

producer. In spite of the fact that the UN machine was procured from a different source, arrangements with Stancil-Hoffman Co. insured that the recorder and reproducer matched. As it turned out, the sound reproduction resulting from the use of this method in Geneva was very satisfactory. Other nations supplied their films narrated in their own languages.

The UN used an interesting method in interpreting and translating the narration from the films of other nations into the four languages. They were all recorded at the same time on the four tracks as a simultaneous interpretation. Four interpreters, provided with a reference script, viewed the film and interpreted the narration as if they were interpreting the speech of the speaker on the podium. This was quite successful, although a time lag was apparent.

It is pertinent at this point to mention that the Russian exhibitors prepared five-track CinemaScope film in English, French, Russian, Spanish and German of their presentations on 35mm film and provided two 35mm American CinemaScope machines. During its first testing, it became apparent that the perforation on the film did not accurately match the sprockets in the penthouse head, causing multiple breaks in the film and tie-ups in the machine. Howard Tremaine, act-

ing as our expert in Geneva, was able to help indicate a solution for this problem.

Since the UN had many films to present, a three-time showing of each of the films during the period of the conference was all that could be assured. Later, additional showings of these films were requested, and with permission of UN authorities we obtained the films and showed them in our own four small theaters.

The four theaters extended across a short side of the balcony of the exhibit hall. Each contained 14 chairs, each chair equipped with a control box on a pillar. This control box allowed the viewer to select any one of the four official languages, and to adjust volume of the track. The headphones were the conventional type, such as are used in radio work, so that complete exclusion of room noise could be obtained. The theaters were well designed and the chairs were comfortable. Back-projection screens provided brilliant high-resolution pictures. The projection rooms were staffed by four men and a supervisor. Later, it became necessary to run longer periods of time each day because of the popularity of the exhibit, so another projectionist and two part-time assistants were added to the staff.

Techniques were developed to allow

one person to operate two of the projectors and reproducers. This was possible only if one of the longer films was one of the two films being projected.

The other type of films were the short ones called Vignettes. They were extremely popular, both as to the character of the films and the method of presentation, which was called the Multivox system. Requests for rental or purchase of these films ranged from the entire selection of 90 reels to selected films, and came from many countries throughout the world. Libraries are now set up in Europe, and are planned for Asia and South America. The rigid scientific approach was pleasing to almost every one of our audience.

The number of persons in the audience during the period of the show totaled 15,186; total number of film showings was 1287. The magnitude of this effort may be appreciated by the fact that the small theaters each contained 14 seats and the average film run was about 12 minutes. The number of times that each film was shown varied from a minimum of five to a maximum of 119. The average was about 50. The film that was shown only five times was entered too late to include in the catalog. The film that was shown 119 times was *The Industrial Applications of Nuclear Explosives*.

A Multilingual Audio-Visual System

An audio-visual system has been designed with a 16mm rear-projection system, electrically interlocked with a 16mm magnetic film reproducer which carries a four-language soundtrack. A selector switch and headphones at each seat in the auditorium permit the auditor to select the desired language.

AS PART OF the United States participation in the Second International Conference for the Peaceful Uses of Atomic Energy at Geneva, four small theaters were constructed for showing 16mm films on the use of atomic energy in scientific and industrial applications. The theaters, built by Lytle Engineering and Mfg. Co., of Culver City, Calif., under a contract with the Atomic Energy Commission, were constructed in a semicircle and utilized a common projection area.

Presented on May 6, 1959, at the Society's Convention in Miami Beach by Howard M. Tremaine (who read the paper), Lookout Mountain Air Force Sta., Hollywood; James W. Green, Magnasync Mfg. Co., 5546 Satsuma Ave., North Hollywood; and Glenn R. Osborn, Lookout Mountain Air Force Sta., Hollywood. (This paper was first received on May 7, 1959, and in final form on October 19, 1959.)

Each theater (Fig. 1) contained 14 to 16 seats and a rear-projection system with separate facilities for reproducing the soundtrack from a 16mm magnetic film in the four official languages: English, French, Russian and Spanish. Selector switches at each seat permitted selection of the desired language.

