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CBS Broadcast Center

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CBS BROADCAST CENTER

PART I. INTRODUCTION

A. BACKGROUND

CBS in New York is undertaking what many U.S. television broadcasting stations have been doing; namely, replacing its original plant to provide a modern, more efficient and flexible facility. The original CBS Television plant, like many others built at the time, was installed quickly during the early days of television broadcasting and expanded piecemeal to meet changing requirements. In this case, the oldest portions of the plant are over 15 years old.

In replacement and modernization, the objective is to bring about a more efficient operation and one which is capable of producing a higher quality product. This may be achieved in part by taking advantage of current technology, particularly in the utilization of more stable and reliable equipment. It may be achieved by designing a plant to meet the known operating and production patterns which have evolved through years of experience and by building in the flexibility needed to meet unknown future requirements.

The concepts which have been followed in the design of this plant to meet operating requirements, although influenced by the sheer magnitude of a network headquarters operation, are consistent with those currently being applied in new television broadcasting plants of all sizes. The approach is more evolutionary than it is radical in concept.

In the case of CBS, New York, an important additional gain in efficiency is afforded through further consolidation of what had become a far-flung,

city-wide, plant. The extent of the CBS television plant at its most dispersed, in the mid-1950's, is indicated in Figure 1A. Changes in the program schedule, production techniques, management methods, and above all, the advent of video tape, have made possible a considerable reduction from this extreme. Given the existing program schedule in the final consolidation, after completion of Broadcast Center, CBS Television will occupy only five locations in New York, as illustrated in Figure 1B.

Most production studios and all central support facilities and services will be consolidated in Broadcast Center on West 57th Street. Off-premise studios will be retained to accommodate audience shows and to provide supplementary production space, as required to handle the inevitable peaks in the production schedule.

B. BROADCAST CENTER

Broadcast Center has been created by conversion of a building, owned by CBS since 1952, but originally built in sections between 1906 and 1939. For many years, designated "Production Center," it has housed CBS television functions such as scenery and property construction and storage; film editing and storage; field, construction and technical maintenance shops, and Operations management. The building was acquired with the thought of ultimate conversion to a centralized broadcasting plant. Studies were undertaken as early as 1955, and in 1961 approval was given for the project now nearing completion.

Upon completion, Broadcast Center will house the CBS Television Network and WCBS-TV local station New York operations, most of the Radio Network

operation, the entire CBS News Division, and many related functions. In its 500,000 square feet of floor space, it will contain six television studios, with all related back-up facilities, such as dressing rooms, viewing rooms, and rehearsal halls; the local and network Newsrooms, including two small television origination facilities; five radio studios; show production units; scenery shops and storage space; central technical equipment; services ranging from a cafeteria to corporate data processing; and related administrative and management functions. The plant will provide a fully integrated, balanced production complex, equipped to deal with all phases of television program production, from script to output signal.

In this paper, only the television portions of the plant are described, with emphasis on the technical facilities and the areas in which they are housed. As indicated in Figure 2, these facilities and areas are located on two floors of the building.

1. Studio Floor of Broadcast Center

The six larger television studios occupy what was formerly the top floor of the western portion of the building. Headroom was created by literally "raising the roof". As shown in Figure 3, new structure was placed, a new roof was finished, and then the old roof and its structure were removed to form the studio blocks. The photograph of Figure 4 shows the interior of one of the studios thus formed (Studio 42) which, with over 6,000 square feet of floor space, has a lighting-grid height of 19 feet. The smallest studio has 3,300 square feet of floor space; the largest, 8,500 square feet, with a grid height of 25 feet.

Because of the fact that the studios are elevated and thus susceptible to sound conduction through the building structure, the floor of each studio is an isolated, spring-supported, reenforced concrete slab. The inside walls of the double-wall construction are supported on the floor slabs. Also, as shown in Figure 5, buffer space is provided around each studio further to insure acoustic isolation. Some of the space between studio blocks on two floor levels was utilized for dressing rooms, conference rooms, offices, scenery ready areas, and, on an upper level, a central area housing the magnetic-amplifier, dimmer units for all six studios. A truck ramp in the original building was retained for scenery handling.

Associated with each of the six studios is a control room. Each control room is on the same floor level and is located immediately adjacent to its studio, providing direct access. Studio-to-control room windows are not provided. To the greatest possible extent, each studio and its control room has been made a self-sufficient production unit. Operational control of all program sources assigned to a studio has been delegated to the control room, but, on the other hand, equipment requiring only set-up adjustment has been placed in a central equipment area.

2. Central Technical Area

As indicated in Figure 2, the Central Technical Area is located on the floor below the studios. This area, shown in more detail in Figure 6, is divided into two principal sections, designated Equipment Center (or rack room) and Operating Center (or "machine" room).

On the periphery are the Telephone Company terminal room, the television maintenance shop, closely-related technical operations offices, and three Program Control rooms.

a. The Equipment Center, occupying 4,500 square feet, houses 265 racks containing studio and telecine camera channel equipment, relay-type studio switcher matrices, the sync pulse system, central intercom and audio facilities, and multiple-function computer control equipment. Included is a Transmission Center, which provides for overall technical surveillance of incoming and outgoing programs and serves as a technical communications center. In the Switching Center, a multiple-channel switching system, with 109 inputs and 197 outputs, provides a computer-controlled interconnection among program sources and control rooms, and remote-controlled selection for monitor and cue channels.

b. The Operating Center initially houses, in its 12,000 square feet of space, 27 film playback channels, six film recording channels, and 24 video tape machines. Related supervisory, assignment control, closed circuit (audition) control, and first echelon maintenance functions are centrally located in the area. Both film and tape material are supplied from a common ready area.

3. Program Control Rooms

Program Control rooms are of two types. One, patterned after a studio control room, will be used to produce News shows originating in the adjacent News area.

The other two Program Control rooms are functionally designed to handle the transmission of a continuous sequence of programs to network circuits and to the local station. In each of these, a two-man team, with the aid of computer memory, can select and control related program continuity for two different destinations.

This has provided a brief orientation as to the location of the Broadcast Center television technical areas. In the next section, attention will be directed to the functional layout of some of the more important operating areas, with emphasis on the underlying operational philosophy.

PART II. TELEVISION OPERATING AREAS

A. PLANT DESIGN

From an operating philosophy viewpoint, the general design targets for the new plant were to increase its efficiency and flexibility through consolidation and modern design, improve the technical quality of the product through improved equipment and operating conditions, and reduce the operating costs through the efficiencies effected. In short, the objective was the goal of any business -- to produce a better product at a lower cost. At the same time, the new plant is designed to open logical avenues to accommodate tomorrow's expansion and change.

The specific plant design was developed by relating these general design targets to individual operating areas and fitting the "design" to the operating "job-to-be-done". Broadly speaking, television broadcasting activity can be divided into two operations: (a) production of programs (recorded or live), and (b) broadcasting of programs in an integrated continuous sequence. The operating control areas are designed specifically to meet the requirements of these two operations and to provide for efficient and convenient utilization of common support facilities.

B. PROGRAM PRODUCTION FACILITIES

Program production is basically a creative operation. Thus, the studio and control room design should provide an atmosphere which aids the production crew in this creative effort. To this end, the Broadcast Center studio control rooms were arranged to group the entire production team close to the

program director and to make them relatively independent of outside support by giving each man control of those program elements for which he is responsible. On the other hand, unnecessary equipment, set-up control, and loading tasks were removed from the control room. Terminal, switching, and power equipment were located in a central area away from the creative activity, and remote control of necessary functions was extended to the control room.

Within the control room itself, there are three closely interrelated jobs to be done during the production of a television program: (a) picture pick-up, (b) sound pick-up, and (c) camera editing.

(a) The picture pick-up is the <u>combined</u> responsibility of the lighting director and the video operator, who are assisted by the lighting crew and switchboard operator.

(b) The sound pick-up is under the control of the audio man who is assisted as required by mike boom operators, sound effects men, audio tape and turntable operators.

(c) The camera editing operation is under the direct control of the program director, who works through the program switcher, or technical director, assisted by the cameraman, dolly pushers, and crane operators.

Of course, all these interrelated jobs are ultimately under the control of the program director.

In recognition of these relationships, the Broadcast Center control room design provides separate picture, sound, and production control areas arranged so that they can be isolated from one another by sliding glass panels, yet all be within line-of-sight with the program director.

The layout of a typical control room, which is about 38 feet long and 20 feet wide and one the studio floor level, is shown in Figure 7. The picture control area is on the left, with the production control area in the center, and the audio control area on the right.

The audio man is at the audio console with the turntable and audio tape machine operators to his right. The lighting director sits between the video man and the lighting switchboard operator and shares a single set of picture monitors with the video man. The program director and his assistants sit at the central console with the technical director, who handles the video switching, and are provided a separate set of picture monitors. These monitors are arranged to provide the best possible viewing display, which is made possible by the elimination of the little-used control room window. Quick access to the studio floor was found to be of far more value than direct line-of-sight in modern production work.

The continually increasing complexity of sound pick-ups in television shows has resulted in the need for additional space and facilities in the sound control area. The audio console required more microphone inputs, more high level inputs for film, tape, and remotes, a greater number of improved equalizers, special effects filters, two completely separate reverberation channels, and seven separate output channels, each able to select any combination of the mixing channels. This latter requirement has resulted from

the need to record simultaneously a composite audio track, a separate dialogue track, music track, effects track, and still provide pre-hear facilities and sound reinforcement for the studio and an audience, if present. As shown in Figure 8, these audio facilities were arranged in a console which can be conveniently and effectively operated by the single audio man.

In the picture control room, shown in Figure 9, the lighting director and video man share a common responsibility for the picture quality and, therefore, share a common control console. The lighting director controls lighting balance and artistic mood of a scene, and the video operator sets the exposure of the camera. The lighting director controls the lighting balance through the lighting switchboard operator to his left, and the video operator controls the camera exposure, black level, and white level through the remote controls extended to his operating console. Together, they observe the final results on a common set of camera monitors, preview monitors, and a line output monitor.

To insure optimum blending and control of all picture material used in a production, the exposure, video level, and black level controls for all supporting picture sources assigned to the studio have also been extended to this console. Thus, the video operator has direct control of the telecine film and slide cameras, playback video tape machines, and processing amplifiers for remote signal sources. These controls are grouped together with those for the studio cameras within the reach of the single video operator.

In the production control room, present-day program requirements make it necessary to be able to handle a large number of sources without enlarging

or complicating the switching panel. The video switcher, shown in the foreground in Figure 10, has twelve inputs for live cameras and remote signal sources and six output switching rows plus preview and special monitoring busses. However, as many as 80 different sources can be assigned to a given studio, and the technical director can "call up" any combination of eight at one time. When selected by the technical director, using a keyboard control, the source is automatically routed to the video control, video switching, and audio control positions, complete with its associated audio, video, intercom, interphone, transport control, video level control, audio level control, and indicating read-outs.

The program director and his assistants are the focal point of the production effort. To simplify their task, a complex and comprehensive intercom and interphone communications network was required. This system has to provide the ability to communicate with a great number of people, singly, and in groups, with as little effort as possible and with maximum clarity.

The "flexibility" design approach was carried into the studio itself and, in fact, many operating features have been introduced whose detailed discussion is beyond the scope of this paper. However, because of its importance to the "picture pick-up" problem, the new studio lighting grid should be mentioned. In Figure 11, a typical broadcast studio lighting grid is shown. The grid is a network of fixed channel struts and walkways arranged to permit a lamp to be hung in virtually any location in the studio. As shown in Figure 12, the lighting crew works in the grid and hangs the lamps from horizontal supporting channels at the operator's waist level. With this system, the scenery can be "loaded in" and "set up" on the floor

while the lighting is being set from above. In the past, these operations were done in sequence in most studios, and, therefore, this system will require less "turn around" time between shows. A light can be raised, lowered, tilted, or re-focussed during a rehearsal or program without disturbing the performers or the production staff. In the past, it was often necessary to wait for a "rehearsal break," when a ladder could be moved into the scene to adjust a lamp. Thus, this system should not only be faster and more flexible, but should also provide higher quality results.

C. PROGRAM BROADCASTING FACILITIES

As contrasted with the creative job of producing programs, the broadcast of programs in an integrated, continuous sequence is more an exercise in accurate scheduling, precise timing, and error-free integration. Therefore, a system which simplifies the assembly, timing, and error-free broadcast of programs with the ability to make last-minute changes, is required. Once the material is assembled and timed, the signal selection and program sequence control is a mechanical and repetitive task. In the Broadcast Center, these operations have been automated through the use of computers.

The actual broadcast operation takes place in a control room designed specifically to handle this function. The layout of a typical Broadcast Center automated Program (continuity) Control room is shown in Figure 13. This control room is operated by a two-man team, a production man, and a technical man. The production man is responsible for the program continuity; the technical man is responsible for audio and video level control and, with the aid of the computer, is also responsible for audio and video switching.

In the view shown in Figure 14, the production man sits on the right side of the console before a set of output monitors and indicating read-outs. The technical man sits on the left side of the console with his set of line output monitors, waveform monitors, indicating read-outs, and test and preview channels.

As in the studio control room, the control console provides remote control facilities to control the audio, video, and transport of the assigned signal sources. However, because of the nature of the work in this case, twelve sources rather than eight may be accommodated. Combined audio-video switching, including fades, dissolves, and special effects, is performed automatically, using computer memory, but a complete switching panel is provided for manual control in an emergency.

Two Program Control rooms of this type have been installed in the plant to service the multiple network feeds that occur, especially during Daylight Savings Time, and each of them can "feed" two output signals when separate "regional" material is fed to different sections of the network within a single show. One room will normally feed the regular network and local New York station WCBS-TV and the other various special networks and the "delayed" network during Daylight Savings Time.

As mentioned previously, a third Program Control room, designed in the manner of a live studio control room, is used to control News programs that originate from the Newsrooms. During other parts of the day, this room can be used for the assembly of pre-recorded material and to serve as an "anchor" studio for programs originating largely from remote locations. With its twelve input channels, it will be especially useful in the assembly of complex multiple-location remote originations.

D. CENTRAL TECHNICAL FACILITIES

The Central Technical Area contains the technical equipment to support the two basic operations described above. In line with the objective of improving flexibility and reducing operating costs, the Broadcast Center design combines like operating functions into a single area and separates operational activity from maintenance activity. As noted previously (Figure 6), the Central Technical Area is divided into two main sections, the Equipment Center and the Operating Center. The Equipment Center is shown in more detail in Figure 15.

The Operating Center, as shown in Figure 16, contains the telecine film and slide projectors, the video tape machines, and the television film recorders. It is the "record" and "playback" factory, which services the studios and program continuity rooms.

The playback operating controls have been delegated to the using facility; thus, the playback operation in this area is effectively a loading and "cueing" operation. The recording operation, on the other hand, is attended and locally controlled in this area. Any given video tape or film recording machine may select any one of 70 inputs from which to record. These recordings are scheduled as part of the daily operating routine. The area is supervised from a Central Operations control room (CO) in the center of the complex. In addition to their supervisory responsibility, the supervisors in this room can override the computer routing assignment in the event of a last-minute machine failure which necessitates a machine reassignment.

The Closed Circuit control area (CC) is an audio and video control point for monitoring and adjusting signal levels for transmission to viewing rooms,

thus eliminating the need to tie up a studio or Program Control room for internal viewings and auditions.

The operating specifications for this plant generated a set of unique engineering design problems. The next section of this paper will outline the design approaches employed to solve some of these problems.

III. TELEVISION TECHNICAL EQUIPMENT

A. MAJOR DESIGN PROBLEMS

As has been indicated, the equipment and controls in Broadcast Center operating areas have been limited to those necessary for actual operating functions. Control room personnel are assigned complete control of the operating functions of the necessary support facilities. The supporting technical equipment is, however, centralized in a Central Technical Area.

In order to enable the separation between operating and supporting technical functions to be effective, rigorous system and equipment design performance requirements had to be met. The major design problems resulting from these requirements are outlined below.

1. Central Routing of Support Facilities

Because of the size of the plant, and the resulting large number of video tape, telecine film channels, and other sources assignable to any one of many control points, a centralized routing and interconnection system is required. To afford efficient control and operation, including use of computer memory for normal assignment control, a remotely controlled switching system of massive size was dictated.

2. Remote Control of Support Facilities

To enable the control room operator to achieve effective self-service control over all sources assigned to him, and to thus minimize the need for standby attention by personnel in the Central Technical Area, extensive remote control circuitry is required. For example, in the case of video tape playback, video gain, black level, capstan

tracking, fast forward or rewind, and the normal start and stop functions, must be carried through the routing system to the control room.

3. Stable Equipment

In such an extensive system, to minimize operating and maintenance effort, signal levels must be uniform and stable; no hour-to-hour, day-to-day, or even week-to-week drifts in terminal equipment can be tolerated. Where variations cannot be avoided, automatic correction equipment must be employed.

B. MASTER EXCHANGE SYSTEM

The interconnection of support facilities to studios and control rooms, and the routing of program signals are handled in a Master Exchange switching system, not unlike a telephone exchange in concept. The equipment is housed in 79 telephone-type relay racks and five cabinet racks. The system occupies 1,200 square feet of floor space in a glass-enclosed area in Equipment Center. Figure 17 is a view taken through the glass window, showing two rows of video and audio switching racks.

In all, 109 input and 197 output channels are provided. The 109 inputs to the system are fed from telecine cameras, video tape units, utility live cameras, on- and off-premise studios, Program Control rooms, and remote pick-ups. Each input channel consists of one video circuit, two audio circuits (the second to accommodate any future stereo installation), communications between operating areas, and up to 21 control circuits. The number of control circuits varies, depending upon the nature of signal source. The channels

for telecine and tape equipment require the maximum number of control circuits. On the other hand, channels fed from on-premise studio outputs require no control circuits.

