economic problems, rather than technical factors, limited the sale and use of the magnetic Movie-Sound-8. Several of these Movie-Sound-8 projectors are now used at Calvin along with current models for inspection of 8mm prints.

Shortly, it is hoped that much of the engineering data and other material concerned with Lloyd Thompson's early work on 8mm sound projectors will be collected under a suitable arrangement so that they may be preserved for use by the industry. It would be in keeping with his outgoing nature that this material be shared with anyone needing help in this field.

In closing, the authors of this paper wish to acknowledge the honor and privilege they enjoyed working with Lloyd Thompson. His work in this 8mm field ably illustrates his professional ability, pioneering spirit and personal integrity.

A REPRINT

Problems in the Design of an 8mm Magnetic Sound-on-Film Projector

By LLOYD THOMPSON

USERS of 8mm motion-picture equipment have long wanted an 8mm sound-on-film projector. Optical type 8mm sound reproducers have proved impractical. The magnetic type of machine seemed to be more promising, for several reasons. With a magnetic sound-on-film projector the user can record his own sound as well as play it back, and this seemed to be a highly desirable feature for amateur film users. Also old silent films can be given a sound accompaniment after a magnetic track has been applied to the film. Magnetic tracks on 8mm films, however, impose their own problems in sound projector design. The 8mm film runs at a slower linear speed than does 16mm or 35mm film. Even when projected at 24 frames/sec its speed is only 18 ft/min. It was considered necessary to design a projector which would satisfactorily record and play back both at the slower silent film speed and at the current sound film speed. Such equipment would interest owners of old film who, by having a magnetic soundtrack striped on them, could add sound to the old films. The two-speed requirement complicated the design problem.

Another source of trouble was in guiding the film. Since the magnetic soundtrack is placed outside the sprocket holes on the margin of the film it can be no wider than approximately 0.025 of an inch. The film must be guided accurately so that the magnetic track will always line up over the record and playback head in the same position. The sound head could not be made wide, extending on both sides of the striping, because some of the magnetic coating might run over into the sprocket holes during application. This would introduce a great deal of sprocket "flutter" if a wide recording and playback head was used. Therefore, the recording and playback head was restricted 0.025 in.

The narrow track and correspondingly narrow recording and playback head require accurate guiding of the film and accommodation for different widths. Because 8mm film is exposed in the camera as 16mm film and slit in half after processing, the accuracy of slitting is not always maintained as it is in the film factory where the unexposed film was produced. Because of slitting inaccuracies and because of shrinkage, 8mm film is not always 8mm wide. A guide system to work satisfactorily has to take this fact into consideration.

Good results in magnetic recording, whether it be on film or tape, demand that the magnetic coating be in good contact with the recording and playback head. Film is rather stiff compared to cellophane tape, which is used for magnetic recording on most $\frac{1}{4}$-in. magnetic tape recorders. For that reason, it is a little more difficult to keep film in good contact with the head. Also different rolls of film will have different amounts of curl in them, so that a contact device must maintain contact even though there is a varying amount of curl in the film itself. Of course, if the film is damaged or there is too much curl in it, it may be impossible to get contact, but such films are in the minority.

The problem of flutter is very bad in 8mm film because the magnetic striping is placed along the outside edge of the sprocket holes. When the sprocket holes are punched in the film, there is naturally a deformation of the film at that point. If the usual method of putting the film around the sound drum is used on an 8mm magnetic film projector, sprocket hole flutter will be introduced in the recording and playback mechanism. A sound system has been developed to overcome the difficulties just mentioned. This system, described in a pending U.S. Patent, is called the Roto-Magnetic Stabilizer. It utilizes a principle which is called a combination of tight loop and loose loop system.

The loose loop system, used on early 16mm sound projectors and some modern ones, is capable of excellent sound results. One disadvantage of such a system, however, is a tendency to produce "wows" in the mechanism or in and out of focus with the light beam if the film has excessive curl. This difficulty was largely overcome by changing to what is known as the tight loop system that is widely used on sound projectors today. For 35mm and 16mm films the tight loop system seems to work quite satisfactorily, but when it is tried with 8mm film it gives difficulty. It has a tendency to damage the sprocket holes rather easily and, because of the closeness of the sprocket holes, it makes such a machine rather difficult to design so that it can be threaded properly.