The rear-projection equipment consisted of a metal framework supporting an RCA Model 400 16mm projector at one end and a front surfaced mirror at the other (Fig. 2). The picture, projected onto the surface of the mirror, reflected to a polarized-type screen (manufactured by Polacoat Inc.) to permit viewing in a high ambient light level.

A projector control box mounted at the rear of the projection stand contains an interlock switch for electrically interlock-

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ing the reproducer and projector motor systems, a pilot light to indicate when the system is in lock, and a start-and-stop switch. Two coding-decode switches associated with a go-no-go control system prevent the projectionist from inadvertently threading the wrong soundtrack. The go-no-go system may be bypassed, if desired, by a switch on the projection control box.

A decoding device which is part of the go-no-go control system, is mounted between the supply and take-up reels on the reproducer transport systems. The decoding device houses a group of microswitches which control the motor starting circuits. The placement of the decoder with reference to the threading path of the reproducer is shown in Fig. 3.

Figure 4 shows how the go-no-go code is punched in the leader of the magnetic soundtrack. The soundtrack to be coded is threaded through a special punching device containing a group of holes in its upper portion, representing 0 to 9 and 0 to 90. In practice, all holes *except* the desired code numbers are punched in the

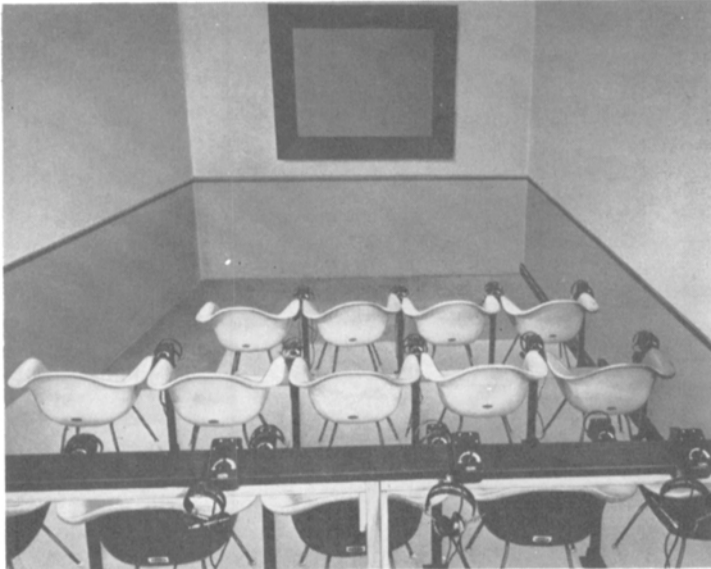


Fig. 1. Interior of theater. Language selector is mounted at each seat. Boxes on rear rail are for the convenience of standees.

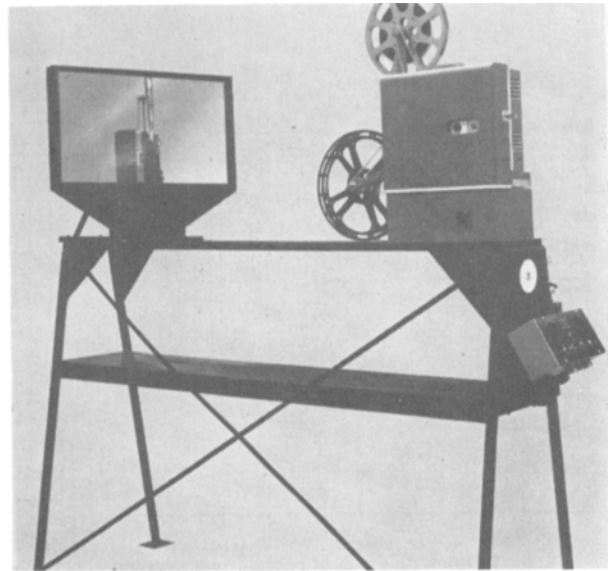


Fig. 2. An RCA Model 400 16mm Projector, with front-surfaced mirror mounted for rear projection.