Of the 197 output channels, 142 provide service to studio and Program Control room switching systems, video tape recording, and film recording. The remaining 55 channels feed outgoing networks, monitors, viewing rooms, and cue circuits. In addition, three channels are allocated for test purposes. Controls for each of the test channels are located at strategic points in the Central Technical Area in order to permit ready operational surveillance of the system performance and maintenance diagnosis of system faults.

To accomplish the many switching functions, two types of relays and one type of motor-driven rotary selector are employed in the Master Exchange system. A total of 35,000 wire-spring relays are used for all signal circuits, audio, video, and communications. Control of input channels is handled by a bank of conventional telephone-type 10-in/10-out, 6-level cross-bar switching assemblies. The 21 control circuits and single tally circuit associated with each channel are switched on 200, 16-deck 51-contact, motor-driven rotary selectors. Figure 18 shows one of the five cabinet racks of rotary selectors.

The switching of audio and video signals is handled at low level in order to reduce to a minimum the number of input amplifiers. Nevertheless, a total of 1,200 video and 309 audio amplifiers are required. Each input video amplifier has a gain of 9 db, three of which make up for the loss in equalization of the input video line. The remaining 6 db permits a level of 2 volts from each of the two outputs to be fed to a splitting network which in turn feeds

twelve cross-points. The cross-point level of 0.07 volts, after switching, is boosted up to a standard 1 volt by the output amplifier. One amplifier is provided for each output. Equalization for frequency response losses in the switching system is provided in the amplifiers. Similarly, 24 db of gain is provided in each of the audio output amplifiers in order to permit one input channel to feed several outputs.

Maintenance of a switching system of this magnitude and complexity would pose serious and costly problems if it were not for the extreme stability of the solid-state components and reliability of the relays. Experience to date indicates that gain variations from input to output can be held to 2 percent, or less. The greatest portion of the overall system gain variation is due to variations in terminating and splitting network resistances. To reduce such variations where tolerances in any one path through system are cumulative rather than averaging, resistors have been selected to reduce the overall level error to under 2 percent. Amplifier gains, on the other hand, are holding to well within $\pm$0.5 percent without any need for periodic adjustment.

Accelerated life tests on the wire-spring relays indicate that at least 30 years of trouble-free service may be expected. Field experience with the cross-bar switchers and rotary selectors in telephone service indicates comparable reliability.

By the use of efficient solid-state components, the power consumption of the complete Master Exchange amplifier system is only 5000 watts. An equivalent load is presented by the relays under normal operating conditions.

The same basic video switching module is used for all of the live studio and Program Control room switchers, thus simplifying maintenance and stocking of spares.

C. COMPUTER CONTROL SYSTEM

The volume of interconnection traffic called for semi-automatic control. Control of the Master Exchange system, as well as other memory and control functions, is handled by two on-line drum-storage computers, each having a total storage capacity of 670,000 bits of information. Normally, the operating load is shared by both computers. However, one unit is capable of handling all of the basic network and local station operations and consequently, the second provides back-up protection. Emergency back-up protection for an hour ahead is provided by a continuing automatic interchange of information between the two computers. The computers serve three basic functions:

(1) The daily assignment of all video tape, telecine, and other source facilities, to control rooms, is recorded on punched paper tape by means of a Flexowriter, at the time the daily operations sheets are typed, and then is fed directly into the computer memory by means of a high-speed tape reader. Any necessary later changes in assignment can be made by punched tape or manually, by means of the digital keyboard in Central Operations.

(2) On-air switching operations of the two Program Control rooms and their related equipment is handled entirely by computer control. Audio and video switching, fading, special

effects, tape and telecine transport, audio tape and turntable transport, and sync-lock, are controlled. The information for control is fed into the computer in the same manner as is the facilities assignment. Changes in the instructions can be made by punched tape or manually, by use of the keyboard in the Program Control room.

(3) Lighting control board presets for all studios can be stored in the computer and recalled to automatically reset the controls as required by actuating a keyboard at the lighting console.

D. REMOTE CONTROL OF ASSIGNED SIGNAL SOURCES

A source assigned to a studio control room may be placed on any of several input channels by the control room operator, and when so placed, provides appropriate signals and control connections to the corresponding channel position on the audio, video switching, and video control consoles. The audio console and the video switching and control panels are designed to accommodate, at one time, a complement of up to eight assigned support facilities, fed through the Master Exchange.

The control circuits are so designed that the same controls interchangeably provide the required control of video tape, telecine, or remote origination channels. The somewhat different control requirements for live cameras, however, dictated that separate controls be provided for the two Master Exchange positions to which live cameras may be assigned.

Figure 19 is a view of the video control and production consoles. The video control panel, shown in more detail in Figure 20, includes individual levers for each live camera channel and each of eight Master Exchange channels. The lever assembly provides control of three functions, viz., (1) video level by movement of the lever, (2) blanking level by rotation of the knob, and (3) selection of the signal for that channel on the preview monitor, by depressing the knob on the lever. The convenience of this method of selecting the appropriate signal makes it practical to omit waveform monitors on all channels. Consequently, the chance of error in levels has been decreased by the use of a single waveform monitor for all level settings, and a more compact monitoring assembly is possible. Auxiliary controls and adjustment for each channel are contained in the 2-1/2-inch wide strip associated with each lever.

Figure 21 is a view of the camera control racks in Equipment Center. Through the use of the simplified remote controls in the studio, and taking advantage of the stability of the camera channels, it is possible to consolidate the set-up equipment in one central area.

E. STUDIO SWITCHING SYSTEM

To the right of the video control panel is the technical director's switching and control panel. This panel, shown in Figure 22, and the accompanying system incorporate several departures from conventional system design practices.

First, all signals in the Broadcast Center are composite. Thus, there is no separation of the functions into composite and non-composite signal

switching. This aids materially in simplifying the switching panel and its operation. Signals which are synchronous with the studio camera sync pulses are stripped of sync and set-up after switching and before being fed to faders or special effects equipment. Sync is then added after the effects operation. In the event that signals are not synchronous with the studio generator, a sync comparator unit detects this condition, automatically bypasses the faders and special effects equipment so that a direct switch results if the operator erroneously attempts to fade or wipe, and indicates the non-sync condition by means of a warning light on the control panel.

In addition to the use of composite-only video signals, further simplification of the control panel has been achieved by the use of mode selection on the preview row of buttons and on the tape and telecine transport controls. The preview row can be used for any one of several preview and monitor control functions or as an emergency air channel by appropriate mode selection. Similarly, forward, rewind, or slide change controls, where applicable, can be assigned to any one or any grouping of tape and telecine equipment.

Any of the input signals can be selected for controlling sync-lock of the generator in Equipment Center assigned to the studio, or the studio can be switched to the generator assigned and designated as the main plant sync source. When a change in sync-generator is made, the sync signals fed to all of the in-plant support facilities assigned to the studio, through the Master Exchange system, are automatically changed so that the sources remain in sync with the studio.

An auxiliary video switching panel is provided at the left of the video console for handling occasional, unusually complex, special effects. This can be seen in the foreground in Figure 19. In addition to the usual wipes and montages, this panel provides a joy-stick positioner for special effects inserts. The technical director, at his discretion, can assign control of the third pair of switching channels to this auxiliary special effects switching panel.

F. STUDIO LIGHTING CONTROL SYSTEM

The lighting console control shown in Figure 23 is a basic three-scene preset system, with provision for computer storage of lighting presets. The console shown is for the smallest studio and consists of thirty, 12 kw dimmer, and thirty, 12 kw non-dim circuits. The largest studio has 100 dimmer circuits. The dimmer circuits can be assigned to any of four master dimmer controls in any desired combination. An additional ganged dimmer control can perform any combination of fades among three preset scenes.

For computer storage of lighting presets, the analogue information corresponding to each dimmer setting is converted to digital coding and stored on the magnetic drum of one of the computers. Recall of lighting presets and automatic setting of the individual dimmers are accomplished merely by punching up the lighting preset identification number on the digital keyboard at the console. The digital data is used to drive the motor-operated dimmer quadrant controls to the proper setting. The lighting preset data developed on rehearsal can be printed out in hard copy from the computer, thus avoiding the need to use the computer memory for long-term storage.

The lighting console controls the studio lights through magnetic amplifiers and a patch panel. All of the magnetic amplifiers for the six studios are located in a single room, situated in the center of the studio complex on the same level as the studio lighting grids. The patch panels are mounted on the lighting grid level in each of the five large studios.

G. STUDIO AUDIO SYSTEM

As noted previously, the audio requirements for present-day network television program production are extremely complex. In the newly designed console shown in Figure 8, a total of 24 microphone inputs are available through twelve low-level channels and fifteen submixer inputs. Ten additional inputs are available for telecine, tape, and remote studios. Outputs include four program, two reverberation, and three utility or special effects channels.

In order to provide increased capacity without increasing the size of the audio control console over the older, standard CBS console, it was necessary to employ different design concepts. First, the conventional rotary attenuator has been replaced by the vertical quadrant assembly to enable a more compact control array. Second, transistors are used in place of vacuum tubes for all circuits. Third, in order to simplify the ganging of fader functions in submixer channels, use has been made of d-c controlled, light dependent resistors in the variable attenuator networks.

A word should be said for the communications system. Invariably, the ultimate requirement is for anyone to be able to talk to anyone else at any time, without interference and with lifelike quality. By the use of

carefully allocated area coverage, specific local coverage, and the use of broadcast components, the Broadcast Center facilities come close to this ultimate. The most striking characteristics of the communication system, other than its flexibility, are uniformity of level and high quality. Communication is made appreciably more effective by the ability of personnel to recognize voices and inflections. This is achieved by the use of fast-acting AGC and broadcast-quality components.

H. CONTINUITY PROGRAM CONTROL ROOM EQUIPMENT

The facilities in the two Program Control rooms (Figure 14) differ from those in production studios in several significant ways:

1. Video and audio normally are switched or faded together. However, variations are easily set up, such as separate announce, tape, or turntable audio at various levels, or in various sequences.

2. Two independent and duplicate output channels, as well as two announce booths, are provided so that split feeds can be accomplished. A common example is the insertion of two different, regionally-oriented commercials into a common network program.

3. All of the switching and fading operations can be controlled from the computer memory system. A precheck of all computer-controlled sequences can be made at any time prior to operation of the sequences, without interference with the program outputs, and changes can be introduced manually as desired.

The program switching panel, located to the right, and shown in more detail in Figure 24, provides full manual switching control in the event of

computer system failure. The keyboard serves the multiple purposes of communicating with the computer and channeling Master Exchange assignments into the desired PC input channels. The technical operator's normal position is to the left, in front of the lever controls for the twelve input channels. The controls for these channels are identical to those in the studio control rooms, except that an audio level control is included on each strip.

The left wing assembly of racks and consoles contains the cartridge tape equipment, turntables, and audio switcher. This is shown from one of the announce booths in Figure 25. Incidentally, it is of interest to note that d-c controlled, light-dependent resistors, rather than relays, are used as the cross-points in the audio switcher.

I. CENTRALIZED SUPPORT FACILITIES

Figure 26 shows a work-in-progress view of the telecine area. In the foreground is 35mm equipment; in the rear, slide projectors. Figure 27 is a view of a continuous-motion, 16mm projector. Except for two 3-Vidicon color channels, each projector is provided with its own camera. In network operation, unlike local station programming, film equipment is assigned to production studios for long periods of time. Thus, for this service, a uniplex set-up is most economical. The uniplexed cameras are mounted on the projectors, thus simplifying installation and providing a stable optical assembly. Auxiliary equipment, including monitors, is housed in two-faced racks, placed to provide convenient operating and maintenance access from two projector/camera units.

Figure 28 shows three of the bank of six transparent-slide projectors.

These units have available complete remote control of random, sequential, or reverse presentation of slides in a choice of direct takes or variable-speed dissolves. Registry of picture material, using special molded slide-mounts, is as good as the sprocket holes in the slide film.

The 24 video tape units are arranged in pairs with each pair fed from an audio and video channel in the recording section of the Master Exchange system. The same assembly of auxiliary equipment is used for both RCA and Ampex pairs. Figure 29 shows three pairs and Figure 30 a close-up of one pair of tape machines.

IV. SUMMARY

This paper has provided an orientation and an introductory discussion of area and equipment highlights in the television technical portion of the CBS Broadcast Center. Although partially obscured by sheer magnitude, many of the basic concepts closely parallel planning considerations followed in new broadcasting plants of all sizes. It is believed that the design concepts employed may provide further stimulus to a more rational split between production and continuity operations, and between operating and set-up functions in many future plants.

The authors have served here as mere reporters for the numerous persons whose individual contributions are built into this new plant. It is anticipated that many of these individuals will, in the future, provide the more detailed descriptions necessary to describe fully the many new and widely-applicable features of the CBS Broadcast Center.

ILLUSTRATIONS

FIGURE NO.	TITLE
1A-B	N.Y. Map, Showing CBS Television Locations.
2	Location of TV Technical Areas in Broadcast Center.
3	Photograph of Studio Roof Framing.
4	Photograph of St. 42 Interior.
5	Studio Floor Plan.
6	Central Technical Area Floor Plan.
7	Studio CR Layout.
8	Photograph of Audio Console.
9	Photograph of Picture Control Room.
10	View of Control Room From Director's Position.
11	Photograph Showing Lighting Grid.
12	Photograph Showing Lighting Man in Grid.
13	Floor Plan of PC Room.
14	Photograph Showing PC Room Console.
15	Equipment Center Layout.
16	Operating Center Layout.
17	Master Exchange Video Switching Racks.
18	Master Exchange Rotary Selectors.
19	Studio Video and Production Consoles.
20	Studio Video Control Panel.

ILLUSTRATIONS (cont'd)

FIGURE NO.	TITLE
21	Studio Camera Control Equipment in Equipment Center.
22	Studio Production Switching Panel
23	Lighting Console and Adjacent Video Special Effects Control.
24	Program Control Room 32 Switching Panel.
25	Program Control Room 32 Audio Console and Racks
26	Telecine Area.
27	16mm Projectors.
28	Slide Projectors.
29	Video Tape Area.
30	Video Tape Module.

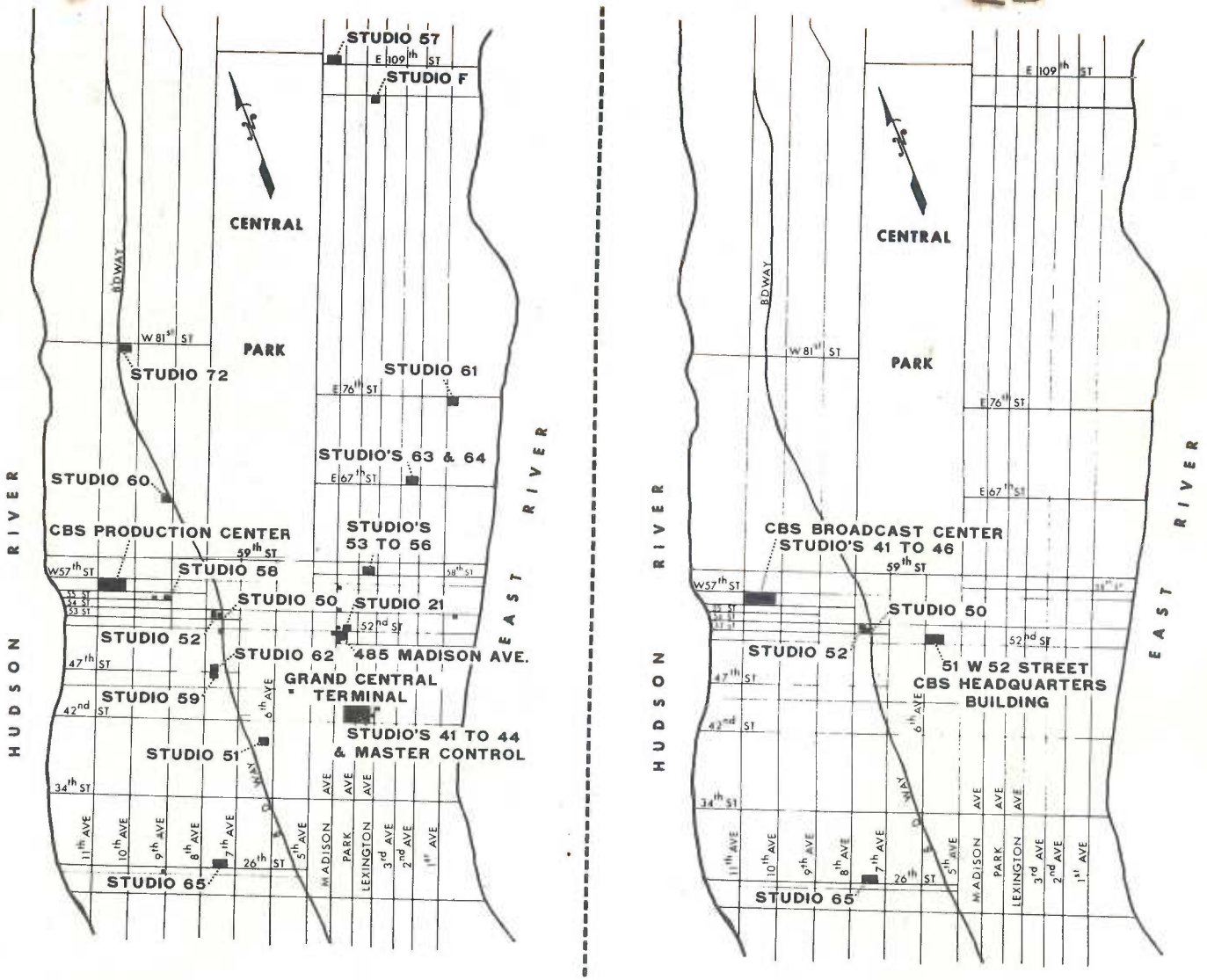


FIGURE 1A - LEFT FIGURE 1B - RIGHT

The city-wide dispersion of the New York CBS television broadcasting facilities during the mid-1950's, as shown in Figure 1A, is contrasted with the consolidated plant which will exist after completion of Broadcast Center (and the new CBS Office Building), Figure 1B. Off-premise Studios 50 and 52, located in the Broadway area, are retained for audience shows. Studio 65 provides supplementary production facilities to handle peaks in the schedule. Broadcast Center will accommodate the bulk of program production, provide all central facilities and service, and handle the continuity of twenty-four hour per day program transmission.

