SERVICING SOUND MOVIE PROJECTORS

First of three articles: How they work, how to thread, adjust and disassemble them.

By JACK DARR
SERVICE EDITOR

HAVE YOU EVER STOPPED FOR A MOMENT to think how many organizations depend on movies for education or entertainment? Visit any school, church or television station and you're sure to find at least one 16-mm sound film projector. Many larger schools have a whole fleet of them, run by an audio-visual aids staff or club. And quite a few individuals own sound projectors, too. Someone's got to service them!

Repairing movie projectors is not difficult, and can be profitable. Most of a projector is, of course, optical-mechanical. But rarely will you find any mechanisms that you might not also run into in TV tuners, tuning drives or record changers. And, since we're talking about talkies, a large part of the machine is, in fact, electronic.

Basic 16-mm sound projector

Each unit includes a movie projector: projection lamp, lenses and a driving mechanism, with reels to feed the film and take it up after showing. The sound is on a *sound track* on the edge of the film. This passes over the *sound head* after it goes by the shutter. An *exciter lamp* throws a beam of light through the track, which is focused on a photocell. The resulting light variations are converted into electrical variations, and amplified by a conventional audio amplifier. Fig. 1 shows the major parts of a typical unit.

Sequence of operation

The sequence of operations is always the same, although there are normal differences between makes. The film comes from the *feed reel,* passes over *idler rollers* (not driven) to keep it in the right path, and *driving sprockets,* provided with teeth which engage the holes in the edge of the film. (All 16-mm sound film has holes on only one side, whereas 35-mm film, as used in theaters, has holes on both sides.) The drive sprockets are always fitted with some kind of spring-loaded latch which holds the film in place on the sprocket, but allows it to slide easily.

The film travels past the shutter, where it is projected onto the screen, then over the sound head, over more idlers, then to the *takeup reel,* which winds it up again. After showing, the film is rewound on the feed reel for the next showing. The reels are both mounted on cast-iron arms, which fasten to the heavy "blimp" cases in which projector and amplifier are mounted. They are driven by coiled spring-steel belts.

The sound for a given frame is always ahead of the picture. Why? Look at Fig. 1. The frame being shown is at the shutter, while the *sound* for that frame is just running past the sound head, several frames in advance! So, we must always thread up the machine so that there is the same number of frames between shutter and sound head. This is the purpose of the lower "loop" seen below the shutter. By adjusting the amount of "slack" in this loop, we can make the sound come out in exact synchronism with the picture. Too much loop, and the sound will be late; the character's lips will move, and the words will come out quite a bit later! It takes only a couple of frames to make a very perceptible difference.

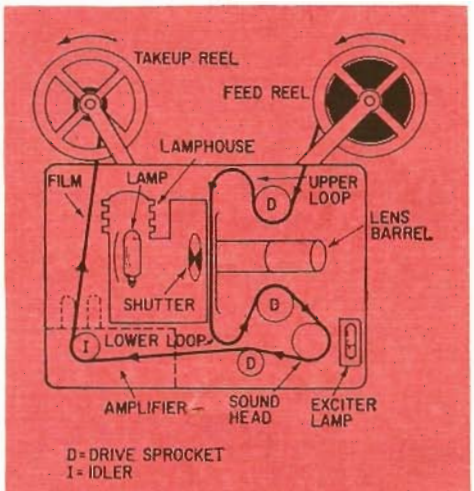

Fig. 1—Locations of major parts in a typical projector.

In most machines, you'll find *guide lines,* made of metal ridges, on the face of the housing, to show you the correct film path. This information is always given in the instruction book. If the book is missing, you'll have to figure it out for yourself. The lower loop is usually about "two fingers": make up the loop, then insert the tips of two fingers between the bottom of the pressure foot and the drive sprocket. This can be checked very quickly as soon as the machine starts! This is important only in films showing people talking. In technical films or documentaries, where you can't see the speaker, it isn't too critical.

The loops

We've mentioned the lower loop. The upper is equally important. The film in these machines does not travel smoothly down past the shutter. It travels in jerks, due to the peculiar method of projection used.

