No. 25 or, if somewhat more haze penetration is desired, the Wratten No. 89 or 89A. A wedge spectrogram showing the sensitizing of the film is in Fig. 1 and the filter factors are given in Fig. 3. The characteristic curve in D-87 is shown in Fig. 2.

4. Uses of the Materials: The Eastman Special Aero Panchromatic Film was developed to provide a material of extremely high speed, yet capable of the high degree of contrast which might be required for some types of work. The Eastman Aero Ortho Film was made primarily to permit the best differentiation of detail in terrain which is rather light in color, such as sand, associated with light green vegetation, such as scrub. This film has proved most satisfactory for survey in open, sandy areas, and for photography of forest areas with snow on the ground. The Eastman Infra-Red Aero Film was made to give the maximum of haze penetration corresponding with acceptable speed, and it is particularly suited for low obliques and long distance photography in general.

Filter Factors

Film	*Aero 1*	*Aero 2*	*No. 12*	*No. 15*	*No. 25*	*No. 89*	*No. 89A*
Special Aero Panchromatic	1.5	2.0	2.0	2.5	4.0	—	—
Aero Ortho	2.0	2.5	3.0	5.0	—	—	—
Infra-Red Aero	—	—	—	—	10.0	15.0	20.0

Fig. 3.

"Air Map Special" Projection and Contact Papers[1]

"Air Map Special" papers are produced in contact and projection speeds; the contact in five grades of contrast (A—soft, B—medium, C—brilliant, D—contrast, E—hard) and the projection in three grades of contrast (soft, medium, and hard).

The raw stock which is white photographic 240 gram double weight is waterproofed with a back coat of lacquer and a face coat of cellulose. This reduces dimensional change in the finished stock due to processing to about "2 parts per 10,000" with the grain, and "3 parts per 10,000" across the grain when processing and subsequent storage for 48 hours are done at 70° Fahrenheit, 60° relative humidity.

The surface of Air Map Special papers is semi-glossy. It has sufficient tooth to retain notations in various pencils, inks, and crayons used in photogrammetry. Developers used with similar types of unwaterproofed papers may be used with both Air Map Special contact and projection papers.

In the standard fixing bath, the fixing is completed in 30 seconds and washing is completed in from two to four minutes.

[1] Manufactured by The Positype Corporation of America.

DIMENSIONAL CHANGES IN AERIAL PHOTOGRAPHIC FILMS AND PAPERS[1]

Raymond Davis, Emory J. Stovall and C. I. Pope

The hygroscopic nature of film and paper makes it necessary to adopt, as standard, a fixed condition of temperature and moisture content of the air to which such materials may be subjected at the time of testing. The rate of approach to dimensional equilibrium with humidity was investigated for three films, and it was found that equilibrium was not reached even after two weeks

[1] In 1937 the National Bureau of Standards made an extensive investigation of the dimensional changes in the films and papers in current use for air photography.

of conditioning. Obviously, moisture equilibrium with the surrounding air cannot be specified; however, 24 or 48 hours of conditioning should be enough for testing purposes. In use, these materials are generally handled under uncontrolled conditions. The shrinkage values found here will therefore not be realized in practice.

The shrinkage of five samples of safety aero film measured at 65% relative humidity ranges from 0.01 to 0.04%, and the differential (difference between lengthwise and crosswise) shrinkage is 0.01% or less. The shrinkage of 20 samples of nitrate film measured at 65% relative humidity ranges from 0.01 to 0.05%, and the differential shrinkage 0.00 to 0.03%. There is no apparent difference in the processing shrinkage of safety and nitrate aero films. The shrinkage is noticeably smaller at 65% than at 50% relative humidity. This indicates that best results from the standpoint of accuracy could be had if all the work with films is done in a room conditioned at 65% relative humidity and 72° F. A humidity much higher than this could not be recommended, because at higher humidities the dimensional behavior of films is erratic. The dimensional change caused by a 15% change in relative humidity (between 50 and 65%) is approximately 0.12% for safety aero film and 0.08% for nitrate aero film.

