Design of Recording Systems

PART ONE

A Discussion of the Principles of Design

Basic Audio Units Required

Selecting Equipment

Electrical Arrangement of the System

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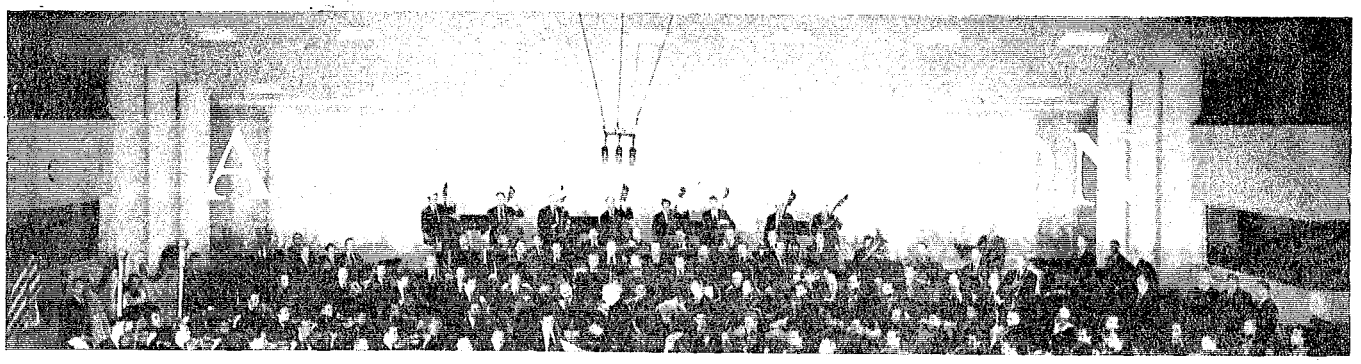

DESIGN OF RECORDING SYSTEMS

THIS DETAILED STUDY REVEALS THAT 14 BASIC UNITS CAN MEET THE INITIAL & FUTURE REQUIREMENTS OF ANY RECORDING STUDIO—*By* LEON A. WORTMAN*

IT is costly to the point of being impractical to design an initial audio recording installation so complete and versatile that it will meet the many special needs that may arise in the course of time. And it is expensive for recording engineers to build their own equipment, even though individual studio requirements vary so widely that custom design is highly desirable.

Recognizing this situation, Fairchild engineers have made an exhaustive study of recording installations now in use, and have consulted a great number of engineers as to their needs and preferences. A subsequent analysis of the information obtained disclosed the fact that recording equipment can be reduced to a series of basic, standardized units which can be combined in accordance with the needs of simple or elaborate systems, offering the advantages of custom design at production-level prices.

Our study showed that any installation, small or large, can be built from combinations of some or all of 14 basic units.

Basic Units of Equipment:

While there might be a difference of opinion concerning some of the units listed below, it must be borne in mind that our selection was weighted by consideration of two important factors. These are the desirability of avoiding 1) obsolesence of initial units as studio facilities are expanded, and 2) loss of initial investment resulting from such obsolescence.

Here is the list of units drawn up at the conclusion of our study:

1. Power Amplifier
2. VU Panel
3. NAB Equalizer
4. Input Switching Panel
5. Output Switching Panel
6. Mixer Panel
7. Preamplifier
8. Auxiliary Power Supply
9. Line Amplifier (booster and monitor applications)
10. Diameter Equalizer
11. Pickup Preamplifier-Equalizer
12. Cuing Amplifer
13. Bridging Device-Isolation Amplifer
14. Variable Equalizer

To check the versatility of installations made up from these units, let us examine the needs of typical recording studios.

Basic Studio Requirements:

For purposes of explanation let's assume that our first requirements are for single-channel recording from a line level source such as a radio tuner. The unit common to all installations is the amplifier supplying power to the cutterhead. Many amplifiers deliver insufficient power at frequencies below 70 cycles and above 4,000 cycles. In order to gain driving power at these important low and high frequencies, some amplifiers have been designed with as high as 50 watts output *at the middle frequencies*. A 30-watt amplifier with constant power output over *all the frequency range* is adequate and is much more desirable from the economy standpoint. The power amplifier should have its own gain control for setting audio levels, or for riding gain on a single channel. Such a fundamental installation, including a means for measuring the audio level fed to the cutterhead, is indicated in Fig. 1.

Now, if it is desirable to record from a low-level source, such as a microphone or pickup, an input switching panel with a built-in preamplifier is recommended because of its versatility. This can be a compact, rack-mounted device containing a preamplifier with a switch to select audio from a variety of sources. These inputs would include microphones, pickups, and a zero-level line. When the input selector switch is in the LINE position, the preamplifier is bypassed.

Purpose of NAB Equalization:

The materials of which the recording disk are composed include relatively rough particles. The effect of these particles in contact with the reproducer stylus is one of objectionable noise. The characteristics of constant-velocity recording are such that the energy put on a disk decreases as the frequency of the recorded signal increases. As a consequence, the ratio of signal to inherent noise decreases at the higher end of the audio spectrum. If the sound energy put on a disk is deliberately increased in direct proportion to the frequency of the recorded signal, it is possible to maintain a nearly constant ratio of signal-to-noise over the entire audio spectrum. The NAB Recording and Reproducing Standards Committee proposed that, in order to produce disks with a high signal level above the inherent noise, the frequencies above approximately 1,000 cycles have a rising characteristic. It was proposed that a 10,000 cycle signal be 16 db higher than a 1,000 cycle signal. With the adoption of this standard, it was possible to design a simple and inexpensive equalizer that can be inserted in the audio line to produce this characteristic curve automatically. By recording with this rising characteristic and playing back with a complementary equalizer to attenuate the high frequencies between 10,000 and 1,000 cycles by a like amount, the signal-to-noise ratio is maintained at higher frequencies and the recorded program material is reproduced exactly as the

* Technical Data Division, Fairchild Recording Equipment Corporation, Whitestone, Long Island, New York.

original. An NAB equalizer, inserted ahead of the power amplifier, meets this standard. The equalizer can be quite compact, mounting in a rack panel space as small as 1¾ in. A switch is needed to permit instantaneous insertion and removal of the equalizer from the electrical circuit. Passive equalizers necessitate insertion losses. If this insertion loss cannot be tolerated, an additional booster amplifier is required.

Adding Another Channel:

Let's now expand our facilities to feed two recorder channels, for simultaneous and segue (continuous) recordings. Figs. 2A and 2B diagram two installations which accomplish these objectives. Fig. 2A is the more elemental. It can be expanded to the installation shown in Fig. 2B with some interesting advantages. The second installation allows complete control of the audio levels and of the program material being fed to the separate recorders. Two completely different programs or an original and a safety disk of the same program can be cut at the same time. Installation 2A limits the facilities to recording one program at a time. The output switch panel indicated in Fig. 2A serves the functions of the VU panel in Fig. 1. A four-position switch permits instantaneous transfer of audio from the power amplifer to cutterheads 1 and 2 singly, cutterheads 1 and 2 simultaneously, or to a line. The output switch panel includes a VI meter, meter attenuator and vernier calibrator, a gain control for the monitor loudspeaker fed from an auxiliary winding on the output transformer of the power amplifier, and a phone jack mounted on the panel. Plugging a headset in the jack automatically silences the loudspeaker.

Many recording installations require the simultaneous operation of multiple input channels. Adding a mixer panel provides for combining audio from any desired number of signal sources. A separate gain control is used on each signal source for mixing and balancing the separate signals. A master gain control for setting the over-all level and fading is part of the unit.

Multiple-Channel Mixing:

A representative installation for multiple-channel mixing is shown in Fig. 3. The number of channels can be increased or decreased to suit the individual requirements. The input channels may be wired for impedances of 50, 150, 250, 500, or 600 ohms. Each preamplifer consists of a 2-stage, single-ended, fixed gain amplifer.

