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.

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Preparation and Transfer of Soundtracks to Four-Track Magnetic Recorder

By GEORGE LEWIN and MAX KOSARIN

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-striped 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, 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.

* 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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