NEW MOTION PICTURE APPARATUS

During the Conventions of the Society, symposiums on new motion picture apparatus are held, in which various manufacturers of equipment describe and demonstrate their new products and developments. Some of this equipment is described in the following pages; the remainder will be published in subsequent issues of the Journal.

A HIGH-PRECISION SOUND-FILM RECORDING MACHINE*

H. PFANNENSTIEHL**

A recording machine for use in present-day commercial production of sound-film must not only be capable of propelling film at a constant velocity to produce high-quality records but must also be designed for simple, rapid, and flexible operation.

The Western Electric recording machine described in this paper was designed to fulfill these requirements after an extensive investigation of approved studio practices and of mechanical, electrical, and optical means best suited for sound-film recording. It is ruggedly constructed of materials selected to give long life with a minimum of maintenance, and all operating mechanisms are enclosed in a compact housing of pleasing appearance.

Fig. 1 is a front view of the recorder with doors closed and film magazine in place. Fig. 2 is a closed rear view, showing the housing on top, which contains a film take-up and drag mechanism, and, at the bottom, four connectors into which may be inserted plugs attached to cabling for all outside circuit connections. The handwheel shown at the left end may be used for turning the film-driving mechanism of the machine.

Film-Driving Mechanism.—The fundamental requirement of a film-recording machine is to propel film past the recording light-beam at a constant speed. In this recorder constancy of film speed is attained by a positive sprocket drive system similar in principle to that employed in the Western Electric recording machine, which has been in use in studios since 1927, but incorporating a number of improvements to assure even more constant and reliable film speed and, consequently, sound records with greater freedom from flutter effects.

The film drive system may be seen in Fig. 3, which is a view of the film compartment of the recorder. The film is propelled through the machine by means of two sprockets driven by a constant-speed motor and a worm reduction-gear

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** Bell Telephone Laboratories, New York, N. Y.

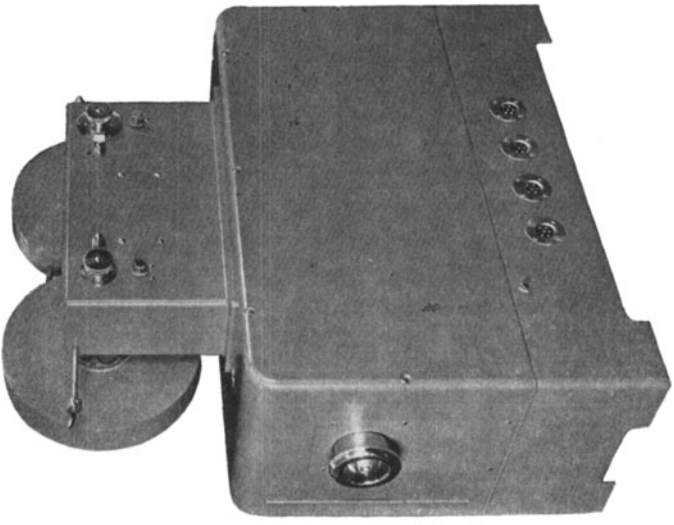

FIG. 2. Rear view of recorder.

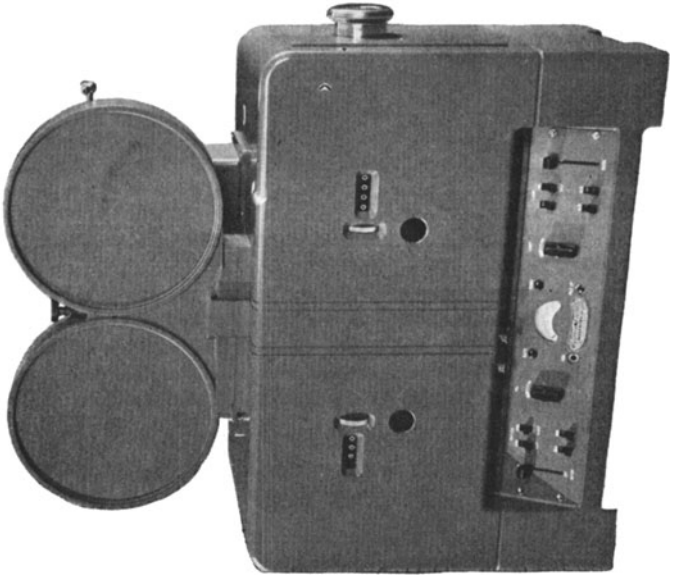

FIG. 1. Front view of recorder.