To allow complete and rapid interchangeability of preamplifiers, audio and power wiring should terminate in multicontact connnectors, with one part secured to a fixed mounting tray and the other on the amplifer assembly. To eliminate hum, the power supply for the preamplifers should be external to the units. An auxiliary power supply, designed as a basic unit for our recording

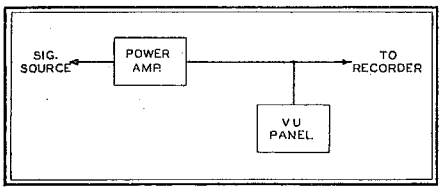

Fig. 1. The basic single-channel circuit

systems, should deliver 300 volts DC up to 210 ma., 6.3 volts up to 8 amps., and a bias of 12 volts DC on the filament supply for further hum reduction. A selenium rectifier is recommended because it eliminates the danger of a vacuum tube rectifier filament burn-out which would disable the entire system. This calls for a three-section, heavy-duty filter to provide virtually pure DC output from the high voltage rectifier.

In installations using line connections between the points of origin and the studio, Fig. 4, experience demonstrates that hum and noise pickup in the line may cause a severe reduction in dynamic range. In such cases, suitable pads and

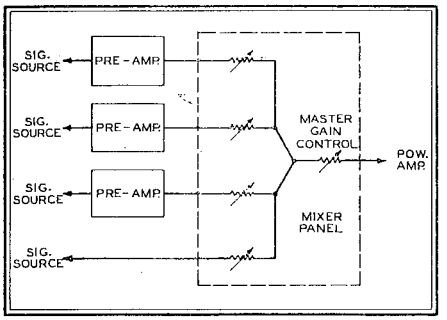

Fig. 3. Setup for multiple channel mixing

booster amplifiers are indicated. Such boosters, or line amplifiers, must have sufficient gain to overcome line-pad losses, and sufficient power-handling capabilities to accommodate program peaks without overloading.

These units, indicated as line and monitor amplifiers in Fig. 4, should have over-all gains of 50 db in order to feed +22 db into the program line with less than 1% distortion from 30 to 15,000 cycles. About 8 watts output is needed for the monitor speaker. By using the same type of amplifier for line and monitor functions, one of these units can act as a spare for both purposes.

The output switch panel specified for Fig. 2A is ideally suited to the type of installation shown in Fig. 4. The control room operator can select any one of three lines for audio feed. A practical example: one line feeds the recording room, a second line feeds a monitor speaker in the studio, and the third line feeds a monitor speaker in the audition lounge. Two of the lines can be fed simultaneously. When checking a playback recording, simply selecting the proper position on the output switch automatically feeds the audio to the audition lounge for sponsor's appraisal, and to the studio loudspeaker for artists' appraisals. The control room monitor speaker is operative at all times and has its own gain control. The monitor

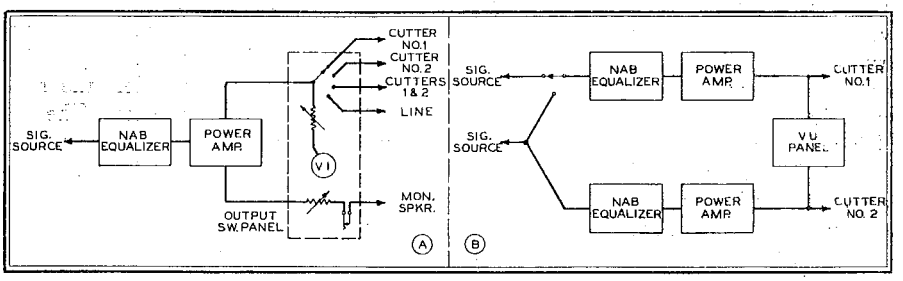

Fig. 2. Here are alternate arrangements for feeding two recorder channels

gain control, headset jack, VI meter and meter attenuator are all mounted on one panel with the output selector switch.

Diameter Equalization:

In recording from outside to inside of a disk, losses in reproduction increase as the diameter decreases. This effect increases at the higher frequencies and varies with disk velocity, making diameter/frequency equalization desirable at 33 1/3 RPM. By increasing the high-frequency input as the cutterhead moves toward the inside diameter, this loss can be overcome. A 10,000 cycle signal should be 8 db higher than a similar 1,000-cycle signal at the inner diameter.

An automatic device with predetermined correction is included in the list of basic units for the recording system.

The proper place to insert the diameter equalizer in the recording channel is shown in Fig. 5.

Equalizing Pickups:

The professional recording installation includes playback equipment for auditions, dubbings and special effects. With the numerous types of pickups needed to reproduce the present variety of commercial and instantaneous disks, the cost of supplying each pickup with an equalizer has increased equipment costs

heavily. Equipment investments can be reduced by eliminating the need for separate equalizers, and making one equalizer serve all the pickups.

A preamplifier and equalizer that are independent of source impedance can be combined in one basic unit. Any constant-velocity pickup vertical, lateral, microgroove, or standard regardless of its impedance, can be operated directly into the input of such a unit without affecting the frequency characteristics of the pickup itself. Equalization can be accomplished after a built-in stage of preamplification, isolating the pickup from the equalizer itself. Since equalization is achieved at comparatively high audio level, hum pickup often encountered in passive-losser equalizers is avoided. The output of this basic unit should be at mixer level to eliminate the danger of hum and noise pickup in the audio wiring between the pickup and the mixer console. It is best to mount it inside the turntable cabinet, upright, with the equalization selector switch protruding through the turntable deck in a position convenient to the operator. If properly designed, there is no danger of hum pickup from the turntable drive motor. The use of DC filament voltages overcome another common source of hum pickup. RC equalization results in smooth curves, free from resonant peaks within the usuable audio spectrum. A 6-position selector is adequate to give a wide choice of vertical and lateral equalization curves.

To provide a means for cuing the disks on the playback turntable, a small 2-stage, push-pull amplifier capable of feeding 3 watts of audio to a loudspeaker is more than adequate. With a 10,000-ohm input impedance through a bridging transformer, it can be connected across any low impedance line, such as the output of the preamplifier-equalizer, without reflecting a mismatch. A popular custom is to mount the cuing loudspeaker on the front access panel of the turntable cabinet. A switch in series with the voice coil is required to silence the loudspeaker during the actual playback.

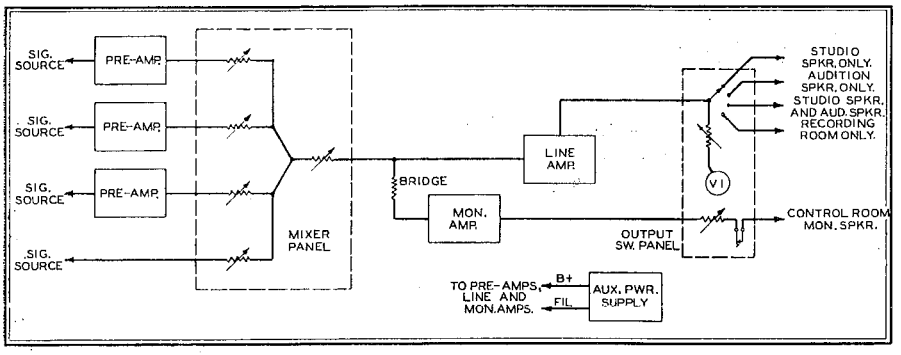

Fig. 4. An installation which provides for the use of three incoming audio lines

Patching Circuits:

It is often necessary to feed more than one circuit from a signal source. It may also be desirable to lift one of the circuits at will. This lifting and inserting, or patching, of one or more circuits can be acomplished without upsetting audio levels or impedances by the simple expedient of bridging or circuit-isolating pads. The diagram of a control room installation in Fig. 4 shows such a

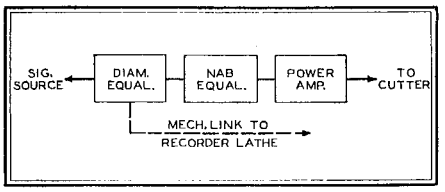

Fig. 5. Inserting a diameter equalizer

pad between the input to the monitor amplifier and the output of the mixers. Since it may be desirable to patch the monitor amplifier for some other purpose, the output impedance of the mixers should be matched to the input impedance of the line amplifier, the more important of the two circuits. The pad absorbs an extremely small amount of power from the audio circuit and affords electrical isolation between the monitor and recording channels.

