Audio Console Design Notes*

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All photographs by the author

The author discusses the design of modern functional control consoles aimed at serving the needs of commercial recording studios. Treated are several microphone-mixing consoles and an editing console for tape work. The use of push buttons for echo selection and for the selection of multiple inputs through one or two high-level positions is discussed. Dealt with, too, are dual-channel design (affording either sub-mixing or stereophonic operation in one console) and the employment of individual-channel equalizers for the correction of room acoustics.

THE MOTIVATING FORCE which prompted the following discussion, developed from embryonic thoughts noted several years ago.[1] It gained impetus through a long period of exposure to network radio and television engineering operations. Most recently the motivation stemmed from the specialized field of communications and recording equipment design and sales.

An excellent discussion of the basic steps to be taken in designing any audio-mixing facility appeared in an earlier issue of the JOURNAL.[2] In the same issue, the ever-present problem of grounds and shielding was given thorough treatment.[3] An exhaustive review of the various considerations involved in good systems design is not our purpose here. Rather, several audio consoles designed specifically for commercial tape- and disc-recording studios will be presented. It will be evident that ideas have been borrowed or adapted from broadcast designs. The author's main theme is, it will be noted, operating ease and convenience.

Modern methods of operation in tape- and disc-recording studios have made necessary mixing facilities of increasing complexity. The commercial client wants and demands all kinds of exaggerated sounds. These involve the use of echo chambers, program equalizers, sound effects and sound-effects filters, a variety of microphone types, vocals isolated and treated independently of the music pickup, tape-live multiple dubbing, and of course, virtually instantaneous playback facilities to both control room and studio personnel. The client tends to use all available facilities liberally in his quest for "different" and "more commercial" sound. The operating engineer must be prepared to conjure up various effects at the flick of his wrist.

FIG. 1. A functionally styled and designed console in everyday use in a busy professional studio.

Figure 1 pictures a functionally styled and designed con-

* Presented at the Seventh Annual Convention of the Audio Engineering Society, New York, October 12-15, 1955.

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[1] P. C. Erhorn, "Flexible Studio Console," *Electronic Industries,* (August 1944).

[2] W. E. Stewart, "Basic Problems in Audio Systems Practice," *J. Audio Eng. Soc.,* 1, 85–87 (January 1953).

[3] A. C. Davis, "Grounding, Shielding, and Isolation," *J. Audio Eng. Soc.,* 1, 103–104 (January 1953).

sole in everyday use in a busy professional studio.[4] The low sloping panel helps to eliminate "glass arm" effects on a long date, and contains all the controls for a fairly complex mixing job. The single tip-ring-sleeve type of jack (as adapted for audio use by CBS) affords a most compact jack field, immediately to the left of the controls. Four rows of cam-operated, leaf-spring pileup pushbuttons to the right offer instantaneous selection of echo feed and remote tie lines to playback or rack-mounted facilities. Details of the center control panel are shown in Fig. 2. Figure 3 is the block diagram of the console.

