A HISTORY OF FLYING AND PHOTOGRAPHY In the Photogrammetry Division of the National Ocean Survey 1919-79

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
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National Ocean Survey
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With deep respect and admiration, this book is dedicated to Captains Oliver S. Reading and Lawrence W. Swanson.

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Introduction

President Thomas Jefferson, in 1807, founded an organization known as Survey of the Coast. In 1836 the name was changed to Coast Survey; in 1878 it became Coast and Geodetic Survey (C&GS). In 1970 the name was changed to National Ocean Survey (NOS). In 1920 the title of Superintendent, C&GS, was changed to that of Director. In 1973 the Photogrammetry Division was renamed Coastal Mapping Division. In January 1979 it again became the Photogrammetry Division. All titles and organizational names used throughout this history are those in effect during the period of reference.

The forerunner of the Photogrammetry Division was established in 1922 as the Photogrammetry Unit in the Division of Hydrography and Topography. It is difficult to determine when photogrammetry was first applied to charting and mapping in C&GS.

"Photogrammetry" can be defined as "an accurate measure of an object recorded on a photograph." It is quite possible that some C&GS employees were using photographs as an aid long before the potential of photogrammetry was recognized and developed to an operational state. By 1927, the full potential of photogrammetry as an aid to the production of charts and maps was recognized by C&GS, which was fortunate at that time to have a young officer, Oliver S. Reading, in its Commissioned Corps who understood the potential of photogrammetry and spearheaded its development. Reading was one of the founders of the American Society of Photogrammetry, and this group regularly met at his home during its fledgling years. The members exchanged ideas and theories, and the heart of the photogrammetric process used in the United States today was formulated at that time. Reading designed the famous 9-lens camera, and provided the genius that led to the formation in 1945 of the Division of Photogrammetry.

History is today 10 years from now, and so the importance of documenting what we do today becomes apparent. From history we learn to avoid many pitfalls. Documenting a failure is just as important as documenting a success. Use of history can help avoid needless expense and hours of research and perhaps direct thinking toward new horizons. In 60 years of flying in the NOS Photogrammetry Division, much knowledge has been gained; both failures and successes have been recorded and are included in this history.

The Photogrammetry Division is proud of its contribution to the science of photogrammetry. It is proud of its aviation history and especially of its flying personnel. This is a story of both men and machines. The aircraft is simply a tool to position a camera at a precise point in space over the Earth at a precise time. The photo pilot is not just a person who is able to fly an airplane. He must also be a skilled navigator, capable of flying a flight line that can be as long as 100 miles. He must never deviate from the required altitude, or drift to the right or left of this imaginary straight line, because if he does the resulting photography will be unusable, and he must assume responsibility for the failure of the mission. The photographer also must understand fully the complexities of aerial photography, part of which is to operate a camera in a hostile environment without making errors in exposure, leveling, camera drift, or any of the many small details. As with navigation errors, the photographer's mistakes are recorded on film, and he must assume responsibility for the failures of the photography.

NOS has developed highly skilled teams of photo pilots, navigators, and photographers who work together under adverse conditions to produce the photographs which represent the heart of the science of photogrammetry. Some employees stayed only a few months, while others remained over 30 years. Regardless of the time frame, all employees left their mark on the organization. Every effort has been made to identify all personnel involved in the flight program, whether they were employed by the bureau or on loan from other services. Many early records did not always identify everyone involved. Accordingly, NOS will appreciate information to fill in the gaps. Please send it to The Director, NOS, Room 1006, Building 1, Rockville, Md. 20852.

The men who guided C&GS and NOS (fig. 1) through these years were and are dedicated public servants whose main objectives are to produce the finest hydrographic and aeronautical charts. The continuing search for improved methods of securing data required to update the charts is evident throughout this history.

Since the founding of the Photogrammetry Division, the men (fig. 2) who brought its organization structure



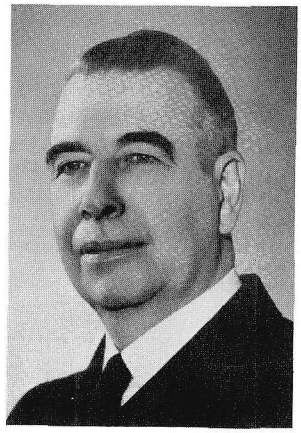
Earnest Lester Jones

16 APR. 1915 TO 9 APR. 1929



Raymond Stanton Patton

29 APR. 1929 TO 25 NOV. 1937



Leo Otis Colbert

8 APR. 1938 TO 7 APR. 1950



Robert Francis Anthony Studds

18 MAY 1950 TO 31 JULY 1955



H. Arnold Karo

17 AUG. 1955 TO 12 JULY 1965



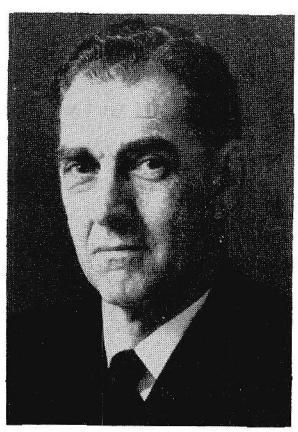
James C. Tison, Jr.

8 SEPT. 1965 TO 31 AUG. 1968



Don A. Jones

1 SEPT. 1968 TO 30 APR. 1972



Allen L. Powell

4 MAY 1972 TO 1 AUG. 1979



Herbert R. Lippold, Jr.

17 AUG. 1979 TO —

FIGURE 1.—Superintendents and Directors of the Coast and Geodetic Survey, and National Ocean Survey, 1919–1979.



Kenneth T. Adams

1 OCT. 1945 TO 18 OCT. 1949



Oliver Scott Reading

19 OCT. 1949 TO 31 AUG. 1954



Lawrence W. Swanson

1 SEPT. 1954 TO 12 FEB. 1962



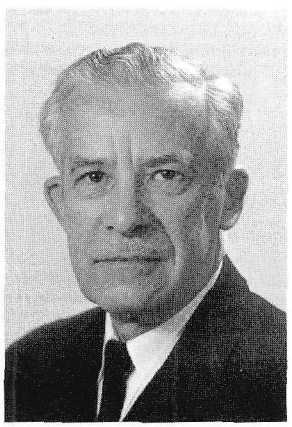
Joseph E. Waugh

18 FEB. 1962 TO 19 MAR. 1966



Lorin F. Woodcock

20 MAR. 1966 TO 1 NOV. 1966



V. Ralph Sobieralski

11 NOV. 1966 TO 30 NOV. 1968



Richard H. Houlder

1 DEC. 1968 TO 31 DEC. 1970



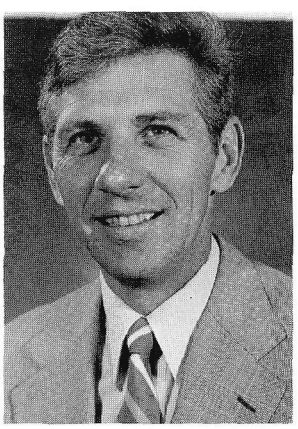
Jack E. Guth

1 JAN. 1971 TO 30 JUNE 1972



Wesley V. Hull

1 JULY 1972 TO 11 AUG. 1975



James Collins

12 AUG. 1975 TO 30 NOV. 1979



Walter S. Simmons

1 DEC. 1979 TO—

FIGURE 2.—Chiefs of the Division of Photogrammetry, 1945–1979.

together did so with one purpose in mind—to provide a service of superior photographs for mapping interpretation. This goal to provide a superior product continues.

The Coast and Geodetic Survey (C&GS) and National Ocean Survey (NOS) have occupied four buildings in the Washington, D.C., area. From 1919 through 1929, the organization was housed in a complex of five buildings at New Jersey Avenue and C Street SE. (figs. 3 and 4). Figure 4 shows the layout of the buildings.

Because of the proposed construction of the House of Representatives Office Building, the bureau moved in May 1929 from the New Jersey Avenue complex to 119 D Street NE. (fig. 5), a 7-story building formerly occupied by the War Department. The move was completed in about 6 weeks. There is no record as to which C&GS divisions occupied which floors of the building.

In 1933 C&GS moved to the Department of Commerce Building on 14th Street and Constitution Avenue NW. (fig. 6). In 1945 the Photogrammetry Division occupied parts of the first and third floors in the south end of the building. In 1964 the Photogrammetry Division moved to Building 1 and 2 at the Washington Science Center, Rockville, Md. (fig. 7). All the photogrammetry operations moved to Rockville except the aerial photographic laboratory, which remains in the Department of Commerce Building.

History is viewed through the eyes of the men who write it. In this history I have made every effort to confirm the record by using at least two reports covering the same time frame. Still, it is my interpretation of the period. In researching this work, I found material for hundreds of human interest stories, each of which could be developed into a book. The camaraderie of men working together under adverse conditions cannot be told in cold facts and figures. It was, therefore, very difficult to determine what should be included and what had to be omitted.

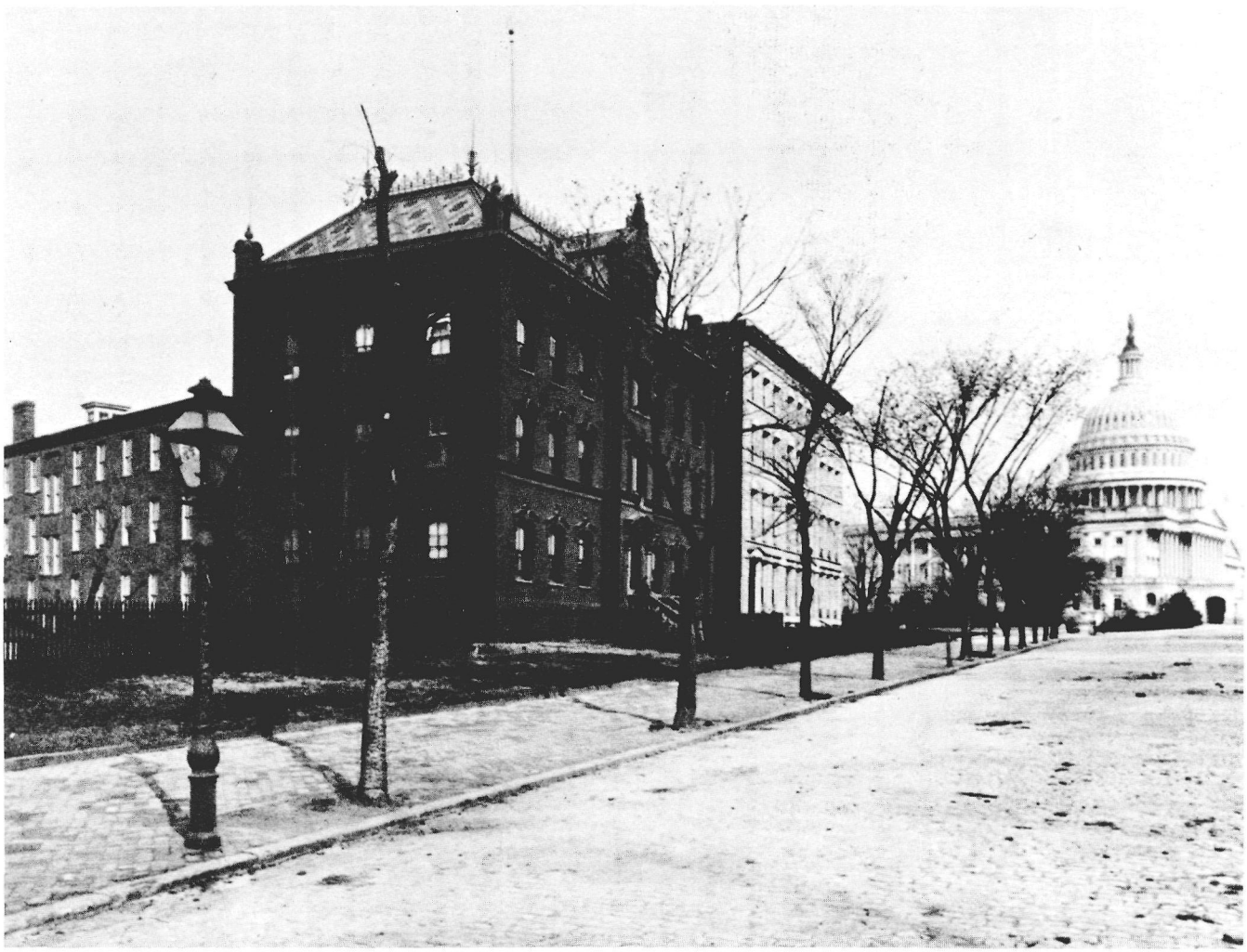


FIGURE 3.—USC&GS building at New Jersey Avenue and C Street SE. (Official NOS photograph.)

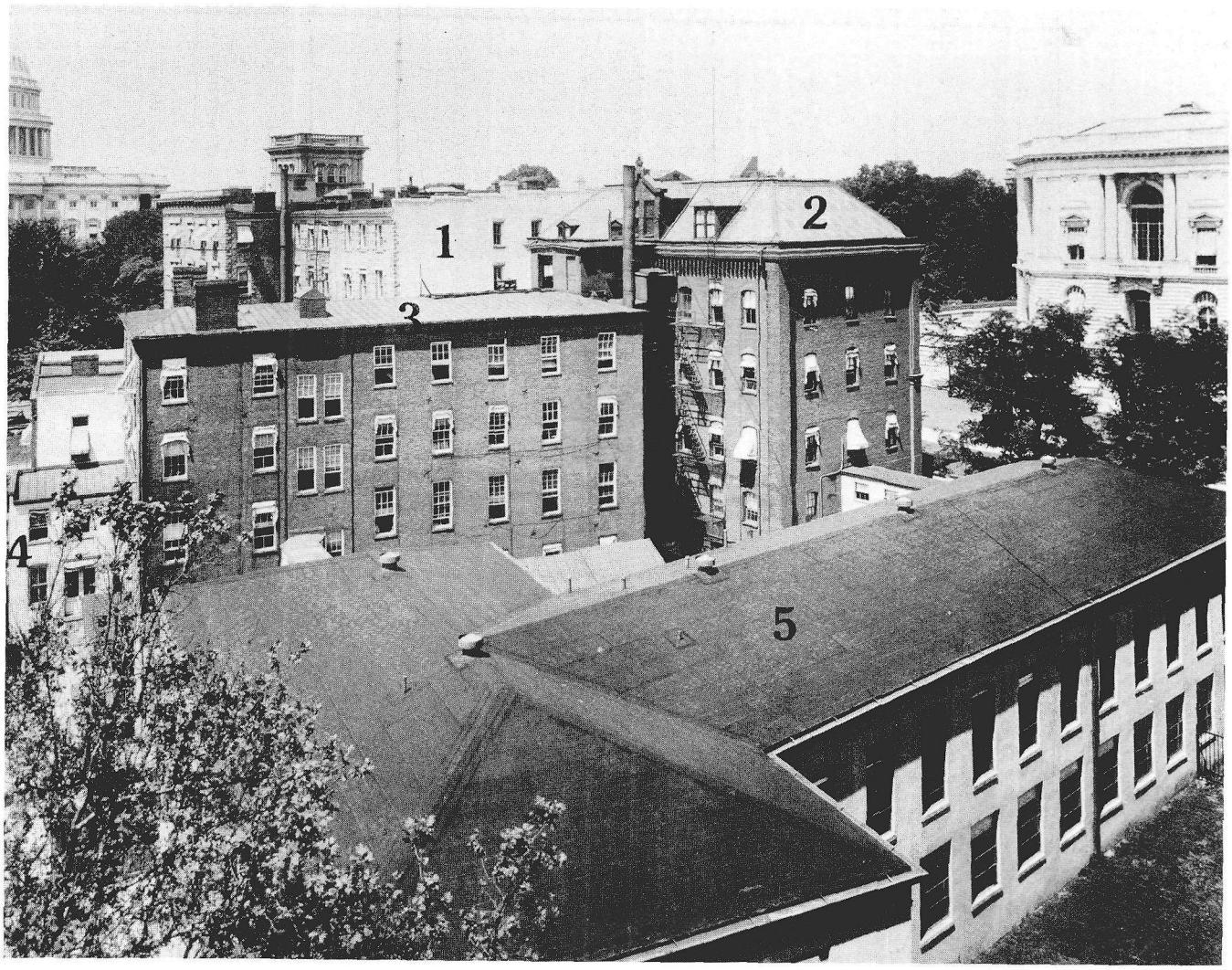


FIGURE 4.—USC&GS building at New Jersey Avenue and C Street SE. The main buildings (marked 2 and 3) were erected in 1871 by A. and T. A. Richards, and were rented by the Coast and Geodetic Survey that same year. The building marked 1 was erected by Gen. Benjamin F. Butler between 1873 and 1874; and was constructed of granite from Cape Ann, Mass., it was occupied immediately by the Coast and Geodetic Survey. A brick building to the rear, marked 4, was formerly a barn and was used for printing the charts. In 1919 the building marked 5 was constructed and occupied by the Survey. In 1919, on the back end of building No. 3, a room was provided for "photographic printing." This was probably the first photographic laboratory in the Coast and Geodetic Survey. (Official NOS photograph.)



FIGURE 5.—USC&GS building at 119 D Street NE. (Photograph courtesy National Archives.)

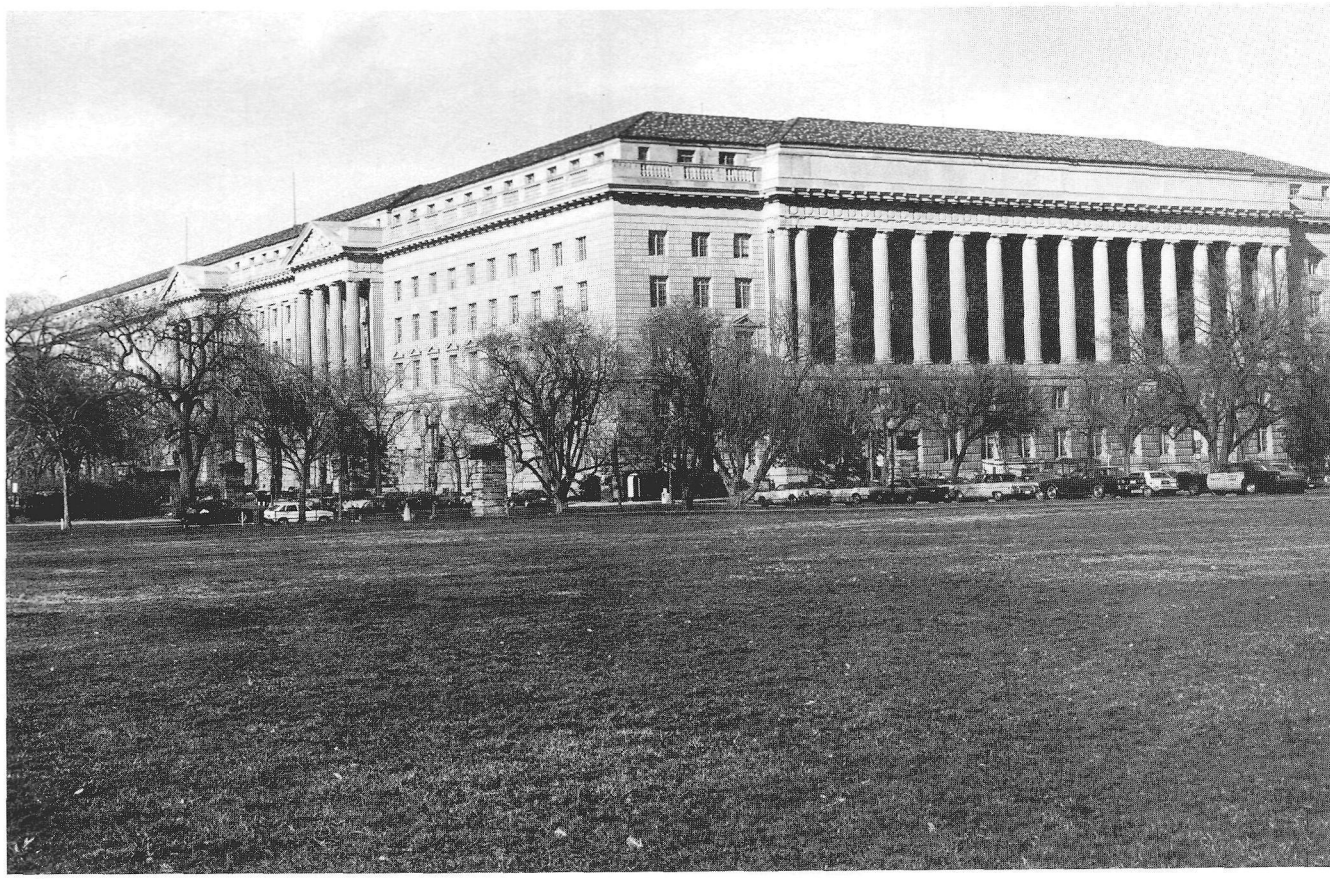


FIGURE 6.—South end, Department of Commerce Building, Washington, D.C. (Photograph by Robert Clark.)

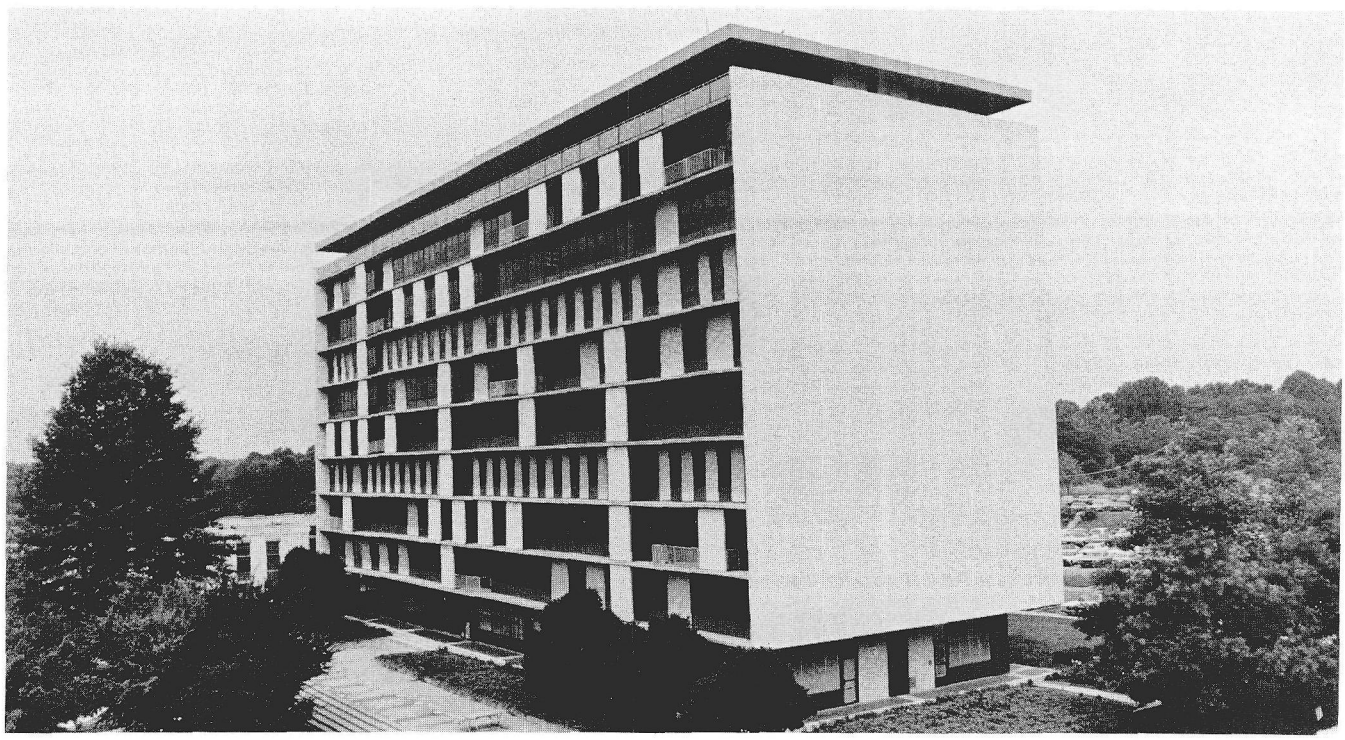


FIGURE 7.—Washington Science Center Buildings 1 and 2, Rockville, Md. (Photograph by Charles Papke.)

Acknowledgments

No matter how careful one is to try to acknowledge all of the persons who helped obtain data for this work, someone's name may be omitted. Therefore, I ask forgiveness of anyone who is left out, and say that I am eternally grateful. The following persons deserve recognition for the valuable advice they gave:

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Louis Casey
(National Air and Space Museum)
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Capt. Hubert A. Paton
(retired)
Lt. Comdr. Arthur N. Flior

Evelyn Brown, who typed the original manuscript. And, last but not least, my wife, Audrey, who gave up so many of her weekends to help, and who typed the final manuscript.

John T. Smith, Jr.

1919

Office Activities—1919

Ernest Lester Jones, Superintendent of C&GS, wrote the Secretary of Commerce William C. Redfield: "There has been much talk, in recent months, in regard to surveying the country from airplanes. This is a subject in which the Coast and Geodetic Survey is much interested, because it seems probable that the airplane can be used to a great extent in revising the topography along the shore of the country, and in some parts of the interior, and also in making original surveys. The Coast and Geodetic Survey is not directly interested in airplane surveying of the interior of the country, but the Survey will certainly be expected to have control extended over the interior of the country, so that airplane maps can be properly made."

On February 26 President Woodrow Wilson submitted to the House of Representatives a recommendation for legislation placing the licensing and the regulation of all aerial navigation under the U.S. Department of Commerce. The need for charts designed specifically for flying was born. Now C&GS would eventually receive the responsibility for compiling charts for flight safety as well as charts for safe ocean navigation.

The airplane had brought the possibility of new surveying techniques.

Field Activities—1919

On June 10 Lt. C. G. Quillian was assigned to investigate the feasibility of using aerial photography in compiling coastal topography. The Air Service of the Army was to cooperate in furnishing planes, pilots, and photographic equipment, and in making the photographs for investigation. C&GS was to locate the control and analyze the results. Atlantic City, N.J., was selected to be surveyed photographically. The Naval Air Service was also interested, and C&GS accepted their offer to cooperate in an independent aerial survey. On June 10, Lt. Quillian left the Washington office for Atlantic City and immediately contacted the Army photographic unit, which had already arrived. The unit comprised Capt. M. A. McKinney, who was in charge, and Lt. J. R. Bradford, the pilot, as well as two sergeants who were to act as photographers. A second Army photographic unit arrived a few days later. The first Army unit had a standard two-seat airplane, which was flown from Langley Field to Atlantic City, a photographic trailer (fig. 8), and an "L"-type camera (fig. 9). The trailer contained a darkroom with an enlarger. The objective was to process all the negatives and furnish all the prints at the worksite so that a rough mosaic could be made in the field to ensure adequate coverage of the entire project.

Lt. Quillian reported that the "L"-type camera (figs. 9, 10, and 11) was fitted with a magazine carrying 25 glass plates.

Lt. Bradford was the pilot during the flights, and he directed the airplane over the photographic site. Sgt. Drake did most of the photography. The system of photographing was to fly along parallel lines about one-eighth to one-quarter mile apart and make exposures at intervals of 10 to 15 seconds, depending on the aircraft speed. The pilot was relied upon to keep the course and maintain the plane on an even keel and at a constant altitude. Lt. Quillian reported: "I was taken over the sections to be photographed a couple of times to note points that would be of advantage as control points and to have some idea as to what to expect in the pictures." The second Army photographic unit, comprising Lts. Jacobi and Boggs, flew in from Bolling Field with a new type of camera. That camera was an experimental K−1 type and used a recently designed roll of film.

During these flights, Boggs was the pilot and Jacobi handled the camera. This party made photographs for 3 days and returned to Washington with the aircraft, film, and cameras.

The Air Service in Washington advised Quillian that a rough mosaic had been made from the developed films but the photographs were taken at such different altitudes that scaling the prints was necessary, and that some time would elapse before the mosaic and pictures could be given to C&GS for analyzing.

While at Atlantic City, C&GS advised Quillian that the Navy Air Service was also cooperating in this work. Quillian reported: "I met Ensign W. Mann, of the Naval Air Service at Atlantic City, and learned that the plans for this party were to make the Naval Air Station at Cape May City Headquarters and to



FIGURE 8.—Photographic trailer and truck, 1919. (Photograph courtesy U.S. Air Force.)

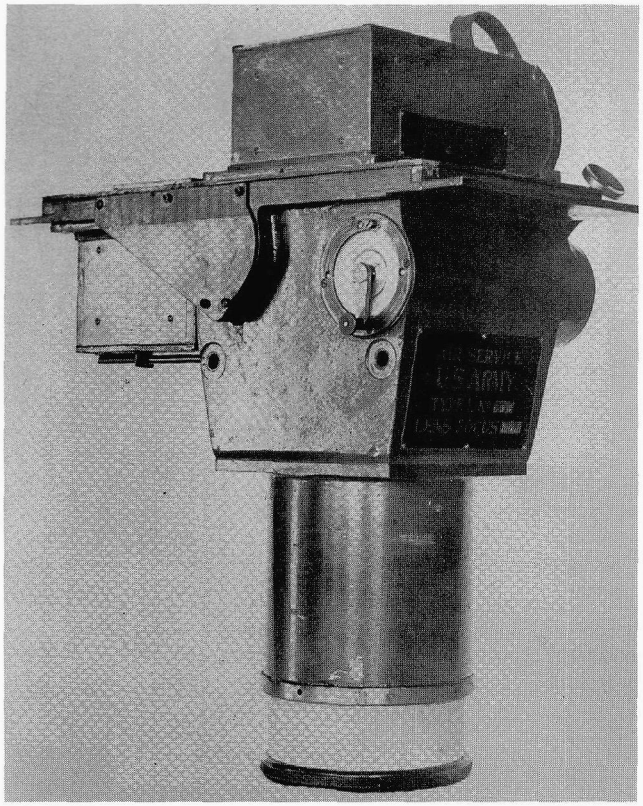

FIGURE 9.—U.S. Army Air Service L Type camera. This view shows the shutter release handle and the lever for moving plates from one magazine to the other. The camera weighed 125 pounds when loaded and it had to be loaded in a darkroom because the plate magazines did not have a dark slide. The photographer did not have a viewing sight; therefore, he had to look over the side of the aircraft to determine what was being photographed. (Photograph courtesy of U.S. Army Air Service.)

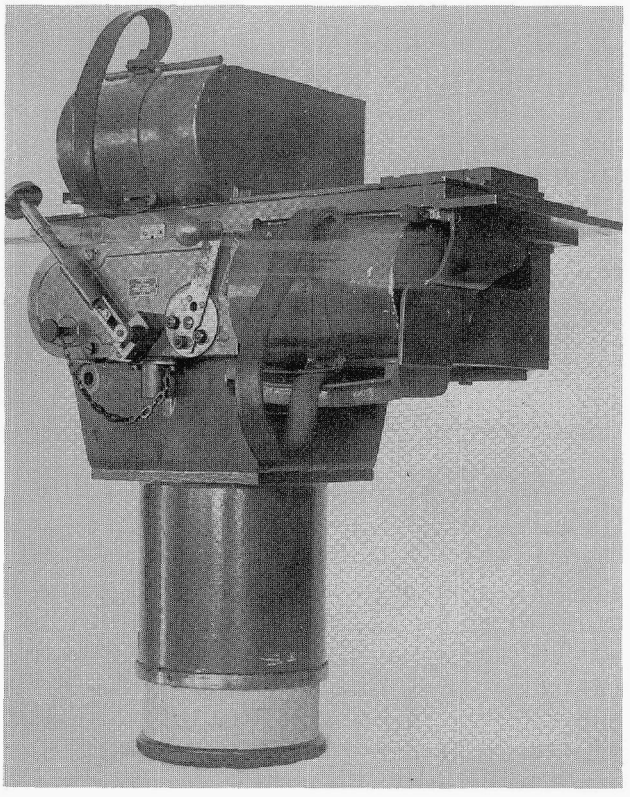

FIGURE 10.—U.S. Army Air Service L Type Aerial Camera. The focal length of the lens is 10⅛ inches. Twenty-five plates were loaded into the magazine on top of the camera and each was moved to the magazine at the rear of the camera after exposure. (Photograph courtesy U.S. Army Air Service.)

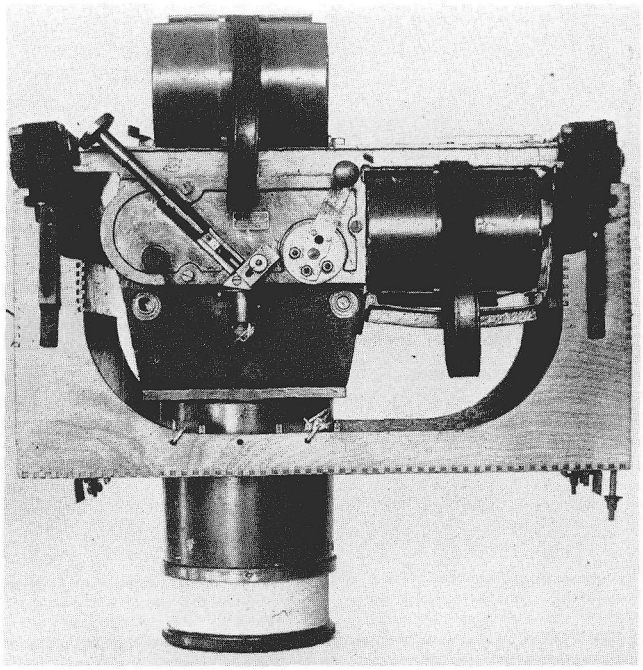

FIGURE 11.—U.S. Army L Type Camera and mount. The mount was bolted directly to the floor of the aircraft; rubber sponges were used at each end to absorb aircraft vibrations. (Photograph courtesy U.S. Army Air Service.)

make the flights from Cape May on each day that photographs could be taken. The photographic altitude was to be 5,000 feet, and that the aircraft would reach this altitude by the time it arrived at Atlantic City. I am now informed that various things interfered with this plan and that very few flights were made. The "L"-type camera that was being used was abandoned because of a larger number of pictures required to cover the area, and a Bagley 3-lens camera (figs. 12 and 13) was obtained from the U.S. Army Engineers and that; this camera was used in some of the flights over a portion of Atlantic City. These films were processed and the slide pictures transformed by the Army Engineers at their station in Washington, D.C. I have looked at these prints and a great number show marked distortions from tilt."

During the end of July Ens. Mann used a dirigible instead of an airplane to make further photographs of Atlantic City with the Bagley camera. Lt. Quillian made the following observations: "The possible use for photography in the Coast and Geodetic Survey is limited because of the relief of Alaska and the lack of equipment in the Philippines make it impractical to consider using such photographs in the region where most of our original surveys are now being made. We can use data from the photographs made along the Atlantic and gulf coast. The surveys of this region will be mainly of a revision type. We can use pictures over these regions to fill in present details by using the original detail of the waterways as control and, thus, bringing the surveys up to date."

On June 10 Lt. G. C. Mattison, in Key West, Fla. received the following instructions from the Superintendent: "Arrangements are being made for the Aeroplane Service of the Navy Department to cooperate with your party to determine if it is possible to locate rocks and coral heads of Florida Reefs by means of photography. It is intended that you shall select an area near Key West that has been thoroughly surveyed and in which there are numerous coral heads such as the vicinity of the Triangles, also the vicinity of Middle Ground northward of Sand Key; and that you shall furnish control by steaming back and forth with the (USCGS Ship) HYDROGRAPHER and launch, locating your vessel and launch by the usual methods, in

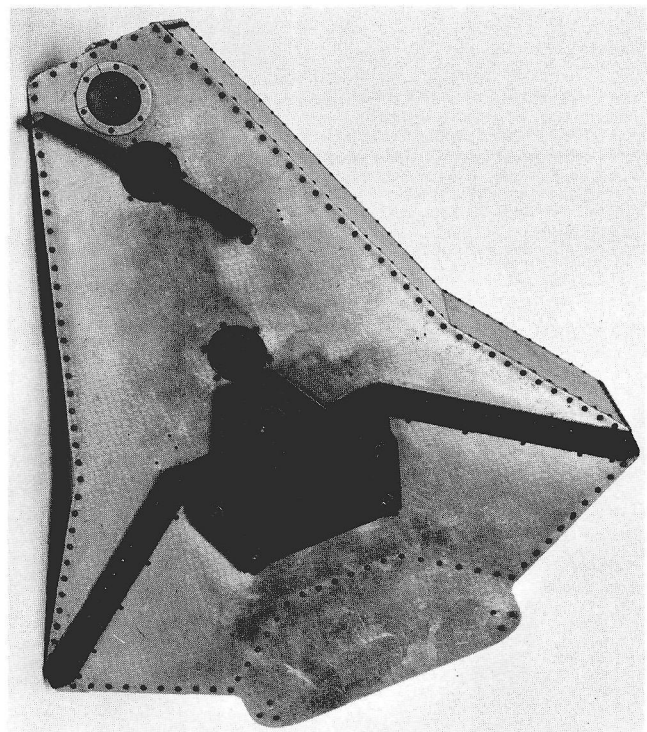

FIGURE 12.—The 3-lens Bagley camera. Major J. W. Bagley of the Corps of Engineers designed the 3-lens camera based on the principle advanced by Capt. Theodore Scheimpflug, an Austrian Army engineering officer. This view of the camera shows the film advance mechanism. (Photograph courtesy Curator of Photography, Smithsonian Institution.)

order that your vessel and launch shall be included in each photograph to be taken by the aeroplanes, and these furnish points of control. The work must of necessity be experimental and various methods will suggest themselves to you. It is thought, however, that photographs should be taken under varying conditions of sunlight and at varying altitudes to determine what are the best conditions for the work. The question of radio communication between the vessel and the aeroplane should be given consideration. If the shoals can be discovered by means of photographs, the ship and one boat or buoys serving as control

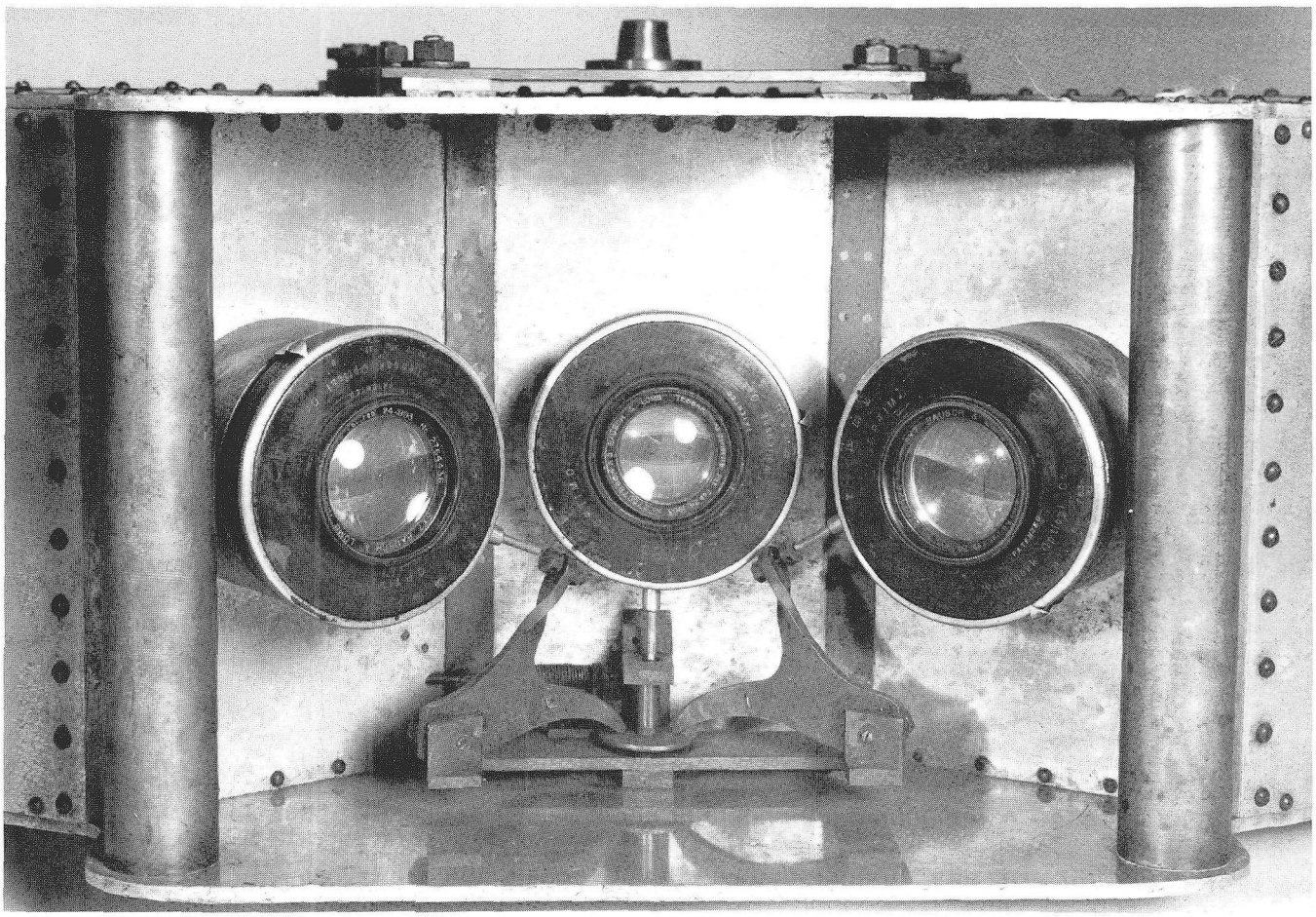

FIGURE 13.—Lenses on the Bagley 3-lens camera were manufactured by Bausch and Lomb. The focal length is 5 inches for the center lens and 7 inches for the two wing lenses. The ingenious trigger mechanism for tripping all three shutters simultaneously is under the center lens. (Photograph courtesy Curator of Photography, Smithsonian Institution.)

points, it will be intended to obtain the location of the shoals from the photograph in order that they could be subsequently located by the hydrographic parties. You will readily see that the entire problem is to obviate the necessity of wire-drag work in developing the Florida Reefs and to have some means of determining for certain that all rocks have been located."

From June 20 through July 31 the first photography specifically for photobathymetry for C&GS was obtained at altitudes of 2,500 to 4,500 feet (figs. 14, 15, 16, and 17).

The U.S. Navy loaned the aircraft, pilot, and a hand-held camera. The U.S. Army loaned a mapping camera. Lt. Mattison and Chief Printer K. E. Willis, U.S. Navy, flew at different times during this period as photographers.

The U.S. Army "L" type camera (figs. 9, 10 and 11) used 4-by-5-inch glass plates. The camera mount was fixed in the aircraft so that it was impossible to correct for any tip, tilt, or crab of the airplane. The hand-held camera (fig. 18) also used 4-by-5-inch glass plates. Figures 15 and 16 were photographed with this camera. In all, some 80 photographic plates were taken, and Mattison reported "the plates and prints were developed with the intention of showing contrast below the surface of the water so that a longer developing and printing time was necessary than if land pictures had been taken."

Lt. Mattison reported the following: "During July, the party on the steamer HYDROGRAPHER (G. C. Mattison, Commanding), cooperated with the Naval Air Service at Key West, Florida, in experiments to determine the possibility of locating submerged rocks and coral heads by means of aerial photography. Various types of cameras were used, as well as different makes of plates and light filters. The photographs were taken at various altitudes and under varying light conditions. The HYDROGRAPHER and launch appeared in each photograph, for purposes of control. This series of experiments proved quite conclusively that airplane photography is of little practical use in locating submerged obstructions."

Lt. Mattison drew the following conclusions: "It is very evident that this method of surveying will not replace the wire drag, owing to the various difficulties encountered.

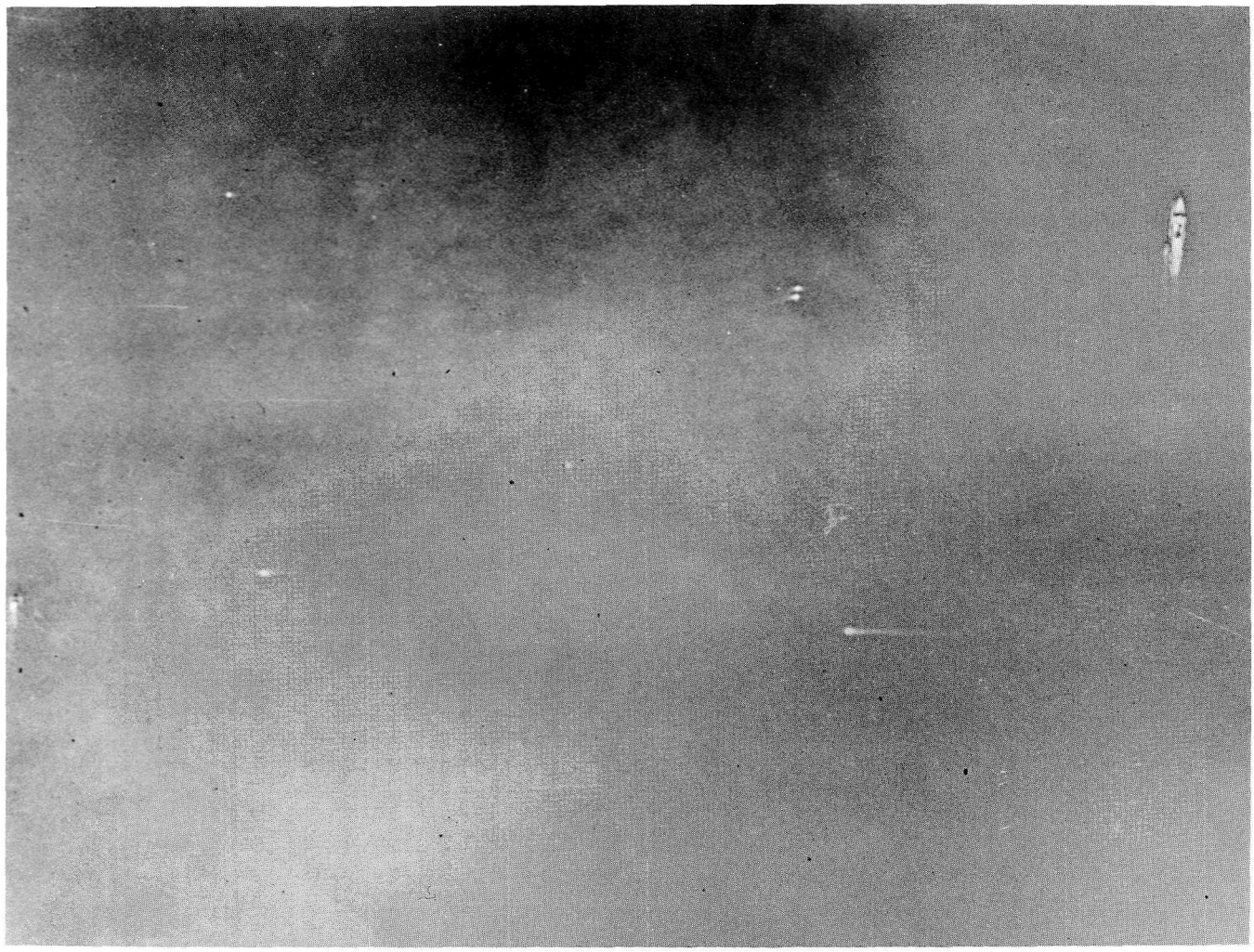

FIGURE 14.—The first aerial photograph taken for photobathymetry June 30, 1919, at 10:23 a.m., over Satan Shoal, Fla. Camera "L" type; altitude 4,500 feet. Kodak standard, orthonon, 4- by 5-inch glass plates. The C&GS ship *Hydrographer* is the control station, there is no indication of an 18-foot least depth shoal that should appear in the middle of the photograph. (Photograph by K. E. Willis, U.S. Navy.)



FIGURE 15.—Vertical photograph of Sand Key, off of Key West, Fla., July 30, 1919, 11:18 a.m. from an altitude of 4,000 feet. Camera is a Navy type with 4- by 5-inch, Kodak Wratten, panchromatic glass plate. This is one of the only clear photographs of bottom features that were obtained during the test. (Photograph by K. E. Willis, U.S. Navy.)

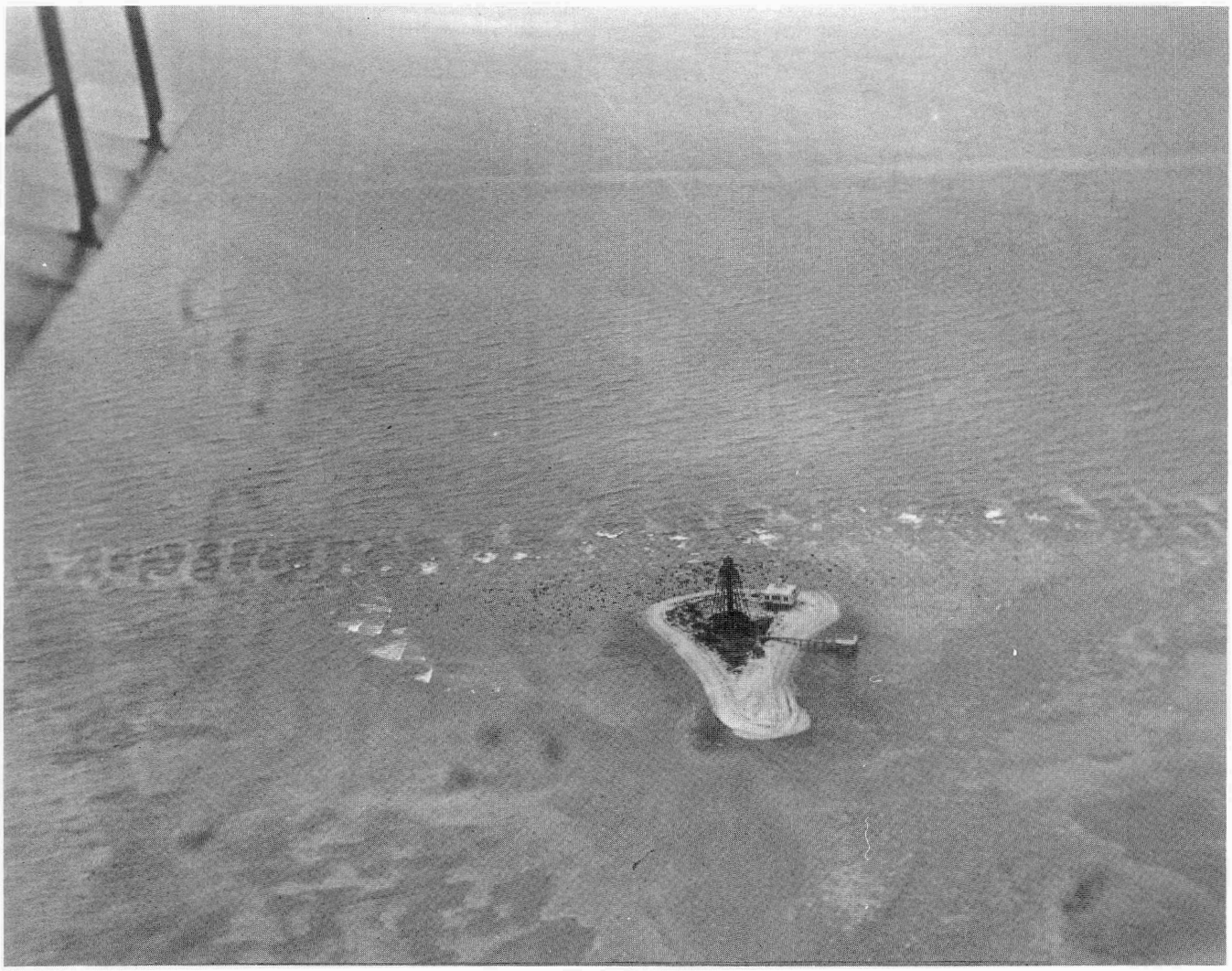

FIGURE 16.—Oblique view of Sand Key Light looking south, July 22, 1919. The wing of the aircraft appears in the upper left corner. (Photograph by G. C. Mattison.)

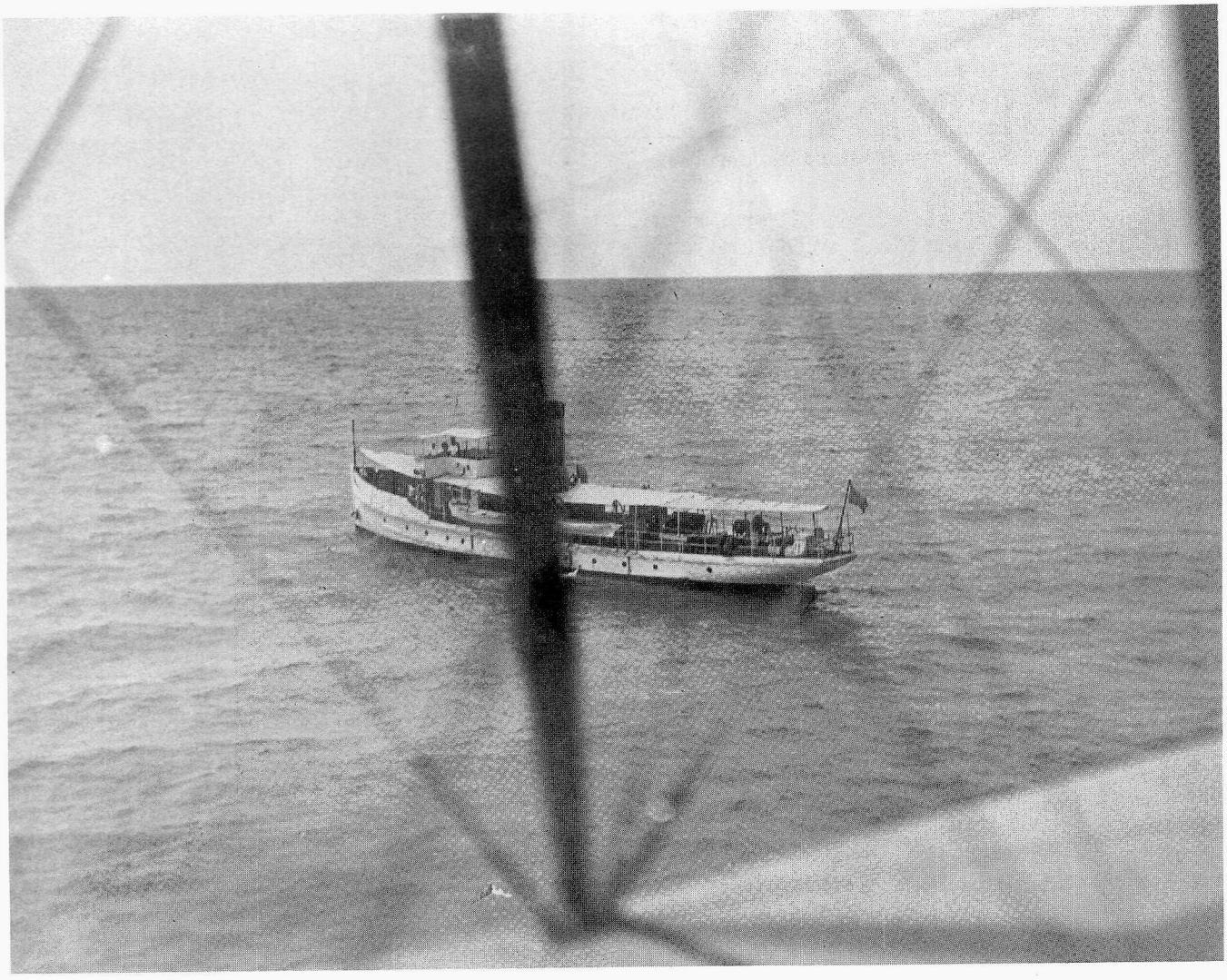

FIGURE 17.—The C&GS ship *Hydrographer* anchored near Satan Shoal, July 22, 1919, as seen through the struts of the aircraft. (Photograph by G. C. Mattison.)

"Photographs cannot be made on days when the sea is rough. This is clearly shown in the photographs taken near Satan Shoal. On this day, the sea was also too rough for launch Hydrography. The broken surface interferes with a clear view of the bottom.

"At this time of the year, hazy weather interferes with photography, especially at the higher elevations. On days when Hydrography or wire drag work can be easily done, no aerial photographs can be satisfactorily obtained owing to the haze. When southeasterly or easterly winds are blowing this is especially true, and as they are the prevailing winds, at this season, at least fifty percent of the days are rendered unsuitable due to this one cause alone.

"Days must be chosen when there are no low clouds in the sky. Special observations would have to be made in order to estimate the percentage of days on which work could not be done owing to clouds. It is difficult at times to estimate the exact elevation of clouds and a trial flight must be made.

"Near the noon hour, it is difficult to obtain good pictures due to the reflections of the sun. This can be remedied by tilting the camera so that the sun is in back of the camera. In this case, there is difficulty in plotting the area covered by the picture. If vertical pictures are obtained about three hours during the middle of the day, they are rendered unsuitable owing to the reflection of the sunlight.

"Whenever there are strong currents, the water is generally in a disturbed condition, and it is difficult to see the bottom. This is true in the channels and within two or three miles of the Keys in the vicinity of Key West.

"An important shoal may be obscured due to a local disturbance, when apparently the water is clear. In that case, if a photographic survey is to replace the wire drag, an area may be considered completed, and there would be no indication of this particular shoal.

"It is difficult to maneuver the plane so as to be directly overhead when the exposure is made, especially if a wind is blowing across the course. This could be overcome by the aviator after a great deal of practice.

"Owing to the noise in a plane, the photographer cannot tell if his camera is operating properly, as he cannot hear the click of the shutter, or the shifting of the plates. A whole days work may be lost, and the first intimation of it will be when the plates are developed.

"A dirigible or balloon would be preferable to an aeroplane."

Lt. C. G. Quillian experimented with the Atlantic City photographs and also made a study of the different problems connected with aerial mapping until December.

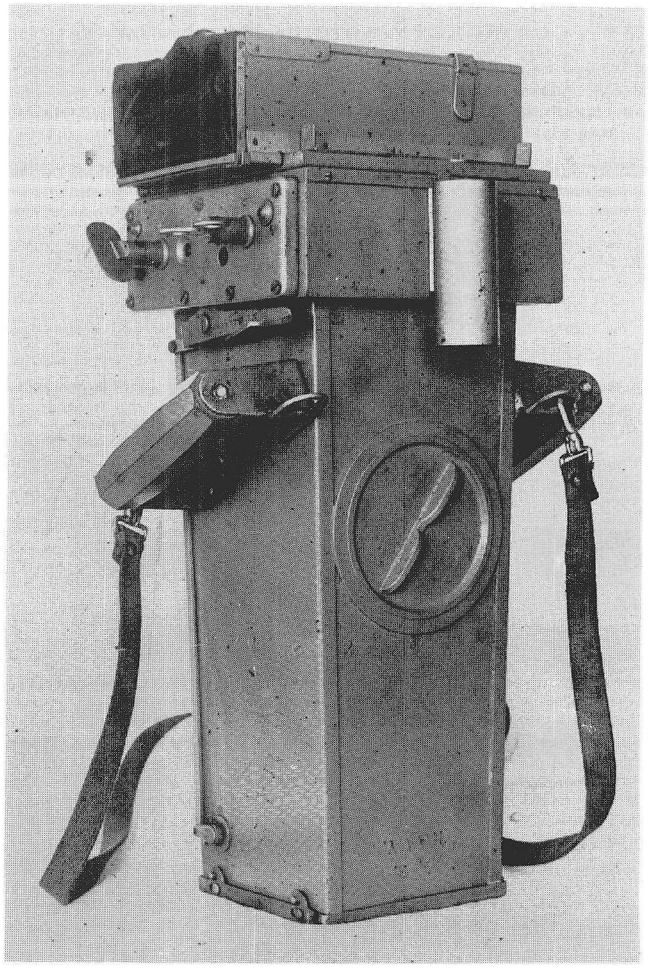

FIGURE 18.—The U.S. Navy Multipurpose camera. Although this camera was designed primarily for hand-held photographs it could be mounted in the aircraft much like the Army model L, but it was only capable of holding eight 4- by 5-inch glass plates. The plates were moved from the focal plane to the top of the plate holder by a clever system of sliding the plate out in a light-tight box and moving it to the top, then pushing it back into the magazine. The camera had a focal length of 9⅞ inches and weighed 60 pounds. (Photograph courtesy U.S. Navy Air Service.)

In addition, E. M. Church was serving as secretary of the C&GS Research Committee engaged in the study of the application of airplane photography to mapping.

At the end of 1919, four branches of the U.S. Government were experimenting in the field of aerial surveys: Army Air Service, Naval Air Service, Corps of Engineers (which was cooperating with the U.S. Geological Survey), and C&GS.

1920

OFFICE ACTIVITIES—1920

Lt. C.G. Quillian, who was assigned the task of reporting on the feasibility of the use of aircraft in mapping, resigned from C&GS at the end of 1919. On January 22, 1920, Lt. George C. Mattison was named to replace him. In March, Mattison reported as follows: "I made a projection on a scale of 1:10,000 of the Atlantic City area with the intentions of using the photographs taken in July 1919 by the U.S. Army Air Service to construct a map. I soon found that there was considerable distortion in the prints furnished by the Air Service. In fact, so much so, that the prints could not be used as an accurate map. New prints have been ordered that will be made on double-weight paper."

At the same time during March, the Director of Air Service, U.S. Army, invited the Superintendent of C&GS to send a representative to attend a series of trials of mapping cameras at McCook Field near Dayton, Ohio.

On April 6 Lt. Mattison went to Dayton, Ohio. He reported: "Unfavorable weather conditions delayed the field work." And it was not until April 29 that conditions were such that "favorable weather prevailed." From April 29 to May 4 the weather conditions were good and considerable work was done. "It became very apparent that weather conditions would have to be taken into consideration in planning any mapping work with airplanes. This is especially true in regards to cloud conditions. And, this has never been a factor that has ever happened in any other surveying work."

The cameras that were tested were the K−1 (fig. 19) and the Bagley 3-lens camera (figs. 12 and 13). Mattison reported: ". . . these two types of cameras are both being improved at the present time. The Eastman Kodak Company and the Fairchild Camera Company are now constructing new cameras that are refinements of the K−1 and Major Bagley is also having a new type of tri-lens camera constructed." The tentative program was laid out by Maj. Bagley. It was a test for tilt, a test for shutter distortion, and a test for comparison for single- and 3-lens cameras during hazy weather. "The test for tilt, this is to be a test to test the accuracy of the level-bubble method of stabilization. The test for shutter distortion is a test to determine the error in the photograph when the camera is equipped with a focal plane shutter." A number of targets were built about 8 feet square and erected in positions forming an equilateral triangle having 1-mile sides. These targets were all leveled to the same elevation. The test for the comparison of the two cameras in the mapping area was to determine the relative merits of the single-lens and 3-lens camera in mapping the same area. "This is in regard to time, cost and accuracy. The area selected is a quadrangle near Dayton, Ohio, and the control consists of a traverse around the edge of the quadrange with points at an interval of 1 mile. Comparison of the two cameras was made in hazy weather as there have been many arguments for and against tri-lens cameras, but these tests are the first ones in that any attempt was made to compare the two cameras under similar conditions." In the wing pictures of the tri-lens camera the rays of light travel through considerably more atmosphere than in the center pictures (fig. 20). "This is believed to be a disadvantage in hazy weather." The aircraft used in the test was a deHavilland DH−4 (fig. 21), which carried the K−1 camera. A negative lens was set on the bottom of the aircraft for the camera operator to observe the images of the terrain. A twin-engine Martin Bomber was used to carry the Bagley camera.

Lt. Mattison came to the following conclusions after observing and participating in the tests:

"1. A large plane with two engines seems to be the best for survey use. The larger the plane, the steadier it is in flight. Additional motors are recommended as a safeguard. A great deal of mapping work by the Agency would be from airplanes that will probably be over swampy or isolated territories, and in the case of trouble with an engine the plane can be flown with one engine until the position of safety is reached. The larger plane would have a greater fuel capacity and, therefore, a greater cruising radius.

"2. As film distortion has been found to be radial only, it now eliminates the only serious argument that was favoring glass plates.

"3. The new K−1 camera is designed to use film of 75-foot lengths.

"4. It is very essential that the pilot and observer or photographer have an idea of the accuracy required in mapping, and that they take an interest in obtaining the best results possible. The larger share of pilots

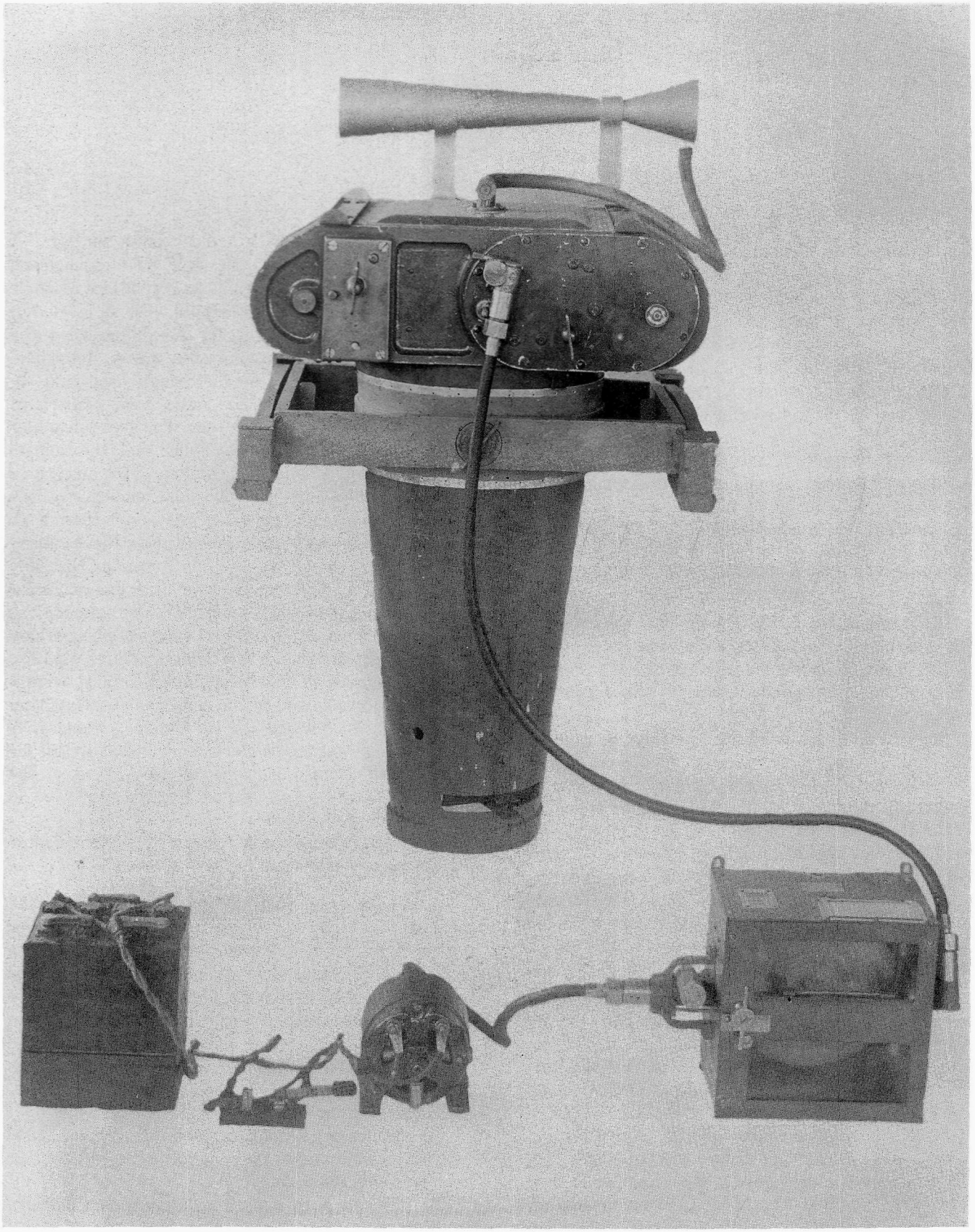

FIGURE 19.—The K–1 type camera was manufactured for the U.S. Army Air Service by the Folmer and Schwing Department of Eastman Kodak Company. The weight of the camera including film is 34 pounds. This does not include the venturi used as a vacuum system for flattening the film, the dry cell battery used as a power source, nor the electrical timing device used to activate the shutter and transport the film. The shutter is a focal plane type, single slit with ¾ of an inch opening. The focal length of the lens is 12 inches and a 75-foot-long roll film is used.

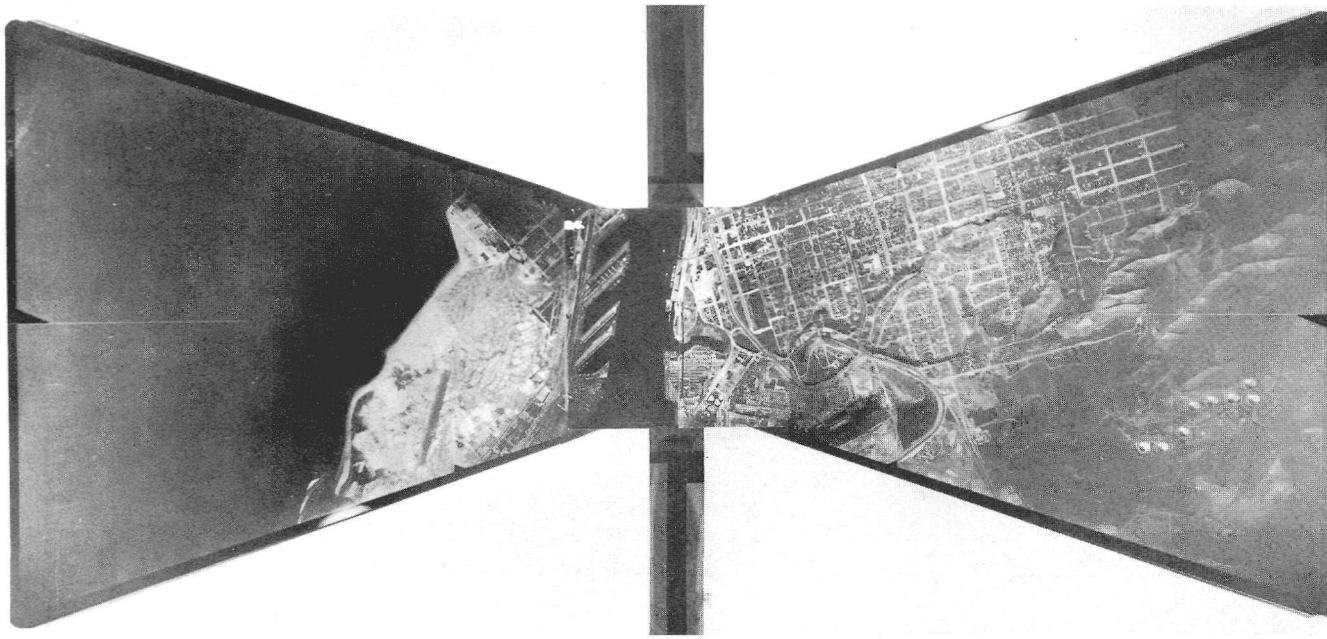

FIGURE 20.—Original Bagley 3-lens photograph on file at Photo Map and Imagery Information Section, Photogrammetry Division, NOS.

and photographers are not interested in mapping as there is not enough variety in the work and it is monotonous to them as the steady flying on a straight course does not appeal to the average pilot."

The bureau obtained no photography during 1920. But the interest in aerial photography continued, and the Director's Report indicated that a mosaic of the New Jersey coast was constructed (fig. 22):

Photographic Surveying

The Director, C&GS, reported:

"On July 1, 1919, the Bureau had an officer at Atlantic City, New Jersey establishing control of airplane photographs, which were subsequently made by the Air Services of the Army and of the Navy for the purpose of determining experimentally how accurately the country could be mapped from such photographs. A mosaic of Atlantic City constructed from these photographs together with the individual photographs, were studied with reference to the control. At the same time, the party on the Survey steamer HYDROGRAPHER was experimenting near Key West, Florida, with airplane photographs of water areas to determine to what extent, if any, submerged objects and the nature of the bottom could be detected on such photographs. These photographs were taken by the Navy Air Service officers stationed at Key West.

"The results obtained from the Atlantic City experiments, while inconclusive and, on the whole, rather unsatisfactory, still indicated that airplane photography may be of great assistance in mapping the land. The results of the Key West work indicated that with present photographic equipment no dependable information can be had of underwater conditions. Because of the very important part that airplane photography will certainly take in land surveying if some of the obvious difficulites can be overcome, it has been considered worthwhile to devote as much study to this subject as practible. One officer has been detailed to devote his entire time to the subject and has been given the best facilities for investigation that the Bureau can supply. He has been in close communications with those who are working on this and allied subjects at Washington and elsewhere. He represented this Bureau at a series of experiments conducted last spring in Dayton, Ohio, by the Air Service of the Army. It is believed that substantial progress has been made during the year, although the disorganized condition of the air services, as the result of demobilization of the Army and Navy, has necessarily retarded experimentation."

The camera format is 18 by 24 centimeters, producing 105 exposures to the roll. The camera can also be reloaded in the air with a new roll of film. (This alone was a great advancement in aerial mapping techniques in 1 year.) The camera was started and stopped by throwing the knife blade switch, and when the camera was operating, the film moved continuously except at the moment of exposure when the vacuum from the venturi held the film flat in the focal plane. The interval between photographs was controlled by speeding up or slowing down the rate of speed of the film. The camera was suspended in a gimbal mount with lead weights attached to the bottom of the camera to assist in stablizing it. A level bubble was attached to the top of the camera to indicate to the photographer when it was out of level. Capt. Albert W. Stevens, U.S. Army Air Service, designed and installed in both cockpits of the aircraft a small electrical light that was wired into the camera circuit. The light came on 5 seconds before the camera shutter clicked. The pilot would then level the aircraft and the photographer would level the camera. (This apparently simple but clever idea was adopted by all aerial camera manufacturers and remains today—even as to timing—the universal signal used to alert the pilot and photographer.) (Photograph courtesy U.S. Army Air Service.)

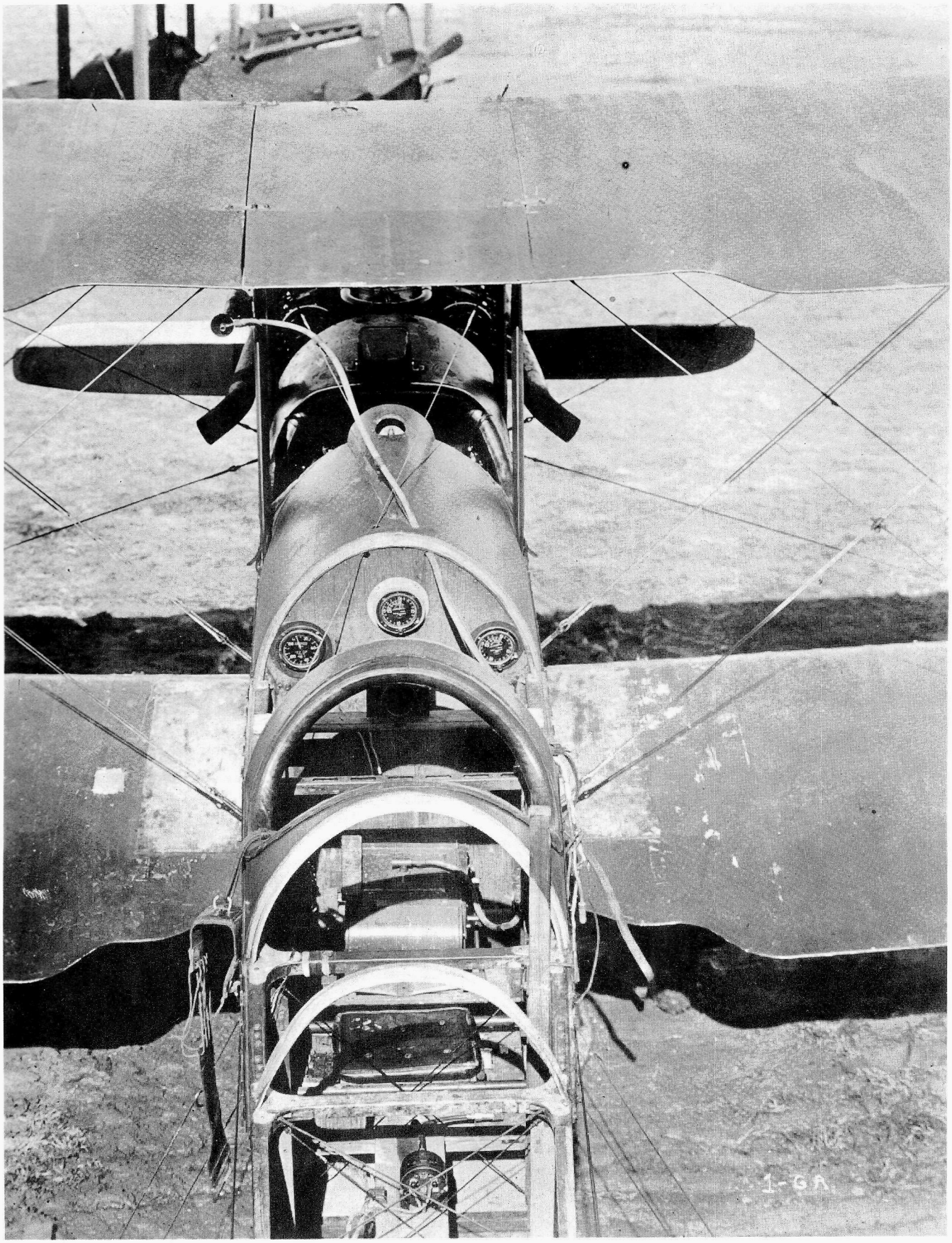
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FIGURE 22.—Mosaic of the coast of New Jersey.

FIGURE 21.—deHavilland DH−4 aircraft used at McCord Field, Dayton, Ohio. The K−1 camera used in the test is installed in the back cockpit with a hose running up to the venturi, which is mounted on a wing strut. (Photograph by G. C. Mattison.)

1921

FIELD ACTIVITIES—1921

Early in 1919, when efforts were being made to place aerial mapping on a stable foundation, the Mississippi River Delta was recognized as being ideally suited to this new technique. The Naval Air Service was again asked to supply an aircraft, pilot, and photographer to help C&GS make an aerial survey of the delta. The Navy complied with this request, and the aircraft arrived at Burrwood, La. on March 24, 1921 (figs. 23 to 31).

Before the commencement of photography, the Corps of Engineers placed targets throughout the delta to control the photographic aerial survey. Lt. Mattison used triangulation to locate the control points (fig. 32). Control was established at intervals of 1 to 5 miles, but only rarely did it exceed 3 miles, and it was felt that it would be advisable to have signals at intervals of 1 mile to maintain standard accuracy of mapping; also, the office work would be considerably simplified by the additional control points. The first photographic flight (fig. 33) began at the south end of the project, generally flown east to west, and gradually the party worked its way north. Chief Printer Culp, U.S. Navy, and Lt. Mattison (fig. 34), C&GS, alternated as photographers on the delta project. Mattison reported: "Although a test flight was made in Pensacola before starting the delta work in order to try out the camera, the work on the delta brought out three glaring faults in the camera mounting, which apparently had not been noticed before:

"1. The optical axis of the camera was not vertical, when the plane was in flight;

"2. The opening in the bottom of the plane was too small, and blocked out the edge of the photographs;

"3. The camera was mounted so that the long edge of the film was in the direction of the line of flight. This long edge should have been perpendicular to the line of flight, as in this way a wider area is covered in each flight."

A circular opening in the bottom of the fuselage was cut just below the camera through which the photographs were made. A sliding door over this opening was operated from the observer's seat and protected the camera from water spray when taking off or landing.

"From March 22nd to May 6th, a total of 47 days, a record was kept by me of weather conditions on the delta, especially as regards photographic conditions. During this period 16 days proved suitable for aerial photography. Five of these days were Sunday, and on 3 of the other favorable, days, the plane was out of commission due to breakages, which resulted in 8 available photographic days in a total of 47."

On May 7 the operation was postponed until October, but unfortunately the air craft had an accident and was not available until December, at which time, because of weather, it was felt advisable to postpone any further work until April of the following year. Despite only 8 flying days, 1,065 photographs were taken on the delta project.

OFFICE ACTIVITIES—1921

The C&GS Director stated in his annual report: "The Mississippi River Delta was photographed by the Air Service of the Navy during March, April, and May 1921, for the use of the Bureau in revising the chart of this area. Office work on these photographs is now in progress. Atlantic City, New Jersey, and the vicinity was photographed in July 1919, by the Air Services of the Army and Navy, and almost the whole of the outer coastline of New Jersey was photographed in March 1920, by the Army Air Service. Revised charts of the New Jersey coast are now being compiled, and will soon be issued, showing corrections as obtained from these photographs. An officer of this Bureau established the ground control and verified the results of the office compilation, making an examination of the photographic mosaics in the field. The results of this work have produced some interesting and important conclusions in regard to chart revision: (1) The cost of the revision of the topography of the New Jersey coast by means of aerial photography is about one-third of the estimated cost by plane-table methods; (2) the inaccuracies to which aerial photographs are subject became negligible when reduced to a scale of 1:80,000, the scale of our coast charts; (3) no better historical record could be kept of shoreline changes than that furnished by aerial photographs, as every detail is shown.

Owing to lack of trained personnel, the Air Services of the Army and Navy have not been able so far to

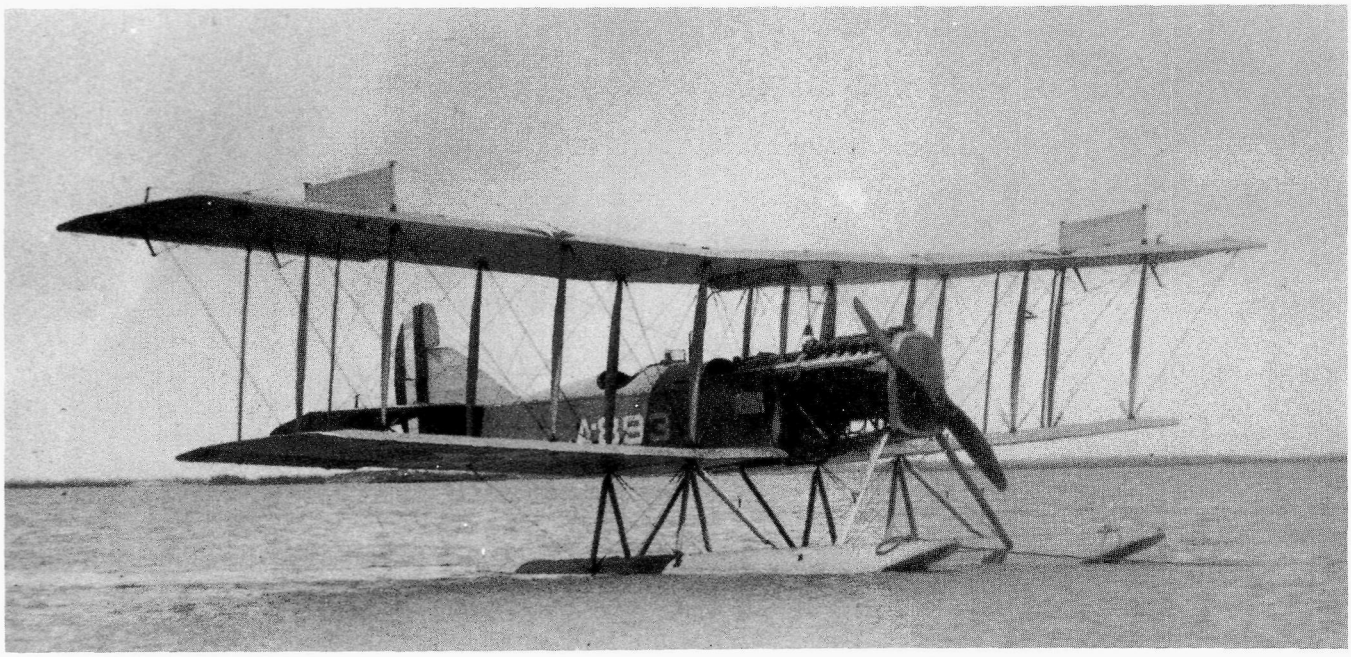


FIGURE 23.—The aircraft, a Curtiss R−6 powered by a 385-horsepower Liberty 12-cylinder engine, had a ceiling of 20,000 feet, could climb to 8,000 feet in 22 minutes, and to 14,500 feet in 55 minutes, but for practical mapping purposes with the photographer and camera equipment on board the aircraft had an operational ceiling of 8,000 feet. It had a top speed of over 90 miles per hour, but on flight lines was flown at 55 miles per hour. The fuel capacity allowed 2½ hours of flight time. (Photograph by G. C. Mattison.)

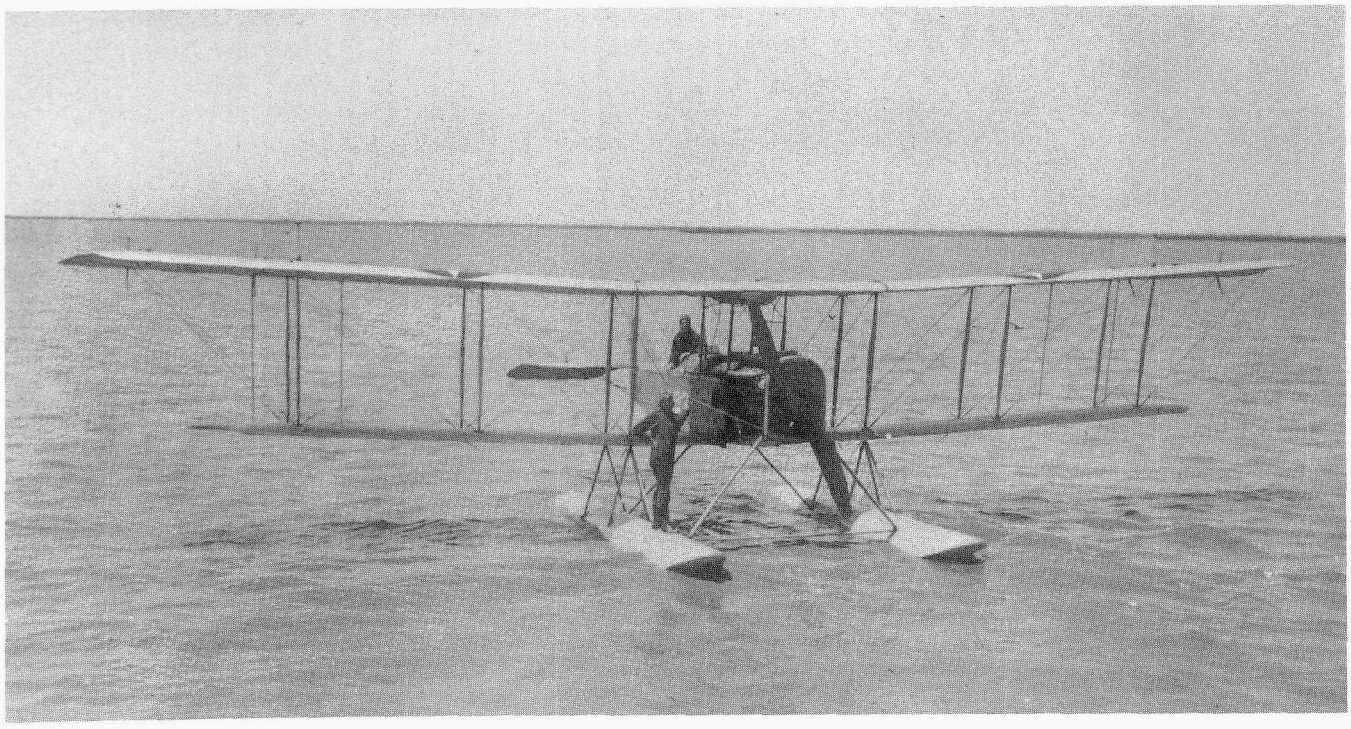


FIGURE 24.—Aircraft waiting to be towed to dock. (Photograph by G. C. Mattison.)

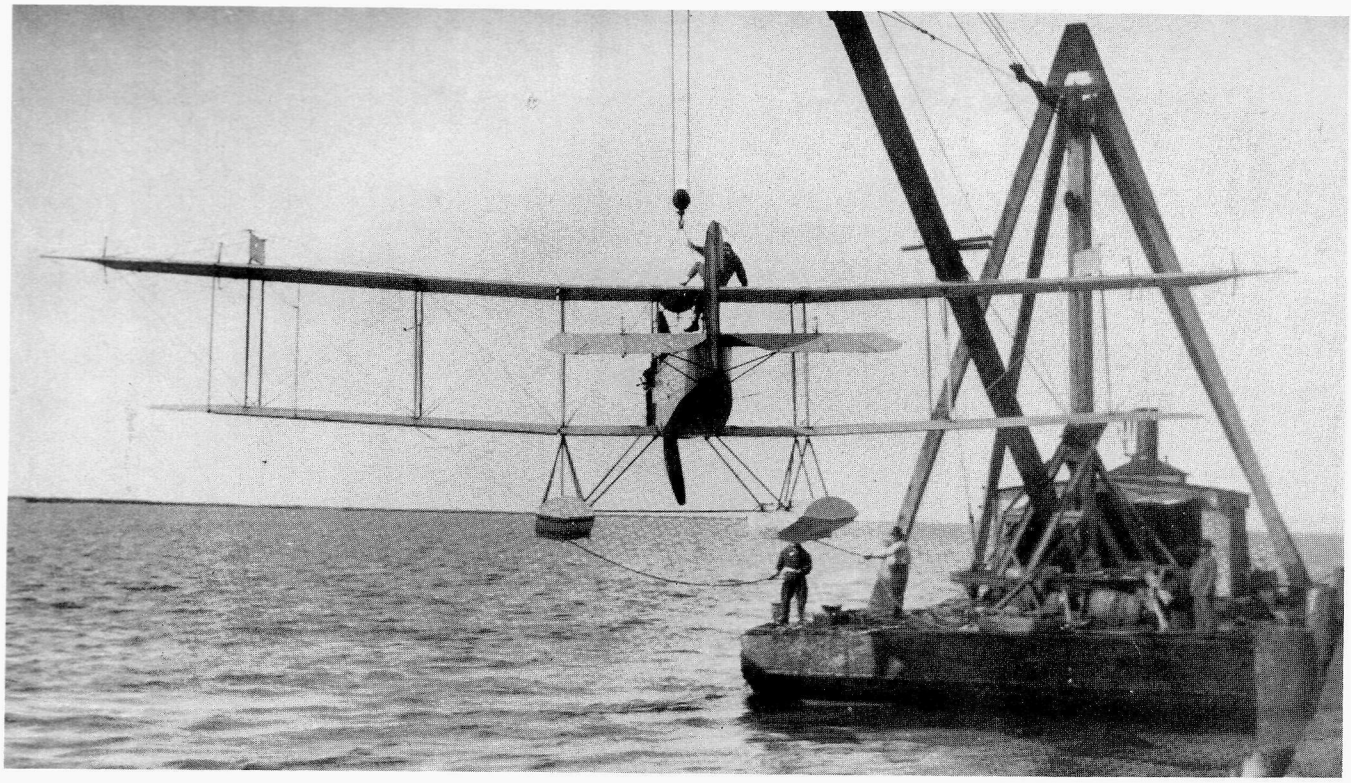


FIGURE 25.—Aircraft is hoisted onto the dock at Burrwood. (Photograph by G. C. Mattison.)

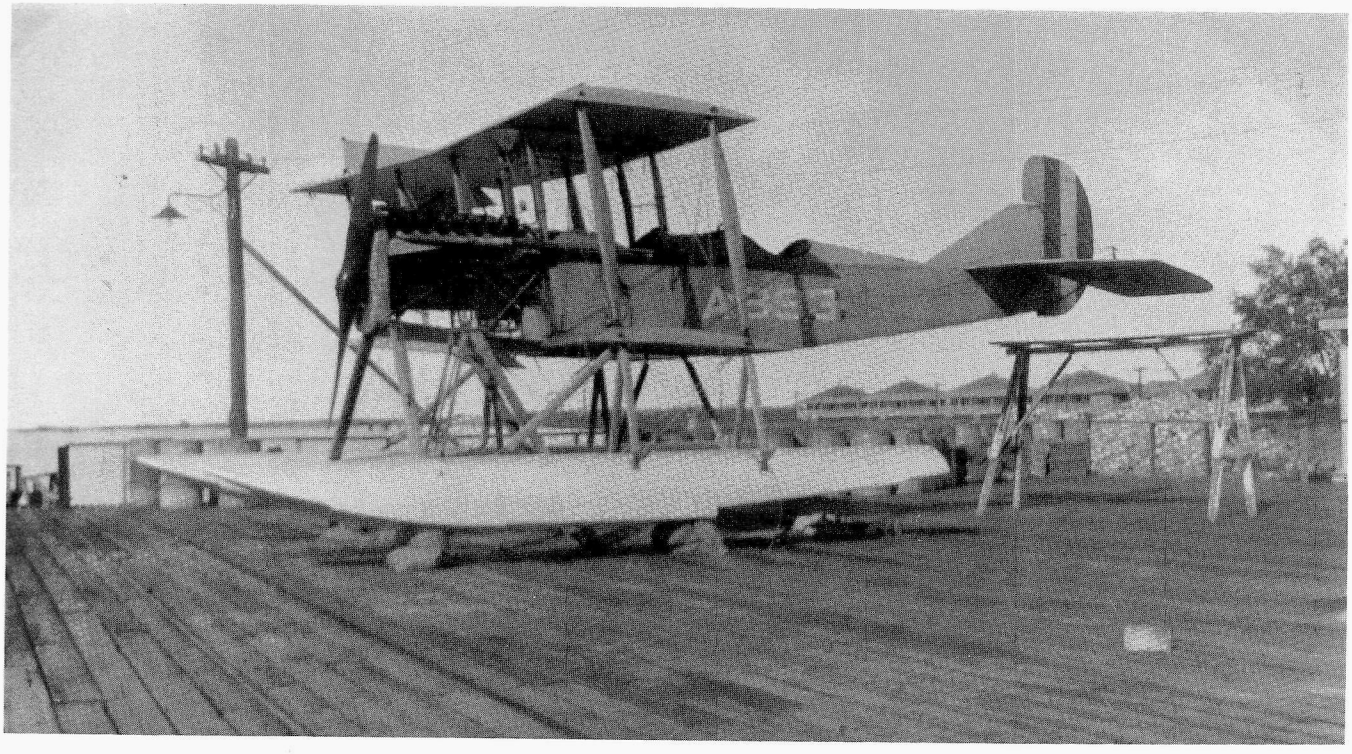


FIGURE 26.—Aircraft ready for camera installation. (Photograph by G. C. Mattison.)

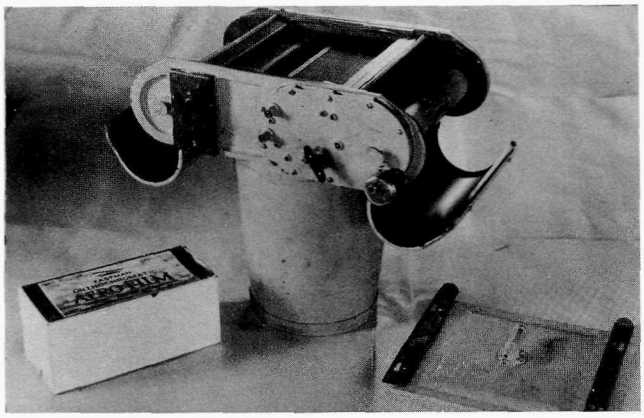


FIGURE 27.—1921 model of K−1 camera which will be installed in the forward cockpit of the Curtiss R−6 aircraft. The slit for exposure by the focal plane shutter can be seen in the opening on the top of the camera. Eastman Orthochromatic aerial film in 75-foot rolls was used on the delta project. (Photograph by G. C. Mattison.)



FIGURE 28.—Chief Printer Culp, U.S. Navy, ready to install the K−1 camera in Curtiss R−6 aircraft. (Photograph by G. C. Mattison.)

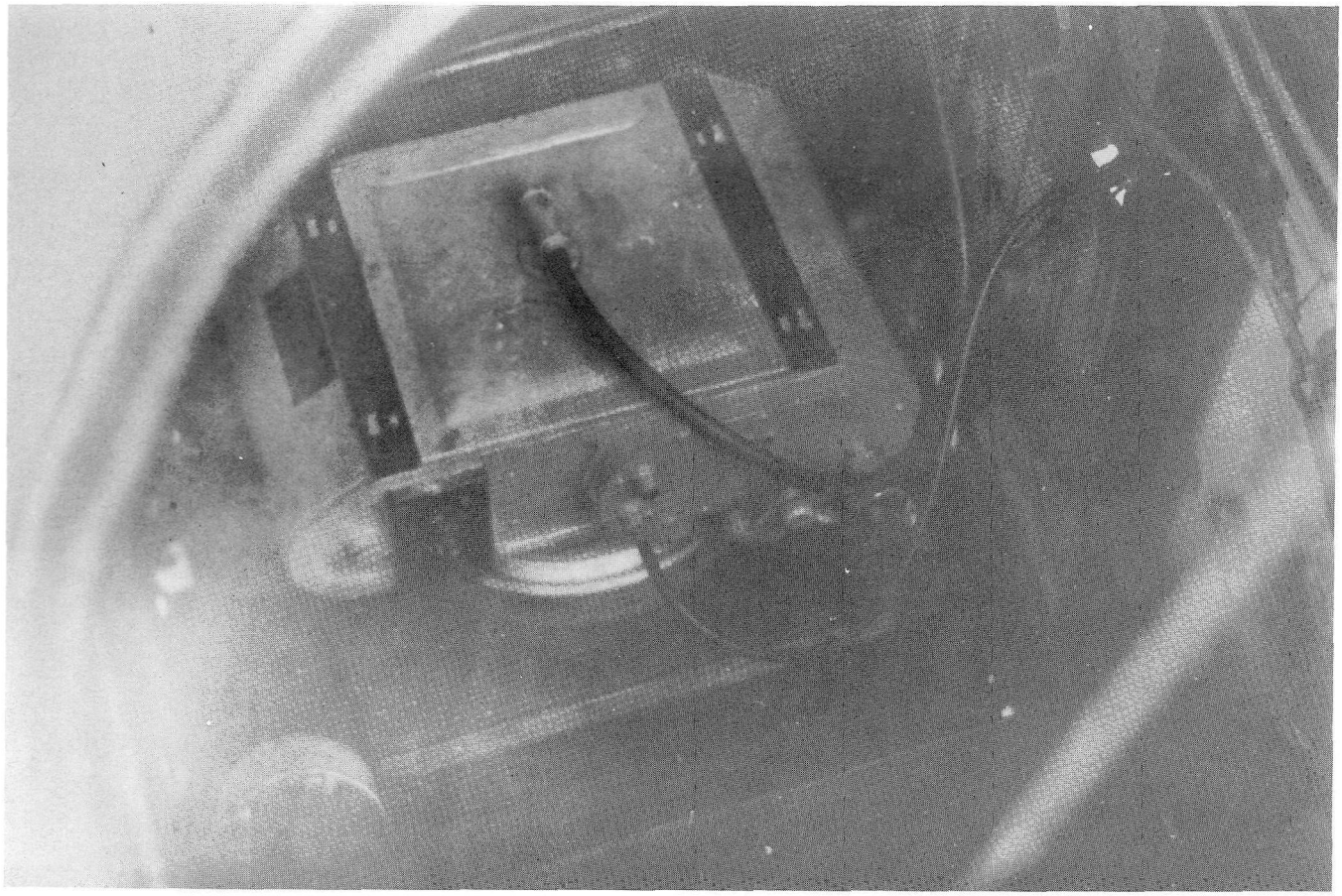


FIGURE 29.—Camera installed in forward cockpit of Curtiss R−6 aircraft. (Photograph by G. C. Mattison.)

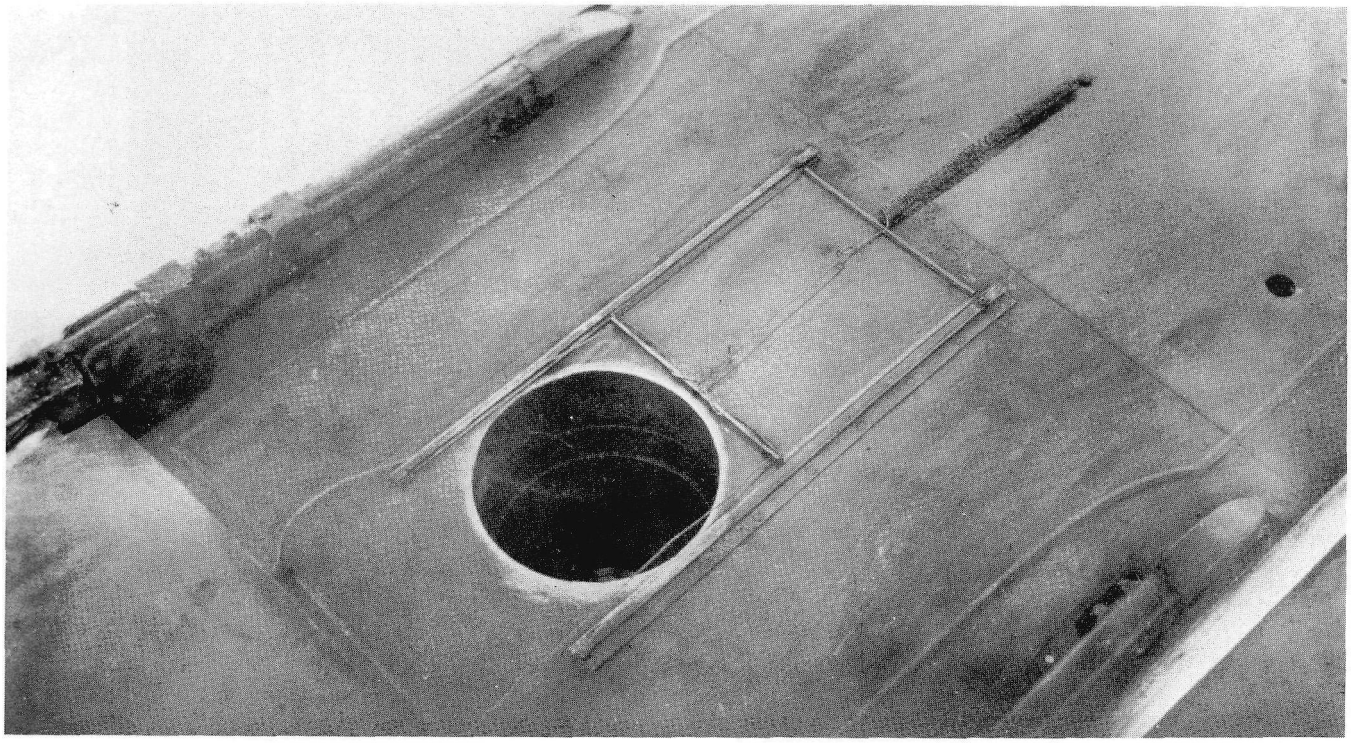


FIGURE 30.—Camera opening in bottom of aircraft. Hatch is on tracks and slides aft, but there is no drift sight for the photographer to view what is being photographed. (Photograph by G. C. Mattison.).

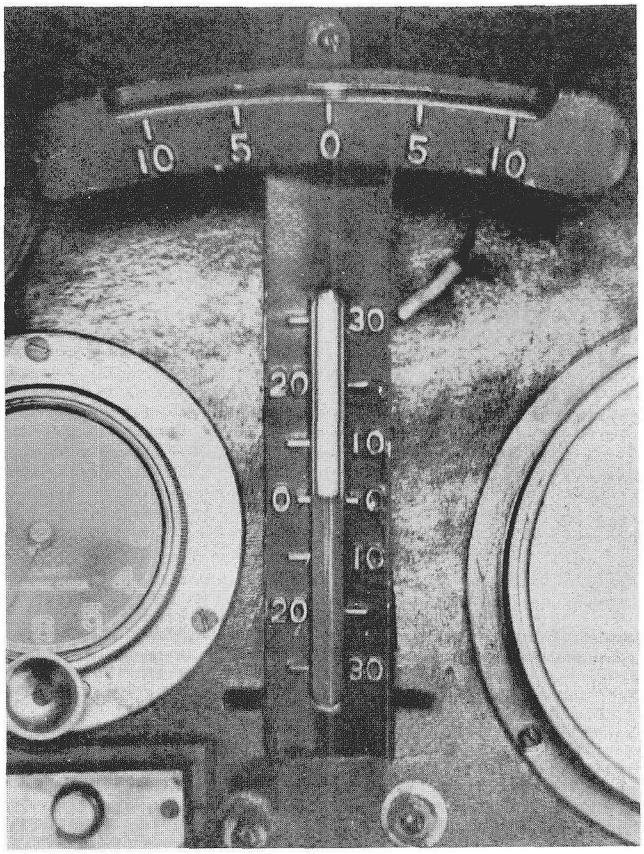


FIGURE 31.—Level bubbles used by pilot Lt. A. M. Darby, U.S. Navy, to keep aircraft level during photography. (Photograph by G. C. Mattison.)

carry out a program of photographing portions of the Atlantic coast as requested by this Bureau for the purpose of chart revision. The situation is improving and these services are planning to cooperate more fully in the near future.

"An officer of this Bureau has devoted practically all of his time during the year to the study of this subject and in keeping in touch with developments. Instruments for use in compiling data are being acquired. In June of this year, a mathematician was assigned to devote a part of his time to the study of the mathematical problems connected with aerial surveying. A draftsman was also detailed for a portion of his time in order to become familiar with the process of compilation of data from photographs. In this way, preparations are being made to handle photographs as they are received from the Air Services. The nucleus of an office and field force is being formed, so that when the time comes that the Air Services will be able to make extensive photographic surveys the Coast and Geodetic Survey will be ready to do its part with a small increase in personnel and the charts of the United States will be closer to perfection, as far as topographic features are concerned, than they ever have been before.

"Too much stress cannot be laid on this successful method of revising our shore topography, emphasizing accuracy, economy, and speed. But the Coast and Geodetic Survey does not maintain airships and seaplanes, and unless there is greater cooperation from the Army and Navy Air Services valuable time will be lost in supplying for charts and maps important information for commercial purposes on sea and land."

Personnel who served on the delta project:

U.S. Navy Air Service

Lt. A.M. Darvy, pilot

Chief Printer Culp, photographer

Coast and Geodetic Survey

Lt. George C. Mattison, Chief of Party



FIGURE 32.—Photographic control points were located throughout the delta. Note white panel on roof of cabin, as well as triangulation signal erected above cabin. (Photograph by G. C. Mattison.)

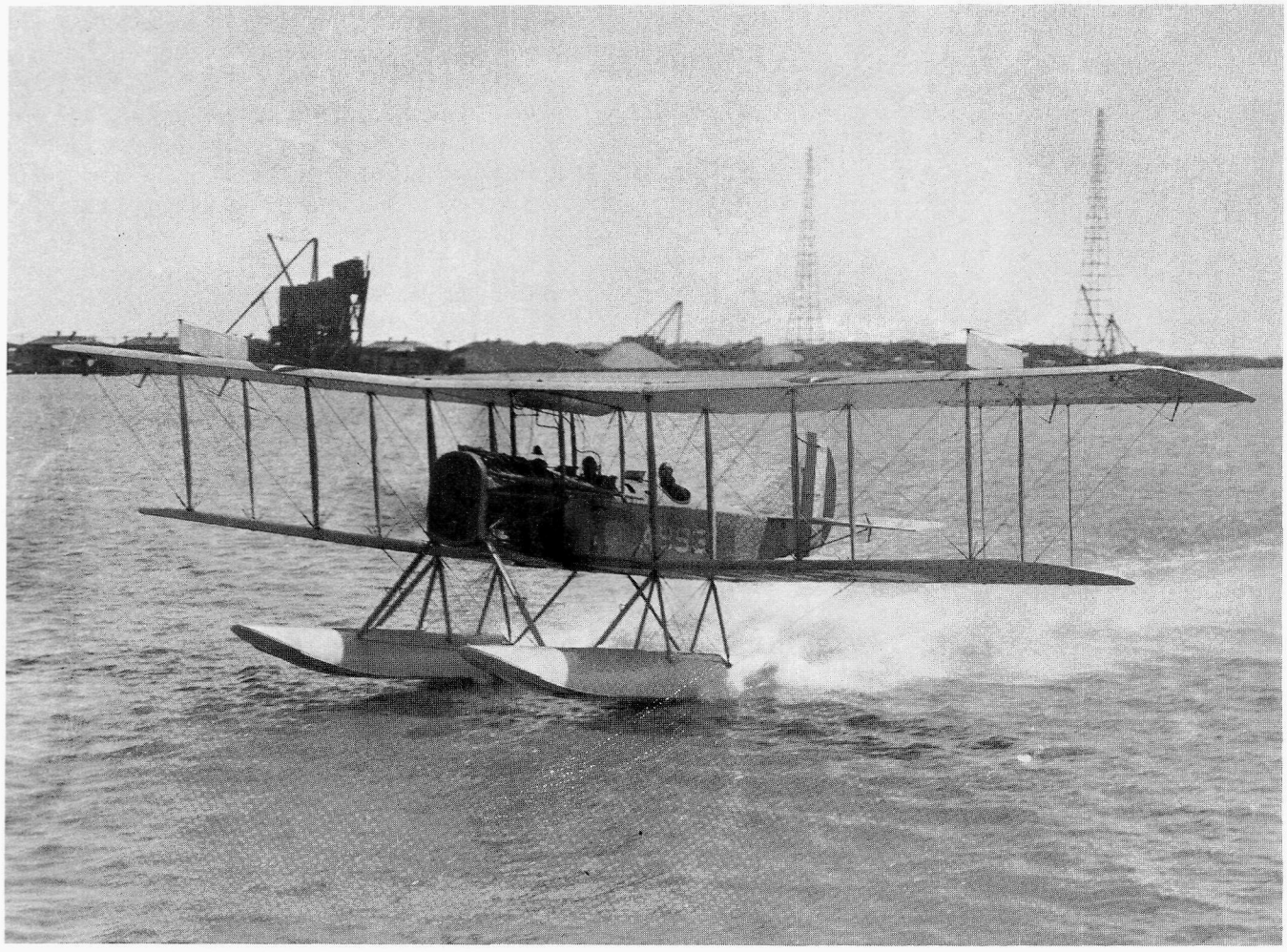


FIGURE 33.—Aircraft taking off on the first mapping flight. (Photograph by G. C. Mattison.)



FIGURE 34.—George C. Mattison. (Capt. George C. Mattison retired on January 1, 1947, after 35 years in the Coast and Geodetic Survey. Capt. Mattison died on August 5, 1972.) (Official NOS photograph.)

1922

FIELD ACTIVITIES—1922

In April Lt. Mattison returned to the delta area with the same flight crew of the previous year.

During a northwest blow on the night of April 17, the plane dragged its mooring and drifted down on the dock, damaging the left wing. A new wing was necessary and was shipped from Pensacola, but did not arrive until April 26. The plane was again in commission by April 28, but 2 favorable days were lost following the blow. April 29 proved to be a good day, and 155 photographs from 5,000 feet were completed in the morning flight.

In April and May, 16 days of photography were accomplished, covering 530 square miles. This completed the whole portion of the delta area covered by chart number 194. The entire project had now been photographed, and Mattison returned to Washington, D.C.

OFFICE ACTIVITIES—1922

The Navy had processed the film of the delta, but, owing to lack of personnel, was unable to furnish prints. Mattison hired two temporary employees and made arrangements to use the photographic laboratory at the Navy Department to make the prints. He hired one additional part-time Navy employee, and together they made over 3,000 prints of the delta project and completed an index of all photography taken (figs. 35 and 36). Mattison reported: "From September 26th to November 12th, I was engaged in field work on the Mississippi River Delta. A scheme of triangulation was completed, for control of the aerial photographs. A field inspection was made of the photographs, and gaps in the photography filled in by ordinary methods." New equipment was bought (figs. 37 and 38), and a temporary draftsman was hired to relieve Mattison of some of the drafting duties. Mattison wrote: "Since employing the draftsman my time has been spent in miscellaneous office work in connection with the delta project, such as transferring data and inking topographic sheets, constructing mosaics, completing triangulation data, and assembling data for a publication of the results of the delta survey."

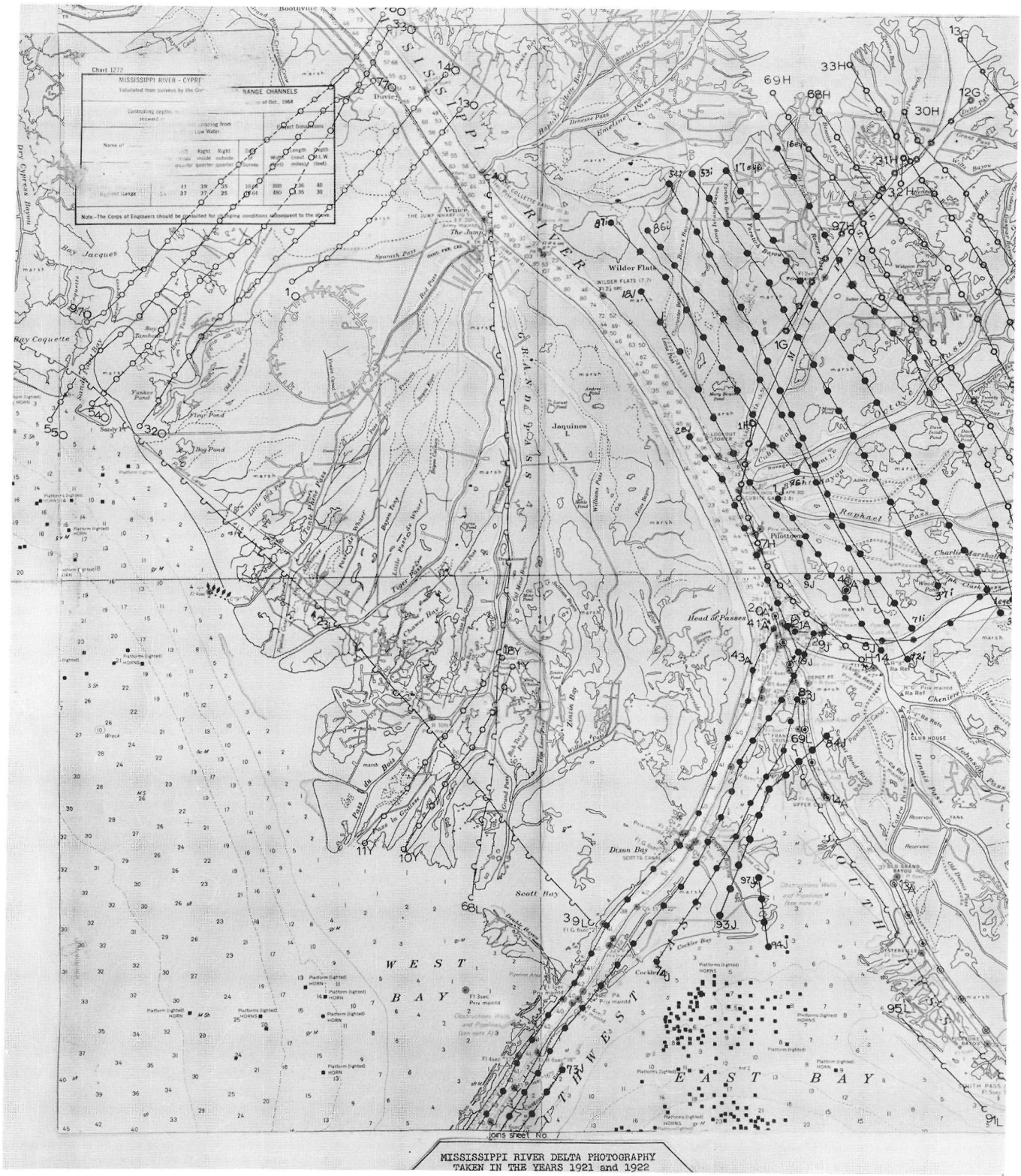


FIGURE 35.—Index of photographs of portions of the Mississippi Delta Survey, which are on file at the National Ocean Survey Headquarters in Rockville, Md.

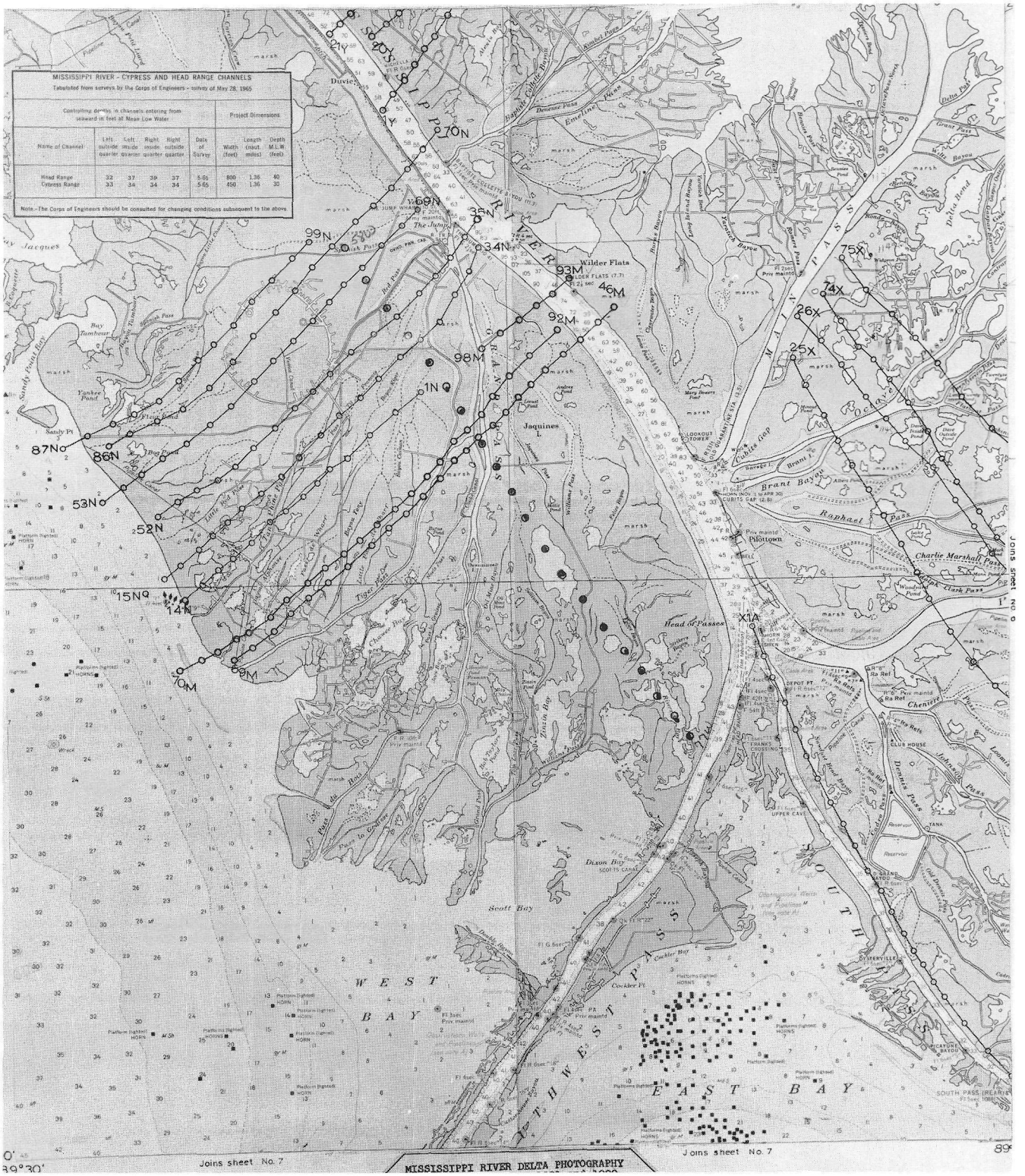


FIGURE 36.—Index of photographs of portions of the Mississippi Delta Survey, which are on file at the National Ocean Survey Headquarters in Rockville, Md.

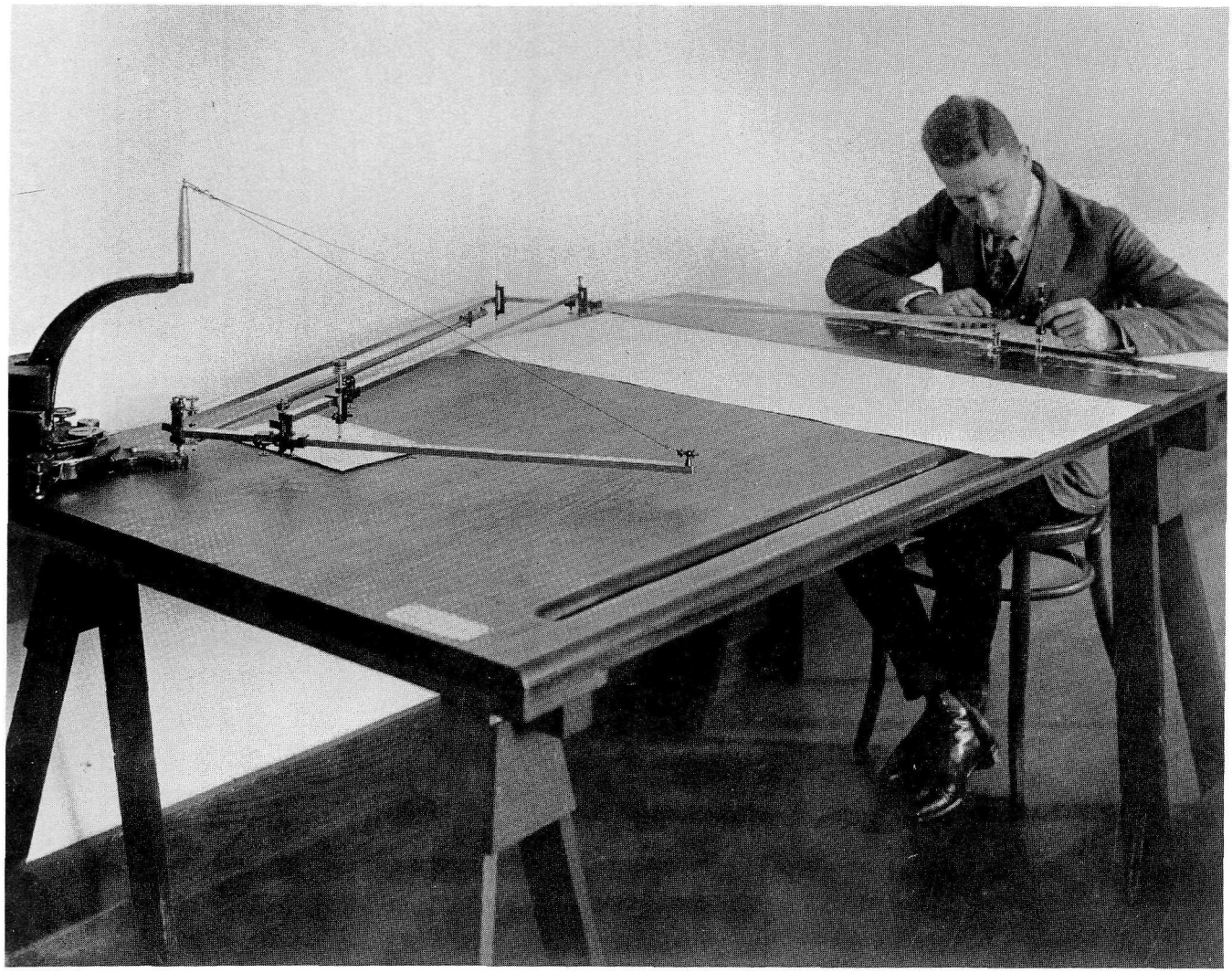


FIGURE 37.—The Pantograph used to reduce the photomosaic to map scale. (Official NOS photograph.)

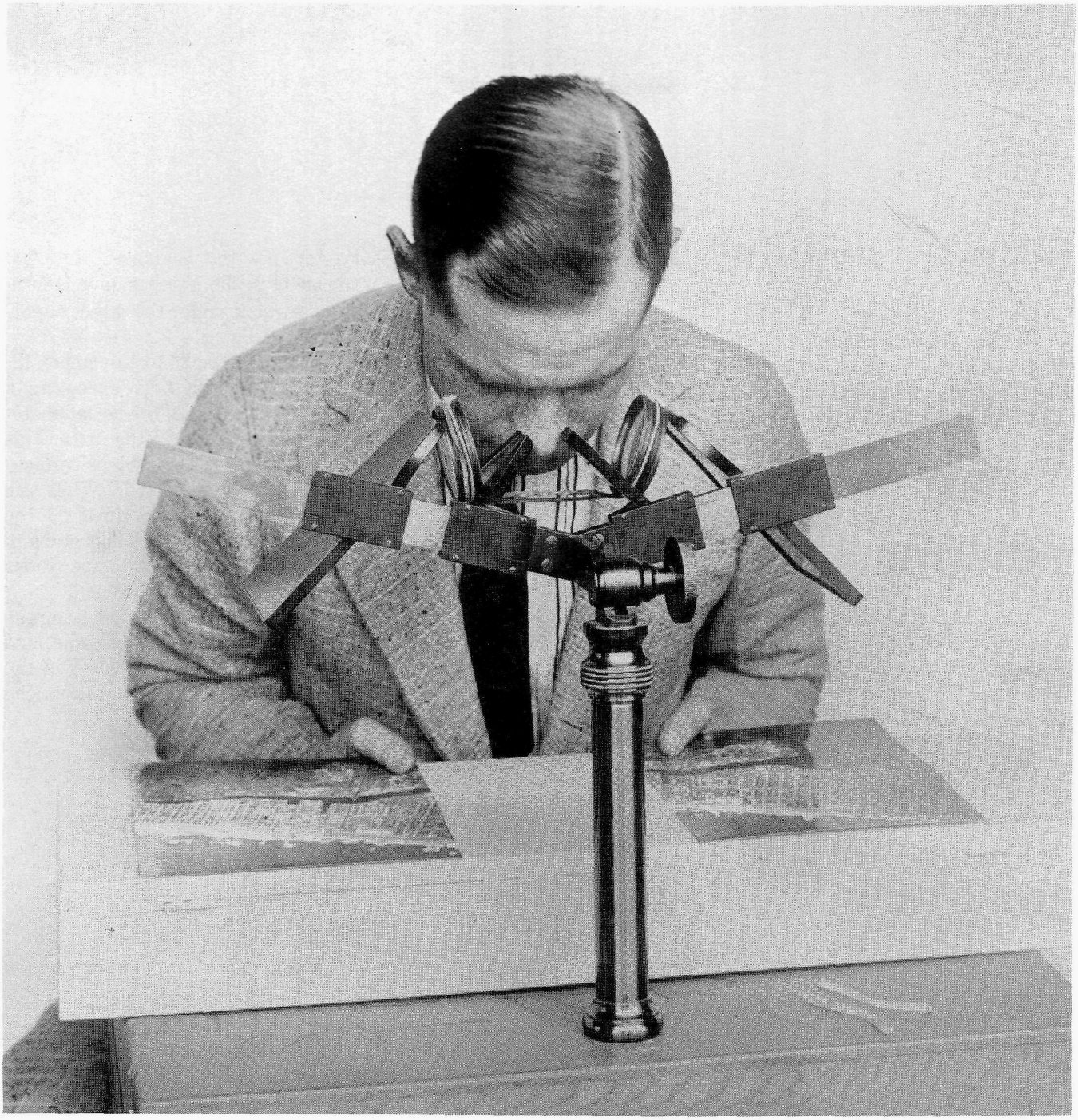


FIGURE 38.—A new stereoscope was designed by the National Bureau of Standards for the specific use of the Coast and Geodetic Survey for interpreting aerial photographs. (Official NOS photograph.)

1923

OFFICE ACTIVITIES—1923

C&GS did not participate in any flight programs during the year, but work did continue with photographs obtained from other sources. The Mississippi Delta Survey was completed, and it is interesting to note that this was *the first aerial mapping project done in the United States*. Director E. Lester Jones reported to Secretary of Commerce Herbert Hoover:

AERIAL SURVEYING

Louisiana
(Lt. G. C. Mattison)

"Practically the entire time of the above-named officer throughout the fiscal year has been devoted to carrying on toward completion the mapping of the Mississippi River Delta from the data secured with the aerial surveys of the previous fiscal year. One of the first necessary steps was the making of over 3,000 prints. These were made in the photographic laboratory of the Navy Department under the direct supervision of Lieutenant Mattison.

"During the period, September 26 to November 12, Lieutenant Mattison was in the field executing a scheme of triangulation for control of the aerial photographs across the northern portion of the delta. This scheme made triple connection with previous triangulation and completed all control necessary. While still in the field, Lieutenant Mattison identified all the control points in the photographs. Upon his return to Washington the completion of control computations was effected.

"The work of constructing mosaics, transferring the data to topographic sheets and inking the same, and assembling data for publication of the results of the survey was then taken up and was in progress at the end of the fiscal year."

1924

OFFICE ACTIVITIES—1924

Work with the aerial photographs that had been obtained previously was continued throughout the year.

1925

OFFICE ACTIVITIES—1925

The U.S. Navy continued to cooperate with C&GS and obtained photography over Lake Okeechobee and the surrounding area. The film was delivered to Washington to be used by the photogrammetric unit.

1926

OFFICE ACTIVITIES—1926

The C&GS Director reported:

SURVEYING NECESSARY FOR AERIAL MAPPING

"The time has come in this country, as it has in many others, when accurate surveying and mapping are considered as absolute essentials for economic progress and the elimination of waste in industry and commerce.

"When land was cheap it was impracticable to incur the expenses incident to very accurate surveys, also when this country was largely agricultural in its pursuits surveys of a detailed and accurate nature were not justified. All this has changed. Our people are engaged in great industrial and commercial work as well as in agriculture. These industrial operations require accurate knowledge of the configuration of the ground as well as of elevations and geographic positions. Very valuable property must be accurately located and its boundaries permanently established and recorded.

"This is the situation in regard to industries and commerce; but we have another problem which is due to the development of the aerial navigation during the past two decades. The pilot of an airship must have a map. He is frequently out of sight of land above the clouds or in the fog or is traveling at night. He must be guided in his flight over the land much as the navigator of a ship is guided over the sea by charts and aids to navigation.

"The aviator who can not see the ground must depend upon the barometer, but the barometer is set to give elevations above the sea and not of the actual land surface. He may think he is one, two, or some other number of thousands of feet above the earth when, as a matter of fact, he may be in imminent danger of colliding with a mountain slope or peak. Therefore, any aviation map between terminal points of an aerial route must show in some way the elevation of the ground.

"The aviator needs to know the relative positions of topographic features along his route, such as railroads, highways, rivers, cities, villages, woods and open country. These features should be shown in their correct shapes and in their correct positions.

"There are very few large areas of the United States having continuous topographic maps. An index map, showing the quadrangles which have been covered by the topographic maps of the United States, reminds one of a cross-word puzzle. This situation should be remedied, not only for the industrial and commercial uses of our people, but in order that route maps for airplanes may be accurately and expeditiously constructed.

"The Department of Commerce was recently charged by Congress with furthering the interests of civil aviation. A part of the duties involved will be the establishment of aids to aviation and the construction of route maps which will enable the aviator to sail over this course without getting lost by lack of map information." (fig. 39)

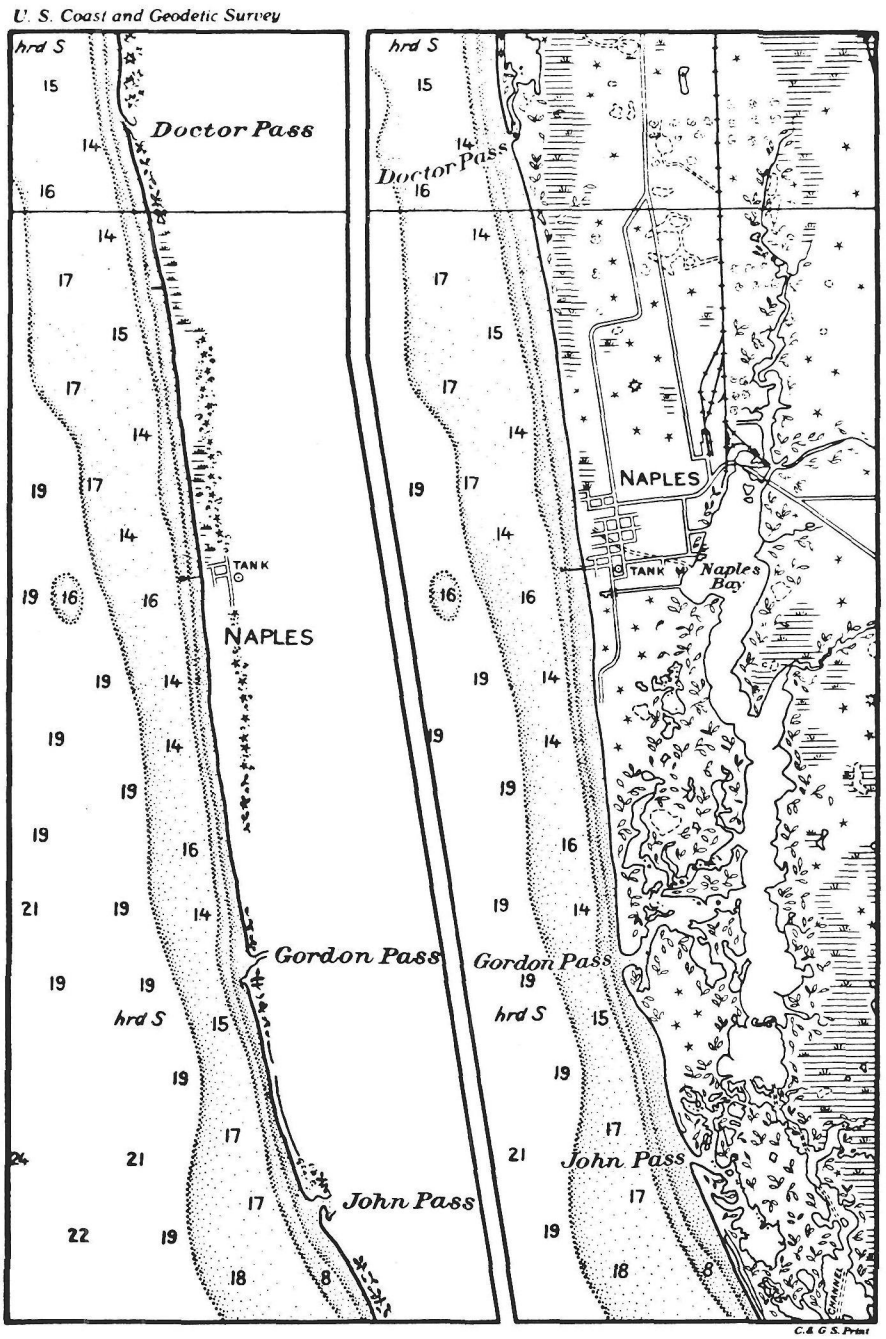


FIGURE 39.—Chart of same coast before and after airphoto resurvey. It has become possible, by airphoto methods, to obtain the topography shown on the right at no greater cost than the limited ground survey shown on the left.

1927

OFFICE ACTIVITIES—1927

The U.S. Army Air Corps took photographs over Florida with a 3-lens Bagley T-1 camera (fig. 40). The photographs were mounted by the Air Corps with more regard for match along trimming line than for retaining azimuths of the wing pictures. About one-fourth of the photographs were remounted after examination under a celluloid template prepared by the C&GS instrument division from the calibration diagram of the camera. In general, the 3-lens photographs required less than half the flying time of single-lens photography, but the detail in the wings was not nearly as clear as the single-lens, because of error in adjustment in the camera, trimming of the film, and mounting. They required as much ground control as single-lens photographs for an equally accurate plot. Because of these handicaps, the 3-lens camera was obsolete for the 1:20,000 or larger scales used by C&GS.

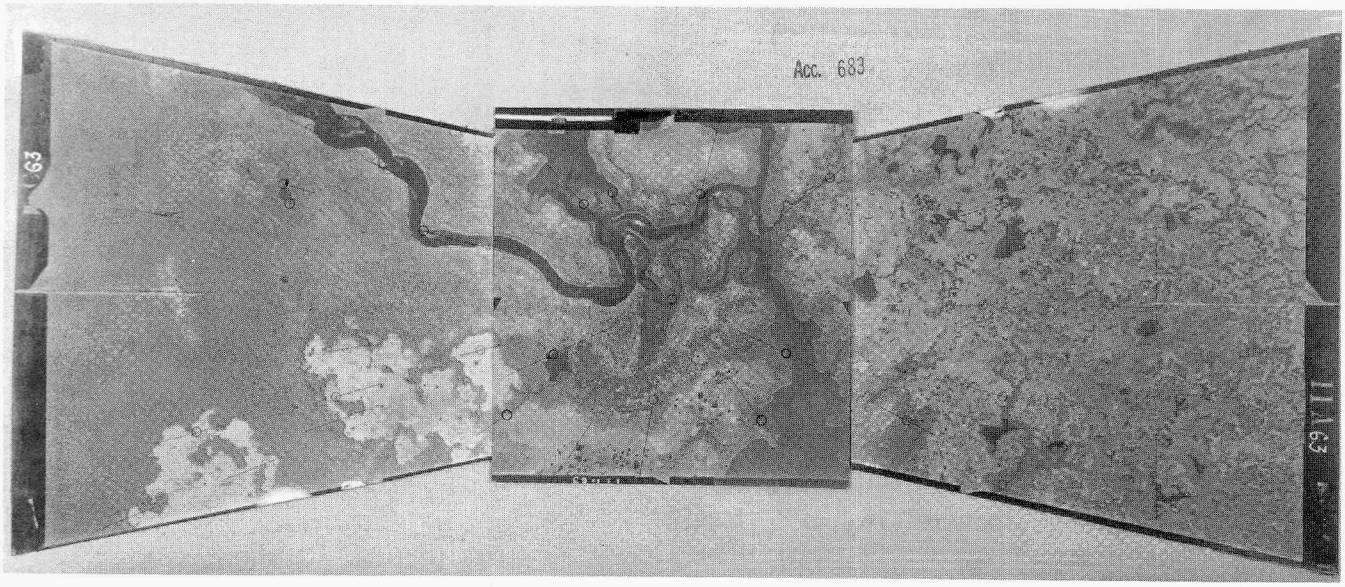


FIGURE 40.—Ten Thousand Islands near Everglades City, Fla. Scale 1:20,000. 1927. (Photographs by Lt. O. S. Reading.)

FIGURE 41.—Aircraft—Loening AP OA1B No. 27–319. The pilot, Lt. J. S. Dexter, is on the right, with photographer MSG A. Mathos holding a 4-lens Fairchild P–2A camera. Pvt. Kallinger, mechanic, on left. Aircraft and camera were used to obtain Florida mapping photography in March and April 1928. (Photograph submitted by Lt. Comdr. L. O. Colbert.)

1928

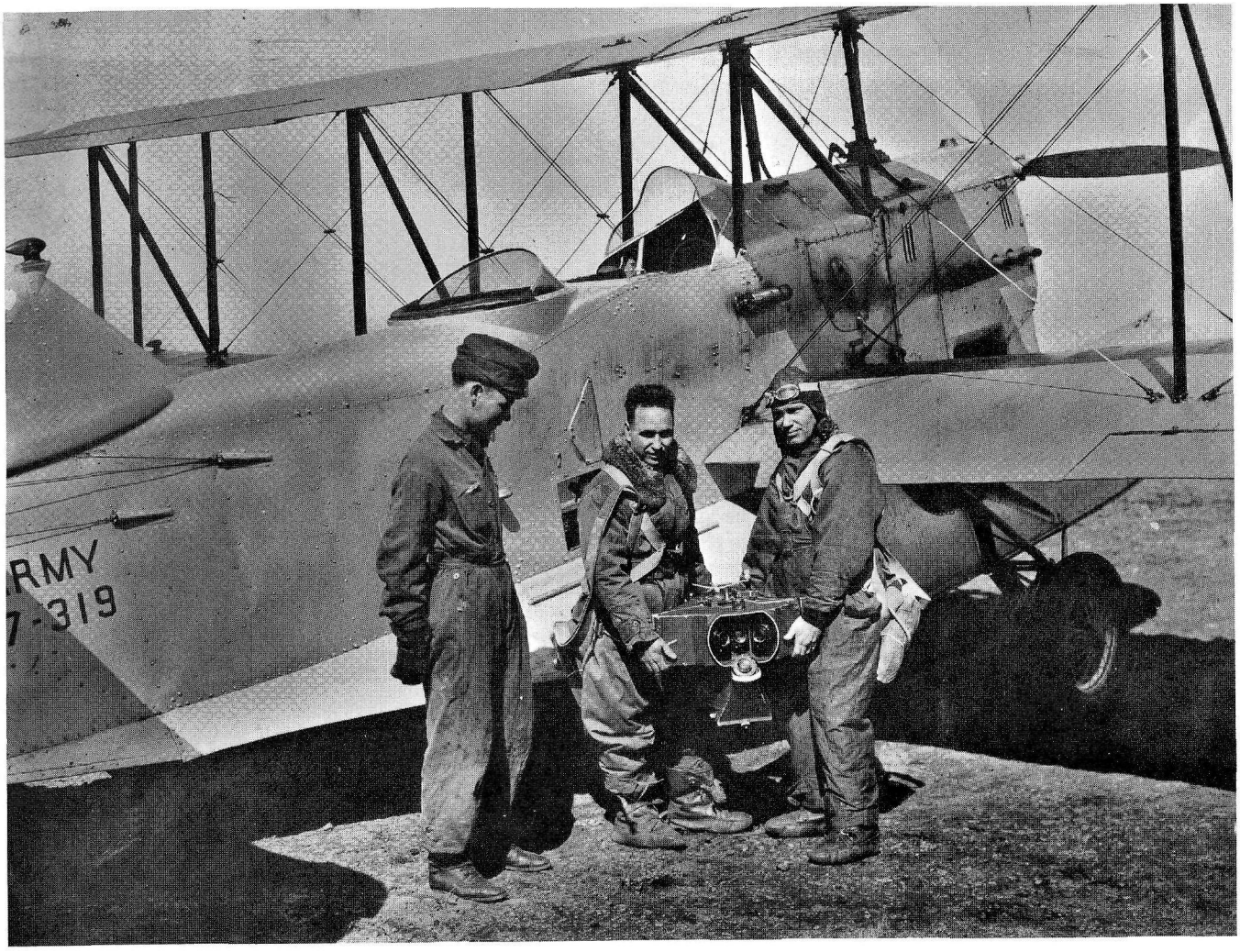
OFFICE ACTIVITIES—1928

The Director stated in his annual report: " . . .under the Air Commerce Act of 1926, the Coast & Geodetic Survey has been charged with producing maps for the guidance of aviators flying over the improved airways of the United States.

"Aviation is still in its infancy. Commercial aviation is developing rapidly, however, and there is no doubt but that the future will bring a tremendous utilization of this newest and most rapid-known means of transportation. The demand for maps to guide air navigators will keep pace with the development of the industry and we must expect that ultimately such maps will be equal in importance to those now provided for the mariner."

FIELD ACTIVITIES—1928

C&GS was now committed to aerial mapping and to photogrammetry as a tool to collect more accurately and quickly the data necessary to keep charts and maps up to date. Lt. O. S. Reading, working with the Army Air Corps (fig. 41), photographed the Ten Thousand Islands and Cape Canaveral areas of Florida with a 4-lens Fairchild T–2A camera that had recently become operational (figs. 42, 43, 44, and 45). Reading reported: "The 4-lens photographs of Florida



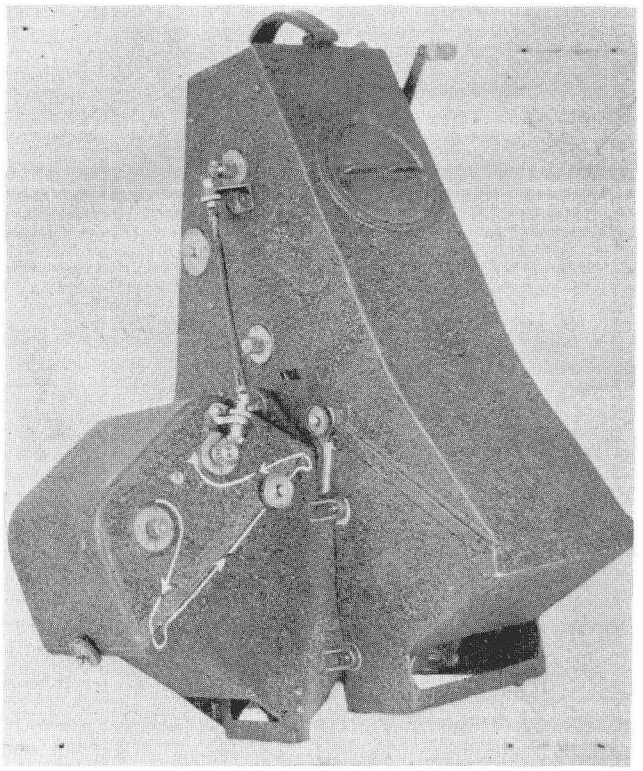


FIGURE 42.—Army Air Corps 4-lens camera, manufactured by Fairchild Camera Corporation. (Photograph submitted by Lt. O. S. Reading.)

were made with a camera out of adjustment as to optical relations and its fourth lens chamber functioned only three-fifths of the time. It was immediately apparent that the calibration diagram furnished by Wright Field would not work. As the camera was still available at Bolling Field, the National Press Building was photographed from across the street and the lines of the windows were used to prepare a substitute calibration for the Florida work. One-fifth of the 4-lens photographs have considerable film sag due to hooking the film over a columnation notch in the camera. It is only fair to the Air Corps to say that they had scarcely time enough to calibrate the camera before the Florida project was flown. The camera had been used by the Geological Survey who reported that it was satisfactory immediately prior to the Florida work. When the derangement occurred is not known, but the experience indicates the desirability of a calibration immediately before and after each project, or better still before and after each flight."

The aircraft used was a Loening AP OA1B, number 27–319, and cost $23,500. The pilot was Lt. Dexter, and the Photographers were Sgt. Mathos and Lt. Reading. The aircraft was badly damaged by a tornado at Bolling Field, Washington, D.C., on June 9, and after being repaired was shipped to the Philippines, where the Army Air Corps was cooperating with C&GS.

PHILIPPINES ACTIVITIES—1928

Lt. J. A. Hawley reported: " . . .the Air Corps of the United States Army cooperated with the Coast & Geodetic Survey by photographing the East Coast of Luzon Island along a stretch of approximately 240 miles, extending from Casiguran Sound to the Vicinity of Port San Vicente at the north end extremity of the island. Although very little control has been established in this region, these operations resulted in a satisfactory survey of the shoreline at an expenditure which in comparison with the cost of executing the survey by former methods, is almost negligible. Subsequently, the photographs both vertical and oblique (fig. 46) were found to be of great value to the engineers of the Bureau in selecting sites for control stations, in checking important topographic features and in noting the existence of shoal areas along the coast." In his book, "Overview" (p. 185), Brig. Gen. George W. Goddard, U.S. Air Force, Ret. (then Lt. Goddard) (fig. 47) said: "I attended a meeting in the General's office to decide on a schedule of mapping projects and it was determined that we should first cover the northeastern section of Luzon requested by the U.S. Coast & Geodetic Survey, the Philippines Forestry Department, and the Philippines Bureau of Public Lands. The most important goal of this project was furnishing to the Geodetic Survey a set of photographs to be used as plane table sheets for adding ground topographical information." Gen. Goddard also said that in the Philippines ". . .there were several Loening amphibians," and it is interesting to note

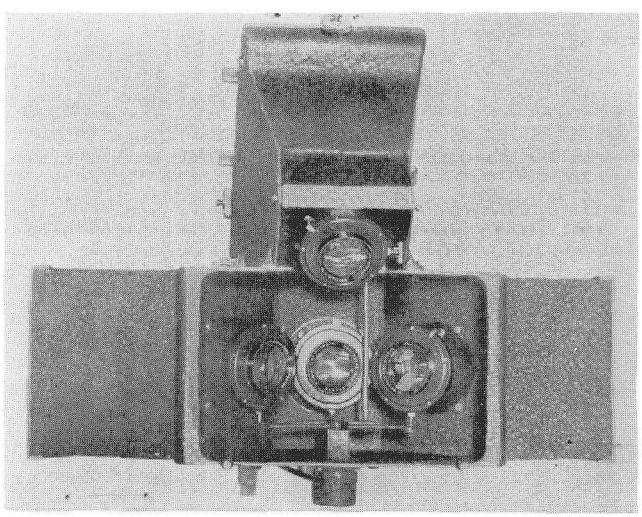


FIGURE 43.—Army Air Corps 4-lens camera, manufactured by Fairchild Camera Corporation. (Photograph submitted by Lt. O. S. Reading.)

that aircraft 27–319 was one of these planes. Lt. Comdr. L. O. Colbert reported: " . . .at the request of this office aerial photographs were made of a section of the northeast coast of Luzon. This work was accomplished by the Army Air Corps in four days and no interruption in the field work of the party occurred. The cooperation between the two services is excellent."



FIGURE 44.—North of Cape Canaveral, Fla. Scale 1:19,000. April 30, 1928. (Photograph by Sgt. A. Mathos, U.S. Army Air Corps.)

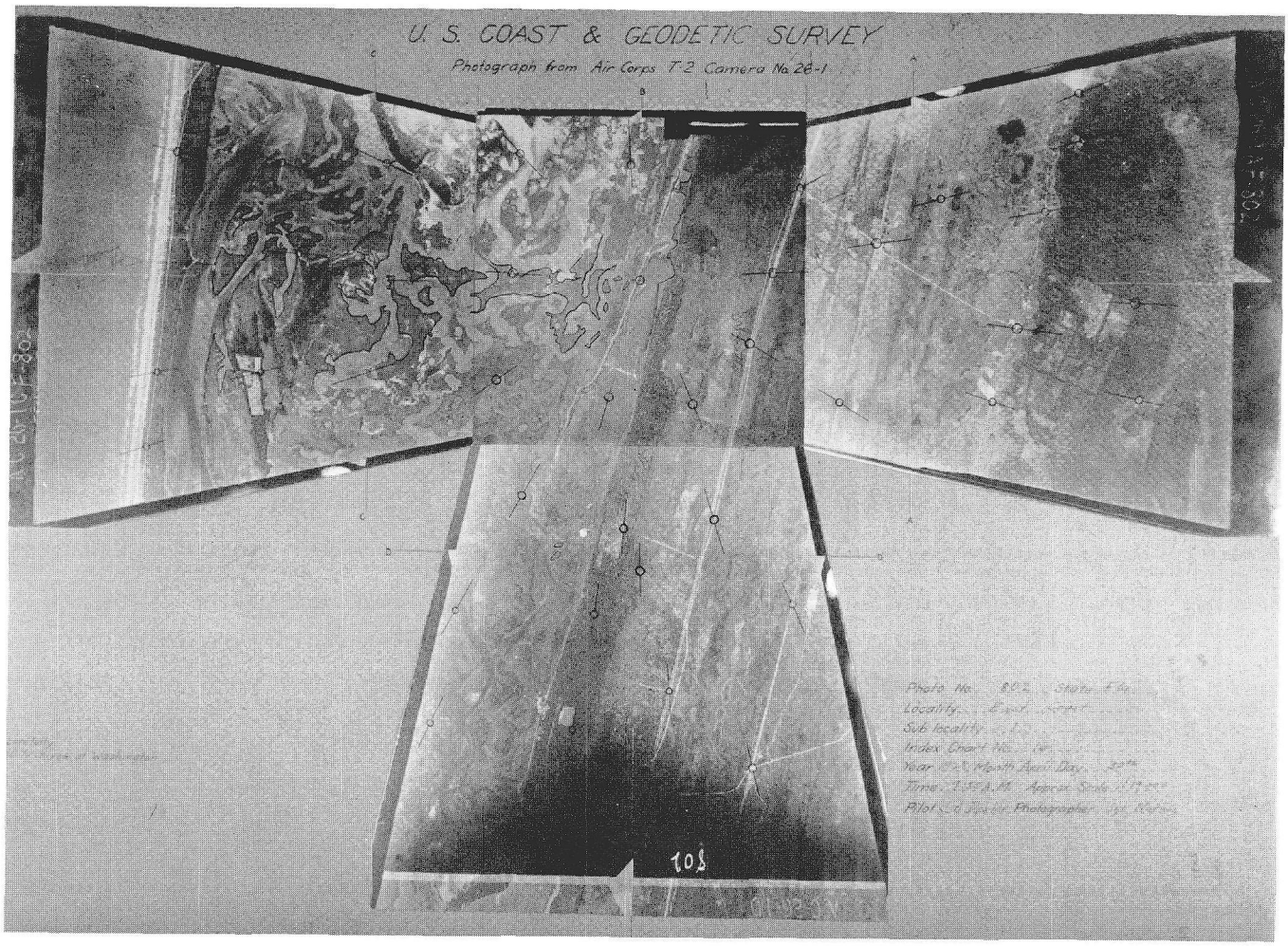


FIGURE 45.—North of Cape Canaveral, Fla. Scale 1:19,000. April 30, 1928. (Photograph by Sgt. A. Mathos, U.S. Army Air Corps.)