Bridge pads are losser circuits. Losses of 25 db in such pads are not unusual. If the requirements of the system are such that the loss cannot be tolerated, the use of another basic unit, a bridging device, is indicated. This is a single-stage, push-pull, fixed-gain, isolation-bridging amplifier. It must operate from source impedances of 600 ohms or less without reflecting a mismatch. The gain of the amplifier compensates for the loss in the bridge. Both the bridging and amplifying components can be combined in one very compact assembly.

Dubbing Methods:

Dubbing has always been a bugaboo that most recording engineers would rather not have to face because of the unusual equalization problems often involved in the process. For example: a record manufacturer obtains a stock of old originals and masters from another company, and decides that time is opportune to re-issue them. However, the disk originals were made in the infant days of the recording art, and may have poor tonal quality, poor bass response, or deficient high response.

Each dubbing presents an individual problem to the recording engineer whose conscientious ambition is to make the new release as perfect as the state of the art will permit.

Also, in recording original music, the recording engineer, musical director, or other person supervising the audio quality may desire heavier bass or middle register, or more brilliance than is obtained by natural studio acoustics. These conditions all indicate the need for a versatile equalizer that can selectively boost or attenuate various portions of the audio band simultaneously. Such a variable equalizer is not required to deliver power or voltage amplification. It is essentially a zero gain device. All signal amplification is achieved by other elements in the recording system. The variable equalizer must deliver, through continuously variable controls, a broad peak at any of the bass frequencies from 20 to 100 cycles and at any of the treble frequencies from 4,000 to 10,000 cycles. Not only must it be possible to select the frequencies at which equalization is to take place, but the degree of equalization must be adjustable in amplitude from zero (flat response) to a maximum boost of 16 db. Separate controls are needed for roll-off of low and high frequencies, and there must be no interaction between the high and low frequency controls. Such a basic unit finds wide application in professional recording.

Vertical and lateral NAB standards, private standards, broadcast audio line equalization, elimination of distorted and noise spectra, pre-emphasis and de-emphasis are all controllable for recording and playing back with the one variable equalizer unit. By mechanically linking the cutterhead with a potentiometer that is electrically connected to the variable equalizer, this unit can be used as an automatic diameter-equalizer. This technique provides the unusual control of both equalization frequencies and maximum boost level. Input and output gain controls allow for handling signals of various levels, and a magic eye on the front panel makes it possible to set the optimum input level for distortionless operation.

The next part of this series will discuss and illustrate specific professional recording installations, and how they have made use of the unitized amplifier system.

Design of Recording Systems

PART TWO

A Detailed Description of A Commercial Recording Studio Composed Entirely of Unitized Audio Equipment

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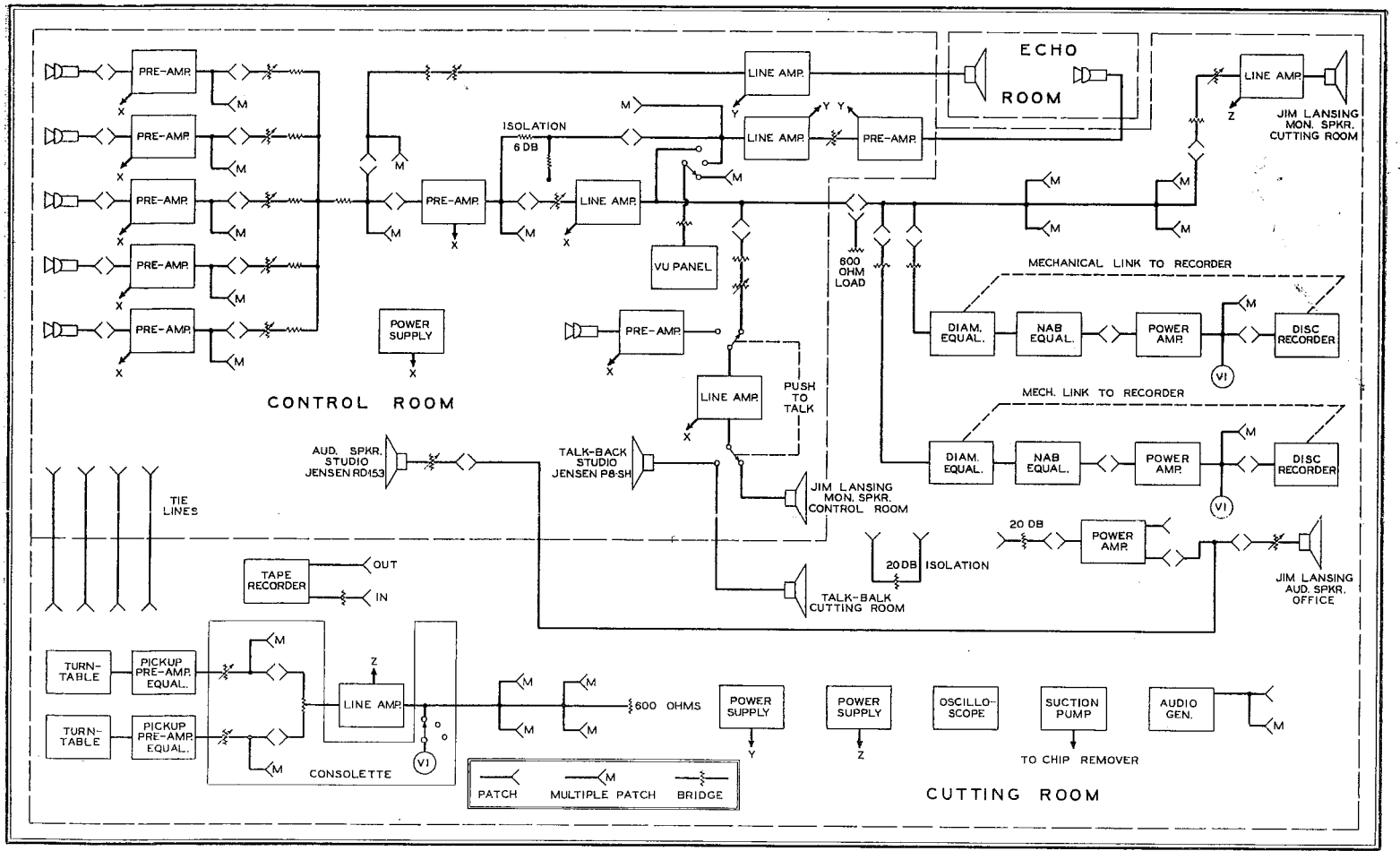

Fig. 3. This block diagram shows the distribution of equipment employed in the control room, cutting room, and echo chamber

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DESIGN OF RECORDING SYSTEMS

PART 2: THIS DETAILED DESCRIPTION OF A COMMERCIAL RECORDING STUDIO SHOWS THE VERSATILITY OF UNITIZED EQUIPMENT—*By* LEON A. WORTMAN*

LAST month, the author discussed the 14 basic elements of professional recording installations. Part 2 undertakes to show how these 14 units, represented in Fairchild recording equipment, can be arranged in a typical commercial studio. The installation shown in the accompanying illustrations called for complete equipment for cutting original and master disks, instantaneous audition disks, and dubbings to afford a program service for commercial broadcasters. Extremely versatile facilities were necessary, since the programs were to include dramatic presentations, comedy, musical variety, disk jockey, and personality interviews, ranging from 5 minutes to 1 hour in length.

In such an installation, program material must be recorded on both tape and disks: tape, so that the program material can be edited for time and context; disks for cutting masters of the program material originally recorded on tape. The character and variety of the programs require multiple-channel mixing of sound effects, voices, and music. This installation, therefore, represents an excellent example of unitized design application because of the extreme degree of flexibility required.