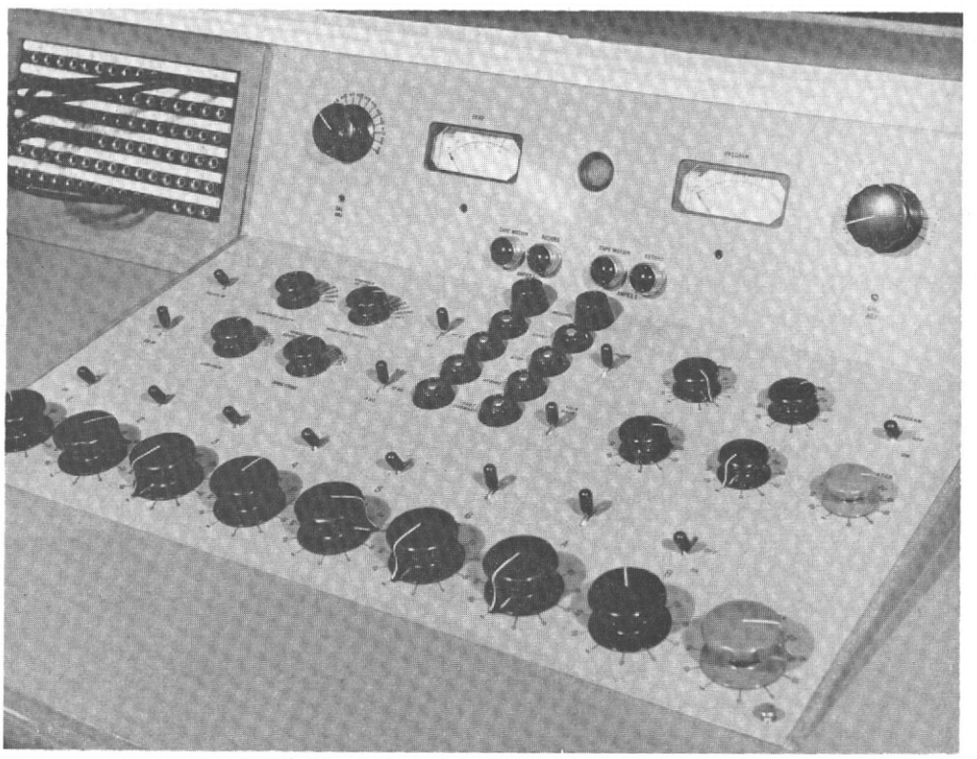

FIG. 2. Details of the center control panel of the console.

It will be seen that there are 6 inputs at microphone level, and 2 more at high level (nominally +4 dbm), labelled *A* and *B* on the mixer. Two sets of 6 pushbuttons are tied to the playback output of 2 tape machines, 2 transcription turntables with self-contained preamplifiers, and 2 rack tie lines. One of these tie lines can furnish echo return. Each remote facility appears on both position *A* and position *B* buttons, thus allowing the operator to switch any two at will. Remote record and tape-motion buttons with indicator lights, an operating "must," are situated at dead center, as shown in Fig. 2. A program equalizer and sound-effects filter are located just to the left of these buttons.

Two more sets of 8 pushbuttons are tied in through simple minimum-loss branching networks immediately after the mixing attenuators. A feed from each one of the eight main mixer positions goes through both sets of pushbuttons and thence to the echo chamber send circuits. By means of the buttons, any two positions (including *A* and *B*) can be instantly selected and mixed for echo feed. To place a different microphone on echo, it is only necessary to "punch up" the associated echo button.

This echo mixer has also been called on for double duty on occasion as the second channel of a stereophonic pickup. The output of a microphone preamplifier can be patched directly to the input of either echo mixer attenuator.

The remainder of the circuits following the mixer networks are standard and are designed to raise the levels up to program or line level (nominally +4 dbm). Attenuators mounted adjacent to the VU meters make possible even higher output levels if the need arises, but within the ample capabilities of the program amplifiers. Jacks have been kept to a minimum without sacrificing operational or emergency patching. Figure 4 reveals the heart of the console, showing the compact but uncrowded placement of most of the components. The plug-in amplifiers are seen mounted vertically at the bottom of the picture, with the various potted

[4] Olmsted Sound Studios, Inc., 1 East 54th Street, New York 22, New York.

