Motion-Picture Sound Systems

L. A. Wortman

The modern motion-picture theater uses highly sophisticated sound systems. This historical and current-state report details Ampex' activities in this field.

THE rasping voice of Al Jolson was immortalized in 1927 in *The Jazz Singer*, the first motion picture employing sound. If Jolson could have foreseen the quality of motion-picture sound today as compared to his era, he probably would have repeated his famous phrase, "You ain't seen nothin' yet."

Magnetic audio recording was introduced by Ampex Corporation in 1947 – and soon thereafter adopted for theater sound. Master tracks of motion pictures were recorded on magnetic tape, then transferred to optical recording systems for playback. Optical sound offered an improvement in sound quality over disc reproduction, which was used for the first motion picture sound tracks.

With magnetic tape came the opportunity for stereophonic sound in theaters. *House of Wax*, a 1951 three-dimensional feature, was the first picture released to use a form of magnetically recorded stereophonic sound. Separate film reels carried picture and sound, with the sound reel containing imageless film coated with an iron oxide.

In 1953, Ampex, working closely with several motion-picture studios, introduced the first true stereo theater sound system. The system made its premiere nationally with the showing of *The Robe*.

The motion-picture industry quickly accepted this system as its standard for high-quality theater sound. Since *The Jazz Singer*, there had been little change in sound-track recording, and the industry was attracted by the advantages of four-channel multidirectional systems with the superior sound of magnetic recording. Another advance, the six-channel magnetic sound system, was developed by Ampex in 1955. For this the Motion Picture Academy of Arts and Sciences presented Ampex an Oscar award.

Oklahoma, released in 1955, was the first movie produced with the Todd A-O process, which used 70mm film instead of 35mm, and six channels of sound instead of four. Five speakers were located behind the screen, and effects speakers drawing from the sixth audio channel were placed on walls of the theater surrounding the audience. Six separate sound tracks, each 100 mil in width, gave *Oklahoma* much better sound reproduction than the standard 50 mill tracks. When first released, the film was shown with separate film and sound tracks. Within six months, sound striping was added to the composite prints.

All theater sound systems employed vacuum tubes until the early 1960s, when solid-state components appeared. Initially, solid-state components often were unreliable because they had not been originally designed for use in theater sound systems, but instead were adapted from other sources. At this time Ampex introduced a line of solid-state components specifically designed for high-quality theater sound reproduction and other commercial-sound applications.

The preamplifier was developed from the solid-state Ampex AG-440 line of professional audio recorders. For theater sound systems, we produce magnetic, optical, phonograph, and microphone preamplifiers. Each has its own equalization and gain controls, and each has a transformer output to balance the output line and to provide ground isolation. Each unit is powered by dual regulated 39.5-volt power supplies, providing all preamplifiers with standby supplies. The one-watt power output capability is four times above what is generally considered necessary. Working so far below overload gives the operator a very clean signal.

The model APM-1 preamplifier modules accept inputs from microphones and phonographs, and the Model APF Series preamplifier modules accept inputs from magentic-head devices such as tape recorders and motion-picture sound tracks. A line amplifier is self-contained in each of the preamp modules, but the input circuitry is varied in each one to match the transducer employed. The model APT-8 preamp trays will accept up to eight preamplifiers and the Model PS power supplies will feed up to 16 preamps.

This theater sound system continues to use the same preamp switching unit popular for many years. This unit is a simple Ledex-operated rotary solenoid-switch mechanism

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Figure 1. The Century 21 theater in San Jose, California features four racks of a six-channel magnetic theater sound system. This installation has the older vacuum-tube model, which has since been replaced by solid-state units.

