

# WMGM Master Control Equipment Design

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Technical data on a modern, high-power, broadcast station installation.

**A**LTHOUGH THERE are many services and functions performed by master control, probably the most important is the switching of programs (remote or studio) to outgoing lines. In addition, monitor facilities are required for offices and lobbies. Moreover, remote line terminations with associated equalizing networks are necessary, and telephone lines must be maintained for communicating to operators handling remote programs. Test gear should be available for making measurements of frequency response, noise, and distortion, of outgoing programs.

At WMGM, multiple output switching is accomplished by a master control pre-set system which performs all operations by means of relays. This system permits the operator to set up the succeeding dispatching circuits ahead of time. Then, during

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a station break interval (sometimes by the operation of a single switch) he can execute comparatively complex switching schedules in a minimum of time and without the chance for error that would exist if each studio had to be switched independently. This system is flexible in that channels can also be operated individually if it is necessary to switch a channel at some time other than a quarter-hour interval when most program changes are made. With the improved performance obtained, and considering that there is less likelihood for operating error, this type of pre-set system is a sound investment.

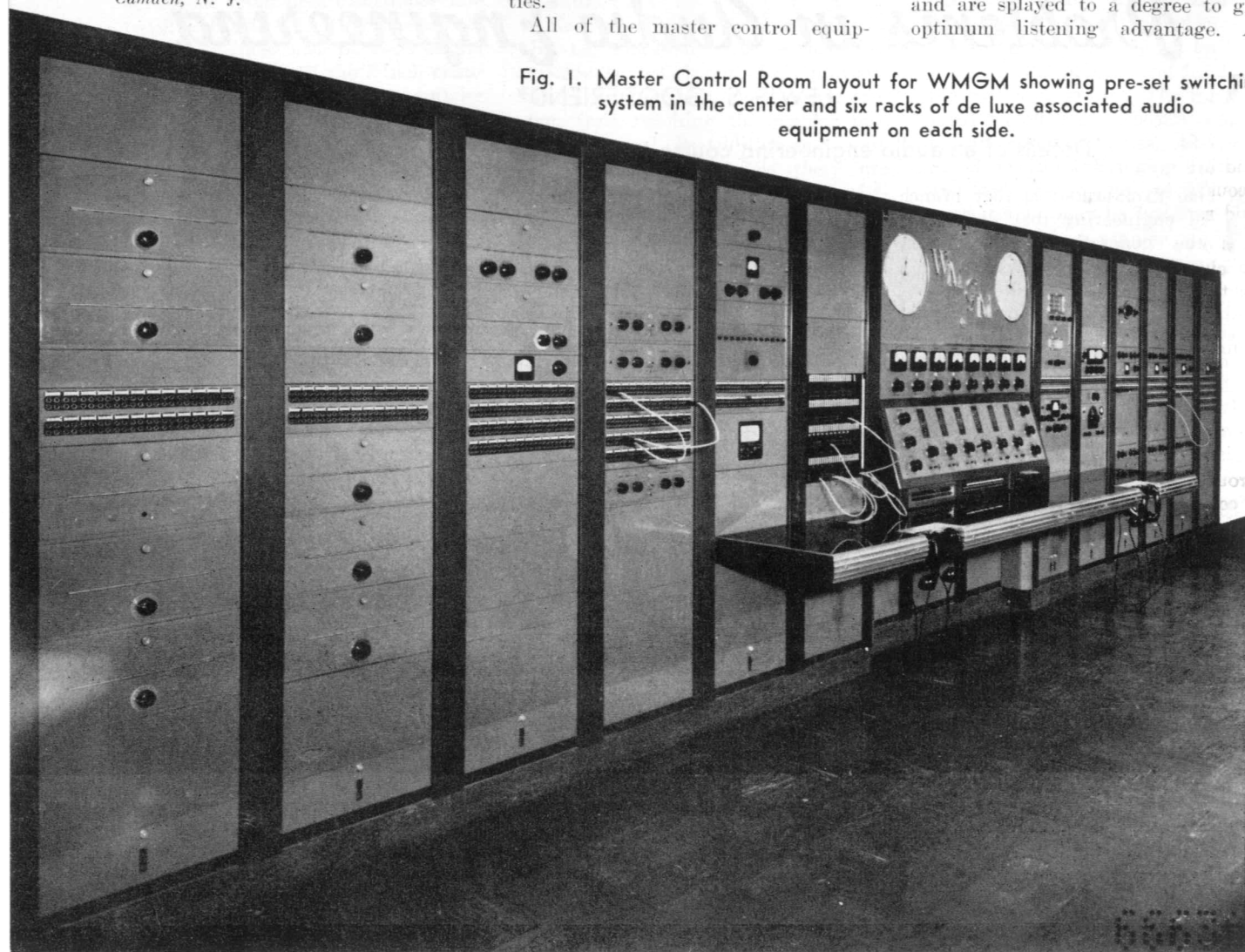
At the present time there are six studios in operation at WMGM and these, as well as three remote program circuits, can be switched to one or all six outgoing channels. In addition, there is one spare program input which may be used as an emergency input or may be reserved for future expansion of studio facilities.