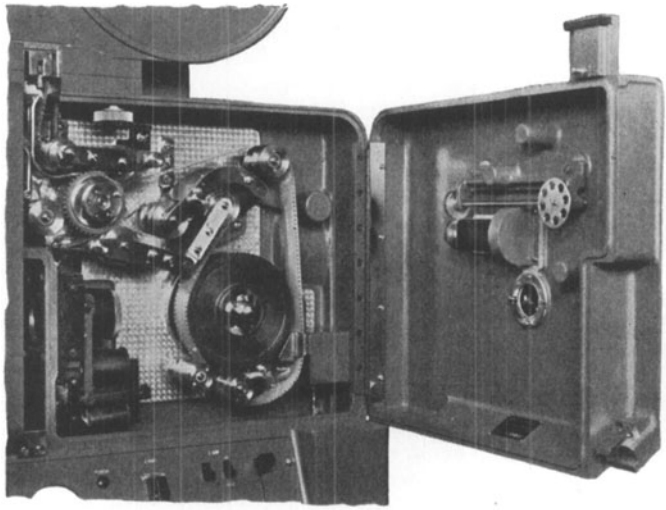

FIG. 3. Film compartment.

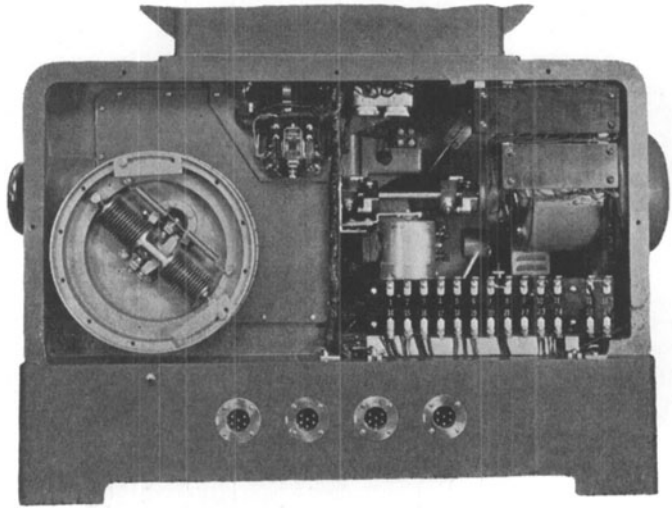

FIG. 4. Rear view, opened.

system. The smaller pull-down sprocket located in the upper left-hand corner of the compartment is directly connected to the gear system. It pulls the film from the magazine and also holds back the film, as it leaves the recorder, against the pull of the film take-up mechanism, thus isolating that section of the film upon which sound is being recorded from disturbances in the magazine mechanism.

The larger of the two sprockets located in the lower right-hand corner of the film compartment is the sound sprocket, which propels the film past the recording light-beam at the required constant speed. This sound sprocket has been designed to be used with film having a shrinkage of as much as 0.1 per cent (which is greater than found in film used for present-day sound recording) without introducing sprocket-tooth modulation in the sound-track sufficient to be noticeable in high-quality records of either music or speech. The sprocket is driven by the worm gearing through a mechanical filter which prevents slight irregularities present in even the most accurately made gears from affecting the constancy of speed of the sprocket. This mechanical filter, shown in Fig. 4, consists of an accurately balanced flywheel rigidly mounted upon the sound sprocket shaft, and a viscous damped resilient coupling connecting the flywheel to its drive gear. The damping element consists of two sylphon bellows connected through a restricted orifice and completely filled with a viscous fluid. Any variation in speed of the gear system lengthens one of the bellows and shortens the other, thus forcing the viscous fluid through the orifice and producing a damping action that effectively prevents the flywheel from oscillating. The viscosity of the damping fluid does not change sufficiently over the temperature range of +20° to +130° F. to affect appreciably the damping action of the mechanical filter.

By properly proportioning the mass of the flywheel, elasticity of coupling springs, size of orifice, and viscosity of damping fluid, the mechanical filter effectively restricts variations in the speed of the sound sprocket to an imperceptible amount, especially in the low-frequency range, where speed variations would produce a "wow-wow" effect in sound records. It also rapidly stabilizes the speed of the sound sprocket after the recorder is started, so that the recording of sound may begin in less than two seconds after the motor has come up to its full speed.