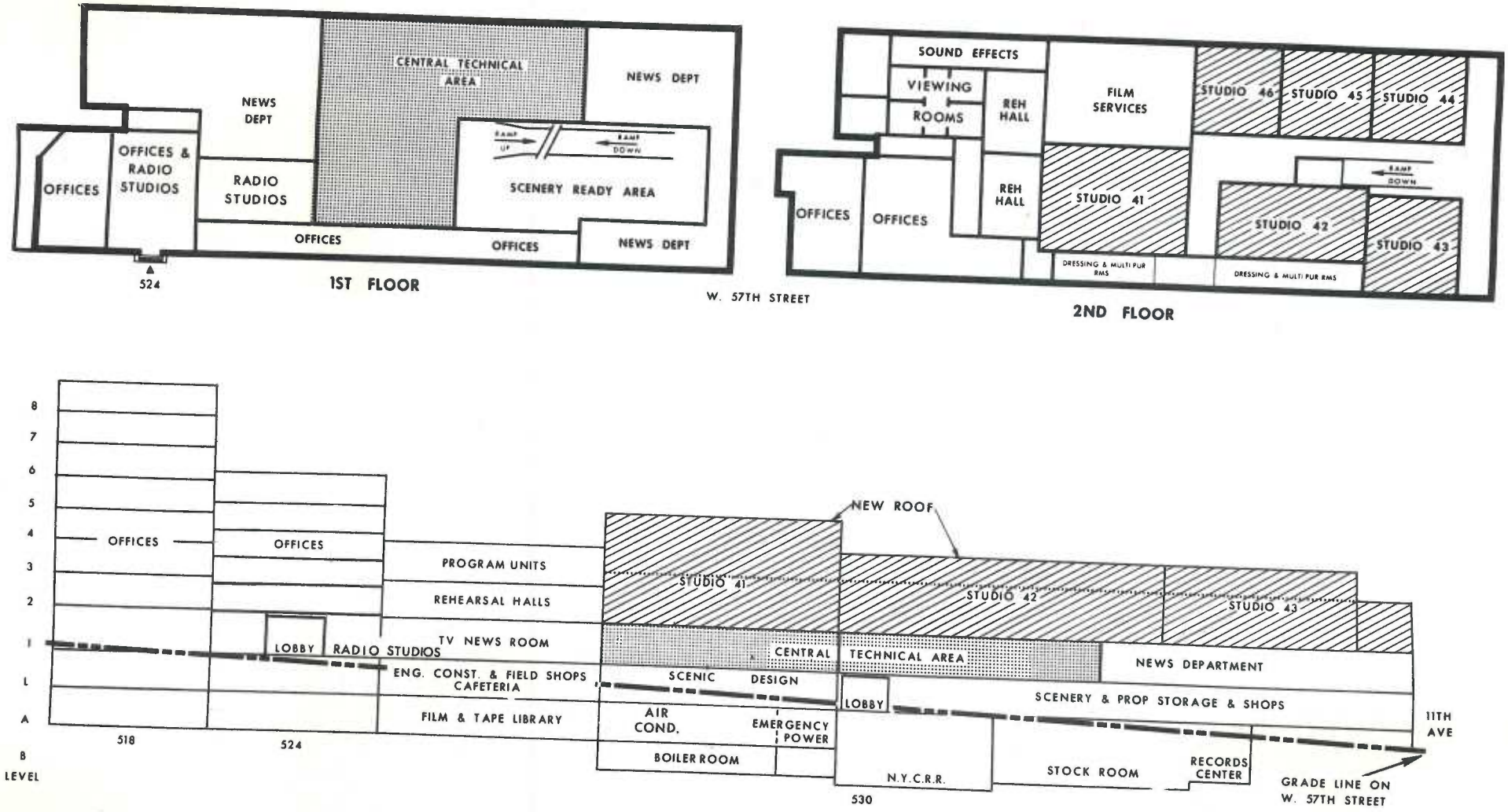


FIGURE 2

The location of television technical areas (shaded) and their relationship to other portions of the Broadcast Center is indicated. The roof was raised from the level shown by the dotted line, to provide headroom for the six studios.

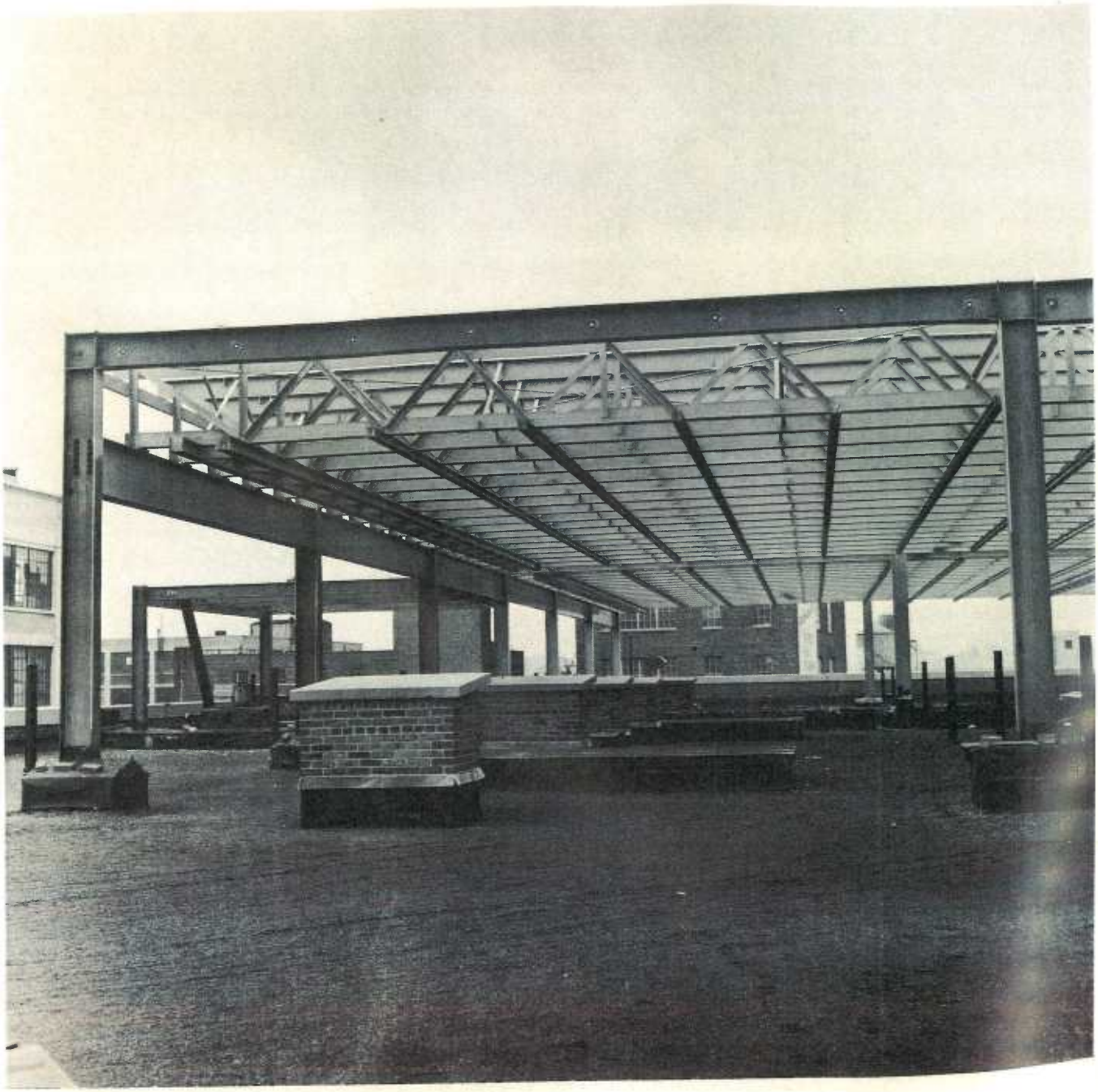


FIGURE 3

A portion of the new steel framing, extending from the foundation level up through the old roof level, is shown prior to application of a new roof and removal of the old, to provide headroom for the studios.

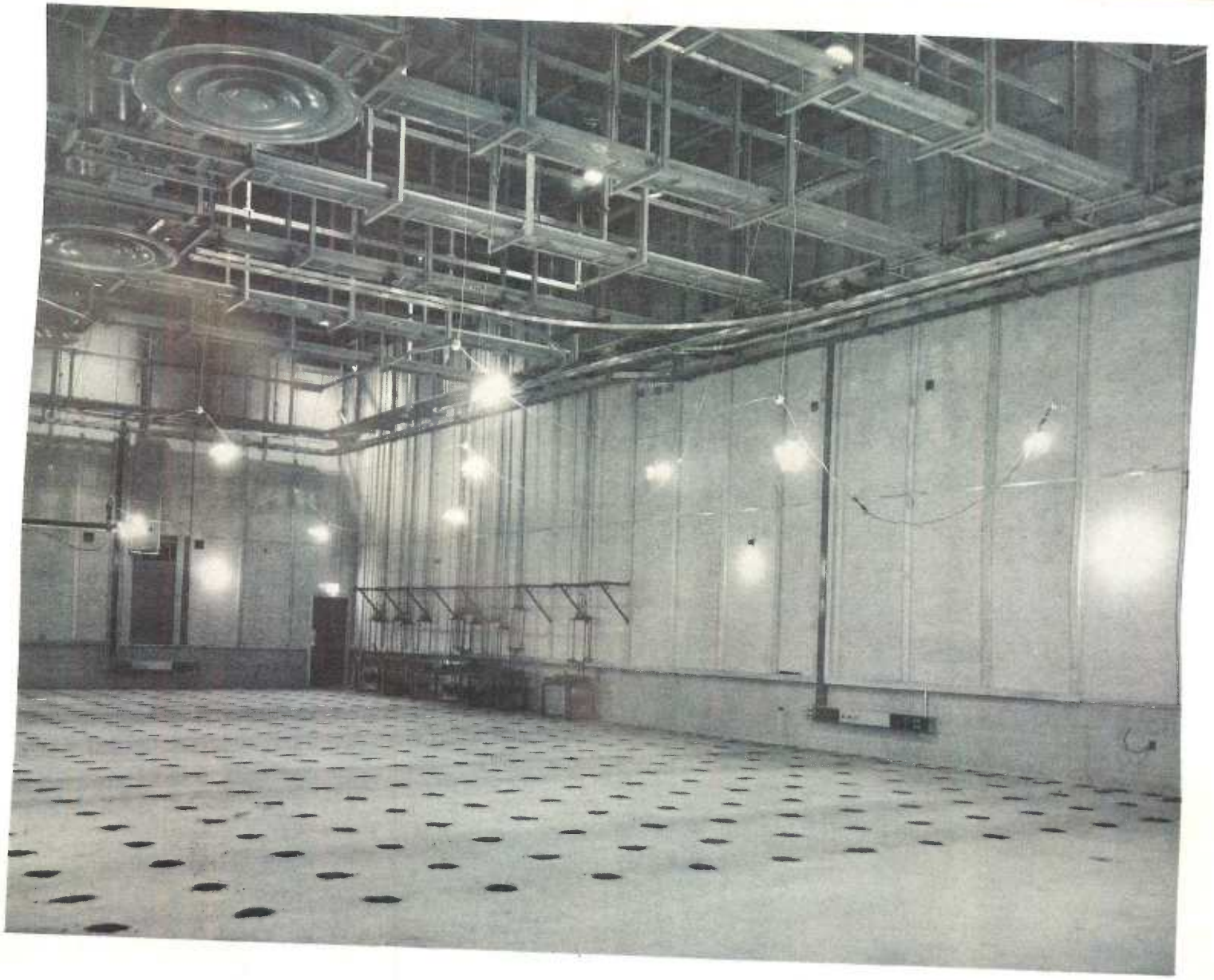
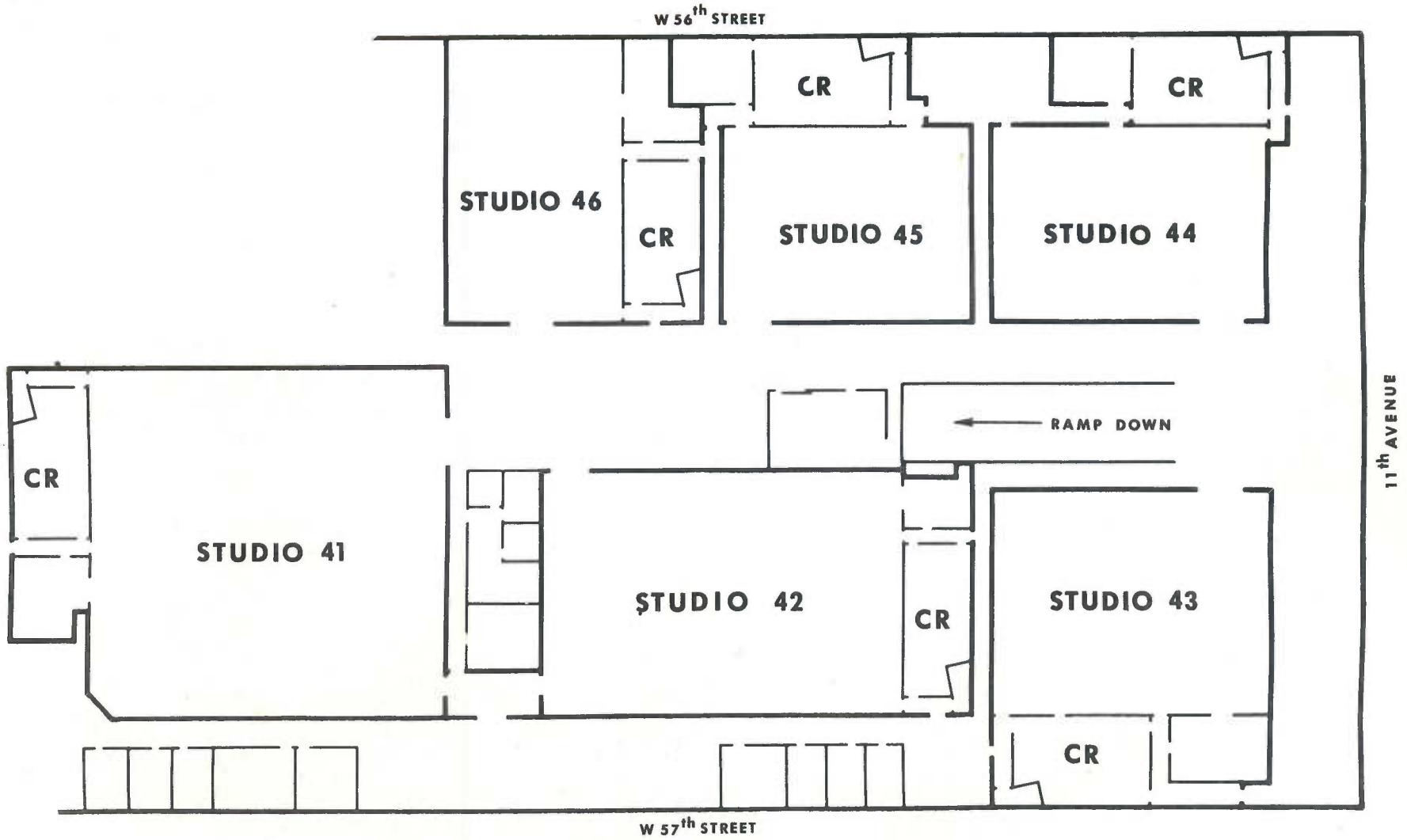


FIGURE 4

Studio 42, showing floor-slab patches applied after the final adjustment of special isolation-spring supports and just prior to application of Monoprene floor covering. The inside studio walls are supported on the isolated slab. Low frequency cue system antenna loops are buried in the floor slab, above the top layer of reenforcing bars.