All of the master control equip-

ment is mounted in standard cabinet racks which are bolted together to form a single unit as shown in *Fig. 1*. The switching system is composed of six identical sets of controls, relays, and lights (one set for each output channel). The counter, approximately 13 feet long, provides working space and gives all the operating conveniences of a desk-type control system. The counter top is covered with burn-proof micarta and the edge is trimmed with 4-inch aluminum moulding. The counter assembly is fastened to the racks by means of heavy angles, thus making it unnecessary to have any legs for support. Cutouts in the counter edge serve as convenient locations for telephones.

All master control racks are mounted flush with the wall. Thus, space at the top and ends is closed off and a door is provided at the left end, leading to the area in back of the racks. Three LC-1A monitor speakers are built into the wall above the racks and are splayed to a degree to give optimum listening advantage. Al-

Fig. 1. Master Control Room layout for WMGM showing pre-set switching system in the center and six racks of de luxe associated audio equipment on each side.



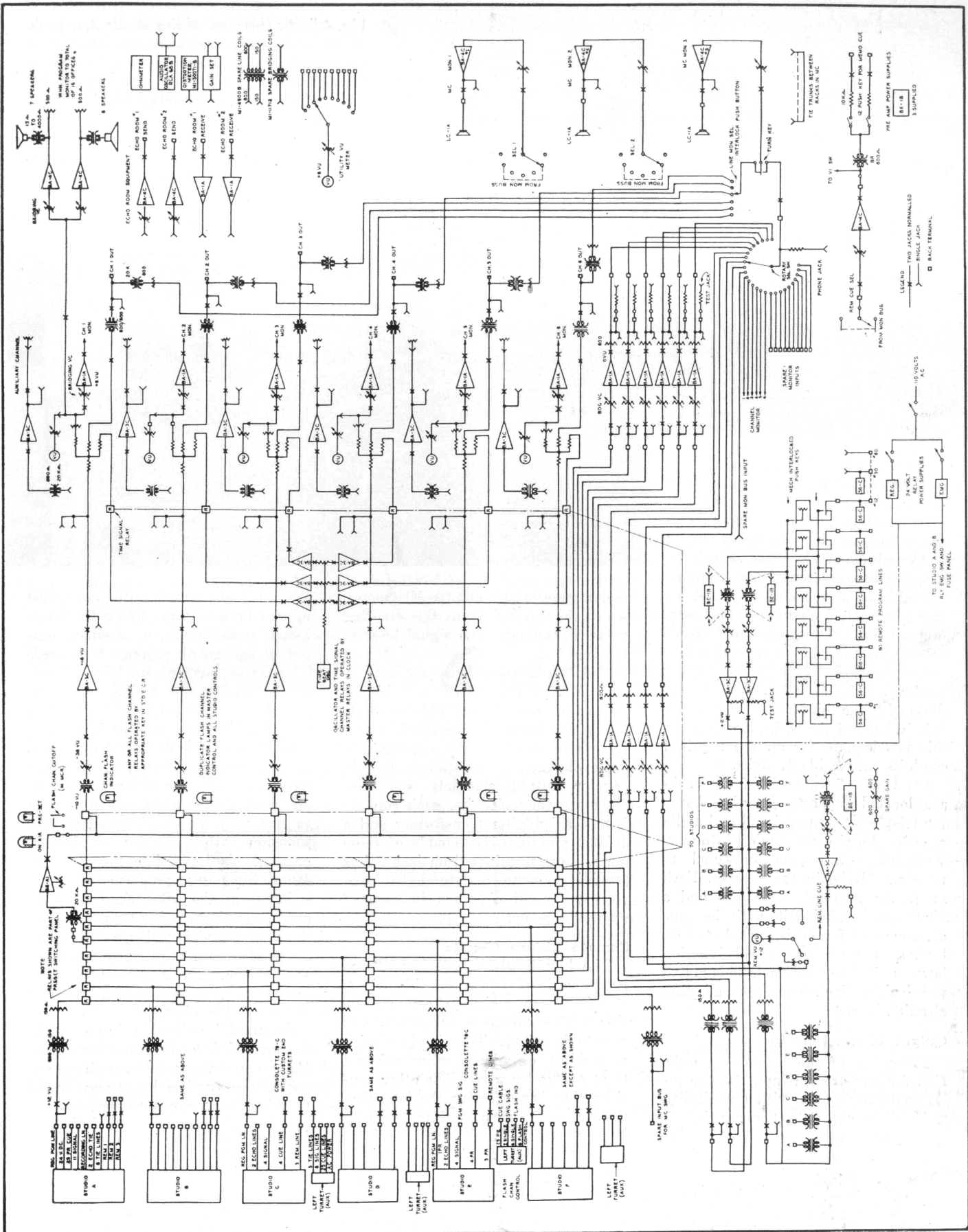


Fig. 2. WMGM Master Control Block Diagram.

