Special Techniques in Magnetic Recording for Motion Picture Production

By George Lewin

Several modifications in standard magnetic recording systems which provide greatly improved operating efficiency as well as economies in time and materials are described. These include facilities for: (1) stopping and reversing recorder and projector without losing synchronism, and (2) changing over from Record to Playback, or vice versa, silently, while running. These facilities make it possible to correct errors in narration and re-recording jobs without need for rethreading, splicing or blooping the film. Also described is a new method for domestic and foreign lip-synchronous production which makes use of 35-mm magnetic loops.

THE SIGNAL CORPS PHOTOGRAPHIC CENTER was one of the earliest, if not the earliest, user of magnetic recording for motion picture production work. As soon as the availability of 35-mm magnetically coated film was announced it was recognized that here was a new medium which offered possibilities for effecting tremendous economies in the use of photographic film and its attendant processing costs. Steps were immediately taken to design an attachment for existing optical-type film reproducers, to permit the recording and reproduction of magnetic sound tracks. An RCA Fantasound type of film reproducer was fitted with an erase and record head and was in successful use for recording and reproducing narration tracks as early as 1947 (Fig. 1).

It was quickly realized, because of the scarcity of magnetic film stock at that time, that it would be undesirable to cut up the film for the purpose of editing out errors in the narration, thereby losing one of the main advantages of magnetic recording, namely, the ability to use the stock over and over again and thus reduce its actual cost to the vanishing point.

Standard Procedure in Photographic Recording

Before the advent of magnetic recording, the normal practice in recording narration tracks for motion pictures was to use regular photographic film, and to record "wild," that is, without picture, and make numerous retakes to obtain the desired inflections and timing. The negative would then be developed and printed, and the print sent to the cutting room where considerable editing would have to be done to cut out errors, splice

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in the corrections, and juggle sentences back and forth to obtain the desired timing. In spite of the high cost of this procedure, the final result often left much to be desired because of the noise introduced by excessive handling of the film, the splices, and the inherent noise of film processing.

Magnetic recording appeared to offer the possibility of eliminating most of these problems. Our reasoning was somewhat along the following lines:

