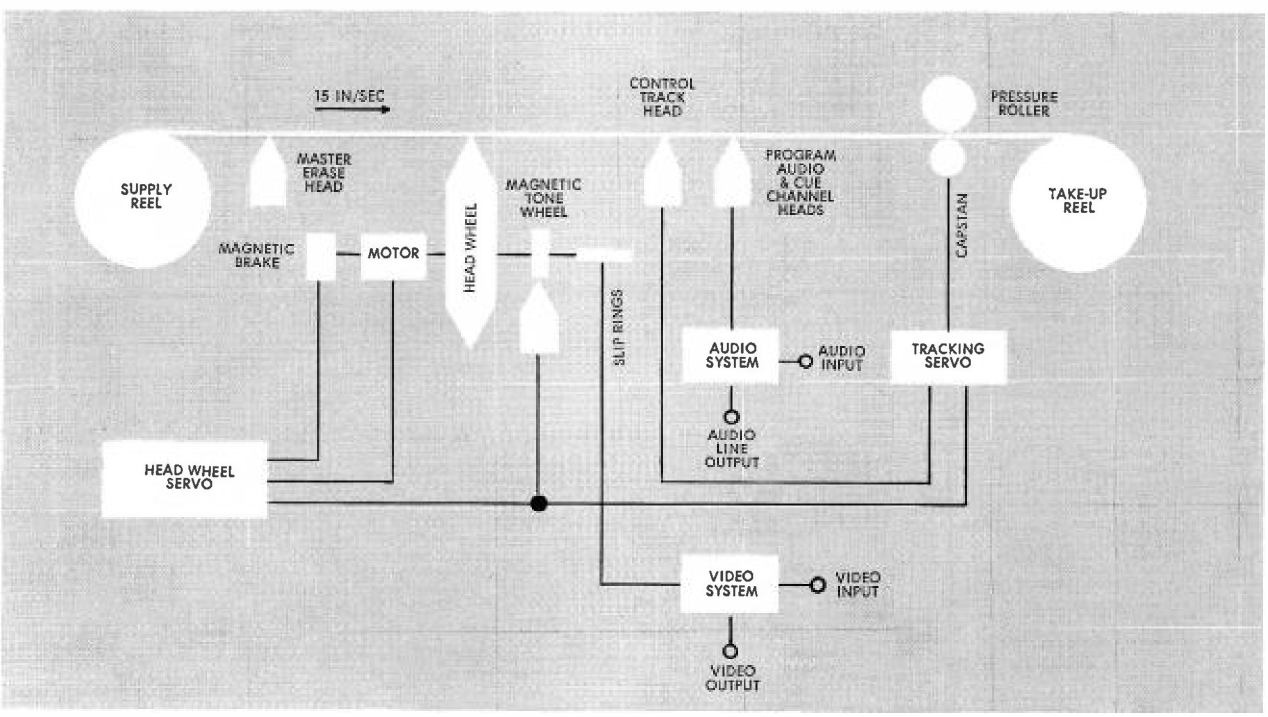


FIG. 6. Simplified diagram of the Video Tape Recorder outlining the functions of the tape transport panel.

corresponds to the speed of rotation of the head wheel.

Still further along the tape path are located a group of audio magnetic heads for the program sound and cue channels. The cue track is recorded adjacent to the control track while the program sound is placed on a track along the opposite edge of the tape. The first pair of heads are erase heads located near the edges of the tape to erase paths for the recording of program sound and cue. The next pair of heads are the program sound and cue channel record heads. A third sound head is provided for simultaneous playback to monitor the program sound channel during recording.

Next along the path is the tape capstan which provides the prime moving force for the longitudinal motion of the tape. The tape is friction coupled to the capstan by means of a pressure roller. During recording the capstan speed is stabilized by a method of control which utilizes a reference signal from the station sync generator. Once past the capstan, the tape passes over a tape guide and then is wound on the take-up reel.

Playback Function

After rewinding, the tape is ready for immediate playback. The tape path for playback is the same as described for recording. See Fig. 6. However, since reproduction is essentially the inverse process of recording, various functions will differ. In playback, the erase heads are not energized. Protection against accidental erasure is provided by electrically interlocking the record and the playback control switches. The control track signal is utilized to lock the motions of the high speed head wheel and the capstan in synchronism to assure tracking of the RF magnetic heads on the transverse recorded tracks. The program sound recording heads are utilized in playback to assure exact lip sync in the resulting program.

Each transverse recorded track contains the video signal for an average of 16.4 TV lines. The signals from the four heads on the rotating head wheel are fed by means of slip rings to four preamplifiers. An electronic switching system selects the successive groups of preamplifier output signals to reconstitute the recorded signal. In the case of color operation, additional electronic processing of the color TV signal is accomplished to re-establish the sub-carrier burst to chrominance signal phase relationship that existed in the recorded color signal.

Fulfills Need

Those who have seen the RCA Color Video Tape Recorder in action have been very favorably impressed with the results. Without doubt, this is the ideal means for handling the recording and reproduction of TV signals for both monochrome and color. It fills a long standing need of the television industry.

Editor's Note: For further information write to RCA, Broadcast Sales, Building 15-2, Camden, New Jersey. Copies of the printed literature illustrated on these pages are available and will be sent gratis.

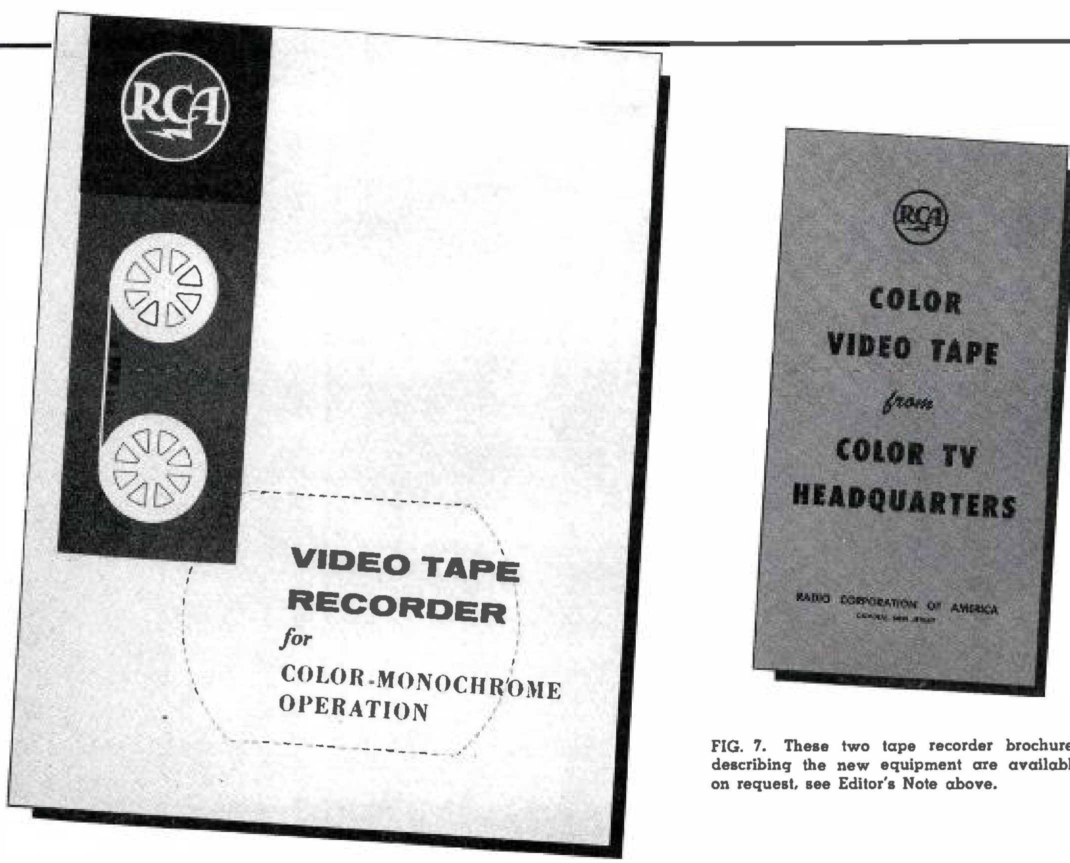


FIG. 7. These two tape recorder brochures describing the new equipment are available on request, see Editor's Note above.

KHQ-TV COLORCASTS LILAC ARMED FORCES

FIRST IN SPOKANE
KHQ-6 TV
NBC
FIRST WITH FULL COLOR

It was a wet day. And although it hadn't rained on Spokane's annual parade for 18 years, the outlook was not good. Rain came down steadily as the crew of the KHQ-TV color remote unit struggled with cameras and cables early in the morning of May 18, 1957. Exactly one year ago, KHQ had first colorcast this famous Lilac Festival and Armed Forces Parade. Then the day was bright and clear. But today they worked out in the open, on top of the remote truck and on the flat bed of a rented truck, trying to warm up and line up two color cameras—in the rain.

They had not expected wet weather. Hastily, Charlie Lohnes, Operations Manager for KHQ, procured some plastic sheeting to cover cameras and crew. Then he sought some frames to give the plastic sheeting a tent effect. Also, he wanted to get raincoats for the crew—however, it was too early, only 6:30 A.M., and stores were not yet open.

Some canvas covers were finally gotten. The cooling fan, tables, other accessories were covered. On the flat-bed truck a lean-to kind of tent with canvas roof was constructed at the back of the driver's cab. Here a table, chair, microphone and monitor were set up to accommodate the announcer. (An RCA 8-inch personal TV set made a convenient monitor—taking its picture off air.) Directly in front of the announcer, on the rear of the flat bed, was a TK-41 color camera mounted on a studio pedestal—shrouded in plastic sheeting.

The other TK-41 color camera was mounted on a tripod, which was fastened to flooring on the roof of the remote unit. It was stationed at the front end of the remote unit looking squarely into the line of march. Behind the camera, a telescoping mast supported a TV antenna some 25 feet above street level. This was off-air pickup for director, located inside the remote unit.

By 6:30 A.M. the power cable had been run to the basement of the nearby Press Club to tap a commercial 110-volt, 3-wire grounded neutral source. Video cable and a twisted audio pair made connections to a previously installed cable.

FIG. 1. On the morning of the parade the day was wet, nevertheless, KHQ-TV put the show on the air.

FESTIVAL AND PARADE — IN THE RAIN

This ran overhead to the Hotel Davenport, directly across the street, and thence some 300 feet to the hotel roof. Here a Type TVM-1A Portable Microwave provided a link with the transmitter, some five miles distant. (Another dish is permanently installed at the 600-foot level of the antenna tower.) By 8:00 A.M. the video link was checked out, using color bars. Then Dee Waymire, Chief Engineer of KHQ, moved hurriedly over to the radio remote car to supervise running of leads for the AM pickup.

Eight-thirty A.M. Cameras were now warmed up and ready for alignment. But where could the test pattern be placed? Ordinarily it was placed on an easel in front of camera, but it was still raining—not heavily, of course, but water *was* coming down. An easy method was soon found for camera No. 2 (the one on the flat bed). Since this truck was in back of, and its camera pointed at the rear of the mobile unit it was only necessary to open the back doors, put the test pattern inside and focus upon it.

Nine A.M. Now the problem was: How to line up camera No. 1? It was on the roof of the remote unit. Finally, someone suggested a nearby protected doorway for the test pattern. This was a logical solution. One crew member held the test pattern and, using a 17-inch lens, alignment was satisfactorily completed by 9:30 A.M.

Now announcers, directors and producers were on hand. Crowds of people were beginning to gather. The full crew took places inside the remote unit: Two men at camera controls, one at switching, one at audio control and the director at his position overlooking the entire operation. (This mobile unit consists of a small Chevrolet truck of the type normally used by bakers, milkmen, etc., and was adapted by KHQ engineers to hold all the necessary equipment for two TK-41 color camera chain in a way to be described later.) Dee Waymire had all technical operation in satisfactory shape and Charlie Lohnes had distributed raincoats to all the boys who were out in the open.

FIG. 2. KHQ-TV Operations Manager, Charlie Lohnes, had the presence of mind to procure plastic sheeting as rain threatened the parade.

FIG. 3. KHQ also picked up the parade for its radio audience using its remote AM unit as base of operation.

At this time, the police began to close off traffic. Then the flat-bed truck was carefully moved into position in the center of the street. Alongside it, but at the curb was the mobile unit. A distance of 12 feet separated the two. They were located at the intersection of First Avenue and Lincoln Street. The parade came directly into the cameras and then executed a right turn directly in front of them.

The producer and announcer took their places in the lean-to tent on the flat bed. The 8-inch monitor was giving a good off-air picture. Audio lines were okay, too. KHQ was all set. Script with full description of parade units was before the announcer. This was a combined Lilac Festival and Armed Forces Day parade. That's the way it happens in Spokane. And that's the reason that bands and floats from all over the Inland Empire, Washington, Idaho, Oregon, and as far off as Alaska come to this annual event. It's the climax of a full week's program of art displays, shows, and dances held in Spokane.

Ten A.M. This is zero hour. Cameras are working well despite the weather handicap. It's still raining. Unit No. 1, the Color Guard, followed by the Grand Marshal is coming down the street approaching the cameras. KHQ-TV gets a good picture. The station goes on air.

The parade is composed of alternate military, commercial and civic displays. (Military installations at Spokane include: the 92nd Bombardment Wing [H] composed of the new eight-jet B52 bombers, and 5500 Air Force personnel at Fairchild Air Force Base; Headquarters 9th Air Division of the Continental Air Defense Command; the 84th Fighter-Interceptor Group, equipped with the new F102A Convair supersonic fighter stationed at Geiger Field; the 142nd Air Defense Wing, Washington Air National Guard and the Naval Air Reserve Facilities, both at Geiger Field, and equipped with F86D jet fighters; the 10th Antiaircraft Battalion, operating four Nike sites at Fairchild and Deep Creek Air Force Bases; the 161st Infantry Regiment of the Washington National Guard; the Naval Supply Depot at Velox, and several active reserve units of the Air Force, Army, Navy, Marines, Coast Guard and ROTC.)

Flights of Thunderjet fighters occasionally roared over the parade route. Flower floats, such as that of the Lilac Queen, were quite colorful and despite the rain, gave an excellent picture on the color monitor. Of course, the colors were subdued but, the illumination was uniform and as the eye became acclimated, the effect was rather beautiful. In fact, it was better than pictures partially illuminated by strong sunlight and partly dominated by equally strong shadows.

High-school bands with gaily dressed teen-agers were there in all their glory. Drum majorettes excited the plaudits of the crowd. The fighter groups, recruiting

FIG. 4. Despite the rain, color equipment functioned perfectly and none of the parade was missed.

unit, infantry regiment, ROTC and reserve unit, bomber and battery units were very impressive. It was a stirring scene—and the KHQ-TV color cameras got it all—for 90 solid minutes.

After the parade started, the rain became lighter. Within approximately thirty minutes it stopped—almost completely. After 60 minutes the plastic sheeting was taken off the cameras. Ironically, as the parade finished the sky brightened as the sun came out for a spell.

Tear down was completed within a half an hour. By noon the cameras, cables, tripods and all equipment were loaded in the mobile unit, and the crew was headed back to the station. The spectators turned away to other pursuits—the teen-agers would enjoy the dance tonight. Thus, the Annual Lilac Festival and Armed Forces celebration went into history again. Despite the rain, KHQ-TV and AM had put the complete show on the air and for the second time in Spokane's history—in color!

FIG. 5. KHQ-TV used its own color mobile unit and a rented flat-bed truck to cover the parade. Note also microphone with parabolic reflector (right) to pick up music and crowd noise.

Station History

Station KHQ-TV and KHQ-AM in Spokane, Washington, are owned and operated by the Cowles Publishing Company, publisher of a local newspaper, the "Chronicle." The AM station operates on 590 KC with 5 KW of power. The TV station operates on Channel 6 with visual ERP of 100 KW (aural 50 KW). It is one of the first stations equipped with two color studio cameras and complete 3-V color film system. Offices are located in the downtown Radio Central Building, while the studio and transmitters are on a 30-acre plot, five miles distant.

KHQ-TV was the first full-power, 100-KW VHF station to go on air, after the freeze in December 1952. Its roots run deep into radio history, having started in 1922. Since 1927 the station has been an NBC affiliate.

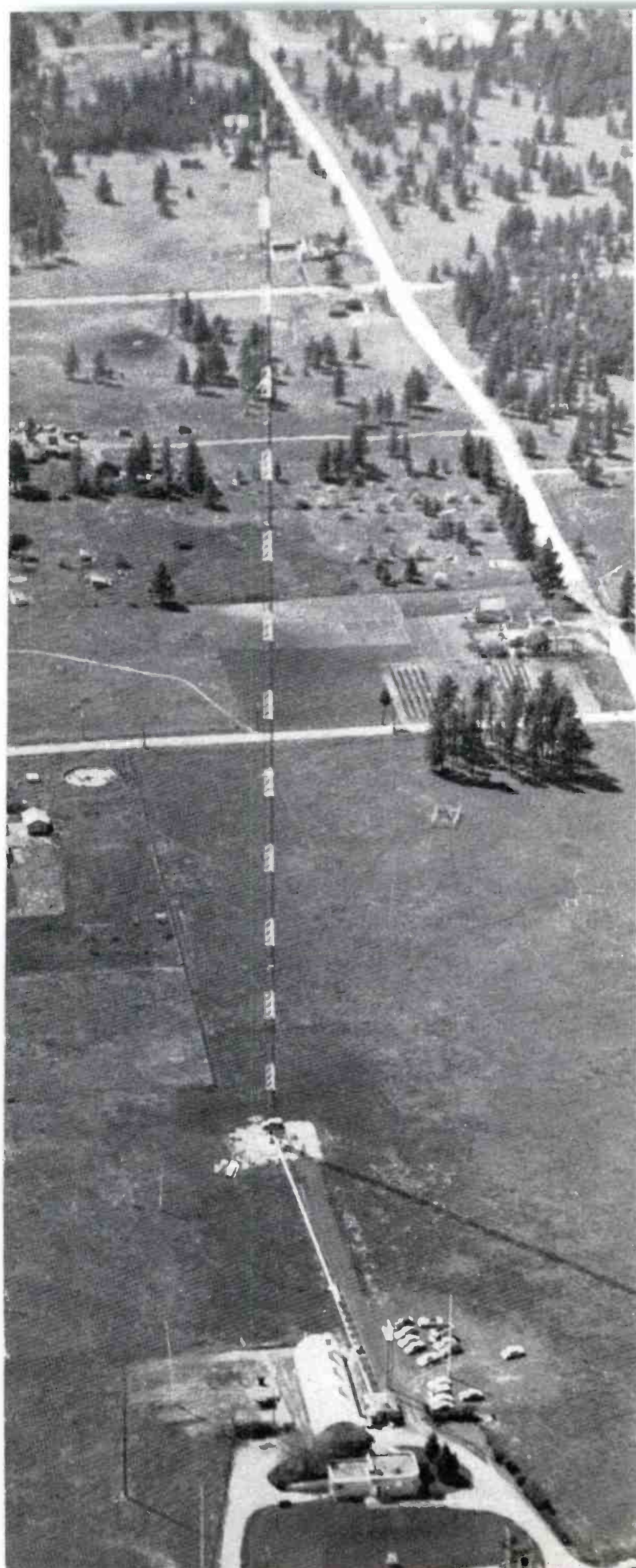
Station Building, Antenna and Microwave

Studios and transmitters of AM and TV operation are located on a 30-acre tract, five miles from offices in the center of Spokane. A quonset hut type of building houses TV studios and transmitter. The antenna is a 5-bay Type TF-5CM Superturnstile which is 826 feet above ground and 940 feet above average terrain. A TF-1 single bay, custom-built Superturnstile mounted on a 90-foot pole, serves as a standby. At the 600-foot level of the tower, two microwave dishes are mounted. One is remotely rotatable for linking with the remote pick ups. This dish feeds through a wave guide into the second dish which is beamed to the receiver mounted under the roof of the studio garage and covered with a rigid plastic roof section, thence by underground cable to the TV control room.

Incidentally, at the 765 foot-level of the tower, directly below the support stub of the antenna, a rotating beacon of 1,600,000 candlepower has been installed as an aid to air navigation. The 300-foot section of the tower, directly below the 765-foot level, is lighted at night by four vertical shafts of red neon. This sight has become a familiar landmark to travelers in this area.

FIG. 6. Entrance to KHQ Studio and Transmitter building.

FIG. 7. Aerial view of KHQ AM and TV station. ▶



STATION PERSONALITIES

FIG. 8A. R. O. Dunning, President and General Manager.

FIG. 8B. Milton Fritsch, Assistant Secretary and Treasurer.

FIG. 8C. Charles E. Lohnes, Operations Manager.

FIG. 8D. John Fahey, Program Director.

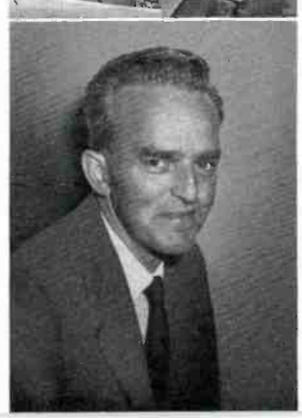


FIG. 8E. Dee Waymire, Chief Engineer.

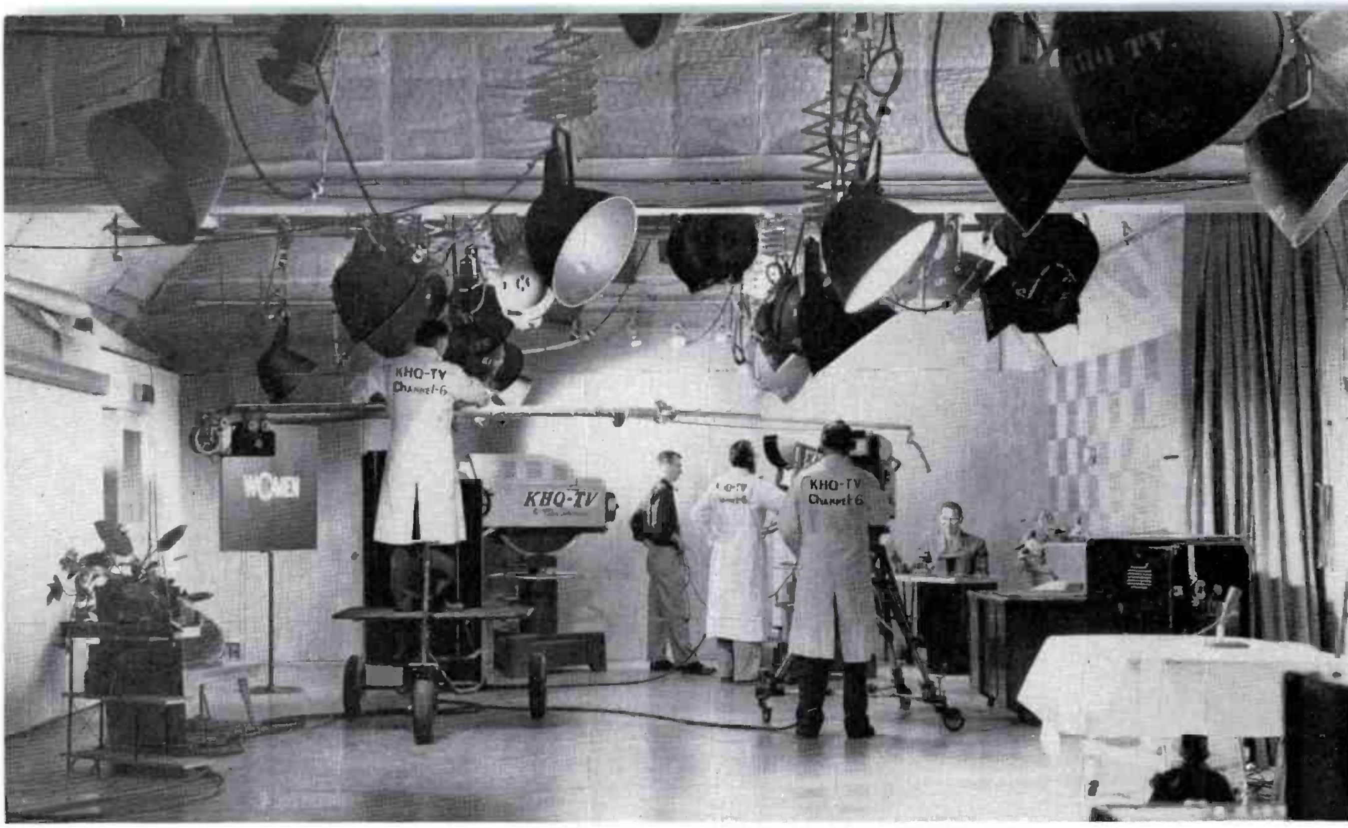


FIG. 9. One of two KHQ-TV studios.

TV Studio

KHQ-TV started out with a quonset-type, metal building 36 by 80 feet which housed both studio and transmitter. A 36-foot addition has since been added giving a total studio area of 25 by 50 feet. Here are shown the TV and lighting equipments also some of the sets employed by the station in this versatile and extremely compact arrangement. Studios are acoustically perfect and are insulated using Fiberglas behind chicken wire. Four huge air exhaust fans supply cooling. Two studios are available: 25 by 25 feet each, separated by a 20-foot archway so both may be used as a single studio when necessary. These take care of all KHQ live TV programming requirements.

FIG. 10. Combination Audio-Video control unit (at operator's left hand) designed by KHQ-TV engineers.

Combination Audio-Video Control

This unit (right) built by station engineers controls the vidicon chain, handles audio from three 16mm projectors plus network and operates all of the projectors. In operation, as a projector show button is pushed, all else is doused and audio comes in with the projectors. (When any one of the operating buttons is pushed, it automatically douses all the others.) This unit slips into a standard RCA master monitor housing for convenient placement in the master control console. Indicator lights show which audio is on, which projector is on, and also supply cue information for the announcer.

Remote Control for 3-V

Note the 3-V remote control unit built into long, narrow box atop MC (right). KHQ engineers have separated the slide change function from the multiplexer (mirror) change function since it is often desirable to return to the same slide. A new button has been added, called "Slide Show."

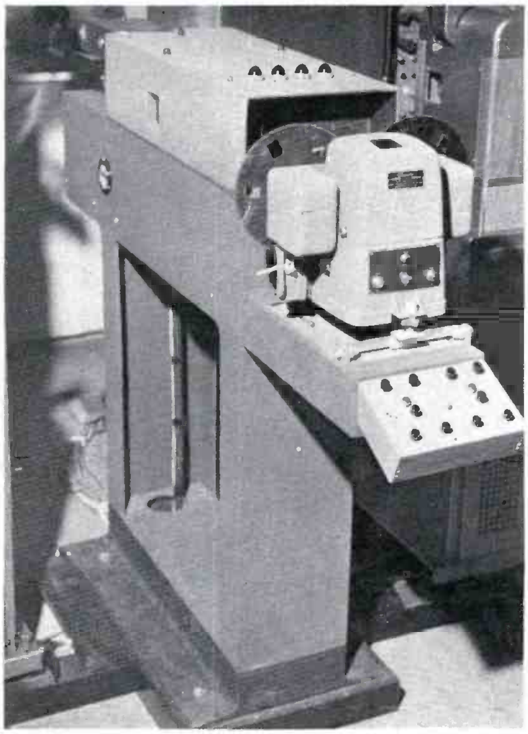
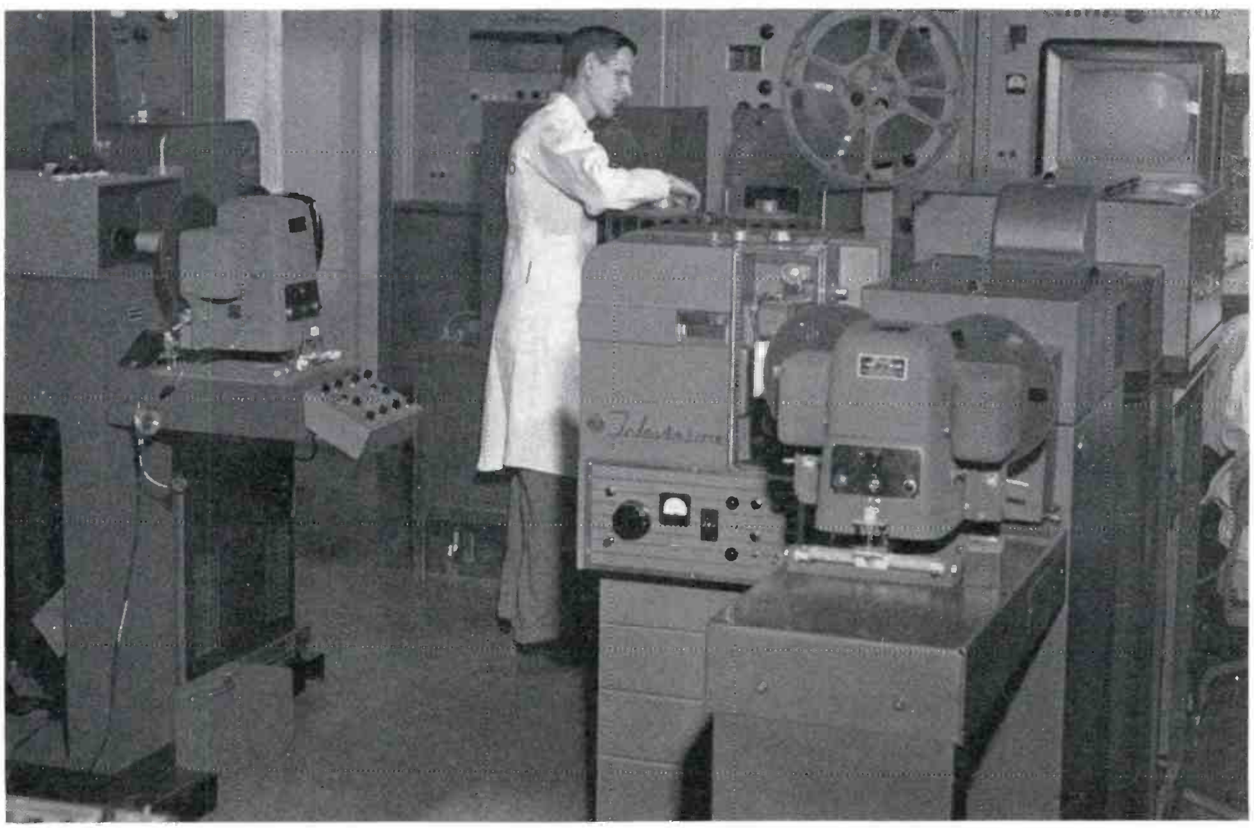


FIG. 11. Composite remote control for film and slide projectors.

Film Area

Being somewhat limited for space in the main TV building, most technical installations are located in the main control and transmitter portion of the building. Three film chains are used. One is a Type TK-20C Iconoscope used with two slide projectors. The second is a TK-21 vidicon with TP-11 multiplexer, TP-7 2 by 2 inch slide projector and two 16mm film projectors. The third is a 3-V film chain using TK-26 color film camera, TP-6 projector, an RCA Opaque Pick-Up Assembly and a TP-3 slide projector. The cover on the TP-11 has four extra indicator lights installed to show which of the four picture sources is in operation.

FIG. 12. Film area houses two black and white and one color chain.



Station Philosophy

In a single word, "individualism" might be summed up the philosophy behind the success of KHQ. Its record of pioneering in radio, TV and color are symbols of independent thought and action of station management. In addition, many unusual devices (described on these pages) also testify of the unique technical talents exhibited by its engineering staff.

Holder for Trimming Filter

For using TK-41 color TV camera outdoors, neutral density filters are used to cope with sunlight. To secure the filters in position behind the lens turret, it was necessary to use cellulose tape. This was a time-consuming procedure especially when removing or changing a filter. Therefore, station engineers designed and permanently mounted a holder for the trimming filter behind the turret.

FIG. 13. Holder for Trimming Filter.

Cuing System

For the cameraman-announcer team, a light cuing system has been devised to supplant hand signaling. A 2 by 4 inch metal box containing three signal lamps is fastened to the front of the TV camera and a 5-position control switch is mounted at the rear. As the cameraman switches from off to position 2, the green light goes on and immediately beneath is a large figure 1, informing the announcer that he has one minute to go. Position 3 puts the green light off and yellow on, meaning one half minute to go. Position 4 puts the yellow off and red on, meaning, 15 seconds to go. Finally, position 5 puts all three lights on—meaning time has run out.

FIG. 14. Camera-Mounted Cuing System (directly beneath turret). Note also camera attached audio amplifier being placed in position on front of TV camera.

Camera Attached Audio Amplifier

This device (see Fig. 14) was especially designed for remote pick ups of the type in which the camera is dollied through crowds, where frequently the mike cable becomes a source of trouble, in moving from one location to another. To avoid these difficulties KHQ-TV engineers devised a complete single channel, AC-operated audio amplifier, encased in a 4 by 12 inch metal box 1½ inches thick, which fastens to the front of the TV camera. A microphone plugs into this amplifier. The output is plugged into the program cue line at the rear of the camera. This puts the audio in the camera cable and is picked off at the camera control, completely eliminating separate mike cables to a camera. The device has been used in camera cable runs as long as 600 feet. It is separately mounted directly below the cuing system lights.

FIG. 15. Automatic Viewfinder Shield.

Automatic Viewfinder Shield

This device acts to shield the studio light from the face of the viewfinder tube. As the camera is tilted either up or down, the shield, which is counterbalanced, stays at a constant angle shielding the face of the viewfinder tube from studio lighting. Small, circular counterbalances, mounted off-center on either end of the shield axle, cause this automatic movement of the shield.

Parabolic Microphone

This is used to pick up march music of parades. It is constructed of a onetime radar disc with a microphone mounted in the center. The unit is highly directional. It creates a close-up effect—as if the microphone were in the midst of the crowd.

FIG. 16. Parabolic Microphone.

how about This for
outdoor remotes.

FIG. 17. Rack equipment for KHQ-TV color remote truck is built into small portable units. These are used both in the truck and in the studio.

Color Mobile Unit

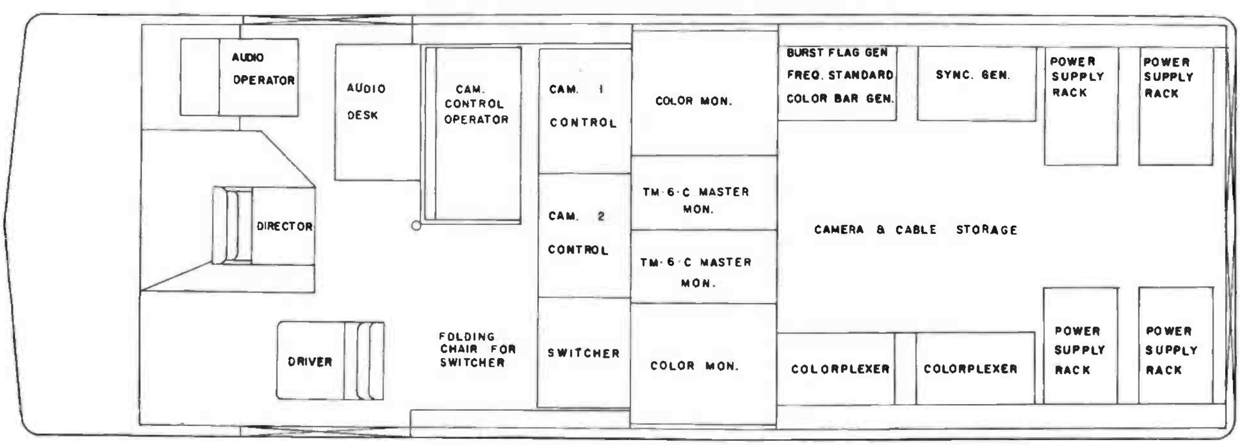
Probably the most significant piece of equipment, designed and built by station engineers, is the dual mobile unit for remote pick ups. This is built into a one-ton Chevrolet truck with custom-built body and 138-inch wheelbase. Control and rack equipments are portable. They are removable so that the truck can be used for either black and white or color TV remotes. These same control and switching equipments are used in the station studio.