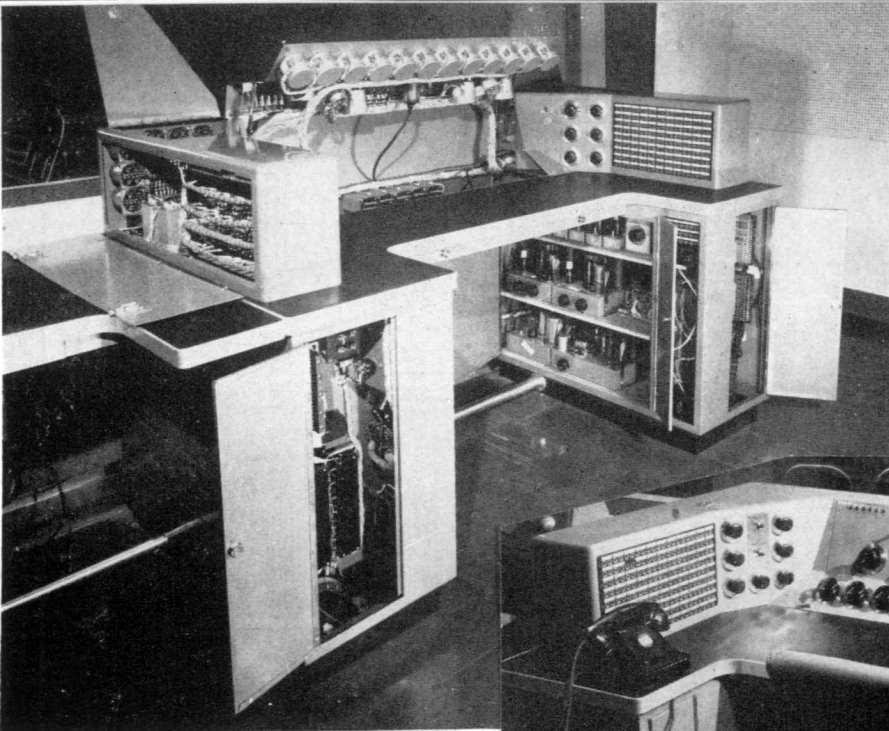


Fig. 4 (left). This view of the Studio A console shows how panels and doors may be opened to provide easy access to all components. Compartments with doors opening to the front contain terminal blocks.

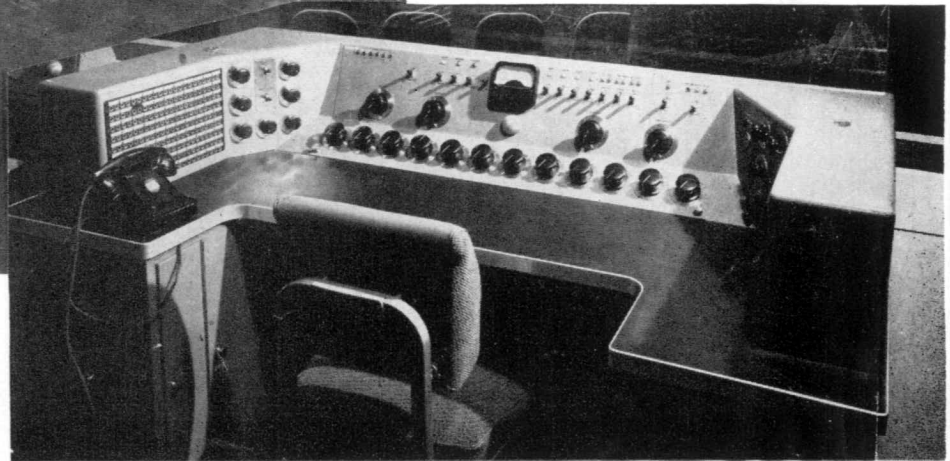


Fig. 3 (below). View of de luxe Studio A control console illustrating convenient location of all controls.

though this installation was made in a room having a concrete floor, what might have been a problem of running conduits and cable troughs to the various racks was easily solved. RCA cabinet racks have 4-inch removable bases. These bases were removed and the racks mounted on two 5-inch steel channels which were laid on floor. These channels extend across the room in a continuous line (with a 6-inch offset for the center section). A false floor of wood is laid flush with the top of the 5-inch channels in back of the racks. Space under this is adequate for all the required conduits and cable troughs.