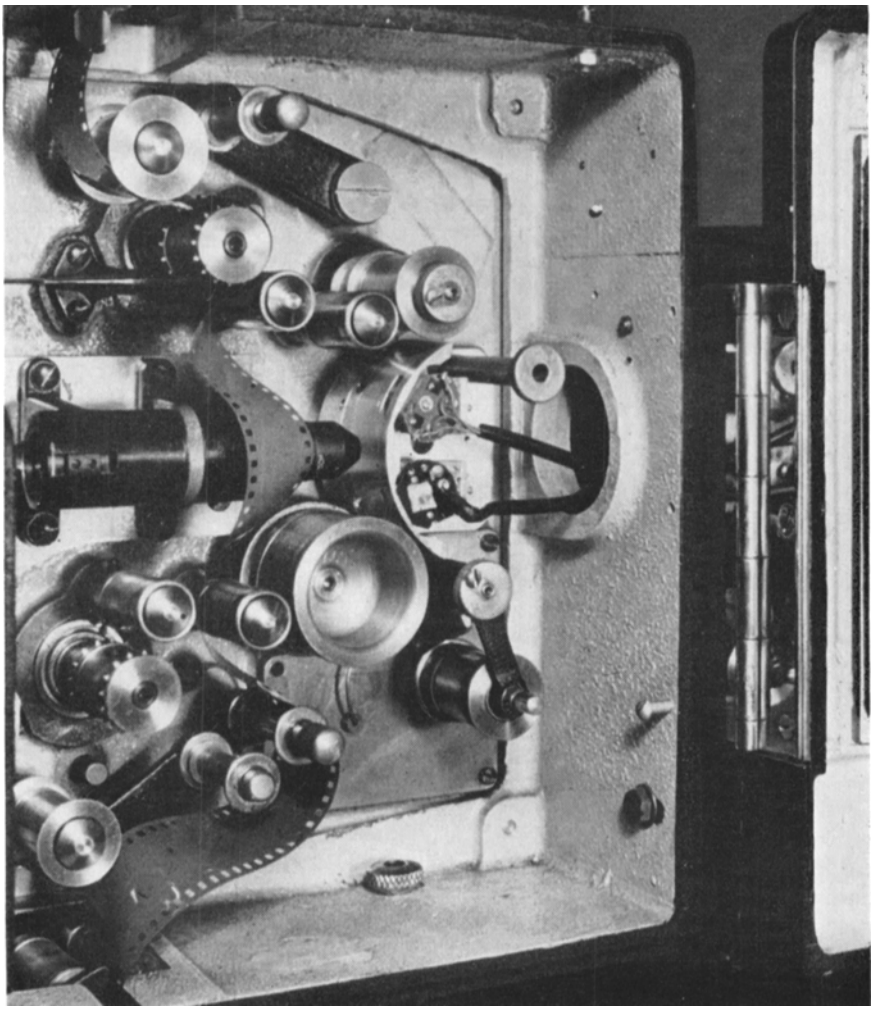

Fig. 1. Signal Corps Photographic Center modification of RCA Fantasound Reproducer showing magnetic erase and record heads set into curved aperture plate.

Requirements for Synchronous Narration of Magnetic Film

Suppose we had a medium which would allow us to stop both picture and sound track if the narrator made an error, back up ahead of the point at which the error was made, then run forward again, correcting the error and proceed onward, all without losing synchronism, and without leaving any telltale bloops or noises. If we could do all these things, we would really have a major improvement in production technique. Not only would we have a perfect narration track ready for immediate use, but we would also have eliminated completely the use of photographic film, its processing, editing, and the attendant cost and time. The fulfillment of all these requirements obviously presented a number of formidable problems, but these were all solved in due course, as improved projection and recording equipment became available and were modified to meet our special requirements.

Modifications for Reverse Drive

The projector (Fig. 2) was equipped with an additional belt coupled to the upper feed reel, which acted as a take-up when the motor was reversed. The intermittent movement of the Century projector head is capable of being driven in reverse with no particular precaution other than reducing the tension of the pressure plate.

The Westrex 1231 type of magnetic recorder (Fig. 3) was fitted with a special take-up and feed assembly which was designed especially for us by Westrex, and which runs equally well in either direction. Figure 4 shows a front view of this recorder.

The 3-phase interlock type of motor distributor system in use at the Signal Corps Photographic Center lends itself to the requirements of running in either direction, while maintaining perfect synchronism at all times, including starting and stopping. A separate bank of motor outlets is provided at the motor patch panel (Fig. 5), and connected to the regular distributor bus through a relay. This relay reverses one pair of rotor and stator leads by remote control from a push button at the distributor start position, which also has incorporated with it the controls for switching from Record to Playback. A foolproofing relay is included which makes the reversing button inoperative until the system has come to a complete stop. Thus, the main distributor motor and its synchronous drive motor always run in the same direction, but only the projector and recorder motors are reversed, which simplifies the wiring problem. (A recent modification now also permits the projection-type footage counter to be reversed, without interfering with the remote control reset feature.)

Figure 6 shows a close-up of the control panel, which is built into the mixing console. The procedure in stopping is to open only the third phase of the main phases to the distributor system, so that all motors can be stopped "in phase." Then the reversing button is pushed, the third phase is closed again, and the system started up once more, with the projector, recorder and footage counter now running in reverse. When the proper picture or footage cue is seen on the screen, the system is again stopped in phase, the reversing button is pushed again, restoring the original polarity, and the system is ready to start rolling in the forward direction. The entire operation takes less than a minute because usually it is necessary to back up only 20 or 30 ft to correct an error.

Figure 7 shows the control panel in relation to the mixing controls. The motion picture screen is visible through the window of the monitor booth.