The truck divides into two compartments. The front compartment contains operating equipment while the rear compartment contains rack-mounted equipments. (See floor plan—Fig. 18)

Front Compartment

In the front are two camera controls for the TK-41 color cameras and a TS-5A switcher. There are two TM-6C master monitors and two TM-10B color monitors. When the mobile unit is to be used, these individual equipments are placed in position one by one and bolted to the steel-plate floor of the truck. Nuts for these floor bolts are permanently welded in place on the underside of the truck floor.

FIG. 18. Plan view of KHQ-TV color mobile unit.



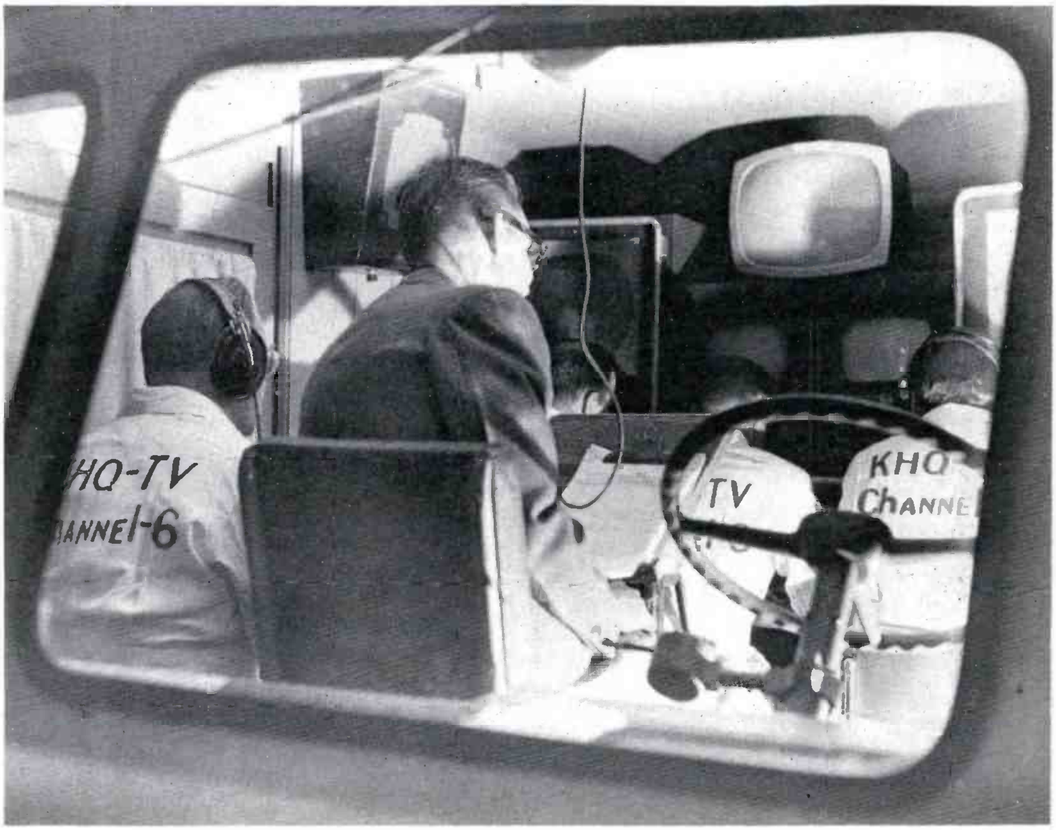


FIG. 19. The color unit, although compact, conveniently accommodates a full crew of five. They handle two-camera color remotes.

The switching console was built by KHQ engineers to contain the TS-5A switcher unit complete with amplifier and power supply. It is constructed of angle iron, covered with masonite, and finished to look like an all-metal console. A desk, covered with linoleum and chrome trim, provides the final professional touch to this unit.

Across the top of these three control consoles is a shelf for supporting the four monitors. This shelf is supported upon an angle-iron frame, which is bolted to the sides of the truck and which rests upon the three control consoles. The net result is extreme rigidity. Master monitor cabinets were constructed of angle-iron frames covered with aluminum, with fans and louvers added for cooling.

Crew Facilities

There are facilities for seating a five-man operating team. A built-in bench serves as seat for the two camera operators and alongside is a folding seat for the switcher operator. Behind the bench a shelf

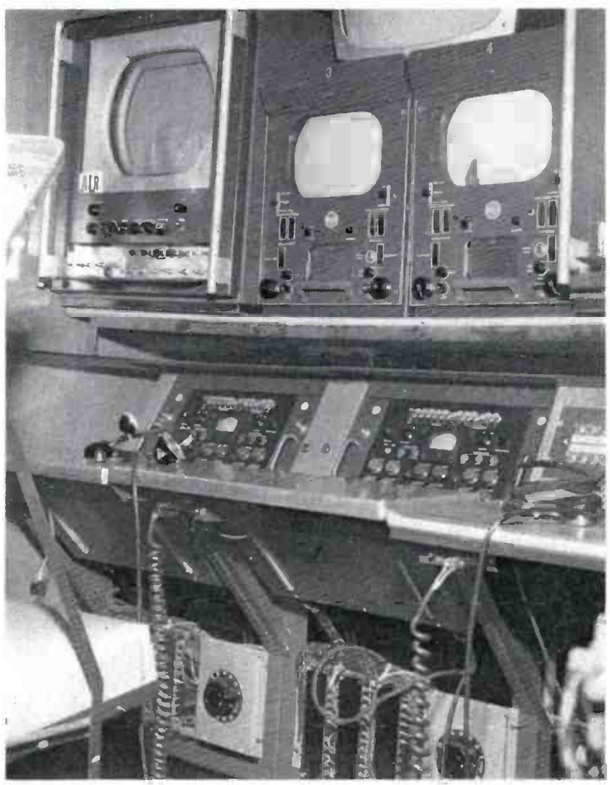


FIG. 20. Camera control positions in remote truck, at left. Switcher position at right. Note equipment is portable and is also used in the studio.

FIG. 21. Rear view of KHQ-TV color remote truck showing portable rack equipment in position. Note use of cross-bars to hold the rack units rigidly in place.

supports the audio control and a seat slides forward on angle-iron supports for the audio operator. (The floor at this part of the truck was originally quite narrow, because of the large area devoted to steps on either side, however, by merely placing covers over the greater part of the opening a much wider floor area was created, yet sufficient step area remained. Incidentally, this also provides space for storing jacks and cables.) A seat in the foremost part of the truck has been made for the director by lifting off the regular driver's seat and placing it upon a mount on the motor cover. This gives the director an elevated view of the monitors. Before him is a small desk to conveniently support his material. Thus all facilities are compactly grouped for ease of operation.

Rear Compartment

In the rear there are eight short racks, four on each side (see Fig. 18). These were constructed by the station engineers of angle-iron framework, covered with ¾ inch plywood, which is bolted to the frames. Handles are fastened to the sides for ease of carrying. These racks are standard width, with the angle iron being drilled and tapped to receive equipment units. Height of the racks range from 29 to 51½ inches.

Rack No. 1, 29 inches high, contains power supplies for the mastor monitor and processing amplifier (one 580C and one WP-33B). Number 2 contains power supplies for centering and focusing currents (two WP-33B units). Number 3 and 4, each 51½ inches high, contain a colorplexer complete with power supply. Number 5, 51½ inches high, contains power supplies for color standard and burst flag, calibrating pulse and bar generators. Included is a coax change switch for using the color bar generator with each colorplexer alternately, without the bother of handling cables. Number 6 contains the sync generator (now in two field cases temporarily but will be installed in rack 6). Numbers 7 and 8 are the same as Nos. 1 and 2.

Four racks are lined up against each other on both sides of the truck in the rear compartment. Several steel bars are locked across the racks to keep them securely in place while driving. Sufficient space is available for men to work conveniently, when necessary, even during telecasting operations.

Loading and Unloading

All the color equipments, including camera heads, tripod and pedestal, can be mounted in and on the truck within a space of three hours. The unloading of the truck and returning equipment to their places in the studio takes two hours. For loading and unloading of black and white TV equipment, the time is considerably shorter. All units are interconnected by plug-in patch cords, thus greatly speeding up the installation or changing of equipment.

Color Decision

When KHQ-TV went into color they went in with both feet—and with both eyes open. Two TK-41 studio color cameras were procured and also a complete three-vidicon color film system with opaque attachments. This was a deliberately planned maneuver.

What prompted this decision to go into color? The answer is quite simple according to Operations Manager Charles Lohnes, "Our management wanted to take part in leadership—we wanted to work out the local pattern of the industry. We, therefore, decided that the single most important thing for our community was *what they saw on the air*. Although we had plans at

FIG. 22. The KHQ-TV program for pushing color TV places emphasis upon colorcasting of special events. This requires extensive use of mobile unit since most of these events are remote pick ups.

the time for a new building, we postponed these in favor of going into color—*we thought it was more important.*"

Color Operations in Easy Stages

From the engineering point of view Color TV posed no particular problems according to Chief Engineer Dee Waymire. "We started out early in 1954 familiarizing ourselves with the network package—color stab amplifier, color monitor, transmitter conversion, etc. The special color issue of BROADCAST NEWS (Vol. No. 77, February, 1954) along with special material offered by RCA Institutes became our two best sources of basic color information. We also attended an RCA Color Seminar.

"Our next step in September, 1954, was to procure an RCA Color Slide Scanner and color bar generator. The color bar test pattern was put on the air daily at station air time. Later in the day a fifteen-minute program was telecast using color slides furnished by the Spokane Camera Club, with appropriate music background and commentary.

"Our next step in January, 1955, was to purchase a three-vidicon system using the TK-26 color film camera and TP-15 multiplexer. After getting used to such common equipments as the colorplexer and the processing amplifier, it was easy to make the transistion to live color cameras. Any station with black-and-white TV background can get the color idea real quick.

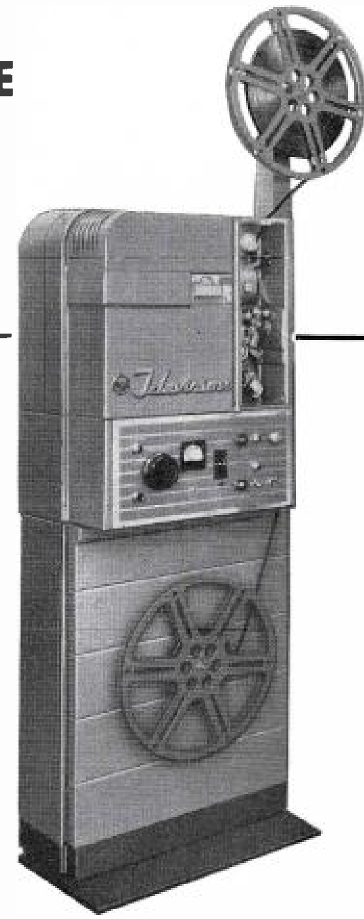
KHQ-TV took delivery of two TK-41 color cameras in early April of 1956, and except for testing the equipment and training technical crews, telecast, as its first major color program, the Lilac Festival-Armed Forces parade during May of 1956.

Serving the Inland Empire

The area of which Spokane is the hub, between the Cascade and Rocky Mountains, constitutes parts of Washington, Montana, Idaho, Oregon and British Columbia. Locally this area is known as the Inland Empire. Approximately fifty per cent of the Spokane retail market comes from this area which includes towns 35 to 150 miles distant, and local merchants depend a great deal upon such trade. Hence, Spokane's TV programs must also serve the same towns. This they do via their own broadcasting and telecasting facilities, and are augmented by some seventy community antenna systems and booster stations in the fringe areas of this vast Inland Empire, thus serving more than fifty thousand additional homes which would otherwise be unable to receive good TV at this distance.

Spokane does not observe daylight saving time, and because of this and the large time difference with the East, many network color shows are delayed. This problem, of course, will become less acute as color programming occupies more hours of the program day. Meanwhile, KHQ-TV has a program of its own to tackle the immediate color situation. This consists of concentrating on special events for colorcasting and at the same time publicizing these color shows as widely as possible. This accounts for the emphasis upon the color mobile unit since most of the special events are remote pick ups. Local RCA Distributors, Prudential Distributors, and others have co-operated in these special color telecasts. Together with the push in color receiver promotion and projected increase in color programming, KHQ-TV hopes to make Spokane one of the leaders in Color Television in the U. S. A.

HOW TO GET TOP PERFORMANCE FROM THE TP-6 TELEVISION FILM PROJECTOR



by R. F. ROUNDY, *Broadcast and Television Sales*

In order to obtain the best performance from the TP-6 projector, it is essential to recognize that the TP-6 is a more precise mechanism than the majority of projectors used in the past by broadcast stations. For example, in the TP-6 projector there are more surfaces for guiding and driving the film. These additional surfaces provide more precise control of film motion which, in turn, improves both picture and sound quality. Operators of the TP-6 projector should give proper attention to all surfaces contacted by the film. All of these surfaces must be kept clean in order to get best results.

Other important considerations are for adequate maintenance and lubrication of the mechanism. In addition, proper film-threading techniques will also aid in obtaining the best performance from the TP-6 projector.

Daily Operational Check-Out

At the beginning of each day it is recommended that 15 to 30 minutes be used to check out the operation of the TP-6 projector. This daily check-out is the single, most important period in the operation of the projector. It will result in the high quality of picture and sound for which the TP-6 projector is designed. A daily check-out will also insure less weekly and monthly maintenance. See Table 1 for an outline of these daily check-out procedures.

Film-Threading Technique

Threading the TP-6 projector is more exacting than threading other projectors which do not have as many precise film-contacting surfaces. As mentioned previously, these surfaces are required to obtain the highest quality of picture and sound. Once the threading technique is mastered, the TP-6 projector can be threaded as quickly as any other type of television projector.

There are two conditions under which the projector is threaded by the operator: First, the normal condition when the operator has ample time to thread the projector as explained in the instruction book. Secondly, the abnormal condition when the operator has to thread the projector rapidly. This may occur during a "panic" period (the showing of several commercials plus station identification). For this condition, the following steps indicate how the TP-6 projector can be threaded in *five seconds* (with a film that is approximately ten seconds in length):

1. Take film off the supply reel that is still running through the projector, previous to the ten-second spot that is to be threaded. Lay the film taken off the supply reel, (and that is still being shown on the projector) over the back part of the projector (lamphouse section) permitting it to lay there until it is completely run through the projector.
2. Put the ten-second reel of film on the supply reel spindle. Pull out the leading section of the film, observing the extent of picture information, so that after this leader is threaded and the projector is started, the right point on the film is shown.
3. At the instant the previous spot has completely run through the projector, thread the leading section of the ten-second spot into the film path of the TP-6 projector as follows:
   a. Take both hands and simultaneously flip open the four sprocket shoes and film gate—thus the film path is ready to "take" the film.
   b. Thread the film around the upper sprocket, through the film gate, and push up the sound tension roller, and then thread the film over the sound drum and sound sprocket. Close the film gate. At this point the film is ready to roll. If haste is required, it can be rolled and then the film threaded over the hold-back sprocket while the projector is running.
   c. Thread the end of the film (that has a piece of scotch tape on it) onto the previous reel of film that is still on the take-up shaft.

Weekly Maintenance

The daily cleaning and adjustment of the TP-6 projector will insure top quality of performance, but there are additional elements of the projector that require attention on a weekly basis. This weekly procedure should average approximately one hour per projector. These steps are outlined in Table II.

Conclusion

Adhering to a schedule of daily and weekly maintenance as outlined in this article has produced for many TV stations outstanding results in quality of projection, efficiency of film handling and long projector life.

Editor's Note: Maintenance of the projector sound system and intermittent mechanism is discussed in detail in a text "How to Get Top Performance From the TP-6 Projector," available on request from RCA Broadcast Equipment Sales, Bldg. 15-6, Camden, N. J.

TABLE I

Daily Operational Check-Out of TP-6 Projector

Item	Procedure	Note
LAMPS	1. Remove projection lamps . . . clean lomp reflectors.	
	2. Replace lomps . . . check for proper operation.	
THREADING PATH	1. Remove film gate slider assembly . . . adjust tension of film gate to No. 1 position . . . make sure film stop pressure spring is at right angles to its holding screws.	It may be necessary to decrease tension when running green or reversal film.
	2. Clean film pressure shoe and nylon roller on film gate.	Be careful not to scratch polished surfaces.
	3. Check spring action of two side pressure shoes.	
	4. Cleon metol surface below aperture plote.	
	5. To cleon guide ond follower, remove condenser lens assembly and turn on projection lamp to give light for observotion.	
	6. Rotote hand turnover knob until claw teeth protrude from aperture plate . . . clean clow teeth.	Toke core not to dislodge sapphire insert or dilute intermittent oil with solvent.
	7. Check oil level of intermittent . . . level should go down os cam starts to pick up oil in operotion.	
	8. Clean film sprocket . . . sprocket teeth . . . film contact teeth . . . pressure shoes.	
LENSES	1. Remove lenses from condenser lens assembly . . . clean . . . reassemble.	
	2. If projector is used in color operation, remove dichroic filter . . . clean.	Use pure isopropyl olcohol only.
	3. Clean projection lens while in place.	Back surface is accessible by removing film gote slider.
SOUND SYSTEM	1. Check sound pressure roller for flat areas which will couse "wow."	
	2. Cleon film contact surface of sound drum.	Pay particular attention to inner edge where dirt moy cause "thump."
	3. Remove sound bracket and cleon mirror . . . phototube . . . both surfaces of optical assembly . . . nylon rollers.	
	4. Check exciter lamps for crystallization, cleonliness, and freedom from fingerprints.	
OPERATIONAL CHECK	1. Reassemble projector parts.	
	2. Using RETMA Test Pattern Film (with 400-cycle sound), check: audio levels . . . focus . . . optical registration . . . optical alignment . . . mechanical operation.	

TABLE II

Weekly Maintenance Procedures for TP-6 Projector

Item	Procedure	Note
FROM THREADING SIDE	1. Remove oll covers . . . clean fins of lamphouse blower ond exposed surfoces of the projector casting.	
	2. Remove nylon rollers . . . cleon shafts and bores.	Cleon with soop ond water only. Do not ollow oil to get on rollers.
	3. Replace rollers and covers.	
FROM OTHER SIDE	1. Remove oll covers . . . cleon shutter motor shaft and exposed costing areos.	
	2. Remove preomplifier.	
	3. Check quolity of oil in gear boxes; if dirty droin completely, flush with light oil ond refill.	Chonge oil about once a month.
	4. Lubricote per Lube Chort supplied with projector.	
FINAL CHECK	1. Reossemble projector ports.	
	2. Using RETMA Test Pottern Film (with 400-cycle sound), check: audio levels . . . focus . . . optical registrotion . . . opticol olignment . . . mechonicol operotion.	

THE RCA TM-21 • A STABILIZED COLOR MONITOR

by **E. E. GLOYSTEIN** *and* **N. P. KELLAWAY**
RCA Terminal Equipment Engineering[1]

The "state of the art" in compatible color television has been advanced by the introduction of the RCA TM-21 Color Monitor. This newly designed color display device is capable of producing high-quality pictures, stable enough to hold adjustments over long periods of time, and rugged enough to stand up under rigorous operating conditions. The TM-21 has been designed "from the ground up" to meet the requirements of broadcast stations and closed-circuit color television plants. It is expected to find many applications as an adjunct to color camera chains, as a general-purpose monitoring instrument, and as a high-quality display device in "prestige" applications, such as clients' booths and reception rooms.

Stable Design Enhances Monitoring Applications

One of the most important applications for a color monitor is in control rooms where operators face the problems of setting up and matching color cameras. Thanks to its high quality and stability, the TM-21 is unusually well qualified for this service. Compared to other monitoring devices the TM-21 offers the following benefits:

(1) It provides a better check of registration during actual programming than the black-and-white master monitor.

(2) Because of its own excellent deflection linearity (within 1% in both directions), a good check of camera deflection linearity is possible.

(3) Provision for underscanning, to show the corners of the picture, permits better checking of camera framing, camera lens aberrations, and camera deflection transients. Underscanning also makes cue marks in the picture corners readily visible.

(4) A highly stabilized method of black-level setting permits better evaluation of camera shading characteristics and clearly indicates the effects of camera pedestal adjustments.

(5) Precision decoder circuits and highly linear output amplifiers produce a picture of improved color fidelity, so that camera color fidelity can be more accurately evaluated.

(6) The improved picture sharpness facilitates checking of camera focus.

(7) Ease of set-up and circuit stability reduce operating cost, because very little operator time is required to keep the monitor operating.

(8) Excellent accessibility for servicing reduces both the maintenance cost and down-time in the event of tube or component failures.

Another important application for the TM-21 is at master control or transmitter monitoring points where the color picture must serve as final indication of the quality of signals being received or transmitted. In this application, the stability of the monitor is particularly significant, because it is important that operators be certain whether observed picture faults are due to the monitor or to the signal itself. When master control or transmitter operators are given a monitor in which they have confidence, they can do a much better job of taking or recommending corrective action when substandard signal conditions are detected.

[1] Development of the TM-21 was accomplished by an RCA engineering team. In addition to the authors, major contributions were made by L. J. Baun, R. A. Dischert, A. C. Luther, F. L. Benchly, R. J. Marian, C. R. Morris and R. H. Schirmer.

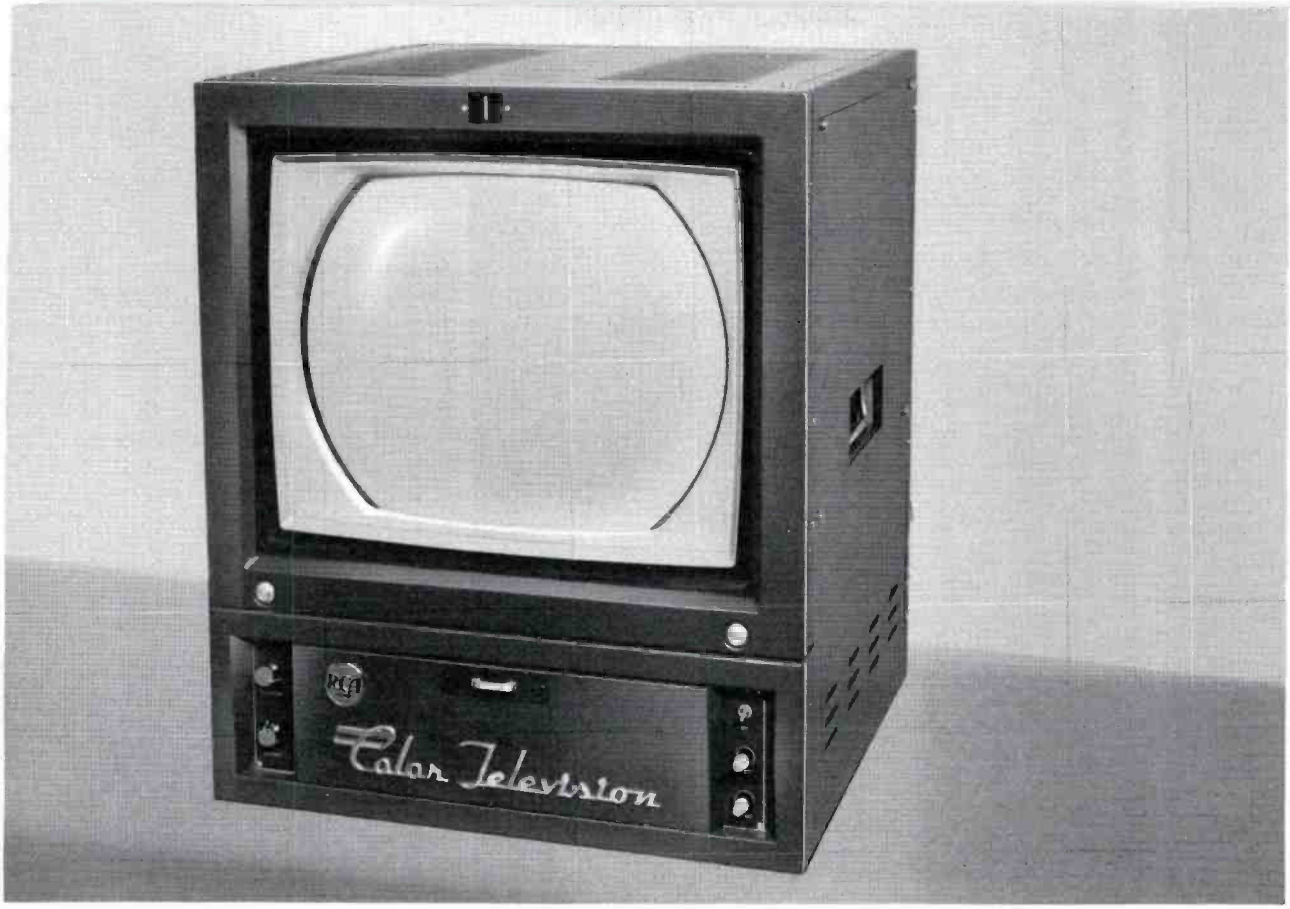


FIG. 1. New RCA TM-21 Color Control Monitor. Only operating controls normally exposed are brightness, contrast and ON-OFF switch.

In general-purpose monitoring applications, the provision for automatically removing the subcarrier trap in the monochrome channel when a monochrome picture is displayed is of special significance. Most compatible color displays are limited in horizontal resolution to about 275 lines because of the necessity for attenuating the color subcarrier at 3.58 megacycles before it reaches the kinescope. This limitation is not serious when the monitor or receiver is producing a color picture, because the addition of color more than compensates for the loss in resolution. When producing monochrome pictures, however, a 275-line limit is quite obvious in comparison with wide-band monochrome displays. The TM-21 has avoided this limitation through its cross connection of the subcarrier trap with the color killer; hence, monochrome pictures are displayed with the full resolution capabilities of the color kinescope, about 450 lines. The TM-21 will do a very satisfactory job of displaying both color and monochrome pictures in many situations where it has heretofore been necessary to provide both a monochrome and a color monitor.

Another application for the TM-21 is in "prestige" situations where it is important that pictures of the highest possible quality be presented. Both the professional appearance of the monitor and its excellent picture are definite assets in such places as clients' booths and reception rooms where the best possible impression on customers or on the public is desired. Stability is important in these situations, too, because the monitor must often operate for long periods with no operator attention.

Serves as System Standard

The TM-21 is the first instrument designed to serve both as a color picture display device and as a piece of test equipment. With respect to circuit design, most previous color monitors have been approximately equivalent to color receivers with the tuner, intermediate-frequency amplifier, and sound sections removed. Most of these devices have been designed with mechanical packaging making them suitable for use in broadcast plants, and have proved generally useful for color display purposes. These previous monitors have not been particularly useful as "standards of reference," however, because they have lacked the stability to suit them for this service. In the TM-21, great pains have been taken to overcome the limitations of conventional receiver designs in order to produce pictures which are limited only by transmission standards, and capabilities of the color kinescope. Stability has been provided by extensive use of feedback and other stabilization techniques, and the mechanical design represents a new high in operating convenience and serviceability.

The Importance of Stability

Before reviewing in some detail the design highlights of the TM-21, it is appropriate to comment briefly on the significance of stability in color monitors. It is not enough to make a color monitor merely capable of *producing* a high-quality color picture—it must be capable of *maintaining* such a picture over long operating periods without frequent readjustments to compensate for circuit drifts. While great progress has been made in reducing color television to a science, there is still enough "art" mixed in with the science to make it necessary that many adjustments in cameras and transmitting apparatus be made on the basis of what they do to the color picture. Unless the operators who make such adjustments are provided with a highly stable color monitor, they can never be quite sure whether some of the effects they see in the monitor picture result from the signal or the display device (monitor).

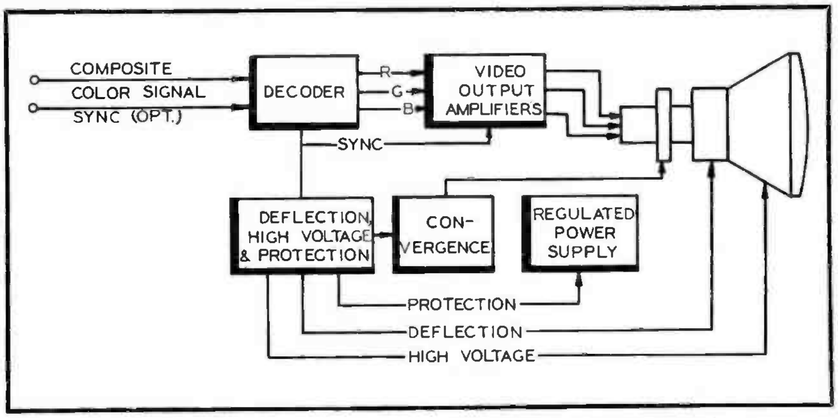


FIG. 2. Over-all block diagram, showing the five major chassis in the TM-21.

Of course, stability in an electronic device doesn't just happen—it is a result of careful design. In the TM-21, for example, a high degree of stability has been achieved by the combination of three design approaches: (a) simplification of the basic circuit configuration to reduce to a minimum the possible sources of drift, (b) frequent use of inverse feedback, and (c) generous reserve factors in cases where feedback is not practical.

Circuitry is Designed About Five Main Chassis

To "set the stage" for detailed discussions of some of the unusual and significant characteristics of the TM-21, let us examine quickly some of the more obvious aspects of the monitor. The front-view, Fig. 1, shows that the monitor has a professional appearance with an over-all size determined primarily by the 21-inch color kinescope. Cabinet dimensions are 27 inches wide, 33 inches high, and 28 inches deep. The only operating controls normally exposed are: brightness, contrast, and the power off-on switch. The main power fuses are also accessible on the front panel. Internally, the monitor consists of five main chassis mounted on a sturdy frame: (1) decoder, (2) output amplifiers, (3) deflection and high voltage, (4) convergence, and (5) power supply. The relationship between these chassis is shown in Fig. 2. The functions of the five chassis are described briefly as follows:

(1) The *decoder* processes the composite color signal to derive red, green, and blue signals suitable for controlling the color kinescope. It also contains a sync separator and a sync interlock circuit which permits optional use of external synchronizing pulses.

(2) The *output amplifiers* increase the amplitudes of the signals from the decoder to the levels needed to drive the electron guns of the kinescope. They also provide for the restoration of the DC components of the signals.

(3) The *deflection and high-voltage chassis* is controlled by composite sync from the decoder chassis. It provides sawtooth currents for the deflection yoke of the color kinescope, plus a source of regulated power at 25 kilovolts for the kinescope ultor. The protection circuits, which prevent kinescope damage from certain types of failure or improper operation, are located within this unit.

(4) The *convergence chassis* develops second-order deflection currents, which are applied to the convergence yoke on the color kinescope for the purpose of adjusting the shapes of the red, green, and blue rasters so that they may be properly registered in all parts of the picture.

(5) The *power supply* provides regulated +B power for the other chassis.

Mechanical Design Features Ready Access to All Components

Figure 3 shows how excellent serviceability is achieved by mounting the four mains chassis vertically with the tubes projecting inward. This design makes it possible to replace any tube from the top or rear of the monitor. Ready access to all small components and wiring is gained by simply removing the side covers.

The same design configuration also provides good separation of heat sources from temperature-sensitive components, so that adequate cooling is possible with natural

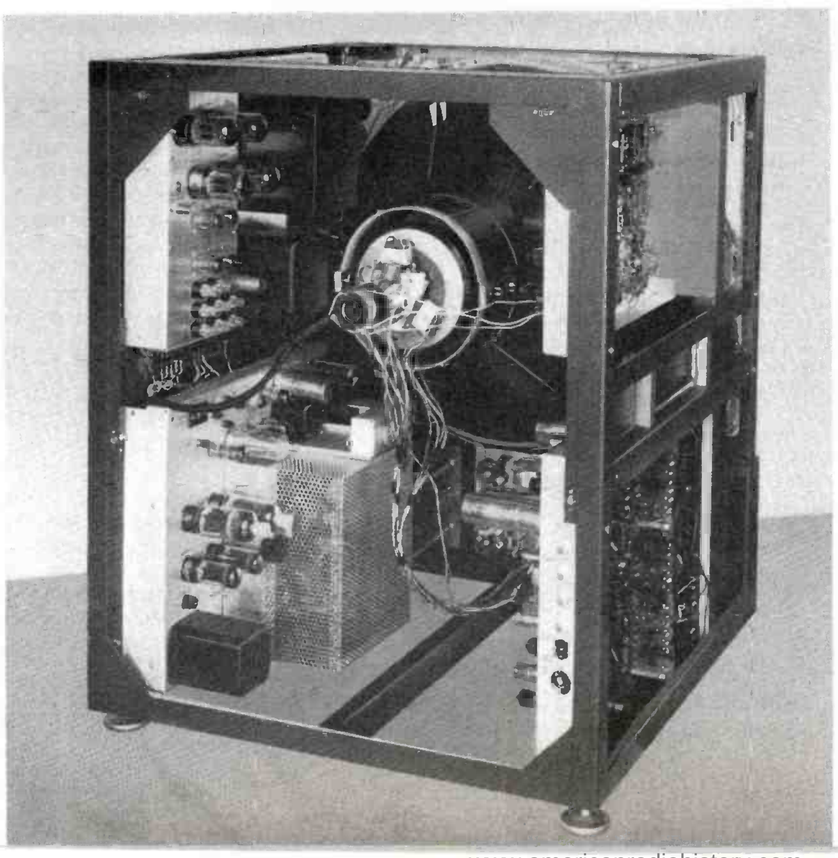


FIG. 3. Rear-quarter view of TM-21 with side and top covers removed, showing how the chassis are mounted within the main frame.

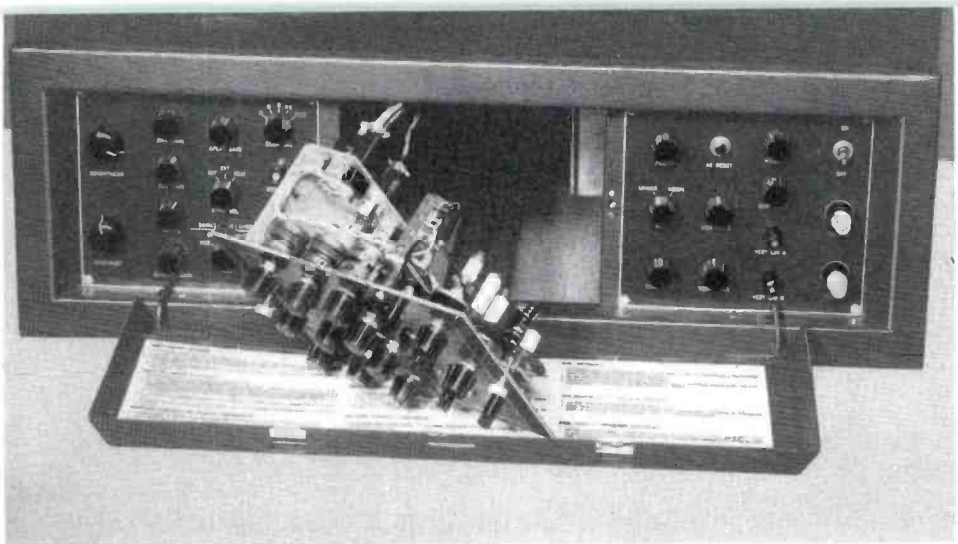


FIG. 4. Front view of the TM-21, with the convergence chassis withdrawn for easy servicing. Contained in cover is detailed procedure for kinescope set-up, including convergence.

convection currents. The mounting frame, made of sturdy aluminum angles, is constructed so that the monitor may be placed on any of its six surfaces without damage. However, it is unnecessary to gain access to the bottom of the monitor for any normal service functions.