On the wall in back of the racks are located separate junction boxes for telephone, power, signal and audio circuits. All circuits coming into master control are cross-connected to terminal blocks in these boxes. Each studio has a block for audio and a block for signal circuits with the same arrangement for leads for all studios, both at the master control junction box and at the studio end. This makes for ease in tracing and remembering circuits.

#### Output Channel Switching

Referring to the block schematic, Fig. 2, there are ten inputs to the relay switching system with a possibility of feeding six output channels. A transformer converts the 600-ohm incoming circuits to 150 ohms for switching. These are terminated by a 150-ohm resistor. This termination is necessary, since all output channels are bridging and several (up to six) channels may take the same program. Each output channel consists of a bridging transformer, a master gain control, a BA-3C line amplifier, and a dividing network which feeds the regular line

and a monitor circuit. A VU meter, which is also fed from the dividing network, indicates the signal level to the line.

Each monitor circuit contains a BA-1A amplifier with a bridging volume control input. This prevents line disturbances in the monitor system from reaching the regular program channel. In addition to the six regular output channels there are six emergency circuits, each consisting of a bridging transformer and a BA-3C amplifier. Both ends of these circuits are terminated on jacks, thus providing complete stand-by protection for all channels in case of any emergency.

#### Remote Pickup Circuits

The handling of incoming remote programs involves two considerations, one being to maintain communication with announcers or operators at remote locations. This is done with a talking circuit usually referred to as an "order wire." The other consideration is to receive the incoming remote on a separate line, equalize it if necessary, and route it either direct to the master control switching system, or to a studio (depending on how the schedule is set up).

WMGM has 60 incoming remote lines, 30 of which have individual RCA type 56-C equalizers. Three type BE-1B variable equalizers are supplied to correct the characteristics of lines other than those which are permanently equalized. Twelve of

the lines are permanently normalled to two banks of mechanically interlocked push keys. The common output of each bank of push keys feeds a separate remote amplifier circuit which enables the signal to be adjusted to the proper level for feeding the switching system. The input to a third remote circuit is not connected to any switching device, but is terminated on jacks. Bridging transformers feed the remotes to all studios so that they may be handled in conjunction with a regular studio program. It is impossible to select the same incoming program on both switches at the same time. This requirement is necessary to maintain the proper load impedance and to preclude the possibility of a mismatch to the line, and is accomplished by having one set of switches wired in series with the other.

An amplifier circuit using a BA-4C is provided to feed cue to the remotes. By means of a selector switch, any one of the monitor buses may be fed to this remote cue amplifier.

#### Monitor System

There are three monitoring circuits, each consisting of a BA-4C amplifier and an RCA LC-1A high fidelity speaker. Input selectors to these amplifiers are connected to a monitor bus system consisting of 16 circuits with isolation amplifiers. Monitoring points available are the ten switching inputs and the six outgoing channels. To provide an additional check on



the over-all channel circuits, a bridging transformer is connected to the terminals where each channel output terminates in the rack. These six outputs appear on a six-position, mechanically-interlocked push-button switch, the output of which can be switched to the input of one of the monitor amplifiers to provide a final program check. Jacks are also available to provide means for additional checking and monitoring.

#### Other Features

A beat-frequency oscillator, feeding six BA-3C amplifiers, provides time tone signals which can override any regular program or announcement on each of the six output channels. Relays operated by the master clock provide "on-the-hour" tone beats.

Another feature at WMGM is that one of the studios (Studio "E") can interrupt the regular program on one or all output channels and feed those channels directly with a special announcement. This by-passes the preset selector system and normal operation is not restored until control is released by Studio "E." There is, however, a cutoff switch in the master control room which can take this control away from the studio. To preclude unwarranted program interruption through misuse of the Studio "E" channel-operate keys, power to actuate the override relays is fed to the studio only by order of station management. Lights in all studio control rooms as well as master control indicate when any channel is interrupted by Studio "E."

Amplifying equipment for two echo rooms is supplied. Each equipment consists of a BA-4C echo speaker amplifier, and a BA-1A echo microphone pre-amplifier. Tie trunks make

it possible to connect the echo circuits to any desired studio.

Two BA-4C amplifiers are bridged across output channel No. 1 and are used for feeding speakers in 15 offices.

Ample test equipment is supplied to provide the station with all the necessary facilities for measuring frequency response, noise, and distortion of any program circuit. Tie lines to the various studios make it possible to pipe studio circuits to master control to utilize this equipment. Spare line and bridging coils, as well as fixed pads of various losses, are provided and can be used as an aid in making measurements.