Modifying Recording Circuits

The biggest problem was to modify the magnetic head switching circuits and the bias and erase oscillator, so that the

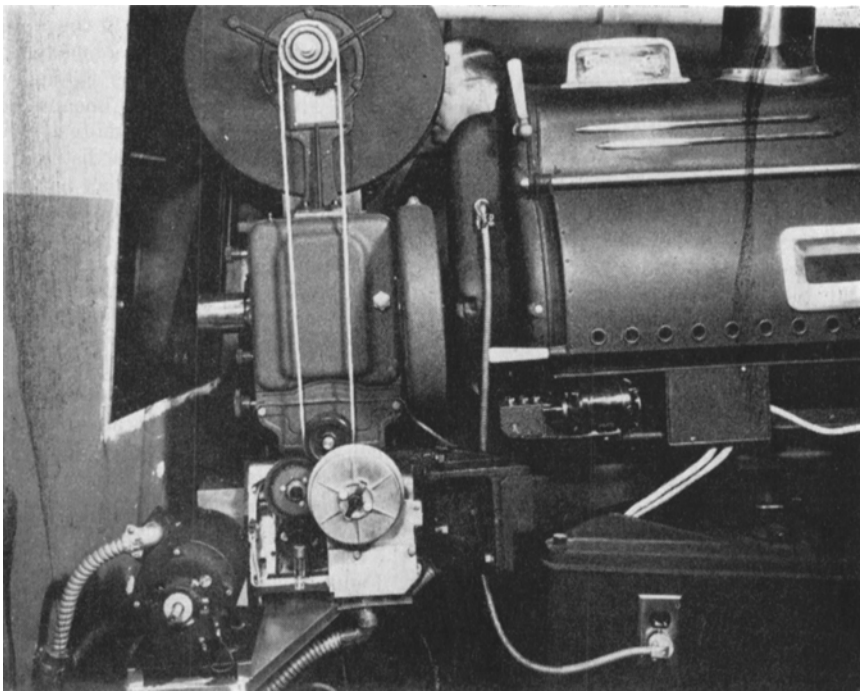

Fig. 2. Projector equipped with belt to provide take-up in reverse direction.

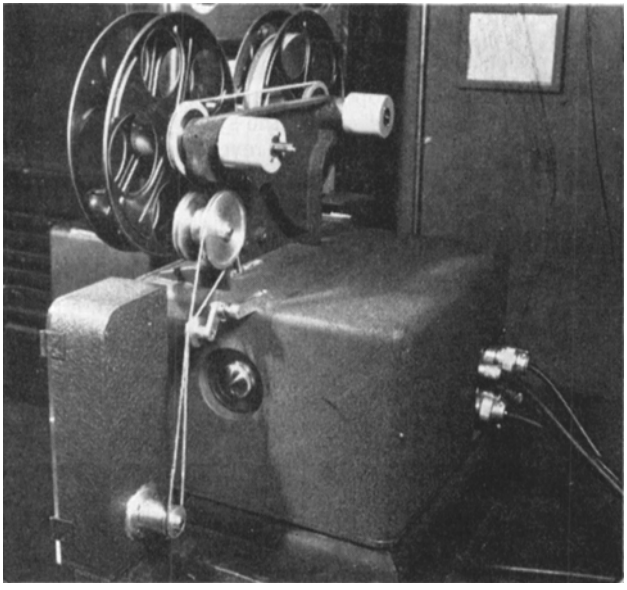

Fig. 3. Rear view of Westrex 1231 Type Magnetic Recorder equipped with special reversible take-up; also additional belt drive for Signal Corps Photographic Center loop magazine.