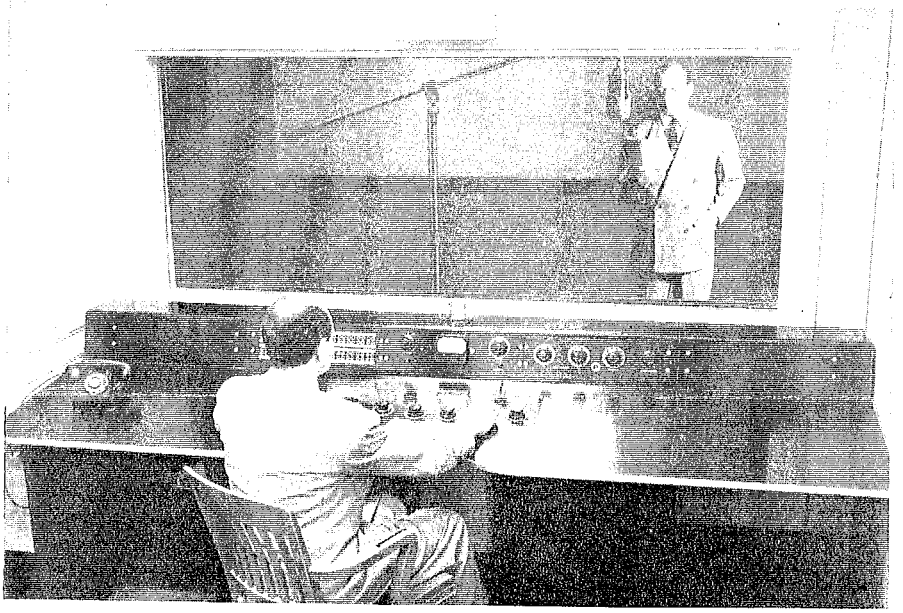


Fig. 1. Arrangement of the control room and studio A. The author is at the mike

*Technical Data Division, Fairchild Recording Equipment Corp., Whitestone, N. Y.

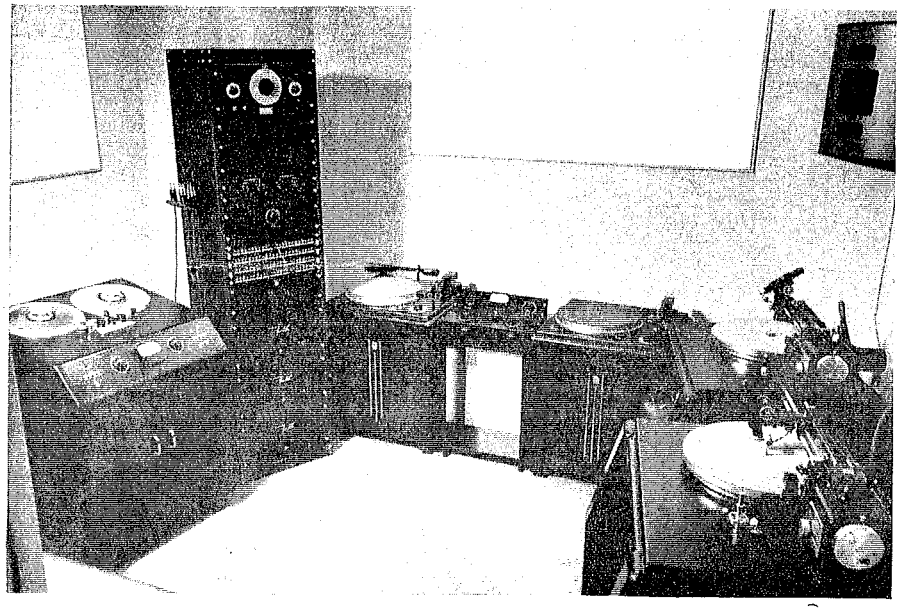


Fig. 2. Cutting-room equipment, in the form of a U, facilitates one-man operation

Plan of the Installation:

Floor space was acquired for the construction of 2 studios, a control room, cutting room, echo chamber, library, offices, and storage space. Studio A, 26 by 30 ft., is used for musical and dramatic shows. Utility studio B, for interviews and disk jockey shows, is 15 by 12 ft. Ceilings are 15 ft. high. Wall and ceiling panels of 3-in. Fiberglas are covered with Monk's cloth. Doors are felt lined and sound-trapped.

The control room, 11 by 11 ft., is shown in Fig. 1. This is adequate for a combination operator's console and producer's desk, with seating facilities for observers. The window separating the control room and studio A is constructed of 2 panes of glass at non-parallel angles, to break up sound reflections and increase the effective acoustic isolation between the two rooms. The felt strips on which the thick glass panes are mounted practically eliminate sound conduction.

The cutting room, Fig. 2, is adjacent to the left wall of the control room. A small 2-pane glass window provides visual communication between control and recording engineers.

Fig. 3 is a block diagram of the complete installation. It should be noted that the entire facilities are made up from the basic equipment units previously described. All preamplifiers, booster and power amplifiers, and power supplies are stock items. The mounting trays and panels for the basic plug-in units require no more than inter-wiring. The only deviations from standard Fairchild production equipment are the control room console and the small consolette between the turntables in the cutting room.

Control Room Equipment:

The control room is equipped to mix audio from five separate signal sources simultaneously. The operator, seated at the console, has all controls and the patch board within arm's length. The table surface is at a slight incline, with the mixing controls mounted on a steel panel at the center. The operator, by pivoting his forearm, can easily handle the 5 mixing controls and master atten-

uator. The VU meter panel carries the master AC switch for the audio equipment. On the same panel is a lever type switch for actuating the talkback circuit. This switch energizes two relays. One transfers the input of the control room monitor amplifier to the output of the talkback microphone preamplifier. The other relay transfers the output of the control room monitor amplifier to the cutting room talkback speaker and to a talkback speaker in studio A.

The VU meter can be transferred, through the patch board, and inserted across three audio lines. A 3-position switch immediately to the left of the meter enables instantaneous VU readings of the three audio channels. The panel to the right of the meter panel carries the gain controls for the input and output audio channels of the echo chamber, control room, and studio monitor loudspeakers. The panel to the left of the meter panel carries the patch board jack strips.

Fig. 4 shows a section of the cabinet space of the console table with the front access door removed. All units plug into the mounting trays, which, in this installation, are mounted on three levels. Details of the trays and plug-in units are shown in Fig. 5. The top level contains the line or output amplifier for the console, which feeds the cutting room. Beside this is the talkback microphone preamplifier and another output amplifier which doubles as the talkback power amplifier and the control room monitor amplifier. The two talkback relays and a loudspeaker matching transformer are also located on the top tray.

The middle tray contains the echo chamber audio channel, comprising two preamplifiers and two line amplifiers. The bottom level carries the power supplies, illustrated in Fig. 5, for the audio equipment in the control room. Fig. 4 shows one of the units removed to demonstrate the plug-in method. The 5 microphone preamplifiers for studio A and the talkback microphone preamplifier are all of the type illustrated in Fig. 5. They plug into one mounting tray in the console cabinet. Fig. 3 indicates the extensive patch system provided for the control room.

On the wall above the observation window are signal lights for standby and go-ahead cues. In addition, telephone communication is provided between the cutting room, control room, and offices.

Cutting Room Installation:

Four tie lines connect the control room with the cutting room, Fig. 2. However, as Fig. 3 indicates, the audio rack in the recording room can be operated for cutting purposes independently of the control room audio equipment. The advantage of this plan is the realization of the most efficient use of studio and electrical equipment from the time standpoint. For example, a program cast can be rehearsed under the ideal conditions of production from the control room monitor, while the cutting room is being used for editing, dubbing, and cutting program material previously recorded.