#### Studio Equipment

A deluxe studio desk, *Fig. 3*, was designed to provide in a single unit all operating facilities for the control of Studio A, which is one of two auditorium type studios in the WMGM operations. It was intended that this studio console should offer the maximum in fidelity, flexibility, reliability and operating convenience. Appearance was also to be of utmost importance considering the prestige of the station.

The desk is constructed entirely of steel and completely replaces conventional rack equipment with its associated console by providing a housing for all the amplifiers, power supplies, relays, etc. These components are mounted and housed in two pedestals which in a conventional type of desk would be reserved for drawer space. Each pedestal has a 2" x 6" opening in the back which is connected to an air conditioning duct in the wall. This provides enough cool air to prevent abnormal temperature rise due to heat from the amplifiers. An air filter is placed over the

duct opening to keep dirt from the pedestal out of the ducts.

Each pedestal has three compartments. Doors to these compartments are flush-fitted and each is supported by a continuous piano hinge, as seen in *Fig. 4*. In the left pedestal there is one large compartment with a door opening to the inside of the desk. There are three shelves in this compartment on which are mounted eleven preamplifiers, two power supplies, and several line and bridging transformers. Amplifiers and power supplies are of the plug-in type. Therefore the removal of these units for any reason is a simple matter.

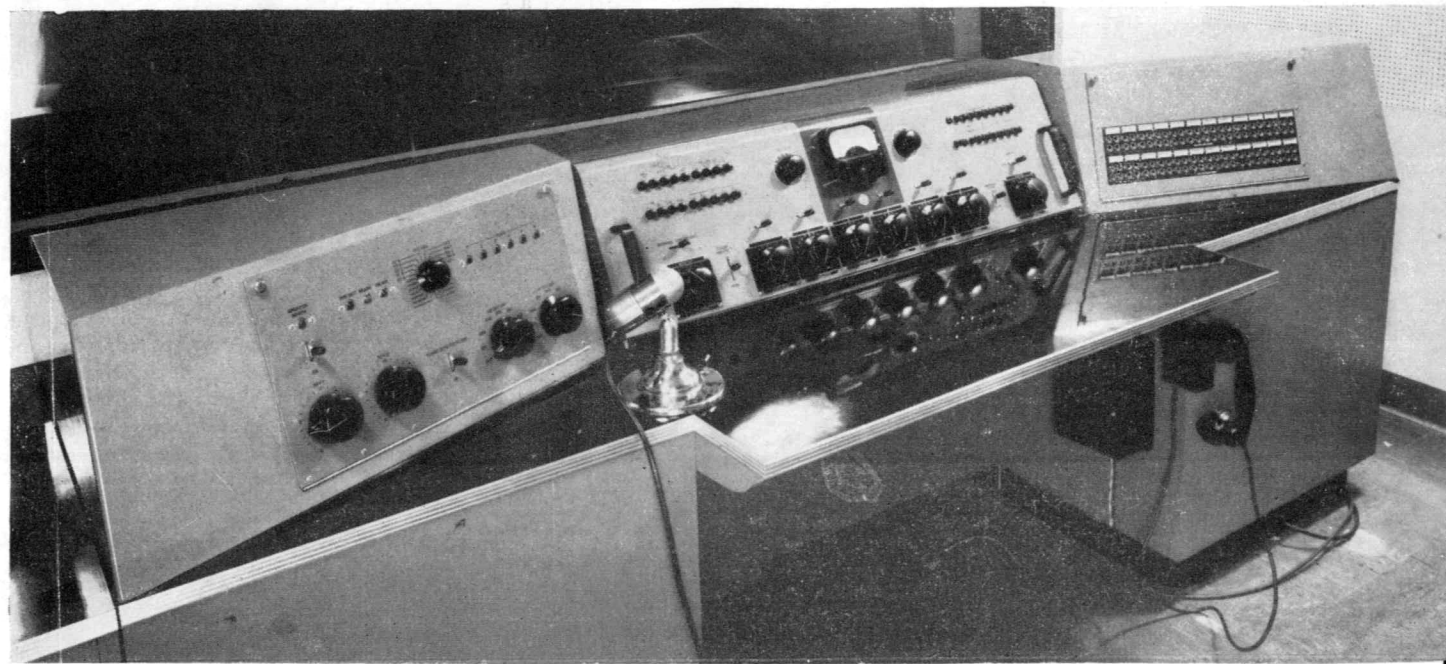
Another smaller compartment, opening to the inside, contains two circuit breakers and pilot lights, a switch for emergency relay voltage and a meter for checking the amplifier tubes. Two selector switches pick up the metering terminals of these amplifiers.

The third compartment contains terminal blocks for connecting to external a-c and d-c power circuits as well as incoming microphone lines. This placement of terminal blocks facilitates trouble-shooting when it is necessary to check external circuits to the desk. Needless to say, the desk installation was less of a problem than with the terminal blocks in some out of the way place.