The lighting grid is supplemented by counterweighted stage rigging at one end of the studio. Audiences can be accommodated on bleacher seats in this studio and in Studio 41

The lighting grid is supplemented by counterweighted stage rigging at one end of the studio. Audiences can be accommodated on bleacher seats in this studio and in Studio 41



STUDIO AREA

FIGURE 5

Peripheral space provided around each studio to further enhance acoustic isolation is used for support, storage, dressing room, office, studio control room, and ready areas. Each

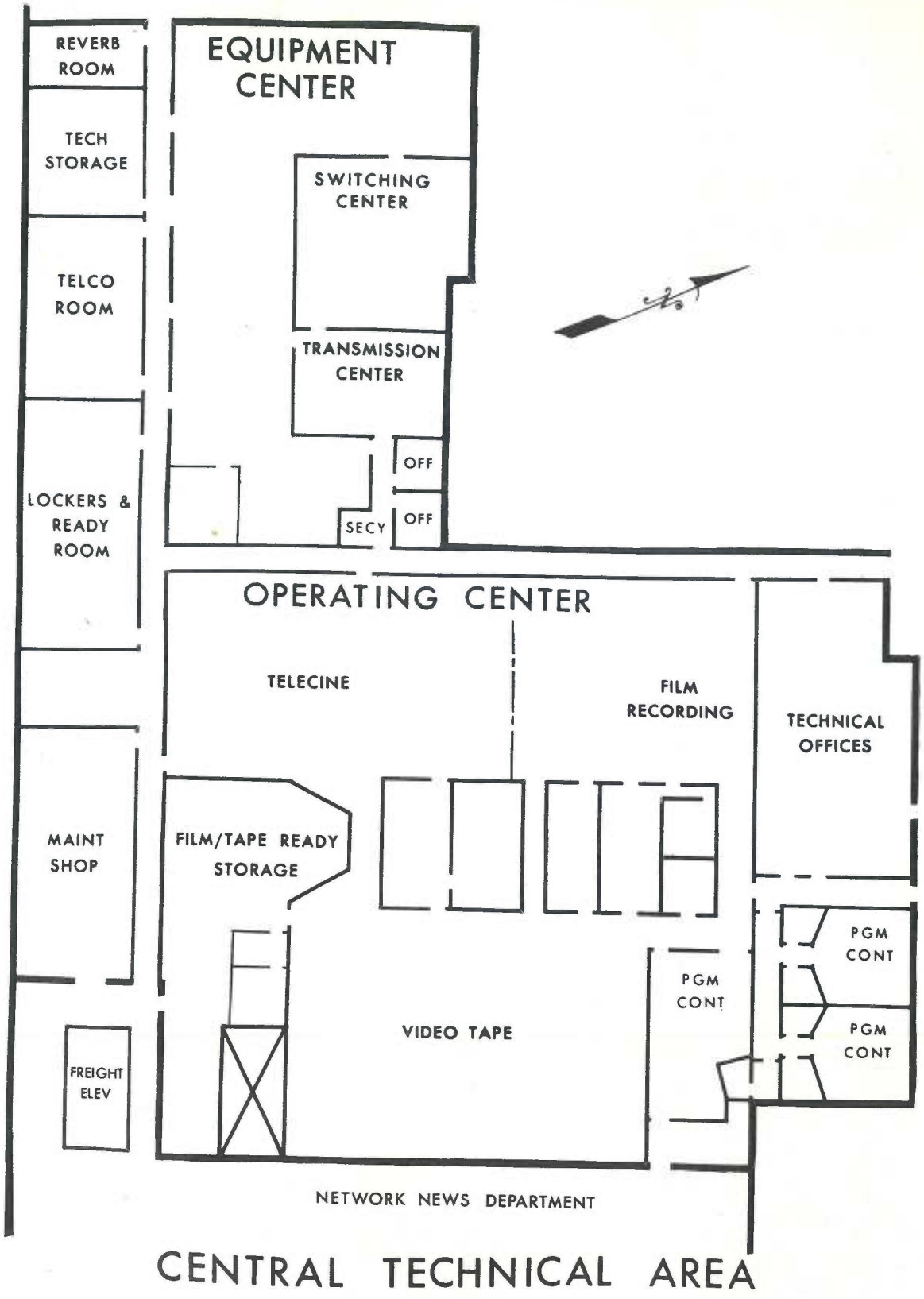
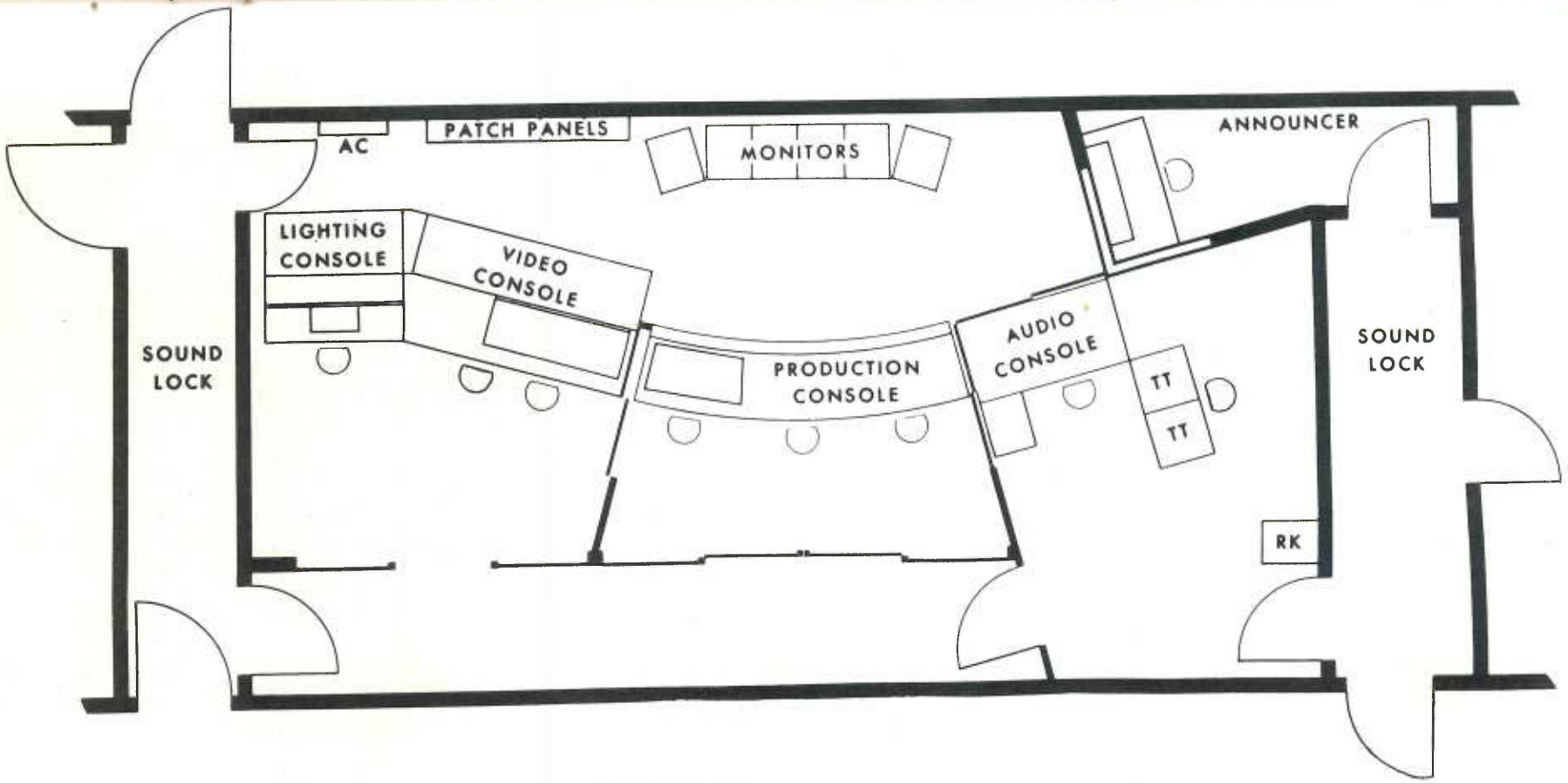


FIGURE 6

The Central Technical Area is divided into two principal centers. Equipment Center houses most of the rack-mounted equipment for the television plant. Operating Center accommodates film and video tape machines and related supervisory, control, and storage functions. Related technical and administrative functions are located peripherally with respect to these centers. Two types of Program Control rooms are located near video tape. One, similar to a studio control room, is used for production of news programs originating in the nearby News Room. The two smaller rooms are specifically designed to handle a continuous sequence of programs to network circuits and to the local station.



STUDIO CONTROL ROOM

FIGURE 7

Each studio control room is placed immediately adjacent to its studio. The control room has three sections which can be opened into one, or closed off by means of sliding glass panels. At the left is the picture control section, including lighting control, lighting director, and video control. At the center, in the production control area, is the director, with the technical director at his left and the assistant director at his right. At the right is the audio section. The control room has been designed to provide an optimum view of picture monitors and for convenient eye contact among members of the control room team, but no studio window is provided.



FIGURE 8

The new, fully transistorized, CBS audio console utilizes quadrant type controls to enable the audio operator to conveniently reach and control its unusually extensive and flexible facilities. Placement in the control room allows an unimpaired view from the operator's position of all monitors in the production area, line-of-sight contact with the director, and intimate visual contact with the announcer, located to the right.

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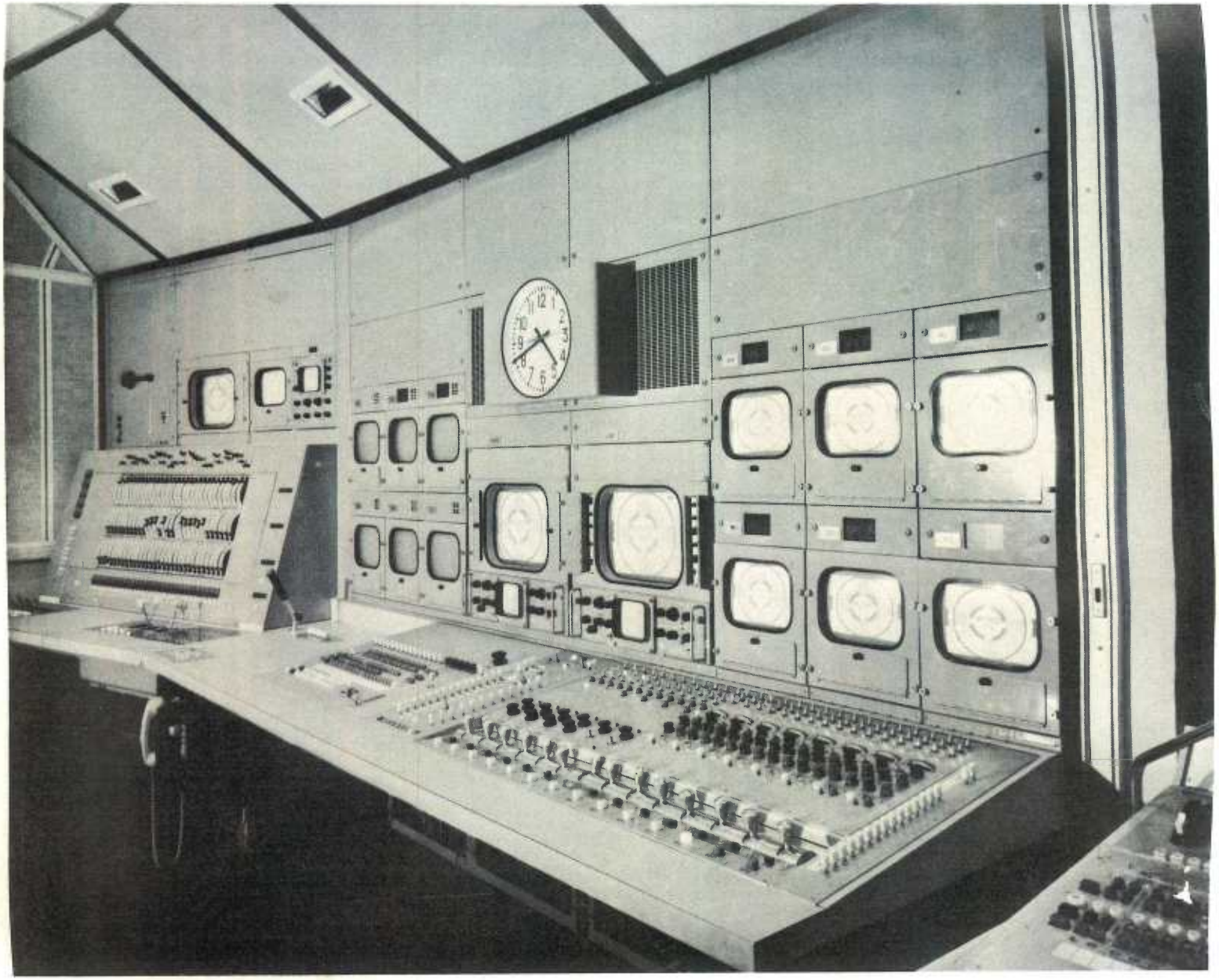


FIGURE 9

The picture control area of the studio control room includes the video camera and source controls in the foreground, an auxiliary special effects panel, a position for the lighting director, and, at the far end, the lighting control console. Close relationship among video control operator, lighting director, and lighting control man, and ability to observe the same monitors, are important to achievement of optimum picture quality.

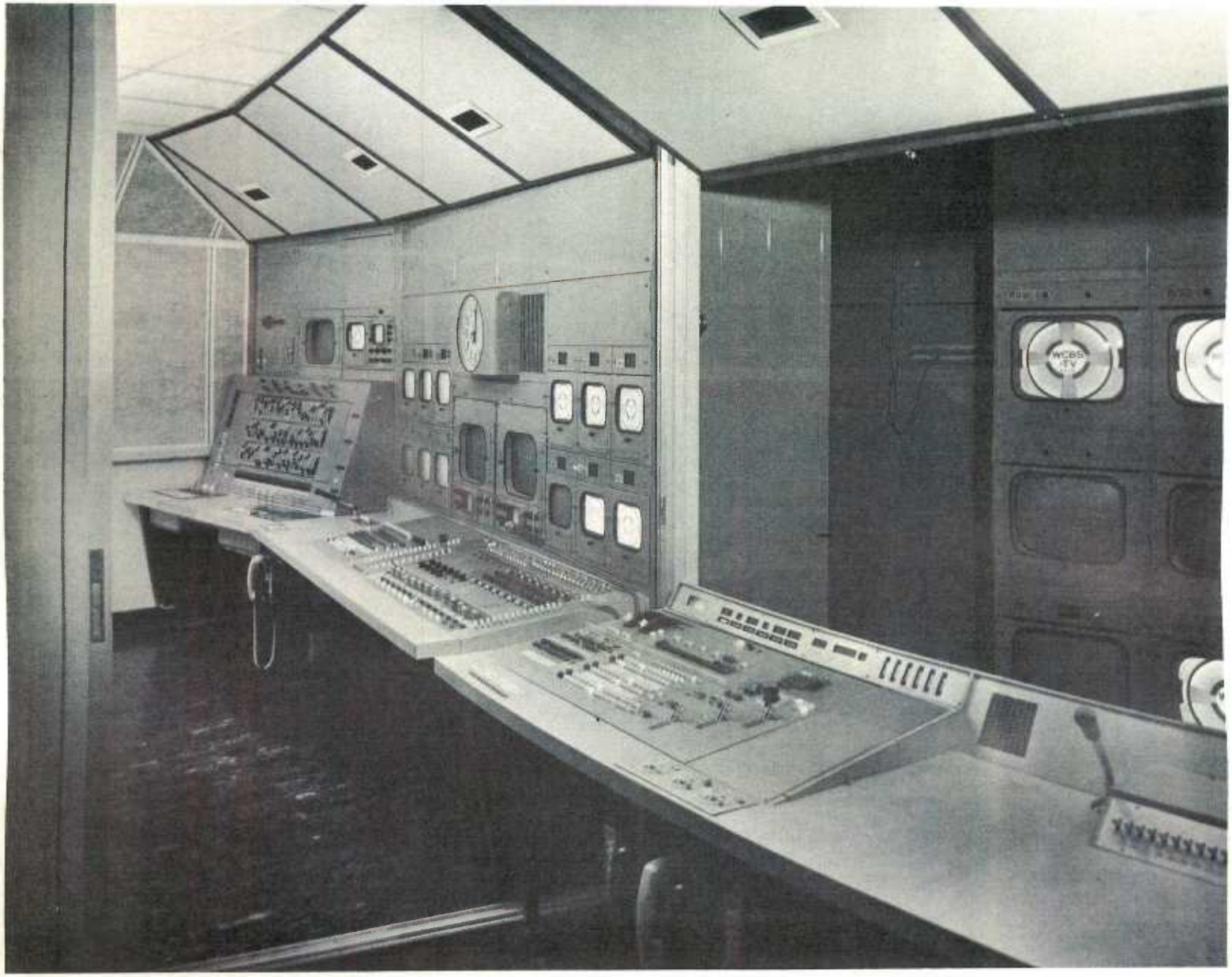


FIGURE 10

A view from the director's position shows the studio video switching panel, and the picture control area with the intervening glass door open.

The slots in the overhead loudspeaker scrim are newly-designed lighting fixtures, using

The slots in the overhead loudspeaker scrim are newly-designed lighting fixtures, using quartz-line lamps.

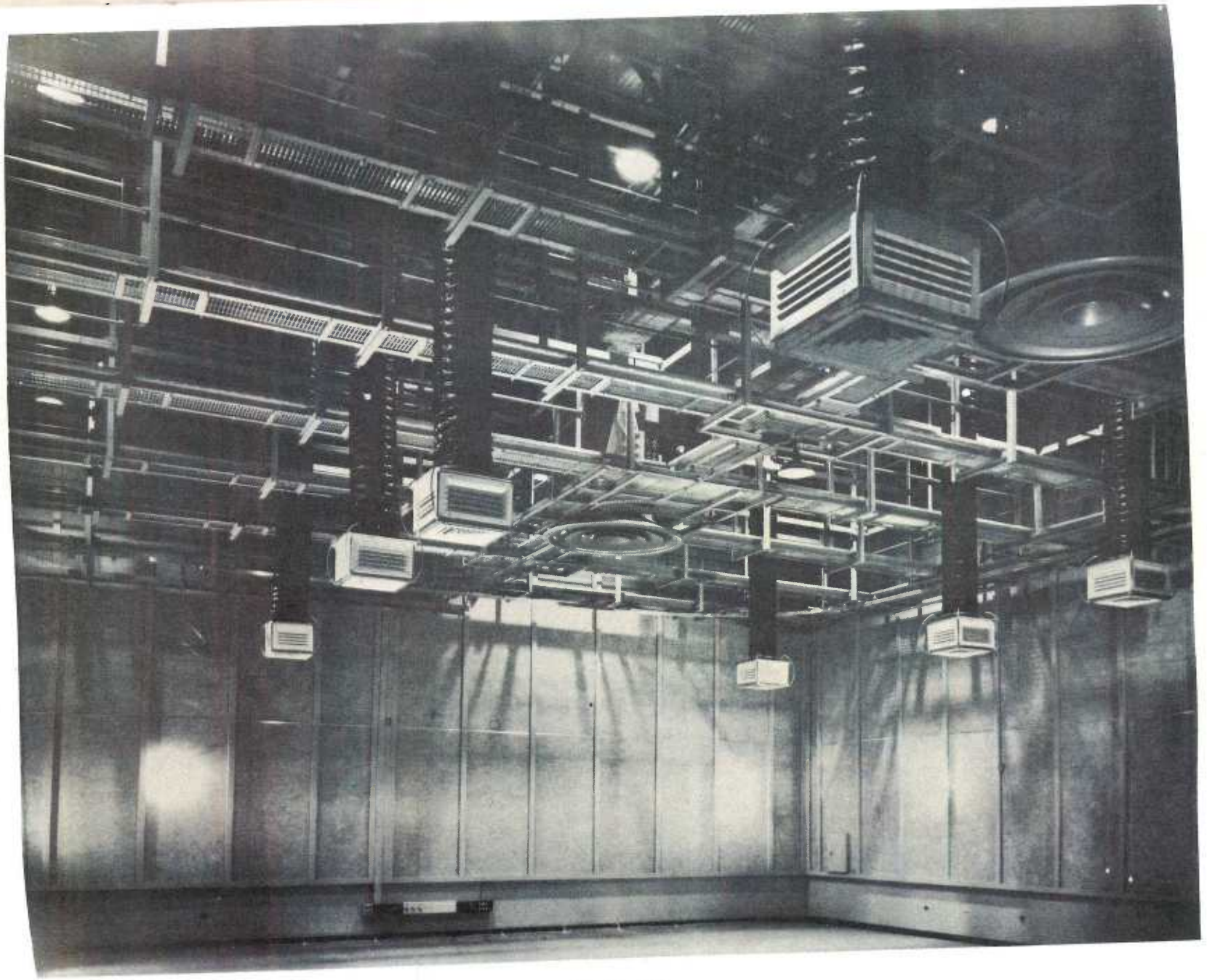


FIGURE 11

Lighting grid shown here for Studio 44, is designed with a network of catwalks to allow access to lighting fixtures throughout the studio. Light rigging and focusing can be done from this overhead structure at the same time scenery is being placed and dressed below.