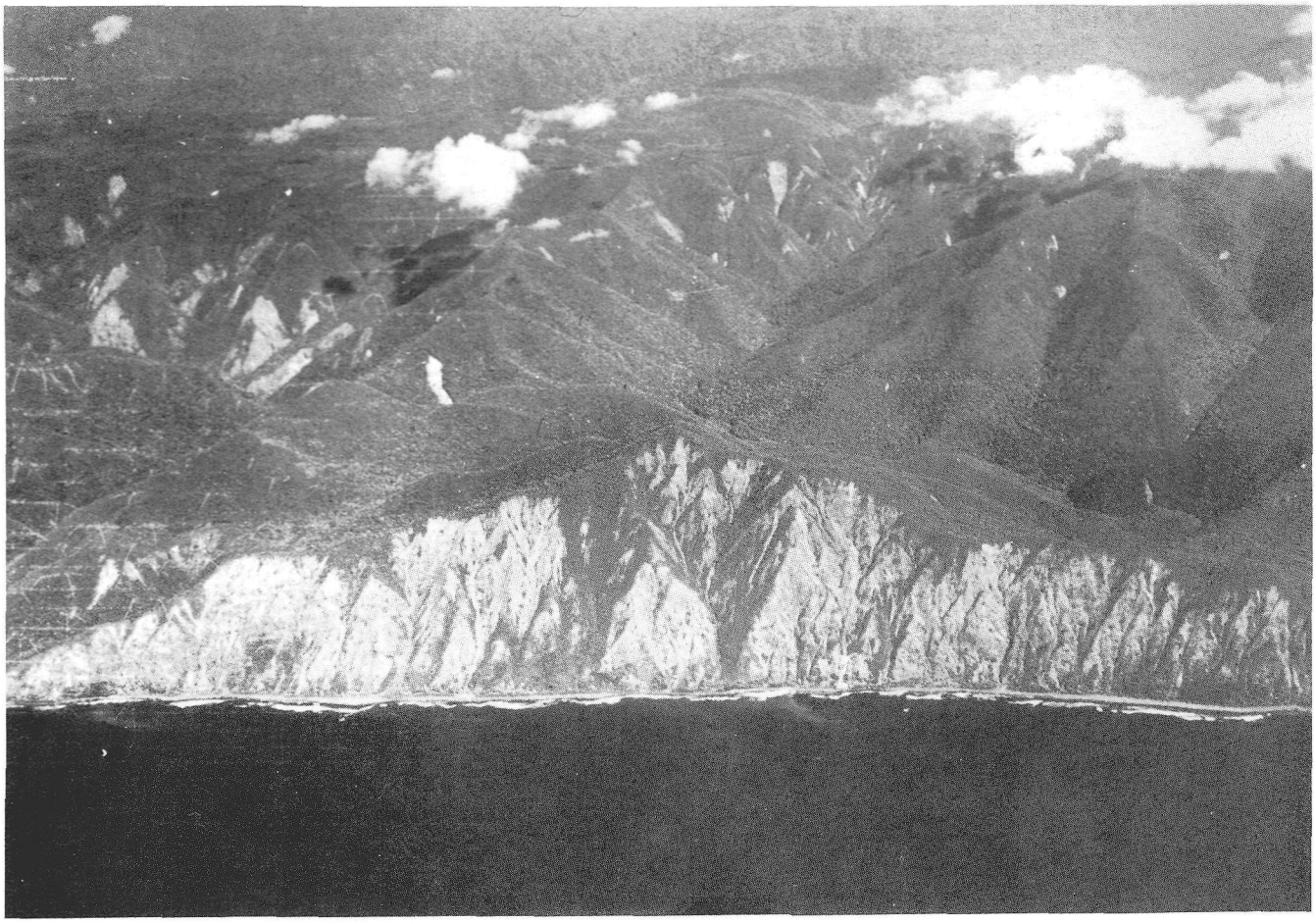


FIGURE 46.—Oblique aerial photograph shows the abrupt nature of the coast of Luzon, Philippines. The narrow beach at the base of the bluffs can also be noted. The hills in the foreground are about 1,500 feet. (Photograph courtesy U.S. Army Air Corps.)



FIGURE 47.—Lt. George Goddard. (Photograph courtesy 1361st Photo Squadron, U.S. Air Force.)

1929

OFFICE ACTIVITIES—1929

Lt. O. S. Reading pointed out the following advantages of aerial photography: "With the material and apparatus at present available, the photographic method is applicable to all terrain on which differences in elevation in excess of 300 feet in the area covered by a single photograph do not occur. Standard accuracy can be maintained in such areas without more control than is required for planetable surveys. Certain areas of our coast, because of the high vegetation, soft ground, or exceedingly complicated detail are impractical for any other method except at prohibitive costs. The Ten Thousand Islands offer an extreme example of this. The coasts of Louisiana, Texas, and the Carolinas have areas which are also impractical to map except by this method.

"In all topographic surveys, except the air photographic, it is necessary to omit detail which can otherwise be shown in order to keep the cost down. Certain other classes of detail must be generalized, sketched, or located with inferior accuracy for the same reason. The air photographic method gives all this detail as accurately as can be shown on the scale of the sheets at very little additional expense. Such exact, instead of generalized, detail is particularly valuable in complicated inside passages, along waterfronts of harbors and in similar places or where it affords instant identification of position and a confidence in the chart which is lacking when sketched or incorrect detail is shown. The small amount of time required to obtain photographs may be advantageous under certain conditions, particularly after the speed of the office reduction has been increased. In the Florida coastal work, allowing for overlapping strips, over 100 square miles were photographed during each hour that the camera was operating." Reading continued: "One has but to look at the good photographs of a changing beach and swash channel to realize that no other method of surveying can furnish such minute but significant detail. Mosaics of rectified photographs on a scale of 1:5,000 layed down on an accurate base map and accompanied by extra prints for study in the stereoscope will furnish the best possible record of the conditions at the time the photographs were taken. Accurate mosaics made at suitable intervals will show the progress of the shoreline changes with a clearness which can be obtained in no other way. An important phase of the usefulness of such accurate mosaics of shoreline changes in their value could decide legal disputes which often arise from uncertain knowledge of the (shoreline) changes. The photo field sheet and, if necessary, the original photograph under the stereoscope will depict the precise condition existing at the time the photographs were taken. Such photographs, accurately rectified and based on geodetic control, will offer such clear and indisputable evidence as to prevent a large percentage of these disputes from reaching the courtroom." Reading then proposed to the Bureau: "It is necessary that the Bureau purchase, or preferably construct, an aerial camera suitable to its needs if the photo base map is to be made economically. No definite program or adequate provisions for photographic work can be made without such a camera. The construction of a multiple lens camera of high precision by this Bureau is recommended both because it seems unlikely that it will be developed elsewhere for many years and because it will be difficult to carry out the comprehensive program while depending on the flying services for the photography."

PHILIPPINE ACTIVITIES—1929

Meanwhile, work in the Philippines continued and Lt. Comdr. E. C. Jones said: "The [USCGS ship] FATHOMER left Manila on May 10, to take up work on the northeast coast of Luzon. The ship arrived on the Casiguran working ground on May 16, and fieldwork was started the following day. On May 19, Army airplanes arrived for photographic work and from that day until May 23, the ship was cooperating with them in obtaining the aerial photography, while shore work and launch hydrography was carried on. The aerial photographs taken the preceding year were found to be of considerable value in the field of topography. The photographs were carried into the field and interpretations and planetable work was carried on."

1930

OFFICE ACTIVITIES—1930

The Director made the following observations: "The Coast and Geodetic Survey is convinced that it is time for the airplane to take its proper place and be officially recognized in the Bureau's mapping program. To accomplish this, four things are required: (1) Part-time use of plane and operating personnel; (2) mapping cameras and supplemental equipment; (3) personnel to produce the maps from the photographs; and (4) such readjustment of increased flexibility in the various sub-items of our appropriations as will permit funds being used for the new method. None of these requirements should present any serious difficulty. Beginning July 1, in 1931, the Aeronautical Branch of the Department of Commerce plans to furnish a plane, and a pilot for this Bureau's exclusive use on the flight checks of the airway maps. General plans for the photographic equipment have been worked out and detailed specifications can be ready by the time funds become available." The Director quoted a letter that he had received from the chief engineer of the Florida East Coast Canal Inland Navigation District: "If these maps had been available some two years since, when we first began our canal survey, they would have saved us many thousands of dollars. Even now, they will be of great assistance to us. So much so that I am taking the liberty of requesting that you send two copies of each of these sheets." The east coast of Florida southward from Ormond was photographed with a 4-lens camera by the Army Air Corps in 1928 and 1929. Compilation from the photographs of standard 1:20,000 scale topographic sheets without contours had been completed except for certain areas of Miami, for which the control was not available.

In cooperation with the Army Air Corps, Lt. Reading continued photographing the east coast of Florida with the T–2A 4-lens camera, and reported: "A cordial personnel contact was established with the Army in connection with the Florida work, especially with Capt. Bruce B. Hill and Lt. J. F. Phillips, officers of the Engineer Corps assigned to Wright Field for investigation of air photo mapping and camera calibration. It was thus possible to have the latest type of 4-lens camera specially calibrated and made available for the Delaware, Chesapeake Bay project. Some difficulty apparently due to film and paper shrinkage was noted in the Florida work. At the insistence of the Bureau, the Bureau of Standards measured two samples of current films and papers. The measurements indicated that Agfa film and a paper manufactured by the Positype Corporation had much smaller and more uniform shrinkage. The Positype Corporation developed a special emulsion for their paper, suited for air photo work. It was called 'Birex Air Map Special,' and these materials were used for the Delaware and Hudson project. The Hudson River photographs were single-lens by the Aero-topograph Corporation under competitive contract. They were generally satisfactory except that the inshore strip had only about 40 percent overlap and there were a few cases of excessive tilt. In view of the high accuracy the photo surveys must have if they are to be used as base maps, it is imperative that photographs having less than 55 percent overlap be rejected in the future. The cordial relations with the Air Corps have just resulted in the photographing of the South San Francisco Bay with their latest 5-lens camera. Although this camera is known to have produced photographs giving errors as high as 7 minutes of radial angle, most of the areas of the photography errors are much less, and it is hoped that the plot of the San Francisco photographs will closely approach the desired accuracy of base topography. Certainly the camera is much superior to any of those used heretofore. It was noted that errors of 0.2 to 0.4 millimeters were common on the settings of the film in the transforming camera in the multi-lens photograph. The film was set by hand without magnification. Arrangements were made whereby the transforming printer for the 5-lens camera was sent to this bureau, and our instrument division built a slow motion screw device for setting the film under four-power magnification. The device was reported to work satisfactorily on the first transformation on the San Francisco film. Since any error in setting the film is magnified 2½ times in the outer wings of the composite photographs, this device could mean a worthwhile improvement. Although the most cordial relations at present exist with the Army with respect to obtaining air photographs, their policy is definitely to use photographic operations for training personnel except for especially arranged projects, and these arrangements may be cancelled at any time. Photographs of indifferent quality are likely to be obtained. We have a very

ineffective voice as to the adjustment or design of the cameras used and it is essential if the high accuracy required for basic topography is to be obtained that the photographs be of a superior quality for which expert pilots, photographers, and cameras in adjustment are indispensable. The Air Corps is purchasing five new 5-lens cameras during 1930. It is possible that unofficial arrangement may be made for this Bureau to work over and specifically adjust one of these cameras with the understanding that it will be used on our project. Notwithstanding this possibility, our own camera and personnel responsible to this Bureau are recommended as soon as possible. The photo-surveys will cost about the same whether they are accurate or indifferent. The importance of accuracy for future revisions is too great to trust to the cooperation of another service whose needs for training and equipment suitable for enlisted personnel are directly opposed to promoting superior quality photographs." Lt. Reading continued by saying: "Try to produce topography as near as standard accuracy as you can without standard Whatman's sheets' were the instructions received under which the compilation of the Florida photographs commenced. In spite of unsatisfactory photographs, we soon found that we were greatly improving the accuracy of planetable work wherever it was extended out of sight of control. More recently on the Hudson we have been able to improve planetable work where control is both plentiful and visible. Probably this is largely due to a distortion of the field sheet which was about 17 meters to the mile. Neither the Florida or Hudson River projects can be considered of satisfactory accuracy any distance from shore control, because of the camera adjustments in Florida and insufficient overlap on the Hudson. But they are so nearly right that it is considered certainly to be only a question of precision photography and taking proper precautions with the plotting to secure the highest accuracy which we can show on the scale maps used. As with all photographs, we are presently feeling our way with the compilation and making the best of existing circumstances and conditions. Our production has been limited at first by frequent changes in personnel and throughout by cramped quarters in which it has been necessary to work with artificial light amid frequent interruptions. More than one officer has observed, 'if you can work here, you can do fine drafting in a boiler factory.' The spirit of the personnel has been high throughout because we realize the importance of our results. The physical conditions may not have affected production very much on that account, but certainly much time has been lost through the lack of confidence in the photographs." Lt. Reading also said, "Words of instructions without the background of experience do not produce satisfactory results." These words are as true today as they were when Lt. Reading wrote them.

On October 13 Lt. (jg) Marshall H. Reese reported to Reading in Washington, D.C., and was assigned to the Air Photographic Compilation Section.

1931

FIELD ACTIVITIES—1931

The San Joaquin area of California was photographed during the year, and Lt. John Bowie reported that the Army Air Corps cooperated most cordially on the project by photographing the area with their new 5-lens camera. In addition, the most distinguished aerial photographer in the country, Capt. Albert W. Stevens (fig. 48), operated the camera, and Lt. J. F.



FIGURE 48.—Capt. Albert W. Stevens. (Photograph courtesy of National Air and Space Museum.)

Phillips, a photographic pilot of rare skill, flew the airplane. (It is interesting to note that on November 11, 1935, Capt. Stevens and Capt. Orville A. Anderson established a new high-altitude balloon record of 72,394 feet, and that Capt. Stevens was twice winner of the MacKay trophy, once in 1929 and again in 1935. The trophy is on display at the National Air and Space Museum in Washington, D.C.) The 5-lens camera T–3A consists of five cameras rigidly connected to form a single unit. Four oblique chambers are arranged around the vertical chamber, the optical axes of the oblique lens being inclined 43° from the vertical. The shutters operate synchronously and are tripped electrically by a single motion of a handle on top of the camera. The film supply, consisting of five rolls of film, is wound simultaneously in all five chambers by operation of a single winding handle (figs. 49 and 50).

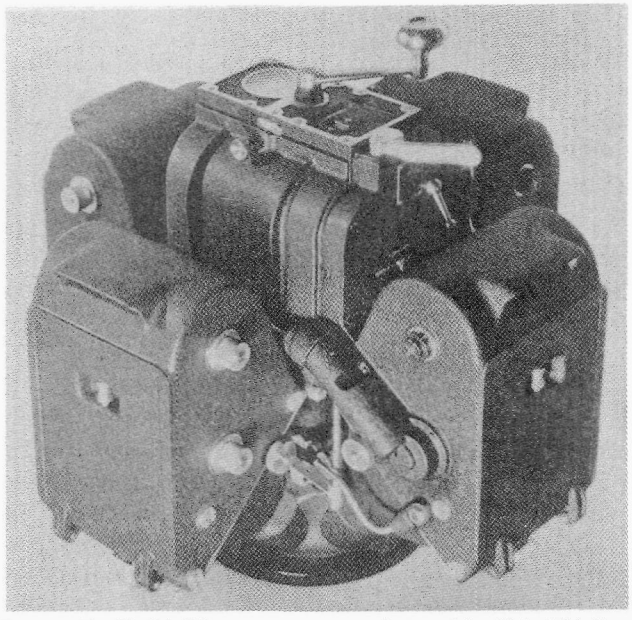


FIGURE 49—T–3A 5-lens camera, manufactured by Fairchild Corporation. Camera data: Negative size 5½ by 6 inches (14 by 15 cm), roll film, capacity of each magazine 200 exposures, vacuum flattening by means of venturi, 6-inch (15 cm) focal length lens with aperture of f/6.8 oblique lenses matched to 0.1 mm in focal length, between the lens shutters, hand operation. (Photograph courtesy of Fairchild Camera Corporation.)

OFFICE ACTIVITIES—1931

The vertical camera negative was contact printed, and the oblique negatives were transformed and printed into the plane of the vertical negative by means of a fixed-type transforming printer. The five separate prints were then mounted to form a single composite vertical photograph in the form of a Maltese cross, 32 inches wide (figs. 51 and 52).

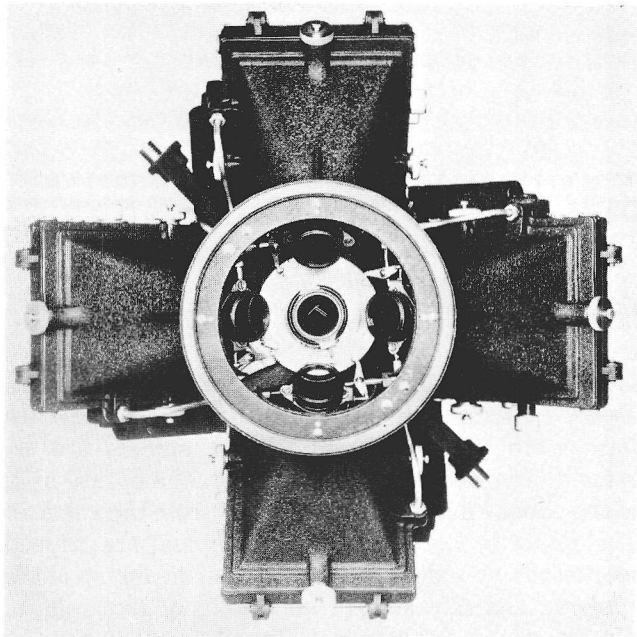


FIGURE 50.—Optical arrangement of T–3A 5-lens camera. The vertical negative was contact printed and the oblique negatives were transformed and printed in the plane of the vertical negative by a fixed type of transforming printer. The five separate prints were then mounted to form a single composite vertical photograph in the form of a Maltese cross, 32 inches wide. (Photograph courtesy of Fairchild Camera Corporation.)

This camera, with its extraordinary field of 135° and its 6-inch focal length lenses, photographed a strip 5 miles wide at 1:10,000 scale from an altitude of 5,000 feet. The photography was overlapped 60 percent both along the strip and laterally, and successive strips are crabbed 15° in opposite directions. The centers of some elevations on successive photographs appear on each picture. There is an interlocking of the photographs so as to give the most rigid radial line plot throughout the area as well as that along the closely controlled river banks. The details were carefully traced from the photographs and then reproduced on 1:10,000 scale by photolithographic methods. Blue line prints on aluminum mounted paper to exact scale and without appreciable distortion were sent to the field for use as planetable sheets on which temporary hydrographic signals could be located directly. Other distortion-free prints were supplied for boat sheets and smooth sheets. Black-and-white prints of these sheets on chart paper were issued to the general public at 50 cents per copy. In addition to supplying information for the charts, it was hoped that the sheets would be of considerable use for the saltwater barrier, flood control, and other engineering studies, as well as for the general future development of the area.

Also noteworthy were the commendable activities of the inspectors of the C&GS San Francisco field station, who placed photographic control stations when necessary and otherwise assisted the field operation.

The Director said in his annual report: "It may be stated that air photo methods have become generally 20 to 30 percent more efficient than ground mapping for mapping the shoreline of the complicated inside waterways of the Atlantic and Gulf Coast. The air photo methods cost only one-third to one-fifth as much and have thus rendered other methods unthinkably wasteful. The phenomenal growth of aviation has made it easily practical to fly the coast and photograph the changes and the developments which must be charted. Where a first basic photo survey has been made, the photographs of such subsequent changes can be readily and inexpensively applied to the charts without further ground measurements. But in order that advantage may be taken of the extraordinary speed, accuracy, and economy of this method for revising the topography of the charts, the basic survey must be of high accuracy. This in turn requires either precision cameras and equipment or large expenses for measurement on the ground to control the plotting of inferior photographs. Only about $30,000 is needed for precision photographic equipment to enable this bureau to make topographic surveys with the gain in efficiency required."

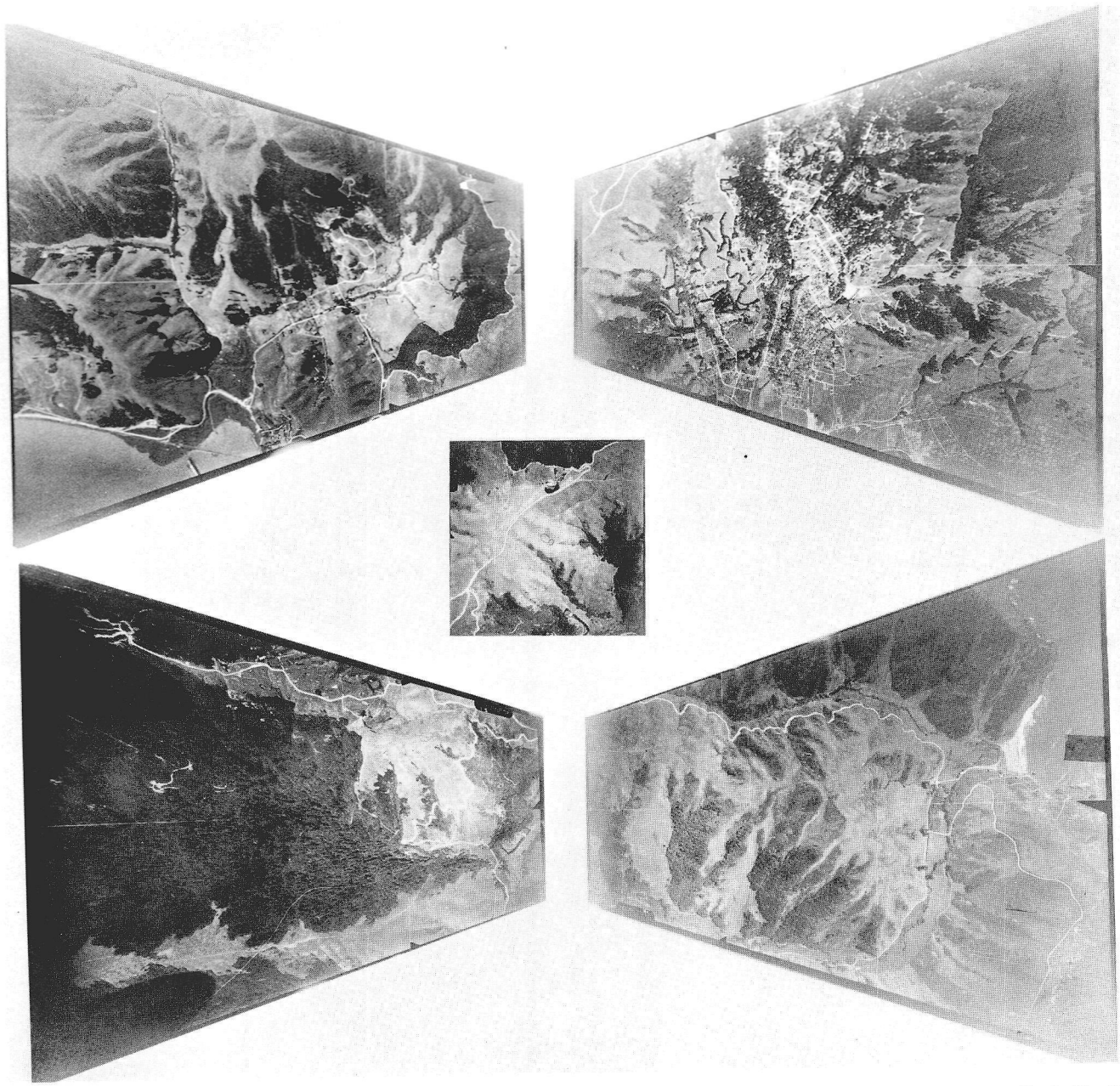


FIGURE 51.—Unassembled 5-lens aerial photograph, San Joaquin, Calif. Original photography on file with National Ocean Survey, Rockville, Md. (Photograph by Capt. Albert W. Stevens.)

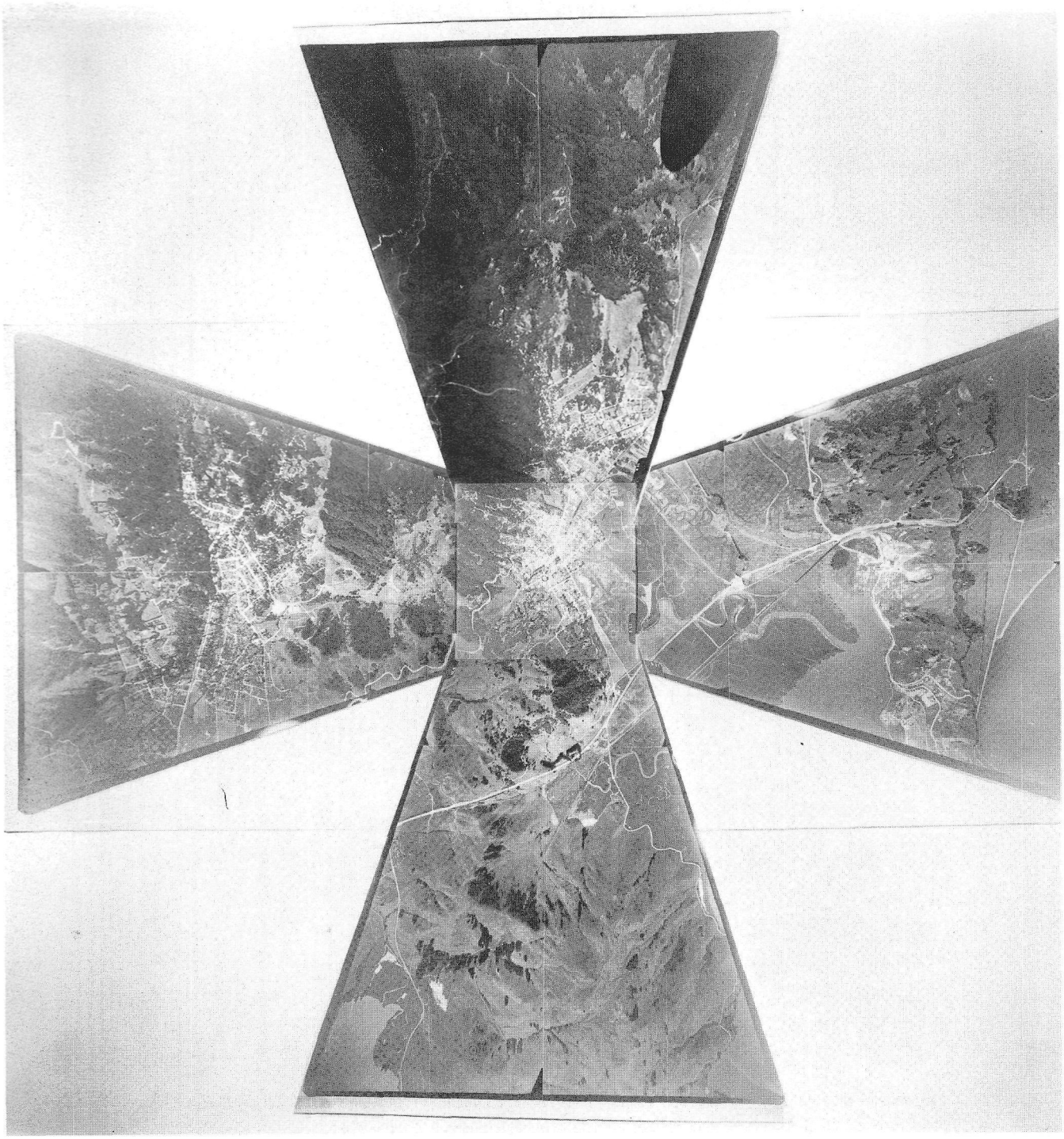


FIGURE 52.—Composite, 5-lens aerial photograph, San Joaquin, Calif. Original photography on file with National Ocean Survey, Rockville, Md. (Photograph by Capt. Albert W. Stevens.)

1932

OFFICE ACTIVITIES—1932

Office work continued on the Sacramento-San Joaquin Delta project with the 5-lens photographs that were obtained the previous year. In October, Lt. Reading proposed the construction of a precision 9-lens camera and rectifier.

Lt. Reese was sent to New York City to organize the first C&GS field office for compiling aerial photographs. The office was opened in New York City on December 1. The photographs compiled were the 5-lens photographs of the valleys of the Sacramento and San Joaquin Rivers, Calif., and the single-lens photographs of the Hudson River in the vicinity of Tarrytown, N.Y.

It was in this project and the project that was directed in the Washington office that the methods of compilation of aerial photographs in C&GS passed the first stage of development.

1933

OFFICE ACTIVITIES—1933

With photographs obtained by the Army Air Corps in southern California and along the Atlantic coast, Lt. Reading planned and supervised a number of photographic projects throughout the year.

Works Project Administration (WPA) funds became available in August, and an allotment was made to C&GS for work on nautical charts. To carry on this program it was necessary to expand temporarily the C&GS personnel.

Air photo compilation offices were opened in Savannah, Ga., Charleston, S.C., and New Orleans, La., under the direction of Lt. O. S. Reading, Officer-in-Charge of aerial photography.

Lt. Reese reported: "The organization of an air-photo compilation project was started in New Orleans, Louisiana, in December 1933. The office was begun with only two experienced men. It was necessary to purchase complete equipment to outfit the whole party. It was also necessary to train draftsmen for the compilation of aerial photographs on this project. Using the two experienced draftsmen as the nucleus of the organization, draftsmen were employed gradually, as it took considerable time to train the new men. When the project reached its maximum working limit, there were 25 draftsmen on the party."

1934

OFFICE ACTIVITIES—1934

Topography by aerial photographic methods was now being done in cooperation with the Army Air Corps using the T−3A 5-lens camera.

Designs had been prepared for a 9-lens camera and rectifying printer (figs. 53, 54, and 55). Bids for the construction of such equipment were sent to manufacturers. Reading reported: "The 5-lens camera required separate film for each lens, resulting in five photographs for each exposure to be assembled, fitted, and mounted; the proposed 9-lens camera was designed in such a manner that the rays of light at exposure from all nine lenses were projected onto a single film resulting in one 35 by 35 inch photograph. At a flight height of 13,750 feet a scale of 1:20,000 is achieved.

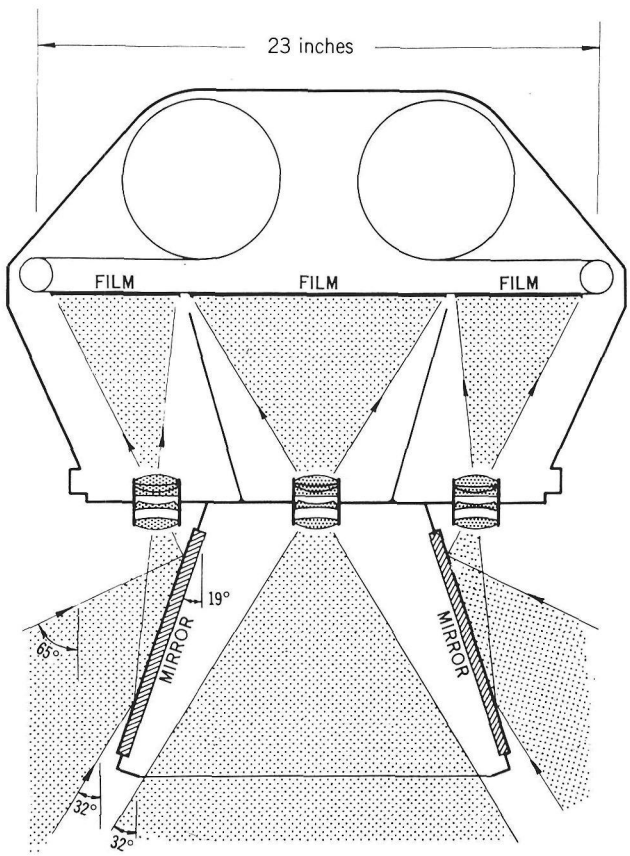


FIGURE 53.—Diagram of proposed 9-lens camera.

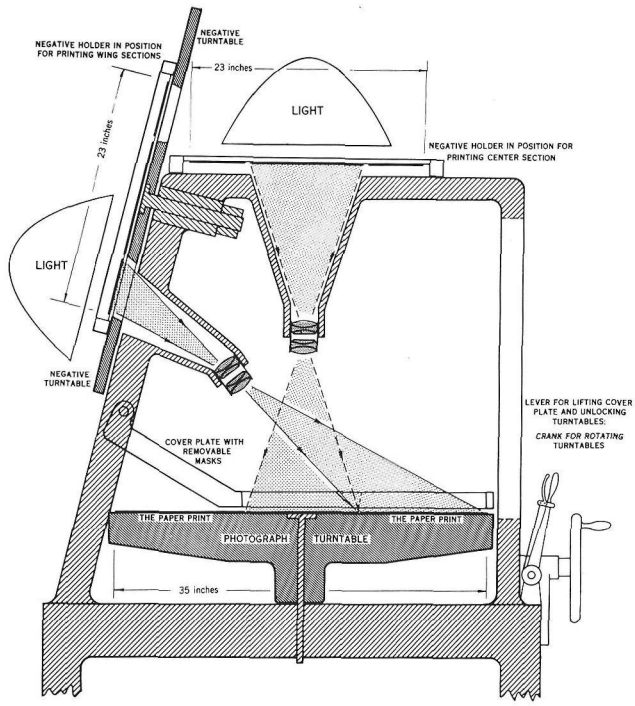


FIGURE 54.—Diagram of proposed 9-lens transforming printer.

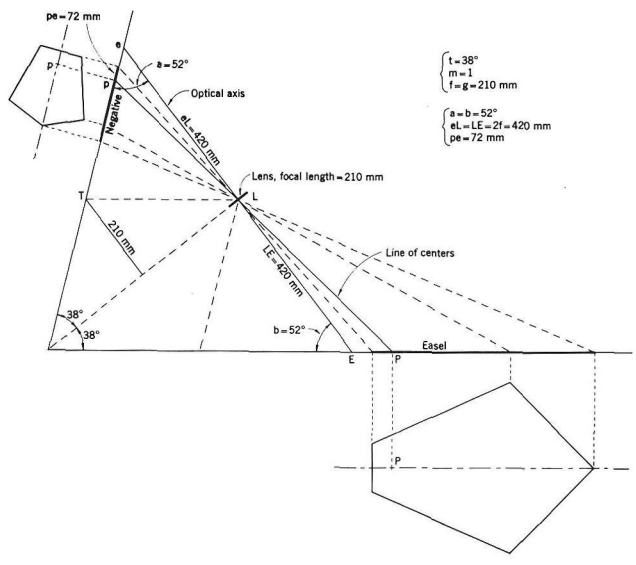


FIGURE 55.—Schematic diagram of 9-lens transforming printer.

This single photograph covers a flight strip 11 miles wide, reducing to one-third the number of photographs necessary to cover a given area. From present estimates such equipment will decrease the cost of ground control by about 50 percent, and the total cost of photographic mapping by about 40 percent."

On the evening of July 29, a small group met at Lt. Reading's (fig. 56) home to discuss the possibilities of forming a photogrammetric society in the United States. The discussion opened with a question from Reading as to whether there were enough men actively interested in air photo mapping to support a national society. He expressed his belief that there were enough persons in the Washington area actively engaged in such work to warrant a meeting perhaps once or twice a month to discuss mutual problems, to display maps and photographs, and generally to give each other the benefits of their experience. C&GS then temporarily employed about 100 men on the compilation of planimetric maps, mostly from 5-lens photography. Of this number, perhaps 5 or 10 would join a national society and pay dues sufficient to support a publication of a modest sort. In the general discussion, it was estimated that there was a similar number of people in other organizations, and in all there might be 50 or perhaps 100 more in the United States who would be willing to pay $3.00 to $5.00 to have a publication with current news and discussions of photomapping in this country. From this meeting, the American Society of Photogrammetry was born. Reading reported at this first meeting that "Virgil Kaufman had recently shown some very interesting photographs in color made by Aero Service of Philadelphia."



FIGURE 56.—Lt. O. S. Reading. (Official NOS photograph.)

1935

OFFICE ACTIVITIES—1935

Capt. Louis J. Rumaggi (USAAC) reported in a Photogrammetric Engineering newsletter: "Tests have been carried on with two five-lens cameras mounted in tandem to effect a composite 9-lens photograph but such tests have not been completed as bad weather has delayed photography. Nothing very new or startling is expected. Photographs of a like nature have been prepared by the Fairchild Aerial Surveys for certain governmental work. The resulting photograph is octagonal-shaped, 32.3 inches across and very nearly 6 square feet in area. At 25,000 feet, the height of the test flights, each photograph covers an area of 540 square miles or considerably more than two 15 minute quadrangles in area.

"The Coast & Geodetic Survey is building a camera capable of photographing a field of 130° square instead of the 83° of the Zeiss 4-lens camera or 52° for single-lens cameras. This will save quite a bit of flying. The camera is daylight loaded and this in itself will save flying time over the five-lens camera by eliminating the necessity to return to the base for reloading of film. The ratio of number of photographs from such a camera to cover the same area at the same scale with stereoscopic overlap will be 20 to 1 for single-lens, 9 to 1 for the 4-lens, and 4 to 1 for the 5-lens photographs (fig. 57). These are the advantages which will occur from the construction of the Coast & Geodetic Survey 9-lens aerial camera."

Maj. Bagley, U.S. Army, developed the first multi-lens camera that was really practical for aerial mapping. This camera, with its three lenses, increased the width of the strip which could be photographed during a single flight to nearly four times that of single-lens cameras. A transforming printer was developed which gave satisfactory projections of the wing chambers into the plane of the central lens. The camera worked very satisfactorily with sufficient ground control, but when experiments were made to determine the minimum amount of control that had to be used to give maps of standard accuracy from the photographs, it was found that the radial line plot deviated considerably in azimuth if an attempt were made to extend the plot beyond the control. A fourth chamber was added in the period 1923–27 to increase the accuracy of the azimuth. This gave such an improvement that still a fifth chamber was added in the period 1926–29. The phrase "in the period" is used as usually several years are required from the approval of the idea of the first model to the completion of a satisfactory camera. The 5-lens camera, operated in 1935, was a thoroughly practical apparatus whose photographs yielded a much more rigid plot than could be obtained from single-lens photographs with an equal amount of ground control. But to obtain sufficient overlap for use of the 5-lens photographs in the stereoscope, it was necessary that the same number of exposures be taken along the flight strip as would be taken with a single-lens camera. In order that the intersections of the radial line plot made from the outer portion of the photographs be well contained, it was necessary that the camera be rotated 45° between alternate exposures. As much as C&GS used the 5-lens photographs and liked them for maintaining accuracy in photomapping, it looked forward to a camera that would fill up the spaces between the wing chambers in the 5-lens camera and reduce the number of photographs that had to be taken over an area.

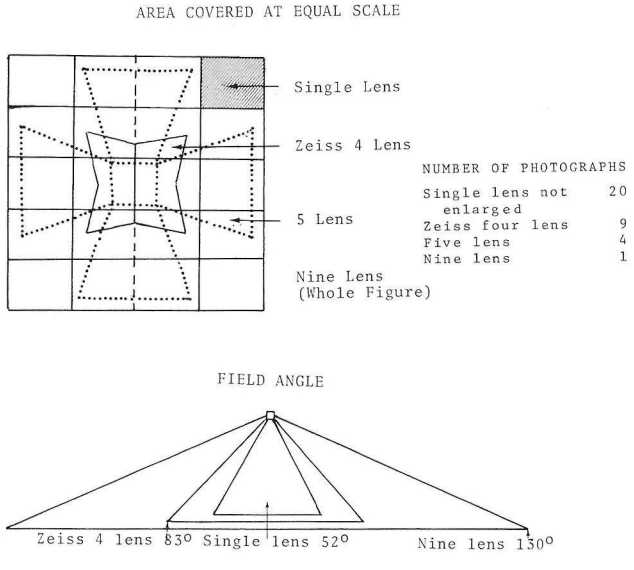


FIGURE 57.—Area covered at equal scale.

In 1926 Leon P. Eliel applied for a patent on a 9-lens camera that would completely photograph a whole square field of the same wide angle as the 5-lens camera. A model of a wing and the center chamber was made, and it took satisfactory photographs from

the air. However, the design resulted in a camera of excessive size if not constructed with very short focal length lenses, and the camera was never built.

Photogrammetrie, Ltd., of Munich, Germany, applied for a German patent on a 9-lens camera, using a double reflection prism in front of the lenses. This camera, as well as Eliel's, registered all of the images on a single film, and these images were transformed to a single composite photograph. Five models of the Photogrammetrie camera were built. These cameras were of a very short focal length and thus entailed such small images of the object as not to be useful except for small-scape mapping. The question of a more suitable focal length for the camera was Lt. Reading's most troublesome problem in the design of the 9-lens camera. It was impractical to do any great amount of enlarging during the transformation of the oblique negatives, beyond that required to project them to the same scale as the center photograph. Because of limiting optical conditions of the transforming lenses, and the necessity of transforming oblique negatives at an angle of 38° to 43°, any increase of the focal length of the transforming lens above that of the air camera lens introduced a marked increase in the acuteness of the transformed plane. On the other hand, a shorter focal length of the transforming lens required an abnormally wide angle of field. On this account, a one-to-one transformation was decided on. Moreover, transformation required that a horizontal object near the margin of the composite photograph be enlarged about seven times in a direction radial from the center, and about 2½ times in the transverse direction. An enlargement greater than seven times required extreme care and unusually good exposure conditions to yield satisfactory results. It was necessary that scales at least as large as 1:10,000 and 1:20,000 to be used for C&GS topographic mapping in order for the topographic surveys to be useful for furnishing shoreline for hydrographic sheets. Also, it was undesirable to photograph at an altitude of less than 6,000 feet, because of the rough air ordinarily encountered at lower altitudes. These conditions indicated that 8¼ inch focal length lenses be used for the camera. This focal length in turn limited the field angle that could be used by the camera without producing a photograph too large to handle and plot conveniently. A field of 130° across the strip, producing a photograph of $35^{4}/_{10}$ inches square, was decided to be optimum. It was considered essential that the aerial photographs be taken on a single film, because of the difficulty of handling, setting, and accurately mounting nine separate negatives and prints for each exposure. For this reason, it was decided to use lenses with parallel axes, projecting their images on a single film and securing the necessary reflection of the side images by means of prisms or mirrors. The prisms were excessive in cost and size for the focal length selection, and it was thought that considerable difficulty would be encountered in holding the adjustment of such prisms, because of the lag in expansion that would occur between the glass and the metal used for mounting them. It was decided, therefore, to use mirrors for the reflection of the side images in the camera. Fortunately, at this time the development by Ross of England of a F−4 lens satisfactorily covering a field of 68° made it unnecessary to use a double reflection to obtain the 130° field of view.

The single mirrors required by this design were 9½ inches long and 5 inches wide; each mirror was locked to the framework by nine adjusting screws with lock nuts, and the whole assembly was adjusted by carefully graduated focal plane plates and collimators set with a theodolite. The mirrors were adjusted for flatness as they were viewed through a quartz optical flat to the correct angles with the collimators, and it was possible to hold them flat on the frame within five or six light fringes by means of the adjusting screws. The framework supporting the mirrors and lenses was made from the same piece of metal as the mirrors, and care was taken to use the same thickness in the cross sections so that the rib accessory had the same thermal expansion and contraction as the mirrors. Several experiments were made, using a test mirror and support, down to temperatures of 46° below zero; the tests indicated that the mirrors would hold their adjustment through a large range of temperatures. The steel used was 0.35 percent carbon and about 14 percent chromium, with only a trace of nickel. The Interferrometry Section of the Bureau of Standards found that this high chromium steel had a very uniform thermal expansion. A precise adjustment of the mirrors was necessary, because any error in their adjustment would double the errors on the composite photographs.

A second critical feature of the camera was the requirement for simultaneous exposures in the nine chambers. The lens shutters were activated by an electrical solenoid, developed by the Army Air Corps and Fairchild Aerial Camera Corp. for the 5-lens camera, and adapted to the 9-lens camera. These shutters were activated, and not merely tripped, by the electrical impulse. The nine separate images on the film were transformed into a single composite photograph by the 9-lens transformer. The film was placed in a carrier that had provisions for centering and measuring the shrinkage of the film. The film carrier was placed on a turntable and each wing image projected in position on the composite photograph on a revolving table below the lens. The two revolving tables were geared together to keep them synchronized, and accurate registration of the setting was secured by means of dowels. Provisions were made for using paper or film held flat with a vacuum back. The film carrier was removed from the turntable when the

printing of the wing chambers was completed and was placed over a central lens for projection of the center chamber at a one-to-one ratio. Practically every element of the transformer was readily adjustable for small mechanical errors. Provisions were made for changing the positions of the lenses and the turntables to compensate for various film shrinkage. The film for the camera, 23 inches wide and 200 feet long, provided for 100 photographs per roll. An automatic device indented the film along each exposure for cutting the film. The film was held flat in the camera focal plane by a vacuum back operated by an electric pump. The fiducial marks were recorded on the film by lenses in each corner. Images of levels, a clock, data card, and counter were photographed at the same time. The image of the counter was so placed that it appears in the corner of the transformed photographs so that numbering of the photographs was not necessary. A telescopic sight was designed to be mounted directly on the camera so that the camera would be automatically oriented when an image on the ground followed the line in the sight. Traveling grid lines were also provided in the sight and were driven in synchronization with the ground by means of a variable speed intervalometer which also automatically operated the shutter release to maintain the desired percentage of overlap on the photography. The camera was about 25 inches by 27 inches in size, about 31 inches high, and weighed about 300 pounds. It was handled and transported on its own gimbal mount, which rested on a cart when it was not mounted in the aircraft. A special hoisting device was used to raise the camera through the hatch cut into the bottom of the aircraft. Fairchild Aerial Corporation built the camera, and C&GS made all of the optical adjustments of the mirrors and lenses. The contract price for the camera was $24,350.

On April 22 and 23, in the auditorium of the National Museum, Washington, D.C., the American Society of Photogrammetry held its First Annual Meeting.

Lt. Reese submitted his thesis on the development of aerial surveying in C&GS to Louisiana State University for his civil engineering degree. In his thesis, Lt. Reese stated:

"The addition of aerial surveying in the U.S. Coast and Geodetic Survey, as one of its major operations, is a normal addition, as it has been the policy of the Survey ever since its organization to create more accurate and economic methods of mapping. During its life of one hundred twenty-five years, the Coast and Geodetic Survey has had, as one of its main principles, to increase the accuracy of this work and make it more economical at the same time. It is from these fundamental principles that aerial surveying has been adopted as a major function of the Survey.

"The first work of the Coast and Geodetic Survey in connection with aerial photographs was the surveying of Atlantic City in 1919 and of the coast of New Jersey in 1920. This work was purely experimental, but it was demonstrated that photographs could be successfully used for securing topographic information necessary for the construction of nautical charts.

"In 1922 an aerial survey was made of the Mississippi River Passes, and it was on this project that the fact was conclusively proven that aerial photographs could be used for securing accurate topographic information.

"The cameras in use at that time were all of the single-lens type; and due to the various limitations of this camera, the Coast and Geodetic Survey was unable to adopt the use of aerial photographs as a standard method of mapping. However, in 1927 a four-lens camera was designed, the features of which made it more desirable for aerial mapping.

"The development of multiple-lens cameras made the radial line method more accurate for compiling aerial photographs into line maps, as it is possible to use less control for multiple-lens photographs than for single-lens photographs, and the obtaining of control is the most expensive part of any mapping project. The radial line method has been used with the single-lens, three-lens, four-lens, and five-lens cameras, and from the standpoint of the Coast and Geodetic Survey the five-lens camera had proved most successful. There is still a number of limitations in connection with mapping from five-lens photographs by the radial line method.

"No accurate map can be compiled without sufficient control, and this control is normally obtained by triangulation and traverse. The compilation of the photographs into line maps presents a specific work for which draftsmen have to be specially trained. The compilation of aerial photographs by the radial line method has been checked by ground methods by the Coast and Geodetic Survey to prove that the radial line method is accurate within the limitations which are known to exist.

"The outstanding advantage of mapping aerial photographs is that all the detail may be traced—not sketched—from the photographs with the same precision as the measured control points are plotted. Another advantage of aerial photographs is that it is difficult in the compilation of such maps to make gross errors or blunders in measurement, as properly overlapped photographs act as a check on the detail shown.

"In mapping from aerial photographs it is necessary to field inspect the area of which the map is being made, as certain data for the proper interpretation of the photographs must be obtained. This field inspection also secures the names of all information which should appear on the finished map.

"The development of aerial surveying in the U.S. Coast and Geodetic Survey can largely be attributed to the untiring efforts of Lieutenant O. S. Reading, who has been in charge of this work since 1927.

"There are many misconceived ideas by the uninformed as to how maps are made from aerial photographs. The general opinion is that to secure a map from aerial photographs is to make a number of exposures from an airplane develop the exposures, match the edges of the prints, and make a tracing of the matched prints. It is possible to secure valuable information in this manner, but to make an accurate line map from aerial photographs the procedure is quite different, and the photographs serve as only one of the many steps in the preparation for such a map.

"The cameras for use in aerial mapping have to be designed specially for aerial work. The designing and manufacture of aerial cameras require precision work, for the quality of aerial photographs for mapping depends directly upon the kind of camera used.

"At the present time a 9-lens camera is being constructed for the U.S. Coast and Geodetic Survey. Lieutenant O. S. Reading of the Coast and Geodetic Survey is to be credited with designing the nine-lens camera.

"In the compilation of photographs, the field inspection and locating of the control stations on the photographs is a very important step in photo compilation, for all subsequent steps depend directly upon the data submitted by the field inspection party. Too much caution and stress cannot be placed upon the necessity of accuracy in tying in triangulation stations on the photographs.

"There is also considerable other important information that has to be obtained by the field inspection party.

"The securing of measurement to objects on the ground which can be identified on the photographs is the most important step of air-photo compilation. These measurements should be made with extreme caution. One of the most common errors is misidentification of points on the photographs to which measurements were taken on the ground.

"Structures and objects such as lighthouses, large water tanks, church steeples, and large smoke stacks can be properly identified on the photographs and picked directly by the use of the stereoscope. For other control points it is necessary to select points on the ground to which measurements are taken to locate stations on the photographs.

"The most satisfactory way to obtain the proper plotting of control points on photographs is to have the control points located near objects which can be readily identified on the photographs. One of the most desirable places to have a control point located is near a road or a street intersection.

"Due to modern methods of securing topographic information from aerial photographs, it is possible to furnish to the public a product which is very valuable to engineers, scientists, mariners, landowners, and others interested in the accurate delineation of the terrain. This information, aside from the cost of compilation, is reproduced and copies of the sheets can be procured for the nominal price of seventy-five cents each for a sheet that represents an area of 130 square miles of topography on a scale of 1:20,000."

FIELD ACTIVITIES—1935

On September 2, Lt. W. H. Bainbridge was working with a field party in the Florida Keys when one of the most devastating hurricanes to hit the United States came ashore. Bainbridge put all of his equipment into service for relief of the stricken areas, including two launches and two barges. Bainbridge reported: "Alligator Reed Lighthouse was put out of commission when the lens and the light were completely demolished; between 6:00 p.m. and 6:30 p.m. the barometer fell from 29.00 inches to 27.84 inches, and winds of approximately 200 miles per hour were estimated although all of the equipment capable of recording the wind velocity had been carried away." He also reported: "Four fishermen in the path of the hurricane reported barometer readings of 26.40 inches. One of the barometers giving this reading was checked and a correction of +0.35 inches was necessary to calibrate the barometer. The second barometer showing the 26.40 inches reading was lost in the following manner: two men had their boat in one of the small creeks near Matecumbe and during the lull one turned his flashlight on the barometer. He did not believe what he saw and he took the light and the barometer to the other man standing in the cockpit. That man took one look and heaved both of them overboard. When asked why he had done that, he replied, 'We weren't going to need them where we were going.' Fortunately, the boat was left high and dry in the mangrove and the two men survived the hurricane."

Bainbridge further said, "That new photography covering the Florida Keys was vitally needed in order to assess the total damage caused by the hurricane."

1936

OFFICE ACTIVITIES—1936

The construction of the 9-lens camera required about 17 months, (figs. 58 and 59) and Bennett G. Jones reported the following: "The camera and transforming printer were delivered by the manufacturer in September 1935 and in January 1936, respectively, and the installation of the lenses and the mirrors and the calibration of the camera and printer were begun immediately in the Washington offices under the direction of Lt. Reading."

The installation and the calibration of the mirrors and lenses required an additional 5 months (fig. 60). Lt. Reading said: "Accuracy always pays and a century of experience in the Coast and Geodetic Survey has taught us that there is only one right place on any map for any object that appears on it." He went on to say:

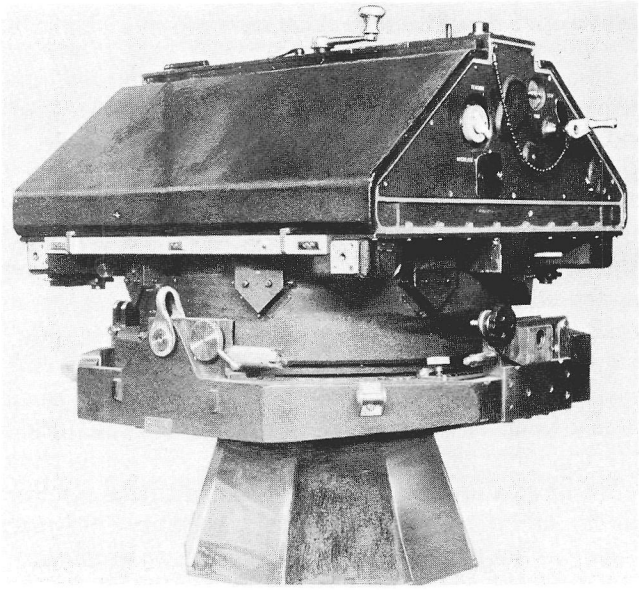


FIGURE 58.—The camera has nine parallel lenses that simultaneously expose separate images on one strip of film. The lenses are arranged so that one central lens is directed vertically and the other eight, arranged peripherally, are directed 38 degrees from the axis of the central lens by means of stainless steel mirrors, producing oblique views. In a complicated transforming printer, these nine separate images are printed one at a time on a single piece of paper, the central chamber being printed vertically by direct projection and the wing chambers printed by being projected obliquely so that they are transformed to the plane of the central chamber. The resultant print looks like and can be used as a photograph taken with a single lens of 8¼″ focal length and 130 degrees field of view. (Photograph courtesy of Fairchild Camera Corporation.)

"Nothing so handicaps progress as the assumption that because a development is difficult it cannot be accomplished." And, it is true, the 9-lens camera was difficult to develop.

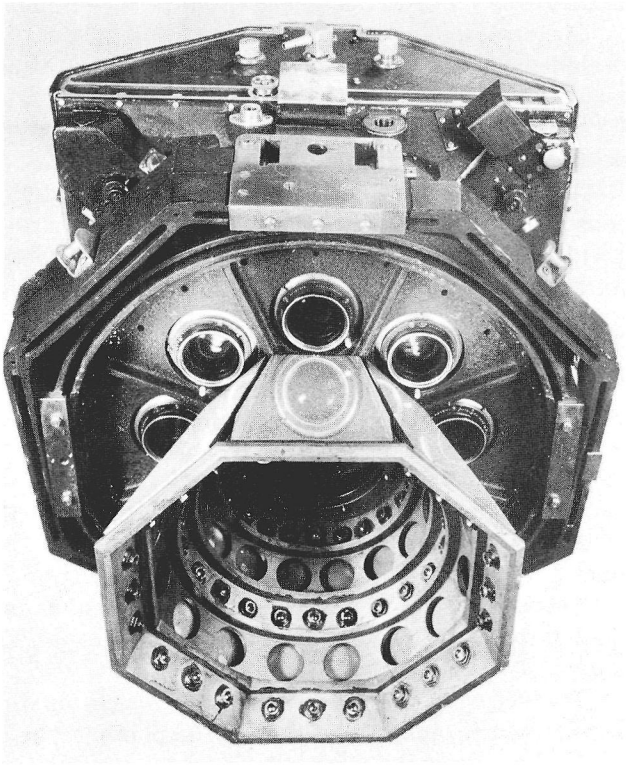


FIGURE 59.—9-lens camera.

Lenses:	9—Ross Express f/4
Focal length:	210 mm (8¼″)
Field of view:	130° square
Dimensions:	*width—29 inches*
	length—27 inches
	height—31 inches
Weight:	net—306 pounds
	equipped—750 pounds
Film:	width—23 inches
	length—200 feet
Exposures:	100
Dimensions:	35 inches square
Coverage:	

Scale	Area	Length of Side
1:5,000	7.8 sq. mi	2.8 miles
1:10,000	31.2 sq. mi	5.6 miles
1:12,000	45 sq. mi	6.7 miles
1:20,000	124 sq mi	11.2 miles

(Photograph courtesy of Fairchild Camera Corporation.)

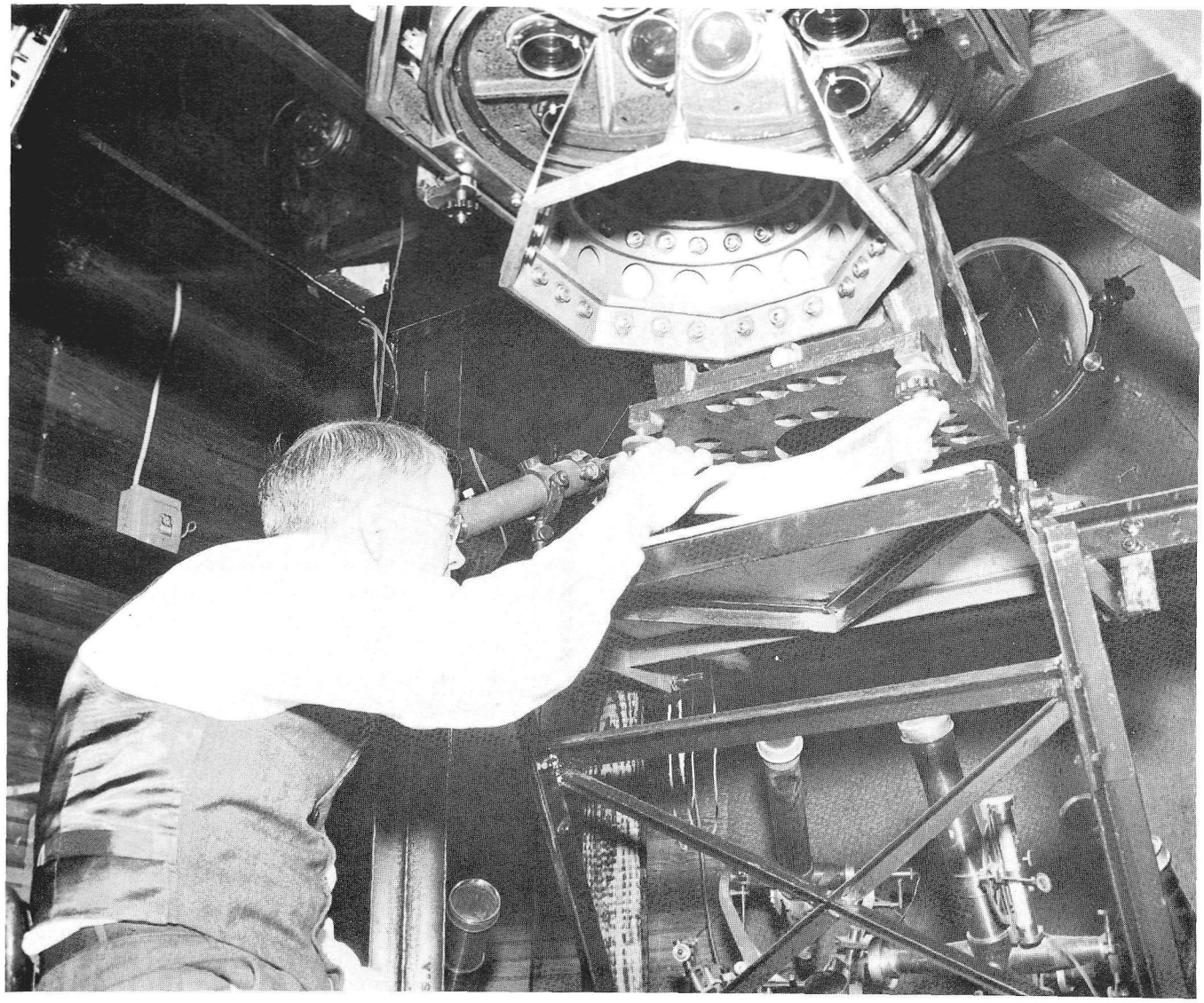


FIGURE 60.—Lt. Reading adjusting the pressure of the optical flat used to measure light fringes. The mirrors were brought to 6 fringes of flatness by applying or releasing pressure on the tension screws located behind each mirror. Six of the nine screws are visible inside the mirror cone. (Official NOS photograph.)

During the year, the feelings were that modern cameras, lenses, and photographic materials, together with the present-day airplane, had made it practical to obtain in a few hours extraordinary details, and accurate and permanent survey records that to duplicate by ground methods would take years of work. The photographic record requires considerable office processing for the construction of a first-class map. But, nevertheless, it represents an advance in surveying efficiency. When one looks at the coverage (fig. 57) of the 9-lens camera compared to the coverage of other cameras available even today, one can understand the tremendous step forward in photogrammetry that this camera represented.

While stationed aboard the USCGS ship, SURVEYOR, which was operating in Alaska on September 26, Lt. (jg.) Marshall Reese, along with Quartermaster Max McLees, were drowned off the north shore of Unalaska when the dory in which they were leaving camp at Wislow Bay capsized in the surf. Reese was one of the first officers assigned the duty of flight-checking sectional airway maps, and additionally spent a great deal of his time in compiling aerial photographs and helping to organize the Photographic Section.

FLIGHT ACTIVITIES—1936

The first flight test of the 9-lens camera was made at Wright Field, Dayton, Ohio, in November (figs. 61 and 62). After the flight, minor corrections were made to the vacuum pump, winding motor, and clutch.



FIGURE 61.—Preparing to install 9-lens camera on Martin B–10–B aircraft at Wright Field, Dayton, Ohio. Left to right: Reynolds Ask (USC&GS), Capt. Rumaggi (U.S. Air Force), Lt. O. S. Reading (USC&GS), and Lt. Tally (U.S. Air Force). (Photograph courtesy G. C. Tewinkel.)

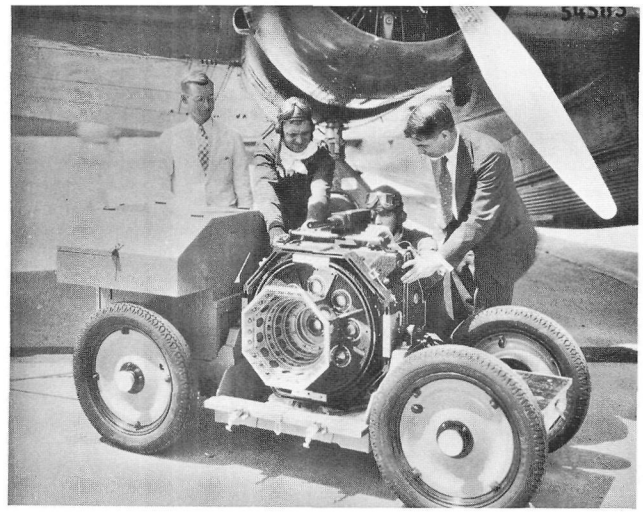


FIGURE 62.—Inspecting the camera drift sight prior to installing the camera on B–10–B aircraft at Wright Field, Dayton, Ohio. Left to right: Reynolds Ask (USC&GS), Capt. Rumaggi (U.S. Air Force), Lt. Tally (U.S. Air Force), Lt. O. S. Reading (USC&GS). (Photograph courtesy of G. C. Tewinkel.)

Following the test flight, the camera operated successfully and no further adjustments to the lenses and mirrors were necessary. Only minor adjustments had to be made to the vacuum pump and the operating mechanism. The adjustments of the lenses and mirrors were checked twice after the original test flight, and no changes were found. The test flight and the subsequent photography were flown by the U. S. Army Air Corps, which provided and equipped a B–10–B Martin bomber for this purpose. The plane was powered with two 700-horsepower engines and had a ceiling of 26,000 feet with a speed of 180 miles per hour at that altitude. The crew was comprised of pilot, navigator, and photographer. Since the plane was designed for military use, mounting the camera required a number of structural changes. A hoist was installed to lift the camera from its cart into the aircraft, and during takeoff and landing the camera was located above the floor level and protected by a sliding door. The camera was lowered into position after the aircraft was in flight.

LABORATORY ACTIVITIES—1936

The transforming printer was installed in room 1234 of the Department of Commerce Building in Washington, D. C. (figs. 63 and 64), and during this time, a rectifying camera was being built under the supervision of Lt. Reading, and plans were being made for a stereoscopic plotting instrument. The addition of these items would result in increased efficiency and economy in the compilation of planimetric maps from 9-lens camera photography.

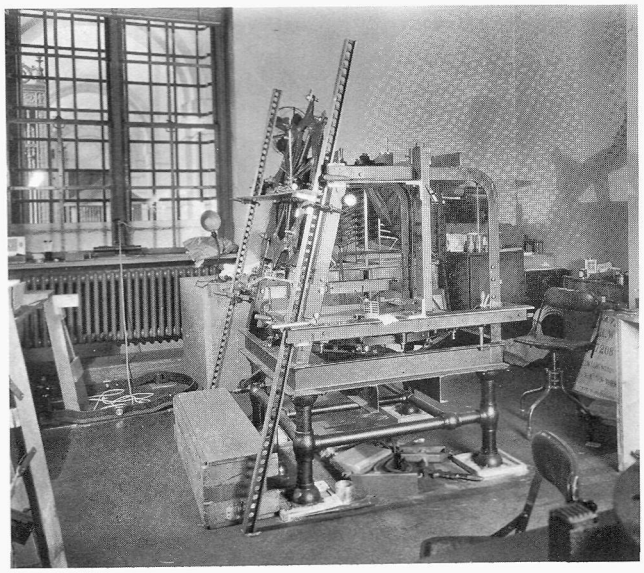


FIGURE 63.—9-lens transforming printer under construction in June. (Photograph courtesy of G. C. Tewinkel.)

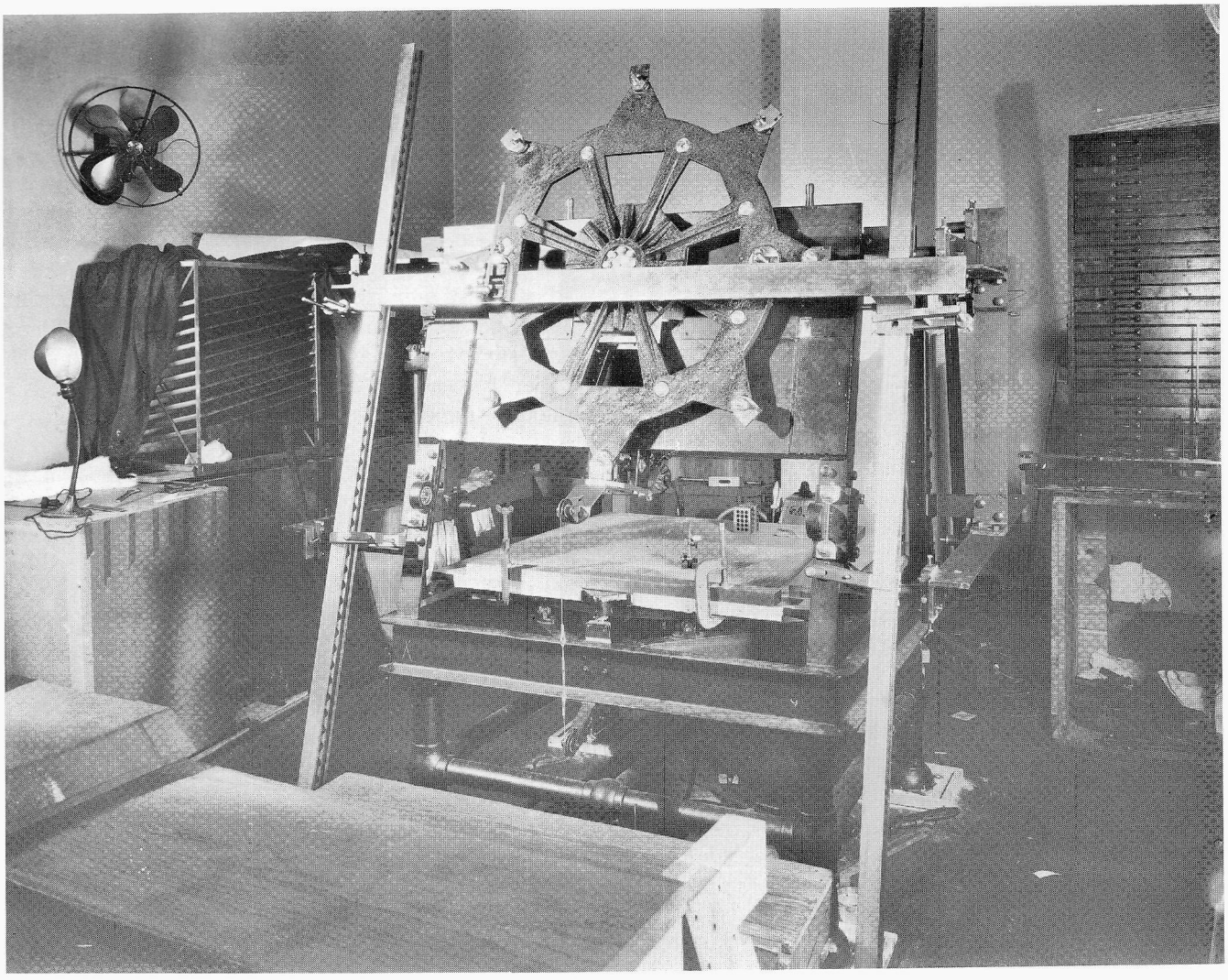


FIGURE 64.—Front view of 9-lens transforming printer, Room 1234, Department of Commerce Building. (Photograph courtesy of G. C. Tewinkel.)

1937

FLIGHT ACTIVITIES—1937

Construction and testing of the 9-lens aerial camera designed by Lt. Reading were completed, and the camera was used on its first flights for survey purposes on April 30. The Air Corps of the U.S. Army, through a cooperative agreement, offered a Martin B–10–B aircraft, No. 34–30, to accommodate the camera, and then made all of the flights required for the preliminary test and adjustments, and also the flights for surveying photography.

The first mapping project with the 9-lens camera was completed on May 2 and covered about 1,200 square miles in the north Chesapeake Bay area. Additional photography with the 9-lens camera included the outer coast of North Carolina from south of Virginia Beach to Cape Lookout, and the Dismal Swamp Canal from Norfolk, Va. to Elizabeth City, N. C.

OFFICE ACTIVITIES—1937

The film obtained by the camera was printed on the transforming printer, and the photography afforded excellent detail of the ground. The large area covered by a single exposure with the camera reduced the ground control necessary for aerial photographic surveys and markedly reduced the cost of surveying with photographs, especially in areas of difficult access.

The Chesapeake Bay project illustrates the practical use of the camera for coastal surveys by graphic methods. The 1,200 square miles were compiled on 50 topographic maps at a scale of 1:10,000. The area was covered by 380 photographs with an average of 7.4 photographs per map. The photographs overlapped 60 percent both along and between flight lines. The northern part of the survey project covered 430 square miles and was completed in the period from August 1937 to October 1938. This work included 20 planimetric maps at a scale of 1:10,000 and 18 hydrographic surveys, 2 at a scale of 1:20,000 and 16 at a scale of 1:10,000. An interesting feature of this project was the *first location by photographic plots of control for hydrographic surveys*. Field inspection was started by a two-man party in September and included the identification of images of natural objects and other points of detail that could be recovered and marked for use as hydrographic stations.

The 9-lens camera was not only reducing the time required for topographic surveys compiled from air photographs but was increasing the accuracy of the results. At an elevation of 14,000 feet, the camera photographed with a single exposure an area of 120 square miles at a scale of 1:20,000. From these photographic surveys, the bureau was now able to further the progress of hydrographic parties by locating in advance, by radial line plots, the positions of identifiable points for use in hydrographic surveys. The large area surveyed by a small hydrographic party in the upper Chesapeake Bay indicated the results that could be expected as the methods became standardized.

The Photographic Laboratory, room 1234 of the Department of Commerce Building, was operational, and the transforming printer (figs. 65, 66, and 67) was producing 9-lens prints on the average of 16 a day, with two shifts operating. The Director reported: "Among the outstanding accomplishments of the year are the completion of a series of 87 sectional aeronautical charts covering the entire United States and the completion and successful use of field surveys of the 9-lens aerial camera designed by this Bureau."

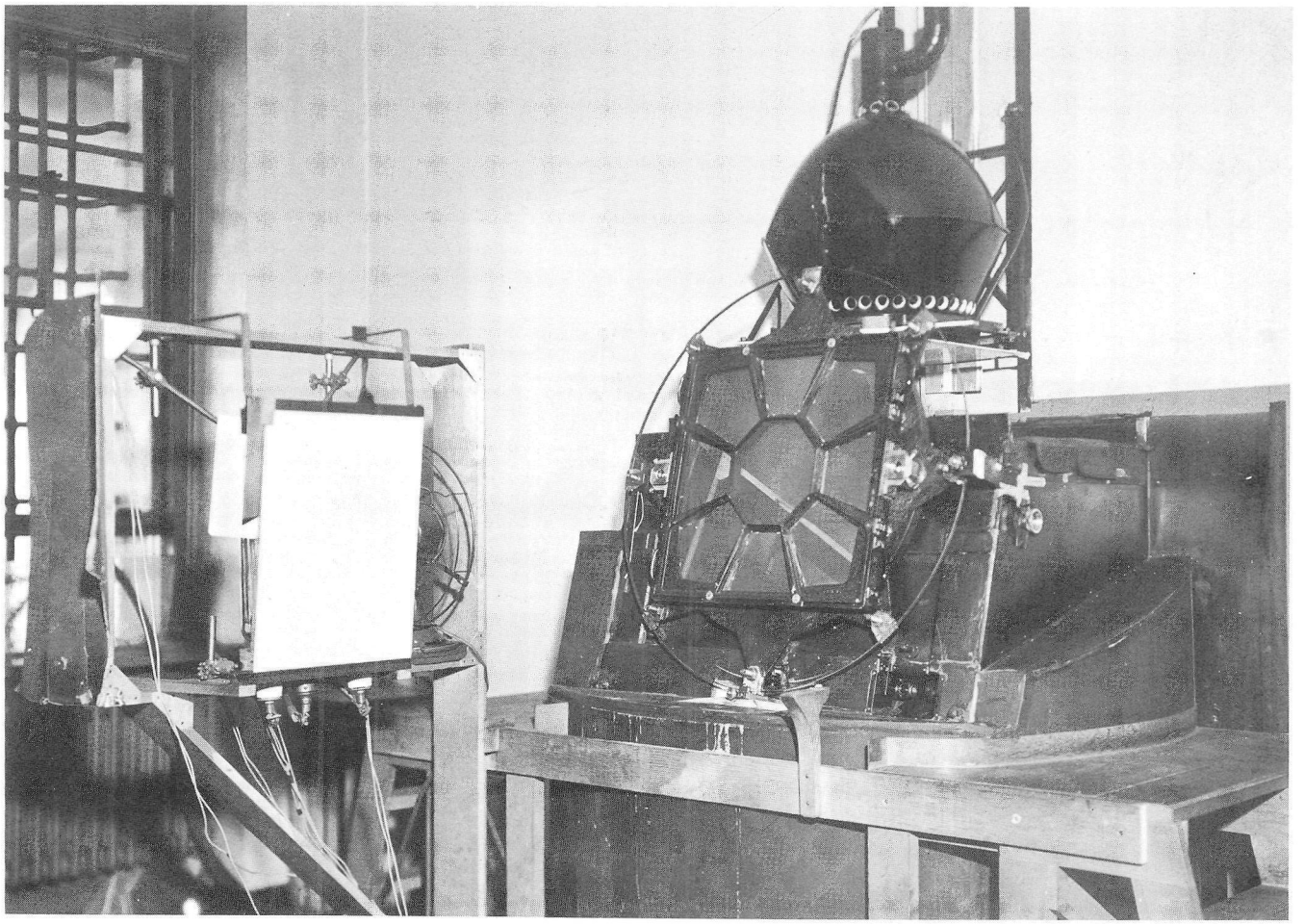


FIGURE 65.—9-lens transforming printer nearing completion as the test of the light-source pattern is conducted. (Official NOS photograph.)

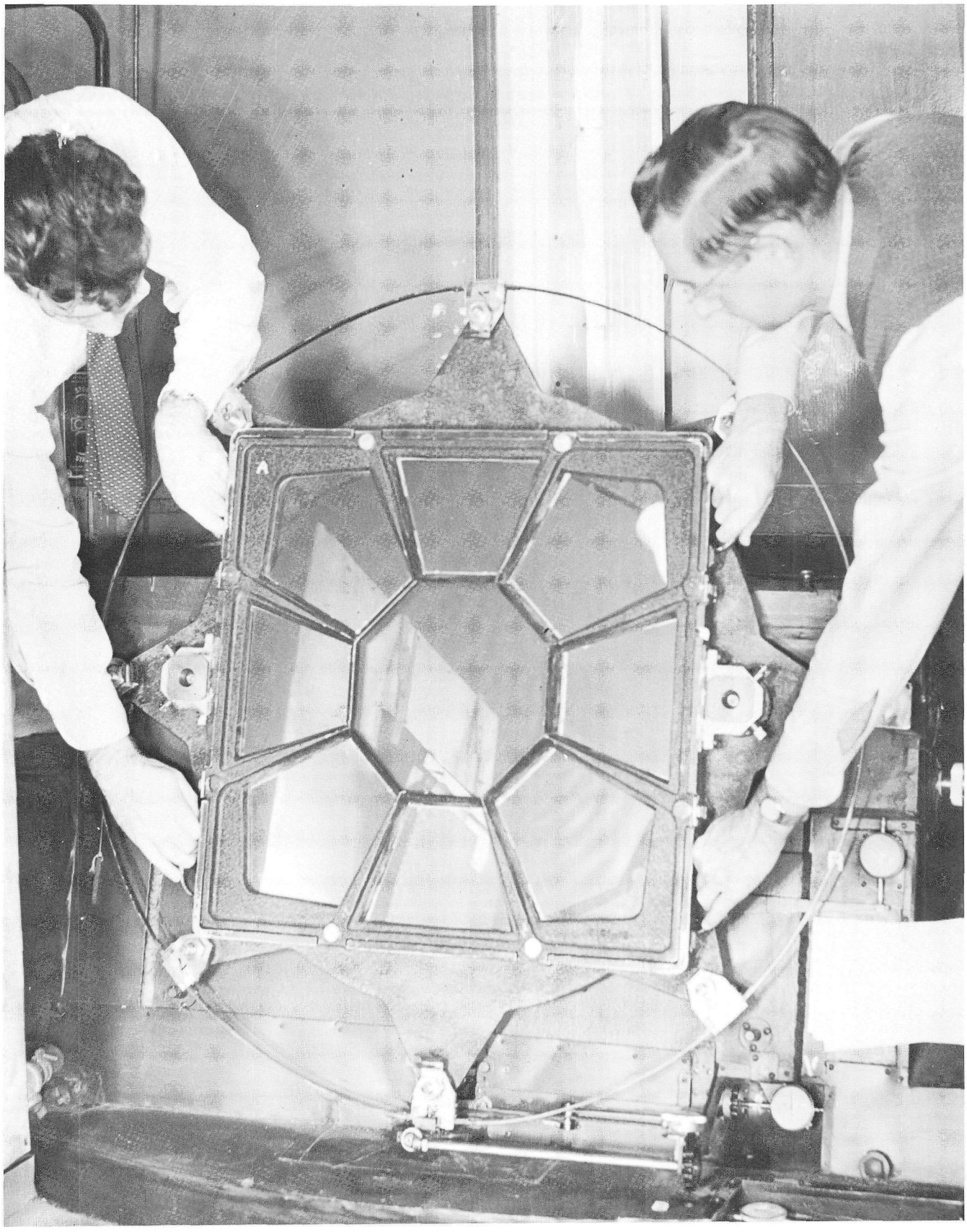


FIGURE 66.—The 9-lens negative being moved from wing position to center printing position. (Official NOS photograph.)

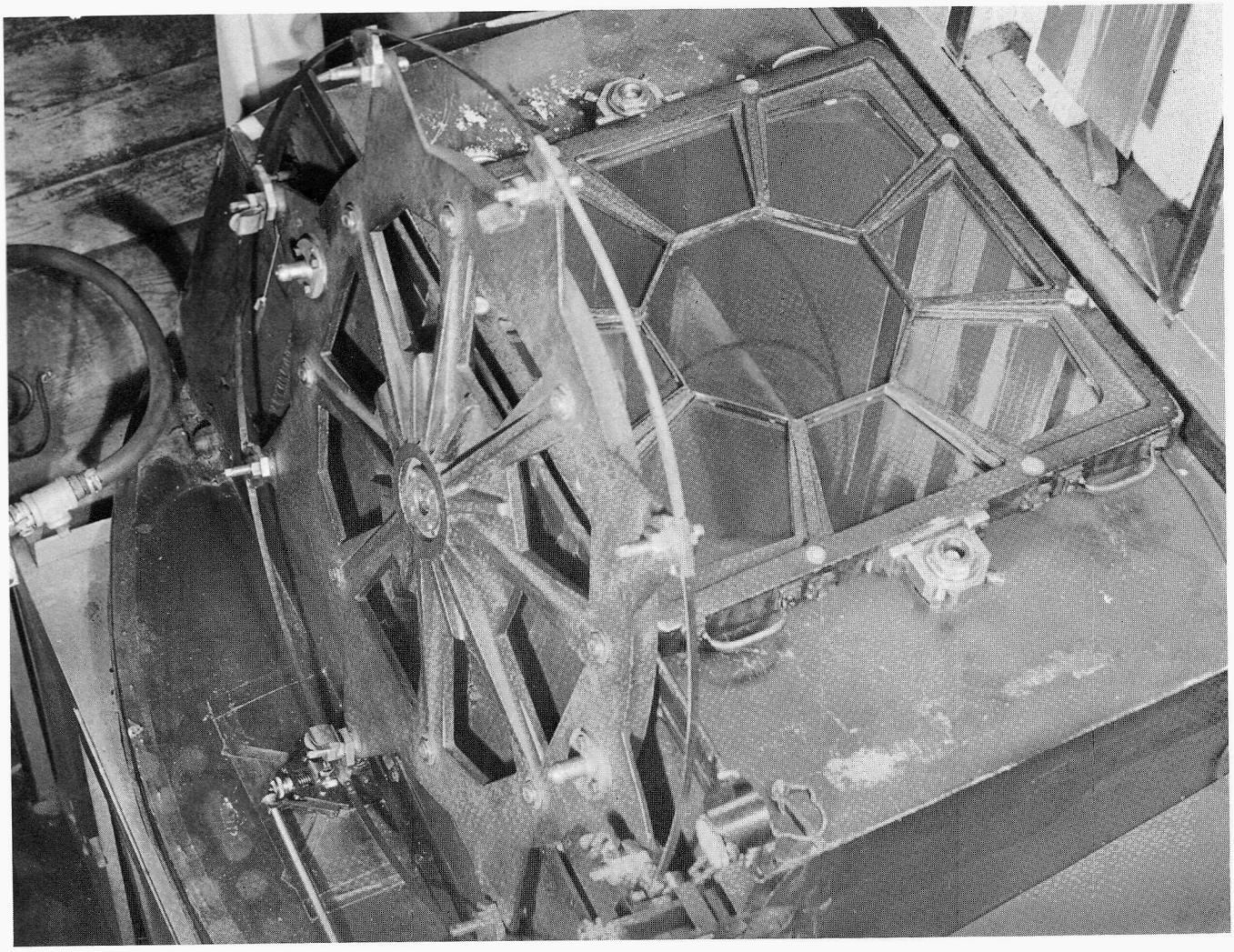


FIGURE 67.—9-lens transforming printer. Film position for printing center chamber. (Official NOS photograph.)

1938

OFFICE ACTIVITIES—1938

The Chief of the Division of Charts reported: "The Division has been cooperating with the Division of Hydrography and Topography in that two employees have been assigned to operate the transforming camera for the 9-lens air camera. In addition, Mr. John D. Kay accompanied Lt. O. S. Reading to Wright Field, to assist in the installation of the 9-lens camera and additional navigational equipment in a U. S. Army airplane."

Small aerial photographic compilation units were located at Baltimore, Md., Palatka, Fla. and Norfolk, Va., doing most of the work during the winter when personnel were available from ships that were laid up for annual repair. Air photographic surveys were made with the Bureau's newly developed 9-lens camera in the upper Chesapeake Bay, and also, in cooperation with the Army, for the Soil Conservation Service at the High Rock Reservoir, N. C., area.

Use of the 9-lens camera made possible an increase in the efficiency of about 20 percent over former methods used in areas of flat terrain. For areas of considerable relief, a specially constructed rectifying camera and contour plotting machines were now being used.

During the year 9-lens photographs at a scale of 1:10,000 were made of Boston Harbor, Cape Cod, New York (figs. 68 and 69) and New Haven, Conn. A total of 775 9-lens photographs were now available for coastal surveys.

By now the construction and testing of the 9-lens camera had shown the following:

1. The design adopted was successful in holding its adjustment through the wide temperature ranges and vibrations encountered in the aircraft.
2. The handling of the large-size photographic materials presented no excessive difficulties with the correct design of the auxiliary apparatus and aircraft.
3. The increased relief displacement due to the wide angle of view made the photograph much less satisfactory for acreage mapping than normal single-lens photography, except for flat land areas. This limitation will be removed when suitable plotting equipment becomes available.
4. The large area covered at a relatively large scale by the photograph permits maintaining the highest graphic accuracy of plotting with about one-fourth the amount of ground control required by the single-lens photograph, and this without the sacrifice of fine details.
5. It was practical to photograph from three to five times as large an area in a given interval of photographic weather as was possible with the single-lens camera. This, of course, compensated for the increased cost of the aircraft, apparatus, and material.
6. It was now practical, with controlled temperatures and humidity and with the new low-shrinkage film and paper and micrometer adjusted to compensate for shrinkage and distortion, to correct the prints within 0.25 mm.
7. It was also practical to exaggerate the stereoscopic relief to five times that of a normal-angle single-lens photograph. This was a tremendous advantage in mapping relatively flat land.

The new 9-lens rectifying camera was installed and operating in room 1234 of the Department of Commerce Building (fig. 70).

Other agencies of the Government were now requesting 9-lens photographs of areas that ordinarily would not be photographed by C&GS, because they had no value in coastal surveys. Among these were the Soil Conservation Service of the Department of Agriculture. The need for the photography was to eliminate the large amount of field work for second-and third-order control necessary for the single-lens photograph, since the much greater span of the 9-lens camera permitted inclusion of widely distributed control points on a single photograph. The projects in progress during the year consisted of an area of about 9,000 square miles in North Carolina and Virginia, and three additional areas totaling about 14,000 square miles in the State of New York, Ohio, Colorado, Oklahoma, and Texas. The photographs were made at a scale of 1:24,000 and 1:31,000.

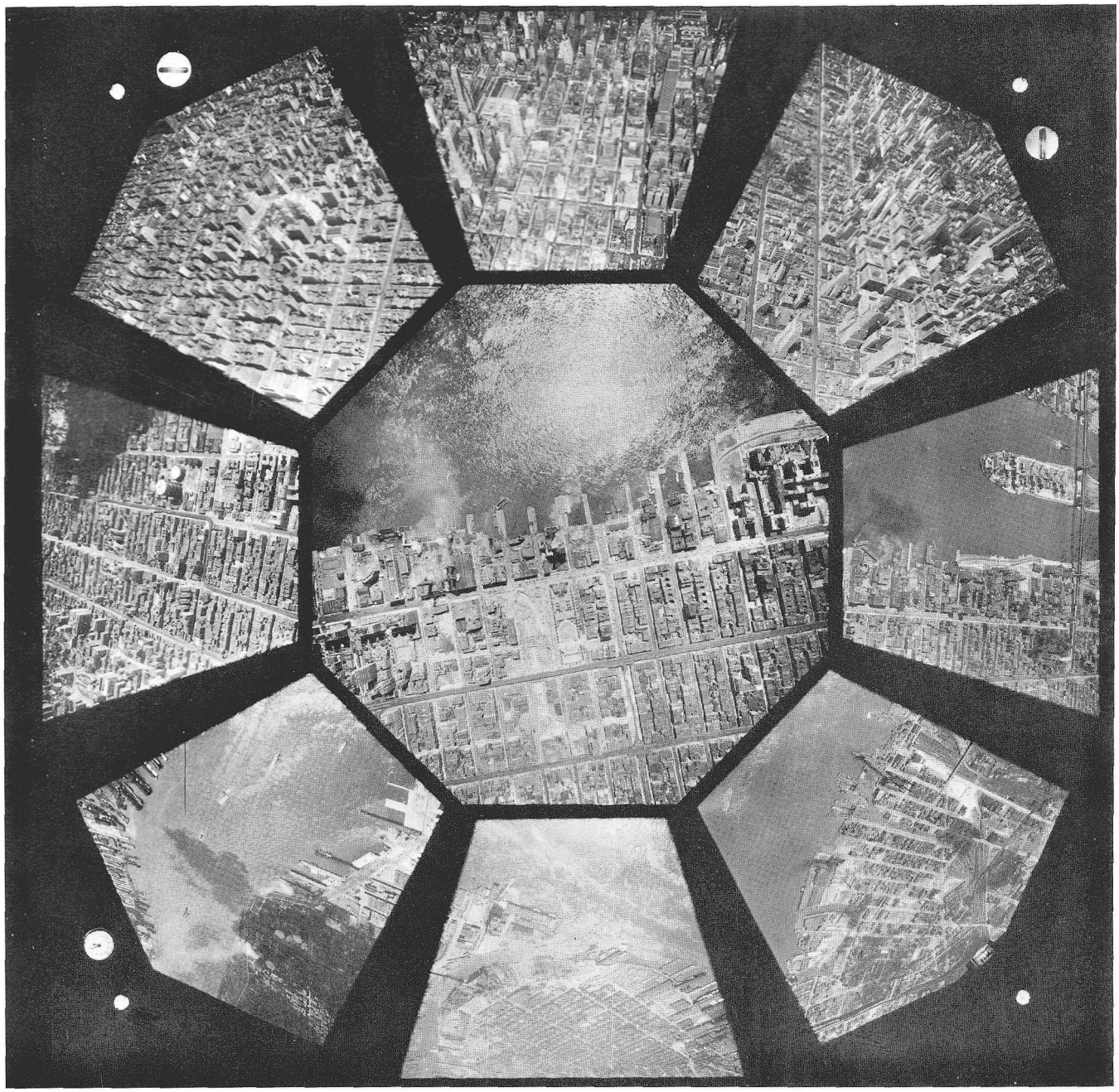


FIGURE 68.—Illustrated in positive for convenience of interpretation, the 9-lens negative from which fig. 69 was transformed into a composite print. (Photograph by Lt. O. S. Reading.)



FIGURE 69.—Aerial photograph used in topographic surveys taken with the Coast and Geodetic Survey 9-lens camera over New York City. Exposed at $^1/_{50}$ second at an altitude of 5,000 feet. (Photograph by Lt. O. S. Reading.)

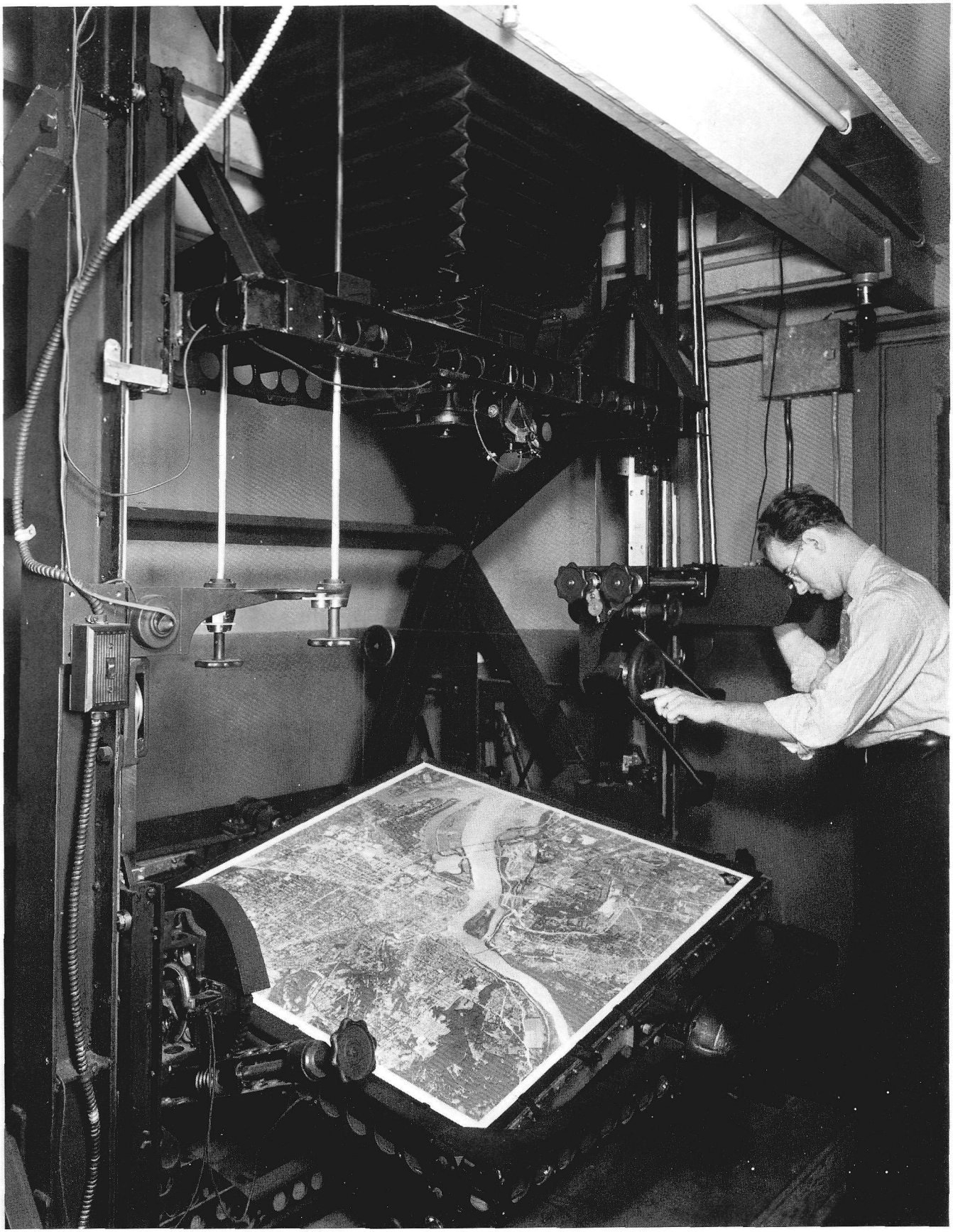


FIGURE 70.—Rectifying camera for 9-lens photography. The camera was capable of rectifying up to 10° tilt or tip of the photograph. (Official NOS photograph.)

1939

OFFICE ACTIVITIES—1939

The Director reported: "Compilation of line maps from air photographs taken with the Bureau's 9-lens camera of Boston Harbor, Chester River, and tributaries of the Chesapeake Bay, the Appalachee Bay, and St. Marks River, on the Florida gulf coast, were completed. Small aerial photographic compilation units are in operation in Baltimore, Maryland, and Tampa, Florida. Air photographic survey in advance of inshore hydrography has proven so efficient and timesaving that this procedure is being used whenever conditions permit."

Nine-lens photography continued throughout the year, doing both airport (fig. 71) and coastal mapping (fig. 72). The accuracy of the product was greatly enhanced with the completion of the Reading stereoplotter (fig. 73 and 74).

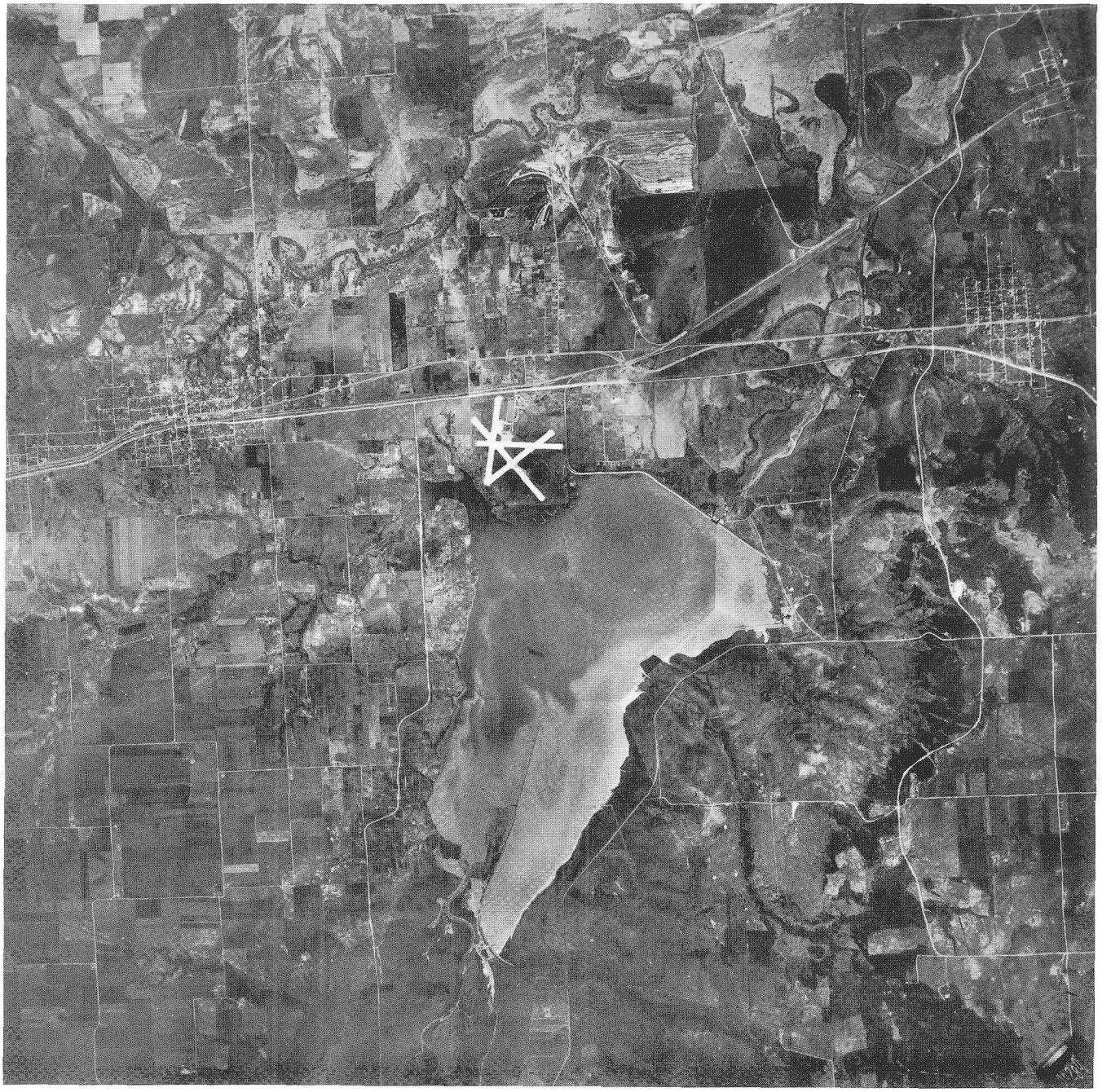


FIGURE 71.—9-lens photograph of Henley Field, Tex. The original photograph was at a scale of 1:40,000. (Photograph by Lt. Comdr. O. S. Reading.)

FIGURE 72.—9-lens photograph of Florida coast, November 30, 1939. (Photograph by Lt. Comdr. O. S. Reading.)

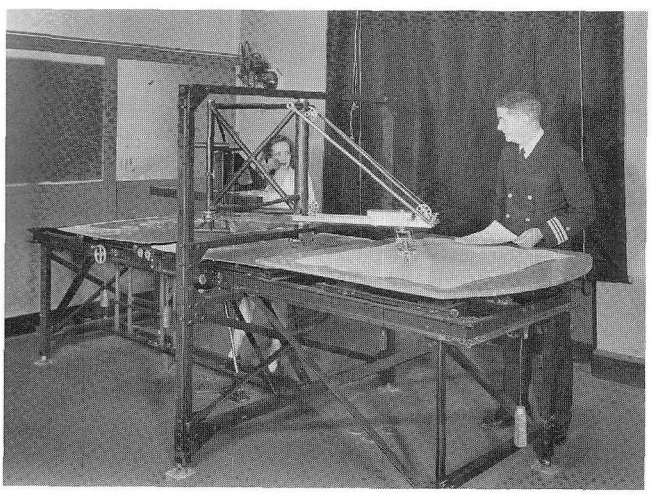


FIGURE 73.—The first 9-lens stereoscopic plotting instrument built by the Coast & Geodetic Survey. Lt. Comdr. O. S. Reading is on the right. (Official NOS photograph.)



FIGURE 74.—The Reading 9-lens stereoplotter. (Official NOS photograph.)

1940

FLIGHT ACTIVITIES—1940

Sgt. F. A. Roll, U. S. Army Air Corps, operated the 9-lens camera for C&GS (figs. 75 and 76), and a considerable amount of 9-lens photography was completed during the year (fig. 77).

In October the cooperative agreement for use of an aircraft with the U.S. Army Air Corps was terminated, and an agreement with the U. S. Coast Guard for the use of a Coast Guard aircraft was instituted.

Aircraft, U. S. Army Air Corps
Martin B–10–B No. 34–30

November 1936 to October 1940

Personnel who served on board:

U. S. Army

Capt. J. W. McCoy
Sgt. F. A. Roll
Capt. Louis J. Rumaggi
Lt. M. W. Schoefhoester
Lt. Tally

Coast and Geodetic Survey Officer

Lt. Comdr. Oliver S. Reading

Coast and Geodetic Survey Civilian

John D. Kay



FIGURE 75.—9-lens camera with Martin B–10–B aircraft at Bolling Field, Washington, D.C., March 12. (Photograph by T. W. Kines.)



FIGURE 76.—Lt. Comdr. O. S. Reading, left, and Sgt. F. A. Roll, inspecting 9-lens camera prior to installation in Martin B–10–B aircraft, March 12. (Photograph by T. W. Kines.)



FIGURE 77.—9-lens photograph of Washington, D.C., from an altitude of 24,000 feet. The photograph covers an area of about 400 square miles. (Photograph by Sgt. F. A. Roll.)

1941

FLIGHT ACTIVITIES—1941

At the end of 1940 a cooperative agreement had been reached with the U.S. Coast Guard to supply an aircraft and crew for aerial photography; a PBY–5 aircraft No. 08055 V–189 was assigned to C&GS (fig. 78). The plane, a Consolidated patrol bomber, was altered to permit the use of the camera. The hatch in the tail of the aircraft was enlarged so that the camera could be lowered out of the aircraft a sufficient distance to take unobstructed vertical photography. Unfortunately, the hatch was not large enough so that a full correction for crab of the camera could be made. The compartment was very cramped, and the cameraman was forced to sit in a very uncomfortable position (fig 79).

Before landing, the camera was hoisted into the aircraft and run forward on a special overhead track into the blister compartment. As there was only about a 1-inch clearance through the passageway into the compartment, it was very difficult to handle the camera; to store the camera required about 20 minutes. As this was a seaplane, the aircraft was moored at night and it was necessary to leave a watch onboard the aircraft. There were berths for three men, but because no heat was available, the plane was very uncomfortable in Alaska. Also, because it is necessary to use oxygen above 12,000 feet, V–189 was equipped with a central source of supply. A rubber mask was worn over the mouth and nose; the masks were extremely uncomfortable, and the air was expelled from the lungs and passed through a canister, where it was purified for reentry to the oxygen system. The canisters were supposed to last about 2 hours, but it was found that they had to be changed every 15 minutes.

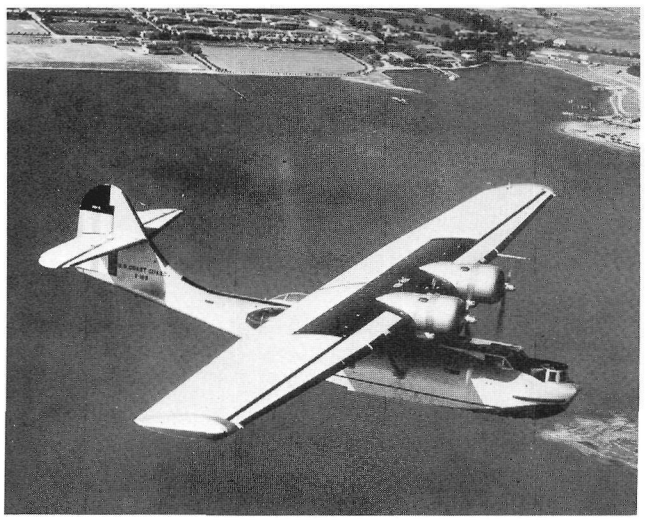


FIGURE 78.—U.S. Coast Guard PBY–5, V–189. The only PBY–5 in service with the U.S. Coast Guard was manufactured by Consolidated Aircraft and was strictly a seaplane with a wing span of 104 feet, a length of 63 feet, a height of 20 feet. Its gross weight was 66,000 pounds, and its cruising speed was 145 miles per hour, with a range of 2,500 miles. (Photograph courtesy National Archive.)

The crew of V–189 was provided with fur-lined flying suits, which were sufficient for most temperatures encountered with the airplane. However, the cameraman was exposed to a strong blast of air that came in around the camera. Two stainless steel processing pans, and developer and hypo solutions were carried on the aircraft, and at the end of a flight, a photographic negative was developed as a test from each day's photography.

The Coast Guard crew of the aircraft was comprised of a pilot, copilot, two mechanics, and two radio operators (fig. 80). During the summer season one of the mechanics assisted in handling the camera and could relieve the cameraman at times. The pilot was Coast Guard Lt. W. J. Smith. The Coast and Geodetic Survey supplied the photographer and the navigator, but for lack of personnel during the first part of the season, John D. Kay served as both navigator and photographer. He served in this capacity until August 18, when he was replaced by Lt. Hubert H. Paton (fig. 81). The camera was originally installed at Elizabeth City, N. C., and V–189 operated throughout the summer in Alaska, arriving back in San Francisco, Calif. on October 1. On October 15, Ray Elliott (fig. 82) was assigned as photographer, relieving Lt. Paton and allowing him to concentrate on the duties of navigator. Throughout the year, a number of airports were photographed as well as coastal mapping projects. The aircraft arrived back at Elizabeth City on December 1, and the mission closed for the season.

Lt. Paton said: "It has always been a bit of pride to me that I was assigned to the position of navigator without any training. Lieut. Smith had to put up with a lot while I learned my job. Mr. Kay, a civilian from

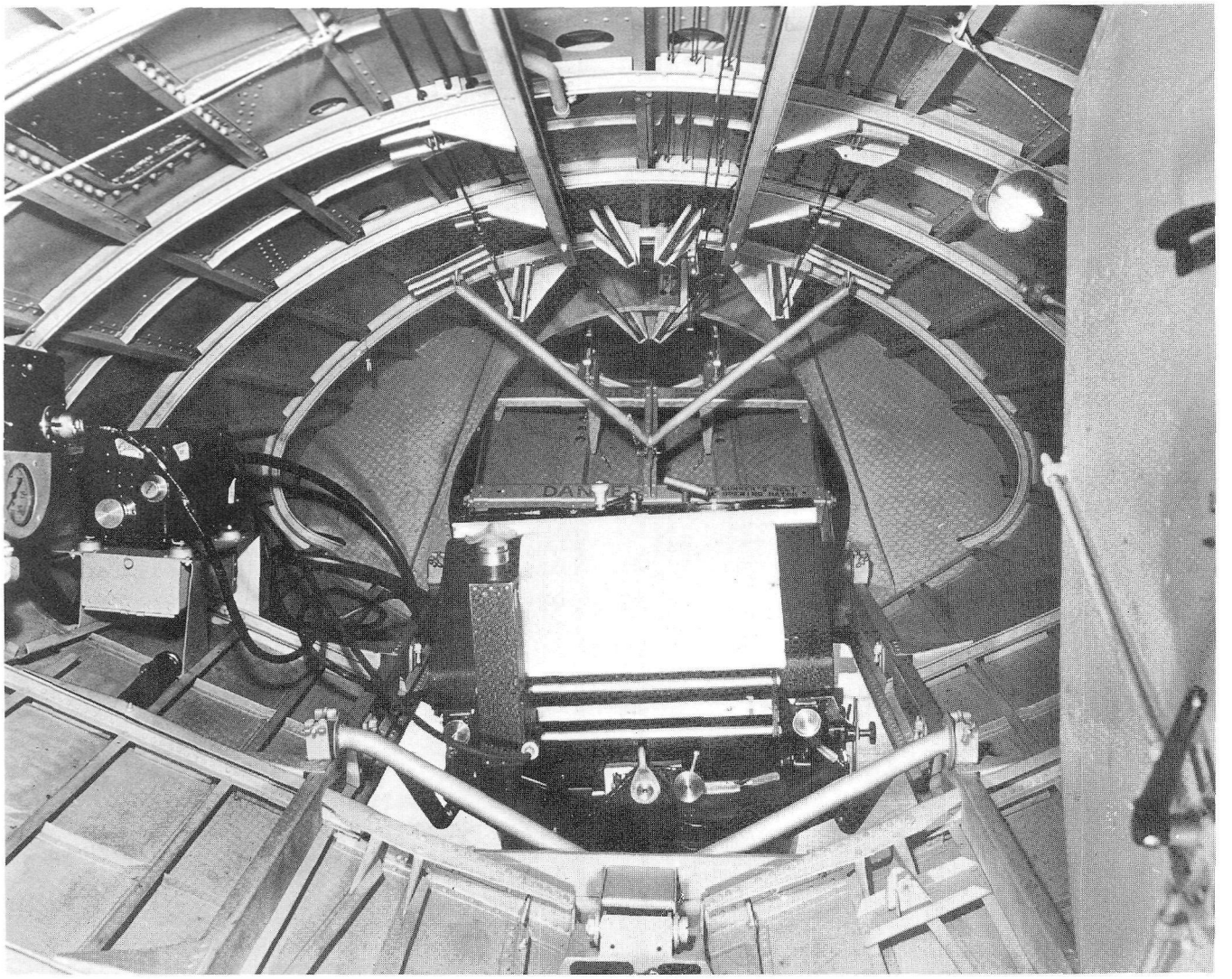


FIGURE 79.—9-lens camera in operation position in the aft area of V−189. Photographer sat in the V-shaped floor of the aircraft; the drift sight is on the left side of the camera. (Photograph by John D. Kay.)



FIGURE 80.—Crew of V–189 standing left to right: Lt. W. J. Smith, Lt. Hubert A. Paton, two unidentified aircraft mechanics, kneeling: Augustus Kleisch, two unidentified radio operators. (Lt. Willard J. Smith became Commandant of the United States Coast Guard on June 1, 1966, and served in that capacity until June 1, 1970.) (Photograph courtesy Capt. H. A. Paton.)

the Washington Office, had been the navigator on the PBY but he had been called for duty with the Army Air Corps and had to be relieved."

Lt. Paton was the first US C&GS officer to be trained as a photopilot; he attended flight school at Elizabeth City, N.C., where he received 19 hours of dual and solo instruction from the U. S. Coast Guard. At the same time, Comdr. Kenneth G. Crosby reported that Deck Officer J. A. Sosbee was attending flight school under the auspices of the Civil Aeronautics Administration, from December 24, 1941, through April 7, 1942, at Pensacola, Fla.

OFFICE ACTIVITIES—1941

Planimetric maps were compiled from air photographs taken with the bureau's 9-lens camera in the vicinity of Easton Bay, Choptank River, and the adjacent tributaries of the Chesapeake Bay, and also of the west coast of Florida from Apalachicola Bay to Tarpon Springs. The field and office operations necessary for the production of these maps were done in Baltimore, Md., and Tampa, Fla.

On December 7 the Japanese attacked Pearl Harbor. This of course, would profoundly change the course of thinking on C&GS mapping programs.

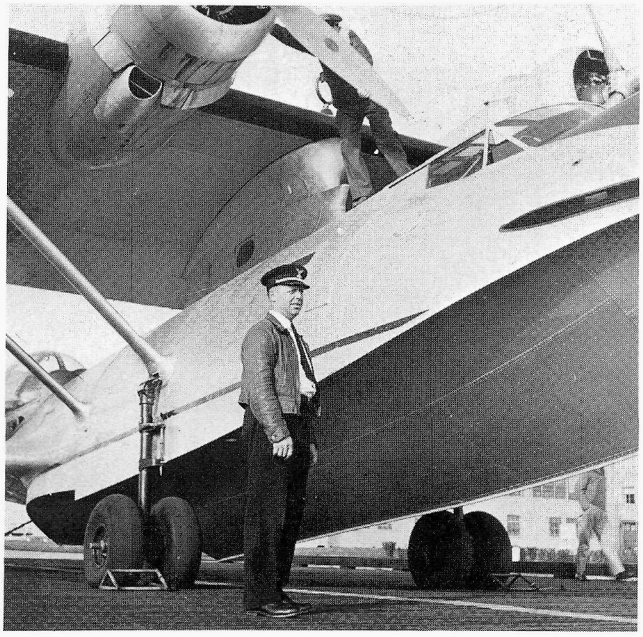


FIGURE 81.—Lt. Hubert A. Paton standing in front of V–189 after aircraft was hauled out of the water to have the hull painted. (Photograph courtesy of Capt. H. A. Paton.)

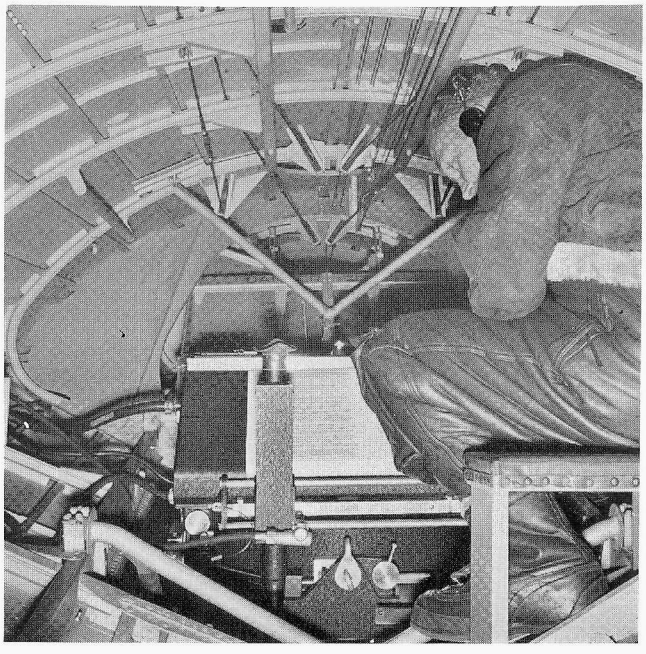


FIGURE 82.—Photographer Ray Elliott operating the 9-lens camera in V–189. (Photograph courtesy of Capt. H. A. Paton.)

1942

FLIGHT ACTIVITIES—1942

Deck Officer Joseph A. Sosbee (fig. 83) reported the following: "After some delay, because of aircraft overhaul and receiving flight releases from the district Coast Guard in San Francisco, the Alaska Aerial Photo Party of the U. S. Coast & Geodetic Survey, in cooperation with the U. S. Coast Guard, left San Francisco on the morning of June 28 for extension of aerial photography in Alaska (on aircraft V–189) (fig. 84)."

Much time was spent in the office of the commander of the Northwest Sea Frontier (Seattle, Wash.) attempting to secure proper Alaska clearances, which were finally received only as far as Sitka. The Army Engineers had previously contacted Comdr. Sobieralski in relation to photography in the areas of Yakutat and Annette Islands, and plans were made to fulfill their request. The aircraft departed July 1 for Sitka, Alaska, and operated from the Sitka base. Because only 12 rolls of film had been supplied the mission, and these were used by August 3, the mission returned to Seattle. The mission moved to San Francisco and overhauled the camera as "some delay in operational progress was due to malfunction of the camera equipment. This trouble was eliminated in the San Francisco overhaul. The only aircraft trouble was one forced landing because of a gas leak in the right engine, but no damage resulted to the aircraft or camera." The aircraft was overhauled in San Diego, Calif. Flight clearances to the western part of Alaska were obtained, and the mission departed from San Francisco for Seattle, Wash. on the morning of August 19, arriving in Kodiak, Alaska, on August 22. Comdr. Storrs of the headquarters of the Alaska sector was contacted for the clearances to the west. The aircraft based at Sand Point in the Shumagin Islands, and photographic operations were started on August 23. Photography was completed over Alaska, and the aircraft returned to Seattle on September 17. On September 18, the aircraft returned to San Francisco. Deck Officer Sosbee said: "Much trouble resulted from many malfunctions of the camera equipment in southeast Alaska, but by the untiring work rendered by Mr. Ray B. Elliott in repairing the camera very little photographic time was lost, and the malfunctions were completely eliminated during the San Francisco overhaul, and the camera operated perfectly after that for the rest of the Alaskan season."

Sosbee reported: "It was my experience that eight hours of photography at -17°C at 14,000 feet was the maximum exposure that the average person on the plane could undergo because of the cold and long period of time on oxygen. High altitude photography in Alaska, as was outlined in this season's expeditions over the center of the peninsula, would run into

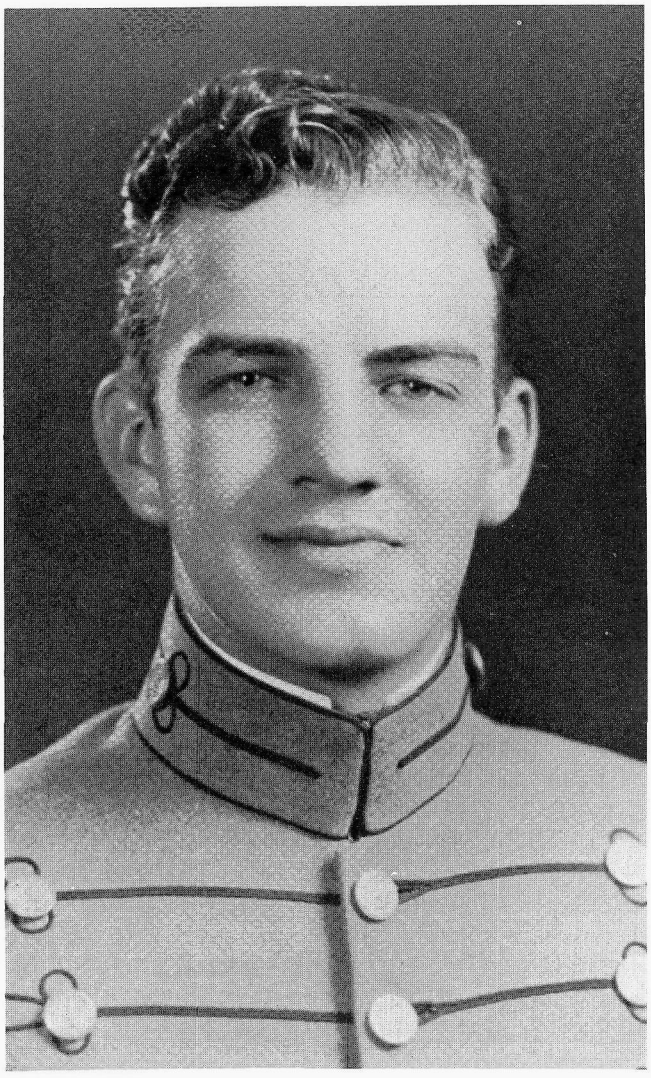


FIGURE 83.—Deck Officer Joseph A. Sosbe joined the Coast and Geodetic Survey in July 1941. (Official NOS photograph.)



FIGURE 84.—Crew of aircraft V–189. Joseph A. Sosbee standing on left, rest of the crew is unidentified. (Official NOS photograph.)

operating temperatures of around -30°C. Long periods of operation could not be undergone at these altitudes unless the aircraft was equipped with a heated cabin or heated suits be provided. The camera operating compartment in the PBY–5 aircraft cannot be heated. Some inconvenience has been experienced at times from the use of strictly a sea plane which could be corrected by the use of an amphibian type such as a PBY–5A. At times, the burdensome beaching gear which must be carried and the base facilities for such planes are uncertain and also being confined to water landings is sometimes very inconvenient; however, this did not hinder the photographic operations appreciably in Alaska."

Sosbee pointed out that cloud conditions were a problem, and that they had a very small amount of film on board and were reluctant to take a chance on wasting it. However, with a good supply of film, "the cost of which is relatively small, we could take whatever photography was possible, and if the area seemed more favorable later on, could then strive for better coverage." He went on to say: "Sand Point in the Shumigan Islands proved an excellent base for photographic operations along the south side of the Alaskan peninsula. However, Sand Point is probably closed at times when there is photographic weather on the north side of the peninsula, and the seaplane is unable to get off the water."

In the Aleutian Islands, fog prevails along the Alaska peninsula, and Sosbee reports: ". . . the greatest during the month of July and August, however, during this time it is sometimes clearer on the north side of the peninsula." Sosbee continues with these recommendations: "A new 9-lens camera or another suitable type (camera) should be put in the process of construction for the purpose of replacing the present

camera in case of an accident and also to be used for extended operations.

"In Alaskan operations, all effort possible should be exerted in securing the shortest operating distance between the area to be photographed and the aircraft base. A sufficient supply of film should be available for the Alaskan operations and operations to the west of Kodiak should be carried out during the months of May, June, and September, with some work along the north side of the Alaskan peninsula during July and August. Operations in southeast Alaska should be carried out during June, July and August."

The aircraft arrived in San Francisco on September 18, having completed the Alaska season. The aircraft then moved to the East Coast and did 9-lens photography along the East Coast and Florida areas (fig. 85).



FIGURE 85.—9-lens photograph of Pine Island, Fla. taken November 10, 1942. (Photograph by Ray B. Elliott.)

1943

FLIGHT ACTIVITIES—1943

V−189 (08055) started the season on January 2, continuing photography in the Continental United States (fig. 86), and left for Alaska on June 4. V−189 had based its operations at Adak, Alaska, and a great deal of photography was obtained in Alaska.

After photography on July 16, Lt. J. A. Sosbee reported: "The air conditions are calm but there is an overcast at 10,000 feet."

On the morning of July 18 the aircraft took off in what appears to have been a heavy fog, and crashed into the side of Mount Moffat. Sosbee and Ray Elliott were killed in the crash. Lt. Sosbee was buried at Adak (in 1948 he was reburied at Little Rock, Ark.). There is no information on where Elliott was buried. Little information is available about the crash of V−189. It appears some of the Coast Guard crew survived the accident, but no written record could be found, probably because the loss of an aircraft during wartime may have been classified.

Mrs. Sosbee said: "My husband had often talked of the hazards of flying in Alaska because of the williwaws" (the winds that come over the mountain peaks from different directions at the same time, some with the velocity of 80 to 100 miles per hour). (It is interesting to know that Lt. Sosbee was responsible for the flight pay that is paid to NOAA pilots. Flight pay was granted to C&GS officers in 1942 by the Congress, but the President did not sign the bill until after Lt. Sosbee's death.)



FIGURE 86.—U.S. Coast Guard PBY−5 (08055) V−189. (Photograph courtesy National Archives.)

Aircraft U. S. Coast Guard V −189 (PBY−5)

May 1941 to July 18, 1943

Personnel who served on board:

U. S. Coast Guard

Bowerman
E. S. Coakley (radioman)
Debord (mechanic)
Evers
Fryer
W. L. Hancock
CAP. August Kleisch (copilot)
McNeil (mechanic)
AMM W. P. Miller
CMM D. A. Moore
Moulton (radioman)
Lt. Comdr. G. O. Olsen (pilot)
Lt. W. J. Smith (pilot)
Lt. C. Vaughn (pilot)
Ward (radioman)

Coast and Geodetic Survey Officers

Lt. Hubert A. Paton
Lt. Comdr. Oliver S. Reading
Lt. Joseph A. Sosbee

Coast and Geodetic Survey Civilians

Ray B. Elliott
John D. Kay

After the crash, the 9-lens camera was returned to Washington and was being rebuilt by the end of the year (fig. 87). In November the Coast Guard supplied another aircraft, a Grumman twin-engine amphibian, Coast Guard designation JRF−5, No. 226 (figs. 88 and 89). A Fairchild F−51 single-lens aerial camrea was installed, and photography continued on the U. S. east coast for the rest of the year.

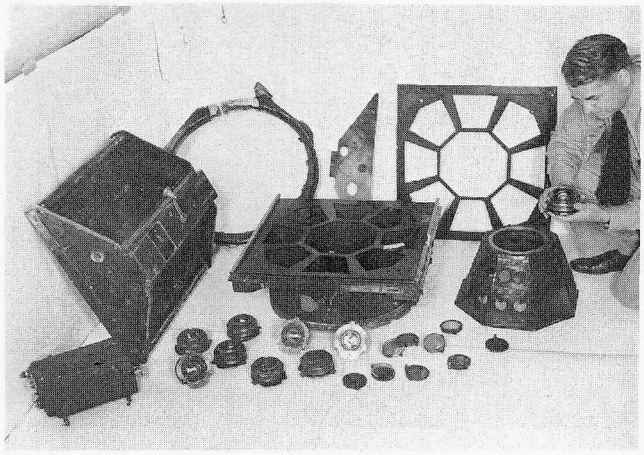


FIGURE 87.—Lt. Comdr. O. S. Reading inspecting the 9-lens camera after the crash of V−189 in Alaska. (Photograph by W. Byron Hale.)

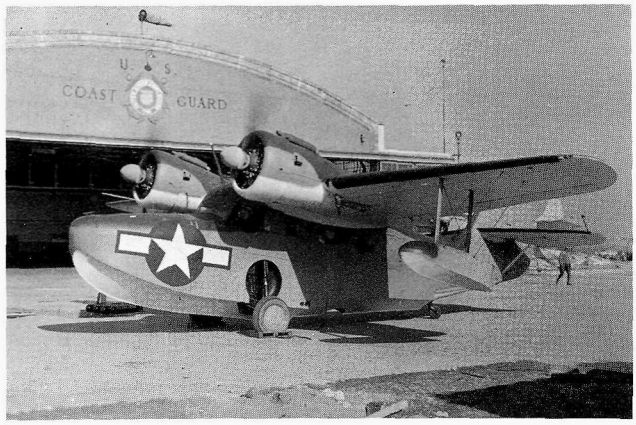


FIGURE 88.—Coast Guard aircraft JRF−5 No. 226. (Photograph by Arnold Friedlander.)

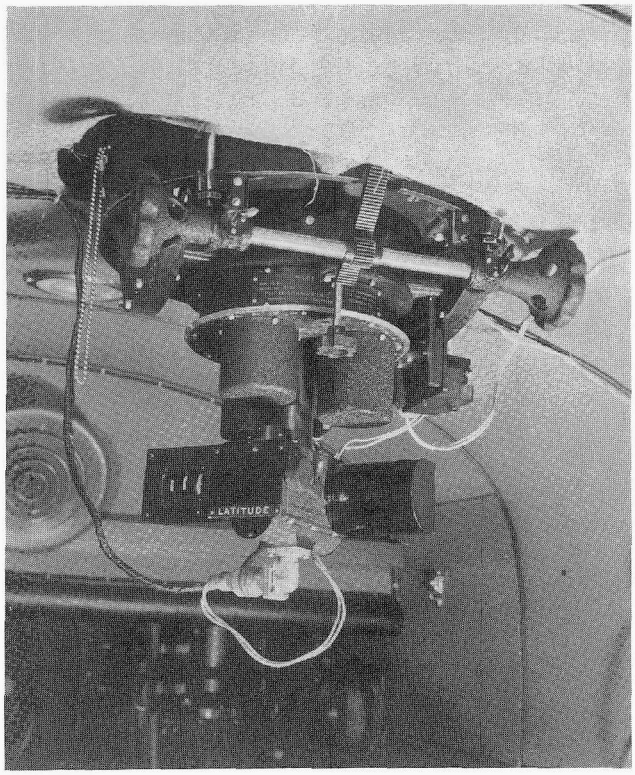


FIGURE 89.—Solar Pilot Direction Finder. (Photograph by Arnold Friedlander.)

1944

FLIGHT ACTIVITIES—1944

The flight mission was activated on May 1. The aircraft was Coast Guard 226 with Coast Guard Lt. (jg.) John A Webber, pilot, Lt. (jg.) Arnold Friedlander, C&GS, navigator, and W. Byron Hale, photographer.

Photography continued along the East Coast under the war emergency plans authorized by the Eastern Defense Command. Friedlander reported that the party operated from bases in Bar Harbor and Trenton, Maine; Salem and Beverly, Mass.; Brooklyn N. Y.; Washington, D. C.; and Elizabeth City, N. C. The aircraft was equipped with the Fairchild F−51 camera (C&GS designation camera "C") and the Fairchild K−17 camera (C&GS designation camera "D") (fig. 90). The K−17 and a K−20 were used for both vertical and oblique aerial photography. (fig. 91).

The cameras did not have intervalometers; therefore, the intervals between exposures were determined by a stopwatch. Friedlander said: ". . . a technique of precomputing course and camera intervals was developed. Camera and interval scales were designed and added to the computer. The technique increased the time spent in actual photography by reducing the time needed for dry runs, and with increased experience it has proved practical to eliminate most of the dry runs formerly required for each new photographic flight line heading." The Director, L. O. Colbert, issued the following instructions to the party: "Flight strips shall be flown in a straight course. Small changes of course on a flight must be made immediately after an exposure, so as to allow the maximum time for steadying the aircraft in flight, and for leveling the camera before the next exposure.

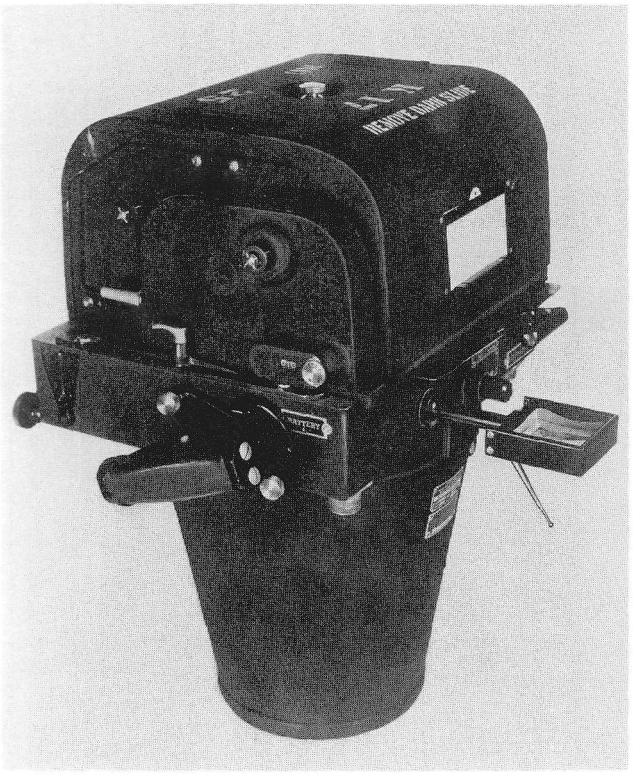


FIGURE 90.—Fairchild K−17 camera "D" with 12-inch lens. (Photograph courtesy Fairchild Camera Corporation.)



FIGURE 91.—W. Byron Hale using K−20 camera to photograph obliques from Aircraft 226. (Photograph by Arnold Friedlander.)

At the beginning of any flight strip, and on a 180-degree turn between flight strips, the airplane should be placed on its course at least one mile away from the first exposure, in order to permit time in steadying of the aircraft on a new course and for leveling the camera. This must be done for all changes in course greater than 20 degrees. Past experience has shown that almost invariably the first photography of a flight strip has been badly tilted through disregard of this requirement. In general, about three exposures should be made just before and just after the photography for mapping. . . . Film to be used for mapping shall not be spliced either before or after the processing. After each day's photography, at least one exposed negative shall be developed as a test to check the camera's operations. All negatives are to be developed as soon as practical after exposure. Experiments to determine the value of infrared film and filters for photographing submerged objects under strong light conditions shall also be made with the K−17 camera. Photographs shall be taken at the same scale from the same directions using panchromatic film with the minus blue filter for comparison. The developed film shall be forwarded to this office by Railway Express as soon as practical after processing and indexing. The inner wrapping of the film shall be marked SECRET and for the attention of Lt. Cmdr. O. S. Reading."

Friedlander reported the equipment for developing and processing film was transported from base to base in a Dodge 1-ton truck. This truck proved quite satisfactory and was large enough for the purpose.

Meanwhile, the photographic laboratory acquired its first single-lens printing equipment early in the year (figs. 92, 93, 94, 95, 96, 97 and 98).



FIGURE 92.—Morse Contact Printer in Room 1229, Department of Commerce. (Photograph by W. Byron Hale.)

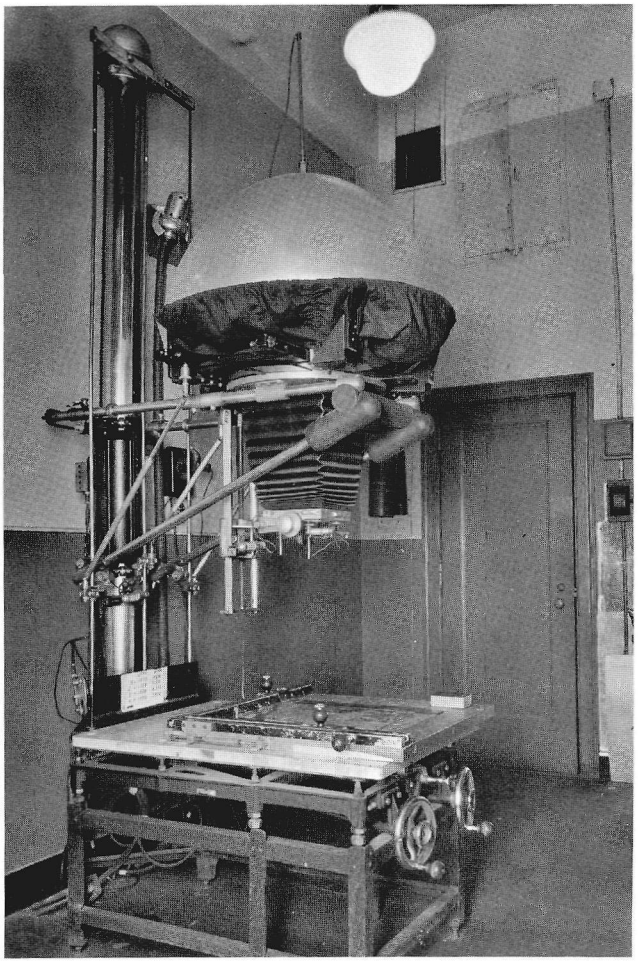


FIGURE 93.—Saltzman single-lens enlarger, installed in Room 1229, Department of Commerce. (Photograph by W. Byron Hale.)

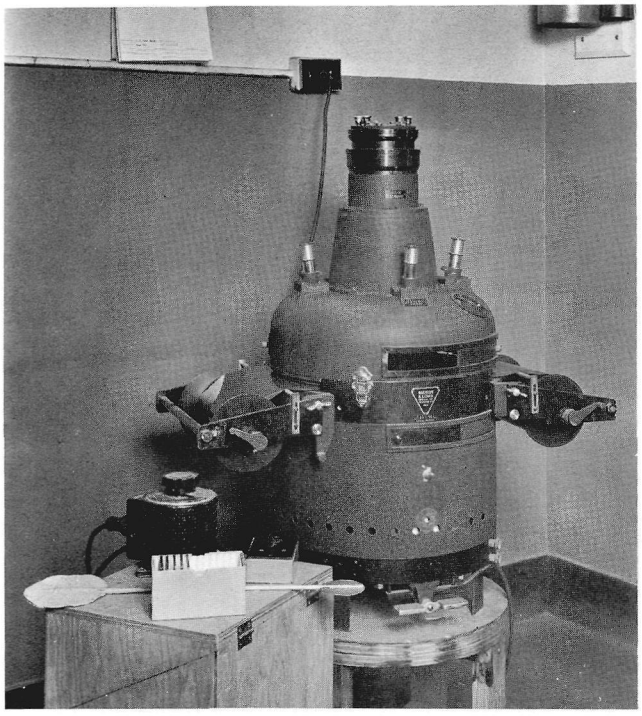


FIGURE 94.—Bausch and Lomb diapositive printer for making 2- by 2-inch multiplex glass plates from 9 by 9 aerial film, in Room 1229, Department of Commerce. (Photograph by W. Byron Hale.)



FIGURE 95.—Reynolds Ask alining single-lens film on Bausch and Lomb multiplex printer. (Photograph by W. Byron Hale.)



FIGURE 96.—Smith single lens-film wind and rewind processing unit. (Photograph by W. Byron Hale.)

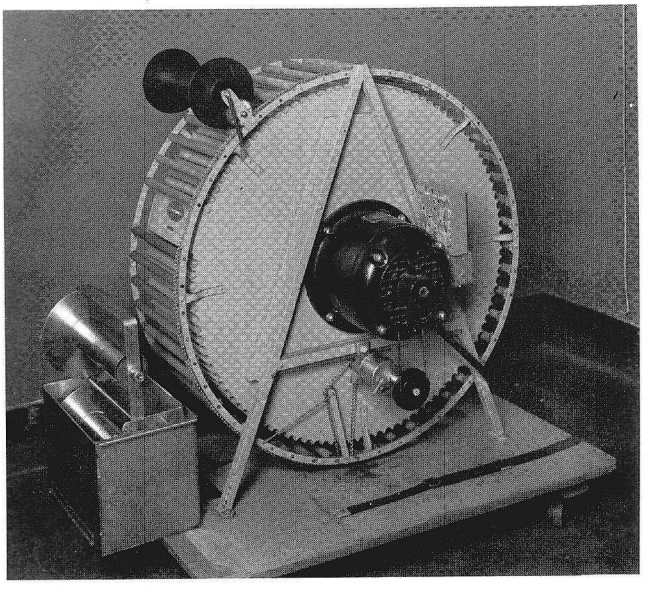


FIGURE 97.—Single-lens film dryer. (Photograph by W. Byron Hale.)

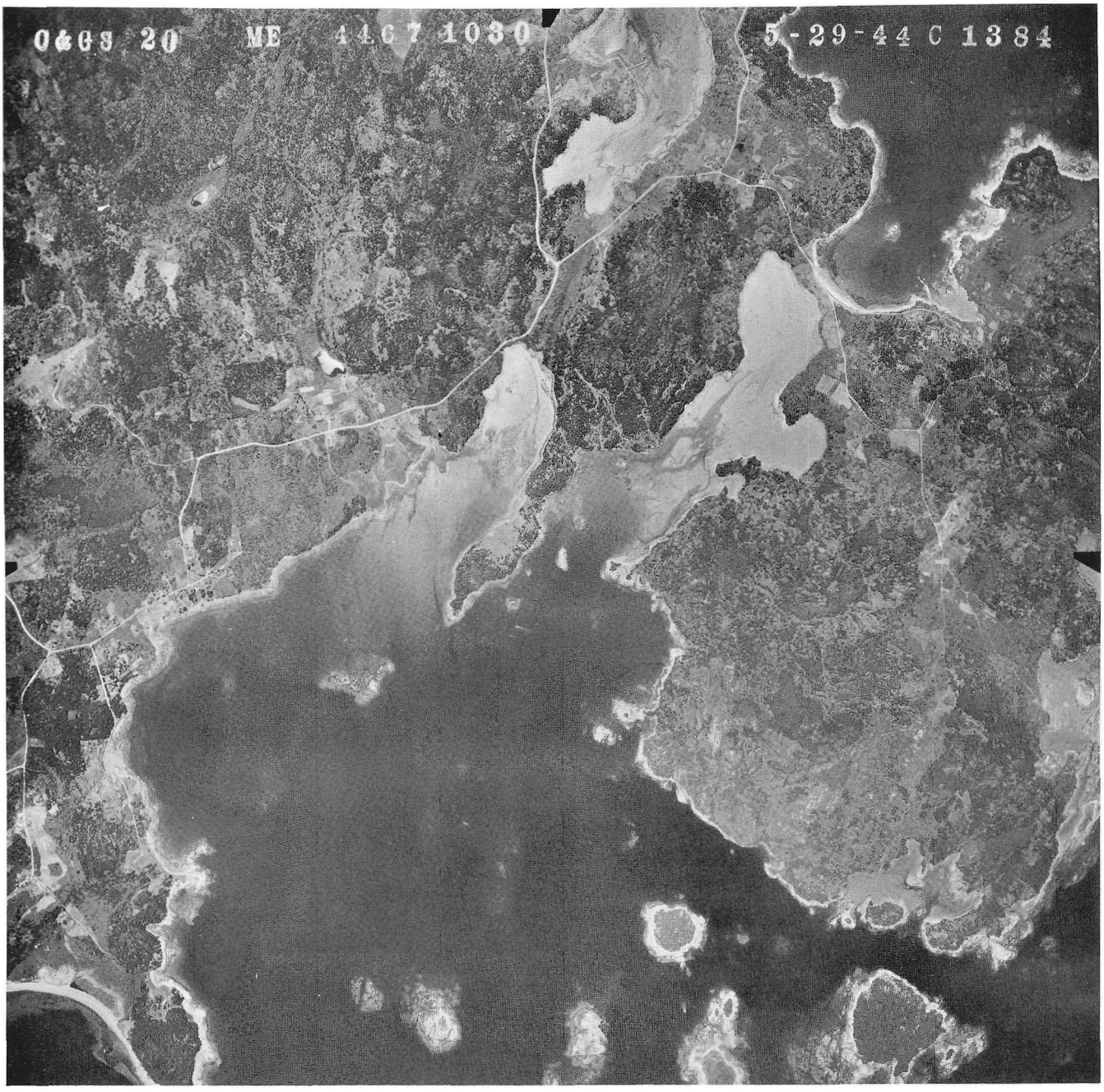


FIGURE 98.—Single-lens aerial photograph taken with C&GS camera "C". (Photograph by W. Byron Hale.)

1945

FLIGHT ACTIVITIES—1945

From January until June, the Coast Guard continued to operate 226 with C&GS personnel on board. Lt. (jg) Robert D. Singel, who had just completed flight training at the Naval Air Station, Dallas, Tex., was navigator, and W. Byron Hale, photographer. Photography continued along the U.S. east coast and the gulf coast of Louisiana. The entire Intracoastal Waterway was photographed, and tests were also made to determine if color or infrared film would be of any use in determining forest floor areas. (This is the first recorded test of color and infrared photography in C&GS.) Singel reported: "It was thought that the color film might pick up the brownish color of the forest floor in contrast to the green of the trees. Or that the infrared film might pick up the differentiation between the dead leaves on the ground and the live leaves still on the trees." In the vicinity of Key West and Miami, Fla., tests were also run with color, infrared, and Super XX black-and-white film to determine which was the most suitable for photography of the shoals and coral heads. The color film was used only with the filters recommended by the manufacturer. With all types of film and filter combinations, three runs were made over the same line, one with one-stop overexposure, one with one-stop underexposure,and one with correctly computed exposure.In the vicinity of Vero Beach, Jacksonville, and Key West, Fla., experiments were run to determine the greatest altitude from which buoys and channel markers could be photographed. Super XX film was used with a minus blue compensating filter and a number 25 red filter. It was found that channel markers and buoys could be distinguished satisfactorily on negatives taken at 2,500 feet with either filter, although the red filter seemed to have a slight advantage. "The shadow cast by the marker was very helpful in identifying it. And it is best to take the photographs 3-½ to 4 hours before or after local apparent noon. It is also very necessary to photograph while the water is still and smooth, as the markers are lost in the waves. It would also be advantageous to use the 9-lens camera or a trimetragon camera, as the main problem, with the exception of actually identifying the buoys, is the controlling of the pictures, and very little area is covered at such a low altitude; it is often impossible to include a land area in the pictures which can be used for control." For this photography the K−17 camera was used with the 12-inch cone. Singel also recommended that "a gunner's belt be provided for the photographer, for use while taking obliques." It is also noted that the photographer, W. Byron Hale, *had found that it was necessary to shim the 12-inch cone used with the infrared film*, the shim being 0.03 inches to allow for the difference in the lightwave lengths between white light and infrared rays.

Singel continued: "Equipment for this project was barely adequate due largely to the fact that such a great variety of photography was covered. Not only was the equipment inadequate but some of it was defective. Much of this is due to the fact that the navigational equipment is not owned by the Bureau, and thus, not maintained by us. It would be very advantageous to have a permanent photo set-up established so that a plane could be properly equipped and modified and a crew could be properly trained for all photography and flight work that is to be done by the Survey. It would be desirable to have several types of planes available. The camera failures held up the photography more than should be reasonably expected and all of the failures were on camera "C." Repair seemed impossible even after attempts were made at the Fairchild factory. The camera continued to malfunction and the same work was necessarily performed on three occasions. This is very uneconomical as well as hard on the morale of the personnel and it is believed that this camera is past due for surveying from the organization." While on actual photographic operations, it was found that the exposure meter readings were of little consequence, as much of the light received by the instrument came from haze, smoke, or clouds. For this reason it was necessary for the photographer to be able to set his exposures largely by experience and judgment. In June, this party closed down.

Aircraft U.S. Coast Guard
JRF−5, No. 226 (Grumman)

November 1943 to June 1945

Personnel who served on board:

Coast Guard Personnel
Airman First Class K. F. Anderson (mechanic)
Airman Third Class N. Sachwald (radioman)
Lt.(jg) John A. Webber

Coast and Geodetic Survey Officers
Lt.(jg) Arnold Friedlander
Lt.(jg) Robert D. Singel

Coast and Geodetic Survey Civilians
Ralph M. Berry
W. Byron Hale

FLIGHT ACTIVITIES PBY–5A—1945

By June the 9-lens camera had been rebuilt and calibrated and it was necessary to have a larger aircraft than 226 to carry the camera. The Coast Guard supplied a PBY–5A Catalina No. 08098 (figs. 99 through 109), and Lt.(jg.) Arnold Friedlander and W. Byron Hale were the C&GS personnel assigned aboard. The aircraft left Elizabeth City, N. C. for Alaska on August 28 (the war had ended with V–J Day on August 14) and based at Naknek and Annette Island



FIGURE 99.—U.S. Coast Guard PBY–5A, No. 08098, was manufactured by Consolidated Aircraft and was an amphibian with a wingspan of 104 feet, a length of 63 feet, a height of 20 feet; Its gross weight was 66,000 pounds, and its cruising speed was 170 miles per hour, with a range of 2,500 miles. (Photograph courtesy Willard A. Kuncis.)

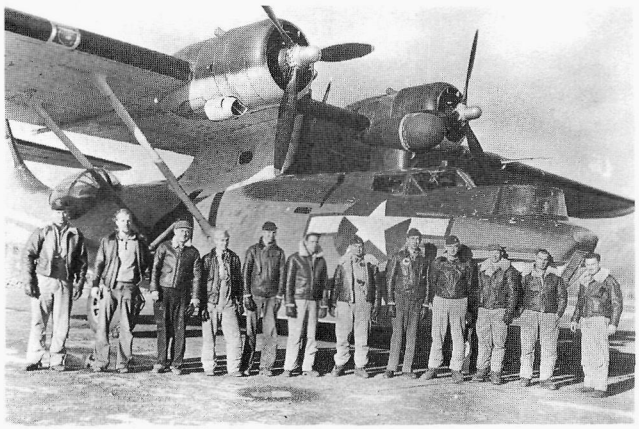


FIGURE 100.—Crew of PBY No. 08098, left to right (many of the crew members are unidentified) seventh from the left is Lt. (jg) Arnold Friedlander (USCGS), eighth is Lt. (jg) Bailey (USCG), at the far right is W. Byron Hale (USCGS). (Photograph from W. Byron Hale's collection.)



FIGURE 101.—Crew 08098 standing left to right, third is Lt. (jg) Bailey (USCG pilot of aircraft), fifth man Lt. (jg) Arnold Friedlander (USCGS), and kneeling fourth from left is W. Byron Hale (USCGS). (Photograph from W. Byron Hale's collection.)



FIGURE 102.—Lt. (jg) Arnold Friedlander (USCGS), and Lt. (jg) J. A. Bailey (USCG), aircraft pilot, reviewing photographic requirements for Coast and Geodetic Survey photography. (Photograph by W. Byron Hale.)

until October 16, when 08098 returned to Seattle, Wash. and based out of Portland, Oreg. On December 31 the mission was working out of San Diego, Calif. A great deal of photography had been accomplished during the season, and Lt. Friedlander made the following recommendations: "The present Catalina PBY–5A is a highly esteemed airplane. It is suitable for present operations with the 9-lens or single-lens camera at altitudes under 15,000 feet. It is slow and does not have a Honeywell autopilot. Operations were conducted with a Norden bomb sight, which has been satisfactory for areas where flight charts are accurate and up-to-date. For high altitudes and large area mapping programs, it is recommended that a B–17G stripped down be employed. The four-engine safety factor, 50% additional cruising speed, higher service ceiling and better placed camera stations make this a very desirable plane."

On November 8 Lt.(jg) Singel replaced Lt.(jg) Friedlander. Singel reported they flew the Portland, Oreg., project using the K–17 camera with a 12-inch cone at 17,000 feet, which is a little over the service ceiling of the airplane. The photography was all processed at the Portland Army airbase, and paper was borrowed from the U. S. Army Engineers in Portland to print the job. He also said that the time processing the film was considerably shortened by the fact that everyone, including both Coast Guard pilots and the entire crew, "turned to" in helping in the printing process. The film and prints were delivered to the Portland office.

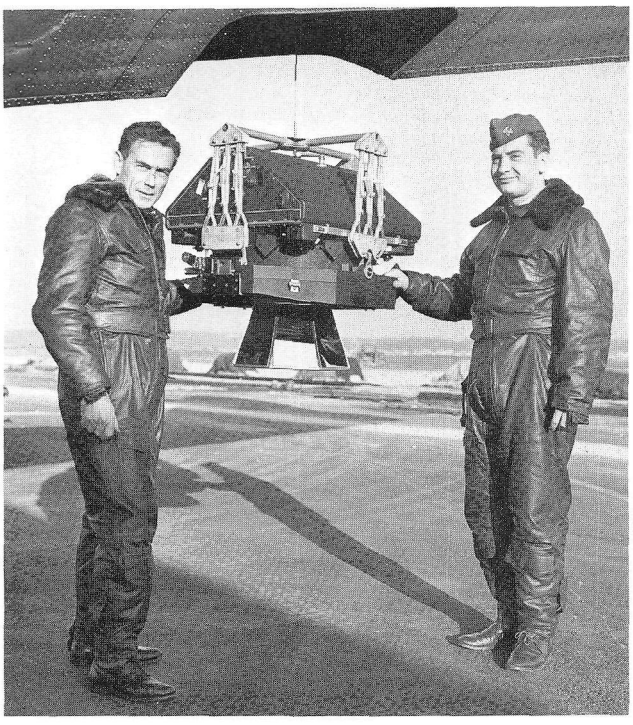


FIGURE 103.—W. Byron Hale, left, and Arnold Friedlander with 9-lens camera as it is being hoisted on PBY 08098. (Photograph by J. A. Bailey.)

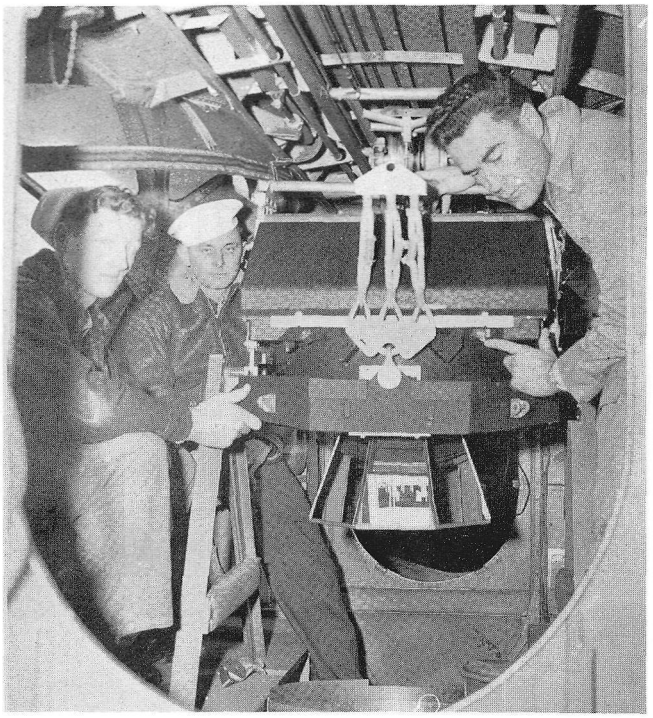


FIGURE 104.—Two unidentified Coast Guard crew members assisting W. Byron Hale on the right in moving 9-lens camera into tie-down position. (Photograph by J. A. Bailey.)