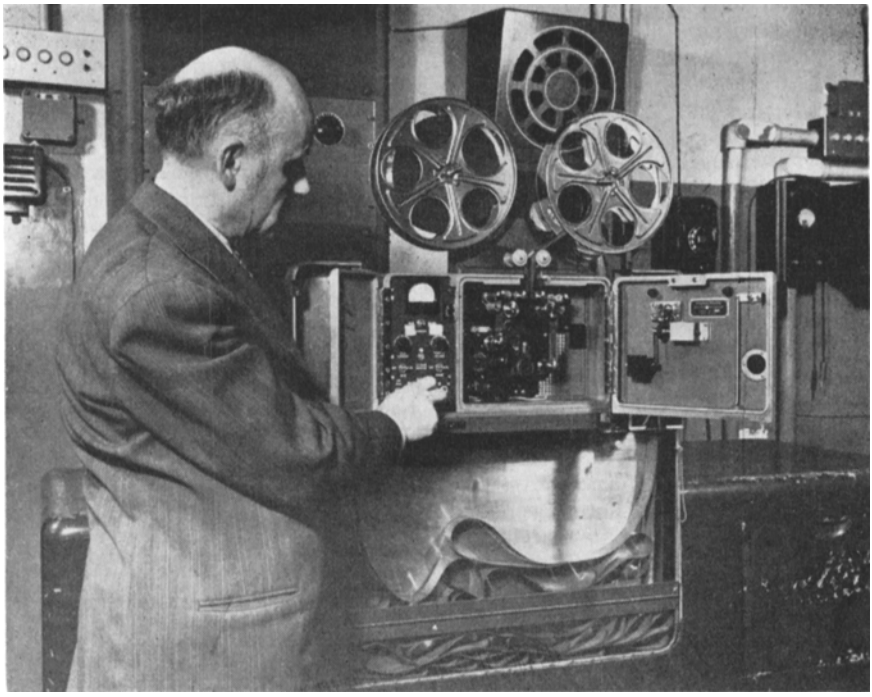

Fig. 4. Front view of Westrex 1231 Type Magnetic Recorder loaded with reels for reversible operation. The glass-door loop magazine is built into the base of the recorder.

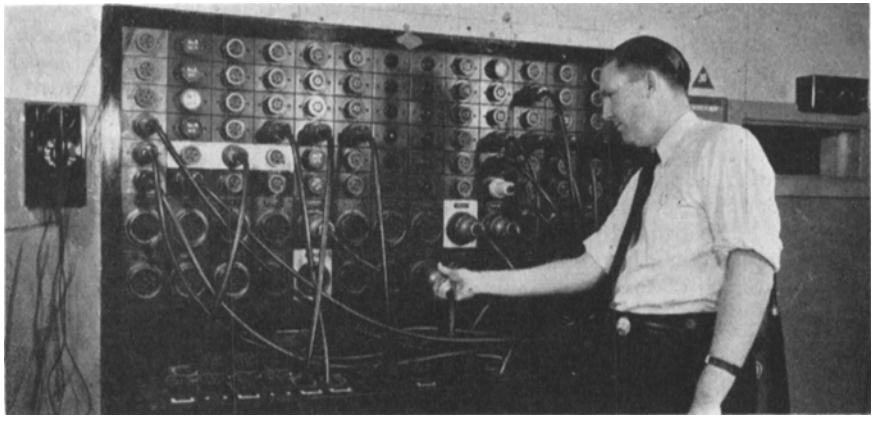

Fig. 5 The motor patch panel. The receptacles which are wired through the reversing relays are indicated by distinctive colors, as are the start positions which have reversing facilities.

transition could be made from Playback to Record with the film running, and yet have absolutely no bloop or click appear on the track. Conversely, in switching from Record back to Playback, which would be necessary if it were desired to insert a corrected paragraph in the middle of the reel after it had been completed, it is required that the end of the newly recorded track be blended into the old one without a bloop.

There would be no point in showing the exact circuit we use since each type of equipment has its own problems, but the general conditions which have to be met are as follows:

(1) The use of a separate playback head is not desirable, because this causes an unavoidable time delay. A single head should be used for both Record and Playback, with appropriate switching.

