

## A SOUND-PICTURE REPRODUCING SYSTEM FOR SMALL THEATERS\*

G. PULLER\*\*

The Western Electric Sound Picture Reproducing System described in this paper was developed by Bell Telephone Laboratories, primarily to meet a demand for a system capable of high-quality reproduction from film in motion picture theaters of small seating capacity. The system was introduced by Electrical Research Products, Inc., during the early part of this year. All the essentials of a good sound-film reproducing system have been incorporated in the new simplified system which is especially designed to fit the needs of small theaters.

A complete system consists of two reproducing sets; a control unit, which provides switching means for the power and voice circuits and the exciter lamps; a system amplifier, power supply unit, and monitoring loud speaker, all housed in a single cabinet; and the stage loud speakers. By means of the control cabinet, either photoelectric cell may be connected to the system amplifier input, the associated exciter lamp current being switched simultaneously to its normal operating value. Both exciter lamps are connected in series, the exciter lamp current of the stand-by reproducer being reduced to about one-half its normal operating value. The equipment is operated entirely from a 105- to 125-volt, 50- or 60-cycle power supply.

The reproducing set consists of a standard Simplex picture projecting equipment employing any of the various Simplex types of projector mechanism, the lower film magazine being supported by either an *R* or an *L* type of pedestal. The sound reproducer reproduces the sound-track recordings of standard 35-mm. variable-width or variable-density sound-film into an electric current suitable for amplification. It is mounted between the usual Simplex pedestal arm and the lower film magazine, as illustrated in Fig. 1, and consists of a frame casting with a single compartment housing the film speed control mechanism which in this reproducer consists of an inertia-controlled scanning drum, or kinetic scanner, mounted on precision ball bearings to reduce friction to a minimum. Extra precautions have been taken to seal the ball bearings effectively against the entrance of dust, which would interfere with the smooth rotation of the scanning drum and introduce disturbances in the reproduced sound. The construction is such that the initial lubrication should last for an indefinite period. The kinetic scanner and its associated parts are manufactured to the highest degree of precision, and the final assembly is accurately balanced in order to assure uniform travel of the film past the scanning point and to prevent the film from weaving

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\* Presented (by title) at the Spring, 1936, Meeting at Chicago, Ill.

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

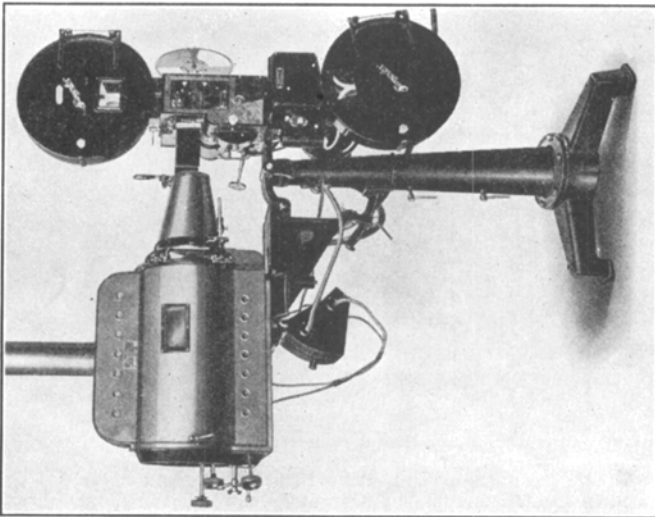


FIG. 1. Sound-picture reproducing system for small theaters, showing the reproducer mounted between the Simplex pedestal arm and the lower film magazine.

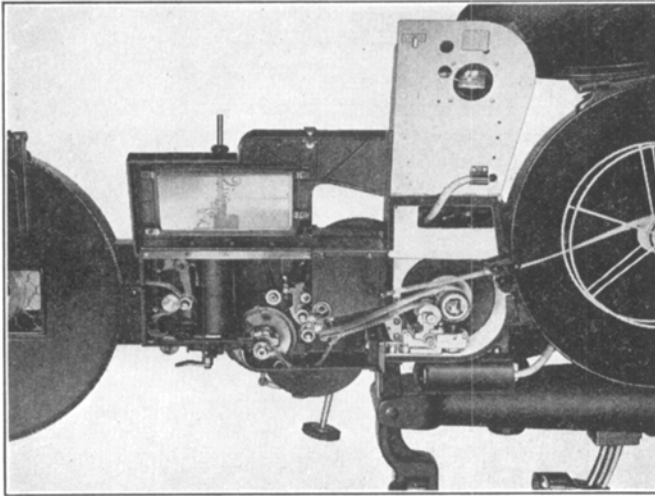


FIG. 2. The path of the film through the projector magazine and the sound reproducer.