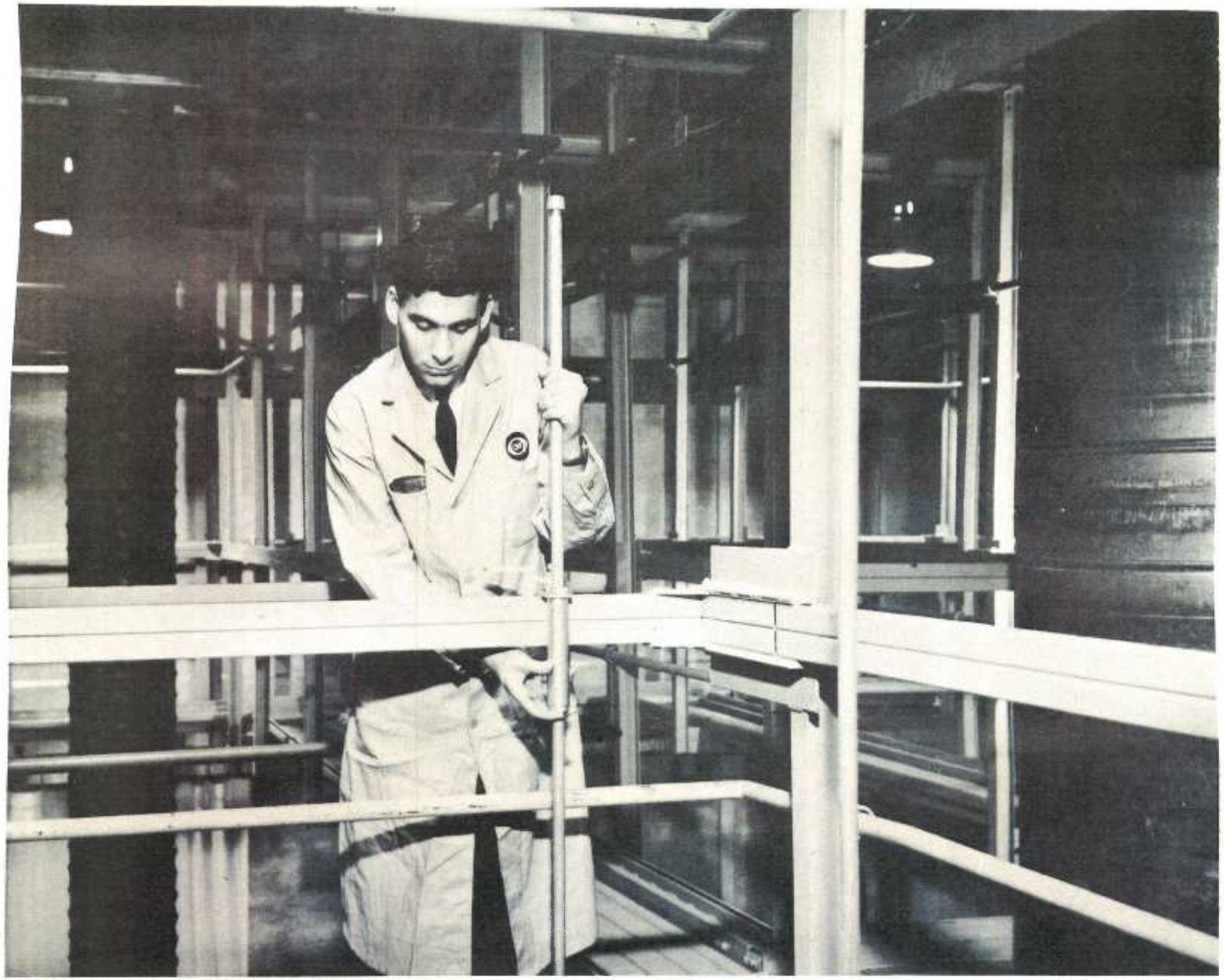


FIGURE 12

A new, quick-release, lighting fixture support fitting, based on the principle of the Indian finger grip, can be operated at waist level by a lighting man standing on the grid catwalk. Clamp is designed to hold the fitting securely with a one-quarter turn on the prefabricated steel channel used for the grid system.

Clamp is designed to hold the [illegible]
steel channel used for the grid system.

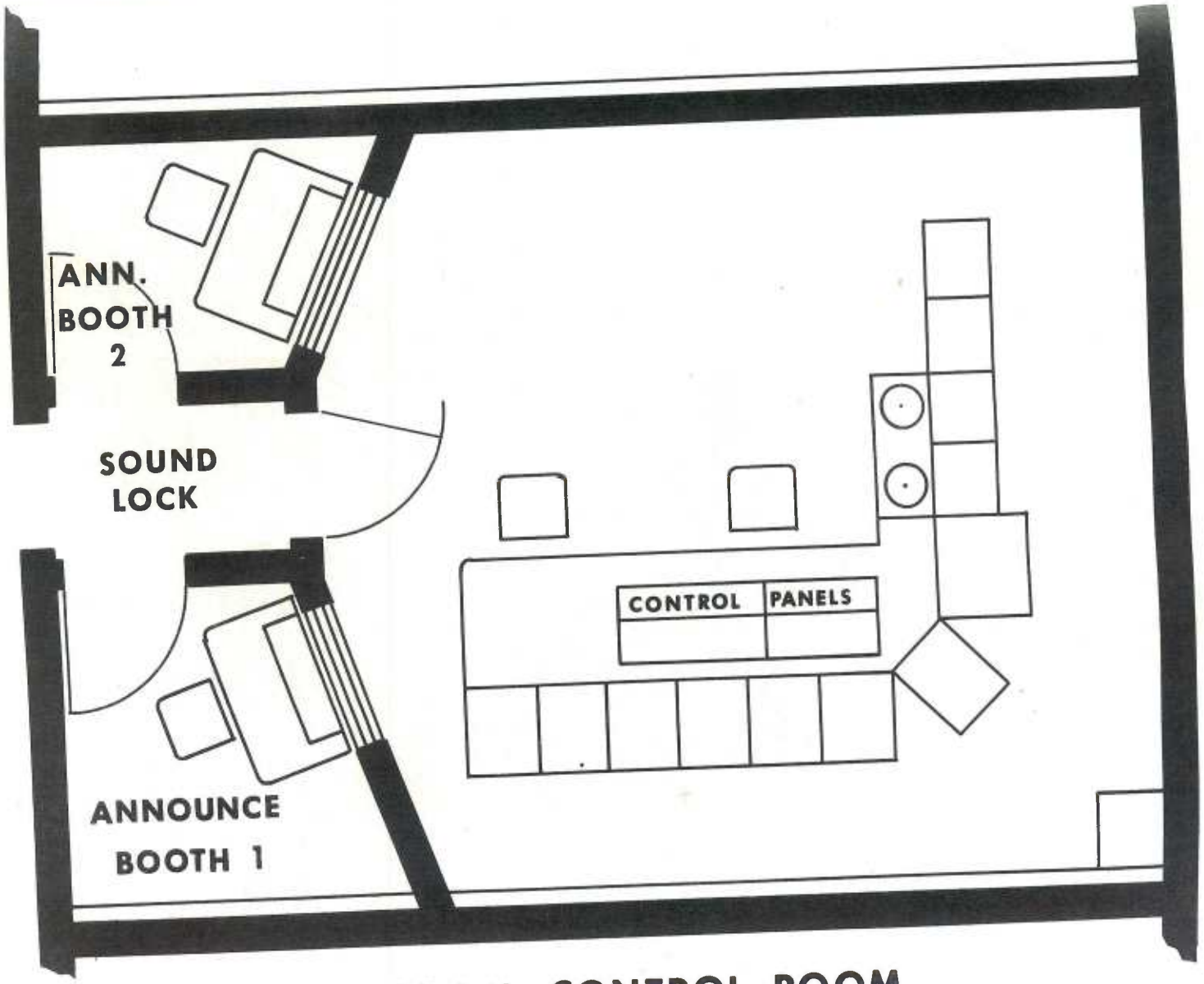


FIGURE 13

Floor plan of continuity-type Program Control room shows technical operator position in front of the control panels and program man position to his right. Both announce booths are used when it is necessary to insert different live announcements for two regional branches of the network to which a program is being fed.

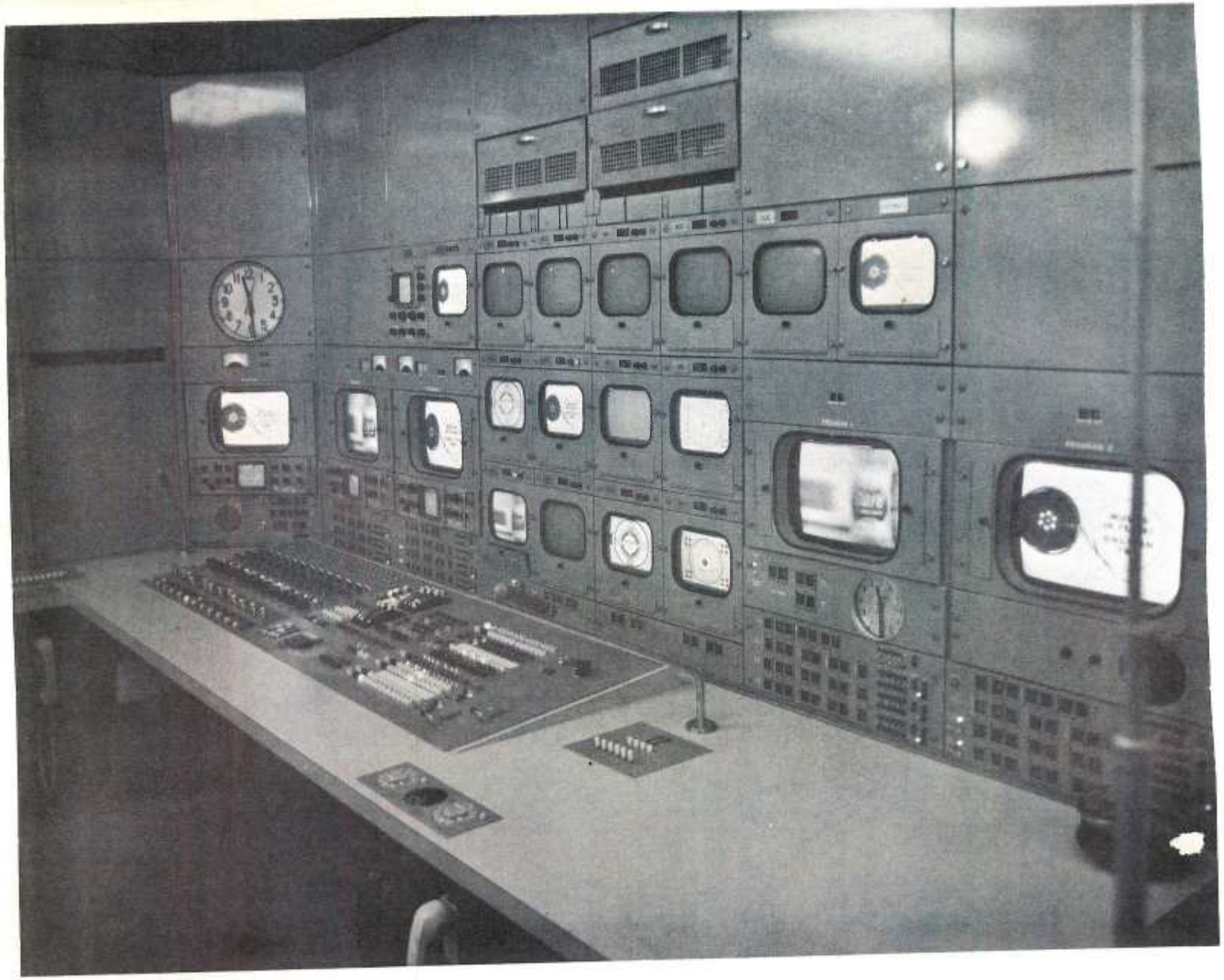
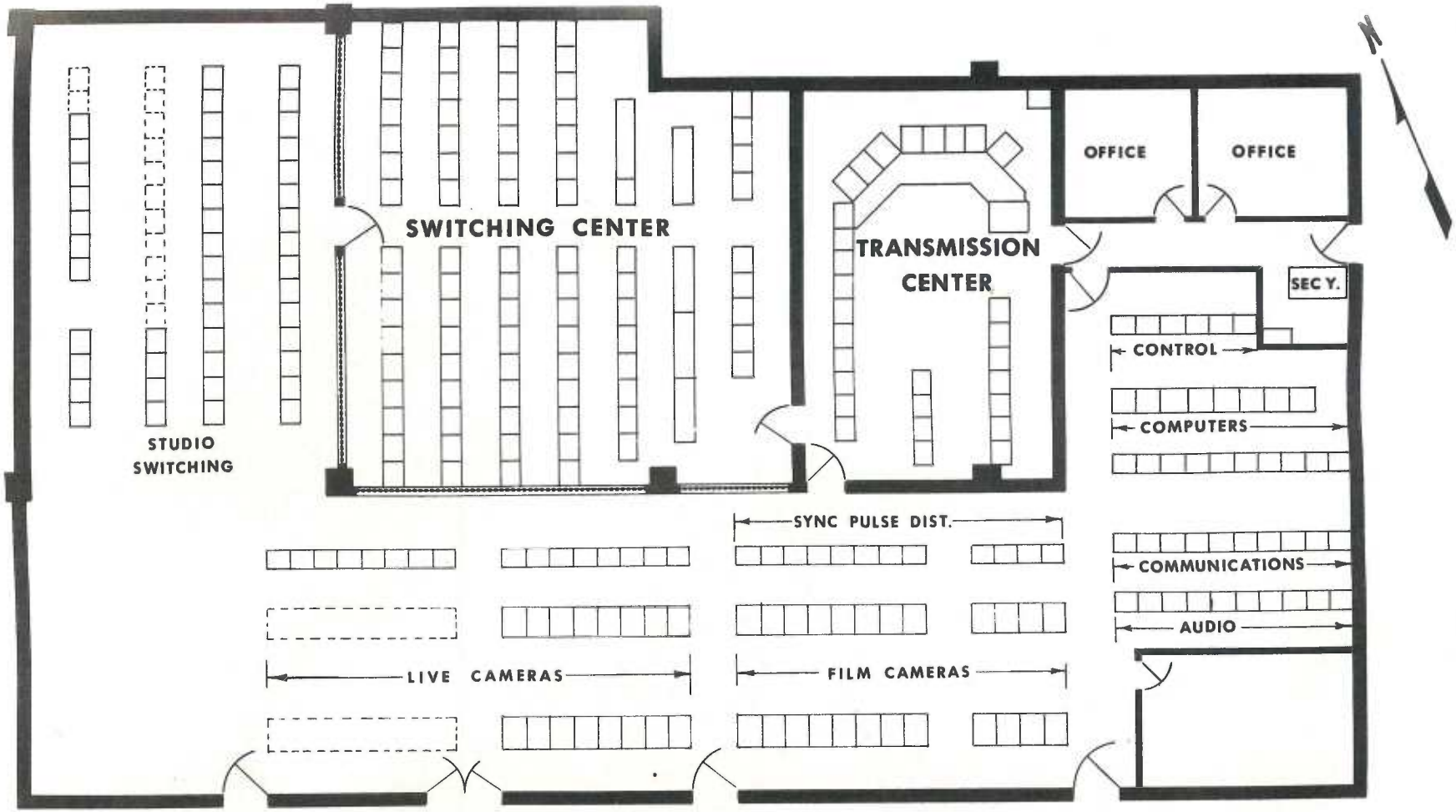


FIGURE 14

This view shows the technical operator, left, and program man positions, in a continuity-type Program Control room. In normal operation, the technical operator sits to the left, monitoring and controlling audio and video quality of the twelve sources which can be controlled from the control room at the same time. Switching is controlled by a digital computer, located elsewhere, the switching panel at the right of the control section being used only for emergency. Duplicate program monitors and computer read-outs are provided on each side of the central bank of twelve smaller input channel monitors.