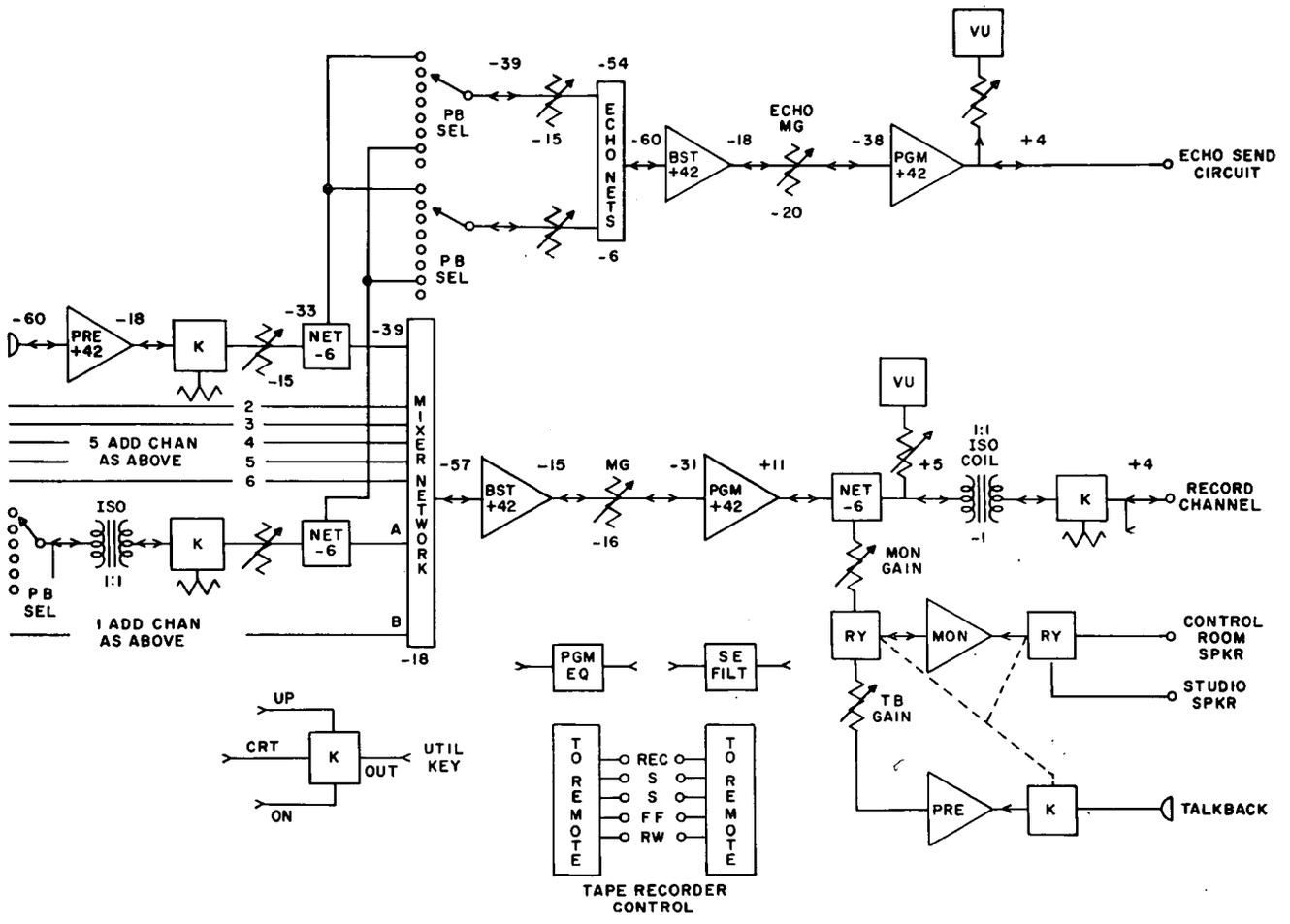

FIG. 3. Block diagram of the console.

mixing and branching networks immediately above. Power supplies and monitor amplifiers are mounted in the base cabinets. All units are highly accessible for service.

The console output coil isolates it from the effects of grounding or unbalance reflected by the input of the various items of equipment which follow it. Since these are almost always the bridging inputs of several tape recorders, the output tie line can be terminated at the remote-facilities rack jack field. Tie lines from this rack also appear on the console jack field.

The console pictured in Fig. 5 was designed for the somewhat more extensive facilities associated with a larger studio devoted to musical production. The physical layout was dictated by space limitations in the control room and the operating engineers' desire for the more familiar, almost vertical, mixer positioning.[5] Again, the single tip-ring-sleeve jacks positioned in the right bay above table level (not visible in the photograph) afford a compact arrangement. Patchcords are short and quite stiff, so that they do not tangle or interfere with mixing operations. Pushbuttons, although proven very reliable, were not used, either for echo selection or remote line selection. Keys and jacks were substituted, with two keys positioned over each mixer attenuator.