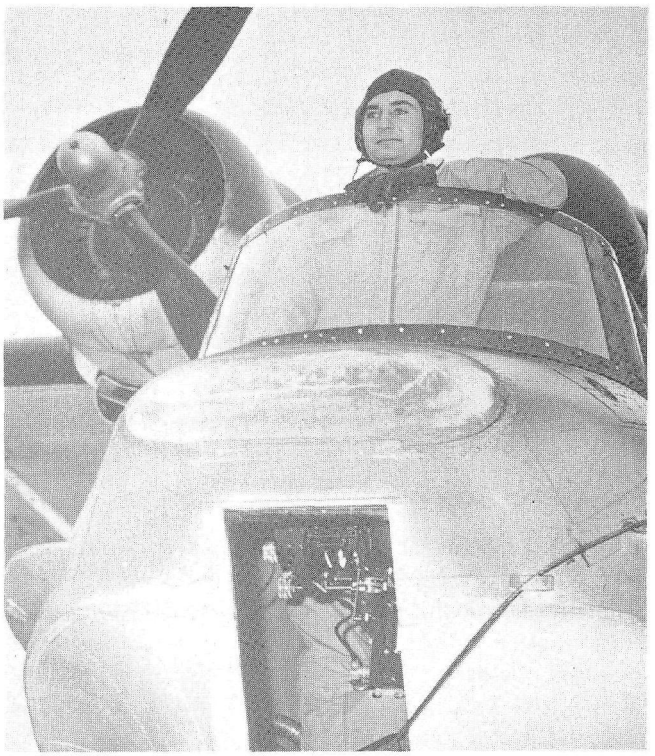


FIGURE 105.—Lt. (jg) Arnold Friedlander (USCGS) navigator, in nose of aircraft No. 08098. (Photograph by W. Byron Hale.)



FIGURE 106.—W. Byron Hale operating 9-lens camera in aft section, PBY 08098, at 10,000 feet over California. (Photograph by Arnold Friedlander.)

Division Activities—1945

In Washington, D. C., the Division of Photogrammetry was organized on October 1, and Comdr. K. T. Adams was appointed Chief. The new Division was a consolidation of the former Topographic Section of the Division of Coastal Surveys and the Photogrammetric Unit of the Nautical Charts Branch in the Division of Charts.

Adams reported that "The U. S. Coast Guard has obtained an SNB−1 airplane, a Beachcraft two-motored bombardier trainer, with a plexiglass nose. Arrangements are now being made to modify it for single-lens photography." If this aircraft became available, the Division of Photogrammetry could operate two airplanes with one dedicated to airport surveys. The Air Photographic Laboratory was now processing both 9-lens and single-lens photographs. A total of 476 9-lens negatives were processed this year.

In December Lt. Comdr. O. S. Reading went to Corpus Christi, Tex., to arrange for the modification of the U. S. Coast Guard SNB−1 airplane, No. 39812, for single-lens aerial photography. This included installing the camera hatch, Norden bombsight, and autopilot.



FIGURE 107.—Aerial view of snowcapped mountains in Alaska. (Photograph by W. Byron Hale.)



FIGURE 108.—PBY−5A just prior to touchdown on the water. (Photograph courtesy U.S. National Archives.)



FIGURE 109.—Photograph with the C&GS single-lens camera "D." (Photograph by W. Byron Hale.)

1946

FLIGHT ACTIVITIES—1946

The Coast Guard PBY−5A aircraft No. 08098 continued photography throughout the year (figs. 110 and 111). The aircraft was in San Diego on January 1 and left for Washington, D.C., on January 18, photographing airports enroute. Over Knoxville, Tenn., the left engine failed; the aircraft landed safely, but required an engine change (fig. 112). The 9-lens camera was returned to Washington, D.C., by truck on February 11, and the aircraft returned to Washington, D.C., on February 16. Lt. (jg) Arnold Friedlander and W. Byron Hale were C&GS personnel on board.

During March the aircraft remained in Washington, D.C. The 9-lens camera fiducials were realined using the new glass template to aline the marks (figs. 113, 114, 115, and 116).

On March 25 Lt. Loren G. Taylor completed naval flight training and was assigned to the aerial photographic mission for training and experience in navigating on photographic flights. The aircraft spent April operating in Miami, Fla. and photographing the U.S. east coast. In May Lt. (jg) Friedlander resigned from the Corps and Lt. Taylor became Chief of Mission (figs. 117 and 118).

The aircraft operated during the month out of Washington, D.C., and Brunswick, Maine and on June 25 departed Washington, D.C., for the West Coast. The aircraft continued photography on the West Coast, operating from San Francisco, Calif., and Seattle, Wash., in completing preparation for the Alaska season. On September 14, all required photography of the U.S. northwest had been completed and the plane left for Alaska, arriving at Naknek on September 20. By October 24 all photography in Alaska had been completed and the mission returned to Seattle on October 27. The mission left Seattle on November 1, photographing enroute to Washington, D.C., where it arrived on November 25. Aerial photography continued during December in the vicinity of Washington, and the mission was secured on December 16.

Arrangements were then made with the Coast Guard for the modification of a PB1G B−17 aircraft No. 77254, to be used for aerial photography, as the Coast Guard was going to scrap the PBY−5A 08098 because it would require an extensive overhaul. During this year the Coast Guard was reorganized, and it cancelled the arrangements for the use of the SNB−1 for single-lens aerial photography. The Coast Guard felt it could not support two aircraft being used for aerial photography by C&GS, but indicated the SNB−1 would be available at certain periods. The 9-lens camera operated perfectly with only a few minor breakdowns throughout the year. A total of 106 airports were photographed, and extensive coastal survey photography was performed over the East Coast, West Coast, and Alaska.

Aircraft U.S. Coast Guard 08098
PBY−5A Catalina

Personnel who served on board:

Coast Guard Officers

Lt. J. A. Bailey, pilot
Lt. Coffce, pilot
AP. F. Lander, copilot
Lt. H. C. Ledbetter
Ens. James W. Swanson, pilot

Coast and Geodetic Survey Officers

Lt. (jg) Arnold Friedlander
Lt. (jg) Robert D. Singel
Lt. Loren G. Taylor

Coast and Geodetic Survey Civilian

W. Byron Hale

DIVISION ACTIVITIES—1946

The air photographic laboratory continued operating two shifts to print 9-lens photographs.

On April 15 Reynolds Ask resigned as Chief of the Aerial Photographic Laboratory, and Granville T. Marts was named to replace him. The Chief of the Division of Photogrammetry, Comdr. K. T. Adams, summarized the functions of the Division:

"1. The production of photographic maps along the coast from the taking of photographs through all necessary field and office operations, including the review and smooth drafting of the maps, but not to include the reproductions.

"2. The production of planimetric maps produced to include all details of topographic maps except contours.

"3. The production of shoreline surveys are essentially planimetric maps limited to a narrow zone along



FIGURE 110.—U.S. Coast Guard pilots, Ledbetter, on the left, and Coffee, on the right, in the cockpit of PBY 08098.
(Photograph by W. Byron Hale.)

the coast or shore. They are made in areas where up-to-date topographic maps are already available, but where future hydrographic surveys are planned. Hydrography surveys require the shorelines and hydrographic signals along the shore at a larger scale than is provided by topographic maps. Shoreline surveys are registered as original surveys but copies are not printed for distribution.

"4. Airport Surveys which furnish the topographic base information for aeronautical instrument approach and landing charts. This activity includes the taking of aerial photographs of the airports and field surveys of the airport. The compilation and review of the field data, and the compilation of a topographic base which is turned over to the Aeronautical Chart Branch of the Division of Charts for use in making the approach and landing charts.

"5. Airport obstruction plans are produced for the principal airports in the U.S. at the request of the air carrier division of the Civil Aeronautics Administration. They show the position and the elevations of all obstructions protruding above a 40 to 1 glide angle within three miles of the end of all runways. These activities include the taking of the photographs, field surveys to identify the obstructions and to determine their elevations, the office compilation and checking of the field results, and the compilation and drafting of an obstruction plan which is then reproduced in the Division of Charts. These obstruction plans are primarily for the Civil Aeronautics Administration. Copies are available for distribution through the Distribution Branch of the Division of Charts.

"6. Miscellaneous field activities in which aerial photographs are used but do not fall within the above five categories."

The Photogrammetry Division had eight stereoscopic mapping instruments, four of which were in the Baltimore photogrammetric office.

The Washington office had one 9-lens plotter and one Bausch and Lomb multiplex, as well as two other



FIGURE 111.—U.S. Coast and Geodetic Survey photographer W. Byron Hale with 9-lens camera and roll of 9-lens film. (Photograph by Loren Taylor.)



FIGURE 112.—U.S. Coast Guard crew changing engine in Knoxville, Tenn. (Photograph by W. Byron Hale.)

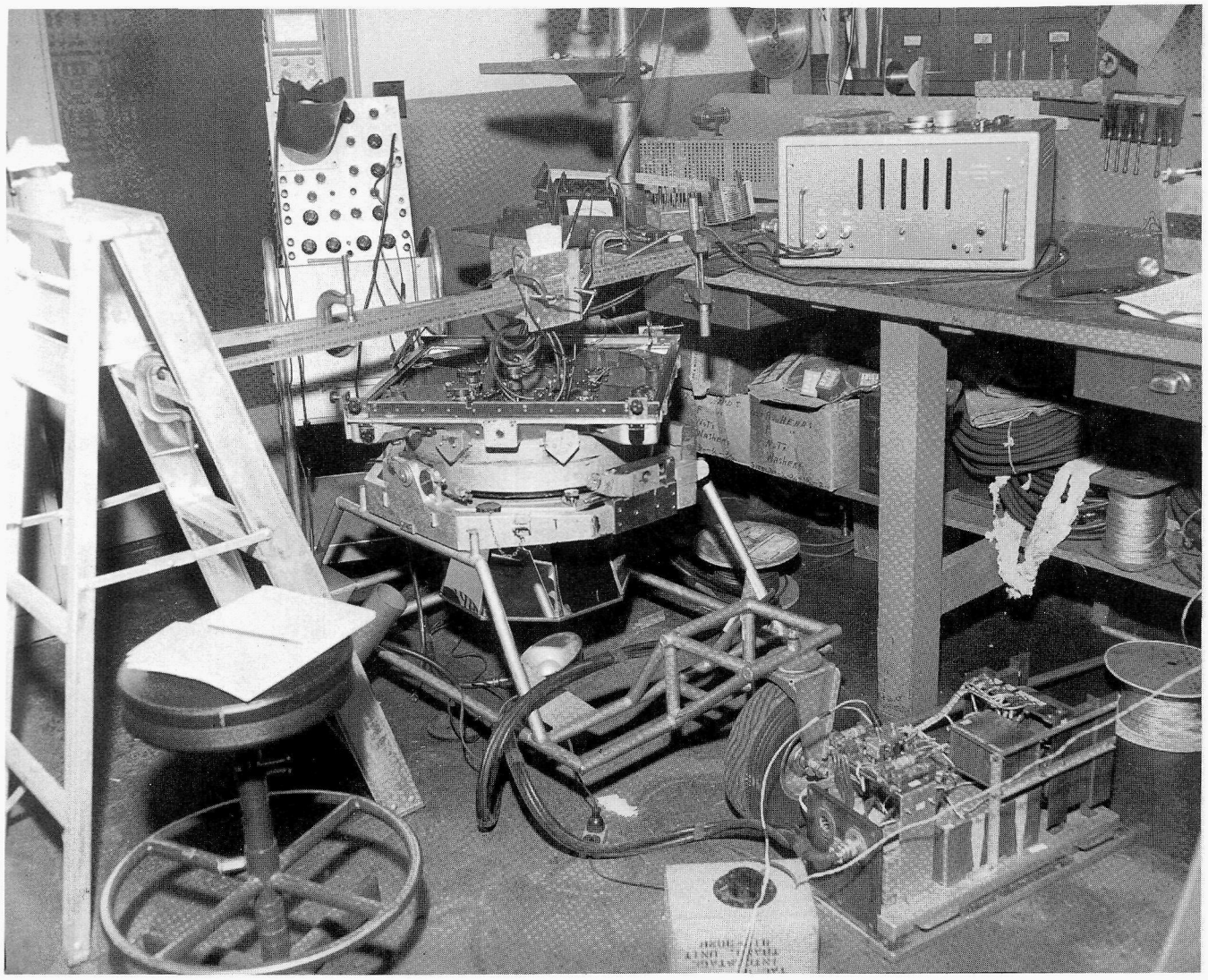


FIGURE 113.—9-lens camera fiducial alinement setup. (Photograph by John T. Smith, Jr.)

instruments. A second 9-lens plotter was being constructed at this time. The Division also received on a long-term loan a captured German Zeiss Stereoplanagraph. The instrument was delivered unassembled and without any instructions, and the instrument division was in the process of assembling it. They also received a captured German Zeiss 4-inch focal length aerial camera, but it was in such poor condition it could not be used without being rebuilt.

The 9-lens camera had been placed back in service after being rebuilt and had additional collimation marks incorporated, for a total of 45. This increased the accuracy of the transformed prints to be used with the stereoscopic mapping instruments (figures 119 thru 130). The Division also had the Fairchild F−51 single-lens camera that was purchased earlier, and the 12-inch K−17 camera that was purchased from the Navy Department.



FIGURE 114.—9-lens camera fiducial alinement. (Photograph by John T. Smith, Jr.)

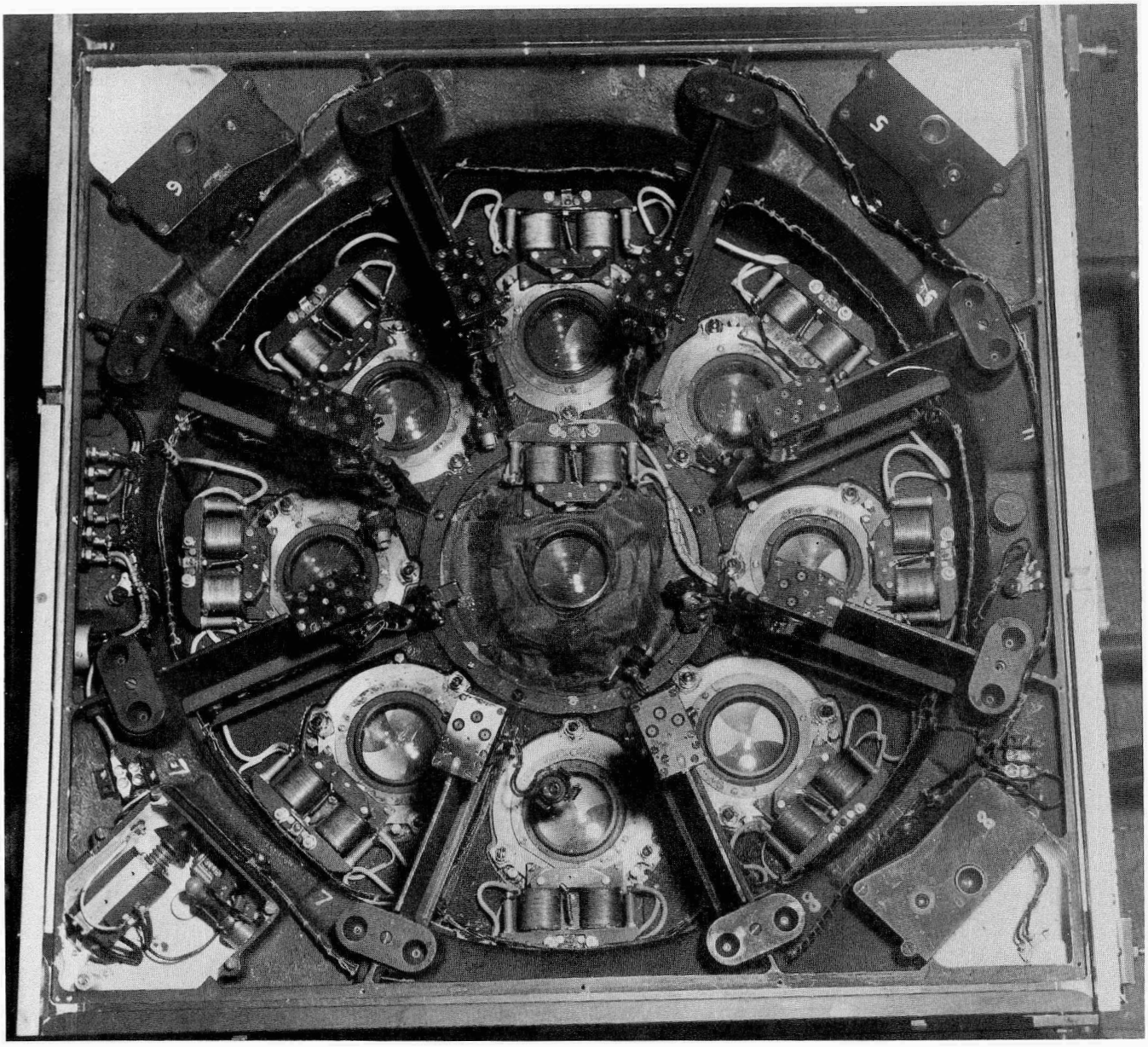


FIGURE 115.—View of inside of 9-lens camera showing the position of the 45 fiducial marks. (Photograph by W. Byron Hale.)

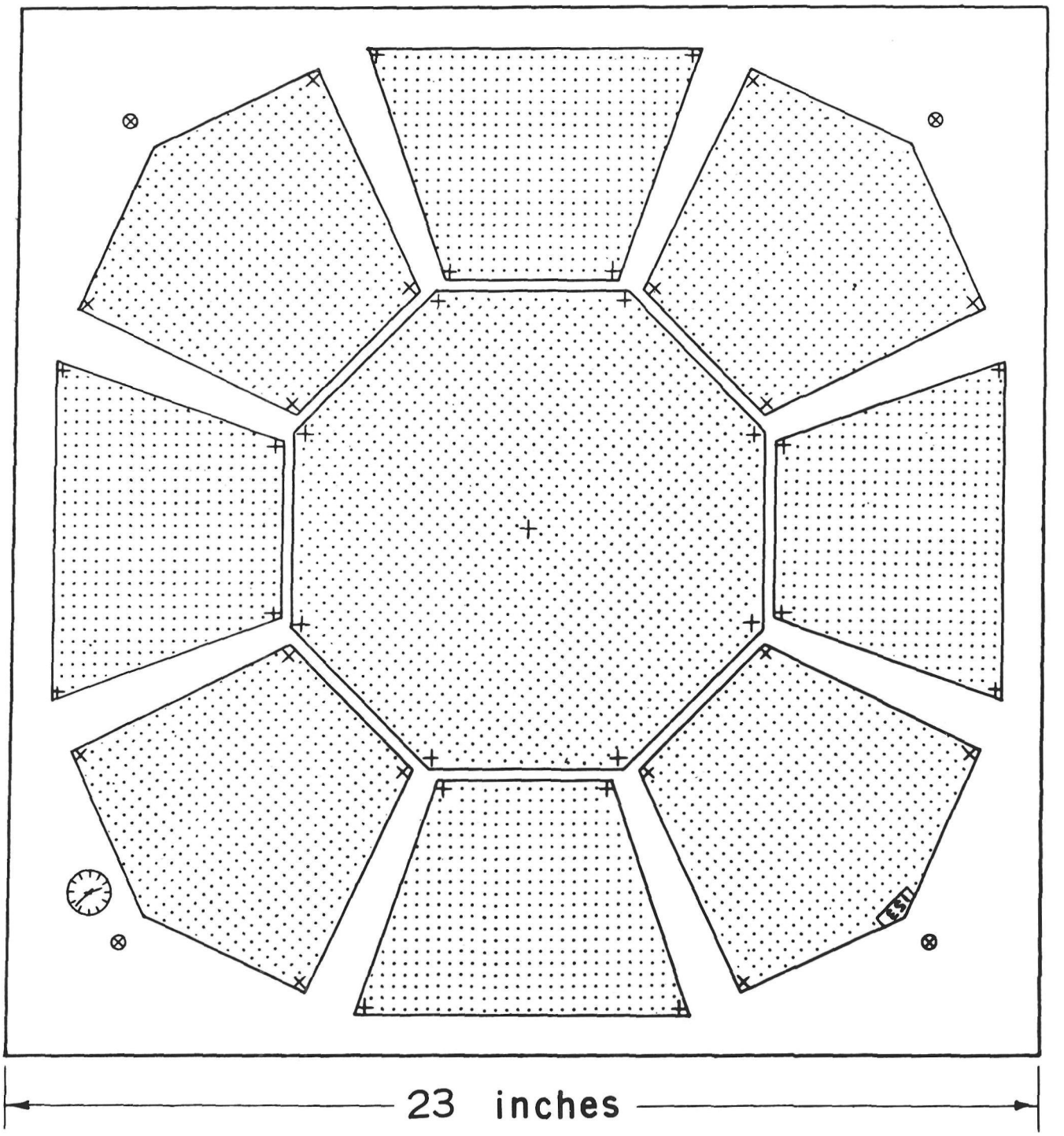


FIGURE 116.—Diagram of fiducial locations on 9-lens photography.



FIGURE 117.—U. S. Coast Guard pilot Ledbetter (left) and U. S. Coast and Geodetic Survey navigator Taylor discussing photographic requirements prior to a flight in PBY 08098. (Photograph by W. Byron Hale.)



FIGURE 118.—U.S. Coast and Geodetic Survey navigator Lt. Loren Taylor in navigator's position on PBY 08098. (Photograph by W. Byron Hale.)

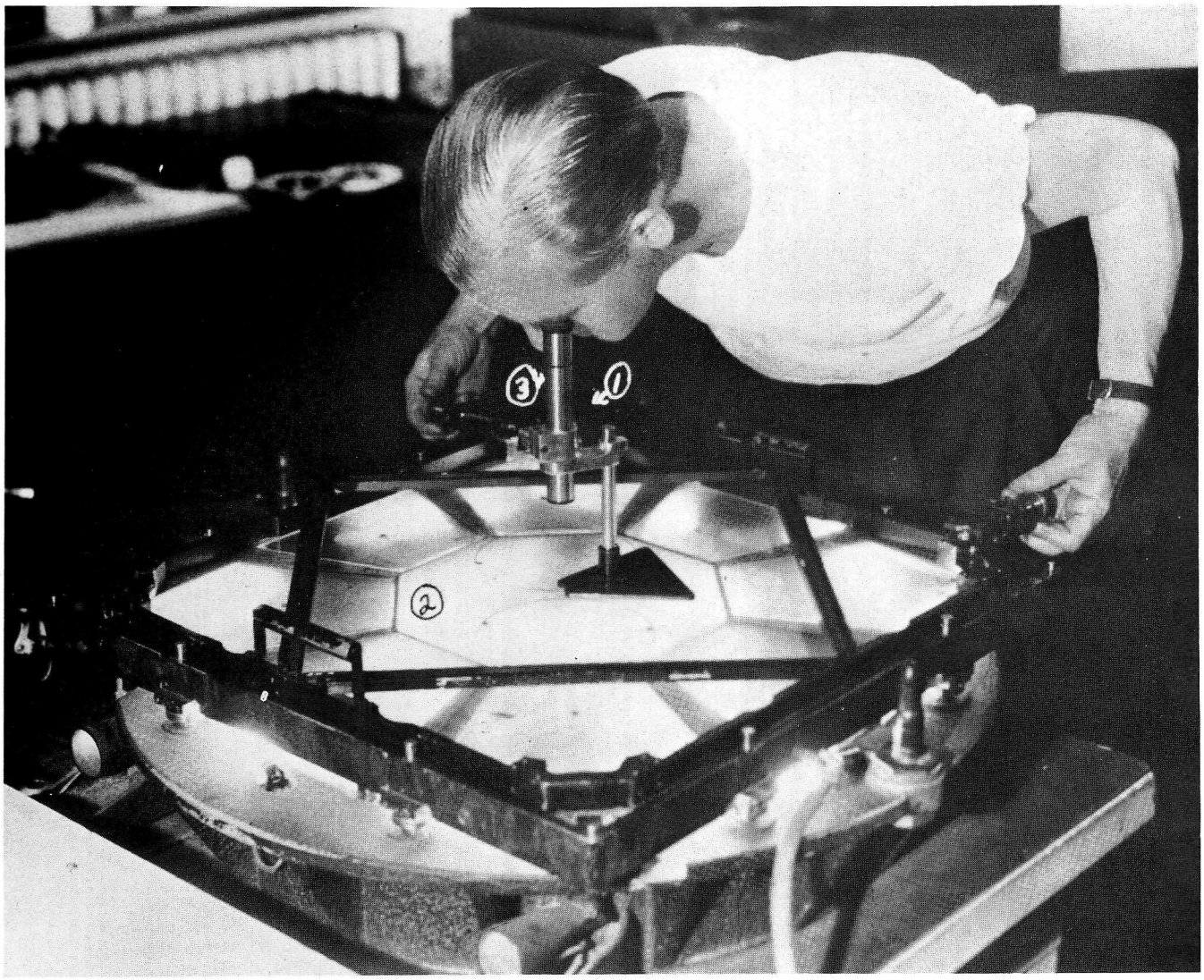


FIGURE 119.—Sigwart Kongslien aligning 9-lens negative carriage prior to placing film in position. (Photograph by John T. Smith, Jr.)



FIGURE 120.—Howard Murray placing top of 9-lens printing vacuum frame in position. (Photograph by John T. Smith, Jr.)



FIGURE 121.—Howard Murray aligning 9-lens negative. (Photograph by John T. Smith, Jr.)

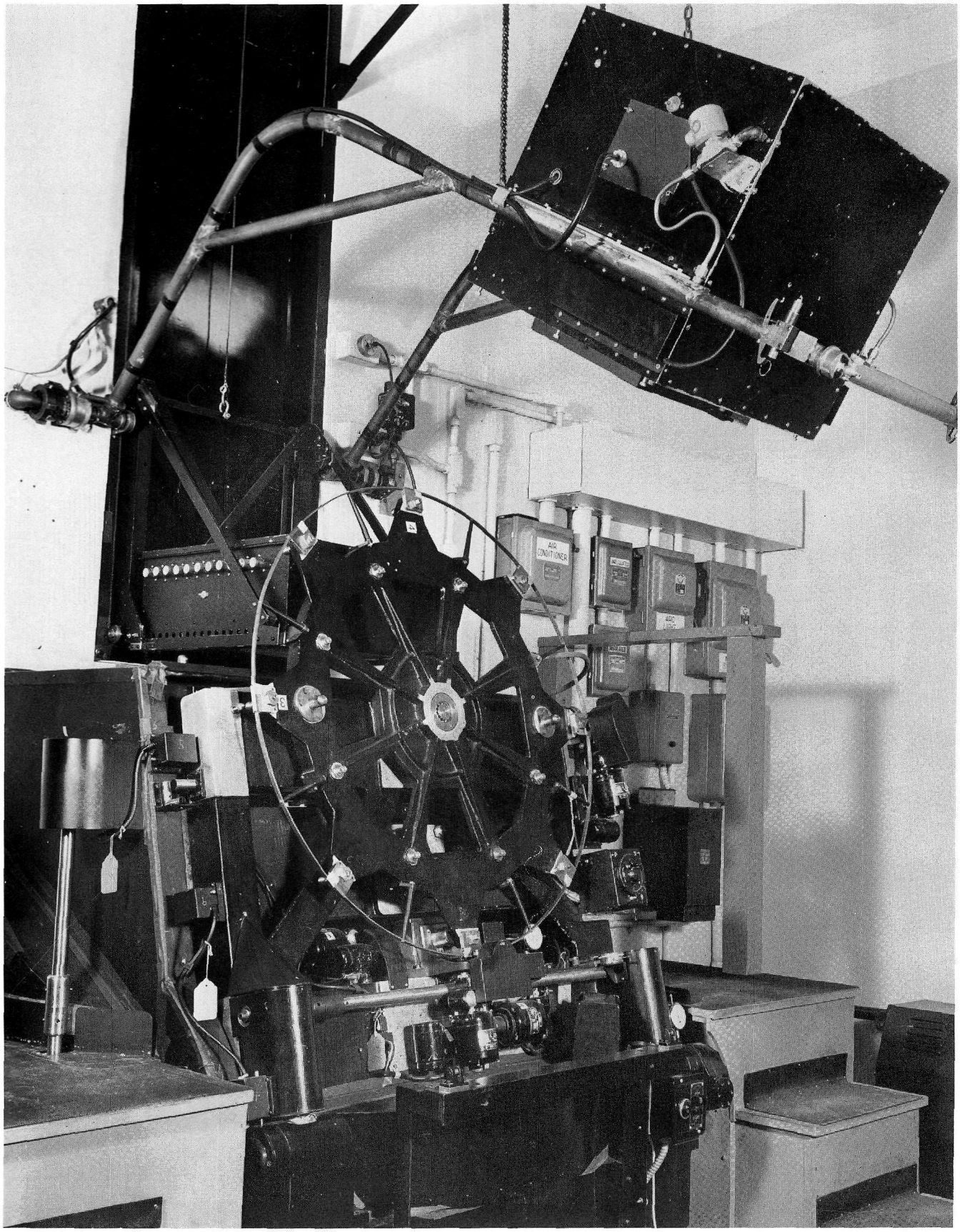


FIGURE 122.—9-lens tranforming printer showing light for printing wings chambers in raised position. (Photograph by John T. Smith, Jr.)

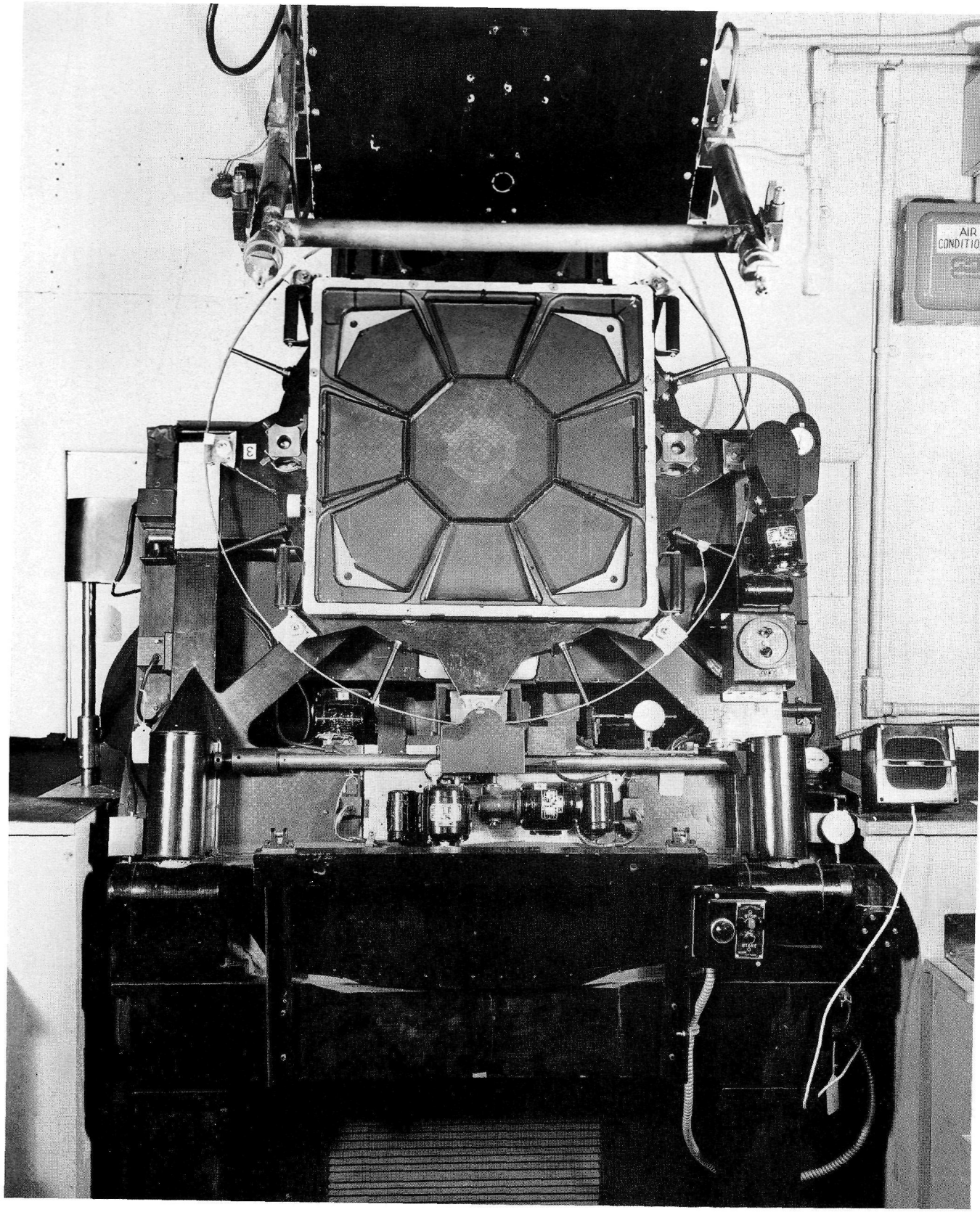


FIGURE 123.—9 lens transforming printer showing negative carrier in position for printing wing chamber. The negative carrier was synchronized to rotate with the printing table located inside the darkroom. (Photograph by *John T. Smith, Jr.*)

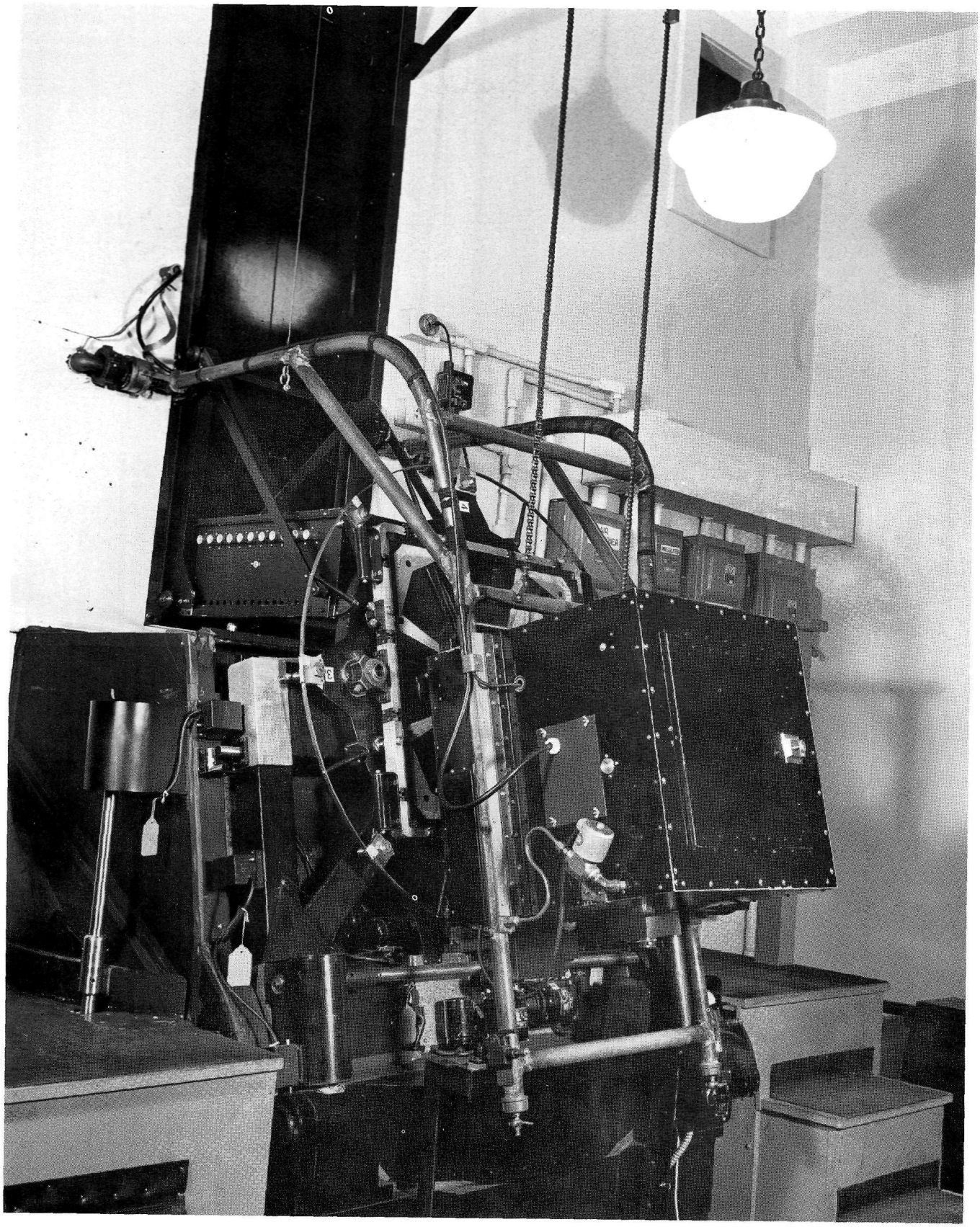


FIGURE 124.—9-lens transforming printer with wing light in printing position. (Photograph by John T. Smith, Jr.)

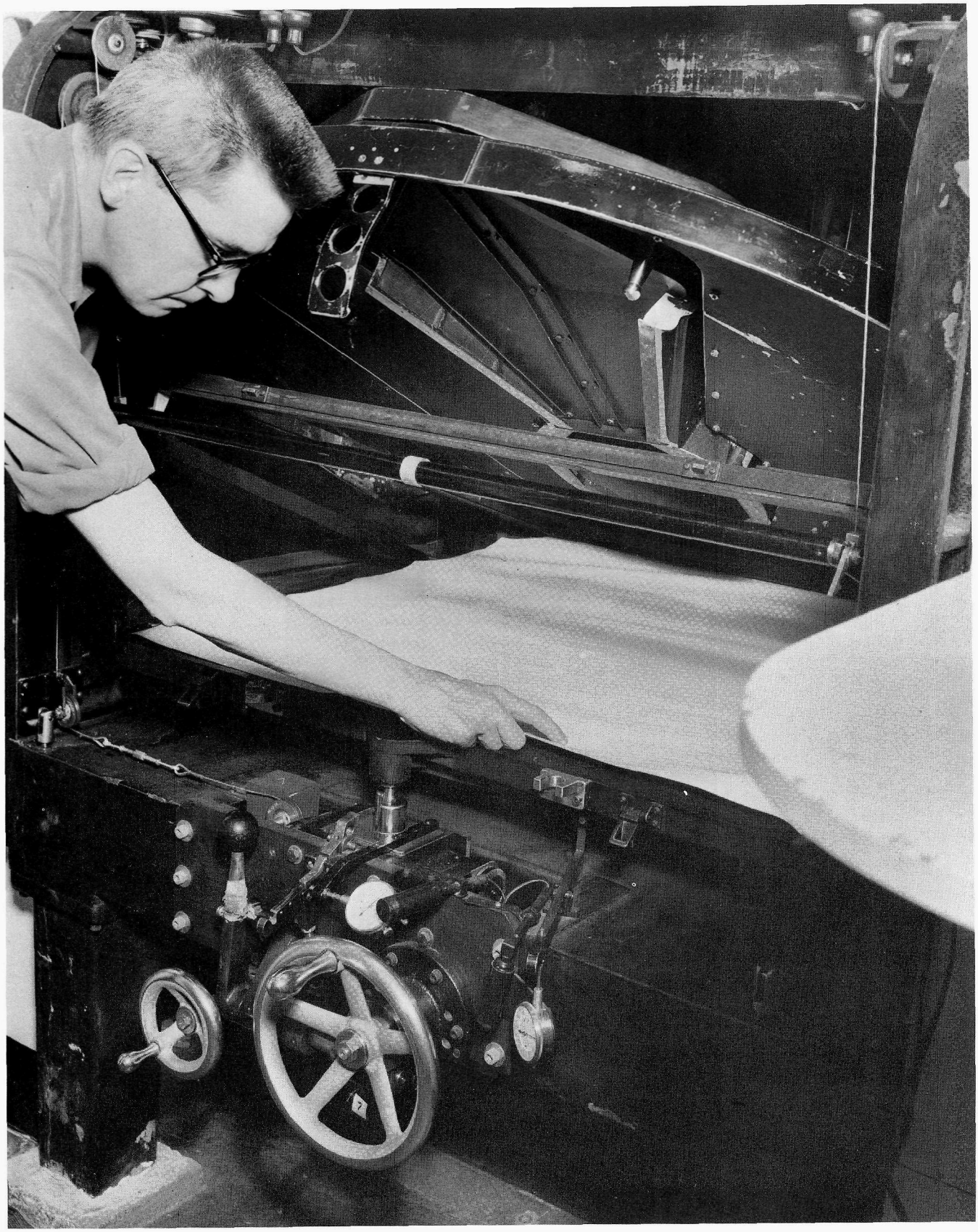


FIGURE 125.—Darkroom side of 9-lens transforming printer. Theodore Hanford placing printing paper on vacuum table. (Photograph by John T. Smith, Jr.)



FIGURE 126.—Theodore Hanford setting printer lens on 9-lens transforming printer to compensate for film shrinkage or expansion. (Photograph by John T. Smith, Jr.)

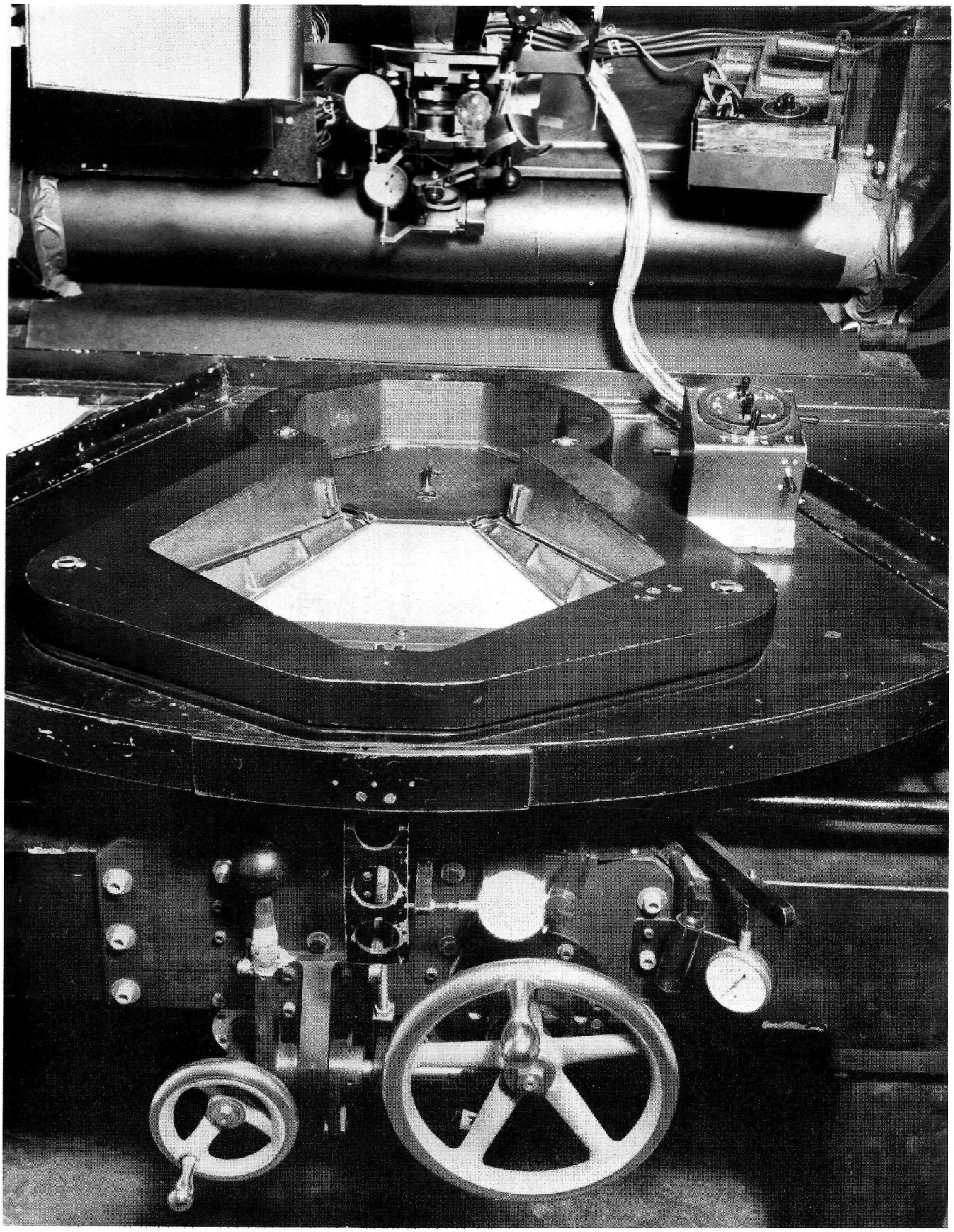


FIGURE 127.—Darkroom side of 9-lens transforming printer showing masking used to print one wing chamber; the side wing was printed, then the table was rotated to the next side chamber. After the four side chambers were printed, the four corner chambers and the center chamber were printed to form the composite 9-lens print. (Photograph by John T. Smith, Jr.)

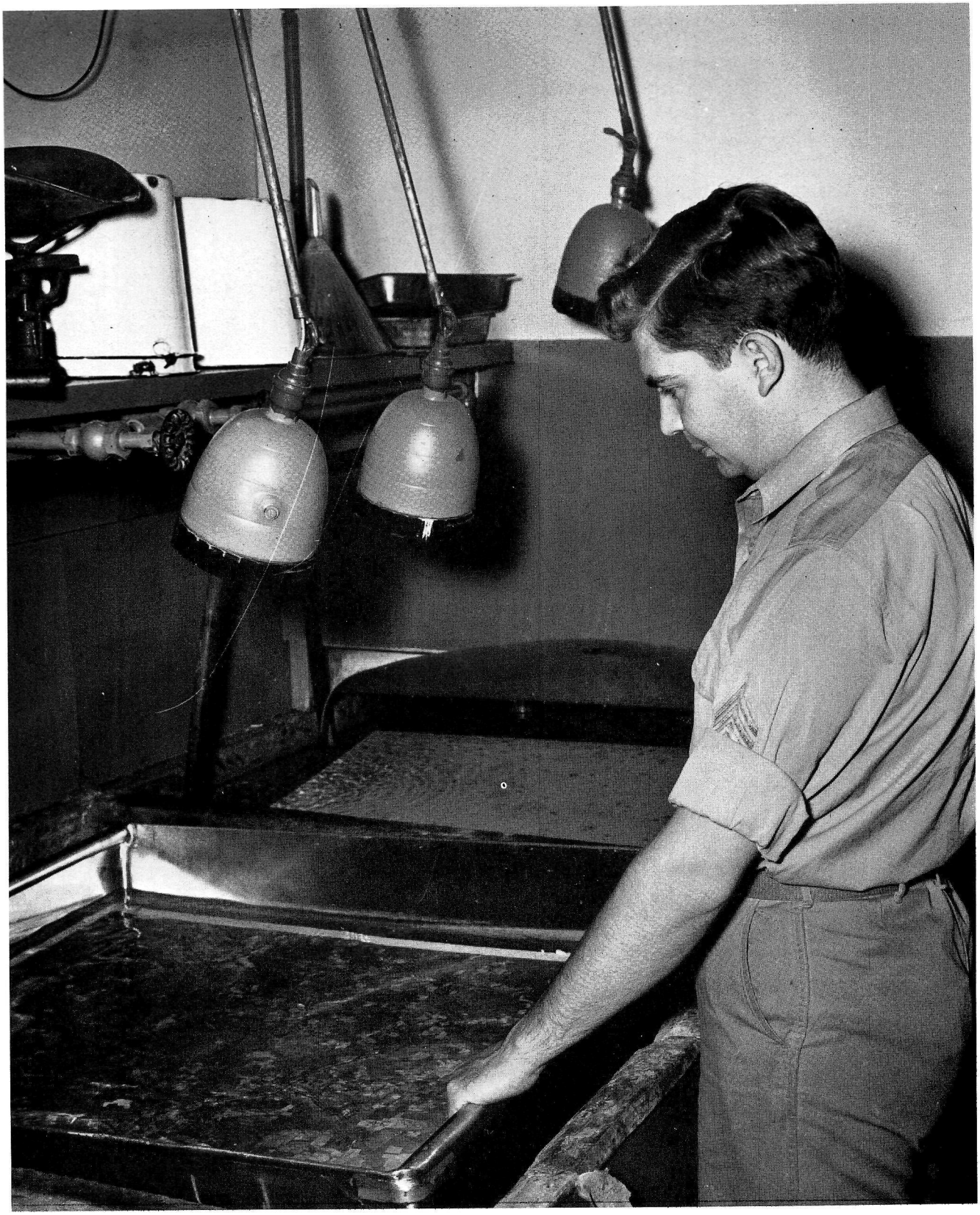


FIGURE 128.—William Duff processing 9-lens print by rocker tray system. (Photograph by John T. Smith, Jr.)



FIGURE 129.—Howard Murray using mirror stereoscope for checking contours. (Photograph by W. Byron Hale.)

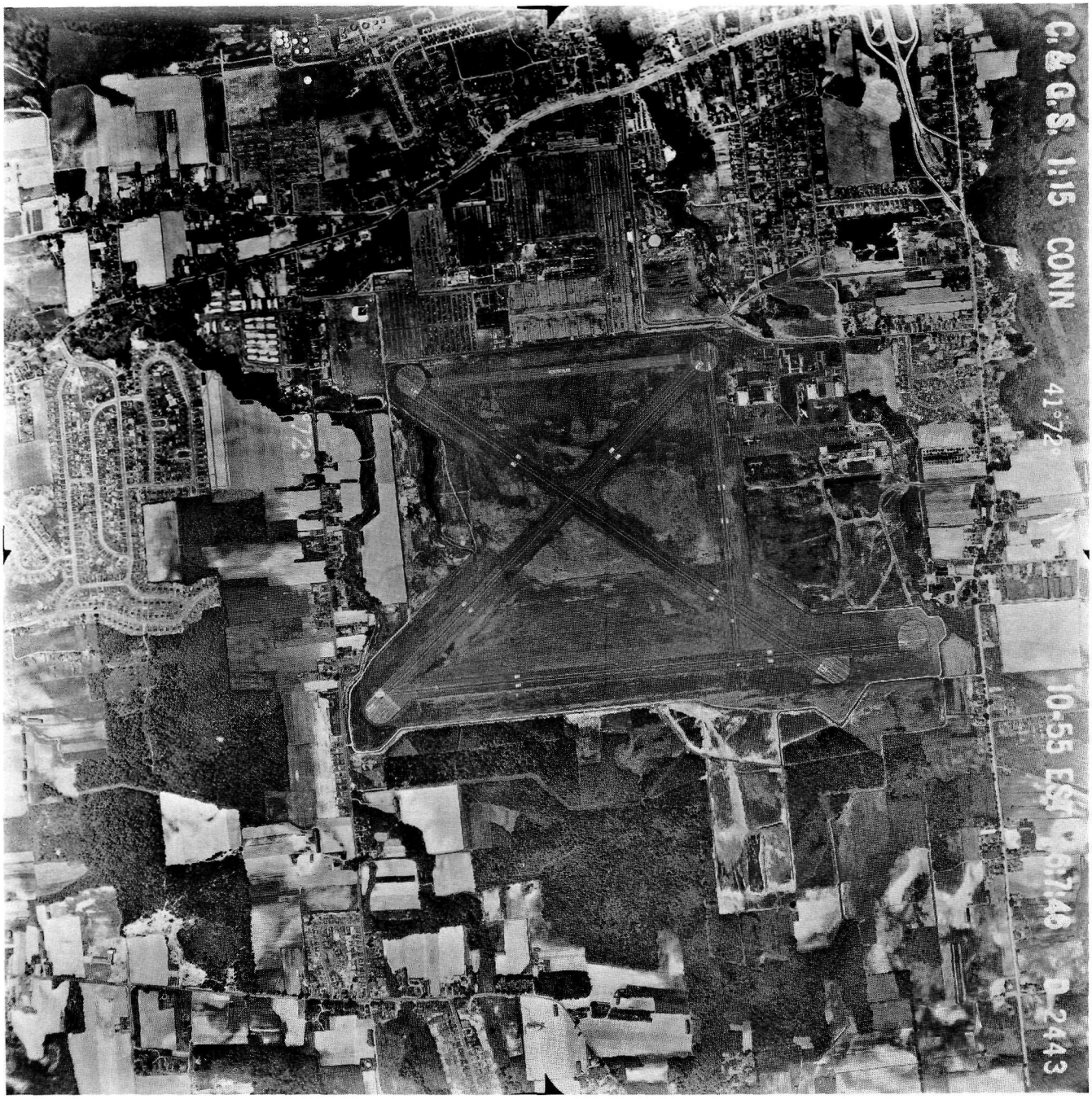


FIGURE 130.—Airport at East Hartford, Conn. C&GS single-lens camera "D." (Photograph by W. Byron Hale.)

1947

FLIGHT ACTIVITIES—1947

As an interim replacement aircraft between the beginning of the year and the time the B−17 (PB1G) was to be ready, the Coast Guard supplied a Beechcraft SNB−1, No. 39812 (fig. 131) for photographic duty, with Lt. (jg) Charles W. Lockwood, U.S. Coast Guard, as pilot; Lt. (jg) Robert D. Singel (fig. 132), copilot/navigator; and W. Byron Hale, who was later replaced by John T. Smith, Jr., as photographer. The cameras were installed at Elizabeth City, N.C., on February 17. The aircraft carried the Fairchild F−51 "C" camera and the K−17 "J" camera (fig. 133).

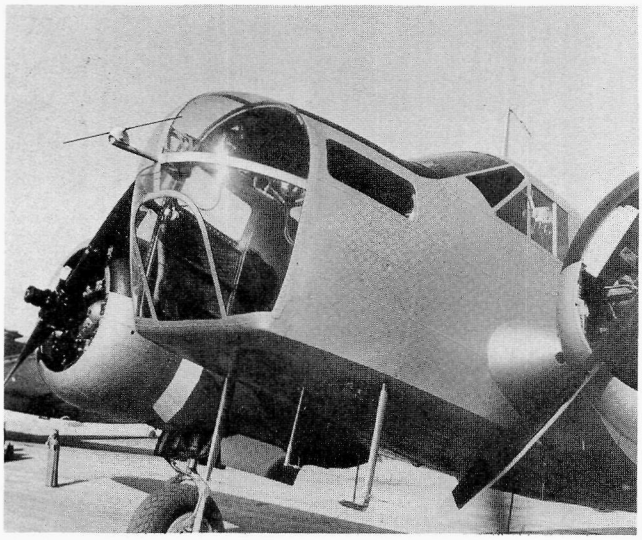


FIGURE 131.—U. S. Coast Guard SNB−1, No. 39812. (Photograph by W. Byron Hale.)

The aircraft was limited to carrying single-lens cameras and was used primarily for airport photography, although parts of the Intracoastal Waterway and the coast of New York were photographed for nautical chart surveys.

On June 30, SNB−1, No. 39812, was returned to the Coast Guard. During its working months, 99 airports had been photographed as well as three coastal mapping projects.

Aircraft U.S. Coast Guard SNB−1 39812

February 17, 1947 to June 30, 1947

Personnel who served on board:

Coast Guard Officer

Lt. (jg) Charles W. Lockwood

Coast and Geodetic Survey Officer

Lt. (jg) Robert D. Singel

Coast and Geodetic Survey Civilians

John T. Smith, Jr.

W. Byron Hale

The 9-lens camera calibration and alinement of the optics was completed on March 26. The Coast Guard aircraft B−17 PB1G 77254 arrived at Bolling Field in Washington, D.C., for camera installation (figs. 134 through 138). Now, for the first time, C&GS had use of an aircraft capable of both long-range and high-altitude flights. The crew of 77254 (figs. 139 and 140) included Coast Guard pilot Lt. (jg) Lloyd Franke and copilot Lt. (jg) Elmer Mathison; C&GS personnel consisted of Lt. Loren Taylor as navigator and W. Byron Hale, photographer. The aircraft was equipped with a plastic nose bubble in which the navigator sat and a Norden bombsight for navigation along flight lines (fig. 141).

The new single-lens 6-inch K−17 C&GS designation "J" camera was installed in the radio compartment, while the 9-lens camera was installed in the waist section. Test flights were completed and photography was undertaken in the vicinity of Washington, D.C. On April 19, while taxiing after landing, the brakes of the aircraft failed and the aircraft hit an American Airlines plane. This necessitated the replacement of the nose section, the No. 3 engine, and a wingtip (fig. 142). The start of the photographic season was delayed until June 17, when the aircraft left Washington, D.C., for Seattle, Wash., photographing enroute.

On June 26, 77254 left for Alaska. The aircraft worked throughout Alaska, basing in Anchorage, Adak, Nome, and Point Barrow (figs. 143, 144 and 145).

Early in September the aircraft returned to Seattle until September 11, when it returned to Nome. It then left Alaska on November 2, arriving in Seattle, Wash., the same day. The mission moved to Portland, Org. on November 11, and to San Francisco, Calif., on November 21.

On November 30 the mission departed San Francisco and moved to West Palm Beach, Fla., arriving on



FIGURE 132.—Lt.(jg.) Robert D. Singel. (Photograph by Edwin D. Hawbecker.)

December 3, continuing to photograph en route. The mission arrived in Washington, D.C., on December 15 and was secured for the season on December 19.

During the first season with 77254, 25 airports were photographed and 28,614 miles of coastal photography was obtained.

With the B−17 in Alaska and airport photography urgently needed in the United States, the Civil Aeronautics Administration (CAA) made an AT−6 aircraft, No. 194 (fig. 146), available for single-lens photography. The aircraft was equipped with the Fairchild F−51 "C" camera, and Lt. (jg) Robert D. Singel was pilot/navigator and Edwin D. Hawbecker photographer. The aircraft operated from September 18 through December 22, when it was returned to CAA. During this period, 40 airports were photographed, largely in the central part of the United States, and one coastal mapping project was completed. Since the aircraft could not carry the luggage and equipment required for the operation of the mission, a truck was driven by the photographer from base to base, and Lt. Singel reported: "Considerable time was lost due to the fact that it was necessary for the plane to wait for the truck each time the base was changed." This, of course, indicated that this type of aircraft was not suitable for long-range photographic missions.

Aircraft CAA NC−194 (AT−6)

September 1947 to December 1947
Personnel who served on board:

Coast and Geodetic Survey Officer
Lt. (jg) Robert D. Singel
Coast and Geodetic Survey Civilian
Edwin D. Hawbecker

DIVISION ACTIVITIES—1947

In December the camera calibration area in McClure, Ohio, was completed under the direction of Lt. Comdr. L. W. Swanson. All of the horizontal control stations were whitewashed so as to be visible on aerial photography, and all of the fourth-order levels had been completed. The Zeiss C−8 stereoplanigraph was placed into operation during the year (fig. 147).

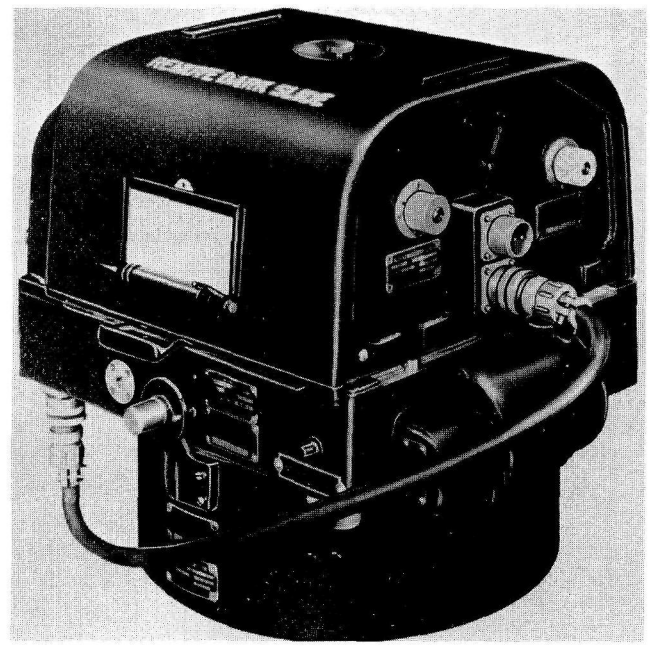


FIGURE 133.—Fairchild K−17 "J" camera with 6-inch lens. (Photograph courtesy Fairchild Camera Corporation.)



FIGURE 134.—PB1G 77254 Coast Guard aircraft used to fly the 9-lens camera which is shown under the nose of the aircraft. The aircraft had a plastic nose bubble in which the navigator sat using a Norden bombsight to navigate photographic flight lines. The B–17 was known as the Flying Fortress and had a wing span of 103 feet, a length of 74 feet, and a height of 19 feet. Gross weight was 55,400 pounds; cruising speed, 200 miles per hour; flight range, 2,500 miles; ceiling, over 30,000 feet. 77254 was flown at 30,000 feet on a number of occasions while doing high altitude photography. (Photograph by W. Byron Hale.)



FIGURE 135.—Lt. Loren Taylor and Coast Guard crew member steadying 9-lens camera while it is being hoisted in B–17. (Photograph by W. Byron Hale.)

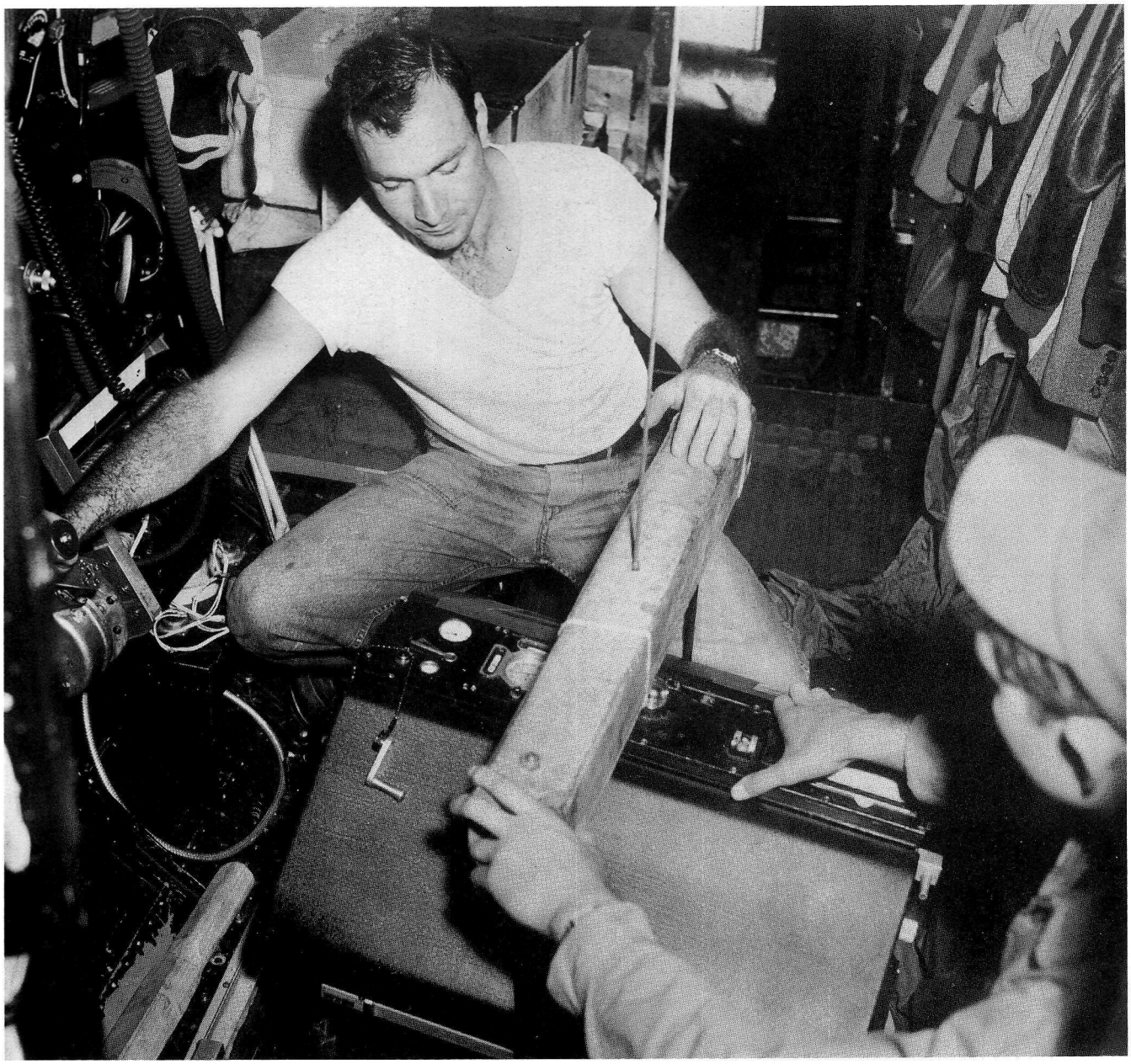


FIGURE 136.—Coast Guard crew members assisting in hoisting the 9-lens camera into B−17. (Photograph by W. Byron Hale.)

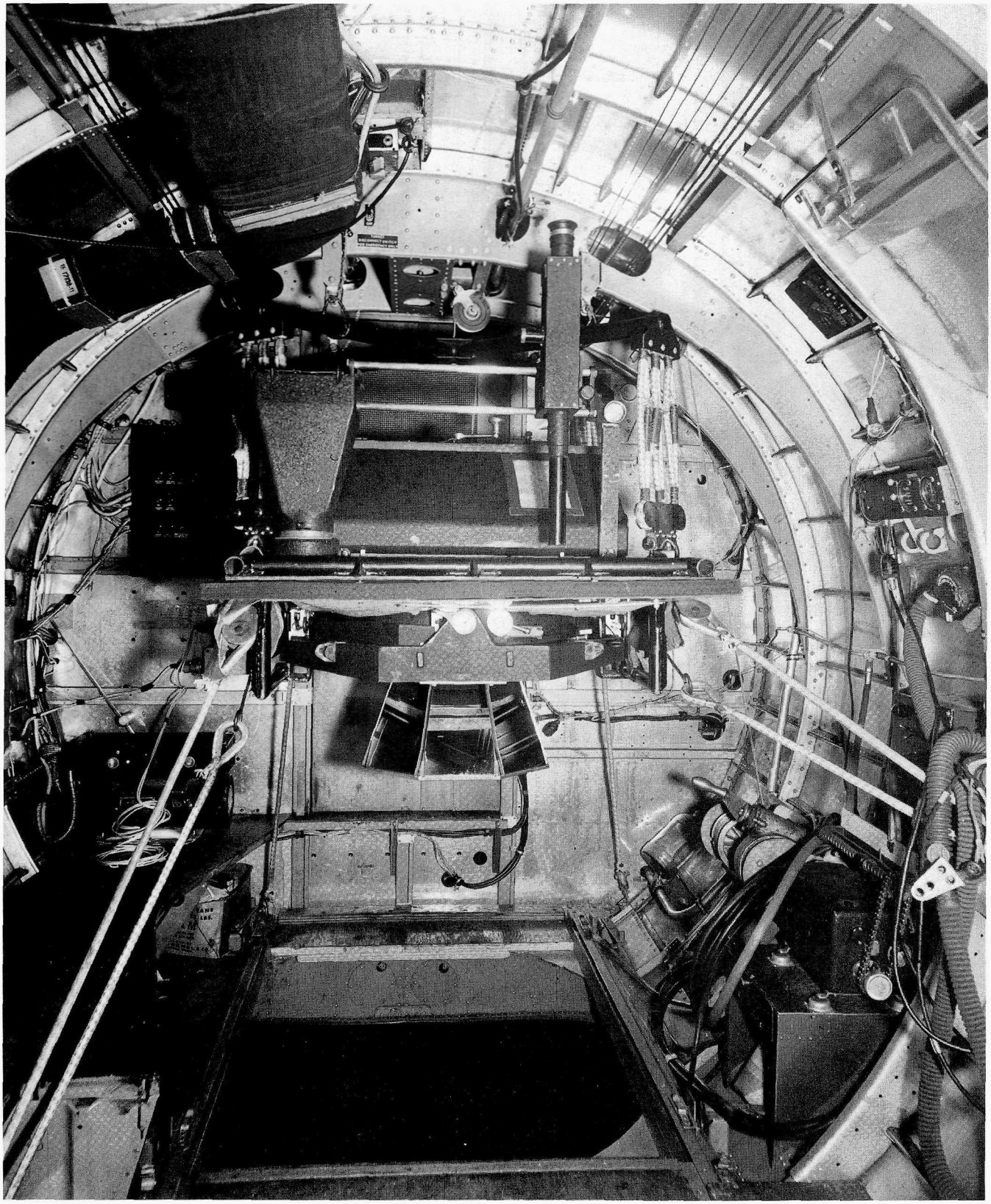


FIGURE 137.—9-lens camera in the tie-down position on B−17. The camera was lowered just prior to photography into the 2- by 4-foot open hatch below the camera by the handcrank on the right. (Photograph by W. Byron Hale.)

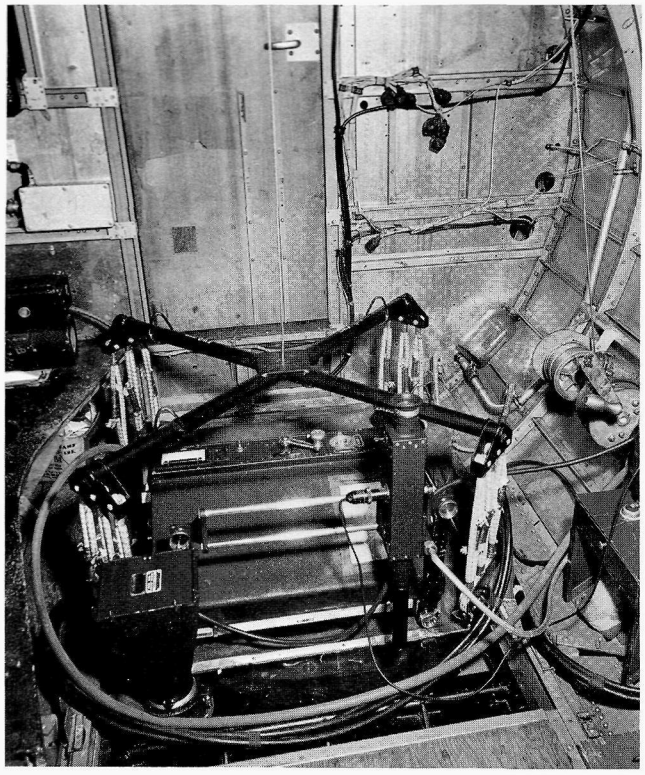


FIGURE 138.—The 9-lens camera after being lowered into photographic position. (Photograph by W. Byron Hale.)



FIGURE 139.—Crew of B−17 at Floyd Bennett Field, New York. Left to right: John Payne, (USC&GS), unknown, Elmer Mathison, copilot, (USCG), unknown, Loren G. Taylor, navigator, (USC&GS), Bennett S. Sparks, (USCG), Lloyd Franke, pilot, (USCG), unknown, unknown. (Photograph by G. E. Moore.)



FIGURE 140.—Pilot Lt.(jg) Lloyd Franke (USCG) on the left and copilot Lt.(jg) Mathison (USCG) in the cockpit of B−17 aircraft. (Photograph courtesy Boeing Aircraft Company.)

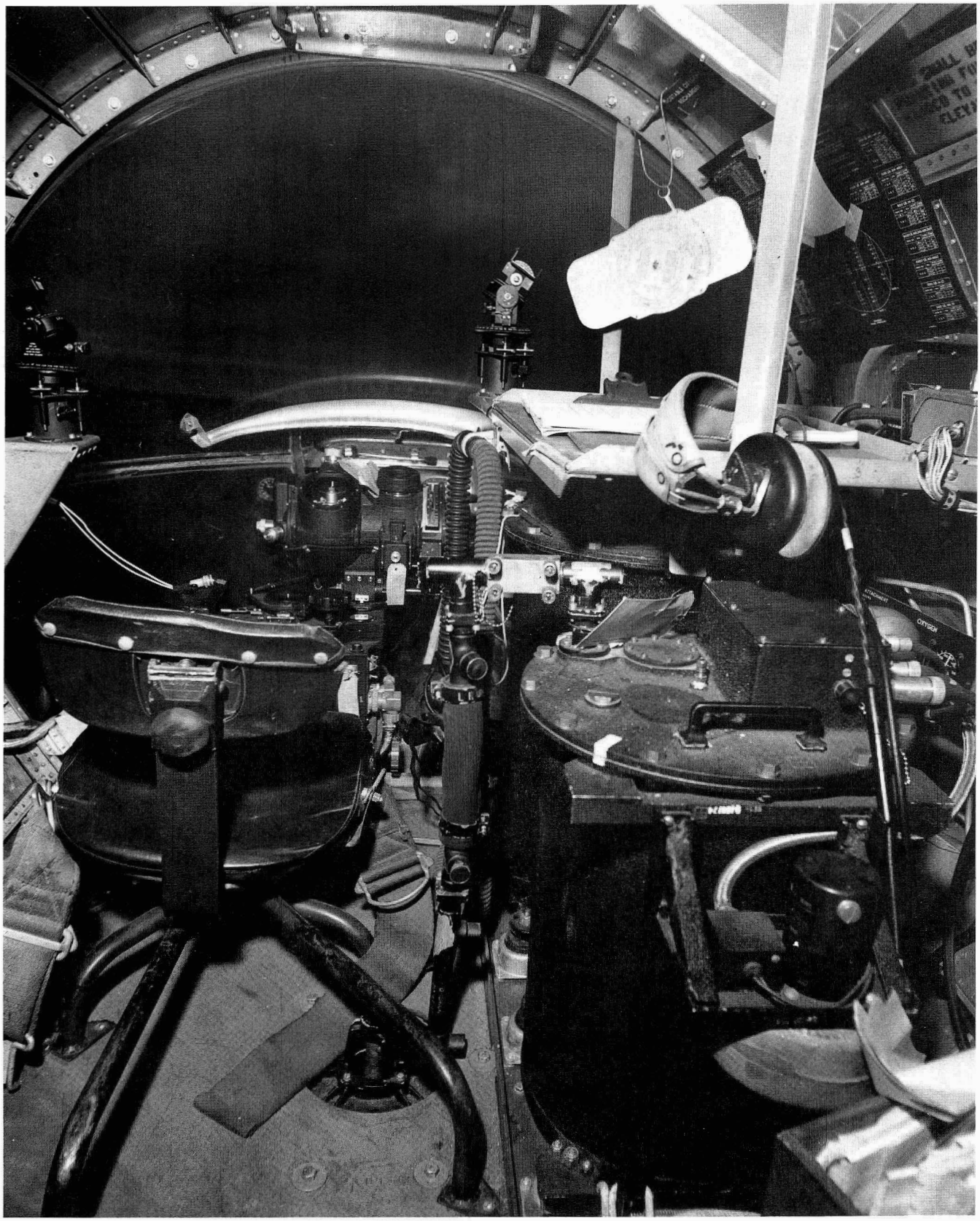


FIGURE 141.—Navigator position on B−17. Norden bombsight is just left of the center of photograph. (Photograph by W. Byron Hale.)

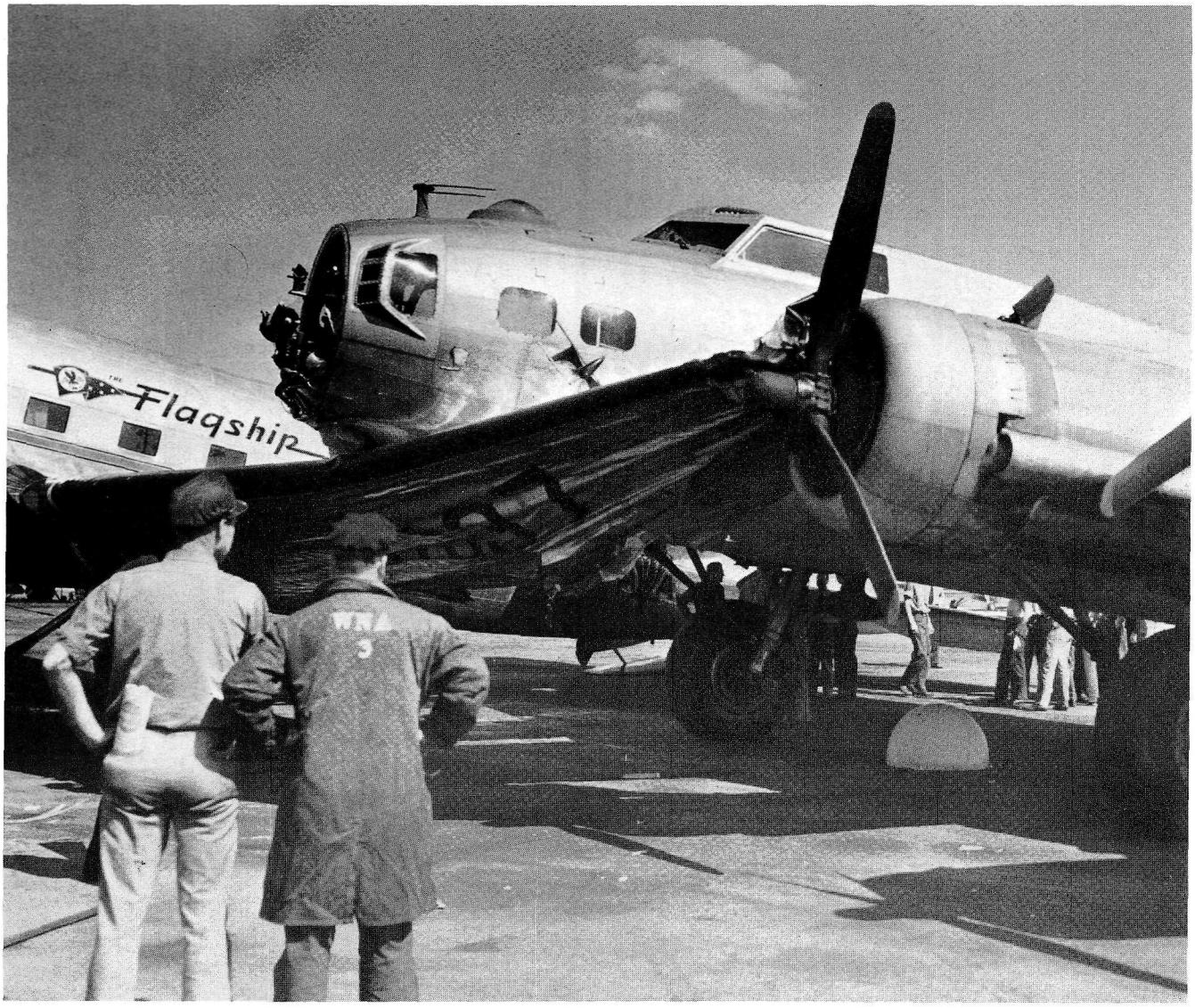


FIGURE 142.—B–17 at Washington National Airport after accident with American Airlines' plane. (Photograph by W. Byron Hale.)

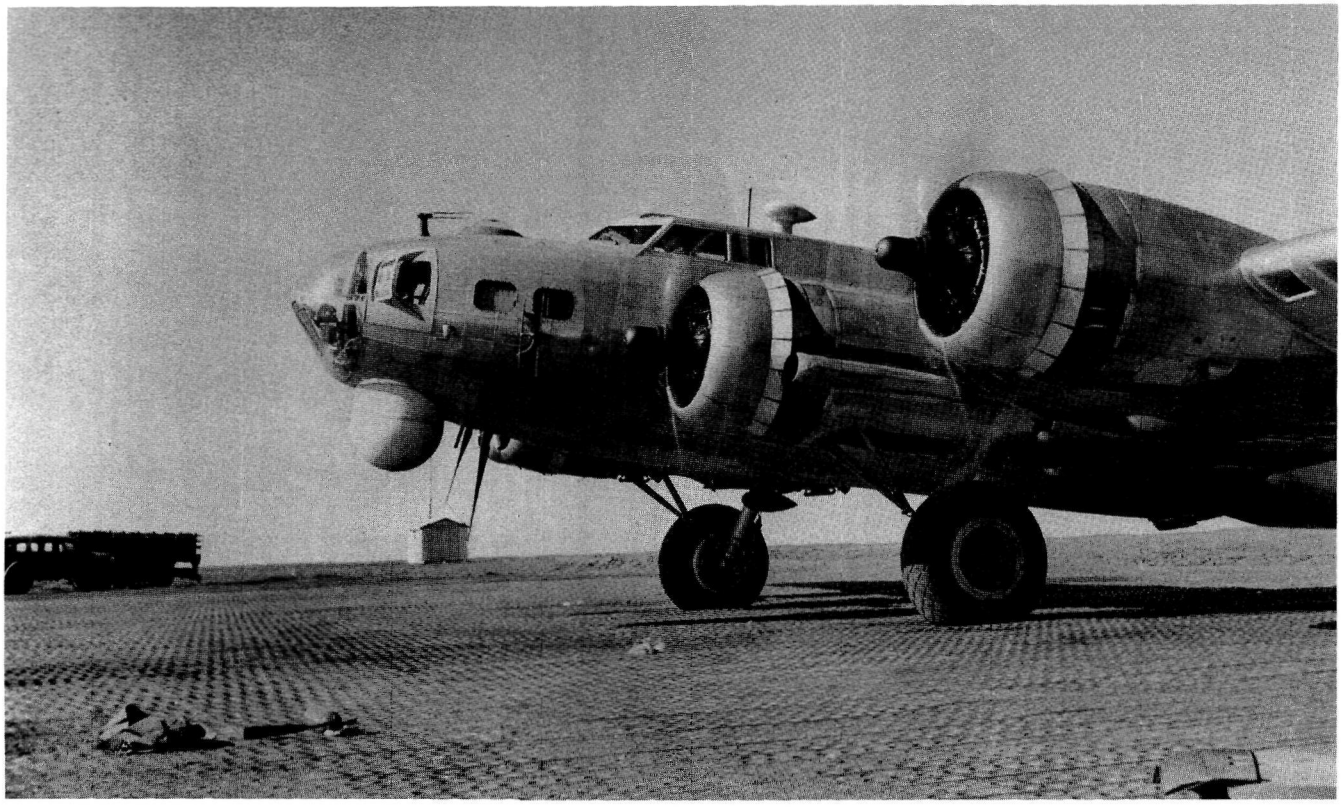


FIGURE 143.—B–17 at Point Barrow, Alaska. (Photograph by W. Byron Hale.)



FIGURE 144.—W. Byron Hale, while flying photography at 24,000 feet in Alaska. (Photograph by W. Byron Hale.)

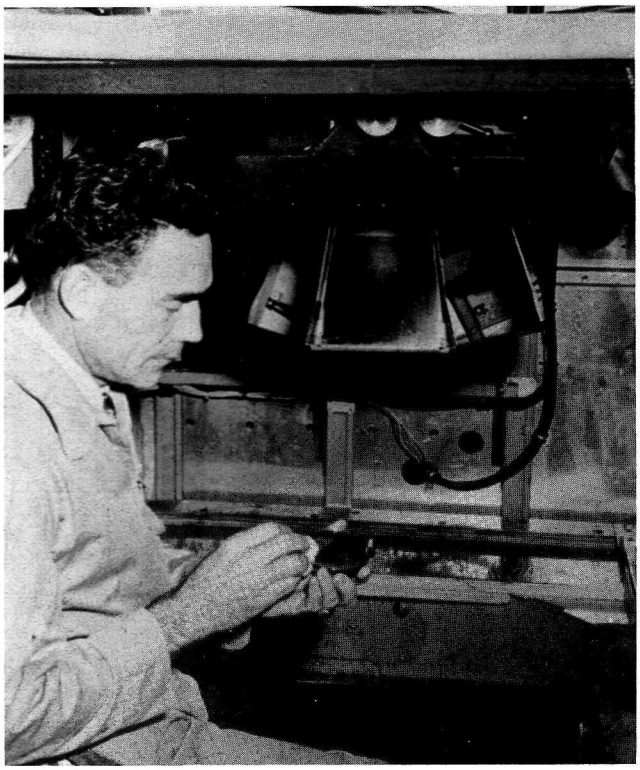


FIGURE 145.—After every flight the mirrors and the filters of the 9-lens camera had to be cleaned with distilled water. (Photograph by W. Byron Hale.)

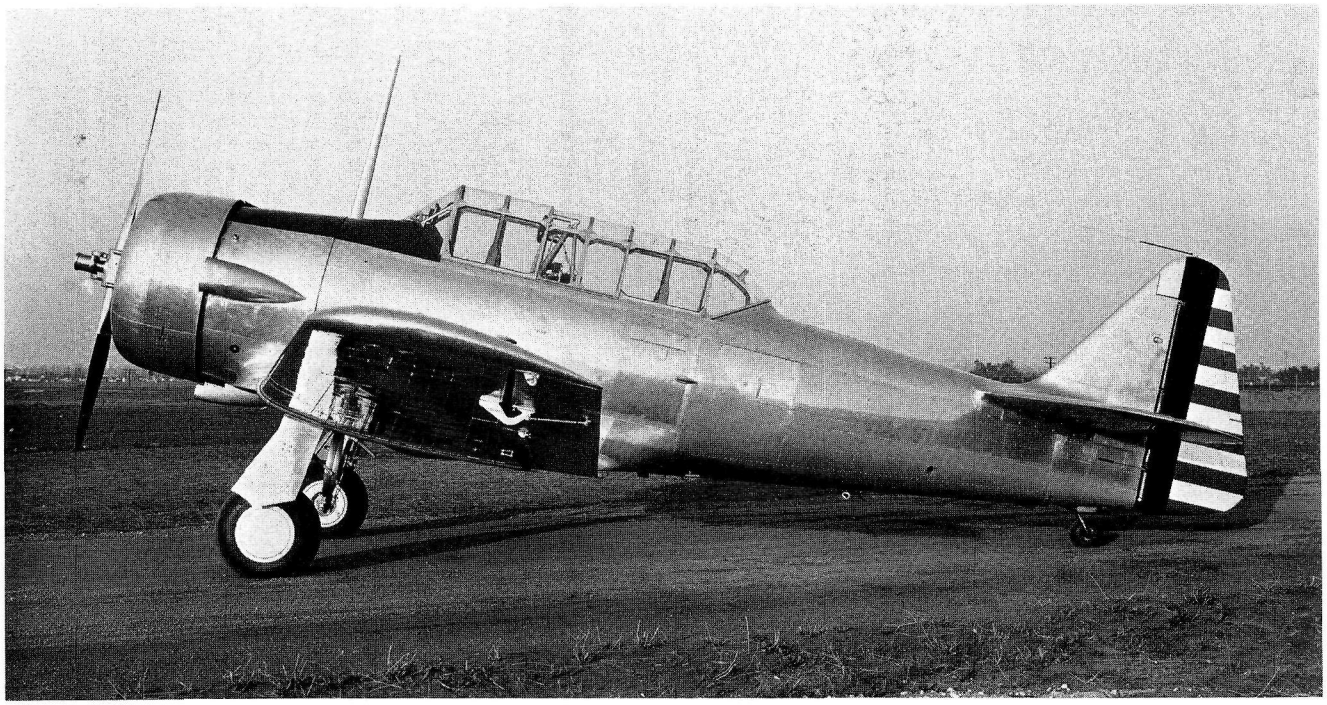


FIGURE 146.—AT–6 aircraft. Unfortunately, there is not a photograph available of aircraft No. 194, but it was identical to that pictured. The AT–6 was known as the Texan and had a wingspan of 42 feet, a length of 29 feet, and a height of 11 feet, with a gross weight of 5,300 pounds. It had a crusing speed of 170 miles per hour with a 750-mile range. (Photograph courtesy Willard Kuncis.)

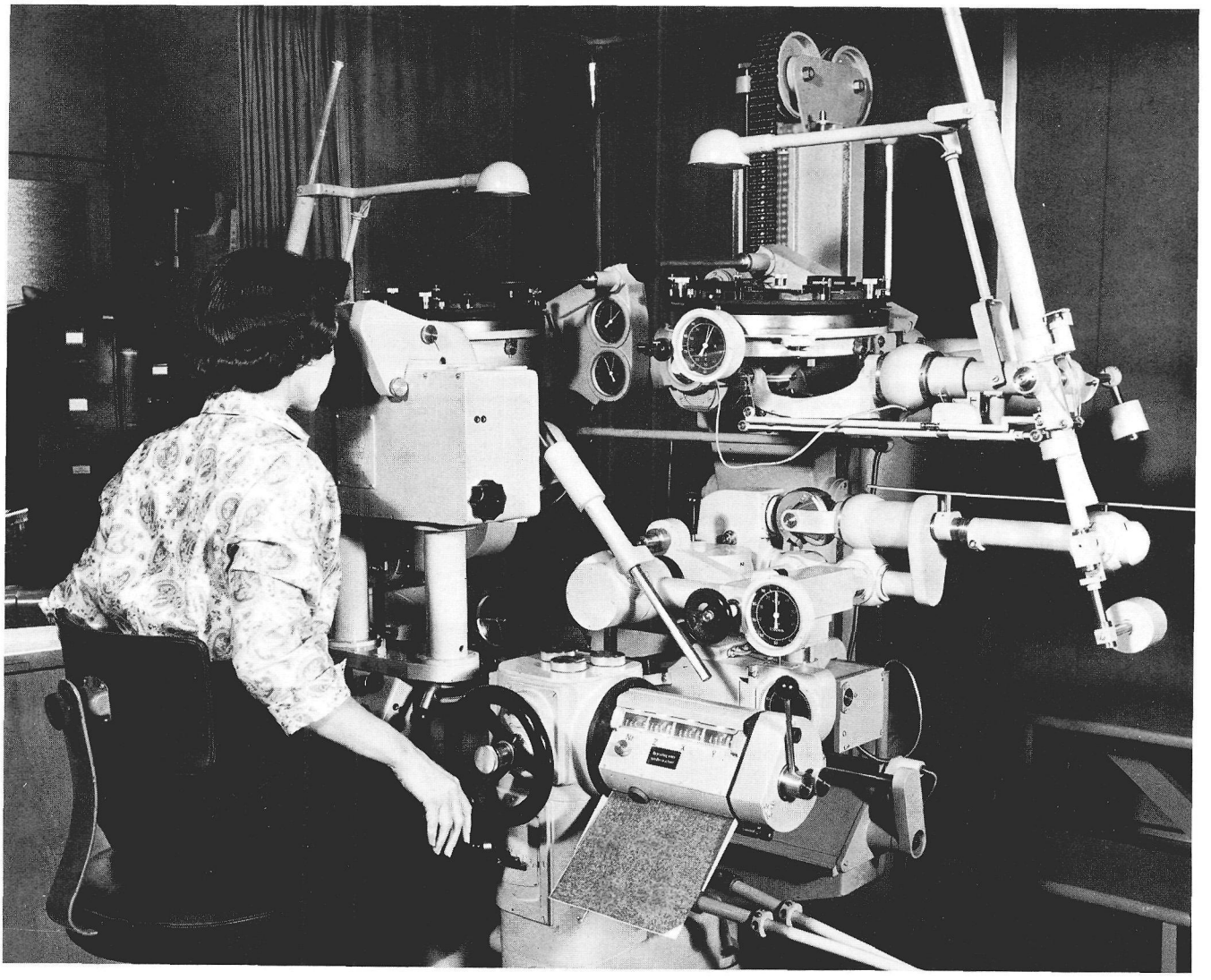


FIGURE 147.—Zeiss C–8 stereoplanigraph. This first order bridging and compilation instrument uses black-and-white glass plates. (Photograph by W. Byron Hale.)

1948

FLIGHT ACTIVITIES—1948

The B−17 aircraft arrived in Washington on February 1, camera installation was completed on February 2, and C&GS personnel were Lt. Loren Taylor, navigator, and W. Byron Hale and John T. Smith, Jr., (fig. 148) photographers. The last 9-lens calibration photograph was taken over the Washington, D.C., calibration site.

Three cameras were tested during the year, designation "E", "F", and "G" cameras (figs. 149, 150, 151). None of the cameras was ever used by the Photogrammetry Division.

On February 5, 77254 left Washington, D.C., for work in the South. The aircraft returned to Washington on February 20 and photographed the new 9-lens calibration area at McClure, Ohio, on February 23. The mission then left the 9-lens camera in Washington for repairs and returned to the South, doing single-lens photography. Three new mirrors were installed on the 9-lens camera, and the film winding mechanism was completely overhauled. During this period, the mission had worked its way to Los Angeles, Calif.; it then returned to Elizabeth City, N.C., where the 9-lens camera and a new Fairchild cartographic camera, C&GS designation "O" (figs. 152 and 153) was installed. The mission then photographed the McClure test area en route to Alaska, arriving at Nome on July 16. Photography was accomplished throughout Alaska (fig. 154) until the middle of November, when the party returned to Portland, Oreg., and continued on to Washington, D.C., doing photography en route and arriving on November 26.

On December 2 the aircraft left for photographic work in Texas and returned to Washington on December 22, at which time the mission was secured for the rest of the year.

DIVISION ACTIVITIES—1948

Lt. Robert D. Singel transferred from the Division in early January.

During February the camera calibration operation was moved from the Department of Commerce Building to the new calibration site at the C&GS Observatory in Gaithersburg, Md. (figs. 155, 156, and 157).



FIGURE 148.—Photographer John T. Smith, Jr., (USC&GS) operating 9-lens camera at 8,450 feet over Washington, D. C., February 3. (Photograph by W. Byron Hale.)



FIGURE 149.—1947 photograph with the USC&GS "E" camera. (Photograph by W. Byron Hale.)



FIGURE 150.—1947 photograph with the USC&GS "F" camera. (Photograph by W. Byron Hale.)



FIGURE 151.—1947 photograph with the USC&GS "G" camera. (Photograph by W. Byron Hale.)

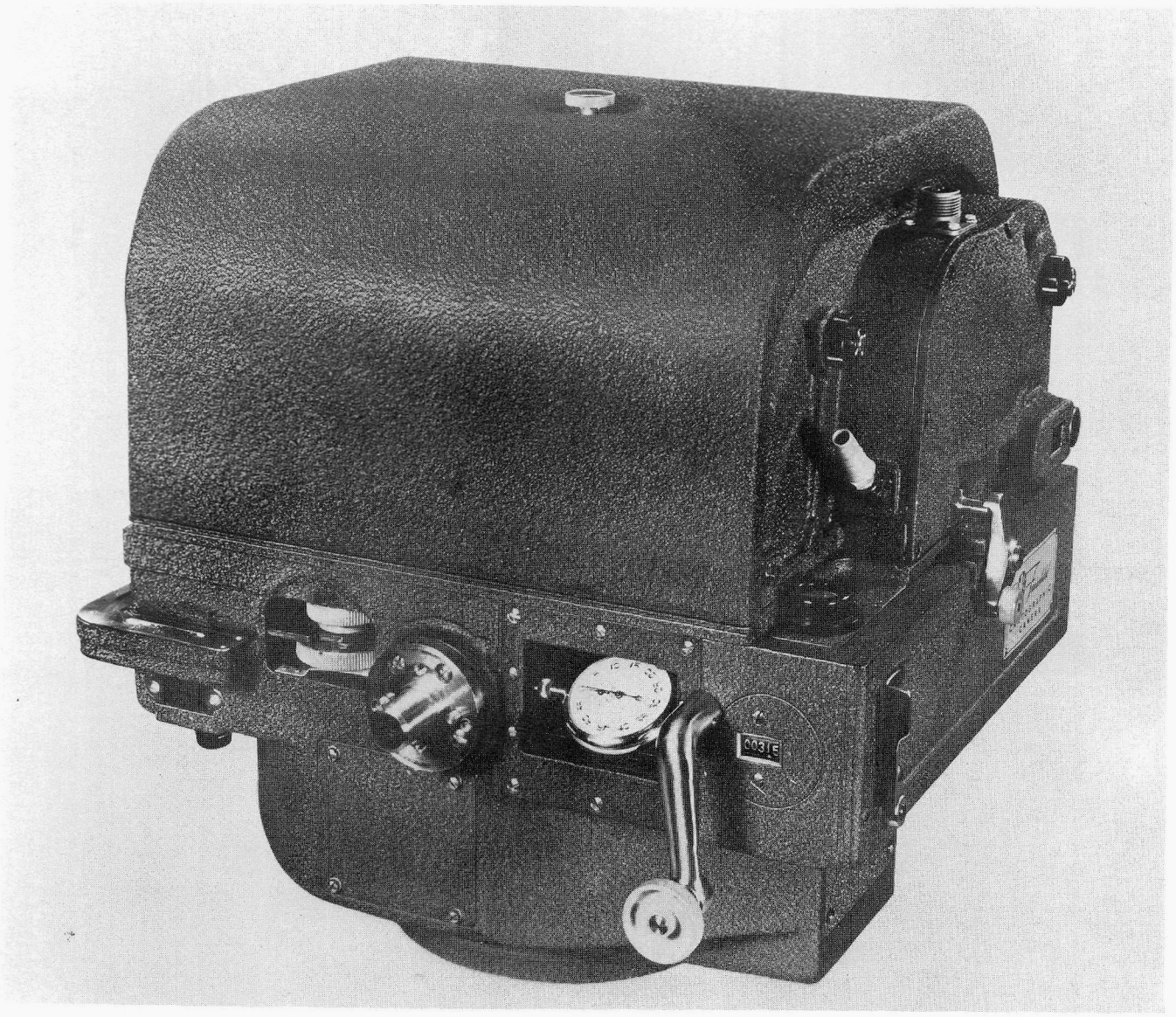


FIGURE 152.—Single-lens Fairchild Cartographic camera, USC&GS designation camera "O." (Photograph courtesy G. C. Tewinkle.)

FIGURE 153.—The single-lens cartographic camera "O" installed in radio compartment of 77254. (Photograph by W. Byron Hale.)



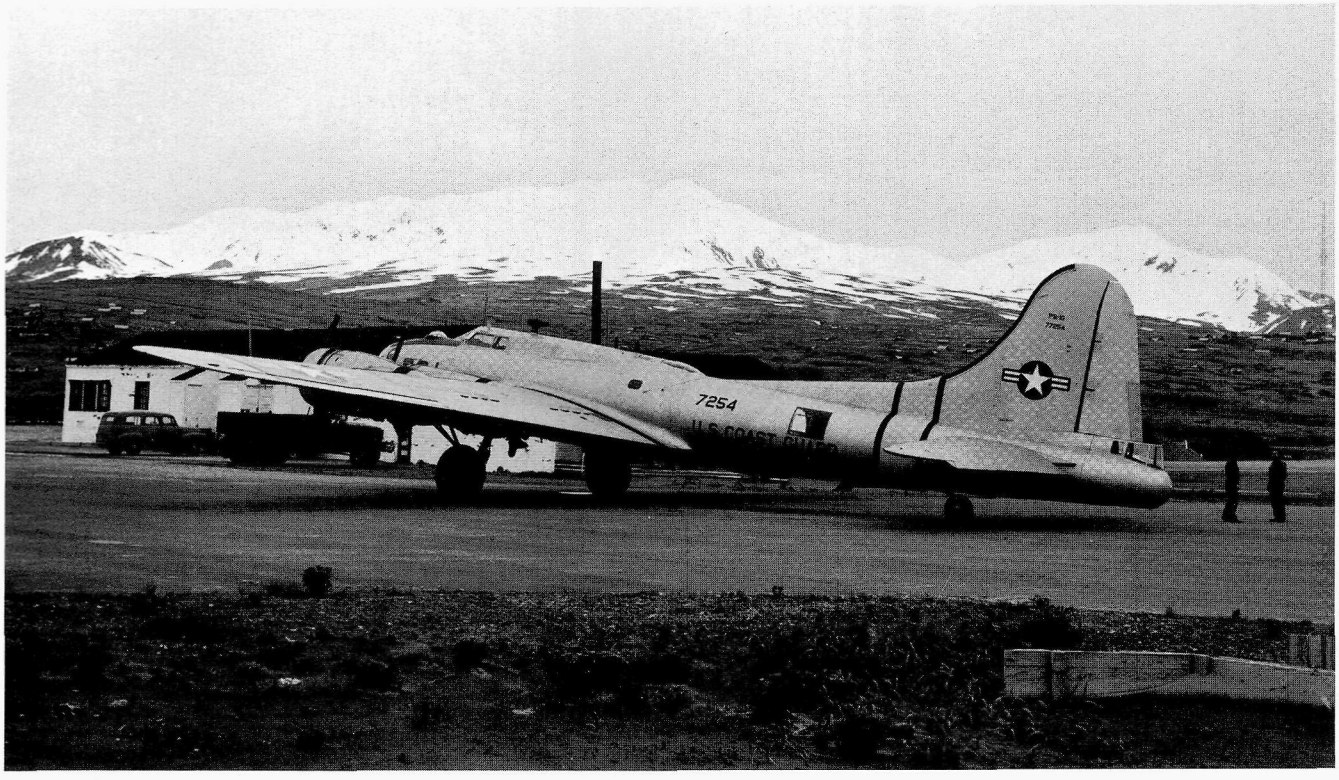


FIGURE 154.—PB1G 77254 at Adak, Alaska. Mount Moffett is in the background. (Photograph by W. Byron Hale.)

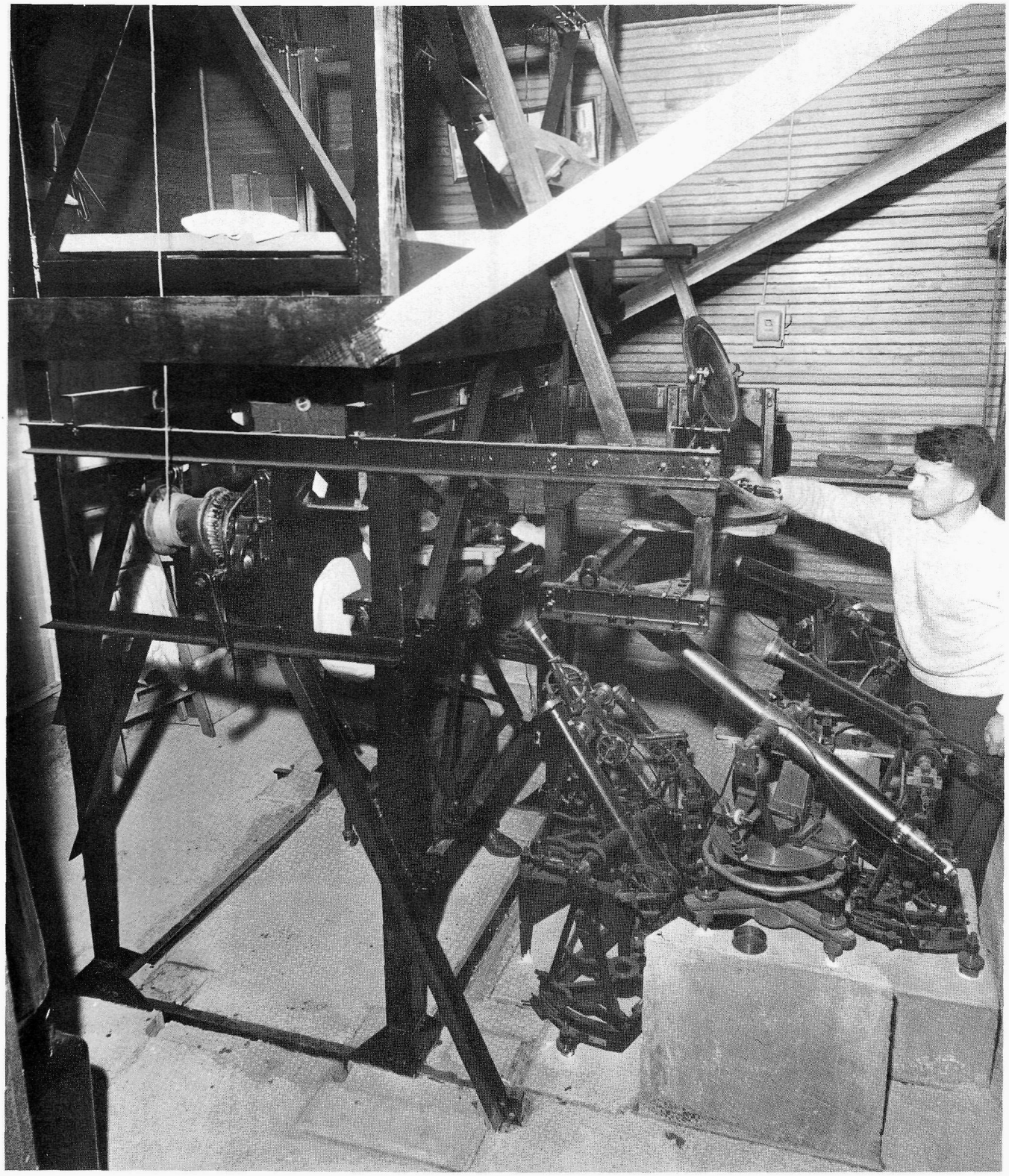


FIGURE 155.—G. C. Tewinkel checks the level of reflecting mirror used to count light fringes. (Photograph by W. Byron Hale.)

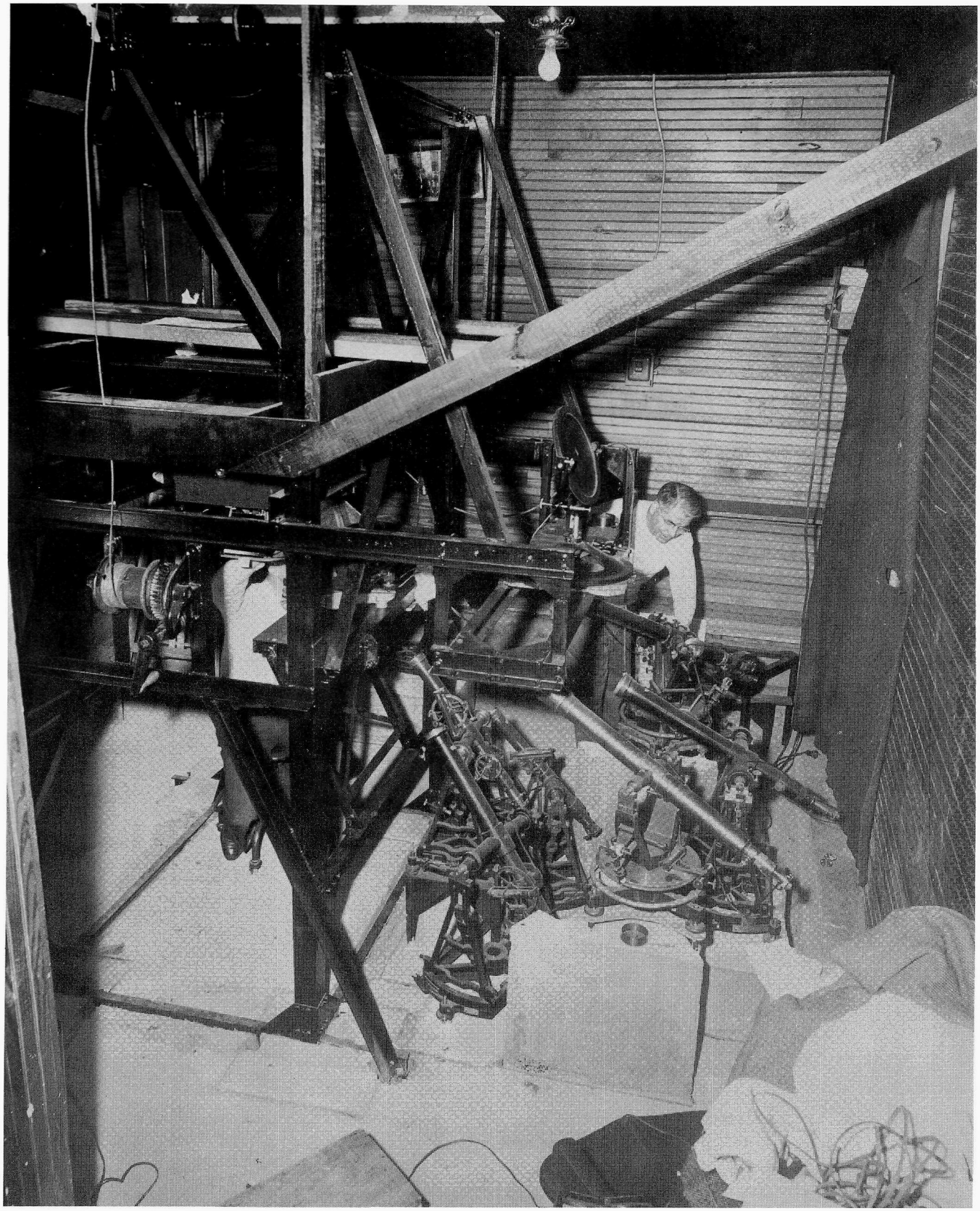


FIGURE 156.—Comdr. O. S. Reading aligning theodolites prior to camera calibration. (Photograph by W. Byron Hale.)

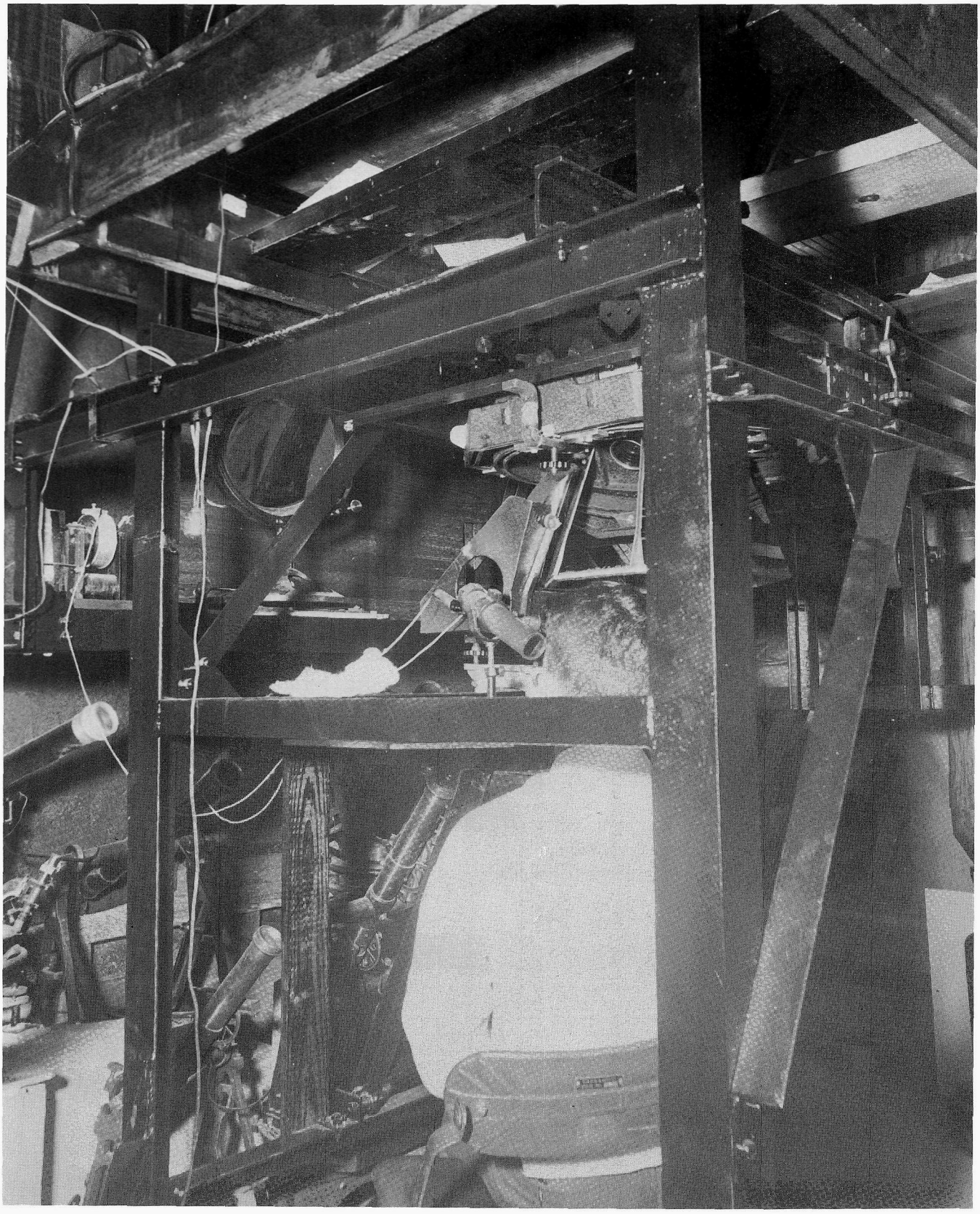


FIGURE 157.—Sighting in to count light fringes while calibrating the 9-lens camera. (Photograph by W. Byron Hale.)

1949

FLIGHT ACTIVITIES—1949

PB1G 77254 arrived in Washington, D.C., on April 4. Lt. Loren Taylor was navigator, and W. Byron Hale, photographer. The cameras were immediately installed, and the aircraft left on the 5th for Florida. The mission returned to Washington on the 29th, and again left on May 21, arriving in Anchorage, Alaska, on June 15, having photographed projects along the way. PB1G 77254 developed serious engine trouble in Alaska, and returned to the Boeing Aircraft Plant in Seattle to have all four engines changed. This work was not completed until July 23, when 77254 returned to Anchorage to commence the Alaska season. Weather and aircraft trouble continued to plague the mission, and in the middle of October it left Alaska to return to Washington, D.C., arriving October 27, at which time the mission secured for the season.

DIVISION ACTIVITIES—1949

On October 19 Capt. O. S. Reading became Chief of the Photogrammetry Division. In November, Lt. Loren Taylor transferred from the Photogrammetry Division. (figs. 158, 159, and 160).

In Alaska, Lt. Comdr. Paton used a unique system to photograph triangulation stations (fig. 161).

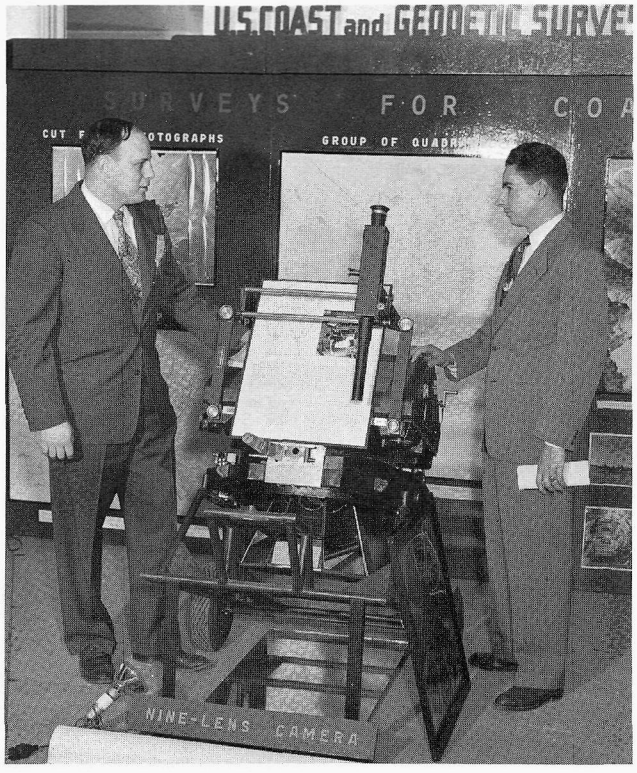


FIGURE 158.—The 9-lens camera on display at the American Society of Photogrammetry Convention. Bennett S. Sparks (USC&GS), left; Howard D. Wolfe (USC&GS) right. (Photograph by John T. Smith, Jr.)



FIGURE 159.—The Kelsh Plotter is a compilation instrument using the anaglyphic principle of seeing stereoscopic models. (Photograph by W. Byron Hale.)



FIGURE 160.—Jayme Presbitero from the Philippines, on the right, being trained by G. C. Tewinkle on the use of the Reading stereoplotter. (Photograph by W. Byron Hale.)

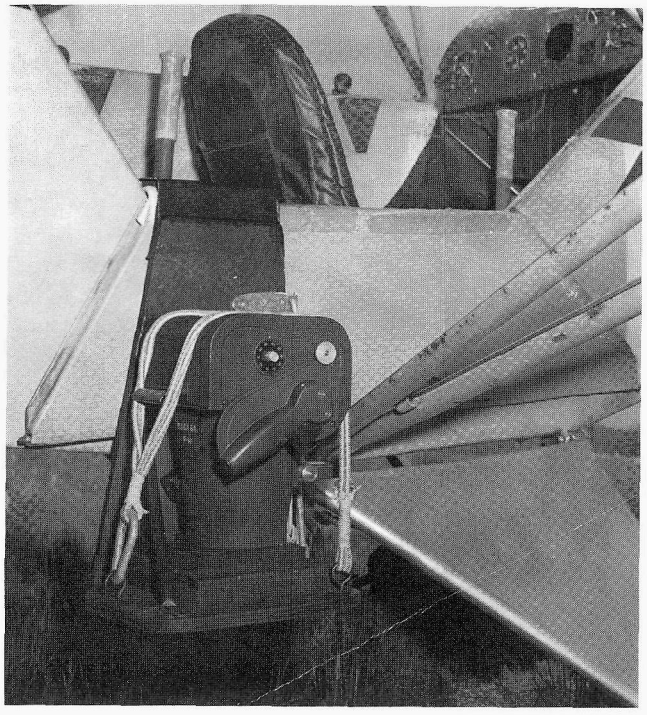


FIGURE 161.—C&GS K–20 camera hung outside of Piper aircraft. (Photograph courtesy of Hubert A. Paton.)

1950

FLIGHT ACTIVITIES—1950

Aircraft PB1G 77254 arrived in Washington, D.C., on April 6. Cameras were installed and the mission commenced photography on April 7, with Lt. Comdr. Hubert A. Paton and Ens. Samuel D. Parkinson (fig. 162) as navigators and Bennett S. Sparks, photographer (fig. 163). Photography continued in many areas of the United States, and on July 15 the aircraft arrived in Anchorage, Alaska. Work continued throughout Alaska until October 12, when 77254 arrived in Seattle, Wash., and worked its way back to Washington, D.C., arriving on November 14, at which time the mission was secured for the season.



FIGURE 162.—Ens. Samuel Parkinson (USC&GS) receives his wings from Capt. J. B. Dunn (USN) on February 23, at Corpus Christi, Tex. (Photograph courtesy U. S. Navy.)



FIGURE 163.—Photographer Bennett S. Sparks inspecting the 9-lens camera filters after a photographic flight. (Photograph by W. Byron Hale.)

1951

FLIGHT ACTIVITIES—1951

U.S. Coast Guard aircraft 77254 arrived in Washington, D.C., on March 7, and on March 10 the first photography of the season was taken.

While the aircraft was stationed at Daytona Beach, Fla., Lt. Parkinson reported that on April 4: ". . . we flew the ill mechanic Jacques M. Leitner to the hospital at Miami, Florida, photographing enroute two airports and the Miami Chart Correction Project. We then returned to Daytona Beach on April 5, where R. I. Mabus replaced mechanic Leitner who remained in the hospital."

On June 9 aircraft PB1G 77254 landed at Missoula, Mont., intending to remain overnight. The only place on the airport which would hold the weight of the aircraft was the concrete surface around the fueling pits, but that was needed for airline use. The aircraft taxied off the concrete and onto the macadam of the runway. As soon as the plane rolled onto the macadam, it began to sink (figs. 164 and 165). The plane bogged down, so the aircraft was attached to two large tractor-type highway trucks with ropes, the engines were revved up, and the aircraft pulled out of the holes. The plane kept moving slowly to prevent any further breakthroughs in the runway as the hauling ropes were cut, but as the aircraft took off, deep furrows were left all along the runway. The aircraft then landed for an overnight stay at Great Falls, Mont. Photography continued throughout the United States until June 25, when the aircraft left Seattle, Wash., and landed at Kodiak, Alaska. It remained in Alaska until October, then returned to Seattle and worked its way across the country, arriving in Washington, D.C., on November 5, and was secured on November 6 for the rest of the year.

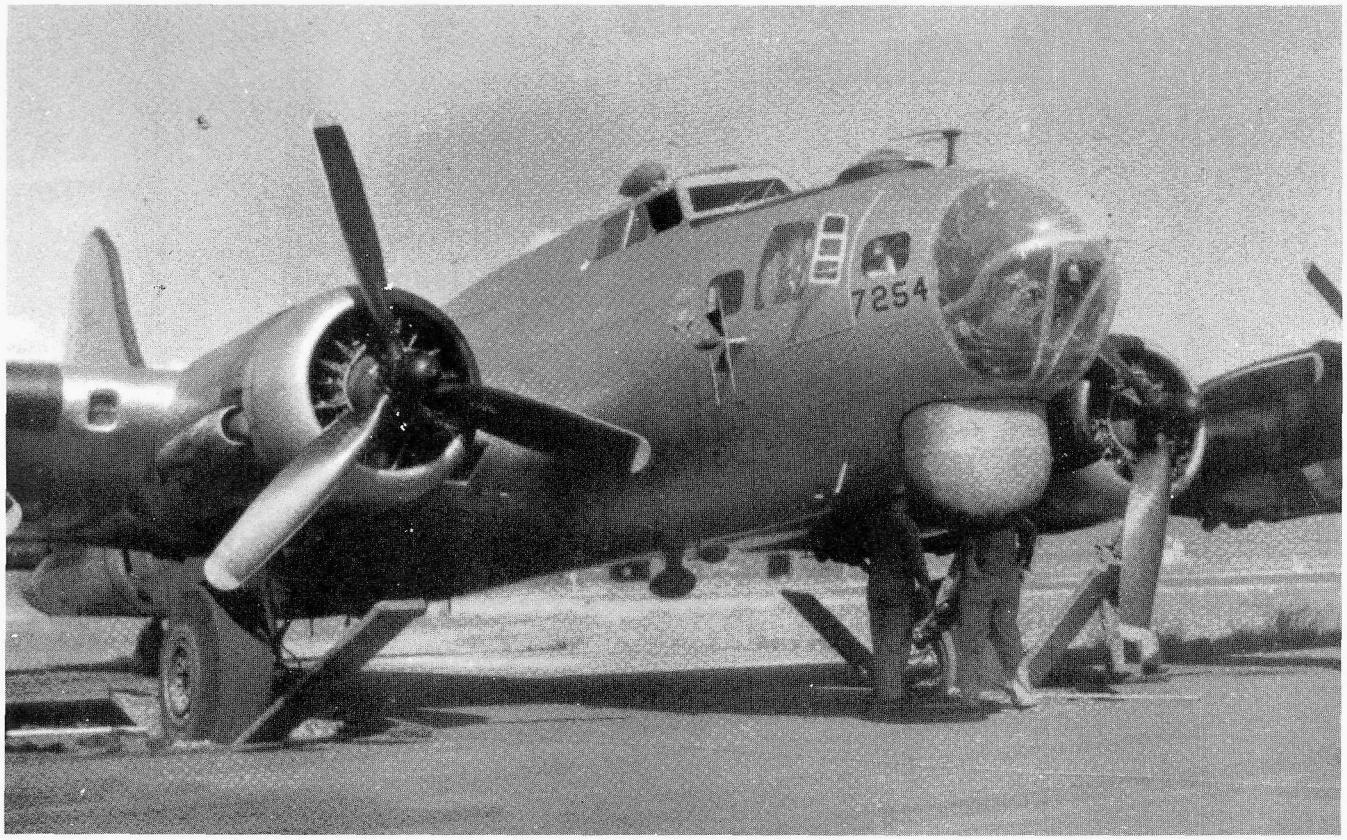
Lt. Samuel Parkinson said in his report that the aircraft engine problem continued. In 1950 two engines had failed in Alaska, and one immediately after return to the "lower 48." In 1951 one engine failed in Alaska, and only by an excessive number of out-of-the-ordinary engine inspections were the other three engines saved. Frequent cylinder changes were required, involving considerable loss of aircraft availability. Parkinson continued to make observations about the statiscope used aboard the aircraft and its inability to function properly. He said: ". . . on subsequent trials the statiscope camera failed to wind properly. To detect this failure the cameraman had to hold one hand lightly on the external winding knob. This procedure revealed a short circuit of some sort. Each time the camera clicks, the cameraman receives a light but unpleasant electrical shock."

It is interesting to note how much effort and enthusiasm were put into obtaining the photographs. Parkinson continued: ". . . the Coast and Geodetic Survey aerial photographer has more duties in flight than he can adequately handle, operating one camera and accessories is a full-time job and is hard enough even with all equipment operating perfectly. Add to this a statiscope, a microphone for intercommunications, giving directions to an inexperienced camera operator who is in training and who is trying to operate the other camera doing tandem photography, being hindered by an oxygen mask, earphones and heavy clothing, the job becomes next to impossible."

PIPER AIRCRAFT ACTIVITIES—1951

As the need for more aerial photography kept increasing, a privately owned Piper Pacer, No. N5258H, was rented. This aircraft was leased through different periods between March 20 and November 8. Lt. Comdr. Hubert A. Paton served as chief of mission and pilot, W. Byron Hale as photographer (figs. 166 and 167). Other personnel who served on board during the season were Lt. William Randall, Leroy Senasack, and Bennett Sparks. The mission operated on the U.S. east coast but was severely handicapped by the fact that the maximum altitude for photographic purposes of the aircraft was 10,000 feet. After completion of the assigned photography, the mission was terminated on November 9.





FIGURES 164 AND 165.—Aircraft 77254 on runway at Missoula, Mont., after breaking through macadam surface. Boards were placed against the wheels in an effort to have the aircraft pull itself out under its own power, but this failed, and the aircraft was finally hauled out under a combination of its own power and two heavy-duty trucks with ropes attached to the undercarriage of the aircraft. (Photograph by Lt. S. Parkinson.)

Aircraft Civilian N5258H

March 20 to November 9

Personnel who served on board:

Coast and Geodetic Survey Officers

Lt. Comdr. Hubert A. Paton
Lt. William E. Randall

Coast and Geodetic Survey Civilians

W. Byron Hale
Leroy Senasack
Bennett S. Sparks

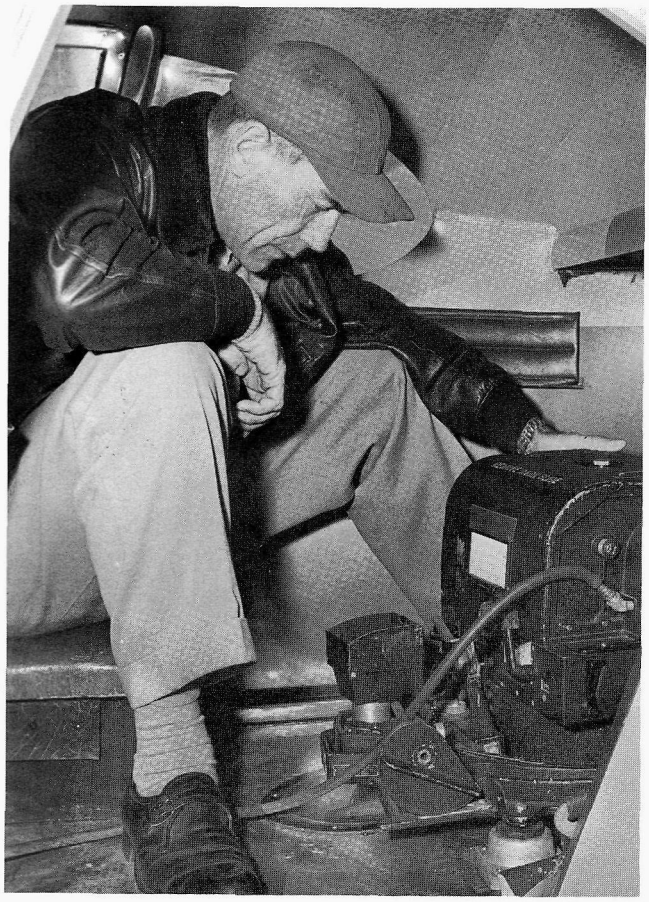


FIGURE 166.—Cameraman W. Byron Hale in position to operate camera in Pacer aircraft. (Photograph courtesy of Capt. H. A. Paton.)

OFFICE ACTIVITIES—1951

Lt. (jg) Allen L. Powell reported to the Chief of the Division on January 12, having been assigned to temporary duty in the Division of Photogrammetry for a period of about 2 years.

On February 25 Capt. O. S. Reading departed for Liberia, West Africa, where he attended a conference on a Point 4 (Marshall Plan) proposal to lend technical assistance for the establishment of a Liberian mapping agency and cartographic survey under the direction of the Department of State.

On June 11 Comdr. George E. Morris reported for duty with the State Department for the Liberian operation. On September 25 he and Lt. John O. Boyer left for Monrovia, the capital city of Liberia.

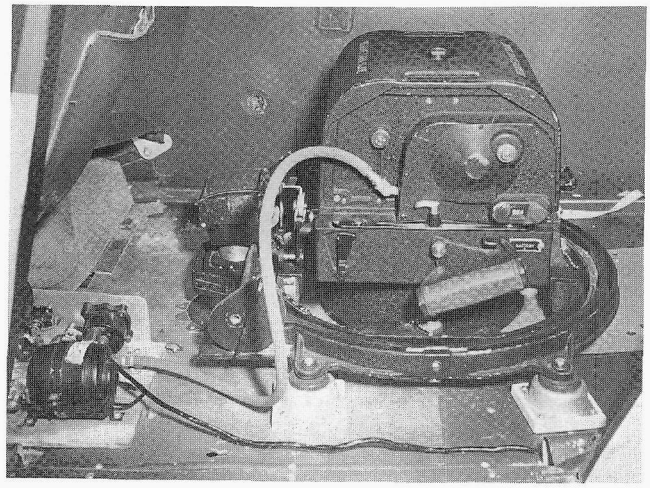


FIGURE 167.—Fairchild K–17 camera "J" installed in Piper aircraft. (Photograph courtesy Capt. H. A. Paton.)

1952

FLIGHT ACTIVITIES—1952

Aerial photographic operations were activated with the arrival of 77254 in Washington on February 4. The aircraft left on February 6 for photography in the United States with Lt. William E. Randall (fig. 168) as navigator and John T. Smith, Jr., as photographer. The aircraft left Seattle, Wash., on May 29, arriving at Annette Island, Alaska, the same day (figs. 169 and 170).

The mission did photography throughout Alaska (figs. 171 and 172) until September 21, when the aircraft returned to Seattle and worked its way across country, arriving in Washington, D.C., on October 13. At that time, the mission was secured for the rest of the year.

PIPER AIRCRAFT ACTIVITIES—1952

From May 14 through October 30 a small civilian aircraft was used to photograph the U.S. northeast coast. Lt. Comdr. Hubert Paton was pilot/navigator, and W. Byron Hale was the photographer.

OFFICE ACTIVITIES—1952

Granville Marts, a Major in the U.S. Air Force, was recalled to active duty in May, and Theodore Hanford was appointed Chief of the Aerial Photographic Laboratory. (Maj. Marts died in 1954 while on active duty with the U.S. Air Force.)

At the American Society of Photogrammetry meeting in March, a paper was presented that described in detail a test for camera mount vibration: a row of lights pointing up had been placed in the desert; these lights were photographed by flying over at 5,000 feet at a predetermined speed with the camera lenses opened. By using lights operating on 60 cycles per second, a pattern was formed on the film from which the vibrations of the camera mount could be determined. The logistical problem as well as the tremendous expense was explained. Capt. Reading posed a question: "How can we at the Coast and Geodetic Survey do this test without spending any money?" After the laughter had subsided, the speaker apologized profusely for not inviting the C&GS to participate in the test, but as the site had been dismantled, the test could not be done again.

A few weeks later, Reading talked with flight personnel, and told them: "We don't have any money to spend on this but it is necessary to know if there are vibrations in our cameras causing distortion in the photography. While I was driving along the Gulf coast of Florida, I noticed some neon signs along the road. If the airplane went out over the water on a moonless night, opened the camera shutters and flew in over the signs, the photographer should have plenty of time to close the shutters before coming over a populated area." Reading believed this would accomplish the same results for a vibration test.

The mission located the area Reading had indicated. As the 9-lens camera had electrical shutters, a technique was designed so that all nine shutters were blocked open as well as the shutter on the single-lens "O" camera. All electrical impulses were disconnected from the camera, and the vacuum pumps were hooked-up directly. On the night of February 27 the mission flew over the area, the film was advanced by hand over the water, the vacuum pumps turned on, and as soon as the signs were flown over the vacuum pump was turned off, and the film advanced, so that by the time the aircraft had reached the populated areas the exposed film was safe. Six passes were made that night, and the film shipped back to Washington, D.C. After being processed, Reading made arrangements for the Air Force to reduce the data; the 9-lens camera proved to be best of the many cameras that had been tested (this may have been because of the weight of the camera). But the single-lens "O" camera showed that quite a bit of vibration was present. New shock absorbers were designed, and a future test showed a great deal of improvement.

In the late 1920's, a young officer had written: "The only problem with photogrammetry is money." The officer was reminded of the story of a man who complained, "All my wife does is ask me for money," His friend asked, "What does she do with all of the money?" He replied: "I don't know, I have never given her any." With Reading, you didn't need money, for he gained much of the information he sought without spending any.



FIGURE 168.—Lt. William E. Randall. (Official NOS photograph.)

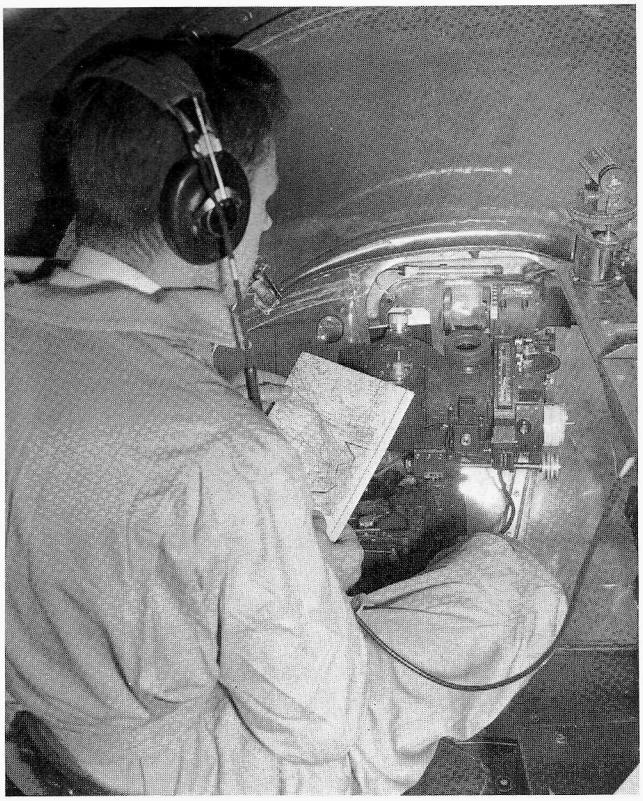


FIGURE 169.—Lt. William E. Randall (USC&GS) navigating airplane 77254 on flight to Annette Island, Alaska. (Photograph by John T. Smith, Jr.)



FIGURE 170.—Radioman sending aircraft position on flight over Alaska. (Photograph by John T. Smith, Jr.)



FIGURE 171.—Accommodations at Adak, Alaska. (Photograph by John T. Smith, Jr.)

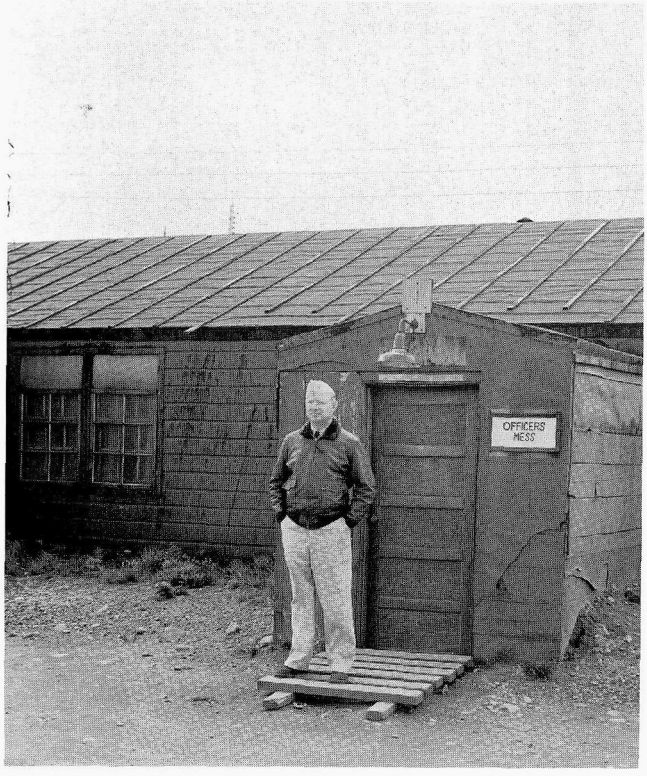


FIGURE 172.—Lt. Augustus Kleisch (USCG) pilot on 77254 in front of mess hall at Fort Randall, Alaska. (Photograph by John T. Smith, Jr.)

LIBERIA ACTIVITIES—1952

In Liberia, Comdr. George E. Morris, Jr., Director of the Liberian Cartographic Service, reported: "The Liberian technical cooperation project is divided into two principal tasks: (1) to provide field inspection of aerial photographic and airborne magnetometer surveys of Liberia, and (2) to organize and operate a Liberian Cartographic Service for surveying and mapping of Liberia." This included the training of Liberian citizens in field and office procedures. American personnel involved in this project were Comdr. George Morris, Jr., Lt. John O. Boyer, and Edwin D. Hawbecker (fig. 173).

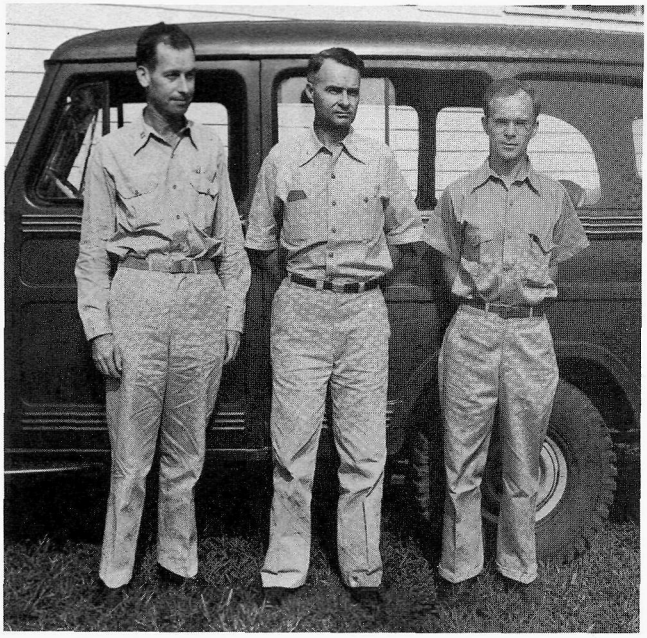


FIGURE 173.—American personnel in Liberia, left to right: Lt. John O. Boyer, Comdr. George E. Morris, Jr., and Edwin D. Hawbecker. (Official NOS photograph.)

The first photography was obtained under contract with Aero Service Corporation on January 19, and work continued throughout the year, with the film being returned to Philadelphia, Pa., for printing. None of the photography was available for use during the year. The Liberian countryside, known locally as the "bush" (fig. 174), is an area over which it is very difficult to control photography. Comdr. Morris said: "Many problems remain to be solved and progress will be slow but the Liberian Cartographic Service is functioning as a Bureau and a start has been made on surveying and mapping in Liberia."



FIGURE 174.—Typical bush country of Liberia. (Photograph by Edwin D. Hawbecker.)

1953

FLIGHT ACTIVITIES B-17—1953

Coast Guard aircraft PB1G 77254 arrived at Washington, D.C., on May 25, and after installation of the camera equipment departed the same day for Elizabeth City, N.C., with Lt. Samuel Parkinson (C&GS) as navigator (fig. 175) and Bennett S. Sparks as photographer. They continued photography in the United States. During takeoff on June 12, at Macon, Ga., the emergency liferaft in the turtleback inflated and flew onto the runway. The aircraft landed and found only minor damage had occurred to the liferaft compartment, but the liferaft had been destroyed.

On July 7 the mission left Seattle, Wash., and arrived at Annette Island, Alaska. The aircraft remained in Alaska (fig. 176) until October 15, when it returned to Seattle, Wash., and continued to do photography in the United States until December 11, when the aircraft returned to Washington, D.C. The camera equipment was unloaded, and the mission was secured for the rest of the year.

PIPER AIRCRAFT ACTIVITIES—1953

As the need for aerial photography continued, the Division rented a Piper Tri-Pacer aircraft on April 26 to obtain photography in the eastern United States.

Lt. William E. Randall was pilot/navigator, and W. Byron Hale was photographer. The single-lens camera "J", was installed. The mission continued to do photography (fig. 177) until December 28, when it was terminated.

Civilian Aircraft Tri-Pacer

April 1953 to December 1953

Personnel who served on board:

Coast and Geodetic Survey Officer

Lt. William E. Randall

Coast and Geodetic Survey Civilian

W. Byron Hale

OFFICE ACTIVITIES—1953

The first LogE automatic dodging printer, manufactured by LogEtronics, was delivered to the Air Photographic Laboratory in June.

In November C&GS tested and then purchased the first Wild RC-5A camera in the United States (fig. 178).

LIBERIA ACTIVITIES—1953

The operation in Liberia continued. C&GS was aware that the photography which was now completed by Aero Service of Philadelphia had gaps, and those gaps in the previous contract photography were in regions of almost continual cloud cover. Probably several dry seasons would be required to complete the

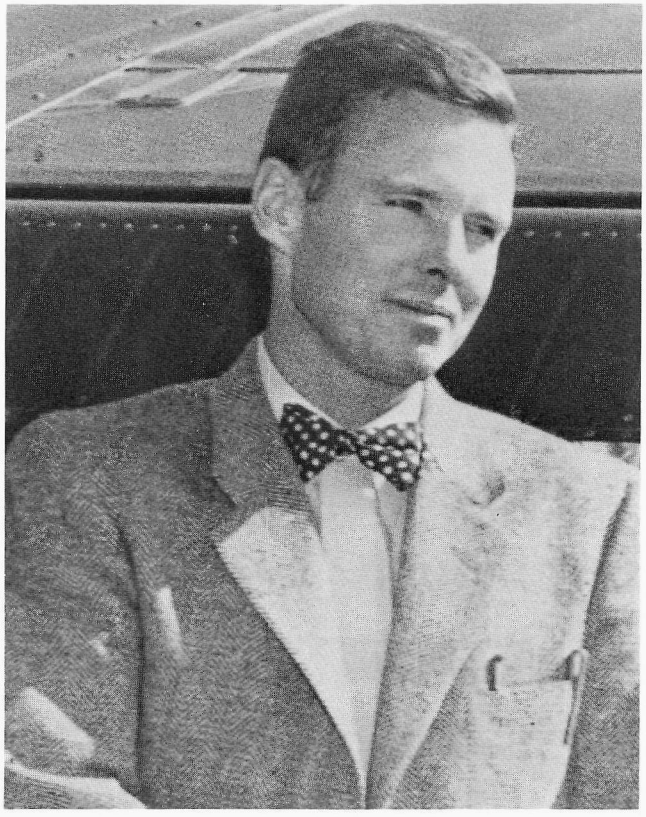


FIGURE 175.—Lt. Samuel B. Parkinson. (Photography by Dan Berry.)



FIGURE 176.—9-lens photograph of the Volcanos on Semisopochnio, mountain in Alaska, original scale of 1:80,000. (Photograph by Bennett S. Sparks.)

photography. The continued operation of a photographic airplane with a competent pilot and photographer was recommended. The aircraft must be able to accomplish aerial photography in areas of interest in the development of Liberia. The aircraft arrived in Liberia on October 1 (fig. 179). By that time all of the photographs taken by Aero Service had been delivered to the Liberian Cartographic Service, and compiling of the first maps of Liberia began.

In November, Comdr. Riley J. Sipe replaced Comdr. George E. Morris, Jr., as Director of the Liberian Cartographic Service.



FIGURE 177.—USC&GS "J" camera, photograph No. 3740, over Wildwood, N.J. (Photograph by W. Byron Hale.)

FIGURE 179.—Edwin Hawbecker, left, with Comdr. George Morris, installing the Liberian Cartographic Service Fairchild cartographic camera in Cessna aircraft. (Official NOS photograph.)

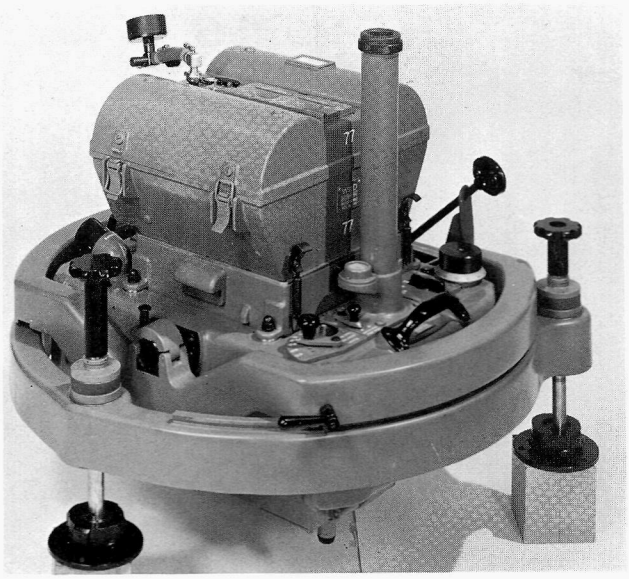


FIGURE 178.—Wild RC–5 camera. Camera is equipped with a 6-inch focal length Aviogen lens. (Photograph courtesy of Wild Company)



1954

FLIGHT ACTIVITIES B-17—1954

In January the calibration and overhaul of the 9-lens camera was being performed, and the new Wild RC-5 camera purchased by the Bureau was being calibrated for use on the B-17. The RC-5 camera carried C&GS designation "W". The cameras were installed on 77254 on April 5, and photographic operations were begun immediately on the East Coast. Lt. William E. Randail (C&GS) was navigator, and W. Byron Hale (fig. 180) and Bennett Sparks, photographers. The aircraft arrived in Alaska on July 9 and continued photography throughout Alaska (fig. 181) until September 24, when the mission returned to Seattle, Wash. It then continued to photograph in the United States (fig. 182) until December 15, when the mission returned to Washington, D.C., and was deactivated for the rest of the season.

OFFICE ACTIVITIES—1954

On August 31, Capt. Oliver S. Reading retired, after serving with the Bureau for over 39 years. On September 1 Comdr. Lawrence W. Swanson was appointed Chief of the Division of Photogrammetry.

In September the second 9-lens transforming printer was put into operation at the Department of Commerce Building. Instruction in Photogrammetry continued (fig. 183).

LIBERIA ACTIVITIES—1954

The project in Liberia continued with the arrival in February of Paul J. Bradley, pilot. The aircraft that had been delivered earlier could now be put to use for photographic mapping.

In March, John T. Smith, Jr., replaced Edwin D. Hawbecker as Chief of the Division of Reproduction. Hawbecker and Smith were the photo/navigators on the aircraft, a Cessna 170, No. N1207D (figs. 184, 185 and 186), which was equipped with a Fairchild cartographic camera. Comdr. Sipe reported: "Due to the fact that a precision enlarger for aerial photographs is not available, the copy camera must be converted to such purposes; thus no accurate production of scale and rectified photographs for map compilation is possible. The delays of months in filling orders for photographic film and supplies have handicapped some phases of the division's photographic operations. Improvements in the way of refrigerated storage for the perishable photographic materials, additional electrical outlets, shelving and film drying cabinets have been installed. A cross-index filing system, cost account, time and attendance records were initiated. A perpetual stock record was instituted to keep records up-to-date and to establish a usage rate for each item.

"The training in photographic techniques has begun but the heavy workload had reduced the amount of time that could be devoted to the division's training program. A resolution chart was prepared and the camera lens tested. Definition of the aerial camera is excellent."



FIGURE 180.—Photographer W. Byron Hale with the 9-lens camera. (Official NOS photograph.)



FIGURE 181.—The crew of 77254 on the Yakutat railroad. (Photograph by W. Byron Hale.)

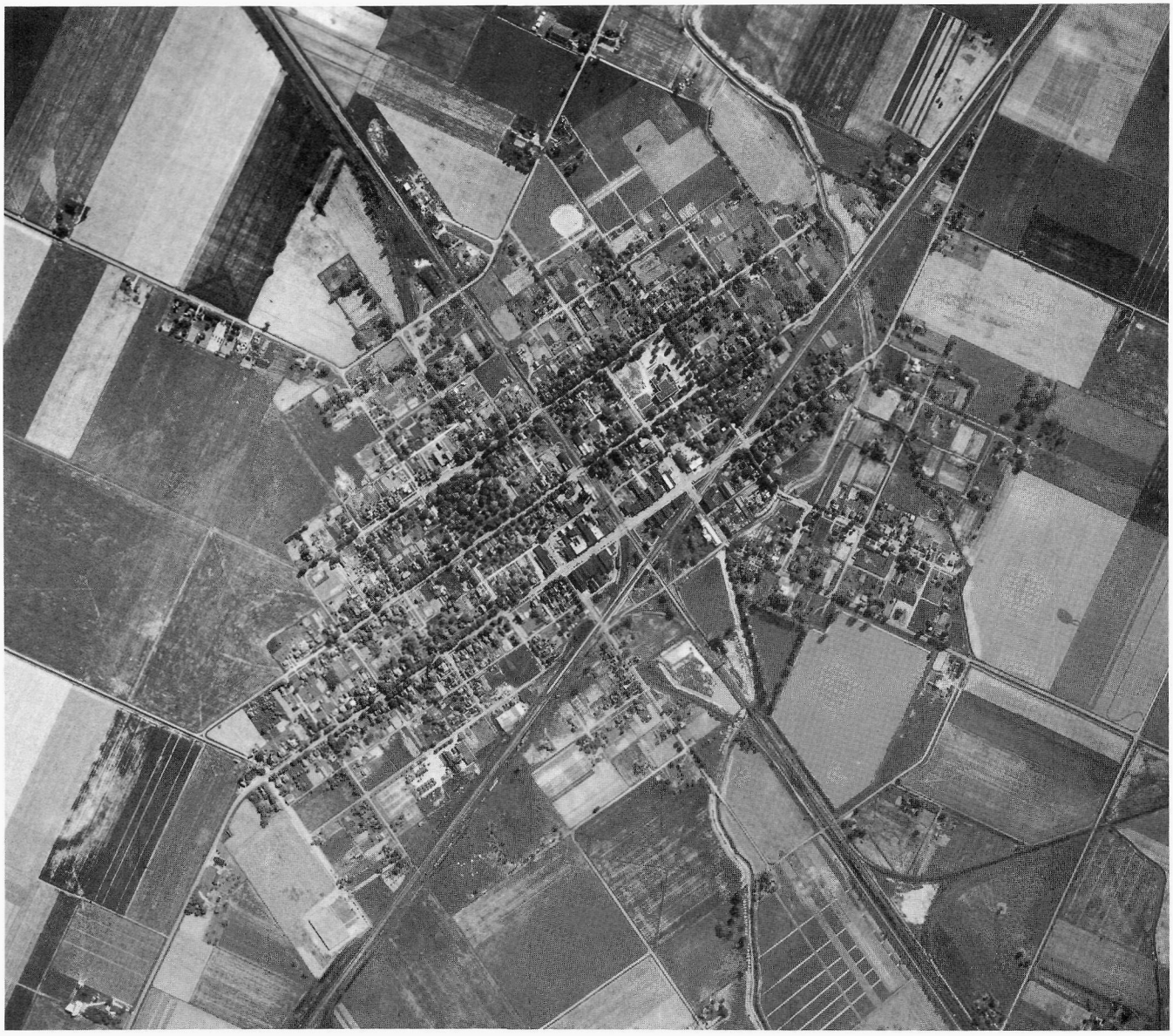


FIGURE 182.—Photographic calibration over McClure, Ohio. Photographed with the Fairchild cartographic camera, C&GS camera "T" 6-inch Metrogen lens, and the Tham curved focal-plane plate. (Photograph by W. Byron Hale.)



FIGURE 183.—Capt. Louis Nicolua, on the left, from Bolivia receiving instructions from Stanley W. Trow on the operations of the Zeiss stereoplanigraph. ((Photograph by W. Byron Hale.)



FIGURE 184.—Liberian Cartographic Service Cessna 170 aircraft, John T. Smith, Jr., left, and pilot Paul J. Bradley, right. (Photograph by Riley J. Sipe.)



FIGURE 185.—Pilot Paul J. Bradley fueling aircraft at Payne Field, Liberia. (Photograph by John T. Smith, Jr.)



FIGURE 186.—Aerial view of downtown Monrovia, Liberia. (Photograph by John T. Smith, Jr.)

1955

FLIGHT ACTIVITIES B–17—1955

On March 8 PB1G 77254 arrived at Washington National Airport and the cameras and equipment were installed (fig. 187). The mission commenced photography on March 9, with Lt. Comdr. William E. Randall and Lt. Alfred C. Holmes as navigators, and Edwin Hawbecker and Bennett S. Sparks, photographers. On April 16 at Ogden, Utah, while taxiing to the runway for takeoff, the aircraft struck a mobile control tower, badly damaging the outboard panel of the wing. The aircraft was grounded until April 29.

On May 22 discussion began to replace the B–17 with an R5–D aircraft. Randall, Holmes, Sparks and Hawbecker went to Corpus Christi, Tex., to discuss the feasibility of converting an R5–D to a photographic aircraft. After these discussions, photography was continued and the mission left Seattle, Wash. on June 7 for Alaska, arriving at Annette Island the same day. While in Alaska, Holmes (fig. 188) relieved Randall as Chief of Party on July 1; Randall joined the USCGS ship PATHFINDER at Dutch Harbor on June 5. The aircraft left Alaska on September 25 and arrived in Seattle the same day. The mission continued to do photography throughout the United States and returned to Washington, D.C., on November 30, when it was secured for the rest of the year.