The large compartment in the right pedestal has 3 shelves, contains six booster amplifiers, two program amplifiers (one regular and one emergency), one power supply, and a studio monitor amplifier.

A second compartment contains a small jack field for all speaker circuits. Since these are high level circuits, this location affords the isolation desired and keeps all loudspeaker

**Fig. 5.** In Studios C and D, a standard RCA 76-C consolette is used in conjunction with auxiliary custom-built side turrets (jack bay at right—and sound effect filters, echo controls, cue selector and supervisory lights at left). Space is provided for turntables at each side of the operator's position.





er jacks out of the main jack field. The studio speaker volume control is in the voice coil circuit and is located in this compartment for the same reason. The balance of space is used for the storage of patch cords when they are not in use.

The third compartment contains audio terminal blocks and speaker relays as well as a volume control for studio headphones. The terminal blocks are placed so that external wiring connections are easily made. Conduits which carry wiring to the terminal blocks come up into the terminal block compartments and are stubbed about two inches above the floor.

The sides or ends of the desk pedestals which are fastened with concealed screws were removed during the time the desk was being wired to provide easy accessibility to all amplifier plug terminals.

Mounted on the desk top is a continuous turret which extends from the left of the operator around to his right. Since the height of this turret is only 39 inches above the floor, adequate visibility into the studio is enjoyed by the control operator while seated at the desk.

The most essential controls are mounted on a panel directly in front of the operator. This panel is hinged at the top for access to any parts requiring maintenance. Two slopes to this control panel provide maximum operating convenience.

There is a jack bay on each side of the control operator, each bay containing 99 pairs of jacks. Access to jack wiring is gained by removing a panel in the back of the turret. Each jack bay turret is joined to the center panel turret thus providing enclosed space for mounting additional equipment, such as PA volume controls, echo mixers, sound effects controls, etc. These controls require

only occasional adjustment, so they need not be part of the main panel. Access to each side compartment is by a hinged lid, flush-mounted in the top.

#### Producer's Desk

An added feature of this studio control equipment is a producer's desk, *Fig. 6*, which is styled similar to the control desk, except it has no over-all control turret. The left end of the desk has a pedestal exactly the same as the pedestals on the main console. The right end fastens to the main console so that it becomes part of it. In the left pedestal are mounted two auditorium PA speaker amplifiers and one client's speaker amplifier, both of type BA-4C. This compartment also has connections to an air-conditioning duct.

The producer's controls consist of a studio talkback microphone with associated "operate" switch and an interval timer used principally for timing shows during rehearsals. These producer's controls are mounted in a small turret placed on the desk.

#### Program Control Facilities

All mixing, amplifying, monitoring and special-effect facilities required to produce and control a program are contained within the control console. A twelve-position mixer which permits simultaneous mixing of ten studio microphones and two incoming remote lines is incorporated in the design. The first six mixer circuits are controlled by one program key and each of the other six mixers has an individual key for cutting the circuit in or out. This feature is especially advantageous for the control of large programs using an orchestra with a multiple microphone pickup. It is possible to cut in single microphones for announcers or vocalists while fading the entire orchestra down with a single control.

Each bank of six mixers feeds into

a separate booster and master gain control. The outputs of these gain controls are combined by a matching network to feed a single channel into a BA-3C amplifier. A spare channel is available for emergency service. A key is provided to feed either channel to master control.

A three-position echo mixer circuit with bridging transformer inputs and a BA-1A booster is supplied. Reverberation characteristics may be applied to as many as three microphone channels by patching from a pre-amp output multiple to one of the bridging transformer inputs. The BA-4C for feeding this signal to the speaker in the echo chamber is located in master control. The echo microphone pre-amplifier, which is also in master control, feeds the signal back to the studio on a tie line. As this is a 600-ohm circuit, it must be patched into an unused mixer position to be combined with the normal program. Two sound-effects filters are supplied to obtain a wide variety of effects in conjunction with the reverberation facilities.

