A Newly Designed Optical Printer

OXBERRY #1000-Series Optical Printer

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A new optical printer has been designed with many new features incorporated in one completely coordinated unit. These features are enumerated and their functions described.

The optical printer described here has been designed by John Oxberry with the aim of constructing a printer for high-quality work accomplished with a minimum of time and effort required of the operator. The new printer incorporates a number of noteworthy features:

1. Automatic follow-focus controlled through one lead screw covers a range of from 1-to-3 blow-up through 1-to-1 down to 4-to-1 reduction.

2. Automatic dissolve provides up to 50 settings ranging from 8 to 120 frames.

3. Interchangeable film transport mechanisms accommodate 35mm and 16mm in one housing which remains in place on the printer to maintain precision alignment.

4. Tilting mechanism aligns a scene precisely without distortion.

5. Improved movements permit adjustments of less than 0.001 in. on lens mount and projector head.

6. Higher efficiency lens and light systems deliver more illumination to the film surface than is possible with straight condensers.

7. Solid steel shafts are used to maintain alignment at all points and permit an extension of lens and camera travel (Fig. 1).

General Construction

To assure stability, the basic console is designed with interlocking, strain-relieved castings which weigh approximately ½ ton. All motors, blower and transmission mechanisms are mounted on a separate steel chassis isolated from the frame on which optical equipment is attached.

The printer has a variable-speed drive, designed to operate at stop-motion speeds through a range of 50 to 240 rpm, which permits the selection of any intermediate speed. An electric tachometer indicates the speed (rpm) at which the printer is operating.

A compact clutch system is employed to speed manual work and facilitate skip-frame tasks which add or drop frames to slow down or speed up the action. An auxiliary mechanism can be provided for automatic skip-frame operation.

Working space between camera and projector is approximately 28 in., allowing the installation of anamorphic and other special lenses. There are 5 counters, 3 for film footage and 2 for position. Five dial indicators facilitate interrelated positioning by the operator.

Dimensions of the printer are: height, 72 in., length, 65 in., width, 28 in. Installation space should provide 18 in. to the rear for servicing, 36 in. at the front for the operator, 18 in. on the camera end, and 18 in. on the projector end. The complete printer weighs approximately 2100 lbs.

Operating on a 115-v., 60-cycle supply, the unit can also be supplied for operation on 50 cycles, either 115 or 230 v. A panel board on the side of the printer includes a safety switch, bypass switch, and other operational controls. Removable plates provide accessibility to electrical and mechanical parts. A duct system permits oiling of a dozen major points by applying lubrication at one location (Fig. 2).

Manual Follow-Focus

The system permits rapid manual zooms and also provides for predetermining zooms and for repeating zooms accurately through use of mechanical indicators and a scale. Two lead screws are built into the unit, one for the lens mount and one for the camera mount. Each lead screw is provided with a mechanical counter and handwheel. This system permits maintenance of optical center with a minimum of friction for delicate axis positioning.

A guide scale with field calibrations is provided for the manual follow-focus operation. Two special flip-over counters designate zoom positions for lens and camera in 100ths of an inch. A calibrated dial subdivides the readings into 100ths of an inch.

Some Automatic Features

The automatic iris adjusts the camera lens automatically, thus eliminating one operation when doing manual follow-focus. Exposure stops are cam-operated throughout the changeover from 3-to-1 blow-up to 4-to-1 reduction.

The automatic skip-frame mechanism may be added to the printer at any time if provision for the addition is made when the unit is under construction. This device automatically handles 1 to 8 frames in the camera, 1 to 8 frames in the projector, or any combination within these limits.

The printer can be made with a built-in feature for automatic focusing through a continuous range from 1-to-3 enlargements through 1-to-1 and down to 4-to-1 reductions. Camera and lens mounts have an additional 1½-in. movement to...
film at the proper film plane. This new feature permits a piece of film, such as a previously exposed or developed frame, to be placed on the registration pins over the ground glass for clearer image. The operator views through the film first and then through the ground-glass field markings which are fixed in relation to the pins.

Markings on the reticle are essentially a series of rectangles. The progression from largest to smallest is as follows: (1) silent aperture, (2) camera sound aperture, (3) 35mm sound projection aperture, (4) dotted 25% TV cutoff aperture for 35mm, (5) 16mm camera aperture, (6) 16mm projection aperture and, (7) dotted 25% TV cutoff aperture for 16mm. Reticles also have horizontal and vertical cross-lines common to all rectangles. A short tick-line represents the center of silent 35mm or 16mm film (Fig. 6).

One may easily view an entire film frame with each etched rectangle; lines are 0.002 in. thick and are clearly apparent. The superimposition ground-glass gauze is mounted firmly on the camera body to assure maximum stability. Only the eyepiece is attached to the hinged section.