LIBERIA ACTIVITIES—1955

Photographic work continued throughout Liberia. To permit the Cessna to do photography at a greater distance from its base at Payne Field in Monrovia, 55-gallon drums of gasoline were spotted throughout the country on dirt airstrips (figs. 189 and 190) so that only brief fuel stops were necessary on good photographic days.

The hangar for the aircraft was completed, and with over 600 hours logged on the aircraft, the pilot, Paul J. Bradley, installed a new engine on the Cessna in March (fig. 191).

The joint operation of the Liberian Cartographic Service under the Treasury Department, Republic of Liberia, and the Foreign Operations Administration, under the U.S. Department of State, was dissolved on June 30. The Liberian Cartographic Service was transferred entirely to the Liberian Treasury Department. Although the official agreement had ended, C&GS personnel continued to do the photographic mapping, training, and map compilation on an extended basis in order to complete the original agreement, which was to develop the Liberian Cartographic Service into a self-sufficient mapping organization staffed by Liberian personnel (fig. 192).

The hydrographic work on the Lofa River was completed in November (figs. 193 and 194), and C&GS personnel moved back to Monrovia.

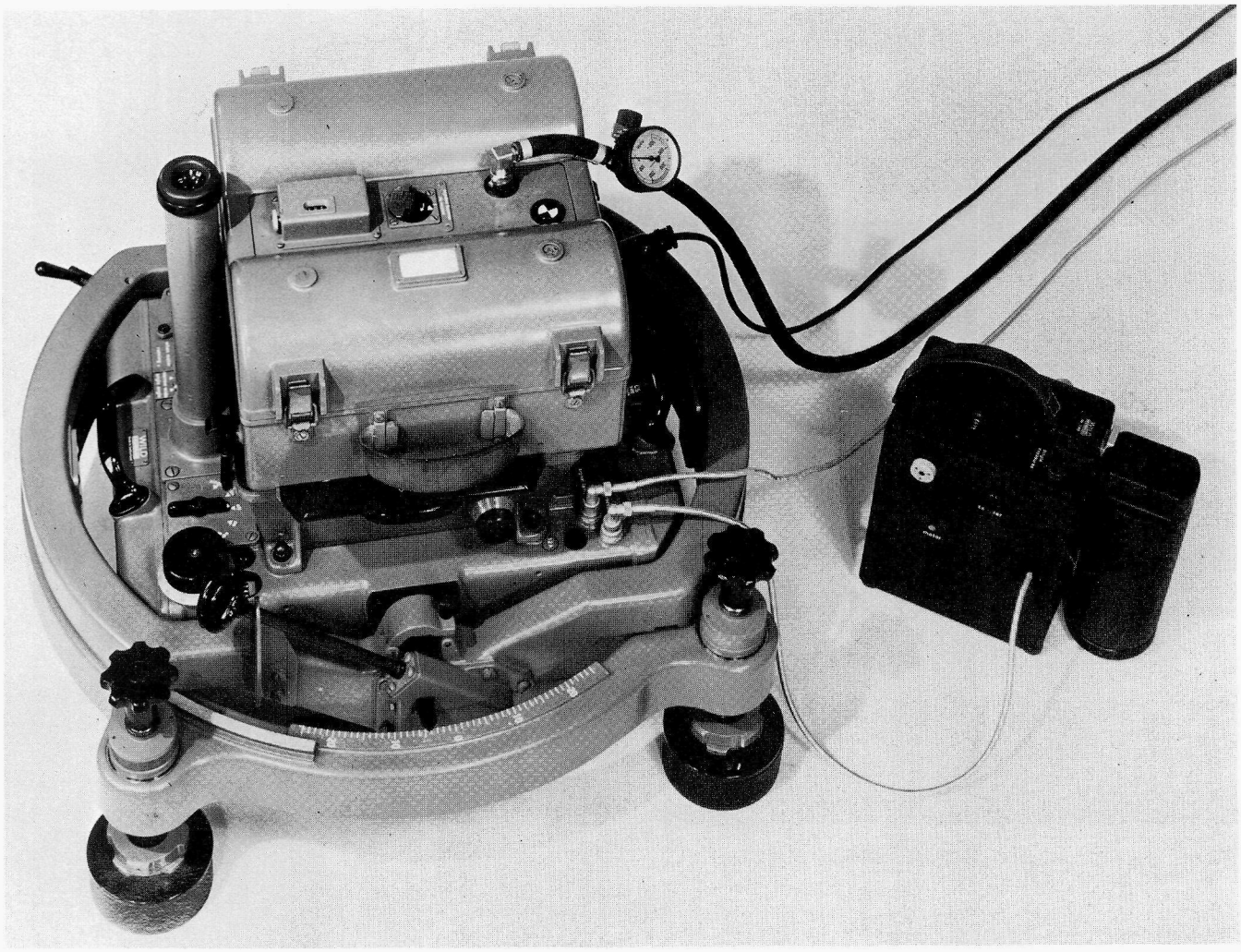


FIGURE 187.—Wild RC−5 camera with statoscope attached. (Photograph courtesy of Wild Company.)



FIGURE 188.—Lt. Alfred C. Holmes. (Official NOS photograph.)



FIGURE 189.—Pilot, Paul J. Bradley, refueling aircraft at Suakoko, Liberia. (Photograph by John T. Smith, Jr.)



FIGURE 190.—John T. Smith, Jr., with motorcycle used for mission personnel transportation in Harper, Liberia. (Photograph by P.J. Bradley.)

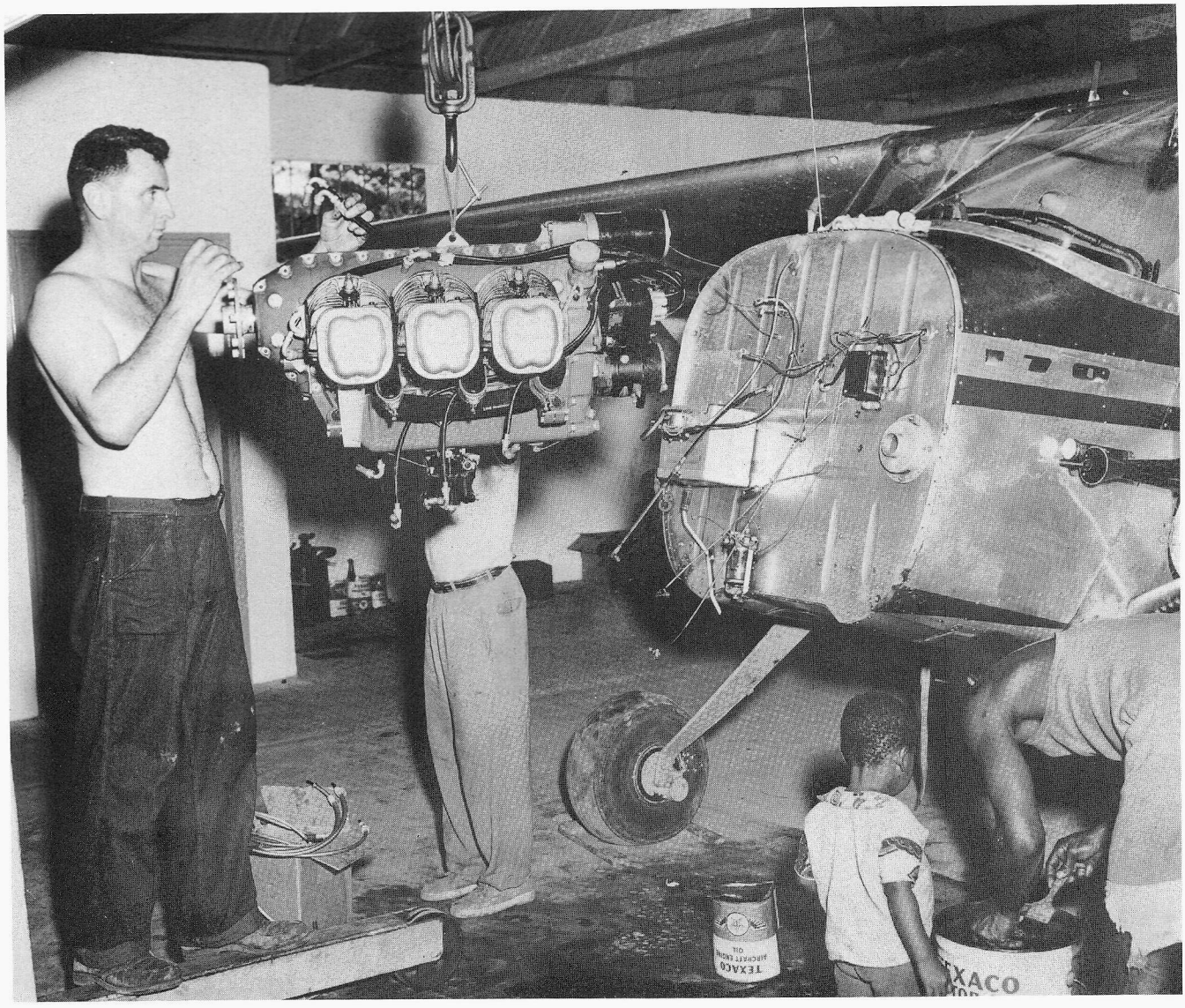


FIGURE 191.—Pilot Paul J. Bradley changing engine on Cessna aircraft. (Photograph by John T. Smith, Jr.)



FIGURE 192.—The Liberian Cartographic Service. Front row, left to right, Hughes, Ajayi, Noah, Rear Adm. Robert Knox, Gibson, Dennis, Yedey, Moses. Back row, left to right, John T. Smith, Jr. (Chief, Div. Reproduction), Woods, Perry, Sawyer, L. Martin Gazik (Chief, Div. Photogrammetry), Capt. Riley J. Sipe (Director), Lt. R. E. Williams (Chief, Div. Geodosy), Cooper, Snowe, Krah, Comdr. Swanson. (Rear Adm. Knox and Comdr. Swanson were in Liberia on an inspection trip.) (Photograph by John T. Smith, Jr.)

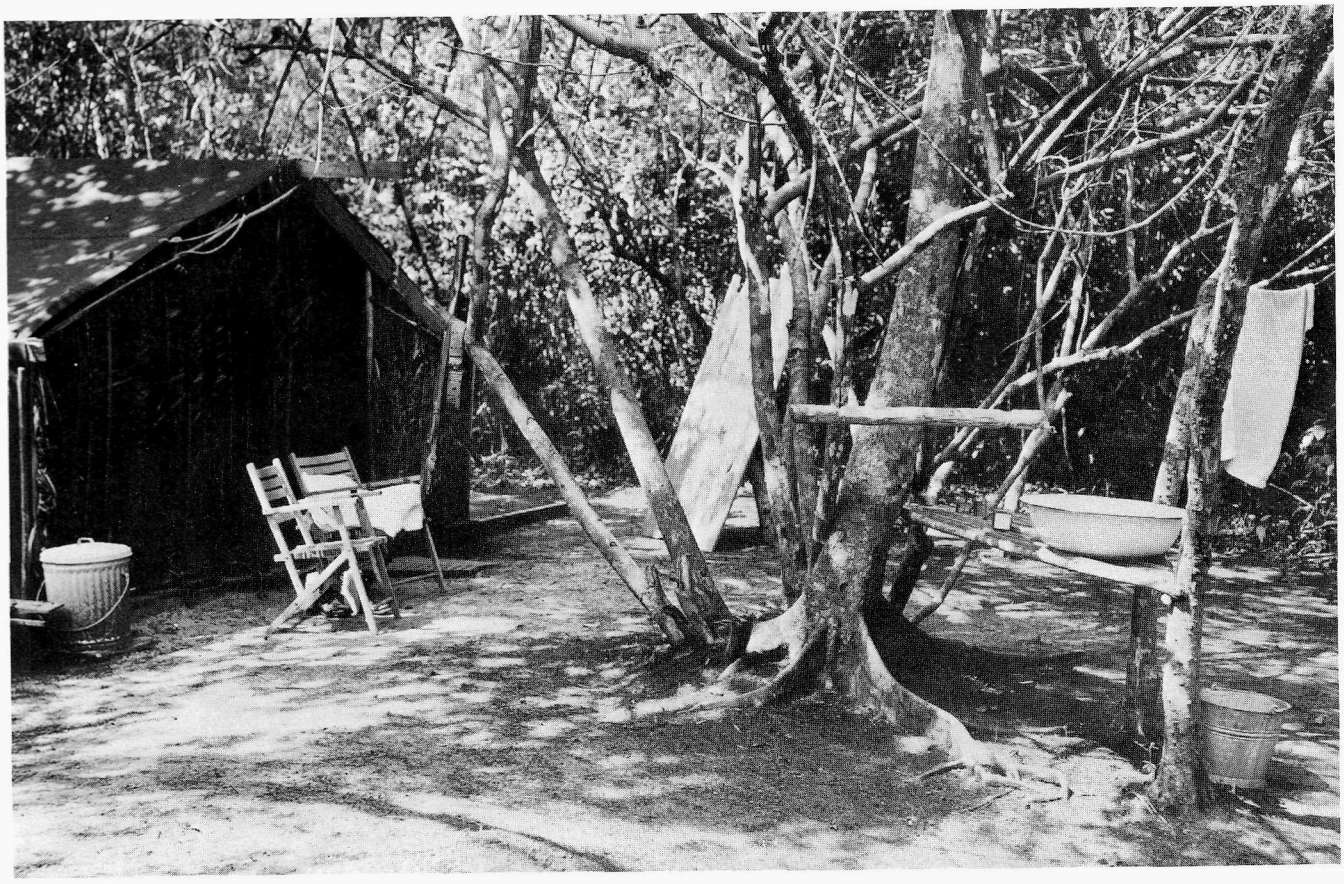


FIGURE 193.—Camp used during hydrographic surveys of the Lofa River. (Photograph by John T. Smith, Jr.)



FIGURE 194.—This enlarged section of an aerial photograph taken from 5,000 feet at the mouth of the Lofa River shows a crocodile sunbathing on the sandpit. (Photograph by John T. Smith, Jr.)

1956

OFFICE ACTIVITIES—1956

In April a Wild RC−8 camera, designated C&GS camera "S", was tested and purchased. This was the first RC−8 camera in the United States (fig. 195).

Capt. Lawrence W. Swanson had begun investigating the use of infrared photography exposed simultaneously with panchromatic film for a water−land interface that would allow the precise recording of the shoreline at a given stage of tide. After confirming that this system would give accurate results, C&GS purchased an infrared camera.

In August the infragon cone for the Wild RC−8 aerial camera was delivered. This was the first infragon cone in the United States, and was designated C&GS "K" camera.

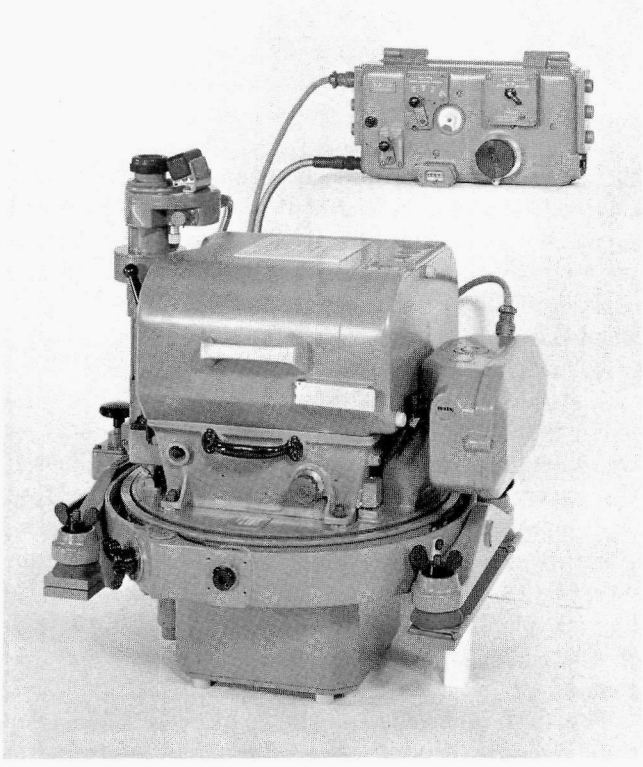


FIGURE 195.—Wild RC−8 camera. (Photograph courtesy of Wild Company.)

FLIGHT ACTIVITIES B−17—1956

PB1G 77254 arrived in Washington, D.C., on April 16, and both the 9-lens and the Wild RC−8 cameras were installed.

The mission left on April 17 to commence photography for the season, with Lt. Alfred C. Holmes as Chief of Party, Lt. Arthur R. Benton, Jr., as navigator, and Bennett S. Sparks and Edwin D. Hawbecker as photographers.

On May 21, in Des Moines, Iowa, Lt. Benton reported: "Following a highly unorthodox takeoff during which a strong crosswind forced the aircraft to leave the runway and to meander through the grass and over drainage ditches, five airports in Minnesota and Wisconsin were photographed, landing at Minneapolis, Minnesota."

The aircraft continued to obtain photography in the United States and departed from San Francisco, Calif., for Alaska on the morning of June 18, arriving at Annette Island, Alaska, on the 19th.

On July 1 Lt. Benton (fig. 196) replaced Lt. Holmes as Chief of Party. The mission remained in Alaska until August 3, when it returned to Portland, Oreg., and did photography in the Western United States until August 11. The mission then returned to Alaska.

The mission was based at Cold Bay on the night of August 29, when a Canadian Pacific Airlines DC−6B crashed (fig. 197) while attempting to land under extreme minimum ceiling conditions. The air photo mission crew helped rescue the seven survivors and continued through the night to search for other survivors and aid in the removal of the bodies from the crash scene. There being no medical facilities at Cold Bay, the USCGS ship PATHFINDER was contacted by radio, and the ship's doctor remained on call throughout the night to advise three local women, who were acting as nurses, on methods for treating three critically injured survivors. The first doctor arrived early the next morning aboard a rescue amphibian aircraft from the Naval Air Station in Kodiak, Alaska.

The mission left Alaska on September 21, and arrived in Seattle, Wash., the same day, returning to Washington, D.C., on September 26. It again left Washington on the 29th to perform photography throughout the Eastern United States. *The first tide-*



FIGURE 196.—Lt. Arthur R. Benton. (Official NOS photograph.)

coordinated photography by C&GS was obtained from September 29 through October 3 over Cobscook Bay, Maine, using the cartographic camera "O" for panchromatic photography and the new Wild infragon cone in the RC−5 camera mount for the infrared photography. Lt. Robert E. Williams was in charge of the ground party supporting the aircraft (figs. 198 and 199).

Photographic operations continued until November 16, when the mission was secured for the rest of the season.

PIPER TRI-PACER ACTIVITIES—1956

Photography was desperately needed for a project by the Bureau of Public Roads to develop the beltway around Washington, D.C., (what is now Highway 95 and 495), and early in the year C&GS rented a Piper Tri-Pacer civilian aircraft for February. Photography was accomplished in the Washington, D.C., area.

Aircraft Piper Tri-Pacer

February 1956

Personnel who served on board:

Coast and Geodetic Survey Officer
Lt. Alfred C. Holmes
Coast and Geodetic Survey Civilians
Edwin D. Hawbecker
Bennett S. Sparks

LIBERIA ACTIVITIES—1956

The Liberian project continued until May 15, when aerial photographic operations were turned over to the Liberian Cartographic Service. All the required photography had been taken, and a Liberian citizen, Robert Perry (fig. 200) had been trained as an aerial photographer. In addition, he was capable of processing aerial film, making prints, laying mosaics, and maintaining the aerial camera.

Whether or not all the goals had been reached, the foundation had been laid for a sound cartographic service to continue operations.

During 1951 to 1956, the period of C&GS involvement, 10 planimetric maps were produced covering the entire country of Liberia, and a number of Liberian citizens were trained in different phases of cartography. In addition to Capt. Sipe (fig. 201) and the flight personnel, in May 1954 Lt. Robert E. Williams replaced Lt. John Boyer, who had returned to the United States in October 1953; L. Martin Gazik served from March 1954 to April 1956 as Chief of the Photogrammetry Division. The mission's accomplishments included:

Photographs of Liberia covered about 87 percent of the country. All of the photographs were indexed. Controlled mosaics at a scale of 1:20,000 covered about 87 percent of Liberia. In addition, hydrographic surveys were completed of the Free Port of Monrovia and of the Lofa River from the entrance to 15 miles inland. Tidal data for the coastal areas had been collected from August 19, 1953, through March 15, 1956.

A street map of downtown Monrovia, showing all public buildings, roads, and streets, was produced, as was a general purpose map of the Republic of Liberia, the latter in a four-color process. This was the first color map printed in Liberia. Topographic maps of Harper, at a scale of 1:4,800, with 5-foot contour intervals, were produced, and reconnaissance shoreline erosion surveys of the Free Port of Monrovia to the St. Paul River entrance were completed. In addition, a map of all the roads in Liberia was completed.

The first Monrovia telephone directory had been compiled and printed. More than half of the first compilation of the geographic names by the Geographic Names Board of the Republic of Liberia had been printed.

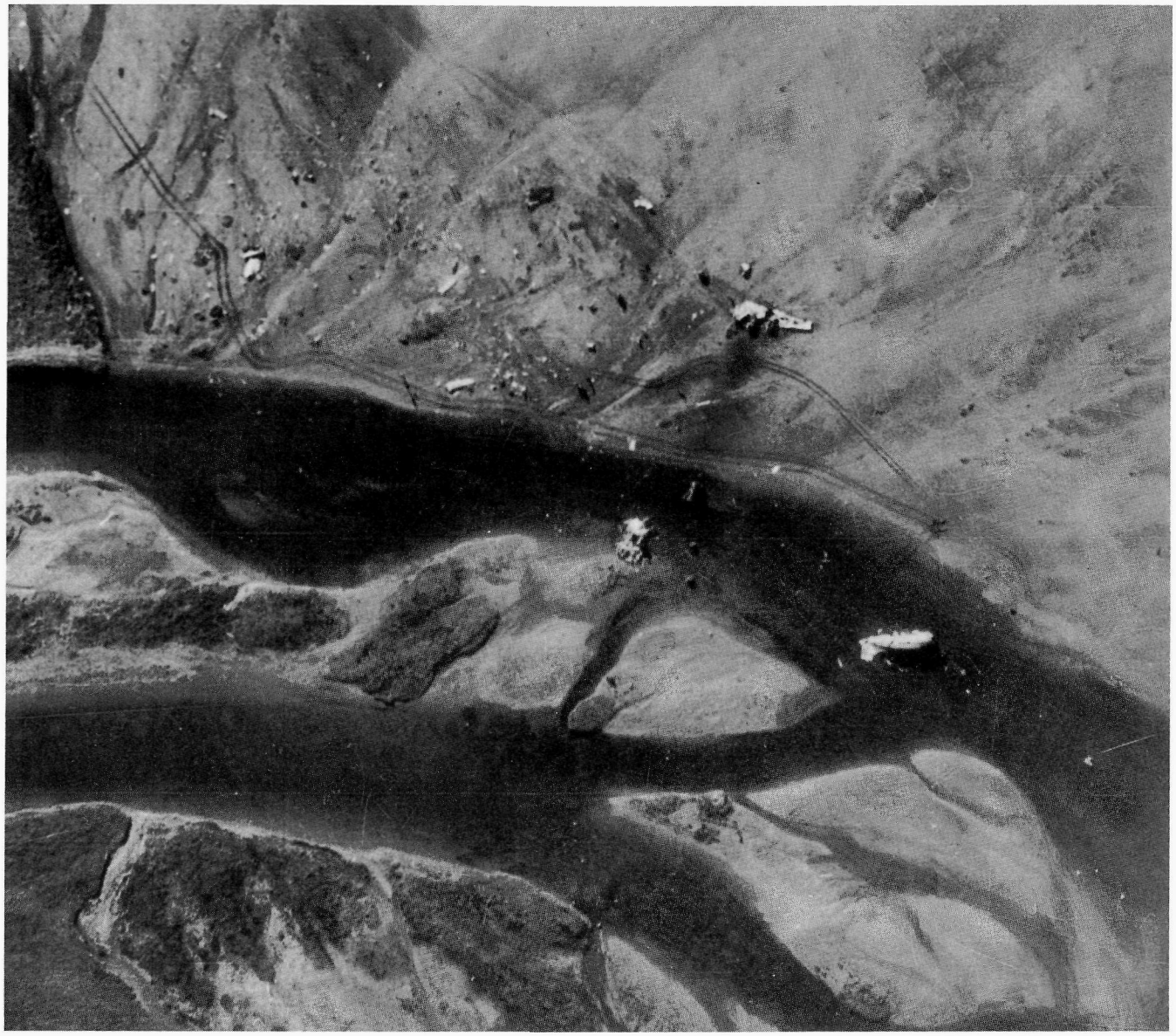


FIGURE 197.—Photograph No. 2926 taken August 31, 1956, with the "W" camera of the crash of a Canadian Pacific Airline DC–6 at Cold Bay, Alaska. The debris is strewn over quite an area. (Photograph by Edwin D. Hawbecker.)

Aircraft - Liberian Cartographic Service
Cessna 170 No. N1207D

October 1953 to March 1956
Personnel who served on board:

Coast and Geodetic Survey Officer
Capt. Riley J. Sipe
Coast and Geodetic Survey Civilians
Paul J. Bradley
Edwin D. Hawbecker
John T. Smith, Jr.



FIGURE 198.—Panchromatic film.

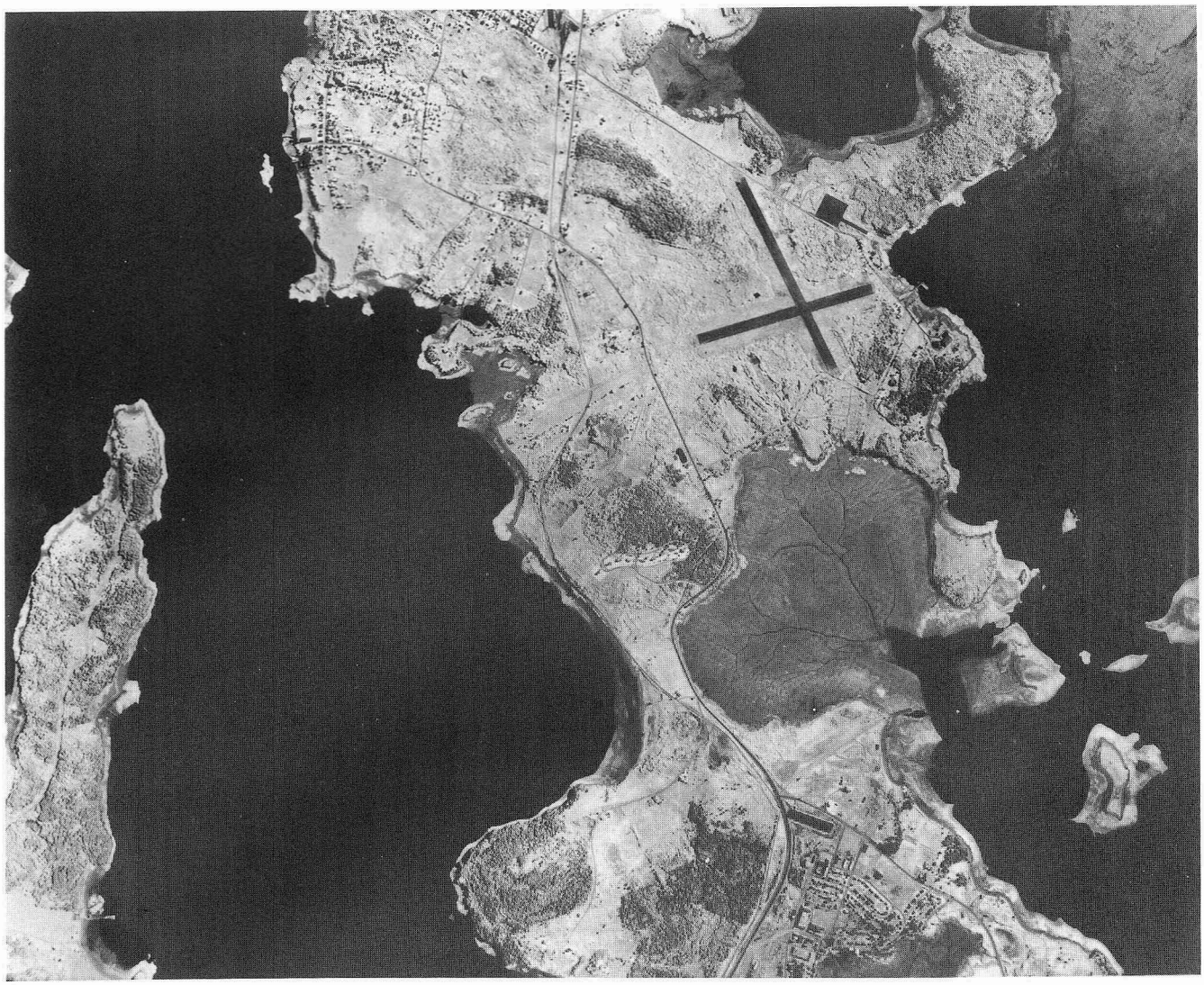


FIGURE 199.—Infrared Film.

Panchromatic and infrared comparisons. The photograph on the left, No. 56–0–647, is a panchromatic photograph over Eastport, Maine, taken on September 30, 1956. (Photograph by Bennett S. Sparks.) Photograph on the right, No. 56–L–271R, is of the same area taken simultaneously with the panchromatic photography, but is taken with infrared film showing the sharp delineation of the water-land interface. The original scale of photography is 1:17,000. (Photograph by Edwin D. Hawbecker.)

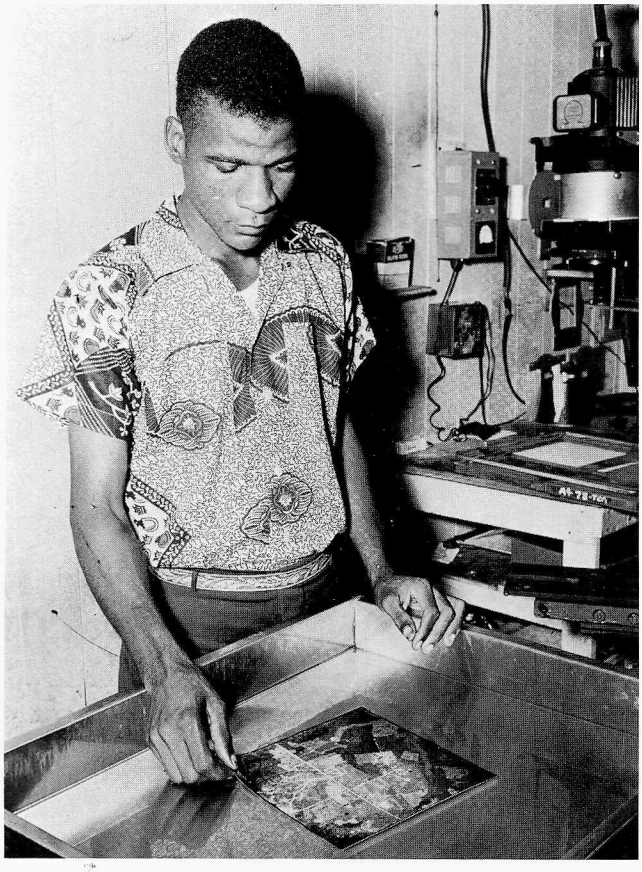


FIGURE 200.—Robert Perry, Liberian citizen and first Liberian aerial photographer, processing aerial photograph in Liberian Cartographic Service darkroom. (Photograph by John T. Smith, Jr.)



FIGURE 201.—Capt. Riley J. Sipe. (Photograph by John T. Smith, Jr.)

1957

AIR PHOTO MISSION 701 ACTIVITIES—1957

PB1G 77254 arrived in Washington, D.C., on April 1, and installation of the cameras, which included the 9-lens and the Wild "W" and "K" cameras, continued until April 3, when the aircraft left to start the season with Chief of Party Lt. Arthur R. Benton, Jr., and Lt. Merlyn E. Natto as navigators, and Bennett Sparks and Edwin Hawbecker as photographers. (The mission was now designated Air Photo Mission 701).

The aircraft obtained photography in the United States until May 17, when 77254 left Seattle, Wash., arriving in Anchorage, Alaska, the same day. Photography continued in Alaska until July 18, when the mission returned from Cold Bay to Seattle, where Lt. Natto (fig. 202) relieved Lt. Benton as Chief of Party.



FIGURE 202.—Lt. Merlyn E. Natto. (Official NOS photograph.)

On August 4 Lt. Natto reported: "While in Ogden, Utah, an unidentified Air Force plane taxied into the B−17 causing extensive damage to the nose section and the loss of the instrument landing system antenna. Replacement of the nose bubble was necessary." Repairs were completed by August 13, and the mission continued photography in the West until August 20, when it returned to Alaska and remained until October 17. The plane returned to Seattle, Wash., and the mission worked its way across country to Washington, D.C., arriving on November 25, at which time it was secured for the rest of the season.

AIR PHOTO MISSION 702 ACTIVITIES—1957

The Federal Aviation Administration was developing the Omni Range Program, and photography was needed to control the sites for the positioning of the Omni stations. On August 1, a new photographic mission was inaugurated (Mission 702), the first (except for a few short-term operations) solely under C&GS control. The aircraft, which was leased by C&GS, was an Aero Commander 680E N6889S (fig. 203) equipped with a new Wild RC−8 camera "S" (fig. 204). Lt. Alfred C. Holmes served as Chief of Party and pilot; Lt. Arthur R. Benton, Jr., copilot/navigator; and John T. Smith, Jr., photographer. Activated in Atlanta, Ga., on August 3, the mission immediately started photography through the United States. (figs. 205, 206, 207 and 208).

On September 20 Lt. Benton was transferred, and Smith assumed his duties. The mission operated until the end of the year as a two-man team. On December 31 the mission was in Boca Grande, Fla.

OFFICE ACTIVITIES—1957

In March the new Wild A−5 autograph plotting instrument was placed into operation.



FIGURE 203.—Aero Commander 680E N6889S. (Photograph by William G. Riggs.)

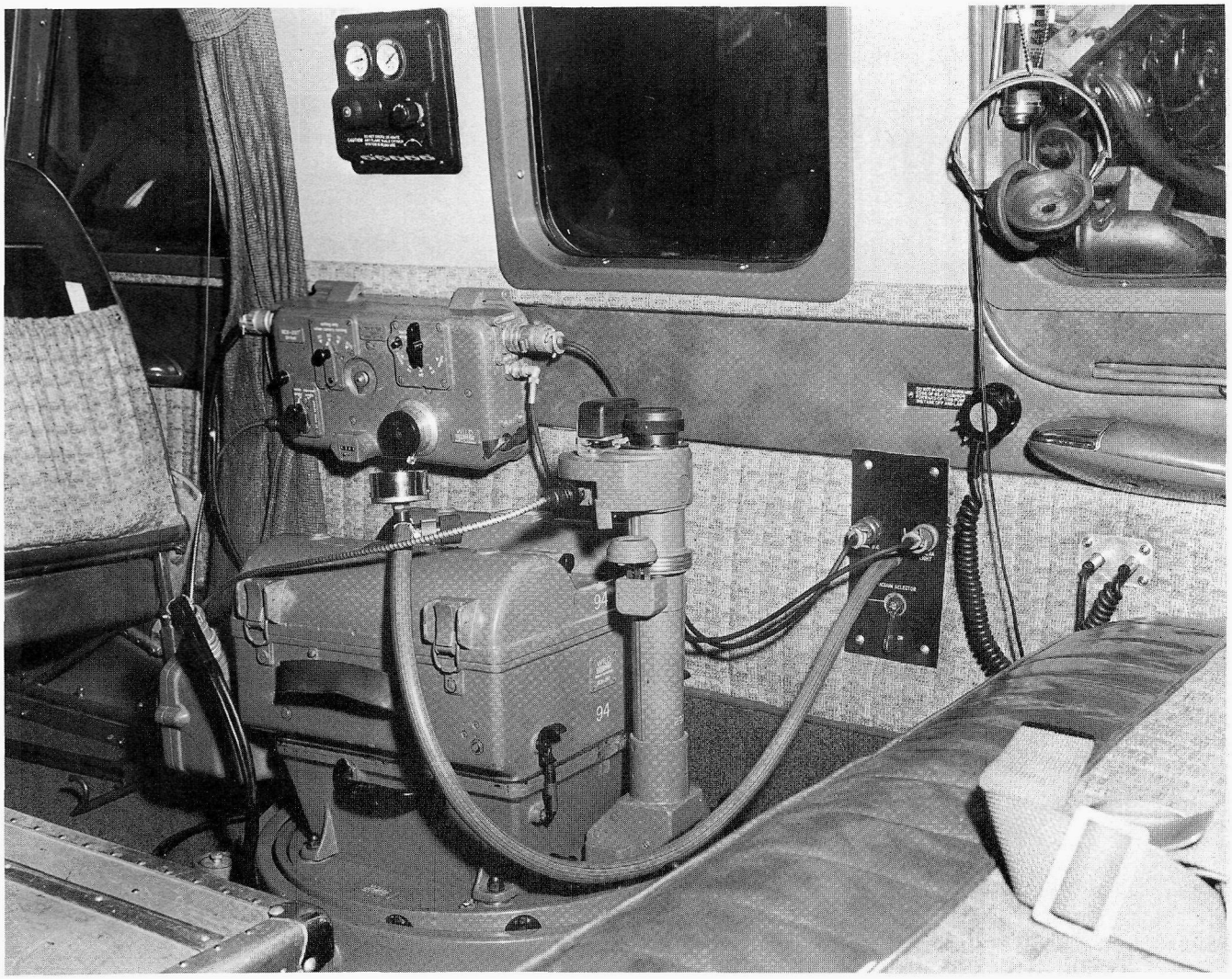


FIGURE 204.—RC–8 camera "S" installed in Aero Commander. (Photograph by John T. Smith, Jr.)



FIGURE 205.—Pilot Lt. Alfred C. Holmes on right, copilot John T. Smith, Jr., left. Note the two white pointers on the nose of the aircraft which were used for navigation in conjunction with the pointer on the bar across the windshield. (Photograph by W. Byron Hale.)

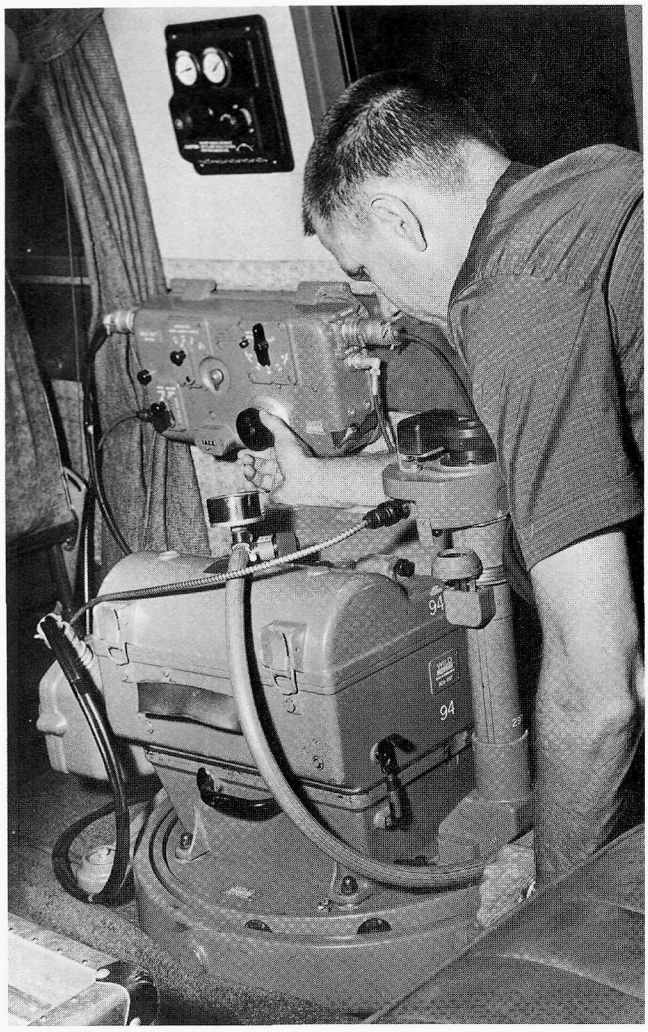


FIGURE 206.—Photographer John T. Smith, Jr., operating RC–8 camera on Aero Commander. (Photograph by Lt. A. C. Holmes.)



FIGURE 207.—The office really did not understand the limitations in the cockpit of N6889S; therefore, at 2:00 a.m., Lt. Holmes was transferring the flight lines from the charts supplied for photographic operations in the north midwest, U.S.A. (Photograph by John T. Smith, Jr.)



FIGURE 208.—Semioblique of Washington, D.C., showing snow and ice on the Potomac River. (Photograph by John T. Smith, Jr.)

1958

AIR PHOTO MISSION 701 ACTIVITIES—1958

The season began for PB1G 77254 on May 19 when the 9-lens and Wild RC−5 cameras were installed and the aircraft left Washington, D. C., for Alaska on the 23rd, with Lt. Merlyn Natto as navigator and W. Byron Hale as photographer. The mission arrived in Alaska on May 27 and continued photography in Alaska until September 23 when it returned to Seattle, Wash., then worked its way across country (fig. 209).

On October 13 William G. Riggs reported aboard the aircraft as a trainee photographer, and on October 19 W. Byron Hale was transferred to Air Photo Mission 702 and John T. Smith, Jr., transferred to Air Photo Mission 701 to test color films.

Capt. Swanson developed an experimental program with color aerial film after looking at color aerial slides he had taken which showed good water penetration capabilities of color photography. The test results showed good color film could be obtained by reformulating the chemistry for processing and, indeed, photobathymetry could be produced using aerial color film over specific types of ocean bottom. Swanson then ordered the first color photobathymetry to be done in October and November at San Juan, P. R. Many obstacles remained: processing techniques had to be developed; full spectrum color light sources had to be installed both in the laboratory printing equipment as well as the plotting equipment; and color-corrected lenses were necessary on the aerial cameras. But the groundwork was laid, and the program progressed at a rapid rate.

Tests were completed in Florida on October 23, and the mission left the United States and arrived in San Juan, P. R. on October 26. There it obtained *the first successful color aerial photography for photobathymetry*. The mission returned to the United States on November 7, arriving in Washington, D. C., on November 12 when the mission was secured for the rest of the year.

AIR PHOTO MISSION 702 ACTIVITIES—1958

Aero Commander N6889S continued photographic operations with the Chief of Mission Lt. Alfred C. Holmes, pilot, and John T. Smith, Jr., copilot photographer. Because of illness, Lt. Holmes was relieved as Chief of Mission in June by John T. Smith, Jr., and a civilian pilot, Adrian Burggraff, joined the mission as pilot. Lt. Richard H. Houlder (fig. 210) reported aboard on August 8. On August 21 the mission successfully completed the first experimental color aerial photography by C&GS. On September 1 Lt. Houlder relieved Smith as Chief of Mission.

On October 19 W. Byron Hale replaced John T. Smith, Jr., as photographer, and the mission continued photography until December 1, when it was secured for the rest of the season. (figs. 211 and 212).

OFFICE ACTIVITIES—1958

On February 23, Edwin D. Hawbecker resigned from C&GS.



FIGURE 209.—Lt. Merlyn E. Natto at Navigation Station on B–17 77254. (Photograph by Edwin D. Hawbecker.)



FIGURE 210.—Lt. Richard H. Houlder. (Official NOS photograph.)

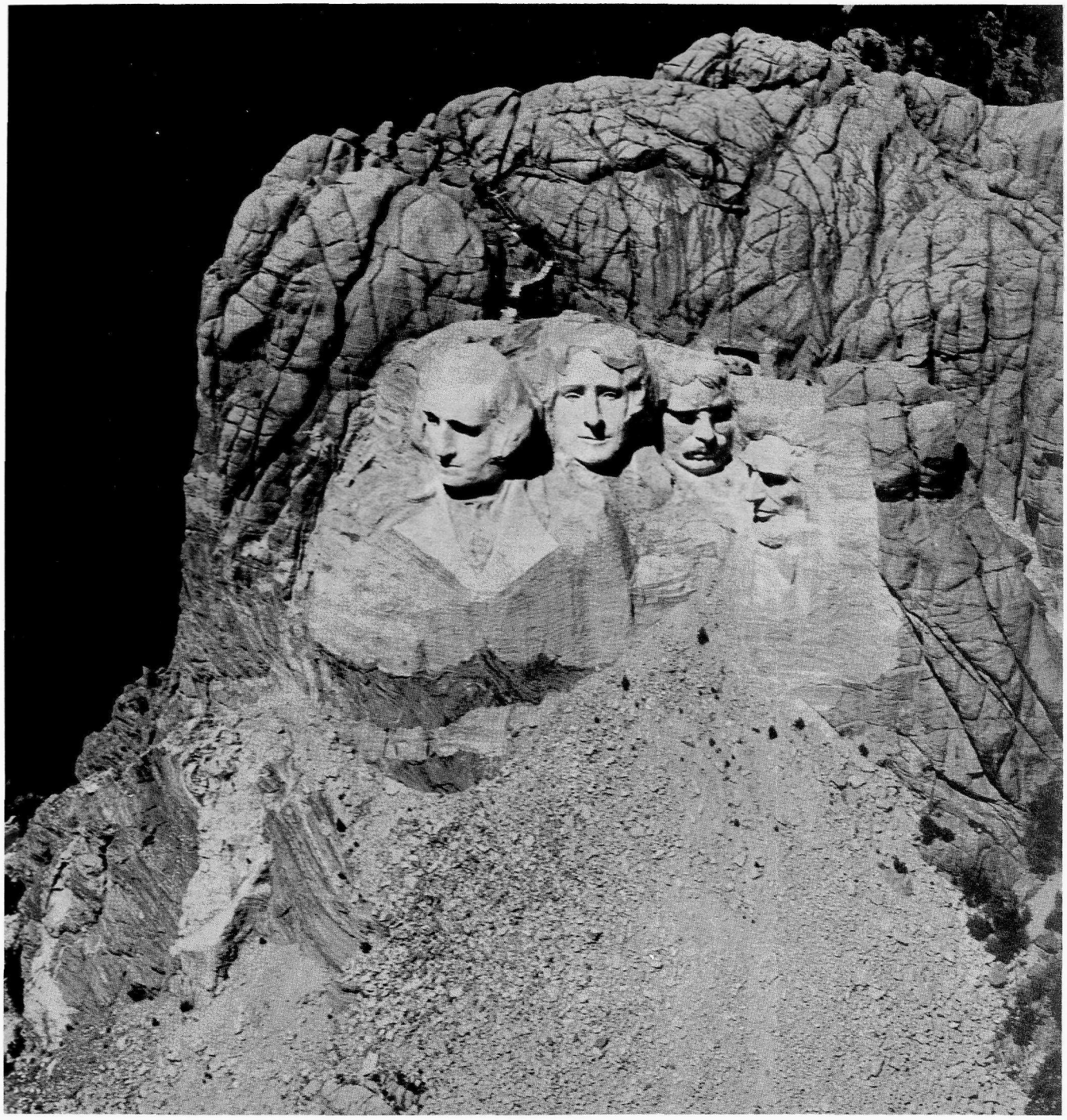


FIGURE 211.—Mt. Rushmore in the Black Hills, S.Dak. Photograph No. 58–S–3738, taken on May 20. (Photograph by John T. Smith, Jr. and Lt. A. C. Holmes.)

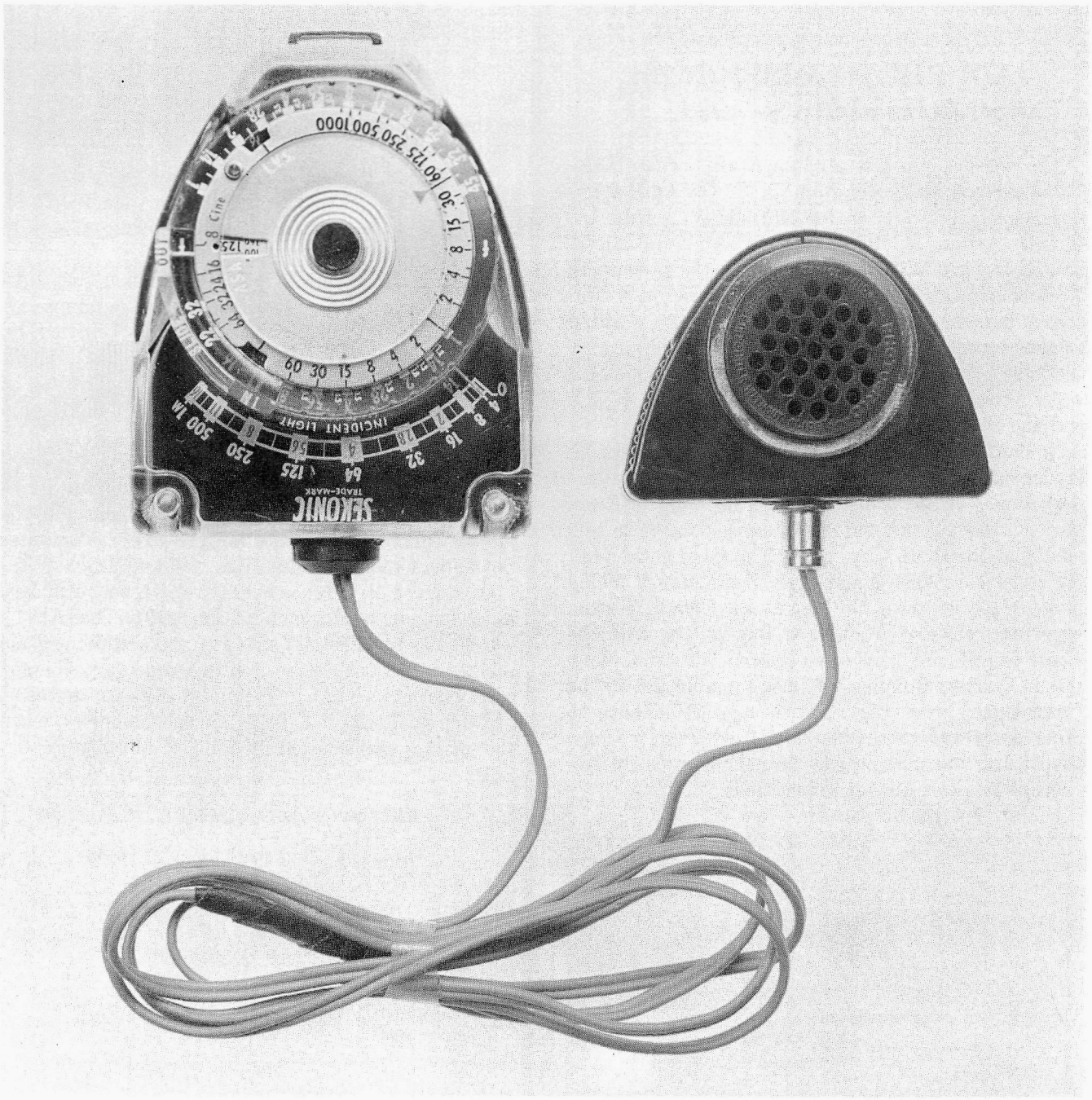


FIGURE 212.—As the need for correct exposure was more critical with the use of color film, a standard exposure light meter was modified by removing the sensing head and attaching this to the camera mount, connecting by a cable to the recording head which was located by the photographer. The sensing cell was coned to a 20-degree field of coverage. (Photograph by John T. Smith, Jr.)

1959

AIR PHOTO MISSION 701 ACTIVITIES—1959

The mission was activated on April 1 when PB1G 77254 arrived in Washington, D. C. On April 3 the mission left Washington for Norfolk, Va., with Lt. Comdr. Arthur R. Benton, navigator, and John T. Smith, Jr., and William G. Riggs, photographers. In Norfolk a meeting was held with Operation & Research personnel of the Navy who would be working on the conversion of an R5–D Coast Guard aircraft that was scheduled to replace 77254 in 1960. On April 9 the aircraft left Miami, Fla. for San Juan, P. R., arriving that afternoon.

Bennett G. Jones of the Photogrammetry Division accompanied the aircraft to observe color photographic operations. After completion of the Puerto Rican project, the aircraft left San Juan on April 25 and landed at Elizabeth City, N. C. The mission then left for Alaska on May 2 and arrived on May 9, doing photography enroute. On May 23 Lt. Comdr. Benton reported: "On arrival at Cold Bay on the 21st the Coast Guard senior aviator declared our usual quarters in Quonset Building T-9 unsuitable for use by the Coast Guard crew. (figs. 213 through 216). Since no other quarters were available at Cold Bay for Coast Guard use, the mission was forced to return to Anchorage to await further instructions.

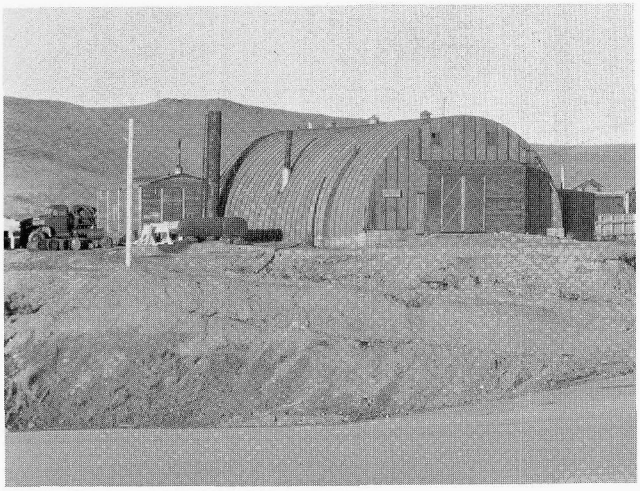


FIGURE 213.—Quonset hut used by Air Photo Mission crew while staying at Cold Bay, Alaska. (Photograph by John T. Smith, Jr.)

"On arrival at Elmendorf Air Force Base, both the senior aviator and the chief of the party sent messages to their respective headquarters advising of the Cold Bay situation.

"On May 22, the senior aviator received instructions from the Coast Guard to proceed to Cold Bay." On July 22 William Riggs returned from the mission to Washington, D. C.

Capt. L. W. Swanson held the opinion that tidal current surveys could be done by photogrammetry, and a pilot program was scheduled at Lituya Bay, Alaska. Accordingly, on August 10, 11 and 15, *the first current surveys by photogrammetry* were done at Lituya Bay with the cooperation of the USCGS ship BOWIE.

Deploying 4- by 8-foot sheets of plywood painted white in the mouth of Lituya Bay at 5-minute intervals, the ship made current measurements while the aircraft photographed the targets every 5 minutes throughout the tidal cycle (figs. 217 and 218).

On August 18, Terence K. O'Driscoll reported aboard as a trainee photographer (fig. 219). The Alaska season was terminated on August 26, and the mission arrived in Seattle, Wash., on the same day. The aircraft worked its way across country (figs. 220 and 221), arriving at Elizabeth City, N. C. on October 14, when the mission was secured for the rest of the year (fig. 222).

Aircraft Coast Guard PB1G 77254

March 26, 1947 to October 14, 1959

Personnel who served on board:

Coast Guard

AD2 Kenneth L. Balkenbush
Crew Chief

AD2 George E. Barnard
Crew Chief

AD2 Colan Best
Crew Chief

AD1 Herbert F. Bolte
Crew Chief

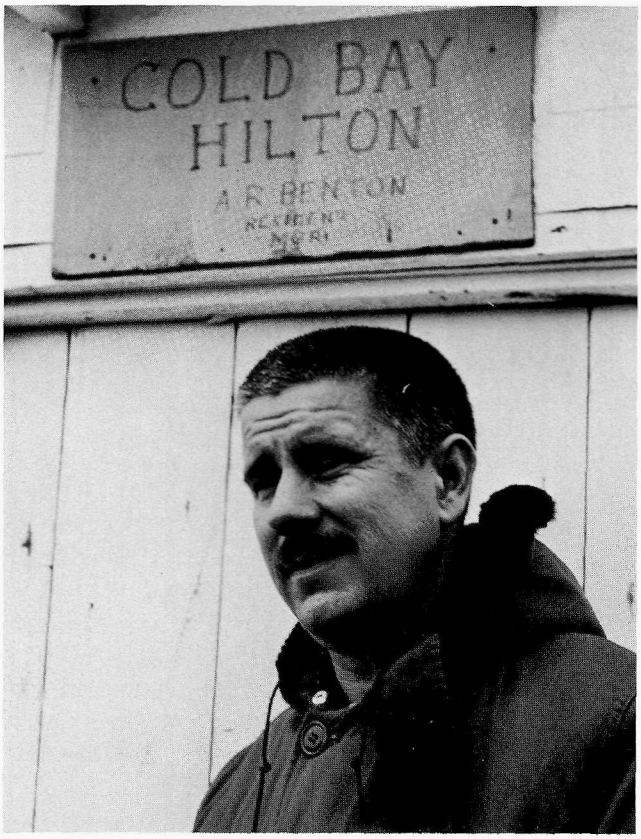


FIGURE 214.—Photographer John T. Smith, Jr., in front of the "Cold Bay Hilton." (Photograph by Lt. A. R. Benton.)

Lt. Bolton
Pilot

AD2 James S. Brand
Radio Operator

Lt. Robert Branham
Pilot

Chief AP Kenneth Canion
Pilot

AD1 Julian C. Crane
Pilot

Lt. Comdr. Crosby
Pilot

AD2 William M. Curtis
Radio Operator

Lt. Dillian
Pilot

Lt. Comdr. William N. Durham
Pilot

ATI Billy K. Evans
Radio Operator

Lt.(jg.) Lloyd E. Franke
Pilot

Lt. David D. Fritts
Pilot

AD2 Randolph O. Grady
Mechanic

AD2 George L. Harrison
Mechanic

Lt. Ernest D. Hedrick
Pilot

Lt. Comdr. Keith Low
Pilot

Lt. Comdr. Augustus Kleisch
Pilot

Lt. J. J. Lamping
Pilot

Lt. Roger F. Lanier
Pilot

AD2 Jacques M. Leitner
Mechanic

AD1 Marvin L. Lofton
Crew Chief

AD2 I. Mabus
Mechanic

Lt.(jg.) Elmer P. Mathison
Pilot

Lt. Comdr. Fred Meritt
Pilot

Lt. Comdr. Charles E. Muller
Pilot

Lt.(jg.) Paul McGill, Jr.
Pilot

Lt. G. E. McGovern
Pilot

McLenden



FIGURE 215.—View toward the galley in quonset hut; note the hot water heater system on top of the stove. (Photograph by John T. Smith, Jr.)

AL2 P. S. Owens
Radio Operator

Lt.(jg.) J. Pfeiffer
Pilot

AD2 Lyndon L. Potter
Crew Chief

Ryan

AD1 Robert J. Sampson
Crew Chief

AD1 E. V. Sapp
Crew Chief

AD1 R. G. Schmidt
Crew Chief

AD2 Winchell D. Smith
Crew Chief

AT1 Bennett S. Sparks
Radio Operator

Lt. J. W. Swanson
Pilot

AT1 Percy E. Talkington
Radio Operator

AD2 W. R. Taylor
Mechanic

Warsham
Mechanic

ADC B. F. Weems
Pilot

AL2 Wayne E. Whitmire
Radio Operator

AD1 Ray H. Woody
Crew Chief

Lt. Comdr. W. Young
Pilot



FIGURE 216.—Interior view of quonset hut occupied by the crew of 77254. (Photograph by John T. Smith, Jr.)

Coast and Geodetic Survey Officers

Lt. Comdr. Arthur R. Benton
Lt. Alfred C. Holmes
Lt. Merlyn E. Natto
Lt. Samuel D. Parkinson
Lt. Hubert A. Paton
Lt. William E. Randall
Lt. Loren G. Taylor

Coast and Geodetic Survey Civilians

Ralph M. Berry
W. Byron Hale
Edwin D. Hawbecker
Terrence K. O'Driscoll
Howard W. Payne
William G. Riggs
John T. Smith, Jr.
Bennett S. Sparks

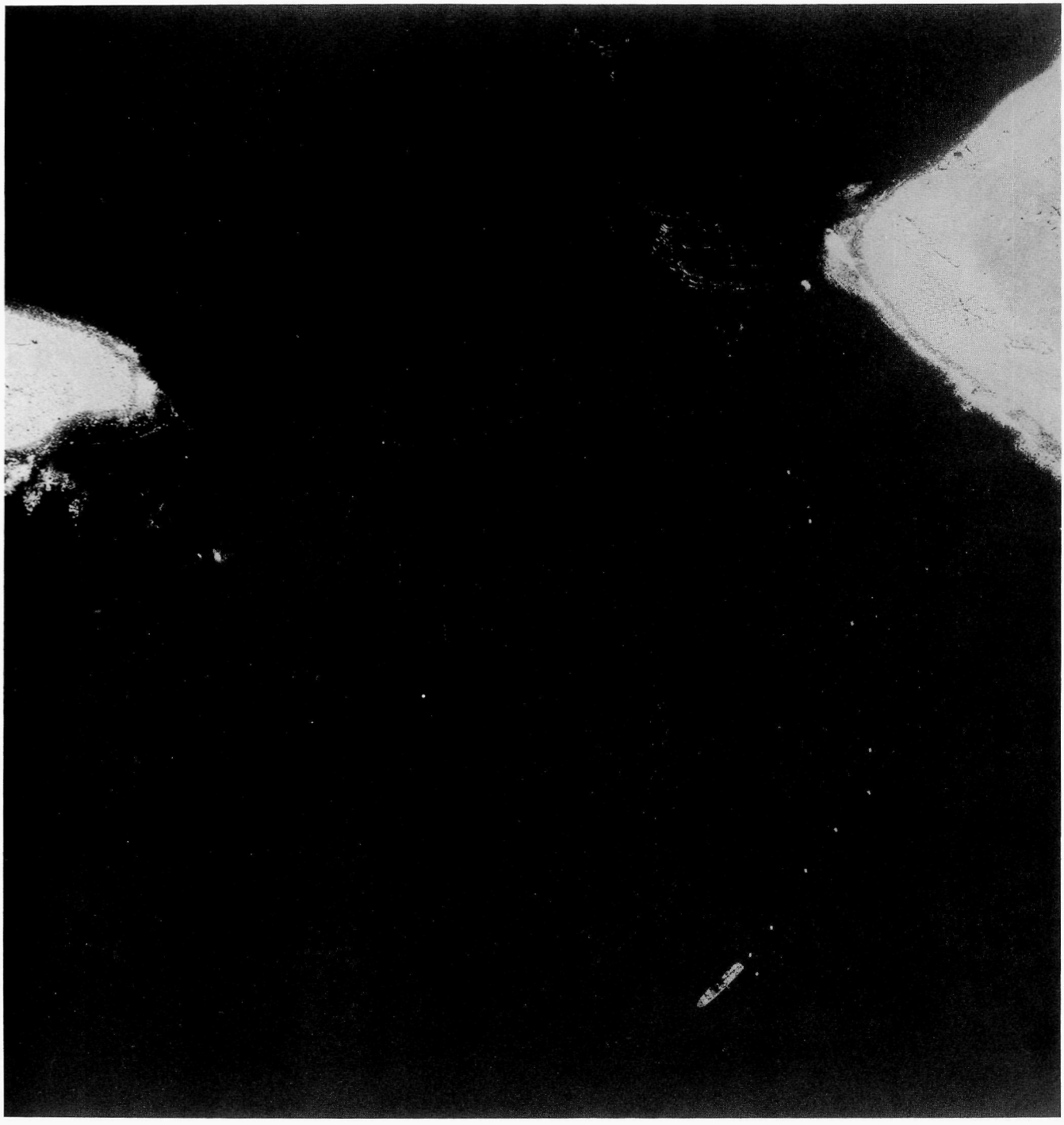


FIGURE 217—The USC&GS ship BOWIE deploying targets for first current survey at the entrance of Lituya Bay, Alaska. Photograph was taken August 11, with the "L" camera, photograph No. 8011. (Photograph by John T. Smith, Jr.)



FIGURE 218.—The USC&GS ship BOWIE deploys targets for first current survey by photogrammetric methods at Lituya Bay, Alaska. Taken on August 15, with the "L" camera, photograph No. 8049. (Photograph by John T. Smith, Jr.)

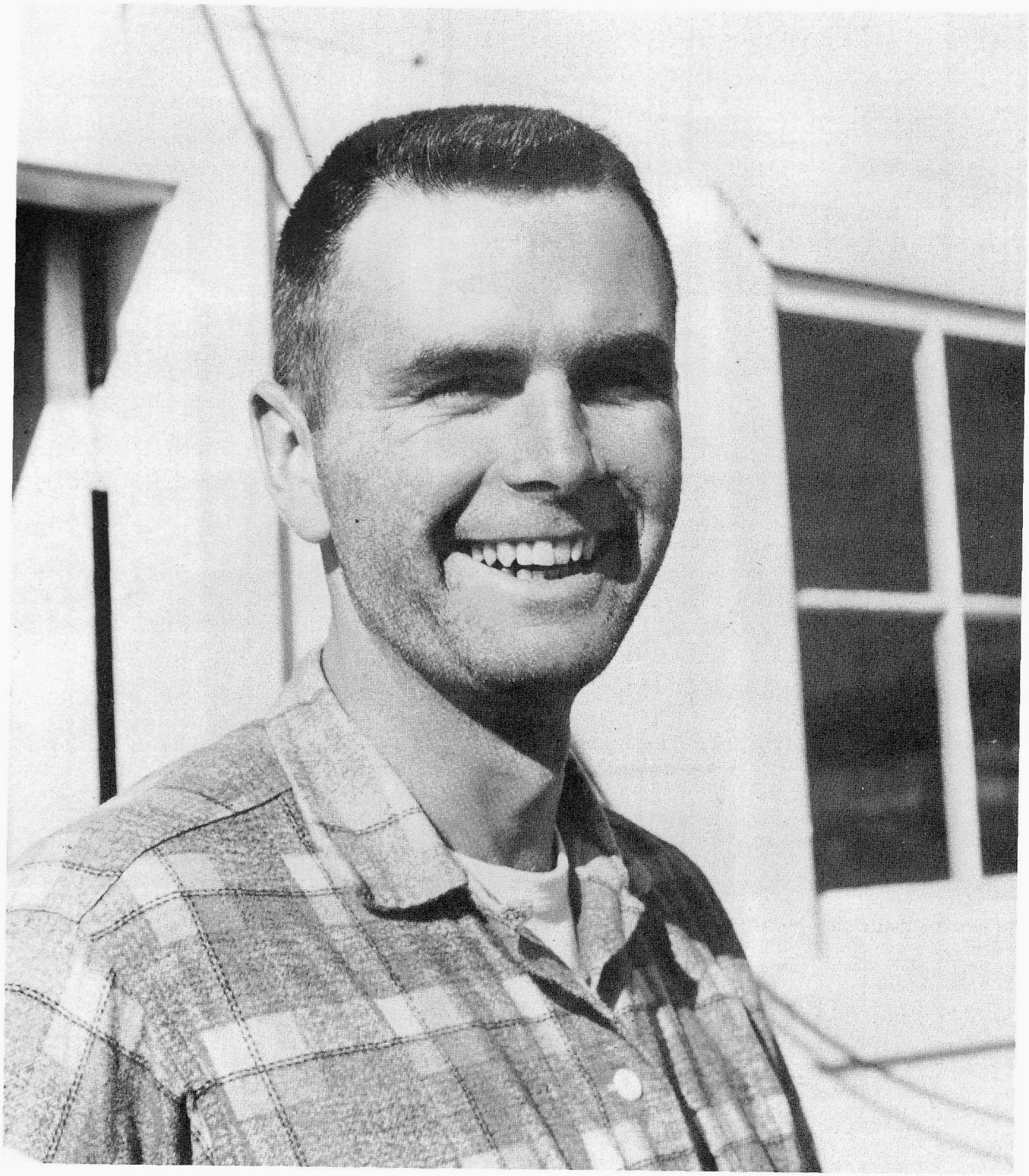


FIGURE 219.—Photographer Terence K. O'Driscoll. (Photograph by John T. Smith, Jr.)



FIGURE 220.—B–17 77254 at Boeing Field, Seattle, Wash.; the last B–17 in military service on her last flight across country. Left to right are the crew members; Terence K. O'Driscoll (USC&GS), Lt. Robert Branham (USCG), Percy E. Talkington (USCG), Lt. Comdr. Arthur Benton (USC&GS), George Harrison (USCG), Lt. Comdr. Fred Meritt (USCG), John T. Smith, Jr. (USC&GS), R. G. Schmidt (USCG), and Warsham (USCG). (Photograph courtesy Boeing Aircraft Company.)



FIGURE 221.—Crew of Coast Guard B–17 inspecting the 9-lens camera. Left to right: Lt. Comdr. Fred Meritt (USCG), Lt. Comdr. Arthur Benton (USC&GS), John T. Smith, Jr. (USC&GS), Terence K. O'Driscoll (USC&GS). (Photograph courtesy Boeing Aircraft Company.)



FIGURE 222.—After 13 years of service with the Coast and Geodetic Survey, Coast Guard PB1G 77254 (B–17) awaits dismantling shortly after her arrival at Elizabeth City, N.C., on October 14. "She was an excellent photographic aircraft and a gallant airplane that carried her crew safely through many a storm and even though her nickname was 'Old Rotten Wings' we all loved her." (Photograph courtesy Willard Kuncis.)

1959

AIR PHOTO MISSION 702 ACTIVITIES—1959

Aero Commander N6889S was activated in March with Lt. Alfred C. Holmes, Chief of Mission; Lt. Richard Houlder, copilot/navigator (figs. 223 and 224); and W. Byron Hale, photographer. The mission continued photography throughout the United States until December 15, when it secured for the rest of the year.



FIGURE 223.—Pilot and copilot of N6889S. Left to right: Lt. Alfred C. Holmes and Lt. Richard H. Houlder with camera and parachute equipment prior to installation on the aircraft. (Photograph by W. Byron Hale.)



FIGURE 224.—Aircraft N6889S in flight, Lt. Alfred C. Holmes on left and Lt. Richard Houlder, right. (Photograph by W. Byron Hale.)

1960

AIR PHOTO MISSION 701 ACTIVITIES—1960

The new Coast Guard R5-D aircraft, No. 72486 (DC-4) (fig. 225) was tested on August 4. The windscreen designed to protect the 9-lens camera mirrors from engine oil was not satisfactory. August 5 to 16 was spent in designing and installing a new windscreen which solved the camera problem, but the aircraft flew as though the flaps were down at all times. This decreased the maximum operational altitude to just below 20,000 feet. In addition to the 9-lens camera (figs. 226 and 227), the aircraft carried the Wild RC−8 "S" camera (fig. 228) and a new super wide-angle 88 mm Wild RC−9 camera purchased on July 22 and designated C&GS camera "M" (figs. 229 and 230). The mission completed the test on August 16 and left for Alaska on August 17 with Lt. Comdr. Merlyn E. Natto, navigator, and Charles Waldron and William Riggs, photographers (fig. 231).

Arriving in Alaska on August 23, the mission remained until September 20, when it returned to Seattle, Wash., then moved to San Francisco, Calif. on the 26th, and left on the 30th for Honolulu, Hawaii, arriving the same day. The mission completed the Hawaii photography and returned to San Francisco on October 30, working its way across country and arriving in Washington, D. C., on November 26, when it was secured on November 30 for the rest of the season.

AIR PHOTO MISSION 702 ACTIVITIES—1960

Aero Commander N6889S was activated on February 15 and commenced photography on the 19th with Lt. Richard H. Houlder, Chief of Mission and pilot; Lt. James P. Randall, copilot/navigator; and William G. Riggs, photographer (fig. 232). On July 22 Riggs was replaced by W. Byron Hale. The mission continued photography throughout the United States (figs. 233 and 234) until December 13, when it arrived in Washington, D. C., and was secured for the rest of the season.

OFFICE ACTIVITIES—1960

In June, Theodore Hanford retired, and John T. Smith, Jr., was appointed Chief of the Aerial Photographic Laboratory.



FIGURE 225.—Coast guard R5–D (DC4) aircraft, No. 72486, manufactured by Douglas Aircraft had a wingspan of 117 feet, was 93 feet long and 27 feet high; with a gross weight of 65,000 pounds, cruising speed of 210 miles per hour, and a range of 2,200 miles. It commenced service as a Coast and Geodetic Survey, U.S. Coast Guard cooperative photographic aircraft on August 4. (Photograph by John T. Smith, Jr.)

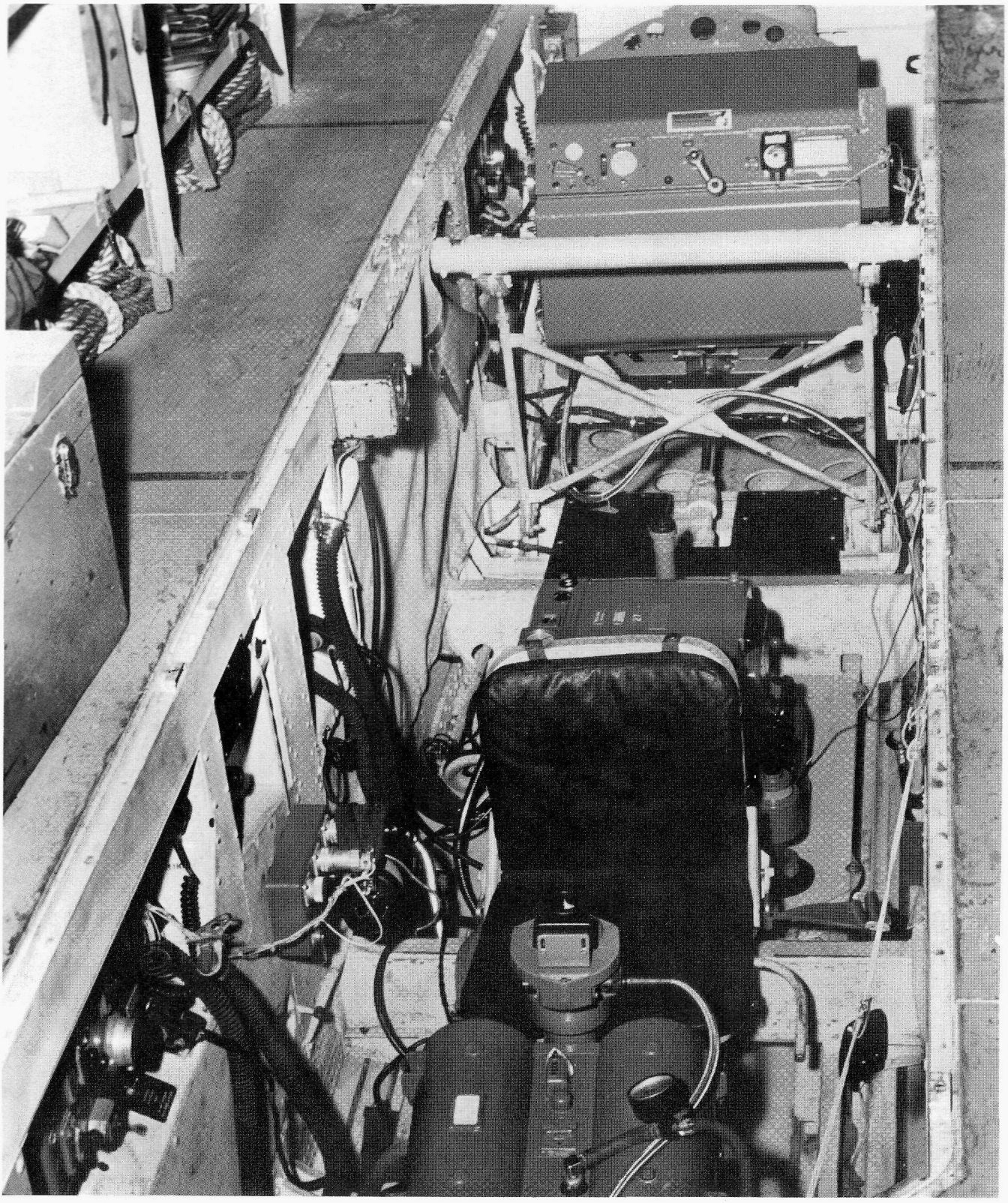


FIGURE 226.—Three cameras were mounted in the R5–D, and RC–8 forward, an RC–9 in the center, and the 9-lens camera aft. (Photograph by John T. Smith, Jr.)

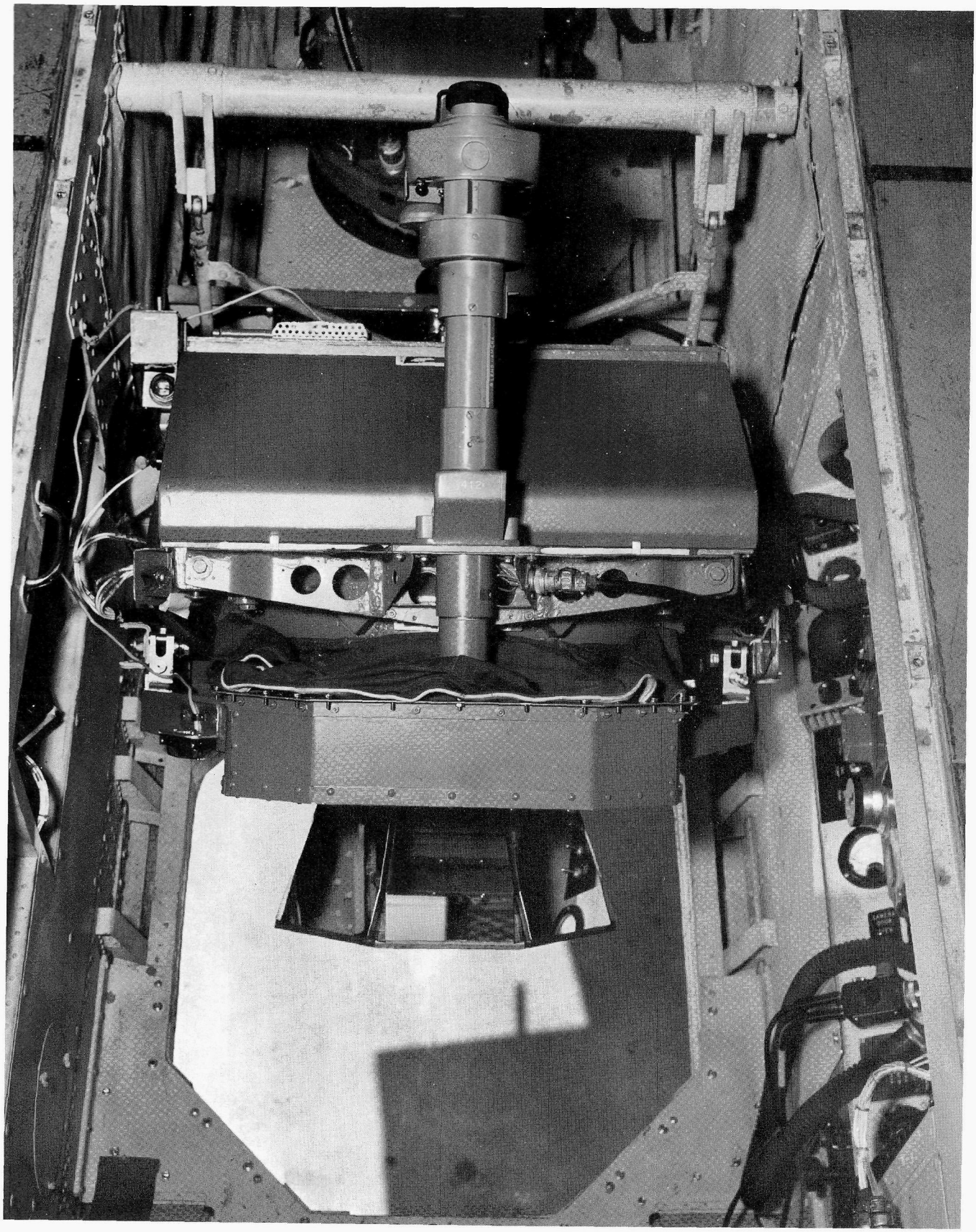


FIGURE 227.—9-lens camera mounted in R5–D with new hydraulic lift system. The camera remained in the raised position until photographic operations were to commence. It was then lowered into the operational position with the mirrors extending below the aircraft. (Photograph by John T. Smith, Jr.)

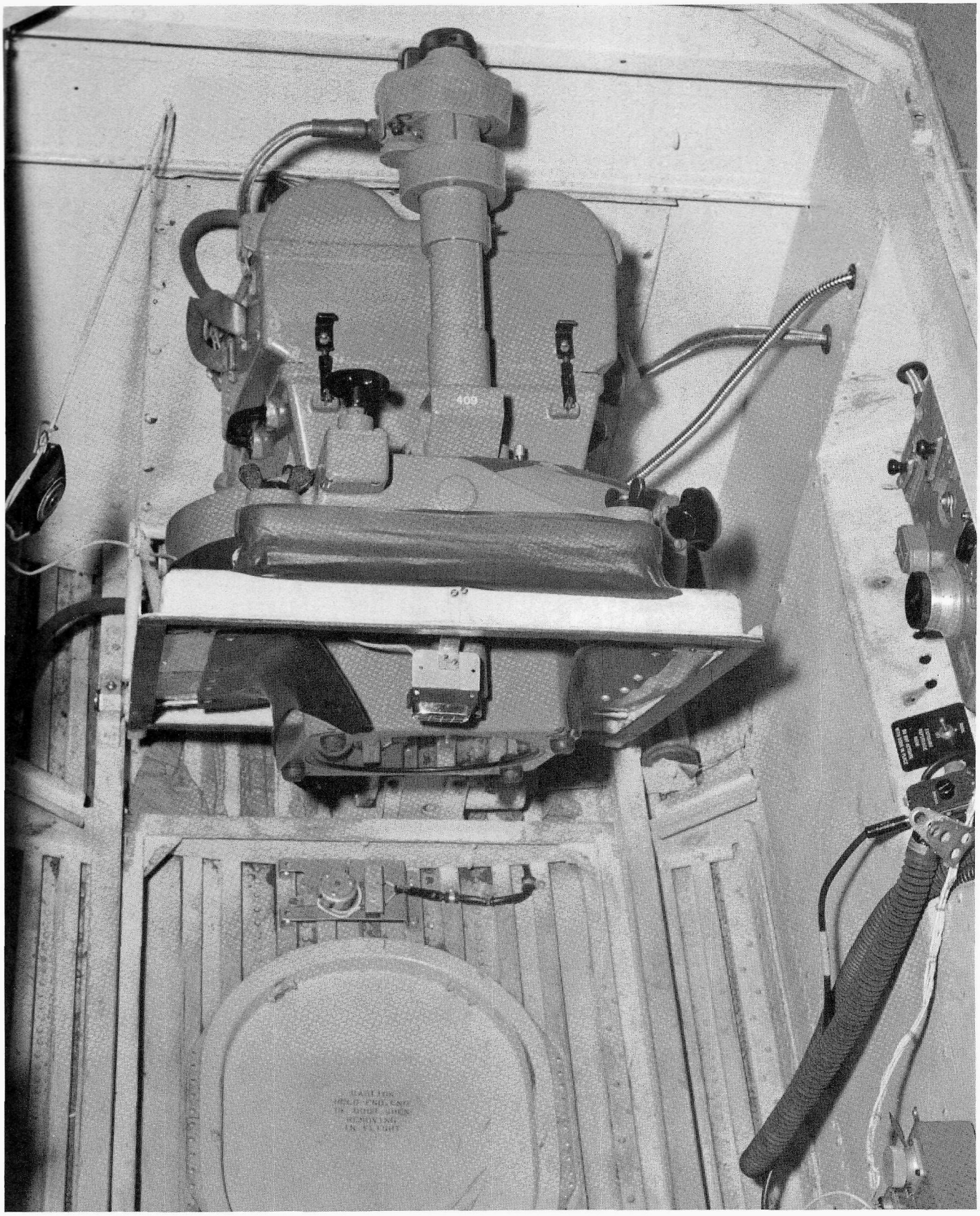


FIGURE 228.—RC–8 "S" camera mounted in R5–D aircraft. A hydraulic lift system was designed by the USC&GS in order that filter changes could be made in the air without removing the camera from the mount. (Photograph by John T. Smith, Jr.)

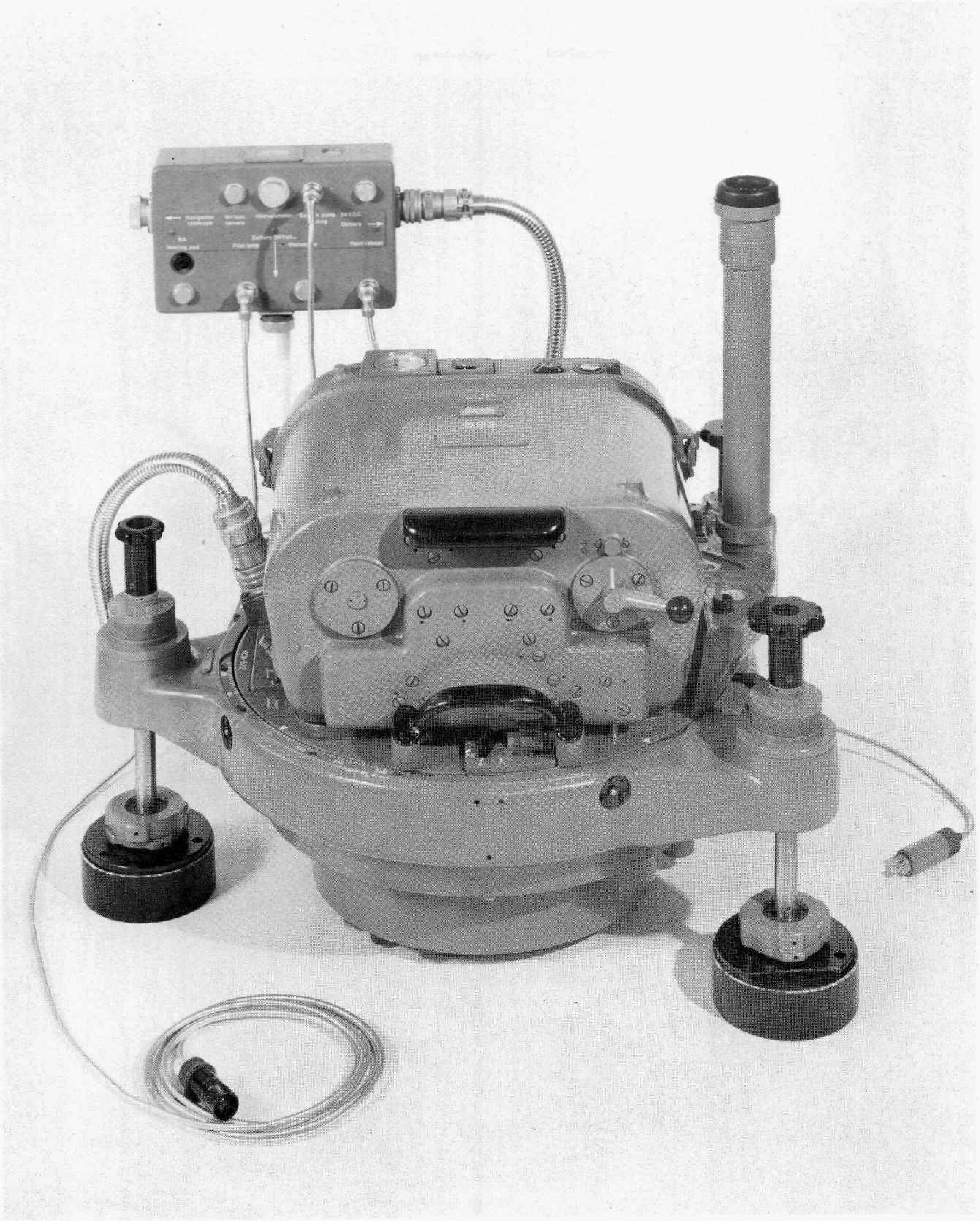


FIGURE 229.—Wild RC−9 camera. C&GS camera "M". (Photograph courtesy of Wild Company.)



FIGURE 230.—The new Wild RC−9, 88 mm "M" camera installed in the R5−D. (Photograph by John T. Smith, Jr.)



FIGURE 231.—Crew of R5–D 72486 top row, left to right: Charles Waldron (USC&GS), Lt. Connor, pilot (USCG), Lt. Rapalus, pilot (USCG), Lt. Merlyn E. Natto (USC&GS), William G. Riggs (USC&GS). Bottom row, left to right: Lyndon L. Potter (USCG), R. G. Schmidt (USCG), R. B. Vanderpool (USCG), K. A. Gallo (USCG), and Douglas (USCG). (Official NOS photograph.)

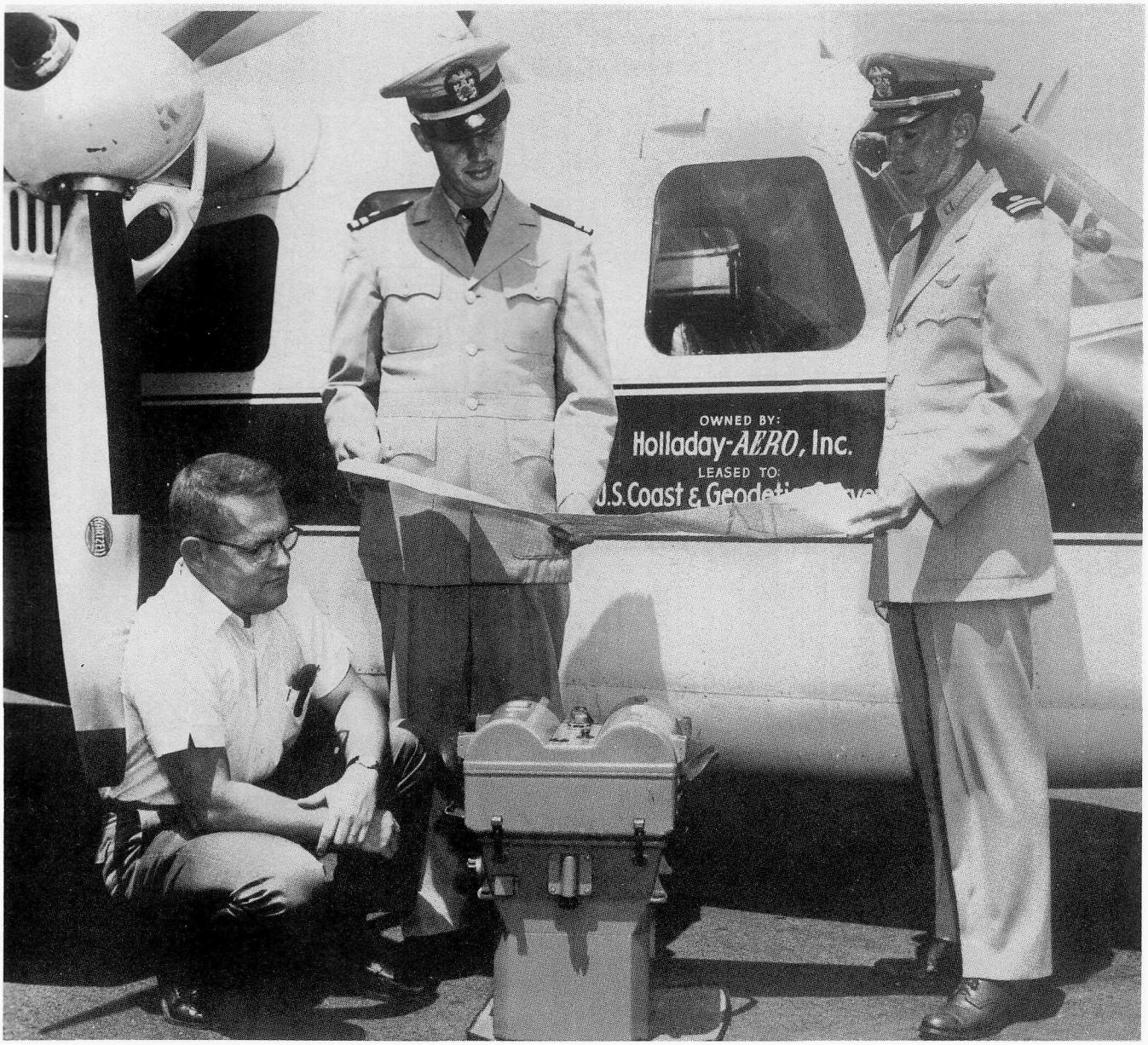


FIGURE 232.—The crew of N6889S left to right: William G. Riggs, photographer. Lt. James Randall, copilot, and Lt. Richard H. Houlder, pilot. (Photograph by W. Byron Hale.)

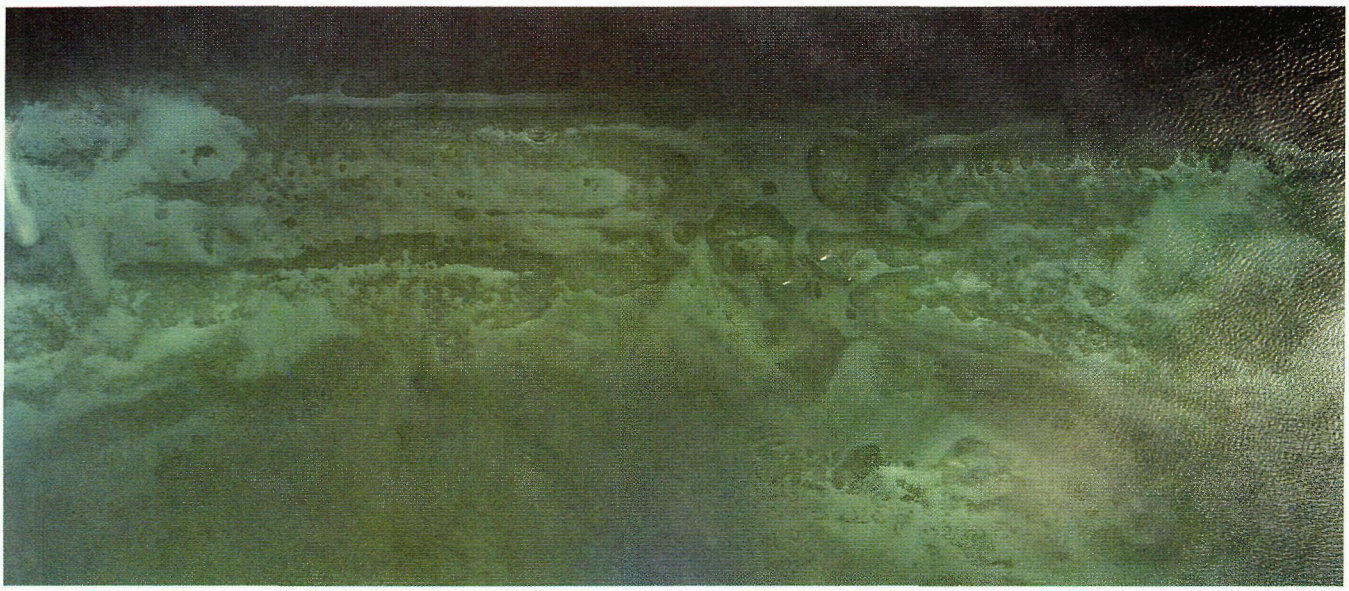


FIGURE 233.—Using aerial color film for photobathymetry had now become standard procedure and on March 11, photograph 605554 was taken over Satan Shoal, off Key West, Fla. It is interesting that this photograph covers the same area as photograph figure 14. (Photograph by William G. Riggs.)



FIGURE 234.—USC&GS "S" camera photograph taken April 27 over Seattle, Wash. (Photograph by William G. Riggs.)

1961

AIR PHOTO MISSION 701 ACTIVITIES—1961

Coast Guard aircraft R5–D 72486 arrived in Washington, D. C., April 3. The 9-lens camera, along with the Wild RC–8 "W" and RC–9 "M" camera, was installed. Photographic operations began on April 4 with Lt. Comdr. Richard H. Houlder, Chief of Party and navigator; John T. Smith, Jr., photographer; and Howard G. Kirkwood, a trainee photographer (figs. 235, 236, 237, 238, 239, 240 and 241). On May 21 the mission arrived in San Francisco, Calif. The 200-hour check of the aircraft indicated that the fuel tanks would require extensive repairs. All of the cameras and related equipment were off-loaded and stored at the C&GS San Francisco office.



FIGURE 235.—R5–D aircraft commander, Lt. Harold B. McDuffey (USCG). (Photograph by John T. Smith, Jr.)



FIGURE 236.—R5–D copilot, Lt. Roger Millett (USCG). (Photograph by John T. Smith, Jr.)

Howard Kirkwood resigned at this time, and Lt. Comdr. Richard Houlder and John T. Smith, Jr., returned to Washington on May 28. On July 3 Edwin D. Hawbecker returned to work for C&GS. The mission was reactivated on July 11 with Lt. Comdr. Houlder, Chief of Party and navigator; Edwin D. Hawbecker, photographer; and Robert Hemingway, trainee photographer. The mission left San Francisco on July 14 and arrived in Juneau, Alaska, that same day.

The mission remained in Alaska until August 21, when it returned to Ontario, Calif., and remained in California until August 30, when it left San Francisco for Hawaii enroute to American Samoa. As C&GS and the U. S. Geological Survey needed photography in Samoa, the two agencies made a cooperative agreement that the photography would be obtained on a cost-sharing basis. An overnight stop was made at Canton Island, (fig. 242) and the mission arrived in Samoa on September 2 (figs. 243, 244, 245, 246 and 247) and continued photography until the 18th. With 95 percent of the photography completed, aircraft problems forced the mission to return to Hawaii.

On September 19, after aircraft repairs, the mission did photography in the Hawaiian Islands until October 3, when it left Honolulu and arrived at Burbank, Calif. The mission then worked its way across country and arrived in San Juan, P. R., on the 16th. It remained at

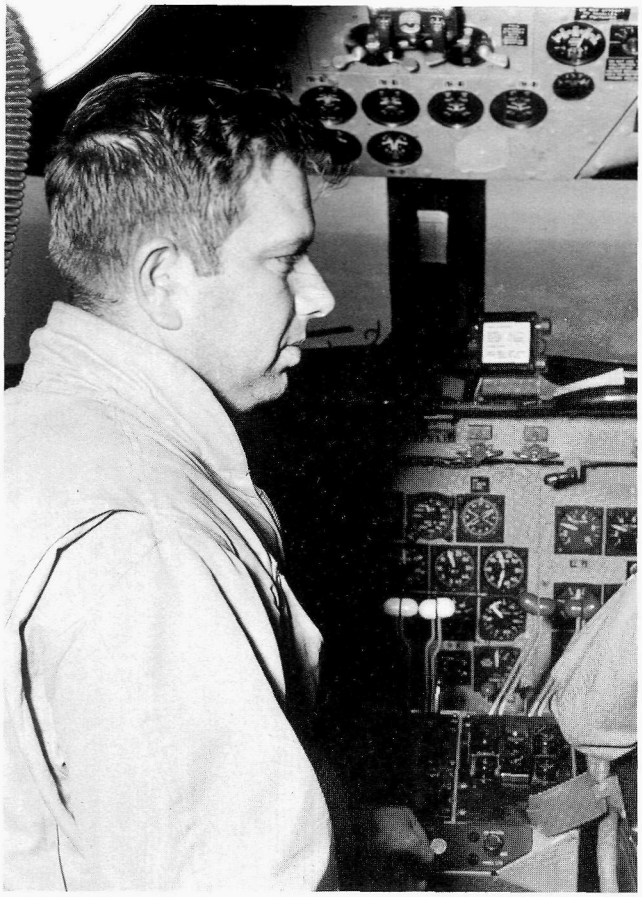


FIGURE 237.—Chief aircraft mechanic Charles C. Brewer. (Photograph by John T. Smith, Jr.)

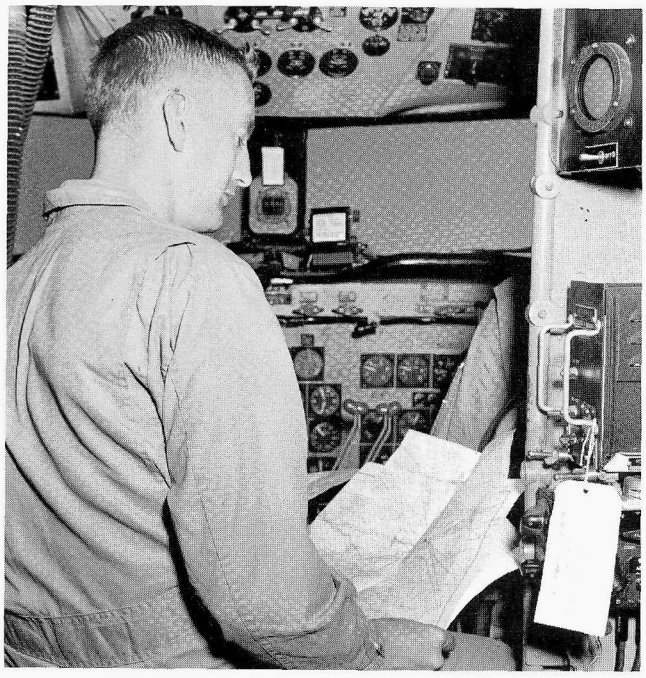


FIGURE 238.—Lt. Comdr. Richard Houlder (USC&GS), chief of mission and navigator on R5–D. (Photograph by John T. Smith, Jr.)

San Juan until the 26th, when it departed and arrived in Washington, D. C., on October 28, when the mission was secured for the rest of the year.

AIR PHOTO MISSION 702 ACTIVITIES—1961

Aero Commander 6889S was activated on March 15 with Lt. James P. Randall (fig. 248) Chief of Mission and pilot; Lt. Kelly E. Taggart, copilot/navigator; and William G. Riggs and Maurice E. Weiss (fig. 249) photographers. The mission photographed in the United States (fig. 250), and on April 25 William Riggs returned to Washington, D. C. The mission continued photography until December 6, when it was secured for the rest of the year.

OFFICE ACTIVITIES—1961

On December 14 C&GS purchased its first Wild B–8 plotter (fig. 251). This was the third B–8 in the United States.

As processing of aerial color photography was not commercially available, Capt. Swanson assigned to John T. Smith, Jr., the task of building a color photographic laboratory. The problems were many, because processing equipment had to be designed or commercially available equipment modified to meet the stringent requirements of color. Work on the laboratory was begun early in the year and was completed in May (figs. 252, 253, 254, 255, 256, 257 and 258). *This was the first aerial color laboratory in the world,* and full-scale processing of film, prints, and transparencies began in June. There was still one bottleneck; color glass plates were not available for printing diapositives to be used with the plotting instruments. A system was devised to use film transparencies sandwiched between glass as an alternative. This worked relatively well, but as the film base of the transparencies was not stable, instrument operators spent much time adjusting for the expansion and contraction of the film.

On April 28, William G. Riggs resigned from C&GS.

On October 28 the last 9-lens photograph was made over the Ohio camera calibration range at McClure, Ohio.

During the year, 10 rolls of 9-lens film were taken. But with the development of the 88 mm. super Aviogon lens with a 120° field of view, the small advantage of the 130° 9-lens camera did not warrant the expense of having custom-made rolls of film and the complexity of the printing process. From 1937 to 1961, 141,000 photographs were taken covering about 1½ million square miles. Maps on pages 429 and 430 show the approximate area mapped by using the photography obtained with the 9-lens camera.



FIGURE 239.—Howard Kirkwood (USC&GS) operating forward RC−8 camera and John T. Smith, Jr. (USC&GS) operating RC−9 camera on R5−D aircraft. Nine−lens camera is in raised position in third camera hatch. (Official NOS photograph.)



FIGURE 240.—Howard Kirkwood (USC&GS) operating RC–8 camera on R5–D. (Photograph by John T. Smith, Jr.)



FIGURE 241.—The crew of R5–D 72486 has lunch at 10,000 feet over New Orleans, La. Left to right: R. O. Rodgers (USCG), K. A. Gallow (USCG), D. L. Butler (USCG), C. C. Brewer (USCG). (Photograph by John T. Smith, Jr.)

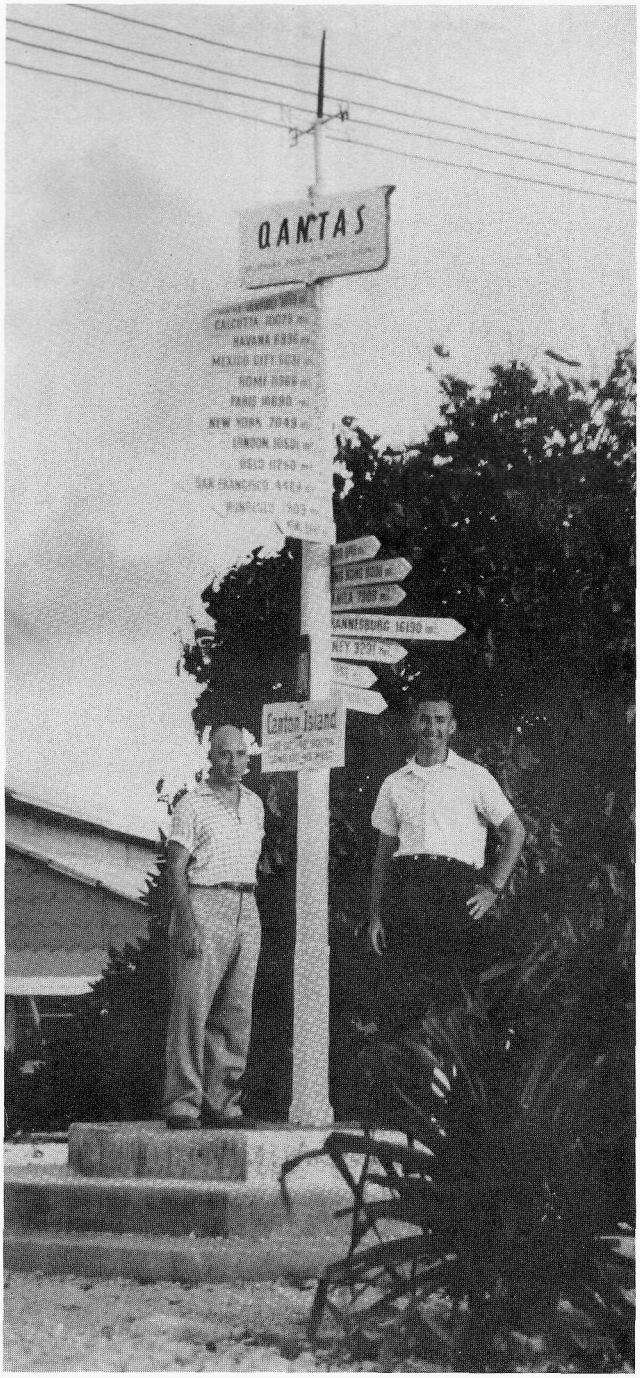


FIGURE 242.—Harland R. Cravat, left and Lt. Comdr. Richard Houlder on Canton Island. (Photograph by Edwin D. Hawbecker.)

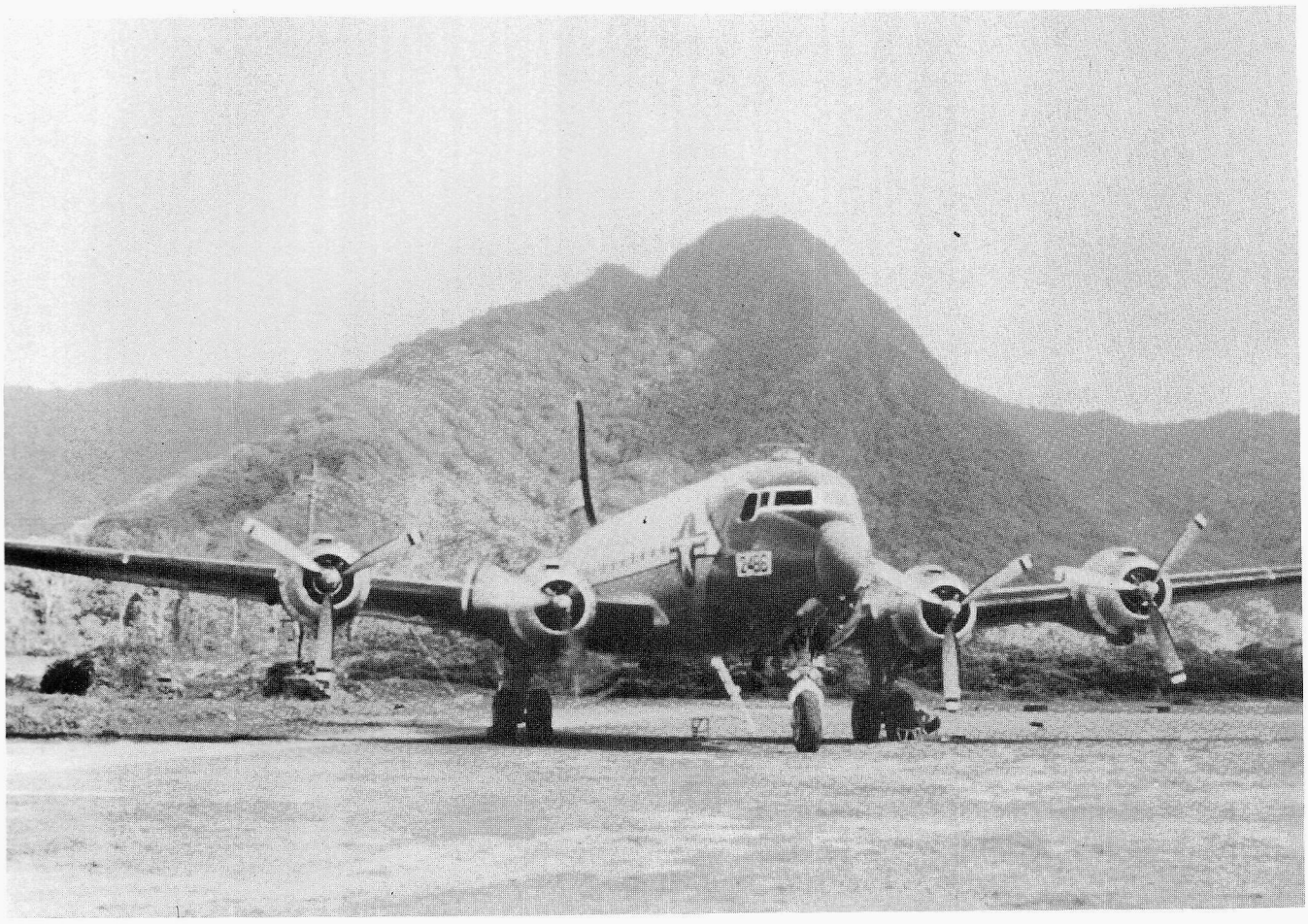


FIGURE 243.—R5–D aircraft in American Samoa. (Photograph by Harland R. Cravat.)



FIGURE 244.—Airport Terminal building, American Samoa. (Photograph by Harland R. Cravat.)



FIGURE 245.—Photographer Robert Hemingway over American Samoa. (Photograph by Harland R. Cravat.)



FIGURE 246.—Photograph No. 61W554 of Samoa taken on September 14. (Photograph by Edwin D. Hawbecker.)



FIGURE 247.—Left to right: Lt. Comdr. Richard Houlder, unidentified, Harland R. Cravat, and Robert Hemingway enjoying dinner in Samoa. (Photograph by Edwin D. Hawbecker.)



FIGURE 248.—Lt. James P. Randall. (Official NOS photograph.)

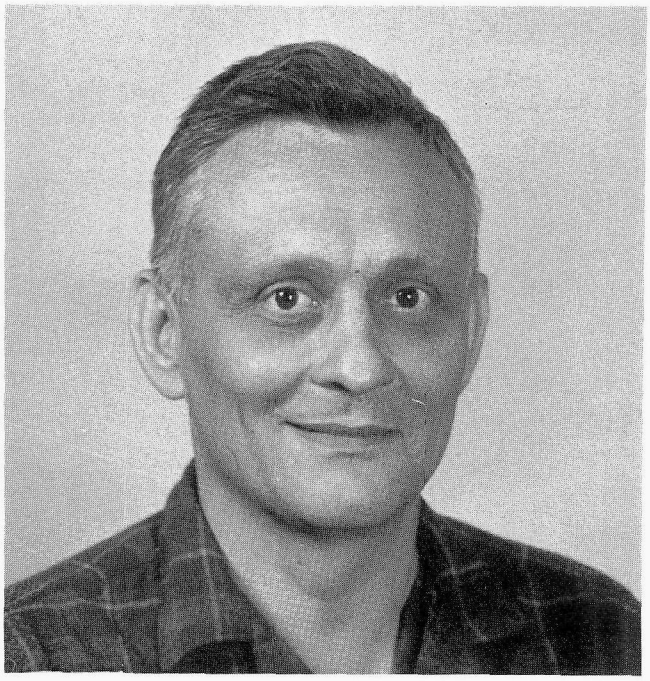


FIGURE 249.—Photographer Maurice E. Weiss. (Official NOS photograph.)



FIGURE 250.—Aero Commander N6889S in flight. (Photograph by Harland R. Cravat.)

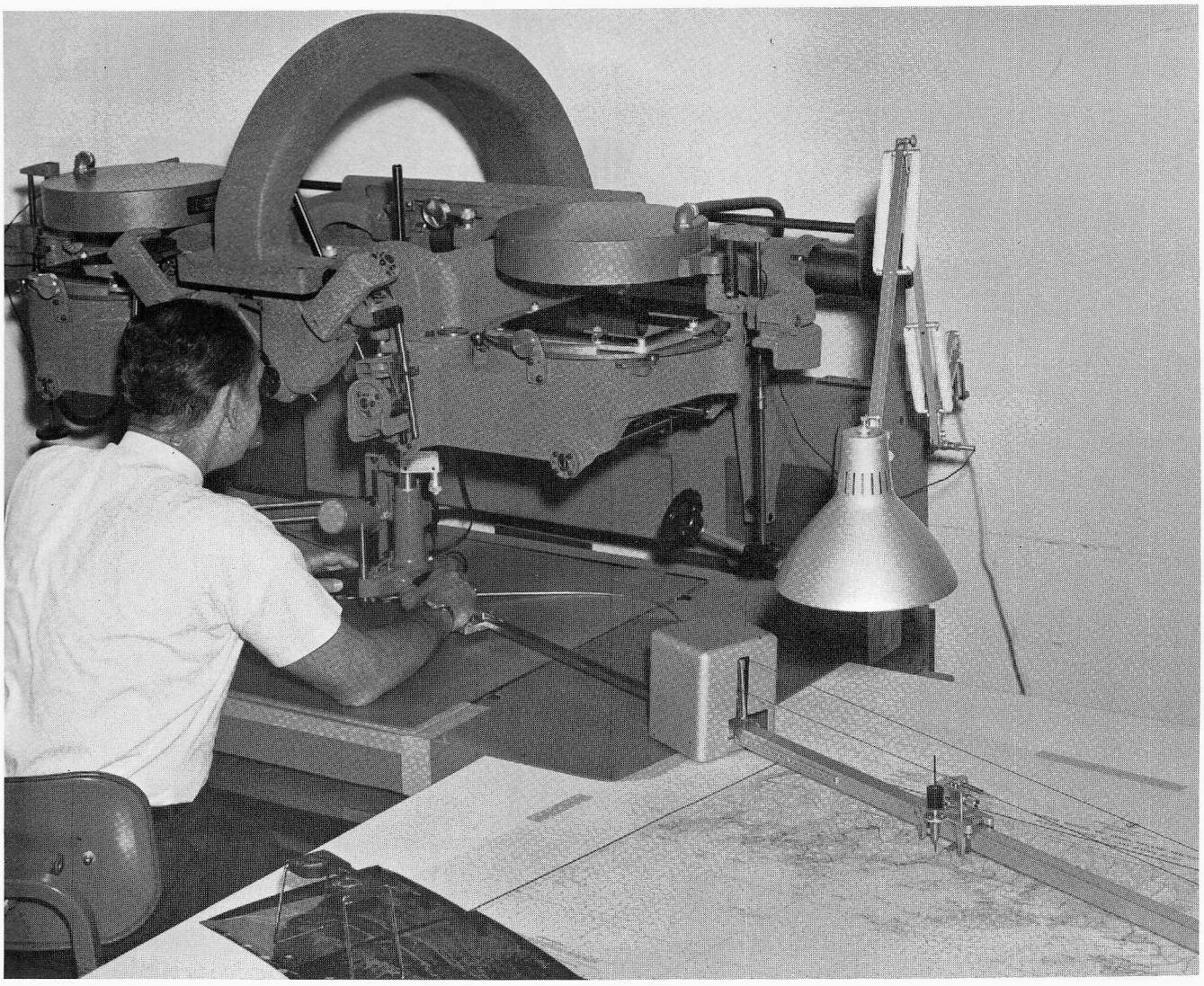


FIGURE 251.—B–8 plotter. (Photograph by John T. Smith, Jr.)

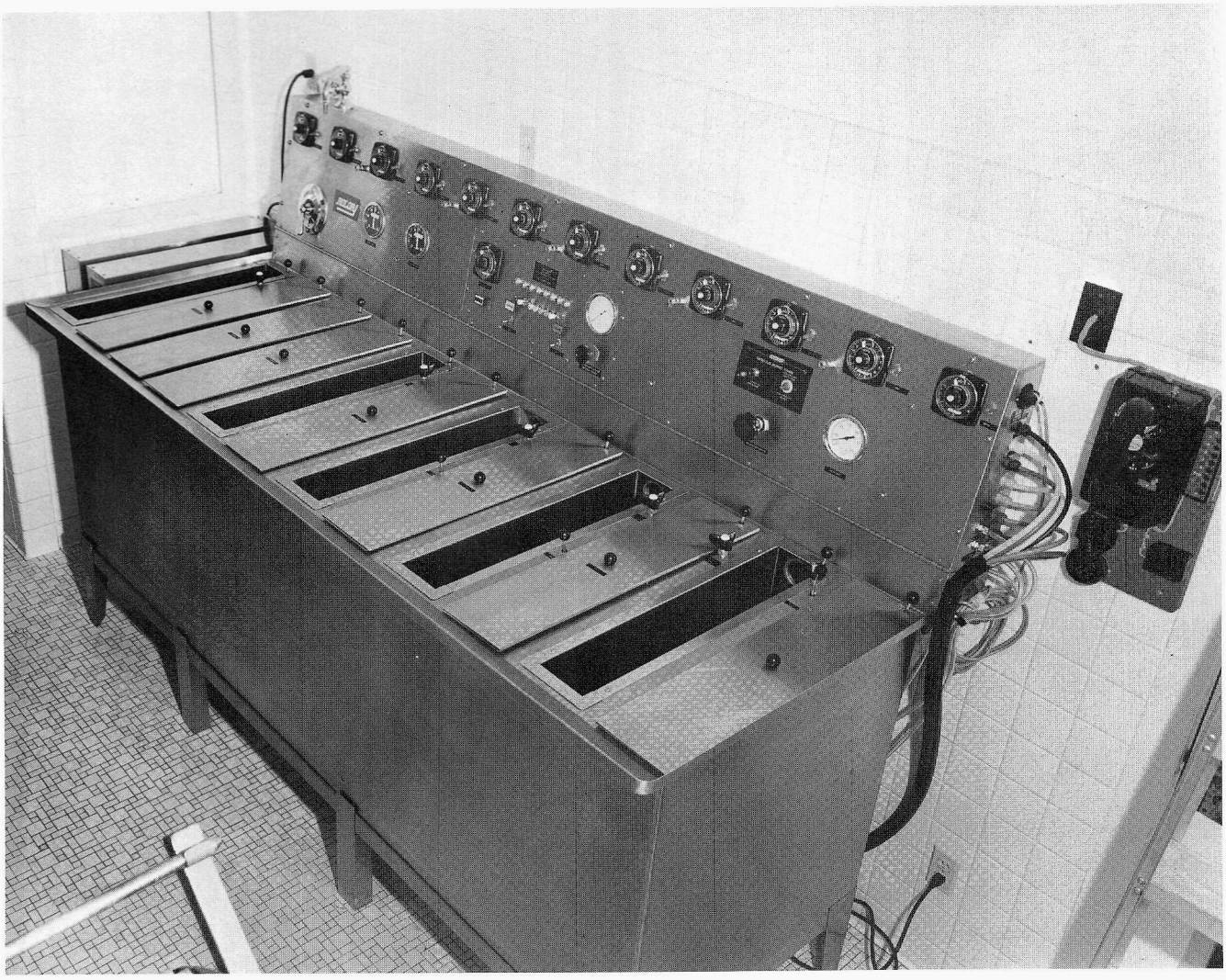


FIGURE 252.—Split-C light room side for processing hard copy color prints and color transparencies. (Photograph by John T. Smith, Jr.)



FIGURE 253.—LogEtronic contact printer in Air Photo Lab's new contact print room. (Photograph by John T. Smith, Jr.)

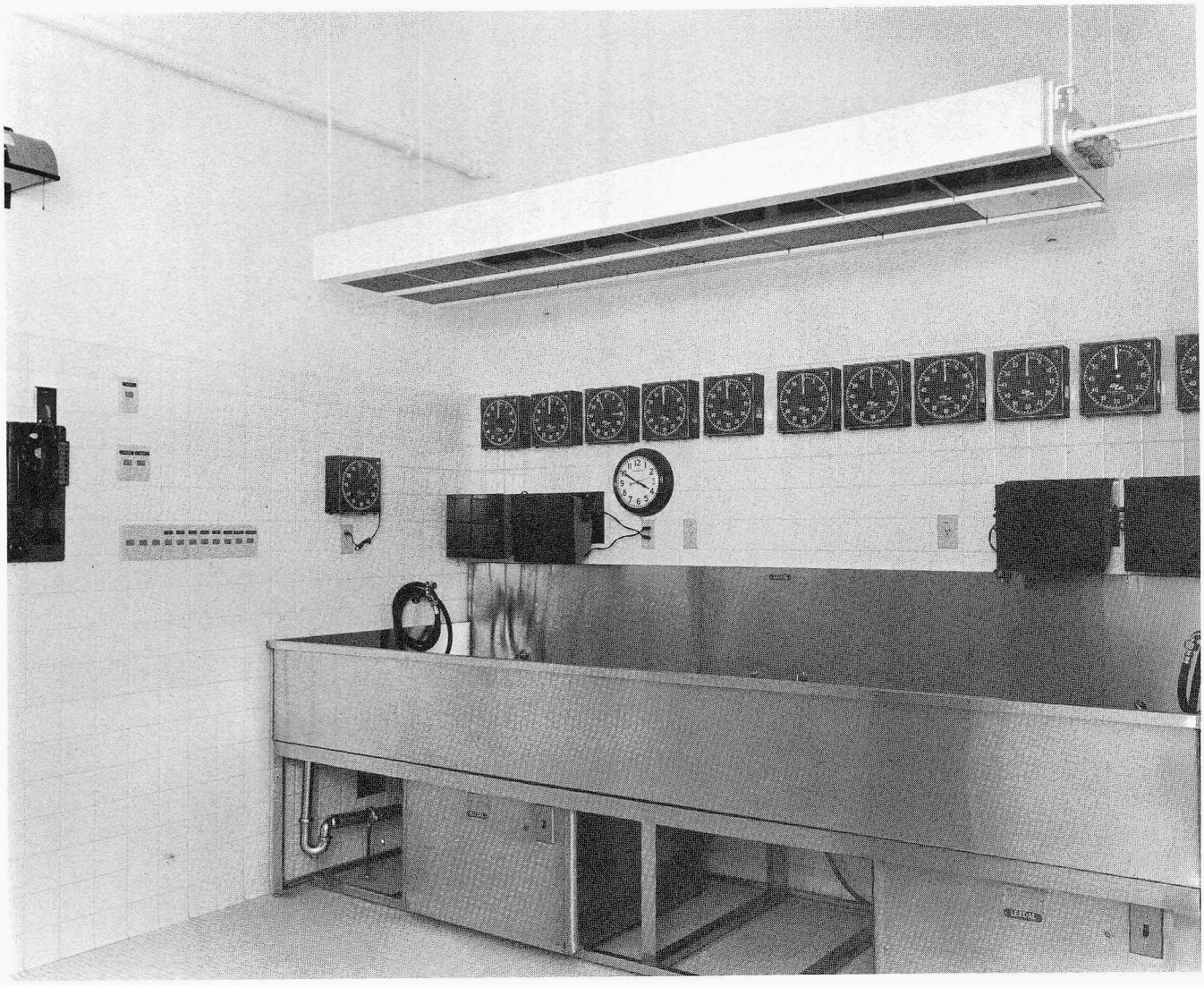


FIGURE 254.—New aerial film processing room for both black-and-white and color film. (Photograph by John T. Smith, Jr.)



FIGURE 255.—Color film processing arrangement in laboratory, Department of Commerce Building; a constantly maintained water temperature bath circulated water between the processing tanks. (Photograph by John T. Smith, Jr.)

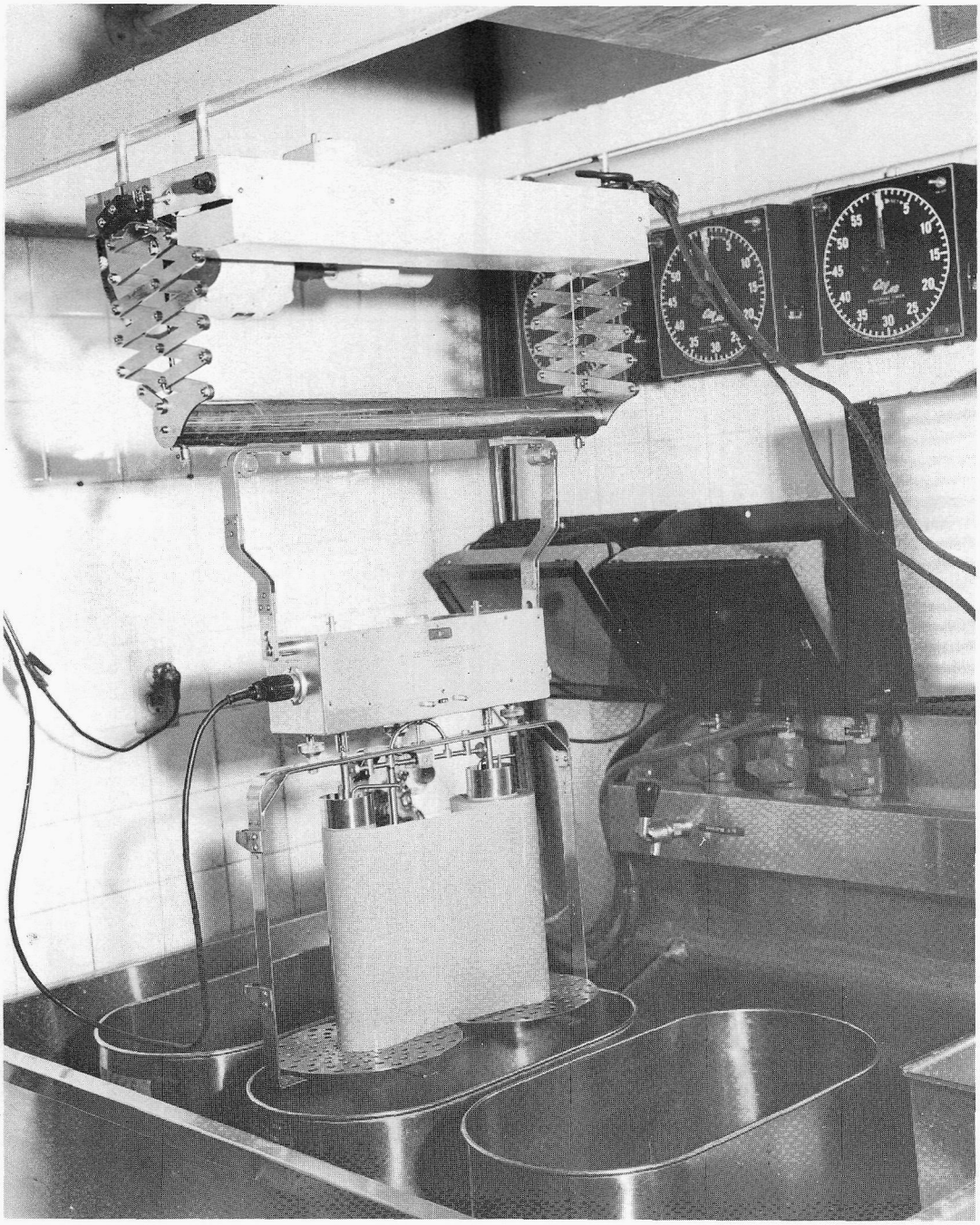


FIGURE 256.—Automated mechanism designed by USC&GS for lifting and moving film from one processing solution to the next. (Photograph by John T. Smith, Jr.)

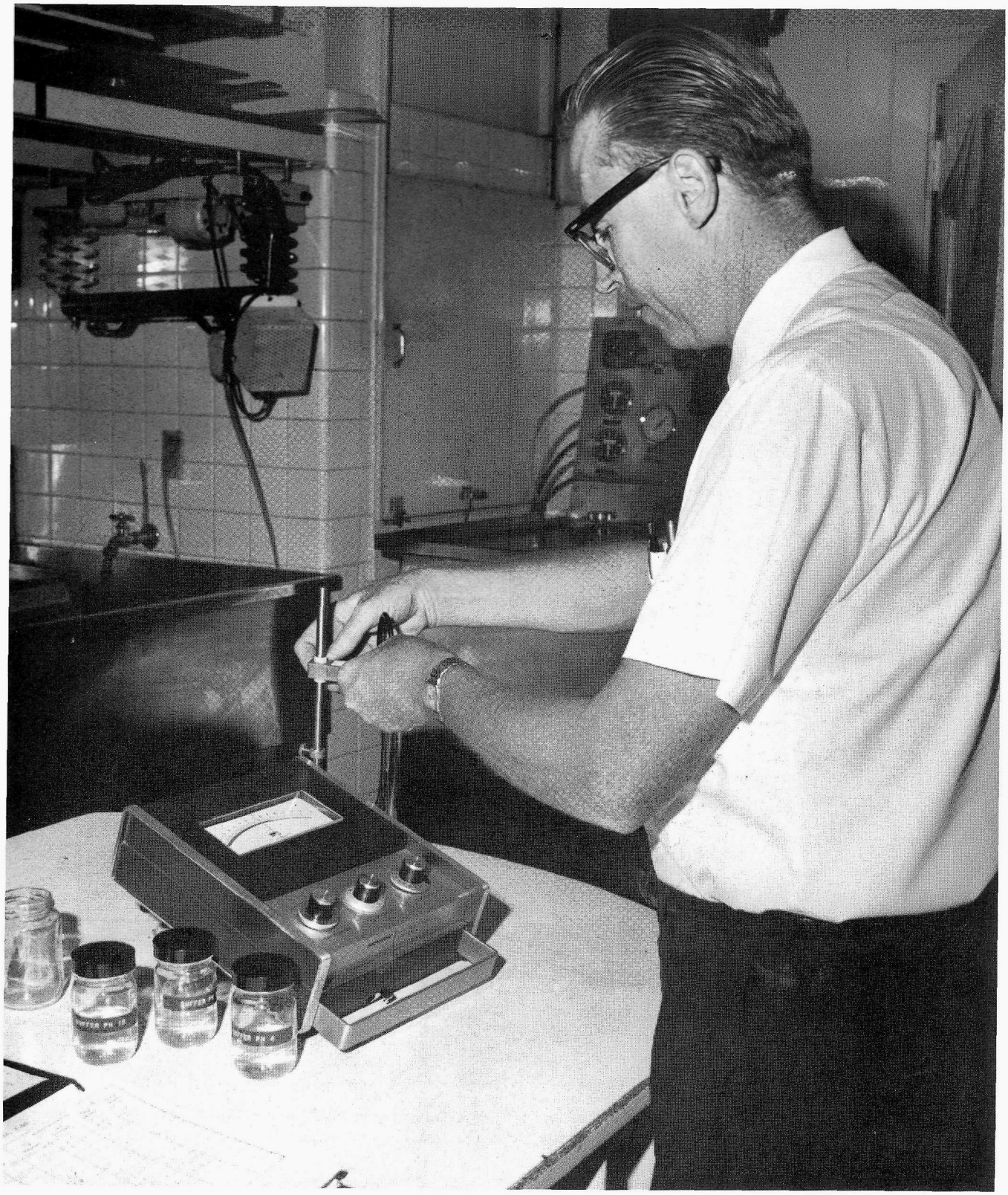


FIGURE 257.—Alva Pyle, technical color specialist, measures the pH of processing chemistry. Pyle was instrumental in the Survey's success with color aerial film. (Photograph by John T. Smith, Jr.)

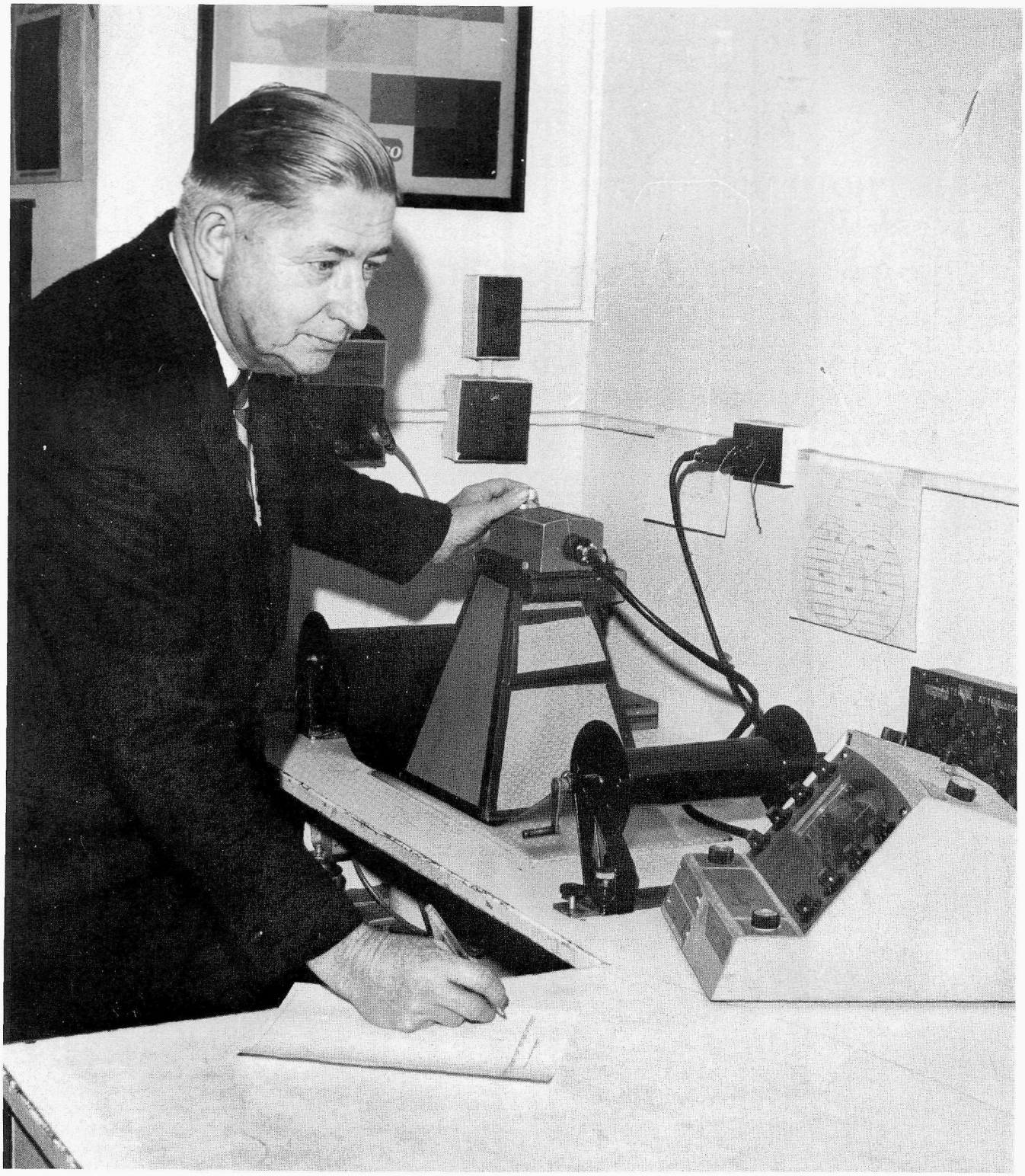


FIGURE 258.—Robert Fowler, assistant laboratory supervisor, analyzing color aerial film to determine the correct color balance and exposure for printing color photographs. (Photograph by John T. Smith, Jr.)

1962

AIR PHOTO MISSION 701 ACTIVITIES—1962

The Coast Guard R5–D arrived in Washington, D.C., on April 6. Cameras and related equipment were installed, and the aircraft left Washington on April 7. Lt. James P. Randall was navigator, and Edwin D. Hawbecker and Maurice E. Weiss were photographers (fig. 259). On May 14, in Grand Junction, Colo. large particles of metal were found in the oil strainers of the number 3 engine and an engine change was completed by May 21. The mission left Seattle, Wash., on June 8, landing at Juneau, Alaska, to begin the season there. The mission arrived at Cold Bay, Alaska, on July 3 (figs. 260 and 261) and remained there until July 29. Continuing to work throughout Alaska until August 29, the mission returned to Seattle and then worked its way across country, arriving in Washington, D.C., on September 7, when the mission was secured for the rest of the season.



FIGURE 259 .—Crew of R5–D 72486. Left to right: James Hardwick (USC&GS), K. A. Gallow (USCG), R. O. Rodgers (USCG), unidentified. Kneeling, left to right: Edwin D. Hawbecker (USC&GS), Lt. James P. Randall (USC&GS), unknown, unknown. (Official NOS photograph.)



FIGURE 260.—A chess game at the "Cold Bay Hilton." Left: Unidentified, unidentified, M. E. Weiss (USC&GS), R. O. Rodgers (USCG) on right. (Photograph by Edwin D. Hawbecker.)



FIGURE 261.—The crew of R5–D 72486 relaxing at the "Cold Bay Hilton." Left to right: unidentified, Lt.(jg.) James L. Haas (USCG), Lt. Harold D. McDuffee (USCG), R. O. Rodgers (USCG), K. A. Gallo (USCG), M. E. Weiss (USC&GS). (Photograph by Edwin D. Hawbecker.)

AIR PHOTO MISSION 702 ACTIVITIES—1962

Aero Commander N6889S was activated on February 1, with Lt. James P. Randall, Chief of Mission and pilot; Lt. Kelly E. Taggart (fig. 262), copilot/navigator; and Maurice E. Weiss, photographer. The mission immediately departed for San Juan, P. R., where it remained until February 21, when it returned to Washington, D. C. Lt. Taggart relieved Lt. Randall as Chief of Mission, and Robert S. Hemmingway relieved Weiss as photographer.

On March 1 Lt. Robert L. Sandquist (fig.263) joined the mission as copilot/navigator, and in April the first full-fledged circulatory current survey was accomplished in Charleston Harbor, S. C. (fig. 264). Lt. Comdr. Houlder temporarily relieved Taggart as Chief of Mission on May 15, and Taggart resumed these duties on June 22. The mission continued photography throughout the United States until December 10, when it was secured for the rest of the season.

OFFICE ACTIVITIES—1962

In February, Capt. Swanson became Associate Director of C&GS, and Capt. Joseph E. Waugh was named Chief of the Division of Photogrammetry.

By the end of 1961, John T. Smith, Jr., had devised a method for laminating color film to glass plates for instrument use. This process worked fairly well, but was extremely slow. The number of glass plates required by C&GS could not be reasonably met in this fashion. Capt. Swanson discussed the problem with Eastman Kodak Company, and it made a sample run of color plates for testing. These proved very successful, and Swanson remarked, "The missing link has now been found" (fig. 265).

At the end of the year, in cooperation with the LogEtronic Company, C&GS helped design and then bought *the first color LogE* printer. The printer was designed with a unique vacuum platen that was capable of printing not only paper prints but also the newly developed Kodak color glass plates.



FIGURE 262.—Lt. Kelly E. Taggart. (Official NOS photograph.)

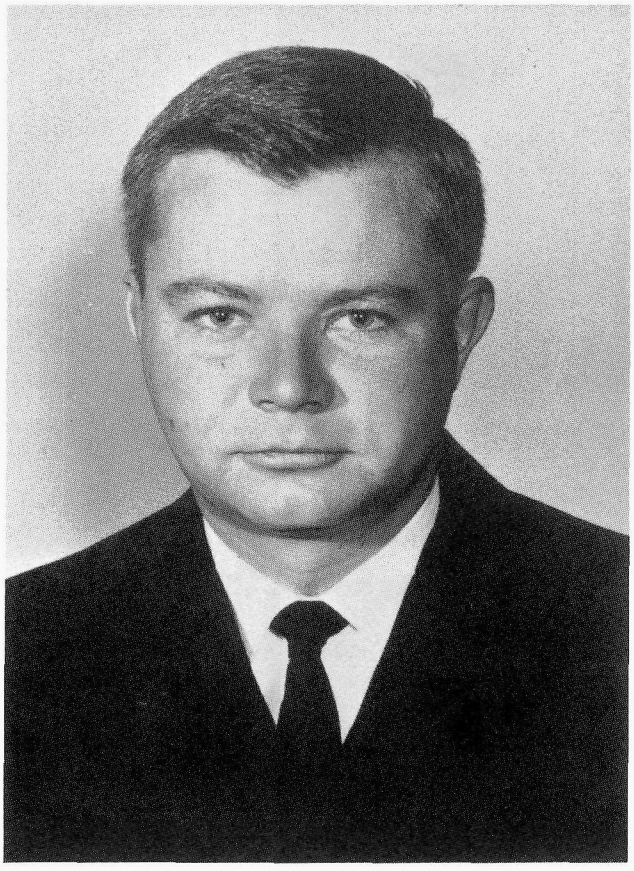


FIGURE 263.—Lt. Robert L. Sandquist. (Official NOS photograph.)



FIGURE 264.—Lt. Robert Sandquist and Lt. Kelly Taggart, discussing flight operations for circulatory project in Charleston, S.C. with Comdr. Woodcock. (Photograph by Jim Hardwick.)



FIGURE 265.—*Members of the U. S. Coast and Geodetic Survey group who visited Kodak to report on its new color glass plates were interested in the picture of the New York skyline used in one of the company's coloramas, because of recent survey work that they did in the waters in the background. John T. Smith, Jr., chief of the Aerial Photographic Laboratory, points out the area. Others, seated from left are: Harland Cravat, chief of operations; Capt. Lawrence W. Swanson, William Harris, chief, Research and Testing; standing from left: Bennett Jones, technical assistant to the chief of photogrammetry; Bob Saintey, Kodak Technical Sales Representative in the Washington area; Bob Schulz and Jim Hawkins of Eastman Kodak Washington office. (Photograph courtesy Eastman Kodak Company.)*

1963

AIR PHOTO MISSION 6401 ACTIVITIES—1963

A large number of research projects were planned for the season with emphasis on the application of photogrammetry to try to answer satisfactorily practical operation in more diversified fields of use. In a cooperative agreement, the Ballistics Research Laboratory at Aberdeen, Md., designed and developed an instrumentation system to furnish precision astronomical data as well as terrestrial photographs. C&GS was to test the camera system and the value of precise solar observation for determination of photographic camera orientation in analytical aerotriangulation. The Coast Guard R5–D aircraft, 72486, was modified by the addition of a 24- by 36-inch window above the camera position. This enabled direct sunlight to fall on the lens of the solar camera when the aircraft was flown over the Ohio test area in an easterly direction within one-half hour of local apparent noon (fig. 266). The photo missions were now designated 6401 for the R5–D and 6402 for the Aero Commander.

The Photo Mission was activated on April 15 with Lt. Comdr. Kelly E. Taggart, navigator; Edwin D. Hawbecker, chief photographer; Jim L. Harwick and Francis E. Buck, photographers in training (fig. 267).

At the end of May the research project on the solar camera had been completed, and general mapping photography continued until June 20, when the aircraft again did a research project on the analysis of the Earth crustal movement at Salt Lake City, Utah (fig. 268). This was completed on June 21, and the aircraft resumed normal mapping photography. During July 4 to 6, in a cooperative agreement with the U.S. Coast Guard, the mission photographed congested boating areas along the Atlantic coast, enabling the Coast Guard to count the number of boats in operation over a July Fourth holiday (fig. 269).

On July 10 the solar camera was reinstalled in the aircraft for additional photography. This work continued until August 9 when the aircraft returned to routine mapping photography.

An experimental research project was begun on August 23 for offshore rock identification at Cape Mendocino, Calif. The purpose was to determine whether the elevations of offshore rocks as far as three-quarters of a mile from the shore could be determined without using the water surface for a vertical datum reference. The area of Cape Mendocino was selected because it introduced such factors as rock configurations, ground swells, and suface waves into the study. Three cameras were operated simultaneously using B&W infrared, natural color, and panchromatic film.

On completion of this test, the mission left for the Hawaiian Islands to run research color comparison tests as well as mapping photography until September 14, when it returned to the Mainland. Mapping photography continued until September 21, when a research program was scheduled using an infrared scanner. The test was run from Charleston, S. C., to Fort Lauderdale, Fla. At the conclusion of these tests, the mission returned to Washington, D. C., on October 1, and was secured for the rest of the season.

AIR PHOTO MISSION 6402 ACTIVITIES—1963

Aero Commander 6889S was activated on February 16 with Lt. Robert Sandquist, Chief of Mission and pilot; Lt. Gerald C. Saladin, copilot/navigator; and Maurice E. Weiss, photographer. The mission continued airport photography throughout the United States until June 24, when it arrived in Anchorage, Alaska, where it remained until July 24. Returning to Seattle, Wash., it worked its way across country until November 26, when the mission was secured for the rest of the season.

OFFICE ACTIVITIES—1963

In December the Division of Photogrammetry loaned the 9-lens camera to the Smithsonian Institution for permanent display (fig. 270). The processing of color prints and plates continued in the Air Photo Lab (figs. 271 and 272).

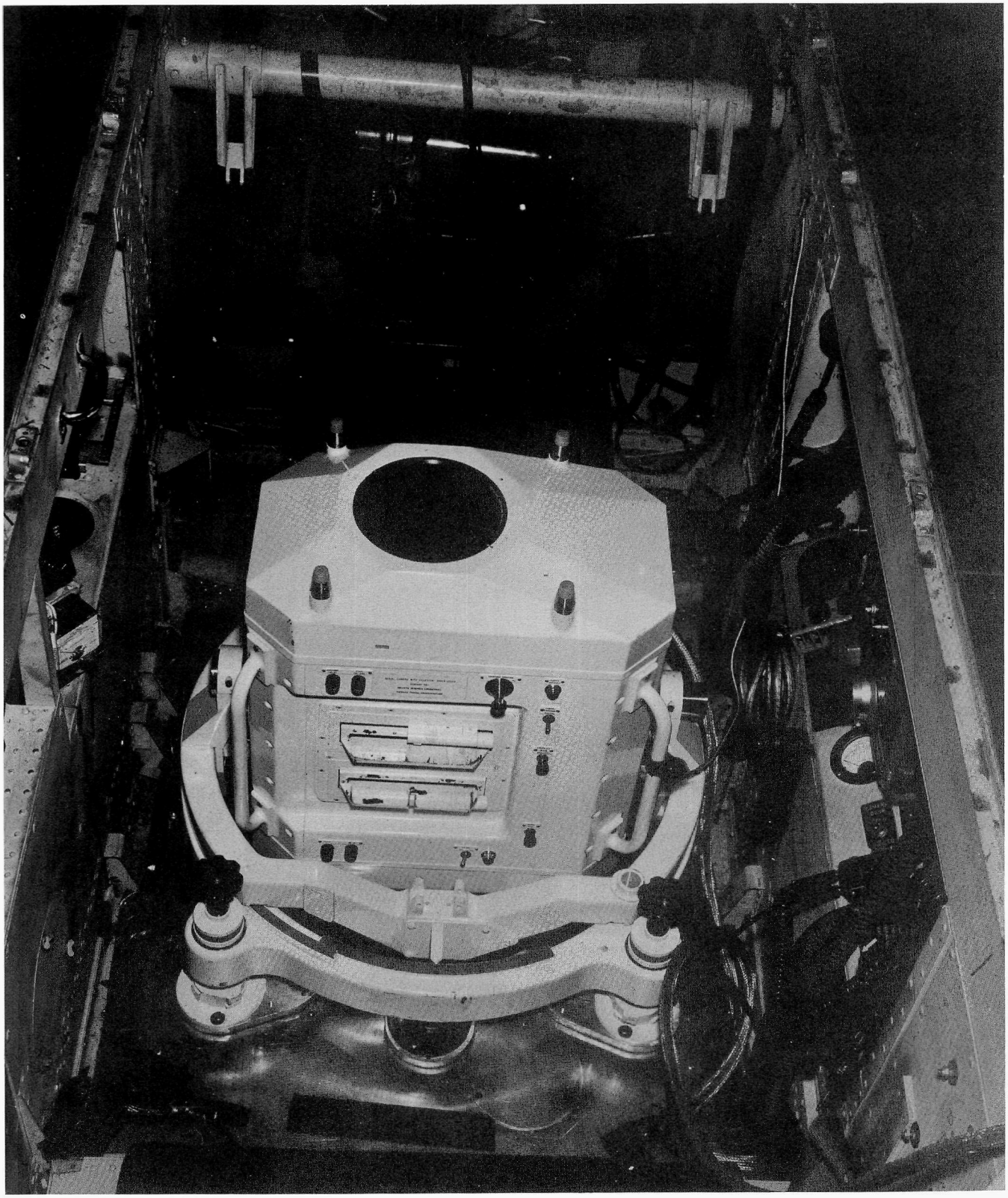


FIGURE 266.—Stellar camera used for photographing simultaneously the position of the Sun and the terrain below. The camera used glass plates and was operated experimentally during the season. (Photograph by Edwin Hawbecker.)



FIGURE 267.—Crew of R5–D aircraft, standing left to right: Edwin D. Hawbecker (USC&GS), unknown, Marshall K. Phillips (USCG), Dan S. Meginley (USCG), Kelly E. Taggart (USC&GS), Francis E. Buck (USC&GS), R. A. Chilco (USCG). Kneeling left to right: Robert S. Barger (USCG), Carl D. Hollingsworth (USCG), S. S. Mazza (USCG), D. C. Lopez (USCG), R. C. Hiner (USCG). (Photograph by Jim Hardwick.)

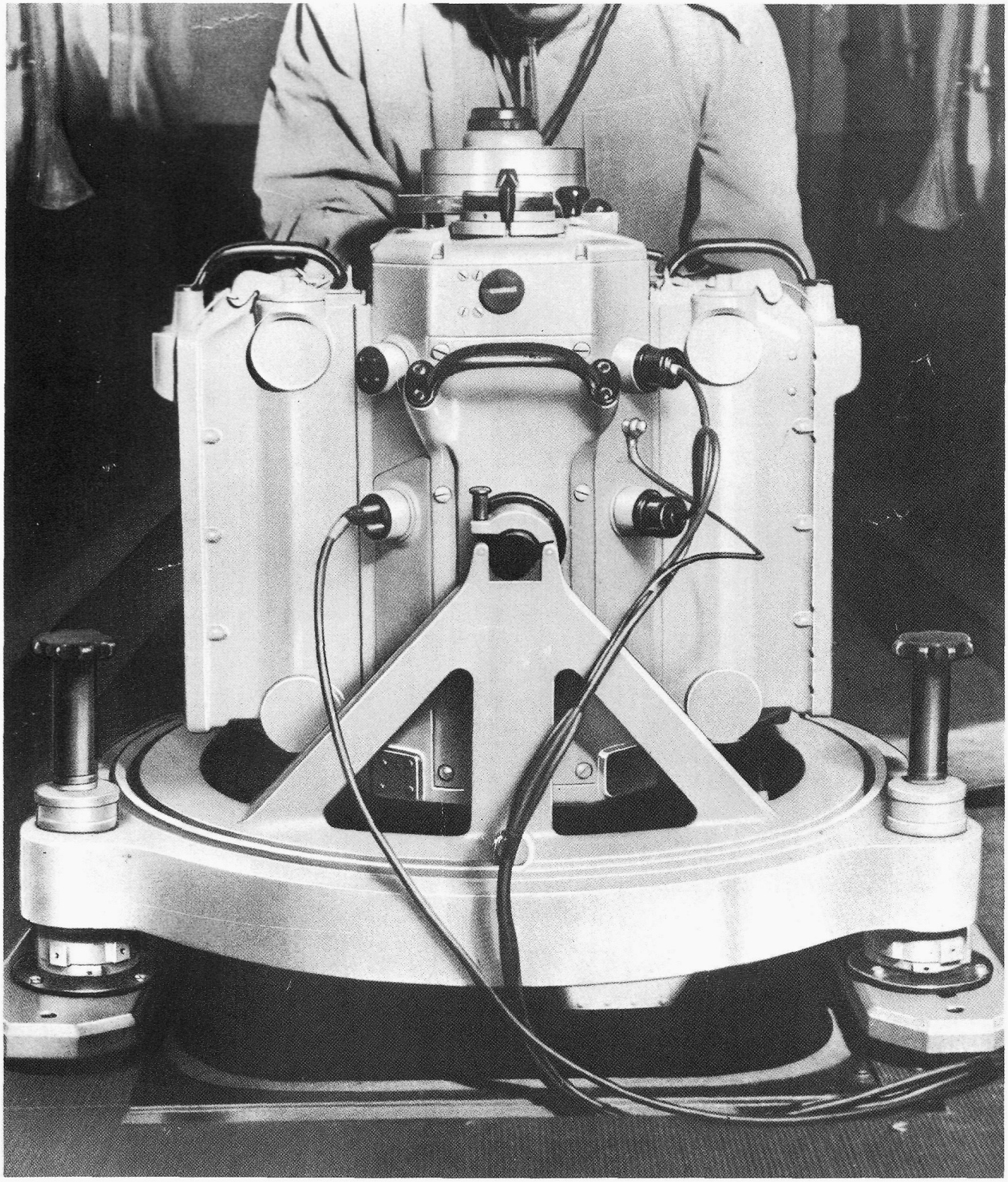


FIGURE 268.—Wild RC–7A Automatic glass plate camera with a 10 cm F/5.6 Aviogon lens. The glass plate size is 15 by 15 cm. The camera is capable of taking 80 exposures using a single magazine and is also equipped with additional plate magazines, therefore, when plates were loaded in the additional magazines this would allow the camera to be operated for about 3 hours of photography. The weight of the camera assembled was 225 pounds, and the weight of the 80 plates 21 pounds. (Photograph courtesy Wild Company.)