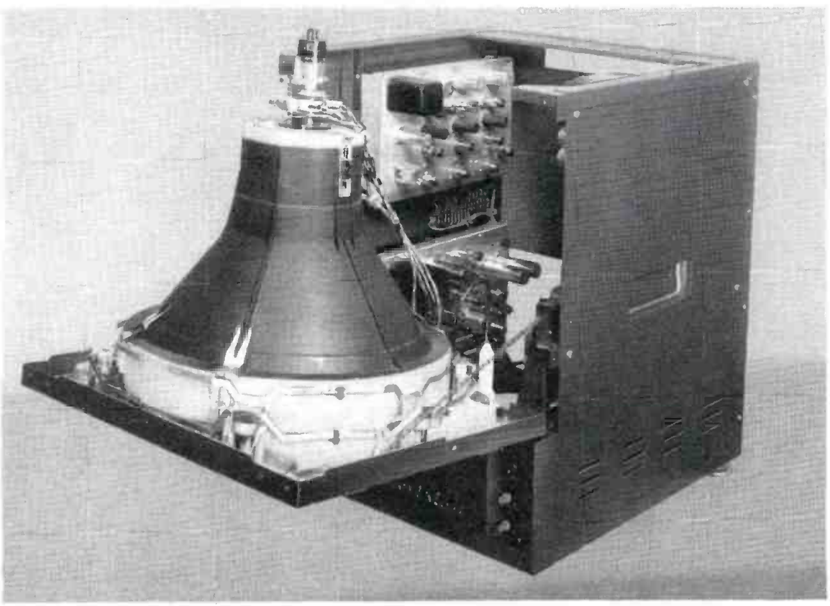
As shown in Fig. 3, the deflection and high-voltage chassis is mounted at the lower left, with the power supply immediately above it. The decoder is at the lower right, mounted below the output amplifiers.

The convergence chassis, not shown in Fig. 3, is mounted as a subassembly just behind the middle portion of the front panel. This chassis, which contains only passive components, can be withdrawn from the front for servicing, see Fig. 4.

Another outstanding feature of TM-21's mechanical design is the arrangement for mounting the kinescope. The decorative bezel surrounding the picture area may be readily removed to provide convenient access to a group of screw-driver slots in the periphery of the mask assembly, (see Fig. 5). These screw-driver adjustments control the equalizing magnets which assure uniformity of color rendition in all areas of the screen. With the bezel removed, the safety glass is easily taken out so the kinescope faceplate can be cleaned. A front-panel, high-voltage interlock protects the operator during this procedure. The metal cone of the kinescope is enclosed by a polyethylene boot, which serves as a high-voltage insulator, as a filter capacitor for the high-voltage power supply (since a conductive coating on the outside of the boot is grounded) and as a mechanical support which is clamped against the front panel. The upper section of the front panel is hinged at the bottom, so that it can be dropped forward to permit convenient replacement of the kinescope as illustrated in Fig. 6.

FIG. 5. Decorative bezel surrounding picture area is removed for access to the equalizing magnets and safety glass.

FIG. 6. Monitor front panel is readily swung down for quick removal of kinescope.



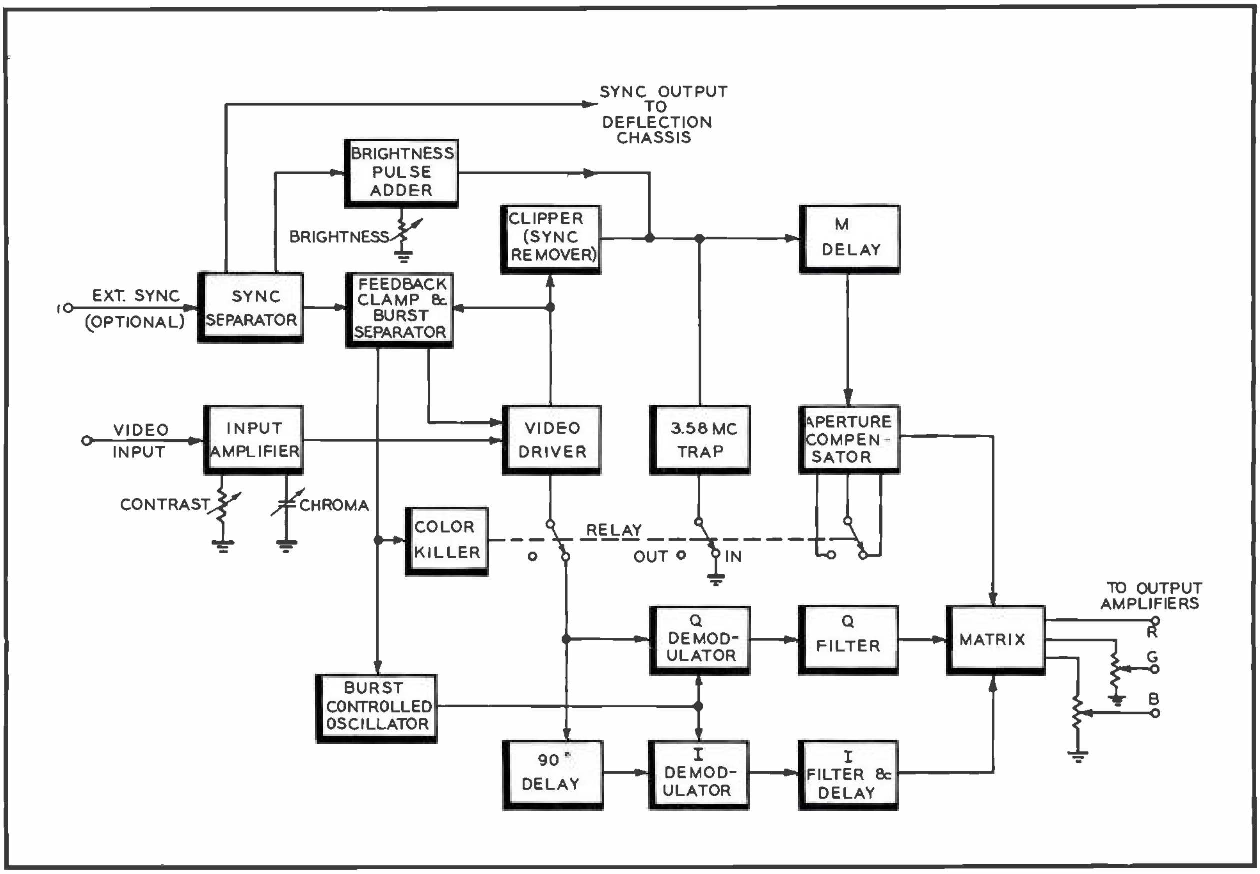
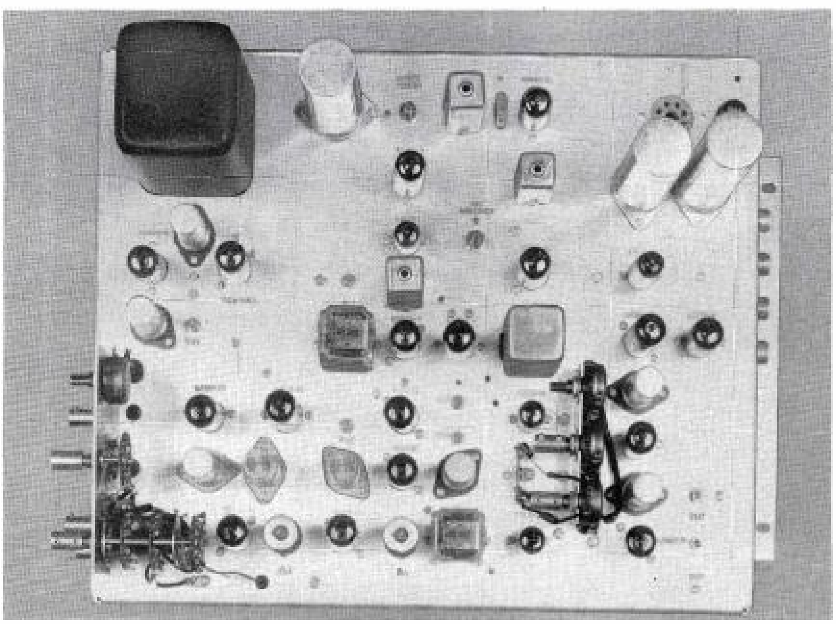


FIG. 7. Simplified block diagram of the TM-21 decoder.

FIG. 8. Decoder circuits are housed on a single chassis.



Decoder Chassis Differs Significantly From Receiver Design

The area in which the monitor differs most significantly from conventional receiver designs is the decoder. The block diagram of this chassis is shown in Fig. 7; a photograph in Fig. 8. Many of the drift problems in conventional receiver or monitor designs fall in this section, because it is necessary that separate but parallel signal channels be used for many of the processing functions. For example, in a receiver the high-frequency portion of the signal must be processed in channels containing demodulators and filters, while the low-frequency portion is passed through delay equalizing networks and an aperture compensator. Drift problems can arise unless such separate but parallel stages are highly stabilized with respect to both gain and phase characteristics. In the TM-21 decoder, the drift problem has been kept under control by reducing the number of stages required in the parallel paths, by eliminating the need for gain in these paths, and by stabilizing each of the individual stages.

Video Driver Handles All Signal Components Simultaneously

The heart of the decoder design is a stabilized "video driver" stage which drives the monochrome channel and the burst-controlled oscillator from its plate circuit, and the two chrominance demodulators from its cathode. The DC component is restored at this stage by means of a feed-back-stabilized clamp. One of the gating stages involved in this feedback clamp has been made to serve as a burst separator as well, thus eliminating a separate tube for this function. In the video driver the plate signal current is inherently equal to the cathode signal current to eliminate the possibility of gain variations in the plate circuit relative to the cathode circuit.

Prior to the video driver stage, the input signal is raised to a relatively high level (about 12 volts, peak-to-peak) by an amplifier equipped with a nonselective or wide-band gain control. By using this high level at the driver stage virtually all of the voltage gain required in the entire decoder is supplied by an amplifier which handles all signal components simultaneously. This technique eliminates the problem of matching the gains of several individual amplifiers. In the stages which follow the video driver, (which must necessarily be split into separate channels), it is possible to sacrifice voltage gain for the sake of stability and still deliver signals at about a 1-volt level at the output of the decoder. The amount of degeneration (or feedback) that it has been possible to incorporate in the TM-21 by following this approach has made practical the elimination of several conventional gain controls (normally provided in decoders to compensate for circuit variations).

Burst Controlled Oscillator Features Single Output

One of the channels following the video driver stage is the burst-controlled oscillator, consisting of a crystal-controlled 3.58 mc oscillator shunted by a reactance tube whose control voltage is derived from a phase detector. This detector compares the oscillator output with the separated bursts provided by the video driver. Special attention has been given to drift problems in this oscillator, so that the phase of its output remains stable relative to the phase of the chrominance signal delivered from the cathode side of the video driver.

In conventional decoder designs, the burst-controlled oscillator normally delivers two subcarrier outputs, (90 degrees apart in phase), to the chrominance demodulators. A popular method of deriving the two outputs is to use a pair of tuned circuits, one tuned above resonance and the other below resonance to achieve the required 90 degree phase shift. In the TM-21 decoder, however, a potential phase stability problem has been avoided by providing only a single output from the oscillator. This output is tied directly to both demodulators, so that there can be no relative phase drift between them. The required 90 degree phase shift is provided in the *video* channel by passing the input signal to the I demodulator through a precision delay line equivalent to 90 degrees at 3.58 megacycles. The delay line is manufactured with a tolerance of only ±1 degree; hence it is possible to eliminate the conventional 90 degree or quadrature phase control. The presence of the delay line in the I video channel poses no problem, because it is very simple to take it into account when adjusting the total delay of the I channel relative to the narrow-band Q channel.

Stabilized Diode Demodulators Eliminate Drift

The demodulators themselves are a stabilized diode type, as shown by the simplified schematic, Fig. 9. In essence, the circuit is a fast-acting clamp. The diodes are closed periodically at a 3.58 MC rate, and their effect on the signal is to connect the output side of the 120 mmf capacitor to ground through the center tap of the 3.58 MC transformer. The charge stored in the 0.01 mf capacitor through the rectifying action of the diodes serves to make the diodes conductive only during the extreme peaks of the subcarrier cycle. Because the clamp is closed only momentarily, the output side of the 120 mmf capacitor is normally free to follow the variations in the input signal. The average output level, however, is a function of the input level at the instants when the diode conduction occurs, as illustrated by the waveform sketches in Fig. 10. This average level is affected by both the amplitude and the phase of the incoming chrominance signal, and represents the desired demodulated signal.

The major advantages of this demodulator circuit are: (1) it has no video gain drift problem, since it behaves in principle like a fast-acting switch, (2) it is insensitive to the level of the CW subcarrier signal, provided the CW signal is always of higher amplitude than the modulated RF signal.

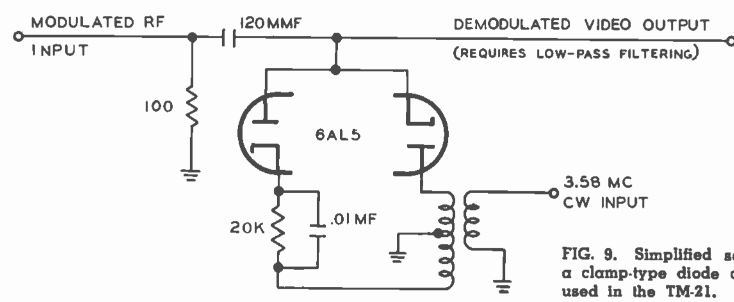


FIG. 9. Simplified schematic of a clamp-type diode demodulator used in the TM-21.

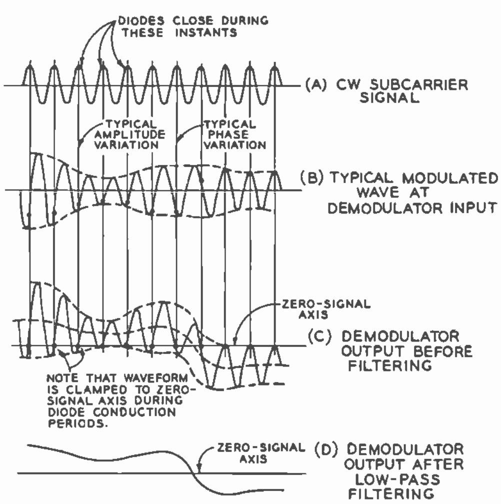


FIG. 10. Waveform sketches illustrating operation of the clamp-type demodulators used in the TM-21.

High Resolution Pictures From Monochrome Channel

There are several unusual features in the monochrome channel of the decoder, driven from the plate side of the video driver. A clipper in the plate circuit removes both the sync and burst components of the input signal. In the blanking interval thus cleared, there is provision for adding a "brightness control pulse" of adjustable amplitude. This pulse is derived from separated sync and makes possible a considerable simplification in the adjustment of the monitor for proper gray scale balance. Since the pulse is introduced in the monochrome channel ahead of the matrixing operation, it is automatically supplied in the proper proportions to the red, green, and blue channels which are separated at the output of the matrix. As will be explained in more detail later, the brightness pulse serves as a reference level to which the signals are clamped in the DC restoration process at the kinescope guns.

In all compatible color display devices it is necessary to provide attenuation in the monochrome channel to prevent the subcarrier components of the signal from reaching the kinescope by this path. In the TM-21, this need is met by a simple trap circuit. When the monitor is operated from a monochrome signal (i.e., one without color sync bursts), the "color killer" not only disables the chrominance channels to avoid crosstalk effects, but also removes the trap from the monochrome channel permitting substantially higher resolution. This feature is of considerable value in situations where the monitor is used for viewing both monochrome and color pictures.

A delay line is needed in the monochrome channel to compensate for the greater delay of the I and Q channels. Following this delay line, an aperture compensator of a linear-phase-shift type provides an adjustable boost for the higher frequency components of the signal to compensate for the finite spot size of the kinescope beams. The aperture compensator is also tied to the color killer through a relay, so that the shape of the high-boost response curve is altered automatically when the monitor is operated from monochrome signals. This automatic shift in aperture compensation further enhances the sharpness of monochrome pictures.

Gain Controls Eliminated in Matrix Section

In the matrix section of the decoder, the M, I, and Q signal components are cross-mixed in the proper proportions to form red, green, and blue signals. The matrix circuit used in the TM-21 is of a new design, requiring only one phase inverter, which is highly stabilized by degeneration. The relative gains of M, I, and Q signals entering the matrix are so thoroughly stabilized that no gain controls are required. To provide for situations where it is desired to use the monitor with a substandard signal having improper amplitude of the chrominance signal relative to the monochrome signal, a "chroma" or saturation control of limited range is provided in the form of a frequency-response trimmer on the input amplifier. In the normal operating condition, (selected by a front-panel set-up switch, to be described later), this chroma control is disabled, and the monitor display may be accepted as a good indication of the actual quality of the signal applied to its input. Gain controls external to the matrix are used for adjusting the amplitudes of the green and blue signals relative to the red. These controls are needed to compensate for component differences in the subsequent output amplifiers and for differences in the relative efficiencies of the three phosphors.

The decoder chassis also contains the sync separator, which provides pulses for controlling the deflection circuits as well as some of the keying functions in the decoder. There is an optional input for external sync for use in situations where the monitor is operated from noncomposite signals. An interlock circuit permits remote selection of internal or external sync in applications where both composite and noncomposite signals are encountered.

Output Amplifiers Feature Excellent Amplitude Linearity, Frequency Response and Gain Stability

The amplifiers which raise the decoder output signals to the levels necessary to operate the color kinescope are mounted on the chassis shown in Fig. 11. In order to maintain the proportionality of the red, green, and blue signals necessary for good color fidelity, the individual amplifiers must have excellent amplitude linearity, frequency response, and gain stability.

The operation of one of the three nominally identical channels on the output amplifier chassis is illustrated in Fig. 12. A current feedback loop from the output stage to the input stage accomplishes the following:

(1) The gain is stabilized against line voltage variations, tube aging, and especially, loss in transconductance in the output stage.

(2) Excellent amplitude linearity is maintained (less than 1 per cent differential gain for an 80 volt white picture).

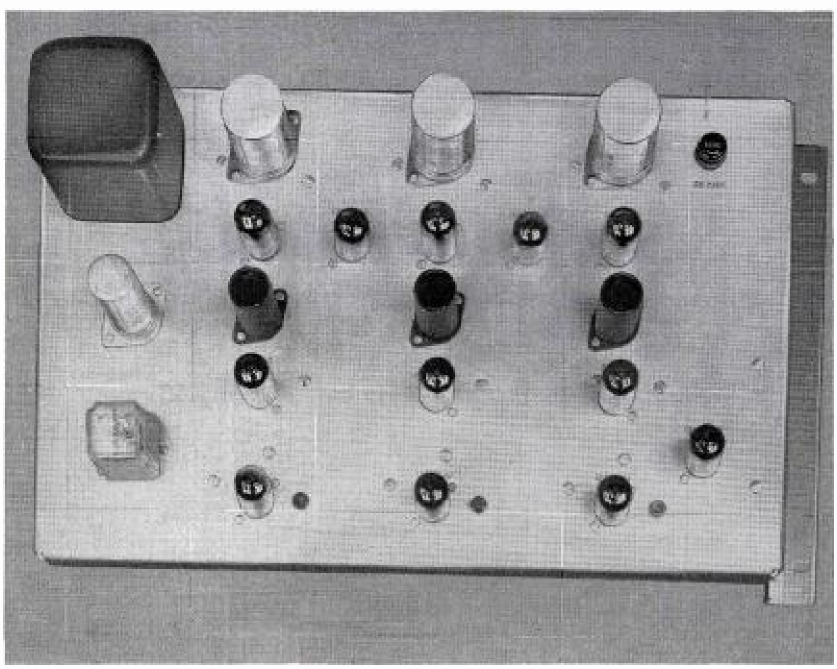


FIG. 11. Output amplifier circuits are housed on a single chassis.

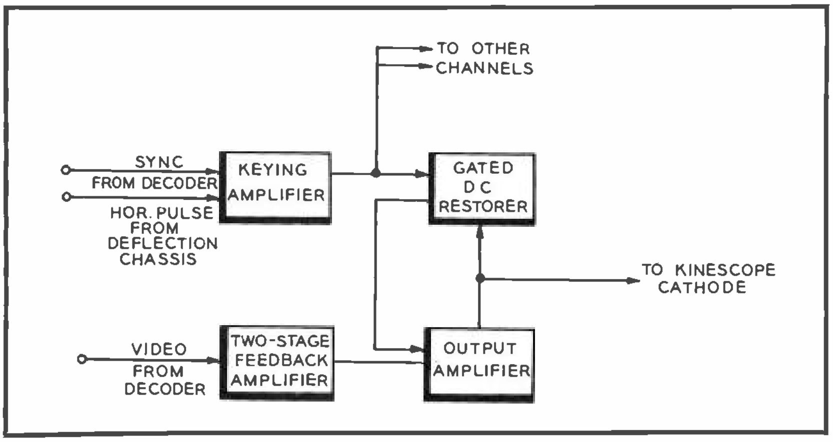


FIG. 12. Simplified block diagram of one output amplifier channel.

(3) Uniform frequency response, in excess of 6 megacycles, is maintained up to the output tube plate circuit. The passive circuitry, which direct-couples each output stage to its respective kinescope cathode, is a series-shunt compensated network that maintains uniform response to about 5.5 MC.

Instead of conventional diode-type DC restorers, the TM-21 employs gated clamps around the final amplifier stages. The three individual clamps are operated from a single reference voltage in such a way that the DC plate voltages for the three output amplifiers are identical. The different grid bias conditions required to maintain this condition are automatically established by the clamp circuits, which sample the outputs at the plates but apply their correction voltages to the grids.

The gated DC restorers are normally operated by separated sync pulses, so that the clamping occurs during the transmission of the special brightness pulse inserted by the decoder. In the event that the sync pulses to the monitor are interrupted, con-

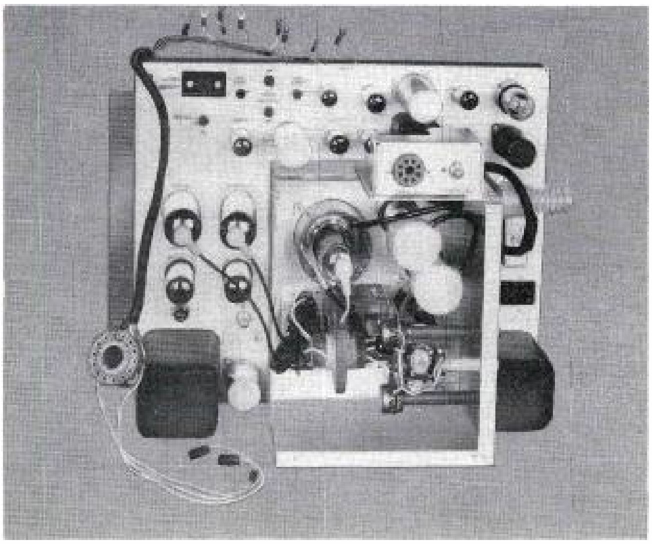
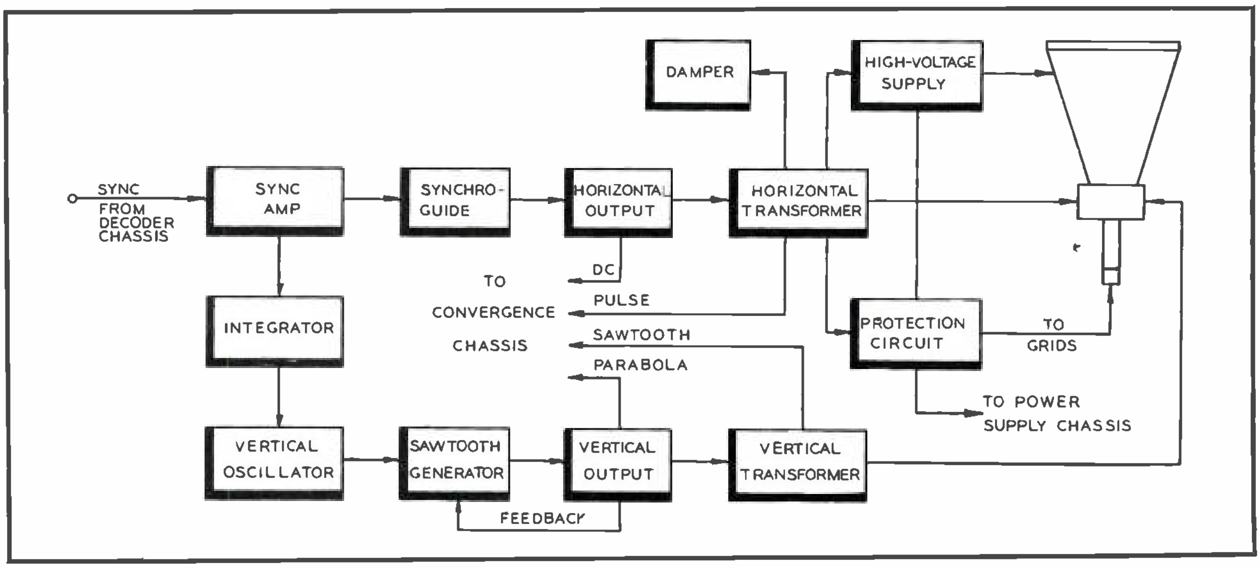


FIG. 13. Deflection and high-voltage chassis.

FIG. 14. Block diagram of deflection, high voltage, and protection circuits.



trol of the clamping operation is automatically taken over by horizontal pulses derived from the deflection chassis. This prevents prolonged operation under improper bias conditions. When the monitor is operated under no-signal conditions, the brightness pulse is absent, but the monitor operates safely with a gray screen of about 20 per cent maximum luminance.

Deflection Circuits are Feedback Stabilized

While the deflection circuits in the TM-21 are based on conventional principles, they include a number of design refinements that are worth pointing out. The circuits are mounted on the chassis, shown in Fig. 13, and their operation is illustrated by the block diagram, Fig. 14.

The vertical deflection circuit is stabilized by a feedback connection between the output stage and the sawtooth generator. This arrangement not only makes the circuit highly immune to variations in supply voltages and tube characteristics, but also permits the vertical size (or height) to be adjusted over wide limits without disturbing the scanning linearity.

The horizontal deflection oscillator and sawtooth generator is a refined version of the conventional synchroguide circuit, offering a good combination of stability, noise immunity, and optimum phasing of the horizontal retrace period. Added stability is provided by "beefing up" the horizontal output circuit to provide generous reserve factors. While typical receiver designs use a single horizontal output tube to deflect the 21-inch color kinescope, the TM-21 employs a pair of 6CD6-GA's in parallel to perform this function, and a pair of 6AU4GTA's to serve as dampers. An unusual type of bifilar winding is used in both the horizontal and vertical output transformers to facilitate the introduction of centering current without requiring bulky isolation chokes around the centering potentiometers.

A unique and significant feature of the TM-21 deflection chassis is the provision of an operational "size" switch for switching rapidly from a normal rounded-side picture to a reduced-sized picture that permits observation of the corners. This switch operates on both the horizontal and vertical circuits simultaneously.

High Voltage Chassis Includes Protection Circuits

The high voltage supply for the kinescope ultor is of the conventional "kickback" type, conservatively designed to deliver all the high-voltage power that the kinescope can safely utilize (1.25 ma at 25 kv). A pair of shunt regulator tubes maintain good regulation under all operating conditions.

Because of the reserve power and signal voltages available to operate the color kinescope near the upper limits of its performance capabilities, special attention has been given to the design of protection circuits to guard against damage to the kinescope in the event of certain failures or improper operating conditions. If the beam current becomes excessive, resulting from improper operating voltages or excessive, video drive, the bias on the kinescope grids is automatically shifted to a safe value to prevent damage to the shadow mask. In the event of horizontal deflection failure, extreme overdrive, or a short-circuit in the high voltage system, the protection circuit not only cuts off the kinescope guns but also disconnects the main +B supply on the power supply chassis. The protection circuit itself is designed to be "fail safe," so that failure in any of its components will turn the monitor off.

Convergence Circuits Designed for Easy Set-Up

The convergence chassis, shown previously in Fig. 4, contains purely passive circuits for modifying certain waveforms derived from the deflection chassis before applying them to the convergence yoke surrounding the kinescope gun structures. The word "convergence," as applied to color-display devices, refers to the process of adjusting the positions of the red, green, and blue beams so that the respective images are registered in all parts of the screen. Because the effective distance between the guns and the screen assembly varies with the deflection angle, it is necessary to control the convergence with dynamic waveforms containing both horizontal-frequency and vertical-frequency components. The basic waveforms consist of a parabola and a sawtooth at each frequency, but these must be mixed in different proportions for each gun.

In the TM-21, unusually good performance with respect to convergence is made possible by the conservative design of the deflection circuits, which provide good waveforms to start with. As indicated in Fig. 14, both the output tubes and the output transformers serve as signal sources for the convergence circuits. Stability and ease of operation were given strong emphasis in the design of the convergence section of the TM-21. An examination of the convergence control panel, shown in Fig. 15, will show how the operation of this section of the monitor has been greatly simplified. Two features of the convergence circuit design which particularly facilitate a straightforward set-up procedure are: (1) the controls are arranged so that the red and green rasters may be adjusted as a pair, relative to each other, after which the blue raster may be brought into registration relative to the red-green pair, and (2) every control has been made to direct some type of movement in either the horizontal or vertical direction, not along the 120-degrees axes that prove to be quite confusing in conventional convergence arrangements.

The large number of convergence controls needed for a tricolor tube (16 in the case of the TM-21) need not seem too formidable if each one performs some readily-understood function. Those used in the TM-21 are so designated and arranged on the control panel that it is easy to visualize them as trimming adjustments for the deflection circuits. There are only five basic types of controls (see Fig. 15) and these are readily understood. The *position* controls are only trim adjustments for the centering function, while *size* and *linearity* carry the same connotation as in conventional deflection systems. The *tilt* and *bow* controls produce these effects on the lines of the grating pattern commonly used to facilitate convergence adjustments. The *bow* control affects the curvature of the lines, while the *tilt* controls are used to make them parallel.

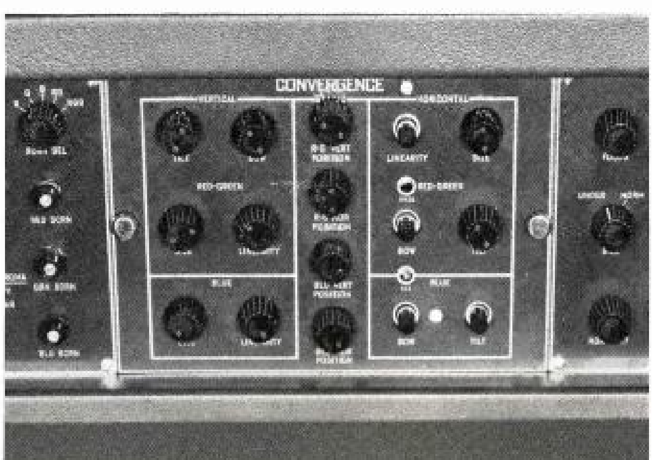


FIG. 15. Convergence control panel.

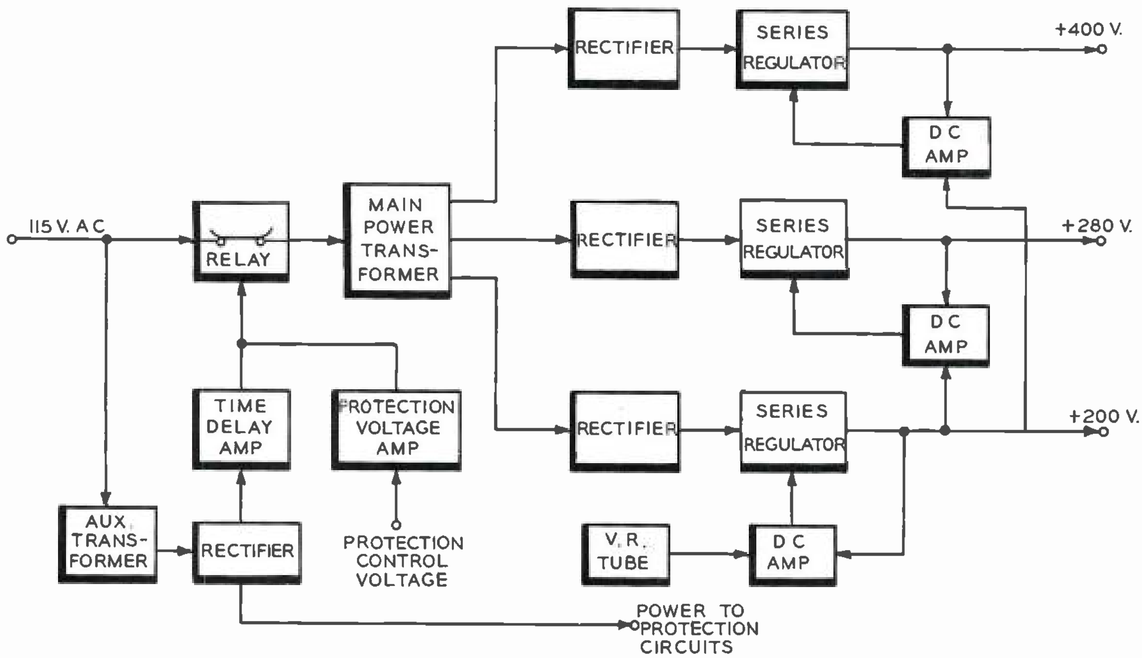


FIG. 16. Block diagram of three-in-one power supply.

Note that the controls are logically grouped in two ways. The *vertical*, *static*, and *horizontal* adjustments are located in separate columns. The upper controls in each column adjust the red and green rasters relative to each other, while the lower controls adjust the blue raster relative to the red-green pair. A screen selector switch just to the left of the convergence control panel makes it possible to view any of the rasters separately, or to view only the red-green pair.

Three-in-One Regulated Power Supply

The power supply for a piece of electronic equipment is often taken for granted as a circuit of obvious function and little significance. In the case of the TM-21, however, the power supply plays a vital role in helping the other sections of the monitor do their jobs properly. The purpose of a regulated supply is to eliminate the interactions and cross-coupling between circuits that occur if supplies of appreciable source impedance are used. Also, the stabilization of the output voltages against line voltage changes preserves the performance designed into the other circuits.

The block diagram, Fig. 16, indicates that the TM-21 supply is actually three power supplies in one. It provides the optimum regulated voltage for each section: +400 volts for the deflection circuits, +200 volts for the video output amplifiers, and +280 volts for most of the other circuits. Since the load requirements were definitely known in each case, an optimum degree of regulation is incorporated without costly over design. As shown in Fig. 16, a common transformer serves all three supplies, but they have separate rectifiers and series regulators. All three are tied to a common voltage-reference system, so that calibrating the +200 volt section automatically sets the others to their proper values. The use of precision resistors in this common voltage reference system eliminates the need for several controls that would otherwise be required.

The use of cool and efficient germanium rectifiers makes it desirable to delay the application of plate voltage to the series regulator tubes until their heaters have had an opportunity to reach the proper operating temperature. The main power transformer is energized through a relay which is controlled by an amplifier deriving its power from a small auxiliary transformer and a vacuum-tube rectifier. Delay is provided by the warm-up cycles of the auxiliary rectifier and the amplifier itself. Time constants give the proper delay when the the monitor is turned off and on again quickly. The same auxiliary power source also supplies current to the protection circuit in the deflection unit. The protection control voltage also operates through the same relay as the time delay amplifier to disconnect the power supply automatically in the event of a failure in the horizontal deflection or high-voltage circuits.

The power supply is mounted on a separate chassis, similar in mechanical design to those used for the other sections of the monitor, see Fig. 19. Note that a number of fuses are provided to protect individual sections of the circuit. All fuse-holders are of an indicating type, so it is easy to determine which fuse has blown in the event of trouble.

