Tension-Free Film Processing Machine

By MERVIN E. FULTON

An abridgment of the author's revision of a paper presented on May 1, 1962, at the Society's Technical Conference in Los Angeles by Mervin E. Fulton, Fulton Productions, Inc., P.O. Box 980, Tulare, Calif. The revision was submitted on May 27, 1964.

A NEGATIVE/POSITIVE continuous processing machine has been designed and constructed by the author.* Design considerations included reliability of operation; simplified maintenance; elimination of every possible cause of film damage; ability to process any type of emulsion to maximum quality; minimum use of chemicals; daylight operation; and light weight for easy portability. Various models of the machine are available for both black-and-white and color.

Major portions of the processor are constructed of high-impact polyvinyl chloride plastic; the frame is of steel, coated with a corrosion resistant finish. No attempt is made to enclose the units with any kind of cabinet. Experience has proven that access for cleaning is simplified with this arrangement. A housing is available to those desiring it for esthetic reasons.

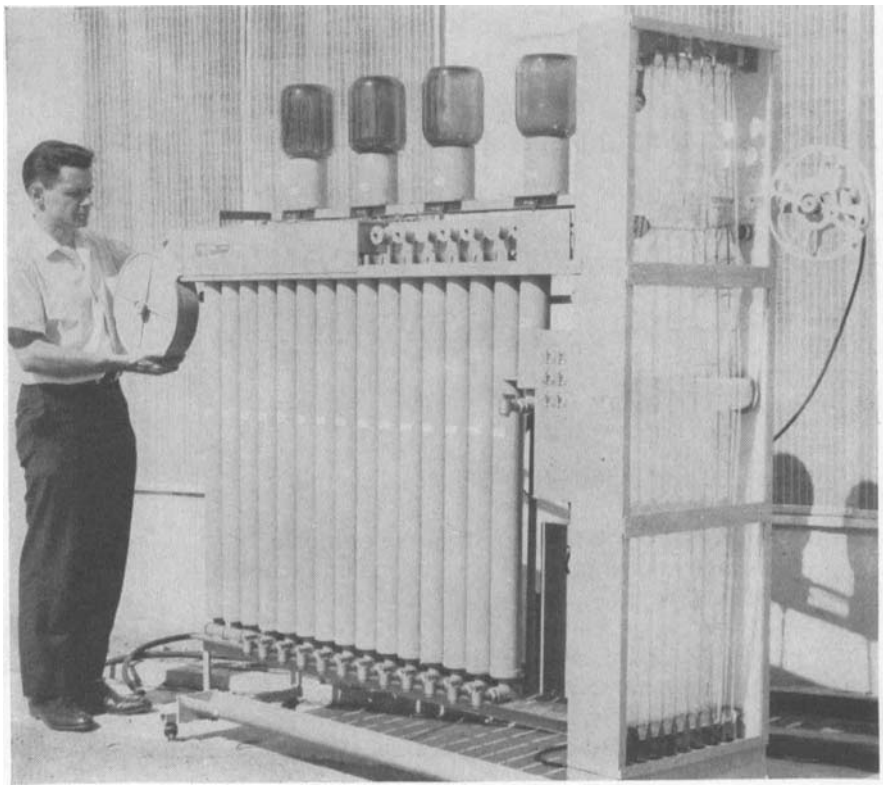

Figure 1

Every effort has been made to permit rapid maintenance. Exotic or custom-made parts have been avoided as much as possible. Most of the parts that can wear or burn out are available in most hardware stores. Other non-immortal parts are standard, off-the-shelf items readily available from the different manufacturers.

The unit shown in Fig. 1 will process 16mm or 35mm black-and-white films at a speed up to 60 ft/min. Its weight is approximately 500 lb when filled with solution and 300 lb when empty.

Other widths of films are handled in units scaled larger or smaller. All models have the same tank design.

The processor is available with an adapter plate to accept any specified camera magazine currently in use. Also available is a stock magazine that will accept up to 1200-ft projector reels.

The dark end of the processor is covered with a small, light-tight lid during operation. This arrangement provides sufficient shielding for operation in direct sunlight.

Immediately after the film enters the processor it is threaded around a roller on a pivoted arm. The tail end of the film when it approaches the arm, thus actuating a mercury switch that opens a low-voltage relay which turns off the drive motor and sounds an alarm.

The normal loading procedure is to place sufficient leader into the magazine to fill the machine. The film to be processed is stapled to the leaders and the processor is full of leader when it shuts off. Figure 2 shows a simplified film path.