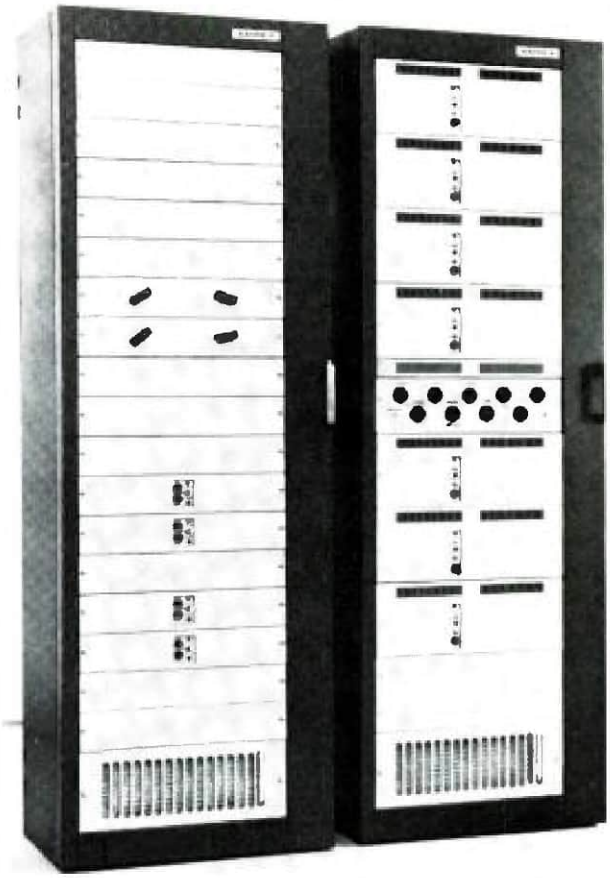

Figure 2. The eight-channel theater sound system developed for Dimension-150. It includes solid-state electronics and occupies about half the space of previous systems. The selector switches on the upper part of the left unit can be moved to AUXILIARY, MULTI-TRACK MAGNETIC, 4-TRACK MAGNETIC, OPTICAL, and NON-SYNC selection.

which is used to allow complete remote operation. By incorporating a preamp for each head and switching at the output at high level, switching noises are eliminated. Sound from one projector may be transferred to another without the audience sensing the changeover. Although other switching techniques are available, none to date has improved upon the reliability, repeatability and noise-free operation of these switches. The preamp switch selects mode and projector remotely from the station control near the projector.

A frequency response of ±1 dB 30 to 20,000 Hz at full output is guaranteed for the Model AH-80 power amplifiers. They are fully protected against failure due to overloading, short circuits, or unexpected power surges. To accomplish this, two scrs are provided — one for short-circuit protection, and one to prevent excessive instantaneous power such as is experienced in the loss of an input ground. One-quarter-volt of input signal is required to drive the power amplifier to an 80-watt output. The power amplifier is 7-inches high, while the preamp trays and preamp power supply each are 3½-inches high. All units are designed for mounting in a standard 19-inch rack.

The amplifier provides 80 watts of continuous power, well above normal needs. This prevents failure, common to early solid-state power amplifiers, due to the operating level being too near the maximum power level.

A standby unit can be switched into service for any power amplifier which has failed. A switch also provides built-in dummy loads for testing. Plug-in accessories for the 80-watt, solid-state amplifier include a dummy card for flat

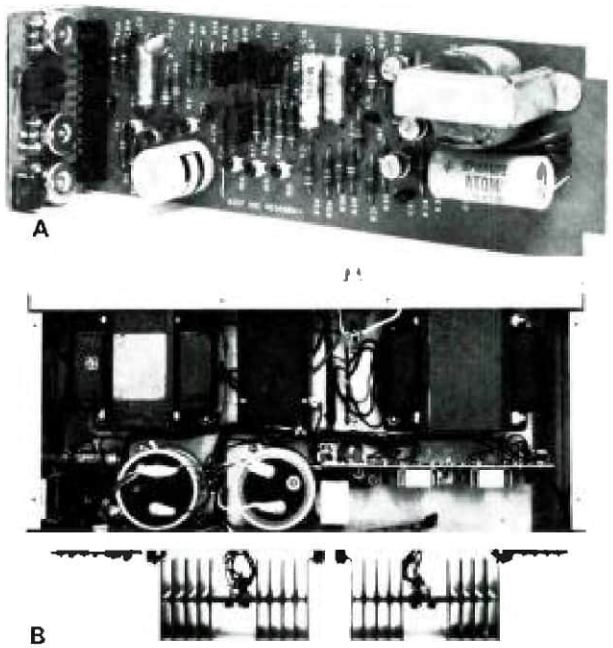

Figure 3. (A) This solid-state plug-in preamplifier offers a one-watt power output capacity. In (B) the 80-watts continuous power amplifier is shown.