The equipment is arranged in a U, to facilitate one-man operation. Along the right wall are two disk recorders, shown in detail in Fig. 6. These units operate at 78 or 33 1/3 RPM. The feed-screw drive mechanism is unusual, in that it affords continuous and instantaneous variation of cutting pitch from 80 to over 500 lines per inch. Thus, standard and microgroove disks can be cut on one machine, and inordinately high average audio levels can be handled by varying the cutting pitch with relation to the modulation level, decreasing the number

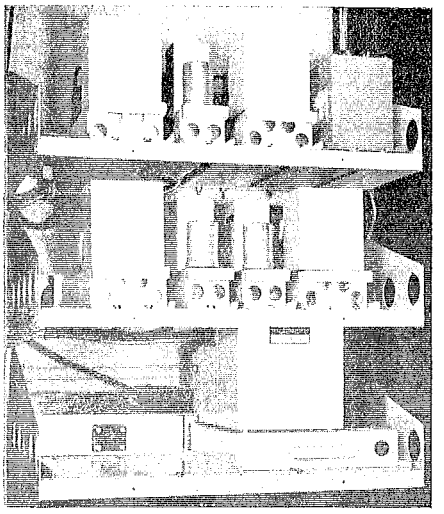


Fig. 4. Plug-in units under control desk

of lines per inch as the audio level increases, thereby avoiding overcutting. This method, rather than closely riding the gain control and destroying the natural dynamic range, results in transcribed programs that delight the critical listener, and gain much in signal-to-noise ratio.

The tape recorder, at the left side of the room, has input and output gain controls and a VU meter conveniently mounted on the sloping front panel. Along the back wall are two transcription turntables. Pickups with 1-, 2.2- and 3-mil stilii are provided for the continuous dubbing of transcribed programs in two or more parts. Mounted on the top of each cabinet is a preamplifier-equalizer. The arrangement can be seen in Fig. 7. Fig 8 shows the complete unit.

The line level output from the playback tables is used to an interesting advantage. A mixing consolette was constructed and placed between the two turntables. Each output is brought up to this consolette and fed to a variable

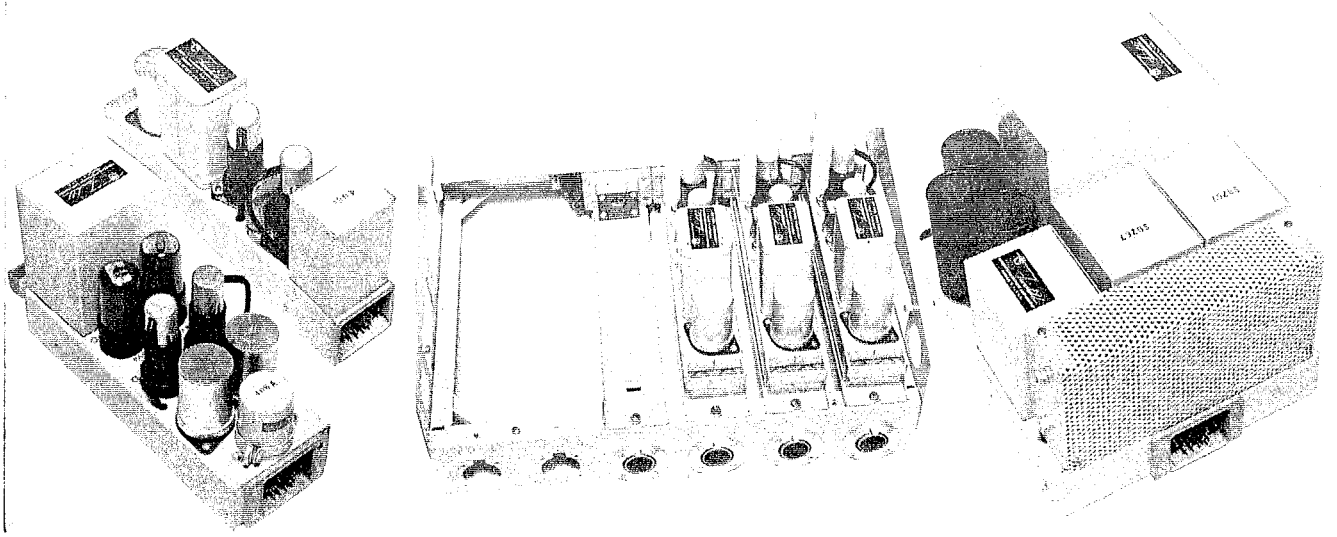
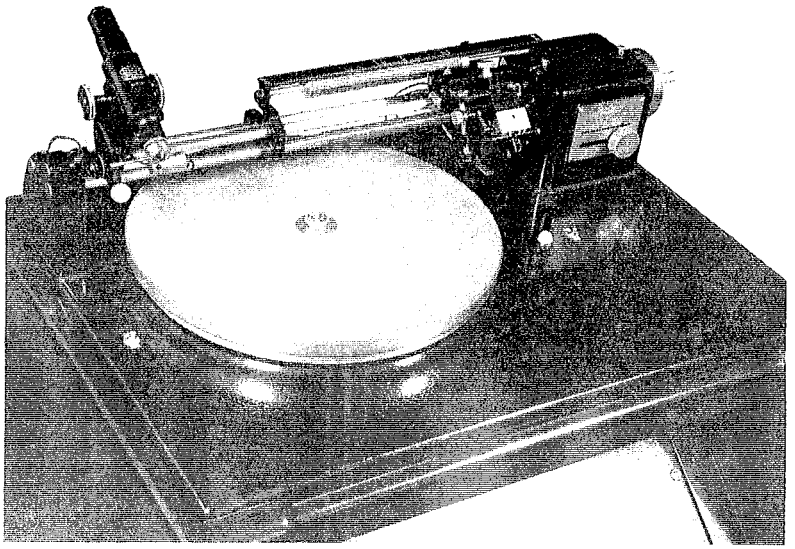


Fig. 5. Fairchild plug-in units, left to right, model 623 line amplifier, 621 preamplifier, plug-in mounting, and 632 power supply



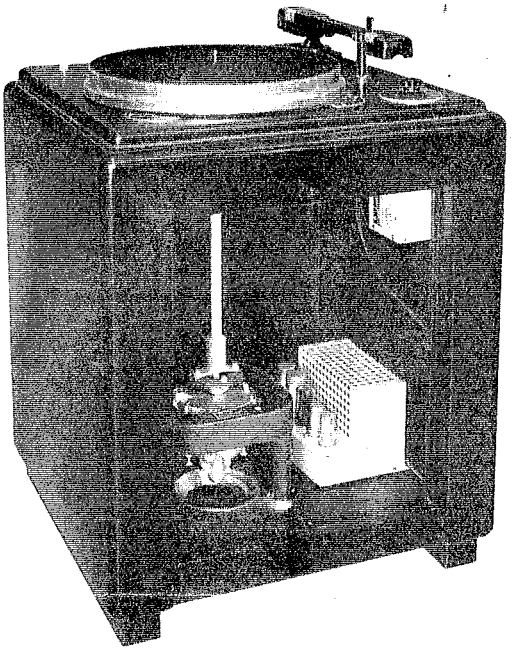


Fig. 6. The Fairchild model 523 recorder provides instantaneous and continuous variation of the cutting pitch. Fig. 7. Transcription turntable has a preamplifier-equalizer at the front right corner of the cabinet

attenuator. The variable attenuators feed a line amplifier, the output of which can be patched to disk recorders, tape recorder, or monitor channels, singly or simultaneously. A volume indicator meter, calibrated in VU and mounted on the consolette, permits the precise adjustment and equalization of audio levels from the output of the pickup preamplifier-equalizers. The method of interconnecting can be seen in Fig. 3.

Two power amplifiers, Fig. 9, are mounted in the audio rack. They feed the cutterheads of the two disk recorders. A third power amplifier, mounted in the same rack, can be patched as a spare recording or monitoring amplifier channel in any emergency. An isolation pad is normalled through the input of this utility amplifier so that it can be inserted across any channel without upsetting impedances or levels.