Reference to Fig. 6, a partial block diagram, shows that following the mixer attenuators is a transfer key which allows each position to be thrown to either one of two mixing networks, or *off*, in the center position. Following the main mixer network, the circuitry is conventional, returning to line level at the output of the console. However, any position can be thrown at will to a submixer network, which combines, as shown, through a simple branching net, back into the main program channel. This bit of additional operating ease makes it possible, for example, for the operator to key the orchestra microphones so that they feed the sub-

[5] Coastal Recording Corporation, 136 West 52nd Street, New York, New York.

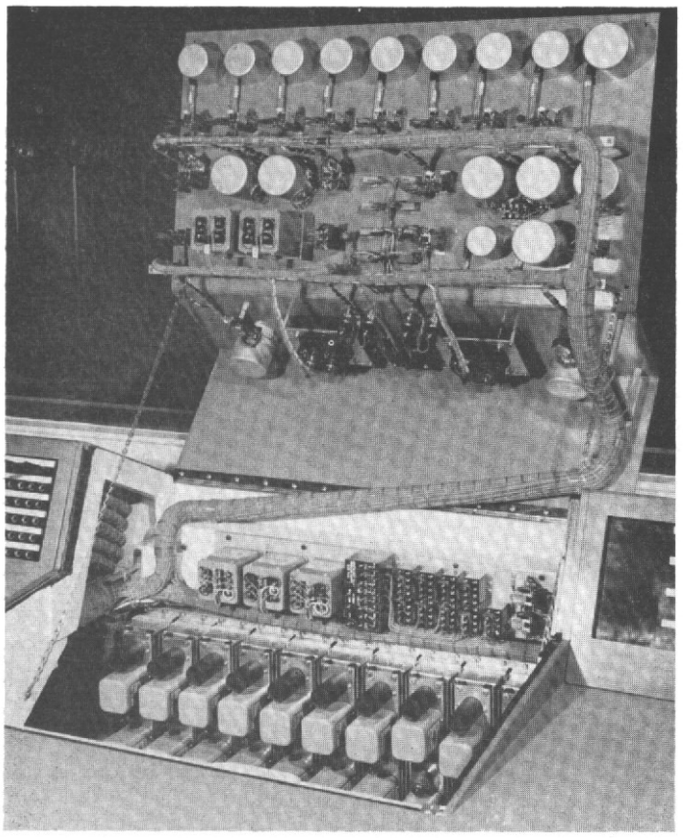

FIG. 4. The heart of the console.

mixer, leaving the main mixer free for solo and chorus control. He need only use the submaster gain control on the accompaniment. This method, although not necessarily ideal, is typical of recording-studio techniques: The philosophy states that a man can do only so much with two hands!

Note that a second output from the submixer net feeds through an isolation amplifier and gain control to one of the echo networks. This provides the means for throwing the entire submixer into or off echo with one key.

Consider the method of echo feed from each of the mixer positions. With the transfer key in the main mixer mode, a bridging coil feeds the echo networks via a cutoff key. With the exception of the echo master gain, the signal feeding the echo chamber is governed solely by the degree of attenuation in the main gain controls. When the transfer key puts a given position on the submixer, gain is still controlled with the mixing attenuator, but echo is controlled—considering the submixer as a whole—as described in the previous paragraph.

Figure 7 illustrates a somewhat more elaborate approach, offering many features of operating convenience normally obtained only by patching in additional, remotely situated facilities.

A microphone input level of −65 dbm was selected as typical of many velocity or pressure-gradient microphones as the ribbon becomes stretched in use. By contrast, modern condenser microphones have such a relatively high output that it becomes fairly simple actually to overload the console preamplifier, unless the amplifier associated with the microphone is padded down ahead of the wall receptacle!