Viewfinder: The camera incorporates a viewfinder which permits the operator to observe the film when checking action and composing. Since the printer may be run at one-half live-action speed, the viewing on the printer is comparable to screening film on an editor. The projector head has a hand control for advancing the film and this permits adjustment of frames while viewing.

Special Critical Viewing: For super-critical lineup work with traveling matte or alignment checking, one may sight directly through shuttle from rear of camera (Fig. 7). The basic design provides for removal of the sprocket assembly as well as a cutout back pressure plate from the shuttle.

Buckle Switch: A special buckle switch in the camera housing provides complete protection against jamming or other improper operation of the film transport mechanism. Should a jam occur, the printer automatically stops and a white signal light on the control panel flashes to indicate the trouble.

Tilt Mechanism: The camera is mounted on a built-in tilting cradle and is accurately positioned by means of a control knob and dial indicator. This permits scenes to be straightened and allows the operator to do precision alignment work. This feature, used in conjunction with projector and camera adjustments, permits a wide latitude of corrective film positioning.

Light Meter

This portable instrument is mounted between the projector head and camera and is readily accessible for light readings with special probes. Probe accessories include: (1) one shutter blank probe holder for camera readings for either 35mm or 16mm, (2) two probe holders to fit the projection aperture, one for 35mm and one for 16mm. The light meter has three foot-candle scales, 0–20, 0–50 and 0–500.

Lenses

Two lenses are recommended as standard equipment and they are readily interchanged in the mount. One is a 4-in. Ektar f/4.5 which is best suited for zoom work. The other lens is a 103mm f/2.8 printing Ektar which is designed for 1-to-1 work. An accessory 90mm lens is available as optional equipment. It is designed for 16mm to 35mm film blow-up work for 35mm to 16mm reductions.

For work with squeezed 35mm to unsqueezed 35mm, a special CinemaScope lens is supplied, when specified by the customer. This is a special CinemaScope lens that is designed to fit the Oxberry mount.

A special flip attachment is attached between the lens and projector head and is designed so that the lens may be positioned at any angle for vertical or horizontal flips (Fig. 8).

The lens mount is designed with three castings which are precision-machined. The mount rides on two ground shafts and is heavily spring-loaded. Lead screw movement is threaded 40 turns/in. and adjustments are made with a knurled knob which provides micrometer action. Vertical movement of the lens mount is essentially the same except that it has
place it on the fixed locating pins. During this cycle the heart cam brings back the carrier pins and the action is repeated. Motive power for the sprockets is delivered by the camshaft worm.

The fixed-pin shuttle design eliminates the need for moving pins—it is the only method so far reported satisfactory for high-precision process work. The new shuttle mechanism is limited by design to speeds below 700 rpm.

**Projector**

The projector head is mounted on a finely controlled compound movement, and two dial indicators are provided for positioning. This compound action assures accurate offset settings such as are used for off-center zooms (tracks). The design also facilitates fine alignment and makes simple changing between 35mm and 16mm. Four spindles each accommodate one 1000-ft reel of film.

The Oxberry compound movement can handle push-offs in either direction, up or down, east or west. The advantage of this action is fully appreciated when explained with a typical example. If the projector head moves 0.001 in., this equals 0.001-in. movement of the camera. When push-offs, drop-shadow or alignment jobs are accomplished with the lens, the adjustment is twice as critical. In such case, a lens movement of 0.001 in. is equivalent to 0.002 in. on the camera.

On this printer, one projector head (Fig. 4) accommodates 35mm and 16mm films. Shuttle and sprocket assemblies are exchanged in less than three minutes with no need for realignment of optical axes. All compensating devices for converting the projector head from 35mm to 16mm are built into the unit. Slots are provided for standard glass filters and a frame counter is built in for single-frame adjustments.

Two high-speed rewind motors operate at 600 rpm in forward or reverse direction, independently for projection head and camera. These units pass the stop-motion clutch and the variable-speed drive. This permits the operator to pass footage on either projector or camera independently or in conjunction with shooting-speed drive, in any combination including forward and reverse.

An air-cooled lamp house attached to the projector head is built to receive bulbs ranging in size from 300 to 1000 w. A constant-voltage transformer in the base compensates for line voltage variations. Controls and a voltage indicator on the panel permit accurate settings for any desired light output.

Instead of the standard condenser lenses in the lamphouse the printer incorporates an achromatic system for maximum light efficiency. It is corrected for spherical, color and coma aberrations. This permits straight-through printing without a diffusing glass at 1 to 1 ratio. The achromatic lens installation delivers 22,000 ft-c of a 500-w lamp. This is 30 to 50% more light output than is possible with the standard condenser lens system.

A traveling matte carrier is attached in front of the projection shuttle for wipes and other special effects. The unit has a single-frame advancement which is manually operated. Master sets of special-effect mattes are supplied when ordered by the customer.