film including an indexing hole. As an example: if the code number is to be 46, all holes *except* 40 and 6 are punched in the film. The distance between the indexing hole and the soundtrack start sync-mark is 52 frames. Because the magnetic reproducer head is not visible in its shield, a second sync-mark is necessary. This second mark is placed at a distance of 27 frames from the indexing hole in the direction toward the sound start sync-mark. When threading the reproducer this sync-mark is placed at the upper edge of the left film gate at the pull-down sprocket, and is used as a sync-mark, rather than the sound sync-mark. When threaded properly, the sound start sync-mark will lie over the gap in the magnetic reproducer head.

The coding dials on the projector control box govern the operation of the go-no-go system. The dials are set to the code number corresponding to the code number of the selected film. If the motor system is locked in and the code punched in the magnetic soundtrack leader corresponds to the code set up on the dials,

the motor system will "roll" when the start button is depressed. If the code punched in the film is wrong, the pilot light on the projector box will not light. This is an immediate indication that the wrong soundtrack has been threaded on the reproducer.

Decoding Device

The decoding device on the reproducer consists of a group of 20 microswitches which are normally open in their upward position. All switches falling under the code number are pressed downward by the pressure of the film on the microswitches and complete the motor control circuits. All other switches in the decoder will remain open because their arms extend through the holes in the film. When the film is pulled downward by the rotation of the pull-down sprocket, a latch at the bottom of the decoder device opens, releasing the film and permitting

it to run free of the decoding switches.

The motor system is a conventional single-phase 115-v selsyn interlock, with provision for running the reproducer or projector separately. The lamp in the projector lamphouse is energized automatically when the motor system starts to rotate.

The four-track 16mm magnetic film reproducer consists of a Mark IX transport system and playback amplifier-manufactured by the Magnasync Manufacturing Co. These are mounted in a standard 7-ft cabinet-type relay rack. This rack also houses four power amplifiers which feed the headphone circuits in the theater auditorium. Four VU meters are provided to indicate the levels fed to the headphone circuits. The balance of the equipment consists of a power supply for the playback amplifiers, jack strips, and an automatic monitoring system for the projectionist. Power for both the pro-

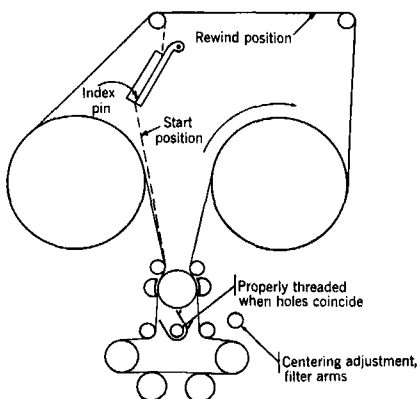


Fig. 3. Threading path of the magnetic reproducer.

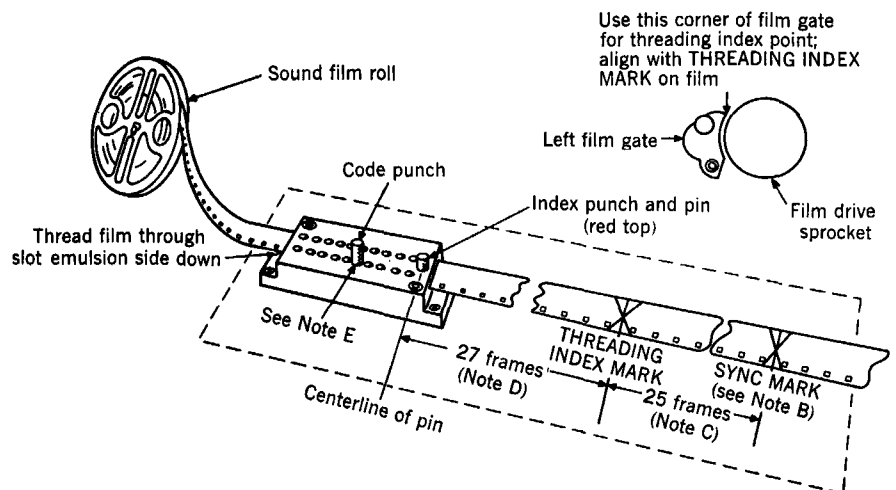


Fig. 4. Go-no-go code punched in leader of magnetic soundtrack. Distance between indexing hole and sync mark is 52 frames.