Rapid Set-Up Procedure

Strictly speaking, a television monitor should not require "operation" because its function in a television system is to serve as a tool for an operator. His main job is to operate a camera, to check the quality of signals, or to select the proper signals for a television program. On the block diagram of a complete television system, the monitors are properly shown as appendages, not as main links in the equipment chains. It is desirable, therefore, to make a monitor so stable that its operation may be taken for granted throughout most of the working day, leaving the operators free to concentrate on their major functions. Such stability has been achieved in the TM-21, so its "operating" controls are more properly called "set-up" controls. Even though the set-up procedure need

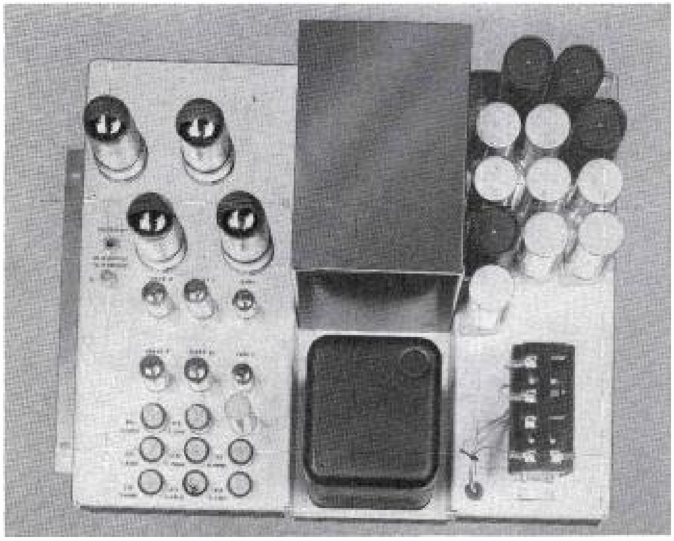


FIG. 17. Three-in-one power supply chassis.

not be carried out very often, no effort has been spared to make the procedure as rapid and straightforward as possible.

All of the controls needed for routine set-up of the TM-21 are mounted on the front panel, which is logically divided into three sections. The center section contains the convergence controls, which were discussed previously. The right-hand side of the panel (see Fig. 18) contains the deflection controls, whose functions are made obvious by clear labeling. Note that the FOCUS control is included in this section of the control panel, along with an A-C RESET button which restores the monitor to normal operation when the protection circuit trips it off. The SIZE switch is mounted directly under the FOCUS control.

The left-hand section of the control panel, shown in Fig. 18, contains the controls for adjusting the decoder and for setting up the kinescope for proper color balance. It is in this section of the panel that the TM-21 differs most radically from conventional color monitor or receiver designs. Not only are there fewer controls to contend with, but also the controls are designed to facilitate an unusually straightforward set-up procedure, requiring no external test apparatus other than a source of standard color-bar signals. While some of the controls shown in Fig. 18 are quite obvious, it may be helpful to describe briefly what they do in terms of the circuits they actually control.

The BRIGHTNESS control produces the same effect as conventional brightness controls, even though it operates in an unusual manner. Instead of varying the bias on the kinescope, it varies the level of a special pulse added to the signal in place of the normal sync and burst signals, see Fig. 19. This technique is made feasible by the use of keyed clamps in the output amplifiers, which operate during the time interval of the added pulses. The virtue of this brightness control technique is that it eliminates the need for individual red, green, and blue background controls. The single BRIGHTNESS knob automatically exercises the proper degree of control over the three color channels because the added pulse is passed through the standard decoder matrix.

The CONTRAST control varies gain of input stage in the decoder (see Fig. 7), and varies the monochrome and chrominance components of the picture equally.

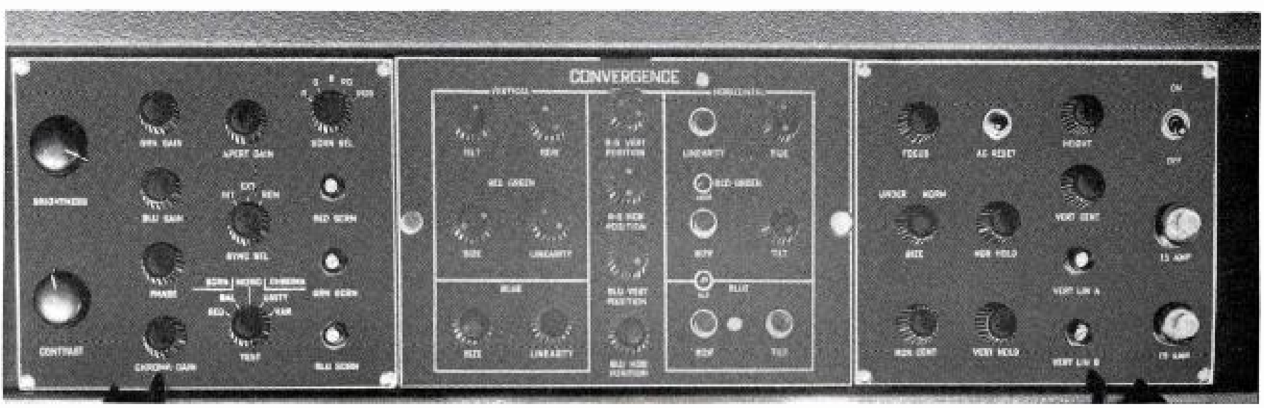
The SYNC SELECTOR enables the operator to switch conveniently between external sync and the internal sync pulses separated from the composite video signal. In the REMOTE position, this switch brings the sync interlock into operation, so that the use of internal or external sync is controlled from a remote point (such as a switcher) through a DC control lead.

The APERTURE COMPENSATOR adjusts the degree of high-peaking in the monochrome channel for optimum picture sharpness without objectionable overshoots.

The TEST switch is the key to the simplified set-up procedure for the TM-21. By moving this switch through its several positions and making specific adjustments at each step, the monitor can be brought into proper operating condition with a minimum of effort. Now, let us go through each of these steps rapidly following the diagrams on the facing page.

In the first position, the signal is automatically disconnected, but a fixed brightness pulse remains. In this position, the RED SCREEN control is adjusted for cut-off. (See Fig. 20A.) The SCREEN

FIG. 18. Close-up of control section. Located left to right are decoder, convergence and deflection control panels.



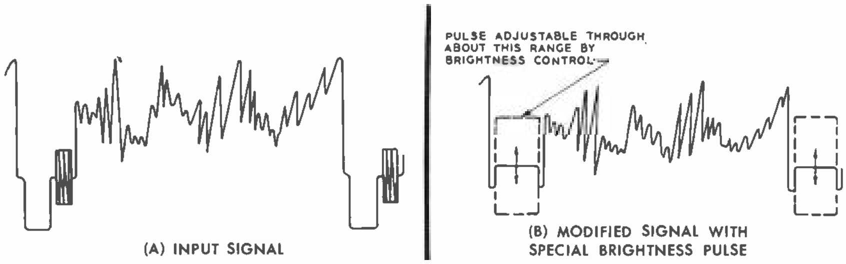


FIG. 19. Waveform sketches illustrating the operation of the BRIGHTNESS control.

SELECTOR switch can be set at R to facilitate this adjustment by cutting off the green and blue beams to avoid confusion.

In the second position, SCREEN BALANCE, both the signal and the brightness pulse are disconnected, and the green and blue screen controls may be adjusted relative to the previously-set red screen to produce a gray screen of approximately 20 per cent brightness. The SCREEN SELECTOR switch must, of course, be in the RGB position for this adjustment. As shown by the sketch, Fig. 20(B), this step brings the kinescope transfer characteristics into coincidence at the point corresponding to about 20 per cent of the maximum signal level.

In the next position, MONOCHROME, both the brightness pulse and the signal are applied, but the chrominance circuits are disabled. In this position, the green and blue GAIN controls may be set to provide proper color balance in all parts of the gray scale. This adjustment is facilitated by the use of a signal containing a gray-scale pattern.

As shown in Fig. 20(c), the absolute signal amplitudes required for the three guns are different because of different phosphor efficiencies. When the proper adjustments are made, however, and the signal scales are normalized, the effective transfer characteristics are essentially coincident, see Fig. 20(d).

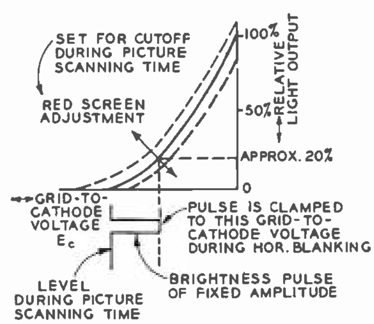
The next position, UNITY CHROMA, is the normal operating position, in which the signal is applied to both the monochrome and the chrominance channels. The CHROMA control is inoperative in this position, and the saturation of the colors in the picture yields a good indication of the quality of the incoming signal. The PHASE control may be set conveniently while in the UNITY CHROMA position by examining the blue component of a standard color bar signal (using the B position of the SCREEN SELECTOR switch). When the phase adjustment is correct, the standard color bar signal produces four blue bars of equal brightness as shown in the rapid set-up chart, page 41. If the phase adjustment is incorrect, the blue bars are of unequal brightness also shown on rapid set-up chart. This test is very sensitive, particularly if the brightness is temporarily reduced to place the blue bars near cut-off on the kinescope characteristic.

In the final position of the TEST switch, VARIABLE CHROMA, the conditions are the same as for the UNITY CHROMA except that the CHROMA control is made operative. This position is intended for operation in applications where the monitor is used to make the most pleasing pictures, even though the signals available are slightly substandard. The CHROMA CONTROL is simply set for the most pleasing over-all effect.

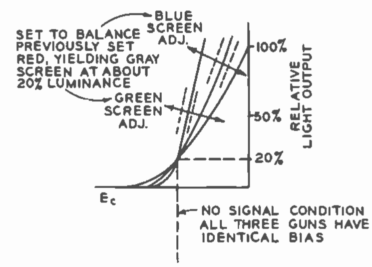
The TEST switch can be used to make a rapid test of the convergence adjustments in the monitor. If there is any uncertainty in the viewing of a color picture as to whether observed misregistration is a fault of the signal or of the monitor, it is only necessary to place the TEST switch in the MONOCHROME position. If the color fringes disappear, they are clearly a fault of the signal, while if they remain it is necessary to touch up the convergence adjustments of the monitor itself.

Conclusion

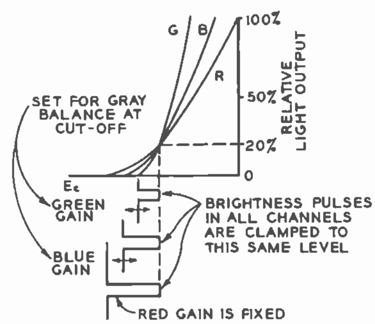
Design and production of this new 21-inch Color Monitor, Type TM-21 represents a significant advance in the "state of the art" in color television. Its test equipment design allows it to be used as a new "standard of reference" for color systems. Color telecasters everywhere will find many applications for this new monitor as a general purpose color monitoring instrument, as an adjunct to color camera chains, and as a high quality display device in clients' and reception rooms.



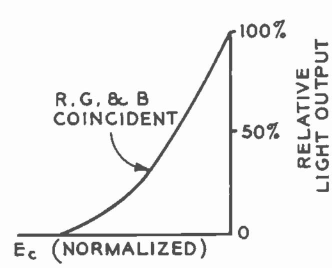
(A) ADJUSTMENT OF RED SCREEN



(B) ADJUSTMENT OF BLUE AND GREEN SCREENS



(C) ADJUSTMENT OF BLUE AND GREEN GAINS



(D) NORMALIZED CURVES AFTER CORRECT ADJUSTMENTS

FIG. 20. Sketches illustrating the procedure for setting color balance in the TM-21. Note: All light output scales are normalized so that 100% R + 100% G + 100% B = 100% White.

5 Easy Steps for Color Monitor Set-up

The rapid set-up chart on these pages pictures the five easy steps for color monitor alignment. Both procedures and results are illustrated to give the operator a clear indication of proper adjustments.

The key to these simplified procedures is the TEST switch. By moving this switch through its several positions, the color monitor can be brought into proper operating condition with a minimum of effort.

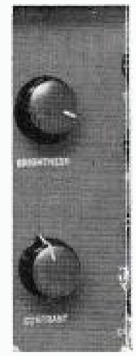
Coupled with the extra stability of the TM-21 design, this rapid set-up feature virtually eliminates "operation" of the monitor. Television operators can have confidence that the pictures on the monitor are a true indication of the signal being fed to it. Once set up, the monitor will not require readjustment for long periods of time. Should imperfections appear in the picture, the monitor can be quickly checked out.

Designed "from the ground up" to meet the requirements of color television stations, the TM-21 Color Monitor can be used in many applications for general purpose monitoring as well as display purposes in clients' and reception rooms.

Editor's Note: The illustrations shown here were taken from the monitor screen with a 35-mm Kine Exacta V. Super Anscochrome film (Daylight, ASA 100) was exposed at f 2.8 at 1/5 second and given normal laboratory processing. In obtaining final engravings, the pictures were not retouched or corrected in any way.

1

Turn test switch (TEST) and screen selector (SCRN SEL) to red screen (R). From full clockwise position, turn red screen control (RED SCRN) counter-clockwise to the cut-off point.

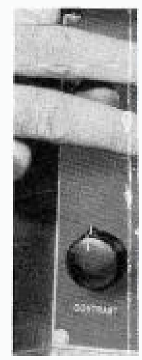


2

Turn test switch to screen balance position (SCRN BAL), screen selector to RGB. Adjust green and blue screen controls (BLU SCRN and GRN SCRN) for gray raster as illustrated. Note: Do not use RED SCRN control for this adjustment.

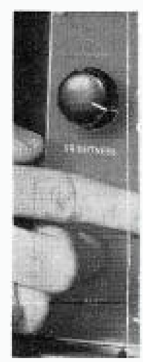
3

Turn test switch to monochrome position (MONO), leave screen switch of RGB. Adjust blue and green gain controls (BLU GAIN and GRN GAIN) for proper gray scale tracking as illustrated.



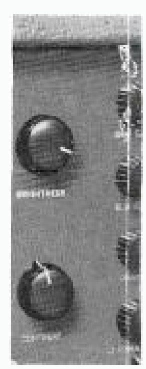
4

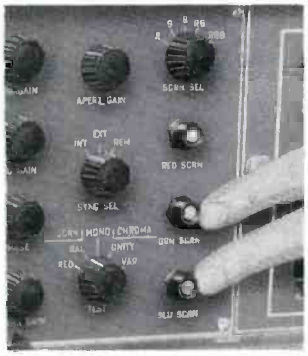
Turn test switch to UNITY CHROMA, screen selector switch to blue (B). Adjust PHASE control for four blue bars of equal brightness as illustrated. Note: incorrect adjustment of this control is illustrated by photos labeled INCORRECT.



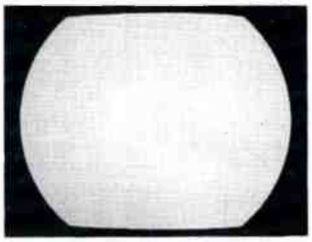
5

Following the blue bar phase adjustment, observe separately (by means of the screen selector) the red, green and composite (RGB) color bar patterns shown.

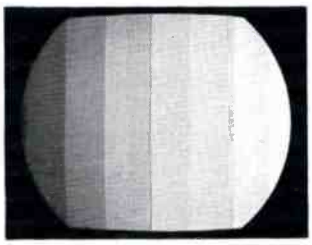




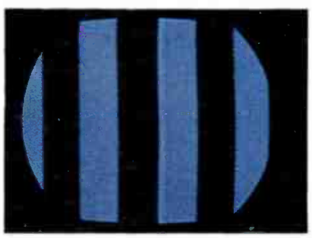
GRAY SCREEN



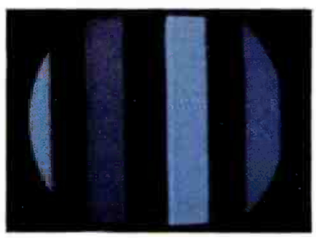
GRAY SCALE



CORRECT

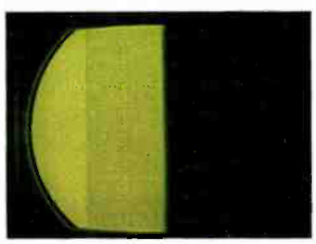


INCORRECT

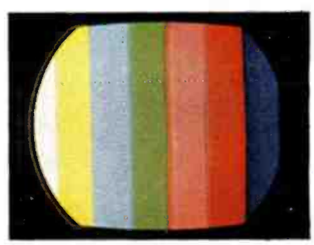


RED BARS

GREEN BARS



COMPOSITE (RGB)



THE ULTRAVIOLET COLOR-TRANSLATING TELEVISION MICROSCOPE

Permits Continuous Observation of Unstained Living Cells so That Chemical Composition Can be Determined Rapidly and Morphology Changes Detected Immediately

Color television joins the hunt for new information about microorganisms by providing the biologist with a new research tool. The Ultraviolet Color-Translating Television Microscope (UVCTM) is now making the study of living cells under normal conditions more practical. It not only makes possible observation of cell structure, but it also translates the chemical composition of the cell into visible color.

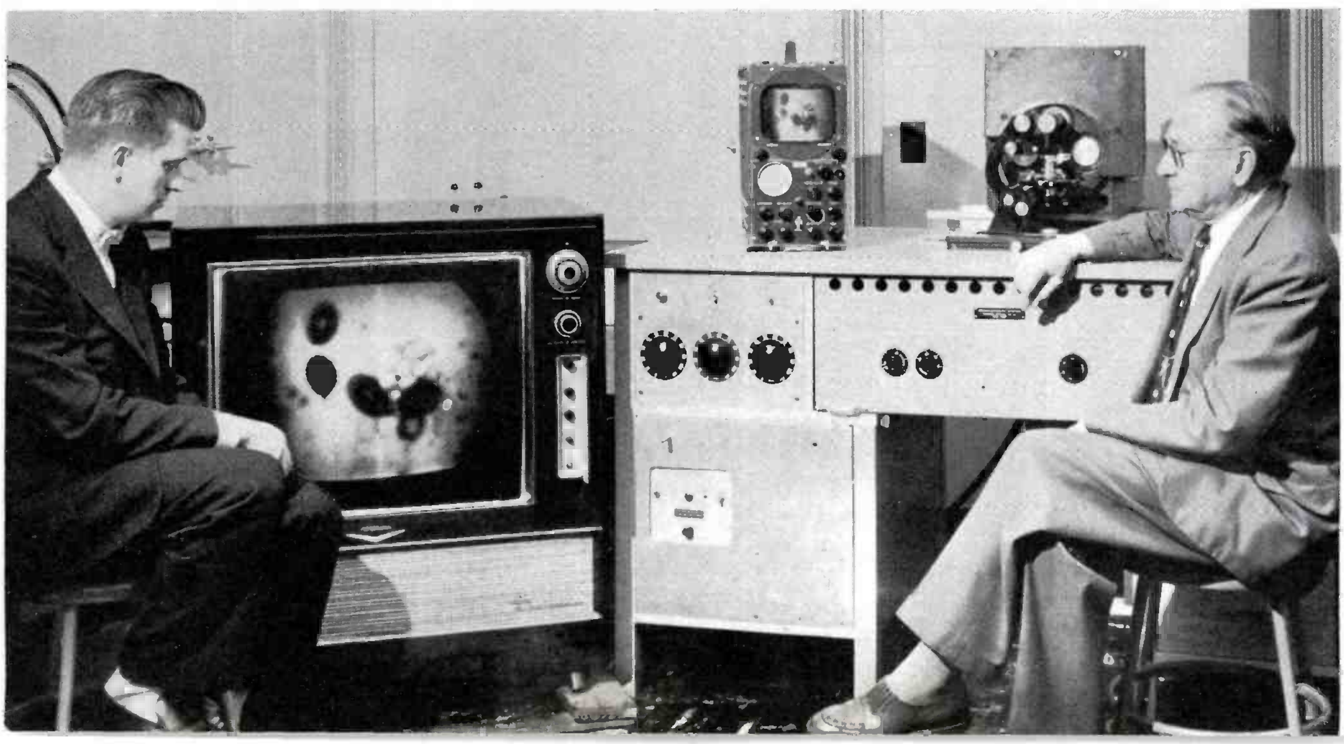
Prior to development of the ultraviolet microscope, it was almost impossible to study organisms under normal conditions. The electron microscope, for example, usually destroys the object being studied by bombarding it with a stream of electrons. The visible light microscope, on the other hand, is inadequate because the cell appears to be a transparent mass of protoplasm in visible light. In order to reveal cell structure, it is necessary to stain the cell with an aniline dye, such as methylene blue. This, however, usually kills the cell. Only the ultraviolet microscope does not harm the cell or effect its normal operation. The application of color TV perfects the ultraviolet principle, enabling the microscopist to study live specimens continuously.

This Ultraviolet Color-Translating Television Microscope was developed by Dr. Vladimir K. Zworykin, Director of the Rockefeller Institute's Medical Electronics Center and honorary Vice President of Radio Corporation of America (see Fig. 1). Dr. Zworykin was assisted by Fred L. Hatke and recently by Carl Berkley of the Rockefeller Institute staff. The highly sensitive image orthicon used in the camera was specially developed by the Electron Tube Division of RCA.

What it Does

Since its development in 1904, the ultraviolet microscope has undergone few changes (however, with the addition of color TV, operation time can be reduced and better results can be obtained). The basic type of ultraviolet microscope operates on a spectrograph principle. The elements that make up a cell will absorb or attenuate various wavelengths of ultraviolet light, particularly in the range from 2200 to 3000 angstroms. (One centimeter is equal 100,000,000 angstroms.) Three wavelengths of ultraviolet are selected and then they are successively passed through a cell, and allowed to fall on a color nega-

FIG. 1. A new ultraviolet color-translating television microscope has been developed at the Rockefeller Institute which will enable scientists to study better the function, structure and chemistry of living cells. Shown at left is Fred L. Hatke, electronics engineer, and at right Dr. Vladimir K. Zworykin, Rockefeller Institute Affiliate and honorary vice-president of RCA.



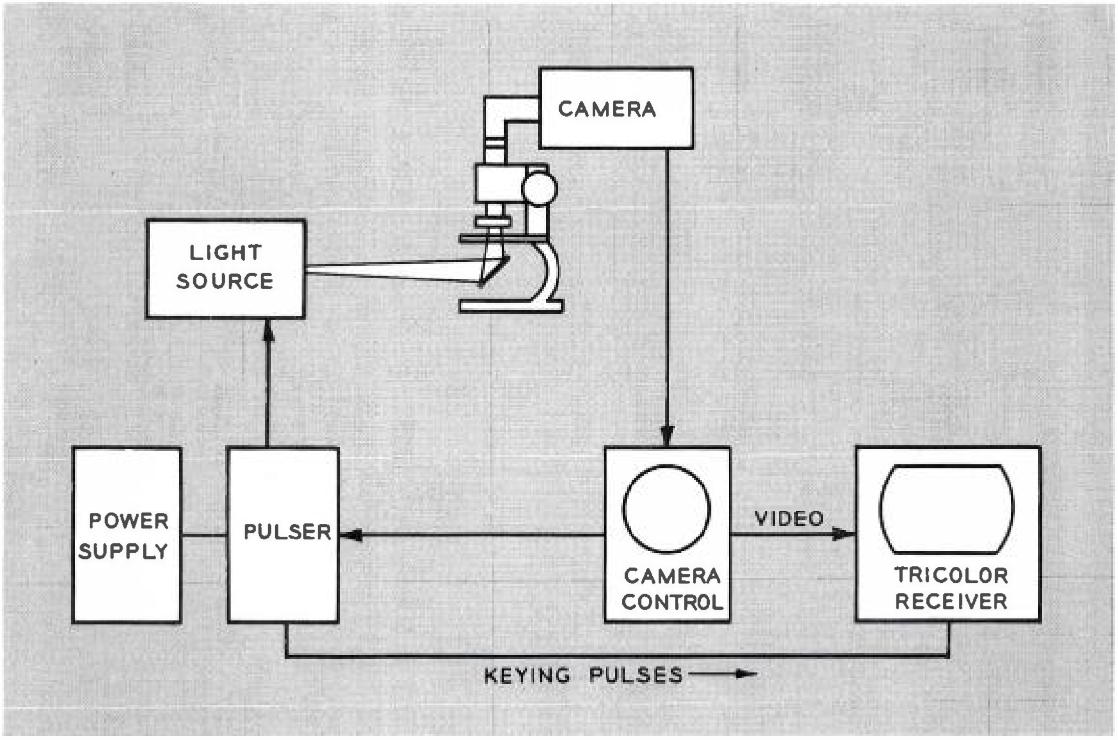


FIG. 2. Basic plan of the Ultraviolet Color-Translating Television Microscope.

tive. The negatives are then used to print a composite photograph in the three visible colors of red, green and blue. The processing of the film required considerable time and errors could not be detected immediately. The addition of color TV eliminates the time delay between exposure and observation. Now, changes in spectral absorption and morphology can be detected immediately.

How it Works

The basic plan of the UVCTM is shown in Fig. 2. A microscope with reflective condenser and objective projects the image on the photosensitive target of a television camera, whose video signal is employed for the reproduction of an image of the specimen on the screen of a color television receiver. Illumination is provided by one or several pulsed light sources and monochromators so arranged that radiation of the three selected ultraviolet wavelengths falls on the specimen at successive pulses. The pulse source also controls the vertical deflection in the camera and receiver in such fashion that the pulses of illumination occur during vertical fly-back time. Thus the picture signal stored by a radiation pulse of a particular ultraviolet wavelength is being utilized for generating a component picture of the corresponding color in the succeeding frame period.

The UVCTM is unique in its ability to translate the chemical composition into visible light on a color TV screen, and its ability to allow continuous observation of the cell. Since ultraviolet displays many properties that are similar to visible light it may be treated in almost the same manner. However, ultraviolet does not easily pass through glass, thus special lenses made of a material such as quartz must be used. A custom-made RCA image orthicon with ultraviolet-transmissive window is employed as camera tube. Three Hanovia 10B1 quartz mercury arc lamps provide the light source for the UVCTM.

Each light source is synchronized with a 60 cycle pulse. (See the block diagram, Fig. 3.) As each light source is pulsed, its light is directed toward the entrance slit of its monochromator. The monochromator operates on a principle similar to that of the dichroic mirror in the broadcast color TV camera. The monochromator is a selective filter that will pass only one narrow band of ultraviolet light. Undesired wavelengths will be eliminated. The output of the tunable monochromator is then directed toward a rotating 45 degree mirror, where it is reflected into a microscope substage. Each light source is pulsed when its light will pass through its monochromator, and fall perpendicular to the surface of the mirror. The rotation of the mirror is synchronized with the same 60 cycle signal that pulsed the light. As the mirror passes each monochromator exit slit, one very narrow band of ultraviolet will be pulsed on. The band of ultraviolet now falls on the rotating mirror, where it will be reflected into the substage of the microscope (see Figs. 4 and 5).

Now basically the three selected wavelengths of ultraviolet have been applied to the microscope substage in succession. The ultraviolet now passes through the cell body where it will be absorbed or attenuated by the elements that make up the cell. The ultraviolet light has in effect been modulated, at least its intensity is no longer constant.

On the viewing end of the microscope the special highly sensitive image orthicon will respond to these variations of the ultraviolet light. The black and white camera is more or less conventional in its circuitry. Only one image orthicon is used, and its deflection is synchronized from the same source that pulsed the light sources. The output signal from the camera is fed to the grids of the tri-color kinescope. (See block diagram, Fig. 3.) At the cathodes of the kinescope there are three multivibrators. The keying of the multivibrators follows the same pattern as the pulsing of

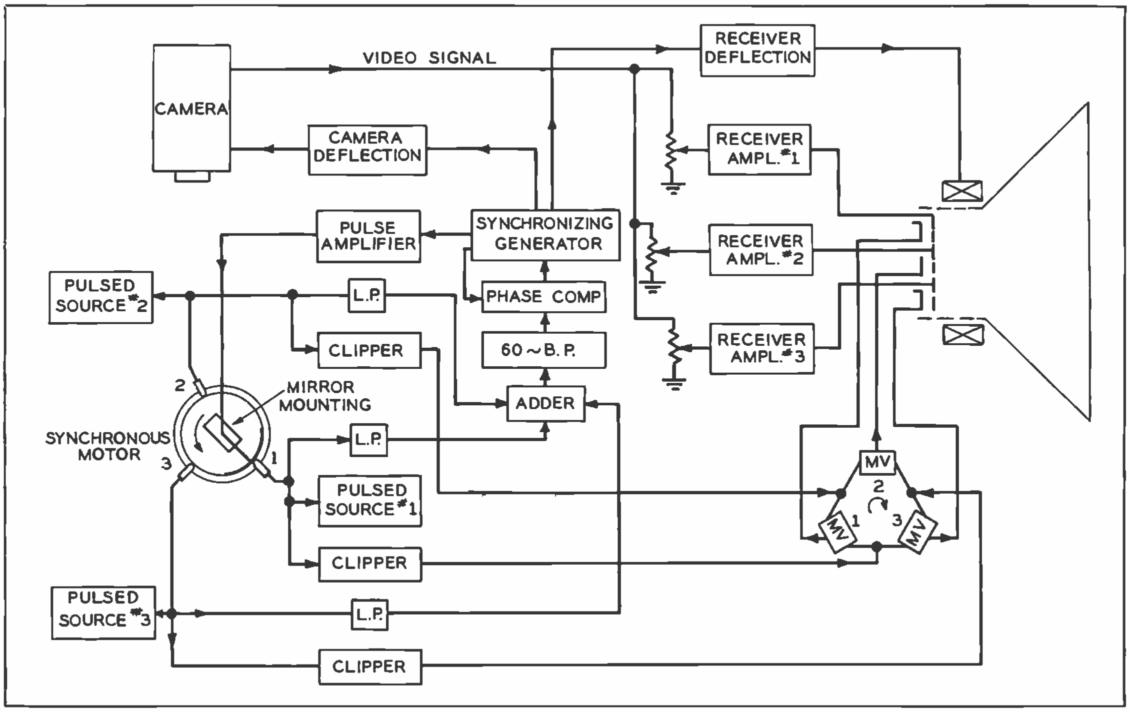


FIG. 3. Block diagram for Ultraviolet Color-Translating Television Microscope.

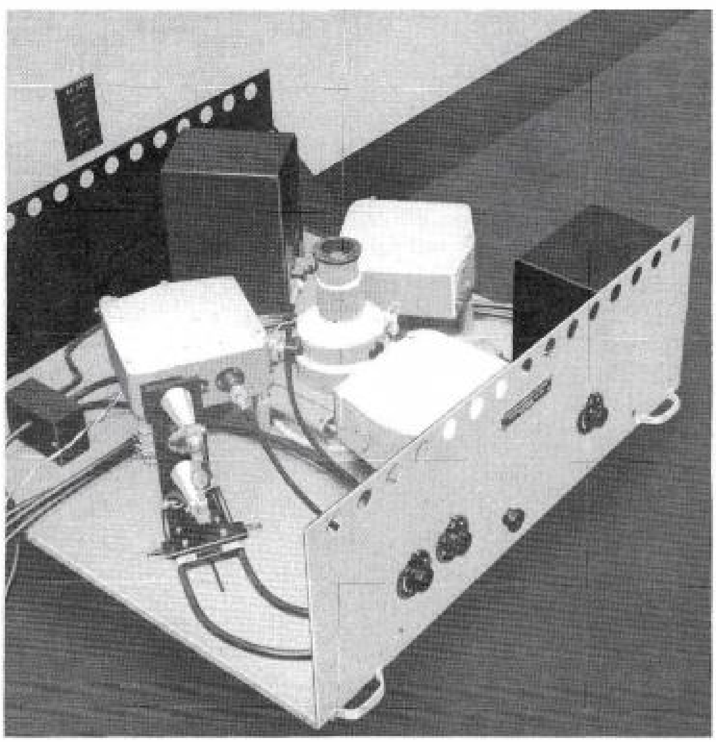


FIG. 4. Illuminating system for Ultraviolet Color-Translating Television Microscope.

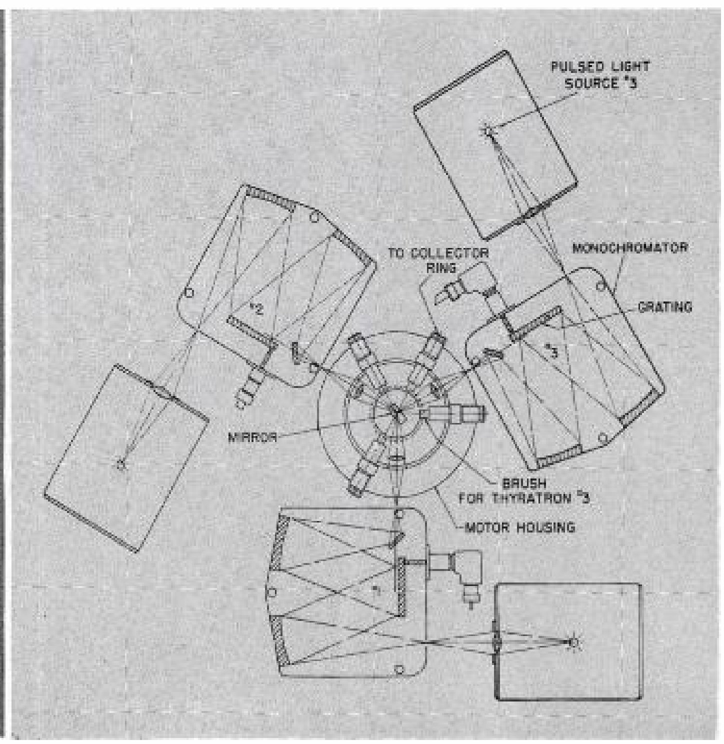
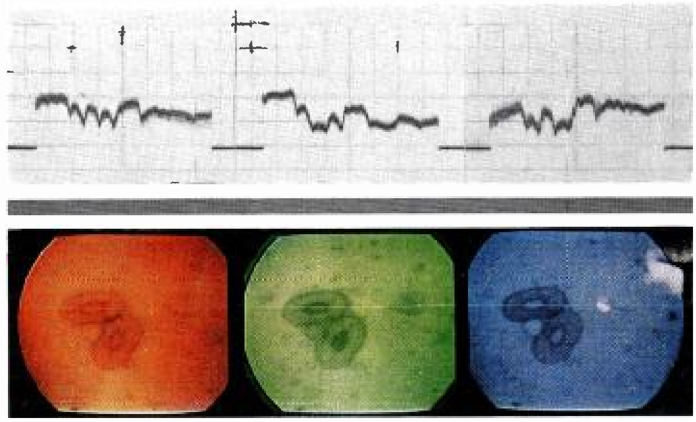


FIG. 5. Schematic diagram of illuminating system for UVCTM.

the light sources. Each time one of the light sources is pulsed one of the picture tube cathodes is keyed in. The remaining two cathodes remain cut-off, until the following light is pulsed on. Then one of the other cathodes will be keyed in while the first is keyed out and the third remains cut-off. This sequence follows one after another until all three colors have been used to scan the picture.

FIG. 6. Separation positives of composite picture, showing individual fields and oscilloscope tracings of line selected video. The specimen is frog blood viewed at 315 mu (Red), 265 mu (Green), and 400 mu (Blue).



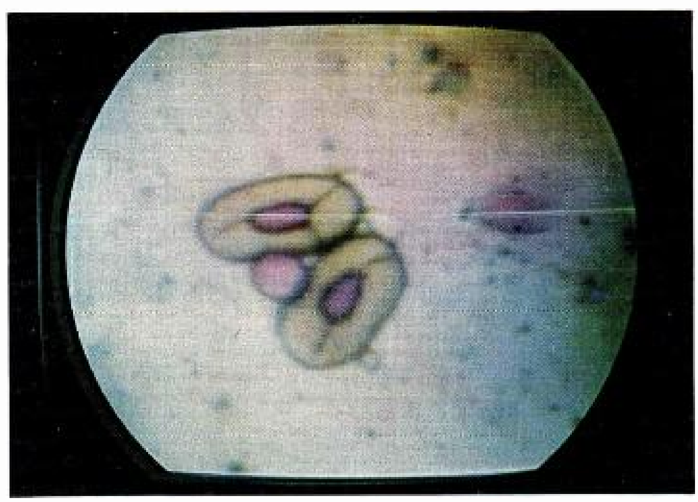


FIG. 7. Composite picture of frog blood produced by Ultraviolet Color-Translating Microscope as viewed on screen of color TV receiver.