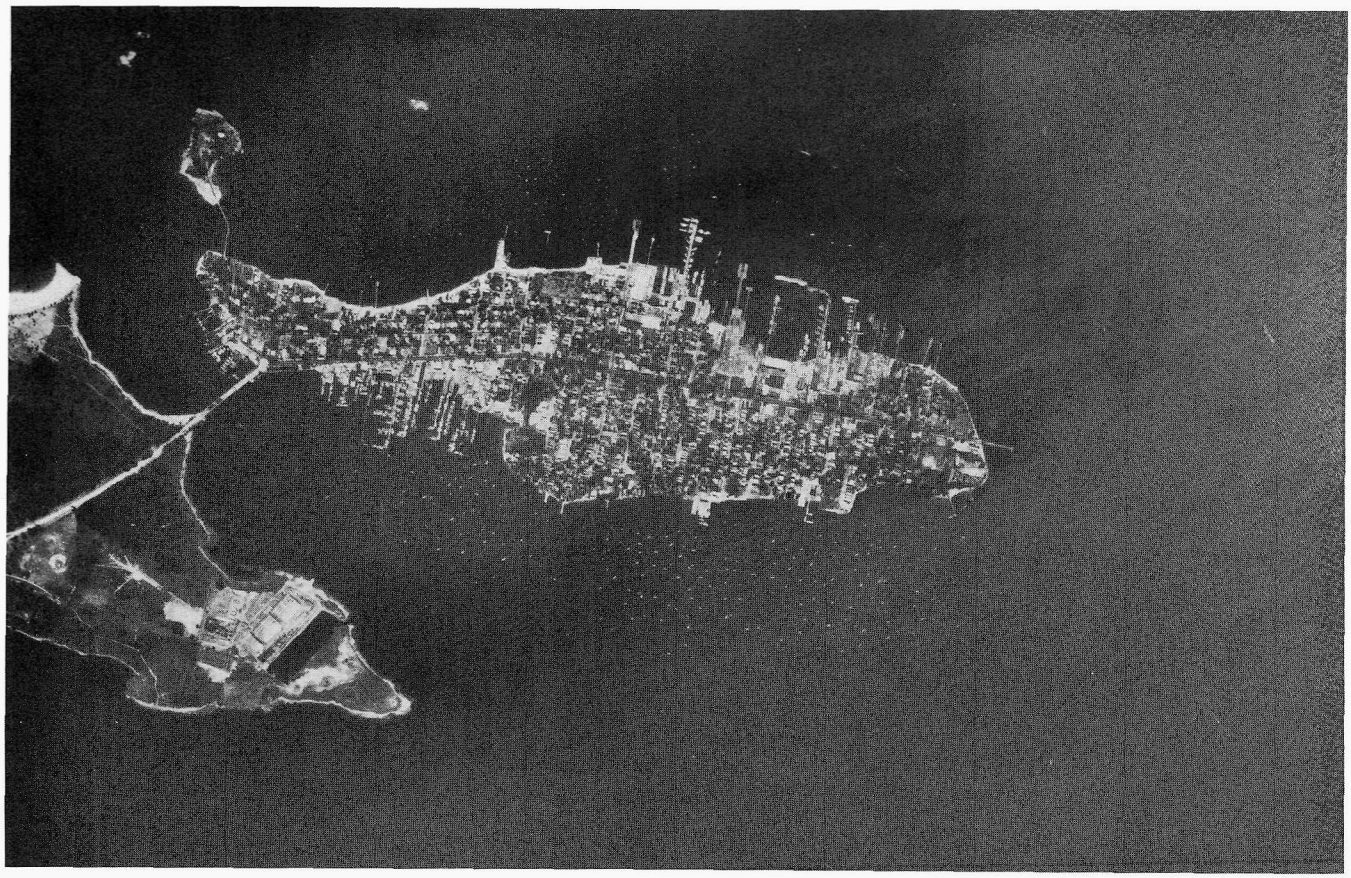


FIGURE 269.—Fourth of July at 11:00 a.m., showing the distribution of boats. (Photograph by Edwin D. Hawbecker.)



FIGURE 270.—Nine-lens camera on display at Smithsonian Institution. Photograph taken August 1979. (Photograph by Lawrence Franklin.)



FIGURE 271.—Alva Pyle processing color glass plates in the processing unit designed and built by the Coast and Geodetic Survey. The unit held 13 plates at a time and had a nitrogen gas burst system for agitation during processing. (Photograph by John T. Smith, Jr.)



FIGURE 272.—Maurice E. Weiss checking color balance on two-time aerial print at the Air Photographic Laboratory. (Photograph by John T. Smith, Jr.)

1964

AIR PHOTO MISSION 6401 ACTIVITIES—1964

On the afternoon of Good Friday, March 27, an earthquake and a resulting tsunami struck Alaska. The Coast Guard was notified that aircraft 72486 was needed as soon as possible. The aircraft arrived in Washington, D. C., on March 30 and left for Alaska the same day, arriving in Anchorage on April 1. Aboard were Lt. Robert L. Sandquist, navigator, and Maurice E. Weiss and James L. Hardwick, photographers. Lt. Comdr. Kelly E. Taggart and John T. Smith, Jr., were aboard as advisers. (Taggart and Smith remained with the mission until April 10.) A meeting was held with the C&GS Director, Vice Adm. H. Arnold Karo, on the evening of April 1, and plans were formulated on the areas to be photographed. Flight maps were drawn in order that photography would cover all affected towns, harbors and coastlines, glaciers,and ice fields so that faulting patterns could be studied, as well as photography covering the area of the earthquake epicenter. Photography began on April 2 (figs. 273 through 284).

More than 2,500 miles of photography had been taken by May 1, and the mission returned to San Francisco, Calif. From May 2 to June 8 the mission continued photography in the conterminous United States, and on June 9 again left for Alaska (fig. 285), remaining there until August 10, when the aircraft returned to San Francisco, worked its way across country until October 13, and landed at Elizabeth City, N. C. Lt. Sandquist reported: "It was planned to complete a photographic assignment in Albemarle Sound on the morning of the 14th and then proceed to Washington, D. C. to close the mission. But on the morning of the 14th temperatures and pressures of the number 4 engine went askew on the takeoff roll and the takeoff had to be aborted. The engine was inspected and it was found that two cylinders had chewed up their respective piston rings, hence requiring an engine change. The mission ended in this manner on the 15th, when the Coast Guard flew all Coast & Geodetic Survey personnel and equipment to Dulles Airport in a C–130."

With the close of the 1964 season, and after 25 years, the cooperative photographic aircraft agreement between C&GS and the U. S. Coast Guard was terminated. C&GS personnel will always be grateful to the Coast Guard crew members who always made life under adverse conditions a little more enjoyable with their dedication and attitude of , "Let's get the job done!"

Aircraft U. S. Coast Guard 2486 (R5–D)

June 1960 to October 1964

Personnel who served on board

Coast Guard

AM–3 Robert S. Barger
AD–2 C. C. Brewer
AD–3 D. L. Butler
AE–3–PI R. A. Chilcot
Lt. Connor, pilot
AD–2Ronald W. Cox
Douglas
AT–2 R. C. Hiner
AD–1–PI Carl D. Hollingsworth
AL–Z K. A. Gallo
LT.(jg) James L. Haas, pilot
Lt.(jg) George A. Kiehle, pilot
AT–2–PI D. C. Lopez
Lt. Harold B. McDuffee, pilot
AD–2 J. N. Mathews
AD–3 S. S. Mazza
Lt. Dan S. Meginley, pilot
AL–2 R. G. Miller
Lt. Roger Millett, pilot
AL–1 Alan V. Naber
AD–1 D. R. Palowski
Lt. Marshal K. Phillips, pilot
AD–1 Lyndon L. Potter
Lt. Comdr. Rapalus, pilot
AE–3 R. O. Rodgers
AD–1 R. G. Schmidt
AD–3 Ronald R. Seabol
SNAD E. C. Taylor
AT–3 R. V. Vanderpool
AT–3 G. C. Walters
AD–2 C. F. Willard



FIGURE 273.—Aerial view of Turnagain Arms, an area of expensive homes in Anchorage, Alaska that was totally destroyed during the earthquake. The tremendous upheaval of the Earth is graphically shown. (Photograph by John T. Smith, Jr.)

Coast and Geodetic Survey Officers

Lt. Comdr. Richard H. Houlder
Lt. Comdr. Merlyn E. Natto
Lt. James P. Randall
Lt. Robert L. Sandquist
Lt. Comdr. Kelly E. Taggart

Coast and Geodetic Survey Civilians

Francis E. Buck
Harland R. Cravat
Jim L. Hardwick
Edwin D. Hawbecker
Robert Hemingway
Charlie R. Johnson
Howard G. Kirkwood
William G. Riggs
John T. Smith, Jr.
Charles Waldron
Maurice E. Weiss



FIGURE 274.—Ground photograph in the area shown in figure 273 in Turnagain Arms, April 2, indicates the violence of the earthquake. (Photograph by John T. Smith, Jr.)



FIGURE 275.—Photograph taken April 2, on the ground in Turnagain Arms shows the destructive force of the earthquake. (Photograph by John T. Smith, Jr.)



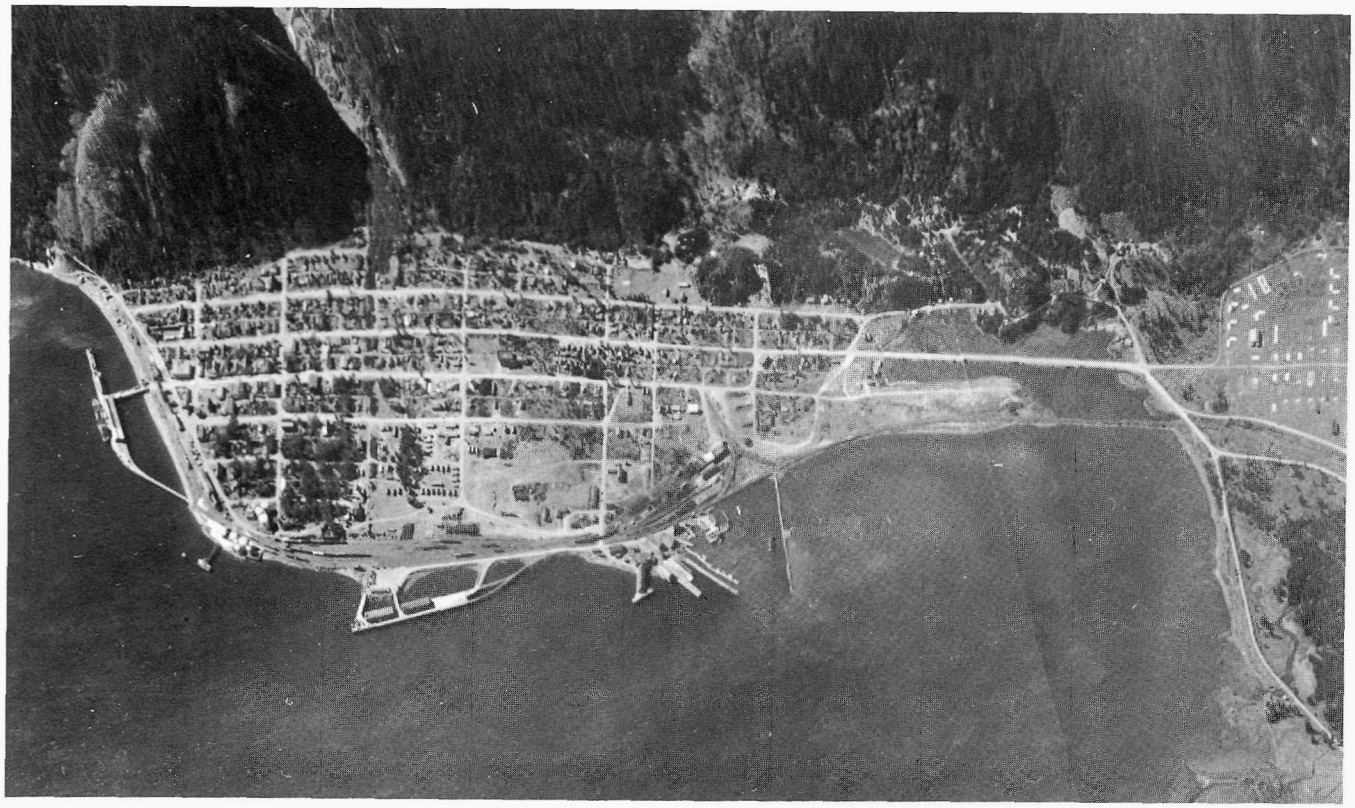
FIGURE 276.—Downtown 4th Street, Anchorage, Alaska, photographed in 1952. Orientation is helped by the D&D Bar and Cafe. (Photograph by John T. Smith, Jr.)



FIGURE 277.—Photograph taken from about the same position as figure 276 on April 2. The drop of the street shows the subsidence of the earth caused by the earthquake. (Photograph by John T. Smith, Jr.)



FIGURE 278.—Boats washed into town of Kodiak by tsunami that followed earthquake. (Photograph by John T. Smith, Jr.)

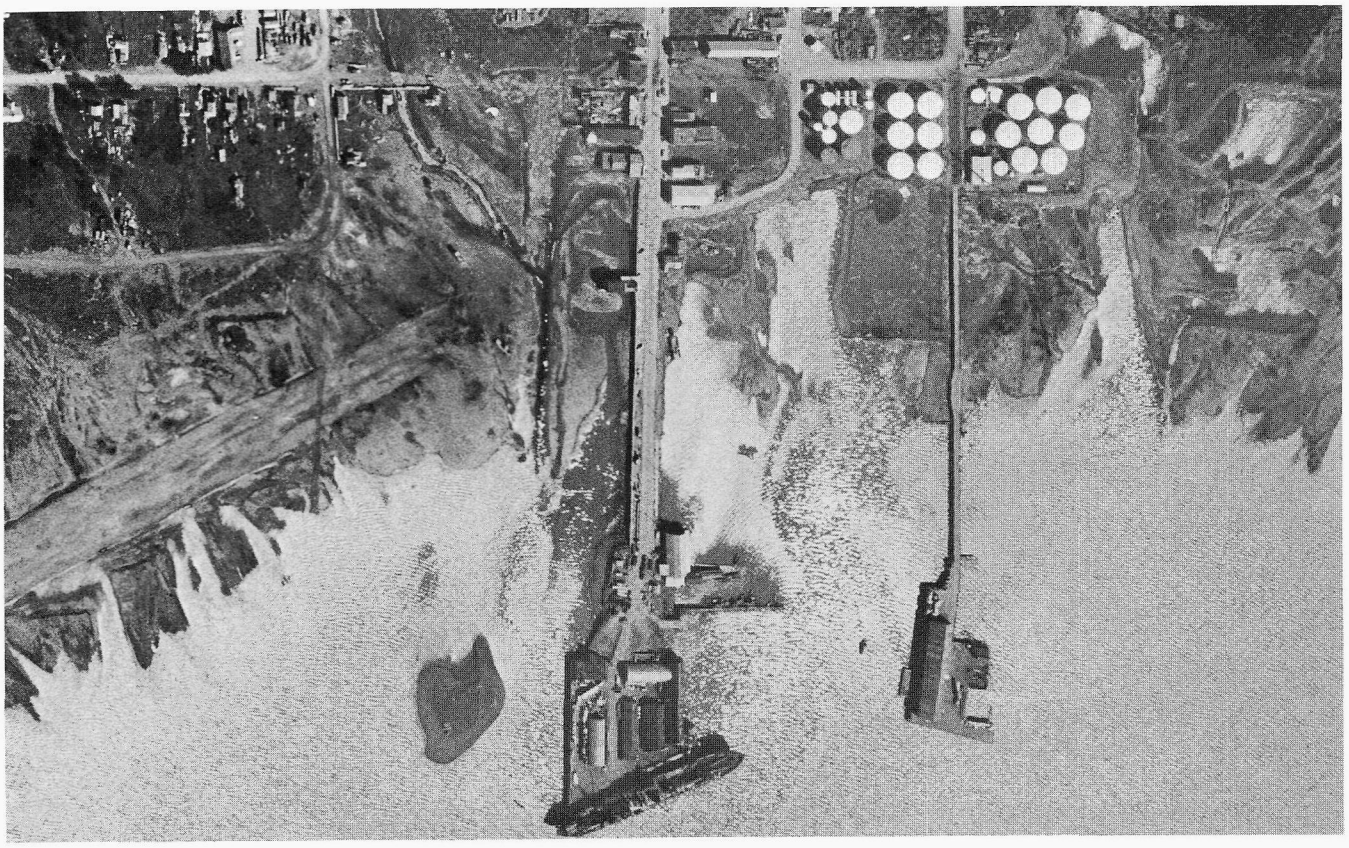




FIGURES 279 AND 280.—Comparison photograph of Seward, Alaska. Top, 9-lens photograph taken in September 1948; lower photograph taken in August 1964 indicates damage sustained by the town of Seward as a result of the earthquake. (Top photograph by W. Byron Hale, lower photograph by M. E. Weiss.)



FIGURE 281.—Port area shown on left side of town in figure 279 as seen from the ground on April 7. (Photograph by John T. Smith, Jr.)





FIGURES 282 AND 283.—Comparison photographs of Valdez, Alaska. Top photograph taken in 1954 showing the port facility. Lower photograph taken in August shows the destruction of the port. (Top photograph by Bennett Sparks; lower photograph by M. E. Weiss.)

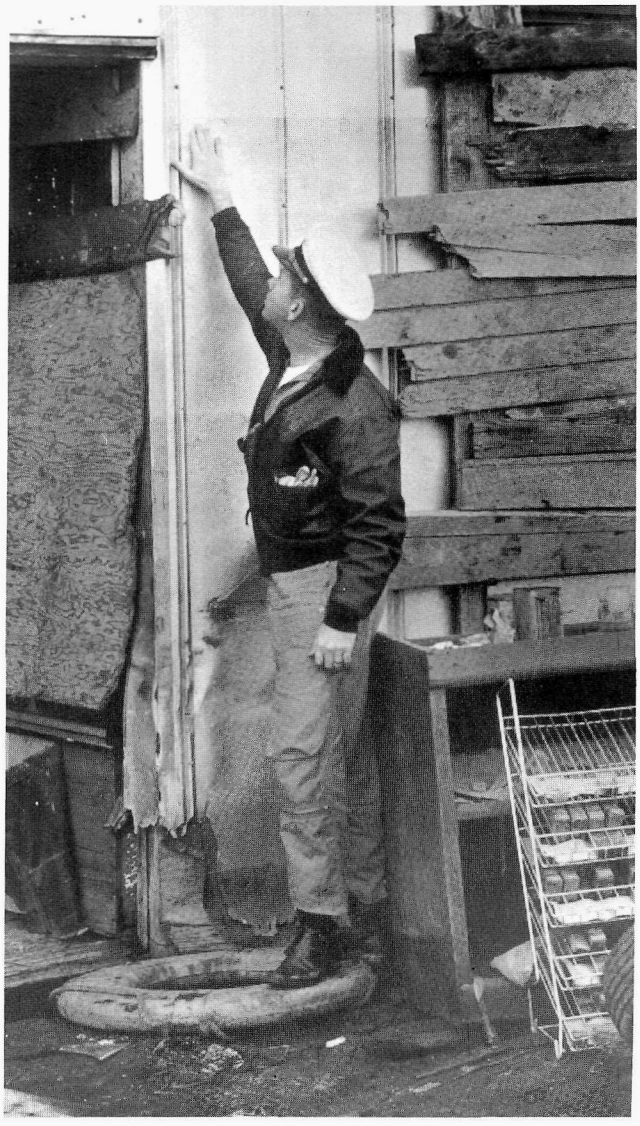


FIGURE 284.—Lt. Comdr. Kelly Taggart stands on life preserver to indicate the high water-mark in the town of Valdez. Photograph taken April 6. (Photograph by John T. Smith, Jr.)

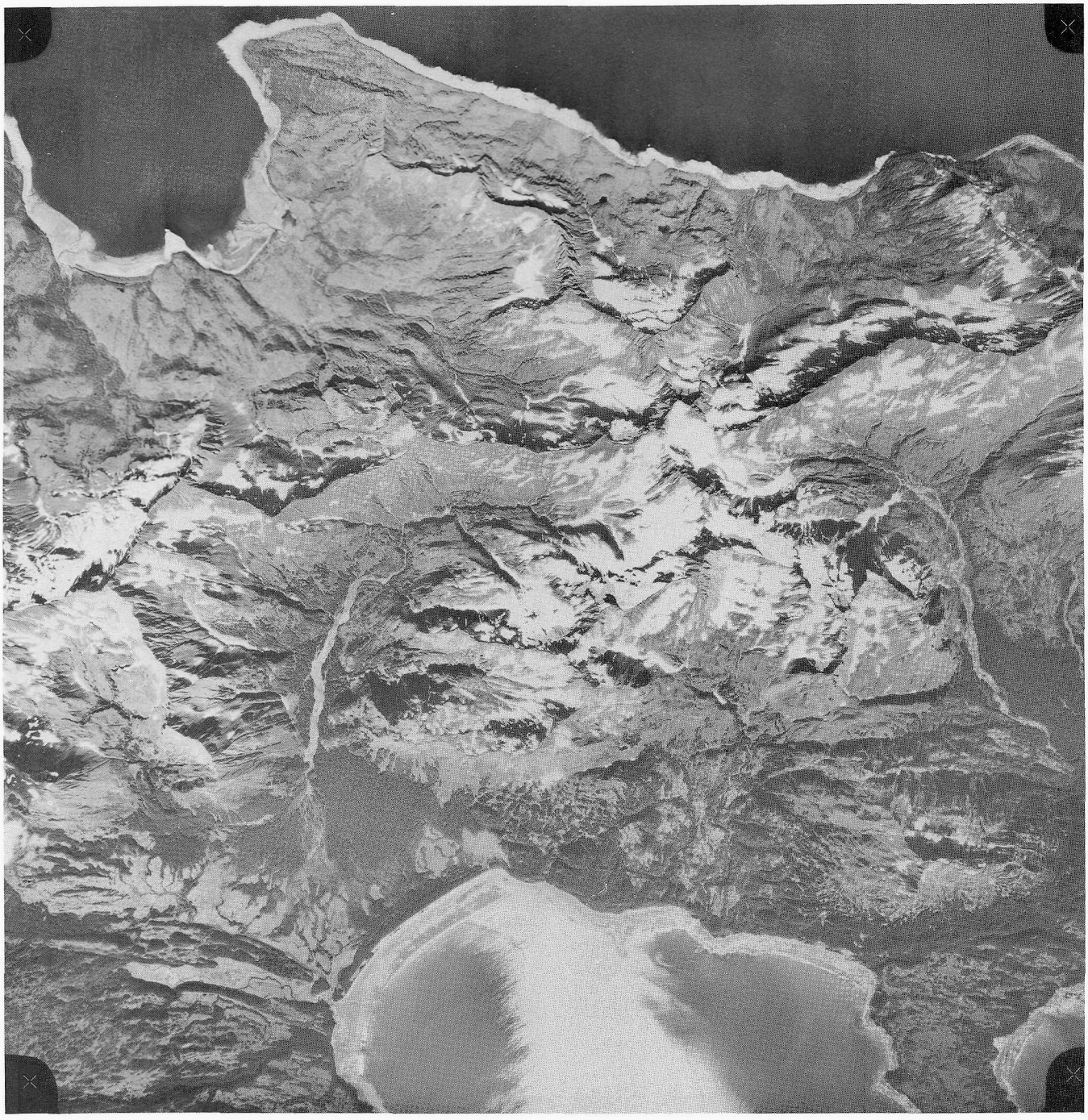


FIGURE 285.—Photograph of Montague Island, Alaska, with RC–9 camera, "M" 88 mm lens, scale 1:70,000. (Photograph by Maurice E. Weiss.)

AIR PHOTO MISSION 6402 ACTIVITIES—1964

Aero Commander N6889S began its season on February 8, with Lt. Robert L. Sandquist as Chief of Mission and pilot; Lt. Gerald C. Saladin (fig. 286), copilot/navigator; and Maurice E. Weiss, photographer. The mission left Washington on the 12th for San Juan, P. R., and remained in San Juan until the 27th, when all mapping assignments had been completed. The mission arrived back in Washington, D. C., on the 29th, and Lt. Saladin replaced Lt. Sandquist as Chief of Mission on March 1. On March 13 Lt. Francis D. Moran reported on board as copilot/navigator and William G. Riggs, Jr. (on March 15 Riggs returned to work for C&GS) replaced Weiss as photographer. The mission continued photography thoroughout the conterminous United States until August 2, when it left Seattle, Wash., for Alaska, arriving at Juneau on the same day. Because of the urgent need for new maps and charts following the earthquake, the mission assisted the R5–D aircraft in photographing Alaska. After completing photography the mission left Alaska on the 20th and returned to Seattle. It then continuted photography throughout the United States until October 22, when the mission returned to Washington, D. C., and was secured for the rest of the season.

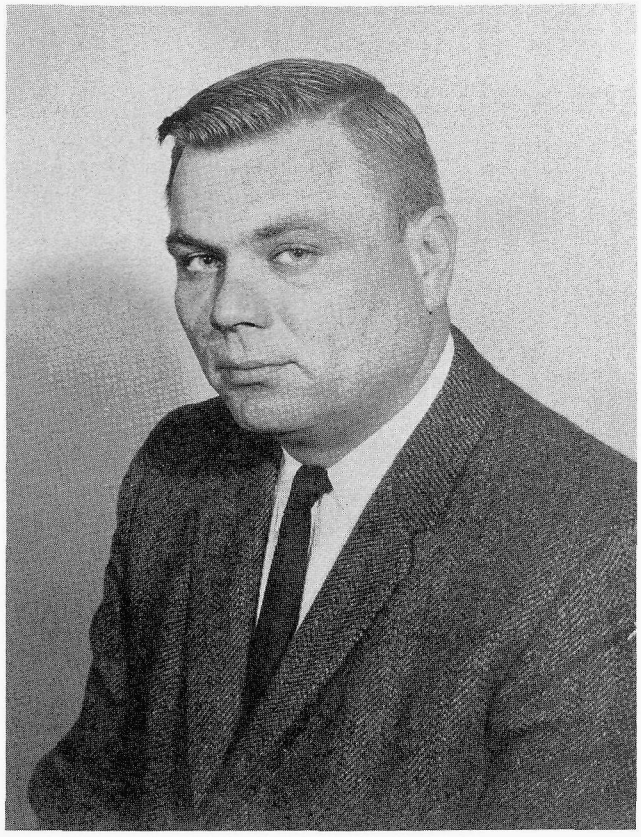


FIGURE 286.—Lt. Gerald C. Saladin. (Official NOS photograph.)

OFFICE ACTIVITIES—1964

In October a new RC–8 camera was purchased (C&GS designation camera "L").

1965

AIR PHOTO MISSION ACTIVITIES—1965

In late fall 1964 C&GS leased a new aircraft, a Grand Commander No. N6375U. (The missions were now designated 375 for N6375U and 376 for N6889S.) The aircraft was modified to carry two Wild cameras and was delivered to C&GS on February 18, 1965, in Oklahoma City, Okla. It was flown to Washington, D. C., for camera installation and testing (figs. 287, 288, 289, 290, 291, 292, 293 and 294), and after completion of the camera test, the mission left Washington, D. C., for Puerto Rico and the Virgin Islands on February 27, with Lt. Robert L. Sandquist, Chief of Mission and pilot; Lt. Gerald C. Saladin, copilot/navigator; and William G. Riggs, photographer. All photography was competed in the Virgin Islands and Puerto Rico, and the aircraft returned to Palm Beach, Fla. on March 2, when Lt. Robert W. Franklin replaced Lt. Saladin. In April the aircraft worked on the Long Island Sound current survey and developed a new method of targeting for current surveys, using aluminum powder dropped from a small aircraft from about 1,500 feet. The aircraft continued photographic operations in the conterminous United States until June 11, when it left for Alaska with Saladin replacing Franklin. The mission arrived in Alaska on June 13. On June 15 Jim Hardwick relieved William Riggs as photographer.

On August 7 Lt. Comdr. Sandquist reported: "Returning from a successful photographic flight at Kachemak Bay,the mission offered its services for a search for a light aircraft that was believed to be down somewhere between Anchorage and Homer. The mission spotted and identified the missing aircraft, radioed its position and circled the area until a helicopter from the Air Force Rescue Coordinating Center was able to proceed to the scene. The four injured occupants of the light plane were flown out by helicopter to the Air Force Hospital at Anchorage and have recovered. The Photo Mission felt quite satisfied that it was able to participate in a successful rescue operation."

On August 14 the mission left Alaska and arrived in Seattle, Wash., the same day. It continued photography on the West Coast until September 4, when Sandquist reported: "On arrival at the San Francisco



FIGURE 287.—Grand Commander N6375U. (Photograph by William G. Riggs.)



FIGURE 288.—Lt. Comdr. Kelly Taggart receives the keys for the Grand Commander from Warren Holiday while Lt. Robert Sandquist looks on. (Photograph by John T. Smith, Jr.)

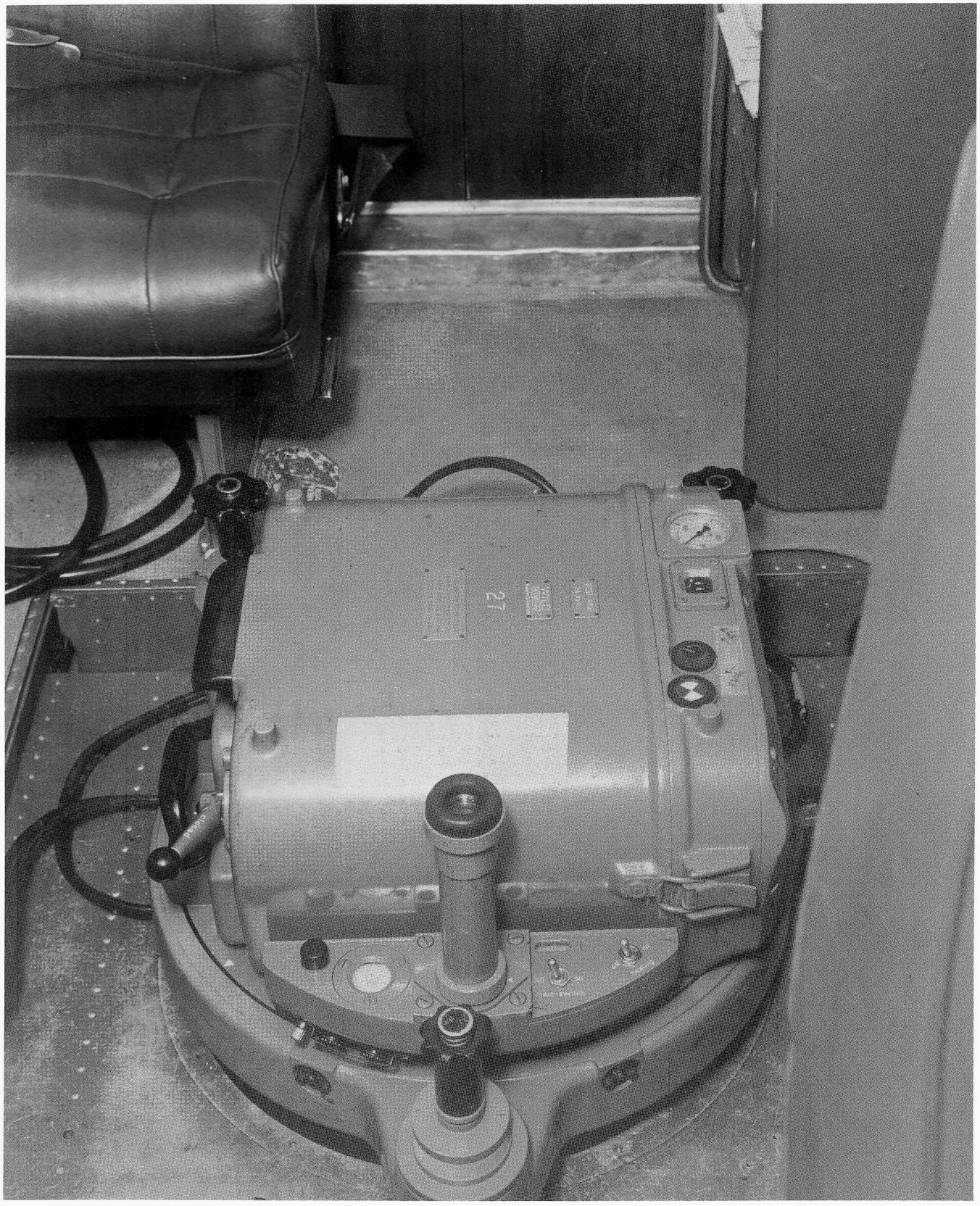


FIGURE 289.—RC−9 camera installed in Grand Commander. (Photograph by William G. Riggs.)

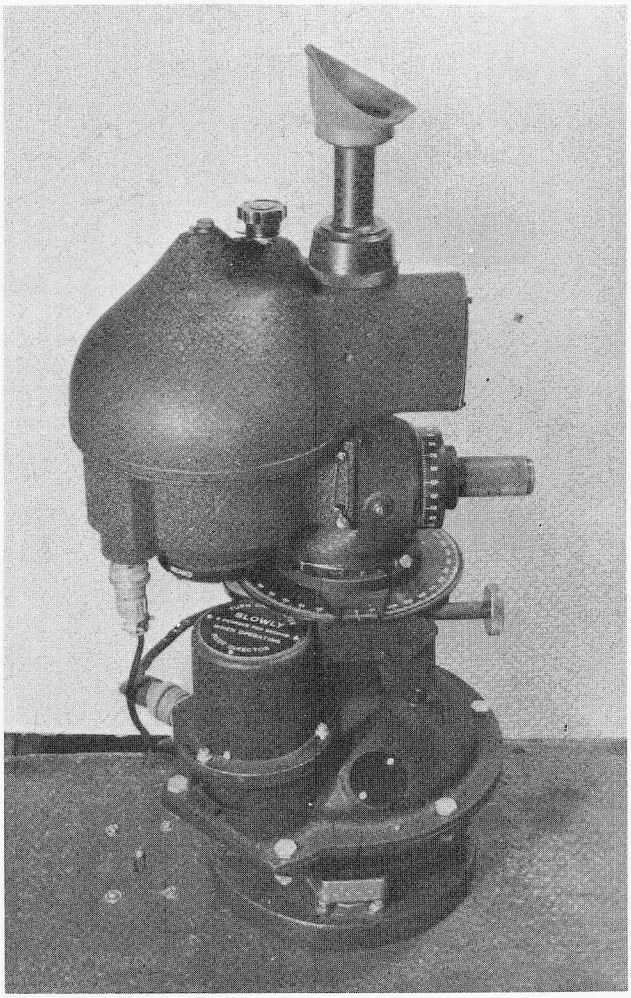


FIGURE 290.—B−4 driftsight. Navigation sight used on Aero Commander N6889S and Grand Commander N6375U. (Official NOS photograph.)



FIGURE 291.—Flight personnel standing in front of Grand Commander. Left to right: Lt. Comdr. Kelly Taggart, Lt. Robert Sandquist, Lt. Gerald Saladin, Lt. Francis Moran; kneeling: Charlie Johnson, William Riggs, Jim Hardwick, Maurice Weiss. (Photograph by Edwin D. Hawbecker.)



FIGURE 292.—Grand Commander N6375U in flight. (Official NOS photograph.)



FIGURE 293.—B–4 driftsight in operation on Grand Commander. (Photograph by James Hardwick.)

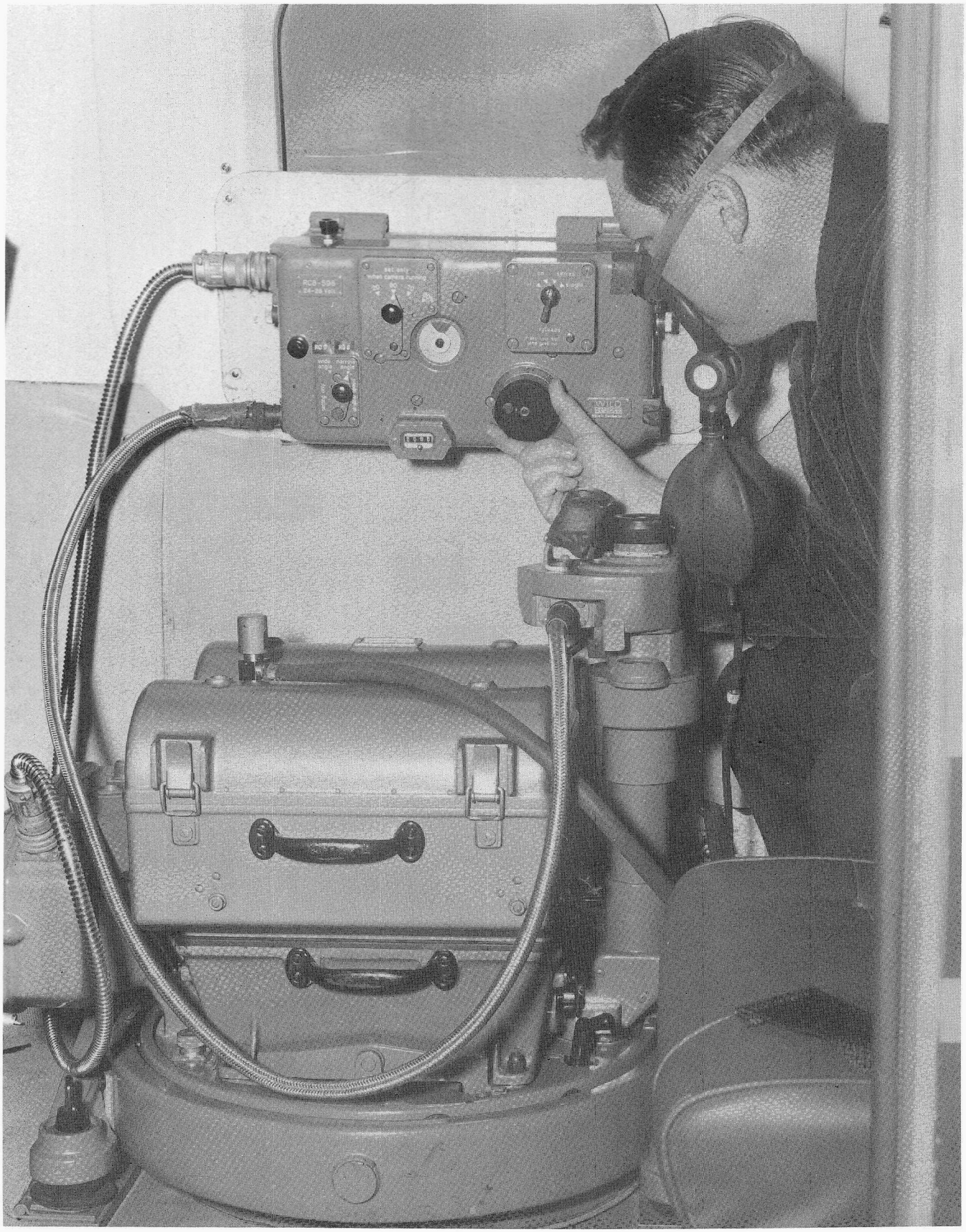


FIGURE 294.—Photographer James Hardwick operating RC−8 camera on Grand Commander. (Photograph by John T. Smith, Jr.)

Airport on the fourth, the mission discovered that the aircraft had been severly damaged (figs. 295 and 296) while in its parking place, by a runaway Beechcraft Bonanza." All photographic equipment, supplies, and personal gear were shipped back to Washington, D. C., and the photographic party returned there on the 9th by commercial aircraft. Before leaving San Francisco, N6375U was turned over to the insurance company for settlement and repairs.

A Cessna 182 was rented during the week following the aircraft damage. The small airplane could only carry a pilot, photographer, and one camera. The Cessna was used until the end of the year, photographing in the Eastern United States. Edwin D. Hawbecker replaced Jim Hardwick as mission photographer at the end of September. Operations continued until November 4, when the mission was secured for the rest of the year.

AIR PHOTO MISSION 376 ACTIVITIES—1965

Aero Commander N6889S (figs. 297 and 298) was activated on April 22 and left Washington, D.C., on April 28 with Lt. Comdr. Robert W. Franklin, Chief of Mission and pilot; Lt. Francis D. Moran, copilot/navigator; and Maurice E. Weiss, photographer. Moran relieved Franklin as Chief of Mission on June 11. Other personnel who served at various times throughout the year included Lt. Comdr. Gerald C. Saladin, Comdr. Alfred E. Holmes, Lt. Raymond L. Spear, Edwin Hawbecker, John T. Smith, Jr., Charlie R. Johnson, and Jim Hardwick. The mission continued photography throughout the United States until November 30, when the mission was secured for the rest of the year.



FIGURE 295.—Grand Commander at airport in San Francisco on September 4, after having been hit by a Beechcraft Bonanza. (Photograph by Jim Hardwick.)



FIGURE 296.—Propeller and front end of Beechcraft Bonanza which struck the Coast and Geodetic Survey Grand Commander N6375U. (Photograph by Jim Hardwick.)



FIGURE 297.—Aero Commander N6889S. (Official NOS photograph.)

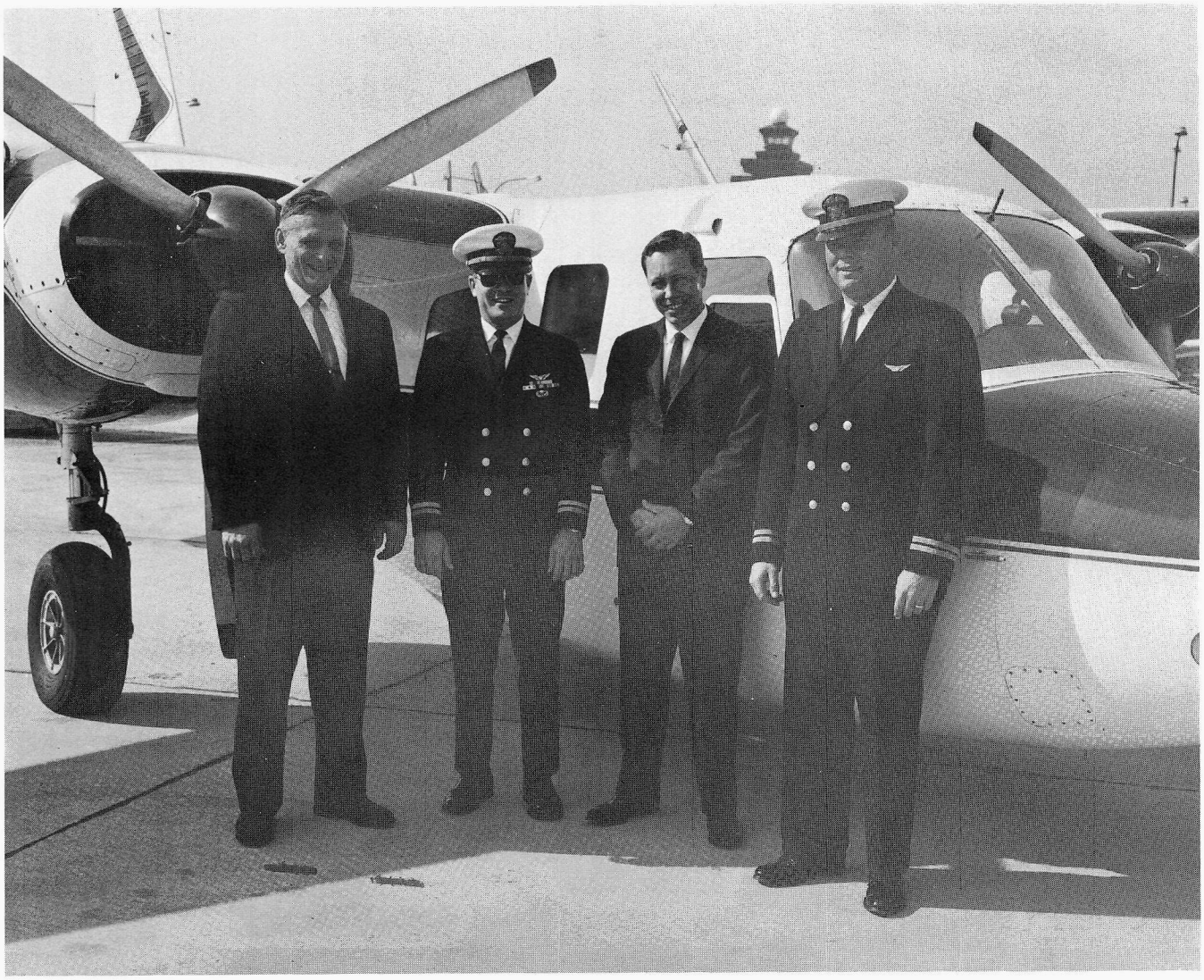


FIGURE 298.—Crew of N6889S, left to right: Maurice Weiss, Lt. Francis G. Moran, James Hardwick, Lt. Gerald Saladin. (Photograph by John T. Smith, Jr.)

OFFICE ACTIVITIES—1965

The processing of aerial photography continued (figs. 299 and 300).



FIGURE 299.—Anthony Ruth, laboratory technician, who has made thousands of prints and glass plates. Because of surgery on both hips, Ruth was required to use crutches, but this was not a handicap as was evident by his high production rate. (Photograph by John T. Smith, Jr.)

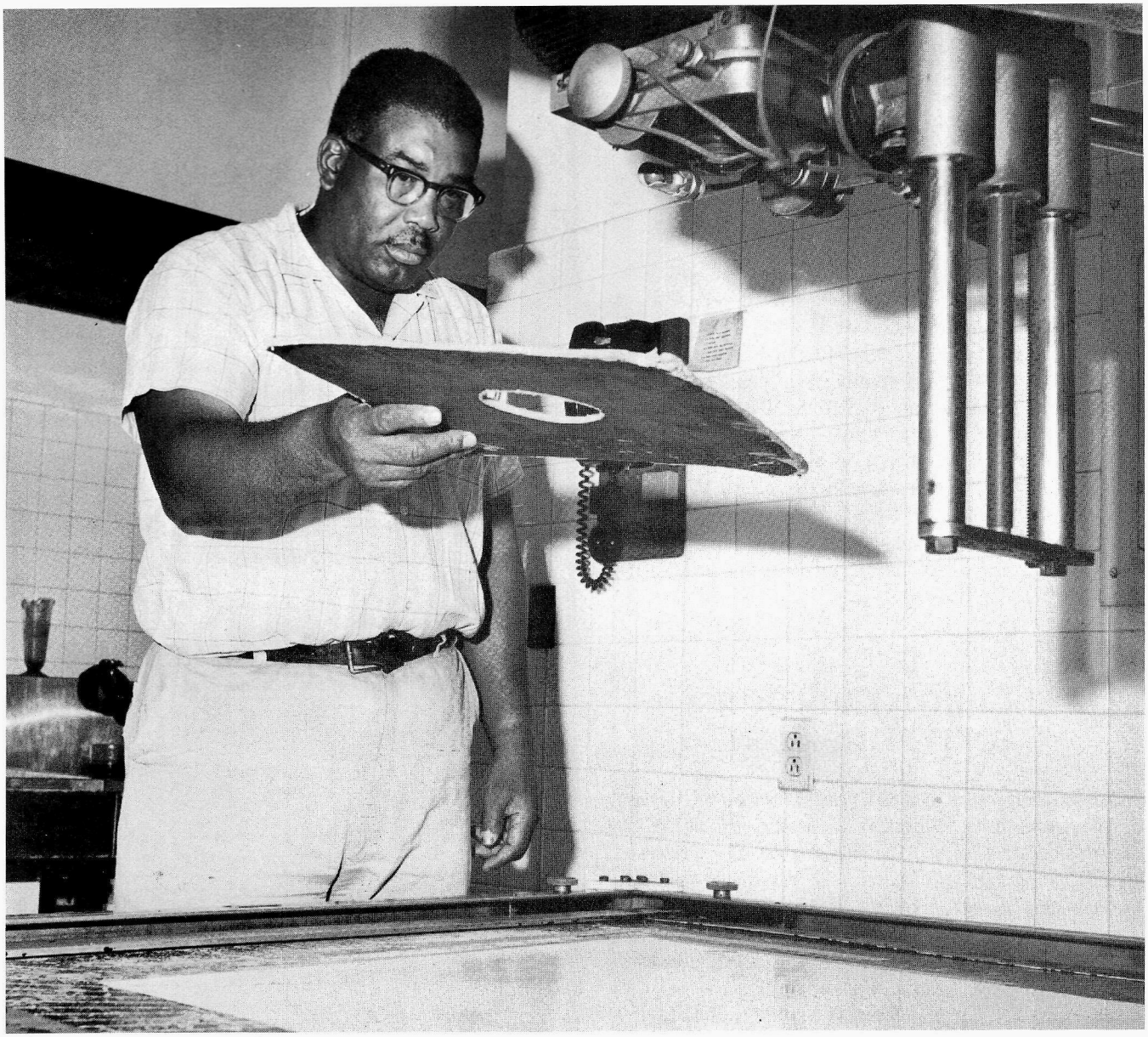


FIGURE 300.—George Reid, laboratory technician, uses the age-old art of hand dodging to enhance print quality. (Photograph by John T. Smith, Jr.)

1966

AIR PHOTO MISSION 1 ACTIVITIES—1966

After repairs had been completed, Grand Commander N6375U was returned to duty on April 13 (N6375U was now designated Mission 1 and N6889S Mission 2), with Lt. Francis Moran, Chief of Mission and pilot; Lt. Comdr. Raymond Speer, copilot/navigator; and Charlie Johnson, photographer. The mission continued photography in the United States until June 21, when it left Seattle, Wash., for Anchorage, Alaska. The mission remained in Alaska until July 17, when it returned to the United States and continued photography until arriving at Washington, D. C. on November 27, when the mission was secured for the rest of the year.

AIR PHOTO MISSION 2 ACTIVITIES—1966

Aero Commander N6889S was activated on January 5, with Lt. Comdr. Robert W. Franklin (fig. 301) Chief of Mission and pilot; Lt. Frederick H. Gramling, copilot/navigator; and Maurice E. Weiss, photographer. Others who served on board the mission during the year were Lt. Comdr. Gerald C. Saladin, Lt. Comdr. Raymond Speer, William G. Riggs, and Edwin D. Hawbecker.

The mission left the United States and landed at San Juan, P. R., on February 17. It remained in Puerto Rico until March 15 and then returned to the United States. From July 6 to July 12 simultaneous camera tests were made between two aircraft in order to freeze wave action and to obtain stereo models of ocean waves. Cessna aircraft No. N6333B was rented. The two aircraft flew together, with the camera shutter in the Cessna radio-controlled from the camera in Aero Commander N6889S. The tests showed that this system would work very well provided the two aircraft had about the same flight characteristics. The mission returned to regular photographic operations, completing a tide-coordinated photographic project in Casco Bay, Mass. on August 28 and 29. It also participated in the Gulf Stream current studies from October 2 through October 10 when it was based at Charleston, S. C.

The mission was plagued by the S-camera shutter system's continuing to fail throughout the year. The camera had been returned to the factory for repairs on four occasions, but the trouble could not be isolated. The mission personnel finally discovered that if the camera was removed from the aircraft every night and "allowed to sleep in a bed in their hotel room," the camera functioned properly the following day. So "this rather unusual procedure was continued for most of the season." The mission returned to Washington, D. C., on October 30 and was secured on October 31 for the rest of the year.



FIGURE 301—Lt. Comdr. Robert W. Franklin. (Official NOS photograph.)

SAUDI ARABIA ACTIVITIES—1966

C&GS entered into an agreement with the State Department and Army Map Service to provide infrared and panchromatic photography of the Saudi Arabia portion of the Persian Gulf, in order to map the mean high and mean low waterline along the coast.

On January 16 the C&GS team left Washington, D.C., by commercial airlines for Saudi Arabia with Lt. Comdr. Gerald Saladin as Chief of Party, and John T. Smith, Jr., and William Riggs, photographers. The team carried as excess baggage an RC−9 camera to be installed in an Air Force C−130 aircraft, along with one RC−9 and one RC−8 camera that were to be brought in by the Air Force. The personnel and luggage, including all films required for the project, arrived in Dhahran, Saudi Arabia, on January 18. Because of aircraft problems, the Air Force plane did not arrive until January 31, and camera installations were completed on February 1 (figs. 302 thru 305).

All photography was completed by March 7. All film was processed in Saudi Arabia, and the completed film turned over to the aircraft commander on March 8 for delivery to the Army Map Service in Washington, D.C. The aircraft also brought back to the United States all the C&GS camera and processing equipment.

C&GS personnel left by commercial aircraft on the morning of March 9 and arrived in Washington, D.C., that same night.

U.S. Air Force Aircraft 70524

Personnel who served on board:

U.S. Air Force

Capt. Charles R. Lyons
Capt. Ballerie
Sgt. Colmer
Sgt. Rush

U.S. Army Map Service

Donald Roberts

Coast and Geodetic Survey Officer

Lt. Comdr. Gerald Saladin

Coast and Geodetic Survey Civilians

William G. Riggs, Jr.
John T. Smith, Jr.

OFFICE ACTIVITIES—1966

Capt. Waugh retired on March 19, and Capt. Lorin F. Woodcock was appointed Chief of the Division of Photogrammetry on March 20. In April John T. Smith, Jr., was named Technical Assistant to the Chief of Operations, and Edwin Hawbecker was named Chief



FIGURE 302.—U. S. Air Force C−130, No. 70524, on Saudi Arabian Project. (Photograph by John T. Smith, Jr.)



FIGURE 303.—Installation of cameras in C–130 aircraft. Camera control RC–9. Middle camera RC–8 and aft camera RC–9. The RC–9's were run in tandem using panchromatic and infrared film. (Photograph by John T. Smith, Jr.)

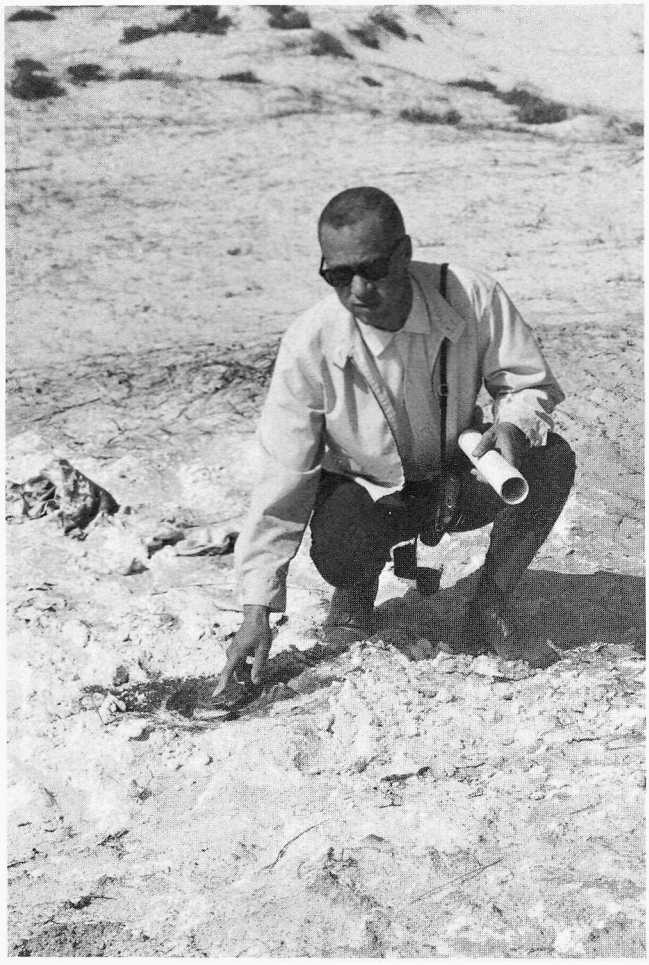


FIGURE 304.—Donald Roberts of the Army Map Service points to a bench mark in the sand dunes in Saudi Arabia. These marks were targeted by pouring oil over the sand. (Photograph by John T. T. Smith, Jr.)

of the Aerial Photographic Laboratory.

In May tests were made on false color infrared film over Bennetsville, S.C., using an Air Force C–130 aircraft. The test films included false color infrared and two new normal color film emulsions. Following the tests, the false color film and the normal color MS film were found to have a resolving power that was equal to or better than the standard black-and-white panchromatic film. Woodcock reported: "Mr. John T. Smith, Jr., Chairman of the Aerial Color Photography Committee of the American Society of Photogrammetry, reports the successful completion of the data acquisition phase of the color tests over the Phoenix, Arizona color calibration area."

In July a new Henson capping shutter was received at the Beltsville Satellite Triangulation Center. The shutter was used for the new system of stellar calibrations of aerial cameras (fig. 306). Woodcock was appointed Associate Director of Geodesy and Photogrammetry in October, and Capt. V. Ralph Sobieralski became Chief of the Division of Photogrammetry on November 11.

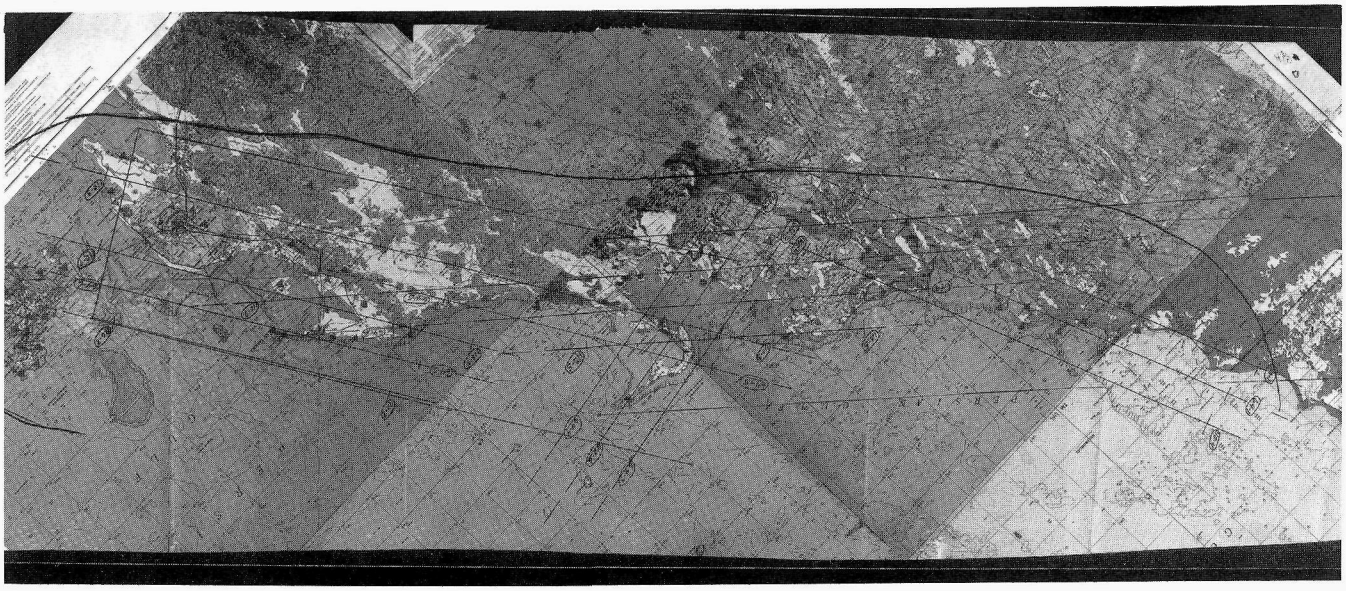


FIGURE 305.—Flight lines flown over Saudi Arabia.

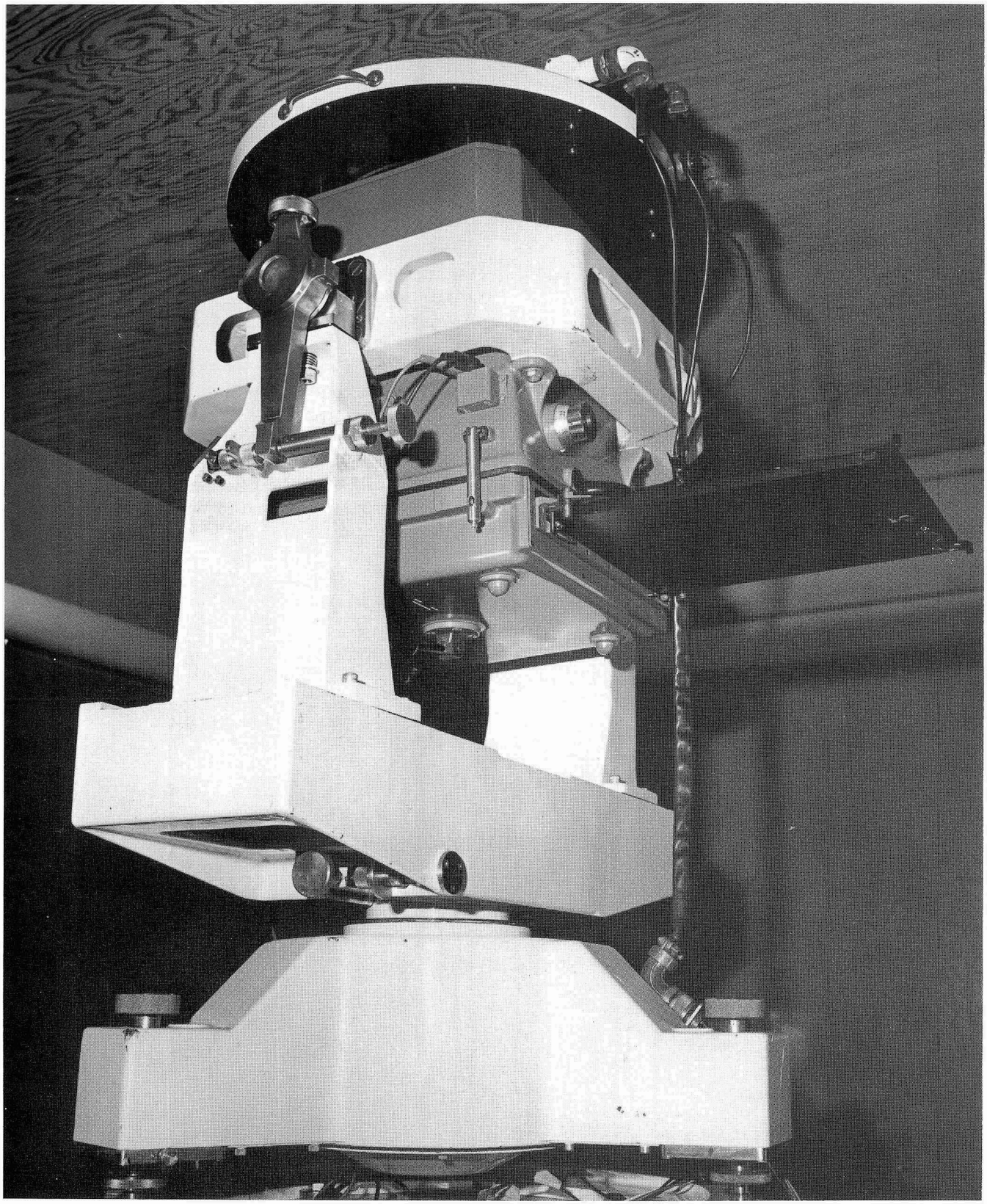


FIGURE 306.—Aerial camera mounted for stellar calibration at Beltsville, Md. (Official NOS photograph.)

1967

AIR PHOTO MISSION 1 ACTIVITIES—1967

Grand Commander N6375U was activated on January 4 and departed Washington, D.C., immediately with Lt. Comdr. Robert W. Franklin, Chief of Mission and pilot; Lt. Robert C. Westphall, copilot/navigator; and Maurice E. Weiss, photographer. Other personnel who served on board at various times throughout the year were Lt. Comdr. Raymond L. Speer, Lt. Comdr. Frederick H. Gramling, Lt. Walter S. Simmons, William G. Riggs, Charlie R. Johnson, and Edwin D. Hawbecker (figs. 307 and 308).

In March a new Wild navigation sight was installed to replace the old B−4 unit. The sight proved to be a great asset in flying the aircraft down predetermined flight lines. The mission continued operations in the conterminous United States until May 30 when it left Seattle, Wash., for Juneau, Alaska, arriving in Juneau the same day. The mission remained in Alaska until August 14, when it returned to Seattle. Photography continued in the United States until November 25 when the mission returned to Washington, D.C., and was secured for the rest of the season.



FIGURE 307.—Pilots of Grand Commander, N6375U. Left to right: Lt. Francis Moran, Lt. Comdr. Frederick H. Gramling, Lt. Robert C. Westphall and Lt. Comdr. Robert W. Franklin with the photographic equipment used on the aircraft. (Photography by William G. Riggs.)



FIGURE 308—Flight crew of N6375U. Left to right: Lt. Francis Moran, Lt. Comdr. Raymond Speer, and Charlie Johnson. (Official NOS photograph.)

AIR PHOTO MISSION 2 ACTIVITIES—1967

Aero Commander N6889S commenced the season on March 10, with Lt. Comdr. Raymond L. Speer, Chief of Mission and pilot; Lt. Comdr. Frederick H. Gramling, copilot/navigator; and Maurice E. Weiss, who was replaced on Mission 1 by William Riggs as photographer on March 1. Other personnel who served at various times during the season were Lt. Comdr. Robert W. Franklin, Lt. Robert C. Westphall, and Charles C. Ferguson. The mission continued airport photography throughout the United States until October 31 when the mission returned to Washington, D.C., and was secured for the rest of the season.

OFFICE ACTIVITIES—1967

In June the last RC−8 camera was purchased by C&GS, and given camera designation "E".

On September 6 the Department of Commerce acquired a deHavilland Buffalo (fig. 309) that had been declared surplus by the U.S. Air Force and was given to the National Aeronautics and Space Administration, which, in turn, transferred the plane to Commerce. The aircraft was one of four prototypes built by deHavilland of Canada. Conversion of the aircraft to a photographic airplane continued through the year.

A new polaroid filter (fig. 310) was designed by John T. Smith, Jr., to remove some of the sun's reflections from the surface of the water so that the timeframe for photobathymetry could be extended later in the morning and could start earlier in the afternoon. The filter proved very satisfactory for water penetration, but it was a rotating filter over the camera lens and destroyed the metric calibration of the camera. Consequently, it could not be used with any accuracy for photobathymetry.



FIGURE 309.—The de Havilland Buffalo. (Photograph courtesy Henry Pfeiffer.)

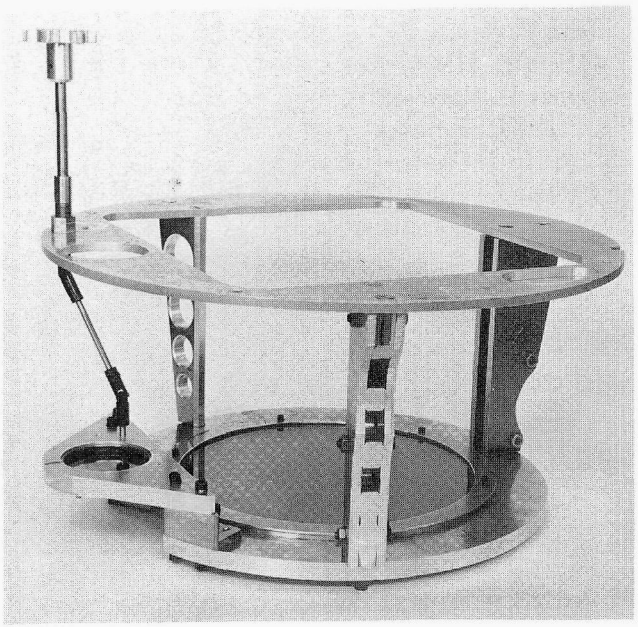


FIGURE 310.—Polaroid filter designed for RC−8 camera system. Note the small polaroid filter operated by the universal knob is geared to the large filter over the lens. The photographer looking through the driftsight could automatically dial the optimum polarization into the system while flying over water. (Photograph by John T. Smith, Jr.)

1968

AIR PHOTO MISSION 1 ACTIVITIES—1968

The Grand Commander N6375U was activated on February 3 and left Washington on February 13 with Lt. Comdr. Raymond L. Speer (fig. 311), Chief of Mission and pilot; Lt. William M. Noble, copilot/navigator; and William G. Riggs, photographer. Charlie R. Johnson and Charles C. Ferguson also served on board at various times during the year. The mission operated throughout the United States during the year and returned to Washington, D.C., on November 26, when it was secured for the rest of the year.

At the end of the season, Grand Commander N6375U was returned to the contractor and the lease terminated.



FIGURE 311.—Lt. Comdr. Raymond L. Speer. (Official NOS photograph.)

Grand Commander N6375U

1964 to 1968

Personnel who served on board:

Coast and Geodetic Survey Officers

Lt. Comdr. Kelly E. Taggart
Lt. Comdr. Robert W. Franklin
Lt. Francis D. Moran
Lt. Robert C. Westphall
Lt. Walter S. Simmons
Lt. Comdr. Robert L. Sandquist
Lt. Comdr. Gerald C. Saladin
Lt. Comdr. Raymond L. Speer
Lt. Comdr. Frederick H. Gramling
Lt. William M. Noble

Coast and Geodetic Survey Civilians

John T. Smith, Jr.
Edwin D. Hawbecker
James L. Hardwick
Charlie R. Johnson
Maurice E. Weiss
William G. Riggs, Jr.
Charles C. Ferguson

AIR PHOTO MISSION 2 ACTIVITIES-1968

Aero Commander N6889S was activated on March 15 with Lt. Comdr. Frederick H. Gramling, Chief of Mission and pilot; Lt. Walter S. Simmons, copilot/navigator; and Charles C. Ferguson, photographer. Lt. Comdr. Raymond L. Speer, Comdr. Robert W. Franklin, and Charlie R. Johnson also served on board at various times during the year. The mission continued airport photography in the United States until November 19, when it returned to Washington, D.C., and was secured for the rest of the year.

OFFICE ACTIVITIES—1968

On November 30 Capt. V. Ralph Sobieralski retired, and on December 1 Comdr. Richard H. Houlder was appointed Chief of the Division of Photogrammetry. At the end of the photographic season all cameras were returned to the Photographic Lab for overhaul and calibration (fig. 312).

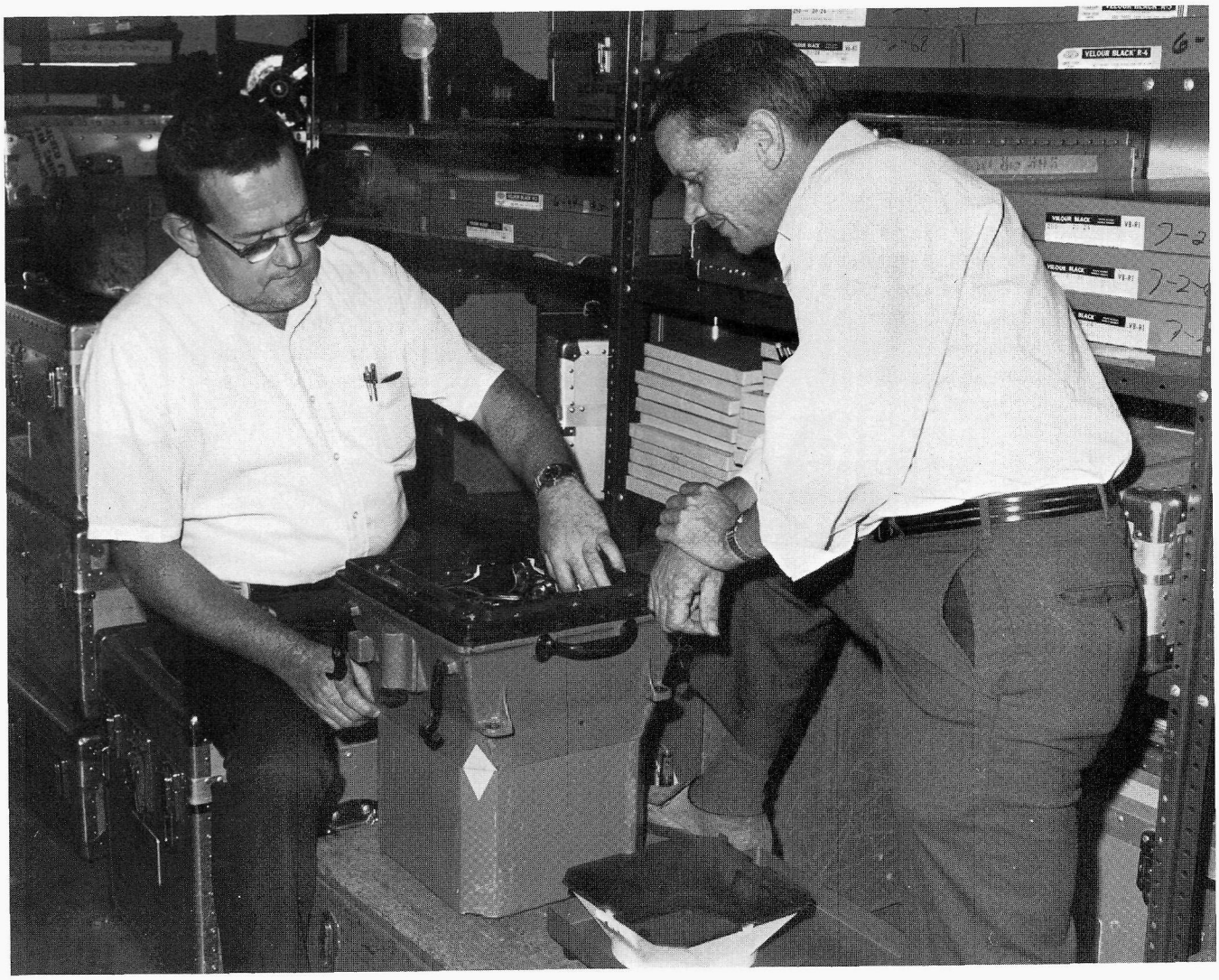


FIGURE 312.—William G. Riggs, left, and Charles Ferguson, right, repairing RC–8 camera in the Department of Commerce Building, Washington, D. C. (Photograph by John T. Smith, Jr.)

1969

AIR PHOTO MISSION 1 ACTIVITIES—1969

The first aircraft owned by C&GS, the deHavilland Buffalo DHC−5 No. ESSA 88 (figs. 313 & 314) had been modified, three camera stations were installed (fig. 315) as well as a navigator's position. All camera flight tests were completed. Lt. Comdr. Robert C. Westphall was Chief of Mission and pilot (fig. 316); Lt. William M. Noble, copilot/navigator; Henry J. Pfeiffer, (fig. 317) flight engineer; and John T. Smith, Jr., photographer. The mission left Washington, D.C., on April 5 (figs. 318 and 319) and arrived at San Juan, P.R. that night. The first photographic assignment for the Buffalo in Puerto Rico was a photobathymetry project at Ponce. The aircraft returned to Washington, D.C., on May 11, and Charlie R. Johnson replaced Smith as photographer. On October 24 Lt. Walter S. Simmons joined the mission (fig. 320), which continued photography throughout the United States until December 18, when it was secured for the rest of the season.



FIGURE 313.—Photogrammetry Division's new Buffalo aircraft after being painted the Coast and Geodetic Survey colors. The de Havilland Buffalo has a wingspan of 96 feet, length of 77 feet, a height of 22 feet. Its gross weight is 38,000 pounds with a cruising range of 2,000 nm. It is a STOL aircraft and is the *first aircraft* owned by the Coast & Geodetic Survey. (Photograph courtesy of Henry Pfeiffer.)



FIGURE 314.—ESSA 88 de Havilland Buffalo at Andrews Air Force Base, Md. The first aircraft owned and operated by the Photogrammetry Division, it possessed all of the requirements needed in a photographic airplane. (Photograph by John T. Smith, Jr.)

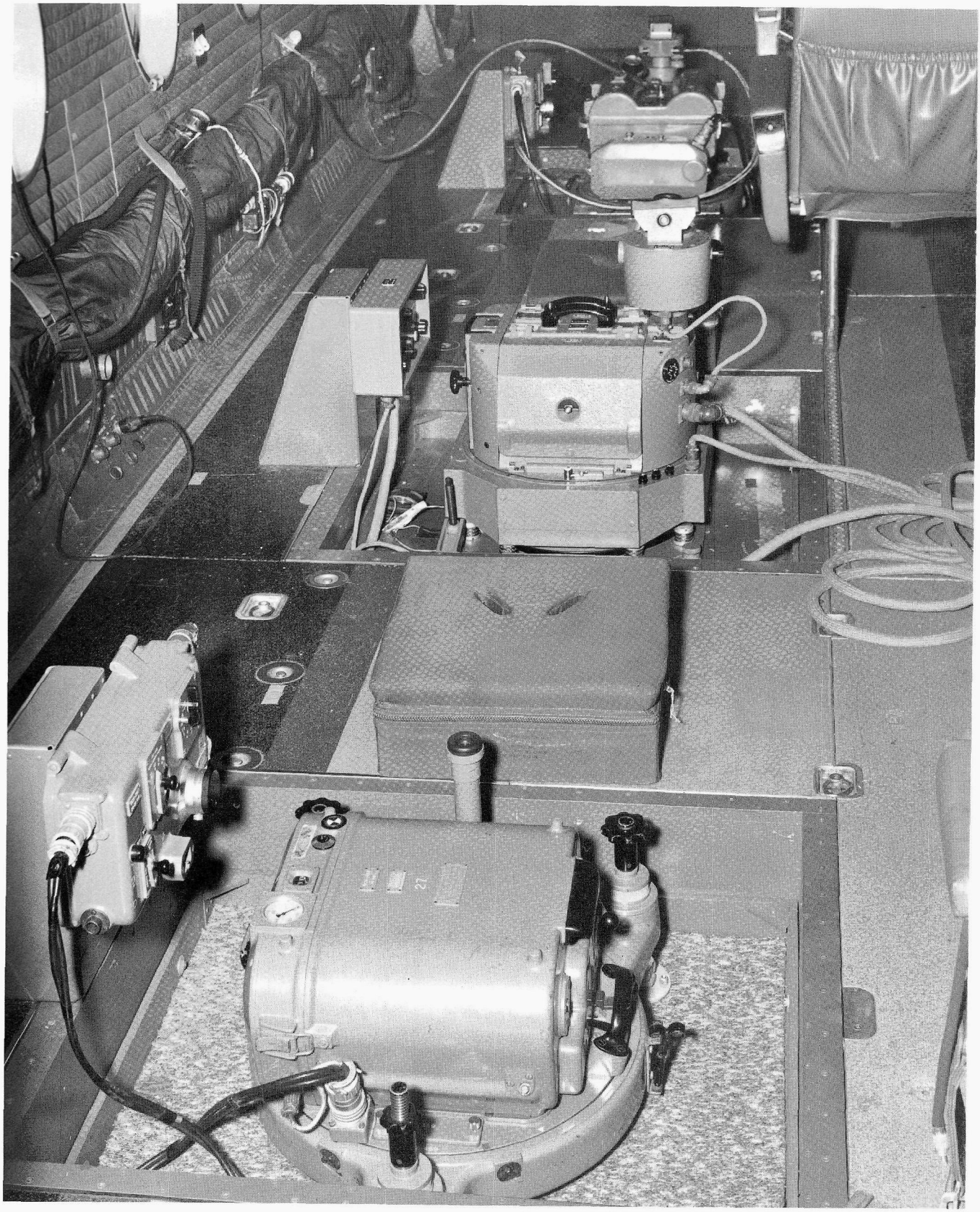


FIGURE 315.—Installation of three cameras in Buffalo aircraft. (Photograph by John T. Smith, Jr.)

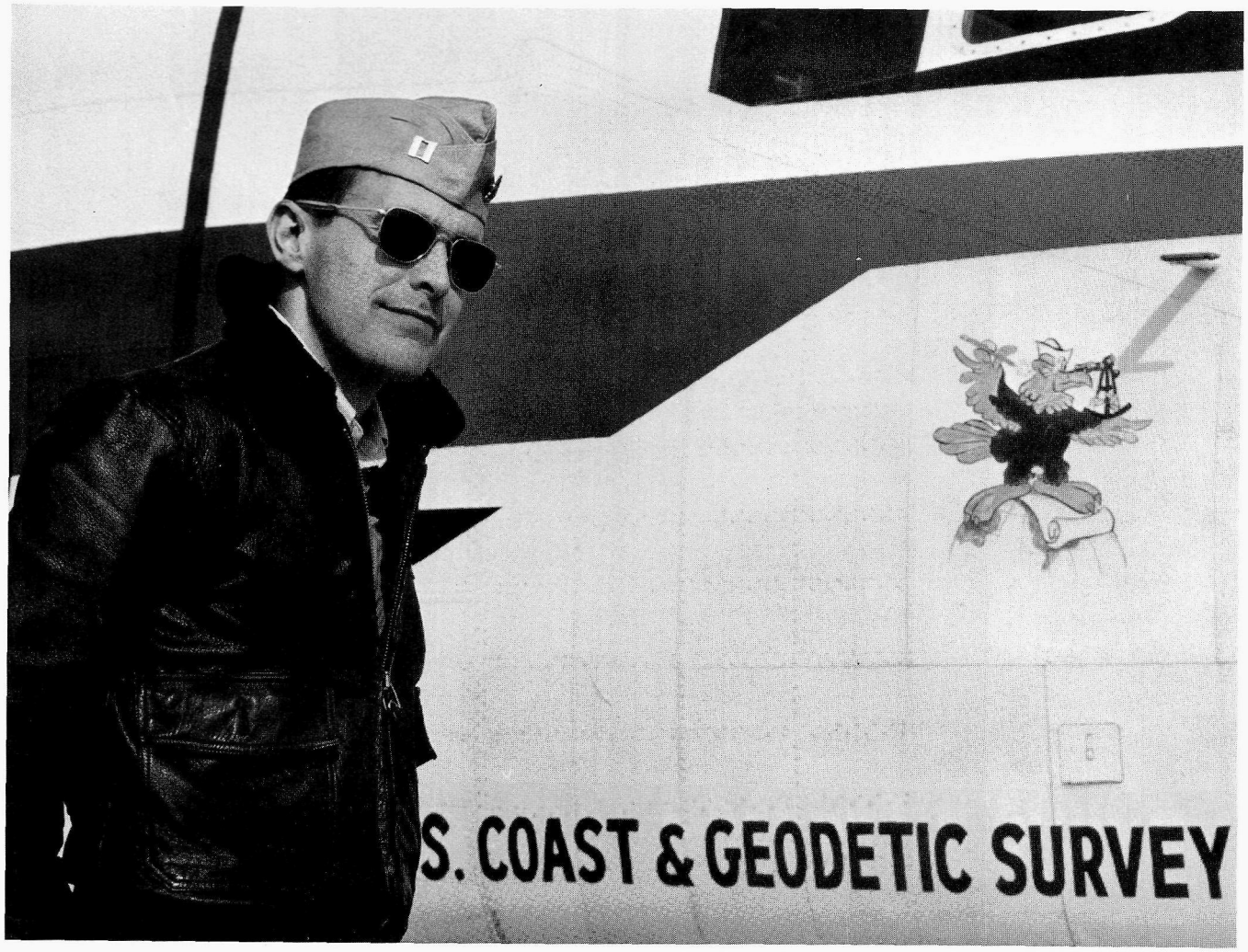


FIGURE 316.—Pilot Lt. Robert Westphall. (Photograph by John T. Smith, Jr.)



FIGURE 317.—Flight engineer Henry J. Pfeiffer, left, and pilot Lt. Robert C. Westphall working on a part of the Buffalo aircraft. (*Photograph by John T. Smith, Jr.*)

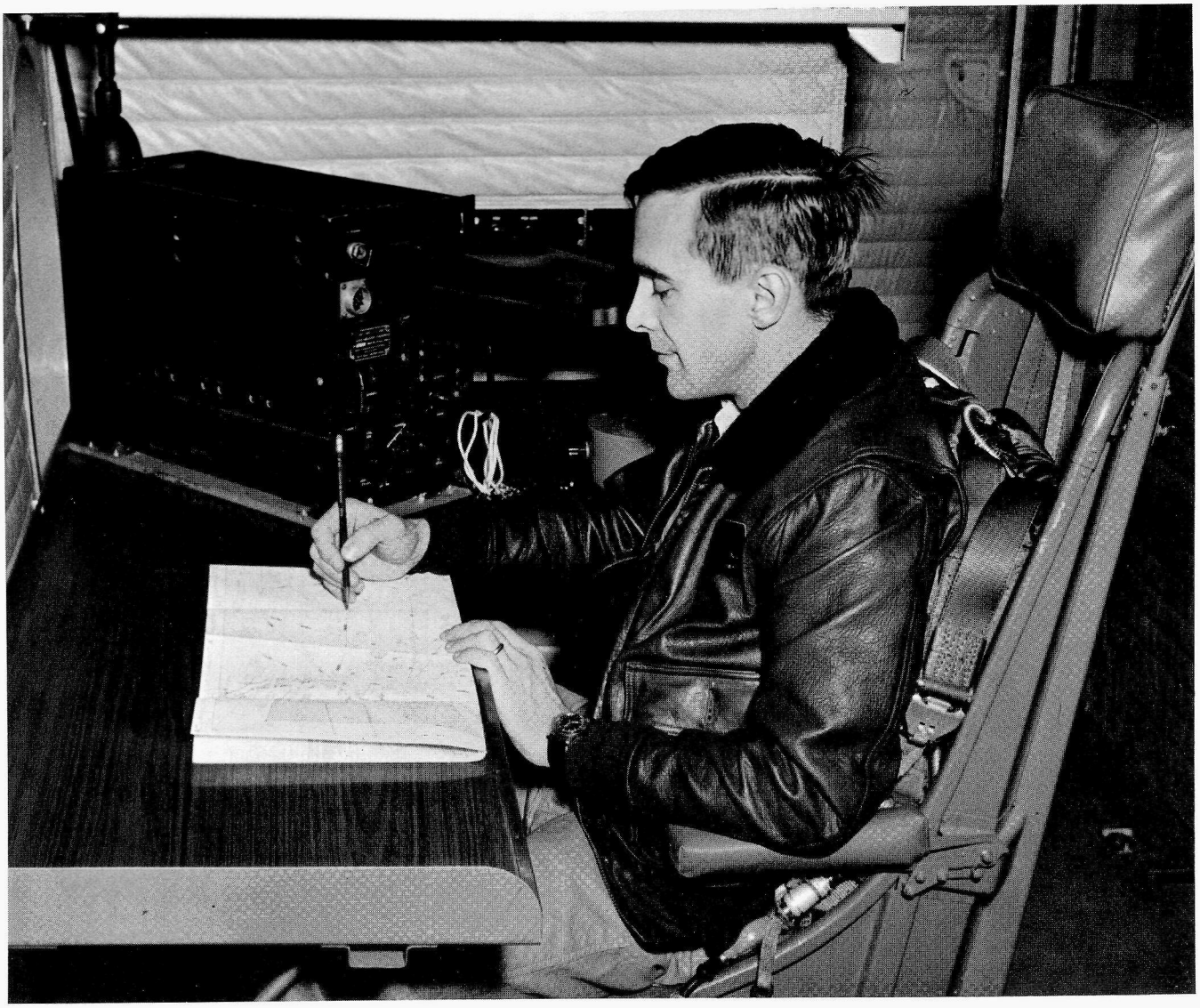


FIGURE 318.—Lt. Robert Westphall using Loran to plot course to San Juan, P. R. (Photograph by John T. Smith, Jr.)



FIGURE 319.—Lt. Robert C. Westphall piloting the Buffalo over Ponce, P. R. (Photograph by John T. Smith, Jr.)

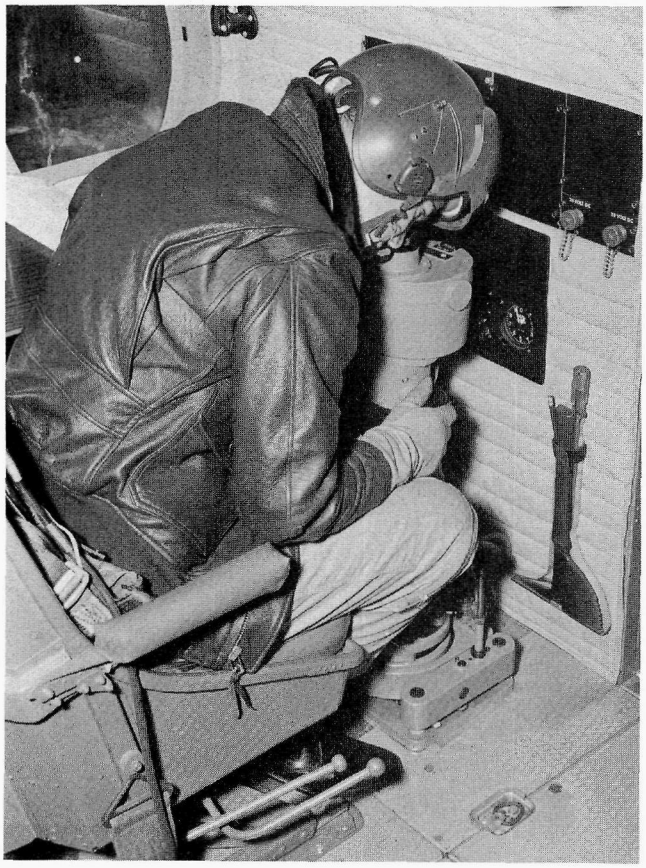


FIGURE 320.—Lt. Walter S. Simmons navigating Buffalo aircraft on flight line using new Wild navigation sight. (Photograph by John T. Smith, Jr.)

AIR PHOTO MISSION 2 ACTIVITIES—1969

Aero Commander N6889S was activated on March 3 with Lt. Walter S. Simmons, Chief of Mission and pilot/; Lt. Leland L. Reinke, copilot/navigator; and Charles C. Ferguson, photographer. Lt. William M. Noble, Lt. Comdr. Raymond L. Speer, Edwin D. Hawbecker, William G. Riggs, Jr., and John T. Smith, Jr., also served on board at various times during the year.

The mission continued photography in the United States until August 17, when Hurricane Camille struck the Gulf Coast with winds of over 190 miles per hour and seas up to 20 feet. The mission immediately diverted to that area and commenced damage assessment photography of the shoreline and harbor facilities in Texas, Louisiana, Mississippi, Alabama, and Florida (figs. 321 through 323). Thereafter, chart correction work and airport photography continued until November 19, when the mission was secured for the rest of the season.

HAWAII ACTIVITIES—1969

A third photographic mission was operated in Hawaii beginning in January, using a leased Cessna 172 aircraft, No. N4105Y (figs. 324 through 326), with Robert Meroz, pilot; Lt. Comdr. Raymond Speer, navigator; and William G. Riggs, photographer. The cameras were shipped to Hawaii via commercial airlines, and the mission completed photographic operations in March, when personnel and equipment returned to Washington, D.C., by commercial airlines.

OFFICE ACTIVITIES—1969

The last 9-lens print was made in the Aerial Photographic Laboratory on February 8 and the last 9-lens Transforming Printer No. 2 was then dismantled to make room for the new Color Automat print processor to replace the split-C unit (fig. 327). The Color Automat had about four times the production capabilities of the split-C. It was also capable of processing 25 color glass diapositives at one time. The Automat was a fully automatic color processor and eliminated the need for manually moving the exposed photographic materials from one chemical tank to the next.



FIGURE 321.—Gulfport, Miss. (Photo 69 L C 3020). An aerial view of three large freighters the *Hulda*, the *Alamo Victory*, and the *Silver Hawk*, all driven ashore by Hurricane Camille. (Photograph by John T. Smith, Jr.)



FIGURE 322.—Biloxi, Miss.; the fishing trawler *Wayde Klein* was washed ashore and came to rest in the front yard of a private residence. (Photograph by John T. Smith, Jr.)



FIGURE 323.—Gulfport, Miss.; the rubble is all that remains of a 32-unit apartment building, the Bellevue, after being struck by Hurricane Camille. (Photograph by John T. Smith, Jr.)



FIGURE 324.—Cessna 172 No. N4105Y aircraft used in Hawaiian photographic operations. (Photograph by William G. Riggs, Jr.)

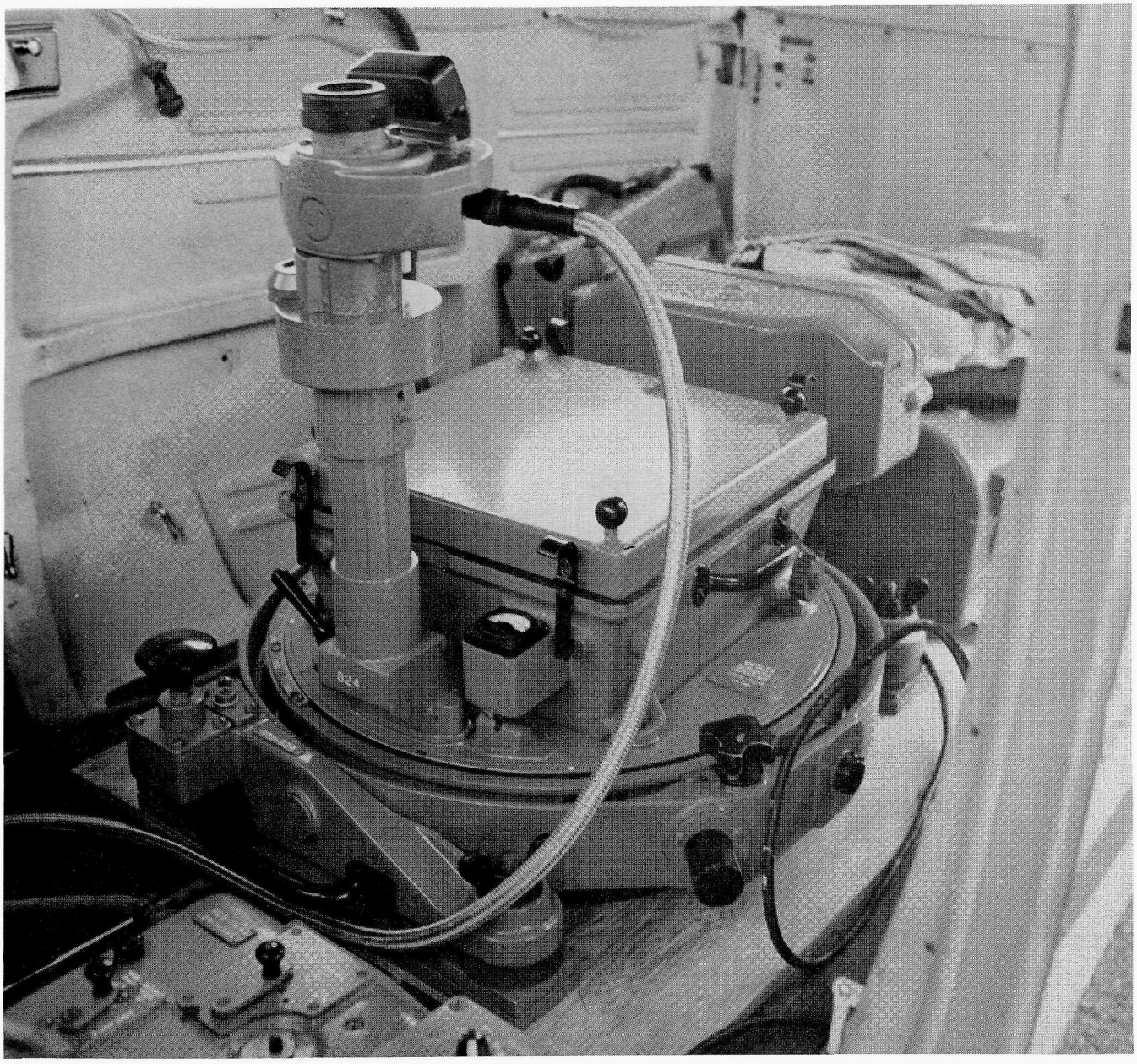


FIGURE 325.—Installation of Wild RC−8 camera in Cessna. (Photograph by William G. Riggs, Jr.)

FIGURE 327.—Alva Pyle and Estelle Sleigh inspecting the processed photograph on the new color Automat processor. (Photograph by John T. Smith, Jr.)

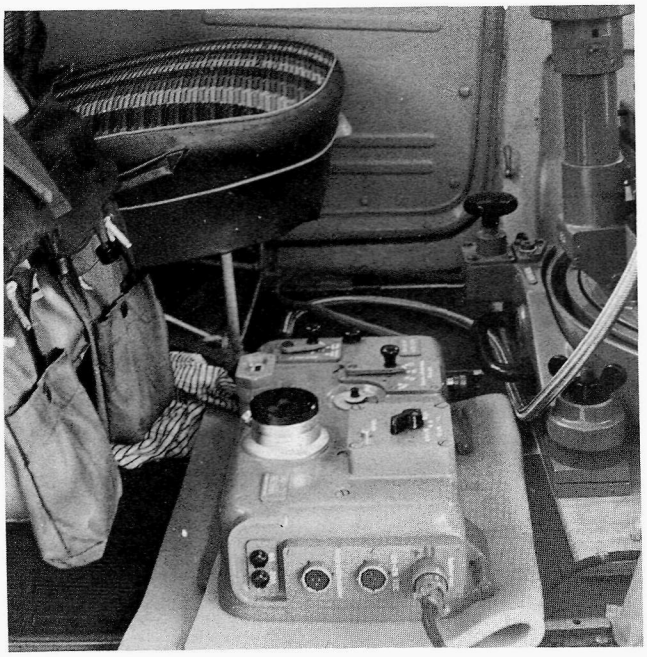
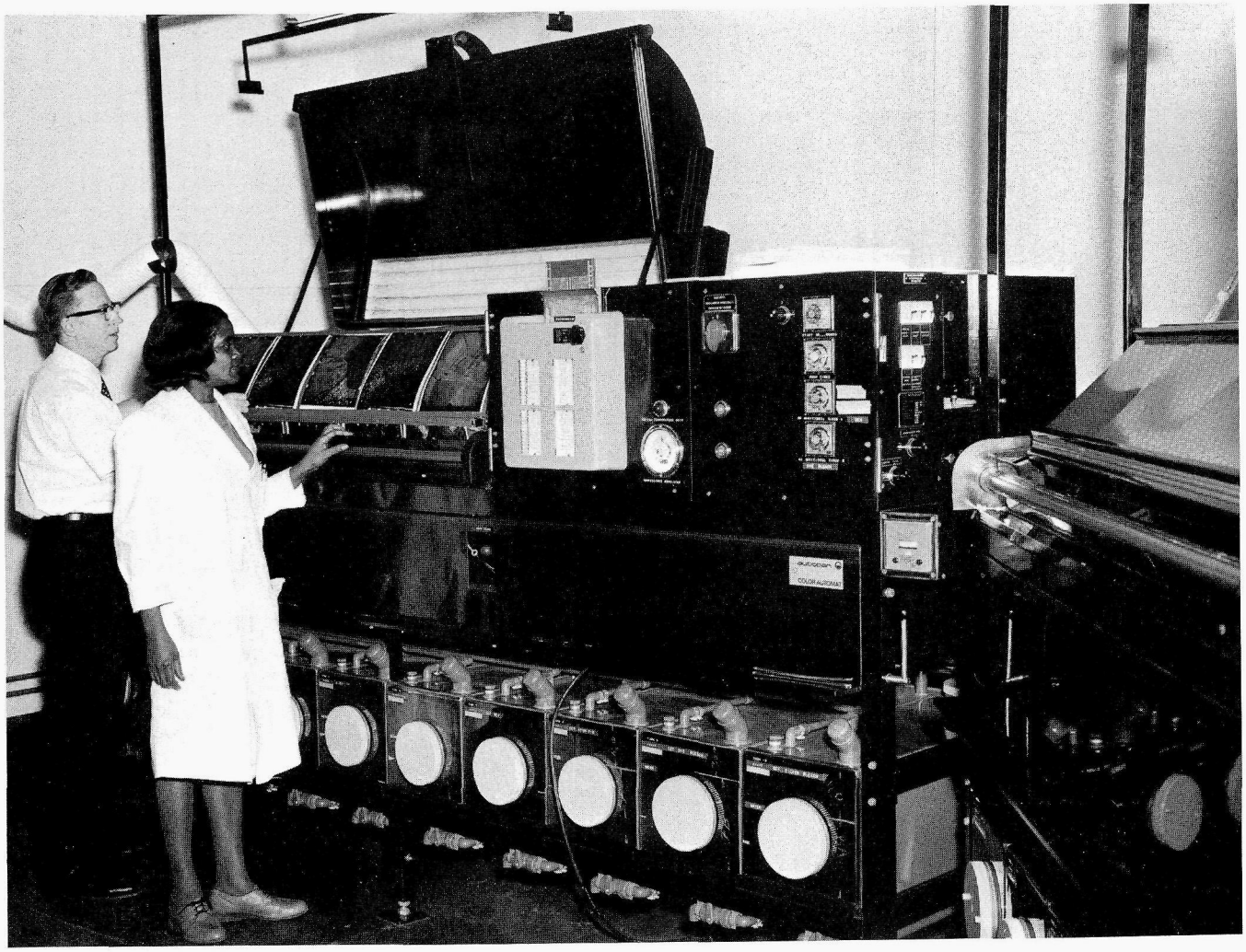


FIGURE 326.—The control box mounted in Cessna aircraft.
(Photograph by William G. Riggs, Jr.)



1970

AIR PHOTO MISSION 1 ACTIVITIES—1970

ESSA 88 was activated on January 21 and left Washington, D.C., with Lt. Comdr. William M. Noble, Chief of Mission and pilot (fig. 328); Lt. Comdr. Leland L. Reinke, copilot/navigator; Henry J. Pfeiffer, flight engineer; and William G. Riggs, Jr., photographer (fig. 329). Lt. Comdr. Walter S. Simmons, Lt. (jg.) Charles Norman Whitaker; John T. Smith, Jr., Charlie R. Johnson, Sterling R. Frizzell, and Frank McCarthy also served on board at various times during the season.

On February 18 the mission left the United States for Puerto Rico and the Virgin Islands, where it remained until March 14. It then returned to the United States and continued photography, leaving for Alaska on June 19.

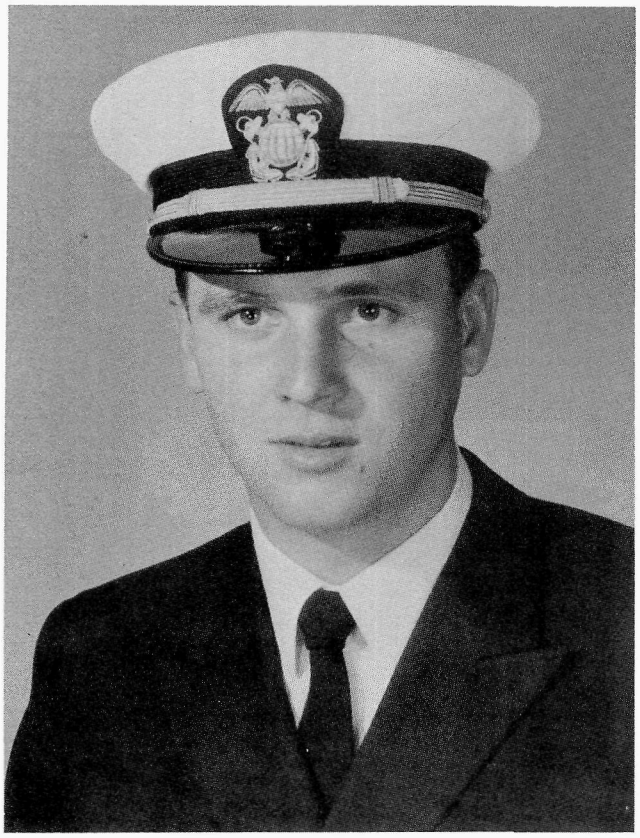


FIGURE 328.—Lt. William M. Noble. (Official NOS photograph.)

On the morning of August 1 the weather was marginal for photography, but the forecast was for clearing conditions to the Southeast. With Noble, Pfeiffer, Johnson, and Frizzell on board, the aircraft left Juneau. Weather conditions were improving, but were still not good enough for photography. The decision was made to land at Annette Island and "stand by". The landing approach for Annette was normal, but at about 50 feet above the runway the spoilers on the aircraft activated (the reason was never determined) and the aircraft literally fell out of the sky, striking the runway on both main wheels. The aircraft bounced back into the air, and Noble immediately applied full power to keep the aircraft flying until an assessment of the damage could be made. Looking out of the cabin windows, Johnson reported that all four tires had been blown out (figs. 330 and 331). Noble contacted Annette tower, and a crew was sent out to the point of impact of the aircraft. They reported they had found pieces of metal that appeared to be part of a landing gear. Noble then contacted the deHavilland Company by radio and requested information on the best landing procedure that should be undertaken under the circumstances. deHavilland advised Nobel that the safest procedure would be to have a runway foamed, retract the landing gear, and land on the belly of the aircraft. Noble then requested help from McChord Air Force Base in Tacoma, Wash. McChord had the equipment to foam a runway and immediately agreed to help. When Noble tried to retract the landing gear, he found that the gear would not come up and the only solution now was to land on the struts. While enroute to Tacoma the cameras were removed from the camera stations and stored. All equipment was secured, and everything was tied down for an emergency landing. The major concern at this time was that one strut would collapse on landing, thus causing the aircraft to cartwheel. On arriving over McChord, Noble advised the tower of the situation. The runway was foamed, and Noble, to quote the personnel who witnessed the event, "made a perfect landing" (figs. 332 through 335). The camera equipment was off-loaded, and emergency repairs made to the aircraft, which was then flown to deHavilland in Canada for proper repairs. There it was found that, except for the landing gear, very little damage had been done to the aircraft. The aircraft was returned to



FIGURE 329.—Crew of the Buffalo, left to right: William G. Riggs, Lt. Comdr. Leland Reinke, Henry J. Pfeiffer, and Lt. Comdr. William Noble, (Official NOS photograph.)

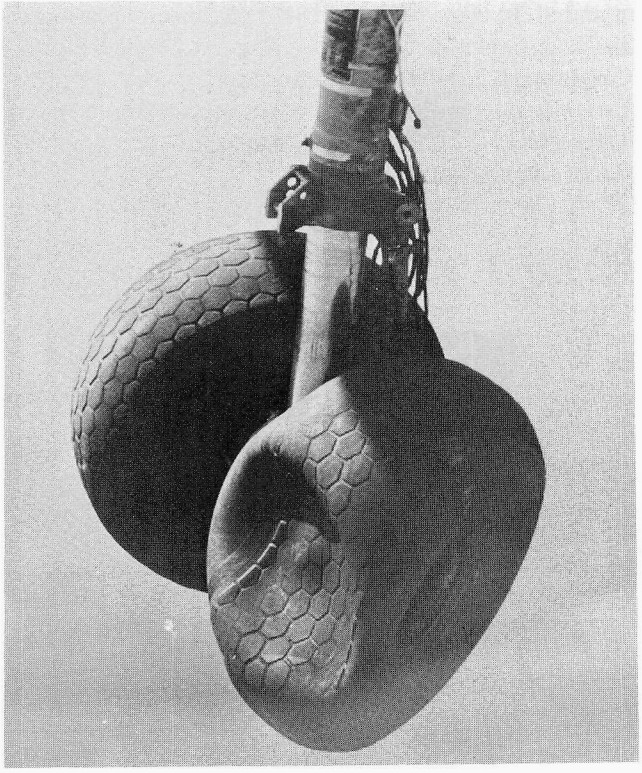


FIGURE 330.—Right main gear taken on flight from Annette Island to Seattle, Wash. (Photograph by Charlie Johnson.)

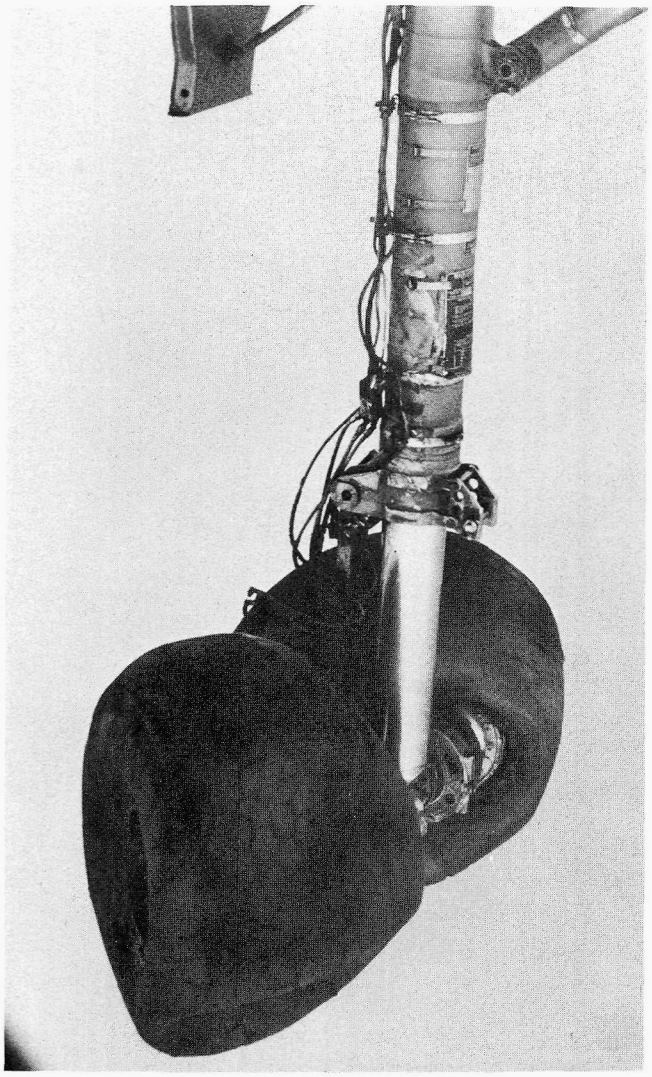


FIGURE 331.—Left main gear. (Photograph by Charlie Johnson.)

service on November 1 and left on November 3 for Seattle, Wash., where the cameras were reinstalled. The mission then continued to work its way across country and arrived in Washingotn, D.C., on November 30. A new Wild RC−10 camera was installed and tested from December 2 to December 7 over Myrtle Beach, S.C. The camera was not purchased, because of dissatisfaction with the camera design (figs. 336 and 337). The mission then returned to Washington, D.C., on December 8, when it was secured for the rest of the season.

AIR PHOTO MISSION 2 ACTIVITIES—1970

Aero Commander N6689S was activated on March 2 with Lt. Comdr. Walter S. Simmons (fig. 338) Chief of Mission and pilot; Lt. Leslie H. Perry, copilot/navigator; and Charles C. Ferguson, photographer. Air Photo Mission 2 continued photography in the United States. On August 3 Hurricane Celia sped ashore in the Gulf Coast, and the mission, then in Tacoma, Wash., immediately left for the storm area, arriving on August 5. Storm damage assessment photography began immediately (figs. 339 thru 343). After completion of that assignment on August 11, the mission left for the Florida east coast for tide-coordinated photography. The mission continued photography in the United States until November 20, when it was secured for the rest of the season.



FIGURE 332.—Moments after landing at Seattle, Wash., the aircraft stopped at the end of the foamed runway. (Photograph by Charlie Johnson.)

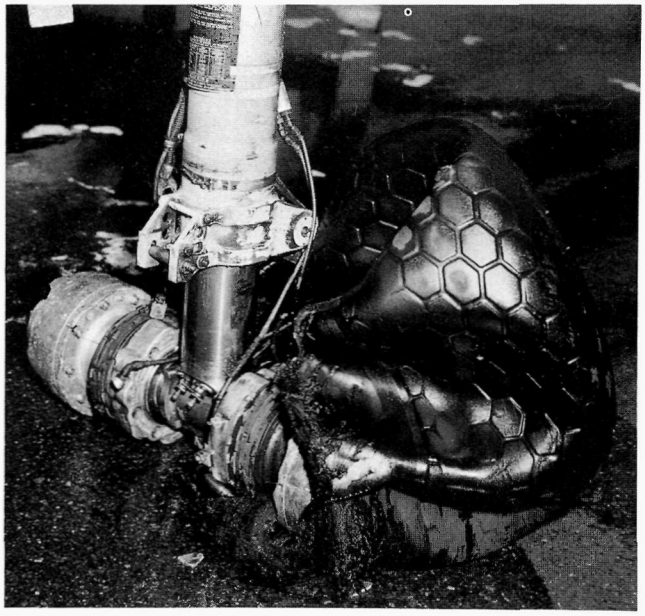


FIGURE 333.—Front of left main gear. (Photograph by Charlie Johnson.)

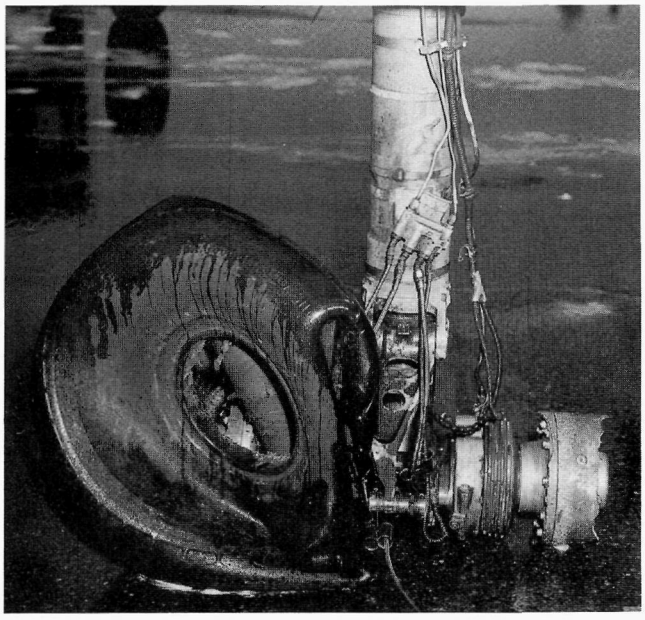


FIGURE 334.—Back of left main gear a few minutes after landing. (Photograph by Charlie Johnson.)

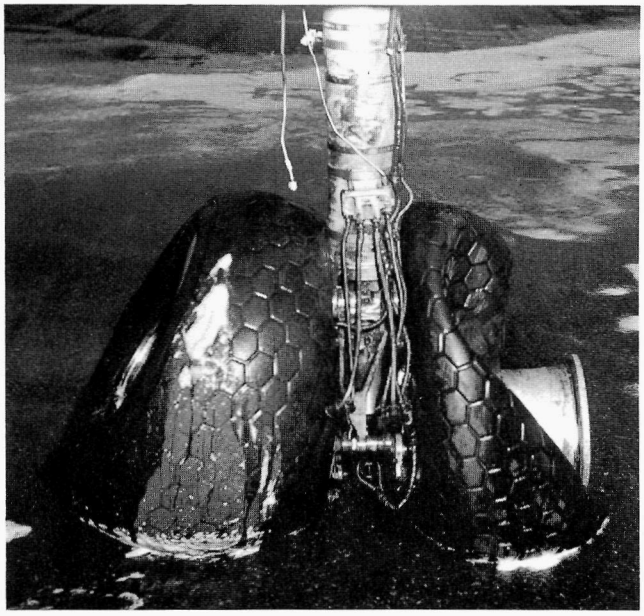


FIGURE 335.—Back of the right main gear. (Photograph by Charlie Johnson.)

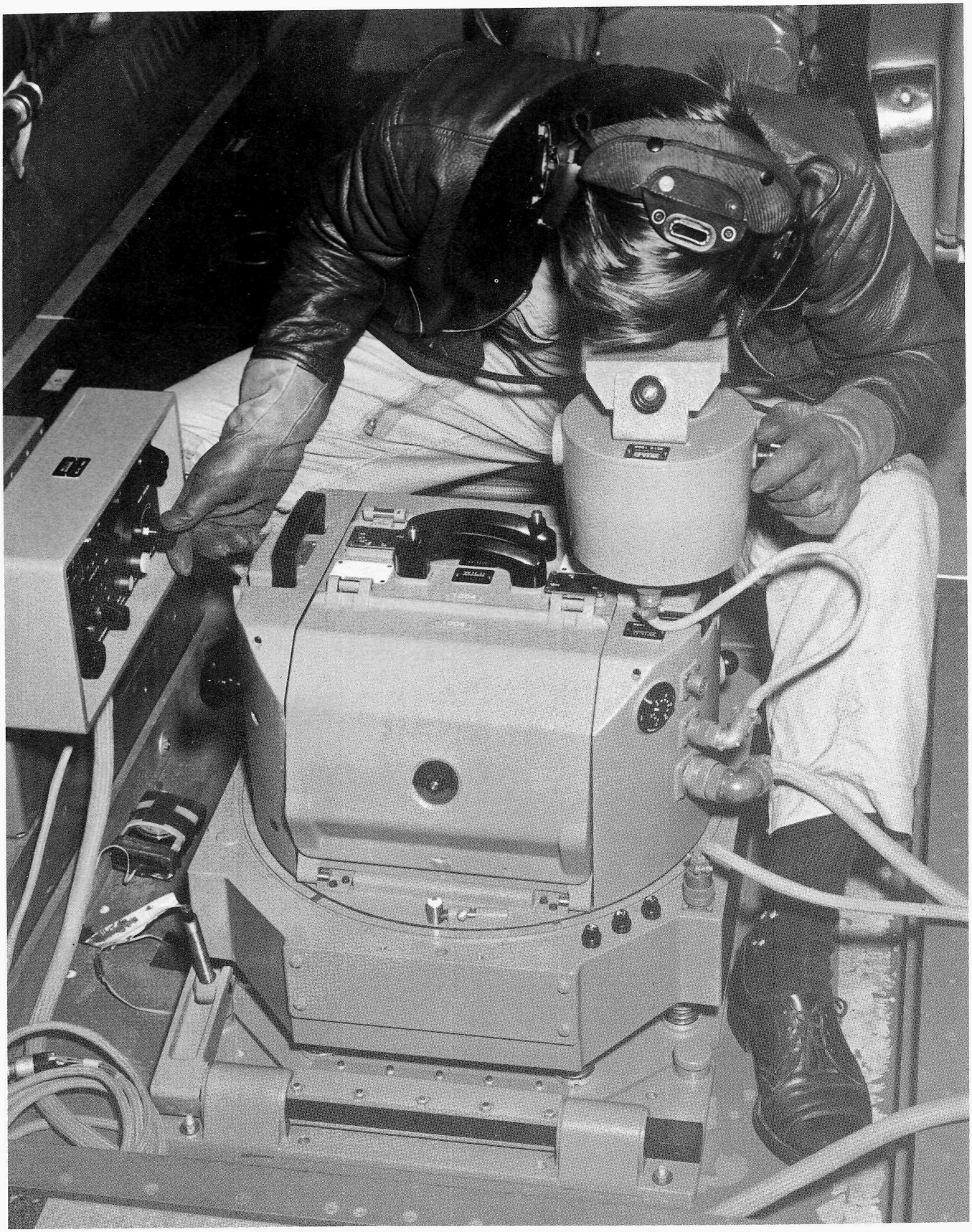


FIGURE 336.—The new RC–10 camera in the initial test of the camera in the United States over Mrytle Beach, S.C. (Photograph by John T. Smith, Jr.)



FIGURE 337.—Three cameras were operated simultaneously on the Buffalo for camera comparison tests. (Photograph by John T. Smith, Jr.)



FIGURE 338.—Lt. Comdr. Walter S. Simmons. (Photograph by John T. Smith, Jr.)

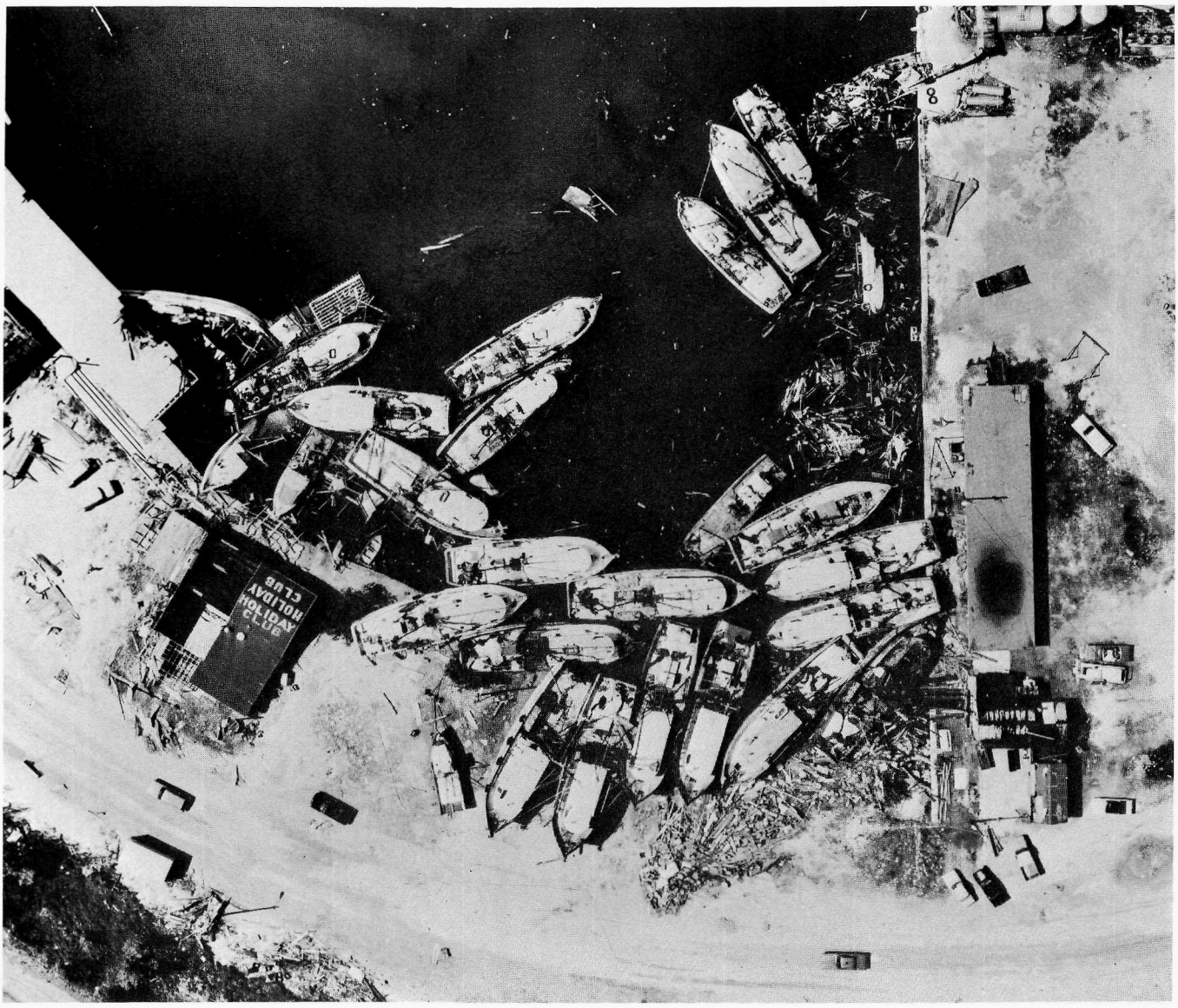


FIGURE 339.—Fishing fleet destruction is well shown in this aerial photograph of the aftermath of Hurricane Celia. (Photograph by Charles Ferguson.)



FIGURE 340.—A ground view showing the destruction of the fishing fleet in Aransas Pass, Tex. photographed in figure 339. (Photograph by John T. Smith, Jr.)

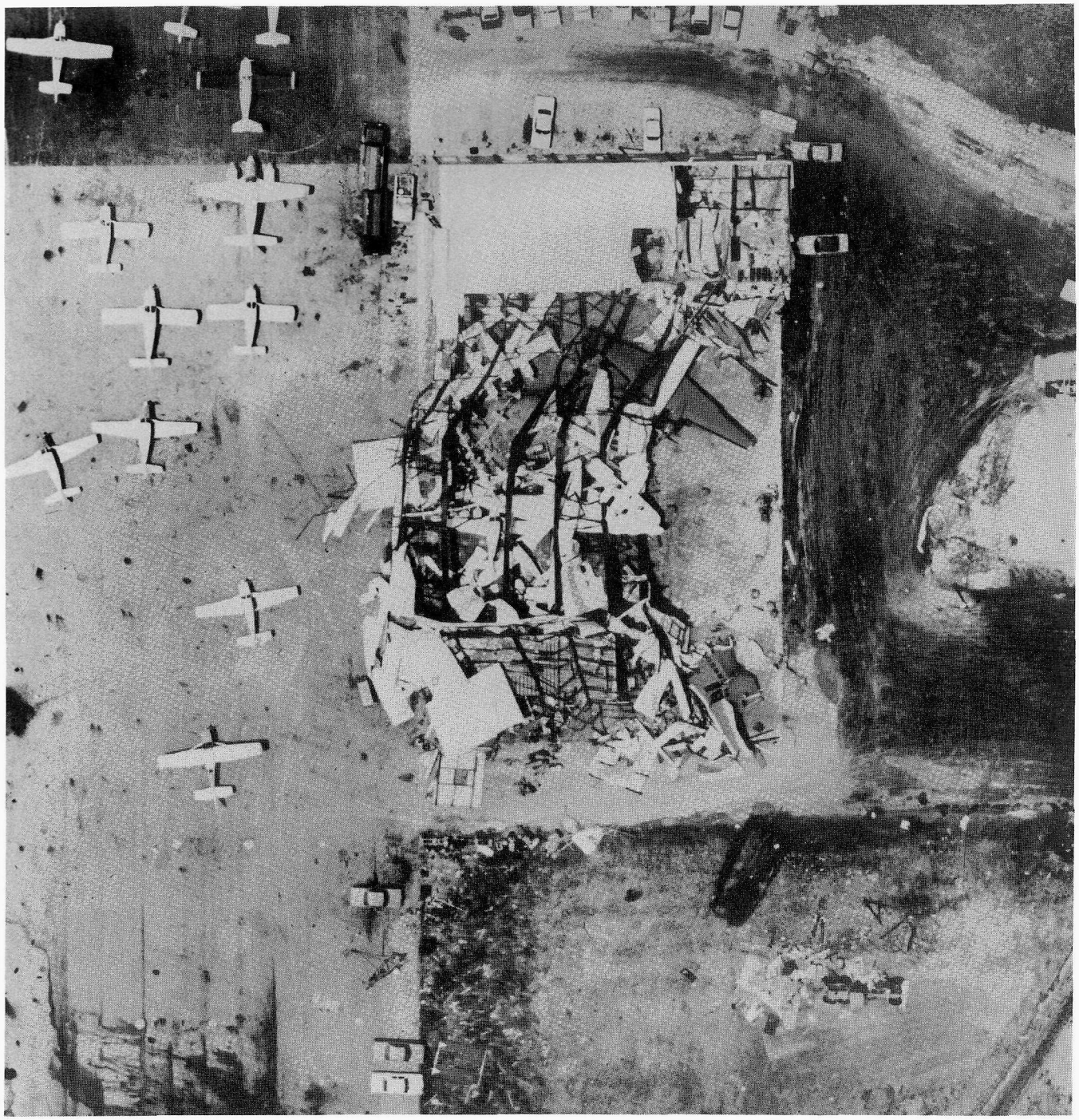


FIGURE 341.—Hangar destruction at the airport in Corpus Christi, Tex. (Photograph by Charles Ferguson.)



FIGURE 342.—Hangar at airport showing destruction to aircraft in Corpus Christi, Tex. (Photograph by John T. Smith, Jr.)



FIGURE 343.—Photograph taken on the ground showing the destruction of the First Baptist Church following Hurricane Celia in Portland, Tex. (Photograph by John T. Smith, Jr.)

1971

AIR PHOTO MISSION 1 ACTIVITIES—1971

ESSA 88 was activated on February 21 and left Washington, D.C., with Lt. Comdr. William M. Noble, Chief of Mission and pilot; Lt. Comdr. Leslie H. Perry, copilot/navigator; Henry J. Pfeiffer, flight engineer; and William G. Riggs, Jr., photographer. Charlie R. Johnson alternated with Riggs as photographer during the year. On March 20 operations began on a project involving a thermal infrared mapper for a tidal current survey at Charleston, S.C. The infrared scanner was used in conjunction with conventional photography to determine if the scanner would be of any value to photogrammetry. The system proved to be of little or no value and was abandoned after the test.

The mission returned to Washington, D.C., on March 28 and on April 1 a request was made to the Division to use the infrared scanner to see if it would detect an offshore oil slick caused by the breaking up and sinking of the tanker Texaco Oklahoma during a storm on March 27. The aircraft flew over the position of the oil slick and photographed it with natural color film as well as using the infrared scan system. It was later determined that by density-slicing the color film a much finer determination could be made of the limits of the oil slick (figs. 344 through 346).

The mission continued photographic operations in the United States until June 30, when it left Seattle, Wash., for Anchorage, Alaska. The mission returned to Seattle on July 21 and worked on the West Coast until August 3, when it again returned to Anchorage and remained until August 15. It returned to the West Coast and worked across country, arriving in Washington, D.C., on September 29. From October 2 through October 9 the mission did a tidal current survey in Boston Harbor (figs. 347 through 349) and then continued photography until November 15, when the mission was secured for the rest of the season.

AIR PHOTO MISSION 2 ACTIVITIES—1971

Aero Commander N6889S was activated on February 16, with Lt. Comdr. Leland L. Reinke (fig. 350), Chief of Mission and pilot; Lt. Lowell Genzlinger, copilot/navigator; and Charles C. Ferguson, photographer. Lt. Comdr. Walter S. Simmons and Lt. Leslie H. Perry served on board at various times during the season.

The mission continued photography in the United States until November 9, when it went to the Virgin Islands and Puerto Rico. Upon completion of the projects in the islands, the mission returned to the United States on December 9 and continued photography until December 22, when the mission was secured for the rest of the season.

OFFICE ACTIVITIES—1971

Capt. Richard H. Houlder was named Commanding Officer of the NOAA ship FAIRWEATHER and transferred on December 31, 1970; Capt. Jack E. Guth became Chief of the Division of Photogrammetry on January 1, 1971.



FIGURE 344.—William G. Riggs operating infrared scan system on ESSA 88. (Photograph by John T. Smith, Jr.)

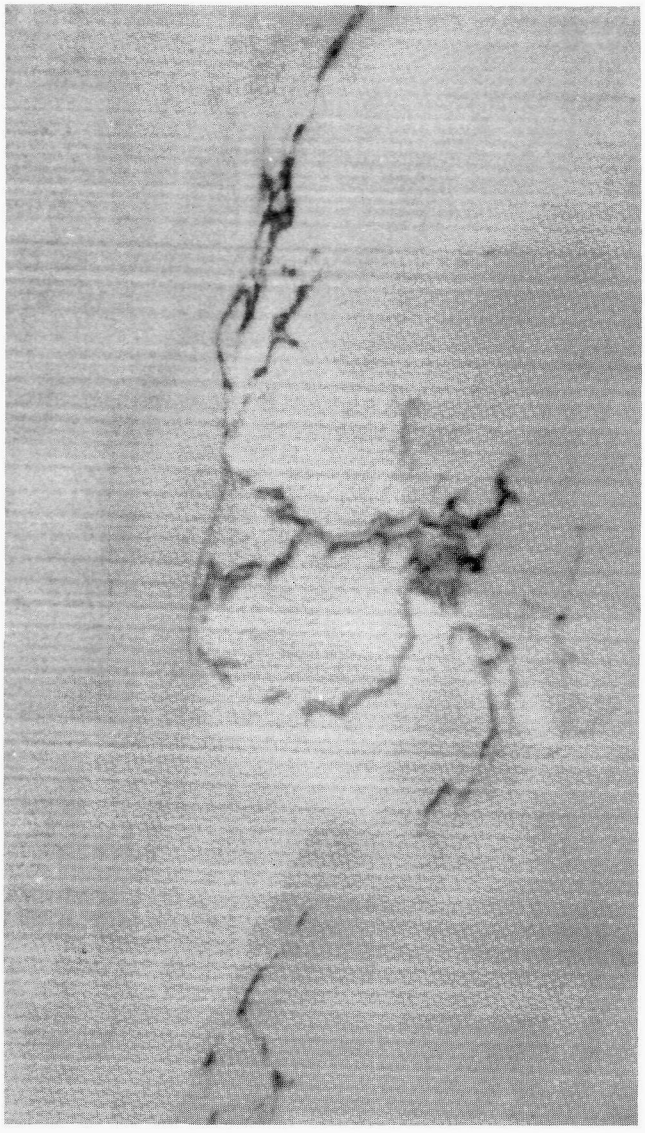


FIGURE 345.—Thermal infrared imagery of oil slick pattern showing dense area in center. (Thermal scan by John T. Smith, Jr.)



FIGURE 346.—Black-and-white reproduction of original color film showing dense area of oil slick. (Photograph by William G. Riggs.)

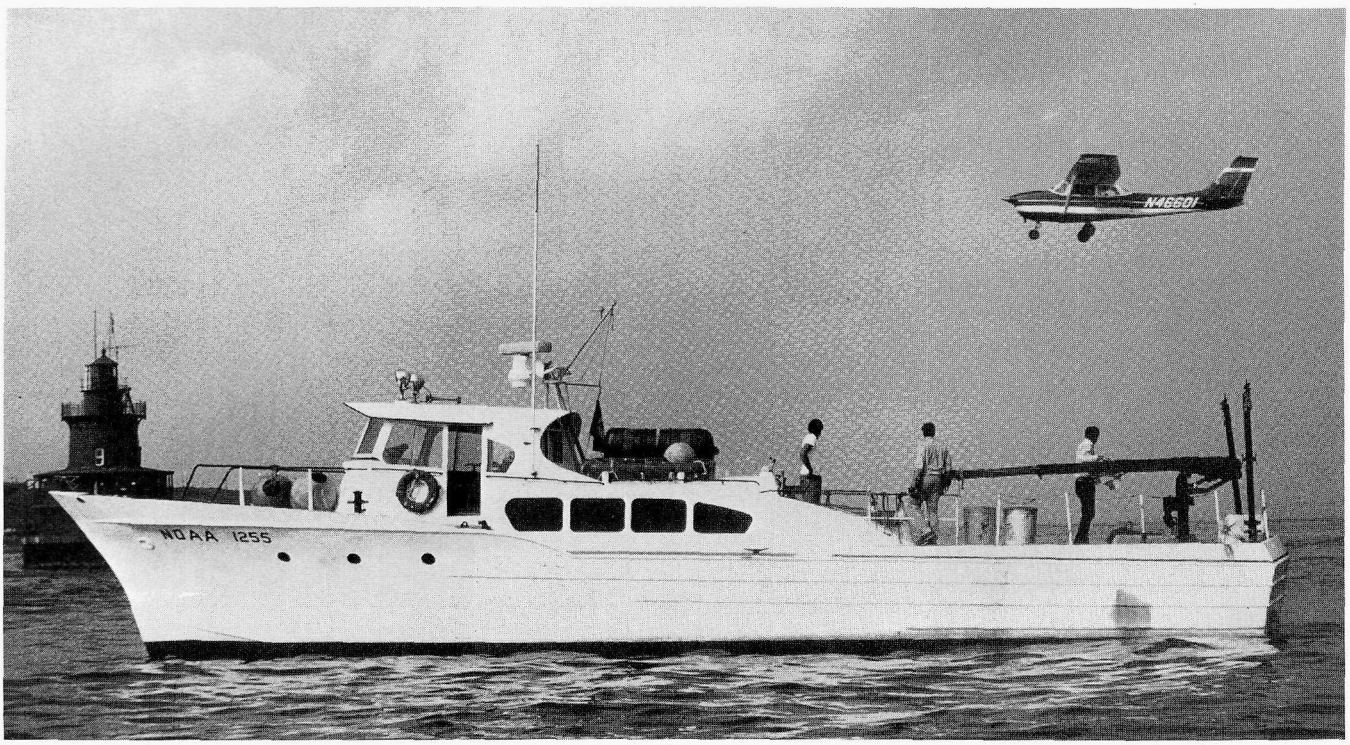


FIGURE 347.—Aircraft N46601 dropping aluminum powder targets near NOAA launch 1255 during Boston current survey project. (Photograph by John T. Smith, Jr.)



FIGURE 348.—E. Hartford releasing a bag of aluminum powder from aircraft during Boston Harbor survey project. Lt. Comdr. Walter Simmons is the pilot. (Photograph by John T. Smith, Jr.)

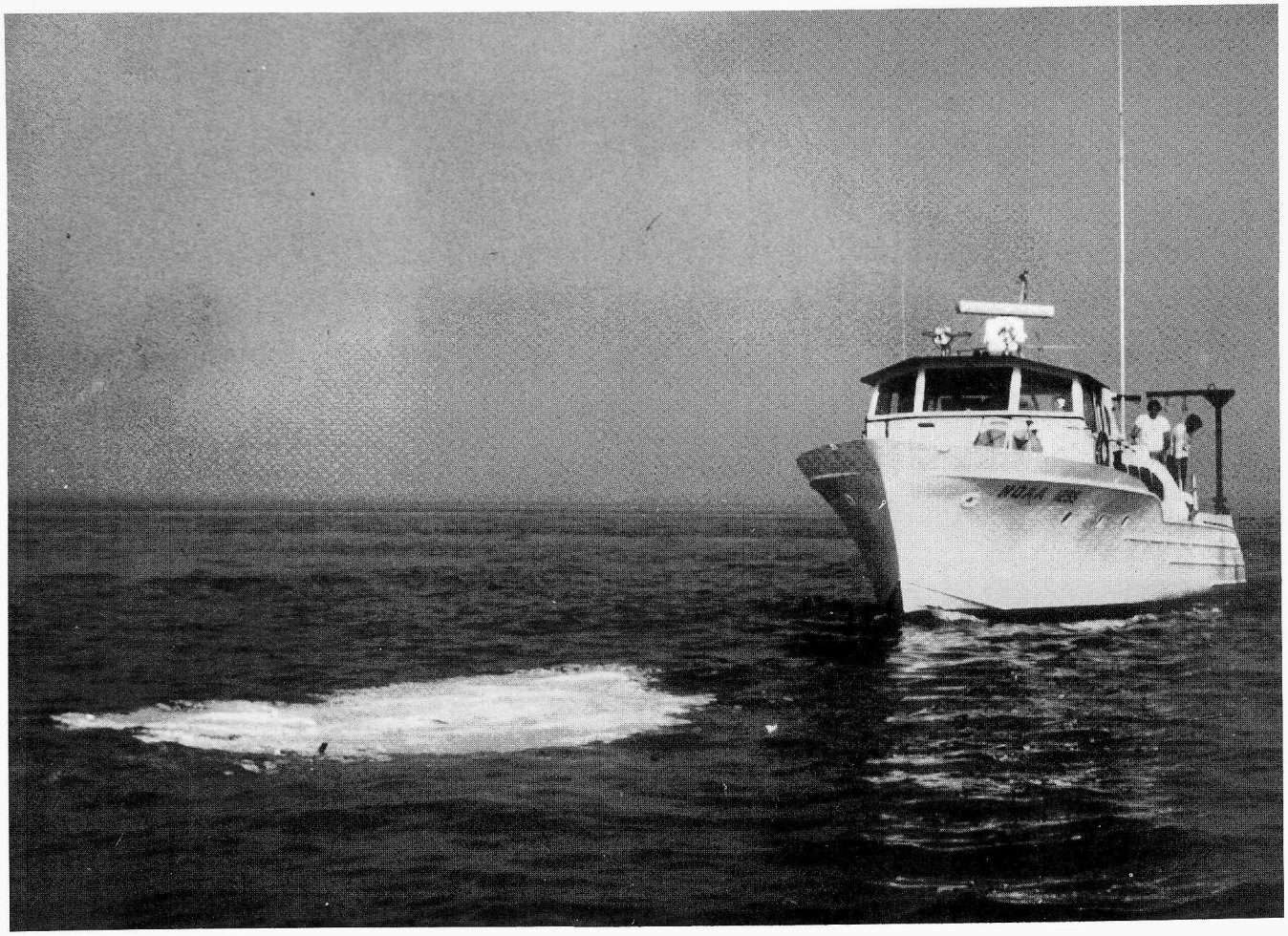


FIGURE 349.—NOAA launch 1255 observing the dispersion of aluminum powder during Boston current survey. (Photograph by John T. Smith, Jr.)



FIGURE 350.—Lt. Comdr. Leland J. Reinke, (Official NOS photograph.)

1972

AIR PHOTO MISSION 1 ACTIVITIES—1972

The deHavilland Buffalo (fig. 351) N13689 (formerly ESSA 88), was activated on February 11 with Lt. Comdr. William M. Noble, Chief of Mission and pilot; Lt. Comdr. Lowell J. Genzlinger, copilot/navigator; Henry J. Pfeiffer, flight engineer; and Charles Ferguson, photographer. Lt. Comdr. Leslie H. Perry, William G. Riggs, Carl Hayes, Charlie R. Johnson, Edwin D. Hawbecker, and John T. Smith, Jr., served on board at various times during the year.

The mission left the United States on February 22 for San Juan, P.R. After completing the photography,it returned to the United States on March 25. Photography continued in the United States until July 1, when the plane arrived in Alaska, where it remained until August 10 and then returned to the United States. Again continuing photography in the United States, on November 13 the mission returned to Puerto Rico and the Virgin Islands (fig. 352). After completion of assigned photography, the mission left on December 13, arrived in Washington, D.C., on the 14th and the mission was secured for the rest of the season.

AIR PHOTO MISSION 2 ACTIVITIES—1972

Aero Commander N6889S was activated on February 28 with Lt. Comdr. Leslie H. Perry (fig. 353) Chief of Mission and pilot. On March 28 Lt. Charles N. Whitaker relieved Lt. Comdr. Walter S. Simmons, who initially served as copilot/navigator. Charles C. Ferguson was the photographer. Lt. Comdr. Bernard N. Mandelkern and Carl H. Hayes also served on board during the year.

The mission carried out airport photographic operations throughout the United States until November 11, when it was secured for the rest of the year.

OFFICE ACTIVITIES—1972

On June 30 Capt. Guth retired, and Comdr. Wesley V. Hull was named Chief of the Coastal Mapping Division (formerly the Photogrammetry Division). The Division chart work continued with a new B–8 stereoplotter (fig. 354).



FIGURE 351.—NOAA Buffalo aircraft N13689 (formerly ESSA 88) preparing for takeoff at Andrews Air Force Base. (Photograph by Charlie Johnson.)



FIGURE 352.—Charlie Johnson photographing with RC–8 camera over St. Thomas, V.I. (Photograph by John T. Smith, Jr.)



FIGURE 353.—Lt. Comdr. Leslie H. Perry. (Photograph by John T. Smith, Jr.)



FIGURE 354.—Harold Brooks and Edward Rolle checking the accuracy of a chart being compiled on the B–8 plotter. (Official NOS photograph.)

1973

AIR PHOTO MISSION 1 ACTIVITIES—1973

Buffalo N13689 was activated on February 12, with Lt. Comdr. Leslie H. Perry (fig. 355), Chief of Mission and pilot; Lt. Charles N. Whitaker, copilot/navigator; Henry J. Pfeiffer (fig. 356) flight engineer; and Charlie R. Johnson, photographer. Edwin D. Hawbecker, Carl Hayes, Robert Clark, and Charles C. Ferguson also served on board at various times during the year.

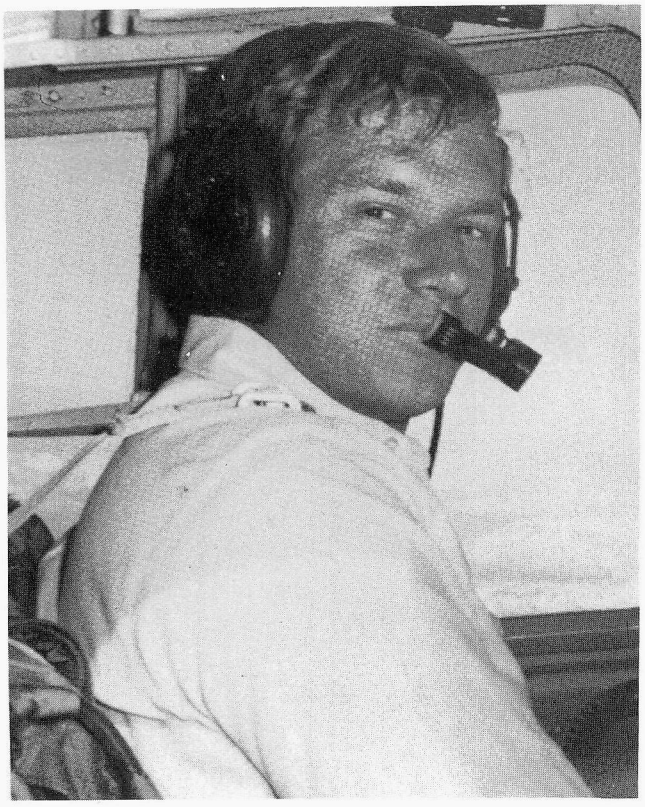


FIGURE 355.—Lt. Comdr. Leslie H. Perry. (Photograph by Charlie Johnson.)

The mission continued photography throughout the United States until June 29, when it arrived in Juneau, Alaska, to begin the season there (figs. 357 and 358). The mission remained in Alaska until August 9, when it resumed photography in the United States. On September 9 Lt. Comdr. Lowell Genzlinger relieved Perry as Chief of Mission and pilot, and Lt. Comdr. Bernard Mandelkern relieved Whitaker as copilot/navigator. The mission continued photography until November 12, when it returned to Washington, D.C., and was secured for the rest of the season.



FIGURE 356.—Henry J. Pfeiffer, flight engineer, also assumes the duties as copilot while on photographic flight lines. (Photograph by Charlie Johnson.)



FIGURE 357.—Charles Ferguson operating RC−10 camera installed on Buffalo aircraft. (Photograph by John T. Smith, Jr.)



FIGURE 358.—Looking forward inside the Buffalo. (Photograph by Charlie Johnson.)

AIR PHOTO MISSION 2 ACTIVITIES—1973

Aero Commander N6889S was activated on March 19, with Lt. Comdr. Lowell Genzlinger (fig. 359), Chief of Mission and pilot; Lt. Comdr. Bernard Mandelkern, copilot/navigator; and Carl Hayes, photographer. Lt. Comdr. Leland Reinke, Lt. Peter Hudes, Lt. Charles Norman Whitaker, Lt. Melvin Grunthal, Robert Clark, and Robert Ehlke also served on board at various times during the year.

The mission continued photographic operations throughout the United States until December 7, when it was secured for the rest of the season.

OFFICE ACTIVITIES—1973

In February the Aerial Photographic Laboratory's name was changed to Imagery Processing Laboratory.

In June, after some redesign, the National Ocean Survey (NOS) purchased its first RC−10 camera system with a 155 mm lens, NOS designation "Z" camera, and an 88 mm lens, NOS designation camera "C" (fig. 360).

On June 23, Harland R. Cravat retired, and on August 5 John T. Smith, Jr., was named Chief, Photographic Operations Branch.



FIGURE 359.—Lt. Lowell Genzlinger. (Official NOS photograph.)

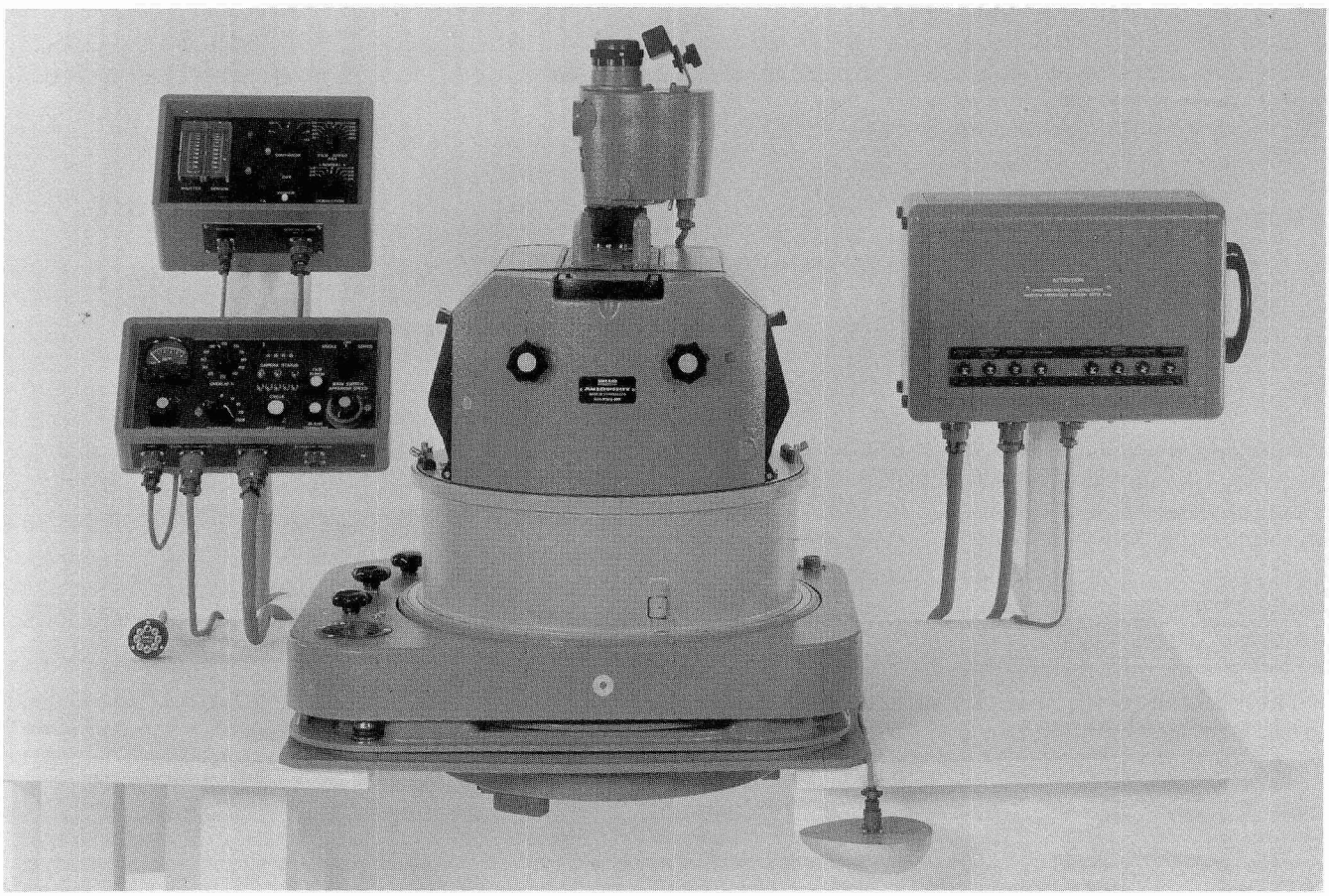


FIGURE 360.—Wild RC–10 camera. (Photograph courtesy Wild Company.)

1974

AIR PHOTO MISSION 1 ACTIVITIES—1974

Buffalo N13689 was activated on January 25 and left for Puerto Rico and the Virgin Islands on January 31, with Lt. Comdr. Lowell Genzlinger, Chief of Mission and pilot; Lt. Comdr. Bernard N. Mandelkern, copilot/navigator; Henry J. Pfeiffer, flight engineer; John T. Smith, Jr., and Carl L. Hayes, photographers (fig. 361). The mission completed a photobathymetry photographic project in the Virgin Islands (fig. 362) and returned to Florida on February 26, doing photobathymetry work in the Florida Keys. On March 14 a new Kodak film designed specifically for water penetration was compared with the normal Kodak MS color film. The Coastal Mapping Division later determined that the film had little value, because it penetrated no greater depth than the standard MS color film.