(2) A single key should be provided, with three positions: Record in one direction, Playback in the opposite direction, and a neutral position in the center.

(3) The bias and erase oscillator should be of a type which provides a separate oscillator tube followed by a driver stage and output stage. This permits the output to be controlled by the voltage on the driver stage, while the oscillator tube operates continuously, so that no trouble is encountered due to frequency shifts.

(4) When throwing the key from Playback to Record, the head should immediately switch from the input of the playback amplifier to the output of the recording amplifier. After a short delay, approximately ¼ sec, the plate voltage is applied to the driver stage of the oscillator, which should be arranged so that bias and erase currents build up gradually in about ¼ sec.

(5) When throwing the key from Record to Playback, the bias and erase currents should be allowed to die down gradually (in about ¼ sec) and then 1 sec later the head should be switched from the Record amplifier to the Playback amplifier. In other words, the important consideration, in effecting quiet transitions from Playback to Record, is to be sure that the head is switched before the bias currents build up; while, in going from Record to Playback, the bias currents must be allowed to die down gradually before the head is switched.

This last precaution, incidentally, insures against the possibility of leaving the head in a magnetized state.

(6) The neutral position of the key is utilized to keep the playback circuit open momentarily while switching from Record to Playback, so that no bloop is heard in the monitor speaker while the bias currents are collapsing.

Correcting Errors in Narration

When the system has been stopped because of an error, and the film is backed up, the sound just recorded is heard reproduced in reverse, and the picture is seen moving backward on the screen. This helps in spotting the cue at which to stop backing up. After stopping, the system is run forward again, and the playback is heard. As soon as the proper cue is reached, the switch is thrown back to Record. The narrator is then given the cue, and by the time he starts to talk, the bias current is up to its normal value.

After the reel has been completed, it is played back with the picture for checking. At this time it is often found that some error has been overlooked, and it then becomes desirable to insert a corrected sentence or paragraph. This can be done smoothly and quietly, as already described. The only additional precaution to be taken is that the inserted paragraph is not longer than the one being replaced.

Explanation of Demonstration Recording

At this point in the Convention presentation a sound recording was run to demonstrate the complete silence of what might be called the "magnetic splices" made by this technique.

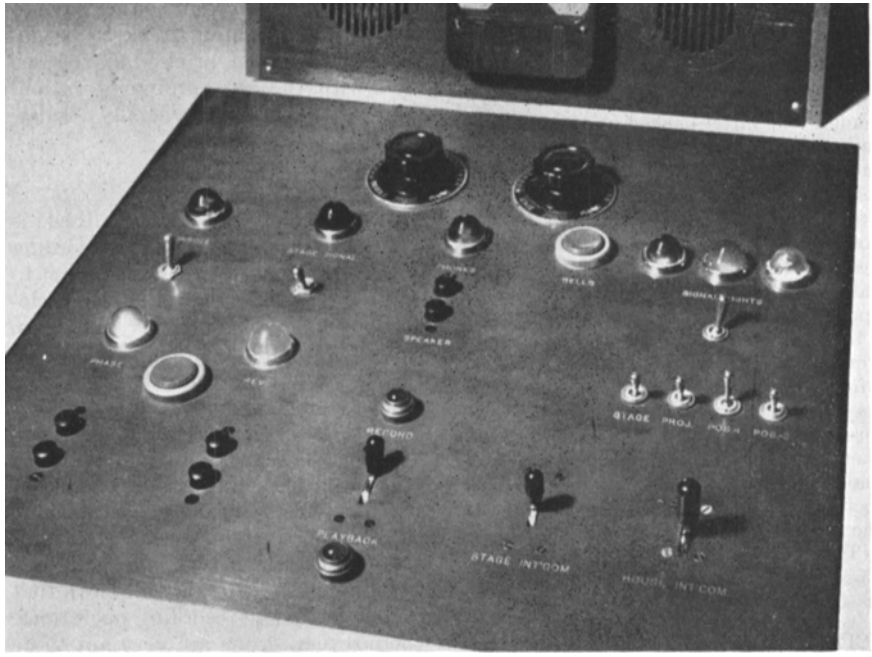

Fig. 6. Remote control panel which is built into mixing console. Complete reversing facilities, as well as switching between Record and Playback, are available.