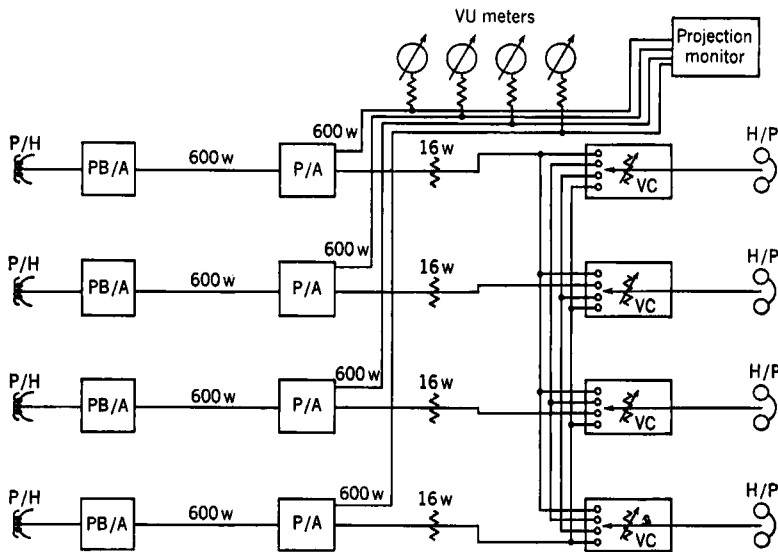


Fig. 5. Block diagram of reproducer system.

jector and reproducing system is brought to a plug panel at the bottom of the rack and then distributed to the projector control box and projector, through cables. Approximately 2500 w is required for each theater.

The projectionists' automatic monitoring system consists of a motor-driven cam switch which alternately connects the projectionists' headphones across each of the four language soundtracks every 15 sec. This provides the projectionist with continuous monitoring of the four soundtracks. The four VU meters at the top of the rack serve to indicate the average level fed to the auditorium headphone circuits. The meters are also used for lining up and setting the headphone levels before the day's work starts.

A block diagram of the audio circuits is shown in Fig. 5. At the left are four input circuits fed from four magnetic heads on the reproducer transport system, terminating in four playback amplifiers. The output from the four playback amplifiers passes through normal jacks, then to four Langevin Model 138SM 8-w

power amplifiers which feed the auditorium headphone circuits. The 16-ohm output winding of the power amplifiers is terminated permanently in a 16-ohm resistive load. From the power amplifiers the signal passes through normal jacks and then to the selector switch boxes in the auditorium which contain a high-resistance volume control feeding a pair of Brush Electronics Model 705B dual crystal headphones. The selector switches are of such design that when a headphone circuit is switched from one language circuit to another, the unused lines are terminated in a resistive load equal in value to the headphone circuit impedance.

Since the headphones and the volume control are of high impedance, and are

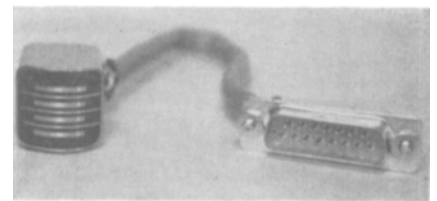


Fig. 6. 16mm four-track recording head.

fed from a 16-ohm source impedance, they function as a bridging load across the output circuit of the power amplifiers. Thus, no change in level is reflected between the headphone circuits when the headphones are switched from one language circuit to another.

The cables feeding the auditorium headphone circuits are of special design, consisting of four twisted pairs individually shielded, each shield covered with a cloth braid. The grounds to the shields are carried back to a single point ground connection at the reproducer rack.