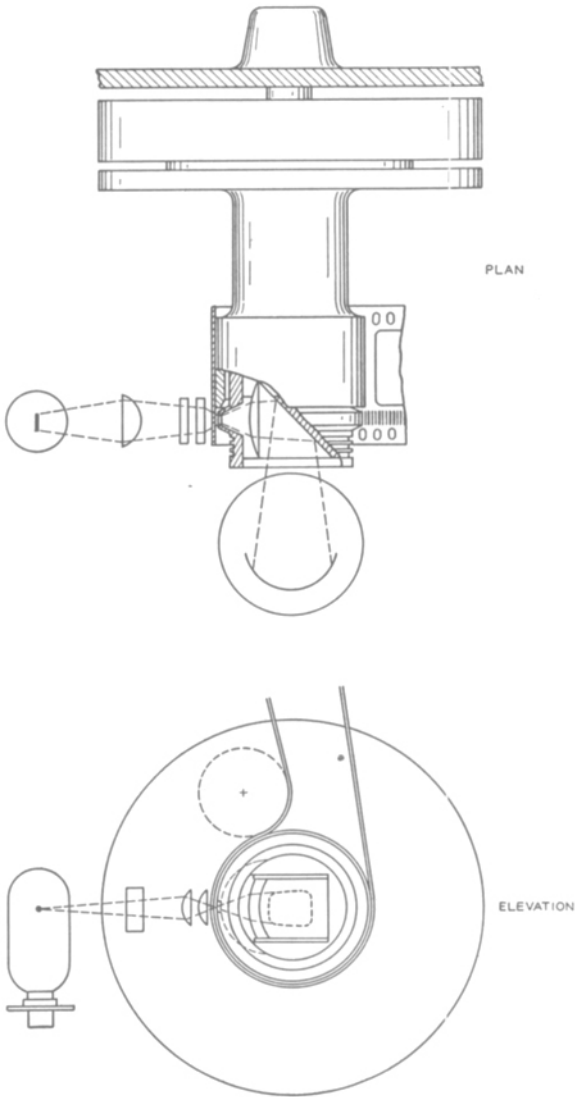


FIG. 3. A totally reflecting prism having one convex surface, located within the scanning drum, deflects and focuses the light-rays at right angles into the photoelectric cell after passing through the sound-track. The aperture in the prism holder limits the length of the scanning line, and is shielded to exclude stray light.

in and out of its proper focal plane. Constant speed of the scanning drum is maintained by means of the specially designed double flywheel of the kinetic scanner. One flywheel is integral with the scanning drum, which effectively prevents high-frequency oscillations of the film; the other is free-floating, and is coupled to the first by means of a mechanical filter which effectively suppresses slow oscillations. The kinetic scanner is so stabilized that a sudden change in the film speed or a disturbance in the film loop, such as the passage of a film splice, has no appreciable effect upon its uniformity of rotation. During the acceleration period of the scanning drum the two flywheels are coupled together by means of a centrifugal clutch.

As shown in Fig. 2, the film is threaded into the projector mechanism in the usual manner, up to the intermittent sprocket, from which it passes directly through a film chute into the sound reproducer. Here it is guided by a pivoted guide roller onto the scanning drum of the kinetic scanner, around which the film is wrapped. From this point it passes up to the lower feed sprocket in the projector mechanism and thence down to the lower film magazine. A clear path is presented for easily threading the film and for accessibility of the parts of the mechanism inside the sound reproducer.

The extremely low friction of the kinetic scanner allows the film wrapped around the scanning drum to rotate the scanner without being subjected to appreciable tension. This results in the formation of an elastic film loop between the scanning drum and the feed sprocket, introducing a compliance between the feed sprocket and the scanning drum and preventing the sprocket tooth impulses from being transmitted to the scanning point. The film chute can be readily dismantled for cleaning. Film scratching and abuse are eliminated by the use of highly polished film guides. The pivoted guide roller is supported between bronze bearings lubricated through covered oil-cups, and provides an adjustable means for guiding the film edgewise around the scanning drum and retaining the sound-track of the film in its proper path with respect to the center of the light-beam. The flanges that guide the film edgewise are chromium-plated to resist wear. The guide roller adjustment is accomplished by a slotted knob accessible through an opening in the closed door. No film sprocket or sprocket drive mechanisms are employed in the sound reproducer, thus resulting in a simple construction. The location of the lower film magazine is such that the usual projection angles are readily attained.

The exciter lamp constituting the light-source is mounted in a separate holder external to the sound reproducer. To eliminate adjustments and to facilitate replacements in case of lamp failure, a new type of lamp provided with a pre-focus skirt on its base is employed.