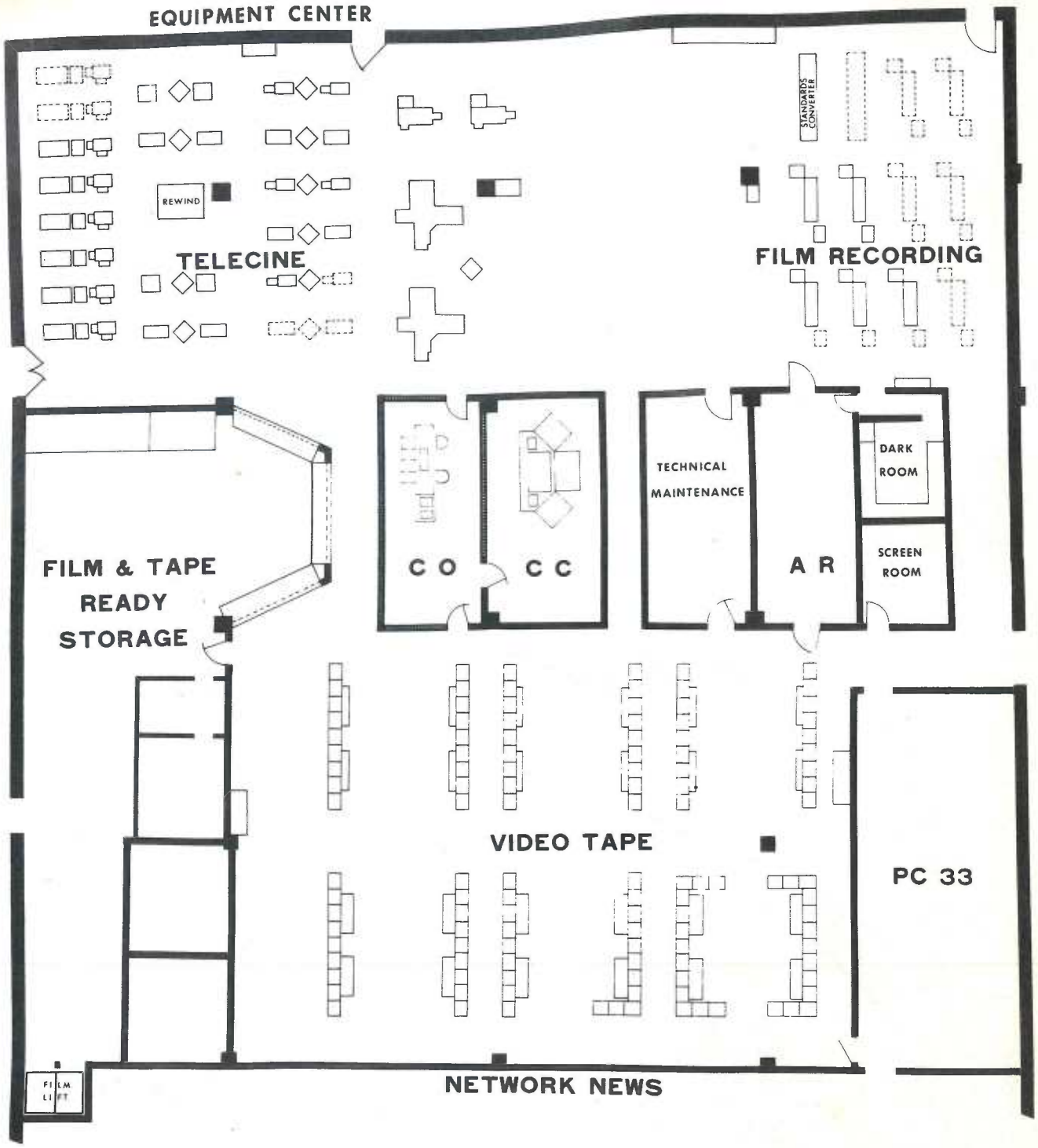
on each side of the central bank of twelve smaller [illegible]



EQUIPMENT CENTER

FIGURE 15

The location of rack equipment centralized within the Equipment Center is indicated. Transmission Center houses all necessary equipment and controls for supervision and test of incoming and outgoing circuit performance, and serves as a principal technical communications center. Switching Center houses the relay and amplifier equipment required to handle the routing and interconnection among sources and control points.



OPERATING CENTER

FIGURE 16

A factory-like flow of bulk film and tape from the Ready storage area to the appropriate section of the Operating Center is provided. The Ready area is tied into shipping and editing areas by a film lift (dumbwaiter) system. The "CO" (Central Operating) room is the supervisory center for this entire area and has facilities for overriding computer assignments of tape and film channels in an emergency. The "CC" (Closed Circuit) control provides a quality control point for auditions or other transmissions which do not require full control room facilities. The "AR" (Audio Recording) room contains auxiliary audio record and playback equipment to serve both film recording and video tape.

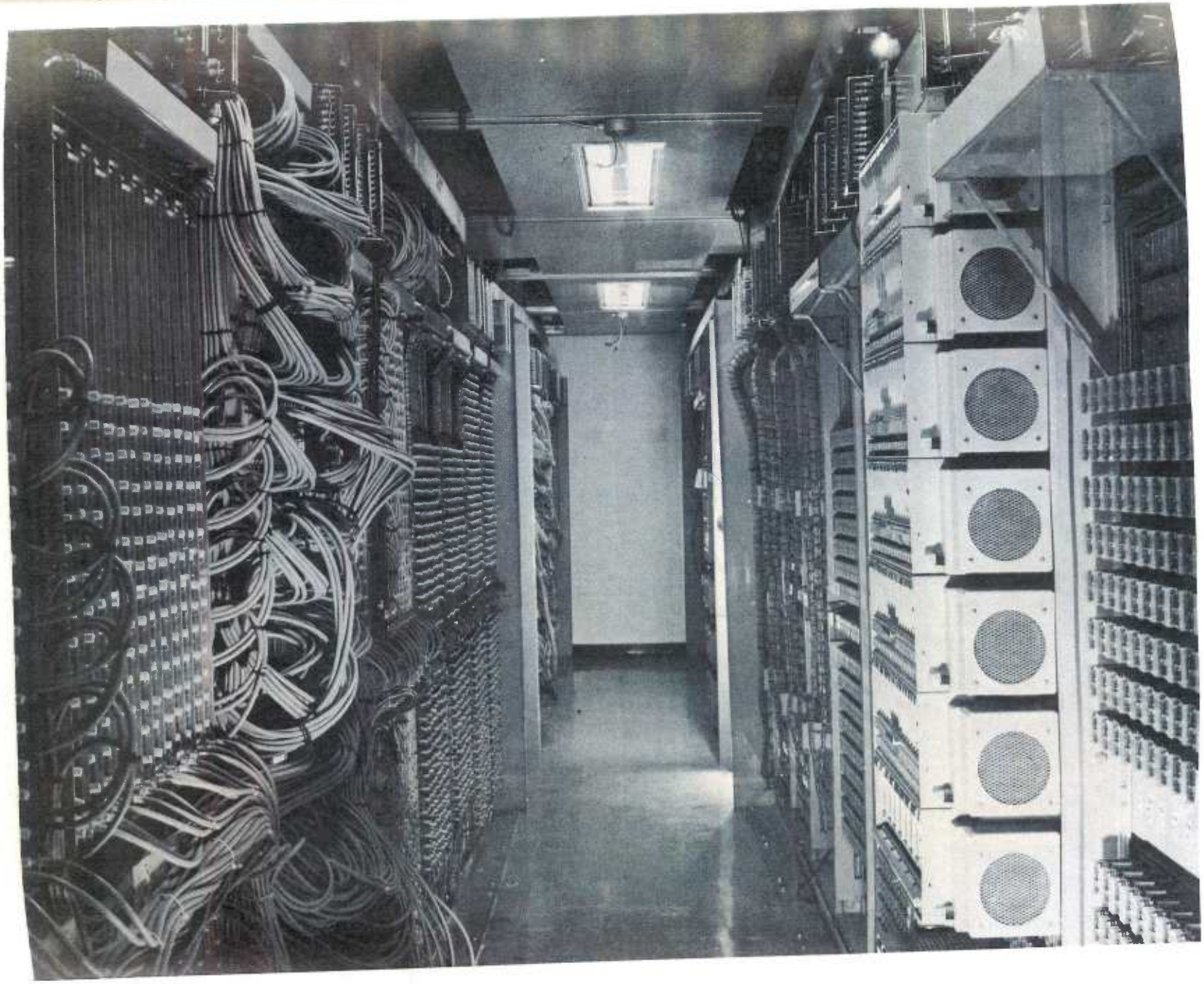


FIGURE 17

This view shows two of the five rows of wire-spring relay selector equipment which makes up the signal selection portion of the Master Exchange switching system. A total of 35,000 wire-spring relays are used to handle audio, video, and communications circuits.

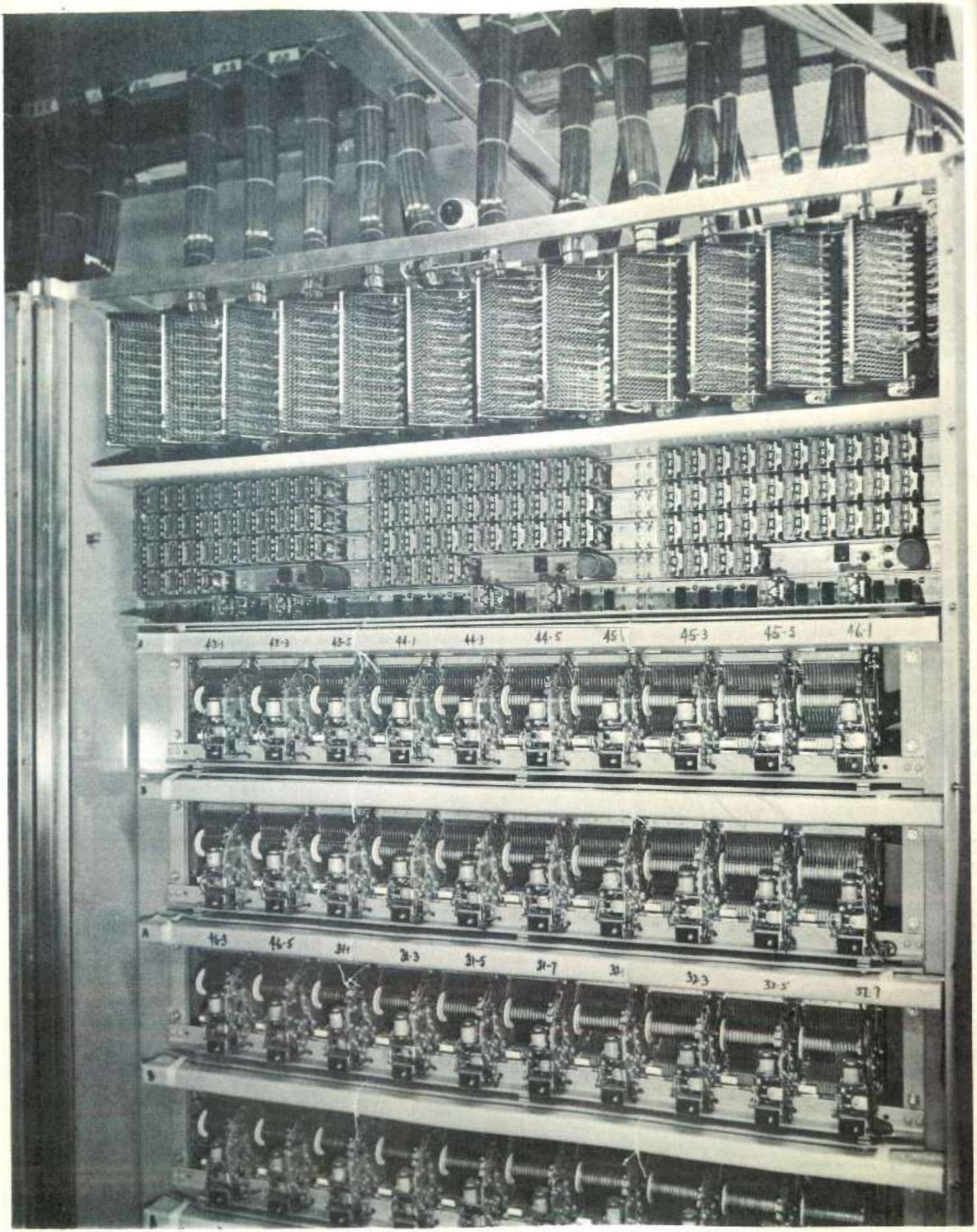


FIGURE 18

In the Master Exchange switching system, control circuits accompanying the signal sources are routed to the assigned control point by means of motor-driven rotary selectors. This



FIGURE 19

The studio control room, as viewed from the lighting director's position, shows in the foreground the auxiliary video switcher and special effects panel. When required by the nature of the program, certain special effects functions may be delegated to this position from the regular video switcher panel.

The next large panel is the video operator's control position. The video switcher position, the production area and, through a sliding glass window, the audio control area, may be seen.

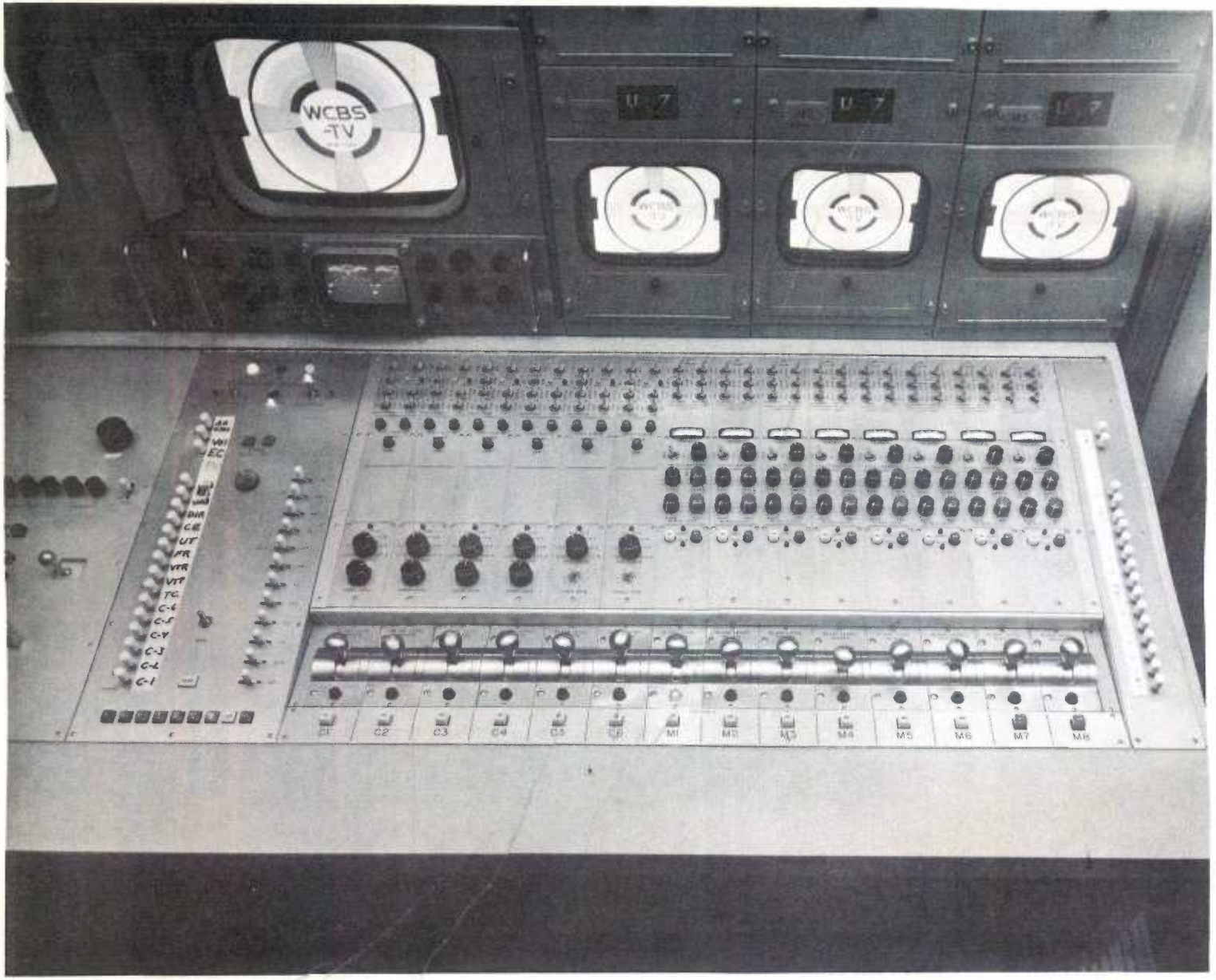


FIGURE 20

A close view of the studio video operator's control position shows six camera control channels, C1 through C6, and eight channels, M1 through M8, equipped to handle tape, film, or remote inputs assigned to the studio through the Master Exchange switching system. Primary control of gain (or exposure) is provided by lever movement, and black level setting by lever-knob rotation. Supplementary gain control, color "black" level controls, tape-capstan tracking, scan reversal, gamma selection, polarity reversal, as appropriate to the source assigned, are provided by knobs or switches on each of the 2½-inch wide control section strips.