In a theater projector, the film is pulled past the shutter by sprocket rollers and travels at a constant speed. The light is interrupted by a shutter, which closes as the interval between frames passes the *gate* (the vertical blanking bar!). In small projectors, however, the film is jerked down by a pair of metal teeth during one of the intervals while the shutter is closed. A special

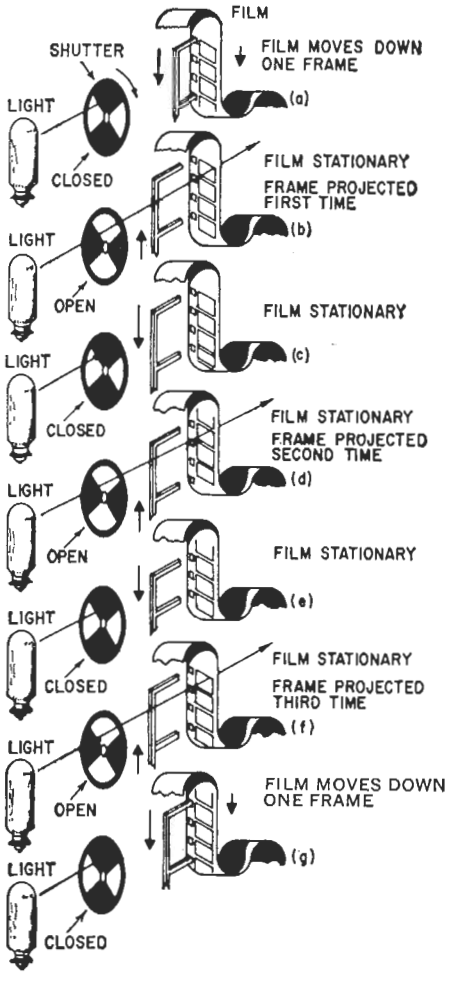

Fig. 2—"Pulldown" action cycle in 16-mm projector film gate.

cam inside the machine causes these teeth to pull the film down on every *fourth* opening of the shutter. Each frame of film is actually projected on the screen *three* times! This is done to avoid flicker on the smaller film.

From Fig. 2, you can see this action. The *pulldown teeth* are mounted in a slide, inside the film gate. A specially shaped cam causes the teeth to move *out* through slots, engage the sprocket holes in the film; and pull it down exactly one frame. The shutter is *closed* at all times while the film is *moving* (a). On the next shutter closing, the teeth pull down again, but this time they're retracted so that they do not engage the holes (c). The shutter opens (b), and one frame is projected on the screen.

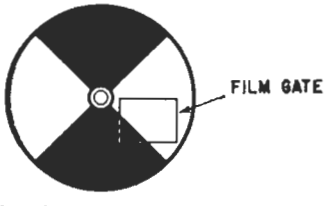

Fig. 3—Shutter of projector is actually a disc, not a flat plate. Its rotation is synchronized with the pulldown mechanism.

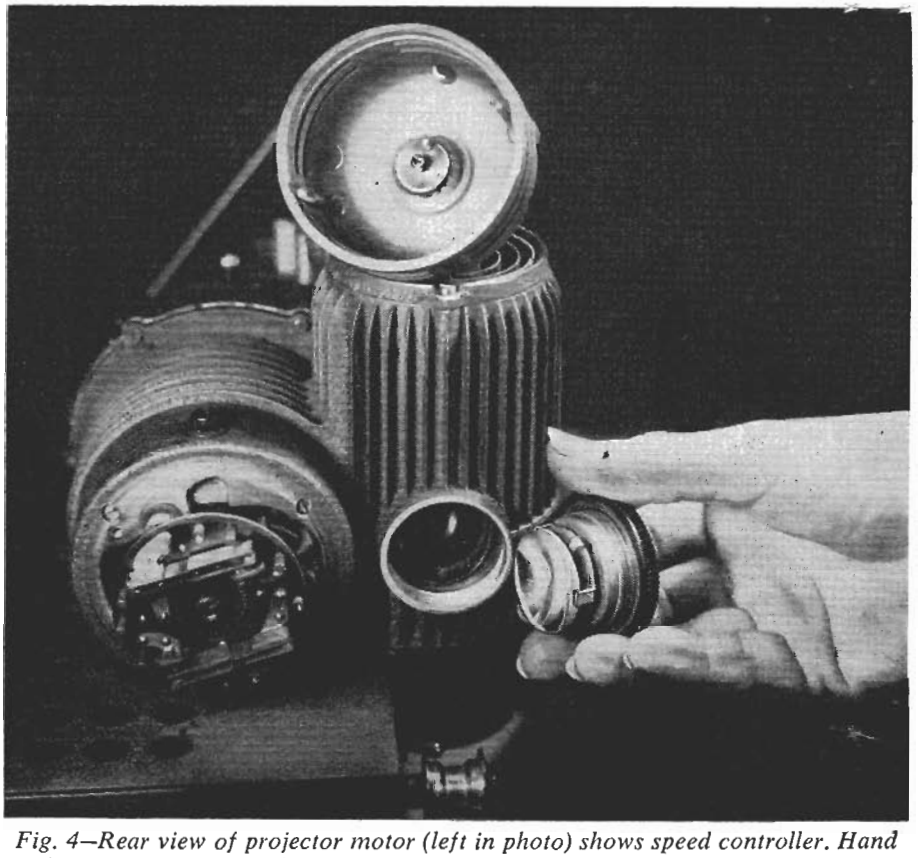

Fig. 4—Rear view of projector motor (left in photo) shows speed controller. Hand is holding parabolic reflector used behind projection lamp. It screws into hole nearby in lamphouse.