Operation of Ultraviolet Color-Translating Microscope

The reproduced picture will be a composite, similiar to the photograph produced from the three negatives (see Fig. 7). This final picture will contain visual colors of red, green, and blue, which correspond to the three originally selected wavelengths of ultraviolet. The saturation of a particular color will indicate to what degree its corresponding wavelength of ultraviolet has been absorbed. The visual inspection, however, is not an accurate method of analysis. More accurate results may be obtained by connecting a line-selector oscilloscope to the red, green, and blue amplifier outputs. As a line is scanned its waveform will appear on the oscilloscope screen. Since each color represents one of the ultraviolet wavelengths it is now possible to measure the absorption of each wavelength. The oscilloscope can be calibrated for the amount of attenuation. The peak to peak voltage of the three video signals can now be used to measure the amount of absorption of the three ultraviolet wavelengths. This calibration of the oscilloscope provides an accurate measurement.

The UVCTM is not a technically complicated device, but its applications help to solve some of the more difficult problems of the microbiologist. A skilled microscopist can be trained to use the UVCTM in a few days. The quantitative chemical analysis of cells can be performed accurately, and in a fraction of the time required in the old type of ultraviolet microscope. At the same time the cells being observed remain unchanged, since they have not been stained or otherwise altered. Also the dosage of ultraviolet light is at a minimum. The pulsed light is only allowed to fall on the cells for only a short time. This chopped radiation is less damaging than continuous exposure to ultraviolet light.

Conclusion

In a lecture before the faculty of the Rockefeller Institute Dr. Zworykin stated that, "Every advance in the design of microscopic techniques has been followed by comparable strides in biological and medical discoveries. This has been true in the introduction of the light microscope, spectrograph, and the electron microscope." The possible applications are enormous. The measurements of proteins and nucleic acids, the basic components of living things, have been greatly simplified with the UVCTM. It will also permit biologists to do more study on the structure of the chromosomes, the tiny bodies that determine heredity.

In summary, the television color-translating microscope makes it possible to examine unstained living material in the ultraviolet with singular ease and discrimination of detail. Furthermore, since any primary color may be correlated with any characteristic absorption wavelength in the ultraviolet, the range of "electronic stains" which may be employed in the color translation technique is extraordinarily wide. Thus the television color translating microscope should prove not only a powerful tool in the study of vital processes in normal and abnormal cells and tissues, but may also become a valuable aid in diagnosis.

RCA ORBITERS EXTEND IMAGE ORTHICON LIFE IN COLOR AND MONOCHROME OPERATION

Built-in RCA Orbiters Feature Remote Control . . .
Require No External Units to Mount on Camera

by S. L. BENDELL *and* K. SADASHIGE, *Broadcast Studio Engineering*

The effective life of the image orthicon tubes in live camera service is significant to TV broadcasters in that IO tube replacement represents a considerable share of station operating costs. As a result, RCA engineers have developed two orbiters, an optical orbiter for color and an electromagnetic orbiter for monochrome. They substantially increase the life of image orthicons. In principle, these devices rotate the camera image in a slow continuous eliptical orbit, undetectable to the TV viewer. The motion is sufficient to prevent "sticking" or "burn-in." Damage caused by these phenomena often requires that the tube be replaced; hence, the RCA orbiters allow such tubes, whose other characteristics have not deteriorated to continue in service.

Cause of Image Retention

Broadcaster experience with image orthicon tubes shows that in most cases a tube is retired because it develops a tendency to "burn-in" or "stick." That is, if a camera is held stationary on a high contrast scene for 10 to 30 seconds or more, that scene (in the form of a well-defined negative image) will persist after the camera is "panned" away. The magnitude of this effect increases with the number of hours of actual tube operation. All image orthicons, even when new, will exhibit some sticking if held on a static scene too long. However, the problem becomes objectionable when the exposure-time required to cause the burn approaches the duration of an average stationary scene encountered in normal programming. The negative image is not permanent, but disappears after an interval ranging from a few seconds to many minutes, depending on the age of the tube and the severity of the burn. It is recognized that a sticking image can be removed more quickly by flooding the photocathode with light, but this is an awkward procedure for broadcast program operation.

Procedures for balancing and registering color cameras require that they be held on test patterns for considerable periods. Sticking under these conditions can become very troublesome. In the case of monochrome the difficulty with sticking on fixed scenes such as weather maps, charts, news commentators, etc., is familiar to all critical viewers of television.

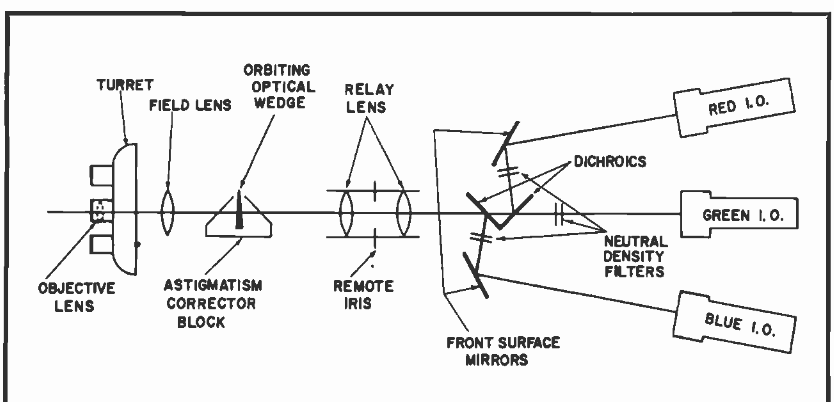


FIG. 1. The optical orbiter fits neatly into the optical system of RCA color cameras between the field and relay lenses.

Why "Sticking" Occurs

The "sticking" effect resides in the thin glass target, but the exact mechanism of its formation is not completely understood. Continuous high-velocity bombardment of electrons emitted from the photocathode together with the scanning of the target by the electron beam causes a net flow of charge through the target glass. As a result, certain physicochemical and electrolytic changes take place in the glass target material. These gradually increase the susceptibility of the tube to target burn.

The photocathode of the image orthicon under all normal operating conditions has, in itself, no tendency for image retention. Ever since the commercial introduction of the image orthicon, much effort has gone into developing improved target materials and into studying the mechanism of target burn, without complete success in finding an ideal material.

It is important to point out that the tendency to stick is aggravated by operating the image orthicon over the "knee," a common procedure in monochrome, but avoided in color cameras. "Over the knee" refers to overexposure (excess light on the photocathode) which produces no further change in the net charge on the target, but rather causes redistribution of electrons in the target in areas surrounding those portions of the picture that are overexposed.

Possible Approaches to Minimizing the Burn Problem

A rather obvious possibility that suggests itself is that of arranging conditions so that no scene can stay in one place on the target long enough to produce a burn. This may be done in any one of the following three ways:

1. Scene motion,
2. Camera motion, and
3. Image motion (without moving either the scene or the camera).

A special case of this last method is orbiting, the technique which is the principal subject of this discussion.

In aligning and registering color cameras it has long been common practice to mount the various test charts on a motor-driven eccentric, which produces a slowly and continuously moving image on the photocathode and also on the target, thereby minimizing burn. Obviously, this idea cannot be used except for specialized applications. Neither is constant motion of the camera itself very practical.

Optical Orbiting Concepts

Rotation or movement of the optical image falling on the photocathode is practical and can be accomplished in a variety of ways. For example, in the RCA color camera a single slowly rotating rim-driven glass wedge, located in a portion of the optical system common to all color channels, is used to make the optical images on the photocathodes of the three image orthicons move in a circular orbit. Since the individual images on the red, green, and blue tubes move together, there is no resultant misregistration. (In monochrome cameras, the small working space in the back of the lens makes it difficult to apply this optical orbiter technique, however, an electromagnetic technique has been developed which will be described later.)

Details of RCA Optical Orbiter

The optical orbiter used in the RCA color camera fits neatly into the existing optical system of that unit as shown in Fig. 1. The rotating optical wedge has a taper of 0.5 degrees and gives a circular movement to the image on the photocathode. An exaggerated deviation is shown in Fig. 2. Here the image moves in a circle whose diameter is approximately 3 percent of picture height. The period of one orbiting cycle is approximately one minute. A small DC motor, acting through a suitable gear train, rotates the optical wedge mounted in the ring gear. See Fig. 3. The small optical taper required for orbiting produces no adverse effects on optical image quality. The complete optical orbiting unit (Fig. 4) is very easy to install in existing equipment and is directly substituted for an existing assembly.

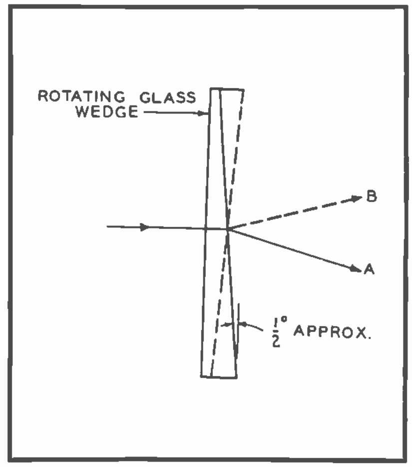


FIG. 2. Sketch showing exaggerated deviation of image resulting from use of optical orbiter.

FIG. 3. Ring gear and optical wedge for the optical orbiter.

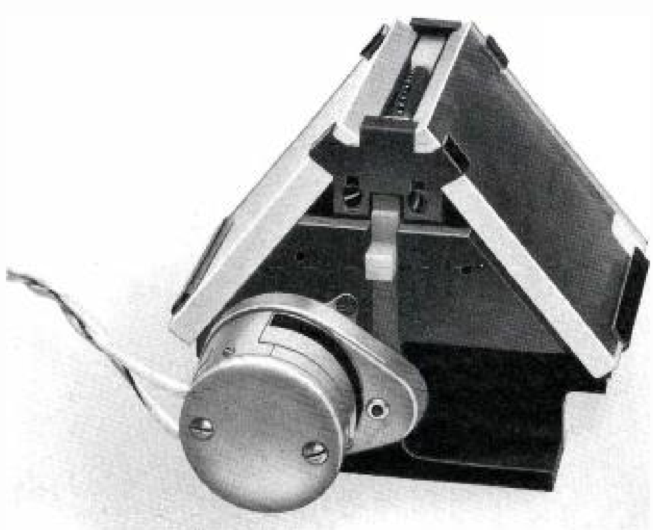


FIG. 4. Complete optical orbiting unit for use with RCA color cameras.

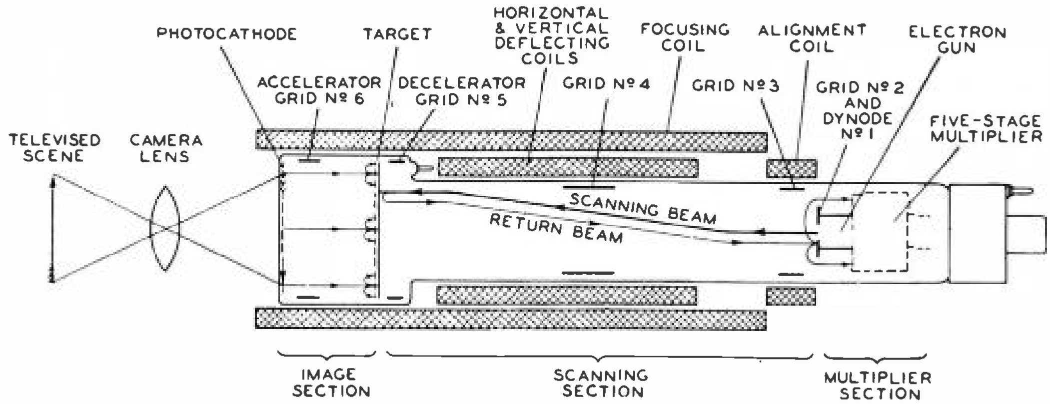


FIG. 5. Schematic diagram of the image orthicon tube showing focus and deflection coil assemblies.

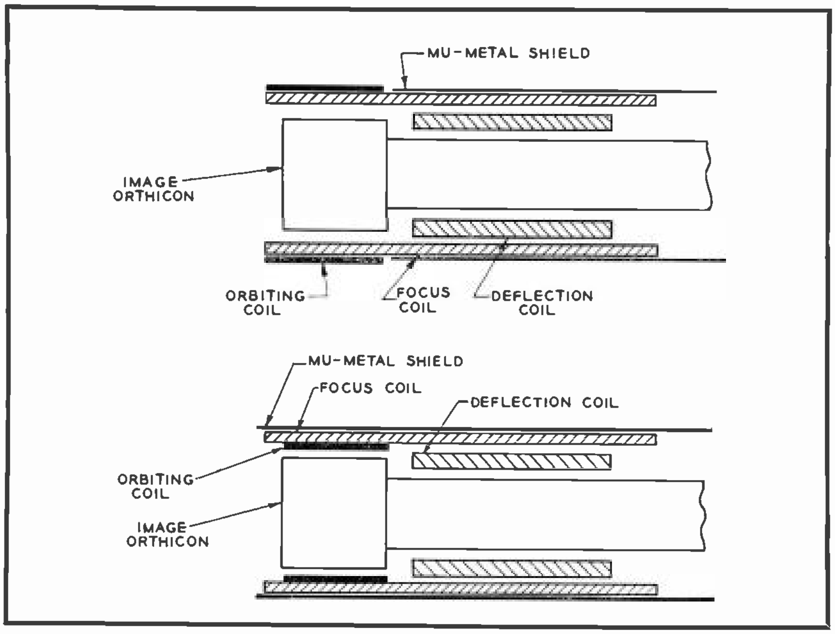


FIG. 6. Diagrams showing how electromagnetic orbiter is mounted on present (top) and earlier (bottom) models of RCA monochrome cameras.

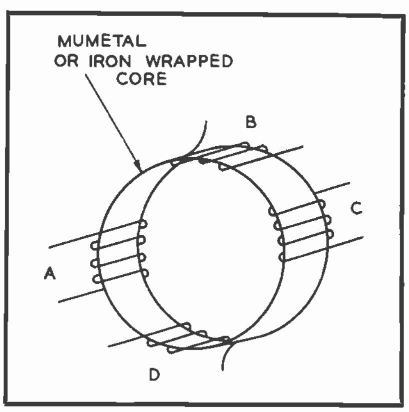


FIG. 7. Sketch showing quadrature windings on mumetal core.

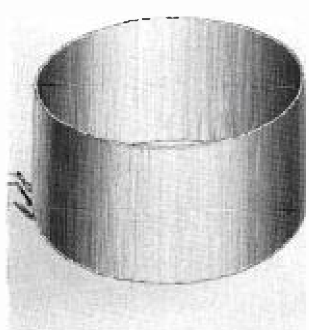


FIG. 8. View of the orbiting coil used with electromagnetic orbiter.

Electromagnetic Orbiting

A suitable deflection yoke placed over the image section of the image orthicon tube, and excited by appropriate currents makes possible a non-mechanical method of orbiting the charge image on the target in its translation from the photocathode to the target. No scanning deflection takes place in the image section. This method, while not practical for color cameras because of the registration problems introduced, is ideal for monochrome cameras.

Operating Principles of the IO Tube

A brief review of the principles of operation of the image orthicon tube may be helpful in understanding the action of an electromagnetic orbiter. A schematic of the image orthicon tube and its focus and deflection coil assemblies is shown in Fig. 5. The focus coil provides a uniform axial field of about 70 gauss in which the tube is "immersed." The combined action of magnetic field and electrode voltages creates a focused image at the glass target of electrons emitted from the photocathode by the action of light from the televised scene. Secondary emission produced by these high velocity electrons striking the target glass causes the formation of a positive-charge image on the thin glass target. This corresponds in detail to the scene being televised.

Electrons emitted from the photocathode, which is at a high negative voltage, are shown striking the very thin glass target. If each electron knocks out three "secondary" electrons on impact, a net positive charge of two units results on the target. The secondary electrons are caught as shown by a fine metallic mesh in front of the glass target.

The charge-image raster is scanned by a focused scanning beam which is deflected by the horizontal and vertical deflection coils. The scanning beam arrives at the target with zero velocity in the absence of light, and no electrons are removed from the beam itself. In this case the return beam goes into the multiplier section and produces *maximum* output current. With light on the photocathode and a positive-charge image on the target raster, only enough electrons are removed from the scanning beam at each point to neutralize the positive charge which exists there. Thus, the return beam is *modulated* by the subtraction of these "neutralizing" electrons. This return beam contains the video signal.

It is evident that a magnetic cross field applied to the image section, at right angles to the normal axial focus field will displace the charge image on the raster. The displacement will follow changes in the direction of this cross field. By making the direction of the cross field change slowly with time, the raster image will move or "orbit" in a small circular path. This variable cross field can be generated by means of a four-winding deflection coil placed over the image section, and suitably excited from a signal generator.

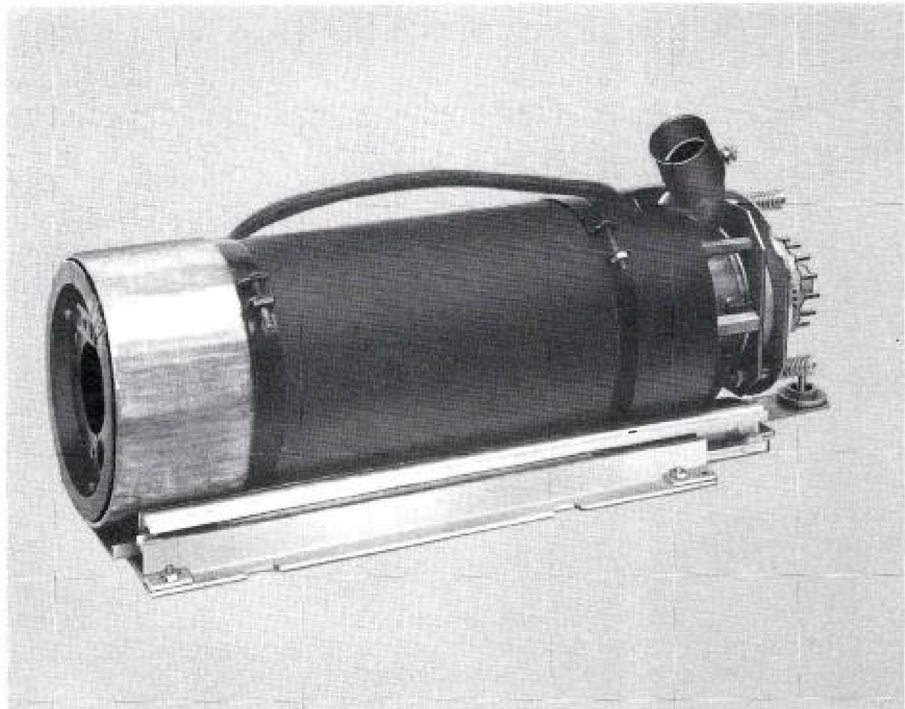


FIG. 9. Orbiting coil installed on the focus coil assembly. Note it is placed over the focus coil for use with latest model RCA monochrome cameras.

Electromagnetic Orbiter Details

The non-mechanical electromagnetic orbiter used in monochrome is composed of two essential parts: a deflection yoke for the image section and a signal generator for supplying the exciting currents.

In the latest monochrome cameras the yoke may be placed over the focus coil while in some earlier models it must go in the space between the tube envelope and the focus coil. See Fig. 6. Either location requires that the yoke be very thin to fit into the available space. A toroidal construction has been used to make the yoke as thin as possible. The core is a thin section of either mu-metal laminations or iron wire. The mu-metal core, in the case of the external yoke, preserves the continuity of the mu-metal shielding over the focus coil. The iron wire core for the internal yoke presents a high-reluctance path for the focus field and hence does not disturb the normal magnetic focus fields within the image section of the tube. Each yoke has two quadrature windings (see Fig. 7). These are supplied with appropriate quadrature sinusoidal currents, causing the electron image to rotate or orbit in a circular fashion. Figures 8 and 9 show the orbiting coil separately and installed on the focus coil assembly.

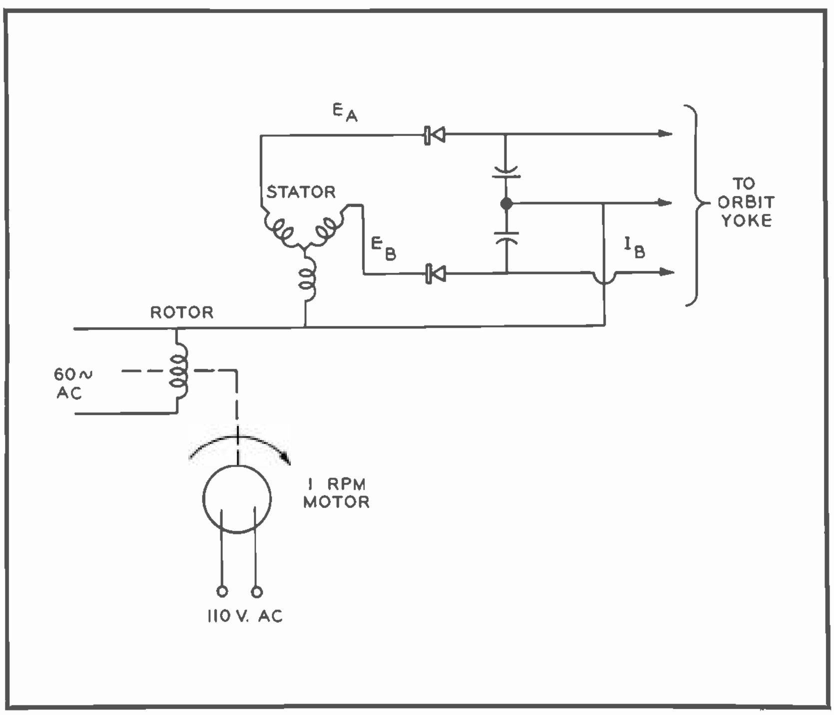


FIG. 10. Block diagram showing motor system used in the electromagnetic orbiter.

Orbiting Signal Generator

The design of a signal generator for this yoke is such that it yields quadrature currents having the extremely low frequency

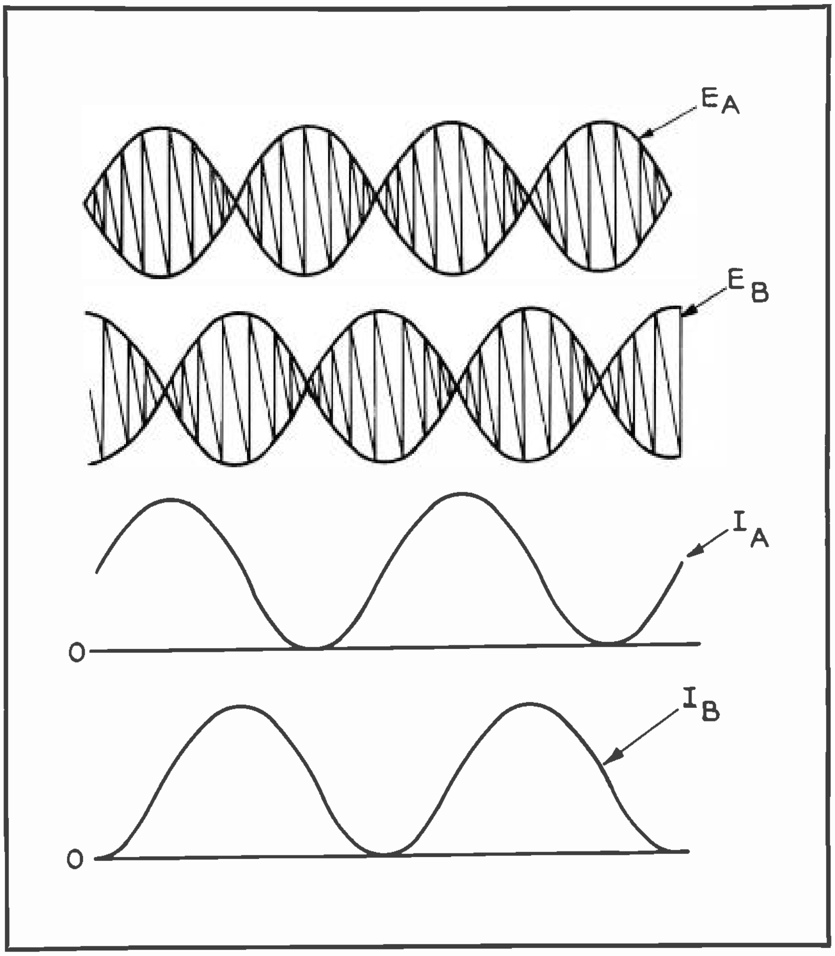
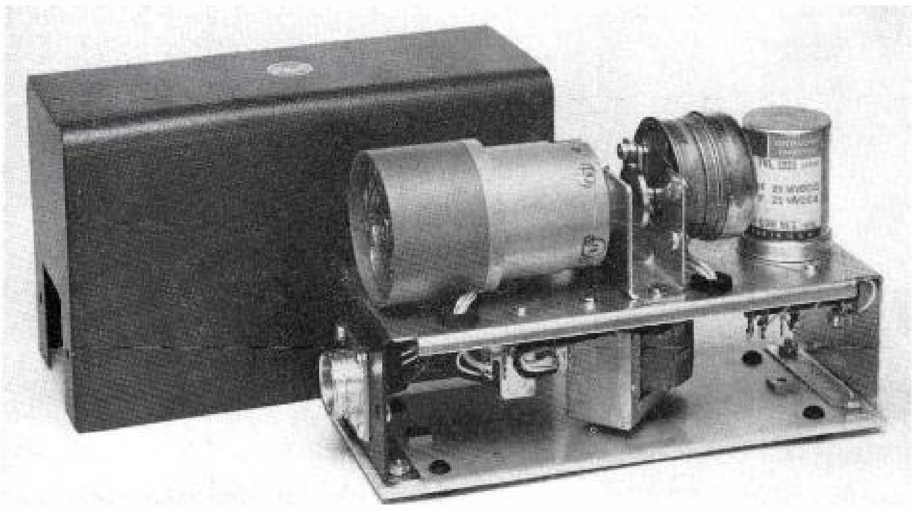


FIG. 11. Waveforms of stator output signals.

FIG. 12. Orbiting generator can be installed at any convenient location remote from camera itself.



of about one cycle per minute. Electronic circuits to generate such low frequency currents can, of course, be made but they become somewhat complicated and cumbersome. A novel method using a small synchro driven by a one rpm motor has proved to be very simple and reliable. The armature of the synchro is excited with 60 cycle AC. The three stator windings are located 120 degrees apart (see Fig. 10). The amplitude of the 60 cycle voltage appearing on each stator winding is a function of the shaft angle of the armature. If the shaft is turned at a constant speed, such as one rpm, the three stator windings will put out three amplitude modulated 60 cycle signals; the phase angle of the one cycle per minute modulating components will be 120 degrees between windings. In a sense the 60 cycle currents may be thought of as carriers modulated at one cycle per minute. Only two of the stator output signals are required—these

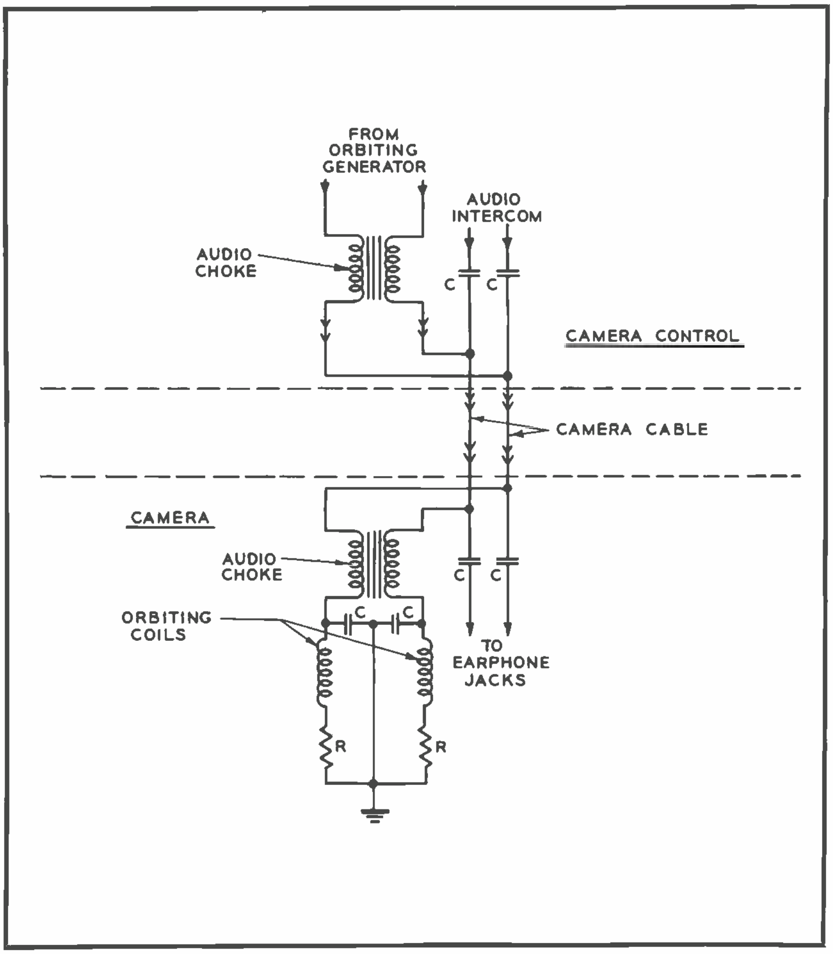


FIG. 13. Schematic diagram showing how the orbiter can be remotely controlled via audio intercom lines.

are appropriately rectified and filtered. Their waveforms are shown in Figure 11. The outputs of the rectifiers are one cycle per minute currents whose amplitudes are sufficient to drive the quadrature yoke winding directly. Both one cycle per minute signals are 120 degrees apart instead of the 90 degrees required for purely circular orbiting. This produces a slightly elliptical path which is completely satisfactory. The orbiting generator unit is shown in Figure 12.

The amount of orbiting (peak-to-peak) is approximately 5 percent of picture height compared to 3 percent in the case of the optical orbiter used in color. It is believed that since monochrome cameras are generally operated over the "knee," where the tendency toward burn is greater, the orbiting should be greater than for color. The orbiting signal generator may be located remotely from the camera and the currents fed to the camera on the audio intercom lines as shown in Fig. 13. Phantom operation of these lines for currents of this type is relatively easy to obtain.

The small amount of orbiting and the slow rate used make the effect not readily apparent to the viewer. By introducing simultaneous centering current changes in the main camera deflection yoke, the image in the final picture can be made to appear motionless or immobilized. Other methods of immobilization which are somewhat simpler are available. However, tests indicate that the very slight amount of picture rotation does not at present appear to justify the extra complexity in equipment. In fact, immobilization may cause a burned border to appear around the edges of the picture. This will cause trouble if that tube is put into another camera with a slight change in angular rotation. In the case where a camera is used for inserts or other special effects the orbiter can be turned off for the duration of the on-air shot.

The manner in which orbiting aids reduction of image burn is that the retained image, while still present, appears as a blur instead of a sharply-defined negative. In pictures of normal scene content this residual blur is, in most cases, not noticeable. In any case, it is far less objectionable than the sharply-defined image which exists where orbiting is not used.

Lengthens Tube Life

Orbiters of both optical and electromagnetic types have been field tested in several broadcast plants. While no accurate estimate can be made as to how much these devices will effectively lengthen tube life, it is worth while to note that in many instances tubes which had been previously taken out of service for burn have been found to be acceptable when used with an orbiter.

FIG. 1. Chief Engineer Howard Lepple of station WLW-T, RCA's Dave Newborg and Merrill Trainer (left to right) inspect the new color mobile unit on its arrival in Cincinnati.

MOBILE COLOR CONTROL ROOM TO SERVE FOUR CROSLEY STATIONS

Plans to virtually convert all of southern Ohio into a vast color stage have been realized with the purchase of an RCA Color Mobile Unit by the Crosley Broadcasting Corp. Now in use by WLW-T, Cincinnati, local color programs are being fed to sister stations WLW-D, Dayton; WLW-C, Columbus; and newly on-air WLW-I, Indianapolis. By pooling color facilities Crosley plans to bring high quality color programming to local audiences at a minimum investment.

Color Debut at WLW-T

Honors as Cincinnati's first local live color program went to Ruth Lyons' "Fifty-Fifty Club," a daily origination, Monday through Friday. Studio visitors, department-store shoppers, advertisers and agency men at the Sheraton-Gibson Hotel and guests in color TV homes viewed this color premiere on August 9. In the weeks that followed additional programs were

FIG. 2. Ruth Lyons' "Fifty-Fifty Club" was first to be colorized in the Crosley move to local live programming.

FIG. 3. Color sets in the television departments of local stores drew big crowds and got real attention.

FIG. 4. In another local store sets were set up in special areas so that shoppers could view the color previewer.

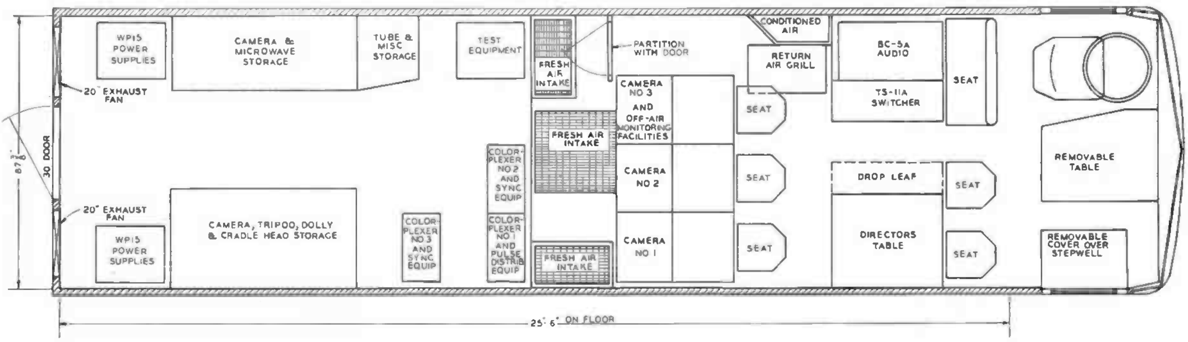


FIG. 5. Plan view of mobile control room.

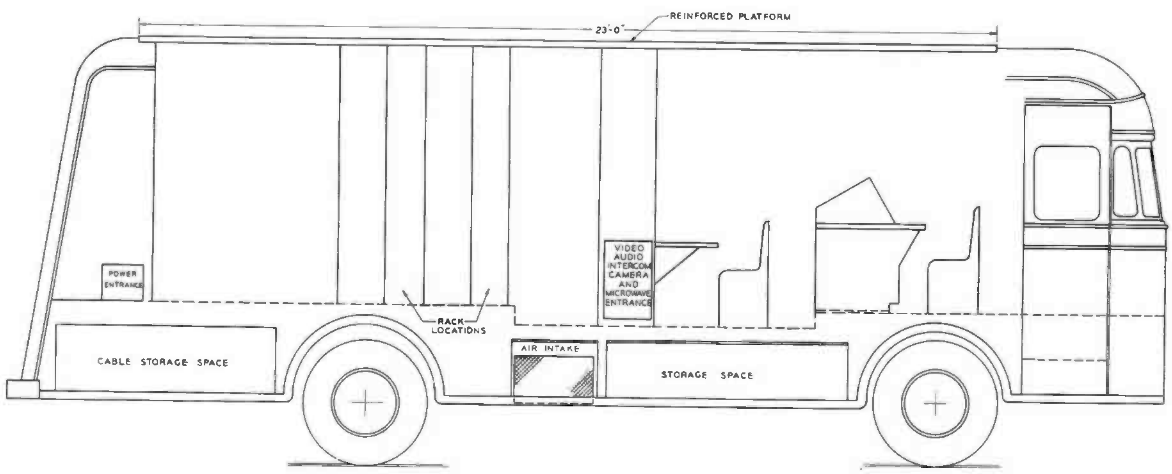


FIG. 6. Side elevation view of mobile control room.

FIG. 7. Inside the mobile unit video operators sit in a recessed area, giving production personnel sitting behind them an unobstructed view of monitors.

colorized—"Midwestern Hayride," Saturday evenings; "The Paul Dixon Show," Mondays through Fridays; "Starmaker Review" and "City Manager Reports" on Sundays.