Each VU meter is connected across a 600-ohm tap on the output winding of a power amplifier. This same winding is also used to feed the projectionists' automatic monitoring system.

The playback amplifiers are equalized in accordance with the ISO-SMPTE standard for reproducing 16mm magnetic film. The signal-to-noise ratio of the entire system when referred to 2.5% harmonic distortion at 400 cycles is 58 db. The crosstalk level between the four reproducer circuits has an average of 54 db at 1000 cycles when a signal is applied to head number two and the crosstalk level measured at head number one and three.

A four-track magnetic recording head is shown in Fig. 6, and the soundtrack

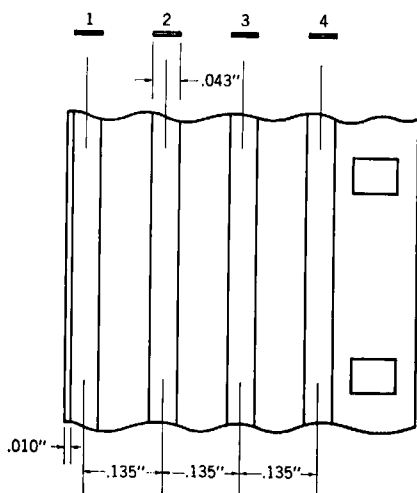


Fig. 7. Soundtrack dimensions.

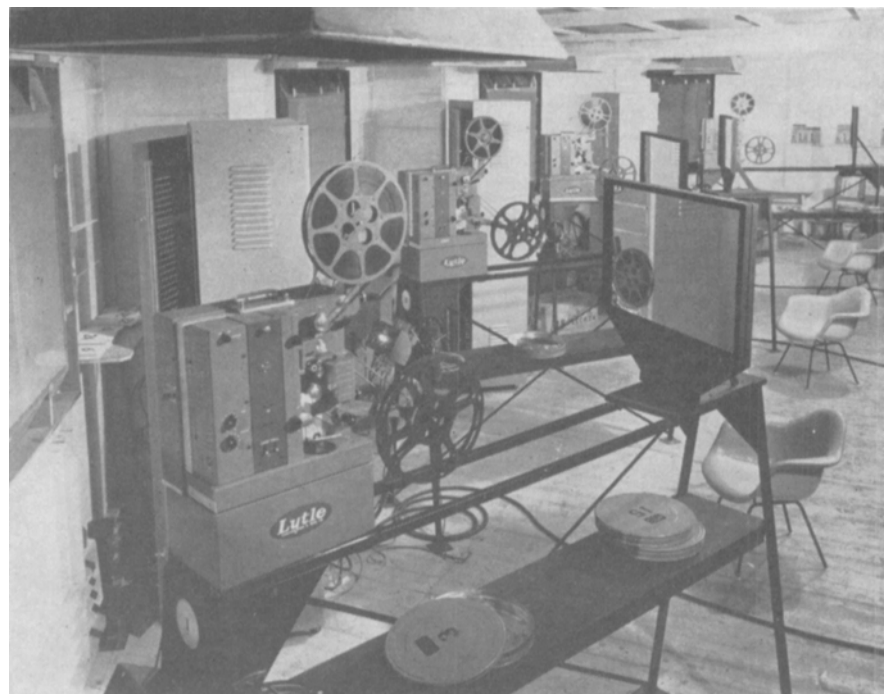


Fig. 8. Rear view of the projection area for the four theaters.

placement dimensions in Fig. 7. Each soundtrack is 43 mils in width, and is placed on a center line between tracks of 135 mils. The recording head impedance is rated 10 ohms at 400 cycles.

The recording amplifiers are designed to permit the four soundtracks to be recorded either singly or in combination. Individual gain controls are provided on the front panel for each recording amplifier, and a variable bias current control on the rear chassis. The VU meter measures both the recording levels and

the bias current for each recording amplifier.

A rear view of the projection area for the four theaters is shown in Fig. 8. The exhibit at Geneva ran for the period beginning September 1 and ending September 15, 1958. To assist the delegates in selecting subject matter for screening, a printed program in the four official languages was available. A hostess who spoke several different languages scheduled the subject material selected by the delegates.