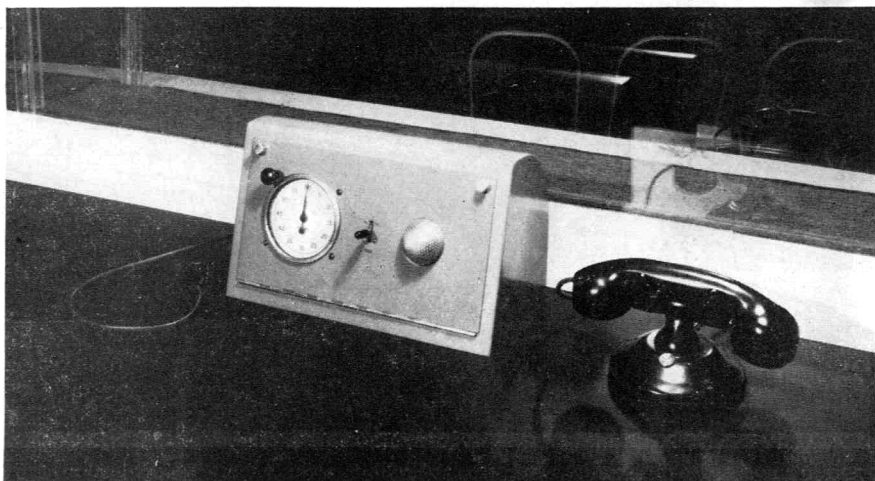
Another three-position mixer circuit with bridging inputs is provided to reinforce certain microphones for the benefit of the studio audience. Microphone reinforcement is often desired by certain radio artists as well.

The output of this mixer system and associated booster amplifier feeds two BA-4C amplifiers, each driving an LC-1A speaker concealed in the proscenium. Gain of the PA amplifiers may be controlled by a person in the back of the auditorium, thereby assuring the proper speaker level for any size audience and at the same time preventing acoustical feedback. Usually it is necessary only to reinforce dialogue, sound effects, vocalists, announcers, or special features and not an entire orchestra playing on the stage.

There are three input possibilities to the monitor amplifier feeding the control room speaker and a studio speaker. The input is normally connected to a dividing network in the output of the program amplifier as a regular monitor. A key transfers the input to a rotary switch for selecting a cue for the studio from any of 16 monitor buses in master control. The studio talkback circuit is connected to the monitor amplifier through a relay which disconnects either the cue or monitor circuits. Two microphones are provided, one on the console control panel and one on the producer's desk. Each is connected to the talkback circuit by a key which operates the talkback relay. When either talk-

[Continued on page 39]

Fig. 6. Closeup view of producer's turret as used in studios A,B,C, and D.



too well for the present state of sound-on-film in England, as compared to disc recording. This comes "direct" from the sound track of the film—trouble might be in the copying. Whatever the reason, the tonal range is conspicuously less than in the fine British recording we usually hear today, the voice is a bit tinny; nothing to bother anyone but an engineer. The excerpts are wonderful for those who have seen the film; not so good for those who haven't, because Olivier naturally acts for the eye (the camera) as much as for the ear, and minus the picture itself his speaking part, all on its own, seems rather colorless and inexpressive. Even so, if you are a Shakespeare reader you will find this most absorbing, and the music (several sides' worth) is excellent, as movie music goes.

## WMGM Master Control

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back switch is operated, the control room speaker is disconnected and the studio speaker is turned on. Whenever the program line switch is operated, the power circuit to the studio speaker relay is broken, thus preventing talkback while the studio is feeding master control. During these periods, a talkback microphone booster is connected to headphones on the stage. These may be used by an announcer or a musical director for taking instructions from the booth during a broadcast. Also, as these headphones are normally in the monitor circuit, a musical director can hear the program as it is fed to master control. One BA-4C amplifier is provided to feed program material to a clients' booth which overlooks the studio.

Supervisory lights on the console are automatically controlled by the pre-set switching system and indicate to the operator when his studio has been pre-set as well as when his studio has been switched to an outgoing channel. When the operator closes his program key a light in master control is energized showing that the program circuit is complete from microphone to channel output.

### Facilities for Other Studios

The facilities for studio "B" are essentially similar to those for "A" but the remaining studios are equipped with standard RCA 76-C consolettes as the nature of program in these studios is not as complex as in Studio "A" and "B."

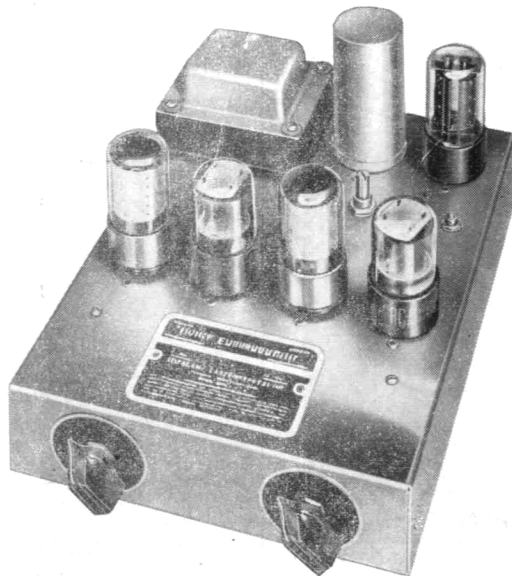
In "C" and "D," auxiliary equipment consisting of a jack bay, echo controls, sound-effects filter and a 24-position cue selector is supplied. This equipment, shown in *Fig. 5*, is built into two turrets with sloping panels, one turret located on each side of the consolette.