By introducing color in these local shows, the Crosley stations have more than doubled the number of hours of color programing previously available in their coverage areas. At this writing, 14½ hours of local live color programming are originated weekly, with plans for more to follow.

Mobile Control Unit With Three Color Cameras

Equipment for Crosley's color operation comprises a complete mobile control room including camera control, audio, switching, terminal and test equipments as well as three TK-41 live color cameras. In operation the three cameras are used in the WLW-T "Studio A" and are connected by 225 feet of camera cable to control units in the mobile truck parked adjacent to the studio building. The truck essentially serves as a "mobile control room," a completely compatible extension of the stations' regular control facilities. This control room can be patched into master control, studio control or when desired, taken out for use on remote pickups. In a matter of hours, complete live color facilities can be made available to sister stations without disruption of their existing facilities.

Equipment Layout

The basic layout accommodates three TK-41 Color Cameras. However, this same arrangement can also handle one color camera and four monochrome cameras or two color cameras and two monochrome cameras. For an over-all plan view of the mobile unit, see Fig. 5.

The forward section "control room" contains all operating control equipment. This area is temperature controlled by a three-ton air conditioner and heating elements. The control room will comfortably seat seven people, however, three people can adequately perform the necessary operating functions. Figure 6 shows a side elevation view of the mobile control room. The video operators sit in a recessed area to allow unobstructed view for operating personnel sitting behind them. (See Fig. 7.)

To the rear of the control room are located the equipment racks which house the distribution, test and terminal equipment. Intercom facilities are provided in the equipment area to permit communication with the individual camera control positions. This permits rapid trouble shooting as well as simplification of setup and adjustment procedures.

The area behind the equipment section is utilized for storage of microwave, spare parts and tubes, cameras and mounting equipment. Cable for cameras, microphones, power and microwave are stored underneath the unit. The power supplies, ac power control circuits, isolation transformer and automatic voltage-regulating equipments are located at the extreme rear of the unit.

An entrance panel is provided on the side wall. (See Fig. 8.) This panel contains the connectors for feeding color cameras, microwave, audio output, microphone inputs, intercom input and output, sync, video line and monitor, and additional inputs to the switcher.

By sharing the facilities of the RCA Color Mobile Unit, Crosley stations have facilitated their expansion to local live color with a minimum investment. Equally important, they have been able to aggressively promote color in their markets to both viewers and clients.

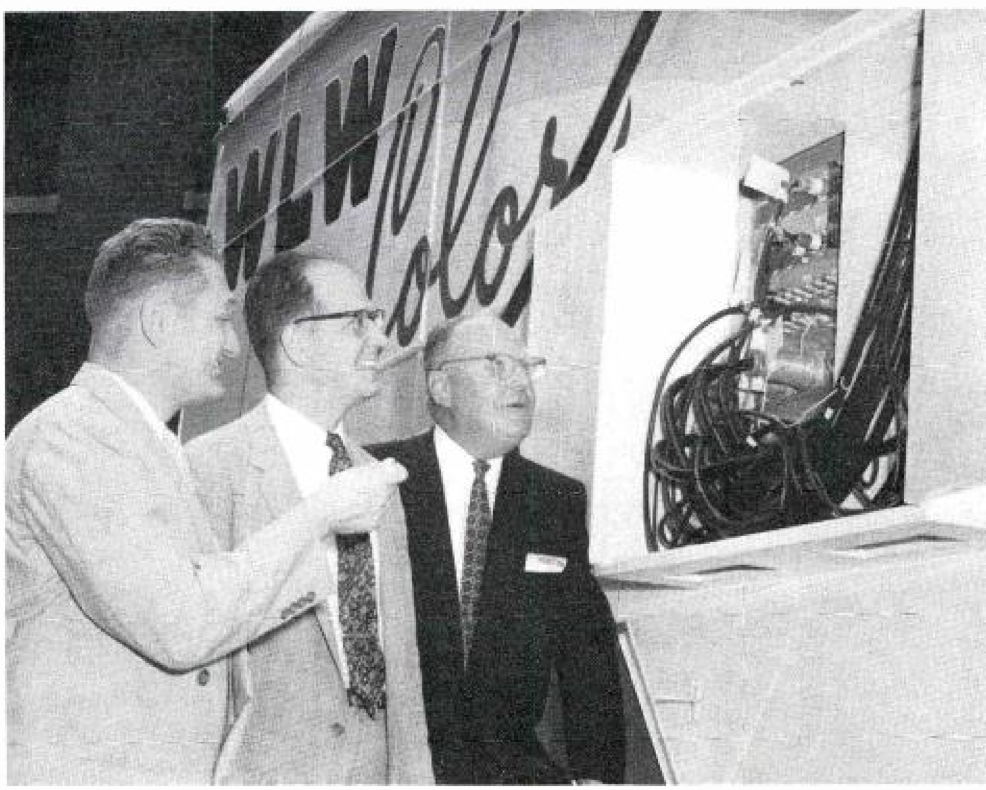


FIG. 8. Located on the side wall of the mobile unit are connectors needed to integrate mobile control room with existing control facilities.

100-WATT TV TRANSMITTER TYPE TTL-100AL/AH

by R. S. JOSE, *Broadcast Transmitter Engineering*

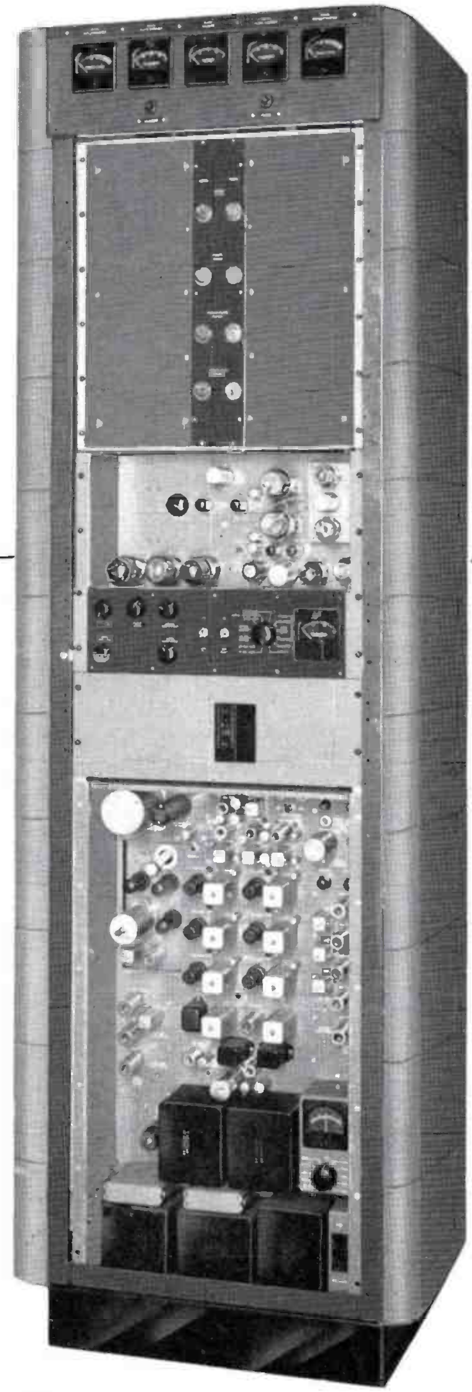


FIG. 1. Standard RCA Type BR-84 Cabinet accommodates transmitter equipment.

This low-cost VHF transmitter, self-contained in a single rack, features a tubeless power supply, is suitable for color TV, is designed for remote operation, and is excellent for satellite use, standby service, and small market applications.

The small television transmitter described in this article was designed to fill the need for inexpensive low-power VHF transmitting equipment. It will serve admirably, for example, as a VHF satellite. It may also be used in small markets using a rebroadcast receiver or local origination video sources. For standby service, it is particularly effective when used as a driver for the TTL-500AL/AH 500-watt linear amplifier.

Type TTL-100AL covers channels 2 to 6, Type TTL-100AH[1] covers channels 7 to 13. This transmitter will develop 120 watts peak visual power, 60 watts aural power.

The transmitter is entirely self-contained in one standard RCA Type BR-84 Cabinet (Fig. 1). This makes installation very

[1] The type designation represents a departure from the standard RCA system to prevent ambiguity with the TT-100AH 100-kw transmitter.

economical, and little space is required for operation. Also, as a result of this feature, the transmitter can be harmoniously installed alongside existing terminal facilities.

This transmitter can be set up in authorized areas for unattended operation. It has provision for remote control or time clock a-c power control. The block diagram (Fig. 2) shows the basic subdivisions of the transmitter.

Exciter

The intercarrier exciter is identical with the unit described in an earlier paper.[2] A block diagram of this unit is shown in Fig. 5. The exciter chassis is hinged at the bottom and can be tilted out of the cabinet to a horizontal position for servicing. The separate aural and visual outputs of the exciter are at respective carrier frequencies on channels 2 to 6 and 1/3 of carrier frequencies on channels 7 to 13.

[2] "Lastest Developments in VHF Television Transmitters," BROADCAST NEWS, Vol. No. 91, pps 48-55, October, 1956.

R-F Circuitry

The aural and visual exciter outputs are connected by coaxial cables to the enclosure near the top of the cabinet which contains the higher power r-f stages. An interior view of this enclosure for the TTL-100AH is shown in Fig. 3, with the aural stages in the left-hand compartment and the visual in the right. Each exciter output drives a 4-65A tripler (which is visible on the lower shelf in Fig. 3), and each tripler drives a 4X250B in the output stage. The visual 4X250B is grid modulated, the aural is a Class "C" amplifier. The coupling circuit between each 4-65A and 4X250B contains a variable capacity voltage divider which serves a coarse r-f excitation adjustment.

The visual plate circuit is double tuned and is capable of being adjusted for a 6-mc (to 1 db down) r-f bandwidth. This is greater than necessary for domestic use but because of the 4X250B characteristics occasions no power reduction.

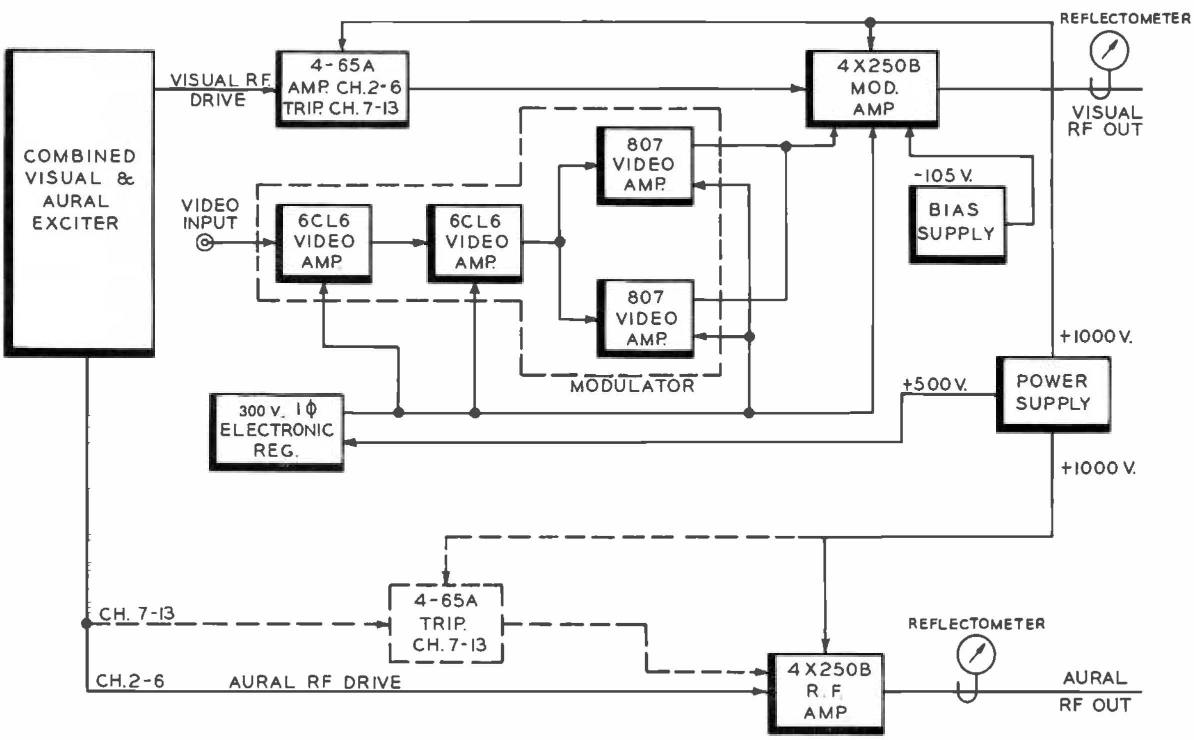


FIG. 2. Simplified block diagram of the TTL-100AL/AH Transmitter.

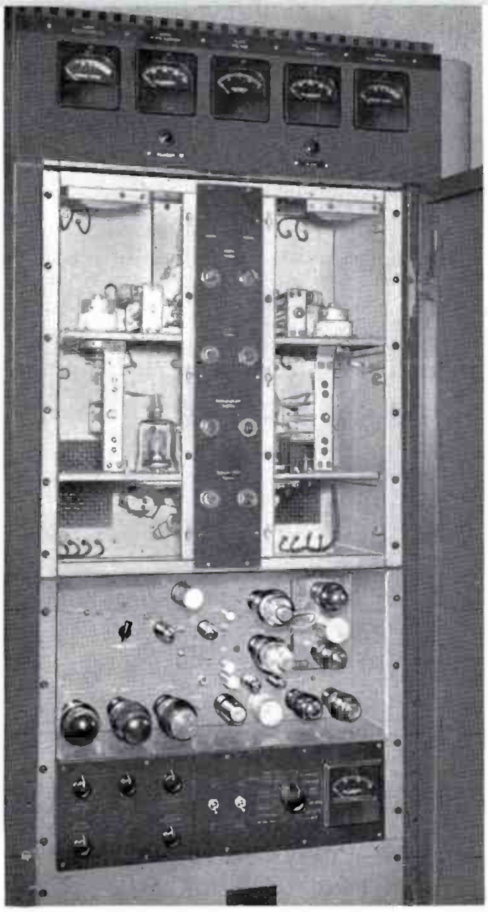


FIG. 3. Open view of the TTL-100AH VHF TV transmitter showing aural visual r-f cubicles, and modulator chassis and control panel mounted below.

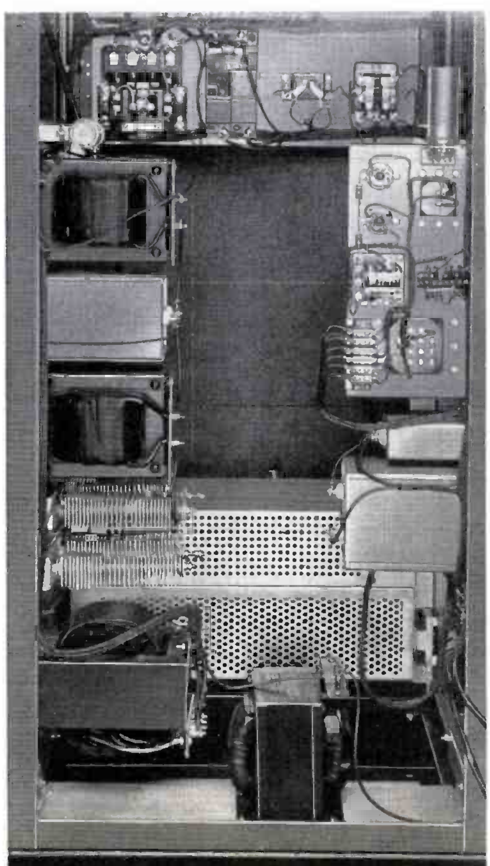


FIG. 4. Rear view, lower portion, showing high voltage transformer, selenium rectifiers and filter as well as bias supply and control components.

The lead between the modulator and modulated 4X250B grid contains an r-f trap. In the TTL-100AH this trap consists of a quarter-wave stub "shorted" at the end opposite the grid by a capacitor. Looking toward the modulator from the grid, the r-f sees a high impedance. The stub is resonant at approximately channel 10, but is effective from channel 7 to 13 without adjustment.

The channel 2 to 6 r-f box version is very similar to channel 7 to 13 with certain exceptions: Since the exciter output is at carrier frequency, the visual 4-65A stage does not multiply. The aural 4-65A is omitted altogether since the aural exciter output is adequate to drive the 4X250B to 60 watts aural power. The coupling method in the wide-band plate circuits or the 4X250B tubes is different from the high channel version, but the bandwidth is the same. Finally, the r-f grid trap is tuned to resonance on each channel by a variable capacitor.

Modulator

The modulator (consisting of the two chassis shown in the lower portion of Fig. 3) contains the video stages and the electronic regulator for the video amplifier and r-f screen voltages. Also, the metering and control circuits for the transmitter.

The output stage of the modulator consists of two 807 tubes in parallel, directly coupled to the 4X250B grid through a bucking bias supply. The bucking bias is obtained from two OD3 tubes in series. The 807 grids are driven by two 6CL6 tubes in cascade and clamped by means of a 1N34 diode. Both 6CL6 stages are series-shunt peaked and have sufficient gain to operate from a 1-volt peak-to-peak input video signal.

The 807 stage is deliberately made about two or three times as large as would be required for monochrome transmission. This is done to achieve a lowered output impedance so that the grid current drawn by the 4X250B will not cause excessive differential phase shift. The 4X250B grid current at black level can, by precise adjustment of the r-f grid drive and broadbanding, be made essentially zero. With less precise adjustment it may amount to 2 or 3 ma. In either case, the modulator will not produce excessive differential phase shift. The over-all modulator video response is essentially flat to at least 5.5 mc.

The metering circuit measures currents in the video amplifier stages and r-f stages as well as the voltage output of the regulator and the black level voltage. The control panel contains controls for aural and

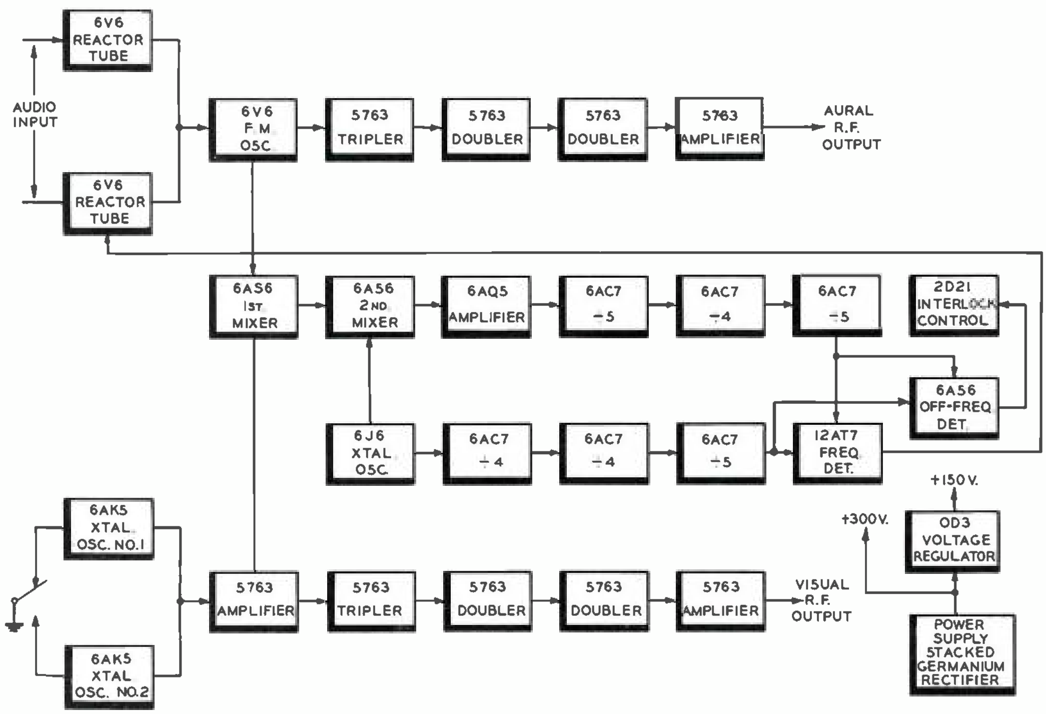


FIG. 5. Block diagram of the TTL-100AL/AH Common Exciter Unit.

visual r-f reflectometer calibration and r-f excitation as well as a black level control. The excitation controls are potentiometers which control the screen voltages of the 4-65A tubes. In the case of the low-band aural amplifier, the screen voltage of the 4X250B is controlled.

Power Supply

A common high-voltage supply is used for the aural and visual r-f stages (Fig. 4). Selenium rectifiers, rated for 25,000 hours minimum life without significant aging, are used. If the seleniums do age, a 5 per cent voltage tap is provided on the transformer primary to overcome this and hence provides for additional service. Four stacks are used in a full-wave bridge circuit providing 1,000 volts, d-c. The center tap of the transformer supplying this bridge feeds the input of the electronic regulator at approximately 500 volts d-c. The plate transformer is visible just below the rectifiers in Fig. 4.

A small bias supply, using germanium rectifiers (upper right, Fig. 4) is the only other power supply. Note that no tube-type rectifiers are used, and because of the life expectancy of the rectifiers used, rectifier replacement should be virtually non-existent. Since the usual rectifier filament transformers and sockets are not needed, this eliminates a common source of trouble; and also reduces the spare parts requirements.

Additional Features

Reflectometers are included in each aural and visual output line. These reflectometers incorporate directional couplers so a qualitative check can be made on the line VSWR by reversing the couplers. Type N fittings are used in the output lines to facilitate reversal.

The transmitter is designed for unattended operation. To this end, the a-c power may be switched remotely over a light duty pair of wires (or telephone lines) with appropriate remote-control equipment. The transmitter incorporates a time delay relay and overload protection (see top of Fig. 4).

If it becomes desirable to add the 500-watt linear amplifier at a later date to an existing TTL-100AL/AH, provision has been made to accomplish this without changes in the cabinet wiring. The interconnected a-c control and protection circuits have been brought out to four terminals in the TTL-100AL/AH and thus it is a simple matter to connect these to the 500-watt amplifier.

The TTL-100AL/AH has been designed and tested for color use. When used with the normal color input equipment, including the phase and amplitude control units and a color-stabilizing amplifier, the unit will perform well within the color transmitting standards.

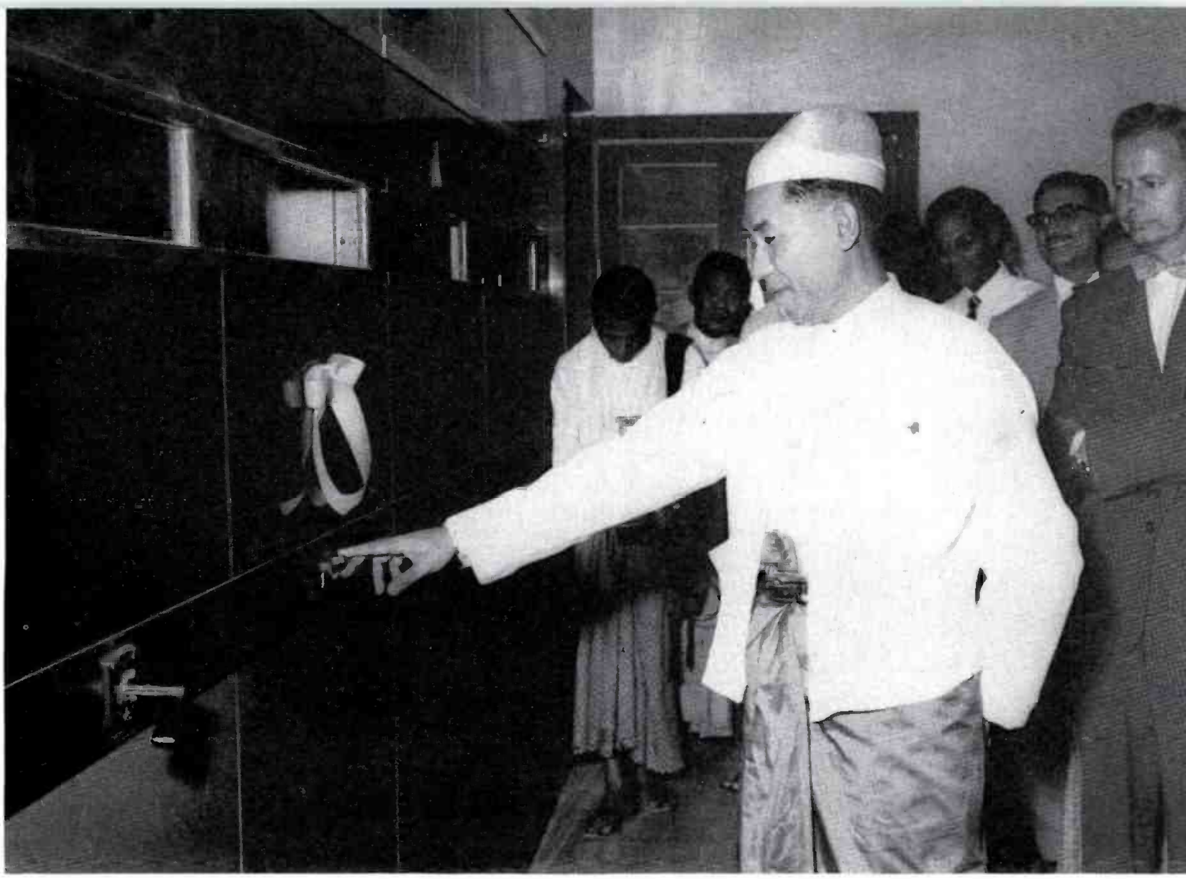


FIG 1. The Hon. Thakin Chit Maung, Minister of Information of Burma, above, switches into operation one of the two new RCA 50KW transmitters of the Burma Broadcasting Service. The ceremony is watched by other Burmese officials. Right is Jean W. Seymour of RCA International Sales.

BURMA PUTS POWERFUL NEW VOICE ON THE AIR

Two RCA 50KW Transmitters Installed; Three More to Come

FIG. 2. U Win Maung, Chief Engineer BBS, explains the operation of the transmitter control console to the Minister of Information and guests.

The Government of Burma has gone on the air with a powerful new voice, two RCA 50KW transmitters, recently dedicated by the Minister of Information, Thakin Chit Maung.

The ceremonies, taking place at Yegu, four miles from the heart of Rangoon, marked the first big step in Burma's reconstruction of its broadcasting services. The two new transmitters, one for short wave and one for medium wave, are the forerunners of a greatly expanded radio information system. Three more RCA transmitters are being installed, which will give Burma one of the world's most powerful broadcasting services, embracing long wave as well as medium and short wave, and providing foreign as well as domestic coverage.

Minister Thakin Chit Maung said at the ceremony, "On this day, the second of the month of Tagu, just as our old year is about to give way to the new, I am happy to be able to open the two new transmitters of Myanma Athan and thereby begin to fulfill the wishes of our listeners.

"I would like to say a few words to explain to you the work of the Burma Broadcasting Service. One aspect of this is the Broadcasting House, now under construction on Prome Road. The other is the transmitting station which is being formally declared open this evening.

"In 1945 a temporary broadcasting studio and transmitting station was set up, using three small mobile transmitters of the British Psychological Warfare Unit to broadcast to Burmese listeners.

FIG. 3. "They work good!"—This is the smiling verdict of the Hon. Thakin Chit Maung seconds after he switched on the 50KW transmitters and Burma's powerful new electronic voice was on the air. At the Minister's left is U Kyaw Sein, Chief Engineer, National Housing Board.

"The Burmese Government is replacing the old studio and transmitters with new ones built on up-to-date lines to afford good reception for listeners in Burma and abroad. We prefer to start commissioning each new transmitter as it is installed. Hence, this ceremony of switching on these two new transmitters this evening.

"To the director and staff of the Burma Broadcasting Service who have struggled with limited technical facilities and shortage of staff, covering wide ground, in extended order, I would like to say that with the installation of more powerful transmitters, more demands will be made on your experience, ability and creative power. I, as Minister of Information, thank you and appreciate the daily tasks you have performed for the welfare of your country."

Assisting at the inauguration ceremonies were U Khin Zaw, Director of Broadcasting U Hla Maung, Chief Engineer, Public Works Department; U Win Maung, Chief Engineer, BBS; U Pe Thau, Deputy Director of Broadcasting and official of the National Housing Board; U Kyaw Sein, Chief Engineer, National Housing Board; H. H. Hong, Director, Jing Hong Trading Corp., Ltd., RCA distributors in Burma; J. C. Webster, Electronic Engineer of Jing Hong.

Engineers of BBS and Jean W. Seymour, RCA International Sales engineer, joined to handle supervising and test of the transmitters and installation. Jing Hong Trading, the RCA distributing organization, has assisted the Burmese Government in its communications development programs.

FIG. 4. General view of the new BBS transmitting hall—Showing the RCA BTA-50F1, medium wave transmitter, control console and monitoring loudspeaker. The transmitting hall also houses two RCA BHF high frequency transmitters, with provision for two more.

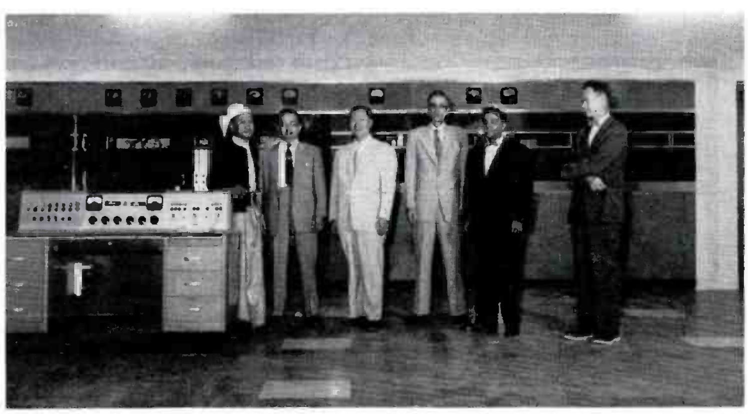


FIG. 5. Helped put transmitters on the air—From left to right, U Khin Zaw, Director of Broadcasting, BBS; U Hla Maung, Chief Engineer, Public Works Department; H. H. Hong, Director, and J. C. Webster, Electronic Engineer, Jing Hong Trading Corp. Ltd.; U Win Maung, Chief Engineer BBS, and Jean W. Seymour, RCA.

Planning a Radio

PART TWO: Transmitter Equipment and Building Requirements; Remote Control; Towers and Antenna Systems

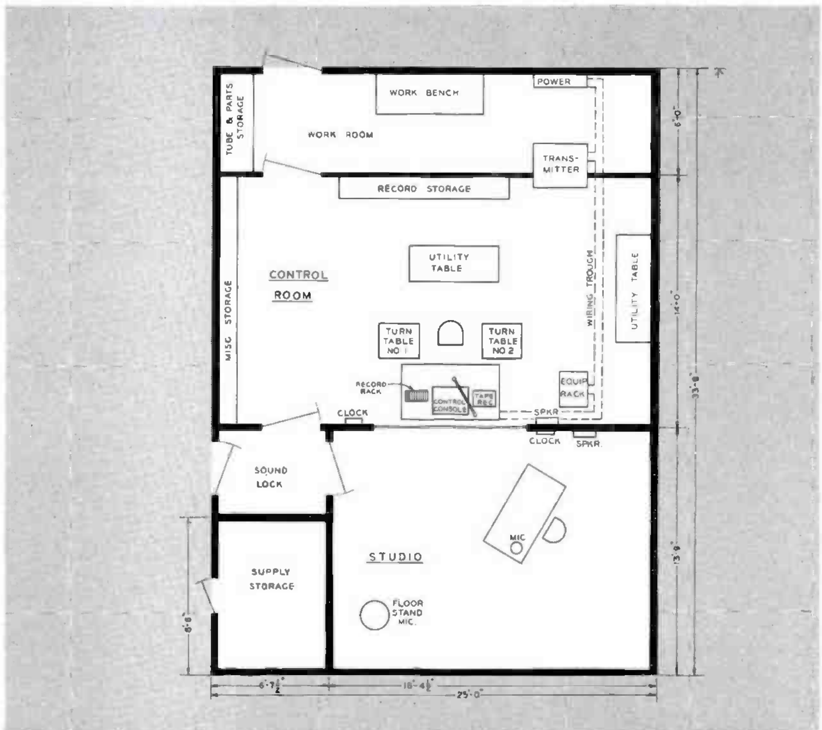


FIG. 1. Layout for Plan "A." This is a combined studio-transmitter arrangement. It is a design for the small, local station.

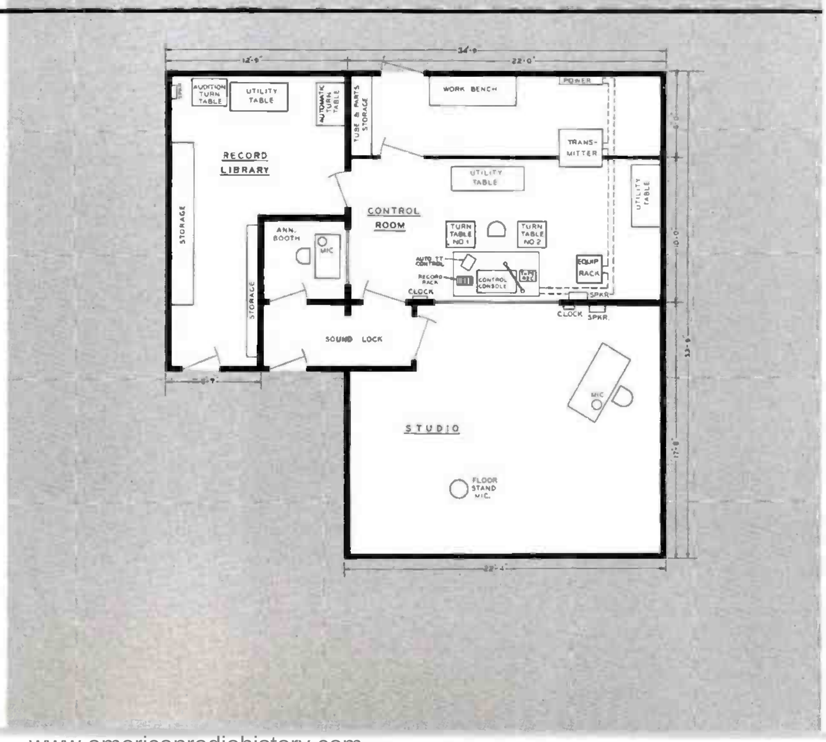


FIG. 2. Layout for Plan "B." This is similar to Plan "A" but has more facilities. It is a design for the medium-size station.

Station

The planning, the construction, and the installation of typical radio stations are covered in this series of planning articles. The first article, covered general planning and presented three radio station plans, concentrating on the studio equipment requirements and remote pickup equipment. This second article in the series will deal with transmitter equipment, the transmitter building, the transmitter building requirements, remote control of transmitters, towers, and antenna systems.

Transmitter Equipment

Plan "A" and Plan "B" cover the type of installation in which the studio and transmitter are both located under the same roof (see Figs. 1 and 2). Plan "C" covers a separated installation, that is, the transmitter is located in a building of its own (see Fig. 3).

Regardless of the plan selected, the factor dictating the transmitter to be used is the authorized operating power of the station. In the United States, operating powers of 250 and 500 watts, 1, 5, 10, and 50 KW are the most common; however, operating powers of 100 watts and 25 KW are sometimes authorized under special conditions. We will not attempt to get into an explanation of the qualifying elements that determine the authorized power. For this we recommend a discussion with an engineering consultant.

Now to get more specific about transmitter equipment. . . . It is well to remember that the purchase of a transmitter is a long term investment, making its selection very important to the station and its operation. A station's success or failure in a highly competitive market may well depend upon the choice of the transmitter.

The engineering department of each transmitter manufacturer has certain design philosophies and concepts that come to be known and identified with the product. Their experience determines certain design parameters such as specifications, features, size, styling, etc. From the design comes the final development and production. Then the manufacturer's success depends, more than anything else, upon the "beneficial performance" of the equipment, as it is operated by the customer.