Fig. 7. The control panel in relation to the mixing controls. The motion picture screen is visible through the window of the monitor booth.

The procedure used in recording this demonstration was to read one complete sentence and continue part way into the next sentence. The system was then stopped, as though an error had been made. The mixer backed up the film into the middle of the previous sentence, and then ran forward in Playback position. As soon as the last word of the sentence was heard, the mixer went into Record position, and the narrator proceeded to read the next sentence completely, and halfway into the following sentence. This operation was repeated for each sentence—a total of twelve sentences—so that there were actually eleven magnetic splices. After the recording was completed in this way, the sixth and seventh sentences were reread, separately, while the mixer inserted them into the record in place of the original sentences, as though they were corrections which were found necessary after the recording was completed.

The actual sound track projected was a 35-mm direct positive, re-recorded from the original magnetic film.

This system has proved successful beyond all expectations. For one thing, we find the narrator does a much better job because he can be more relaxed, knowing that if he makes an error no particular harm is done. He also does not have to keep going if he feels himself getting tired or tense, or wants to clear his throat. He simply stops and rests a moment, while we back up a little way and get ready to proceed again.

The system has proved especially valuable on rush projects, of which we have had a great many since the start of the Korean crisis. For example, Staff Film Reports, which are weekly summaries of latest battle reports made for high echelon review in the Pentagon, are narrated in the morning by this method. Immediately upon completion of each reel of narration it goes into the re-recording room, where it is mixed with the necessary music and sound effects, and transferred to the release negative, all within the space of a few hours. By the old method, we would either have to wait for the narration track to be developed and edited, or else mix the live voice with the re-recording operation, which is a difficult and generally unsatisfactory procedure.

Re-recording Operations

The technique above described is equally adaptable to all re-recording procedures as well as re-recording to sound tracks for certain types of television productions, such as newsreels. In fact, it should be adaptable to any type of production which requires the rapid assembling of narration with other sound tracks.

In the case of re-recording operations, it is entirely feasible to back up an entire bank of reproducing machines along with the magnetic recorder and projector, and we have plans for doing this in the near future. This will mean that in complicated re-recording operations, where several errors are very apt to be made in a reel, it will be possible either to correct these errors as we go along or to insert the corrections after the reel is completed, whichever happens to be more suitable. This is obviously superior to the usual procedure of doing over a complete reel because of one or two errors.

Of course, we already do all our re-recording operations on magnetic film first, and then transfer the OK take to photographic film, so that no film is ever wasted because of errors. This has been standard practice now for over two years. In this process, as with the reversing process, we have also found that there is a greater smoothness of operation and a reduction in tension on the part of the mixers, because they know that an error does not mean a waste of film. In fact, it is customary to make a magnetic recording on what would ordinarily have been a rehearsal by the old method, and it is often found that the rehearsal is a perfectly good take.

Magnetic Loops for Lip-Synchronous Operations

Another application of magnetic recording, which is still under development but will soon be in operation, is in the type of production known as foreign adaptation, or lip synchronization (lip sync for short). This is the operation in which a completed English version of a production is provided with a new sound track in which a foreign language has been substituted for the original version. Where actual dialogue is involved, the translation to the foreign version is made with a view toward having the foreign words match as closely as possible the actual syllables of the English words. The recording of this translation then becomes a very exacting process, wherein the speaker must synchronize his words as closely as possible to the actual lip movements of the person on the screen; hence, the term lip sync.

This procedure is also often used to replace original recordings by a new sound track in English, when the original is not usable due to bad pickup conditions, or to some trouble having developed in processing. Certain location jobs are often deliberately shot without sound, or with a cue track only, because of impractical pickup conditions and the sound is added later by the lip-sync process. All of the following remarks would apply equally to English and foreign lip-sync operations.