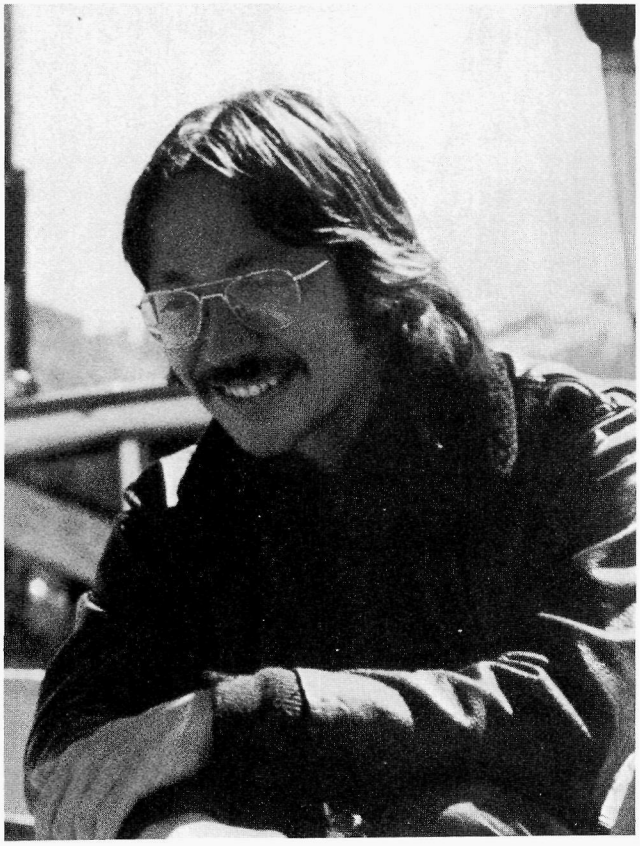


FIGURE 361.—Photographer Carl. L. Hayes. (Photograph by Harvey Carlson.)

On March 24 the Spartanburg, S.C., airport was surveyed at 1:60,000 scale using the new RC−10, 88 mm camera, NOS designation camera "C." Genzlinger reported: "This is the first airport photography using the 3½" lens and could point the way to its routine use in future airport work." The mission continued photography in the United States. Harvey Carlson reported for duty on the mission on June 14 to replace Smith, who had left the mission at the end of March. On June 20 the mission moved from Seattle, Wash., to Juneau, Alaska, and remained until July 5 when it returned to Seattle to have the main wing spar on the Buffalo x-rayed. During this time Lt. Comdrs. Mandelkern and Genzlinger went to Oklahoma City for ground school and flight checking in a new Turbo Commander 690 intended to be a replacement aircraft for Aero Commander N6889S. At the end of July the mission returned to Alaska, completed photography by August 3, and returned to Seattle.

On September 9 Lt. Comdr. Charles Norman Whitaker replaced Genzlinger as Chief of Mission and pilot, and on September 18 flew a special aerial photographic mission over the New York Bight acid waste dumping site. The photography was used to acquire data on the movement of two specific dump sites and to study the waste diffusion and diversion in the water. On October 20 the mission completed tests with a new 6-inch geodetic lens cone, designated "G" camera, to be used with the RC−10 camera system. On December 10 the mission returned to Washington, D.C., and was secured for the rest of the year.

AIR PHOTO MISSION 2 ACTIVITIES—1974

Aero Commander N6889S was activated on January 2, with Lt. Comdr. Charles N. Whitaker (fig. 363), Chief of Mission and pilot; Lt. Comdr. Melvyn C. Grunthal, copilot/navigator; and Robert Clark, photographer. The mission continued photographic operations in the United States until July 10, when N6889S

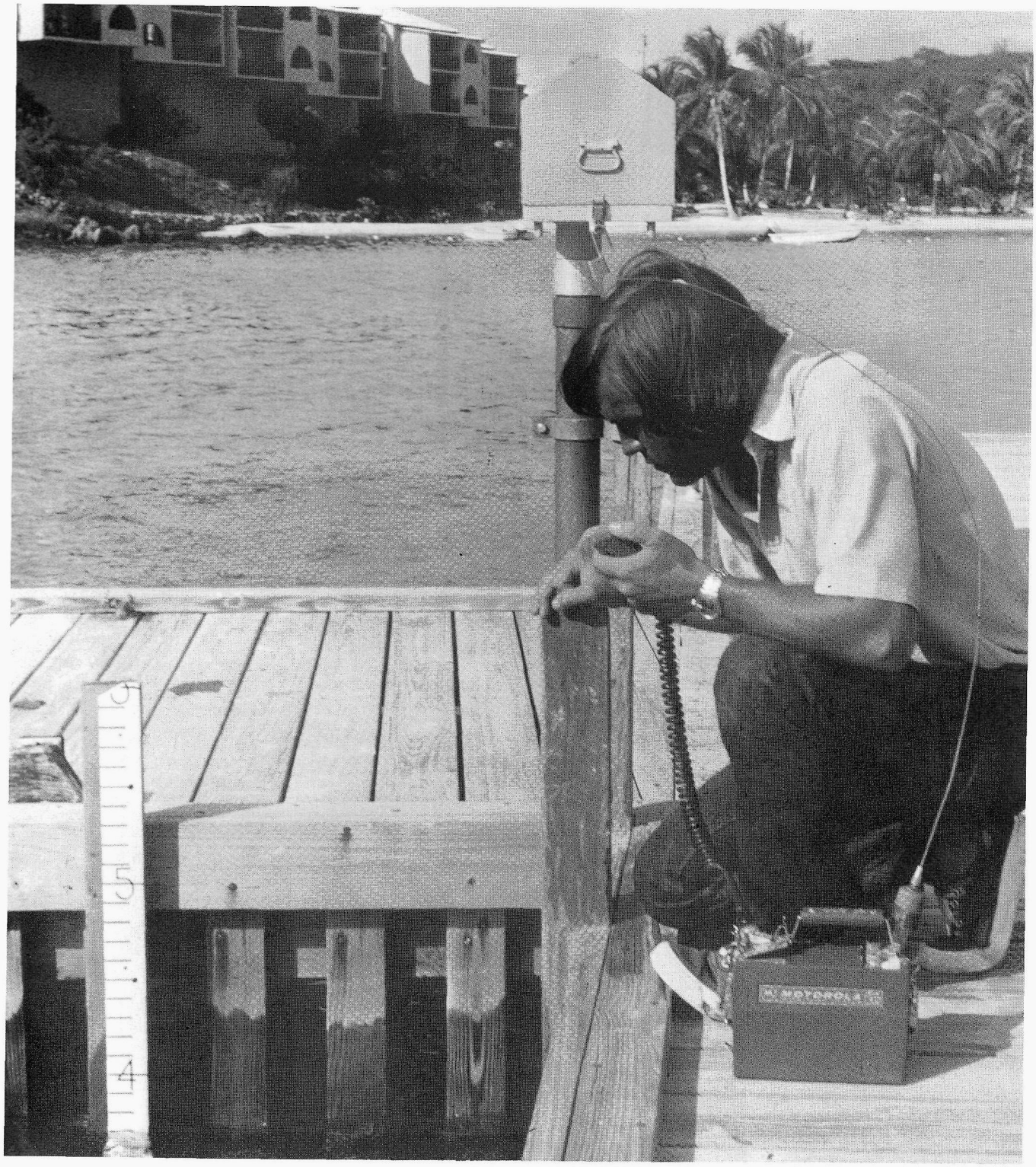


FIGURE 362.—Tide staff being read during tide-coordinated photography in the Virgin Islands. Staff readings are radioed to the aircraft. (Photograph by John T. Smith, Jr.)



FIGURE 363.—Lt. Comdr. Charles N. Whitaker. (Photograph by John T. Smith, Jr.)

was flown as a photographic airplane for the last time. N6889S was in service with C&GS/NOS, Coastal Mapping Division, for 18 years and during this time flew more than 191,000 miles of aerial photography.

Aero Commander, 680E N6889S

1957 to 1974

Personnel who served on board:

Officers

Lt. Alfred C. Holmes
Lt. James P.Randall
Lt. Merlyn E. Natto
Lt. Robert L. Sandquist
Lt. Francis D. Moran
Lt. Raymond L. Speer
Lt. Robert C. Westphall
Lt. William M. Noble
Lt. Leslie H. Perry
Lt. Comdr. Charles N. Whitaker
Lt. Arthur R. Benton
Lt. Kelly E. Taggart
Lt. Richard H. Houlder
Lt. Gerald C. Saladin
Lt. Comdr. Robert W. Franklin
Lt. Frederick H. Gramling
Lt. Walter S. Simmons
Lt. Leland L. Reinke
Lt. Lowell J. Genzlinger
Lt. Comdr. Bernard N. Mandelkern
Lt. Comdr. Melvyn C. Grunthal

Civilians

John T. Smith, Jr.
William G. Riggs, Jr.
Robert S. Hemingway
Charlie R. Johnson
Charles C. Ferguson
W. Byron Hale
Maurice E. Weiss
Edwin D. Hawbecker
Carl L. Hayes
Robert Clark
Robert Ehlke
Adrian Bergraff, civilian pilot

Air Photo Mission 2, with the new aircraft, a Turbo Commander N57074 (figs. 364 and 365), was reactivated on July 31, and on August 1 Lt. Comdr. Melvyn C. Grunthal replaced Lt. Comdr. Whitaker as Chief of Mission and pilot, with Lt. Peter S. Hudes, copilot/navigator; and Robert Clark, photographer. The mission continued airport photography throughout the United States until December 6, when it was secured for the rest of the year.



FIGURE 364.—Turbo Commander 690A, N57074 was delivered to the Coastal Mapping Division, on July 31. The aircraft is a twin-engine turboprop aircraft with a cruising altitude of 31,000 feet, a speed of 250 knots, and a range of about 1,500 nautical miles. The aircraft is pressurized and the camera station has a sealed 1¼-inch-thick glass optical flat, which is removable for metric photography. The aircraft was equipped with one RC–8 Wild camera, Coastal Mapping Division, designation "L" camera, and a new Wild NF–2 navigation driftsight. (Photograph by John Rector.)



FIGURE 365.—Crew of N57074, left to right: Robert Clark, Lt. Comdr. Melvyn Grunthal, and Lt. Peter Hudes. (Photograph by Robert Clark.)

1975

AIR PHOTO MISSION 1 ACTIVITIES—1975

Buffalo N13689 was activated on March 31, with Lt. Comdr. Charles N. Whitaker, Chief of Mission and pilot; Lt. Comdr. Melvyn C. Grunthal, copilot/navigator; Henry J. Pfeiffer, flight engineer; and Robert R. Clark, photographer. Lt. Comdr. William M. Noble, John T. Smith, Jr., John Rector, and Lawrence Franklin also served on board at various times during the year.

Photographic operations continued throughout the United States until the mission arrived in Anchorage, Alaska, on June 27 to commence the Alaska season, and continued photography (fig. 366) until September 3, when the mission returned to Seattle, Wash. On October 20 photography was flown over the Casa Grande, Ariz., test range to calibrate the RC−10 geodetic cone system. Photography was also flown by Mission 2 over the Casa Grande test range during the same period to make a comparison of photography exposed through the optical flat now being used by Mission 2. The mission continued photography in the United States until it was secured on December 20.

AIR PHOTO MISSION 2 ACTIVITIES—1975

Turbo Commander N57074 was activated on March 1 with Lt. Comdr. Bernard Mandelkern (fig. 367), Chief of Mission and pilot; Lt. Peter Hudes, copilot/navigator; and Robert C. Clark, photographer. A new

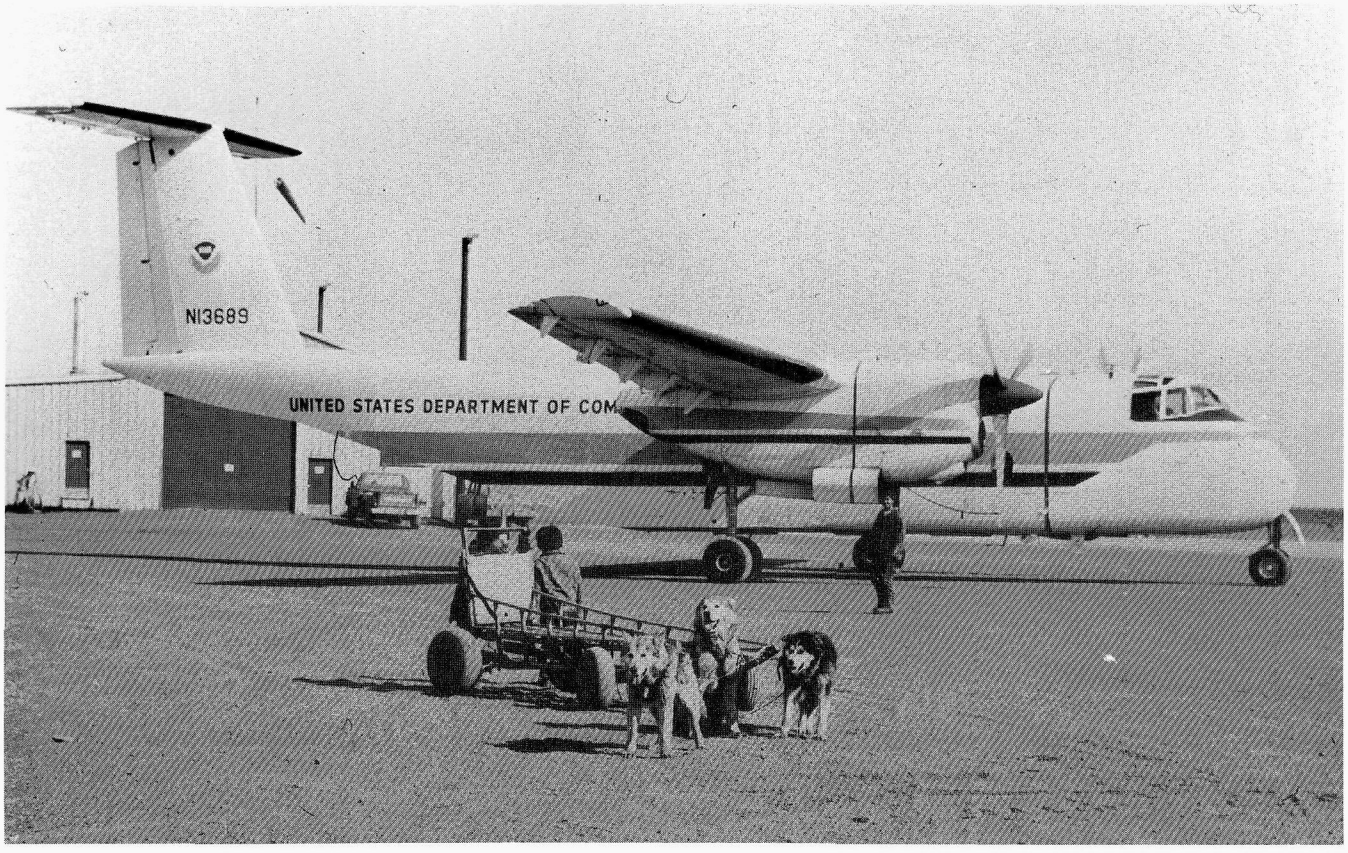


FIGURE 366.—Buffalo aircraft parked at Point Barrow, Alaska. Eskimo dog teams are now used to pull carts. (Photograph by Lawrence Franklin.)

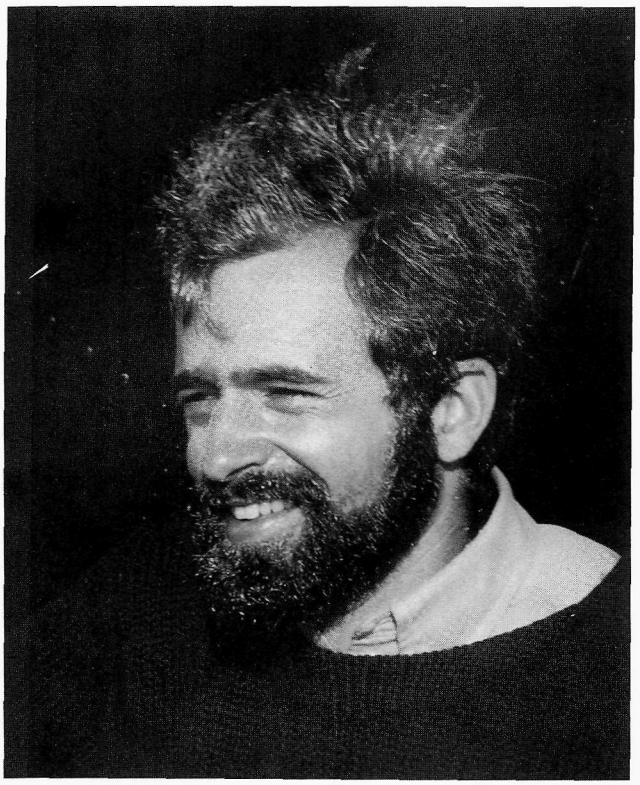


FIGURE 367.—Lt. Comdr. Bernard Mandelkern. (Photograph by John T. Smith, Jr.)

RC–10 camera, designated camera "B," with an automatic exposure control system was purchased and installed in March. In May, Hudes resigned, and for the next several months Lt. Comdrs. Genzlinger and Whitaker, and Comdr. Walter Simmons filled in as copilot on a standby basis. Photography continued throughout the United States. On June 15 Lt. Bradford B. Meyers joined the mission as copilot/navigator. On July 12 the mission arrived in Alaska to assist Air Photo Mission 1 with airport photography (fig. 368) and remained until August 10, when it returned to Seattle, Wash. The mission continued photography in the United States (fig. 369) until November. A week was spent in the Virgin Islands attempting photography without success. Returning to the United States at the end of November, the mission was secured for the rest of the year.

OFFICE ACTIVITIES—1975

On August 11 Comdr. Wesley V. Hull was transferred, and Comdr. James Collins was appointed Chief, Coastal Mapping Division on August 12.



FIGURE 368.—The pride of the Coastal Mapping Division, Buffalo aircraft N13689 and Turbo Commander N57074 parked side-by-side on the ramp at the airport at Anchorage, Alaska. (Photograph by Lawrence Franklin.)



FIGURE 369.—Photograph 75–BC–5350 taken September 10 over Annapolis, Md. One of the photographs used to compile the one billionth chart published by NOAA. (Photograph by Robert Clark.)

1976

AIR PHOTO MISSION 1 ACTIVITIES—1976

Buffalo N13689 (fig. 370) was activated on March 7 with Lt. Comdr. Melvyn C. Grunthal, Chief of Mission and pilot; Lt. Comdr. Bradford B. Meyers (fig. 371), copilot/navigator; Henry J. Pfeiffer, flight engineer; and Robert R. Clark and Charles W. Papke, photographers. Lt. Comdr. Arthur N. Flior, Harvey Carlson, and John T. Smith, Jr., also served on board during the season.

The mission continued photographic operations throughout the United States until its departure from Seattle, Wash., for Juneau, Alaska, on June 4. The mission remained in Alaska until August 5, when it returned to Washington, D.C., arriving August 8 in preparation for a camera comparison test in cooperation with the U.S. Geological Survey (fig. 372). The test was completed on September 12, and the mission left Washington on September 17 for a Florida mapping project, returning to Washington on October 29. On November 5, with Lt. Comdr. David Goehler of the Office of Aeronautical Charting on board, the aircraft did test photography for a program to determine the height of towers by photogrammetric methods. The tests were completed on November 7, and the mission was secured on November 8 for the rest of the year.

AIR PHOTO MISSION 2 ACTIVITIES—1976

Turbo Commander N57074 was activated on March 10 with Lt. Comdr. Bernard N. Mandelkern, Chief of Mission and pilot; Lt. Comdr. Arthur N. Flior (fig. 373), copilot/navigator; and John A. Rector, photographer (fig. 374). The mission continued photography throughout the United States. On September 9 Lt. Daniel S. Eilers replaced Lt. Comdr. Flior as copilot/navigator. On November 16 the mission left the United States for the Virgin Islands, remained there until completing photography on December 16, and returned to the United States, arriving in Washington, D.C., on December 17, when it was secured for the rest of the year.

OFFICE ACTIVITIES—1976

Edwin D. Hawbecker was named Technical Assistant to the Chief of Photographic Operations on February 14, and William G. Riggs was named Chief, Imagery Processing Laboratory on February 15. R. Adm. Holmes retired (fig. 375).



FIGURE 370.—The Buffalo aircraft with the new weather-radar nose cone installed in late 1975. (Photograph by Lawrence W. Franklin.)

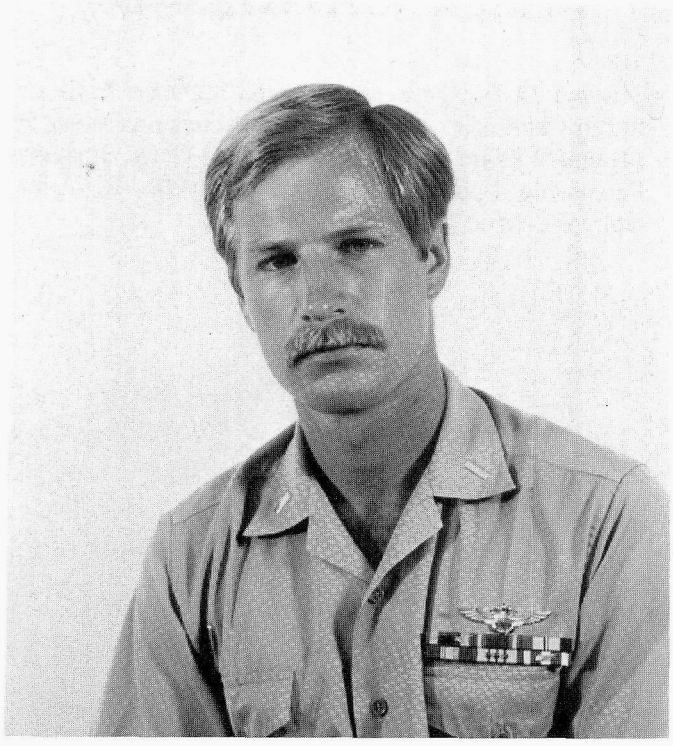


FIGURE 371.—Lt. Bradford B. Meyers. (Official NOS photograph.)

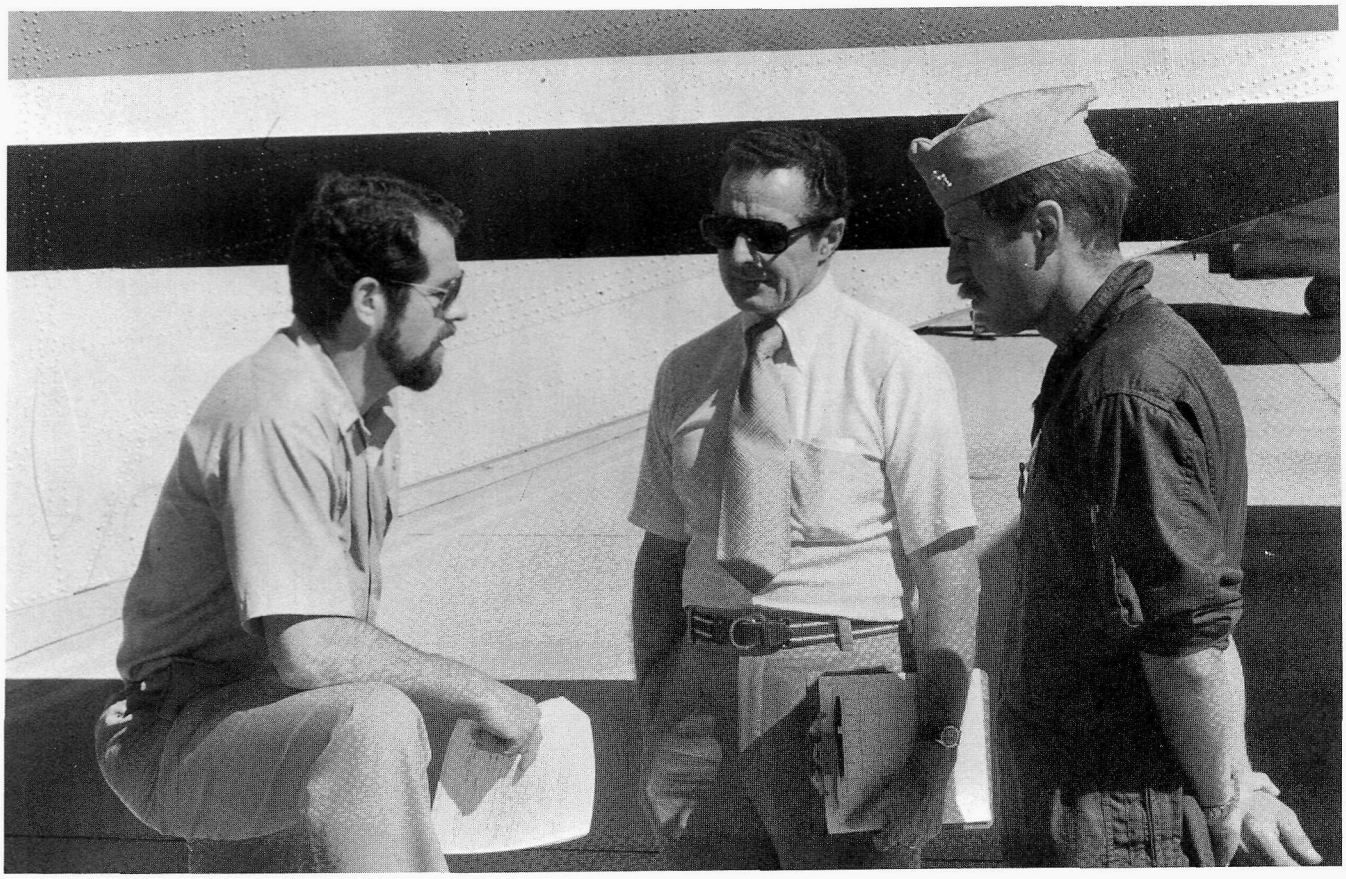


FIGURE 372.—Discussing the test prior to the flight for camera comparisons, left to right: Pilot, Lt. Comdr. Melvyn Grunthal, William Tayman (USGS project manager), and copilot Lt. Bradford Meyers. (Photograph by John T. Smith, Jr.)



FIGURE 373.—Lt. Comdr. Arthur N. Flior. (Official NOS photograph.)

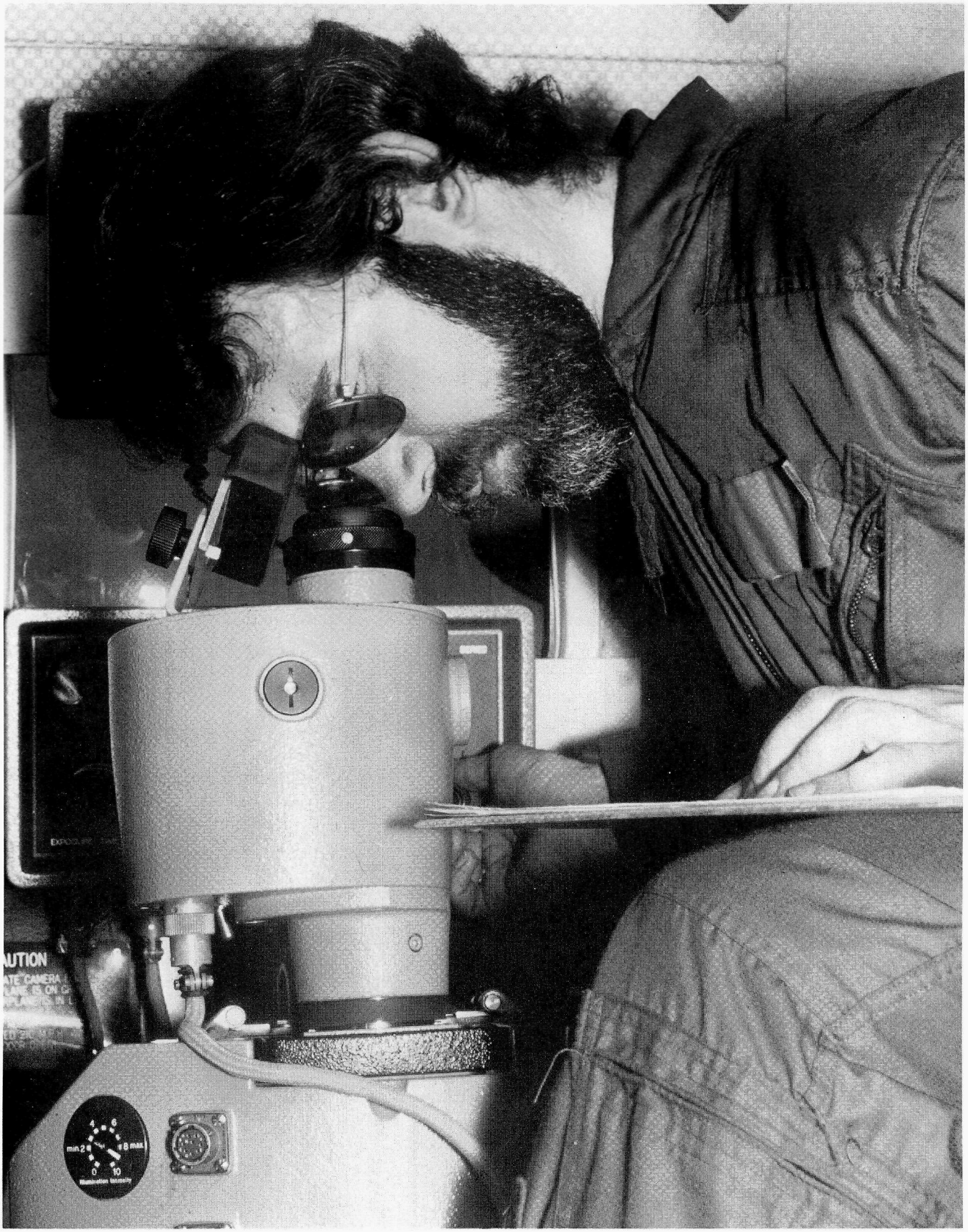


FIGURE 374.—Photographer, John Rector, operating RC–10 camera. (Photograph by John T. Smith, Jr.)



FIGURE 375.—Rear Adm. Alfred C. Holmes, NOS's highest ranking pilot, retired on May 1, after more than 29 years of service. (Photograph by John T. Smith, Jr.)

1977

AIR PHOTO MISSION 1 ACTIVITIES—1977

Buffalo DHC−5, N13689 was activated on January 12 with Lt. Comdr. Bradford B. Meyers, Chief of Mission and pilot; Lt. Comdr. Arthur N. Flior, copilot/navigator; Henry J. Pfeiffer, flight engineer; Harvey Carlson, chief photographer; and Charles W. Papke, second photographer. Flior was replaced by Lt. Daniel S. Eilers (fig. 376) as copilot/navigator on January 27 after Eilers had completed his transition flight.

The mission left Washington, D.C., for Panama City, Fla. on January 18. While doing photography over the Florida coast, Meyers reported: "Photographer Charles Papke developed symptoms which the mission chief suspected might be caused by high altitude depression sickness which Mr. Papke had experienced the previous year. A flight surgeon at Tyndall Air Force Base diagnosed this to be the case and Mr. Papke was treated at the Naval Experimental



FIGURE 376.—Lt. Daniel S. Eilers. (Photograph by John T. Smith, Jr.)

Diving Unit at Panama City. He was sent home by ground transportation and was grounded for the remainder of the photographic season." John Rector replaced Papke on May 1. Lt. Comdr. Melvyn Grunthal, Lt. Richard K. Muller, Edwin Hawbecker, and John T. Smith, Jr., also served on board at various times during the season. The mission continued photographic operations throughout the United States until June 14, when the mission arrived in Anchorage, Alaska, from Seattle, Wash.

Photography was continued in Alaska until the mission returned to Seattle on August 1, by which time the aircraft had had two inflight electrical fires. The aircraft was grounded in Seattle until August 9 when repairs were completed, and was reactivated and continued photography in the United States until November 1, when the mission arrived in St. Croix, V.I. for a photobathymetry project.

On December 17 all photography was completed and the mission returned to the United States, continuing photographic operations until arrival at Andrews Air Force Base, Md., on December 21. The mission was secured on December 22 for the rest of the year.

AIR PHOTO MISSION 2 ACTIVITIES—1977

Turbo Commander N57074 was activated on January 13, with Lt. Comdr. Bernard Mandelkern, Chief of Mission and pilot. Mandelkern was relieved January 25 by Lt. Comdr. Melvyn Grunthal, who was relieved on February 12 by Lt. Comdr. Arthur N. Flior. Lt. Comdr. David J. Goehler (fig. 377) was copilot/navigator after March 31, and Lawrence A. Franklin photographer (fig. 378). The mission continued photography throughout the United States until December 20, when it was secured for the rest of the year.

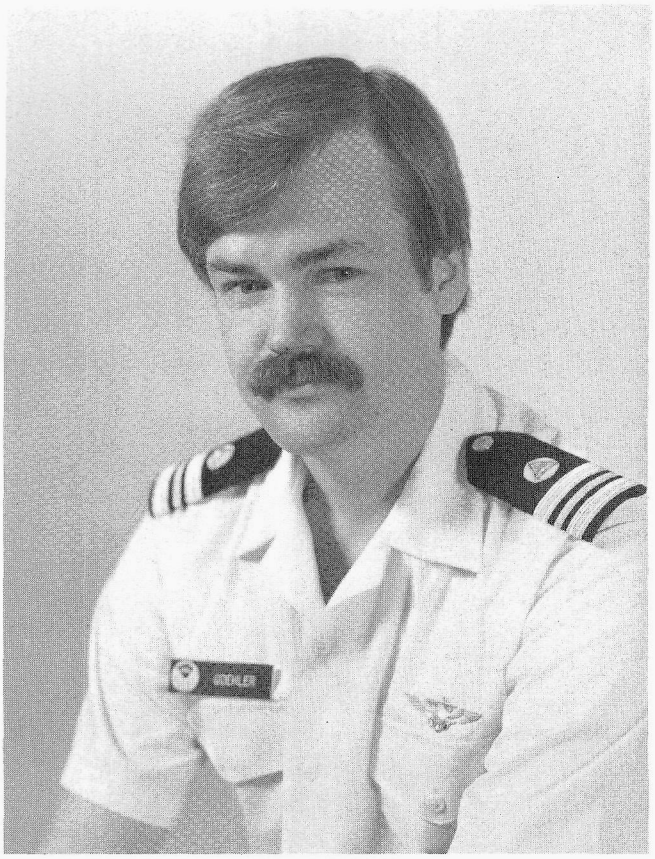


FIGURE 377.—Lt. Comdr. David Goehler. (Official NOS photograph.)



FIGURE 378.—Photographer Lawrence A. Franklin operating RC−8 camera. (Photograph by Harvey Carlson.)

1978

AIR PHOTO MISSION 1 ACTIVITIES—1978

Buffalo N13689 was activated on January 14 with Lt. Comdr. Bradford B. Meyers, Chief of Mission and pilot; Lt. Comdr. Daniel S. Eilers, copilot/navigator; Henry J. Pfeiffer, flight engineer; Robert B. Clark, chief photographer (fig. 379); and Lawrence A. Franklin, photographer. Edwin D. Hawbecker and John T. Smith, Jr., also served on board during the year.

On February 10 the mission returned to Washington, D. C., for storm damage photography along the northeast coast of United States (fig. 380). The photography was completed by February 13.

On March 5 Eilers replaced Meyers as Chief of Mission, and Lt. Comdr. Richard K. Muller (fig. 381) became copilot/navigator.

On May 22 the aircraft had a total electrical failure, but was able to restore necessary systems and photograph two airports and a mean low-water revision photographic project from Connecticut to Massachusetts.

On June 11, after taking off from Peoria, Ill., the aircraft had another electrical fire, which was followed by a total electrical failure. The aircraft landed at Akron–Canton Airport for repair to the electrical system. Photography then continued throughout the United States until September 23, when the mission flew the *first photogeodesy project* in Ada County, Idaho. The project was completed on September 24. The mission then continued photographic operations throughout the United States (fig. 382) until December 11, when the mission was secured for the rest of the year.

AIR PHOTO MISSION 2 ACTIVITIES—1978

Turbo Commander N57074 was activated on January 31 with Lt. Comdr. Arthur N. Flior, Chief of Mission and pilot; Lt. Comdr. David J. Goehler, copilot/navigator; and Charles W. Papke, photographer (fig. 383). Goehler replaced Flior as Chief of Mission on May 22. Lt. Comdr. Melvyn C. Grunthal, Lt. Comdr. Bradford B. Meyers, Comdr. Thomas Garrish, Lt. (jg) John P. Rubino (fig. 384), Lawrence A. Franklin, Harvey C. Carlson (fig. 385) and John T. Smith, Jr., also served on board at various times during the year.

Photography was obtained in the United States until February 22, when the mission departed for St. Thomas, V. I. The mission remained there until March 13, when it left St. Thomas and arrived in Washington, D. C., the same day. Photographic operations continued throughout the United States (fig. 386) until December 18, when the mission was secured for the rest of the year.



FIGURE 379.—Chief photographer Robert Clark operating RC−10 camera. (Photograph by Richard L. Horton.)



FIGURE 380.—In one of the worst storms to hit the northeast coast of the United States, this aerial photograph of a section of Scituate, Mass., clearly illustrates the force of the wind and sea action. (Photograph by John T. Smith, Jr.)



FIGURE 381.—Lt. Comdr. Richard K. Muller. (Official NOS photograph.)



FIGURE 382.—Key West, Fla. with NOS camera "E". (Photograph by Robert Clark.)



FIGURE 383.—Photographer Charles W. Papke operating RC–8 camera. (Photograph by Lawrence Franklin.)

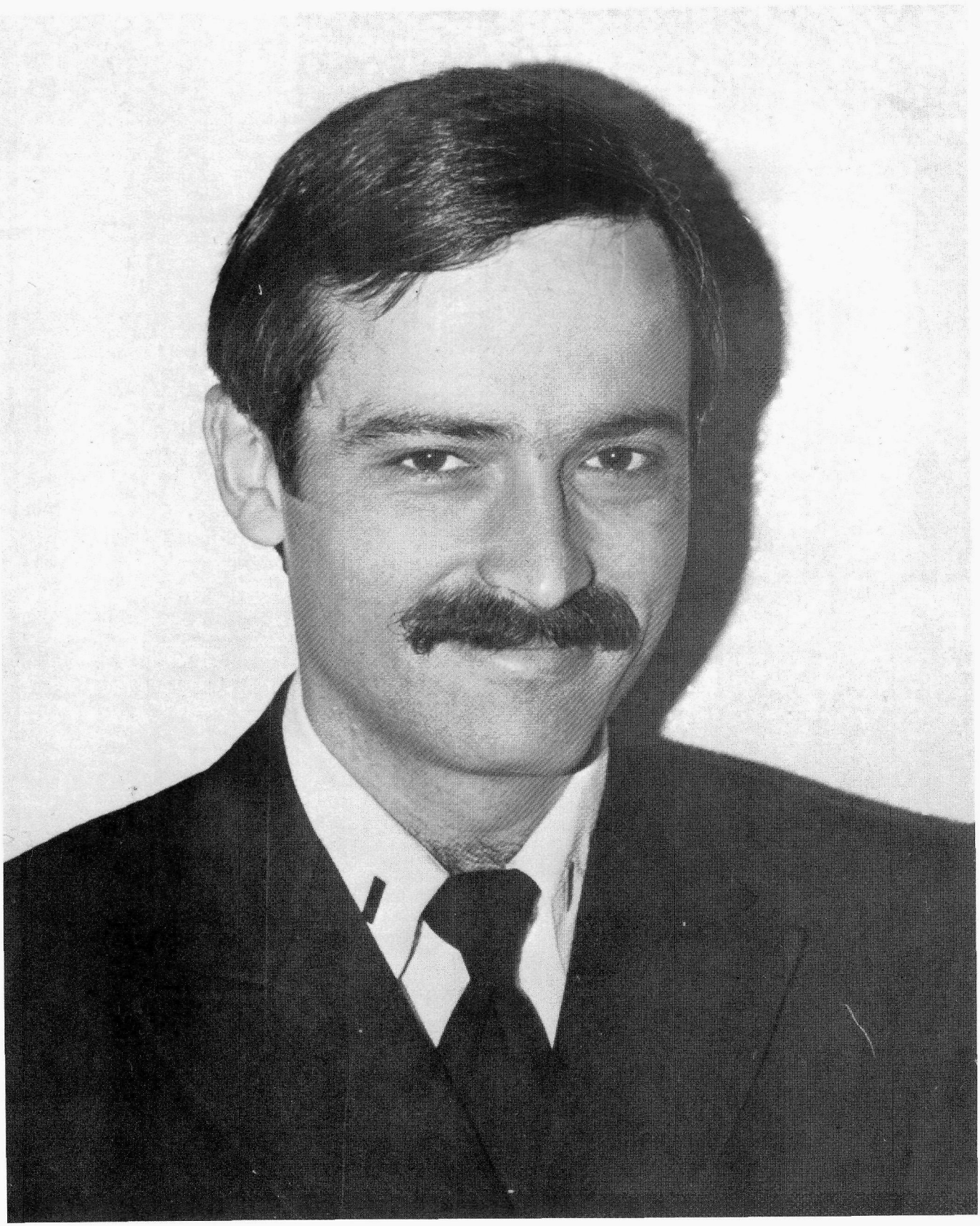


FIGURE 384.—Lt. (jg.) John P. Rubino. (Official NOS photograph.)

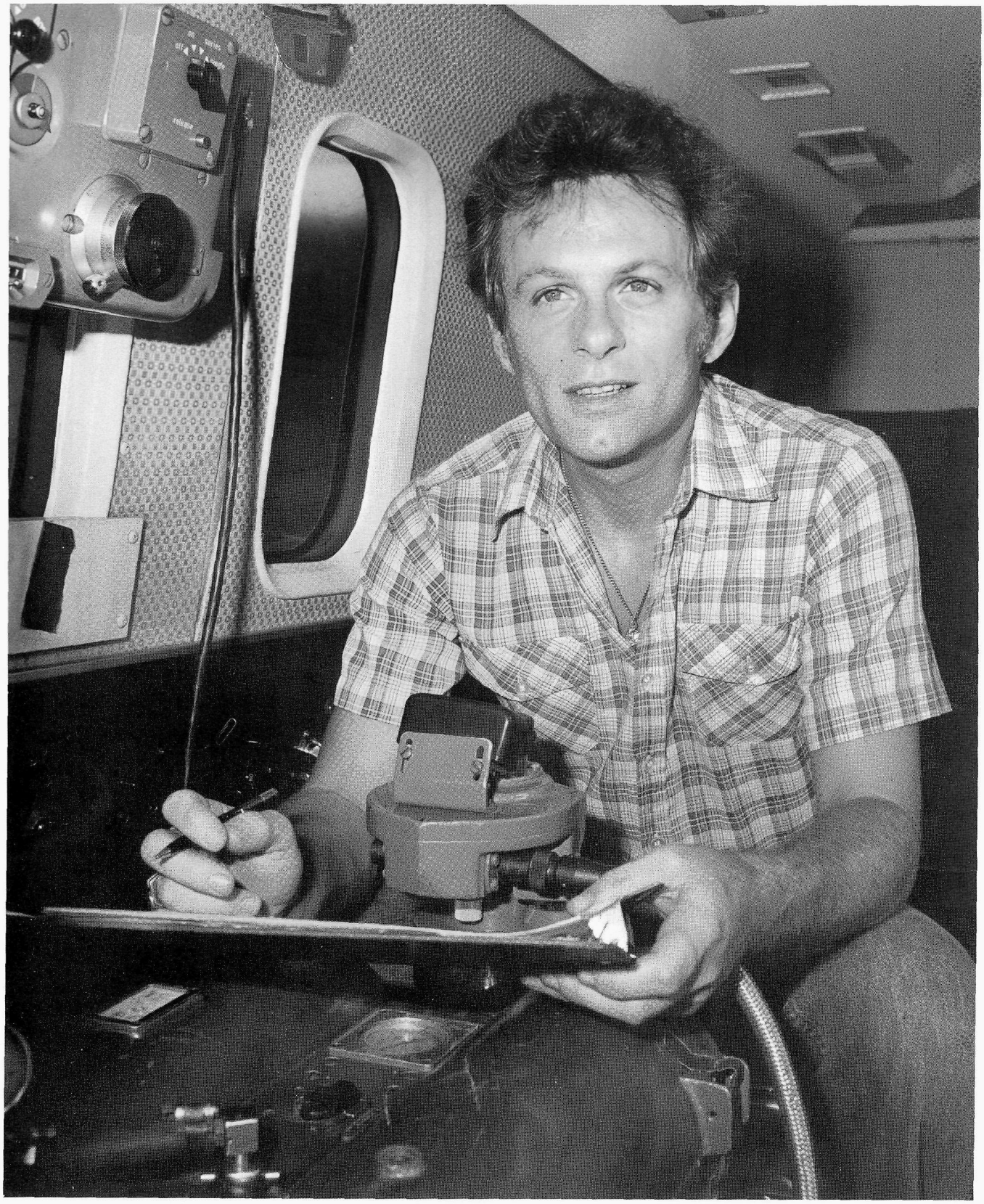


FIGURE 385.—Photographer Harvey C. Carlson. (Photograph by Lawrence Franklin.)



FIGURE 386.—Capital City Airport, Frankfort, Ky. Photographed with NOS "B" camera. (Photograph by Lawrence A. Franklin.)

1979

AIR PHOTO MISSION 1 ACTIVITIES—1979

Buffalo N13689 was activated on February 2, with Lt. Comdr. Daniel Eilers, Chief of Mission and pilot; Lt. Comdr. Richard Muller, copilot/navigator; Henry Pfeiffer, flight engineer; and Harvey Carlson, photographer. Comdr. Walter S. Simmons and John T. Smith, Jr., also served on board at various times throughout the year. The mission left Washington on February 5 for photographic operations in the Southeast United States. The mission returned to Washington, D. C., on March 29, and left on April 8 for the Cayman Islands, arriving on the 9th.

A cooperative agreement had been reached earlier in the year with the U. S. Navy to obtain photobathymetry photography in the Cayman Islands for charts that were being prepared of the Islands by the Navy, in cooperation with Great Britain. Robert Clark joined the mission as second photographer for this project. About 25 percent of the photography (fig. 387) was obtained by May 8, but deteriorating weather caused the project to be postponed until January 1980 when weather should improve in the Islands.

On May 9 the mission was preparing to depart, but a Convair 990 was taxiing and hit the left wingtip of the Buffalo (fig. 388). A replacement wingtip was shipped from Seattle, Wash., and repairs were completed on the evening of the 11th. The aircraft left on the 12th for San Juan, P. R., where it remained until the 17th, when it arrived at Miami, Fla. The mission then returned to Washington on May 18, remaining there



FIGURE 387.—Georgetown, Grand Cayman Island, British West Indies. NOAA–NOS photograph No. 79–BC–0527 taken April 26. (Photograph by Harvey Carlson.)



FIGURE 388.—Damage to the left wing tip of the Buffalo aircraft after being struck by Convair 990 aircraft. (Photograph by John T. Smith, Jr.)

until June 11, when it departed for photography over the Great Lakes. On June 20 the mission returned to Florida, and on the 25th to Washington, D. C. On July 21 Robert Clark replaced Harvey Carlson as photographer.

On July 27 a request was received to use the aircraft to monitor an oil slick in the Gulf of Mexico that was caused by a blowout in an offshore well in Mexico. The mission immediately began monitoring operations over the Gulf (figs. 389 through 393) and was the first to determine that oil was coming ashore on the U. S. beaches outside Brownsville, Tex.

Lt. Comdr. Daniel Eilers reported: "In response to a request from the National Oil Response Team, Air Photo Mission 1 departed Andrews Air Force Base and arrived in Corpus Christi, Texas on 26 July. The Buffalo was to provide support to the Coast Guard on-scene Commander who was in charge of the team activated in connection with possible oil impact in the United States coastline due to the Campeche Bay oil spill. After installing a Loran-C unit in Dallas for offshore navigation, the Buffalo was used to photograph Mexican and United States coastlines to help in damage assessment and oil identification. The majority of flight hours (116 in 18 flight days) were used to visually search (11,300 linear nautical miles) the ocean and locate oil as it progressed into the United States waters and toward United States beaches. Being an excellent visual search platform the Buffalo was also used to locate and identify shrimp and fishing boats working in oil contaminated waters."

On August 21, while working on the Campeche oil spill, flight engineer Henry Pfeiffer on deplaning had a ladder slip from under him, and he broke his left arm in four places. Pfeiffer was taken to the Naval Regional Hospital in Corpus Christi, Tex., and remained there while the Buffalo was ferried back to Andrews Air Force Base on August 26. Pfeiffer returned to Washington on September 4, but was unable to resume the duties of flight engineer.



FIGURE 389.—The oil slick monitoring team. Left to right: David Bean, Coast Guard Oceanic Unit; Jim Lyons, NOAA, Office of Marine and Pollution Assessment; Lt. Comdr. Daniel Eilers, pilot; Lt. Comdr. Richard Muller, copilot; Henry Pfeiffer, flight engineer; and Richard Hayes, Coast Guard Oceanic Unit. (Photograph by Robert Clark.)

The aircraft was grounded for repairs until September 21 when the aircraft was reactivated to assist with the Campeche oil spill. The aircraft left Washington, D. C., on September 23 and after having a Loran unit installed at Dallas, Tex., arrived in Corpus Christi on September 25 when surveillance of the oil spill resumed. From September 29 through October 3 the aircraft was again grounded for maintenance. On October 4 the Buffalo flew the last oil spill reconnaissance, and from October 6 through October 10 flew photography in Texas, Florida, and North Carolina, returning to Andrews Air Force Base on October 10. As the aircraft did not have a flight engineer on board at this time, major maintenance was done at transit main-



FIGURE 390.—Henry J. Pfeiffer, flight engineer, pumping up APU unit on the Buffalo prior to an engine start. (Photograph by Robert Clark.)

tenance facilities at military bases. Because of the complexity of the aircraft, the lack of scheduled maintenance, as well as overdue maintenance, a maintenance engineer from Canada was contracted to inspect and make the necessary repairs. From October 17 to October 24 he fulfilled the contract, and although no immediate flight safety items were revealed, he stated what was known for quite a while—". . . unless a lot of money is spent on this aircraft, it is totally a piece of junk." With this in mind, the aircraft was restricted to only short flights to do vitally needed photography. From October 30 to November 27 the aircraft photographed part of Cape Cod, Mass., and part of North Carolina. On November 27 the Buffalo was retired as a photographic aircraft from NOS, and the era of the Buffalo came to an end (fig. 394).



FIGURE 391.—*Lt. Comdr. Daniel Eilers flying the Buffalo aircraft over oil slick. (Photograph by Robert Clark.)*

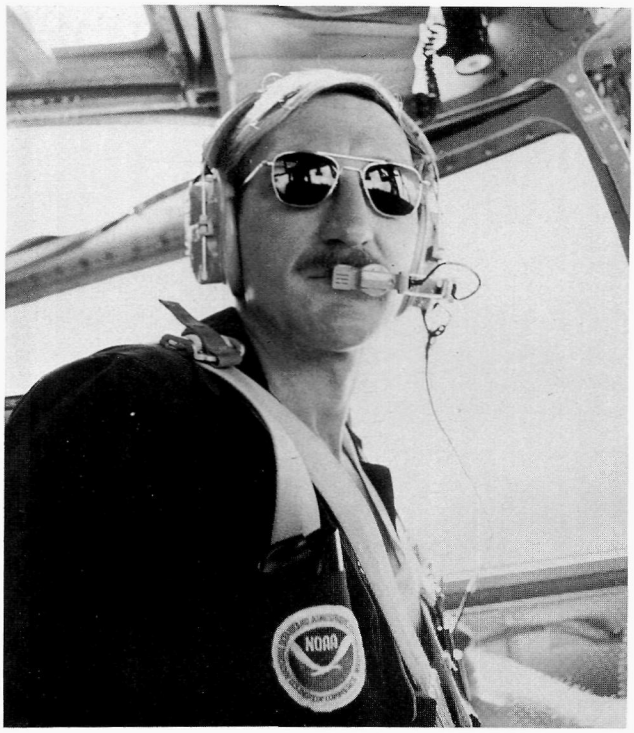


FIGURE 392.—Last aircraft commander, Lt. Comdr. Richard Muller flying the Buffalo. (Photograph by Robert Clark.)

Buffalo (ESSA 88) N13689

1967 to 1979

Personnel who served on board:

NOAA Officers

Lt. Comdr. Robert C. Westphall
Lt. Comdr. Leland L. Reinke
Lt. Comdr. Charles N. Whitaker
Lt. Comdr. Melvyn C. Grunthal
Lt. Comdr. Bernard N. Mandelkern
Lt. Comdr. Arthur N. Flior
Lt. Comdr. Lowell J. Genzlinger
Lt. Comdr. William M. Noble
Lt. Comdr. Walter S. Simmons
Lt. Comdr. Leslie H. Perry
Lt. Comdr. Daniel S. Eilers
Lt. Comdr. Bradford B. Meyers
Lt. Comdr. Richard K. Muller
Lt. Terry M. Laydon

NOAA Civilians

John T. Smith, Jr.
Charlie R. Johnson
Frank McCarthy
Carl L. Hayes
Harvey Carlson
Robert B. Clark
William G. Riggs
Henry J. Pfeiffer—Flight engineer
Sterling R. Frizzell
Charles C. Ferguson
Edwin D. Hawbecker
John A. Rector
Charles W. Papke
Lawrence A. Franklin

AIR PHOTO MISSION 2 ACTIVITIES—1979

Turbo Commander N57074 was activated on January 19, with Lt.(jg) John Rubino, Chief of Mission and pilot; Comdr. Walter S. Simmons, copilot/navigator; and Charles Papke, photographer. The mission left Washington, D. C., on January 22, and returned on the 25th , leaving on the 29th for photography in the southeast United States. On the 20th the aircraft had an engine failure while over Florida. The plane landed at Ft. Lauderdale. The engine work was completed on March 8, and the aircraft departed Augusta, Ga., for San Francisco, Calif., on the 14th. As Rubino was resigning from the service, Comdr. Simmons replaced him as Chief of Mission on March 17, and Comdr. Thomas Gerish (fig. 395) assumed the duties of copilot/navigator. On April 16 Comdr. Bernard Mandelkern relieved Gerish, and on May 17 Mandelkern relieved Simmons as Chief of Mission, and Lt. Terry Laydon (fig. 396) reported on board as copilot/navigator. On June 20 Lawrence Franklin replaced Papke as photographer.

The aircraft continued photography throughout the United States. On September 17 Comdr. Thomas Gerish returned to the mission, replacing Laydon as copilot. On October 16 the aircraft depressurized and landed at Dallas, Tex., without serious damage. After repairs were completed on October 18, the mission continued to do photography until December 18, when it was secured for the season.

Turbo Commander N57074

1974 to 1979

Personnel who served on board:

NOAA Officers

Lt. Comdr. Melvyn C. Grunthal
Lt. Peter S. Hudes
Lt. Comdr. Bernard N. Mandelkern
Lt. Bradford B. Meyers
Lt. Comdr. Arthur N. Flior
Lt. Daniel S. Eilers
Lt. Richard K. Muller
Lt. Comdr. David J. Goehler
Comdr. Thomas Gerish
Lt.(jg) John P. Rubino
Lt. Terry M. Laydon
Comdr. Patrick L. Wehling, Jr.
Comdr. Walter S. Simmons
Lt. Thomas A. Bergner

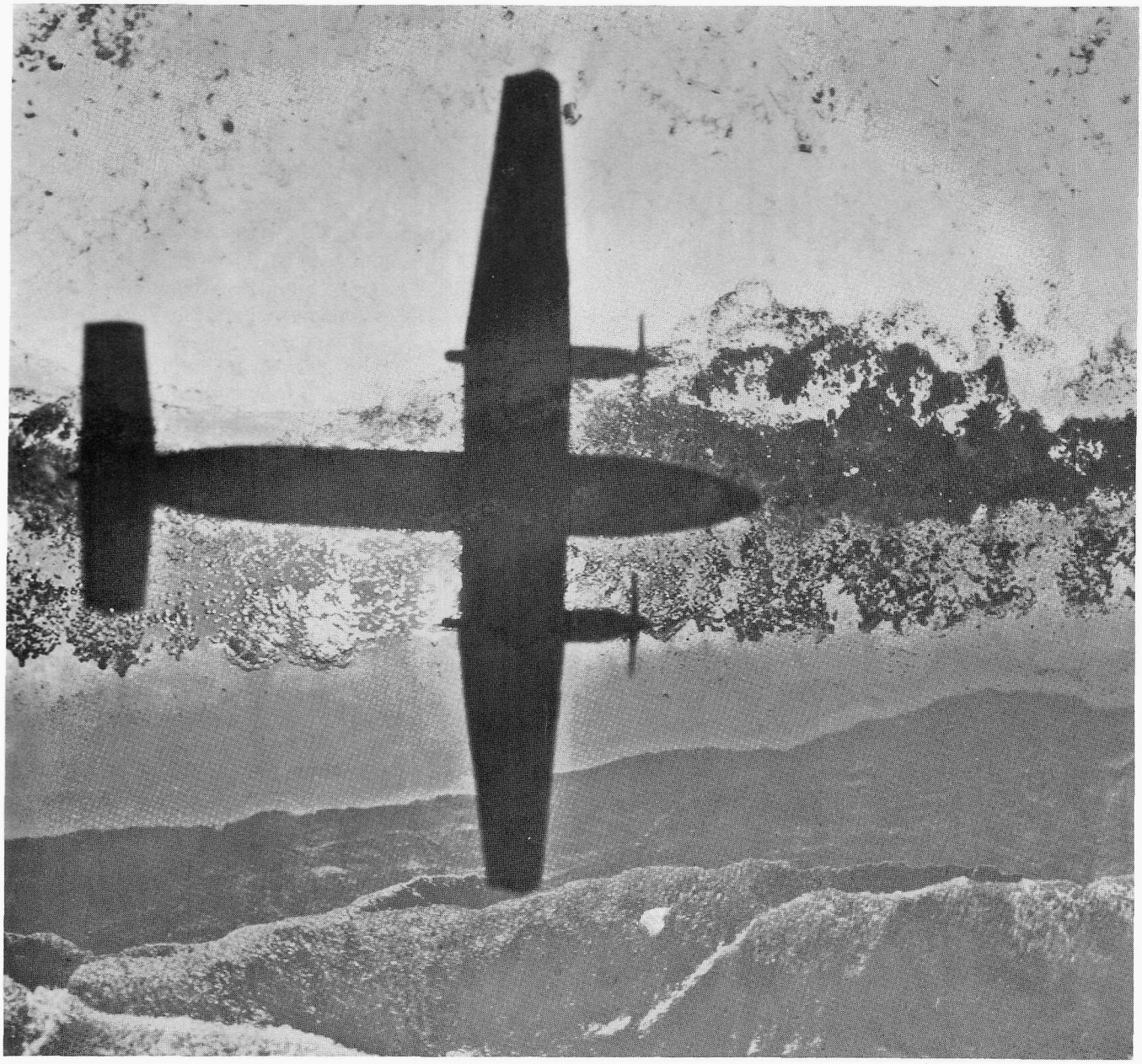


FIGURE 393.—NOAA casts its shadow over the world. Oil from the Campeche spill on a beach in Mexico 60 miles south of Brownsville, Tex. (Photograph by Robert Clark.)

NOAA Civilians

Robert B. Clark
Harvey Carlson
Charles W. Papke
John A. Rector
John T. Smith, Jr.
Lawrence A. Franklin
Edwin D. Hawbecker

SPECIAL AIR PHOTO MISSION ACTIVITIES—1979

On September 12 Hurricane Frederic struck the U.S. Gulf Coast. Because the Buffalo was unable to fly, an aircraft was borrowed on September 13 from the Office of Aeronautical Charting and Cartography of NOS in order to photograph the storm damage resulting from the hurricane. Aircraft N95SA, an Aero Commander 500S, which is normally used for visual chart flight editing and low-altitude obstacle and landmark photography, was provided to the Division of Photogrammetry, and was flown to New Orleans with Comdr. Patrick L. Wehling, Jr. (fig. 397), Chief of Mission and pilot and Lt. David J. Tennesen, copilot/navigator. They arrived in New Orleans on the night of September 13, where Lawrence Franklin, photographer from the Photogrammetry Division, met them. On September 15 photography of the damage to



FIGURE 394.—The Buffalo at Andrews Air Force Base, December 12. The last aerial photographic flight and the last pictures were taken on November 17. All equipment usable by the Photogrammetry Division was removed by December 12 and the Buffalo now awaits a ferry flight to her rendezvous with destiny. (Photograph by Lawrence Franklin.)

Dauphin Island, Southwest Mobile Bay, Pensacola up to Mobile Point, Pascagoula and the islands west of Dauphin Island was taken. On September 16 Lt. Tennesen was replaced by Comdr. Walter S. Simmons. The weather was not clear enough for photography until September 19, when all the photography necessary was completed. On October 21 the aircraft flew to Washington, D. C., and was returned to the Office of Aeronautical Charting and Cartography.

OFFICE ACTIVITIES—1979

In January, the Coastal Mapping Division's name was changed to Photogrammetry Division.

In October the second pilot to become an NOS Admiral, Richard H. Houlder, was sworn in (fig. 398).

On November 30 Comdr. James Collins was transferred, and on December 1 Comdr. Walter S. Simmons became Chief of the Photogrammetry Division.



FIGURE 395.—Comdr. Thomas Gerish. (Official NOS photograph.)

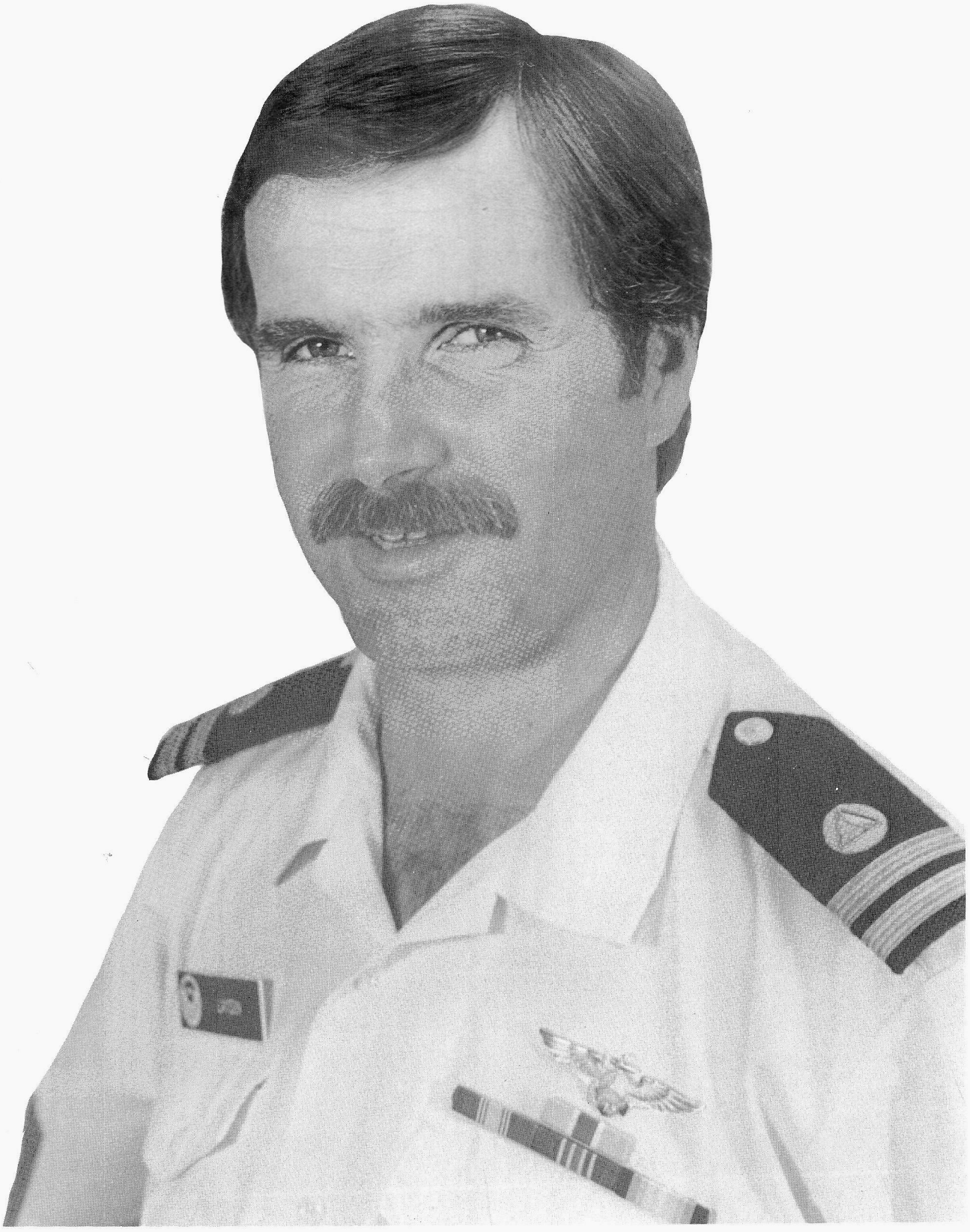


FIGURE 396.—Lt. Terry Laydon. (Photograph by Lawrence Franklin.)



FIGURE 397.—Lt. Patrick L. Wehling, Jr. (Official NOS photograph.)

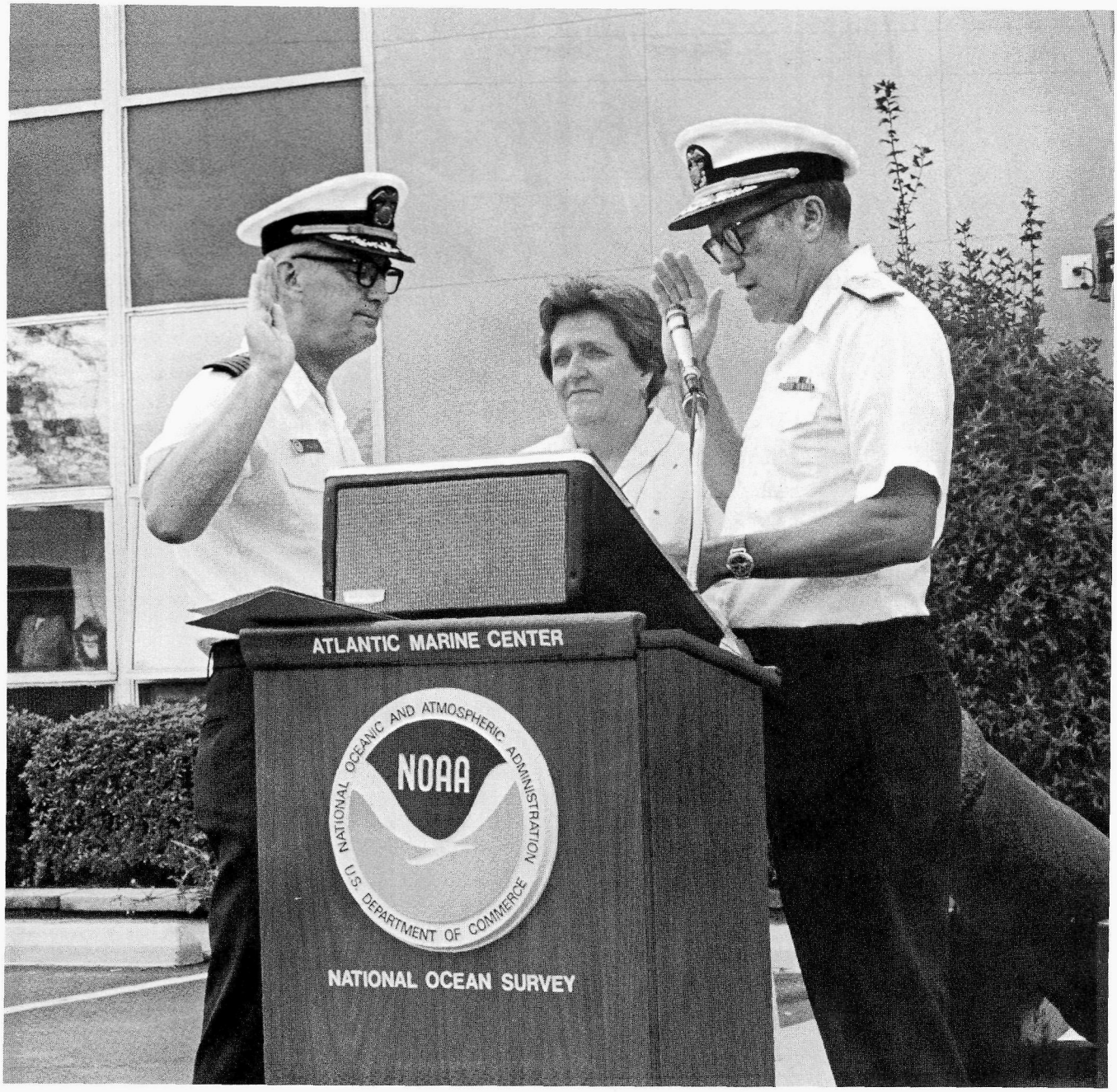


FIGURE 398.—The second photogrammetry pilot to become an admiral in the National Ocean Survey. Richard H. Houlder, on the left, is sworn in by Adm. Lippold while Mrs. Houlder observes the ceremony on October 1, 1979. (Official NOS photograph.)

APPENDIX

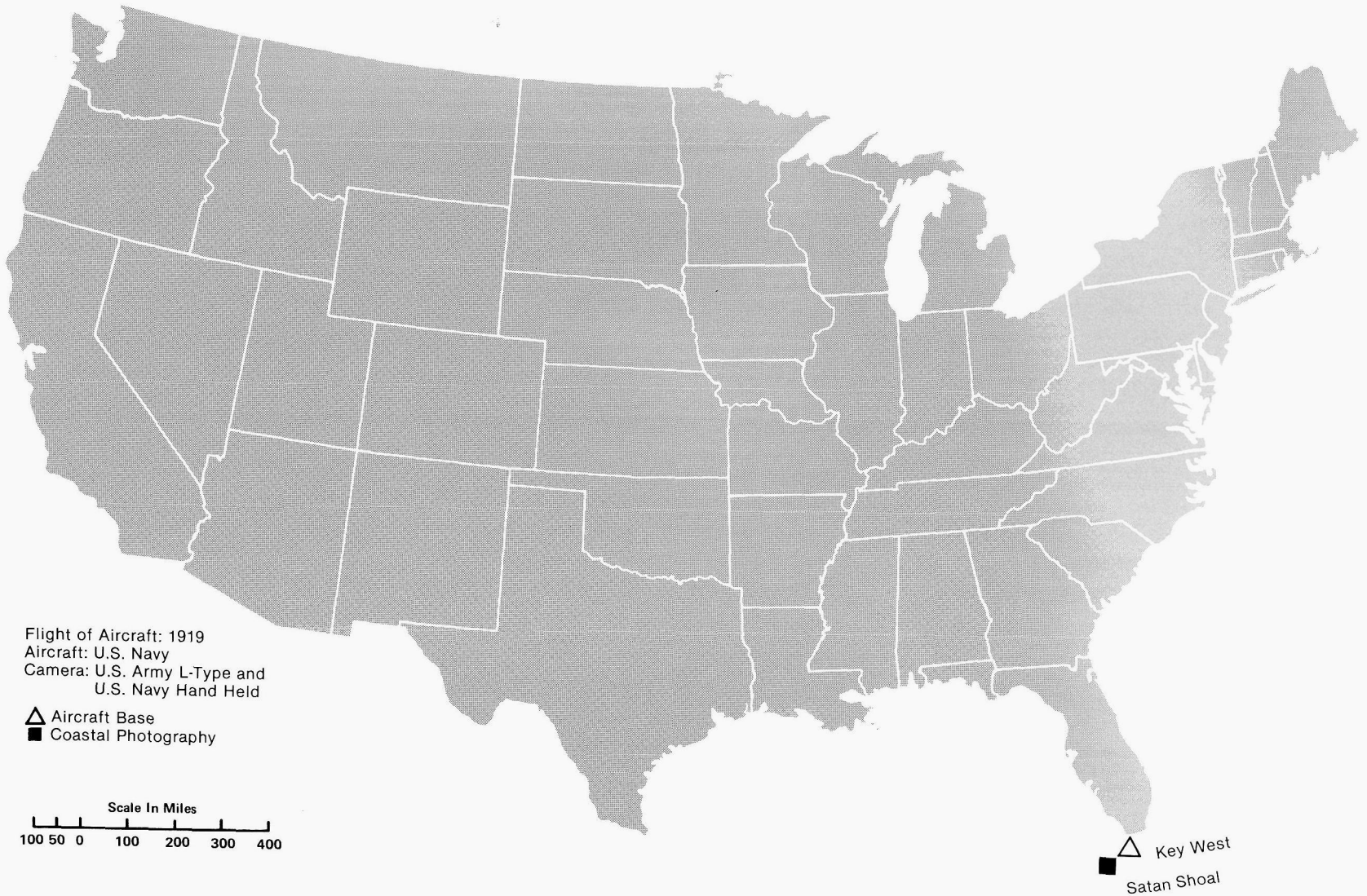
Aerial Cameras of the Photogrammetry Division

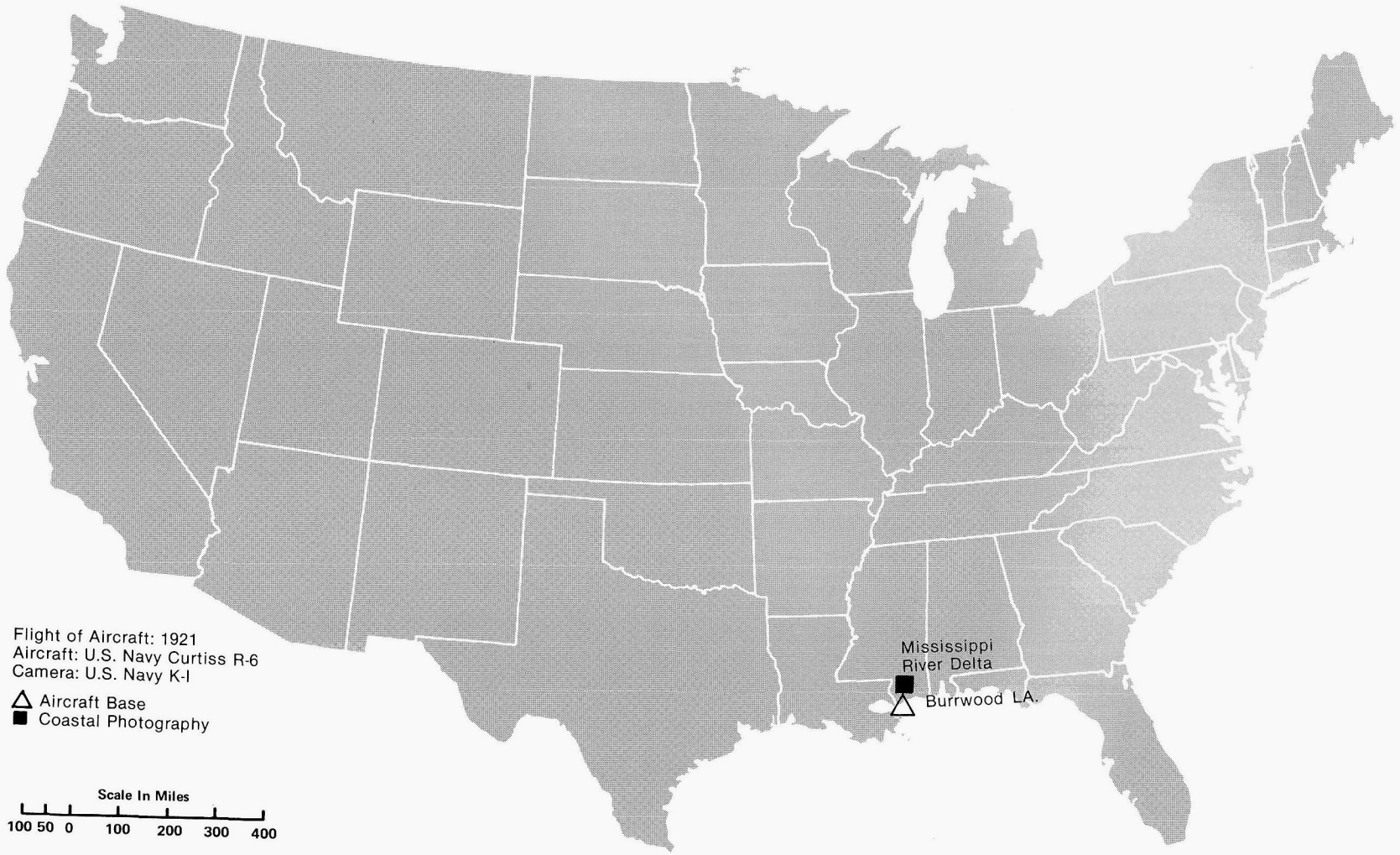
CAMERA	LENS	PHOTO FORMAT (Inches)	FIDUCIAL MARKS	NOTES
"A"	210 mm F/4 Ross Express	35.4 by 35.4	4	Original 9-lens camera (exposures below No. 14687) Years in service, 1936–43
"B"	210 mm F/4 Ross Express	35.4 by 35.4	45	Rebuilt 9-lens camera (exposures above No. 14687, September 15, 1945). Years in service, 1945–61
"C" Fairchild F-51	6-inch Metrogon	9 by 9	4	With or without focal plane grid plate, calibrated. Years in service, 1943–48
"D" Fairchild K–17	12-inch Aerostigmat	9 by 9		Not calibrated. Years in service, 1944–49.
"J" Fairchild K–17	6-inch Metrogon	9 by 9		Not calibrated. Years in service, 1947–53
"K"		4 by 5		All K–20 cameras, were not used for photogrammetry.
"O" Fairchild cartographic (F–224)	6-inch Metrogon	9 by 9	4	Calibrated, flat focal plane plate. Years in service, 1948–56.
"T" Fairchild cartographic (F–224)	6-inch Metrogon	9 by 9	4	Tham curved focal plane plate. Years in service, 1954.
"W" Wild RC–5a	6-inch Aviogon	9 by 9	4	Calibrated. Years in service, 1954–66.
"L" RC–8	Universal Aviogon f=152.71 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400–0.900μ. Years in service, 1956–74.
"M" RC–9	Super Aviogon f=88.2 mm	9 by 9	4 (corners)	Color corrected for 0.400–0.700 μ. Used B&W Plan. Natural-color film emulsion should be used with caution due to poor image sharpness. Years in service, 1960–72.
RC–7	Aviogon f=100.4 mm	140 by 140 mm	4 (midsides)	Used B&W Pan on glass plates (2 mm thickness). Years in service, 1961–64.

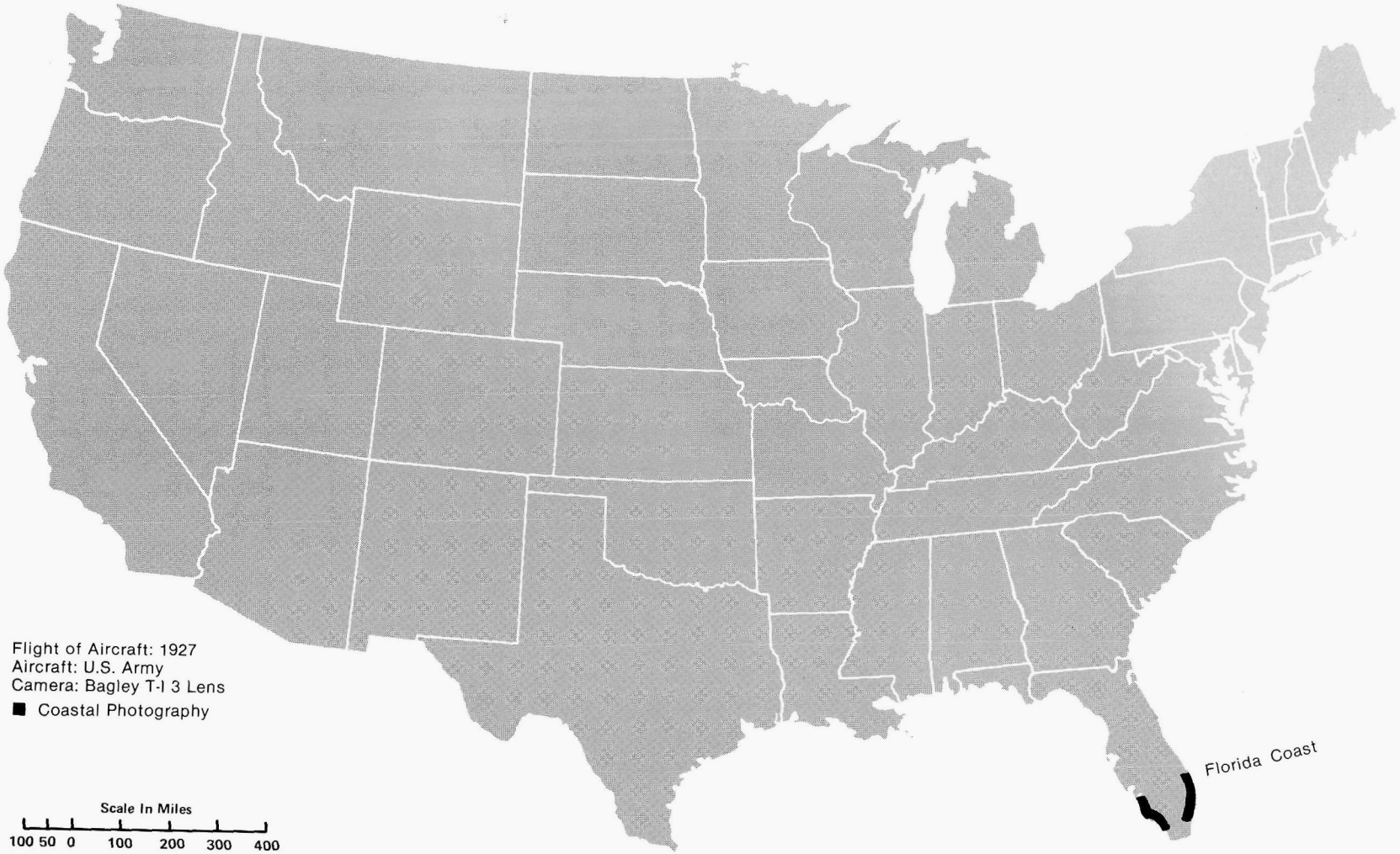
The above cameras are no longer in service with the National Ocean Survey.

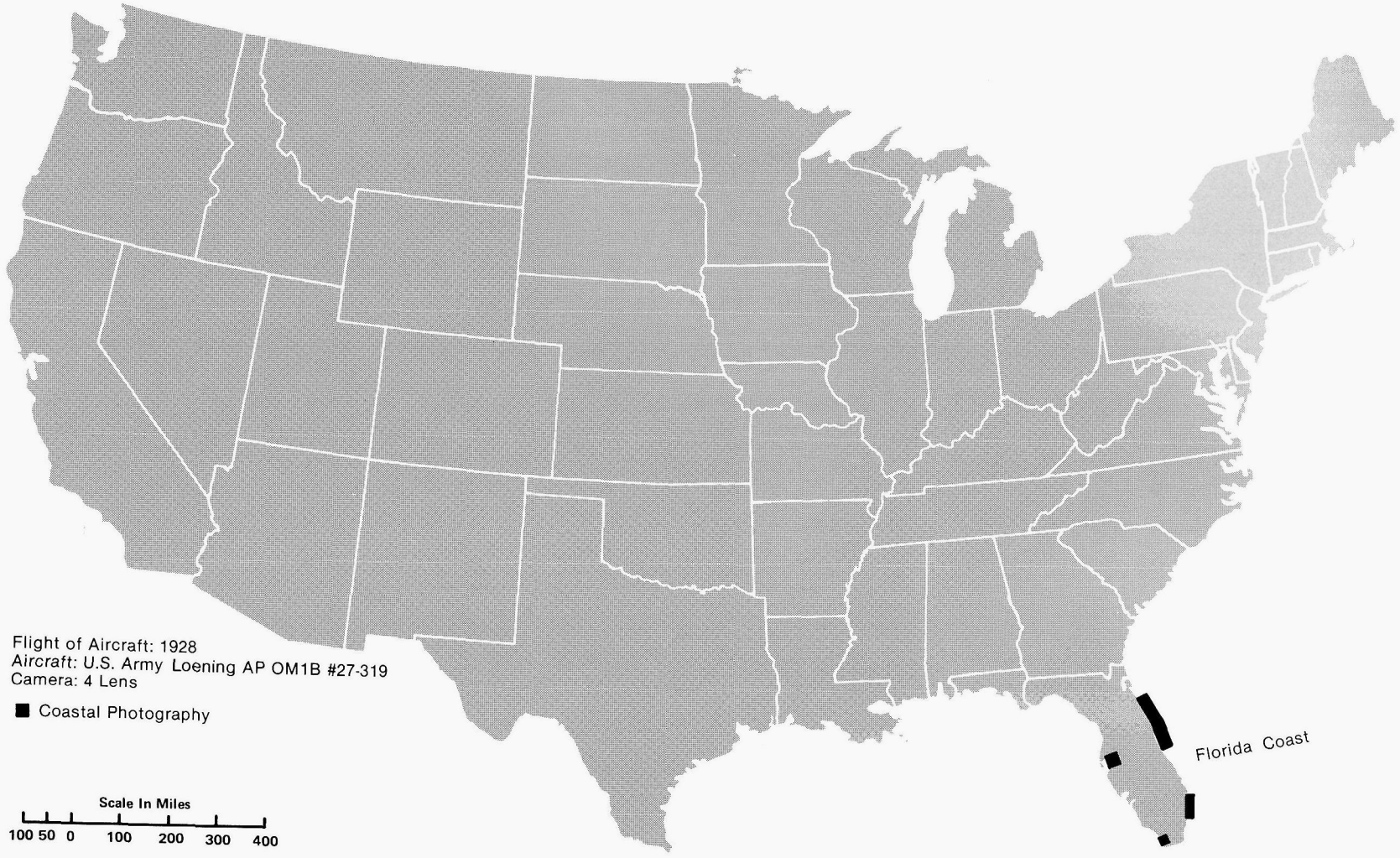
Aerial Cameras of the Photogrammetry Division
[Cameras in use in 1979 by the Photogrammetry Division, NOS]

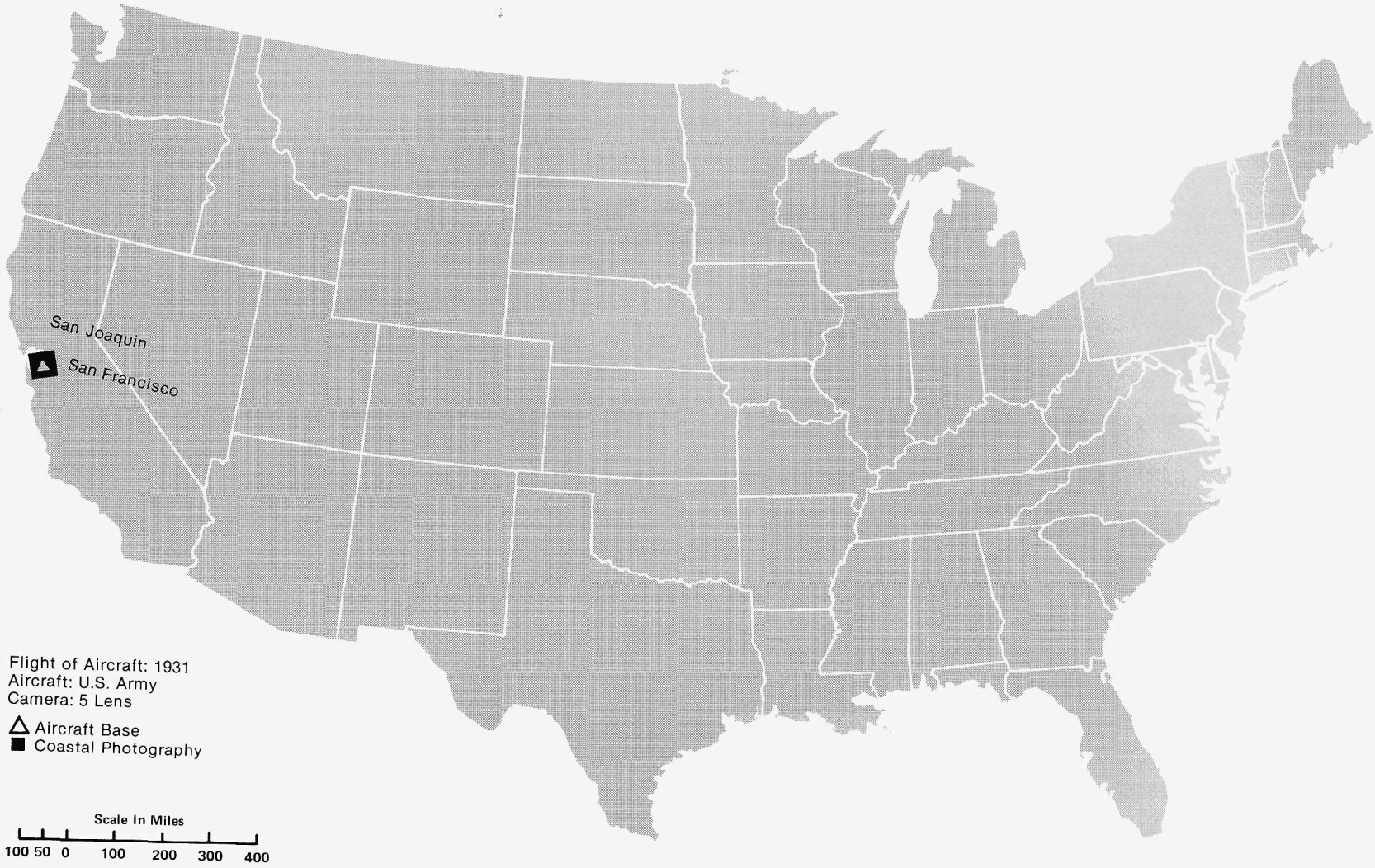
CAMERA	LENS	PHOTO FORMAT (Inches)	FIDUCIAL MARKS	NOTES
"S" RC–8	Aviogon f=152.29 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400-0.700 μ. Use only B&W Pan or natural color film emulsions. Years in service, 1957–
"E" RC–8	Universal Aviogon f=152.21 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400-0.900 μ. Use all current film emulsions. Years in service, 1968–
"K" RC–8	Infragon f=151.77 mm	9 by 9	4 (corners)	Use only B&W infrared film emulsion. Years in service, 1956–
"Z" RC–10	Universal Aviogon f=153.14 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400-0.900 μ. Use all current film emulsions. Years in service, 1973–
"B" RC–10	Universal Aviogon f=153.14 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400-0.900 μ. Use all current film emulsions. Years in service, 1975–
"C" RC–10	Super Aviogon II f=88.47 mm	9 by 9	8 (corners and midsides)	Color corrected for 0.400-0.900μ. Use all current film emulsions. Years in service, 1973–
"G" RC–10	Universal Aviogon f=153.14 mm	9 by 9		Geodetic lens cone. Years in service, 1974–

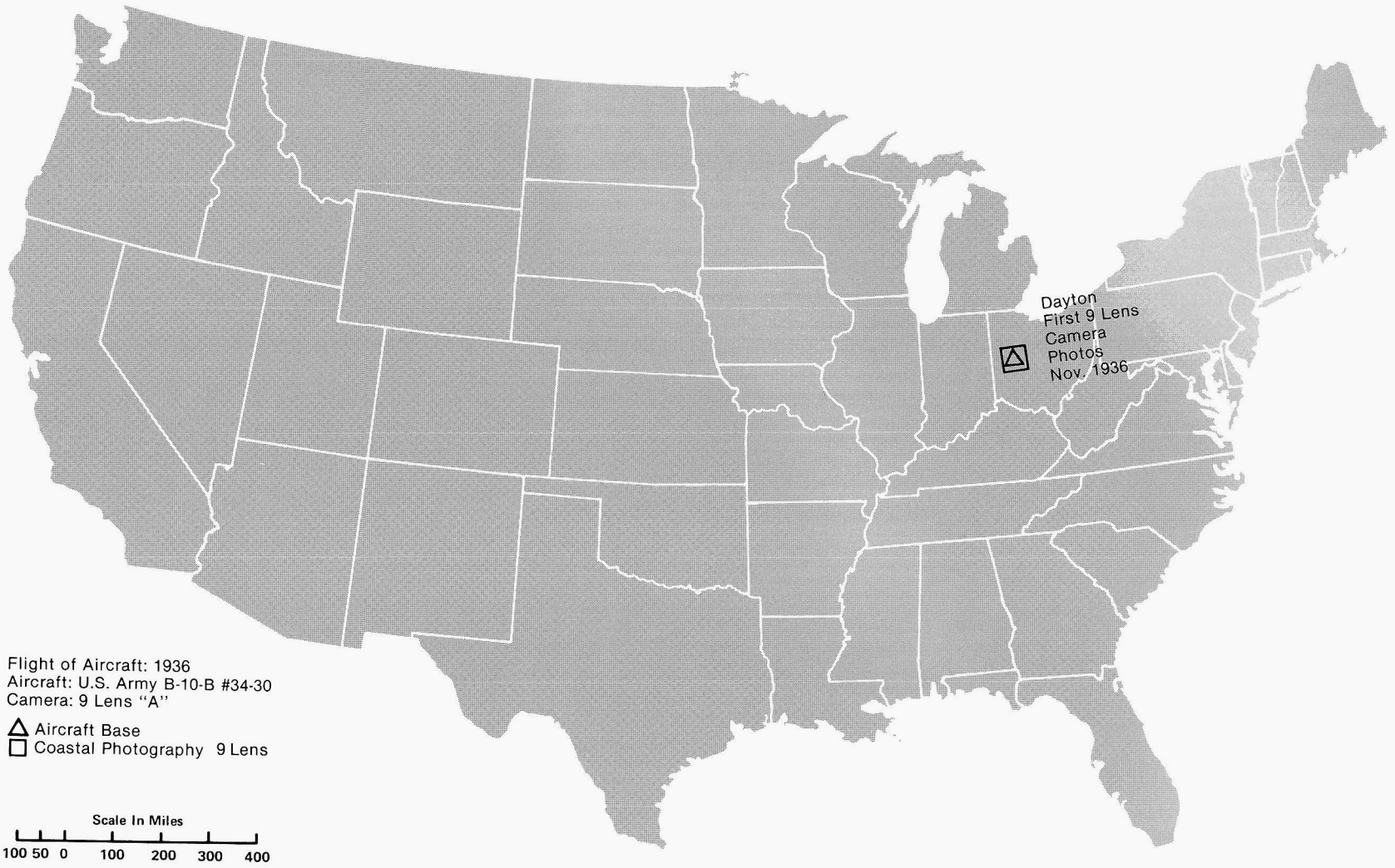

Flight of Aircraft: 1919
Aircraft: U.S. Navy
Camera: U.S. Army L-Type and
U.S. Navy Hand Held
Aircraft Base
Coastal Photography
Scale In Miles
100 50 0 100 200 300 400
Key West
Satan Shoal

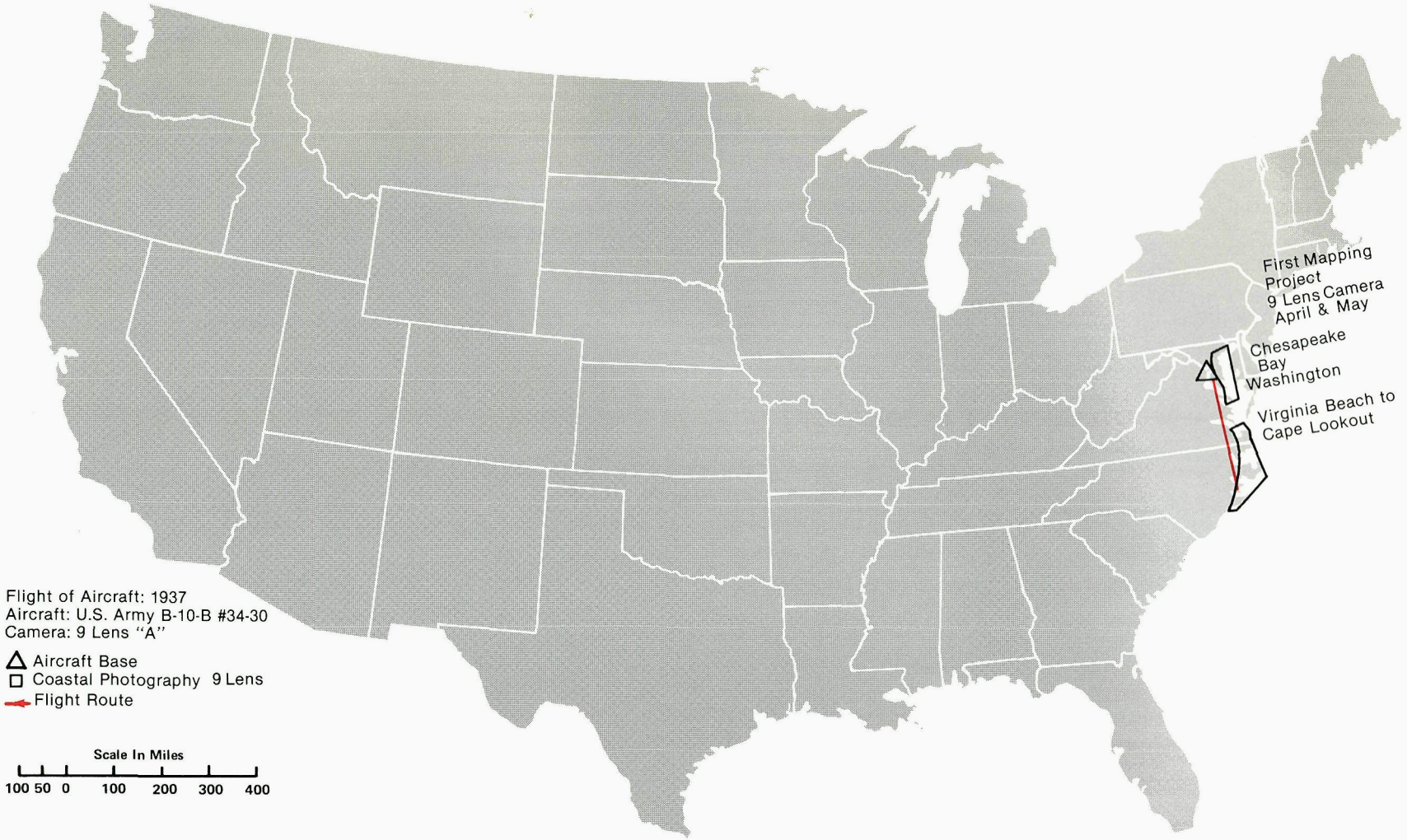

Flight of Aircraft: 1921
Aircraft: U.S. Navy Curtiss R-6
Camera: U.S. Navy K-I
Aircraft Base
Coastal Photography
Scale In Miles
100 50 0 100 200 300 400
Mississippi
River Delta
Burrwood LA.

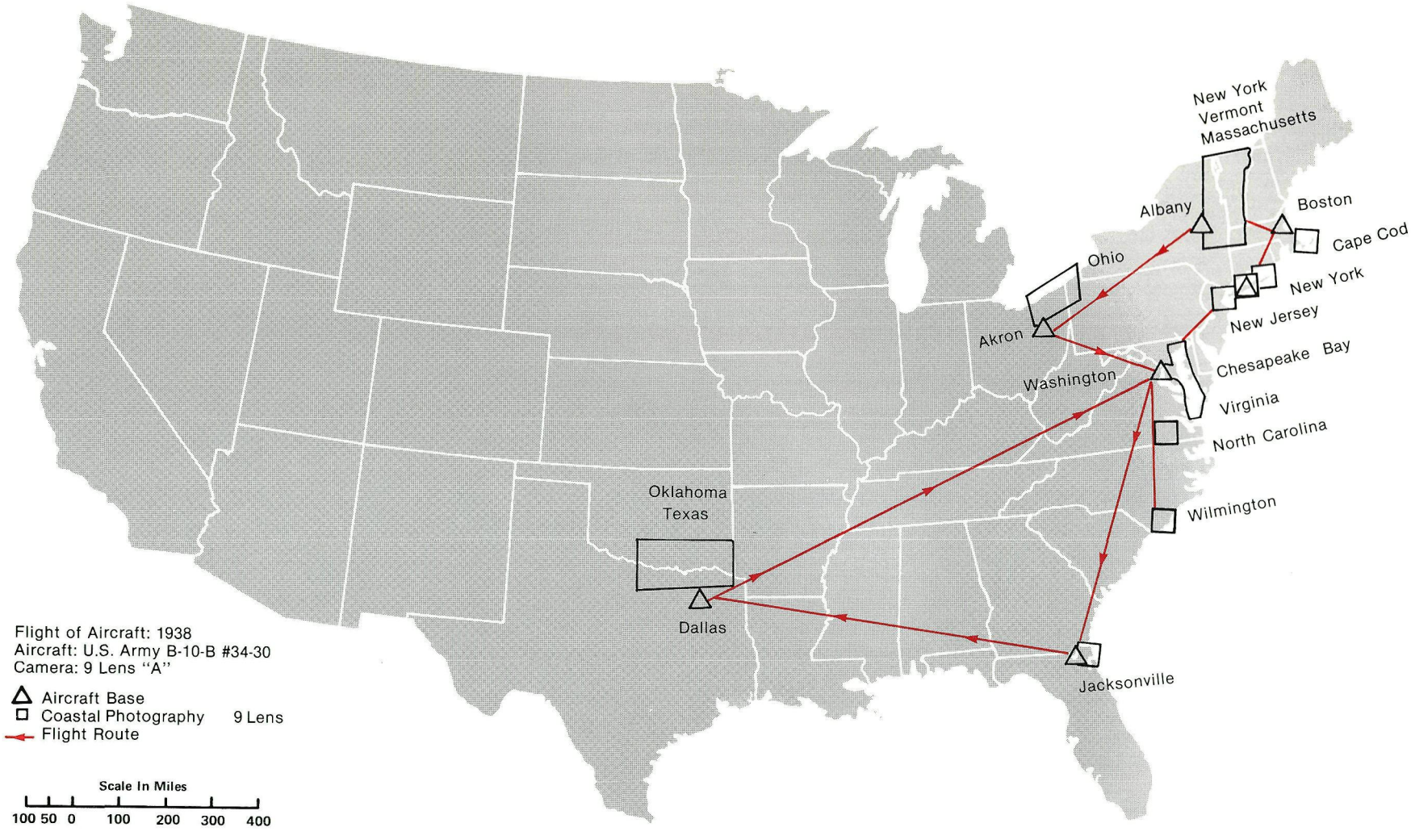

Flight of Aircraft: 1927
Aircraft: U.S. Army
Camera: Bagley T-I 3 Lens
Coastal Photography
Scale In Miles
100 50 0 100 200 300 400
Florida Coast

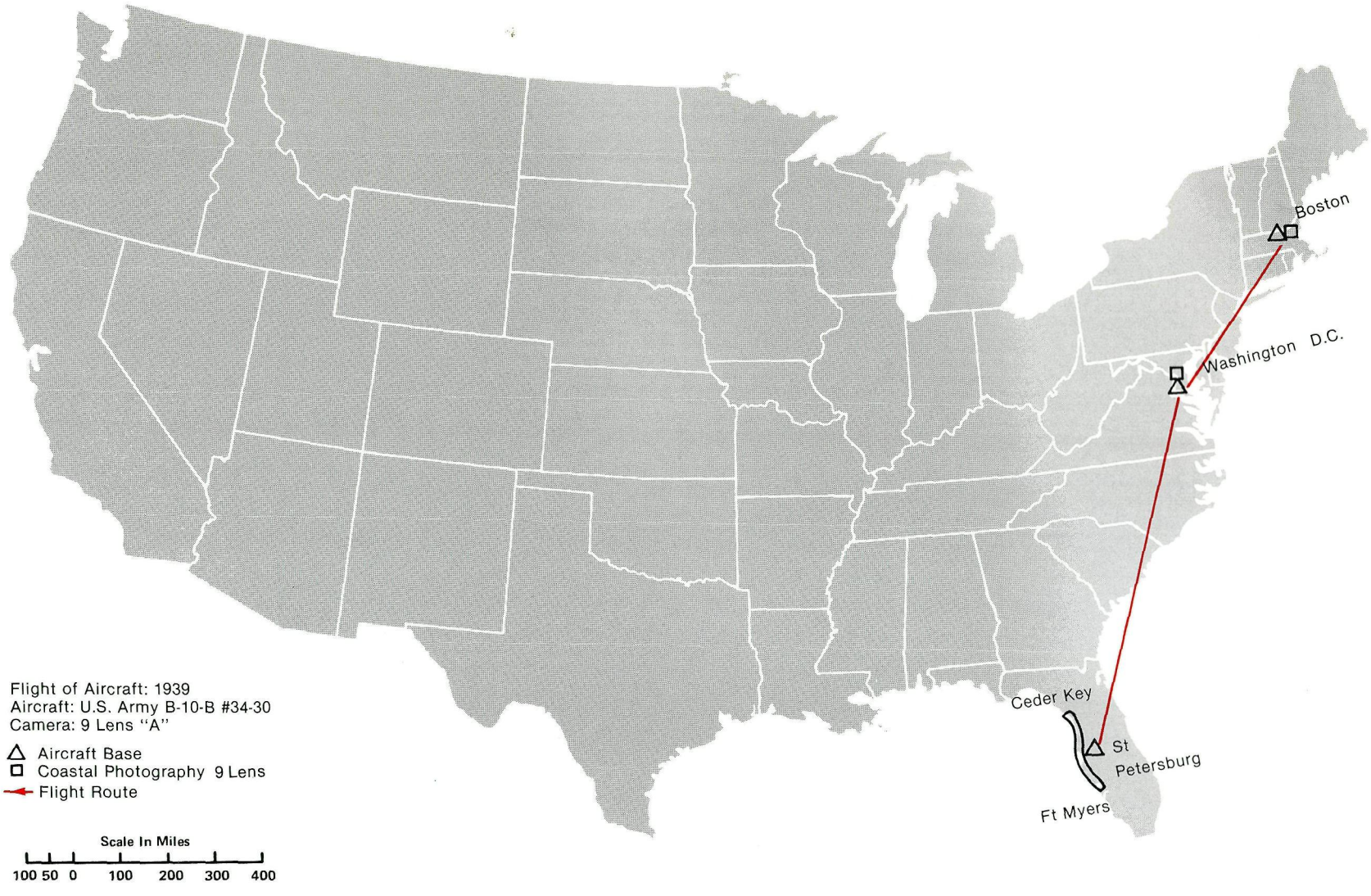

Flight of Aircraft: 1928
Aircraft: U.S. Army Loening AP OM1B #27-319
Camera: 4 Lens
Coastal Photography
Scale In Miles
100 50 0 100 200 300 400
Florida Coast

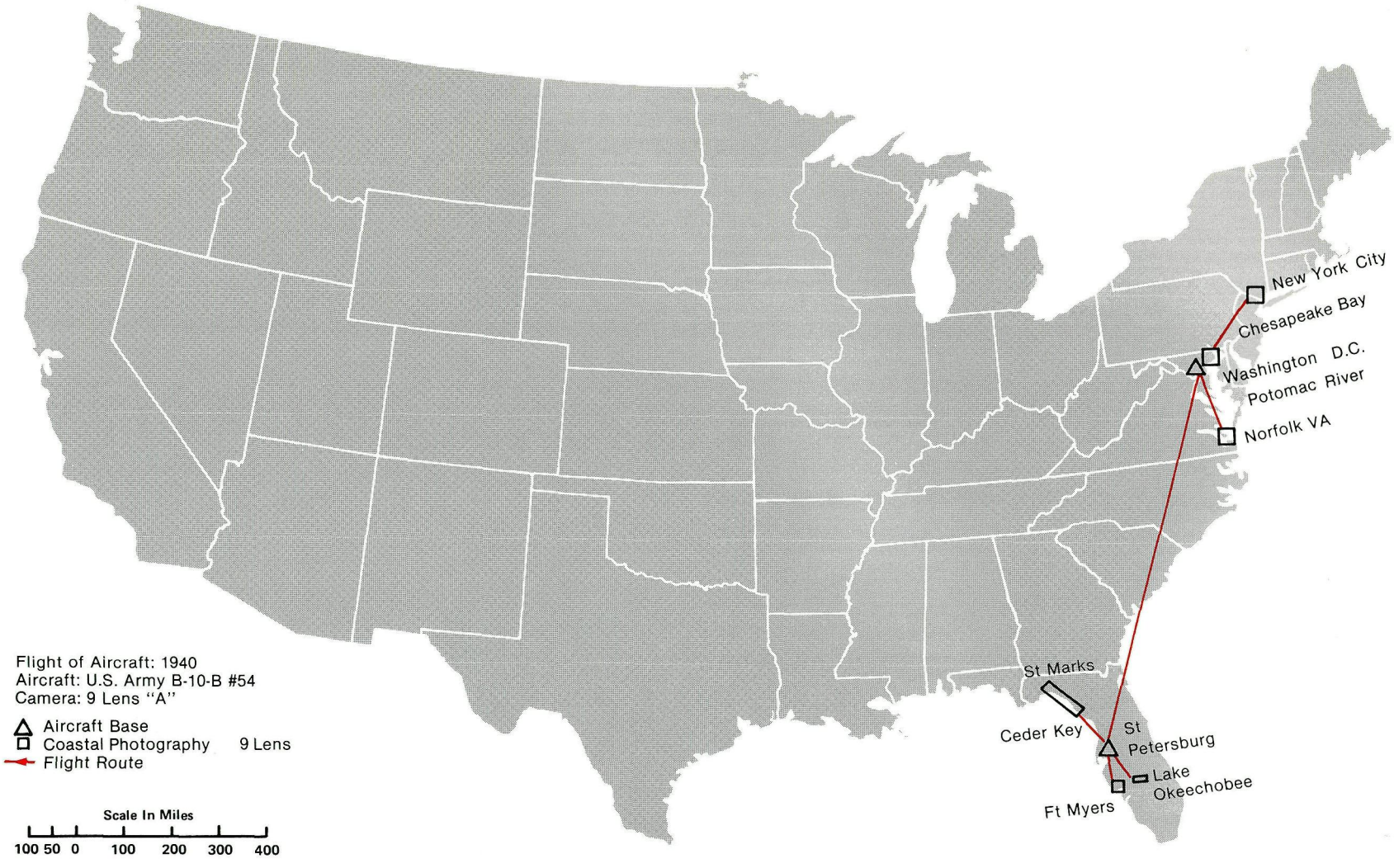

San Joaquin
San Francisco
Flight of Aircraft: 1931
Aircraft: U.S. Army
Camera: 5 Lens
Aircraft Base
Coastal Photography
Scale In Miles
100 50 0 100 200 300 400


Dayton
First 9 Lens
Camera
Photos
Nov. 1936
Flight of Aircraft: 1936
Aircraft: U.S. Army B-10-B #34-30
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Scale In Miles
100 50 0 100 200 300 400

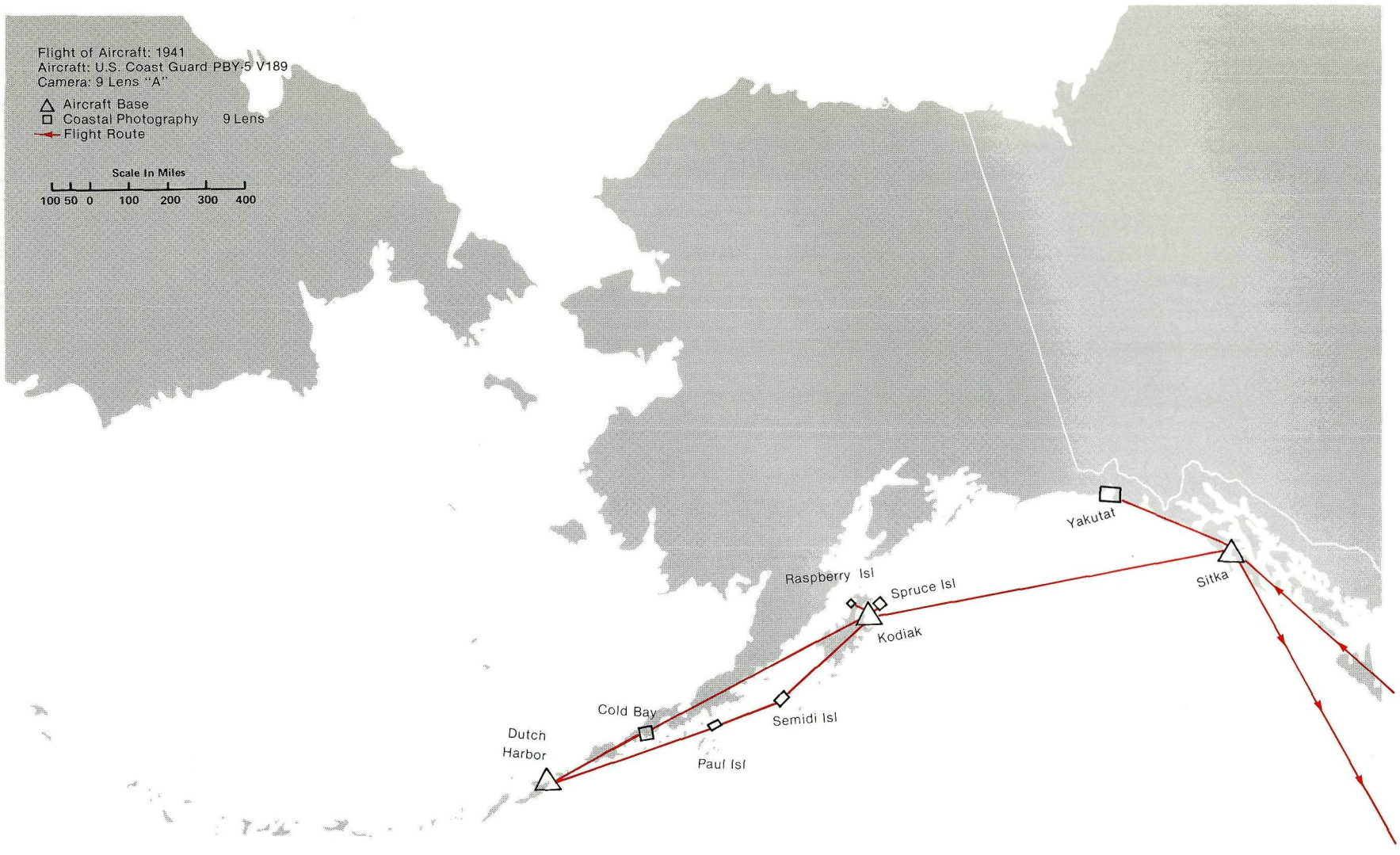

First Mapping Project
9 Lens Camera
April & May
Chesapeake Bay
Washington
Virginia Beach to Cape Lookout
Flight of Aircraft: 1937
Aircraft: U.S. Army B-10-B #34-30
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

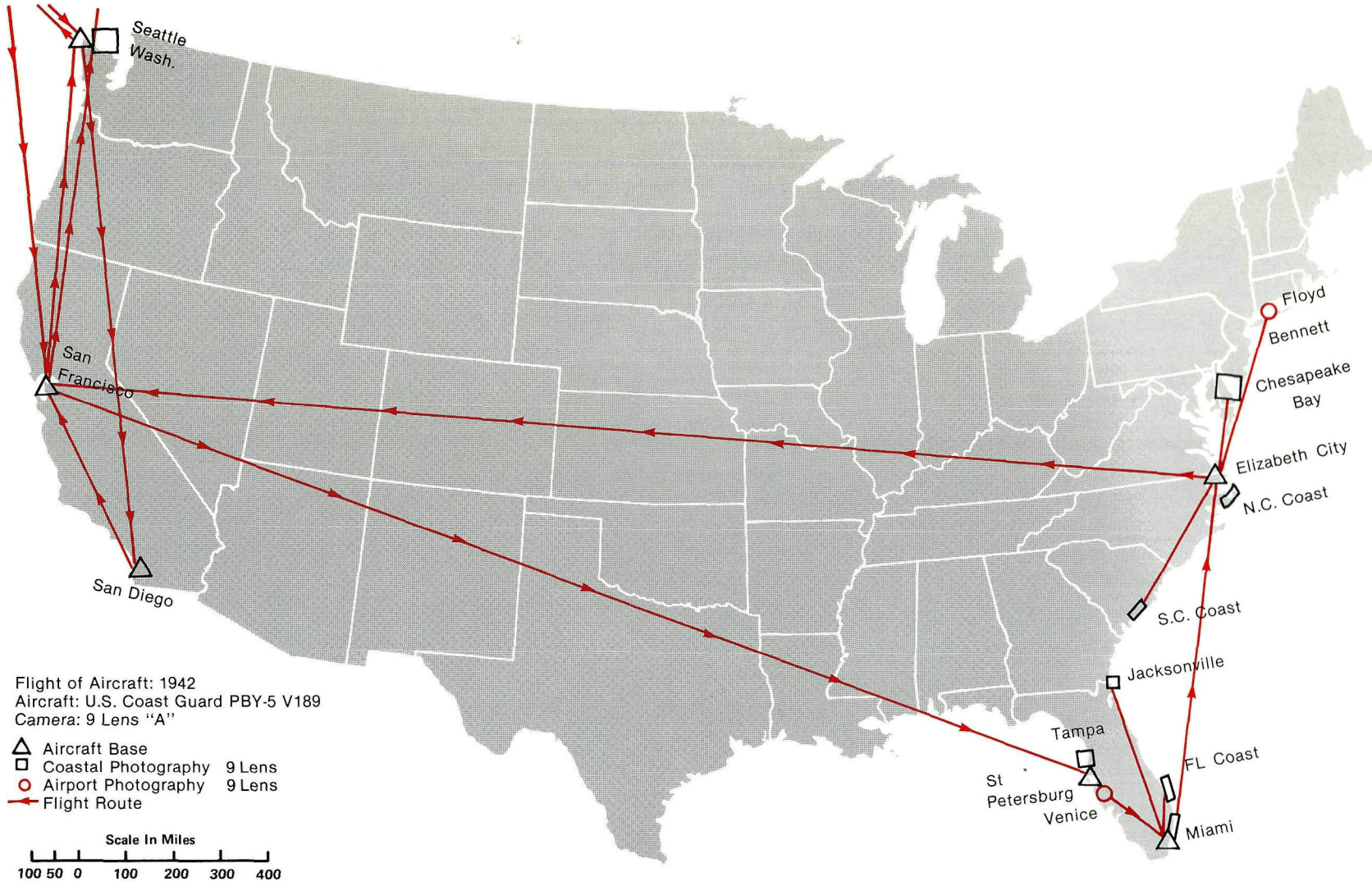

New York
Vermont
Massachusetts
Albany
Boston
Cape Cod
Ohio
New York
New Jersey
Akron
Chesapeake Bay
Washington
Virginia
North Carolina
Oklahoma
Texas
Wilmington
Dallas
Jacksonville
Flight of Aircraft: 1938
Aircraft: U.S. Army B-10-B #34-30
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

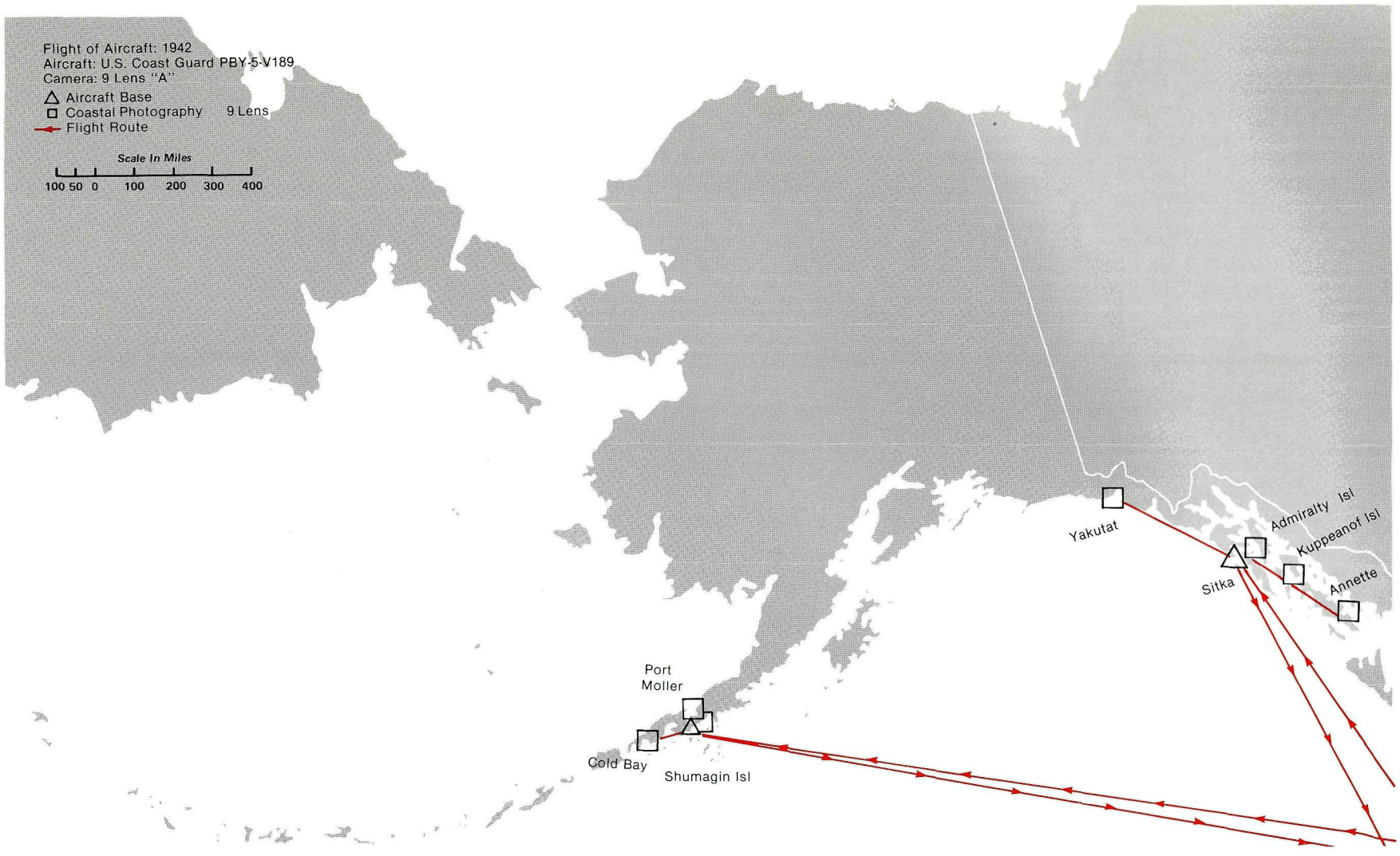

Boston
Washington D.C.
Ceder Key
St Petersburg
Ft Myers
Flight of Aircraft: 1939
Aircraft: U.S. Army B-10-B #34-30
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

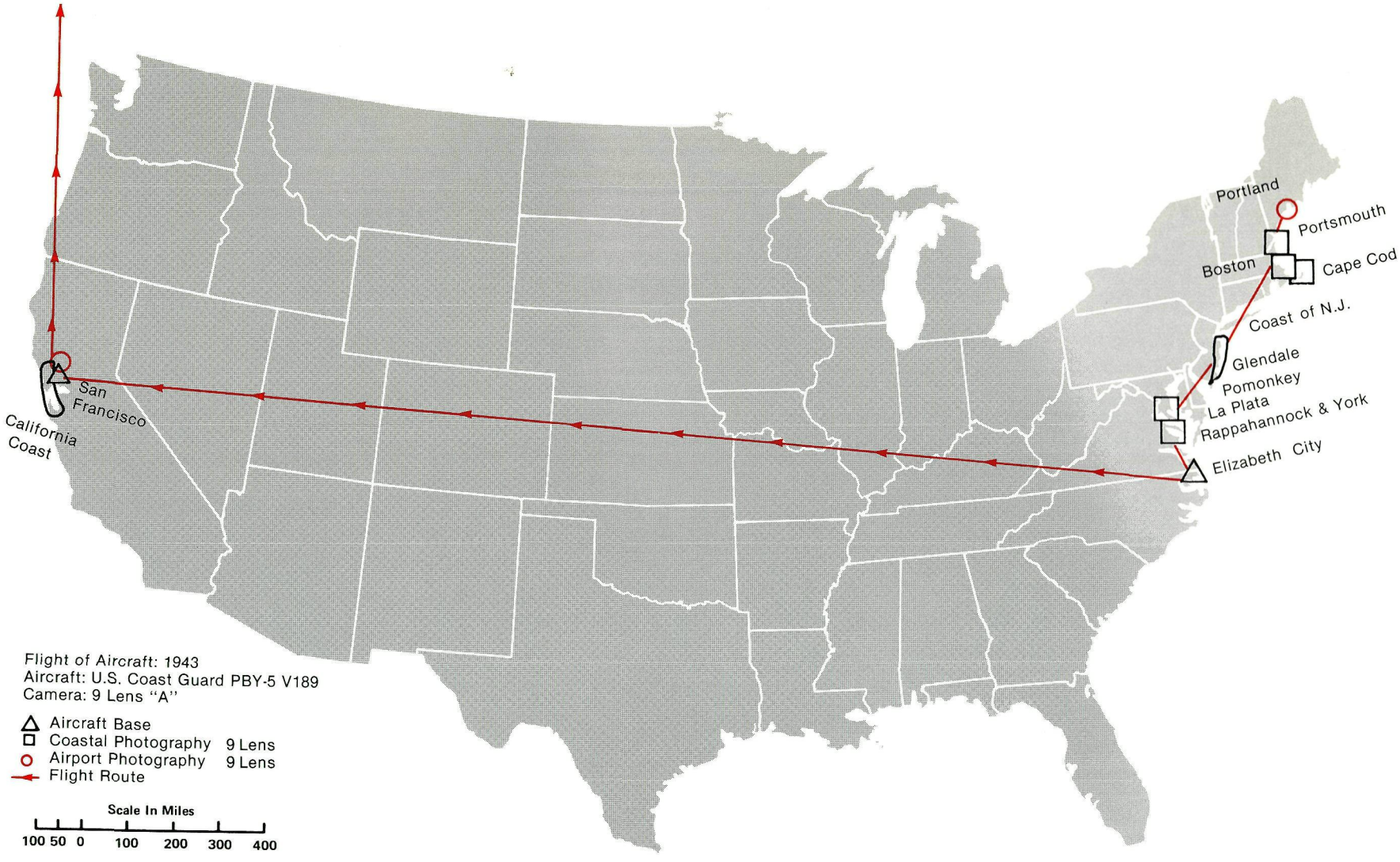

New York City
Chesapeake Bay
Washington D.C.
Potomac River
Norfolk VA
St Marks
Ceder Key
St Petersburg
Lake Okeechobee
Ft Myers
Flight of Aircraft: 1940
Aircraft: U.S. Army B-10-B #54
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

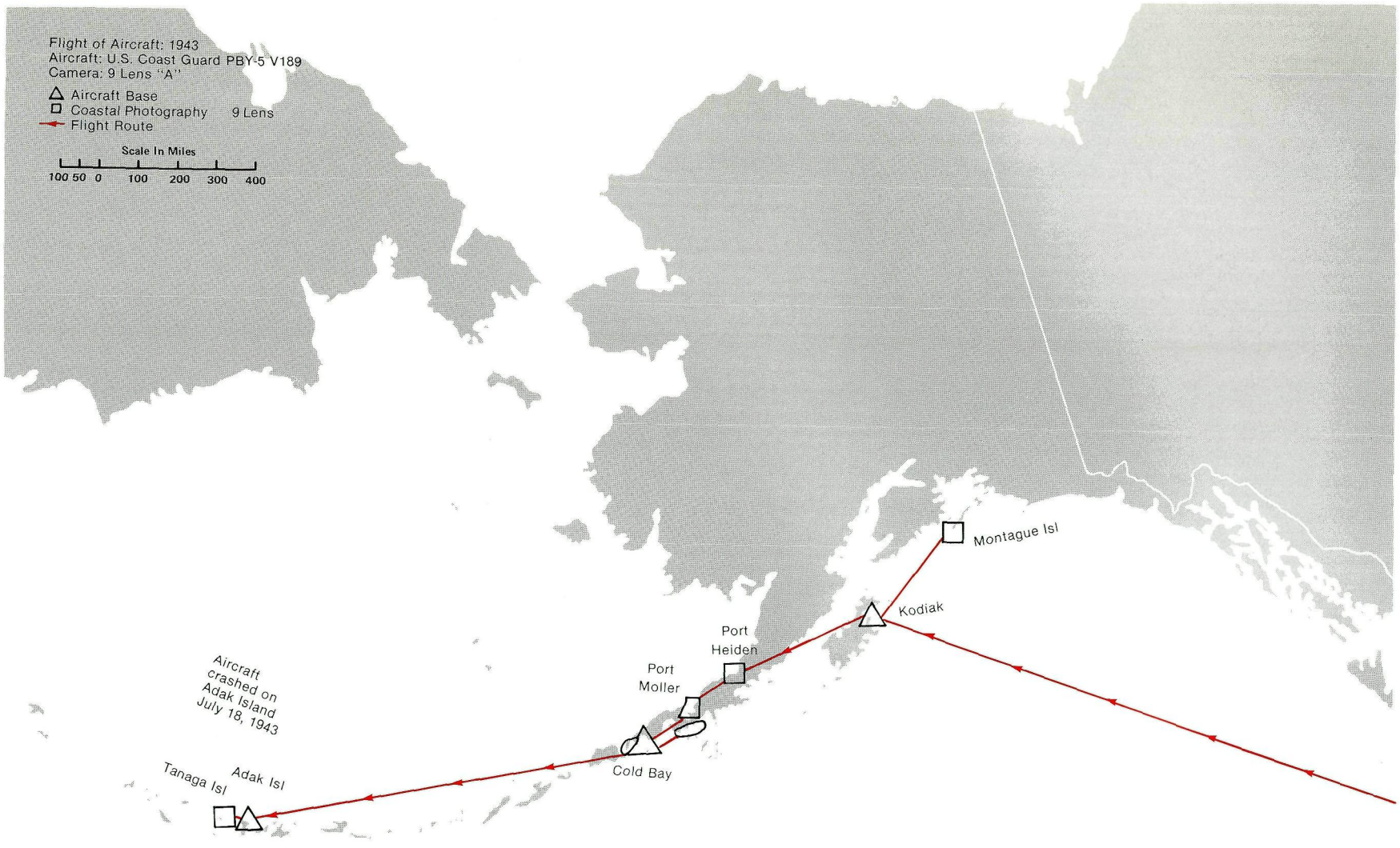

Return from Kodiak Alaska
To Sitka Alaska
San Francisco
Oakland & San Francisco
Los Angeles
Long Beach
San Diego
Tucson AR
Wink TEX
El Paso TEX
Savannah GA
Charleston SC
Murrells Inlet to Parris Isl
James River
Norfolk VA
Elizabeth City NC
Baltimore MD
Washington D.C.
Bridgeport
Hartford
Salem MA
Flight of Aircraft: 1941
Aircraft: U.S. Coast Guard PBY-5 V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Airport Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

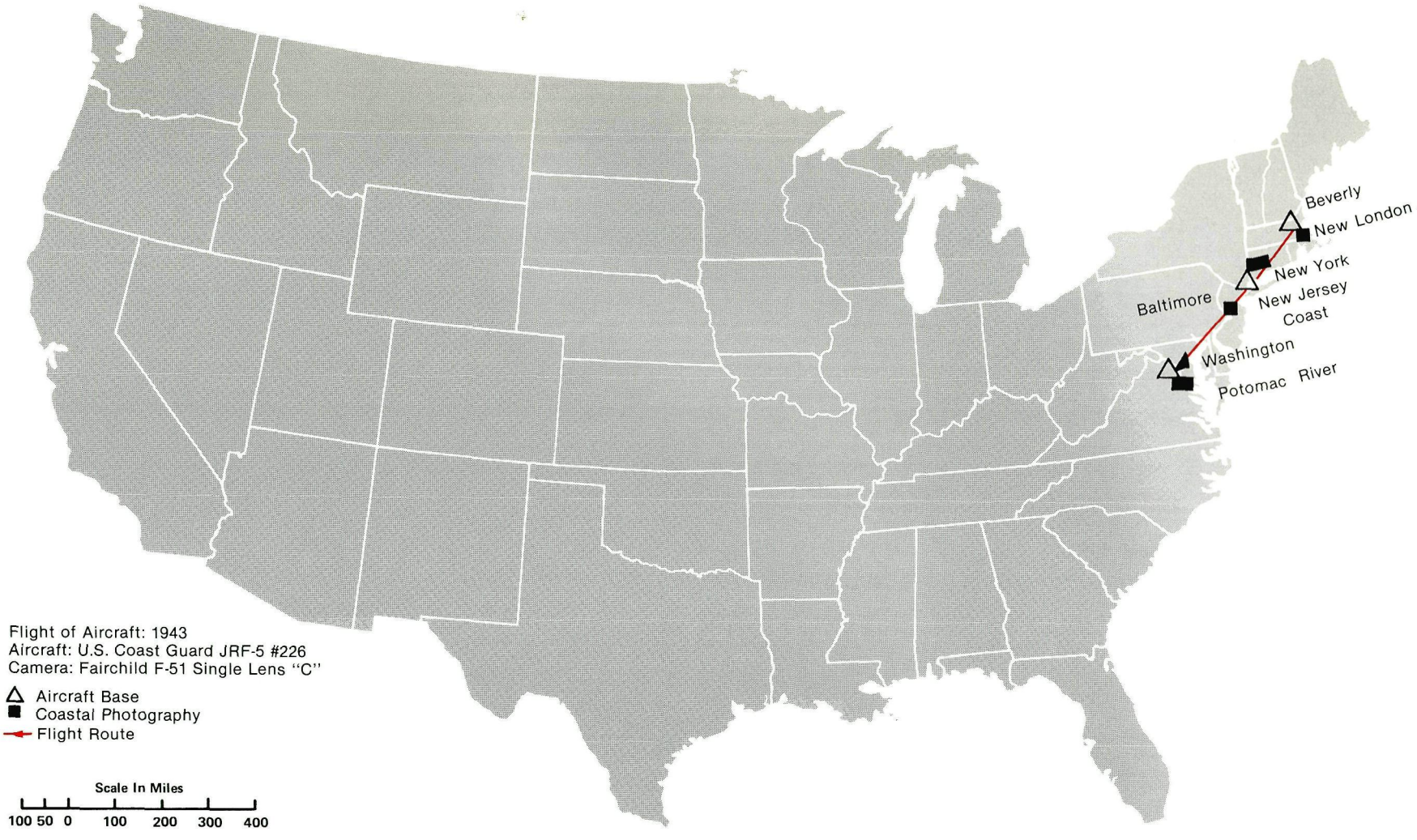

Flight of Aircraft: 1941
Aircraft: U.S. Coast Guard PBY-5 V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Yakutat
Sitka
Raspberry Isl
Spruce Isl
Kodiak
Cold Bay
Semidi Isl
Dutch Harbor
Paul Isl

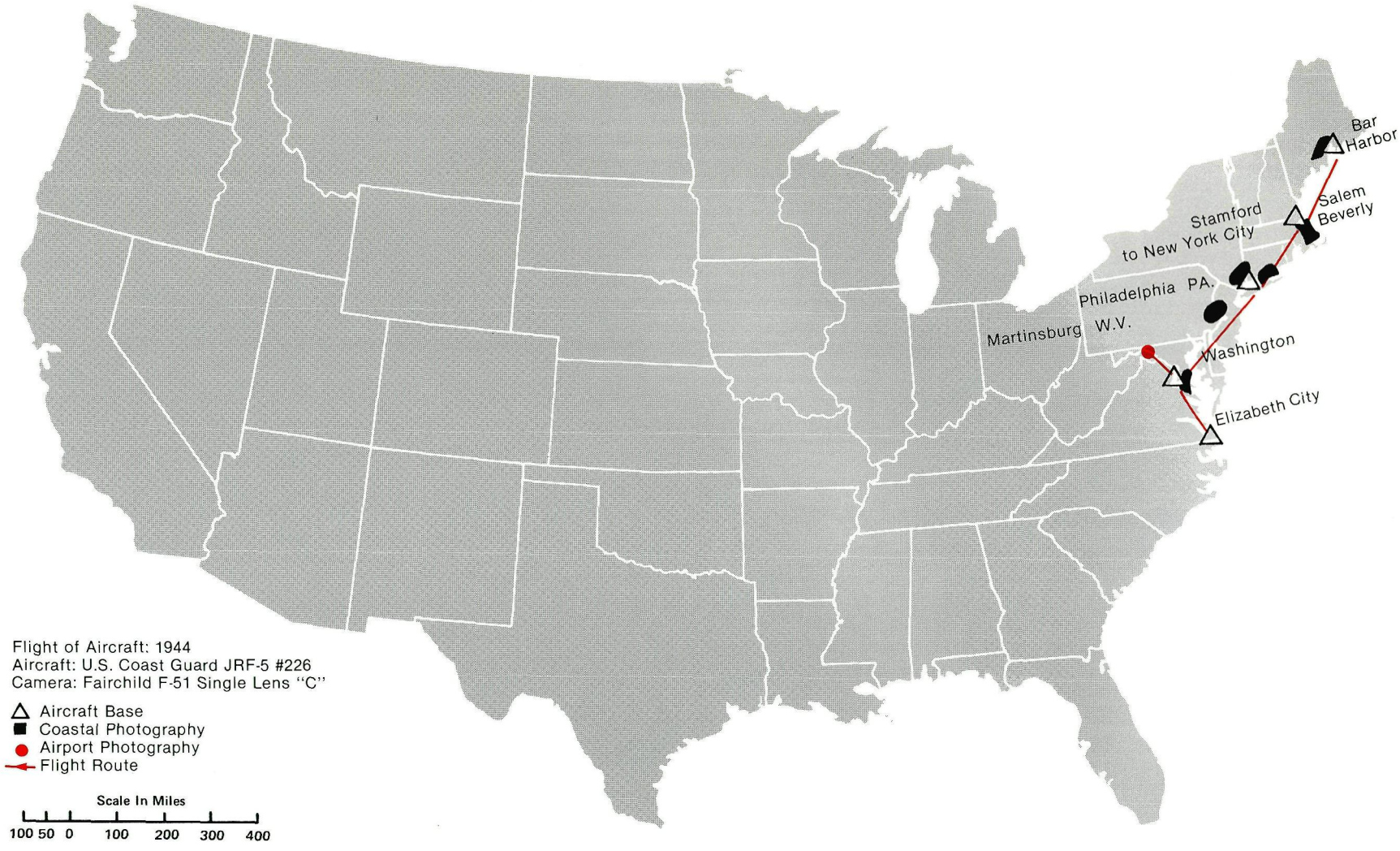

Seattle
Wash.
San
Francisco
San Diego
Floyd
Bennett
Chesapeake
Bay
Elizabeth City
N.C. Coast
S.C. Coast
Jacksonville
Tampa
St
Petersburg
Venice
FL Coast
Miami
Flight of Aircraft: 1942
Aircraft: U.S. Coast Guard PBY-5 V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Airport Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

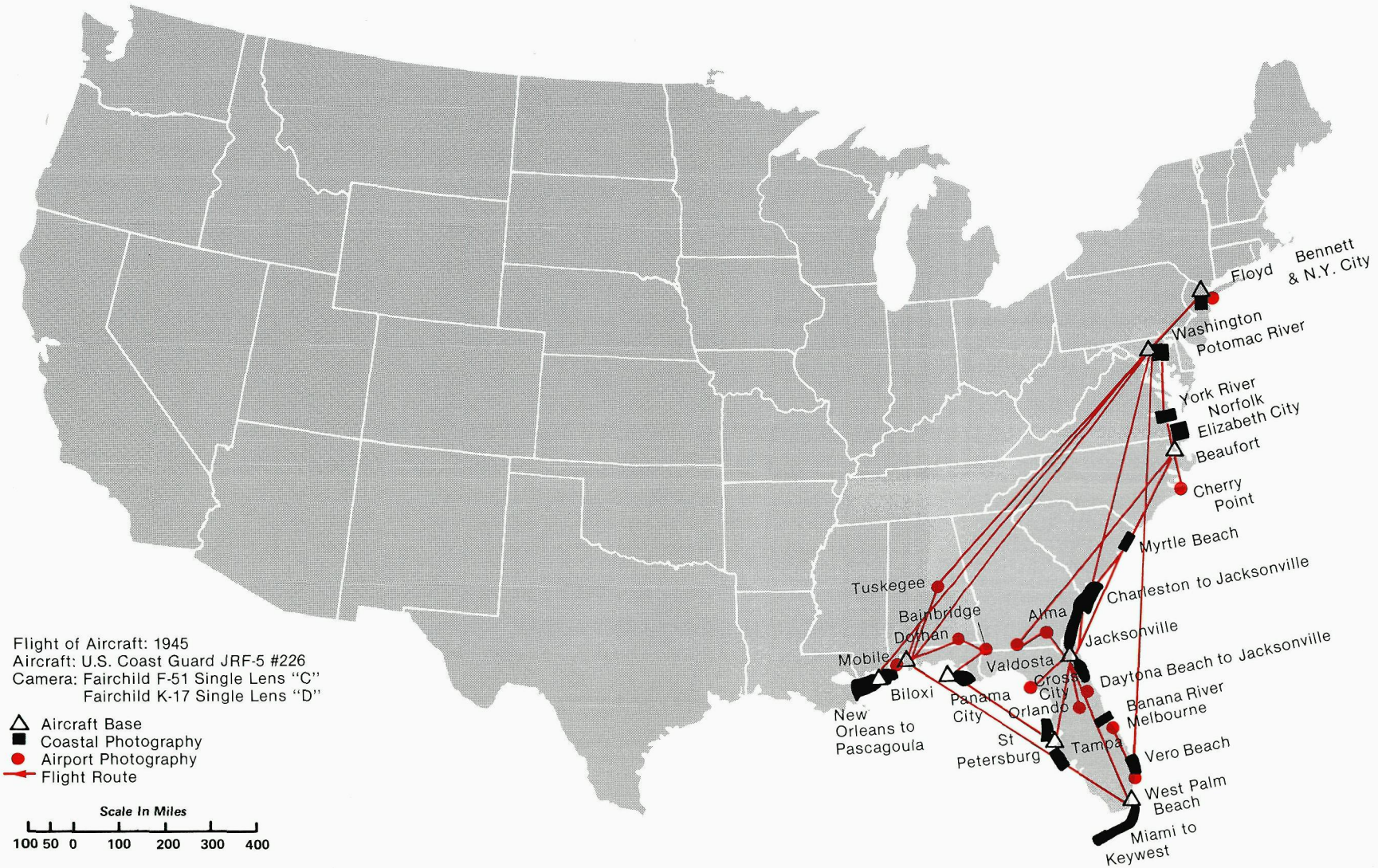

Flight of Aircraft: 1942
Aircraft: U.S. Coast Guard PBY-5-V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Yakutat
Admiralty Isl
Kuppeanof Isl
Sitka
Annette
Port Moller
Cold Bay
Shumagin Isl

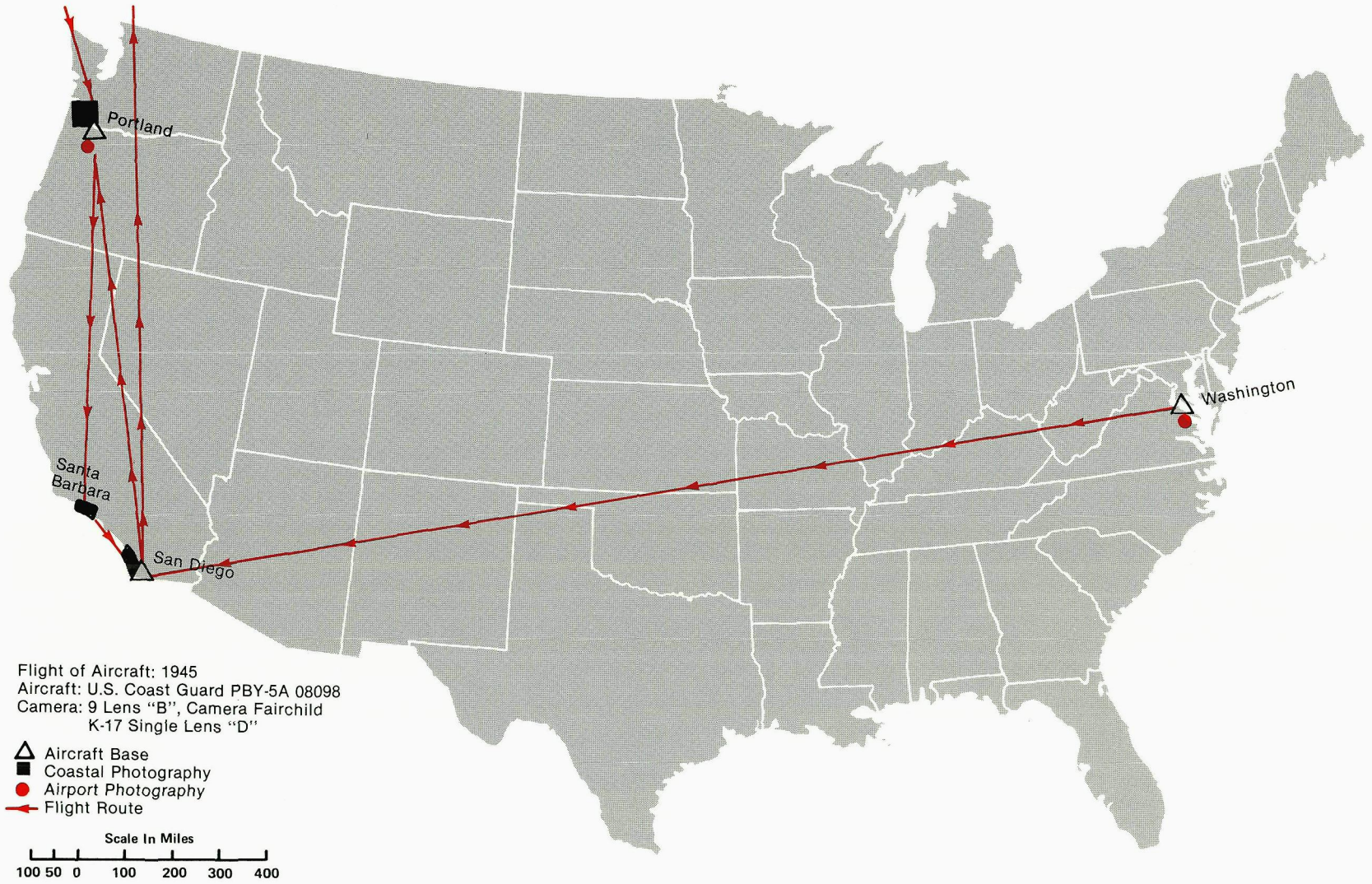

Portland
Portsmouth
Boston
Cape Cod
Coast of N.J.
Glendale
Pomonkey
La Plata
Rappahannock & York
Elizabeth City
San Francisco
California Coast
Flight of Aircraft: 1943
Aircraft: U.S. Coast Guard PBY-5 V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Airport Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

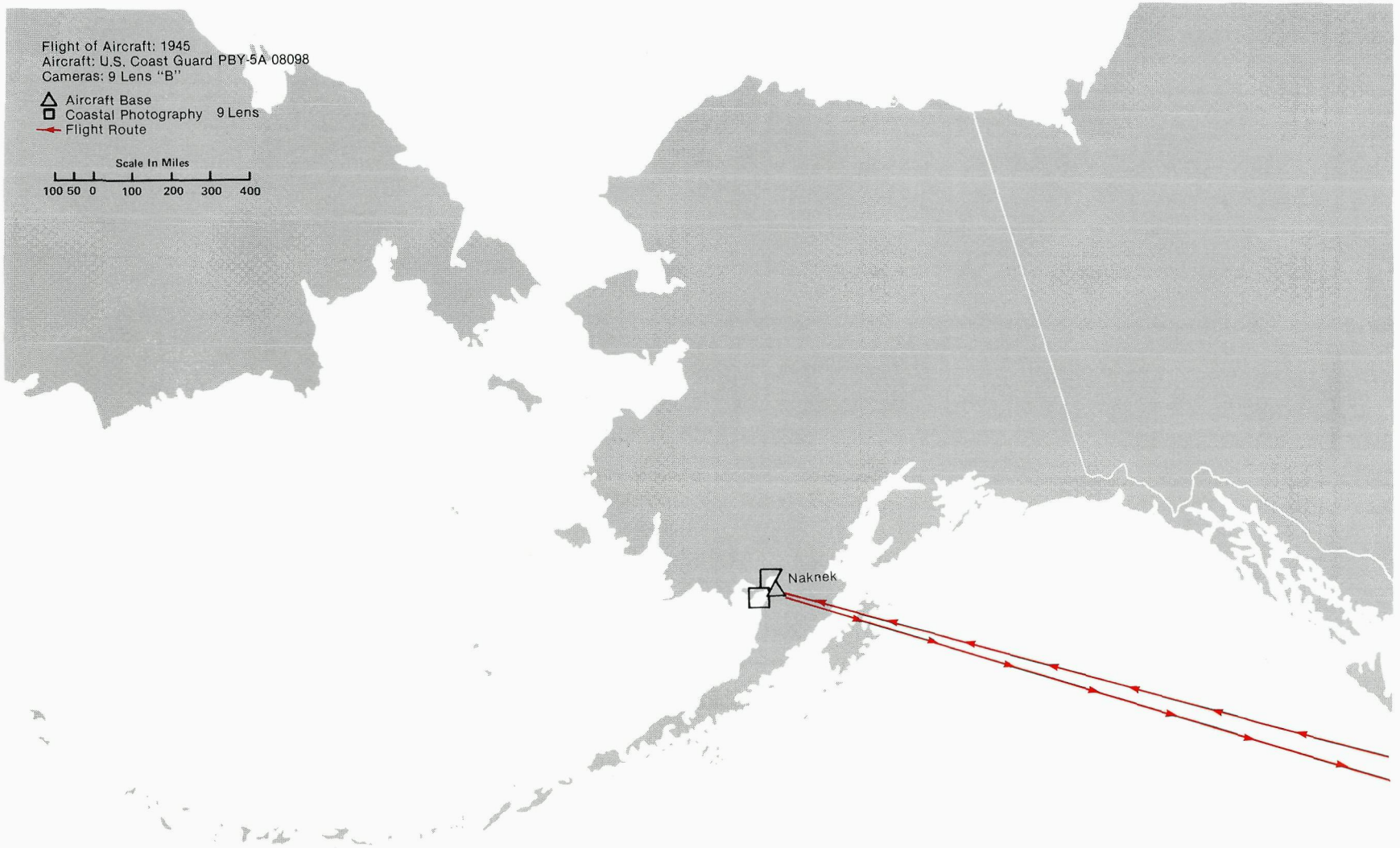

Flight of Aircraft: 1943
Aircraft: U.S. Coast Guard PBY-5 V189
Camera: 9 Lens "A"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Montague Isl
Kodiak
Port Heiden
Port Moller
Cold Bay
Aircraft crashed on Adak Island July 18, 1943
Adak Isl
Tanaga Isl


Beverly
New London
New York
New Jersey
Coast
Baltimore
Washington
Potomac River
Flight of Aircraft: 1943
Aircraft: U.S. Coast Guard JRF-5 #226
Camera: Fairchild F-51 Single Lens "C"
Aircraft Base
Coastal Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

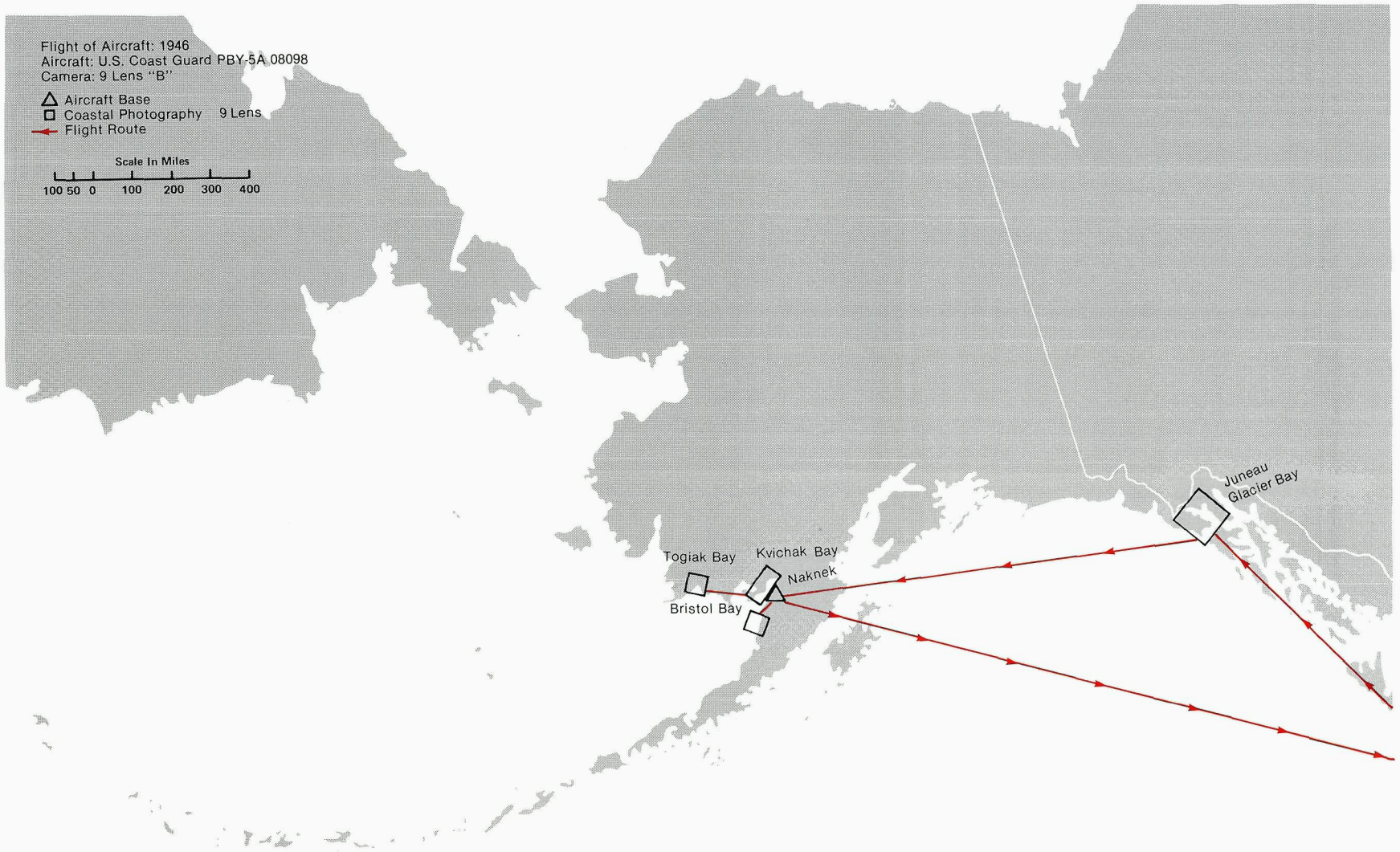

Bar Harbor
Salem
Beverly
Stamford
to New York City
Philadelphia PA.
Martinsburg W.V.
Washington
Elizabeth City
Flight of Aircraft: 1944
Aircraft: U.S. Coast Guard JRF-5 #226
Camera: Fairchild F-51 Single Lens "C"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