Individual position equalizers raise and lower the spectrum up to 8 db at 100 cps and at 5 kc and are in the circuit at all times. Each microphone, for example, can be "doctored" to produce a "presence" rise or to take advantage of what appears to be a human preference for bass emphasis in music. The rolloff curves, on the other hand, make it possible to compensate for overbassy announcers and for proximity effect with velocity microphones. Excessive condenser-microphone sibilance can be alleviated by means of the high-frequency rolloff.

There is no question but that those of us with backgrounds in flat broadcast transmission systems will raise an eyebrow at the extravagance of position equalizers. Suffice it to say that most recording studios are on the small side, physically; the use of such equalizers as a means of correcting for acoustic deficiencies or providing the client with the exaggerated sound which he feels he needs, turns out to be most convenient. A particular effect can be tried out without wast-

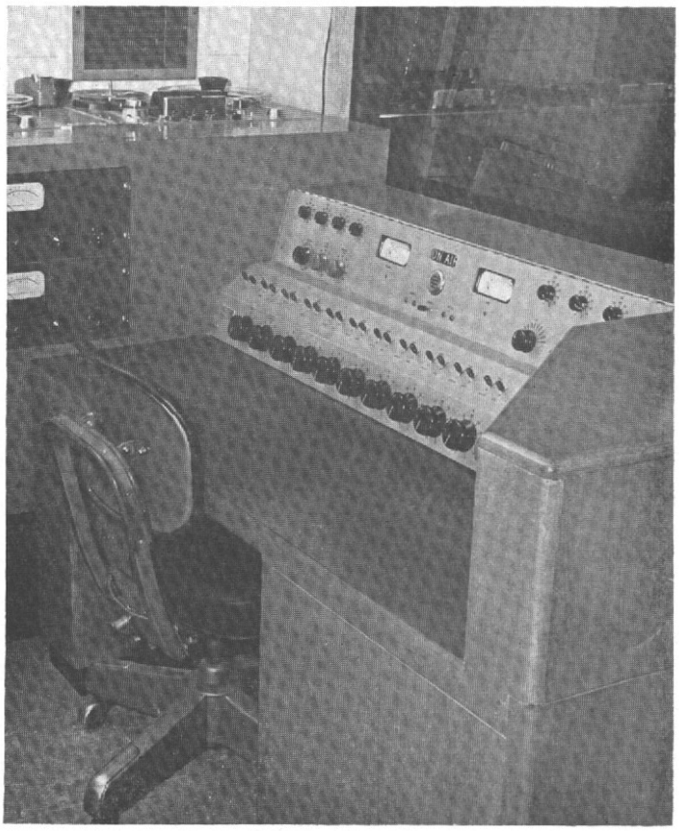

FIG. 5. A console for a larger studio devoted to musical production. Control-room space was limited.