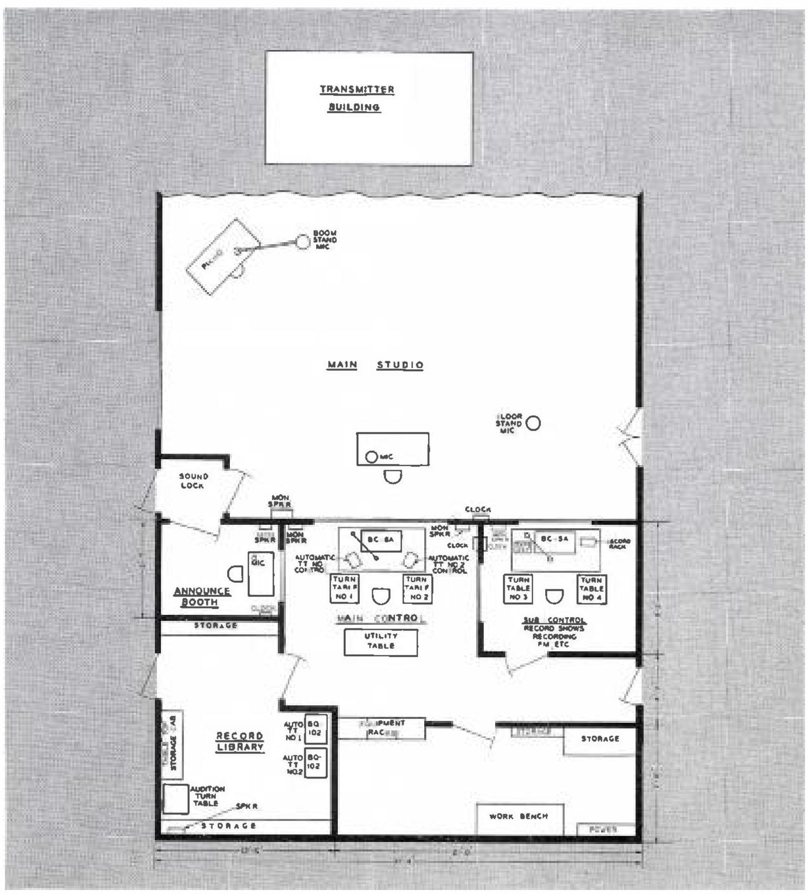


FIG. 3. Layout for Plan "C." Here the studio and transmitter are located in separate buildings. This is the studio plan (Fig. 6 shows the transmitter plan). This is a design for the larger, community-type station.

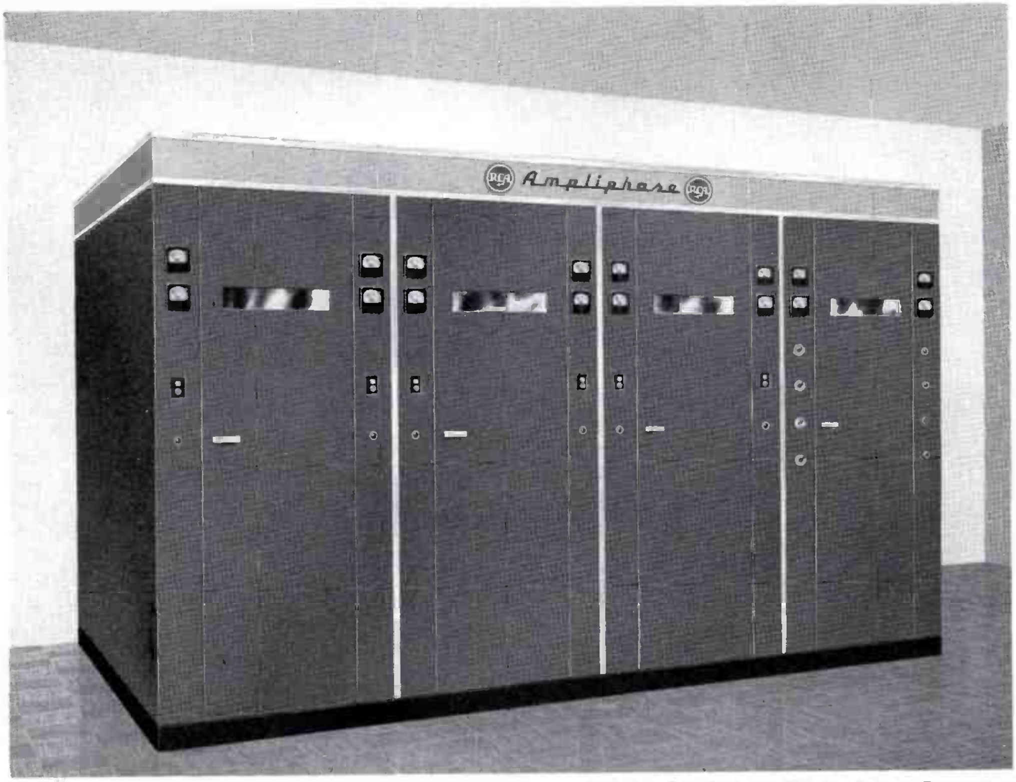


FIG. 4a. BTA-50G—50 KW Ampliphase Transmitter.

FIG. 4b. BTA-5H/10H—5/10 KW Transmitter.

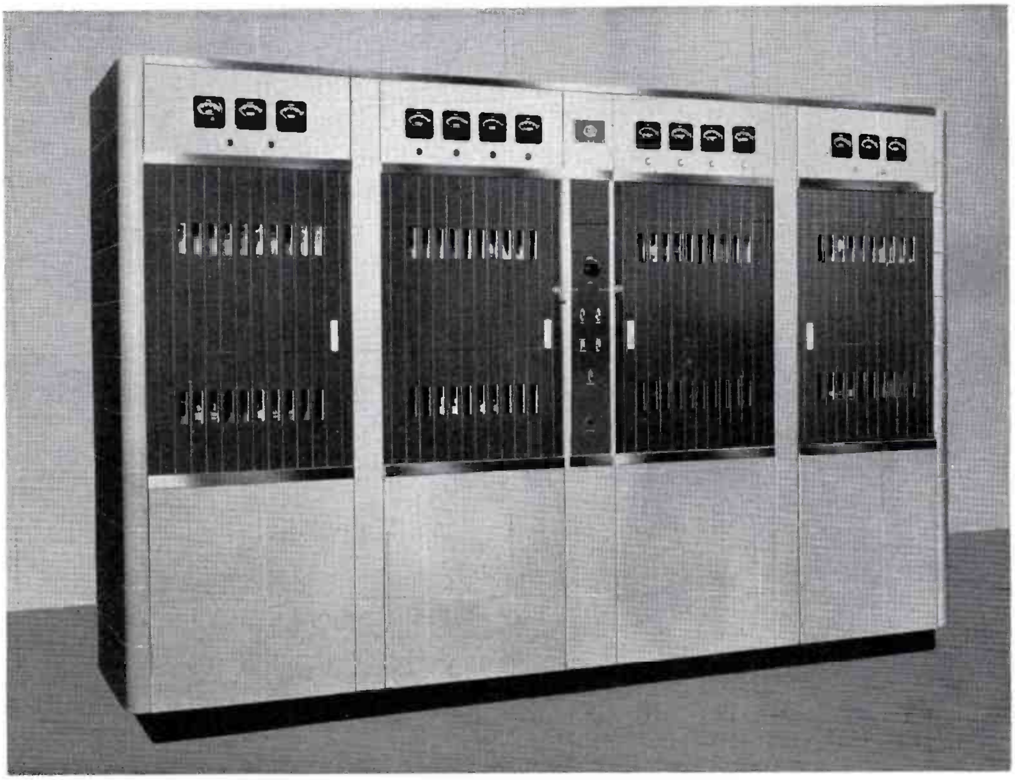


FIG. 4c. BTA-1MX/500MX 1 KW/500-Watt Transmitter.

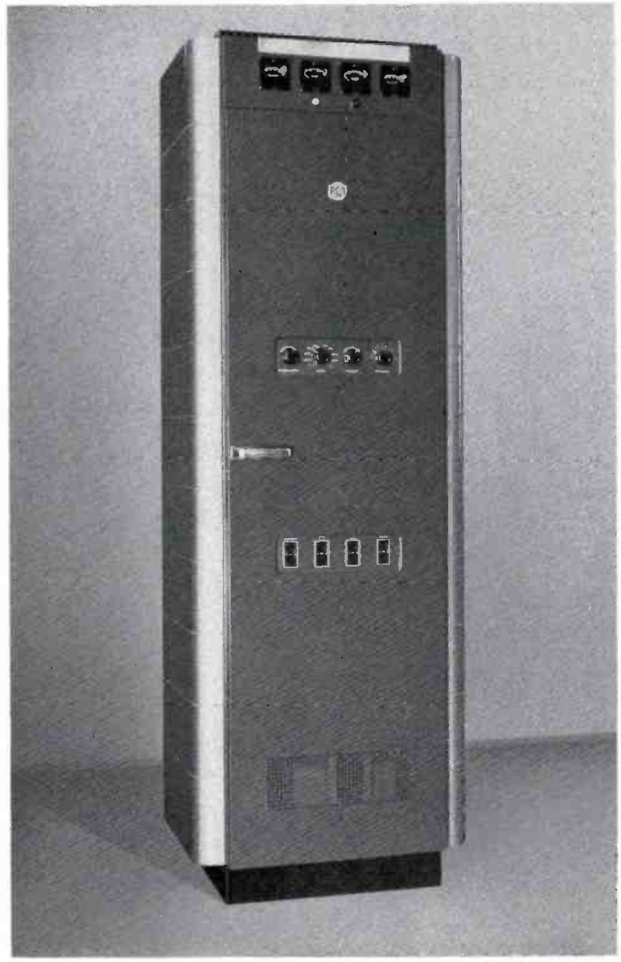


FIG. 4d. BTA-250M—250-Watt Transmitter.

How to Rate a Transmitter

Here is a check list that is recommended as a guide when selecting a transmitter. Three major factors should be checked: Reliability, soundability, and modulation capability. These will assure performance that gives greatest benefits to the user.

Reliability

This applies both to the equipment and to the manufacturer. For a transmitter to give day-in and day-out service without failure, it must be of sound design. It must use quality components that are conservatively rated and operated. Regardless of printed performance specifications, the transmitter has to stay on the air. Maximum reliability almost always costs a little more initially, but always costs less in the long run. The reliability of a particular make of transmitter can be verified by questioning a user. If it is a new one without a history of operation to refer to, the reputation and experience of the manufacturer is usually a safe guide.

Soundability

Regardless of a manufacturer's published specifications, the real "proof of performance" is how good the transmitted signal sounds. Sound is the medium upon which one relies for station income. So the "best sound possible" must be delivered to the listeners for maximum listenership. There is universal agreement that the number of listeners has a definite relationship to the number of sponsors. A transmitter that will give the "best sound possible" is the one to buy. Since there is a difference, it will be well worth the time spent to discover this difference.

Modulation Capability

Whatever the authorized transmitter power—1 KW or 50 KW—one cannot exceed the authorization, yet a comparison of two different makes of one kilowatt transmitters will many times reveal a decided difference in "program coverage." This holds true for all power levels of transmitters. It is recognized that frequency, ground conductivity, terrain and pattern have a lot to do with this. But with all these things being equal, there is still a noticeable difference. Perhaps the most important contribution to "maximum program coverage" is the ability to achieve and to maintain consistently a high average level of modulation, with minimum distortion and excellent frequency response. With present day automatic gain control amplifiers and limiter amplifiers, an extremely high average level of modulation can be maintained if the transmitter has the capabilities. This "modulation capability" must be designed into the transmitter. Make sure the transmitter selected has this modulation capability. If not, "maximum program coverage" will not be achieved.

Beyond these three major guide points, general specifications should be examined and due consideration given to them in the choice of the transmitter.

Transmitter Building Requirements

Space required for the transmitting equipment is determined primarily by the power of the transmitter and whether or not it is to serve a directional array and house the phasing and branching equipment. Referring again to plans "A" and "B", (Figs. 1 and 2) where the transmitter is located in the same building as the studio equipment, it will be noted that provisions were not made for location of phasing equipment. Figure 5 shows how phasing equipment could be accommodated in either of these plans.

When a separate building is desirable for housing the transmitting equipment, some special considerations must be made. The transmitter power of the station, antenna requirements, and whether this is to be an attended or a remote controlled operation all must be considered, when selecting the transmitter building.

Since directional antenna systems are becoming more of a rule than an exception, let us consider the building plan for an attended one kilowatt transmitter operation with a *directional antenna system*. A typical transmitter building layout for such a system is shown in Fig. 6.

As you examine Fig. 6, note that in addition to the transmitter and phasing cabinet, an equipment rack is included. Also there is a work bench, a storage cabinet, and a small desk or utility table. Other items such as the power panel, ventilating fan, etc., are optional to a certain extent, depending on type and location. A small room heater will usually be required, and the choice of type and size will vary with local weather conditions.

This is the type of transmitter building layout that normally goes with Plan "C" as shown in Fig. 3, but could go with any separated type of installation.

For transmitter powers of higher than one kilowatt, a good rule to follow is to expand the building, both in length and width, by the same additional dimensions of the larger equipment items.

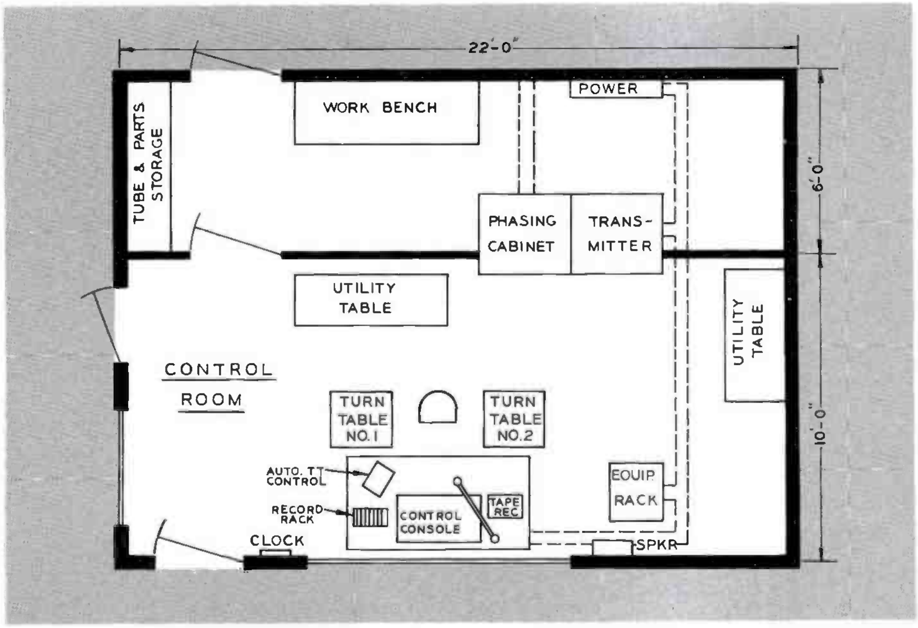


FIG. 5. The control room of Plan "B" is shown here with the phasing equipment added. (The phasing equipment is required for feeding a directional antenna system.)

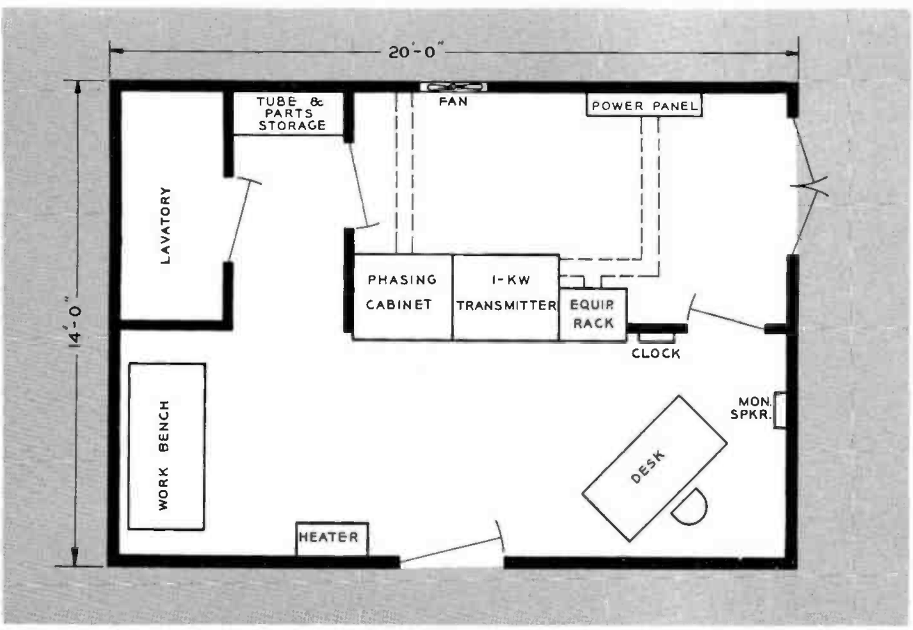


FIG. 6. This is the transmitter building floor plan for a directional, 1-KW attended operation. Observe how the phasing cabinet and equipment rack have been placed alongside the transmitter. Also note the convenient wiring troughs.

Equipment Details

Now, referring to Fig. 8, we have a layout of the cabinet rack, showing the location of recommended transmitter input and monitoring equipment. Figure 7 provides a complete list of the necessary equipment (note that these items have already been included in the Equipment Lists for Plans "A" and "B" in Part One. It is given here for use with Plan "C").

Figure 9 provides a typical block diagram, showing how the input and monitoring equipment go together.

There are some special features to be noted. For example, open jacks are connected in parallel with the normalled-through jacks of the main program circuit, to provide convenient monitor and measurement points. These will be very helpful in isolating a case of trouble or in performing routine maintenance. In addition, if line loss is high, a boost in gain is necessary to raise the audio level for proper operation of the limiter amplifier, therefore, a booster amplifier is suggested as optional equipment for use when the line loss to the transmitter exceeds approximately 24 dbm. Also a monitor amplifier input switch is included in the Equipment List (Fig. 7) for convenience in selecting various monitoring points throughout the system.

Jack panel designations with some additional details are shown in Fig. 10. Two fixed pads are designated. They have a value of 20 db and 40 db, respectively, at 600 ohms. Attenuation pads have real value when making certain performance measurements. These pads are optional and not operational.

A phase monitor is shown in both the Equipment List and the rack layout. It is used in connection with a directional antenna system, and will be discussed later.

FIG. 7. A complete list of the input and monitoring equipment required at the transmitter building for Plan "C." (Many of these items were also listed in the Equipment Lists for Plans "A" and "B" in Part One, since these plans located the transmitter in the studio building.)

TRANSMITTER INPUT AND MONITORING EQUIPMENT

Item	Quantity	DESCRIPTION
1	1	BR-19 Cabinet Rack
2	1	BW-11 AM Frequency Monitor
3	1	BW-66 Modulation Monitor
4	1	WM-30 Phase Monitor (Required only if a directional antenna system is used)
5	1	BA-6 Limiting Amplifier With Tubes
6	1	Mounting Shelf for BA-6 Amplifier
7	1	BJ-24 Double Jack Panel
8	1	Single Jack Panel Mat
9	1	20 db, 600 ohm Fixed Pad
10	1	40 db, 600 ohm Fixed Pad
11	1	BI-5 VU Meter Panel
12	1	Monitor Input Switch
13	1	SA-10 Monitor Amplifier
14	1	Plug-in Transformer for SA-10 Amplifier
15	1	BR-22 Mounting Shelf for Monitoring Amplifier
16	1	Switch and Fuse Panel
17	1	$5\frac{7}{32}$ inch Blank Panel
18	1	$6\frac{31}{32}$ inch Blank Panel
19	4	Audio Patch Cords, 2 ft in Length
20	1	Terminal Board Mounting Bracket
21	1	Terminal Power Strip
22	1	Terminal Audio Block
23	400 ft	Interconnecting Cable for Audio Rack Wiring, #20 Shielded Pair, Solid Conductor
24	200 ft	Interconnecting Cable for AC and Filament Circuits, #18 Shielded Pair, Stranded Conductor
25	100 ft	Interconnecting Cable for Audio Circuits, #22 Shielded Pair, with Cotton-Braided Outer Cover
26	1	Monitor Speaker Mechanism
27	1	Housing for Monitor Speaker
28	1	Clock
29	1	BA-21 Booster Amplifier (Optional—Obtain Power from BA-6 Limiter Amplifier)

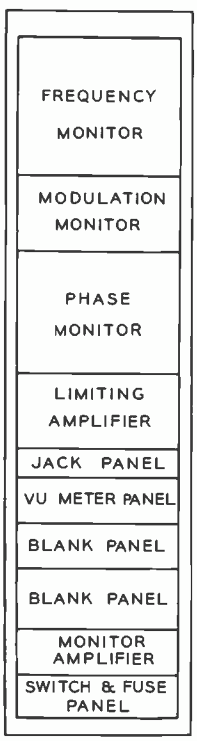


FIG. 8. Only one standard cabinet, such as the RCA BR-84 or the BR-19, is required to hold the necessary input and monitoring equipment. Operational efficiency is improved with this central equipment location.

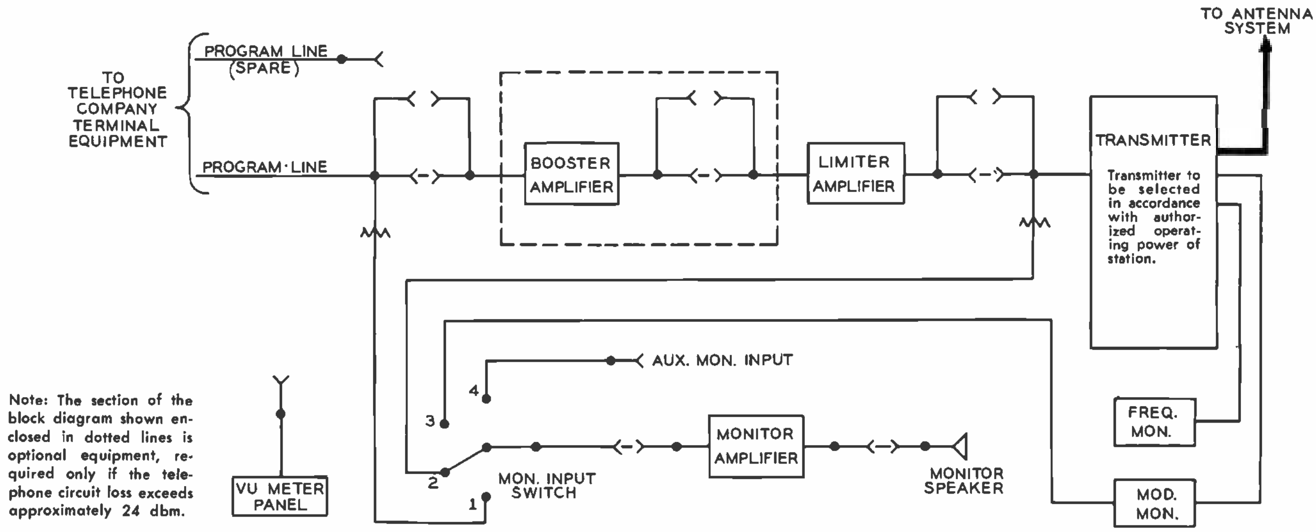
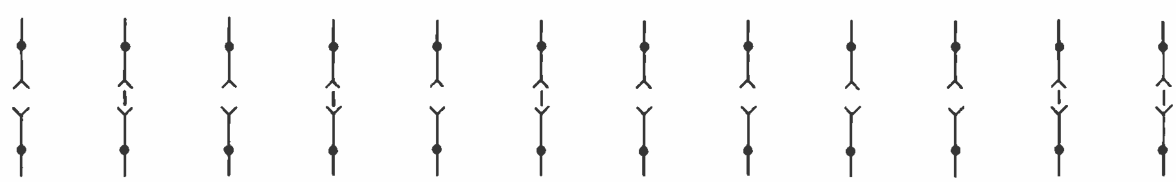


FIG. 9. This block diagram shows how the input and monitoring equipment are connected. The booster amplifier is necessary if line loss from the studio exceeds 24 dbm.

PGM LINE Ⓢ	PGM LINE	PGM LINE Ⓜ	BOOSTER AMP OUT	BOOSTER AMP OUT Ⓜ	LIMITER AMP OUT	LIMITER AMP OUT Ⓜ	20 DB PAD IN	40 DB PAD IN	AUX MON INPUT	MON IN SW	MON AMP OUT
SPARE	BOOSTER AMP IN	BOOSTER AMP IN Ⓜ	LIMITER AMP IN	LIMITER AMP IN Ⓜ	XMITTER IN	XMITTER IN Ⓜ	20 DB PAD OUT	40 DB PAD OUT	VU METER IN	MON AMP IN	MON SPKR



LEGEND :- —•—< OPEN JACK —•—<->—•— NORMALED THROUGH Ⓜ MULTIPLE JACK Ⓢ SPARE

FIG. 10. Jack panel designations of the input and monitoring equipment.

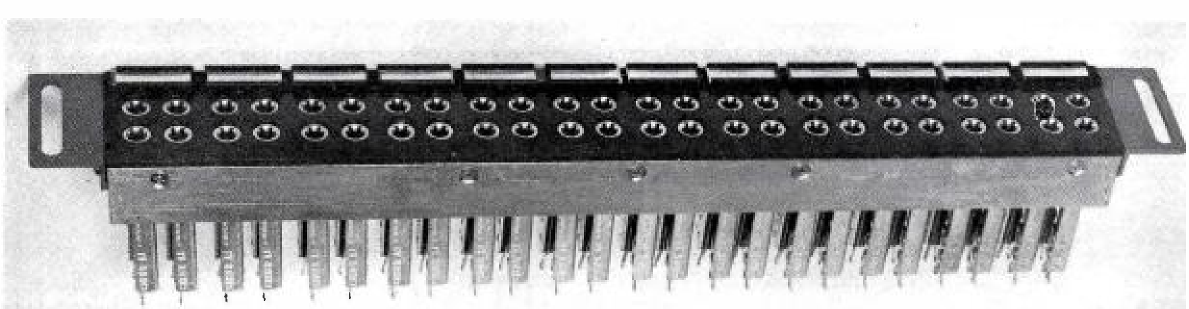


FIG. 11. This is a type BJ-24 double jack panel.

Remote Control of Transmitters

Where the transmitter and studios are not located under the same roof, it is advantageous in many cases to remote control the transmitter, if this type of operation is permitted by the FCC. (When contemplating the remote control operation of a transmitter, the reliability factor previously discussed becomes doubly important.)

A remote control system provides an extension of essential control functions and meter readings from the transmitter to the studio. A typical list of control functions and meter readings is as follows:

Control Position	*Control Function*	*Meter Reading*
1	Calibrate	Set meter calibration
2	Filaments on-off	Line or Filament Voltage
3	Plate Voltage on-off	PA Plate Voltage
4	Over-load Reset	PA Plate Current
5	Power Ouput Control	Antenna Current
6	Tower Lights on-off	Tower Lighting Current
7	Frequency Monitor	Frequency Deviation
8	Modulation Monitor	Percentage of Modulation
9	For Later Assignment	
10	For Later Assignment	

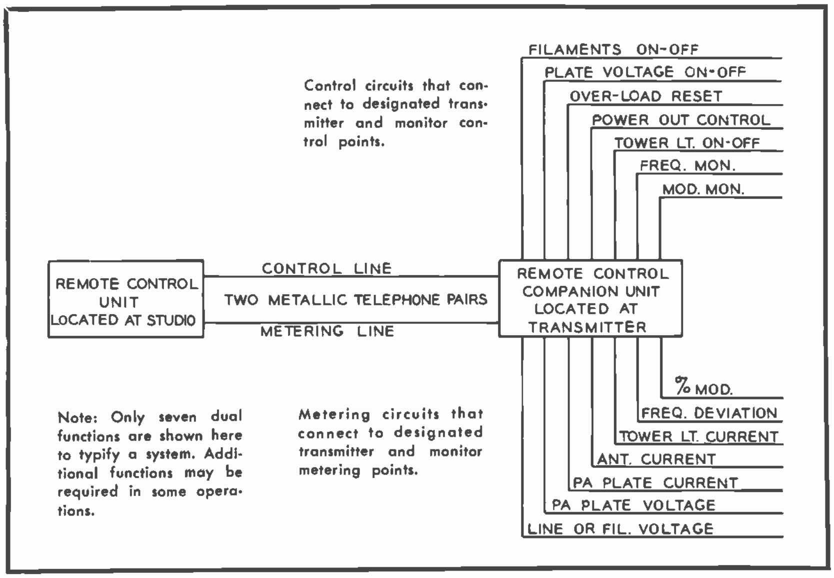


FIG. 12. Block diagram of a typical remote control system. Two telephone lines are used between the studio and transmitter. One line is for control, while the other is for metering. Additional functions may be added to the system when needed.

A remote control system usually consists of two basic units; a control unit, located at the studio, and a companion unit, located at the transmitter. Some accessory items will then be required, and they will vary with the type of transmitter used. For example, to raise and lower the power output in the RCA Type BTA-1MX, a small motor-driven rheostat is required. Various relays may be desirable in some circuits. Then meter multipliers and shunts will always be required, if not already supplied with the transmitter. The block diagram (see Fig. 12) will provide some additional details as to how the system goes together.

When operating the transmitter equipment by remote control it is very important that a definite preventative maintenance schedule be established with emphasis on keeping the equipment clean and all moving parts such as blowers, controls, etc., well lubricated. For that matter, preventative maintenance is an absolute necessity when operating any station, remote controlled or attended.

Logically, if the transmitter equipment is to be operated *unattended*, by remote control, the building requirements can be reduced accordingly. Figure 13 shows a floor plan providing minimum requirements for a remote control, one kilowatt transmitter operation. Note that sufficient room is left to get around the equipment for servicing. Comparing this layout with the building layout for an *attended* installation (Fig. 6) reveals how the building can be reduced in size and in facilities. The requirement for a small room heater should not be ignored in most areas. During off-air periods the room should not be allowed to go below 50 degrees F.

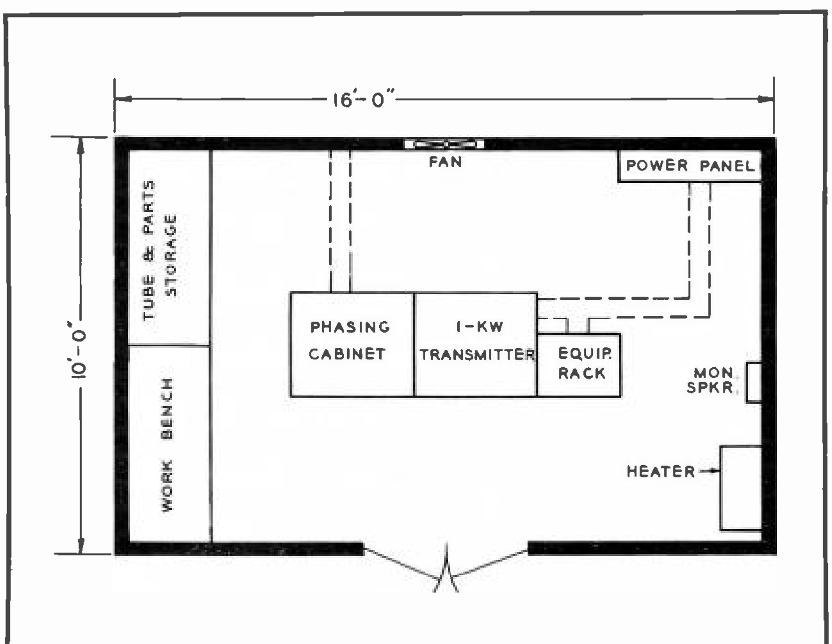


FIG. 13. This is the transmitter building floor plan for a 1-KW remote-controlled operation. Space has been reduced to a minimum, however, sufficient room for the equipment and for servicing is provided.

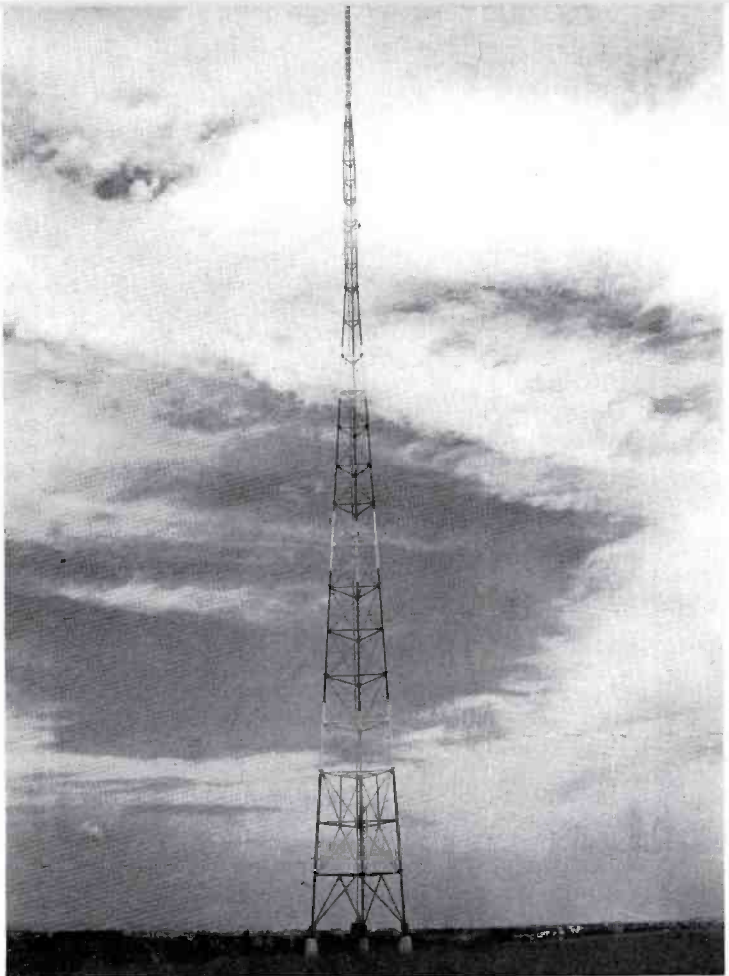


FIG. 14. This is a self-supporting tower. The larger base area supports the entire structure. No guy wires are required.

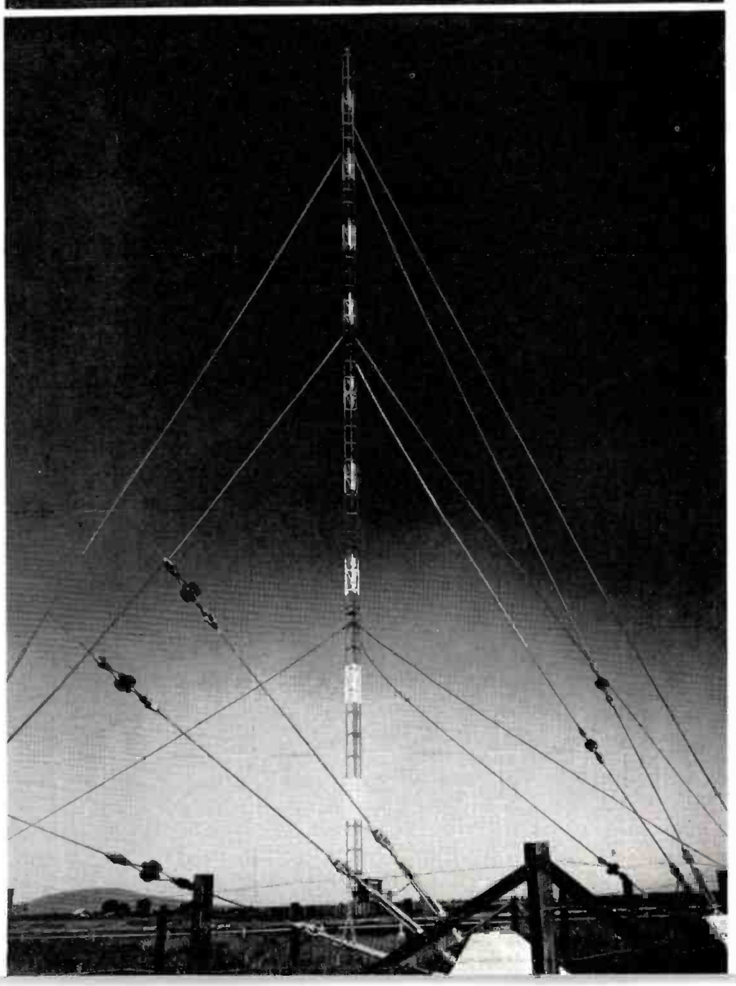


FIG. 15. An insulated-guyed tower and a small building to house the antenna tuning unit is shown here. Observe the insulators used to break the continuity of the guy wires.