The shrinkages of two makes of waterproof papers are about the same as aero films, the maximum shrinkages (measured at 65% relative humidity) ranging from 0.01 to 0.06%, and the differential shrinkages from 0.00 to 0.05%. One make of waterproof paper was all purified wood fiber stock, the other contained some rag fiber. The processing shrinkage of the wood fiber paper was greater in the machine direction, while that of the paper containing rag fiber was greater in the crosswise direction.

The shrinkage due to processing of ordinary papers is much larger, the maximum shrinkage ranging from 0.20% to 0.80%, and the differential shrinkage from 0.00 to 0.36%. Furthermore, the shrinkages of ordinary papers are not nearly as reproducible as in the case of waterproof papers.

The dimensional changes of both waterproof and ordinary papers caused by changes in relative humidity may be rather large. The dimensional change for a 15% change in relative humidity (between 50 and 65%) for ordinary papers ranges from 0.20 to 0.30% in the crosswise direction and 0.07 to 0.13% in the machine direction, and for waterproof papers the dimensional change ranges from 0.14 to 0.20% in the crosswise direction and 0.04 to 0.09% in the machine direction. The hysteresis effect ranges from 0.10 to 0.14% in the crosswise direction, and 0.02 to 0.07% in the machine direction for ordinary papers; and from 0.04 to 0.12% in the crosswise direction and 0.01 to 0.04 in the machine direction for waterproof papers.

It is recommended that the machine direction of cut-to-size film and paper be identified by the manufacturer, either on the package or by printing on the back in the case of paper. If this is done, the total differential shrinkage of the combined negative and print or enlargement can be kept at a minimum by having the direction of maximum shrinkage of negative and positive material at right angles to each other. For example:

	Machine directions parallel		
Negative	Cross. 0.05	Mach. 0.01	Diff. 0.04
Positive	Cross. 0.06	Mach. 0.03	Diff. 0.03
Resultant	0.11	0.04	Diff. 0.07
	Machine directions at right angles		
Negative	Cross. 0.05	Mach. 0.01	Diff. 0.04
Positive	Mach. 0.03	Cross. 0.06	Diff. 0.03
Resultant	0.08	0.07	Diff. 0.01

Under the recommended conditions the combined differential shrinkage of the positive and negative material would always be less than the value for the material having the greatest differential shrinkage.

In the past, nitrate film has been used exclusively in aero-surveying. Nitrate film is known to be unstable chemically, decomposing spontaneously with time, so that negatives made on this type of base cannot be classed as permanent. In addition, a large quantity of nitrate film concentrated in one place constitutes a serious fire hazard with consequent danger to such official records and personnel as may be in the immediate vicinity. The better grades of safety (acetate) base are much more stable chemically than the nitrate base, being in a class with high grade paper with respect to fire hazard and permanence. Ordinary safety film is not used in aero-surveying because it has inferior shrinkage characteristics. This investigation shows that modern aero-safety film as now manufactured is practically as good as aero-nitrate film. Considering the lack of permanence and the hazard of storing nitrate film, together with the good behavior of the safety film tested, it seems that further attention to this kind of film is warranted.

Fairchild-Smith Roll Film Developing and Drying Equipment, Fairchild Aerial Camera Corporation

The developing equipment consists of three nesting tanks, a film reel unit, an electric motor drive unit, film loading bracket and carrying case. The equipment is very compact and is packed telescopically into a small carrying case. It is readily transportable and effects a saving both in time and in chemicals. Operation is either automatic or manual. Data: capacity—suitable for all roll film up to 9½ inches (24 cm.) wide and 120 feet (36.6 m.) long, solution required—3 gallons (10.3 liters), dimensions—largest tank 11½×7×13½ inches (29×18×34 cm.), trunk 18½×14½×8 inches (46×36×20 cm.), weight complete with trunk 30 lbs. (12 kg.).