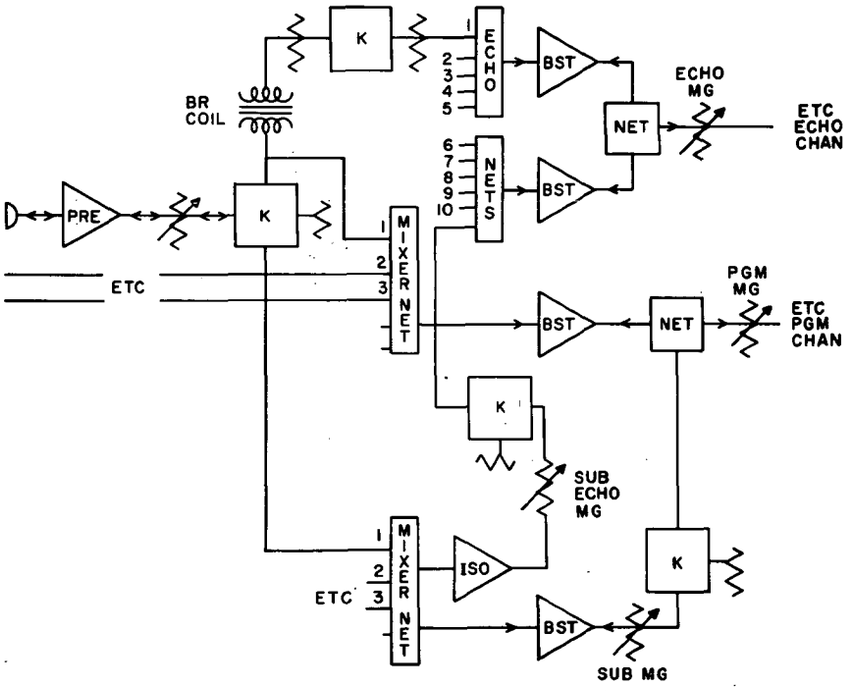

FIG. 6. A partial block diagram of the mixing and echo facilities of the console shown in Fig. 5.

ing expensive talent time while patching.

With respect to the echo facilities, note that a simple branching network makes possible either of two feeds to two different echo chambers, with individual mixing control. Practically everything these days is recorded (or rerecorded) with some degree of echo. With two chambers (one of which might be "tape reverb") the degree of echo used on the vocal can be different in character and time delay from that used on the accompaniment. The accompaniment can be switched to channel 2, via the transfer keys, and channel 2 then becomes a submixer, combined later on into channel 1. Channel 2 can also be used for stereo operation, which seems to be commercially just around the corner. It can be used as a cue channel, for multi-dubbing tape and live talent, or for isolating voice track from orchestra track. By this last means, if, at the end of a session, the client feels that he does not have a satisfactory vocal, he will still have a separate orchestra accompaniment track. The vocal can then be redone at a later date, with cues fed to the vocalist so that he can "sync" with the orchestra track to make the composite.

Note that when any one position is open to echo, all other positions can also feed echo back through the main mixer network and the splitting pads. Because this leakage path is at least 31 db below the desired echo signal, no practical problem exists. An obvious saving is attained by the elimination of bridging coils. Ideally, the Wheatstone Bridge type of splitting pad offers much greater isolation between the branches. However, the requirement for a balancing coil in one of the legs would again bring up the cost, and further isolation appears unnecessary in practice.

The new Unilevel[6] peak-level-control amplifiers (shown on patch facilities) actually may be substituted for the regular program amplifier. Adjustable threshold controls set the point at which compression begins, and some 30 db of gain reduction can be had with unusually low distortion and no "thumping." This device is an excellent tool in the struggle to put more level on a record.

In conjunction with the live recording of talent are the separate but closely related requirements for tape editing. Of course, the regular studio console can be used in the business of editing and dubbing, but any successful studio almost immediately finds a need for a separate editing room. This permits simultaneous operation of both facilities, meaning increased business, but calls for some form of convenient control. A neat and compact arrangement of a typical editing and dubbing console is pictured in Fig. 8.

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[6] Manufactured by General Electric Company, Model 4BA9A/B.