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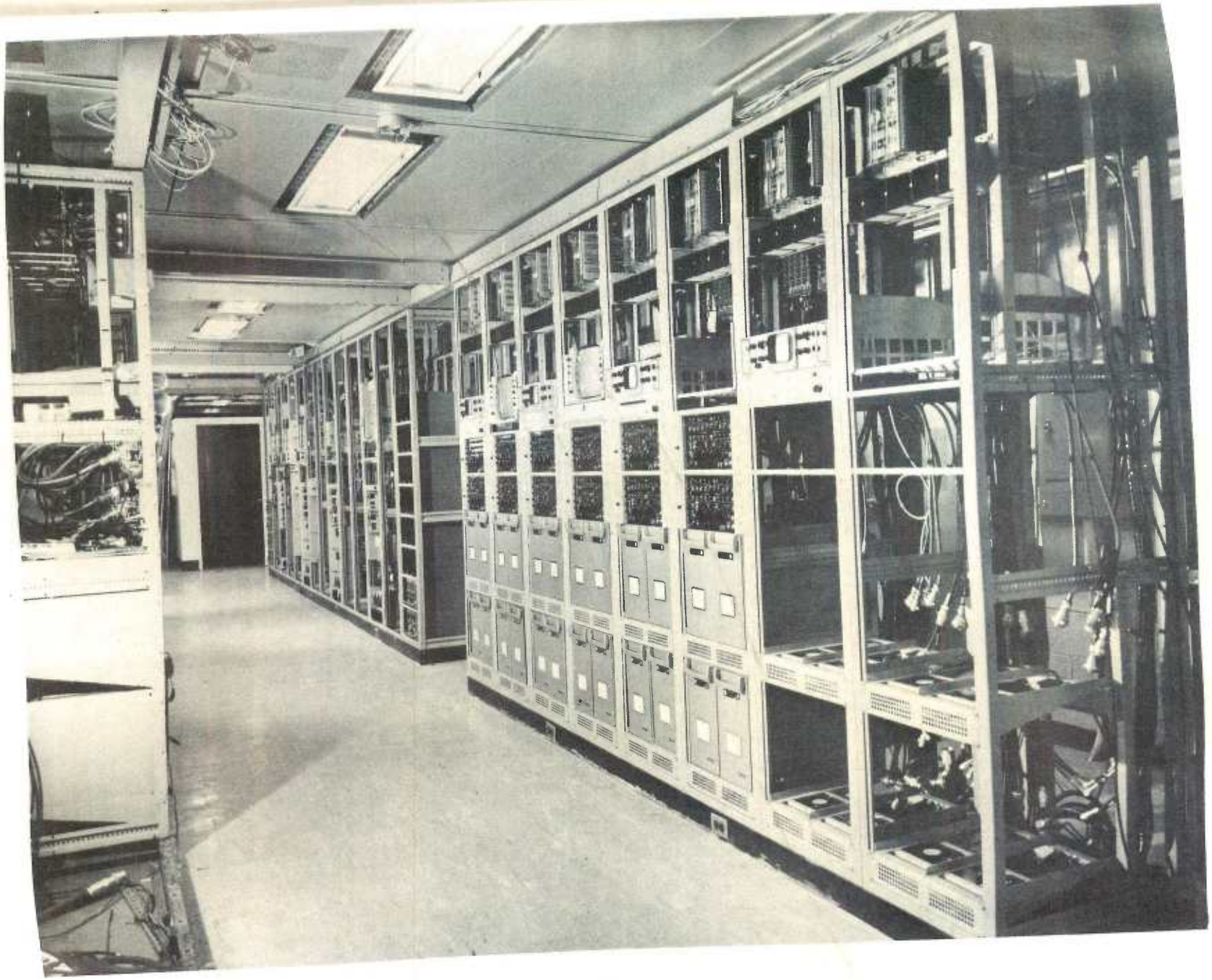

FIGURE 21

Camera channel equipment and pre-operational adjustment controls are centralized in the Equipment Center. Live camera controls are in the near group of racks; monochrome and color film [illegible] in the farther group.

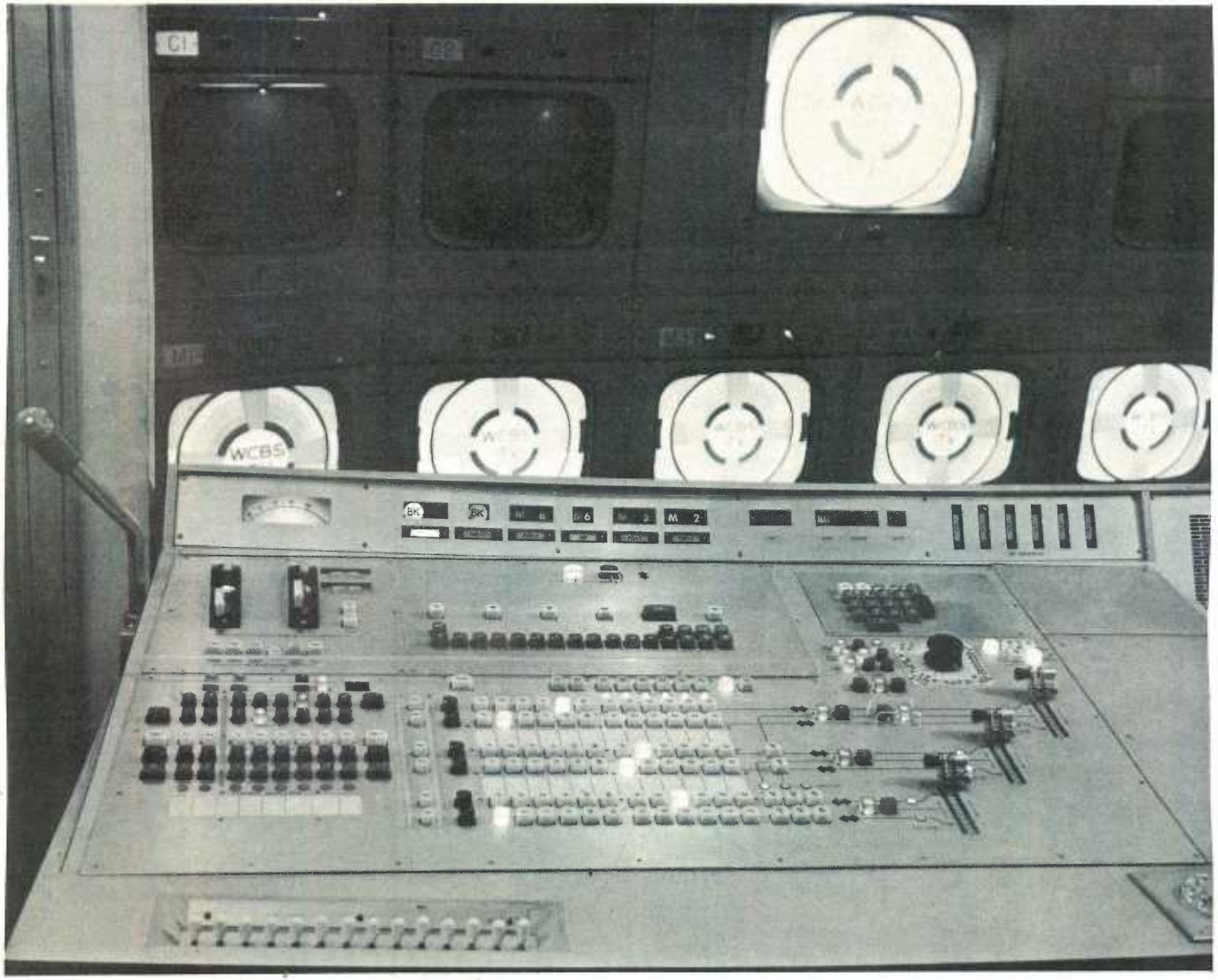

FIGURE 22

The studio switcher panel has been kept simple in appearance and operation. Two fader/effect rows feed into a master fader/effect output. In addition to studio cameras, the twelve inputs accommodate up to eight of 80 or more central film, tape, or remote sources which may be assigned to the studio. These may be placed on any desired position by use of the "adding machine" keyboard in the upper right portion.

The centrally-located preview selector row, by appropriate mode-selection, may be used to operate several different preview selectors or as an emergency output selector. Combined audio/video switching and control of audio output level may be delegated to the video switcher when full audio facilities are not required. Individual and grouped stop and start for assigned tape, film, and slide playback equipment are provided in the lower left portion. Fast forward and rewind tape modes may be controlled as well as normal start and stop. Intercom keys are recessed in the immediate foreground.

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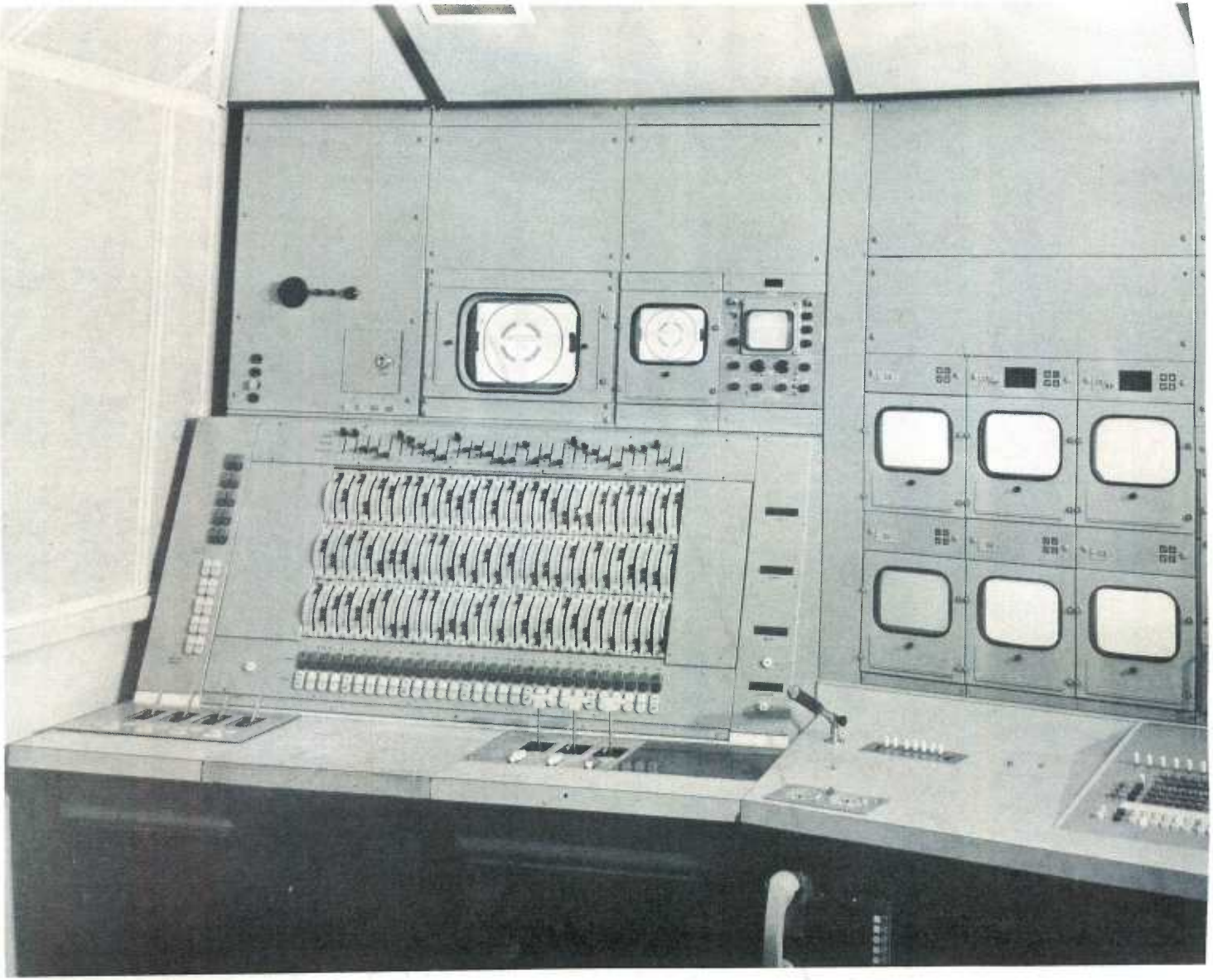


FIGURE 23

The lighting console shown here is for the smallest studio and has 30, 12-kw dimmer circuits with another 30 non-dim circuits. The console may be used manually as a three-scene preset console with provision for cross-fades or ganged fades among any combinations of the three scenes. Alternately, the control settings for a scene may be stored in the central computer memory. The quadrant controls are set as desired, a scene number assigned, and the information read directly into computer memory by merely pressing a button. Recall, by keying in the assigned scene code number, causes the next-scene quadrant control levers to be reset by motor drive to the positions which they had been set on read-in. Magnetic amplifier dimmers are controlled by the settings of the quadrant levers.

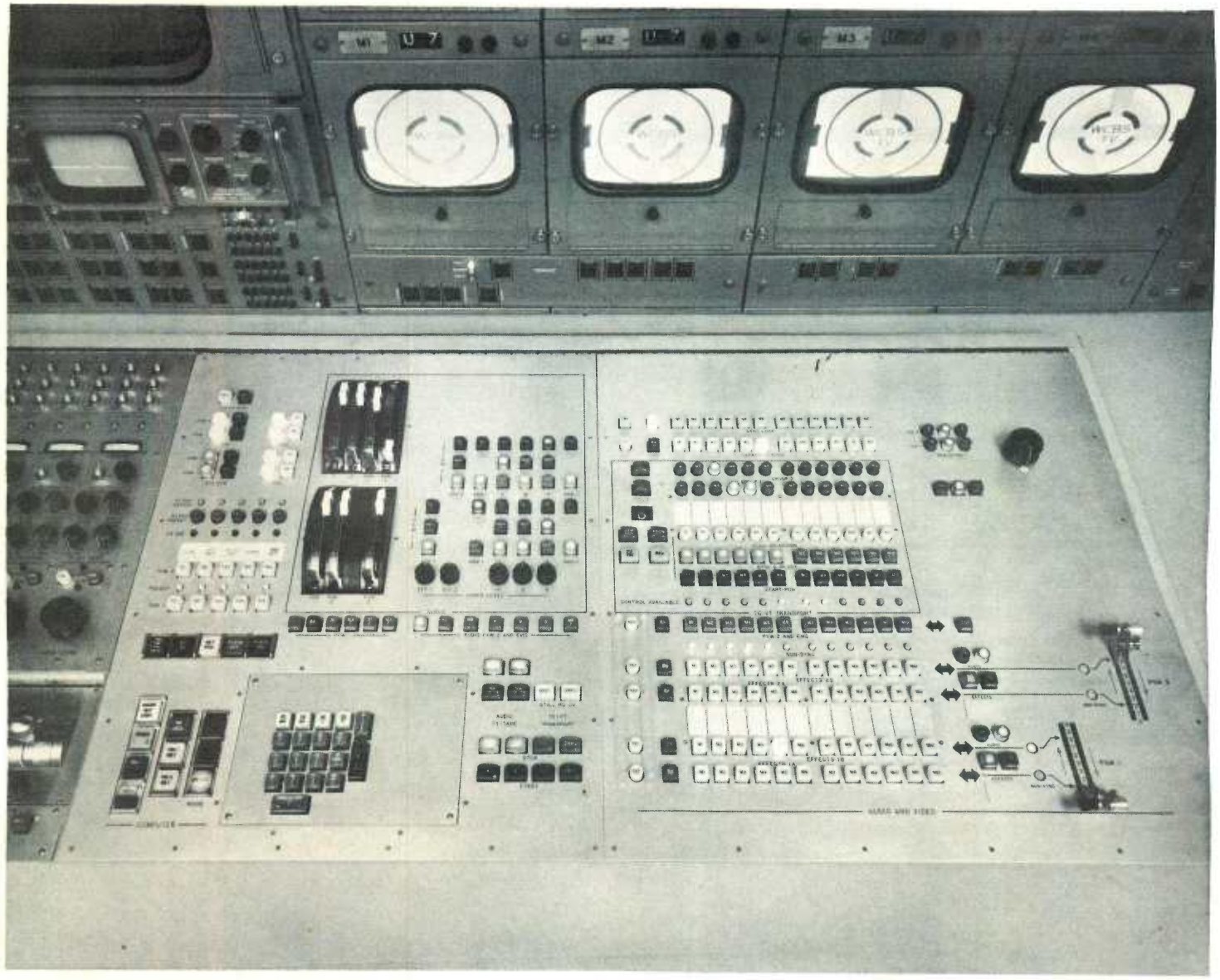


FIGURE 24

In normal Program Control operation, the combined audio/video switching is completely controlled from computer memory. Fader/effects levers are motor driven, separate audio selection and control are introduced, sync lock is activated, sources are preselected and continuity switching for two different output feeds controlled in accordance with instructions previously stored in the central computer system. The panel shown here provides a complete backup facility which affords manual control in an emergency. Changes in instructions stored in the computer, as well as the call-up and positioning of assigned signal sources, are accomplished by means of the keyboard in the left foreground. This is located where it can be reached from the normal operating position to the left.

operating position to the left.

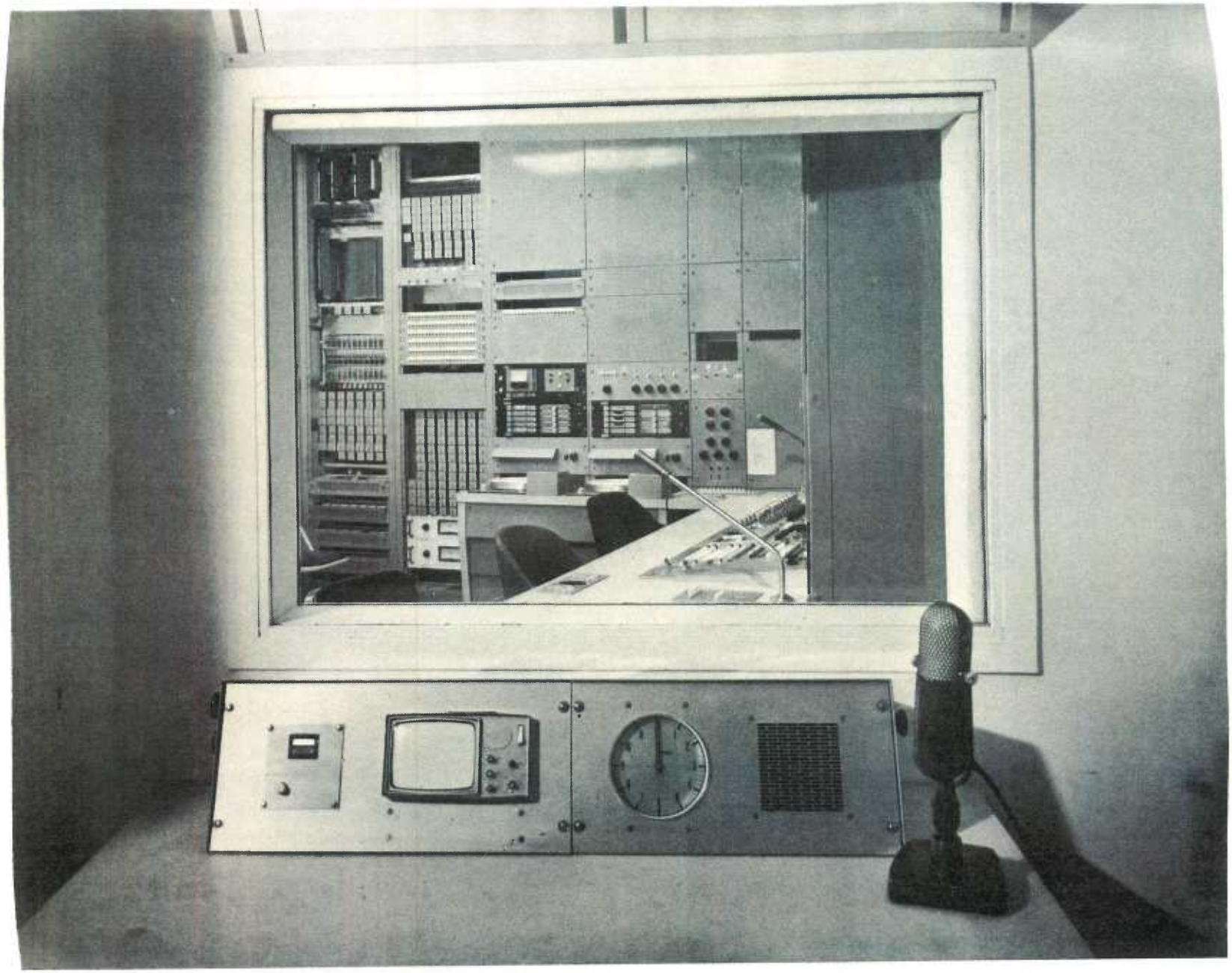


FIGURE 25

Program Control audio turntables and cartridge tape equipment and the audio switcher, all located to the left of the technical operator's position, are seen from the announcer's position.