The elevators are formed in a double-concave shape. When the elevator is inserted into the tubular tank the solution area is reduced to about half the total area and forms two elliptical passageways for the film between the elevator and tank walls (Fig. 3). This provides a film path that prevents the surface of the film from touching anything that could cause abrasion. The hollow polyvinyl chloride ele-

* U. S. Patents 3,041,953, July 3, 1962; and 3,043,206, July 10, 1962.

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vators are drilled with holes wherever it is necessary to spray or turbulate the solutions to a high degree.

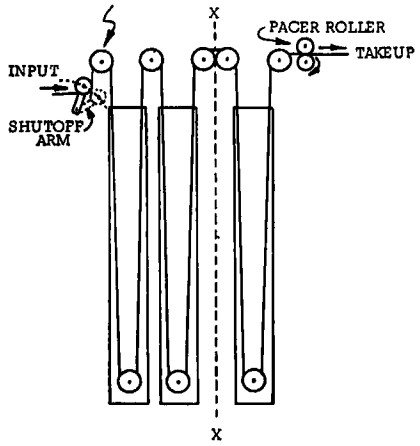


Figure 2

The tanks are brimful at all times. The solutions are mechanically pumped into the hollow elevators and submerged sprayed out of the holes onto the film. Where less turbulence is required, an air-pump is used. Compressed air, metered through a needle valve, is injected at the bottom of the heat exchanger and forms bubbles which rise in the tube. The solution is forced ahead and drawn behind each bubble. The sidearm connection allows the solution to circulate through the tank at the rate of ¼ to ½ gal/min. This system obviates extra mechanical pumps and reduces the possibility of mechanical pump breakdowns. The small amount of air used does not cause oxidation problems.

Replenishment

Replenishment is simplified, since there is a relatively small amount of solution in each tank. New solutions are metered into the bottoms of the tanks, and the overflow from single tanks goes to the drain. The chemicals reach an equilibrium after a few hundred feet of film have been run. Whenever the processor is drained for cleaning, the seasoned solutions are saved for refilling.

Under average operating conditions negative black-and-white developers are replenished at the rate of one gallon for every 4,000 ft of 16mm or 2,000 ft of 35mm film. Fixing baths yield approximately the same footage. Microfilms and other emulsions require even less replenishment, depending upon carryover.

This system greatly increases the life of stop baths, fixers, hardeners, bleaches, etc. where dilution by carryover from washes or other solutions is normally a problem.

All washes are of the counterflow type. The last tank of any series of washes is equipped with a spray at the exit strand of film. Total water demand for a 35mm

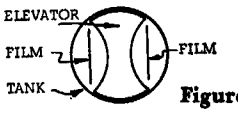


Figure 3

processor is approximately 1½ gal/min at operating speeds up to 26 ft/min.

A reduction in the compressed air requirements for the squeegee has been accomplished by a special design. Films up to 90-mm width have been adequately cleared of surface moisture using the air from a ½-hp piston compressor.

A design feature is the extreme thinness (about 0.001 in.) of the metal through which the orifices are drilled. The shallow depth of the holes permits the air to exit with less turbulence in the holes. The resulting jets of air are of high velocity and narrow cross-section.

Some models use conventional dryboxes with bottom drive rollers. Other models use a semi-impingement dryer consisting of series of plastic tanks containing perforated elevators through which warm air is blown against the film. Color processors use a manually controlled air recirculation path to control humidity.

All models are equipped with an electrostatic filter on the freshair intake. This filter removes the fine particles of dust from the air without external high-voltage power supplies. It acquires this property from the friction of the air against the woven plastic of which it is constructed. This static charge is opposite in polarity to dust particles, and attracts them to the plastic mesh, where they adhere. The filter is cleaned for re-use by washing it in warm water, only.

Drive System

The film rollers are a V-shape without lands, except on multiwidth models. In these models the narrower films ride in the V groove. The drive system places so little tension on the film that there is no distortion of the edges. The film remains in an emulsion-up position throughout the machine.

The weight of the film in each tank is nearly displaced by the solution, so there is almost no downward pressure on the top driven rollers. The driven top rollers are separated by two or three intermediate idler rollers. This spacing determines the amount of built-in tension desired—the fewer idlers, the less tension. The final pacer roller meters the film with a positive holdback action. This roller is about 10% smaller than the drive rollers. This arrangement causes slack film to build up within the tanks. A limit is reached when the slack becomes sufficient to raise the top film loops away from the driven rollers.

Under this condition there will be no drive force applied to the film until the pacer roller pulls enough film to cause re-establishment of friction between the film and drive rollers. In actual operation a degree of equilibrium is reached where friction and slack are sufficient to allow the film to lightly contact the driven rollers, causing a sufficiently steady motion of the film. Badly torn film will run quite safely.