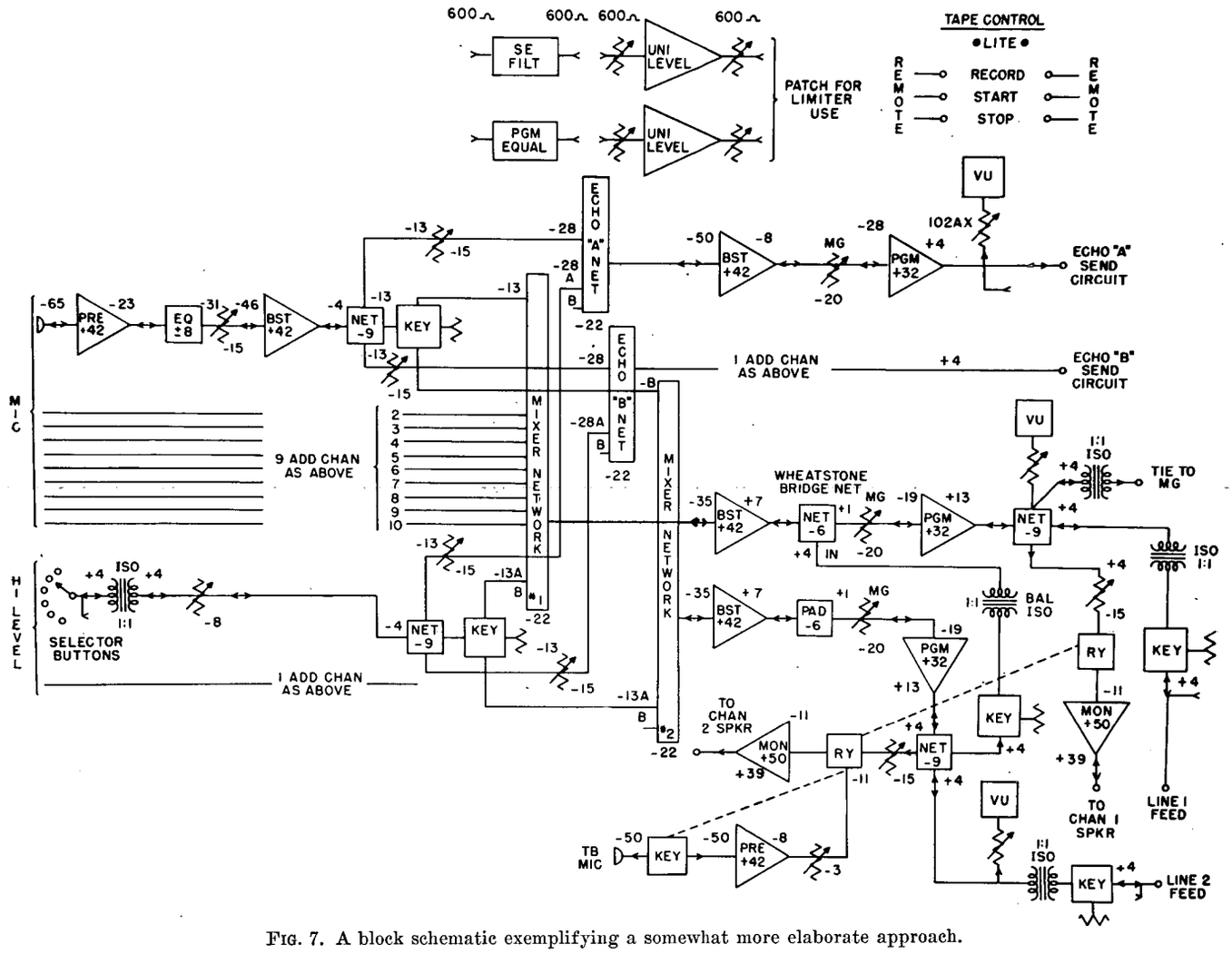

FIG. 7. A block schematic exemplifying a somewhat more elaborate approach.

The operator sits with the controls directly in front of him and with the two basic recorders situated one on each side of him. By simply angling his chair, he can readily reach all three control points. In the arrangement pictured,[7] a third recorder and transcription turntable are positioned behind and to the left. The rack containing amplifiers, jack field, tuners, equalizer, etc., is located at the right, all within reach of a well-oiled swivel chair. Across the control desk sits the production man or client and the ever-present telephone.

The block diagram of Fig. 9 shows the relative simplicity of the few basic components needed to tie the editing facilities together for maximum operating convenience. Three tape machines and the transcription turntable are normalled to transfer keys which feed the main program circuit in the "down" position, are *off* in the center, and feed a simple cueing circuit in the "up" position. The cue monitor is actually a program amplifier,[8] rather than a power amplifier, and produces more than adequate volume for the purpose.

The associated equipment rack contains the TV and FM-AM tuners for off-the-air feeds, as well as amplifiers and power supplies. In this particular installation, the program equalizer is a most versatile new tool, the award-winning Graphic equalizer.[9] The compact control panel for this instrument is at the end of a lengthy cable which allows it to be placed in the most convenient operating position.