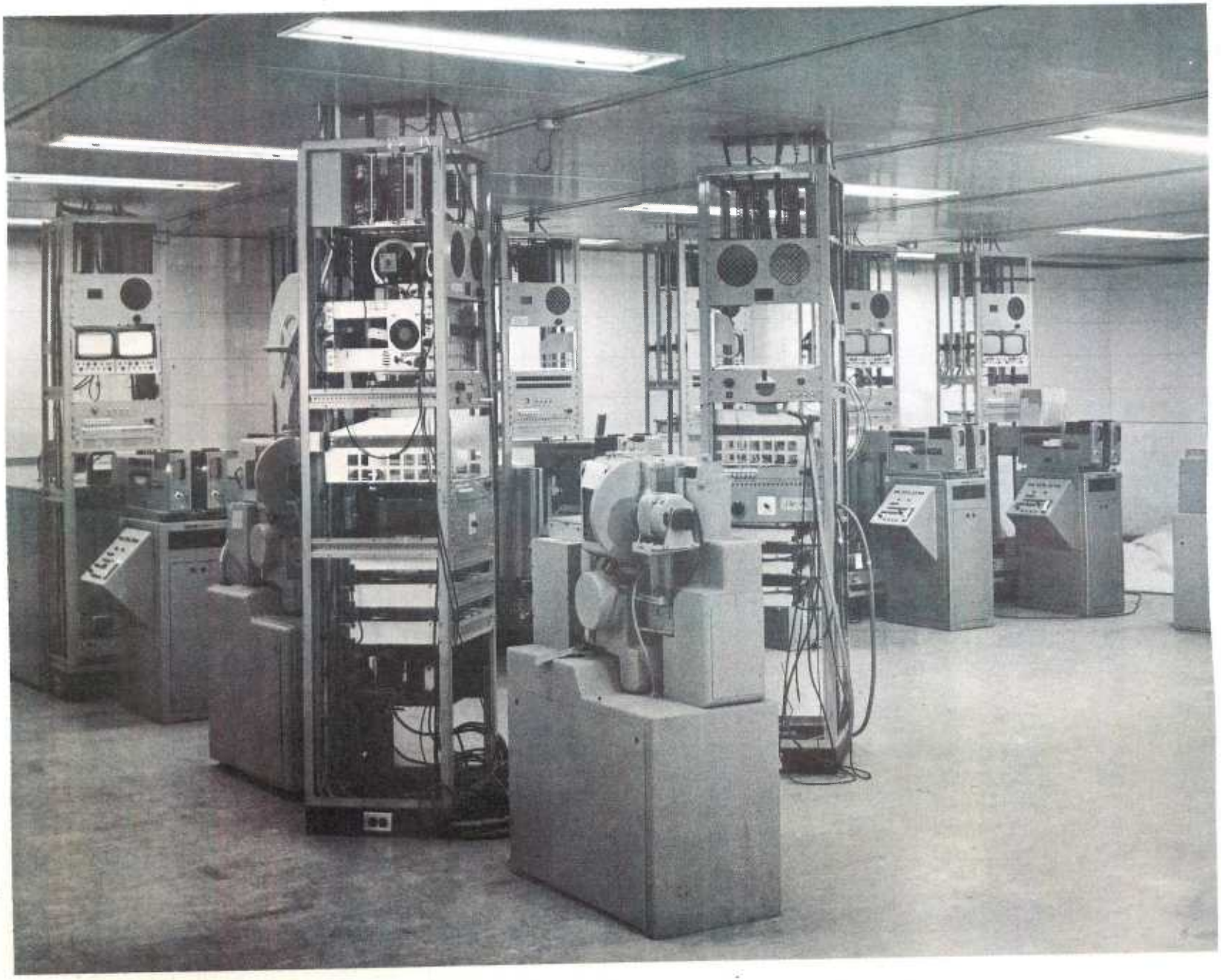
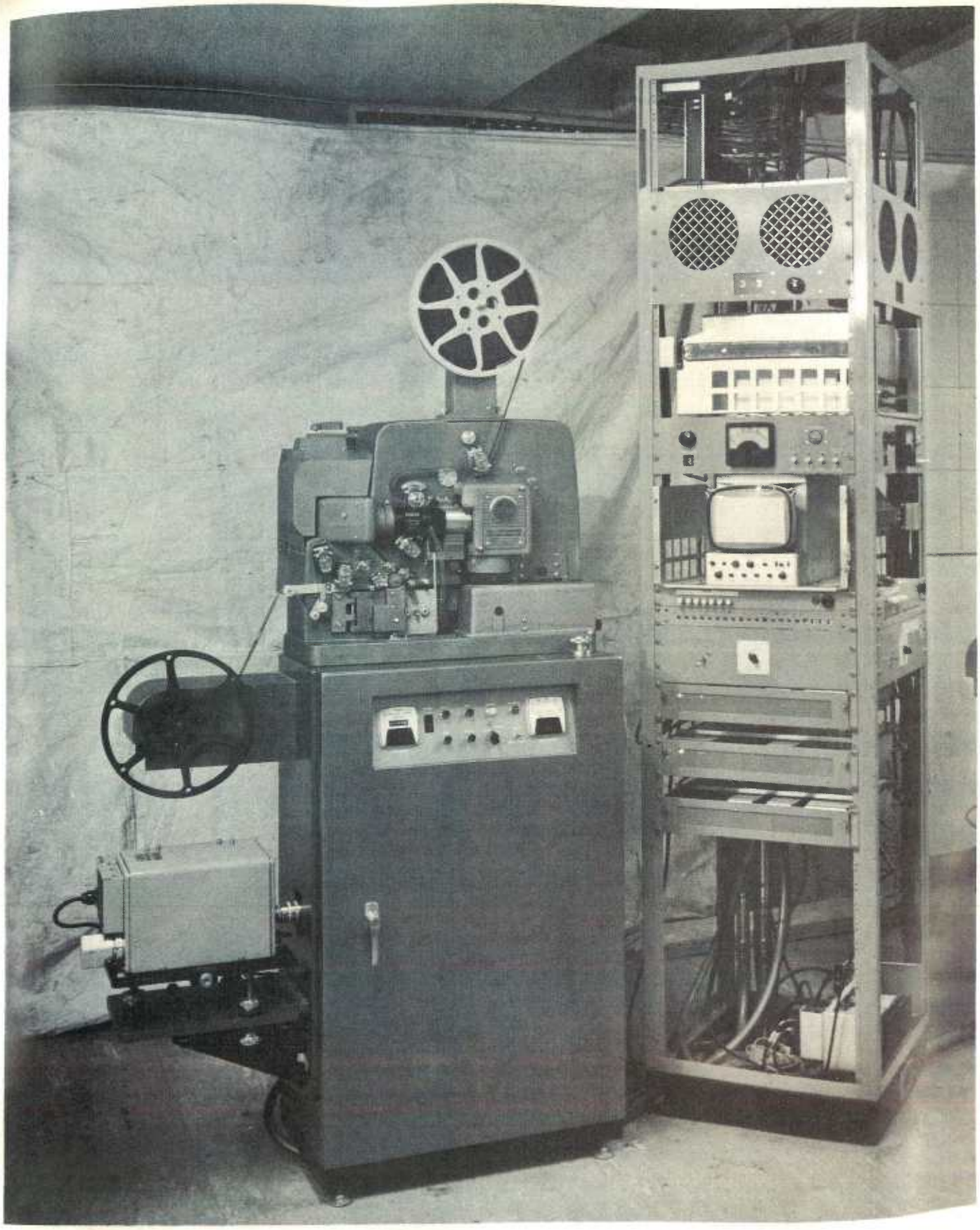


FIGURE 26

A section of telecine during installation shows two 35mm projectors and a row of six dual-channel slide projectors.



channel slide projectors.

FIGURE 27

A 16mm projector with its own vidicon film camera and rack is shown during installation test. Use of a separate camera for each monochrome projector is dictated by the long periods during which a projector must be assigned to a control point in network production work.

A single equipment rack, with monitors facing outward on two adjacent sides, is placed at an angle in a position which provides convenient access and good visibility from the loading



FIGURE 28

Two of the six dual-channel slide projector channels are shown. The slide projectors provide random access, lap dissolves, and superimpositions, under complete remote control. Computer control of these functions is provided when they are assigned to one of the Program Control rooms.

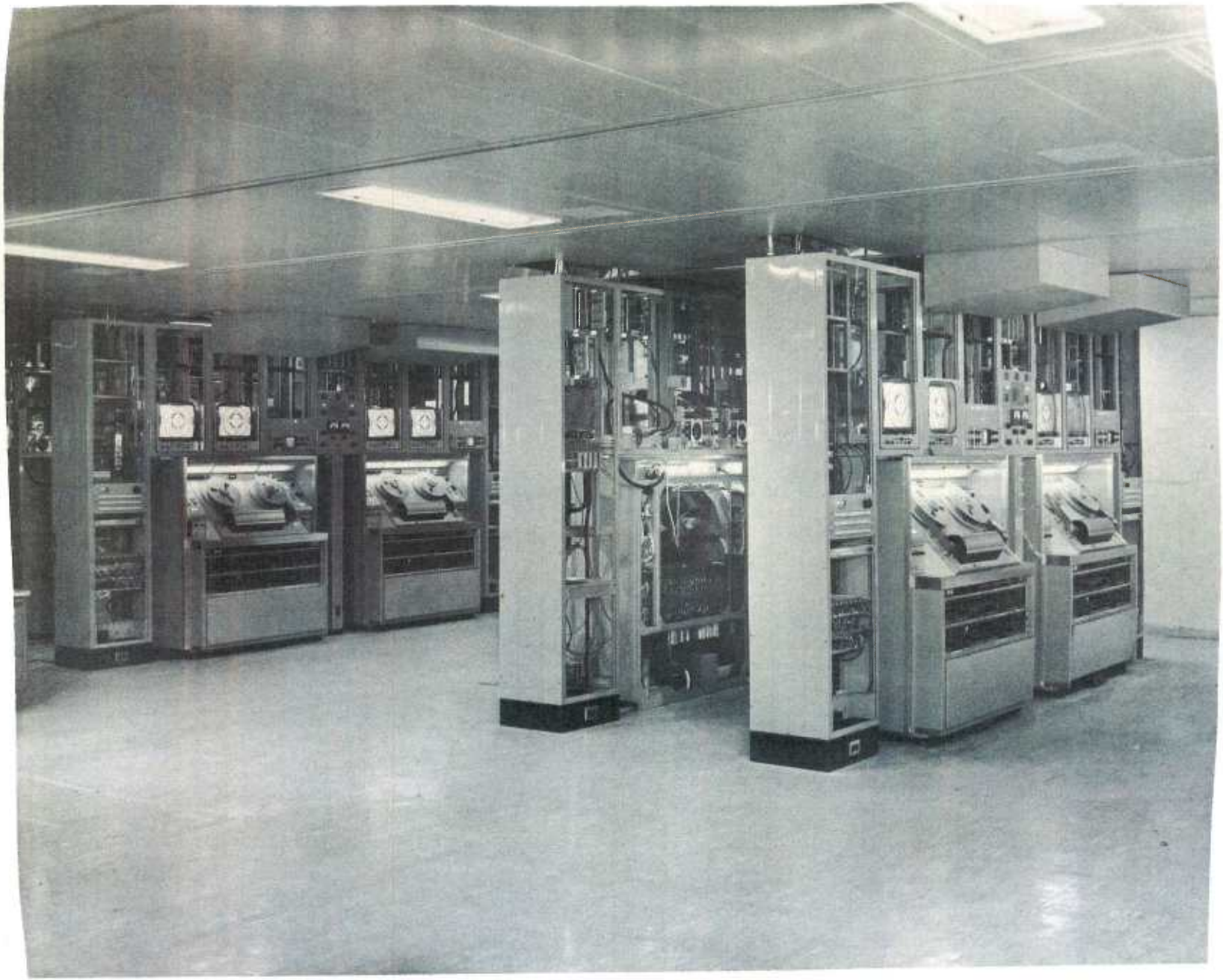


FIGURE 29

Video tape machines are grouped in pairs and placed in facing pairs. Thus, four machines are grouped together in a space easily covered by an operator and yet spacious enough to accommodate several non-related recording or editing operations without undue interference.

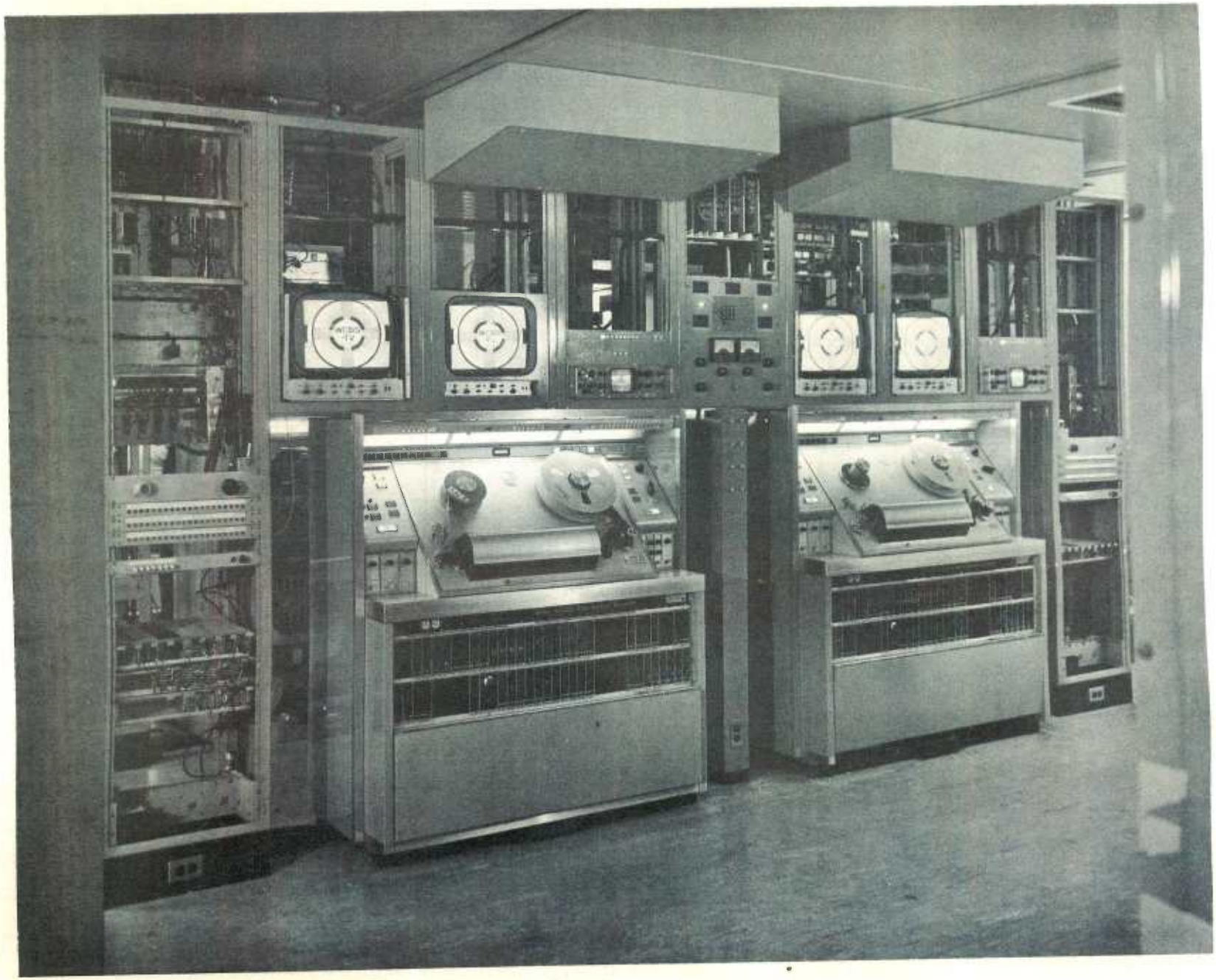


FIGURE 30

Two video machines are shown during installation in a typical paired group. The associated overhead and end rack assemblies are identical for the Ampex and RCA video tape machines employed.