The roll film dryer consists of a metal drum about 30 inches (76 cm.) in diameter and about 10 inches (25 cm.) wide. A fan, driven by an electric motor, sucks fresh air into the drum through a screen at the center of one of the sides, and then forces the air out through the veins in the periphery. Around the periphery and spaced about 1 inch (2.5 cm.) above the air veins, a series of rollers are mounted at intervals of about 1 inch (2.5 cm.). The film is threaded between the periphery of the drum and the rollers. Therefore, the blast of air keeps the back of the film pressed against the rollers. Inasmuch as every third roller is individually driven by an electric motor, each section of film is pushed along individually and there is no tension whatever exerted on the film. Throughout the entire dryer the emulsion side of the film is prevented from touching anything and is supported only by the blast of air.

The roll film dryer will accommodate film 9½ inches (24 cm.) wide and in any desired length. Roll film dryers sufficiently wide to accommodate the 12 inch (30 cm.) film occasionally used in Europe can also be supplied. To dry the film it is necessary only to take the film out of the washing water and mount it on the film dryer. After threading the film between the rollers and the air veins, the film makes one complete passage around the drum and emerges near the starting point completely dry. It is then attached to a take-up roller and, from this point onward, the operation is automatic with wet film going onto the drum and winding up on the take-up spool thoroughly dry. For a standard 75 foot roll of film the longest drying time necessary under normal conditions is about 17 minutes, while under very humid conditions the maximum time required is about 30 minutes.

The principal advantages of this roll film dryer are as follows: (1) it can handle any length of film, (2) it is very compact, requiring only about one-tenth of the space required by the old-fashioned wagon wheel drying drums, (3) it eliminates the possibility of distorting the film, (4) it does not require

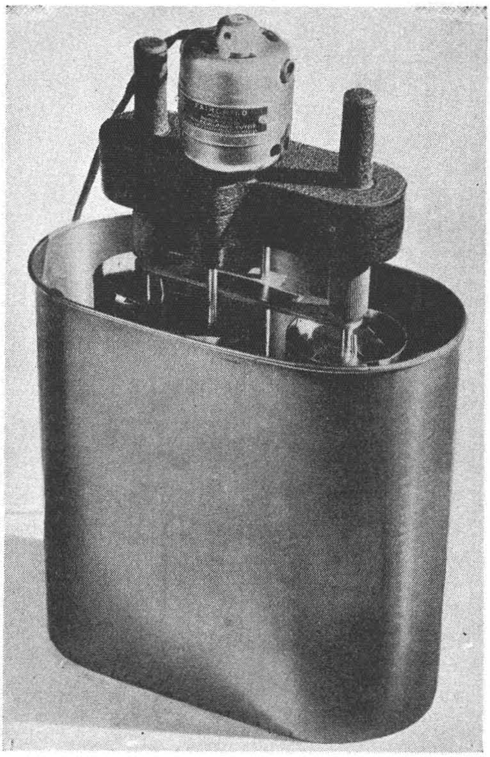


Fig. 1.
Roll Film Developer

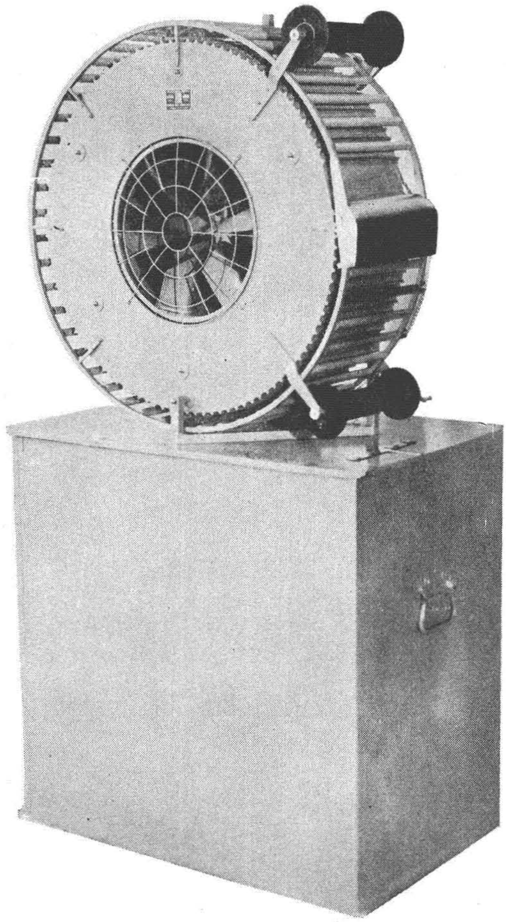


Fig. 2.
Roll Film Dryer

attention after the operation has started, (5) it has an adjustable speed of drying which can be varied according to humid conditions, (6) it cannot scratch the emulsion, (7) it is easily portable.