The bearings of all dry driveshafts are of graphite-impregnated nylon; drive chain sprockets are of nylon. The power to drive an 8-ft/min 35mm processor is 1/70 hp. A constant speed back gear motor is used. Speed changes are accomplished in a few seconds by means of a quickly detachable motor mount. Variable-speed motors are not used in order to keep the

processing under absolute control at all times.

Speed changes necessary to compensate for under or over exposure are made only after a test strip is run through the processor, since it is too late to alter the developing time once the film is visible in the daylight section. The processing has been reduced to two variables: solution temperature and camera aperture. It has been found that with inexperienced and experienced personnel it is too easy for the speed to be changed slightly—and then the temperature and time, until the entire process is out of control. Elimination of adjustable elevators and variable-speed motors has solved this problem.

The take-up reel is clutch-driven in such a way that, as the diameter of the roll of film increases, the film tension remains relatively constant.

The control box at the rear of the machine houses all of the electrical controls, as well as the air blower and heaters. An external source of hot and cold water is connected to the processor through regular garden hoses. Power requirements are 20-amp, 117-v, 60-cycle a-c.

On tanks requiring temperature control there is an individual water-jacketed heat exchanger in the circulation system. Hot and cold water are passed through a thermostatically controlled water tempering valve, and then into the heat exchangers. After being used in the heat exchangers it is used in the washes. In most black-and-white and color processors the operating temperature is 80 F or higher, thereby eliminating the use of refrigeration.

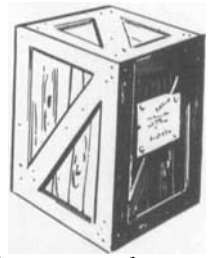
Conclusion

The submerged spray system gives exceptionally uniform development, especially under high temperatures and short developing times. All developer by-products are instantly removed from the surface of the film by the high velocity jets of solution impinging upon the film. Once the film is immersed in the tank, there are no low-velocity areas or air pockets to restrict film contact with the solutions.

Since the tanks are brimful at all times and the exposed solution area is small, there is no danger of aerating solutions that are easily oxidized, such as color developers.

High-velocity submerged-spray processing combined with small tank volume has reduced uneven development and density variations to less than 0.010. Gamma variations from day-to-day are nil, since the film tanks are continuously replenished with fresh solutions of constant strength. A separate overflow is available for the fixer tanks to permit silver recovery.

Another result of this high-velocity submerged-spray system is that the films show less graininess and higher resolution. This is apparently due to the turbulence quickly removing bromides from the area of the developing grains, as well as providing more surface development. Line records reveal increased image boundary line sharpness. This has been useful in the computer-recorder field where it has increased by from 50% to 100% the number of clearly resolved dots to the square inch on reversal-processed high-speed blue-sensitive recording film.



new products
(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

A color television pickup tube called Selenicon has been announced by the Radio Corp. of America. The photosensitive layer of the tube incorporates the element selenium to multiply the tubes sensitivity to light. Selenium is extremely sensitive to light but is unstable at temperatures encountered in an operating television camera. In the Selenicon a specially developed stable selenium alloy is deposited on the inner surface of the glass window at the front of the tube. Its behavior is similar to that of the retina of the human eye when exposed to light.

A four-tube camera employing three Selenicons to generate red, blue and green signals together with an image orthicon to provide a separate black-and-white signal has been developed, the announcement stated. The new color tube is said to operate on the same principle as a vidicon pickup tube, i.e., when light from the scene being telecast passes through the window and falls on the tube's retina, it generates a pattern of electrical charges that correspond in every detail to the variations of intensity present in the light itself.

Thus, an electrical "negative" of the real scene is impressed on the layer and remains until an electron beam sweeping back and forth across its back "neutralizes" or erases it. As this takes place a tiny current varying with the amount of charge being erased at any one point on the layer is generated, picked up and transmitted as a TV signal. The new color tube is said to more than double the camera's color sensitivity.

A new 16mm/8mm Hycam High-Speed Camera having a 400-ft film capacity and framing rates from 10 to 20,000 pictures/sec has been announced by Red Lake Laboratories, Inc., 2971 Corvin Drive, Santa Clara, Calif. 95002. The new camera has the same basic 2-section design as that of the original 16mm 100-ft capacity Hycam (*Journal*, p. 896, Nov. 1962) comprising the film transport unit and a simple optical head. Optical heads are mechanically interchangeable among all Hycam cameras except that the optical head from the 100-ft model requires the addition of a speed-sensor to make it respond to the electronic