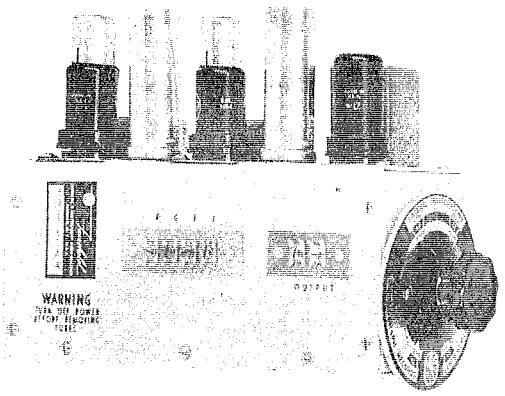
Automatic diameter equalizers and NAB equalizers are incorporated in the system, with in-out switching brought to a convenient panel on the cutting room rack. The block diagram, Fig. 3, shows that recording channels for the disk and tape recorders have bridging inputs. Each input and output channel normals through patch terminations. Thus the input of any channel can be lifted, transferred to, and inserted across another circuit without upsetting levels or impedances. Multiple, or paralleling jacks are used extensively.

The cutting room monitor amplifier is the same type of unit used as a booster amplifier for the playback turntable pickups and control room line, monitor, and talkback circuits. With an overall gain of 50 db, an output capability of 8 watts, and response of 30 to 15,000 cycles ± 1 db, this unit proves its versatility in an installation such as this one.

An auxiliary power supply, Fig. 5, for the cutting room monitor and pickup line amplifiers mounts in the audio rack. A rack-mounted audio generator, with its output terminating at the patch board, provides an ideal means for audio-level reference adjustments. Four pairs of shielded cables, terminating at the cutting room patch board, and at the control room patch board, are provided as utility and spare interconnections. The cutting room monitor loudspeaker is a Jim Lansing D-1001 woofer-tweeter, while the talkback monitor loudspeaker for aural communication and cueing from control room to cutting room, is a Jensen P8SH in an H-81 enclosure.

It seldom happens that any two installations for recording studios are just alike. However, the foregoing description indicates the unlimited possibilities of adapting the same basic units of equipment to any specific requirements.

The third and concluding part will describe another installation of an entirely different sort, in which the same equipment is employed.



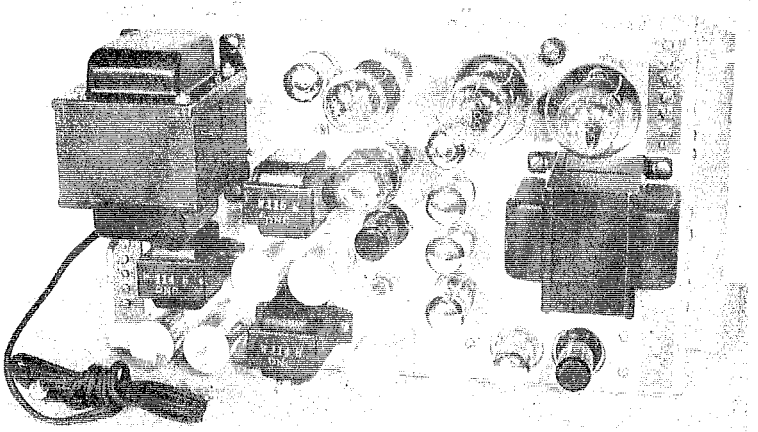


Fig. 8. A preamplifier-equalizer is mounted on each turntable cabinet. Fig. 9. Power amplifier used to feed the cutter head

Design of Recording Systems

PART THREE

Describing One of the Largest Recording and Re-recording Installations in the United States

As Published in FM and Television

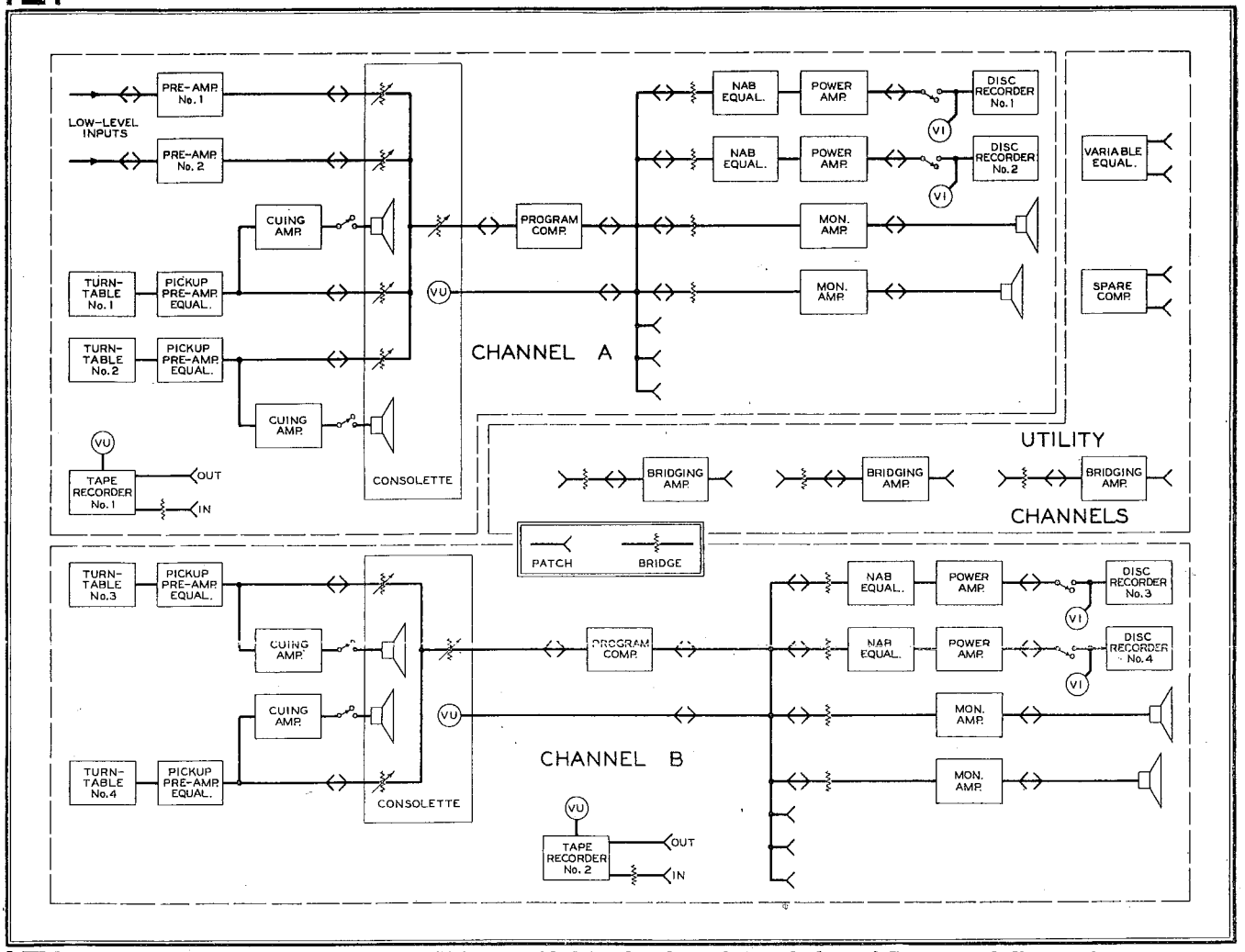


Fig. 6. Block diagram of the facilities provided in the channel A and channel B tape and disc cutting rooms

Fairchild

RECORDING EQUIPMENT CORPORATION

154TH STREET AND 7TH AVENUE, WHITESTONE, L. I., N. Y.