On the next two cycles (c–d; e–f) the same action is repeated. The teeth are driven up and down in synchronism with the *shutter,* but the cam keeps them retracted. So, each frame of the film is shown three times. On the fourth cycle (g), the cam pushes the teeth out again, they engage the film and pull the next frame down before the gate. The shutter is a disc (Fig. 3) with wedge-shaped slots in it.

In the 16-mm projectors used for TV films, there is a different cycle of projection. To make the frames come out "even" with the frame scanning rate, the projector shows one frame twice, then the next frame three times, then twice, and so on. This peculiar transport rate makes the frames come out even with the 60-cycle vertical scanning rate, and eliminates the flicker. (They were quite a while working that out, though!)

Now, you can see why the loops! They act as "shock absorbers" to take up the jerking motion of the film, and allow it to be drawn at a steady speed over the sound head. You can imagine what the sound would be like if this intermittent motion were used there!

Speed control

In sound projectors, film speed is very important. It must be exactly right, or we get the familiar wow and "funny sound" we'd get if a phonograph turntable was running at the wrong speed! So, a controller is used on the motor (Fig. 4). This is a centrifugal speed control similar to those used on electric mixers, etc. The end bell of the motor is the object lying on top of the lamp housing. The disc in its center engages the controller, and is used to drive a pulley for running the rear belt.

Many projectors provide dual-speed operation: 24 frames per second for sound, and 16 for silent films. The speed is changed by switching a resistor in series with the controller.

The optical system

The light from the projection lamp must be concentrated into a beam. Projectors like this use a system of reflectors and condenser lenses, as shown in Fig. 5. The parabolic reflector behind the lamp can be seen in the hand in Fig. 4. This

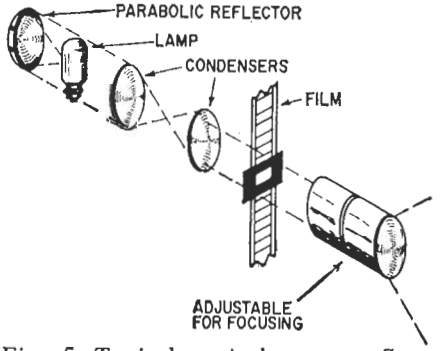

Fig. 5—Typical optical system. Some machines use fewer lenses, but idea is the same.

Fig. 6—Closeup of condenser lens, removable for cleaning. Other one is still inside, about 1 inch left of slot.

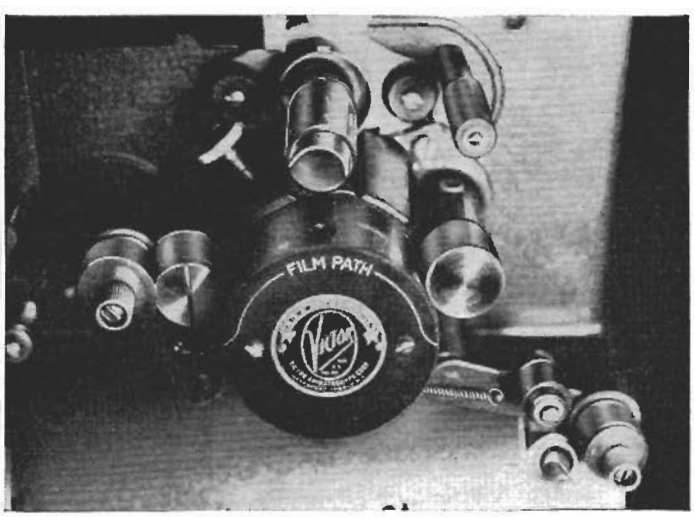

Fig. 7—Sound-head assembly.