The lens tube assembly is hermetically sealed and is exceptionally efficient in terms of light output. It images the incandescent filament of the high-intensity exciter lamp as a concentrated line of light directly upon the sound-track of the film by means of cylindrical lenses without the use of a mechanical slit. It operates in an over-all distance of 75 millimeters between lamp filament and film plane. The lens tube assembly may be adjusted when the compartment door is closed by removing a latch plate, thus exposing an opening through which the focusing adjustment at the back of the lens tube may be made and a screw and lock-nut for adjusting the light-beam azimuth. A totally reflecting prism having

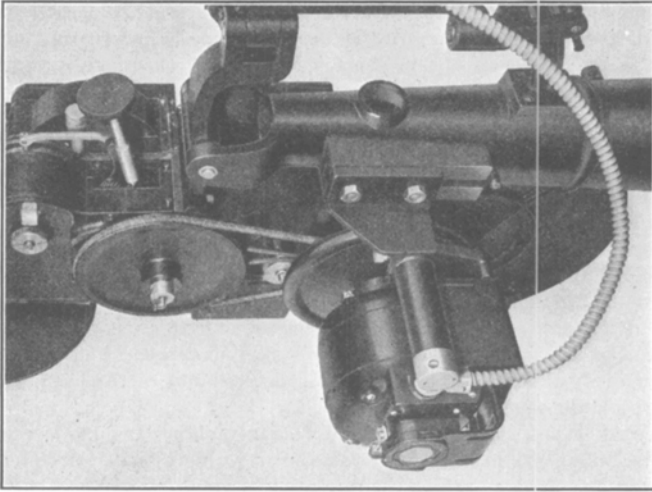


FIG. 5. The endless belt drive of the Simplex projector mechanism.

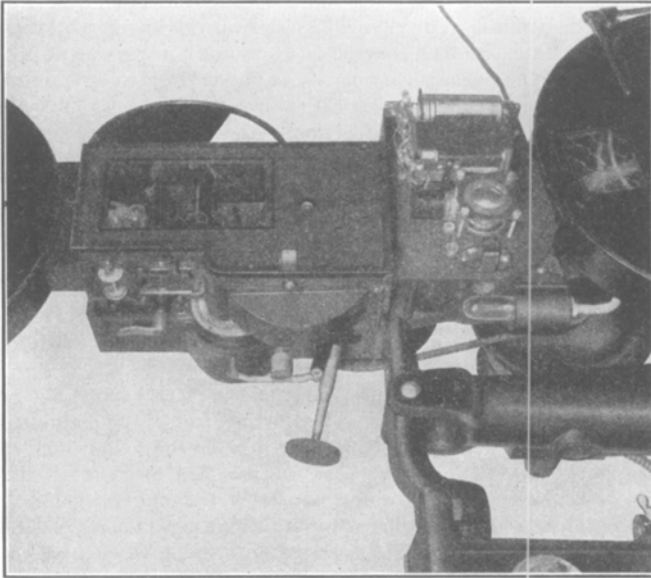


FIG. 4. The photo cell and associated transformer and condenser are mounted upon the door of the film compartment, shielded against electrical disturbances by a sheet metal cover.

one convex surface is located within the scanning drum to deflect and focus the light-rays after passing through the sound-track, out at right angles into the photoelectric cell, as shown in Fig. 3. The prism is mounted in a holder which can be removed readily for inspection and cleaning without disturbing its adjustment. The prism holder incorporates an aperture which is introduced immediately behind the point at which the film is scanned to limit the length of the effective scanning line. The aperture opening is such that only the light passing through the 0.083-inch-long aperture reaches the photoelectric cell by way of the prism, the aperture being shielded to prevent stray light from entering and affecting the



FIG. 6. The cabinet containing the amplifier, rectifier, monitoring loud speaker, and associated equipment.

sound reproduction. Precaution have been taken to assure that the mask aperture is not easily obstructed by dirt or film particles adhering to its edges.

Although the system was primarily designed for use with Simplex projectors, a similar sound head is available for Powers projectors.

The Western Electric photoelectric cell with its associated transformer and condenser are mounted upon the door of the film compartment, as shown in Fig. 4. The entire assembly is protected by a sheet metal cover which acts also as a shield against stray electrical disturbances.

The photoelectric cell is mounted in a cushion support to minimize vibration and resultant microphonic disturbances. The associated photoelectric cell transformer is likewise cushion-mounted, in order to eliminate microphonic

disturbances. A flexible armored cable is employed to bring the photoelectric cell circuit from the door to the terminal compartment: at the front end of the sound reproducer. From here the sound circuit extends through the main amplifier and thence to the stage and monitor loud speakers. To facilitate ready inspection and to avoid damage during shipment, the kinetic scanner is arranged for easy removal. Since its removal also necessitates the removal of the optical assembly, this part is located in the sound reproducer frame by removable dowel pins, thus assuring the correct replacement of the optical assembly after having been removed.