The dual flywheel system of recording and playback is a tight loop system that gives very good results with 35mm and 16mm films but when used with 8mm film it seems to have certain disadvantages.

For those reasons, the Roto-Magnetic Stabilizer was designed to use the tight loop system only on the take-up side of the record and playback head. Between the intermittent and the record playback head the loose loop system is used. Such a system makes the projector easy to thread, it is easy on the film being handled, and it is comparatively simple to build. As shown in Figure 1 [see Fig. 5 in the preceding paper in this *Journal*], two drums are used as in the double flywheel arrangement. How-

Reprinted by permission of Robert L. McIntyre, Editor, PSA Journal, from *Photographic Science and Technique*, PSA Technical Quarterly, February, 1954. The late Lloyd Thompson was Executive Vice-President, a co-owner and co-founder of The Calvin Company, Kansas City, Mo. This paper was adapted from a talk presented before the Motion Picture Division at the PSA National Convention in New York, August 12 to 16, 1952.

ever, on the Roto-Magnetic Stabilizer the double flywheels are used in a different manner. On the drum next to the take-up sprocket is mounted a rather large flywheel which floats on the shaft. It was necessary to use this rather large flywheel in order to get good film motion at the slow speed at which 8mm travels. It floats on the shaft to avoid injuring the film when the mechanism first starts. On the back of the other drum is a rather small flywheel. This tends to hold the film tight between the two drums as it goes over the record and playback heads.

The drum containing the large flywheel has been made with an edge guide and has been tapered slightly in manufacture so that the film has a tendency to run to the outside edge and against the guide on the edge of the drum. This means that the outside edge of the film containing the sound stripe is always in line with the record and playback head and this is done automatically whether the 8mm film has been slit oversize or undersize.

The other sound drum is covered with a rubber tire which has a tendency to grip the film so that the film is always held back at a uniform tension as it passes over the record and playback head. The intermittent motion is filtered out just before the film reaches this drum so that by the time it reaches the record and playback head there is no trace of the intermittent motion left in the film. Contact on the record and playback head and on the erase head is maintained with small rollers.

In building an 8mm sound-on-film projector, it was impossible to adopt very much of the conventional 8mm silent projector design. For example, most silent projectors have a universal type of motor with a brush-type commutator. Such a motor can be quite small and it also can be placed quite close to the rest of the operating mechanism on the projector. In an 8mm sound projector, it is impossible to do this because there is so much noise created by a brush-type motor or a governor-type motor. It is much simpler to use a motor without brushes than it is to try to get the noise out. Even so, the motor is likely to cause electrical disturbances and for that reason it is a good idea to get the motor as far away from the recording head as possible. A Bodine constant-speed motor was selected and placed on the back of the machine as far away as possible from the sound head. Conventional projectors have always used high-speed motors because they are cheaper and also because the higher speed gave them more air for cooling purposes, which was needed with large lamps. While high-speed motors are satisfactory from this standpoint, they are more noisy than slow-speed motors and a high-speed fan is rather noisy in operation. A slow-speed motor was selected, therefore, and a slow-speed fan to deliver a volume of air to cool lamps up to 750 watts, without noise from either the motor or the fan. In storing the projector, the reel arms are taken from the machine and placed in the lid of the case, which also contains the speaker and microphone, so that the whole unit fits into one case [see Fig. 4 in the preceding paper in this *Journal*]. The weight of the machine is approximately 35 lb.

The machine comes with a two-channel amplifier for recording purposes. It is possible, therefore, to record from a microphone and from another source of sound such as a turntable at the same time. The two signal sources can be mixed together so that there is background music or sound effects behind voice, and the level of the voice and the music are independently controlled. A headphone jack is provided so that the mix can be monitored at the time of recording. A separate mixer with several channels is available as an accessory.

The volume is indicated by a small neon lamp, Figure 3 [a large view of the control panel, not reprinted]. An erase head has been built into the record and playback head so that any old signal is automatically erased just before the new signal is recorded when the amplifier is in record position. A mechanical safety lock is built into the control switch so that it is not possible to accidentally erase previously recorded sound.

In order to record sound-on-film, it is only necessary to place a magnetically striped film in the projector and put the control switch on record position, adjust the volume for recording, and proceed to record. After the recording is done, the film is rewound, it is rethreaded into the projector and projects a sound picture. If, for any reason, the recording is not satisfactory, a new recording can be immediately made and the old track will be erased as the new one is being recorded.