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DESIGN OF RECORDING SYSTEMS

PART 3: A DESCRIPTION OF THE REEVES SOUND STUDIOS INSTALLATION, THE CONCLUDING DISCUSSION OF UNITIZED EQUIPMENT—*By* LEON A. WORTMAN*

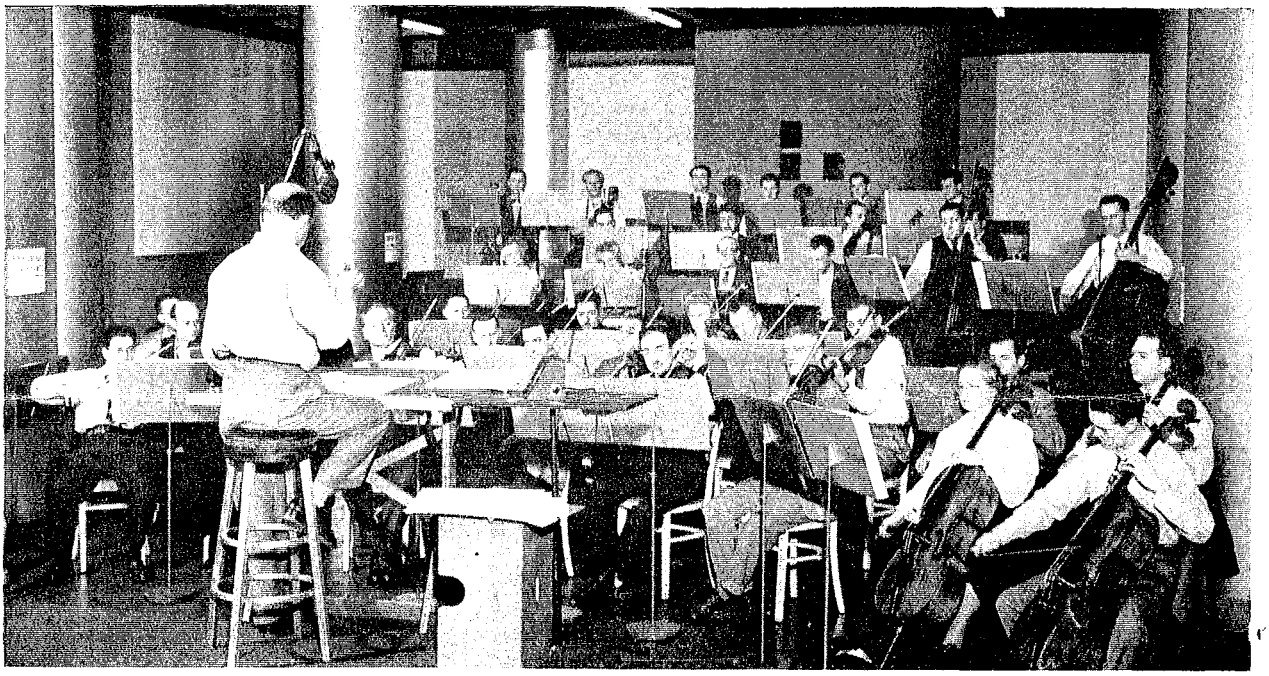


Fig. 1. Reeves Studio B, showing the setup for recording the Philadelphia Philharmonic Orchestra, Eugene Ormandy conducting

ONE of the most interesting sound recording operations in the United States is located at 304 East 44th Street, New York City. The five floors of this building, occupied by Reeves Sound Studios, are devoted to film, disc, and tape recording, operated on a 24-hour schedule. This installation, because of its magnitude, has been selected as the second example of the application of unitized audio equipment, and its adaptability to both conventional and special operating requirements of sound studios.

*Technical Data Division, Fairchild Recording Equipment Corp., Whitestone, N. Y.

TV, Film, and Sound Studios:

The first and second floors of the Reeves building are devoted principally to sound studios. Studio A, used for producing television and theatre films, is 60 ft. deep,

Fig. 2. Studio A console. Fig. 3. C. Robert Fine, chief engineer of Reeve's tape and disc division, in the channel A cutting room

54 ft. wide, and 30 ft. high. An elaborate profusion of cameras, lights, microphone booms, and props is in evidence there.

Studio B, on the second floor, is one of the largest in the country devoted to the sole purpose of recording musical groups. The back wall is 79 ft. from the observation window of the control room. Fig. 1 does not indicate the actual size of the studio, for it is actuallly 55 ft. wide and 15 ft. high. This photograph shows the setup for recording Robert Flaherty's "Louisiana Story," with Eugene Ormandy conducting. In this case, the conductor is facing the rear of the studio. Many of the scores for motion picture film are recorded there, and much of the music that is processed and pressed for broadcasting and home reproduction.

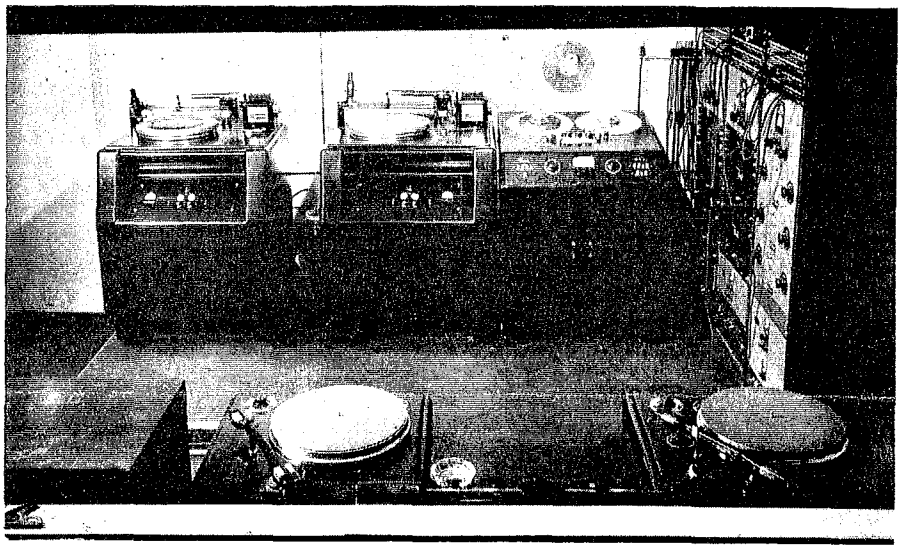


Fig. 4. Tape and disc recording equipment and turntables in channel A cutting room

When a film is being scored, the motion picture is projected on a screen above the control room observation window so that the music conductor can synchronize sound and picture. An acoustically-isolated projection booth, shown in Fig. 1, is located at the rear. The control room is as large as the average broadcast station studio, measuring 30 by 18 ft. Complete monitoring facilities are provided at the control console, Fig. 2. Standard VU meters and an oscilloscope are built in across the top. One VU meter indicates average audio levels, while the 'scope accurately reveals the peaks. The second VU meter indicates the degree of compression, when the program-compressor is utilized. In order to simulate as nearly as possible actual theatre listening conditions, an Altec A-4 theatre speaker is mounted against the far left wall of the control room, covered by the heavy drapes which can be seen in Fig. 2. The control room monitor amplifier to drive the speaker is mounted in the control console.

On the third floor are Studio C, called the mixing theatre, and the film recording facilities. Final production for movie shorts, trailers, and travelogs is done in Studio C. All sound sources originating on disc, tape, or film are mixed here for the final sound tracks. The technicians work at a console as they watch the motion picture projected on a screen at the far end of the studio wall. The studio is designed to simulate the acoustics of the average theatre. Also located on this floor are the film vaults, 14 master film dubbers, numerous 16-mm. and 35-mm. optical recorders, dark rooms, and cutting rooms.

Tape and Disc Recording:

Two narration studios, for voice-track recording, and the tape and disc recording facilities, Figs. 3, 4, and 5, have been installed on the fourth floor. Fig. 6 gives a block diagram of the equipment. The operating staff refer to these rooms as channels A and B. Equipment for each studio is practically identical, comprising two transcription turntables for dubbing, a compact mixing board, and a compressor feeding a program bus. Bridged across the bus are two monitor amplifiers for the loudspeakers, and two power amplifiers feeding the studio recorders. Each channel includes a tape recorder. These are not normalled through, but terminate at the patchboard. Since the audio input for the tape recorder must be at the program bus level, bridging input is used to make the unit a completely self-contained recording channel.

Input and output connections of all units, including the recorders, turntables, amplifiers, and speakers, terminate at the patchboard shown in Fig. 3. However, a normal through arrangement of these terminations is such that, with all patch cords removed, the facilities are connected automatically for dubbing from the transcription turntables to the recorders.