The drive gear system is enclosed in a housing containing a reservoir of oil, oil from which is circulated by means of a pump through tubing to the mesh of the worm and worm gears and to the sound sprocket gear bearings, which are thereby kept constantly flooded with oil while the machine is in operation. Effective means have been employed to prevent leakage of oil from the housing, especially into the film compartment. The level of oil in the reservoir may be checked conveniently on a gauge-glass located in the film compartment.

Referring again to Fig. 3, it will be seen that threading the film through the recorder is simple and rapid. After leaving the storage compartment of the magazine, the film passes through a guide which holds it in focus for a slating device (to be described later), over a roller to the pull-down sprocket, and thence over a series of three rollers to the sound sprocket. The middle one of the three rollers is mounted in a pivoted frame which is weighted to produce a definite and constant tension in the section of the film passing between the two sprockets. This film-tensioning roller assists in keeping the film speed constant at the sound recording point by maintaining a constant film load on the filtered sound sprocket. The

roller of this series nearest the sound sprocket is equipped with spring-retained flanges to guide the film past the recording light-beam so that the sound-track is located within 0.001 inch of its correct position upon the film.

After leaving the sound sprocket, the film passes as a loose loop over guide rollers and through a punch (to be described later), and thence over a guide roller to the pull-down sprocket, which maintains the loop against the pull of the film take-up mechanism. In going from this sprocket into the magazine, the film passes a switch mechanism which is tripped when a loop forms in this section due to any failure of the film to take up in the magazine. The tripping of this switch, due to the piling up of film, closes a contact that lights a signal lamp on the instrument panel and also operates a relay to stop the motor. By this means the is film is stopped before it can pile up in the machine and cause damage.

All film-guiding and controlling rollers are ruggedly mounted and rotate on precision ball bearings having exceptionally low and uniform friction. They are lubricated for ordinary life and sealed against leakage of lubricant and entrance of dirt. The worm-gear and sprocket shafts of the film-driving mechanism are also mounted upon the same type of ball bearings.

A brake is provided which may be operated from a lever on the instrument panel to stop the recorder quickly after current to the motor has been cut off, and thereby reduce film wastage. The brake may also be arranged to be operated by an electromagnet for remote control.

The film take-up mechanism contained in the housing on top of the machine in back of the magazine consists of a frictional slip clutch driven by a silent chain and sprocket gearing from the main drive gears, and is arranged to be coupled to the spool in the magazine upon which the film is wound. This slip clutch may be adjusted while the machine is in operation. An adjustable slip friction drag mechanism also is included in this housing which couples with the pay-off spool in the magazine to prevent the film from unwinding too rapidly and to keep it slightly taut as it enters the recorder. Either the Mitchell or the Bell & Howell film magazine may be used with this recorder.

A film footage counter mounted on the right-hand door is so arranged that when the door is closed it is coupled through gearing to the pull-down sprocket shaft.

Fig. 5 is a front view with the doors opened exposing the film sprockets and guide rollers, film punch mechanism, and shutter, in the film compartment at the right; and in the compartment at the left, the recording optical system, light-valve, monitoring system, slater, and drive motor. All manual controls for operating the recorder are accessibly arranged on an inclined instrument panel located at the bottom of the housing.

Modulator and Monitoring System.—Light-valves and their associated optical systems to modulate the recording light in either the standard or push-pull method of recording may be interchangeably mounted upon an optical bench located in the left-hand compartment of the recorder. This optical bench is equipped with adjusting screws to locate the recording lamp and to focus the recording light-beam upon the film.

Associated with the modulator is an optical system, photoelectric cell, and amplifier which provide for high-quality photoelectric cell monitoring of either standard or push-pull recording. In the optical system a thin glass plate, located

in the recording light-beam, between the light-valve and the recording objective lens, diverts about 10 per cent of the total useful recording light-beam projected into the photoelectric cell, by means of lenses and a prism. The output of the amplifier associated with the photoelectric cell is wired to a jack on the instrument panel for connection to a monitoring head-set receiver.