[7] Olmsted Sound Studios, Inc.

[8] Cinema Engineering Company, Type 102-AX.

[9] Cinema Engineering Company, Type 7080-A.

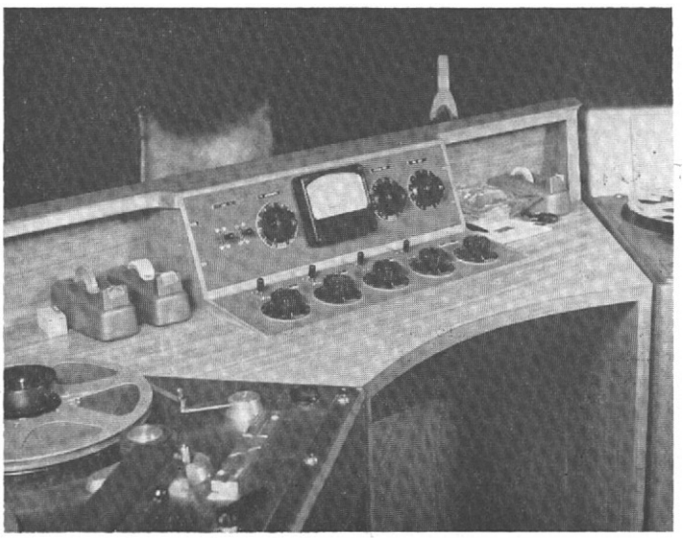

FIG. 8. A console for editing and dubbing.

If the monitor speaker is positioned aloft in a corner-horn type of cabinet, a minimum of standing-wave pattern exists, and critical listening can be done even in this typically small, acoustically treated room.

ACKNOWLEDGMENT

Considerable credit is due James L. Fouch of the Cinema Engineering Company (a division of Aerovox) who was involved intimately in carrying out the exemplary fabrication evident in the larger consoles pictured.

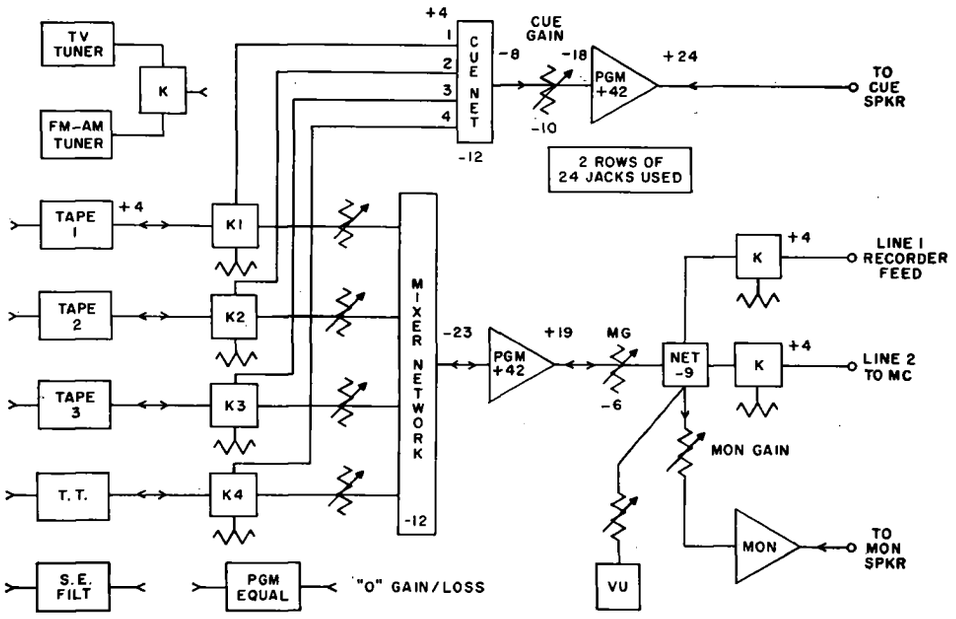

FIG. 9. Block diagram of an editing console.