Acknowledgments

The authors express their appreciation to Col. J. L. Gaylord, manager of the Lytle Engineering Co., Culver City, Calif.; and Forrest E. Jaquart, engineer, also of Lytle, for his supervision of the operating and installation personnel at Geneva; and to D. J. White, W. H. Stutz and P. F. Schieke of Magnasync Mfg. Co., for their valued suggestions and construction of the recording and reproducing equipment.

Preparation and Transfer of Soundtracks to Four-Track Magnetic Recorder

Ninety-three reels of narration, each in four languages, were prepared and transferred to a special 4-track (Multivox) magnetic recorder. Problems of synchronization and other technical problems were involved.

FORTY-FOUR DIFFERENT FILMS, comprising 93 individual reels of narration, were prepared by the Army Pictorial Center to fulfill the requirements of the Atoms for Peace Conference at Geneva. Since each reel was to have four languages, the number of individual reels to be transferred to the Multivox recorder was a total of 372.

The original source material, in most cases, consisted of a 16mm composite print in English. From this, translations of the narration were prepared in French, Russian and Spanish. Opening and closing title music tracks were also made and special picture titles were prepared showing the title of each picture simultaneously in all four languages.

A "live" mix was then made of each narration and music. This was recorded on 35mm magnetic-stripped film with appropriate start marks. Three 35mm magnetic reproducers and one 16mm optical reproducer were then interlocked for simultaneous transfer of all four languages to the 16mm full-coated magnetic film used by the Multivox recorder.

The problem of synchronizing Army Pictorial Center equipment, which is all 220-v, 3-phase interlock, with the Multivox which is designed for 110-v, single-phase selsyn operation, was solved by replacing the Multivox selsyn motor temporarily with a 3-phase interlock motor to match our system, and by changing the gears to accommodate

the 1200-rpm speed of this motor rather than the regular 1800-rpm motor.

The problem of crosstalk between channels proved to be unusually severe because of the fact that the audience must use individual headphones rather than a common loudspeaker. The headphones tend to screen out other extraneous noises such as audience noise which would ordinarily completely mask out any crosstalk. The problem is further aggravated by the fact that the number of words required for technical phraseology is completely different for different languages. The result frequently is that when there is a pause in the narration of a given track the adjacent tracks continue at full level and can be heard because of the crosstalk. This was found to be true even when the measured crosstalk level was fully 43 db below normal signal level. This fact resulted in the recommendation to the equipment manufacturer that the tracks be reduced from 85 mils to half that width so as to more than double the space between them. This did result in a reduction of approximately 6 db in the crosstalk but it is still faintly audible during pauses.* Of course,

* The apparent discrepancy between the 49-db (43 + 6) figure which we obtained and the 54-db value which Dr. Tremaine quotes in the accompanying paper can be explained by the different measuring method employed. We feel our measurements are more realistic in that they show the crosstalk existing in an unmodulated track when full modulation is taking place in both adjacent tracks simultaneously.

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during actual modulation the crosstalk is completely obliterated and presents no problem.

Interchangeability

One other problem which arose was the matter of interchangeability of recordings made on other similar equipment. For example, the United Nations produced some films which were recorded on a similar multitrack recorder of different manufacture. While the soundtracks were quite satisfactory when played on the same machine on which they were recorded, differences of as much as 10 db appeared when recordings were interchanged. Fortunately, the inherent signal-to-noise ratio of magnetic recording is such that it was only necessary to readjust the playback gain of the various channels in order to obtain completely acceptable reproduction of the interchanged tracks.

Time did not permit us to make a thorough study of all the contributing causes of level differences; but two major causes can be cited: (1) lack of a precise standard for width and location of the individual tracks; and (2) lack of a common standard for establishing the correct recording level.

It is to be hoped that on any future project of this nature, there will be an agreement among the parties concerned—in advance of recording a large number of films—so that satisfactory interchangeability can be achieved.

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