Overall dimensions in carrying case—34×22×34 inches (86×56×86 cm.), weight 136 lbs. (61.8 kg.).

Mobile Photographic Laboratory
Fairchild Aerial Camera Corporation

The Mobile Photographic Laboratory consists of a specially constructed body, 16 feet long, 7 feet wide, and 8 feet high. The interior of the truck body is so designed as to accommodate all equipment necessary for developing film, contact printing, one and one-half diameter enlarging, mosaic construction and line map construction.

The Mobile Photographic Laboratory is an entirely self-contained unit having its own electrical power supply, water storage tanks, refrigeration units, heating unit for cold weather, cooling system for hot weather, and space for the operators to sleep when necessary.

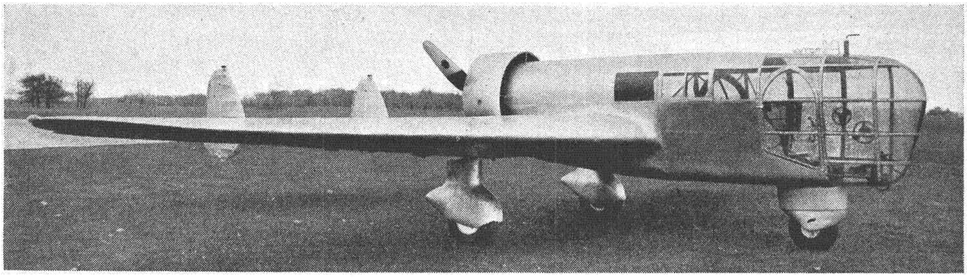
Aircraft and Navigating Equipment

In the United States a large part of the air photography has been done with conventional commercial and military aircraft.

In addition to the above the Fairchild Model "71" and Model "82" planes are equipped especially for air photography. The Model "71" has been in use for a number of years.

The Fairchild "82" is designed to accommodate the largest multiple lens cameras or the usual single lens cameras. A very complete set of instruments on a special panel is provided for the photographer from which he can tell at a glance whether the cameras are working satisfactorily and whether the pilot is flying the airplane in the most satisfactory manner. This instrument panel, furthermore, contains switches and rheostats for controlling and regulating the operation of the camera. All the electrical wiring and vacuum or pressure tubing are built into the walls of the airplane and into the floor. Outlets, in the form of floor sockets, close to the point where the wires connect to the camera, are provided. Thus, there are no loose wires to be tripped over, and the photographer can move completely around his camera without being obstructed by wires or tubes.

This photographic airplane has a range of over 700 miles (1100 km.), a cruising speed of 140 m.p.h. (240 km.p.h.), a single engine of 550 H.P., an absolute ceiling of 25,000 feet (9,050 m.) and a service ceiling of 21,000 feet (7,600 m.). The gross weight of the airplane, complete with a photographic load and personnel, is 5,862 lbs. (2,650 kg.). Inasmuch as the airplane is licensed for a gross weight of 6,325 lbs. (2,870 kg.), it is possible to carry extra tanks of gasoline, thereby increasing the range of the airplane.



Abrams' Plane

The Abrams Aircraft Corporation of Lansing, Michigan, has recently completed the first model of a plane especially designed for air photography which differs radically from conventional types. The first model is now undergoing service tests.

The following features of special importance in air photography have been included in the design: forward and downward visibility, rapid climbing ability, high cruising speed, stability, long cruising radius, supercharged motor, and oxygen supply for the crew when working at high altitudes.