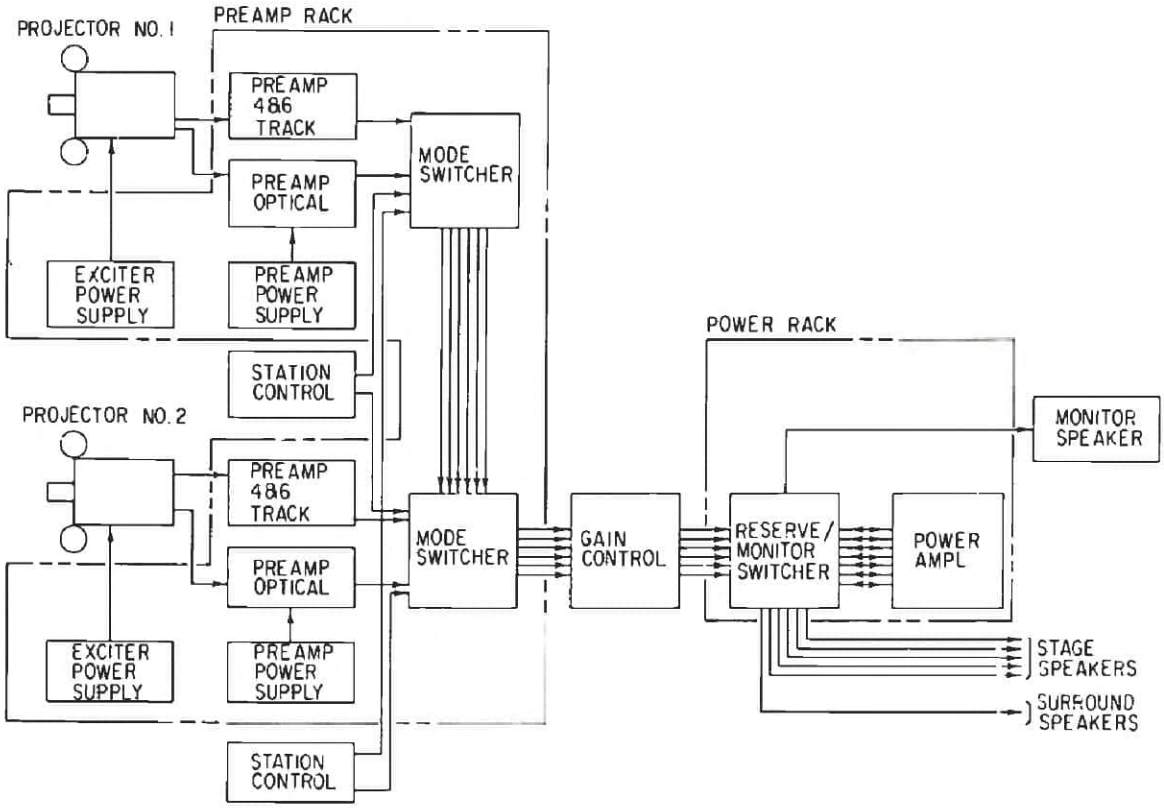

Figure 4. This system block diagram shows a typical motion-picture theater sound system.

response, a high- and low-frequency equalizer with or without a presence equalizer, a microphone preamplifier, a phono preamp, a 600-ohm line bridging transformer, and a 600-ohm line matching transformer. These options offer greater utility for the power amplifier.

An 80-volt dual power supply (one-half standby) powers the Ledex drive to the preamp switcher. This dual supply is in addition to the 39.5-volt preamp power supplies.

A well-filtered 10-volt d.c. supply energizes the exciter lamp used on optical tracks. Its standby feature permits an operator to switch to a.c. if there is a supply failure.

In 1967, we developed an eight-channel solid-state theater sound system for use with the versatile new D-150 All Purpose Projection System developed by Dimension-150, Inc. The system occupies about half the space of previous systems.

In the D-150 process, five speaker systems are located behind the stage, with three banks of effects speakers surrounding the theater audience. In six-channel systems, all surround speakers derive their signals from one audio track, while the D-150 eight-channel system has three separate channels to drive the surround speakers. These channels provide more subtle control and flexibility of the individual surround channel to enhance the emotional effects.

The picture-screen width of conventional 35mm film (1.85:1 aspect ratio) is 40 feet. For 35mm anamorphic systems (Cinemascope, Panavision, etc.) the width is 47 feet. Conventional 70mm screen width (Todd A-O, Ultra Panavision, Super Technirama, etc.) is 53 feet. Dimension-150 uses a 70-foot wide screen. This last figure is variable, depending upon the geometry of the theater, since the width of auditoriums, ceiling height, and length of throw must be considered.

Despite the deep curvature of the screen, the D-150 process eliminates the problem of cross-reflection, while increasing contrast and color-saturation. The lenses introduce mild rectification of the image to permit distortion-free viewing. Sixteen foot-lamberts of light are returned to the viewer. The gain factor is approximately two.

Lenses range from 150-degree to extreme telephoto. The field of a 150-degree lens approximates the human binocular field of view – it includes essentially everything a person would see if he were standing at the camera's vantage point.

D-150's motorized screen masking system is controlled by simple push-button selection at each projection operating station. Separate adjustments for top masking and side masking provide an unlimited variety of picture widths and heights. Duplicate control panels are provided to operate screen masking and the curtain from a backstage location, should the need arise. Screen frame, curtain, and masking tracks all are combined into a self-contained package.

In addition to the eight-channel system, a six-channel system exists for 35mm films. Either four-channel magnetic or single-channel optical sound is available for indoor theaters. (Drive-in theaters only use single-channel optical systems.) 70mm films always use at least a six-channel system. Large-scale sound systems are available that reproduce all of these combinations.

It appears that the most significant improvement foreseeable for theater sound systems in the near future lies in the field of automated control of projection, screen and audio systems. The continuing process of miniaturization and simplification will mean more technical versatility, reliability and maintainability for theater operators and consistent listening pleasure for their customers.