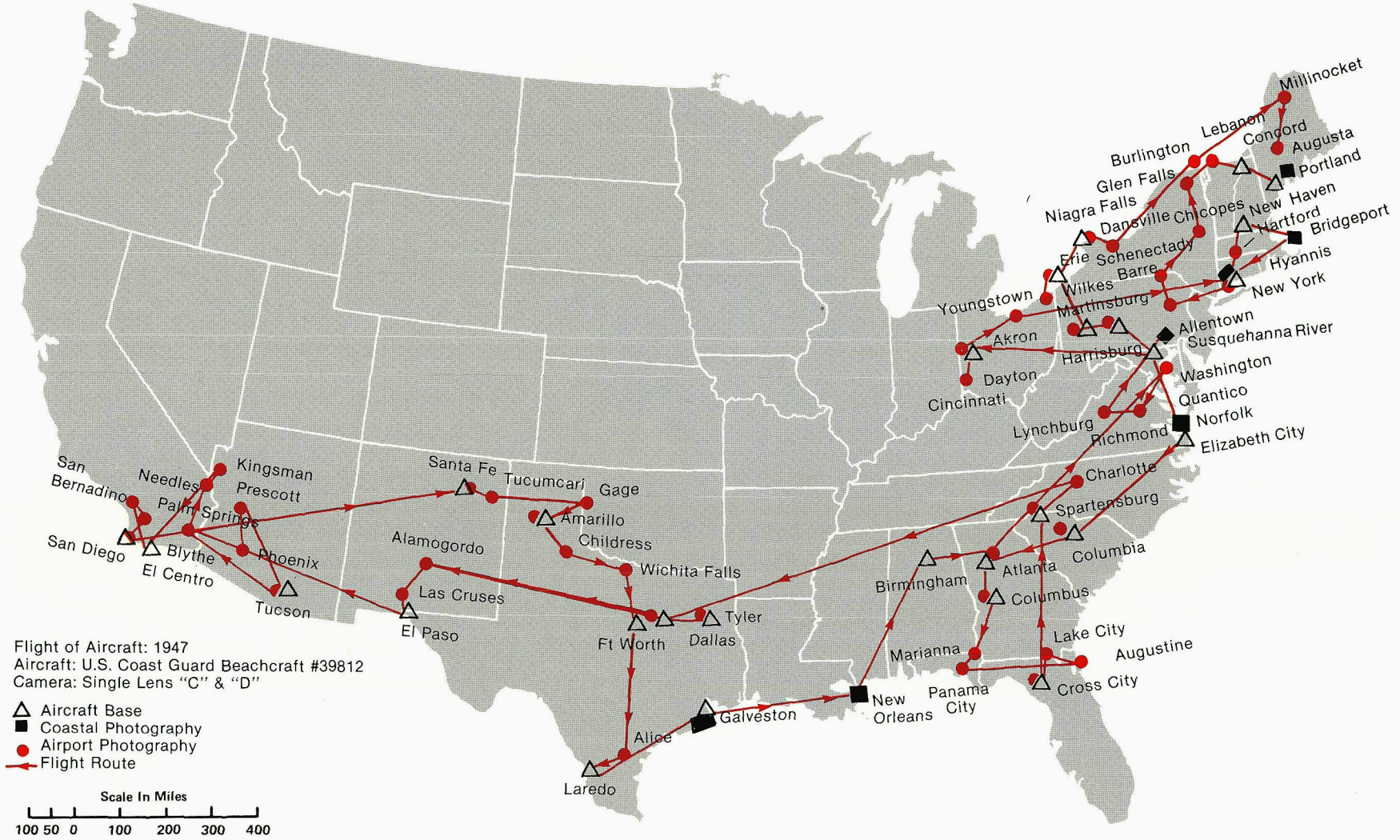

Floyd
Bennett & N.Y. City
Washington
Potomac River
York River
Norfolk
Elizabeth City
Beaufort
Cherry Point
Myrtle Beach
Charleston to Jacksonville
Jacksonville
Daytona Beach to Jacksonville
Banana River
Melbourne
Vero Beach
West Palm Beach
Miami to Keywest
Tuskegee
Bainbridge
Dothan
Alma
Mobile
Valdosta
Cross City
Biloxi
Panama City
Orlando
New Orleans to Pascagoula
St Petersburg
Tampa
Flight of Aircraft: 1945
Aircraft: U.S. Coast Guard JRF-5 #226
Camera: Fairchild F-51 Single Lens "C"
Fairchild K-17 Single Lens "D"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

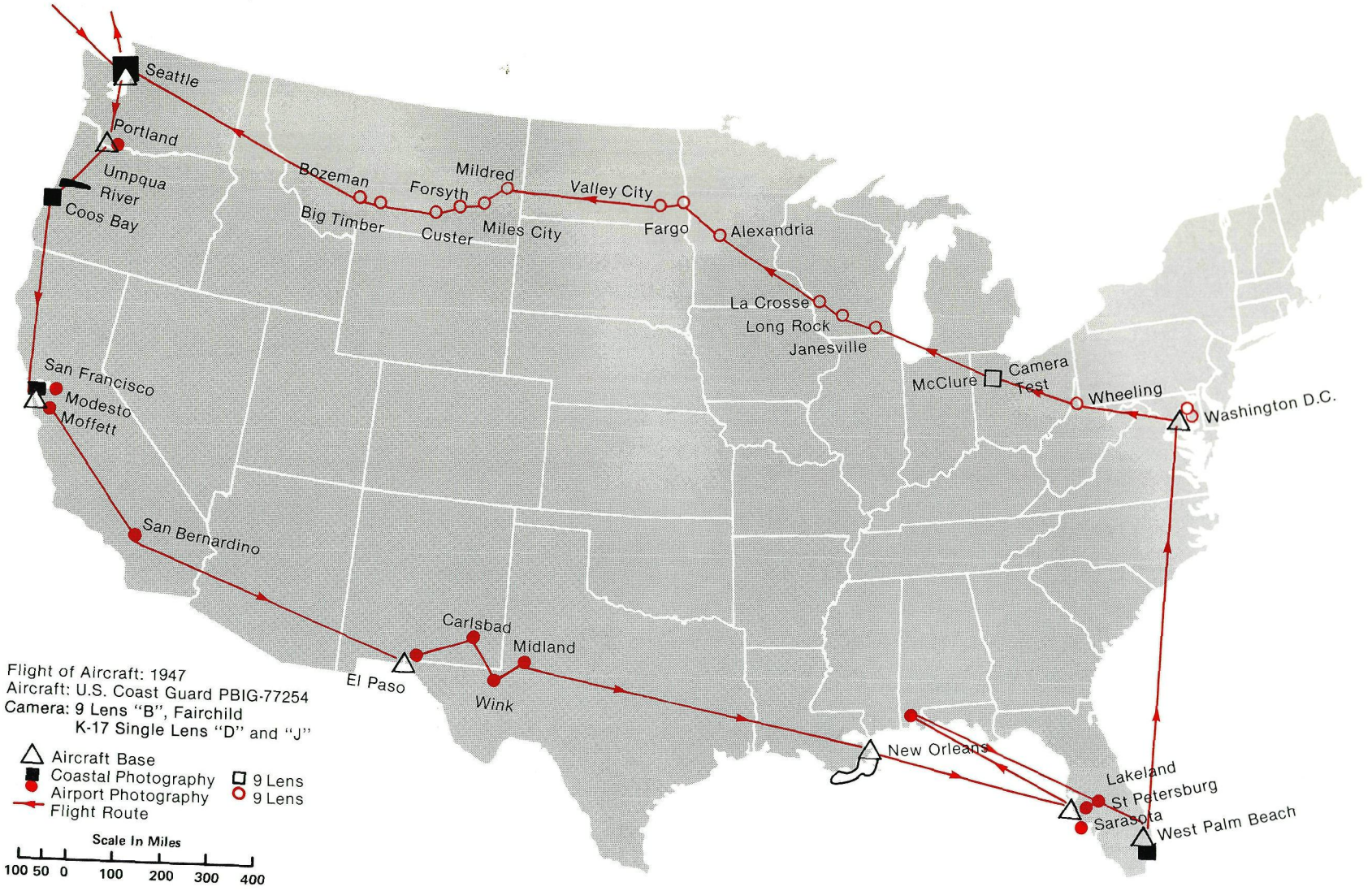

Portland
Santa Barbara
San Diego
Washington
Flight of Aircraft: 1945
Aircraft: U.S. Coast Guard PBY-5A 08098
Camera: 9 Lens "B", Camera Fairchild
K-17 Single Lens "D"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

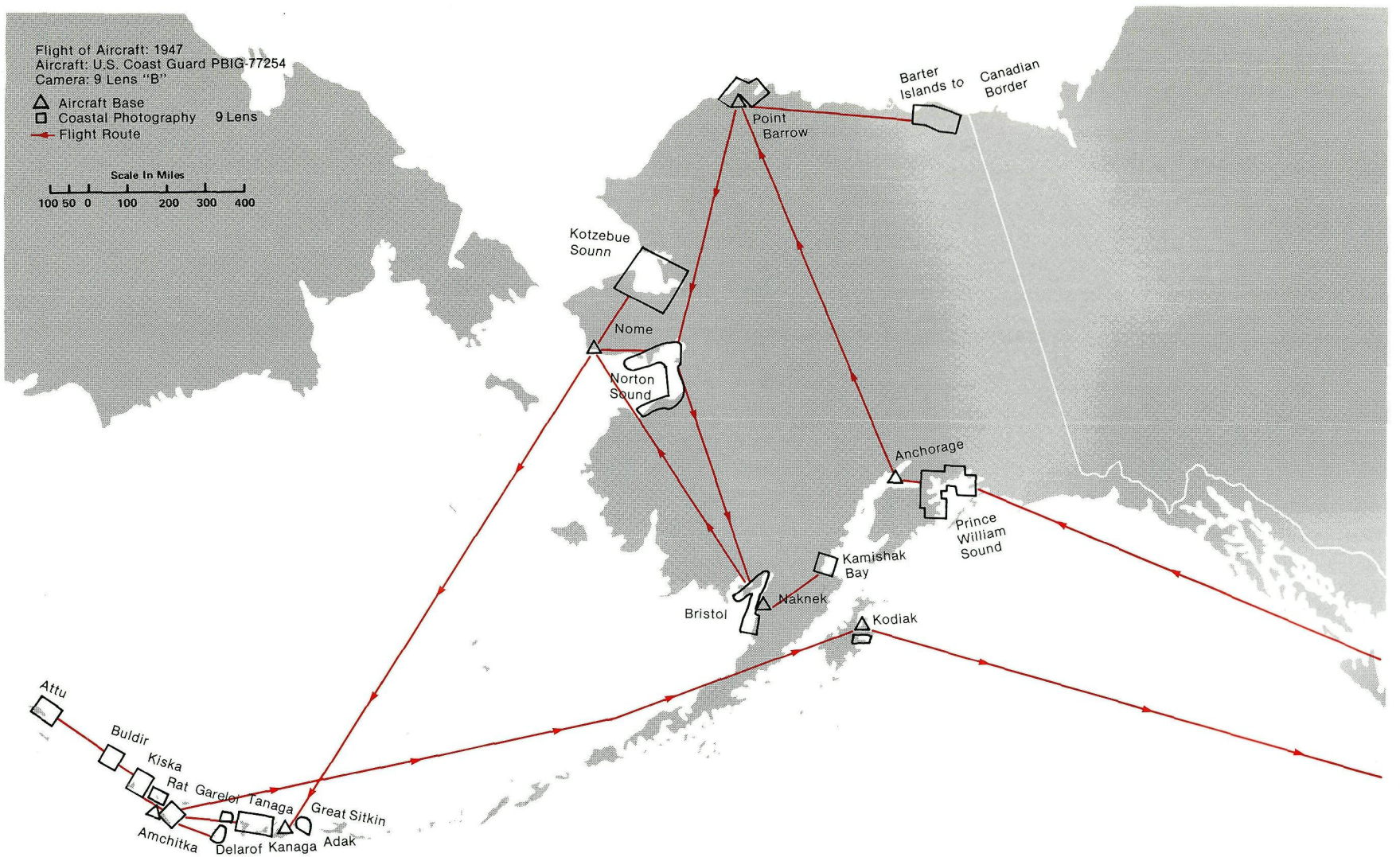

Flight of Aircraft: 1945
Aircraft: U.S. Coast Guard PBY-5A 08098
Cameras: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Naknek

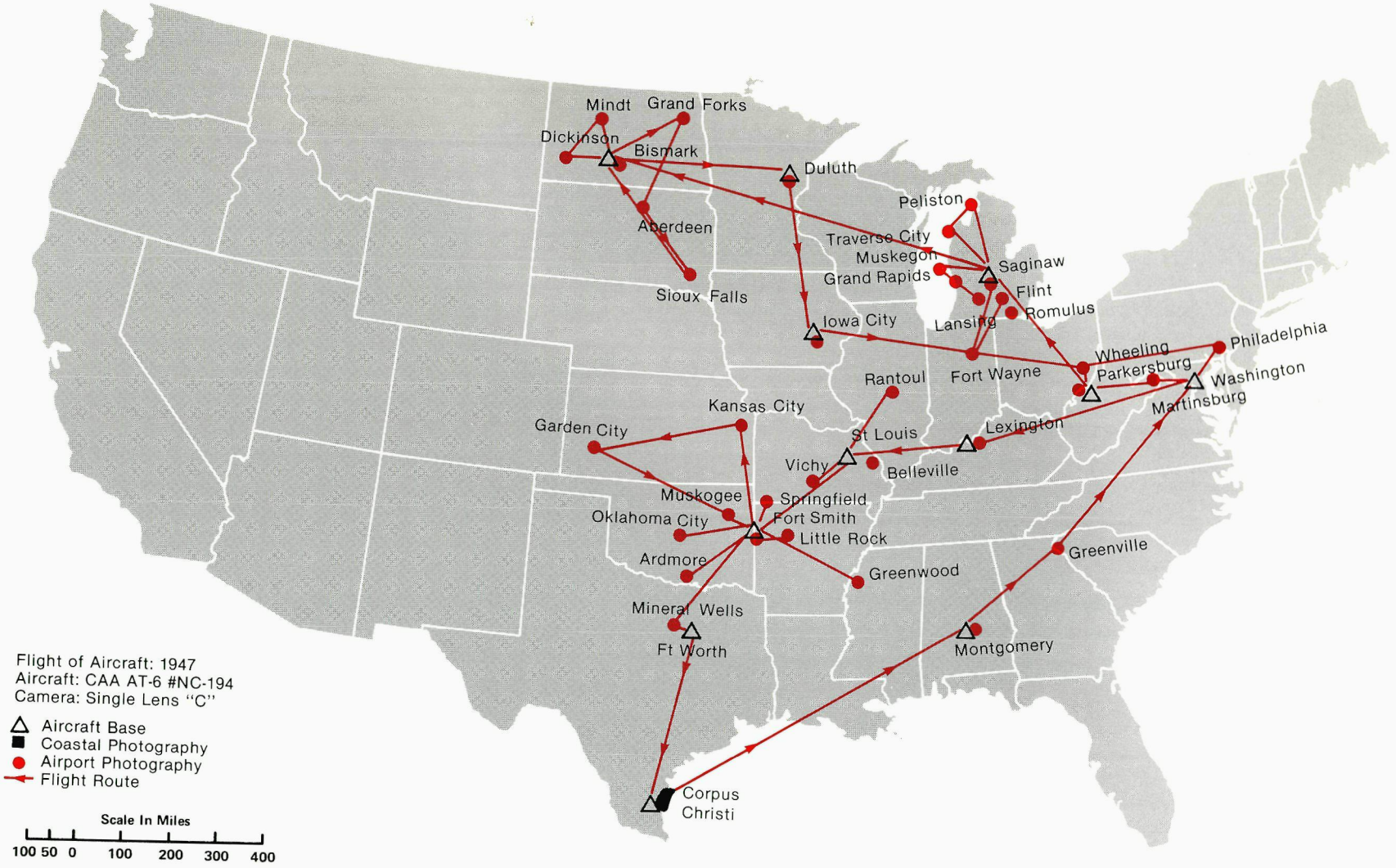

San Juan Isl
Bellingham
Seattle
Yakima
Spokane
Toledo
Walla Walla
Grate Falls
Helena
Lewiston
Butte
Billings
Salem
Eugene
Medford
Idaho Falls
West Yellowstone
Sheridan
Pocatello
Spearfish
Rapid City
Pierre
Watertown
Huron
St Paul
Red Bluff
Reno
Elko
Ogden
Wendover
Salt Lake City
Cheyenne
North Platte
Omaha
Sioux City
Madison
Milwaukee
Chicago
Toledo
Detroit
Cleveland
Buffalo
Albany
Rochester
Williamsport
Hartford
Brunswick
Pittsburgh
Harrisburg
Philadelphia
Akron
Bend
Burlington
Des Moines
South
Sacramento
Stockton
Monterey
Salinas
Visalia
Santa Barbara
Los Angeles
San Diego
Las Vegas
Boulder City & Dam
Grand Canyon
Winslow
Dughlas
Roswell
Albuquerque
Denver
Colorado Springs
Las Vegas
Amarillo
Lubbock
Big Spring
Midland
Abilene
San Angelo
Eldorado
Austin
San Antonio
Laredo
Corpus Christi
Brownsville
Lincoln
St Joseph
Kansas City
Topeka
Hutchinson
Witchita
Joplin
Dodge City
Tulsa
Ponca
Moskogee
Waco
Temple
Texarkana
Shreveport
Monroe
Beaumont
Lake Charles
Baton Rouge
Houston
New Orleans
Meridian
Mobile
Montgomery
Dothan
Macon
Albany
Atlanta
Tallahassee
Savannah
Brunswick
Daytona
Melbourne
Vero Beach
Florida Coast
Miami
Ft Myers
Augusta
Columbia
Raleigh
N.C. Coast
Elizabeth City
Winston Salem
Greensboro
Kingsport
Knoxville
Chattanooga
Paducah
Evansville
Louisville
Columbus
Cincinnati
Dayton
Terre Haute
Peoria
Ft Wayne
Morgantown
Elkins
Clarksburg
Chop Tank River
Washington
Flight of Aircraft: 1946
Aircraft: U.S. Coast Guard PBY-5A 08098
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Airport Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

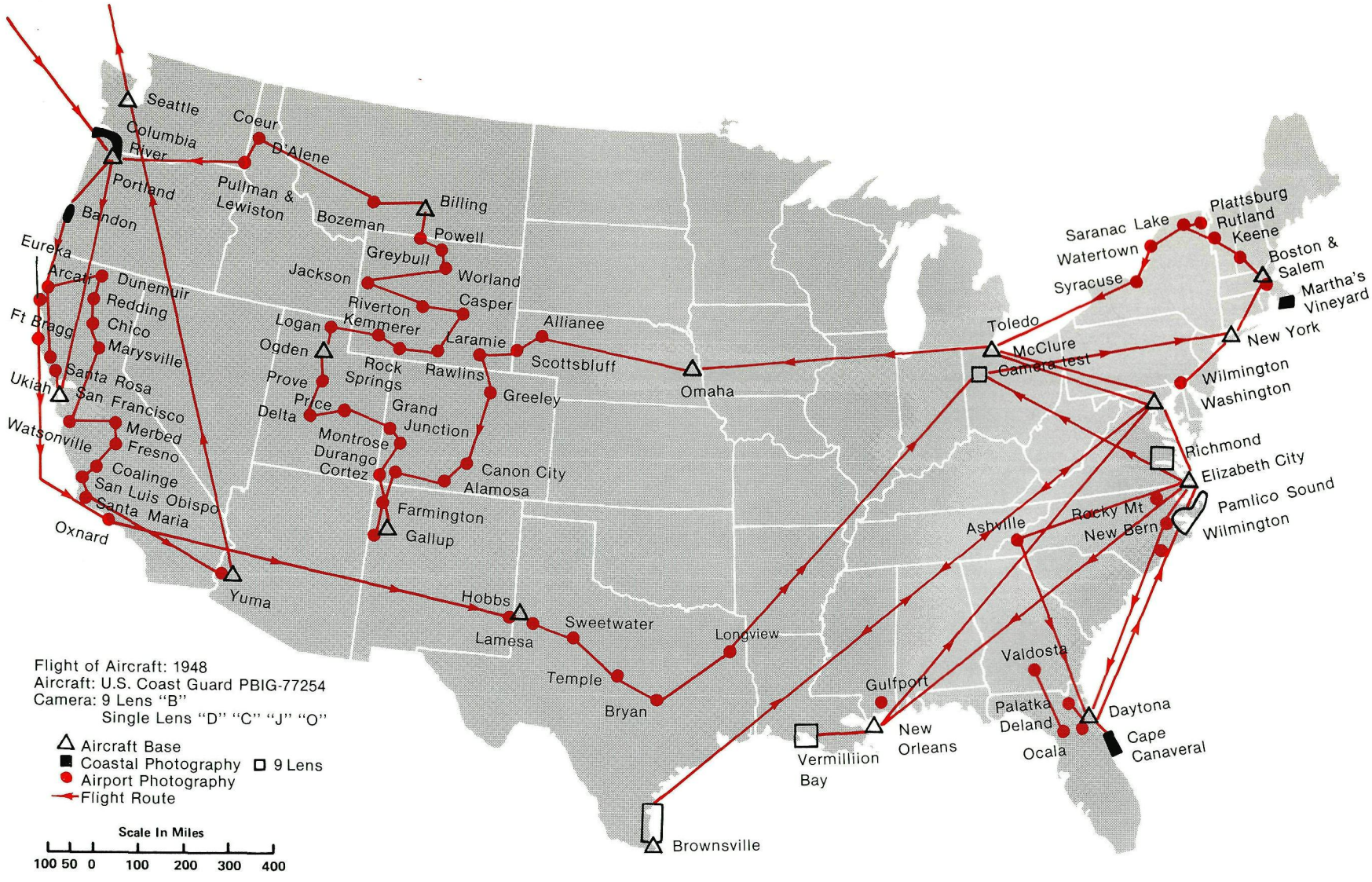

Flight of Aircraft: 1946
Aircraft: U.S. Coast Guard PBY-5A 08098
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Juneau
Glacier Bay
Togiak Bay
Kvichak Bay
Naknek
Bristol Bay


Millinocket
Lebanon
Concord
Augusta
Burlington
Portland
Glen Falls
Niagra Falls
Danville
Chicopes
New Haven
Hartford
Bridgeport
Erie
Schenectady
Hyannis
Wilkes Barre
New York
Youngstown
Martinsburg
Allentown
Akron
Susquehanna River
Harrisburg
Washington
Dayton
Cincinnati
Quantico
Lynchburg
Norfolk
Richmond
Elizabeth City
Charlotte
Spartensburg
Columbia
Birmingham
Atlanta
Columbus
Lake City
Augustine
Marianna
Panama City
Cross City
New Orleans
Galveston
Alice
Laredo
Ft Worth
Dallas
Tyler
Wichita Falls
Childress
Amarillo
Gage
Tucumcari
Santa Fe
Alamogordo
Las Cruses
El Paso
Tucson
Phoenix
Blythe
El Centro
San Diego
Palm Springs
Prescott
Kingsman
Needles
San Bernadino
Flight of Aircraft: 1947
Aircraft: U.S. Coast Guard Beachcraft #39812
Camera: Single Lens "C" & "D"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Seattle
Portland
Umpqua River
Coos Bay
Bozeman
Big Timber
Forsyth
Custer
Mildred
Miles City
Valley City
Fargo
Alexandria
La Crosse
Long Rock
Janesville
McClure
Camera Test
Wheeling
Washington D.C.
San Francisco
Modesto
Moffett
San Bernardino
Carlsbad
Midland
El Paso
Wink
New Orleans
Lakeland
St Petersburg
Sarasota
West Palm Beach
Flight of Aircraft: 1947
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B", Fairchild
K-17 Single Lens "D" and "J"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
9 Lens
9 Lens
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1947
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Barter Islands to Canadian Border
Point Barrow
Kotzebue Sounn
Nome
Norton Sound
Anchorage
Prince William Sound
Kamishak Bay
Naknek
Bristol
Kodiak
Attu
Buldir
Kiska
Rat
Garelol
Tanaga
Great Sitkin
Amchitka
Delarof
Kanaga
Adak


Mindt
Grand Forks
Dickinson
Bismark
Duluth
Peliston
Aberdeen
Traverse City
Muskegon
Saginaw
Grand Rapids
Flint
Sioux Falls
Romulus
Iowa City
Lansing
Wheeling
Philadelphia
Fort Wayne
Parkersburg
Washington
Rantoul
Martinsburg
Kansas City
Garden City
St Louis
Lexington
Vichy
Belleville
Muskogee
Springfield
Oklahoma City
Fort Smith
Little Rock
Greenville
Ardmore
Greenwood
Mineral Wells
Ft Worth
Montgomery
Corpus
Christi
Flight of Aircraft: 1947
Aircraft: CAA AT-6 #NC-194
Camera: Single Lens "C"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400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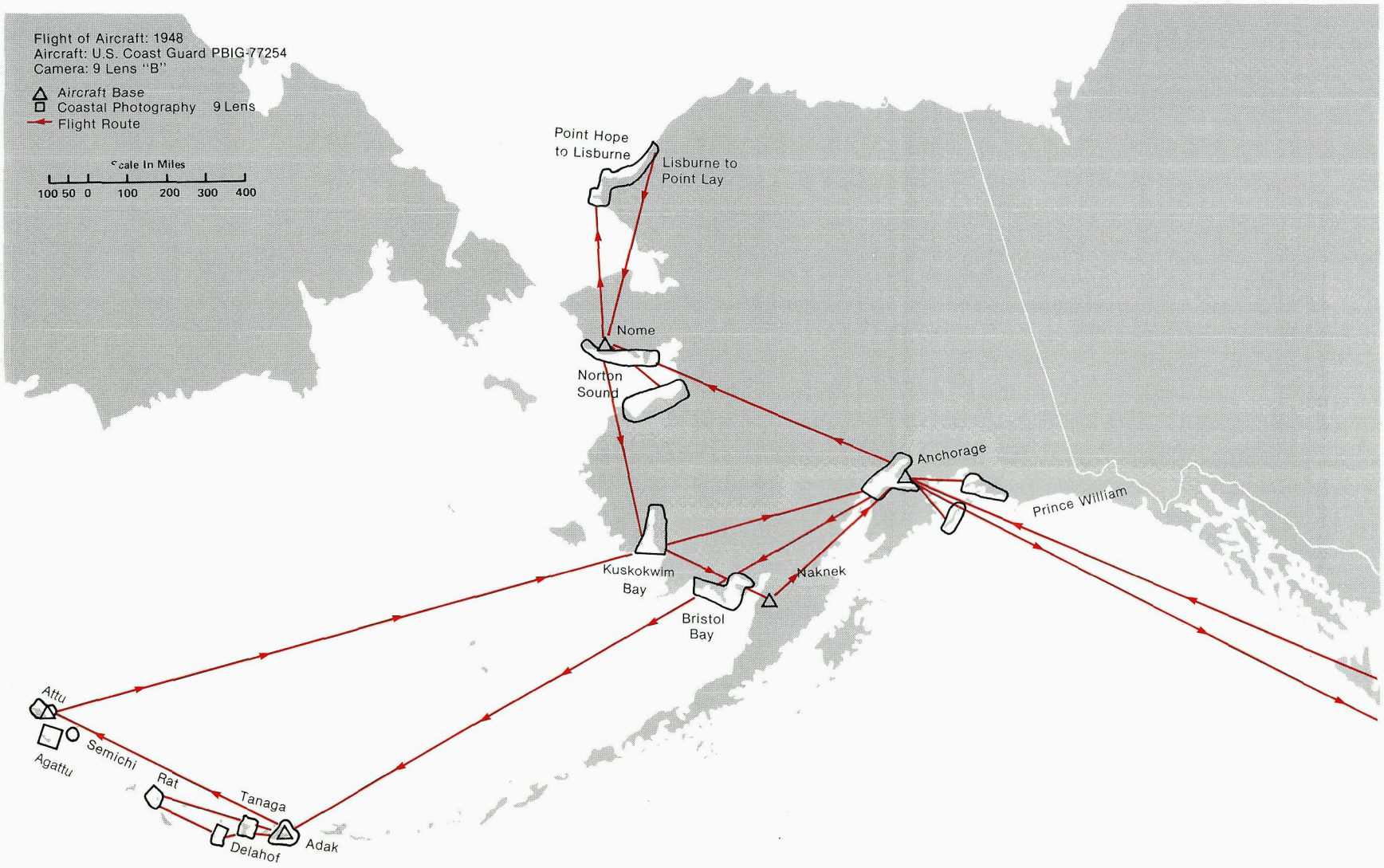
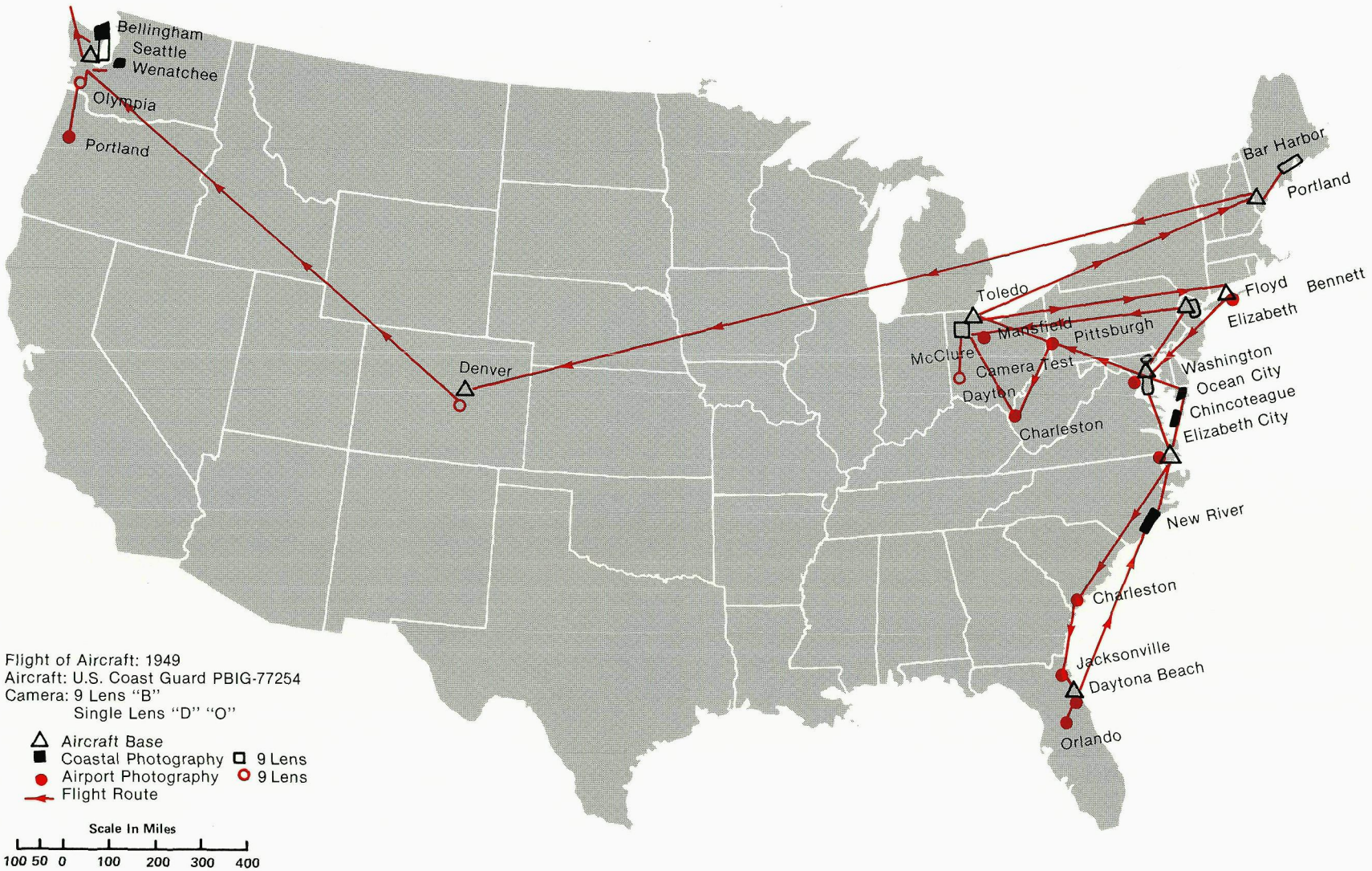
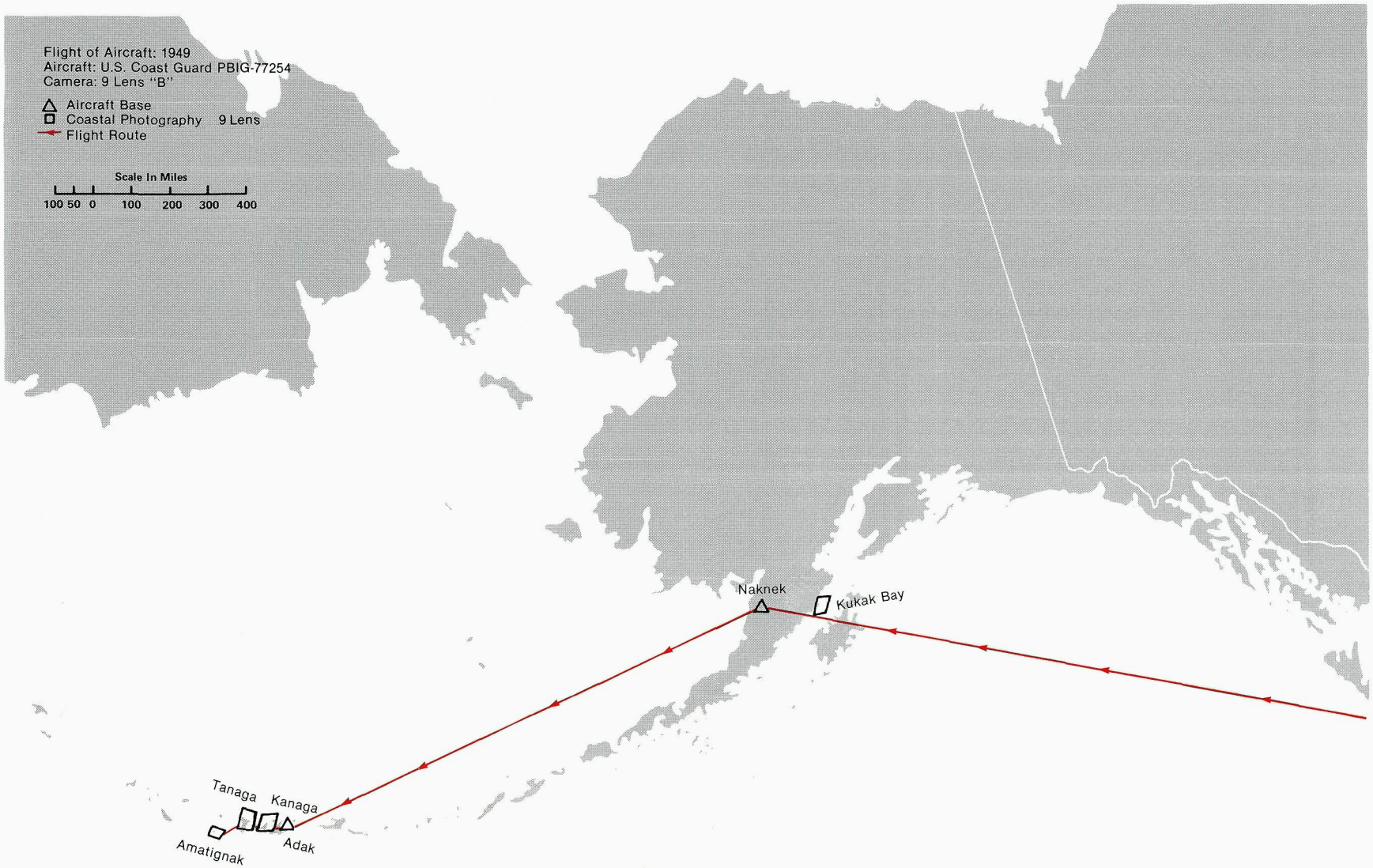
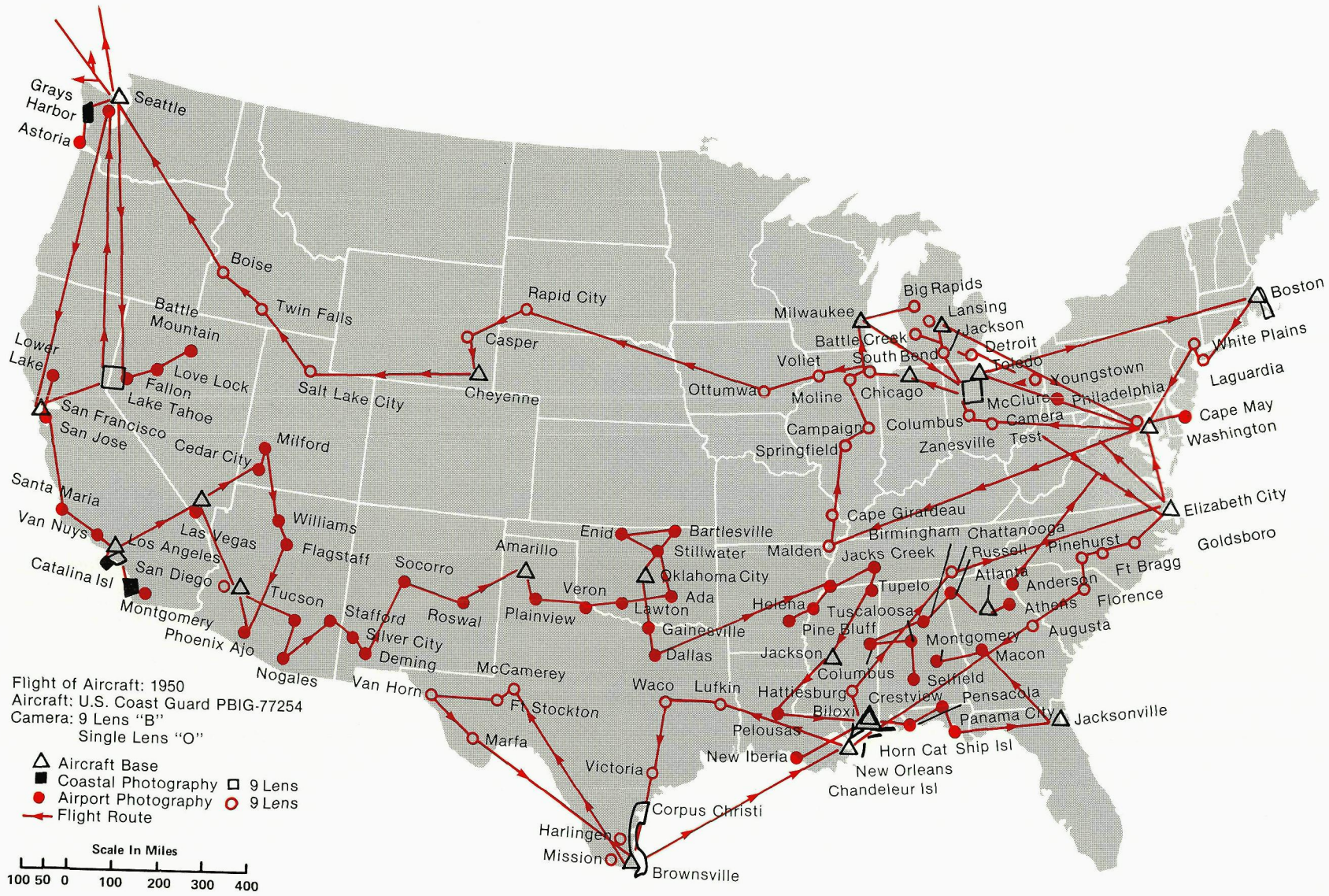
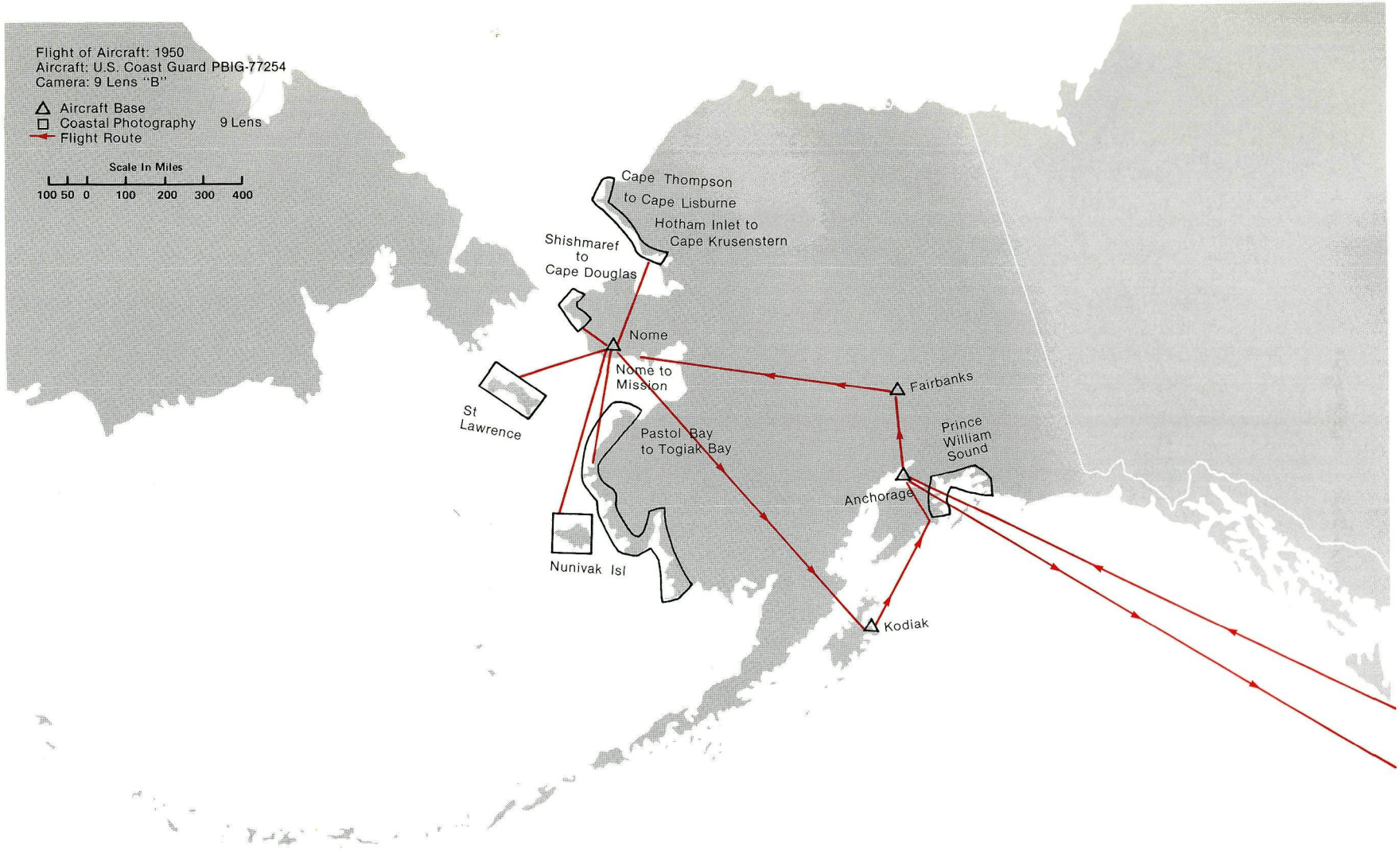
Columbia River
Portland
Coeur D'Alene
Pullman & Lewiston
Billing
Bozeman
Powell
Greybull
Jackson
Worland
Riverton
Casper
Logan
Kemmerer
Laramie
Allianee
Ogden
Rock Springs
Rawlins
Scottsbluff
Prove
Price
Grand Junction
Greeley
Delta
Montrose
Durango
Cortez
Canon City
Alamosa
Farmington
Gallup
Omaha
Bandon
Eureka
Arcata
Dunemuir
Redding
Chico
Marysville
Ft Bragg
Santa Rosa
Ukiah
San Francisco
Merbed
Fresno
Watsonville
Coalinge
San Luis Obispo
Santa Maria
Oxnard
Yuma
Hobbs
Lamesa
Sweetwater
Temple
Bryan
Longview
Brownsville
Vermilliion Bay
Gulfport
New Orleans
Toledo
McClure
Camera test
Saranac Lake
Watertown
Syracuse
Plattsburg
Rutland
Keene
Boston & Salem
Martha's Vineyard
New York
Wilmington
Washington
Richmond
Elizabeth City
Pamlico Sound
Wilmington
Rocky Mt
New Bern
Ashville
Valdosta
Palatka
Deland
Ocala
Daytona
Cape Canaveral
Flight of Aircraft: 1948
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "D" "C" "J" "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

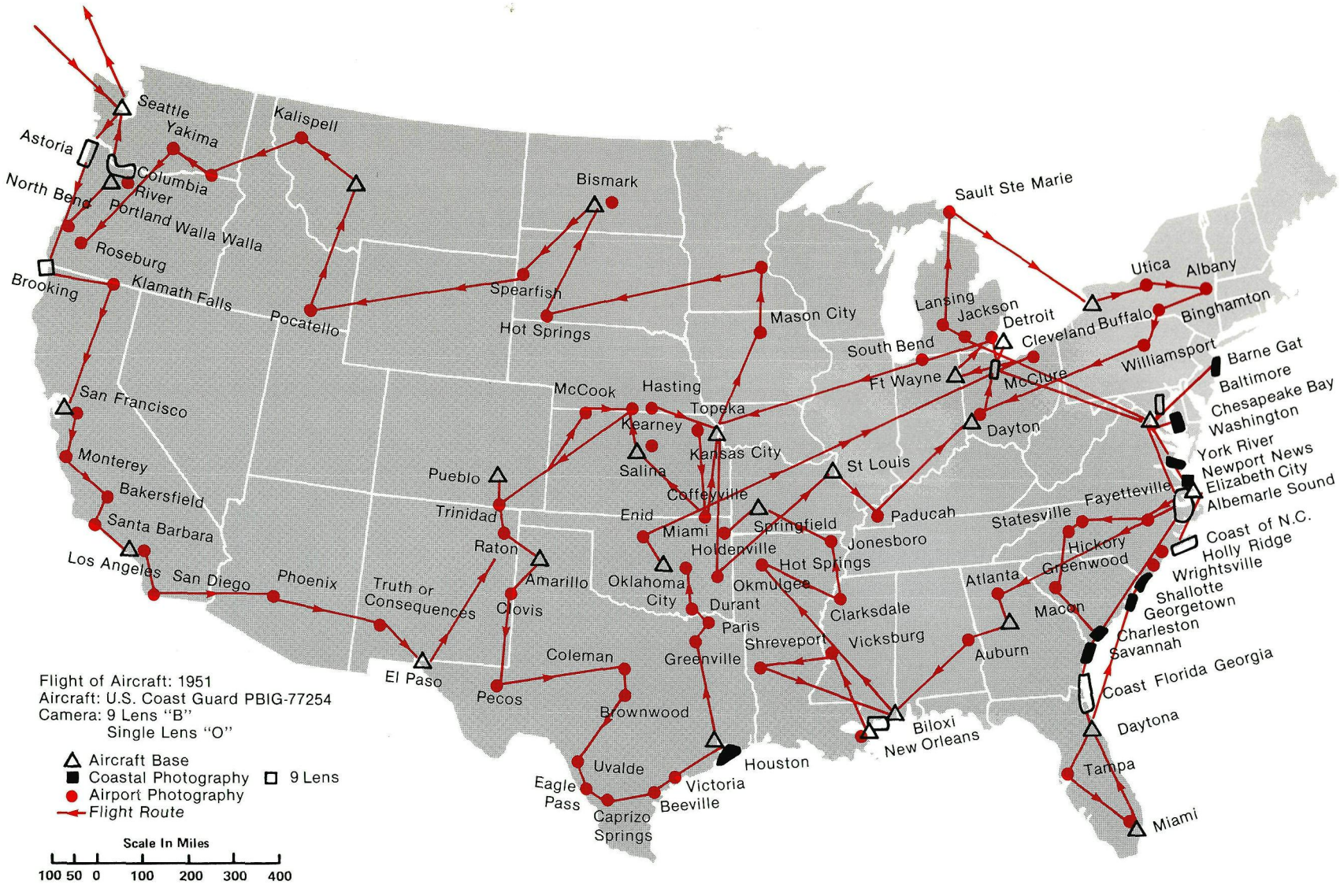

Flight of Aircraft: 1948
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Point Hope to Lisburne
Lisburne to Point Lay
Nome
Norton Sound
Anchorage
Prince William
Kuskokwim Bay
Naknek
Bristol Bay
Attu
Agattu
Semichi
Rat
Tanaga
Adak
Delahof

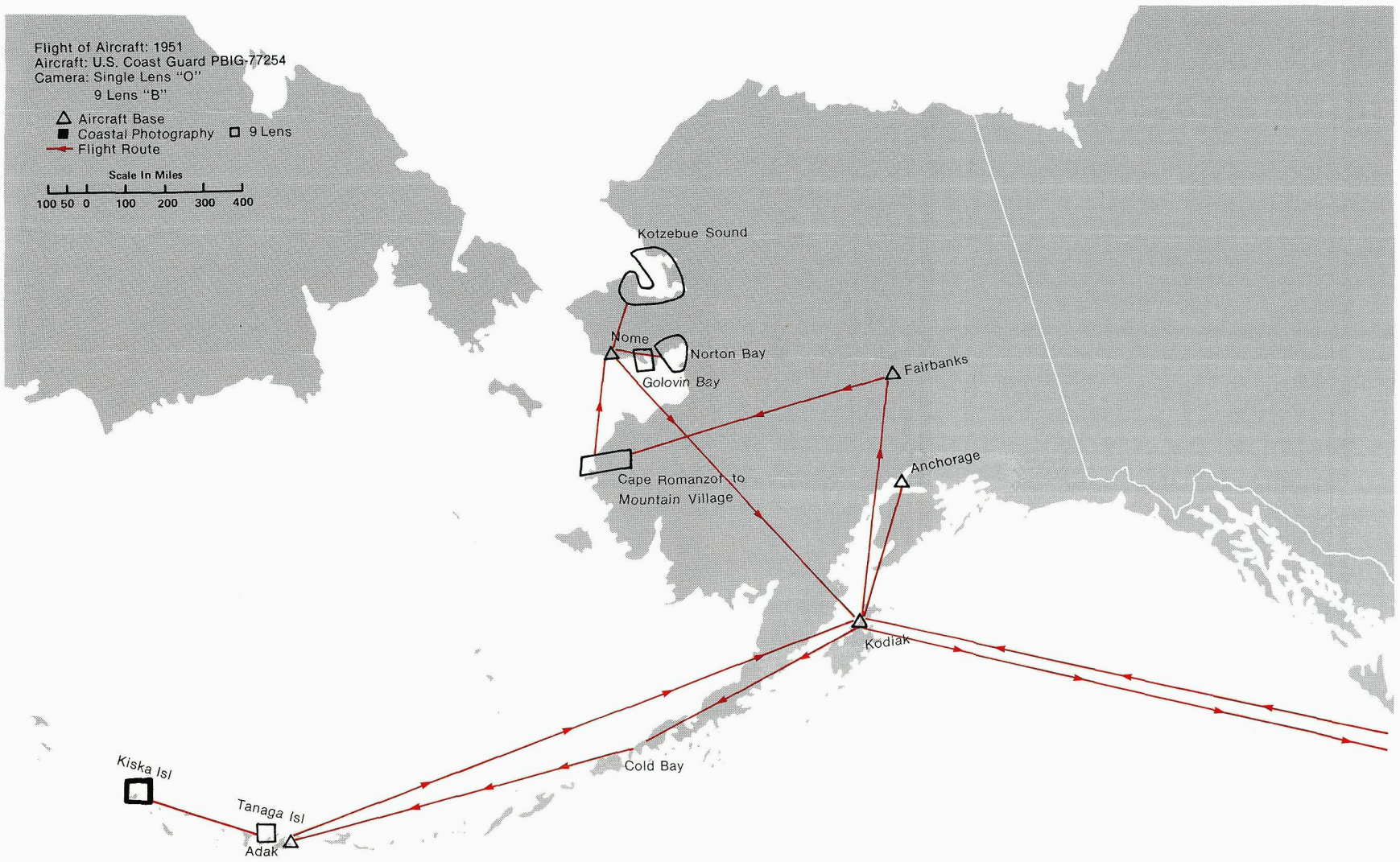

Bellingham
Seattle
Wenatchee
Olympia
Portland
Denver
Bar Harbor
Portland
Toledo
Floyd Bennett
Elizabeth
Mansfield
Pittsburgh
McClure
Camera Test
Dayton
Washington
Ocean City
Chincoteague
Elizabeth City
Charleston
New River
Charleston
Jacksonville
Daytona Beach
Orlando
Flight of Aircraft: 1949
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "D" "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

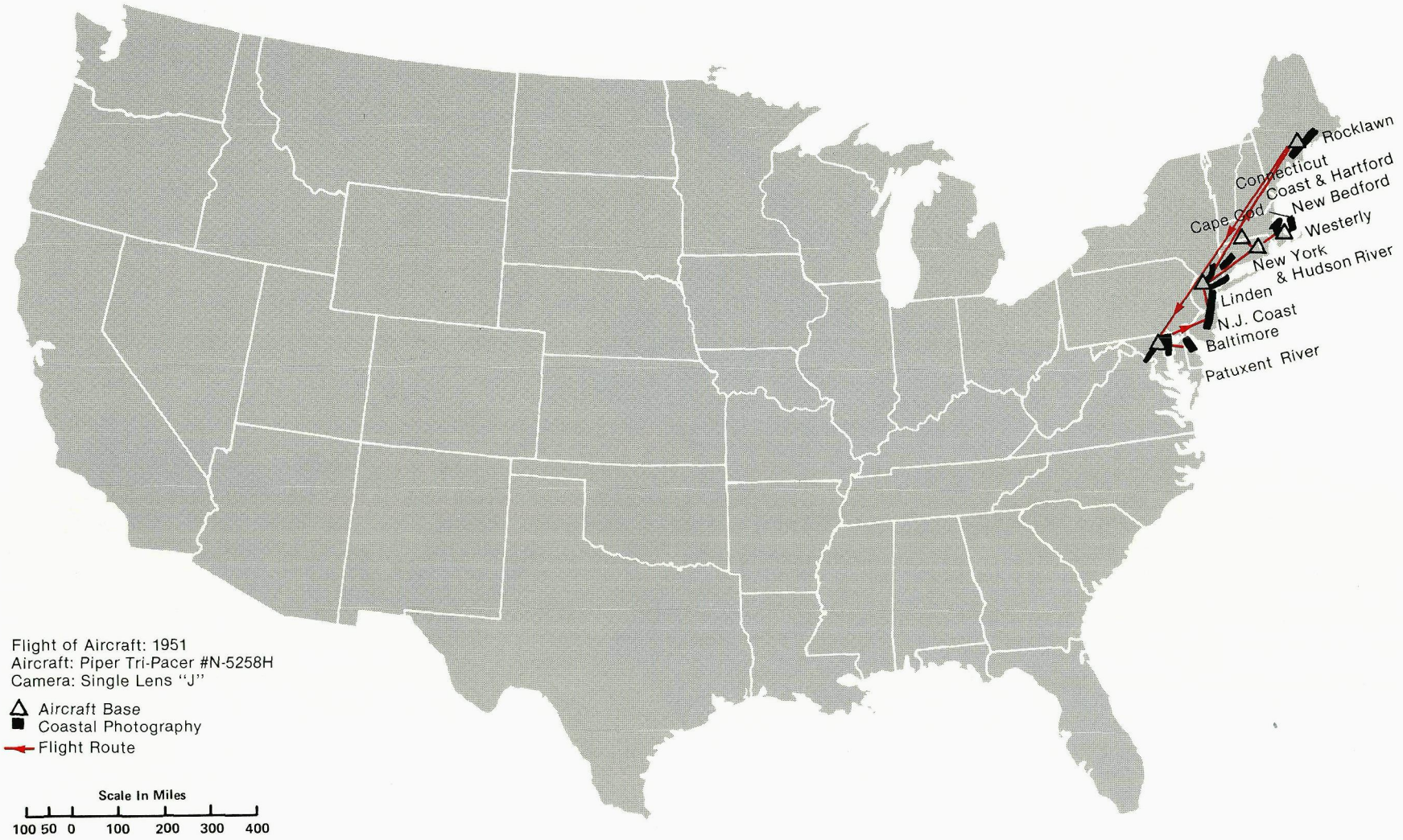

Flight of Aircraft: 1949
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Naknek
Kukak Bay
Tanaga
Kanaga
Adak
Amatignak

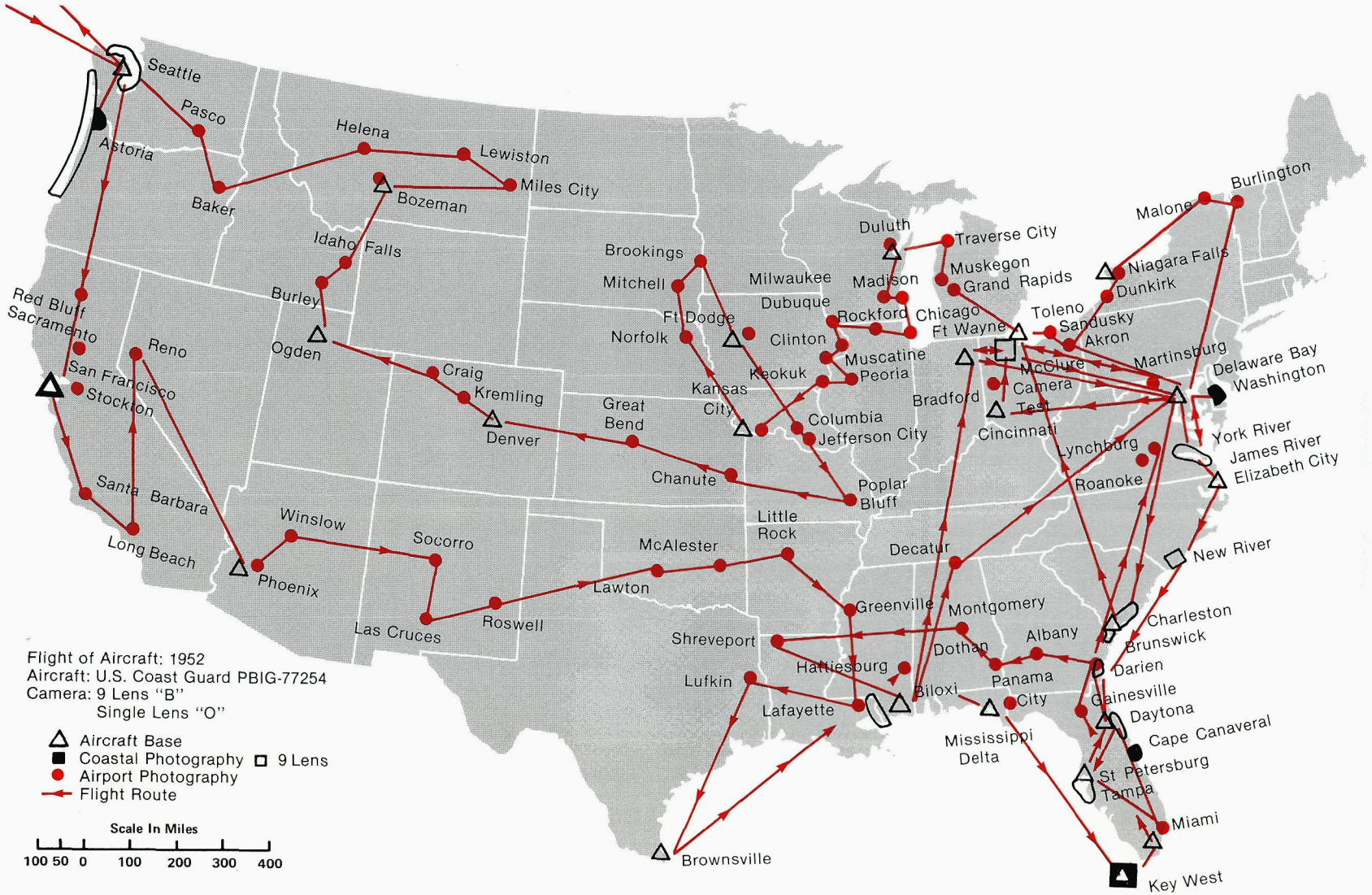

Grays Harbor
Astoria
Seattle
Boise
Twin Falls
Battle Mountain
Lower Lake
Love Lock
Fallon
Lake Tahoe
Salt Lake City
Rapid City
Casper
Cheyenne
San Francisco
San Jose
Cedar City
Milford
Santa Maria
Van Nuys
Las Vegas
Williams
Flagstaff
Los Angeles
San Diego
Catalina Isl
Tucson
Montgomery
Phoenix Ajo
Nogales
Stafford
Silver City
Deming
Socorro
Roswal
Van Horn
Amarillo
Plainview
McCamerey
Ft Stockton
Marfa
Enid
Bartlesville
Stillwater
Oklahoma City
Ada
Lawton
Veron
Gainesville
Dallas
Waco
Lufkin
Victoria
Corpus Christi
Harlingen
Mission
Brownsville
Ottumwa
Milwaukee
Big Rapids
Lansing
Jackson
Battle Creek
Detroit
Voliet
South Bend
Toledo
Youngstown
Moline
Chicago
McClure
Philadelphia
Campaign
Columbus
Camera
Springfield
Zanesville
Test
Cape Girardeau
Malden
Birmingham
Chattanooga
Jacks Creek
Russell
Pinehurst
Tupelo
Atlanta
Anderson
Ft Bragg
Helena
Tuscaloosa
Athens
Florence
Pine Bluff
Augusta
Jackson
Montgomery
Macon
Columbus
Selfield
Hattiesburg
Crestview
Pensacola
Biloxi
Panama City
Jacksonville
Pelousas
New Iberia
Horn Cat Ship Isl
New Orleans
Chandeleur Isl
Boston
White Plains
Laguardia
Cape May
Washington
Elizabeth City
Goldsboro
Flight of Aircraft: 1950
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

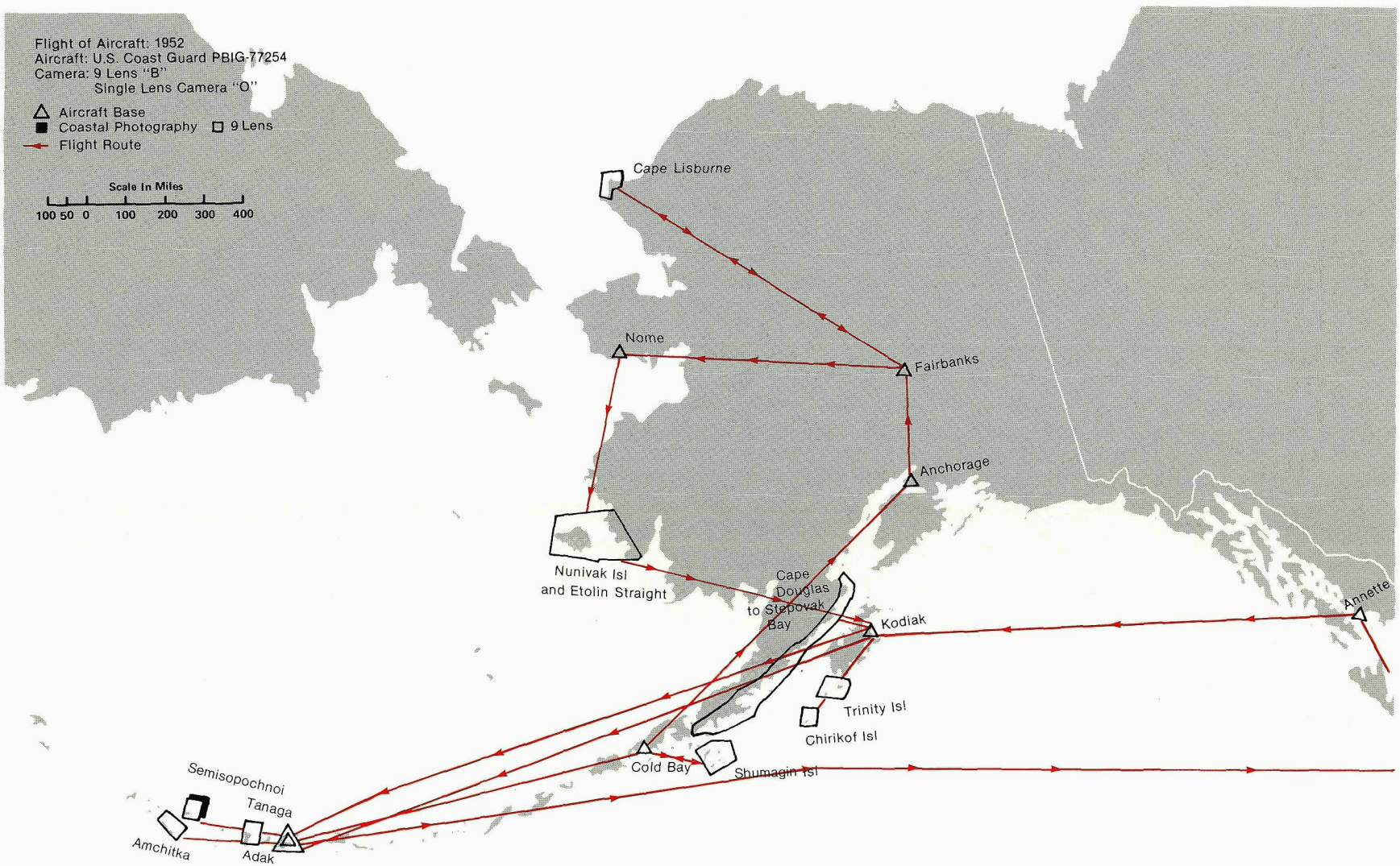

Flight of Aircraft: 1950
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Cape Thompson
to Cape Lisburne
Hotham Inlet to
Cape Krusenstern
Shishmaref
to
Cape Douglas
Nome
Nome to
Mission
St
Lawrence
Pastol Bay
to Togiak Bay
Nunivak Isl
Fairbanks
Prince
William
Sound
Anchorage
Kodiak

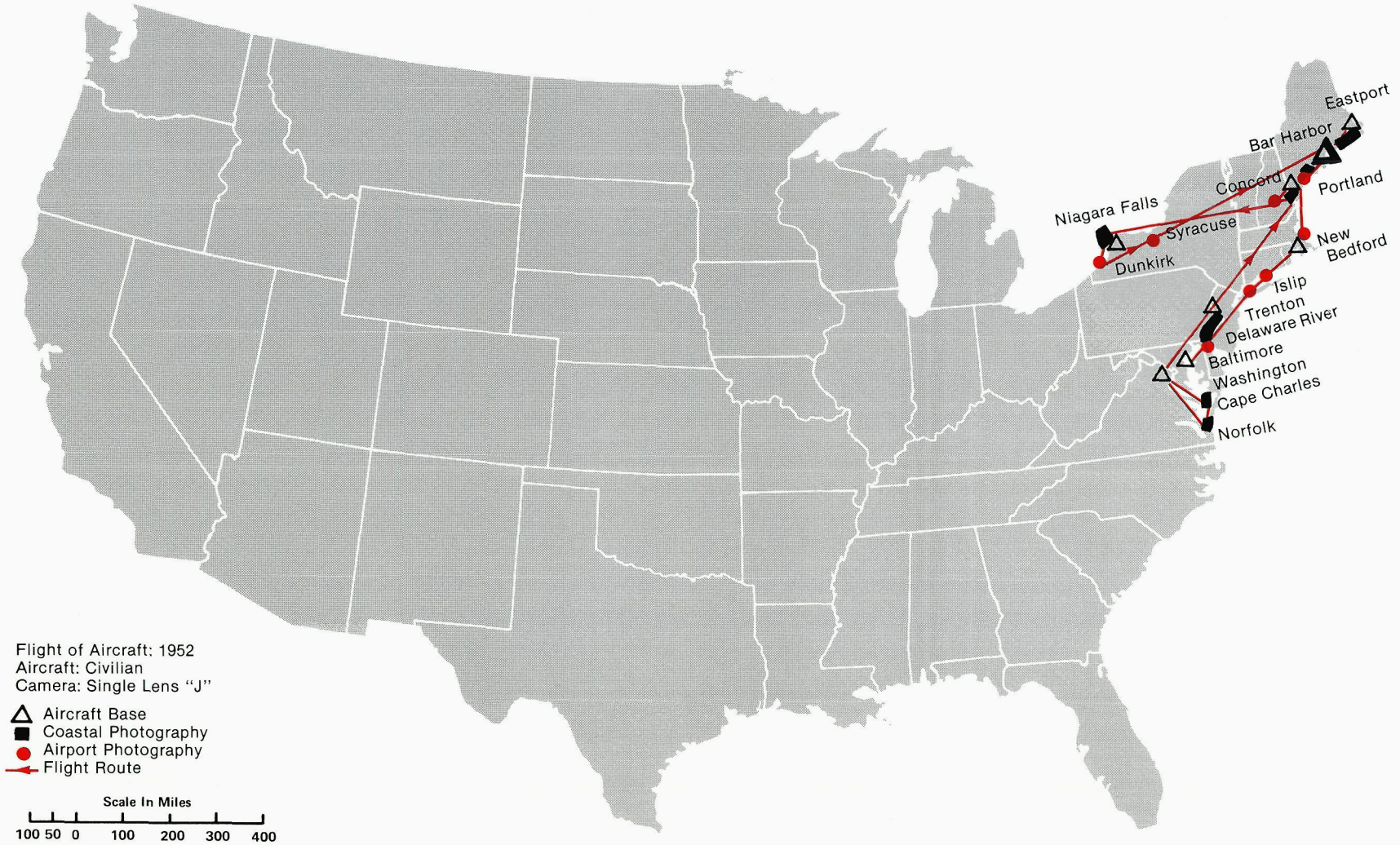

Seattle
Yakima
Kalispell
Astoria
Columbia River
North Bend
Portland
Walla Walla
Roseburg
Brooking
Klamath Falls
Pocatello
Bismark
Spearfish
Hot Springs
Mason City
Sault Ste Marie
Utica
Albany
Lansing
Jackson
Detroit
Cleveland
Buffalo
Binghamton
South Bend
Ft Wayne
McClure
Williamsport
Barne Gat
Baltimore
Chesapeake Bay
Washington
Dayton
York River
Newport News
Elizabeth City
Albemarle Sound
San Francisco
Monterey
Bakersfield
Santa Barbara
Los Angeles
San Diego
Phoenix
Truth or Consequences
El Paso
Pueblo
Trinidad
Raton
Amarillo
Clovis
Pecos
McCook
Hasting
Kearney
Topeka
Salina
Kansas City
Coffeyville
Enid
Miami
Holdenville
Springfield
St Louis
Paducah
Jonesboro
Hot Springs
Oklahoma City
Okmulgee
Durant
Paris
Greenville
Coleman
Brownwood
Uvalde
Eagle Pass
Caprizo Springs
Victoria
Beeville
Houston
Shreveport
Clarksdale
Vicksburg
Biloxi
New Orleans
Auburn
Atlanta
Macon
Statesville
Fayetteville
Hickory
Greenwood
Coast of N.C.
Holly Ridge
Wrightsville
Shallotte
Georgetown
Charleston
Savannah
Coast Florida Georgia
Daytona
Tampa
Miami
Flight of Aircraft: 1951
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

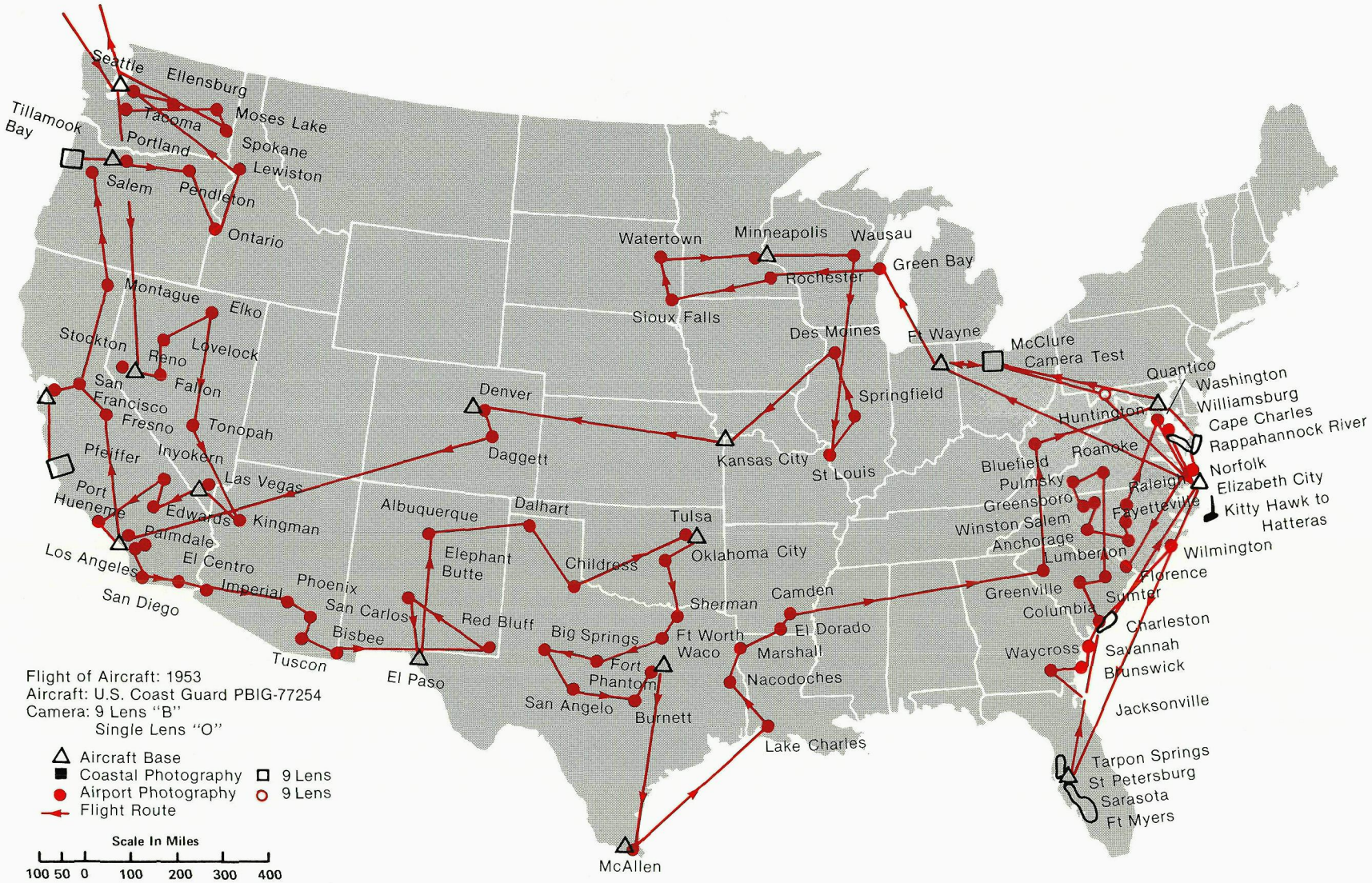

Flight of Aircraft: 1951
Aircraft: U.S. Coast Guard PBIG-77254
Camera: Single Lens "O"
9 Lens "B"
Aircraft Base
Coastal Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Kotzebue Sound
Nome
Norton Bay
Golovin Bay
Fairbanks
Cape Romanzof to
Mountain Village
Anchorage
Kodiak
Cold Bay
Kiska Isl
Tanaga Isl
Adak

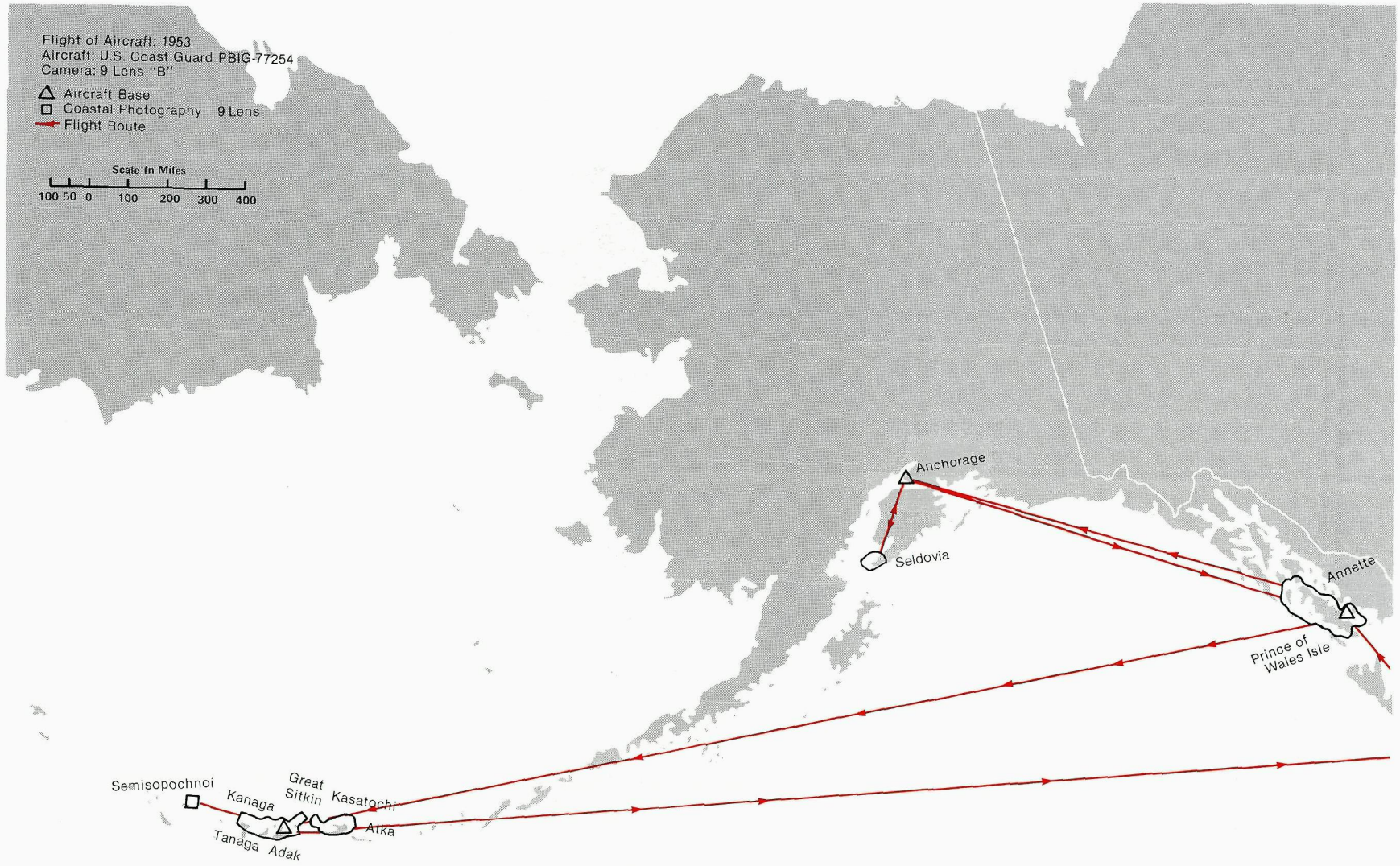

Rocklawn
Connecticut Coast & Hartford
Cape Cod
New Bedford
Westerly
New York & Hudson River
Linden
N.J. Coast
Baltimore
Patuxent River
Flight of Aircraft: 1951
Aircraft: Piper Tri-Pacer #N-5258H
Camera: Single Lens "J"
Aircraft Base
Coastal Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

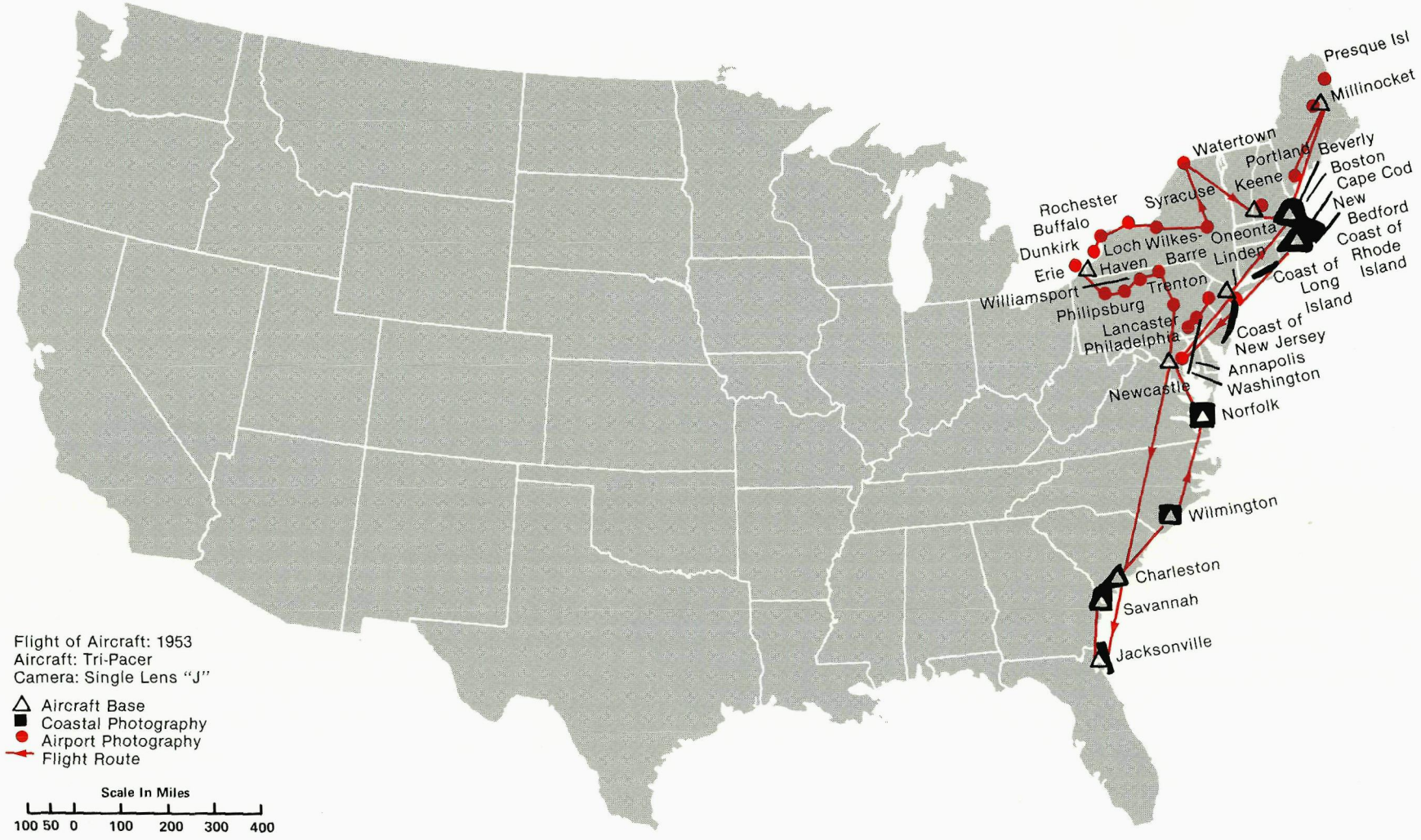

Seattle
Pasco
Astoria
Helena
Lewiston
Miles City
Baker
Bozeman
Idaho Falls
Burley
Red Bluff
Sacramento
Reno
San Francisco
Stockton
Ogden
Craig
Kremling
Denver
Great Bend
Chanute
Santa Barbara
Long Beach
Winslow
Phoenix
Socorro
Las Cruces
Roswell
Lawton
McAlester
Little Rock
Poplar Bluff
Brookings
Mitchell
Norfolk
Ft Dodge
Kansas City
Milwaukee
Dubuque
Clinton
Keokuk
Columbia
Jefferson City
Muscatine
Peoria
Rockford
Madison
Duluth
Traverse City
Muskegon
Grand Rapids
Chicago
Ft Wayne
Bradford
Cincinnati
Toledo
Sandusky
Akron
McClure
Camera
Test
Malone
Burlington
Niagara Falls
Dunkirk
Martinsburg
Delaware Bay
Washington
York River
James River
Elizabeth City
Lynchburg
Roanoke
New River
Decatur
Greenville
Montgomery
Albany
Dothan
Shreveport
Hattiesburg
Lufkin
Lafayette
Biloxi
Panama City
Mississippi Delta
Charleston
Brunswick
Darien
Gainesville
Daytona
Cape Canaveral
St Petersburg
Tampa
Miami
Key West
Brownsville
Flight of Aircraft: 1952
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

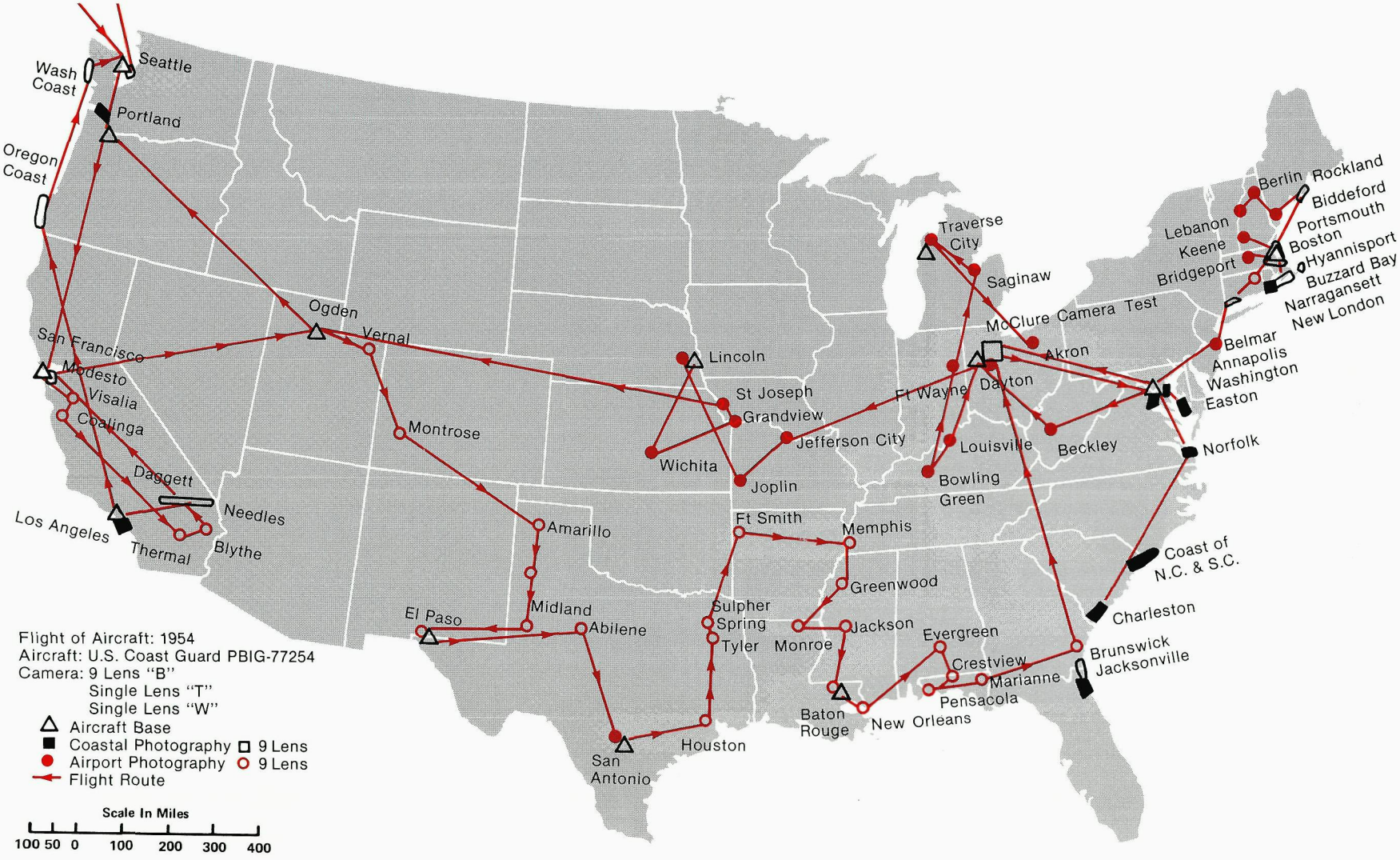

Flight of Aircraft: 1952
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens Camera "O"
Aircraft Base
Coastal Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Cape Lisburne
Nome
Fairbanks
Anchorage
Nunivak Isl
and Etolin Straight
Cape
Douglas
to Stepovak
Bay
Kodiak
Annette
Trinity Isl
Chirikof Isl
Cold Bay
Shumagin Isl
Semisopochnoi
Tanaga
Amchitka
Adak

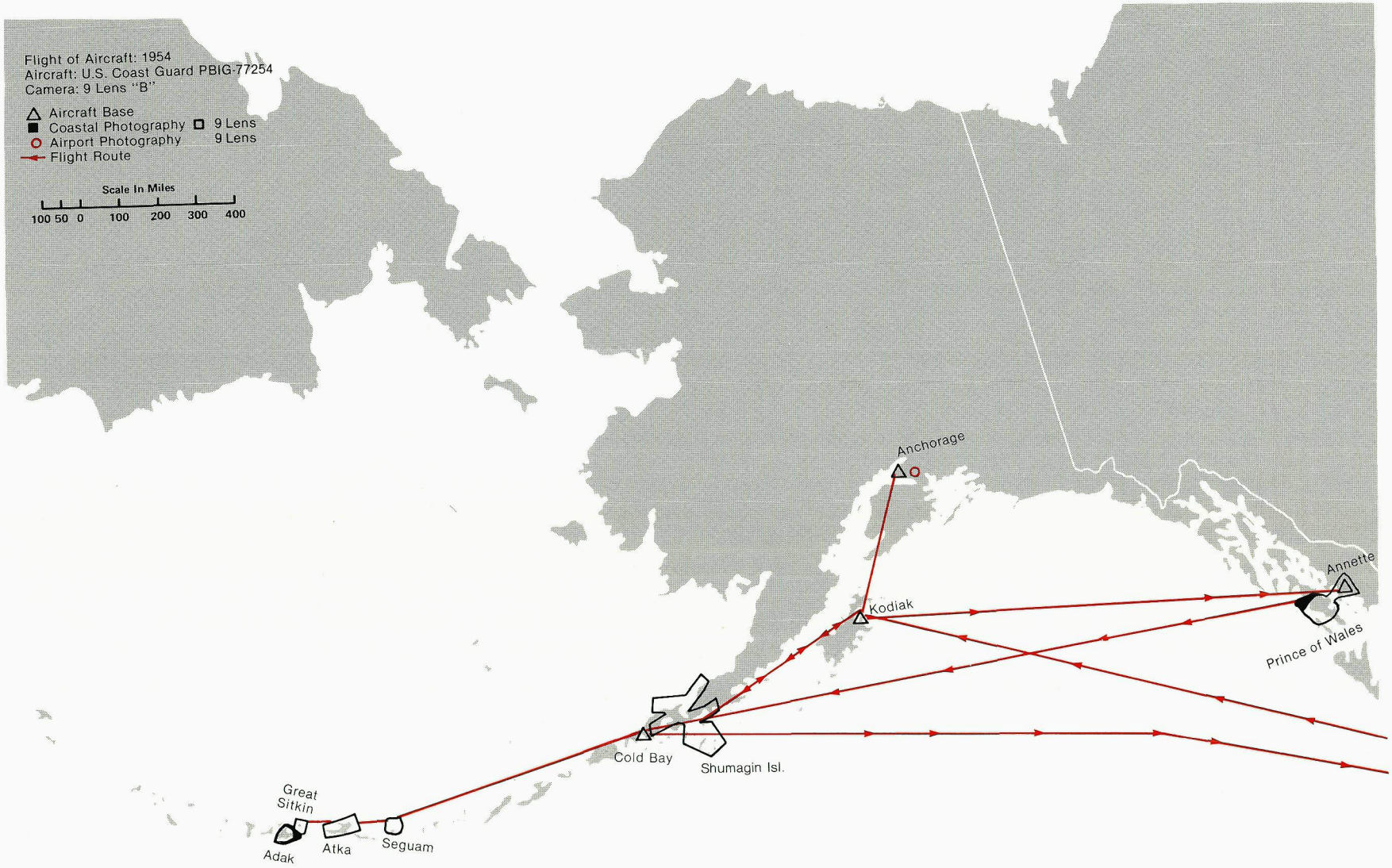

Eastport
Bar Harbor
Concord
Portland
Niagara Falls
Syracuse
New Bedford
Dunkirk
Islip
Trenton
Delaware River
Baltimore
Washington
Cape Charles
Norfolk
Flight of Aircraft: 1952
Aircraft: Civilian
Camera: Single Lens "J"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Seattle
Ellensburg
Tacoma
Moses Lake
Tillamook Bay
Portland
Spokane
Lewiston
Salem
Pendleton
Ontario
Montague
Elko
Stockton
Reno
Lovelock
San Francisco
Fallon
Fresno
Tonopah
Pfeiffer
Inyokern
Las Vegas
Port Hueneme
Edwards
Kingman
Palmdale
Los Angeles
El Centro
San Diego
Imperial
Phoenix
San Carlos
Bisbee
Tuscon
El Paso
Albuquerque
Elephant Butte
Red Bluff
Denver
Daggett
Dalhart
Childress
Tulsa
Oklahoma City
Sherman
Big Springs
Ft Worth
Waco
Fort Phantom
San Angelo
Burnett
McAllen
Lake Charles
Watertown
Minneapolis
Wausau
Green Bay
Rochester
Sioux Falls
Des Moines
Springfield
Kansas City
St Louis
Ft Wayne
McClure Camera Test
Quantico
Washington
Williamsburg
Cape Charles
Rappahannock River
Huntington
Roanoke
Bluefield
Pulmsky
Greensboro
Winston Salem
Anchorage
Raleigh
Fayetteville
Norfolk
Elizabeth City
Kitty Hawk to Hatteras
Lumberton
Wilmington
Florence
Greenville
Sumter
Columbia
Camden
El Dorado
Marshall
Nacodoches
Charleston
Waycross
Savannah
Brunswick
Jacksonville
Tarpon Springs
St Petersburg
Sarasota
Ft Myers
Flight of Aircraft: 1953
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

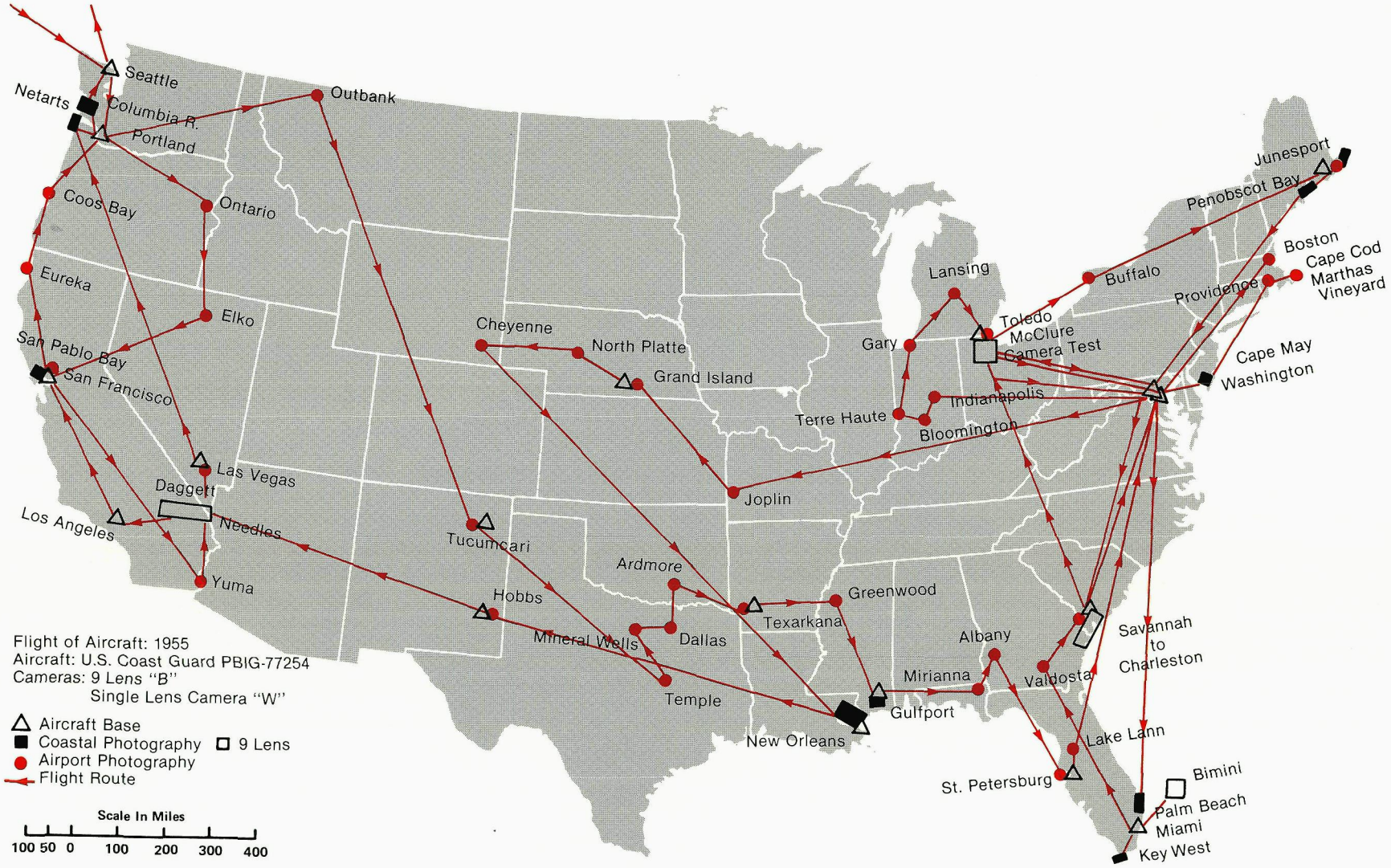

Flight of Aircraft: 1953
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Seldovia
Annette
Prince of Wales Isle
Semisopochnoi
Kanaga
Great Sitkin
Kasatochi
Atka
Tanaga
Adak

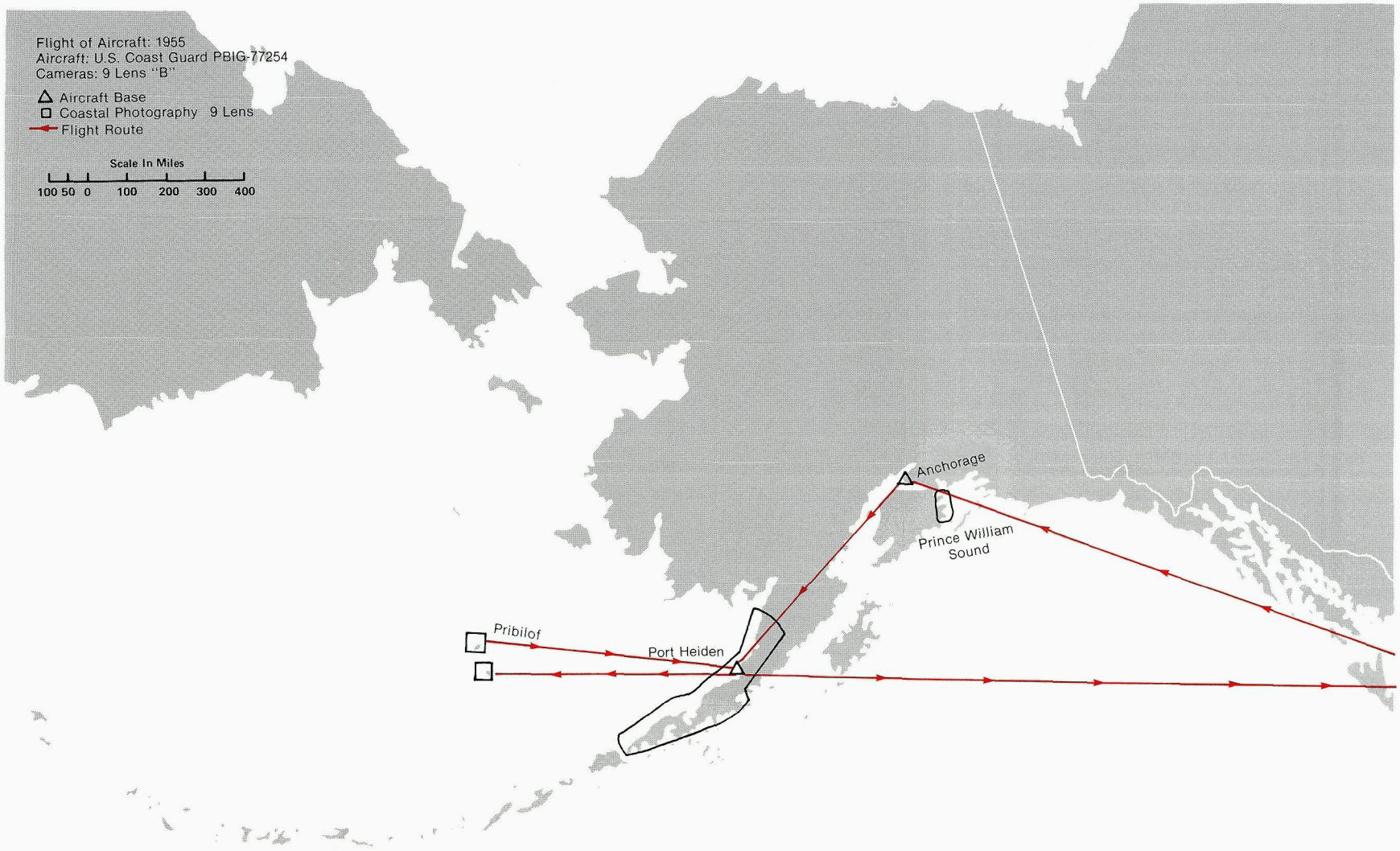

Presque Isl
Millinocket
Watertown
Portland
Beverly
Boston
Keene
Cape Cod
New
Bedford
Coast of
Rhode
Island
Coast of
Long
Island
Coast of
New Jersey
Annapolis
Washington
Norfolk
Wilmington
Charleston
Savannah
Jacksonville
Newcastle
Philadelphia
Lancaster
Philipsburg
Williamsport
Trenton
Linden
Barre
Oneonta
Wilkes-
Loch
Haven
Erie
Dunkirk
Buffalo
Rochester
Syracuse
Flight of Aircraft: 1953
Aircraft: Tri-Pacer
Camera: Single Lens "J"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

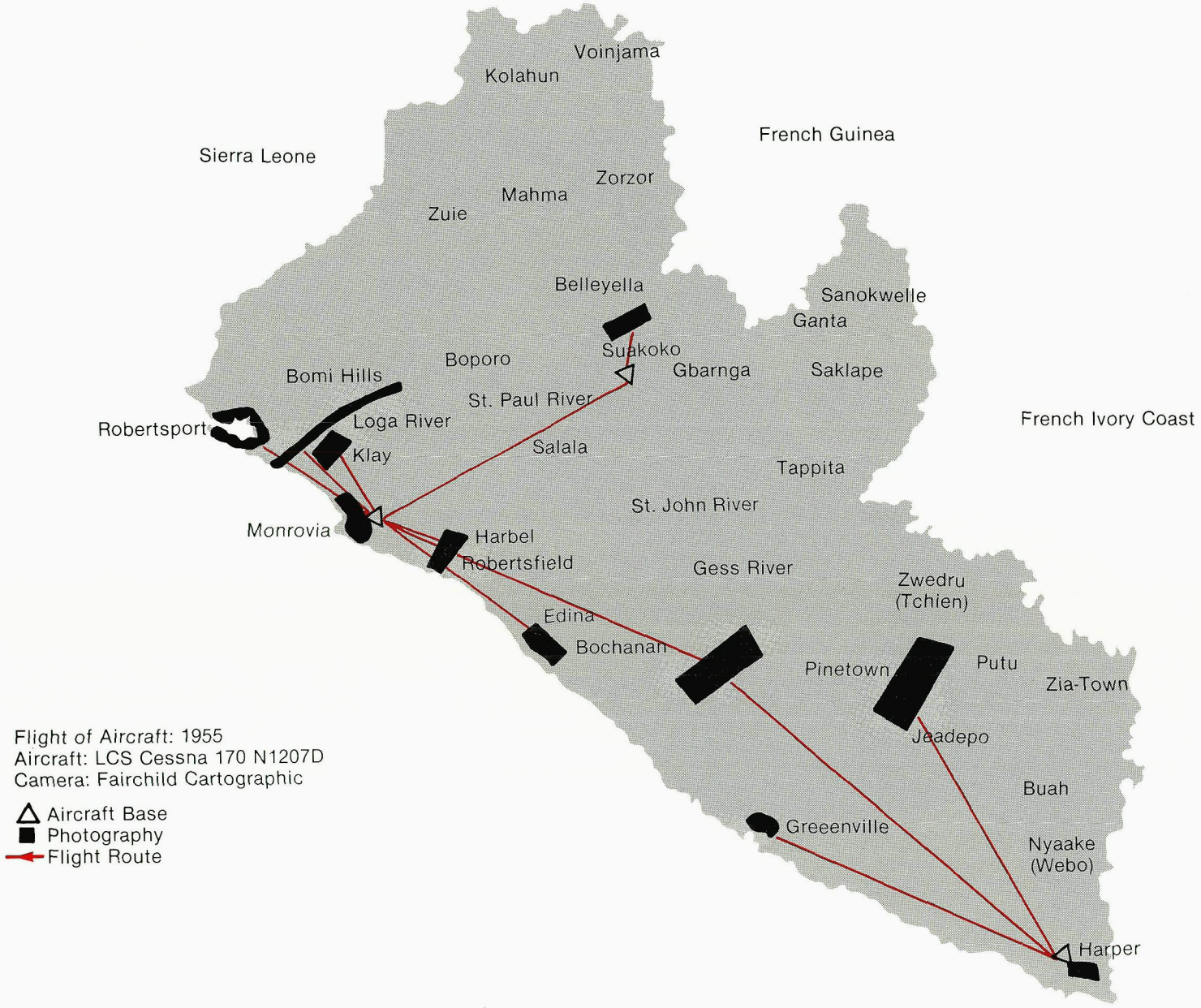

Seattle
Wash Coast
Portland
Oregon Coast
San Francisco
Modesto
Visalia
Coalinga
Daggett
Needles
Los Angeles
Thermal
Blythe
Ogden
Vernal
Montrose
Amarillo
Midland
El Paso
Abilene
San Antonio
Houston
Lincoln
St Joseph
Grandview
Wichita
Joplin
Jefferson City
Ft Smith
Sulpher Spring
Tyler
Memphis
Greenwood
Monroe
Jackson
Baton Rouge
New Orleans
Traverse City
Saginaw
McClure Camera Test
Akron
Dayton
Ft Wayne
Louisville
Bowling Green
Beckley
Evergreen
Crestview
Marianne
Pensacola
Berlin
Rockland
Biddeford
Portsmouth
Lebanon
Keene
Boston
Bridgeport
Hyannisport
Buzzard Bay
Narragansett
New London
Belmar
Annapolis
Washington
Easton
Norfolk
Coast of N.C. & S.C.
Charleston
Brunswick
Jacksonville
Flight of Aircraft: 1954
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Single Lens "T"
Single Lens "W"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1954
Aircraft: U.S. Coast Guard PBIG-77254
Camera: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Airport Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Kodiak
Annette
Prince of Wales
Cold Bay
Shumagin Isl.
Great Sitkin
Adak
Atka
Seguam


Voinjama
Kolahun
French
Guinea
Sierra
Zorzor
Mahma
Zuie
Morro
River
Belleyella
Sanokwelle
Ganta
Suakoko
Cape
Mount
Bomi Hills
Boporo
Gbarnga
Saklape
St Paul
River
Robertsport
French
Ivory
Coast
Klay
Salala
Lofa
River
Tappita
St John
River
Monrovia
Harbel
Robertsfield
Zwedru
(Tchien)
Cavalla
River
Cess River
Buchanan
Pinetown
Putu
Zia-Town
Jeadepo
Buah
Greenville
Nyaake
(Webo)
Harper
Flight of Aircraft: 1954
Aircraft: LCS Cessna 170 #N1207D
Camera: Fairchild Cartographic
Aircraft Base
Coastal Photography
Flight Route


Seattle
Netarts
Columbia R.
Portland
Outbank
Coos Bay
Ontario
Eureka
Elko
San Pablo Bay
San Francisco
Las Vegas
Daggett
Los Angeles
Needles
Yuma
Cheyenne
North Platte
Grand Island
Joplin
Tucumcari
Ardmore
Hobbs
Mineral Wells
Dallas
Texarkana
Greenwood
Temple
New Orleans
Gulfport
Mirianna
Albany
Valdosta
Savannah
to
Charleston
Lake Lann
St. Petersburg
Bimini
Palm Beach
Miami
Key West
Lansing
Gary
Toledo
McClure
Camera Test
Terre Haute
Indianapolis
Bloomington
Buffalo
Junesport
Penobscot Bay
Boston
Cape Cod
Marthas
Vineyard
Providence
Cape May
Washington
Flight of Aircraft: 1955
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens Camera "W"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1955
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Prince William Sound
Pribilof
Port Heiden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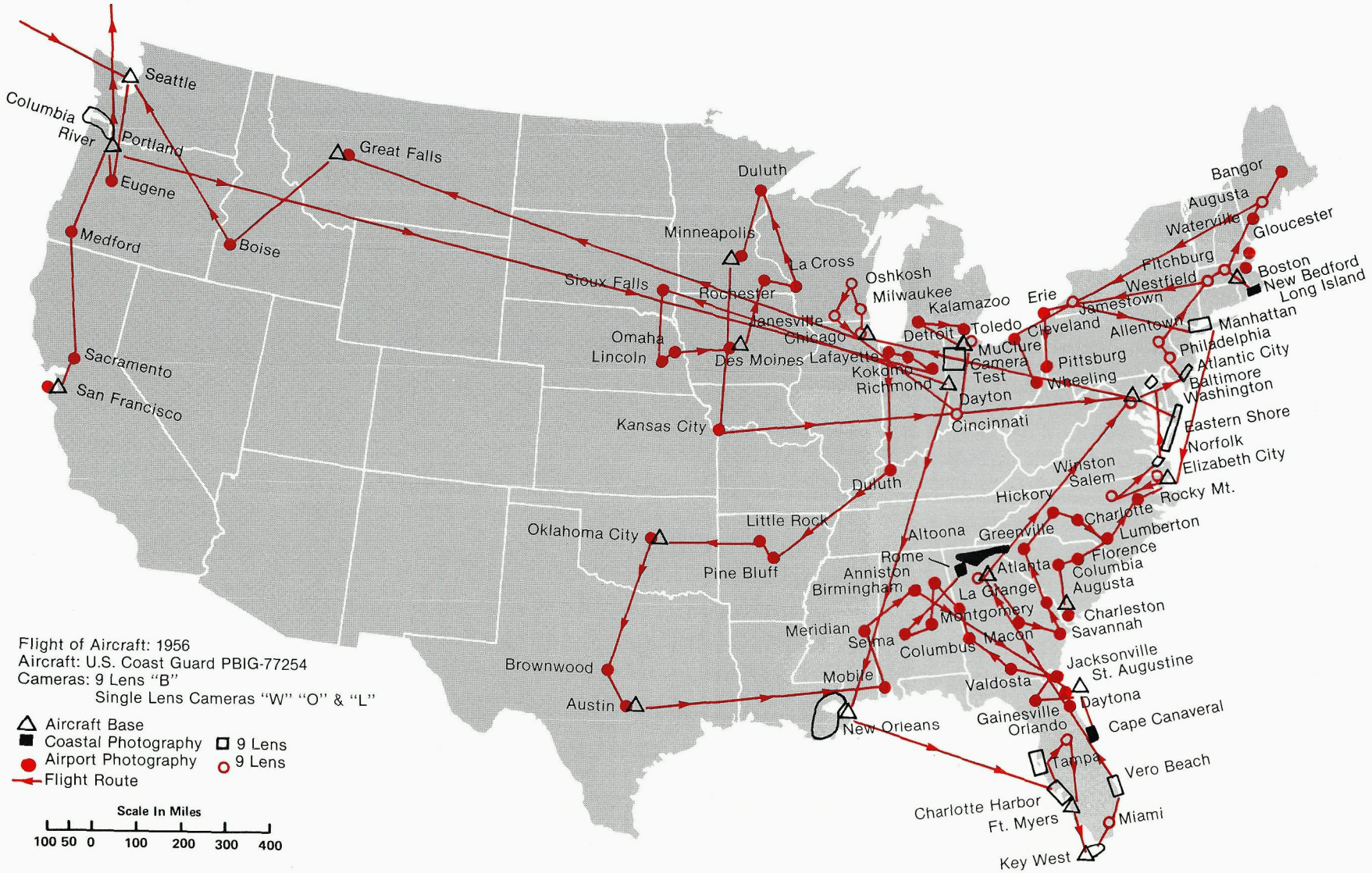
Kolahun
Sierra Leone
French Guinea
Zorzor
Mahma
Zuie
Belleyella
Sanokwelle
Ganta
Suakoko
Boporo
Gbarnga
Saklape
Bomi Hills
St. Paul River
Loga River
Robertsport
French Ivory Coast
Klay
Salala
Tappita
St. John River
Monrovia
Harbel
Robertsfield
Gess River
Zwedru
(Tchien)
Edina
Bochanan
Pinetown
Putu
Zia-Town
Jeadepo
Buah
Greeenville
Nyaake
(Webo)
Harper
Flight of Aircraft: 1955
Aircraft: LCS Cessna 170 N1207D
Camera: Fairchild Cartographic
Aircraft Base
Photography
Flight Route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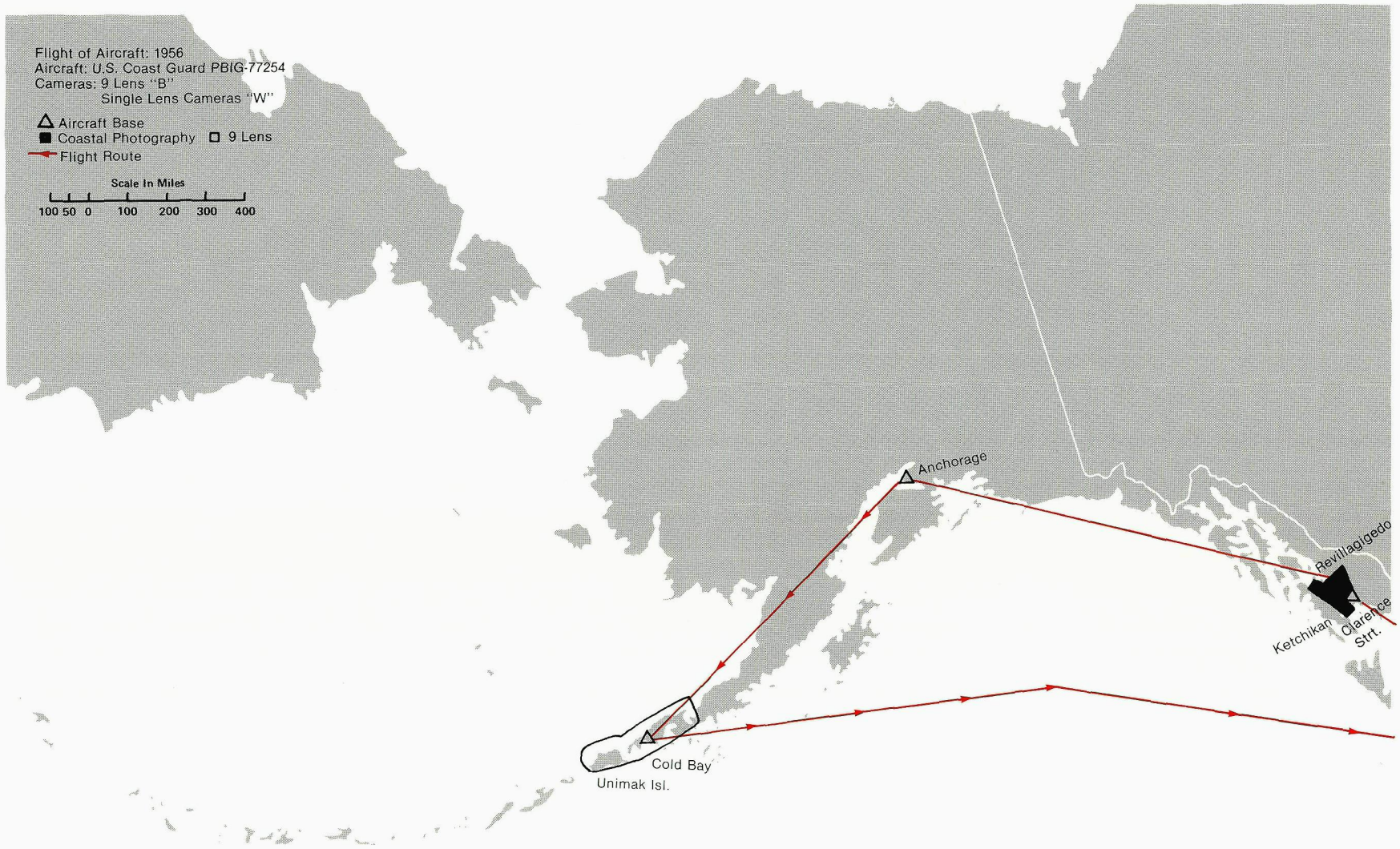
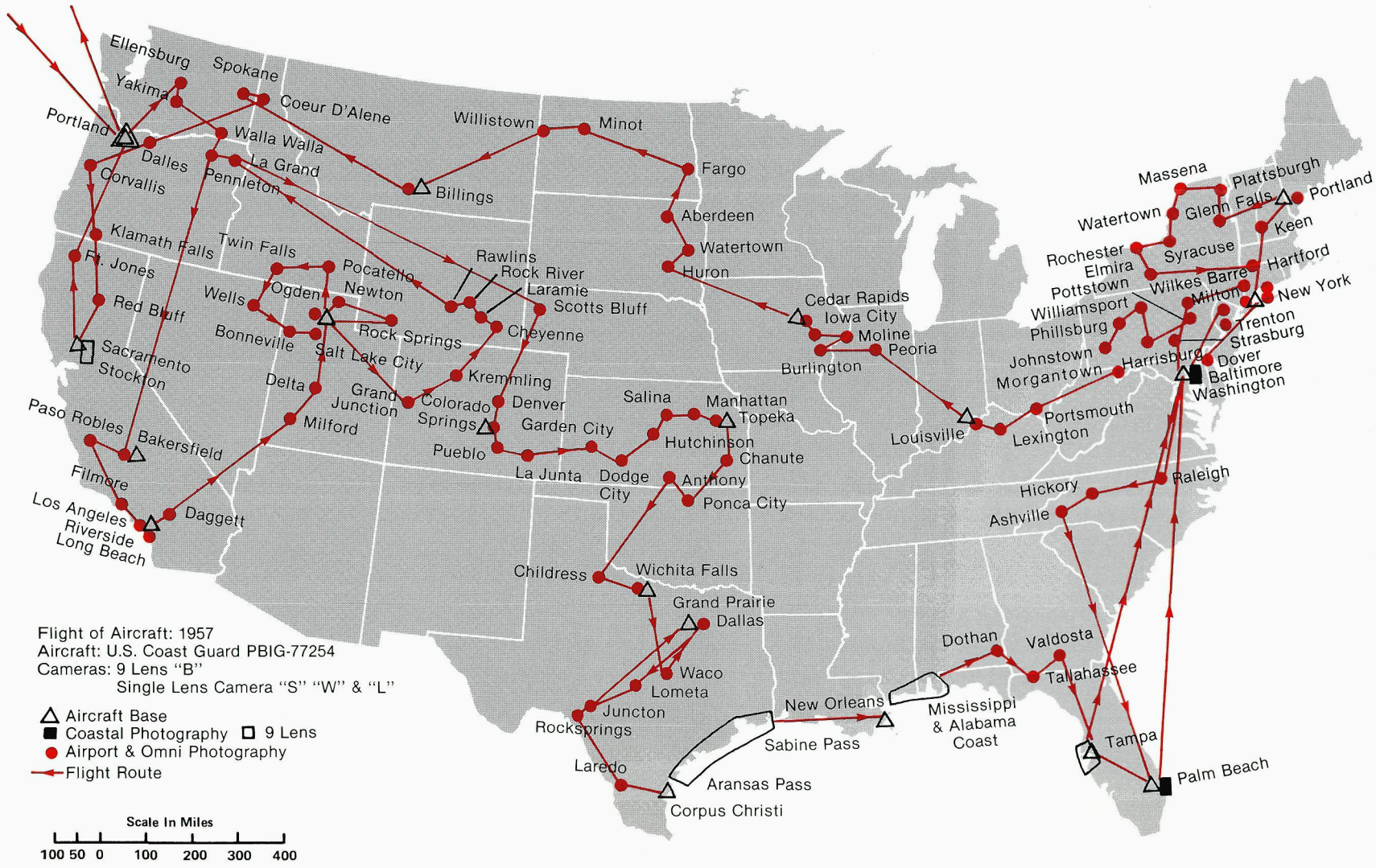
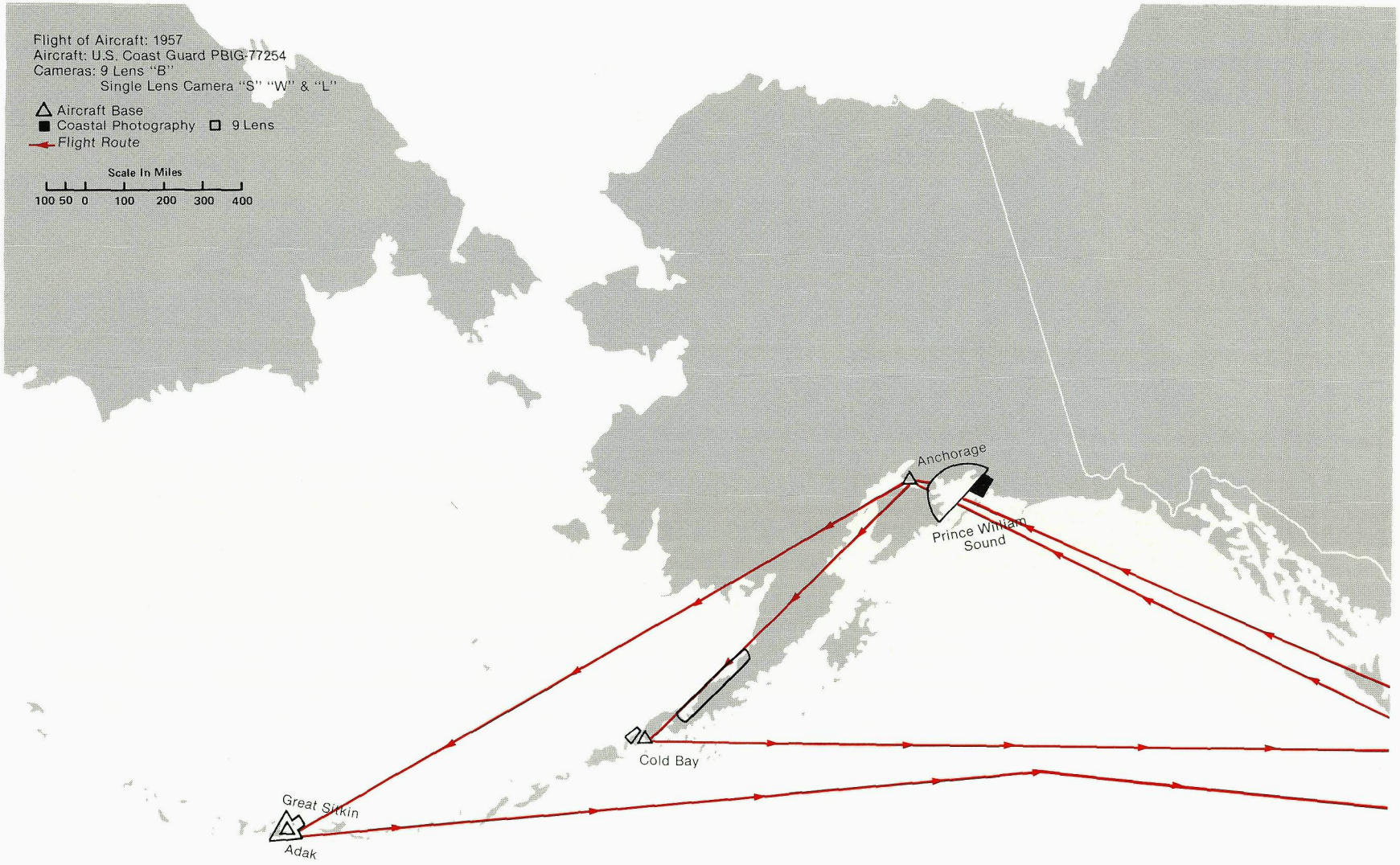
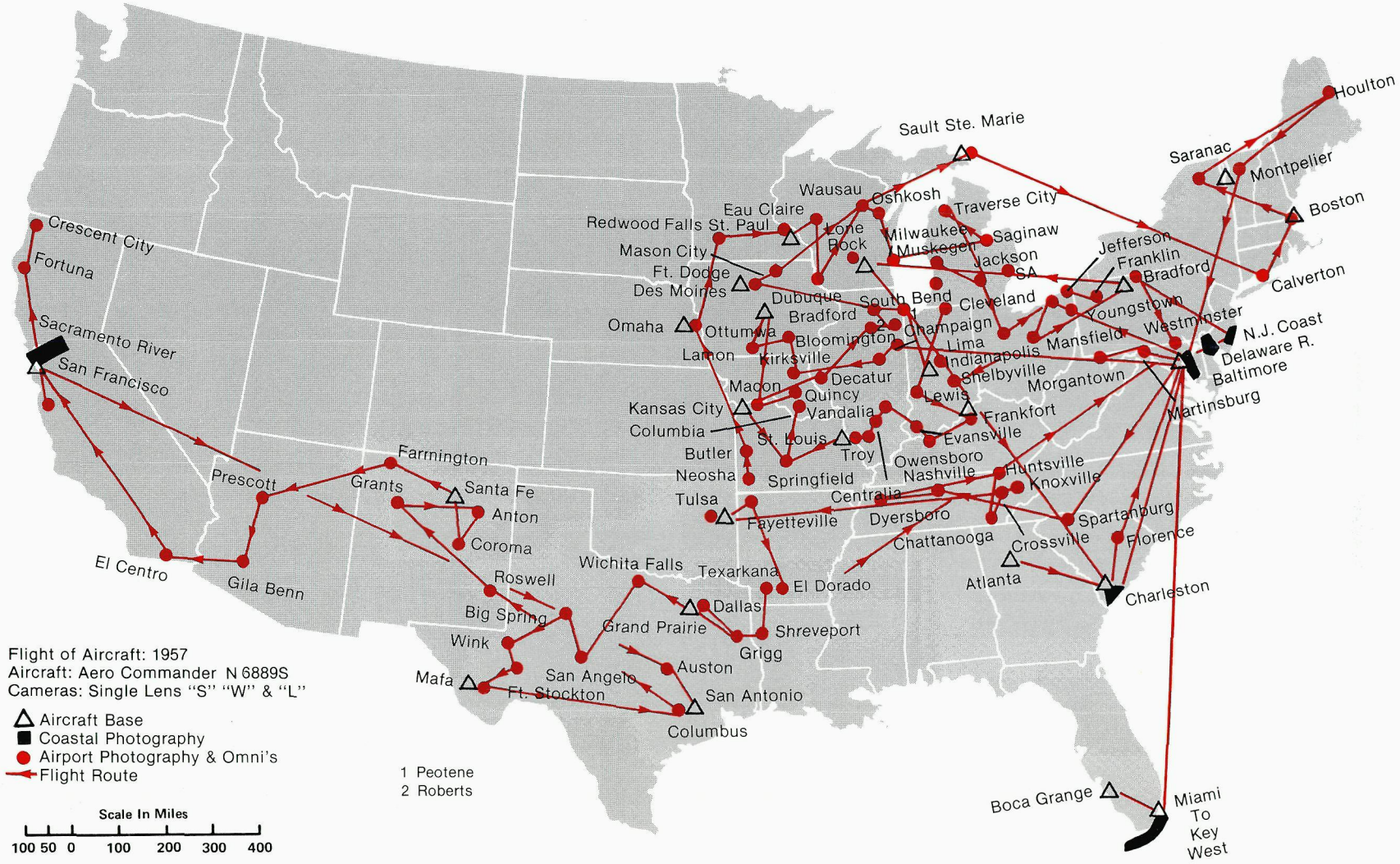
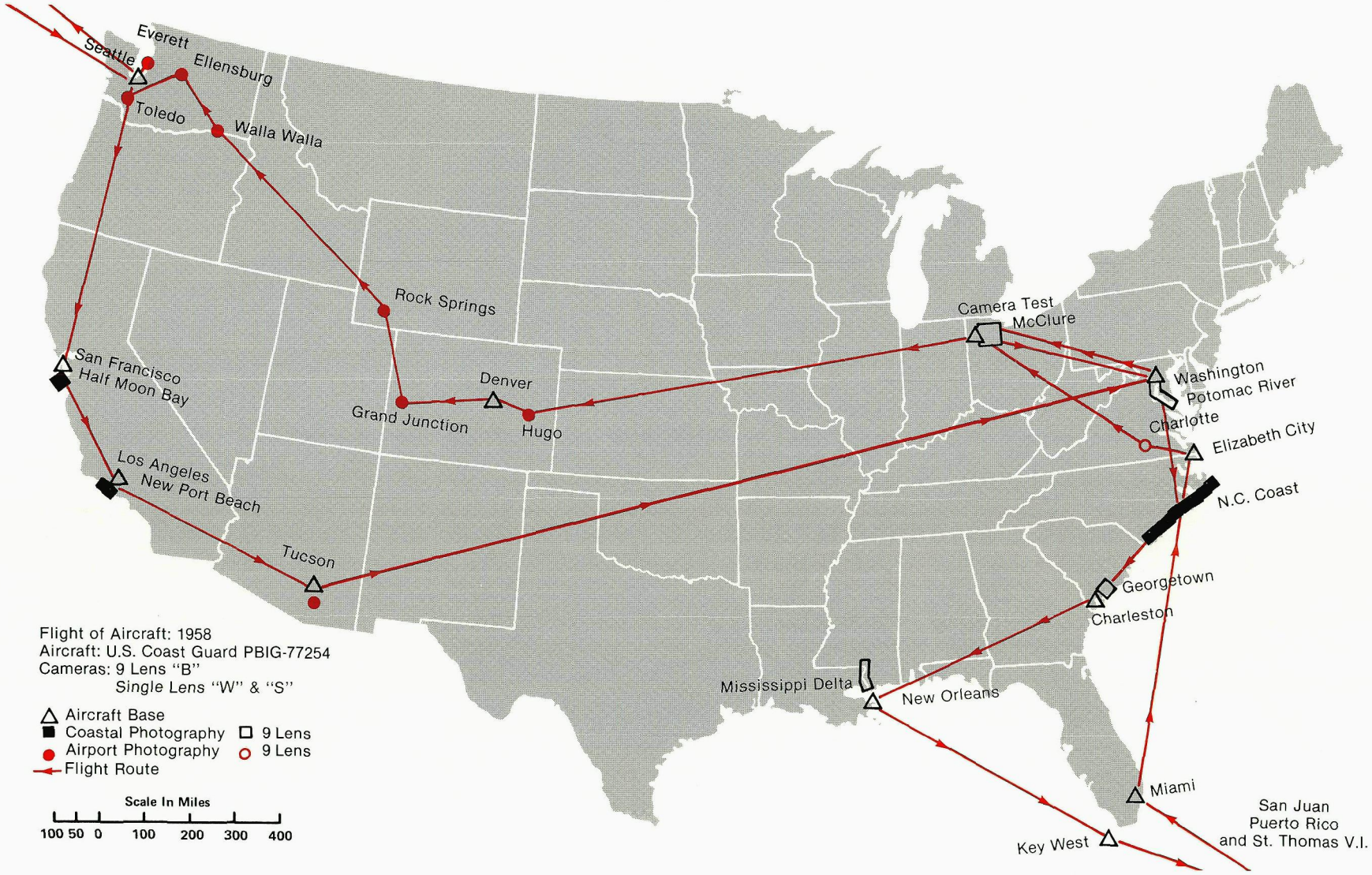
Columbia River
Portland
Eugene
Medford
Boise
Great Falls
Sacramento
San Francisco
Duluth
Minneapolis
La Cross
Oshkosh
Milwaukee
Sioux Falls
Rochester
Janesville
Chicago
Omaha
Lincoln
Des Moines
Lafayette
Kokomo
Richmond
Kansas City
Oklahoma City
Little Rock
Pine Bluff
Brownwood
Austin
Mobile
New Orleans
Meridian
Selma
Birmingham
Anniston
Rome
Altoona
Kalamazoo
Detroit
Toledo
Erie
Cleveland
MuClure Camera Test
Pittsburg
Wheeling
Dayton
Cincinnati
Duluth
Hickory
Winston Salem
Greenville
Charlotte
Atlanta
La Grange
Montgomery
Columbus
Macon
Valdosta
Gainesville
Orlando
Tampa
Charlotte Harbor
Ft. Myers
Key West
Miami
Vero Beach
Cape Canaveral
Daytona
Jacksonville
St. Augustine
Florence
Columbia
Augusta
Charleston
Savannah
Lumberton
Rocky Mt.
Elizabeth City
Norfolk
Eastern Shore
Baltimore
Washington
Philadelphia
Atlantic City
Allentown
Manhattan
Long Island
Jamestown
Westfield
Fitchburg
Boston
New Bedford
Gloucester
Waterville
Augusta
Bangor
Flight of Aircraft: 1956
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens Cameras "W" "O" & "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
9 Lens
9 Lens
Scale In Miles
100 50 0 100 200 300 400

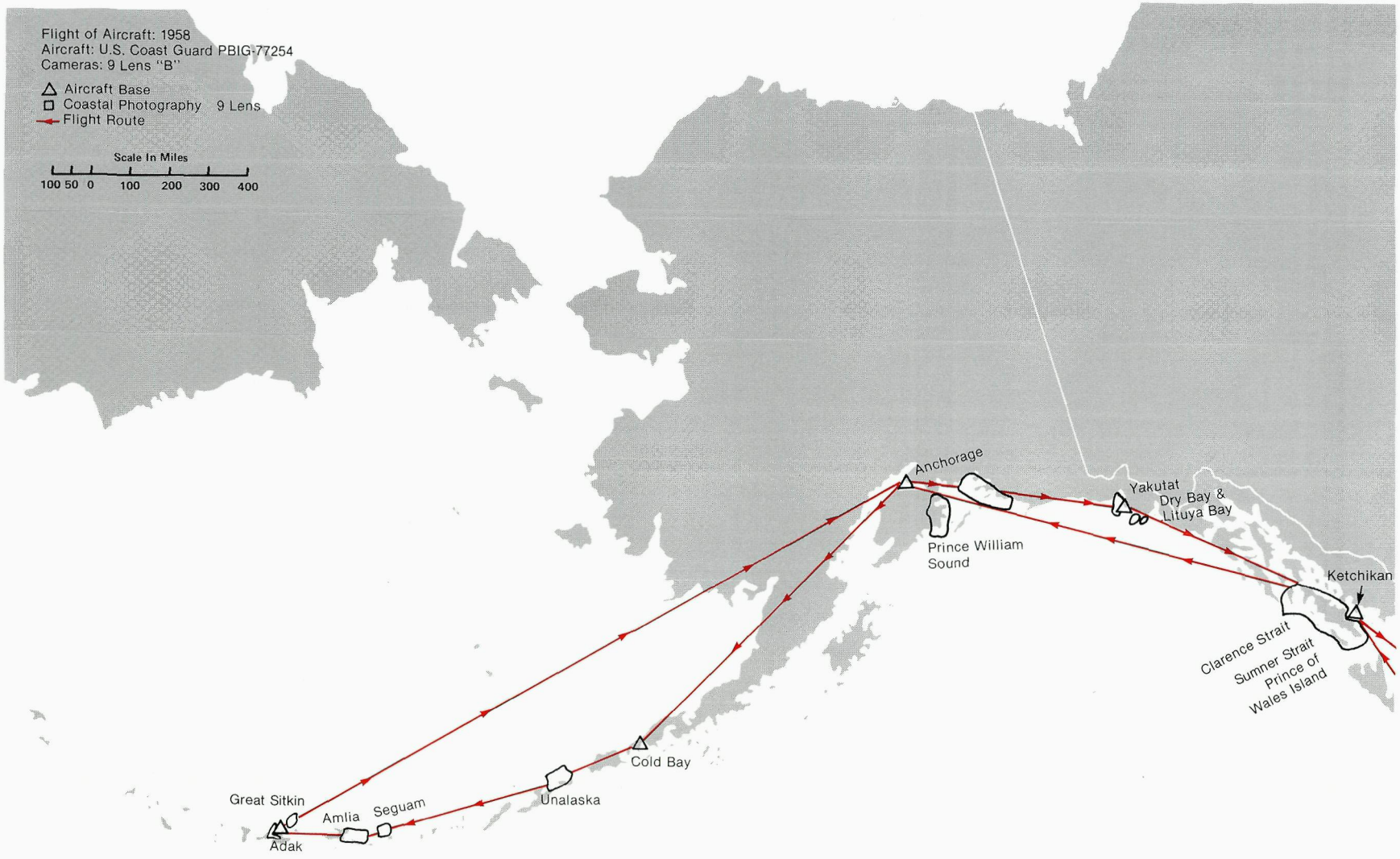

Flight of Aircraft: 1956
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens Cameras "W"
Aircraft Base
Coastal Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Revillagigedo
Ketchikan
Clarence Strt.
Cold Bay
Unimak Isl.