Studios "E" and "F" do not have a

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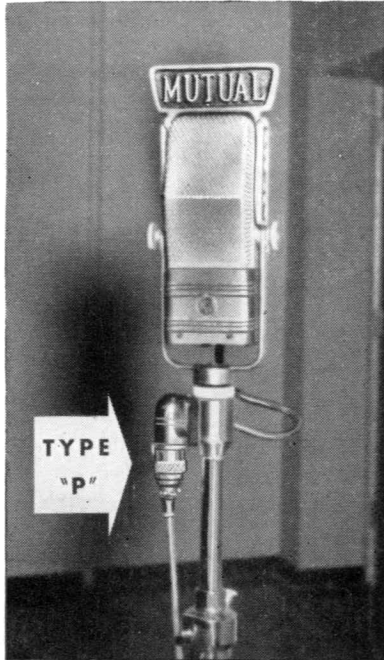
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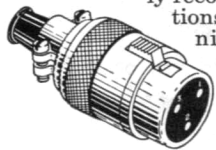
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jack bay or a sound-effects filter. However, Studio "E" does have the channel override controls mentioned previously.

A producer's desk and control turret similar to that in Studio "A" and "B" is furnished in both "C" and "D."

### Acknowledgement

The design of the above station facilities has resulted from combining the experience of WHOM engineers with the engineering and manufacturing resources of the Radio Corporation of America. All the equipment is of the latest design to assure the station high standards of performance, dependability and service.

## 6AS7G Amplifier

[from page 19]

signed for feeding a speaker or a 500/600-ohm line, but it is difficult to obtain optimum performance from a transformer designed for both types of output load. Consequently, the output transformer has only one output winding covering three speaker impedances.

### Control Section

The three tubes in the control section actually constitute five stages.  $V_1$  is a dual triode in a conventional peramplifier circuit, with feedback equalization to supply turnover frequencies of 350 and 500 cps. One section of the input selector switches the pickup, or grounds the first grid. The second section varies the turnover frequency, and adjusts it to 350 cps for microgroove records. The third section connects the amplifier to the phonograph level-adjusting potentiometer at the output of the preamplifier in positions 1 and 2, to the AM and FM potentiometers in positions 3 and 4, and to the preamplifier through a roll-off circuit in position 5 for microgroove records. Thus the long-playing records are normally reproduced on the position 2, the "flat" settings of the tone controls. Victor and Decca frr records reproduce best on position 3 of the high-frequency control, Columbias on position 4, and exceptionally noisy records on position 5. The treble control is numbered counterclockwise, the bass control clockwise.

The two tone controls are designed to work together and into a grid with no resistance loading, as is the volume control. Since feedback is introduced at the stage ahead of the driver, the volume control is placed between the two sections of  $V_2$ , the first section acting as a cathode follower.  $V_3$  is triode connected, and is shunt fed with the coupling capacitor in the cathode leg. This capacitor and the

cathode bypass for  $V_3$  are located in the power section.

The 6AS7G circuit is similar to those previously employed, with the 600-ohm 5-watt resistors in separate circuits, the 500-ohm potentiometer serving to balance plate currents, and the three heaters in series being connected between the arm of the balancing potentiometer and the negative side of the supply circuit. The 600-ohm value is used in the cathode circuits because of the drop across the heaters. The 7500-ohm resistor bleeds the additional 30 ma for the control section heaters.

Subjective listening to this amplifier has indicated excellent performance, but since thorough measurements are not yet available from the testing laboratory, they will be presented next month in Part II, along with details of chassis layout and wiring. A complete list of components will be furnished to anyone desiring them. Address your request to AUDIO ENGINEERING, 342 Madison Ave., New York 17, N. Y.

## Phonograph Preamplifier

[from page 16]

paring the music to the original rather than to some other reproducing equipment with which they were familiar.

Even though the curve of a particular record is not known, a little listening experience enables one to select quite readily the proper equalizing characteristic; indeed, in the case of many records, only one setting sounds at all satisfactory, others being very obviously wrong. Occasionally a record turns up for which no settings will provide any illusion of realism.

After having lived with this preamplifier for several months, we feel tempted to conclude somewhat as follows: The input data, upon which the whole design was based is certainly in error by much more than 2 db in certain frequency ranges and on certain recordings. The probable error in over-all equalization in the next record played will very likely be well over 3 db, which is about the maximum deviation between characteristics obtainable with the foregoing circuits. This says that further progress is impossible or unwise until more reliable input data is on hand.

The finished product is compact, simple to construct, and inexpensive. It does not demand critical tolerances nor particularly careful physical layout. It will accommodate any current low-level wide-range cartridge and correct any current