As shown in Fig. 5 the Simplex projector mechanism is driven by means of a round endless belt. The motor used to drive the equipment is a  $1/8$ -hp. single-

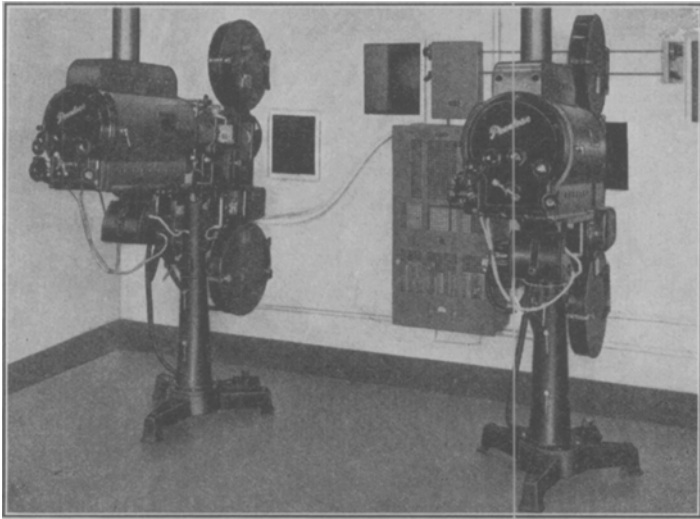


FIG. 7. A typical projection room installation.

phase induction motor having a split-phase starting winding. A combination flywheel and handwheel is attached to the driving motor to prevent the projector mechanism from starting too rapidly when the current is turned on, which might result in film damage, and to facilitate turning the machine over by hand during the film-threading operation. The pulley which is integral with this handwheel is arranged to propel the film at a speed of 90 feet per minute. As usual with this type of motor the speed regulation depends upon the frequency of the power supply. The motor is suspended in a rubber-cushioned frame in order to reduce vibration to a minimum. This, in turn, is mounted upon a pivoted bracket secured to the projector pedestal. In order to adjust and maintain the driving-belt tension to the minimum required to drive the projector mechanism reliably, the motor weight supplying the tension is partly balanced by means of an adjustable torsion spring.

The driven pulley is equipped with a gear which meshes with the projector gearing. This pulley and gear rotate on a stationary shaft supported from the projector. Lubrication is provided through an oil-cup conveniently located. The take-up drive of the lower film magazine is connected by a belt directly to the projector mechanism in the conventional manner, an adjustable tension pulley being provided for maintaining the proper tension to the belt driving the lower take-up reel.

The associated amplifier set is housed in a perforated steel cabinet intended for mounting upon a wall and suitably ventilated. A removable metal front is provided so as to simplify maintenance. In Fig. 6 is shown the cabinet in which are mounted the amplifier, rectifier, monitoring loud speaker, and associated equipment. A three-stage resistance-coupled amplifier is used, employing two suppressor-grid pentodes in the preliminary or voltage amplification stages, one high-transconductance triode in the output stage, and one full-wave rectifier tube. The amplifier also furnishes polarizing potential for the photoelectric cells and field energy for the monitoring loud speaker in the amplifier set. It has

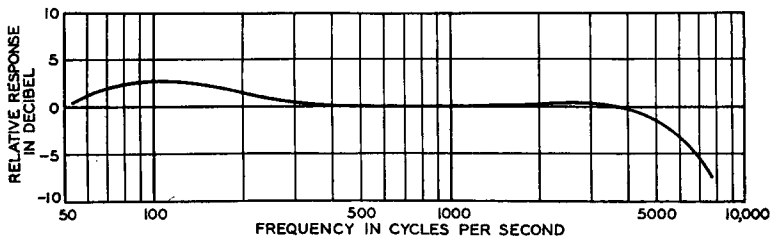


FIG. 8. The relative transmission-frequency characteristic of the system, from modulated light into the photocell to the amplifier, in terms of output load.

an undistorted power output of 8 watts. A separate power supply furnishes rectified and filtered current for the fields of the loud speakers on the stage and for the photoelectric cell exciter lamps.

A control cabinet intended for mounting upon the front wall of the projection room between the two projectors is used for connecting the output of either of the two reproducer sets to the amplifier, for volume control, for switching between exciter lamps, and for exciter lamp equalization. The extension controls with which this cabinet is furnished makes it convenient for operation from either of two projectors. A typical projection room installation is illustrated in Fig. 7. The potentiometer associated with the control cabinet permits adjustment of the input level to the amplifier in 2-db. steps. From the amplifier the sound circuits are conducted to the stage loud speakers, the number and size of which depend upon the installation requirements.

In Fig. 8 is shown the relative transmission-frequency characteristic of the system, from modulated light into the photocell to voltage out of the amplifier, in output load. The new system is compact, easy to operate, and as simple and economical in construction as is consistent with the maintenance of high-quality sound reproduction.