Procedure in Photographic Recording

The usual procedure throughout the industry is to break the picture down into a large number of short loops and project each of these repeatedly while an actor speaks the foreign words and attempts to match his lip movements to those on the screen. Several rehearsals are made, followed by a number of takes on film. The percentage of NG takes is usually rather high, resulting in unavoidable wastage of film. In an effort to reduce the wastage, it is customary to print several takes and combine the best portions of them. This entails considerable work in the cutting room, and infinite care on the part of the editors to accomplish a smooth job, free from noise due to handling and splicing of the film. Since considerable NG footage must be developed and printed, the process is rather costly, but this was unavoidable before the advent of magnetic recording. In any event, the process is still much more economical then reshooting the entire picture for foreign release, or making retakes where original English is involved.

Procedure for Magnetic Loops

Tremendous reduction in cost is anticipated by the use of recording on magnetic loops. Instead of breaking the picture down into loops of assorted sizes, all the loops will be cut to a few standard lengths, down to an exact number of sprocket holes. This can easily be done by adding blank leader when necessary. A number of magnetic loops are then made up to these exact sizes. The recording machine is equipped with a loop magazine, which permits convenient handling of the loops (Fig. 8). With this method it is easy to make as many takes as necessary in order to get as nearly perfect a take as possible, without wasting a single foot of photographic film. As soon as a good take is obtained, it can be played back immediately in synchronization with the picture, and as many times as desired, without even the need of stopping the film. If it is adjudged a good take, it can be immediately transferred to a photographic recorder which is always standing by ready to roll, right alongside the magnetic recorder.

In this way, the editor receives only OK takes from the laboratory, and needs only to splice them together in proper sequence to make a complete sound track. Bloop marks can be recorded from the projector in the usual way to aid in proper synchronizing.

The photographic film and its processing are thus reduced to an absolute minimum. It is conservatively estimated that film and processing costs can be reduced at least 75% by this method, while the reduction in working time in the cutting room is even greater than this.

The use of photographic film can even be eliminated completely, at this point, by re-recording the OK loops to another magnetic recorder, and assembling the completed reel by cutting the magnetic film. Moviola equipment is already available for doing this, but it has not been used as yet because of the relatively high cost of the 35-mm tape. Besides, we have plans for accomplishing this on ¼-in. synchronous tape, which would be more economical of both material and storage space. This will be touched upon in the next paper, on ¼-in. synchronous recording.

Explanation of Demonstration Film

At this point in the convention presentation a reel was run to demonstrate the result of a lip-sync operation using a magnetic loop.

A sequence from the standard SMPTE theater test reel was selected because of its familiarity to the audience. The sequence was 100 ft long, and, with the leader, made a loop 111 ft in length. While such a long loop would rarely be necessary in practice, it was used here to demonstrate that it can be done. Moreover, the great length of the loop made it possible to demonstrate that after looking at the Playback, and deciding which parts were good and which were not, it was feasible to retake the bad portions, while preserv-