The light-diverting glass in the monitoring optical system is readily removable for cleaning. It may be replaced by a silvered mirror, so that all the recording light-beam may be reflected into the photoelectric cell for testing purposes. A jack located in the top of the amplifier and connected into the photoelectric cell circuit provides means for connecting a microammeter into the circuit for the purpose of setting lamp current and the noise-reduction biasing current, checking

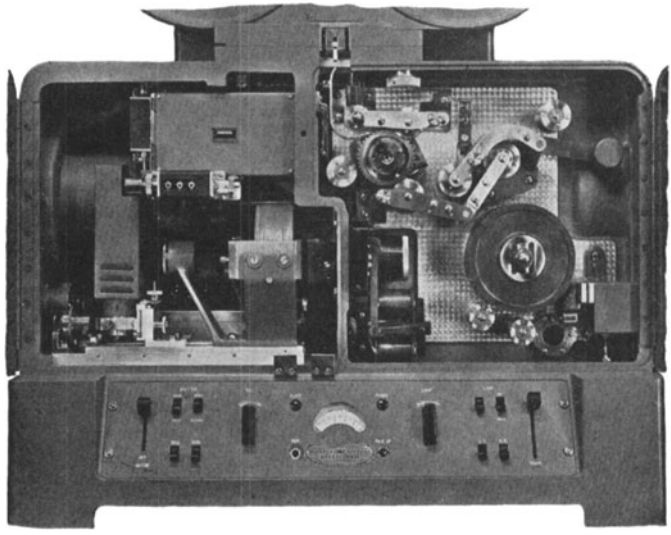

FIG. 5. Front view.

light-valve overload, or, in the case of previous lamp calibration, for checking the light-valve spacing.

Accessories.—Several accessory devices that may be mounted as component parts of the recorder are provided to facilitate such practices as marking the "take" number of the record, punching an identification notch or hole into the film and rapidly cutting in or out the recording light-beam. An automatic switch for controlling the various operations in their proper sequence is also provided.

The slater shown in the upper part of Fig. 5 is used to mark photographically the "take" number of the film. It contains two counters: one located so that its figures are visible through an opening in the left-hand door, when closed, and the other located with its figures in the plane of the sound-track center-line. Upon operating a push-button on the instrument panel, two lamps illuminate the

figures on the dials of the latter counter, which are projected upon the sound-track area of the film with a reduction of approximately 4 to 1. A lever on the door steps the dials of both counters, which are geared together to operate in synchronism so that the number appearing upon the door counter is the number photographed upon the film. Additional identification marks may be photographed upon the film by inserting cards in slides adjacent to the illuminated counter dials.

An electromagnetically operated punch unit located in the lower right-hand corner of the film compartment shown in Fig. 5 may be used to punch a notch in the edge or a hole in the center of the film, as desired. A button on the control panel is provided for operating the punch.

The projection of the modulated light-beam from the light-valve to the film is controlled by means of an electromagnetically operated shutter located on the wall between the film and optical compartments, as shown in Fig. 5. A switch on the instrument panel is provided to operate the shutter, which opens or closes in $^1/_{200}$ second or less. At this speed a definite and sharp line is produced upon the sound-track at the cut-off point, which may be used as a synchronizing mark. The recording objective lens mounted on the shutter frame is adjustable by means of a screw to locate the modulated light-beam at the proper distance from the perforations in the film.

A switch mechanism contained in the upper housing of the recorder is operated from the main drive system to control various operations of the machine automatically in proper sequence. When the recorder starts, the switch automatically changes the current to the recording lamp from its "hold" to its "on" value so that it is lighted to full brilliancy before recording begins; it opens the shutter to permit the recording light-beam to be projected upon the film after the slater marks in the sound-track area have passed beyond the recording point, thereby preventing fogging the marks by the recording light, and it disconnects the battery from the slater and punch so that these devices can not be accidentally operated and damage the film while the recorder is running. Upon stopping the recorder, the switch automatically restores the recording lamp current to the "hold" value, eloses the shutter, and restores the battery to the slater and punch.

Provisions are made to connect remote-control devices for operating the slater, punch, shutter, noise-reduction circuit, *etc.*

This sound recording machine has been developed by the Bell Telephone Laboratories to meet not only the studios' basic requirements, but to facilitate their specialized methods. Thus has been provided a recorder that contains not only the mechanical elements necessary to film propulsion and sound quality of the highest precision, but also those conveniences demanded by the production methods of the studios and their operating personnel.