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**Camera**

**Superimposition Device:** The gauge plate in this unit has a ground-glass reticle mounted in a steel dovetail slide having two film registration pins (Fig. 5). A compound adjustment on the gauge plate provides for realignment when necessary. The superfine ground glass is precisely mounted and aligned to match the film registration pins in the shuttle. In order to match the film plane, the eye picks up the image on the top ground-glass side of the reticle plate.

The design compensates for the index factor of the glass in order to place the...
allow for out-of-focus shots. This is in addition to normal lead screw movements and is useful for focusing flip-lens
and other similar tasks.

Precision and Economy of Operation

The dissolve mechanism saves time since it operates from 8 through 120 frames for a dissolve and is actuated by
an infinitely variable speed unit. This is a straight cross-dissolve mechanism that permits selection of 10, 11, 12 or any
number of frames up to 120 and is especially useful for short dissolves such as are in demand for television. A two-
position switch controls and indicates shutter position as to cross-dissolve-in or cross-dissolve-out. Camera dissolve
action is started by a button on the control panel and after the correct number of frames are exposed, the dissolve mecha-
nism disengages automatically.

The automatic dissolve allows the operator to stop-motion a frame at a time with the shutter closing at its pre-
determined position each revolution. In other words, frames can be exposed with stop-motion while the automatic dissolve
is engaged. A reversing switch permits operation of the camera with a designated dissolve in reverse.

A knob is provided, together with a logarithmic calibrated scale for fade-in and fade-out. Logarithmic scales are
marked for 16 and 24 frames to suit customer preference.

The following actions are possible with the automatic dissolve: (1) automatic linear cross dissolve, (2) wide range of
selection from 8 to 120 frames, (3) forward dissolve and reverse dissolve, (4) stop-motion and continuous and,
(5) nonlinear hand scale for fade-outs.

The 170° dissolve scale is marked in frames so it can be used for 35mm or 16mm films. The linear mechanical sys-
tem gives equal segments for each designated dissolve. There are two scales calibrated in 16ths and 24ths. An exten-
sion handle on the hand dissolve permits easy operation.

The film transport mechanism has been designed to avoid critical alignment problems. The new design employs one
housing for both film sizes and this housing remains in place on the printer at all times. Only the shuttles and
sprocket assemblies (Fig. 3) are changed for 35mm and 16mm work. Built-in gears and cams function automatically to
provide proper speed and action when either 35mm or 16mm mechanism is slipped into place.

Shutters are designed with fixed pilot-pin registration. The principle underlying this design is based on pilot pins
which are fixed in their relationship to the aperture. With this construction, all movement is confined to the film, a con-
dition that is vital for no-play, rock-steady pictures on the screen. This is essential for double exposure and matte
work. A spring-loaded pressure plate accommodates three films without adjustment. Loading of film is facilitated by
a latched lift button that relieves plate pressure when the shuttle is being threaded.

Shutters are constructed so the aperture can be changed quickly by removing four screws from the front, making it
unnecessary to strip down the shuttle. Various apertures are available for use on the projector head and camera. In-
cluded are: full-silent aperture, sound (Academy) aperture, split-half-way screen aperture, horizontal half-split
aperture and four-way-split aperture. The latter provides hard or sharp-edge split.

Each shuttle is machined from a solid steel block and has a cast steel yoke with hardened faces that engage the cams.
The entire camshaft is cut from one piece of steel and it includes three cams and a worm. One heart cam comes into play
when the 35mm shuttle is inserted, another heart cam performs a similar function when the 16mm shuttle is used.
Shuttle forks are so placed that they pick up action from the proper heart cams whenever the 35mm or 16mm mecha-
nisms are inserted.

In operation, the action is as follows: Barrel cam strips the film off the fixed locating pins and onto the carrier pins
activated by the heart cam — this advances the film one frame. Next, the barrel cam comes into play again to
strip the film from the carrier pins and
ball-bearing rollers for extreme sensitivity. The two movements make it possible to obtain very accurate zero positioning.

**Magazines and Take-up**

The printer is built to receive altered S-series Mitchell magazines, 400 ft, 1000 ft and bipack, either 35mm or 16mm. The 16mm film size is symmetrically placed in the center of the modified 35mm magazines. All magazines are easily attached and removed.

This unique Oxberry mechanism utilizes an electrical-mechanical system that eliminates the usual problems encountered with spring-belt take-ups. A torque motor is mounted on each of the four spindles. One pair handles forward movement and the other pair handles reverse. The change of operating conditions is accomplished automatically when the printer is shifted from forward to reverse or vice versa. The non-driving pair of motors is electrically energized to provide braking action to keep the film under proper tension. The take-up accommodates 400-ft, 1000-ft or bipack magazines for 35mm or 16mm film. Tension control may be adjusted to provide proper torque. Figure 9 shows how the film travels through the camera and projector.

It is expected that the new concepts employed in the optical, mechanical and electrical systems of this printer, the new features added to it and the major improvements made in its other components will provide greater precision, an increased range of application, and simplified setup and shooting procedures.