Tower Types and Utilization

One of the most important parts of an AM broadcast station is the tower; it is the radiating element of the system. Towers to be used as RF radiators are divided into two types; self-supporting and insulated guyed. (See Figs. 14 and 15).

If space is at a premium, a self-supporting tower may be used. As a general rule the distance between the self-supporting tower legs can normally be considered as ⅛ the height of the tower structure.

However, insulated guyed towers are the most popular, because they are less expensive and generally of a smaller uniform cross-section, making a very efficient and satisfactory RF radiator. With a guyed tower, it is always necessary to insulate the guy wires from the tower, and it is also necessary to insert several insulators in each guy wire to break the electrical continuity. This is to detune any guy wire from possible resonance at broadcast frequencies, which would effect the radiation pattern.

When selecting a tower, thorough consideration should be given to the "Windload" rating in the specifications, with due reference to wind and weather conditions of the area.[1] Building codes and zoning ordinances should also be carefully investigated. Then if the soil condition of the tower site is unknown, test borings should be made. Soil samples may then be analyzed, and foundations designed accordingly. This careful approach to tower requirements means, in the final analysis, tower security.

[1] For more information on antennas and installation procedure refer to "Installing Antennas for AM Operations." (BROADCAST NEWS, Vol. No. 95, June 1957).

Methods of RF Feed

There are two common methods of feeding RF energy to the tower or vertical radiator, as it can now be called. They are "series fed" or "shunt fed." Perhaps the simplest way to show the difference is to examine Figs. 16 and 17, which are fundamental diagrams, but do provide an electrical explanation. You will note that in the "series fed" example, an insulator at the tower base is required. The requirements relative to the base insulator applies to both guyed and self-supporting structures.

In the "shunt fed" example, the base of the tower is grounded directly and the energy is supplied to the tower via a slanted wire connected at a point, well up on the tower, above ground (see Fig. 17). This section of the tower, between the feed point and ground serves as an element of sufficient impedance, so that in combination with the matching network, satisfactory current distribution along the tower can be produced, to obtain proper radiation of RF energy.

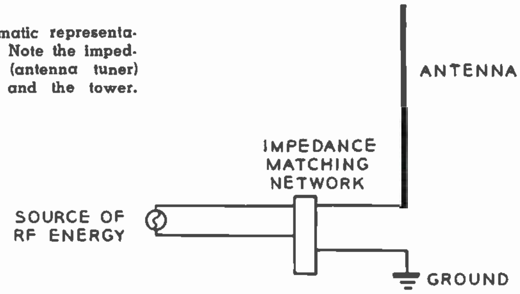


FIG. 16. This is a schematic representation of a series-fed tower. Note the impedance matching network (antenna tuner) between the transmitter and the tower.

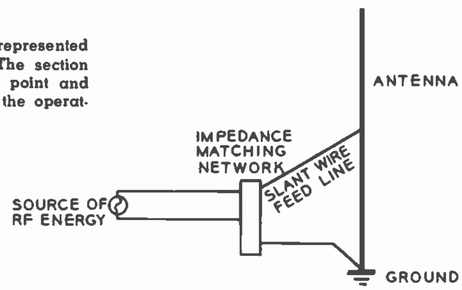


FIG. 17. A shunt-fed tower is represented here. Observe the feed point. The section of the tower between the feed point and ground offers an impedance at the operating frequency of the station.

Antenna Systems

Now that the tower as the RF radiator or antenna has been discussed, the entire antenna system can be considered, of which the tower is only a part. Closely associated with the tower is the antenna ground system. This usually consists of at least 120 radials of No. 10 soft copper wire, as long or longer than the associated tower is high. The radials are spaced 3 degrees apart around the entire tower base. Then a ground screen or mat, made of expanded copper is located completely around the tower base, covering an area of approximately 24 by 24 ft., (see Fig. 18). The entire system is bonded together around the base of the tower. In some cases this mat can be replaced by increasing the number of radials. Short radials about 50 ft. long can be placed between the full length radials to replace the mat or screen.

This ground system is an extremely important part of the antenna system. It is utilized in an attempt to achieve nearly

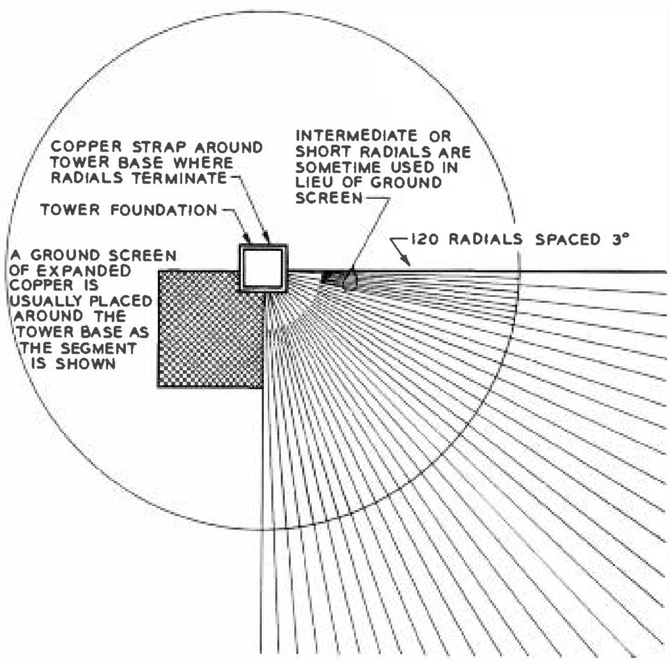


FIG. 18. Typical ground system constructed about the antenna. Radials are placed around the base of the tower to form a complete circle. A ground screen or mat is also positioned all of the way around the tower base. (Note that this drawing shows radials and the mat in only one quadrant, whereas both actually go completely around the tower.)

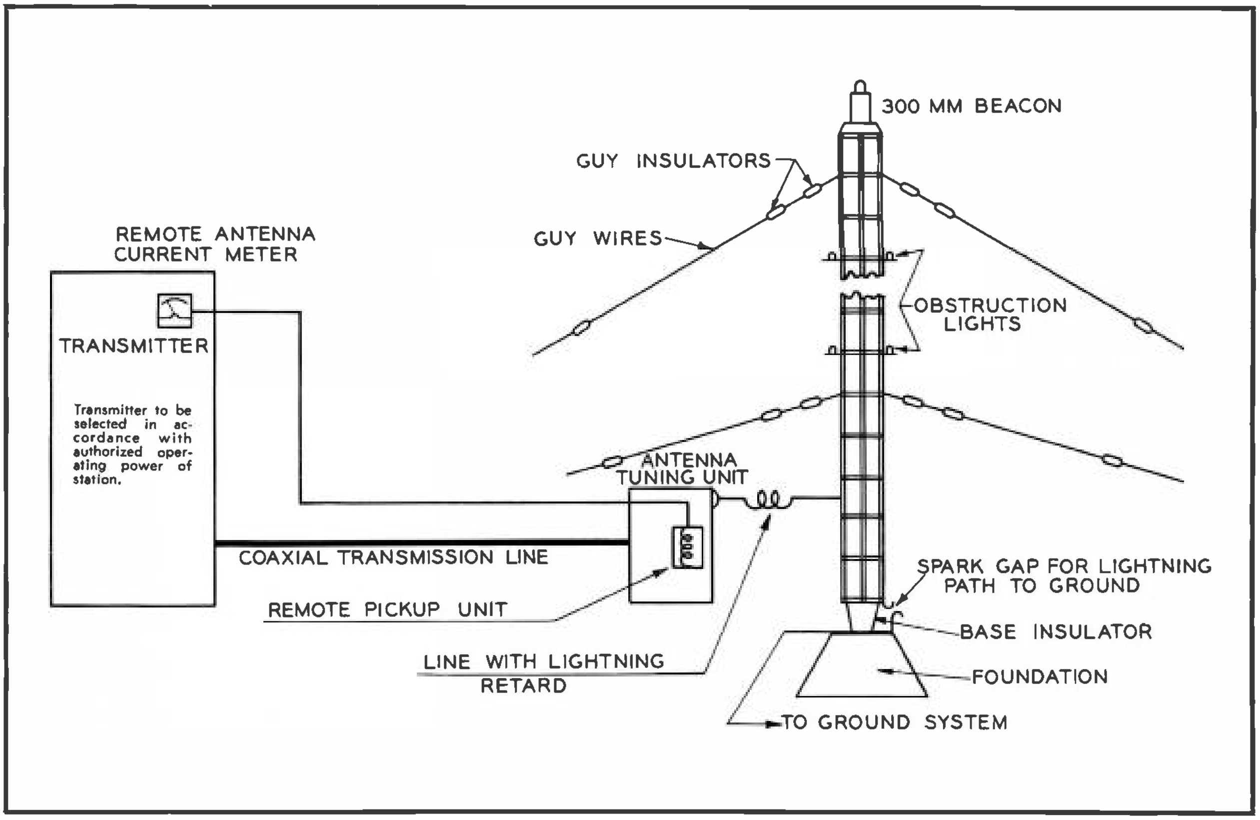


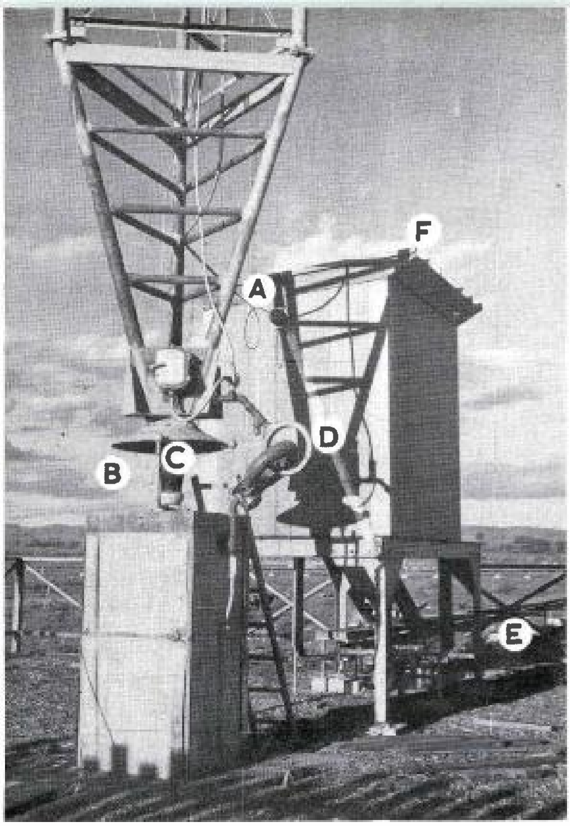
FIG. 19. This is a typical single tower system. Note how the remote antenna current is measured at the transmitter, also observe the position of the tower lights.

perfect conductivity at the earth's plane. True, this improvement of conductivity is localized to the area around the tower. Fortunately, this is where the improvement is most effective when related to the radiated signal.

Each tower and its associated ground system will take on a definite identity of its own. Its identity will be determined by measurement; it will be known by its radiation resistance value, and whether it is capacitive or inductive at the station's operating frequency. The resistance is designated in ohms, and it becomes necessary to match the antenna resistance to the source of RF signal for maximum transfer of power to the antenna. It is also necessary to cancel out the capacitive or inductive reactance in the antenna to produce a purely resistive load. This is accomplished with a matching network, which is usually referred to as an antenna tuning unit.

In Fig. 19 we have a typical single tower antenna system. The RF signal is carried from the transmitter to the antenna tuning unit at the tower, via a coaxial transmission line. This line usually has a characteristic impedance of 50-52 ohms, or 72-75 ohms, which is matched to the tower by the antenna tuning unit. A short section of copper tubing is used between the antenna tuning unit and the tower. Note two loops or turns are in this line. These are put in to retard lightning so that the major surge will go to ground via the spark gap, shown at the base of the tower.

The FCC requires that output power be determined by the direct method, that is, measurement of the antenna current at the antenna. Thus, the reason for the remote pick-up unit shown at the antenna tuning unit. The pickup unit provides a direct current proportional to the antenna current, that can be easily supplied over a pair of wires, and read at the transmitter at the required intervals.



A A lightning loop
B Insulated tower base
C Lightning spark gap
D Austin transformer
E Transmission line
F Equipment house for antenna tuning unit

FIG. 20. This is a typical insulated-guyed tower base. The two loops, next to the base insulator, are the components of the Austin lightning transformer, which isolates the beacon power circuit from the RF potential of the tower. The tuning house, spark gap, and transmission line are also shown.

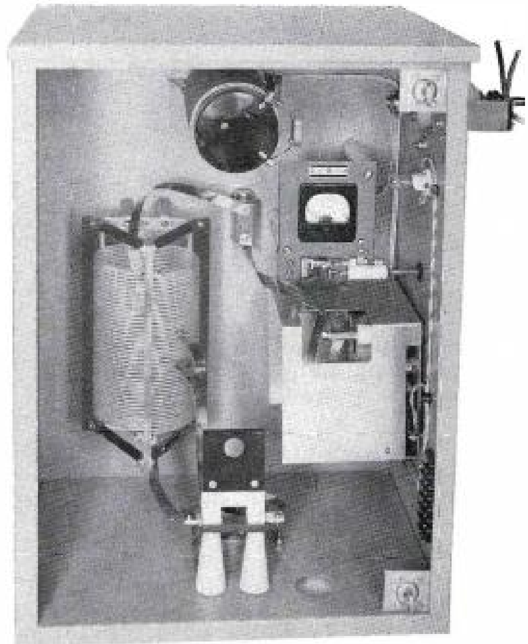


FIG. 21. This is an antenna tuning unit for a 1-KW station; it is usually located at the base of the tower. The lighting choke coils are shown in top-center of cabinet.

Tower Lighting Requirements

In most areas the CAA will require that any tower over 150 ft. in height be lighted. In some areas lighting will be required for towers of even lesser height. Two hundred foot towers are commonly used, and the CAA usually specifies that the tower lighting should consist of one flashing 300-mm. beacon at the top of the tower, and obstruction or sidelights at one lower level (see Fig. 19). A further requirement is that provisions be made to turn the tower lights on and off automatically by means of a photo-electric control, which operates in accordance with the light intensity of the north sky. The light intensity required to operate the lighting system is specified in footcandles.

In order to connect the AC power to the tower lighting equipment on a series fed tower, which is most commonly used, it is necessary to isolate the high RF potential of the tower from the power line. This may be accomplished by use of an Austin isolation transformer, as shown in Fig. 20, or by a multi-section choke, as shown in Fig. 21. A block diagram of a typical single tower lighting circuit is shown in Fig. 22.

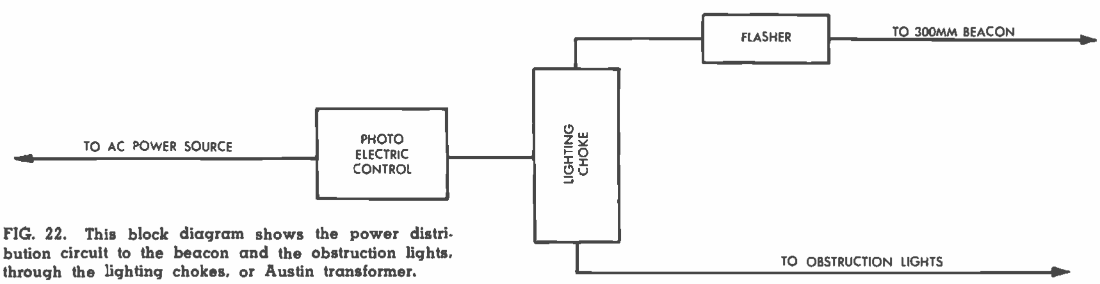


FIG. 22. This block diagram shows the power distribution circuit to the beacon and the obstruction lights, through the lighting chokes, or Austin transformer.

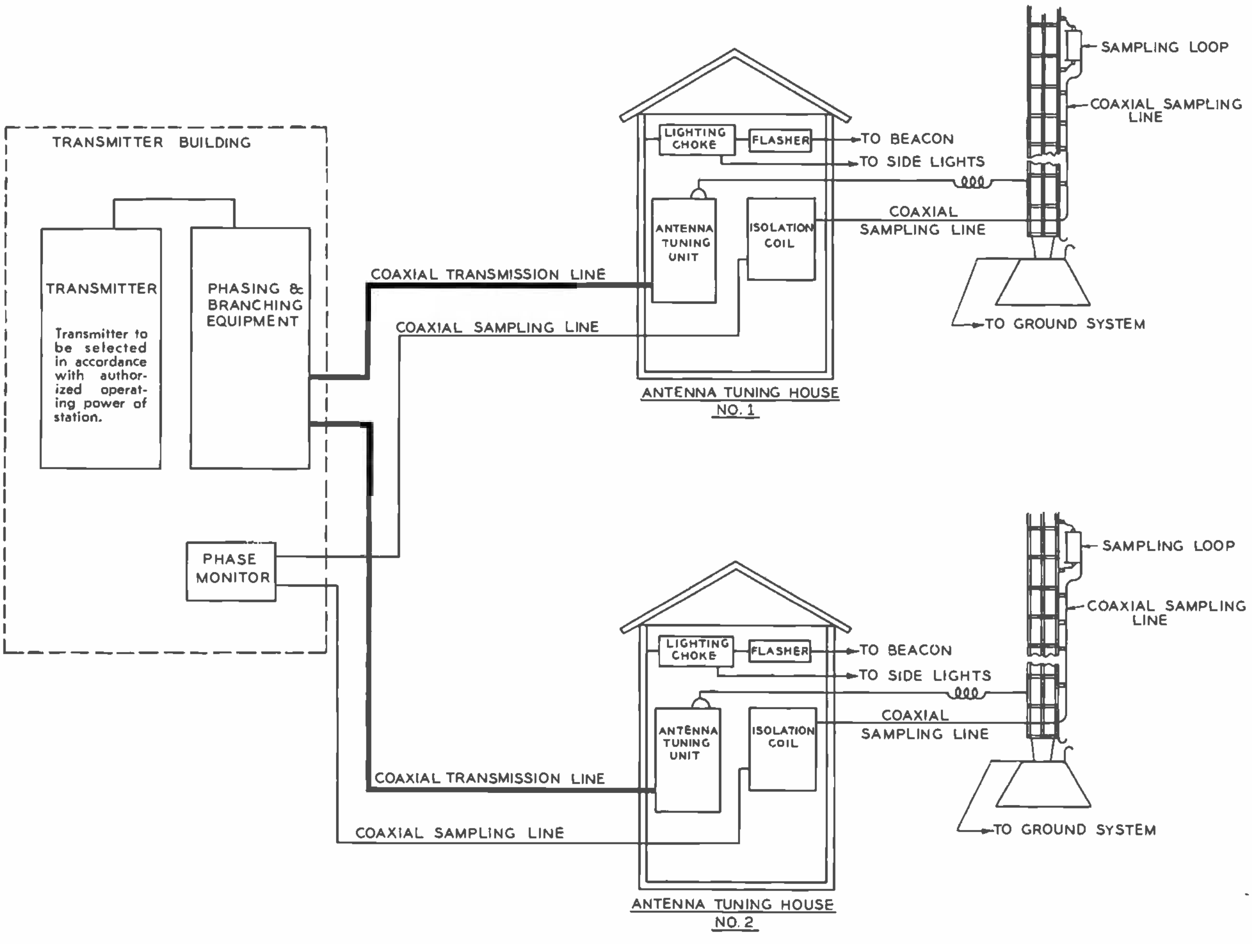


FIG. 23. This drawing shows how the phasing and branching equipments are used to feed a two-tower directional system.

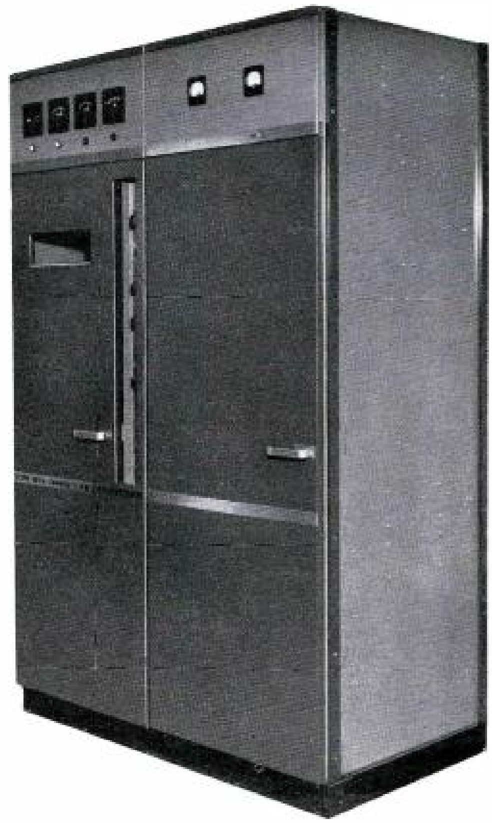


FIG. 24. This is an example of how a transmitter and the phasing equipment can be combined at the transmitter location. On the left there is an RCA transmitter. The right-hand cabinet contains the antenna phasing equipment.

Directional Antenna Systems

The discussion on towers, ground systems, tuning units, tower lighting, etc., may be considered applicable to either single tower or multiple tower (directional) installations. Figure 23 provides the layout fundamentals of a typical two-tower directional antenna system. Small buildings have been included at the towers to house the various equipment items previously discussed: such as antenna tuning units, lighting chokes, and flashers. Some new items appear in this diagram. A sampling loop on each tower is connected, via coaxial line, through an isolation coil back to a phase monitor located in the transmitter building. The purpose of the sampling loops is to pick up some of the radiated RF energy from each tower, and feed it back to the phase monitor so that the phase relationship between the towers can be determined.

In a directional antenna system the radiation pattern is determined by the phase relationships of the RF signal in each tower and by the way the power is divided between the two towers. The power division and phasing of the signal is accomplished and controlled at the phasing and branching equipment cabinet. Figure 24 shows a typical cabinet of RCA phasing equipment for a 1 KW directional antenna system.

Conclusion

Transmitters, building requirements, remote control, towers, and antenna systems have now been discussed. In this discussion we have considered typical systems and given general principles of application. These can be adapted to specific installations according to the individual requirements of the station.

Editor's Note: Part three of this series will cover Installation, Operation, and Maintenance of the typical stations described in Parts One and Two. It will appear in the next issue of BROADCAST NEWS.

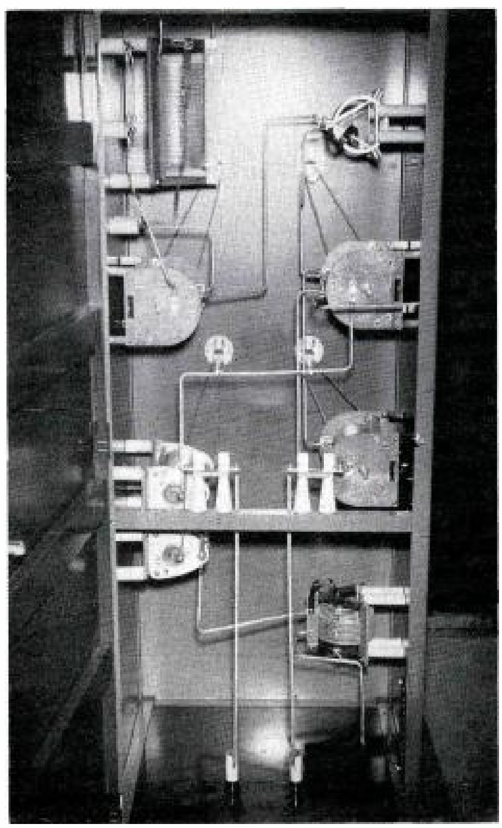


FIG. 25. This shows a rear view of the phasing equipment in its cabinet.

Unlimited system
plus superb picture quality...make RCA best

Improved technical quality in your film programs need not require a big investment

ICONOSCOPE CONVERSION

You can start simply and build gradually, if you prefer, first by converting iconoscope film cameras to RCA vidicon film cameras. You'll get marked improvement in gray scale, tremendously increased signal-to-noise ratio, improvement in resolution, and provision for automatic black level control . . . all with a minimum of operating attention. The "snap," clarity and live effect will be immediately reflected in advertiser preference.

MONOCHROME SYSTEM EXPANDABLE TO COLOR

Or, you can start with the superior vidicon film system expandable to color. Using the RCA TP-15 universal multiplexer, color and monochrome film equipment can be completely integrated—by adding a TK-26 color film camera at any time. This new multiplexer accommodates up to four projector inputs, all of which are available to two film camera outputs.

COLOR FILM SYSTEMS

To go to color *now*, you can select from various equipment combinations which use the RCA TK-26 three-vidicon film camera. In TV stations where superb picture quality and operational simplicity count, the TK-26 is the preferred system for color film programming. It has been selected after careful comparative evaluation with other systems and found to produce finer quality film pictures in both monochrome and color. Superior results are achieved at minimum cost with maximum operational simplicity.

LIVE COLOR, TOO

It is possible to use the RCA three-vidicon film system for pickup of opaques, live commercial products and demonstrations within a limited area.

See your RCA Broadcast Representative for more details on Vidicon Film Systems. He will be glad to answer your questions. Let him help plan a film system that can start you on the road to the new and additional revenue that will come from color!

NEW STANDARDS OF QUALITY

The RCA Vidicon Film System has established a standard of film reproduction by which all other methods are judged. You can expect and get the highest quality reproduction, with protection against obsolescence for years to come. To give some idea of the wide range of system possibilities with RCA equipment we submit four diagrams, at right, from the very simplest equipment to a Dual Color Film System.

Monochrome film system expandable to color.

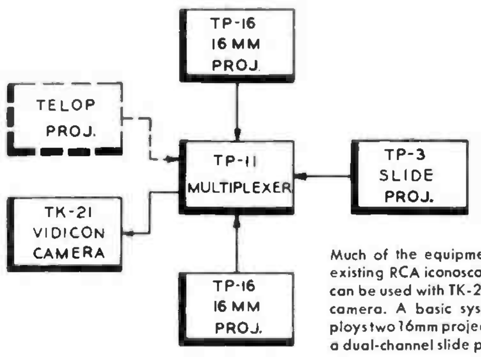
RADIO CORPORATION of AMERICA

BROADCAST AND TELEVISION EQUIPMENT **CAMDEN, N.J.**

possibilities . . .

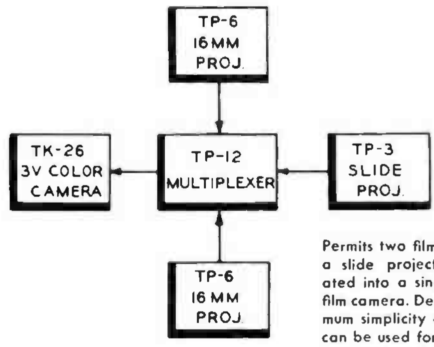
buy in film equipment—monochrome and color

1. CONVERSION OF ICONOSCOPE FILM SYSTEM TO VIDICON



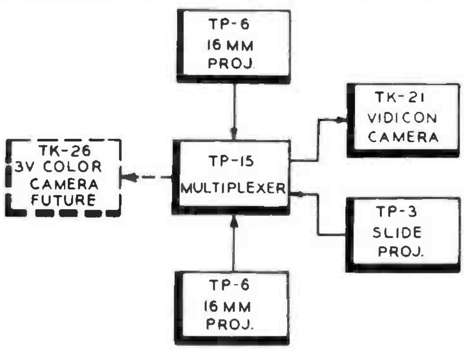
Much of the equipment in an existing RCA iconoscope chain can be used with TK-21 vidicon camera. A basic system employs two 16mm projectors and a dual-channel slide projector.

3. BASIC COLOR FILM SYSTEM



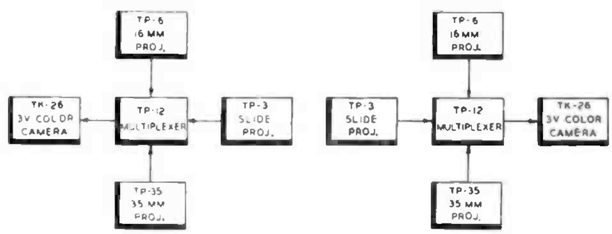
Permits two film projectors and a slide projector to be operated into a single TK-26 color film camera. Designed for maximum simplicity and economy, it can be used for both color and monochrome film.

2. MONOCHROME FILM SYSTEM EXPANDABLE TO COLOR



Combines a TK-21 monochrome film camera with projectors and multiplexing equipment, which are usable in color as well as monochrome. At any time a TK-26 color film camera can be added, retaining the TK-21 for the monochrome channel.

4. DUAL COLOR FILM SYSTEM



Will handle a large number of inputs and therefore provides maximum program protection. Two completely independent program channels provide the ultimate in reliability and assure continuous programming. Permits previewing in color.

Best for color and monochrome because it uses proved-in components!

VIDICON TUBE . . . . RCA development

Vidicon storage tube is outstanding from standpoint of high signal-to-noise ratio, reliability and low-cost operation. It produces a sharp lifelike picture—equally good in monochrome or color. Replacement involves minimum of equipment readjustment.

STANDARD-TYPE PROJECTORS FOR 35 and 16MM

Standard of the motion picture industry, the intermittent projector produces a beautiful steady picture. It involves none of the critical mechanical tolerances of the continuous projector for 16mm. RCA now offers the TP-6 series projector designed from the beginning for professional 16mm television use. Provides maximum video and audio quality with operating convenience and dependability. RCA neutral-density-filter light control makes it possible to achieve satisfactory results with practically all kinds of film.

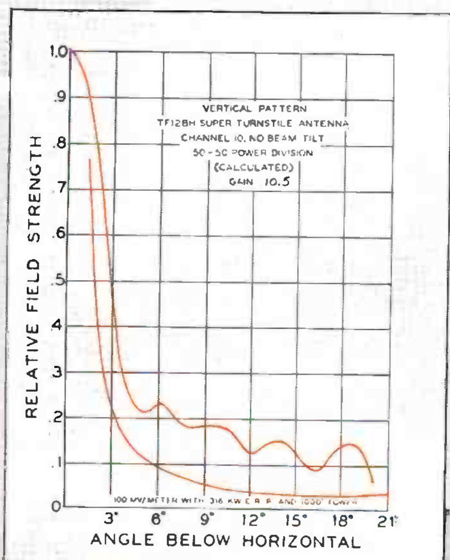
NEW TYPE TP-15 MULTIPLEXER

Provides for complete integration of color and monochrome. Offers flexibility and protection of two-camera system without the necessity of buying separate projectors for each camera. Permits preview of one program while another is on-air.

OPERATING CONVENIENCE AND SIMPLICITY

Only two simple controls are employed in "on-air" operation. Pedestal level and Master Gain. For assuring picture perfection, all controls, together with waveform and picture monitors, are located at the operating position.

How to "saturate"



Vertical Field Pattern of new RCA TF-12BH 50-kw antenna. Note complete absence of vertical nulls. Operated in conjunction with an RCA 50-kw TT-50AH transmitter, this antenna will "saturate" your service area with strong signals.

RCA 50-kw VHF transmitter. TT-50AH Now in regular production, this transmitter is the ultimate in high power for channels 7 to 13. P.A.'s operate with standard power tetrodes (obtained from any RCA Tube Distributor).

an entire service area

(CHANNELS 7 TO 13)

RCA's new 50-kw VHF transmitter, and an RCA TF-12BH Superturnstile antenna, will "flood" your service area with strong signals — close in AND far out!

Tailored to "consultants' specifications," RCA's 50-kw antenna-transmitter combination is your answer for maximum ERP *and* "saturation" coverage on channels 7 to 13.

"Rain" your signals in all directions!

No need to "beam" to reach specific areas. You get saturation everywhere—close in *and* far out. Reason: RCA's TF-12BH high-gain antenna delivers two to three times the required field strength—even in minimum signal areas. And it makes no difference whether you use an extremely high tower—or one of average height. This is the one transmitter-antenna combination that develops 316 KW ERP—*with power to spare!*

Antenna System takes full 50-kw Input!

RCA's TF-12BH high-gain antenna and antenna components will take the full output of the 50-kw VHF transmitter—with a high factor of safety. Designed for pedestal or for tower-mounting, RCA antennas withstand windloads of 110 miles, and more. A unique switchable feed system enables you to switch power from one part of the antenna to another QUICKLY—an important advantage that will keep you on-air during an emergency.

A 50-kw VHF System—completely matched!

RCA can supply 50-kw systems matched precisely for peak performance—from antenna, transmitter, transmission line, fittings, tower, r-f loads, wattmeters, and diplexers—to the hundreds of individual components required by the carefully planned station plant.

Qualified planning help is vital!

For experienced assistance in planning a transmitter-antenna system that will literally "blanket" your service area with strong signals, call your RCA Broadcast Sales Representative. *He knows systems-planning from A to Z.*

RCA PIONEERED AND DEVELOPED COMPATIBLE COLOR TELEVISION

RADIO CORPORATION of AMERICA

BROADCAST AND TELEVISION EQUIPMENT • CAMDEN, N. J.

of the high-power "VHF's"

Known for their "powerhouse" reliability in the nation's 25- and 50-kw VHF TV transmitters, RCA-6166's have been running up outstanding life performance records ever since the advent of higher power.

What's back of RCA power-tube reliability?

It is tube-design experience...almost a quarter century of it in building tubes for virtually every transmitter application and power requirement. And it is tube engineering "know-why"...acquired by working hand in hand with station engineers and transmitter designers.

Your RCA Industrial Tube Distributor is ready to meet your tube requirements around the clock. Call him for the RCA types you need.

HOW TO GET THE MOST FROM AN RCA-6166

- Hold filament voltage at 5 volts ...right at tube terminals.
- Keep air cooling system clean ...to prevent tube and circuit damage from overheating.
- If power amplifier uses spring-finger socket contacts, make sure each finger is clean...and has ample tension for good contact (to prevent arcing).
- Handle tube carefully to avoid damage through mechanical shock.
- Operate tube within RCA ratings; follow instructions packed with each tube.
- Operate spare tubes periodically.
- Test each RCA-6166 in actual operation as soon as you receive it.

RADIO CORPORATION OF AMERICA
® *Electron Tube Division* — *Harrison, N. J.*

From the stunning new Mark Series, *The Townsend*, 260 sq. in. viewable area. In genuine walnut veneers and solids (21CD890) $795.00.

The pride of ownership is second only to the pleasure

You know the great gifts—there are only a few. The fine motor car, the rich fur, and now color television. Like each of the others, Color TV is a gift distinguished not by its price, but by the extra pride you take in giving it—or owning it. That, and the very special *beauty* and *excitement* of color.

Today's "Living Color" TV by RCA Victor is brilliant and lifelike. It is performance-proved—like world-famous RCA Victor black-and-white TV, "Living Color" TV has been proved reliable in tens of thousands of homes. It is simple to tune, a delight to own. Prices start at $495. See a demonstration of "Living Color" TV, including the superb new Mark Series, at your RCA Victor dealer's.

Consider a moment. *Isn't Christmas the ideal time to give your family the gift of color?*

SEE COMO, GOBEL, FISHER, "Tic Tac Dough," "The Price is Right" on NBC in Compatible Color co-sponsored by RCA Victor.

RCA VICTOR FACTORY SERVICE CONTRACT. Fine service for the finest in television! Only RCA Victor TV owners can buy an RCA Victor Factory Service Contract for expert service and installation by RCA's own technicians. Branches in most TV areas.

Manufacturer's nationally advertised VHF list prices shown, subject to change. UHF optional, extra. Slightly higher for West, South.

RCA PIONEERED AND DEVELOPED COMPATIBLE COLOR TELEVISION

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SYMBOL OF RCA VICTOR COMPATIBLE COLOR TV

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