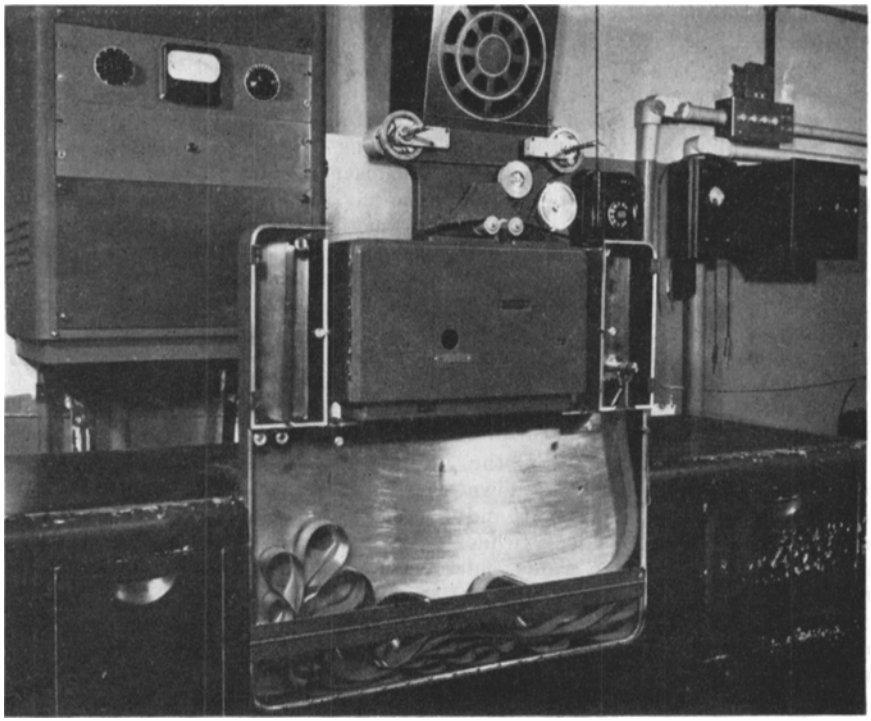

Fig. 8. Magnetic recorder threaded for loop operation.

ing the good portions. Thus, the technique for making corrections in narration is combined with the technique of using magnetic loops. The result is the production of long sequences of lip-sync without the need of editing, other than the simple transfer of the completed loop to a photographic negative for making the composite print.

Simplified Procedures

Another innovation which is being planned to simplify the lip-sync operation is to eliminate completely the use of a monitor room. We have installed facilities for doing the mixing and remote control directly on the narration stage. This means, of course, that no monitor is heard during the actual take, but the selected take is immediately heard on the playback speaker. In this way, the actor, director, mixer and script clerk become a closely knit crew without the need for an intercom system and a separate monitor room, thus simplifying and speeding up operations. Even the recording machines can be placed in a glass-enclosed booth which we have on the stage, within sight of the rest of the crew, resulting in even better coordination of the operation. Only the projection machines would remain isolated because of their high noise level.

In closing, it is desired to acknowledge the efforts of: James J. Kennedy, Jr., Chief, Transmission Section; Norman Kessel, Chief, Projection Section; Steven Szeglin and M/Sgt Sanford Hanscom, of Transmission Section; all of whom made valuable contributions to the successful completion of the work described in this paper.

Discussion

WILLIAM JORDAN: When you back up how do you eliminate the NG material?

MR. LEWIN: Before you start backing up, you throw over to Playback. That, of course, is essential otherwise you would be erasing and you might erase the wrong thing. So you hear the material in reverse and you also see the picture on the screen with everything moving backwards. That helps you to know just where to stop. Then you stop and run forward, still in Playback, so you're hearing the last part of the OK sentence. As soon as you reach the end of that sentence, the narrator gets his cue to start talking and you go into Record, erase whatever is NG on the film and substitute the correct dialogue.

DR. E. W. KELLOGG: One wonders whether this same system can be applied to correcting errors in tapes while photographing.

MR. LEWIN: Well, I suppose you could, but after all there is nothing you can do about the picture when they make a flub. Some day when we have electronic means for recording the picture, you will undoubtedly be able to erase the picture as well and correct them both.

JOEL TALL: How fast can you make the change from Play to Record without getting the sharp erase wavefront?

MR. LEWIN: The actual speed that we use is approximately a quarter of a second although we haven't made any tests yet to determine whether we can shorten that. I rather suspect we can make it quite short, but what we used in this particular setup came out about a quarter of a second. As you noticed in the demonstration, there isn't any appreciable lag between the end of one sentence and the beginning of the next, even though we had to go through the procedure of throwing the key before each sentence.

(All photographs for this paper are U.S. Army photographs.)