The only difference between the two channels is that channel B console contains two turntable fader controls and one master gain control. Channel A consolette has four faders and one master control. The two additional faders are at the output of preamplifiers for any condition that might require the use of microphones or other low-level equipment in the recording room.

These facilities are in great demand in the film and record production industries. Many of the musical scores for television and motion picture films are recorded at the Reeves studios. For example, the photograph of the Philadelphia Philharmonic Orchestra, Fig. 1, was taken during the actual recording of the musical score for "Louisiana Story." Disc and tape recording was done on channel B equipment, and played back for the director's approval.

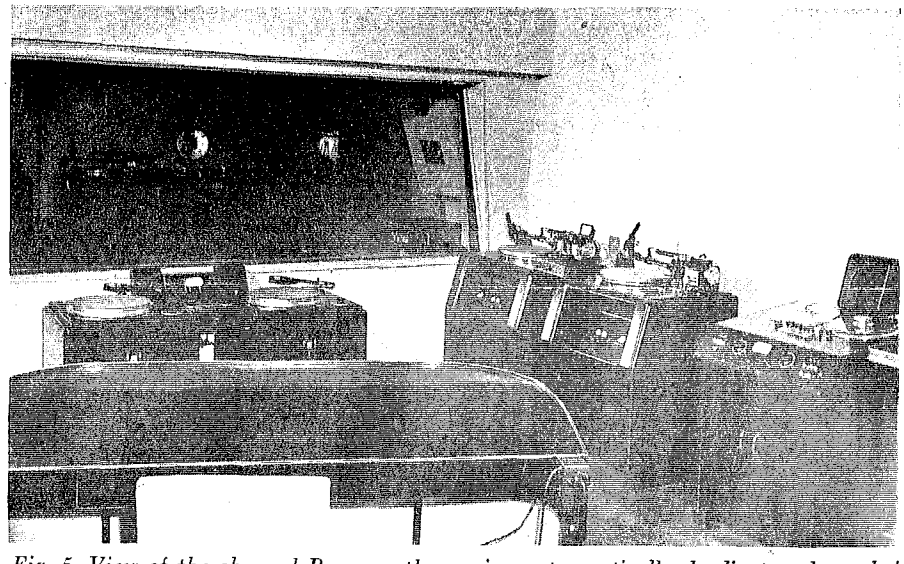
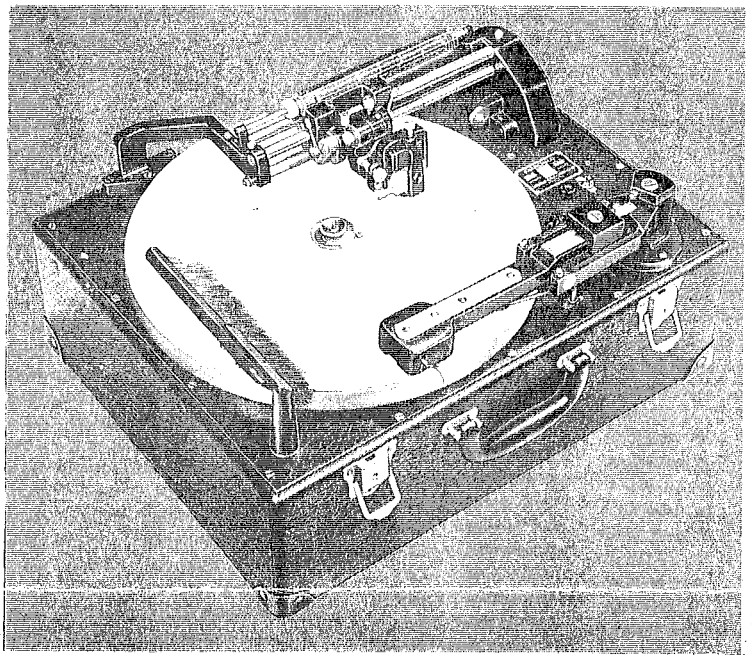


Fig. 5. View of the channel B room; the equipment practically duplicates channel A

Fig. 7. Fairchild portable, lip-synchronous recorder. Fig. 8. George Piros at the control of the variable-pitch recorder



Lip-Synchronous Recording:

Recording sound tracks for motion picture film production requires recording and playback turntables that hold lip synchronism over long periods of continuous recording and playback. For this purpose, Fairchild recorders with direct-to-center turntable gear drive were used. They afford an accuracy of 1 part in 4.6 x 10^6 at the turntable. This means that during 20 minutes of program material, recorded and played back, the maximum time-error encountered is .0052 second. This far exceeds the requirements for motion picture productions.

The portable, synchronous unit shown in Fig. 7 is used in the field for location shots, and the discs dubbed to sound-on-film tracks at the studio. This eliminated most of the bulky, direct sound-on-film optical recording equipment usually required in location work.

Recording Full Dynamic Range:

Standard and long-playing Mercury records are produced in the Reeves plant. Every Mercury record label is marked Reeves-Fairchild Margin Control. These words indicate that full dynamic range is obtained through the use of the instantaneous,* variable-pitch recorder described in Part 2 of this series.

Limiting factors of dynamic range have been the high basic noise level of record pressings which masks pianissimo passages, and the danger of overcutting on full forte passages. Before the perfection of vinilyte processing, it was necessary to cut all sound at maximum level to override the high basic noise of shellac-composition pressings. However, now that the basic noise has been so greatly reduced, the recording studios have gone all out for life-like dynamic range. Records cut in this way are beautiful to hear, for pianissimo passages are no longer lost in background noise and, by varying the cutting pitch, to avoid overcutting as the signal level increases, a full dynamic range can be achieved. The method of operation is shown in Fig. 8, where Reeves recording engineer George Piros is listening to the orchestra on the monitor system and, using a cue sheet, rides gain on loud passages simply by varying the cutting pitch. The control knob is located at the right of the lathe mechanism. Instantaneous and continuous pitch variation is accomplished simply by rotating this knob. It is not uncommon to find that the pitch is varied from 160 to 320 lines per inch during a single selection. The actual level recorded on Mercury records through the use of this technique is not below that recorded on standard 78-RPM discs. The dynamic range recorded is claimed to be as great as 62 db.

The cutterhead used to record the full forte without distortion is illustrated in Fig. 9. Because correct armature alignment is essential in order to maintain low distortion at high recording levels, a window is provided for visual checking of alignment. The adjustment, if needed, is simple and is made without disassembling the unit.

Master Control Room:

All audio facilities in the entire Reeves building terminate in the master control room on the fifth floor. Arranged in a wide U are 20 rack bays carrying the preamplifiers, amplifier power supplies, and relay power supplies for all the control rooms, and a total of 1,922 pairs of patch jacks. Every microphone outlet, control room mixer, tie line, monitor bus and program bus terminates at the master control patchboard. Thus any on-the-air studio can be fed to the optical film recorders on the third floor and to the disc and tape recorders on the fourth floor singly by direct patching, or simultaneously by multiple patching.

Conclusion:

Elaborate as the Reeves installation is, it employs the same basic recording and playback units listed in Part 1, and described in detail in Part 2. This confirms the statement made earlier that, by selecting units that are fully coordinated in mechanical and electrical design, the simplest studio equipment can be readily revised and expanded to meet new requirements, and without discarding any part of the original installation.

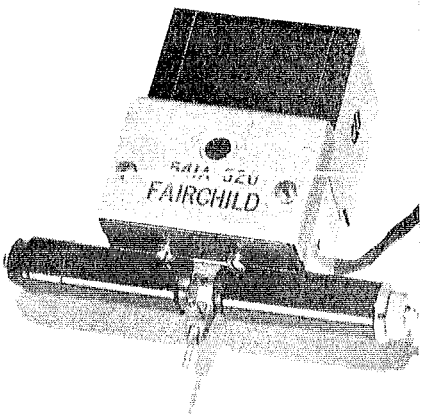


Fig. 9 High-level recording head