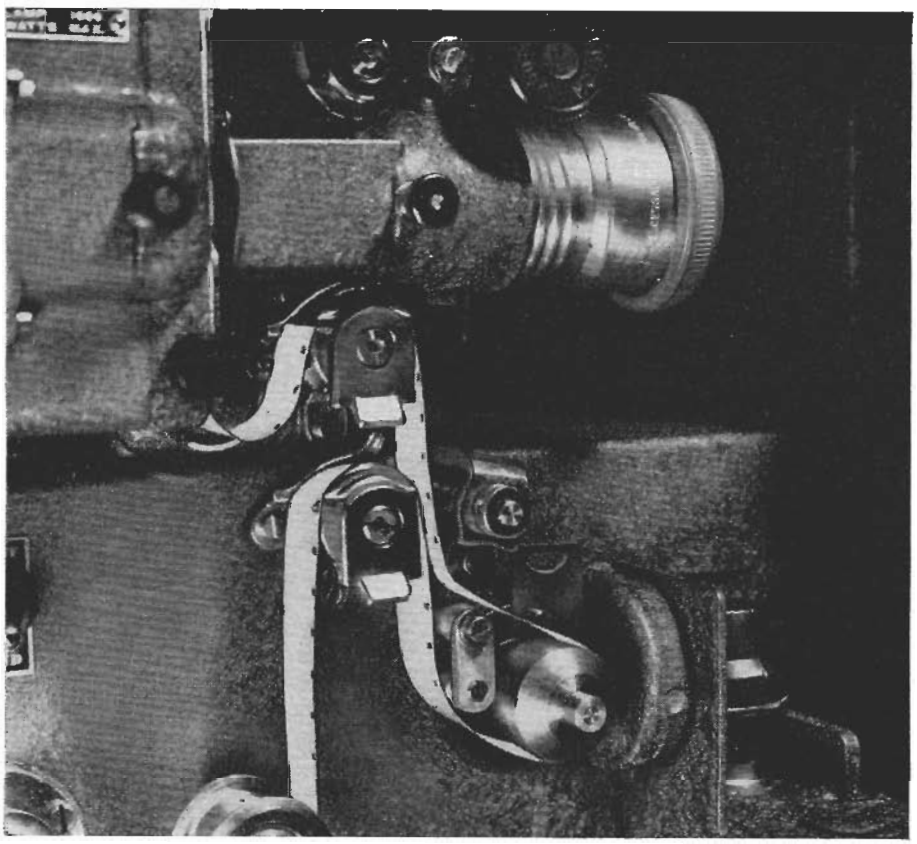

Fig. 8—Another sound-head assembly. Note shielded exciter lamp, lower right, and spring-loaded idlers between sprockets. They keep film tension constant.

reflector screws into the back of the lamp housing and can be removed for cleaning.

Two more lenses are used between the lamp and the film gate. These are also removable, as seen in Fig. 6. In the front of the gate, the projection lenses are mounted in a removable barrel. (This assembly can be seen in Fig. 1.) These outer lenses are used for focusing the light on the screen by moving the lens barrel back and forth in its holder. A locking screw is provided on all machines to keep the vibration of the motor from jiggling the lens out of focus.

The sound head

The sound head assembly of the projectors consists of an exciter lamp, a phototube and some method of moving the film past a very tiny slot, so that the light will pass through the sound track and fall on the phototube. A typical assembly is seen in Fig. 7. The exciter lamp here is inside the center housing. The hole can be seen on top, just above the words FILM PATH. The photocell is above this. In operation, of course, a lightproof shield is placed over this lamp. This is usually of metal, to prevent stray hum pickup, since this is always a high-impedance circuit.

The two drive sprockets are shown in Fig. 7, with the two spring-loaded rollers that hold the film in place, the idlers. This machine uses idlers on spring-loaded arms. The one at left is in place; the one at right open, ready to accept the film.

Fig. 8 shows the same assembly on a different machine. Here, the exciter lamp is behind the partition, at the right. The lens and slot are in the partition, and the roller in the center holds a mirror. This is set to reflect the light beam onto the phototube, which is mounted on the amplifier chassis itself, inside the projector base.

The one most important thing about the sound head is that the film must be kept at exactly the right tension as it passes over it. Notice the elaborate arrangement of drive sprockets and spring-loaded idlers used on both machines. The film must be held down very snugly against the sound head. If it is too loose, you'll get a sort of "monkey-chatter" effect, like a phonograph with a *very* bad needle and record at the same time! If you hear this kind of sound, look at the sound head to see that the drives haven't "jumped a frame" on the sprocket holes, or done something else that would allow the film to become too loose.

Next month, a look at the drive clutch and "safety shield", among other things. You'll find that threading and running are pretty much the same in all projectors, regardless of make and model. We won't get to the simpler electronics end until the third and final part, but then—making minor mechanical repairs on projectors can be a profitable venture, and will win you customers! TO BE CONTINUED