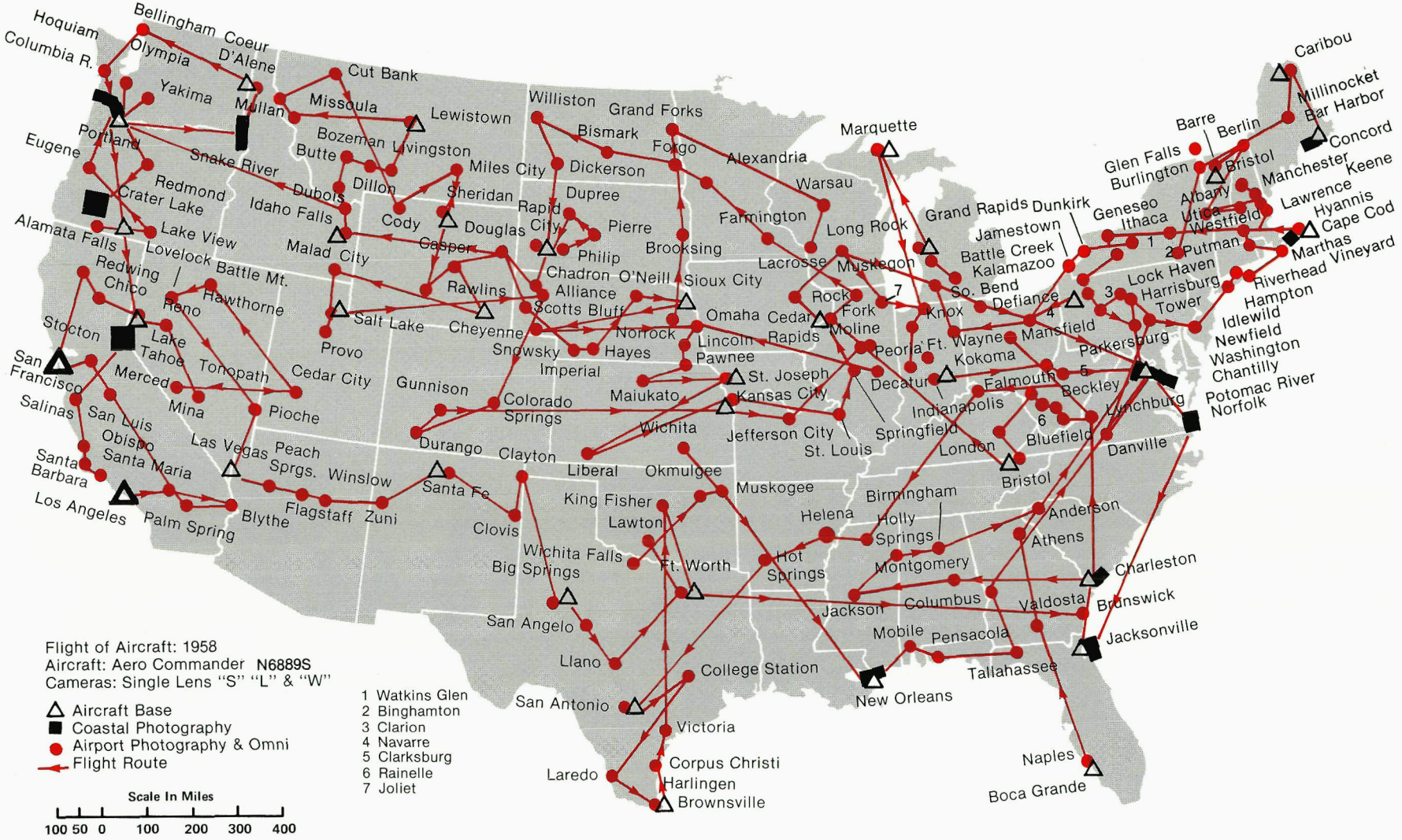

Ellensburg
Spokane
Yakima
Coeur D'Alene
Portland
Walla Walla
Dalles
La Grand
Pennleton
Corvallis
Billings
Willistown
Minot
Fargo
Aberdeen
Watertown
Huron
Klamath Falls
Twin Falls
Ft. Jones
Pocatello
Rawlins
Rock River
Laramie
Ogden
Newton
Scotts Bluff
Wells
Red Bluff
Cheyenne
Bonneville
Rock Springs
Salt Lake City
Sacramento
Stockton
Kremmling
Delta
Grand Junction
Colorado Springs
Denver
Salina
Manhattan
Topeka
Garden City
Milford
Hutchinson
Pueblo
Chanute
Paso Robles
Bakersfield
La Junta
Dodge City
Anthony
Ponca City
Filmore
Daggett
Los Angeles
Riverside
Long Beach
Childress
Wichita Falls
Grand Prairie
Dallas
Waco
Lometa
Juncton
Rocksprings
Laredo
Aransas Pass
Corpus Christi
New Orleans
Sabine Pass
Mississippi & Alabama Coast
Dothan
Valdosta
Tallahassee
Tampa
Palm Beach
Cedar Rapids
Iowa City
Moline
Peoria
Burlington
Louisville
Massena
Plattsburgh
Portland
Watertown
Glenn Falls
Keen
Rochester
Syracuse
Elmira
Hartford
Pottstown
Wilkes Barre
Milton
New York
Williamsport
Phillsburg
Trenton
Strasburg
Johnstown
Harrisburg
Dover
Morgantown
Baltimore
Washington
Portsmouth
Lexington
Hickory
Raleigh
Ashville
Flight of Aircraft: 1957
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens Camera "S" "W" & "L"
Aircraft Base
Coastal Photography
9 Lens
Airport & Omni Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

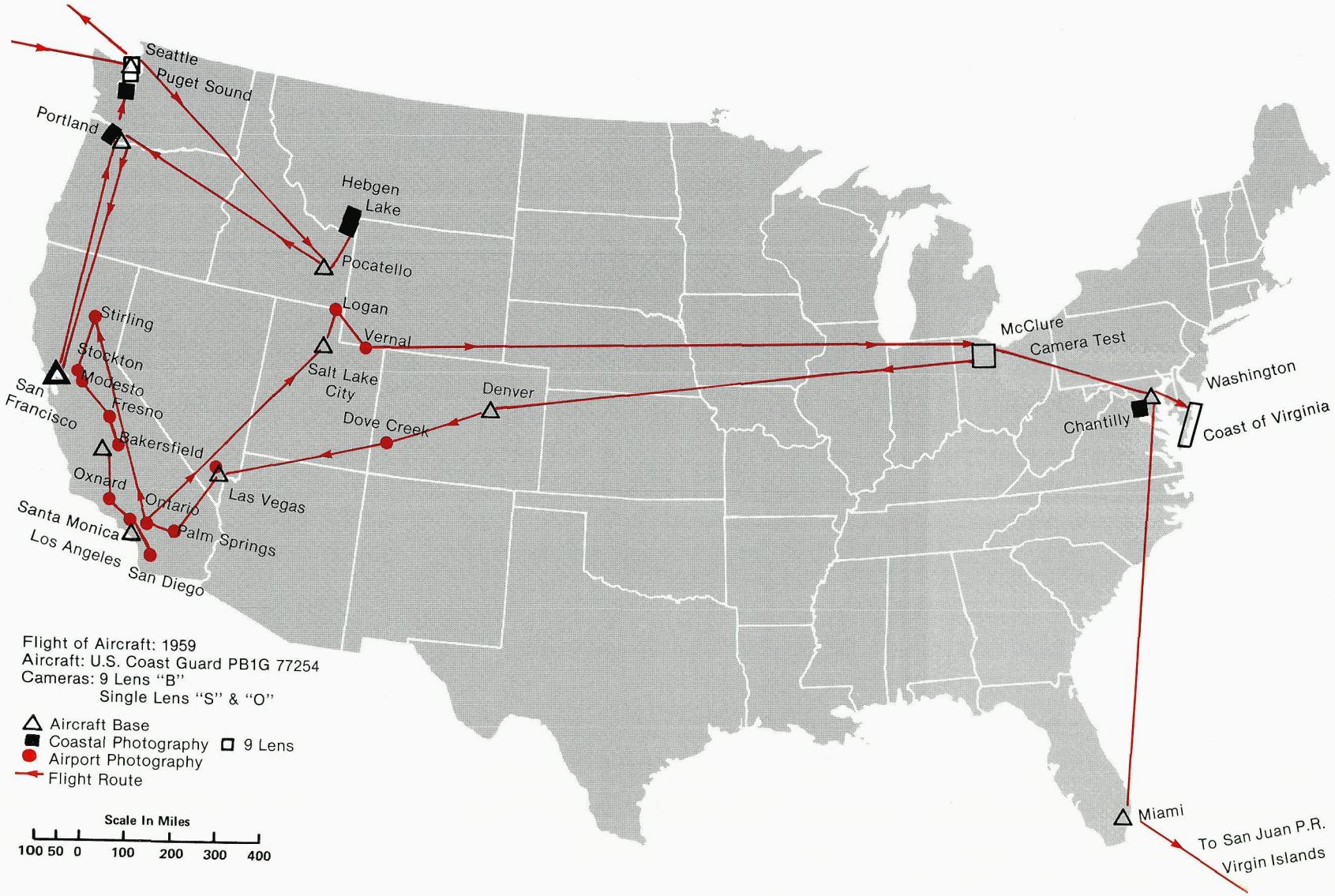

Flight of Aircraft: 1957
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens Camera "S" "W" & "L"
Aircraft Base
Coastal Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Prince William Sound
Cold Bay
Great Sitkin
Adak

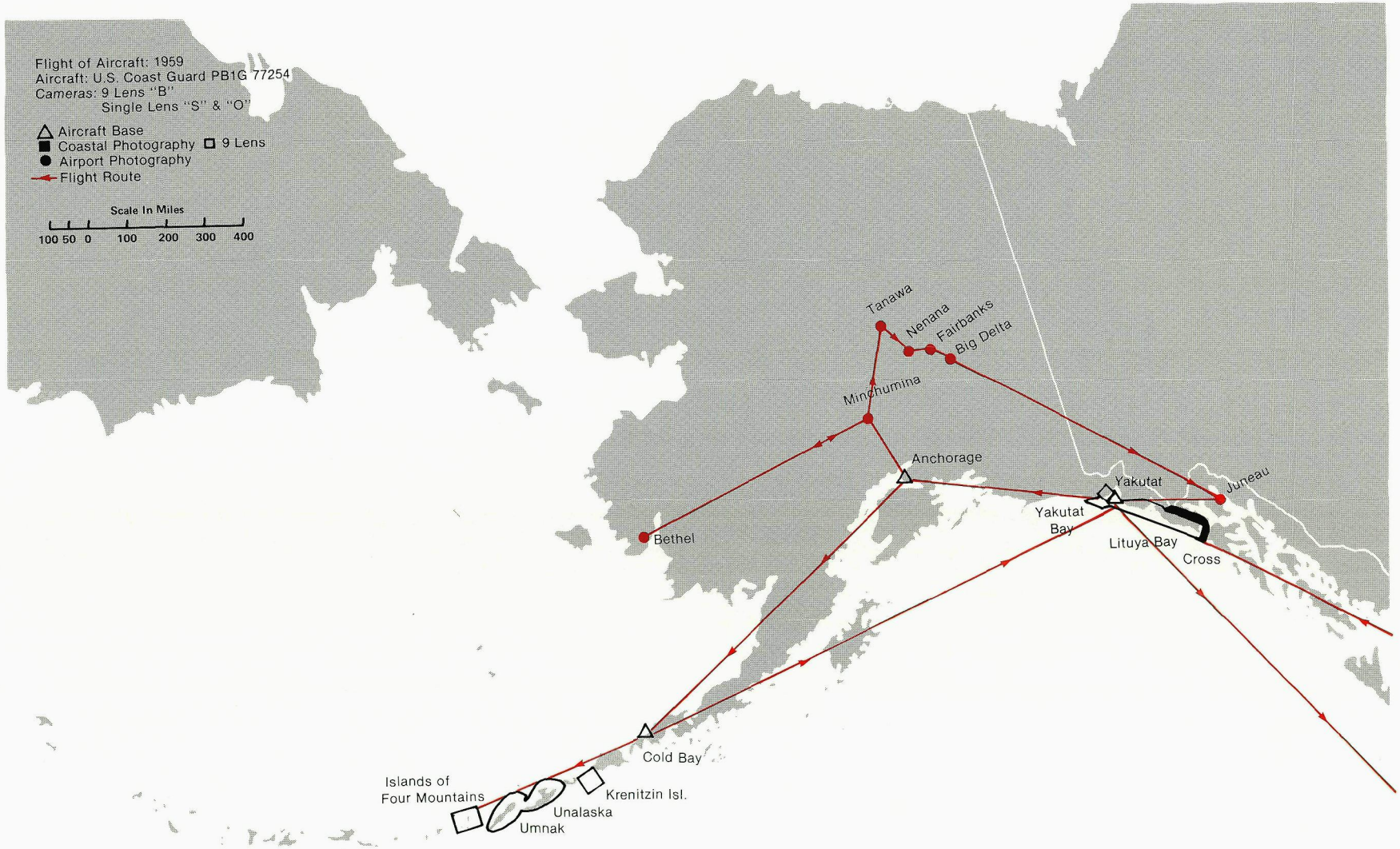

Houlton
Sault Ste. Marie
Saranac
Montpelier
Boston
Wausau
Oshkosh
Traverse City
Eau Claire
Redwood Falls
St. Paul
Lone Rock
Milwaukee
Muskegon
Saginaw
Jefferson
Franklin
Bradford
Calverton
Mason City
Ft. Dodge
Des Moines
Jackson
SA
Dubuque
South Bend
Cleveland
Youngstown
Westminster
N.J. Coast
Delaware R.
Baltimore
Omaha
Ottumwa
Bradford
Champaign
Lima
Mansfield
Lamon
Bloomington
Kirksville
Indianapolis
Shelbyville
Morgantown
Martinsburg
Macon
Quincy
Decatur
Lewis
Kansas City
Vandalia
Frankfort
Columbia
St. Louis
Evansville
Butler
Troy
Owensboro
Huntsville
Neosha
Springfield
Nashville
Knoxville
Tulsa
Centralia
Fayetteville
Dyersboro
Spartanburg
Chattanooga
Crossville
Florence
Atlanta
Charleston
Wichita Falls
Texarkana
El Dorado
Dallas
Grand Prairie
Shreveport
Grigg
Auston
San Antonio
Columbus
Crescent City
Fortuna
Sacramento River
San Francisco
Farrington
Prescott
Grants
Santa Fe
Anton
Coroma
El Centro
Gila Benn
Roswell
Big Spring
Wink
Mafa
San Angelo
Ft. Stockton
Boca Grange
Miami
To
Key
West
Flight of Aircraft: 1957
Aircraft: Aero Commander N 6889S
Cameras: Single Lens "S" "W" & "L"
Aircraft Base
Coastal Photography
Airport Photography & Omni's
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Peotene
2 Roberts

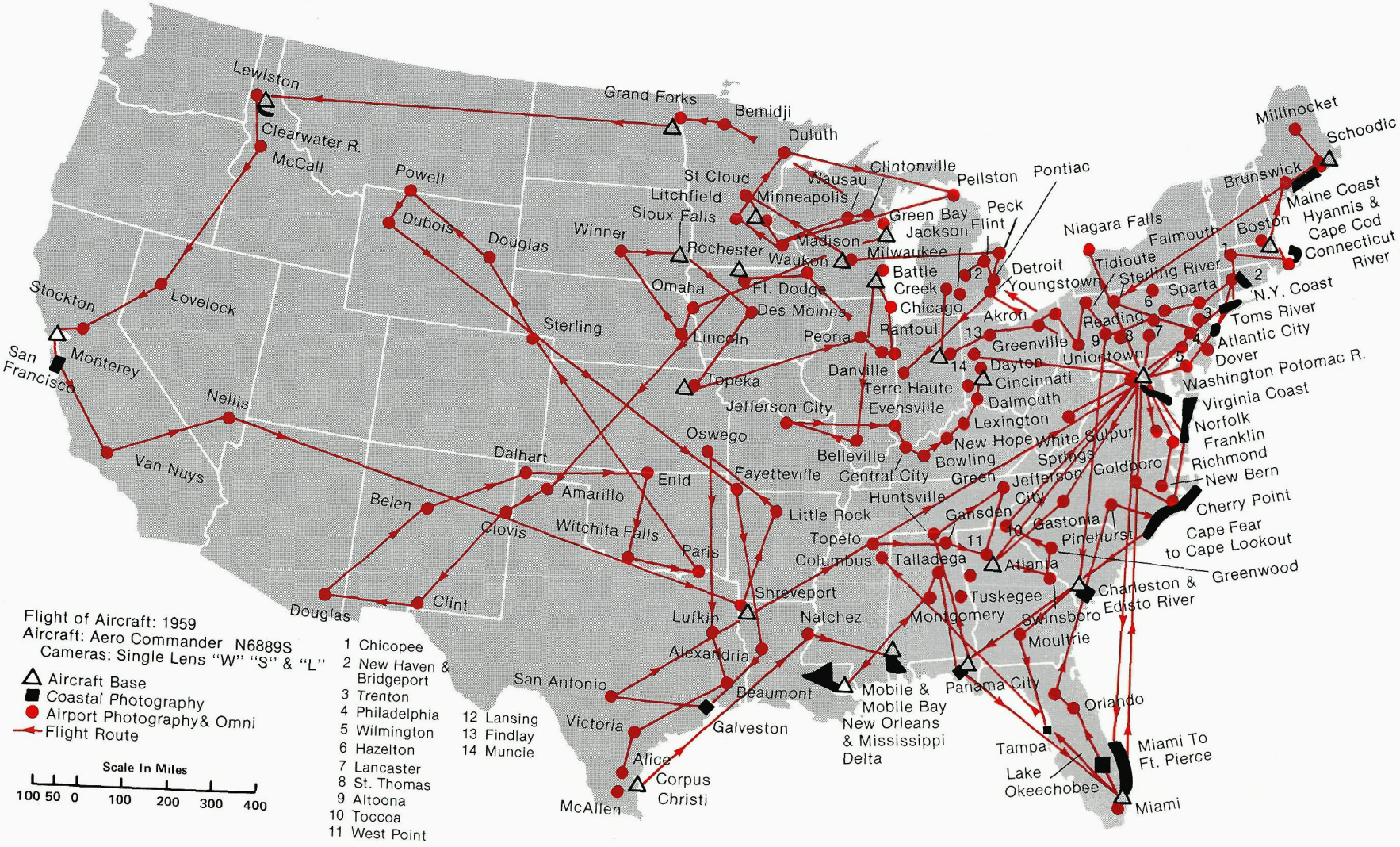

Everett
Seattle
Ellensburg
Toledo
Walla Walla
Rock Springs
Camera Test
McClure
San Francisco
Half Moon Bay
Denver
Grand Junction
Hugo
Washington
Potomac River
Charlotte
Elizabeth City
Los Angeles
New Port Beach
N.C. Coast
Tucson
Georgetown
Charleston
Mississippi Delta
New Orleans
Miami
Key West
San Juan
Puerto Rico
and St. Thomas V.I.
Flight of Aircraft: 1958
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Single Lens "W" & "S"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400

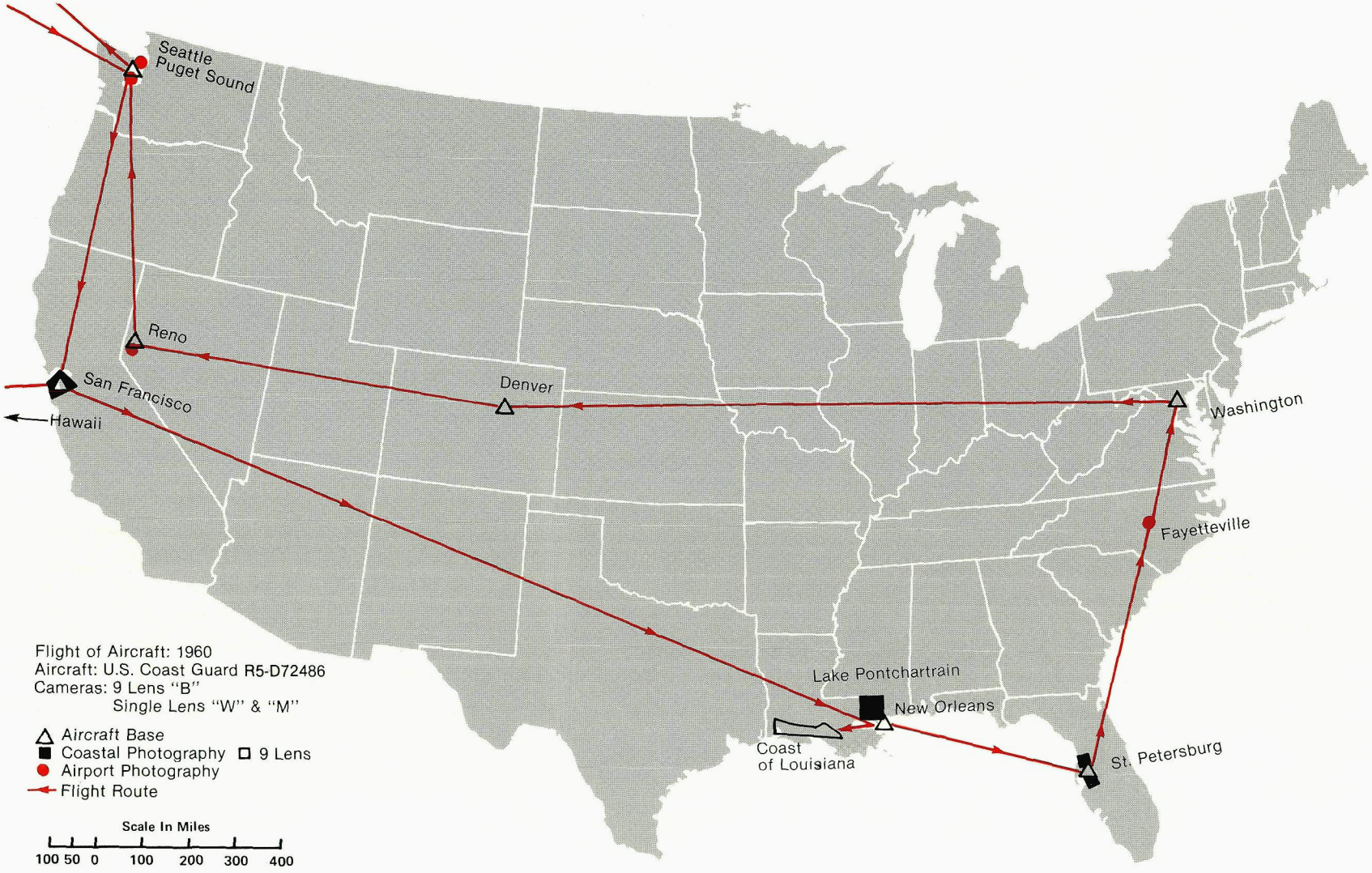

Flight of Aircraft: 1958
Aircraft: U.S. Coast Guard PBIG-77254
Cameras: 9 Lens "B"
Aircraft Base
Coastal Photography 9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Prince William Sound
Yakutat
Dry Bay & Lituya Bay
Ketchikan
Clarence Strait
Sumner Strait
Prince of Wales Island
Cold Bay
Unalaska
Great Sitkin
Amlia
Seguam
Adak

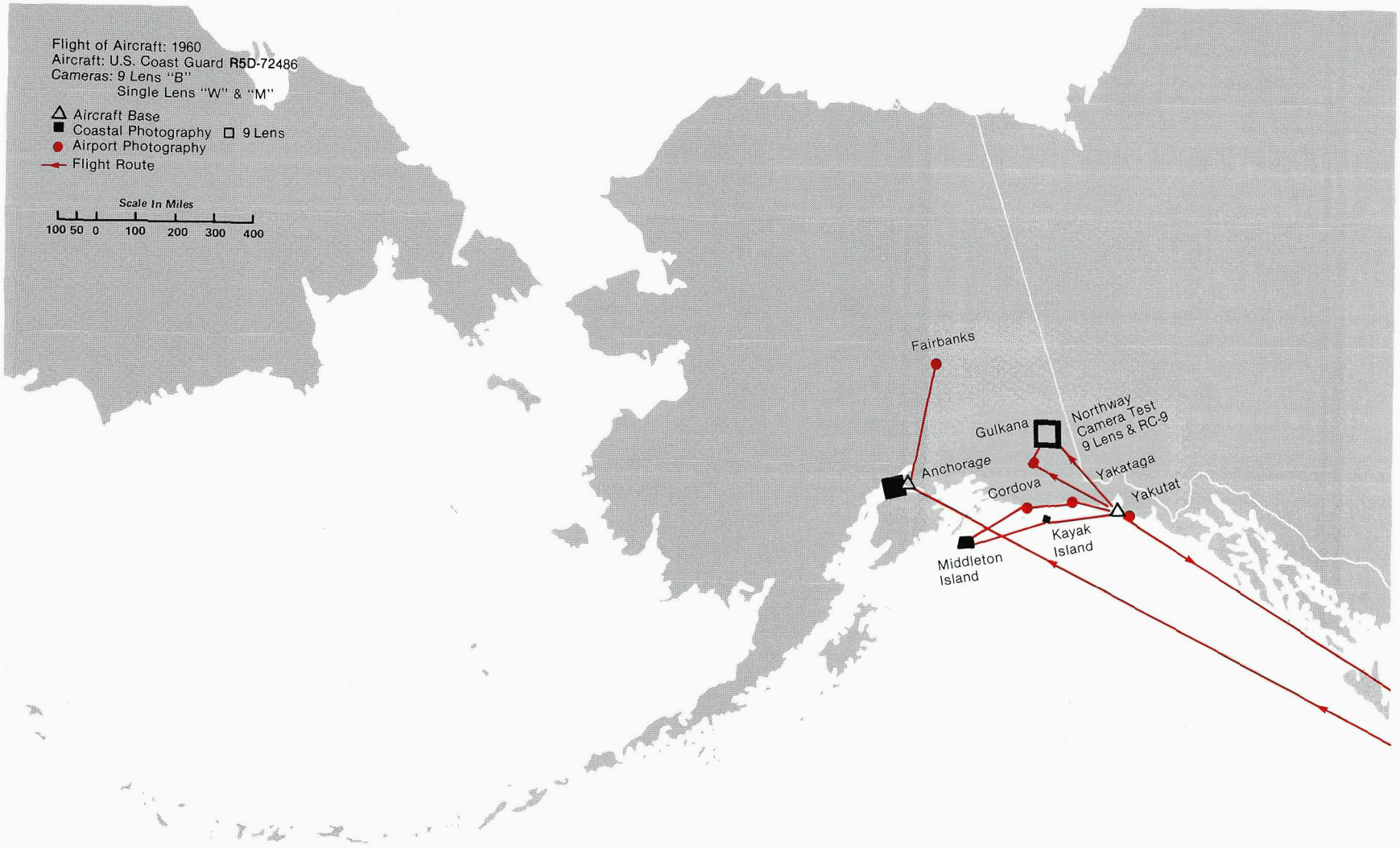

Flight of Aircraft: 1958
Aircraft: Aero Commander N6889S
Cameras: Single Lens "S" "L" & "W"
Aircraft Base
Coastal Photography
Airport Photography & Omni
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Watkins Glen
2 Binghamton
3 Clarion
4 Navarre
5 Clarksburg
6 Rainelle
7 Joliet
Hoquiam
Columbia R.
Bellingham
Coeur D'Alene
Olympia
Yakima
Mullan
Portland
Eugene
Snake River
Redmond
Crater Lake
Alamata Falls
Lake View
Lovelock
Battle Mt.
Redwing
Chico
Reno
Hawthorne
Stocton
Lake Tahoe
San Francisco
Merced
Tonopath
Mina
Pioche
Salinas
San Luis Obispo
Santa Maria
Las Vegas
Peach Sprgs.
Winslow
Santa Barbara
Los Angeles
Palm Spring
Blythe
Flagstaff
Zuni
Cut Bank
Missoula
Lewistown
Bozeman
Livingston
Butte
Dillon
Miles City
Dubois
Idaho Falls
Sheridan
Cody
Douglas
Malad City
Casper
Rawlins
Salt Lake
Cheyenne
Provo
Cedar City
Gunnison
Colorado Springs
Durango
Clayton
Santa Fe
Clovis
Williston
Grand Forks
Bismark
Forgo
Dickerson
Dupree
Rapid City
Pierre
Philip
Chadron
O'Neill
Alliance
Scotts Bluff
Norrock
Snowsky
Hayes
Imperial
Brooksing
Sioux City
Omaha
Lincoln
Pawnee
Maiukato
St. Joseph
Kansas City
Wichita
Jefferson City
St. Louis
Liberal
Okmulgee
Muskogee
King Fisher
Lawton
Wichita Falls
Big Springs
Ft. Worth
San Angelo
Llano
Hot Springs
Helena
Alexandria
Warsau
Farmington
Lacrosse
Long Rock
Cedar Rapids
Rock Fork
Moline
Peoria
Decatur
Springfield
Marquette
Grand Rapids
Muskegon
Knox
So. Bend
Defiance
Ft. Wayne
Kokoma
Indianapolis
Jamestown
Battle Creek
Kalamazoo
Dunkirk
Geneseo
Ithaca
Mansfield
Falmouth
Beckley
Bluefield
London
Bristol
Birmingham
Holly Springs
Montgomery
Jackson
Columbus
Mobile
Pensacola
Tallahassee
New Orleans
Anderson
Athens
Valdosta
Charleston
Brunswick
Jacksonville
Naples
Boca Grande
Lynchburg
Danville
Parkersburg
Lock Haven
Harrisburg
Tower
Glen Falls
Burlington
Barre
Berlin
Albany
Utica
Westfield
Putman
Bristol
Manchester
Keene
Lawrence
Hyannis
Cape Cod
Marthas Vineyard
Riverhead
Hampton
Idlewild
Newfield
Washington
Chantilly
Potomac River
Norfolk
Caribou
Millinocket
Bar Harbor
Concord
Corpus Christi
Harlingen
Brownsville
Laredo
Victoria
College Station
San Antonio

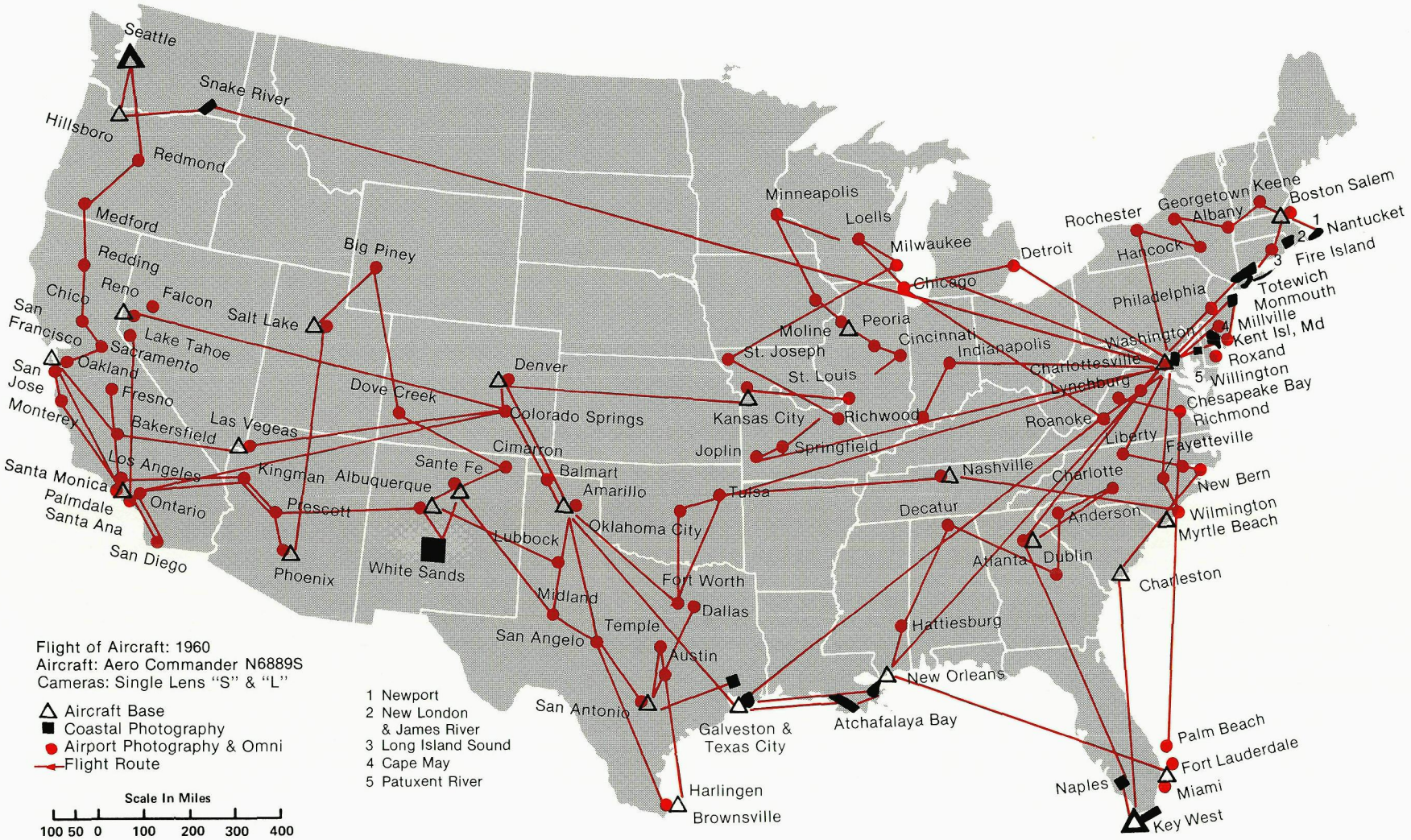

Seattle
Puget Sound
Portland
Hebgen Lake
Pocatello
Logan
Vernal
Stirling
Stockton
Modesto
Fresno
San Francisco
Bakersfield
Oxnard
Santa Monica
Los Angeles
San Diego
Ontario
Palm Springs
Las Vegas
Salt Lake City
Dove Creek
Denver
McClure
Camera Test
Washington
Coast of Virginia
Chantilly
Miami
To San Juan P.R.
Virgin Islands
Flight of Aircraft: 1959
Aircraft: U.S. Coast Guard PB1G 77254
Cameras: 9 Lens "B"
Single Lens "S" & "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

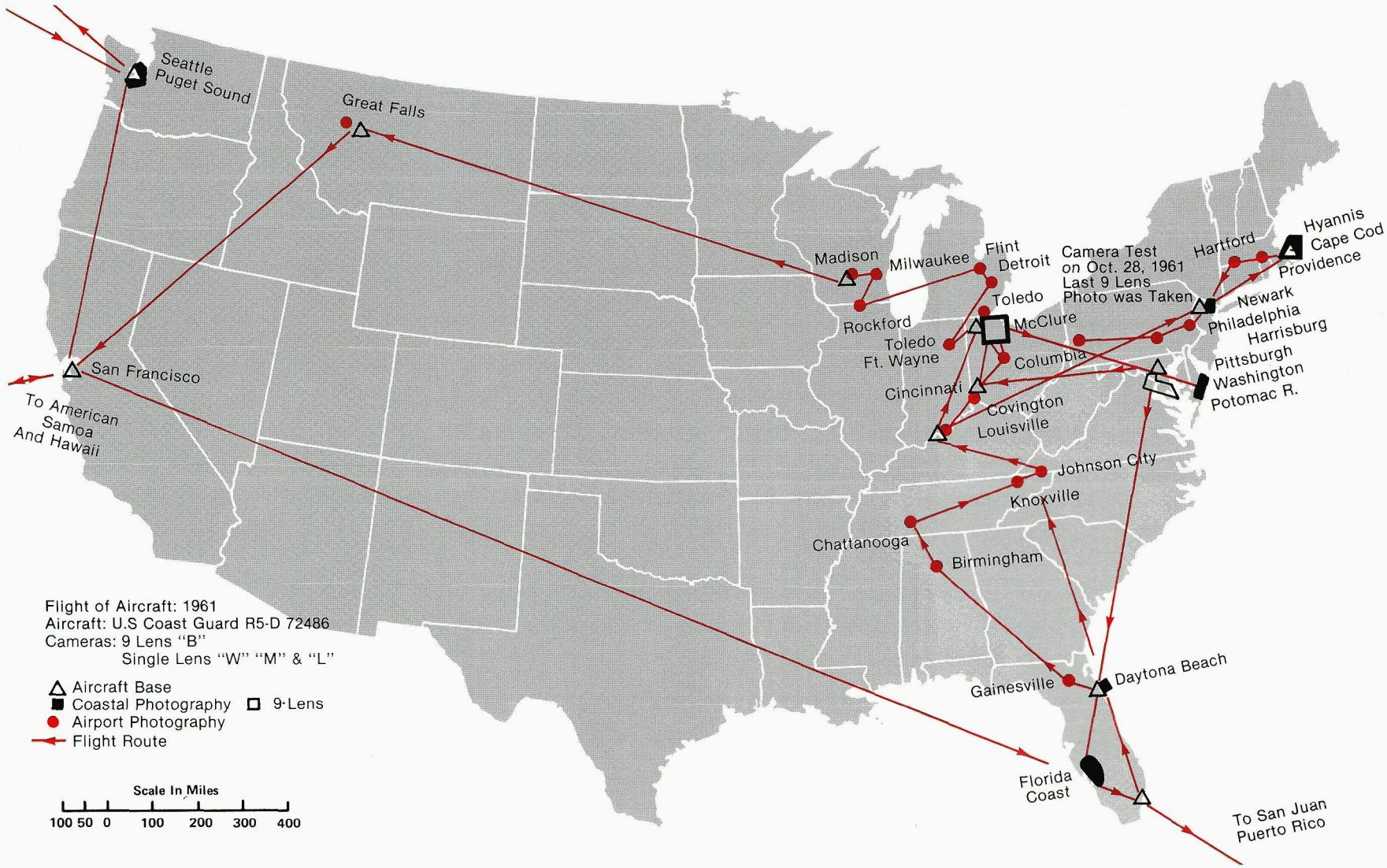

Flight of Aircraft: 1959
Aircraft: U.S. Coast Guard PB1G 77254
Cameras: 9 Lens "B"
Single Lens "S" & "O"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Tanawa
Nenana
Fairbanks
Big Delta
Minchumina
Anchorage
Bethel
Yakutat
Juneau
Yakutat Bay
Lituya Bay
Cross
Cold Bay
Islands of Four Mountains
Krenitzin Isl.
Unalaska
Umnak

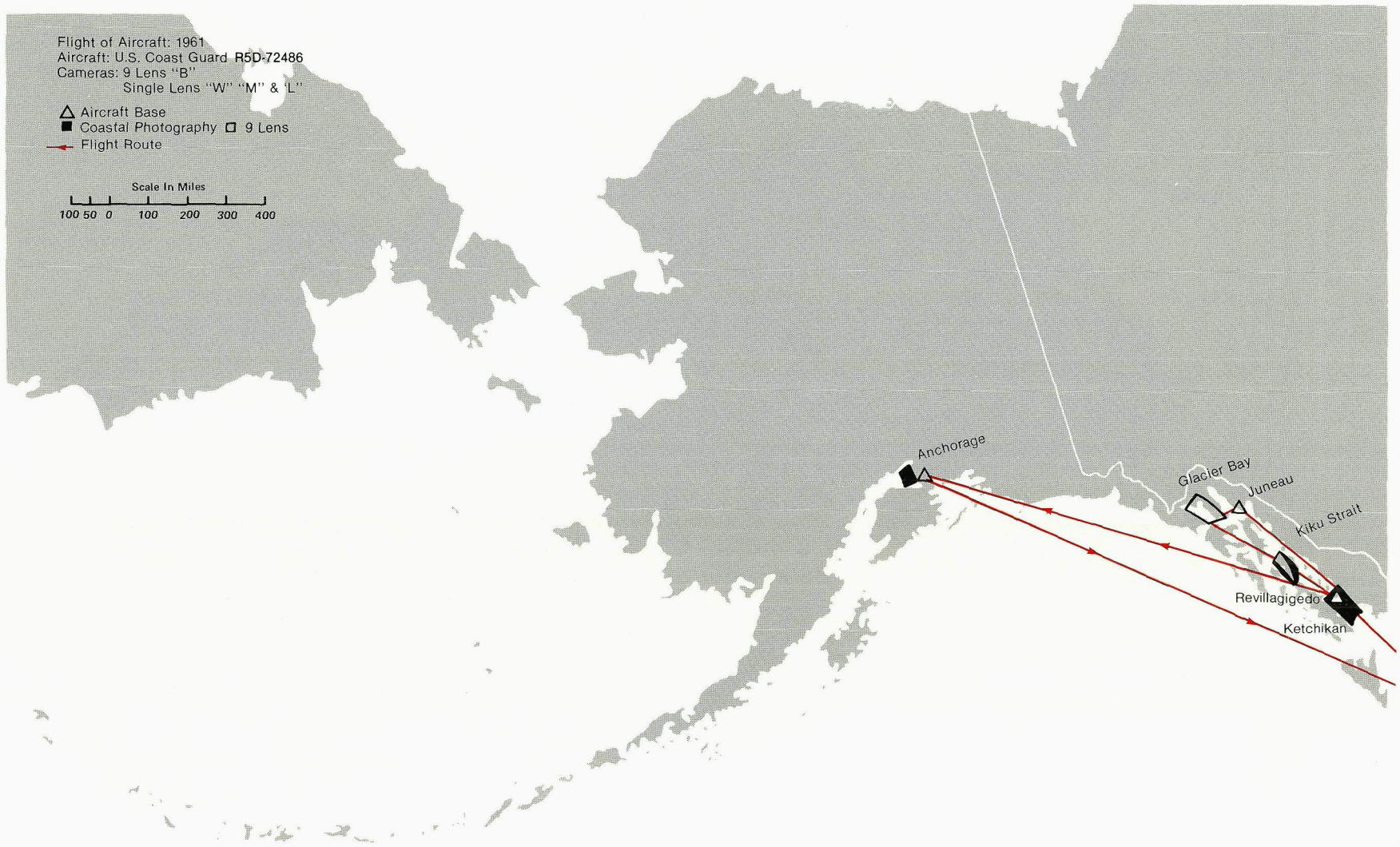

Lewiston
Clearwater R.
McCall
Grand Forks
Bemidji
Duluth
Powell
Dubois
Douglas
Winner
St Cloud
Litchfield
Sioux Falls
Minneapolis
Wausau
Clintonville
Pellston
Pontiac
Green Bay
Jackson
Flint
Peck
Madison
Milwaukee
Waukon
Rochester
Omaha
Ft. Dodge
Des Moines
Battle Creek
Chicago
Detroit
Youngstown
Tidioute
Niagara Falls
Falmouth
Millinocket
Schoodic
Brunswick
Maine Coast
Hyannis &
Cape Cod
Boston
Connecticut River
Sterling River
Sparta
N.Y. Coast
Toms River
Atlantic City
Dover
Washington Potomac R.
Virginia Coast
Norfolk
Franklin
Richmond
New Bern
Cherry Point
Cape Fear
to Cape Lookout
Greenwood
Charleston &
Edisto River
Swinsboro
Moultrie
Orlando
Miami To
Ft. Pierce
Miami
Lake
Okeechobee
Tampa
Panama City
Mobile &
Mobile Bay
New Orleans
& Mississippi
Delta
Montgomery
Tuskegee
Atlanta
Talladega
Columbus
Topelo
Huntsville
Gansden
Gastonia
Pinehurst
Goldboro
Jefferson
City
White Sulpur
Springs
Bowling
Green
New Hope
Lexington
Dalmouth
Cincinnati
Dayton
Greenville
Uniontown
Reading
Akron
Rantoul
Peoria
Danville
Terre Haute
Evensville
Belleville
Central City
Jefferson City
Topeka
Lincoln
Sterling
Oswego
Fayetteville
Little Rock
Shreveport
Natchez
Lufkin
Alexandria
Beaumont
Galveston
San Antonio
Victoria
Alice
Corpus
Christi
McAllen
Douglas
Clint
Paris
Witchita Falls
Clovis
Amarillo
Belen
Enid
Dalhart
Van Nuys
Nellis
Monterey
San
Francisco
Stockton
Lovelock
Flight of Aircraft: 1959
Aircraft: Aero Commander N6889S
Cameras: Single Lens "W" "S" & "L"
Aircraft Base
Coastal Photography
Airport Photography& Omni
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Chicopee
2 New Haven &
Bridgeport
3 Trenton
4 Philadelphia
5 Wilmington
6 Hazelton
7 Lancaster
8 St. Thomas
9 Altoona
10 Toccoa
11 West Point
12 Lansing
13 Findlay
14 Muncie

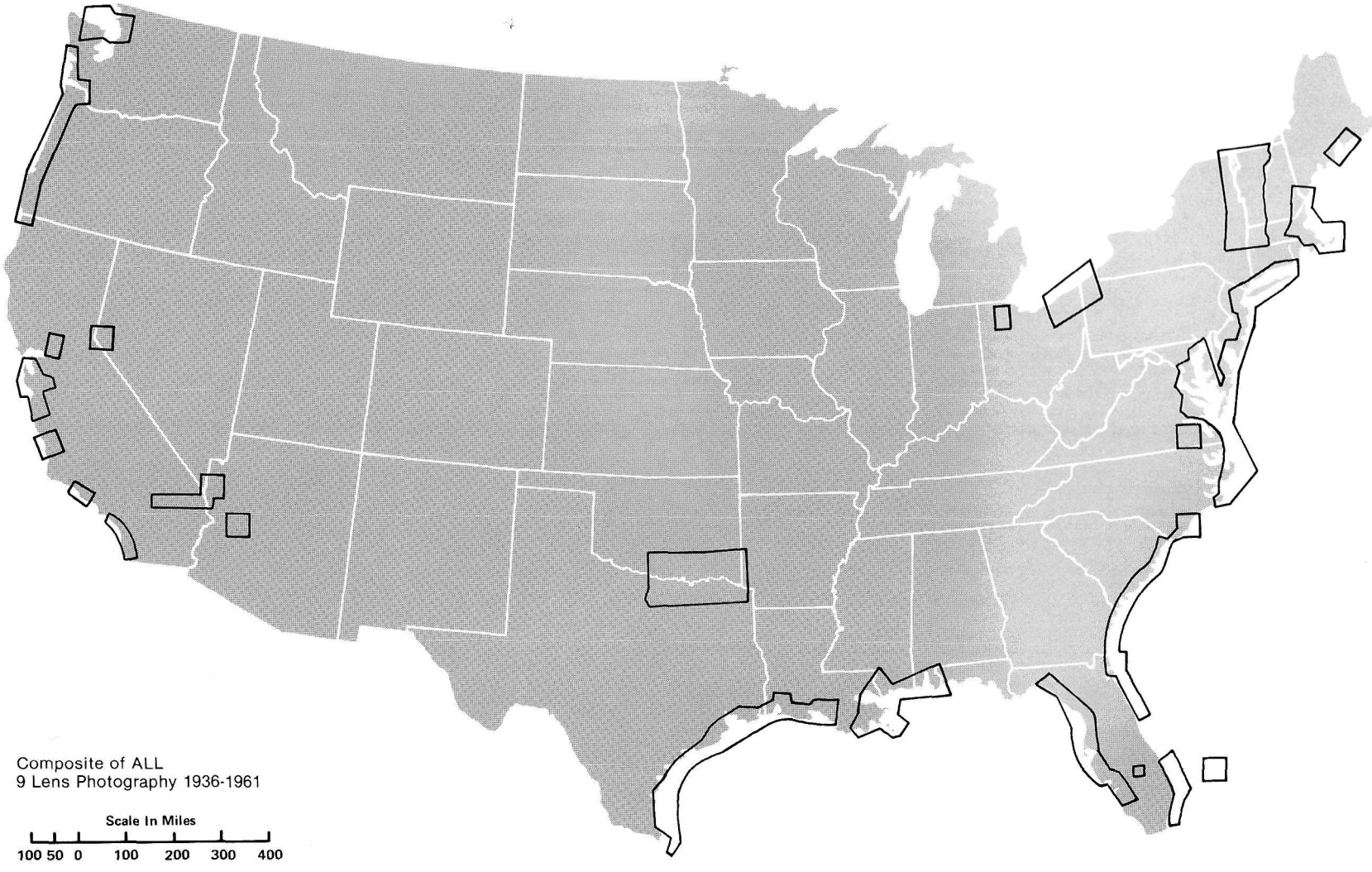

Seattle
Puget Sound
Reno
San Francisco
Hawaii
Denver
Washington
Fayetteville
Lake Pontchartrain
New Orleans
Coast
of Louisiana
St. Petersburg
Flight of Aircraft: 1960
Aircraft: U.S. Coast Guard R5-D72486
Cameras: 9 Lens "B"
Single Lens "W" & "M"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1960
Aircraft: U.S. Coast Guard R5D-72486
Cameras: 9 Lens "B"
Single Lens "W" & "M"
Aircraft Base
Coastal Photography
9 Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Fairbanks
Gulkana
Northway
Camera Test
9 Lens & RC-9
Anchorage
Cordova
Yakataga
Yakutat
Kayak
Island
Middleton
Island

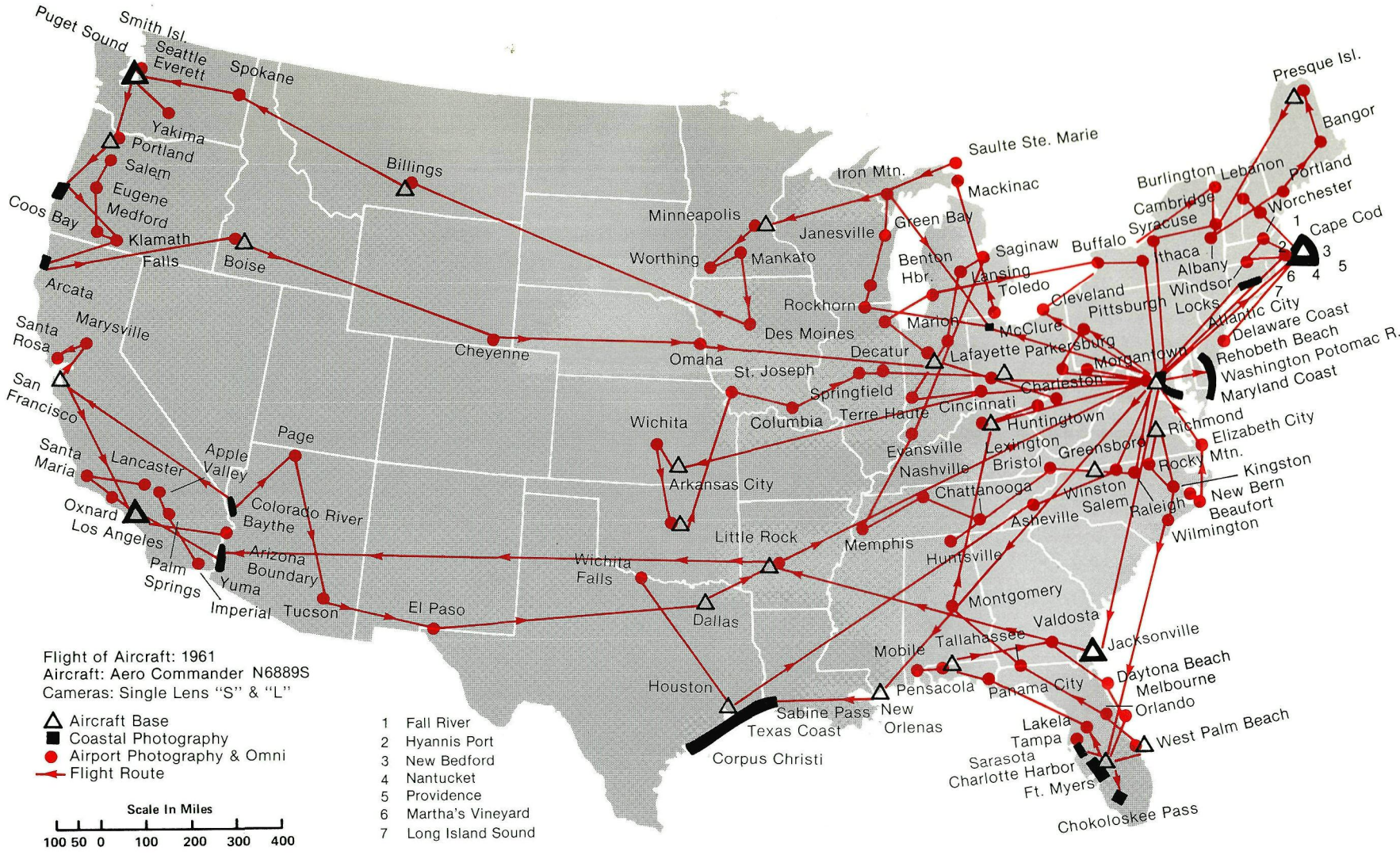

Seattle
Snake River
Hillsboro
Redmond
Medford
Redding
Chico
Reno
Falcon
Salt Lake
Big Piney
San Francisco
Lake Tahoe
Sacramento
Oakland
San Jose
Fresno
Monterey
Bakersfield
Las Vegeas
Dove Creek
Denver
Colorado Springs
Cimarron
Sante Fe
Balmart
Amarillo
Albuquerque
Kingman
Los Angeles
Santa Monica
Palmdale
Santa Ana
Ontario
San Diego
Prescott
Phoenix
White Sands
Lubbock
Midland
San Angelo
Temple
Fort Worth
Dallas
Austin
San Antonio
Harlingen
Brownsville
Galveston &
Texas City
Atchafalaya Bay
New Orleans
Hattiesburg
Minneapolis
Loells
Milwaukee
Chicago
Detroit
Moline
Peoria
St. Joseph
St. Louis
Kansas City
Richwood
Joplin
Springfield
Tulsa
Oklahoma City
Cincinnati
Indianapolis
Nashville
Decatur
Atlanta
Charlotte
Anderson
Dublin
Charleston
Rochester
Georgetown
Albany
Keene
Boston
Salem
Nantucket
Fire Island
Totewich
Monmouth
Millville
Kent Isl, Md
Roxand
Willington
Chesapeake Bay
Richmond
Hancock
Philadelphia
Washington
Charlottesville
Lynchburg
Roanoke
Liberty
Fayetteville
New Bern
Wilmington
Myrtle Beach
Palm Beach
Fort Lauderdale
Miami
Naples
Key West
Flight of Aircraft: 1960
Aircraft: Aero Commander N6889S
Cameras: Single Lens "S" & "L"
Aircraft Base
Coastal Photography
Airport Photography & Omni
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Newport
2 New London
& James River
3 Long Island Sound
4 Cape May
5 Patuxent River

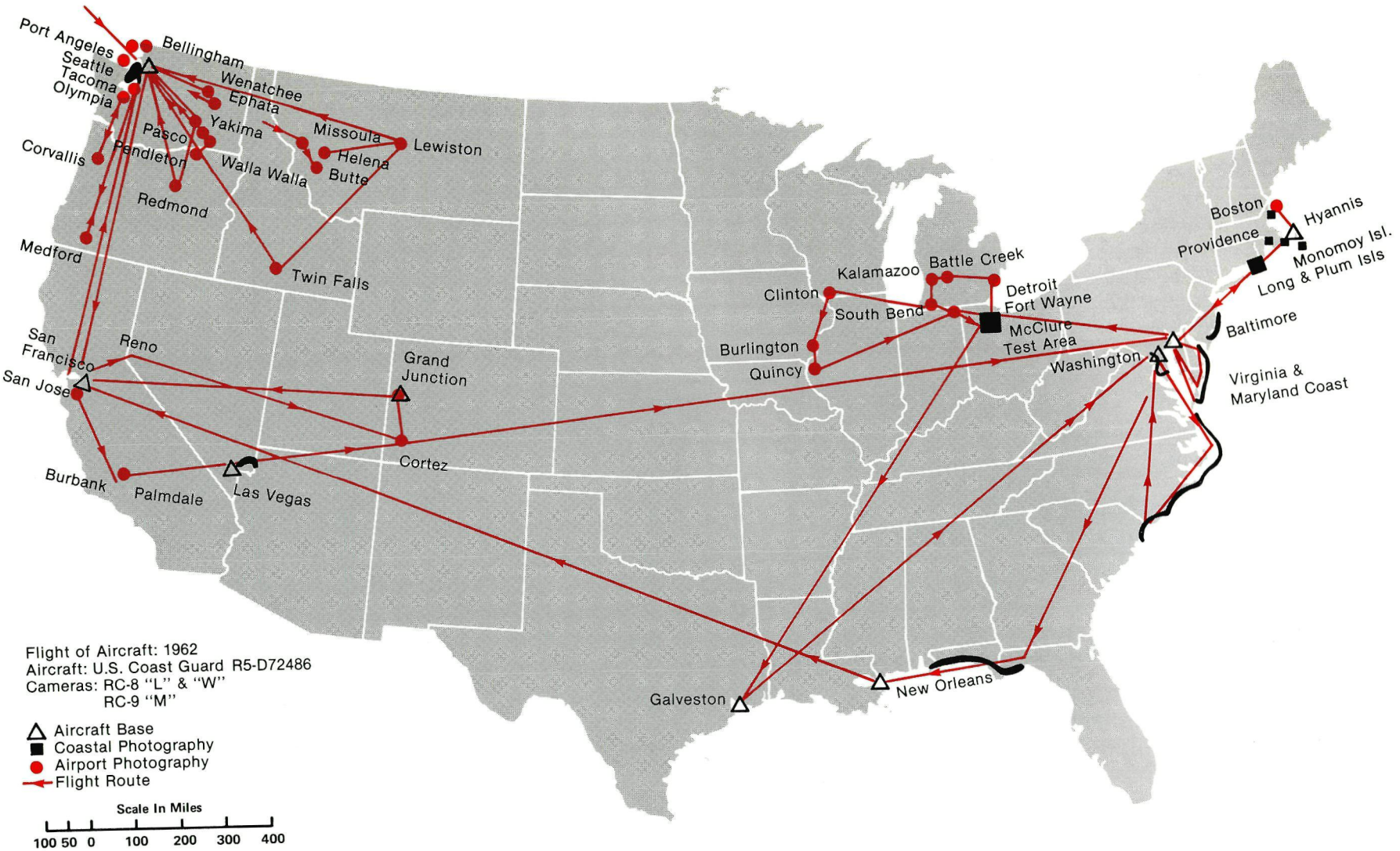

Seattle
Puget Sound
Great Falls
Madison
Milwaukee
Flint
Detroit
Camera Test
on Oct. 28, 1961
Last 9 Lens
Photo was Taken
Hartford
Hyannis
Cape Cod
Providence
Toledo
Rockford
Toledo
Ft. Wayne
McClure
Columbia
Newark
Philadelphia
Harrisburg
Pittsburgh
Washington
Potomac R.
San Francisco
To American
Samoa
And Hawaii
Cincinnati
Covington
Louisville
Johnson City
Knoxville
Chattanooga
Birmingham
Gainesville
Daytona Beach
Florida
Coast
To San Juan
Puerto Rico
Flight of Aircraft: 1961
Aircraft: U.S Coast Guard R5-D 72486
Cameras: 9 Lens "B"
Single Lens "W" "M" & "L"
Aircraft Base
Coastal Photography
9-Lens
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

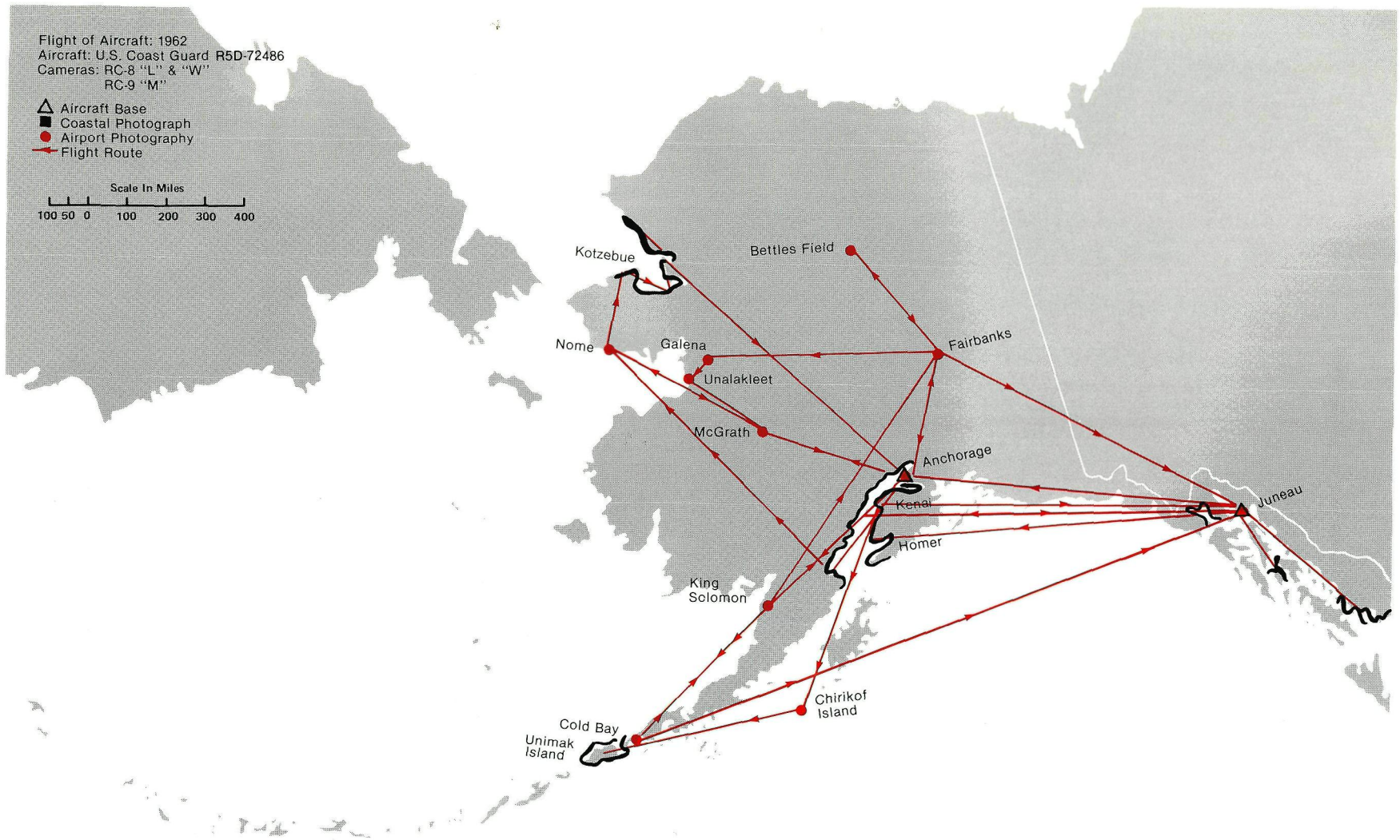

Flight of Aircraft: 1961
Aircraft: U.S. Coast Guard R5D-72486
Cameras: 9 Lens "B"
Single Lens "W" "M" & "L"
Aircraft Base
Coastal Photography
9 Lens
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Glacier Bay
Juneau
Kiku Strait
Revillagigedo
Ketchikan

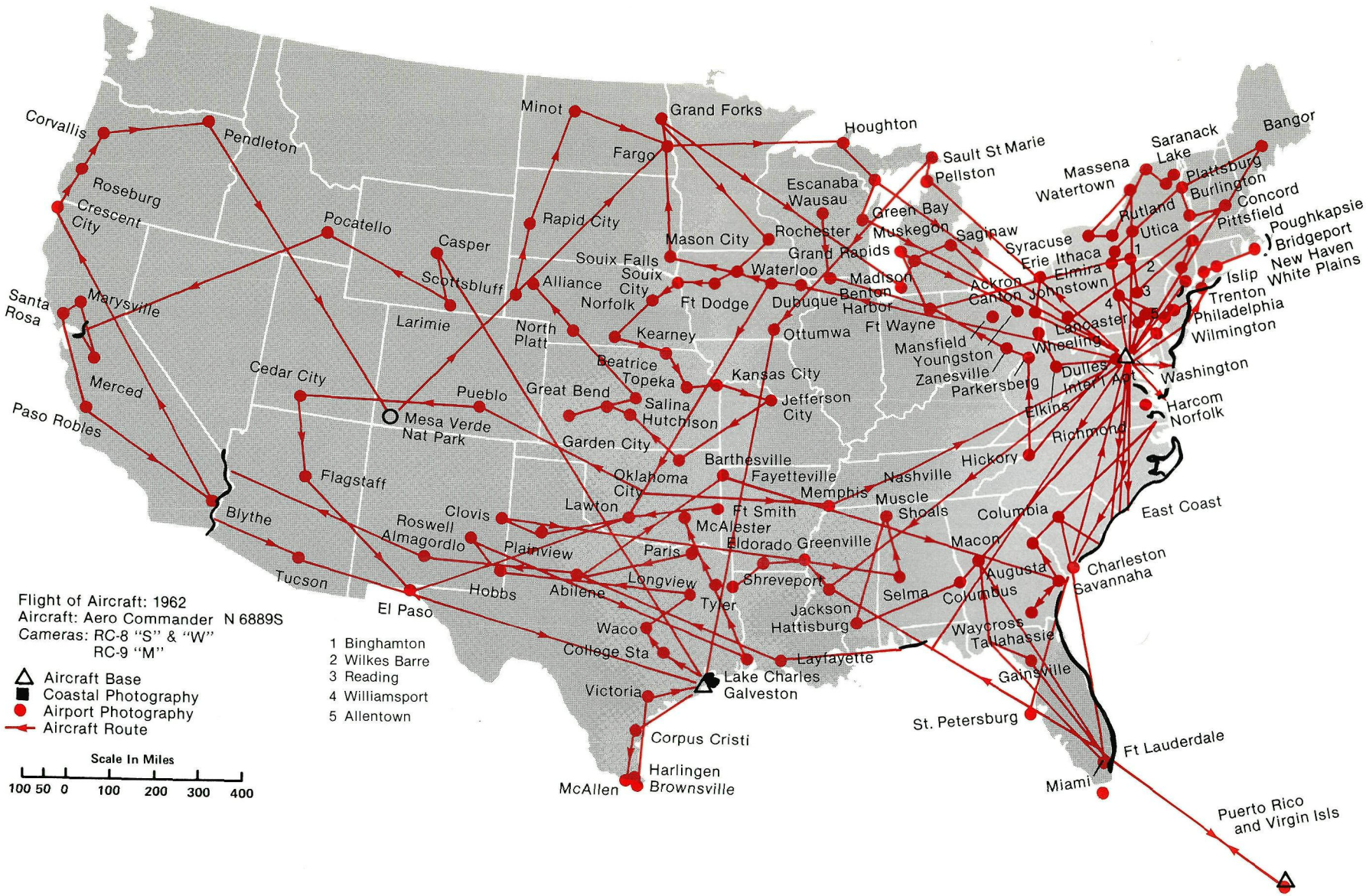

Composite of ALL
9 Lens Photography 1936-1961
Scale In Miles
100 50 0 100 200 300 400

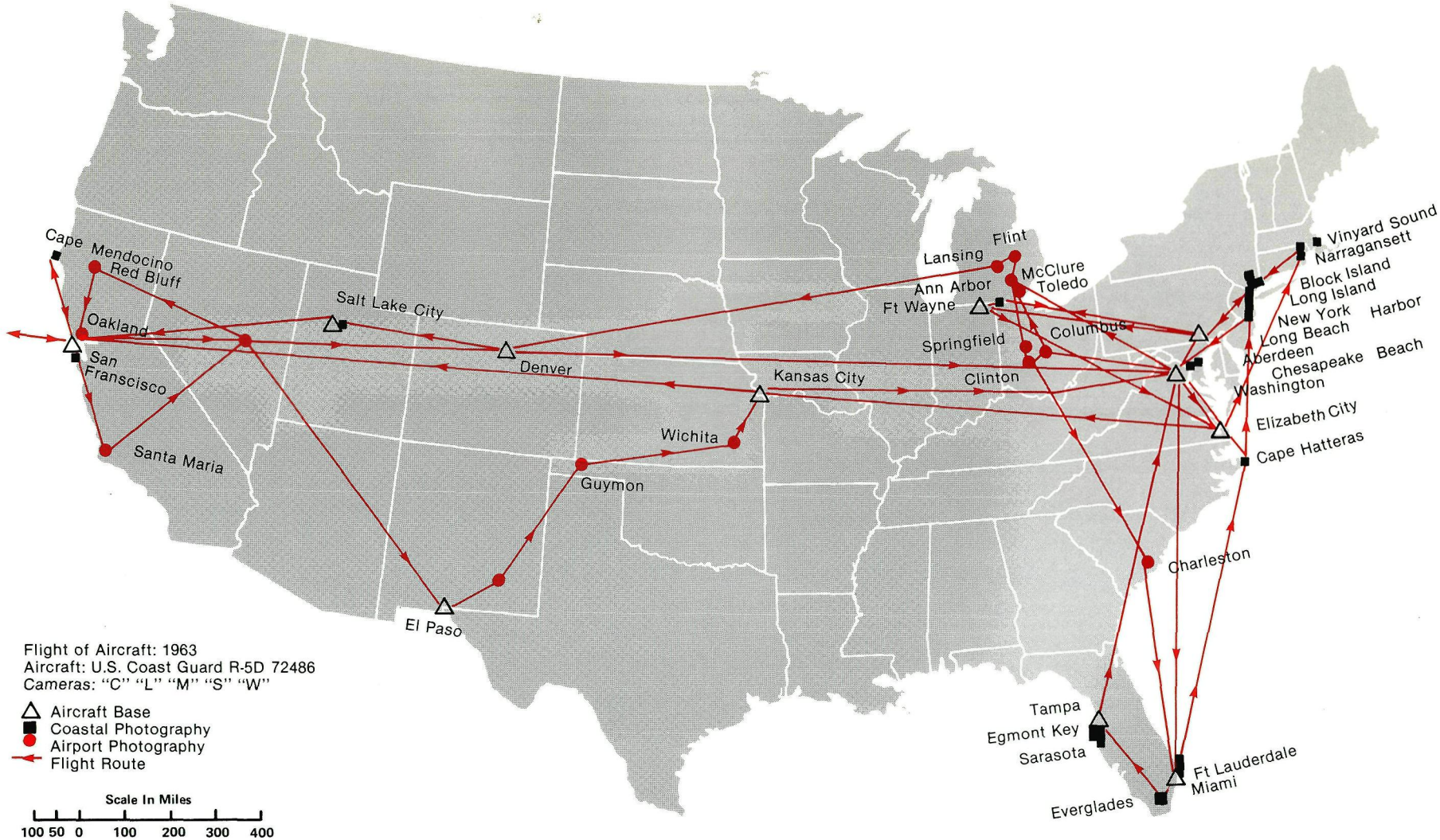
Composite of ALL
9 Lens Photography 1936-1961
Scale In Miles
100 50 0 100 200 300 400

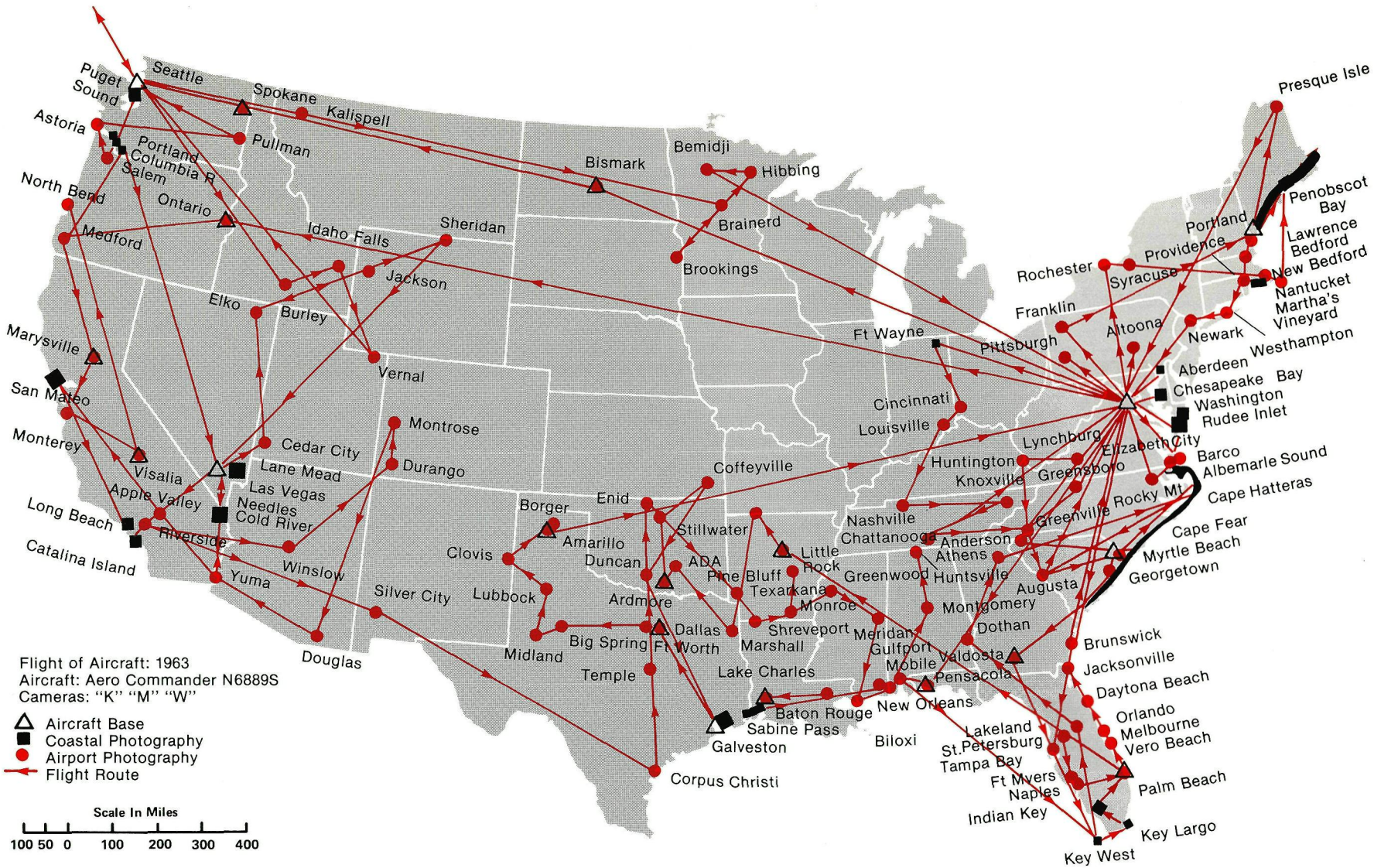

Puget Sound
Smith Isl.
Seattle
Everett
Spokane
Yakima
Portland
Salem
Eugene
Medford
Coos Bay
Klamath Falls
Boise
Billings
Arcata
Marysville
Santa Rosa
San Francisco
Santa Maria
Lancaster
Apple Valley
Page
Oxnard
Los Angeles
Colorado River
Baythe
Arizona Boundary
Palm Springs
Yuma
Imperial
Tucson
El Paso
Cheyenne
Minneapolis
Worthing
Mankato
Omaha
Des Moines
Rockhorn
St. Joseph
Wichita
Arkansas City
Columbia
Springfield
Wichita Falls
Little Rock
Dallas
Houston
Corpus Christi
Sabine Pass
Texas Coast
Saulte Ste. Marie
Iron Mtn.
Mackinac
Janesville
Green Bay
Benton Hbr.
Saginaw
Lansing
Toledo
Marion
McClure
Decatur
Lafayette
Terre Haute
Evansville
Nashville
Memphis
Chattanooga
Huntsville
Mobile
Pensacola
New Orlenas
Montgomery
Tallahassee
Valdosta
Jacksonville
Daytona Beach
Melbourne
Orlando
Lakela
Tampa
Sarasota
Charlotte Harbor
Ft. Myers
West Palm Beach
Chokoloskee Pass
Panama City
Buffalo
Cleveland
Pittsburgh
Parkersburg
Morgantown
Charleston
Cincinnati
Huntingtown
Lexington
Bristol
Greensboro
Winston Salem
Asheville
Raleigh
Wilmington
Kingston
New Bern
Beaufort
Richmond
Elizabeth City
Rocky Mtn.
Syracuse
Ithaca
Albany
Windsor Locks
Burlington
Lebanon
Cambridge
Portland
Worchester
Presque Isl.
Bangor
Cape Cod
Atlantic City
Delaware Coast
Rehobeth Beach
Washington Potomac R.
Maryland Coast
1 Fall River
2 Hyannis Port
3 New Bedford
4 Nantucket
5 Providence
6 Martha's Vineyard
7 Long Island Sound
Flight of Aircraft: 1961
Aircraft: Aero Commander N6889S
Cameras: Single Lens "S" & "L"
Aircraft Base
Coastal Photography
Airport Photography & Omni
Flight Route
Scale In Miles
100 50 0 100 200 300 400

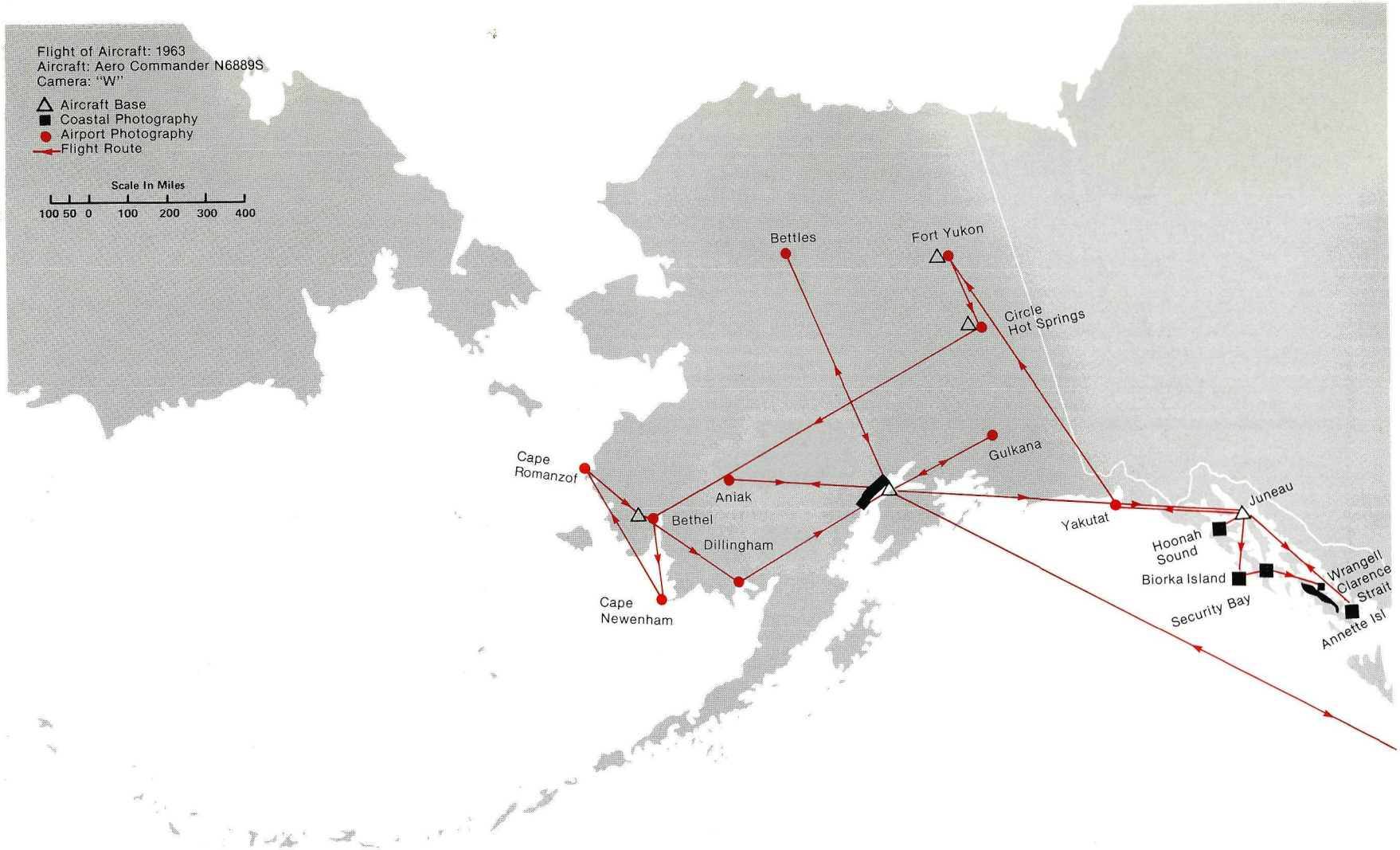

Port Angeles
Bellingham
Seattle
Tacoma
Olympia
Wenatchee
Ephata
Yakima
Pasco
Pendleton
Walla Walla
Missoula
Helena
Butte
Lewiston
Corvallis
Redmond
Medford
Twin Falls
San Francisco
Reno
San Jose
Grand Junction
Cortez
Burbank
Palmdale
Las Vegas
Clinton
Kalamazoo
Battle Creek
South Bend
Detroit
Fort Wayne
McClure Test Area
Burlington
Quincy
Washington
Boston
Hyannis
Providence
Monomoy Isl.
Long & Plum Isls
Baltimore
Virginia & Maryland Coast
Galveston
New Orleans
Flight of Aircraft: 1962
Aircraft: U.S. Coast Guard R5-D72486
Cameras: RC-8 "L" & "W"
RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

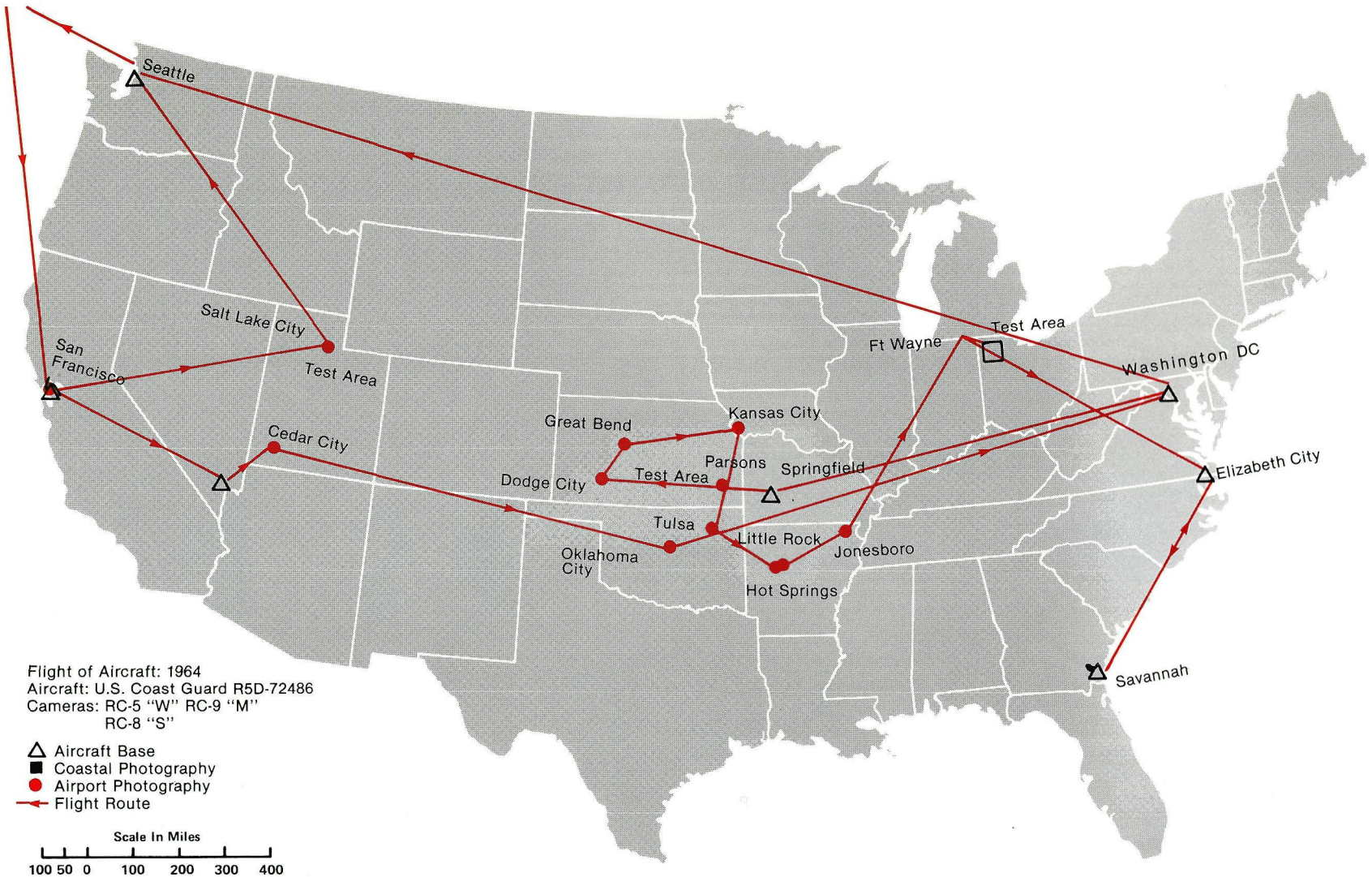

Flight of Aircraft: 1962
Aircraft: U.S. Coast Guard R5D-72486
Cameras: RC-8 "L" & "W"
RC-9 "M"
Aircraft Base
Coastal Photograph
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Kotzebue
Bettles Field
Nome
Galena
Fairbanks
Unalakleet
McGrath
Anchorage
Kenai
Juneau
Homer
King Solomon
Chirikof Island
Cold Bay
Unimak Island

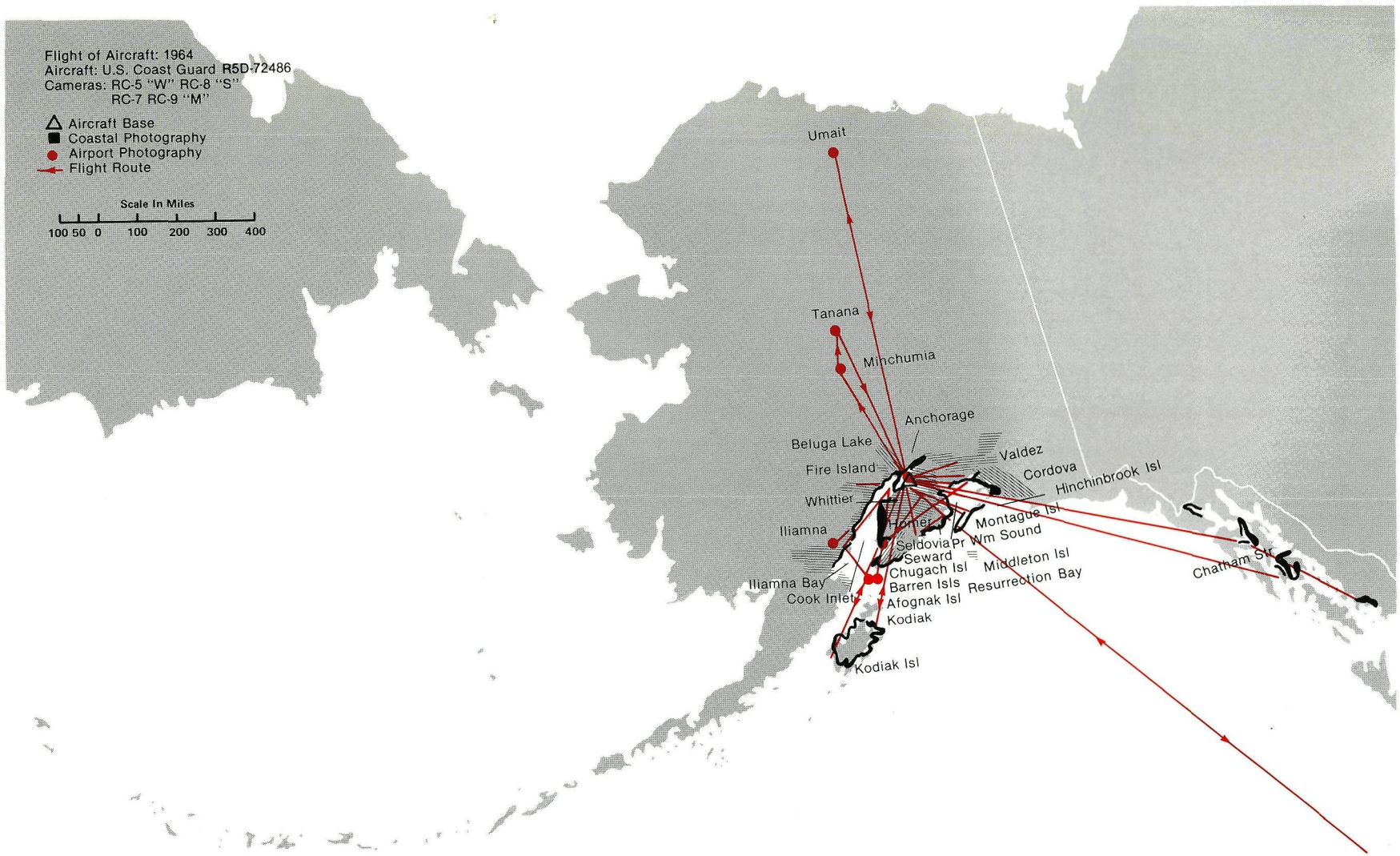

Corvallis
Pendleton
Roseburg
Crescent City
Santa Rosa
Marysville
Merced
Paso Robles
Blythe
Tucson
Pocatello
Casper
Scottsbluff
Larimie
Cedar City
Mesa Verde Nat Park
Pueblo
Flagstaff
Roswell
Almagordlo
Clovis
Plainview
Hobbs
El Paso
Minot
Rapid City
Alliance
North Platt
Great Bend
Garden City
Lawton
Abilene
Waco
College Sta
Victoria
Corpus Cristi
McAllen
Harlingen
Brownsville
Grand Forks
Fargo
Souix Falls
Souix City
Norfolk
Kearney
Beatrice
Topeka
Salina
Hutchison
Oklahoma City
Paris
Longview
Tyler
Lake Charles
Galveston
Mason City
Ft Dodge
Kansas City
Jefferson City
Barthesville
Fayetteville
Ft Smith
McAlester
Eldorado
Greenville
Shreveport
Jackson
Hattisburg
Layfayette
Houghton
Escanaba
Wausau
Rochester
Waterloo
Dubuque
Ottumwa
Green Bay
Muskegon
Grand Rapids
Madison
Benton Harbor
Ft Wayne
Sault St Marie
Pellston
Saginaw
Ackron
Canton
Mansfield
Youngston
Zanesville
Parkersberg
Wheeling
Dulles
Inter'l Apt
Elkins
Hickory
Nashville
Muscle Shoals
Selma
Macon
Columbus
Augusta
Waycross
Tallahassie
Gainsville
St. Petersburg
Miami
Ft Lauderdale
Puerto Rico and Virgin Isls
Columbia
Charleston
Savannaha
East Coast
Richmond
Washington
Harcom
Norfolk
Lancaster
Syracuse
Erie
Ithaca
Elmira
Johnstown
Massena
Watertown
Saranack Lake
Plattsburg
Burlington
Rutland
Utica
Concord
Pittsfield
Poughkapsie
Bridgeport
New Haven
White Plains
Islip
Trenton
Philadelphia
Wilmington
Bangor
1
2
3
4
5
Flight of Aircraft: 1962
Aircraft: Aero Commander N 6889S
Cameras: RC-8 "S" & "W"
RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Aircraft Route
Scale In Miles
100 50 0 100 200 300 400
1 Binghamton
2 Wilkes Barre
3 Reading
4 Williamsport
5 Allentown

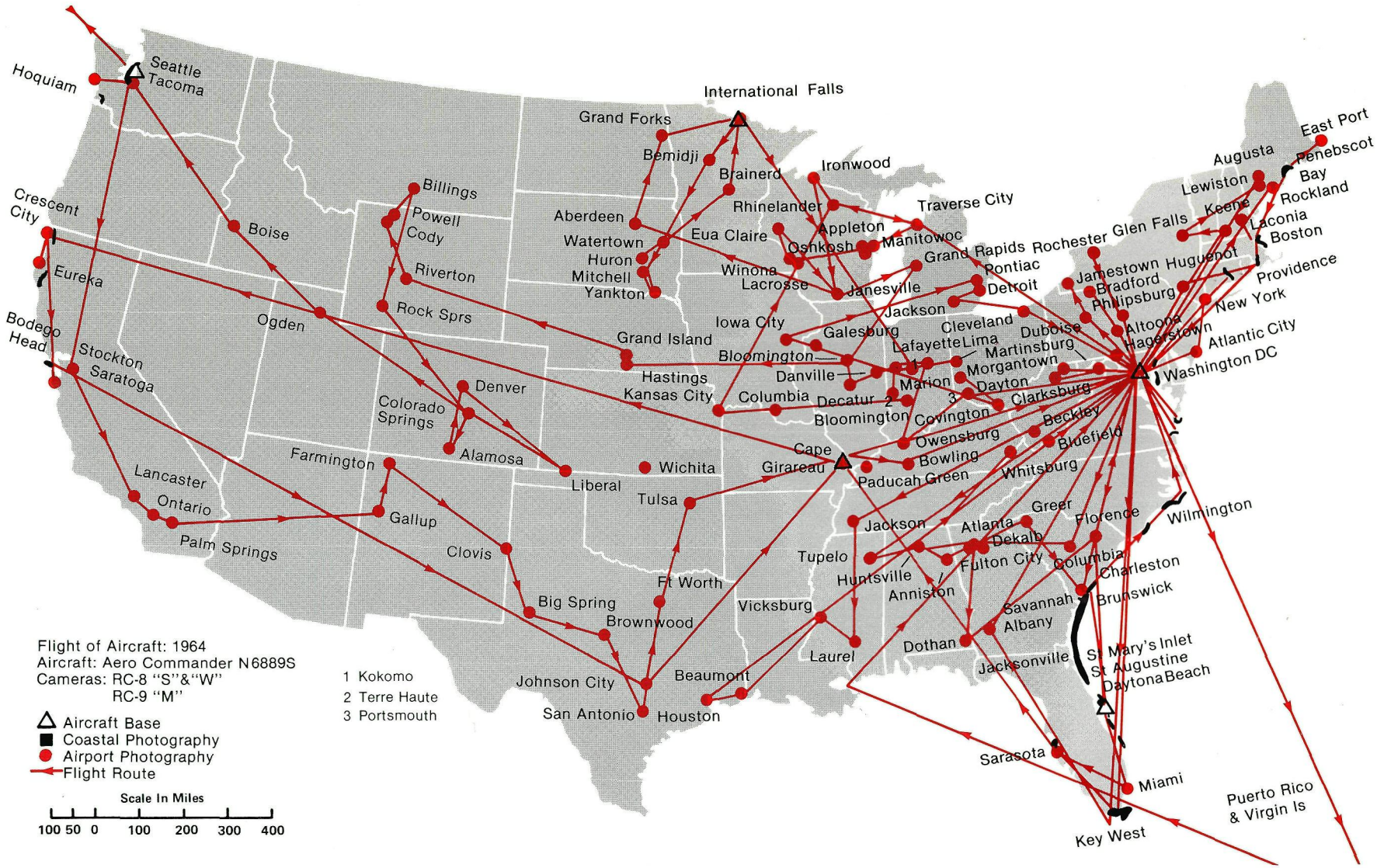

Cape Mendocino
Red Bluff
Oakland
San Franscisco
Santa Maria
Salt Lake City
Denver
El Paso
Guymon
Wichita
Kansas City
Clinton
Springfield
Lansing
Flint
Ann Arbor
Ft Wayne
McClure
Toledo
Columbus
Vinyard Sound
Narragansett
Block Island
Long Island
New York Harbor
Long Beach
Aberdeen
Chesapeake Beach
Washington
Elizabeth City
Cape Hatteras
Charleston
Tampa
Egmont Key
Sarasota
Ft Lauderdale
Miami
Everglades
Flight of Aircraft: 1963
Aircraft: U.S. Coast Guard R-5D 72486
Cameras: "C" "L" "M" "S" "W"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

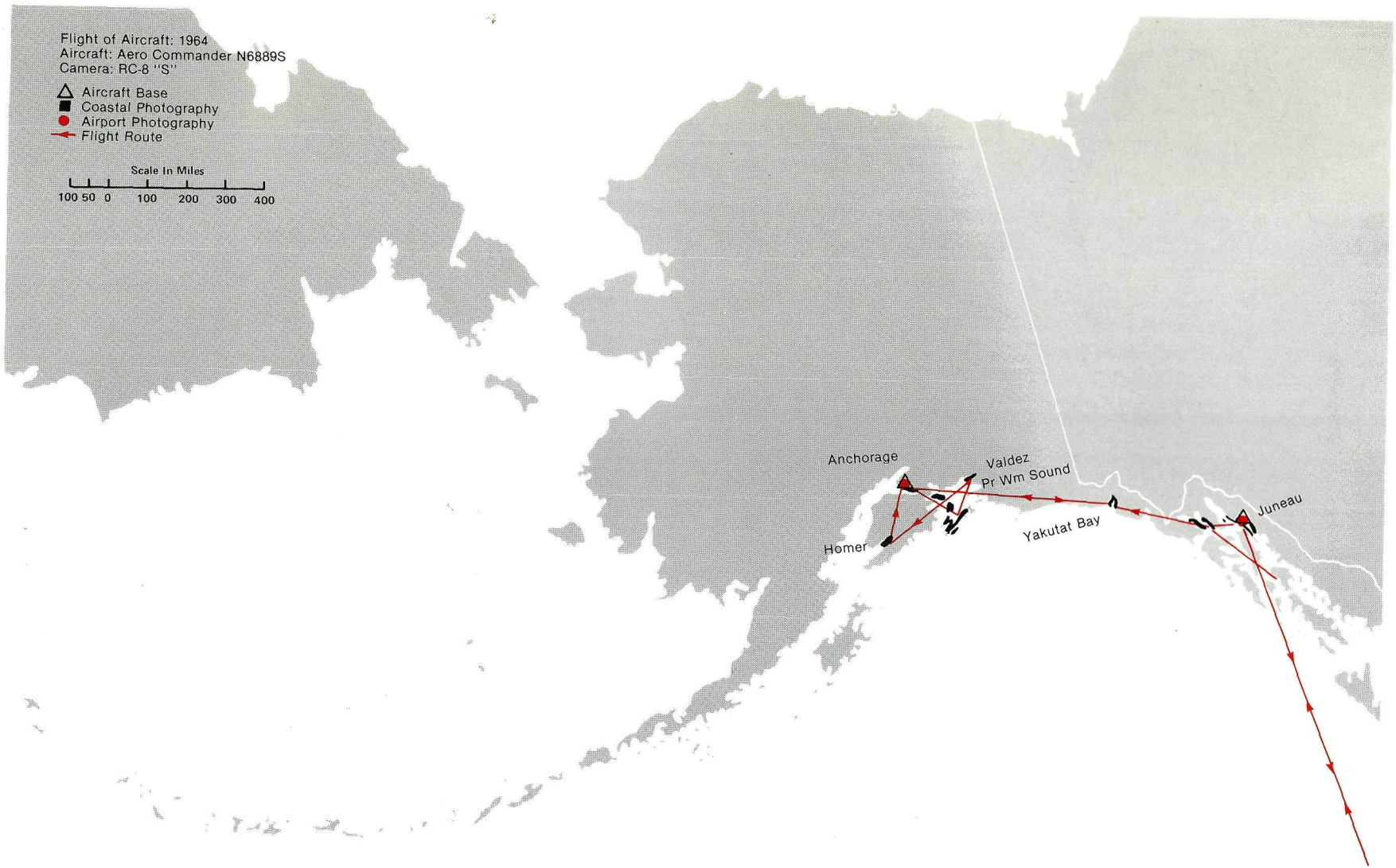

Seattle
Puget Sound
Spokane
Kalispell
Astoria
Pullman
Portland
Columbia R
Salem
North Bend
Ontario
Medford
Idaho Falls
Sheridan
Jackson
Elko
Burley
Vernal
Marysville
San Mateo
Monterey
Visalia
Apple Valley
Long Beach
Riverside
Catalina Island
Cedar City
Lane Mead
Las Vegas
Needles
Cold River
Yuma
Winslow
Silver City
Douglas
Montrose
Durango
Bismark
Bemidji
Hibbing
Brainerd
Brookings
Presque Isle
Penobscot Bay
Portland
Providence
Lawrence
Bedford
New Bedford
Nantucket
Martha's Vineyard
Westhampton
Rochester
Syracuse
Franklin
Altoona
Newark
Aberdeen
Chesapeake Bay
Washington
Rudee Inlet
Barco
Albemarle Sound
Cape Hatteras
Cape Fear
Myrtle Beach
Georgetown
Ft Wayne
Pittsburgh
Cincinnati
Louisville
Lynchburg
Elizabeth City
Huntington
Knoxville
Greensboro
Rocky Mt
Greenville
Nashville
Chattanooga
Anderson
Athens
Greenwood
Huntsville
Augusta
Montgomery
Dothan
Meridan
Gulfport
Mobile
Valdosta
Pensacola
Brunswick
Jacksonville
Daytona Beach
Orlando
Melbourne
Vero Beach
Palm Beach
Key Largo
Key West
Lakeland
St.Petersburg
Tampa Bay
Ft Myers
Naples
Indian Key
Biloxi
New Orleans
Baton Rouge
Sabine Pass
Galveston
Corpus Christi
Lake Charles
Shreveport
Marshall
Texarkana
Monroe
Little Rock
Pine Bluff
Coffeyville
Stillwater
Enid
Borger
Amarillo
Duncan
ADA
Ardmore
Dallas
Ft Worth
Big Spring
Midland
Temple
Clovis
Lubbock
Flight of Aircraft: 1963
Aircraft: Aero Commander N6889S
Cameras: "K" "M" "W"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

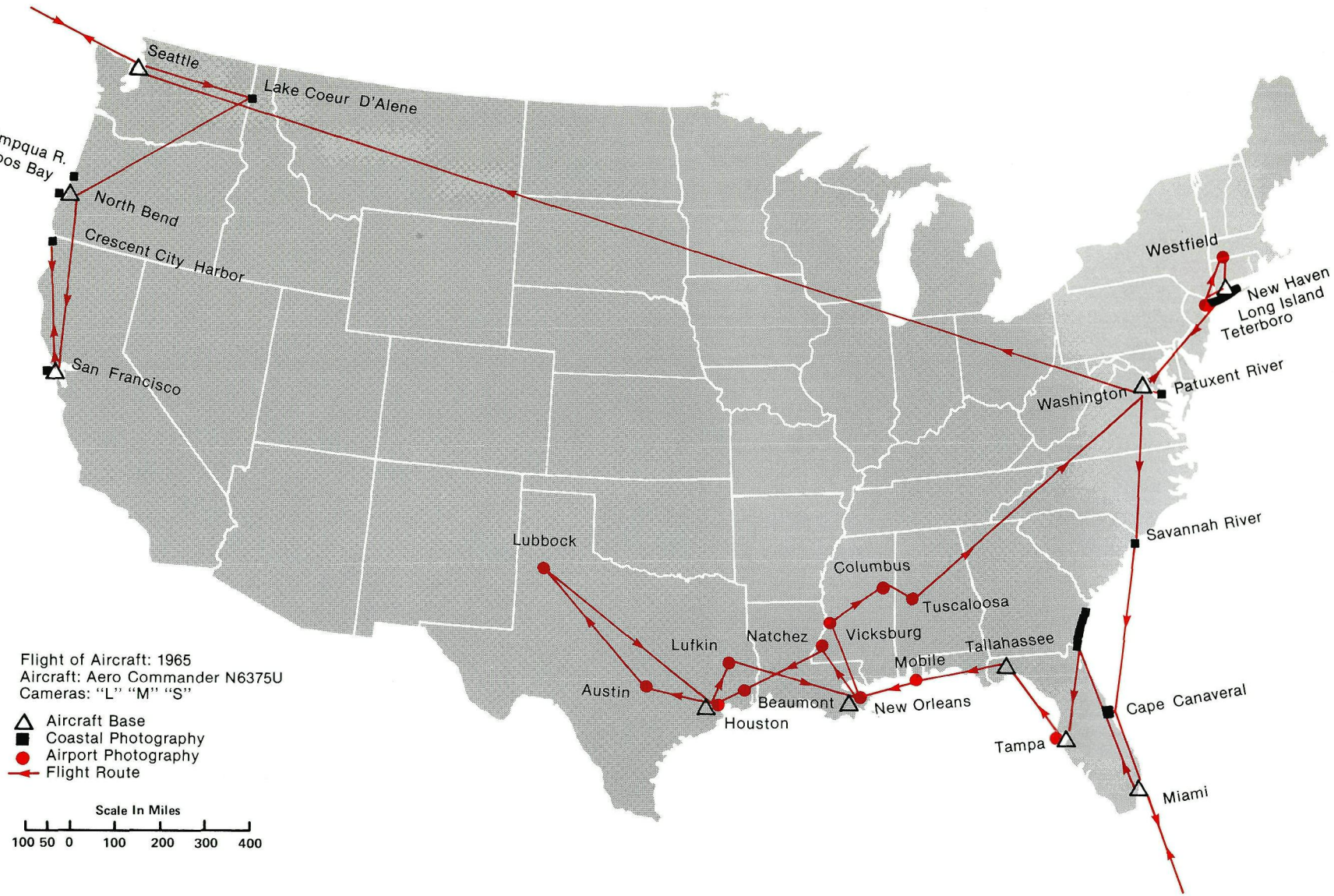

Flight of Aircraft: 1963
Aircraft: Aero Commander N6889S
Camera: "W"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Bettles
Fort Yukon
Circle Hot Springs
Gulkana
Cape Romanzof
Aniak
Bethel
Dillingham
Cape Newenham
Yakutat
Juneau
Hoonah Sound
Biorka Island
Security Bay
Wrangell
Clarence Strait
Annette Isl

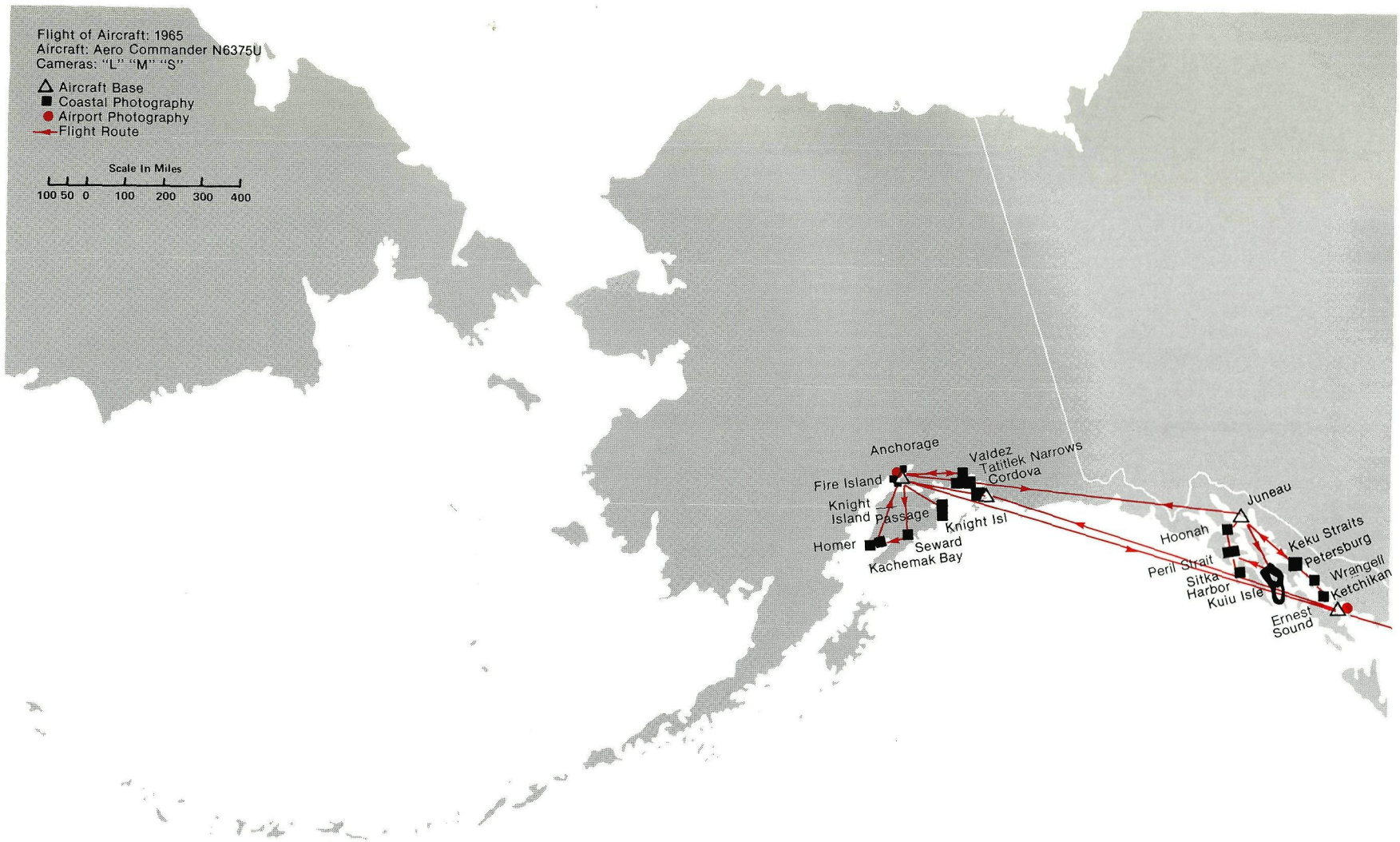

Seattle
Salt Lake City
San Francisco
Test Area
Cedar City
Great Bend
Kansas City
Dodge City
Test Area
Parsons
Springfield
Tulsa
Oklahoma City
Little Rock
Jonesboro
Hot Springs
Ft Wayne
Test Area
Washington DC
Elizabeth City
Savannah
Flight of Aircraft: 1964
Aircraft: U.S. Coast Guard R5D-72486
Cameras: RC-5 "W" RC-9 "M"
RC-8 "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

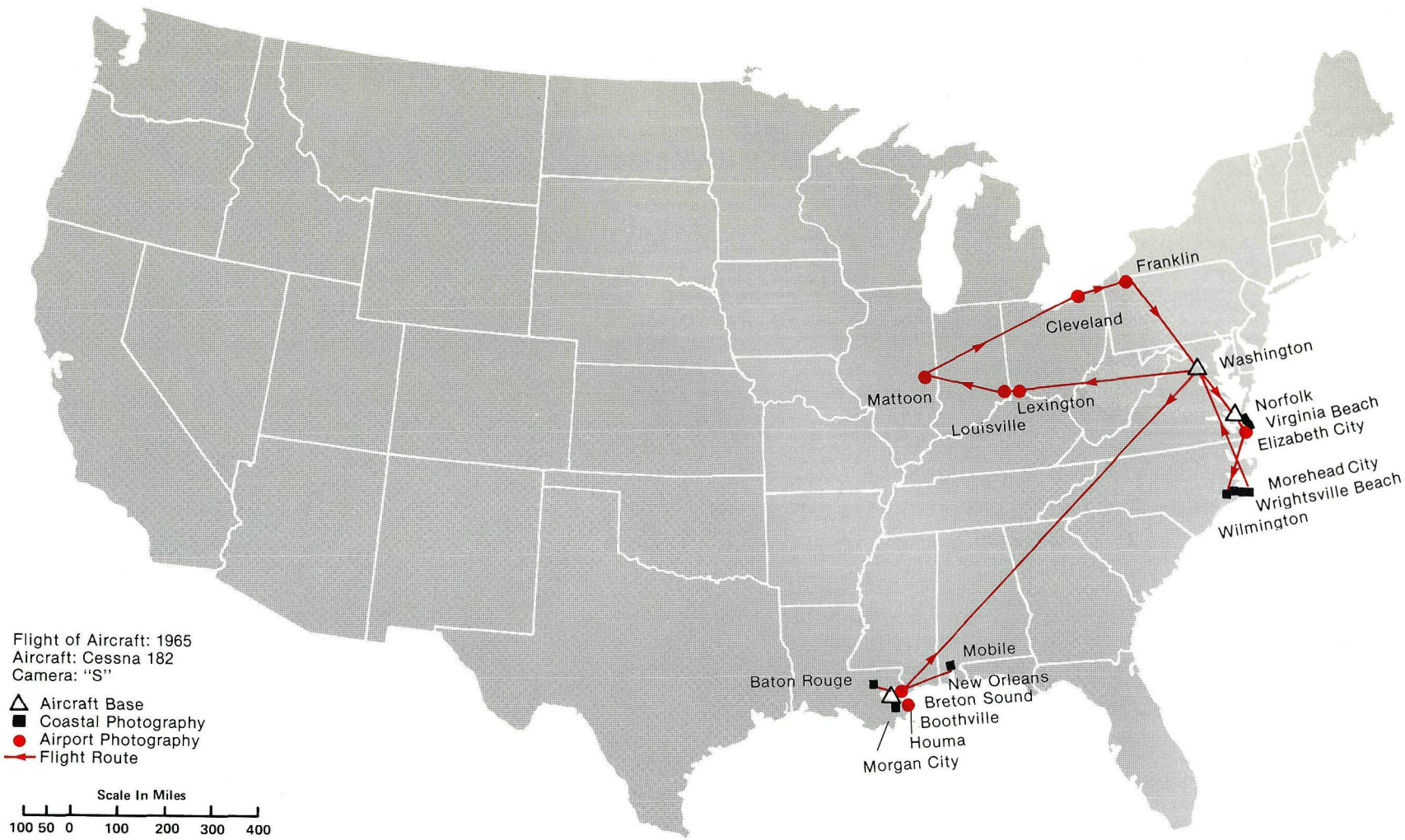

Flight of Aircraft: 1964
Aircraft: U.S. Coast Guard R5D-72486
Cameras: RC-5 "W" RC-8 "S"
RC-7 RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Umait
Tanana
Minchumia
Anchorage
Beluga Lake
Fire Island
Whittier
Iliamna
Iliamna Bay
Cook Inlet
Homer
Seldovia Pr
Seward
Chugach Isl
Barren Isls
Afognak Isl
Kodiak
Kodiak Isl
Valdez
Cordova
Hinchinbrook Isl
Montague Isl
Wm Sound
Middleton Isl
Resurrection Bay
Chatham Str

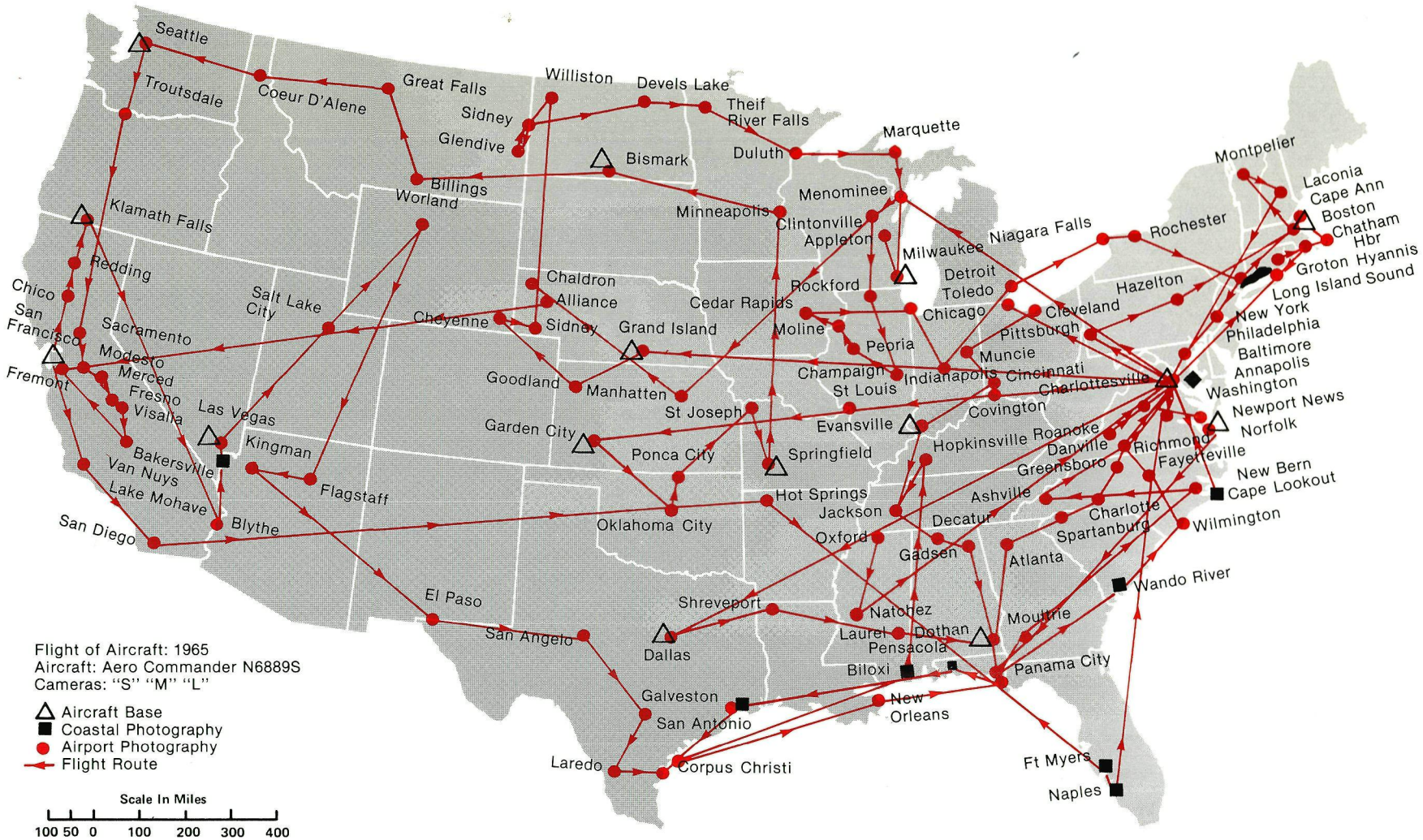

Hoquiam
Seattle
Tacoma
Crescent City
Eureka
Bodego Head
Stockton
Saratoga
Lancaster
Ontario
Palm Springs
Boise
Ogden
Billings
Powell
Cody
Riverton
Rock Sprs
Denver
Colorado Springs
Alamosa
Farmington
Gallup
Clovis
Liberal
Big Spring
Brownwood
Johnson City
San Antonio
Houston
Beaumont
Ft Worth
Tulsa
Wichita
Grand Island
Hastings
Kansas City
Grand Forks
Bemidji
Aberdeen
Watertown
Huron
Mitchell
Yankton
Brainerd
Eua Claire
Winona
Lacrosse
Iowa City
Bloomington
Columbia
Danville
Decatur
Bloomington
Cape Girareau
Paducah
Ironwood
Rhinelander
Appleton
Oshkosh
Manitowoc
Janesville
Traverse City
Grand Rapids
Pontiac
Detroit
Jackson
Galesburg
Lafayette
Lima
Marion
Cleveland
Martinsburg
Morgantown
Dayton
Clarksburg
Covington
Owensburg
Bowling
Green
Whitsburg
Beckley
Bluefield
Duboise
Rochester
Glen Falls
Jamestown
Bradford
Philipsburg
Altoona
Hagerstown
Washington DC
Atlantic City
New York
Providence
Huguenot
Keene
Laconia
Boston
Lewiston
Augusta
Rockland
Bay
Penebscot
East Port
Wilmington
Florence
Greer
Atlanta
Dekalb
Fulton City
Columbia
Charleston
Brunswick
Savannah
Albany
Jacksonville
Dothan
Laurel
Vicksburg
Tupelo
Huntsville
Anniston
Jackson
St Mary's Inlet
St Augustine
Daytona Beach
Sarasota
Miami
Key West
Puerto Rico & Virgin Is
1 Kokomo
2 Terre Haute
3 Portsmouth
Flight of Aircraft: 1964
Aircraft: Aero Commander N6889S
Cameras: RC-8 "S"&"W"
RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400

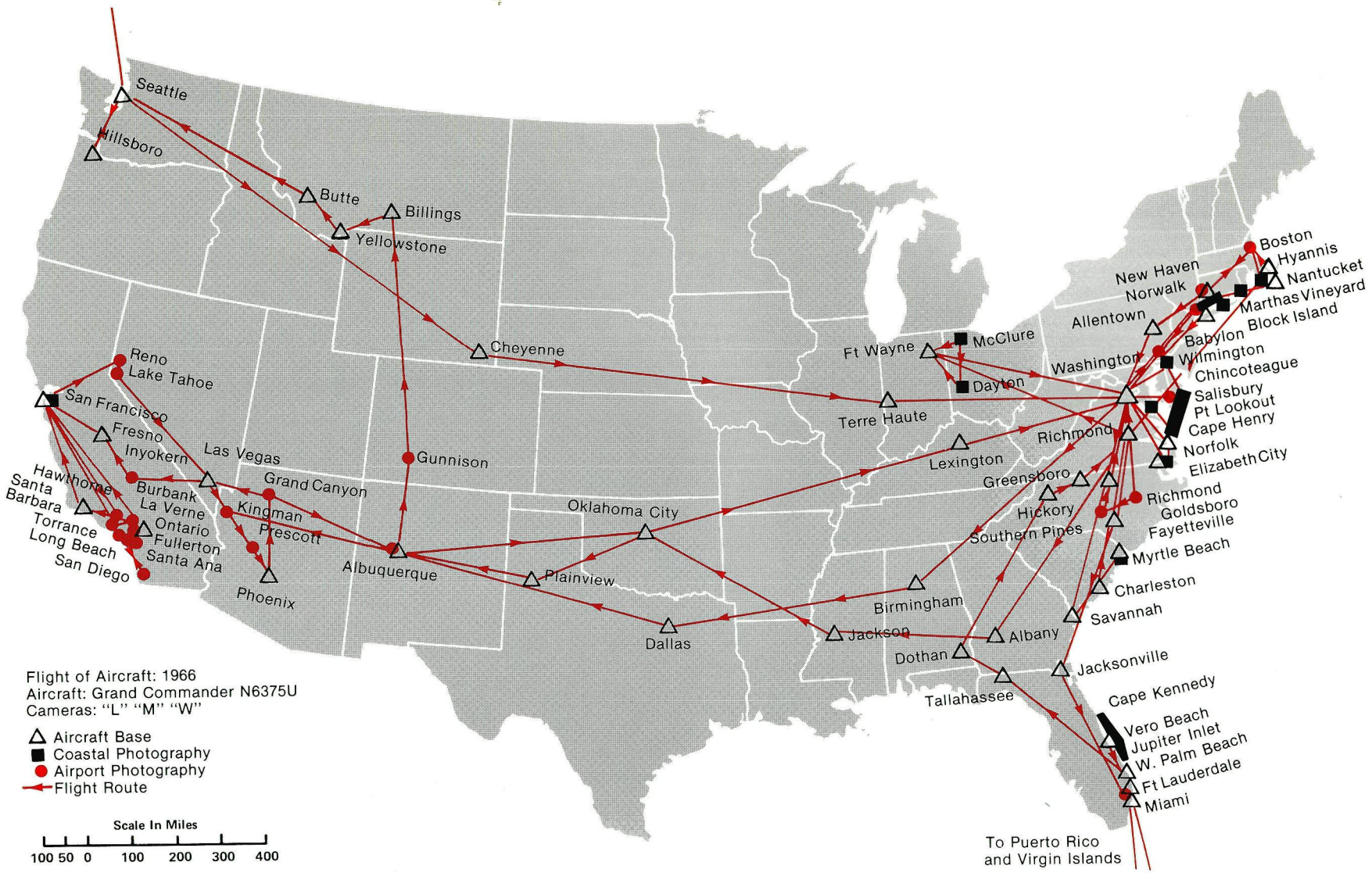

Flight of Aircraft: 1964
Aircraft: Aero Commander N6889S
Camera: RC-8 "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Valdez
Pr Wm Sound
Homer
Yakutat Bay
Juneau


Seattle
Lake Coeur D'Alene
Umpqua R.
Coos Bay
North Bend
Crescent City Harbor
San Francisco
Westfield
New Haven
Long Island
Teterboro
Patuxent River
Washington
Savannah River
Lubbock
Columbus
Tuscaloosa
Natchez
Vicksburg
Lufkin
Tallahassee
Mobile
Austin
Beaumont
New Orleans
Houston
Cape Canaveral
Tampa
Miami
Flight of Aircraft: 1965
Aircraft: Aero Commander N6375U
Cameras: "L" "M" "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1965
Aircraft: Aero Commander N6375U
Cameras: "L" "M" "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Fire Island
Knight Island Passage
Homer
Seward
Kachemak Bay
Knight Isl
Valdez
Tatitlek Narrows
Cordova
Juneau
Hoonah
Peril Strait
Sitka
Harbor
Kuiu Isle
Keku Straits
Petersburg
Wrangell
Ketchikan
Ernest Sound


Franklin
Cleveland
Washington
Mattoon
Lexington
Louisville
Norfolk
Virginia Beach
Elizabeth City
Morehead City
Wrightsville Beach
Wilmington
Mobile
Baton Rouge
New Orleans
Breton Sound
Boothville
Houma
Morgan City
Flight of Aircraft: 1965
Aircraft: Cessna 182
Camera: "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Seattle
Troutsdale
Coeur D'Alene
Great Falls
Williston
Devels Lake
Theif River Falls
Sidney
Glendive
Bismark
Duluth
Marquette
Billings
Worland
Minneapolis
Menominee
Clintonville
Appleton
Milwaukee
Niagara Falls
Rochester
Montpelier
Laconia
Cape Ann
Boston
Chatham Hbr
Groton Hyannis
Long Island Sound
New York
Philadelphia
Baltimore
Annapolis
Washington
Newport News
Norfolk
New Bern
Cape Lookout
Wilmington
Klamath Falls
Redding
Chico
San Francisco
Sacramento
Modesto
Merced
Fresno
Visalia
Fremont
Salt Lake City
Chaldron
Alliance
Cheyenne
Sidney
Grand Island
Cedar Rapids
Rockford
Moline
Peoria
Chicago
Detroit
Toledo
Cleveland
Hazelton
Pittsburgh
Muncie
Champaign
Indianapolis
Cincinnati
Charlottesville
St Louis
Covington
Goodland
Manhatten
St Joseph
Evansville
Hopkinsville
Roanoke
Danville
Richmond
Fayetteville
Greensboro
Ashville
Charlotte
Spartanburg
Atlanta
Las Vegas
Kingman
Flagstaff
Bakersville
Van Nuys
Lake Mohave
Blythe
San Diego
Garden City
Ponca City
Springfield
Hot Springs
Jackson
Oxford
Decatur
Gadsen
Oklahoma City
El Paso
San Angelo
Shreveport
Natchez
Laurel
Dothan
Pensacola
Moultrie
Wando River
Dallas
Biloxi
Panama City
Galveston
San Antonio
New Orleans
Laredo
Corpus Christi
Ft Myers
Naples
Flight of Aircraft: 1965
Aircraft: Aero Commander N6889S
Cameras: "S" "M" "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400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Las Vegas
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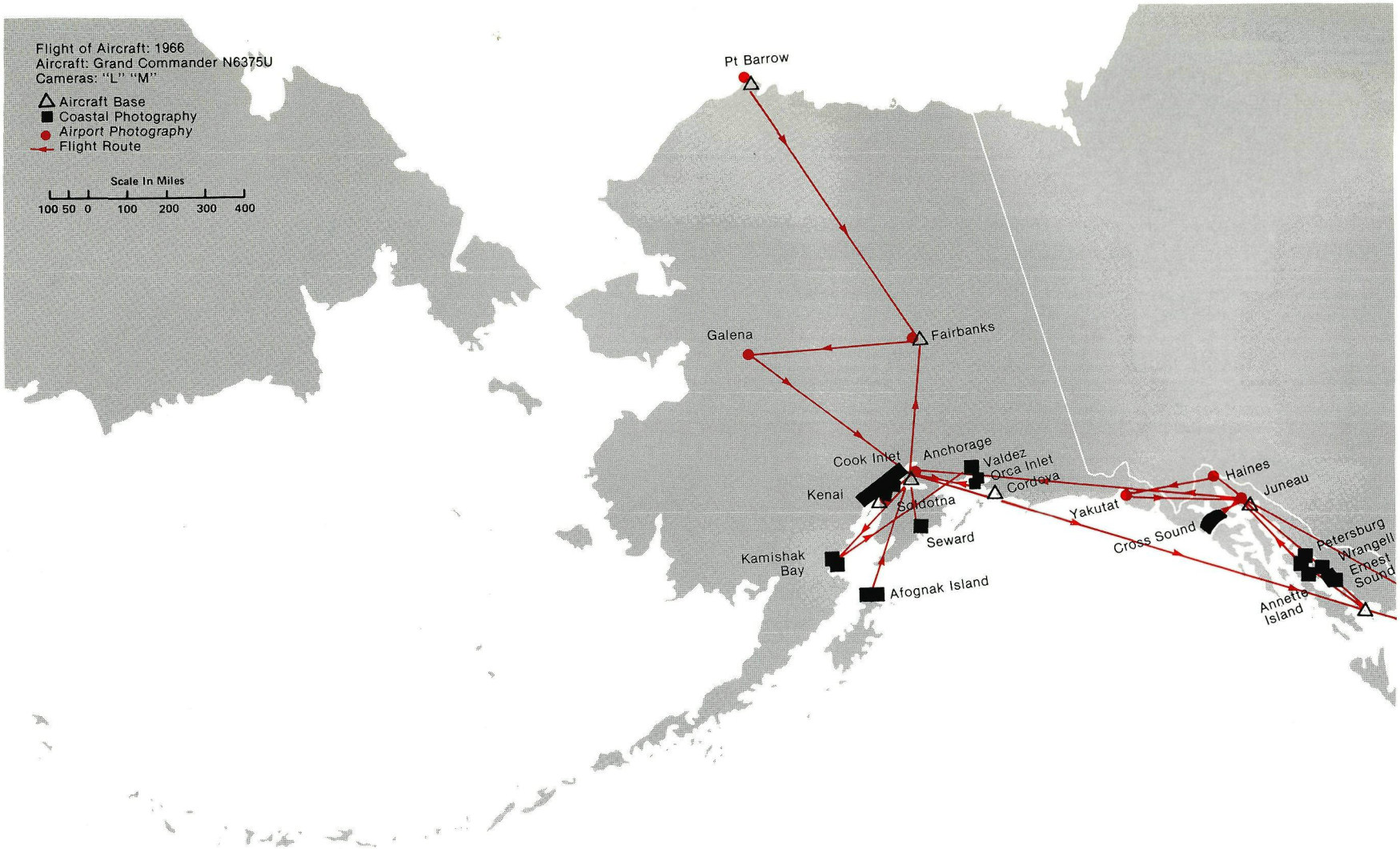
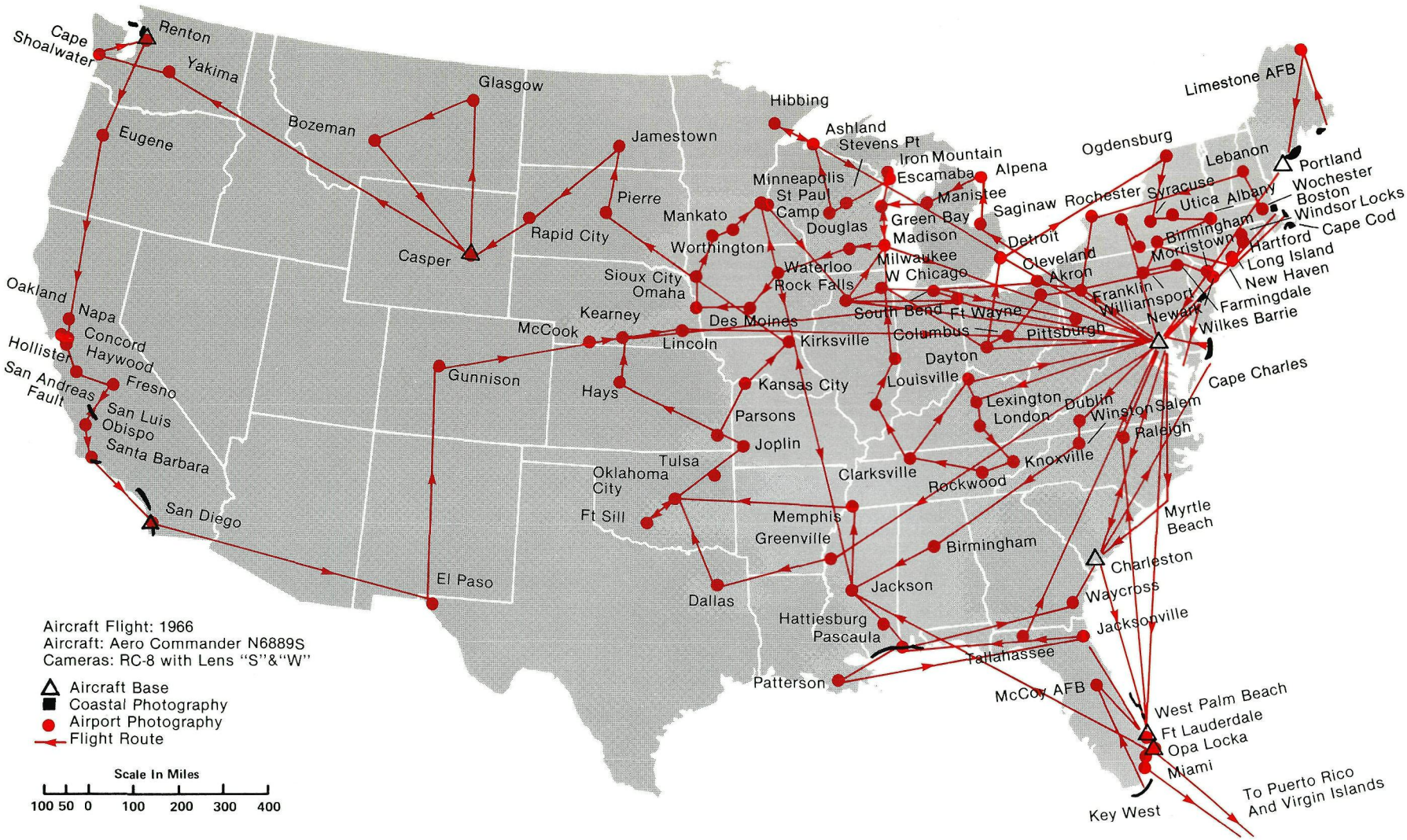
Grand Canyon
Hawthorne
Santa Barbara
Burbank
La Verne
Ontario
Fullerton
Torrance
Long Beach
Santa Ana
San Diego
Kingman
Prescott
Phoenix
Albuquerque
Oklahoma City
Plainview
Dallas
Terre Haute
Ft Wayne
McClure
Dayton
Lexington
Richmond
Greensboro
Hickory
Southern Pines
Birmingham
Jackson
Albany
Dothan
Tallahassee
Washington
New Haven
Norwalk
Allentown
Boston
Hyannis
Nantucket
Marthas Vineyard
Babylon Block Island
Wilmington
Chincoteague
Salisbury
Pt Lookout
Cape Henry
Norfolk
Elizabeth City
Richmond
Goldsboro
Fayetteville
Myrtle Beach
Charleston
Savannah
Jacksonville
Cape Kennedy
Vero Beach
Jupiter Inlet
W. Palm Beach
Ft Lauderdale
Miami
To Puerto Rico
and Virgin Islands
Flight of Aircraft: 1966
Aircraft: Grand Commander N6375U
Cameras: "L" "M" "W"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1966
Aircraft: Grand Commander N6375U
Cameras: "L" "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Pt Barrow
Galena
Fairbanks
Cook Inlet
Anchorage
Valdez
Orca Inlet
Cordova
Kenai
Soldotna
Seward
Kamishak Bay
Afognak Island
Yakutat
Cross Sound
Haines
Juneau
Petersburg
Wrangell
Ernest Sound
Annette Island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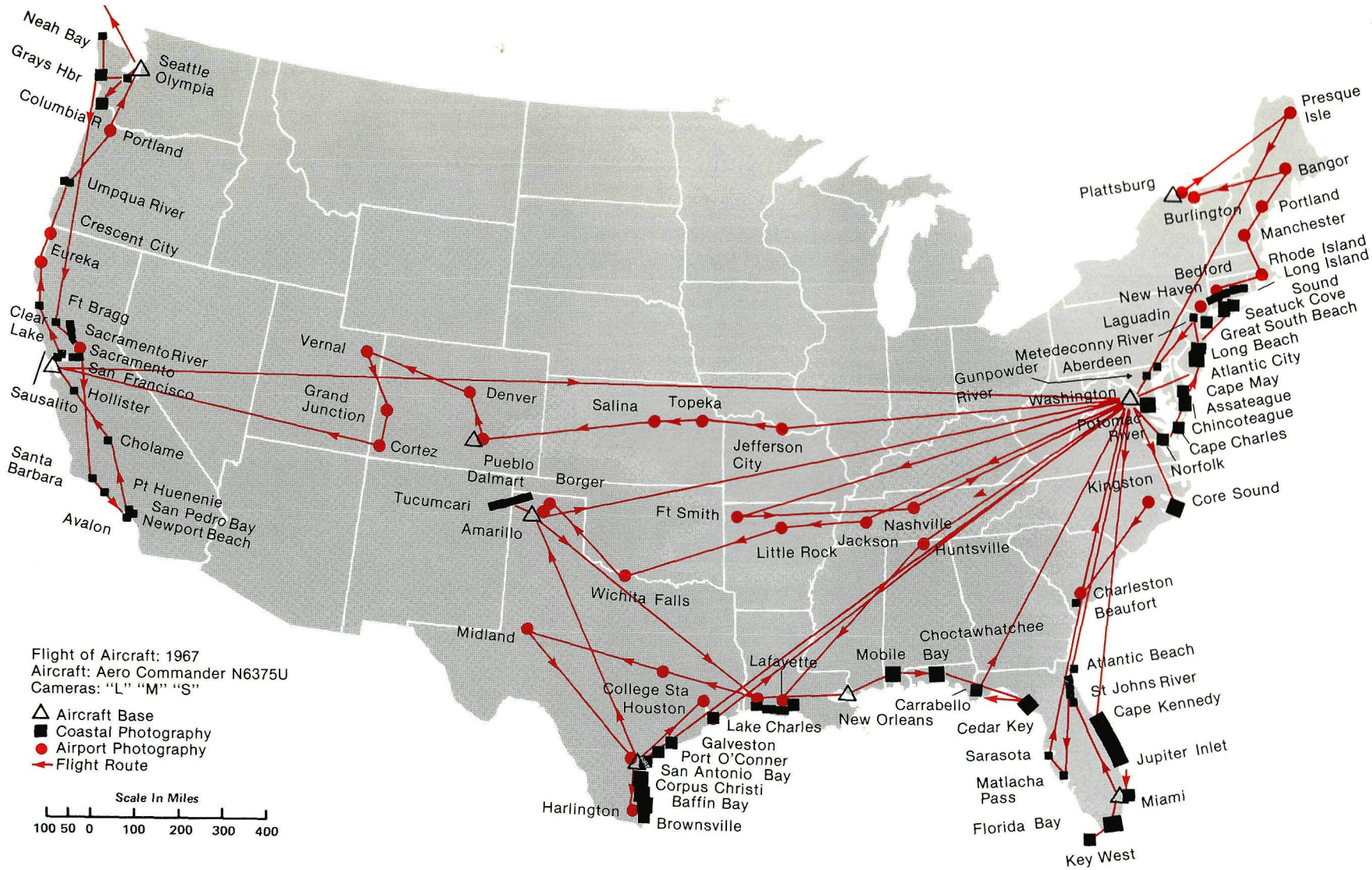
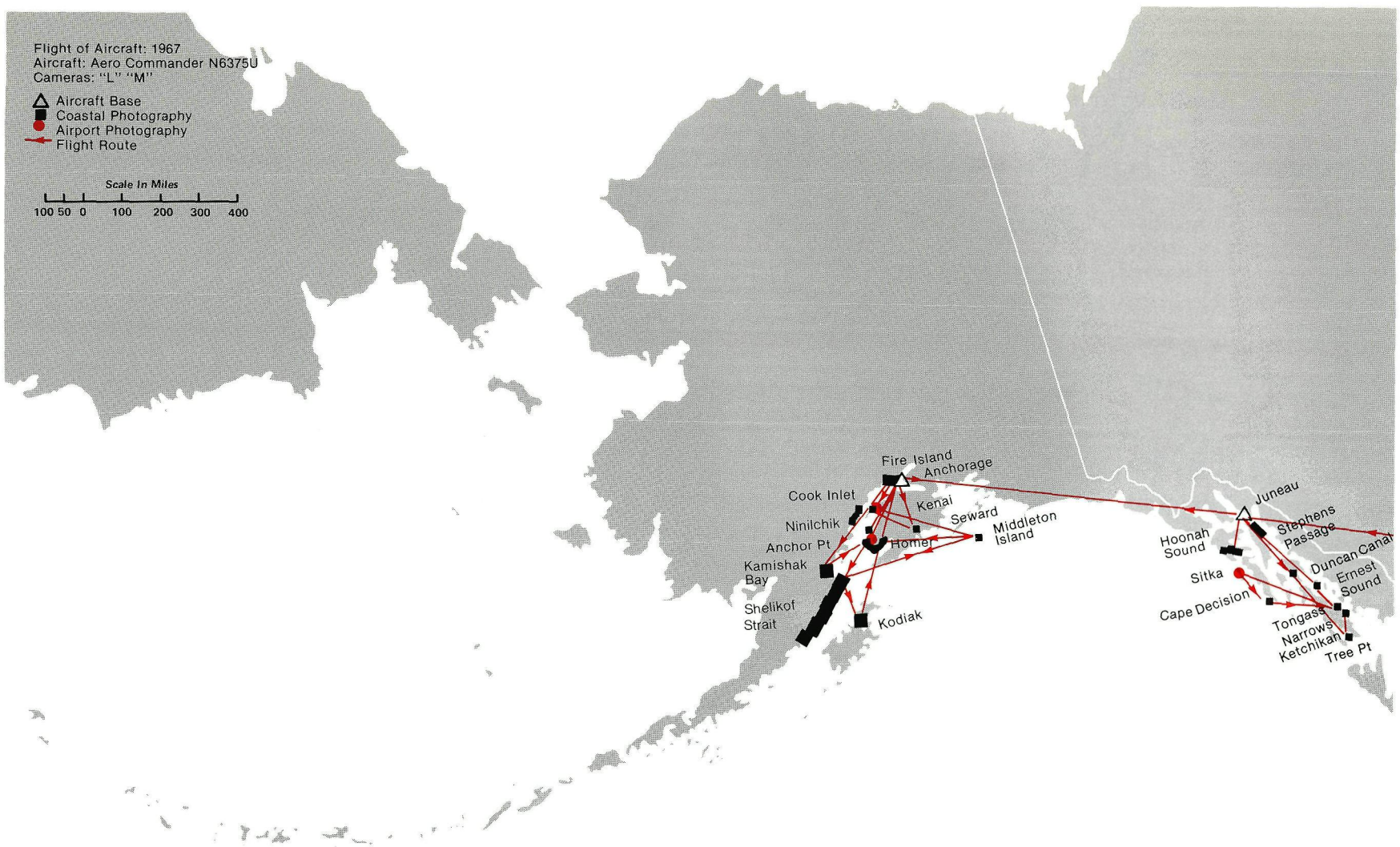
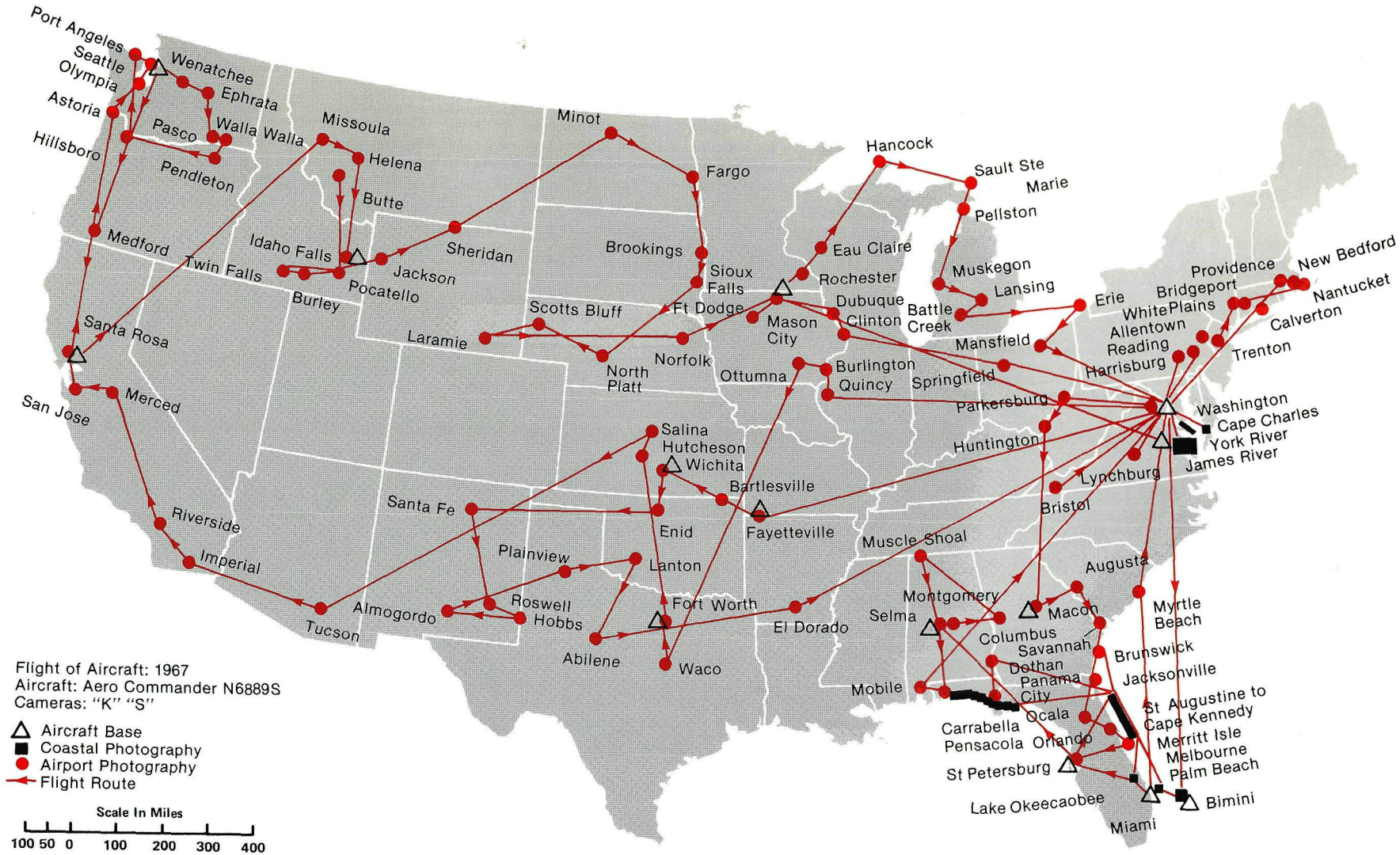
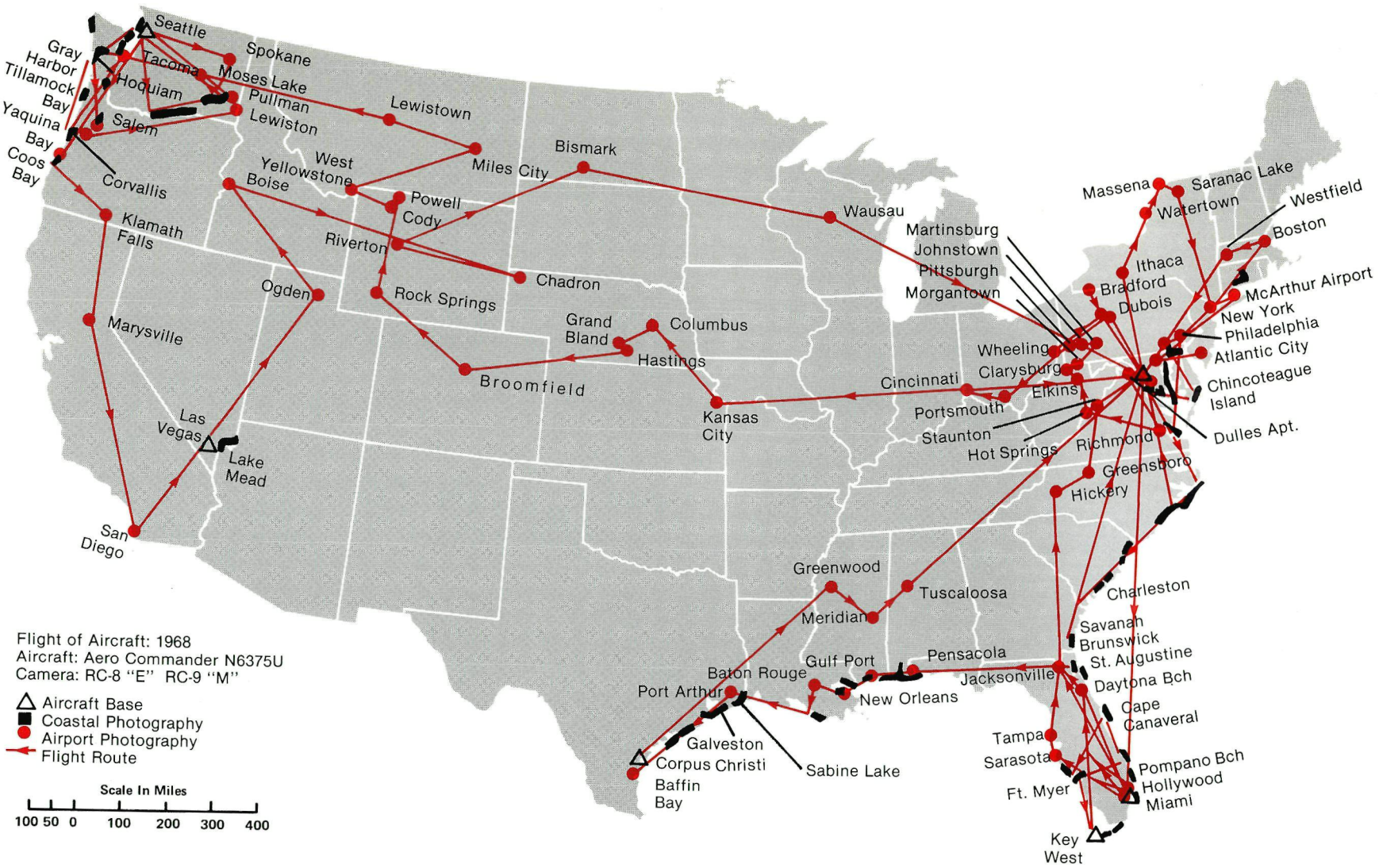
Renton
Yakima
Eugene
Bozeman
Glasgow
Casper
Rapid City
Pierre
Jamestown
Hibbing
Ashland
Stevens Pt
Iron Mountain
Escamaba
Alpena
Minneapolis
St Paul
Camp Douglas
Manistee
Green Bay
Madison
Milwaukee
W Chicago
Waterloo
Rock Falls
Mankato
Worthington
Sioux City
Omaha
Kearney
McCook
Lincoln
Des Moines
Kirksville
Kansas City
Hays
Gunnison
Parsons
Joplin
Tulsa
Oklahoma City
Ft Sill
Dallas
El Paso
Memphis
Greenville
Jackson
Hattiesburg
Pascaula
Patterson
Clarksville
Rockwood
Knoxville
Louisville
Dayton
Columbus
Pittsburgh
Cleveland
Akron
Detroit
Saginaw
Rochester
Syracuse
Ogdensburg
Limestone AFB
Lebanon
Portland
Wochester
Boston
Windsor Locks
Cape Cod
Utica
Albany
Birmingham
Morristown
Hartford
Long Island
New Haven
Farmingdale
Wilkes Barrie
Franklin
Williamsport
Newark
South Bend
Ft Wayne
Lexington
London
Dublin
Winston Salem
Raleigh
Cape Charles
Myrtle Beach
Charleston
Waycross
Jacksonville
Tallahassee
McCoy AFB
West Palm Beach
Ft Lauderdale
Opa Locka
Miami
Key West
To Puerto Rico
And Virgin Islands
Oakland
Napa
Concord
Haywood
Hollister
Fresno
San Andreas Fault
San Luis Obispo
Santa Barbara
San Diego
Aircraft Flight: 1966
Aircraft: Aero Commander N6889S
Cameras: RC-8 with Lens "S"&"W"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Neah Bay
Grays Hbr
Columbia R
Seattle
Olympia
Portland
Umpqua River
Crescent City
Eureka
Ft Bragg
Clear Lake
Sacramento River
Sacramento
San Francisco
Sausalito
Hollister
Cholame
Santa Barbara
Pt Huenenie
San Pedro Bay
Newport Beach
Avalon
Vernal
Grand Junction
Cortez
Denver
Pueblo
Dalmart
Borger
Amarillo
Tucumcari
Salina
Topeka
Jefferson City
Ft Smith
Little Rock
Nashville
Jackson
Huntsville
Wichita Falls
Midland
College Sta
Houston
Lafayette
Lake Charles
Galveston
Port O'Conner
San Antonio Bay
Corpus Christi
Baffin Bay
Harlington
Brownsville
New Orleans
Mobile Bay
Choctawhatchee
Carrabello
Cedar Key
Sarasota
Matlacha Pass
Florida Bay
Key West
Miami
Jupiter Inlet
Cape Kennedy
St Johns River
Atlantic Beach
Charleston
Beaufort
Kingston
Core Sound
Norfolk
Cape Charles
Chincoteague
Assateague
Atlantic City
Long Beach
Great South Beach
Seatuck Cove
Sound
Long Island
Rhode Island
Manchester
Portland
Bangor
Presque Isle
Plattsburg
Burlington
Bedford
New Haven
Laguadin
Metedeconny River
Aberdeen
Gunpowder River
Washington
Potomac River
Flight of Aircraft: 1967
Aircraft: Aero Commander N6375U
Cameras: "L" "M" "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1967
Aircraft: Aero Commander N6375U
Cameras: "L" "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Fire Island
Anchorage
Cook Inlet
Kenai
Seward
Ninilchik
Middleton Island
Anchor Pt
Homer
Kamishak Bay
Shelikof Strait
Kodiak
Juneau
Stephens Passage
Hoonah Sound
Duncan Canal
Sitka
Ernest Sound
Cape Decision
Tongass Narrows
Ketchikan
Tree Pt


Port Angeles
Seattle
Olympia
Wenatchee
Ephrata
Astoria
Pasco
Walla Walla
Missoula
Hillsboro
Pendleton
Helena
Butte
Minot
Fargo
Hancock
Sault Ste Marie
Pellston
Medford
Idaho Falls
Sheridan
Jackson
Twin Falls
Pocatello
Burley
Brookings
Sioux Falls
Eau Claire
Rochester
Muskegon
Lansing
Erie
Providence
Bridgeport
New Bedford
Nantucket
Calverton
Trenton
Dubuque
Clinton
Battle Creek
Mason City
Scotts Bluff
Ft Dodge
Laramie
Norfolk
North Platt
Ottumna
Burlington
Quincy
Springfield
Mansfield
Harrisburg
Reading
Allentown
White Plains
Santa Rosa
San Jose
Merced
Salina
Hutcheson
Wichita
Bartlesville
Fayetteville
Parkersburg
Huntington
Washington
Cape Charles
York River
James River
Lynchburg
Bristol
Riverside
Imperial
Santa Fe
Enid
Plainview
Lanton
Muscle Shoal
Augusta
Myrtle Beach
Montgomery
Selma
Macon
Columbus
Savannah
Brunswick
Jacksonville
Dothan
Panama City
Mobile
Ocala
St Augustine to Cape Kennedy
Merritt Isle
Melbourne
Palm Beach
Carrabella
Pensacola
Orlando
St Petersburg
Lake Okeecaobee
Miami
Bimini
Almogordo
Roswell
Hobbs
Fort Worth
El Dorado
Tucson
Abilene
Waco
Flight of Aircraft: 1967
Aircraft: Aero Commander N6889S
Cameras: "K" "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400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Spokane
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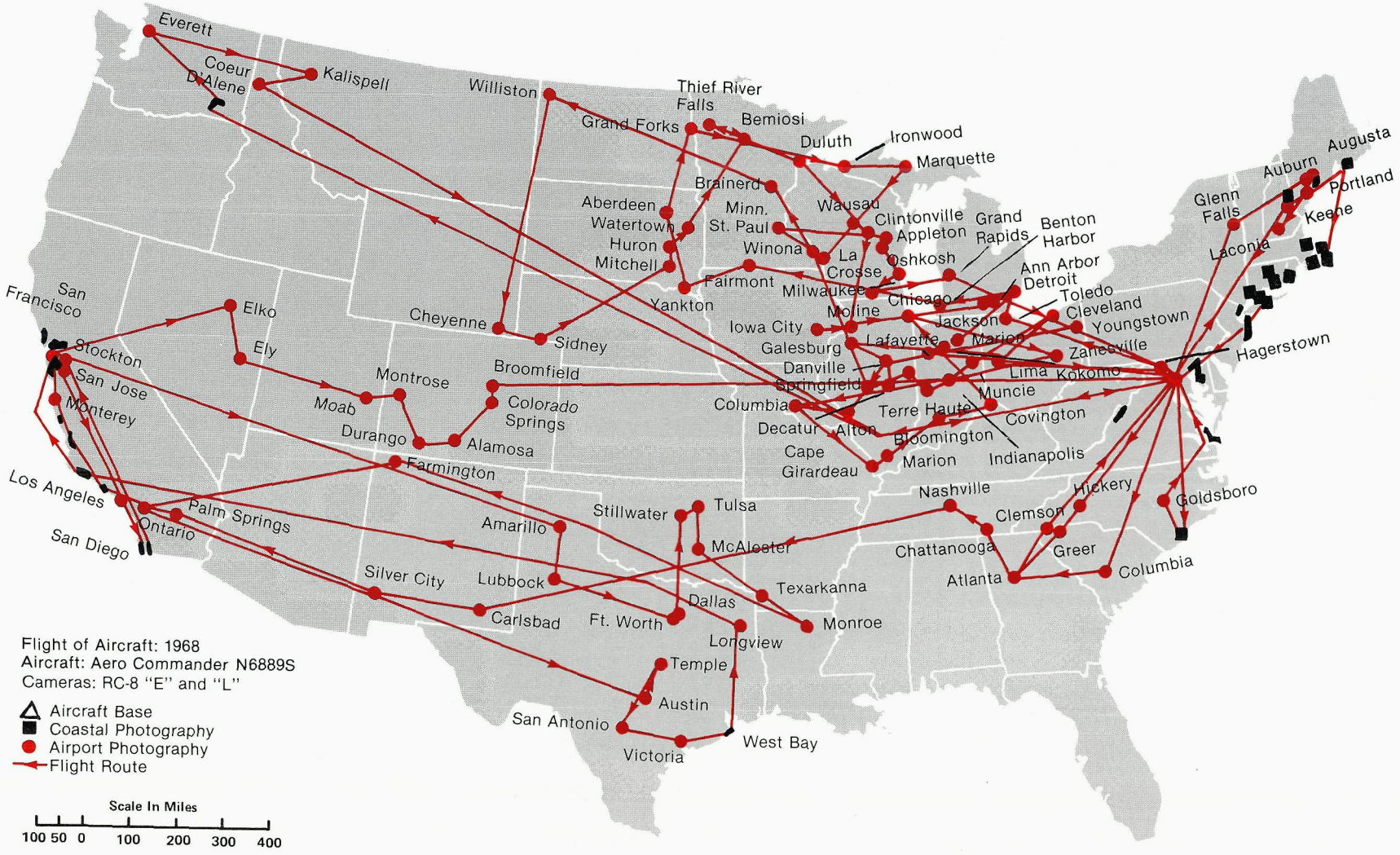
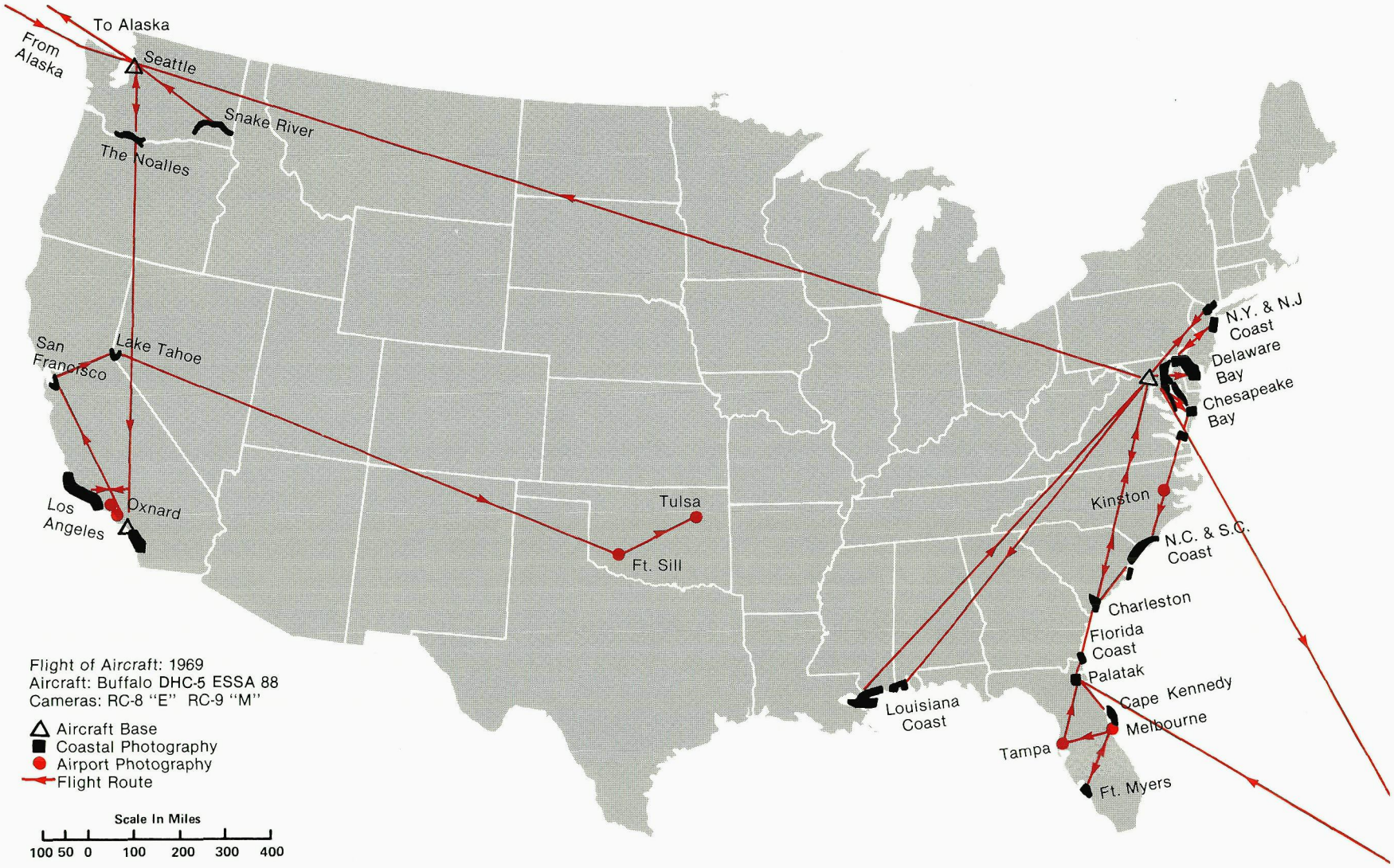
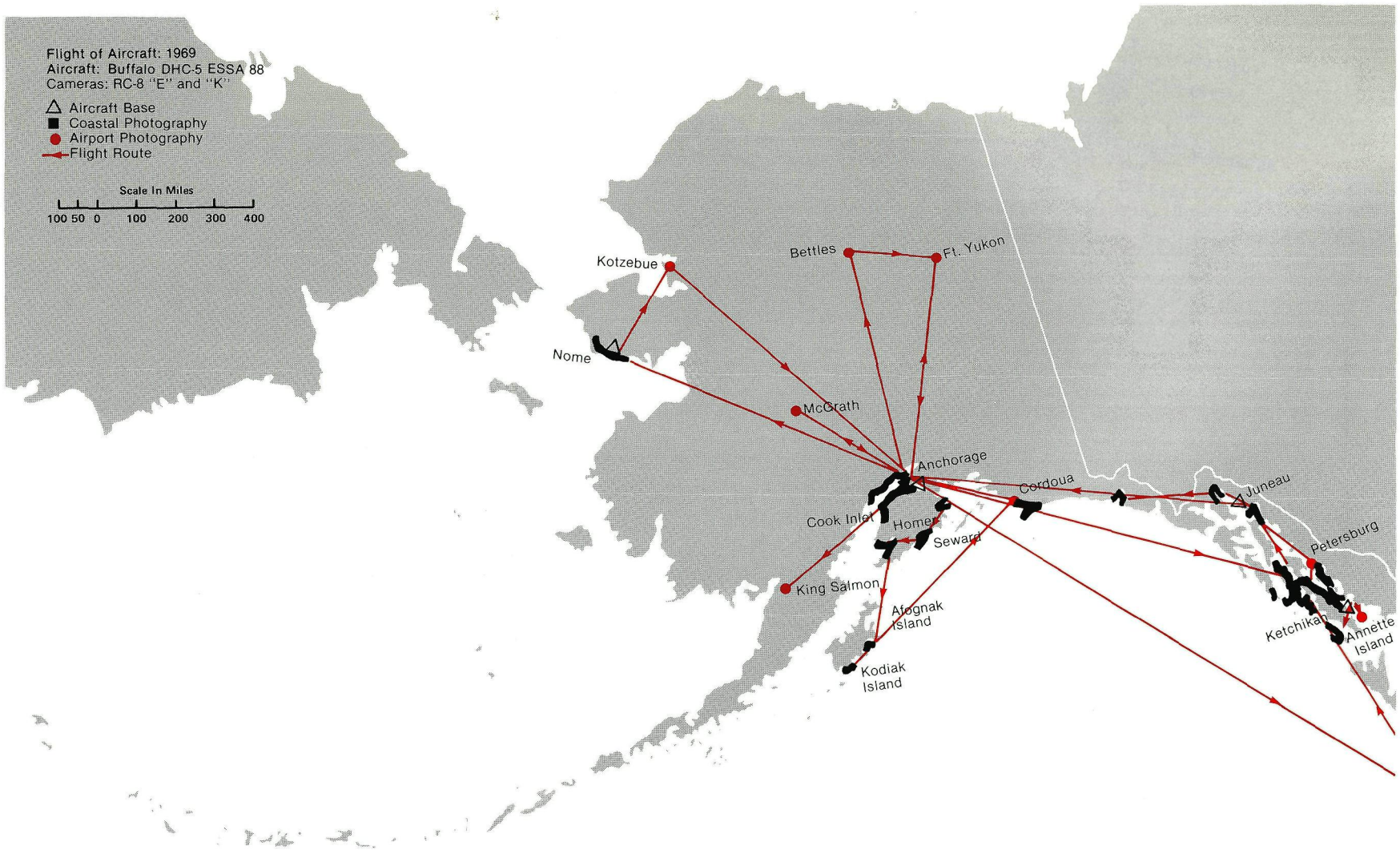
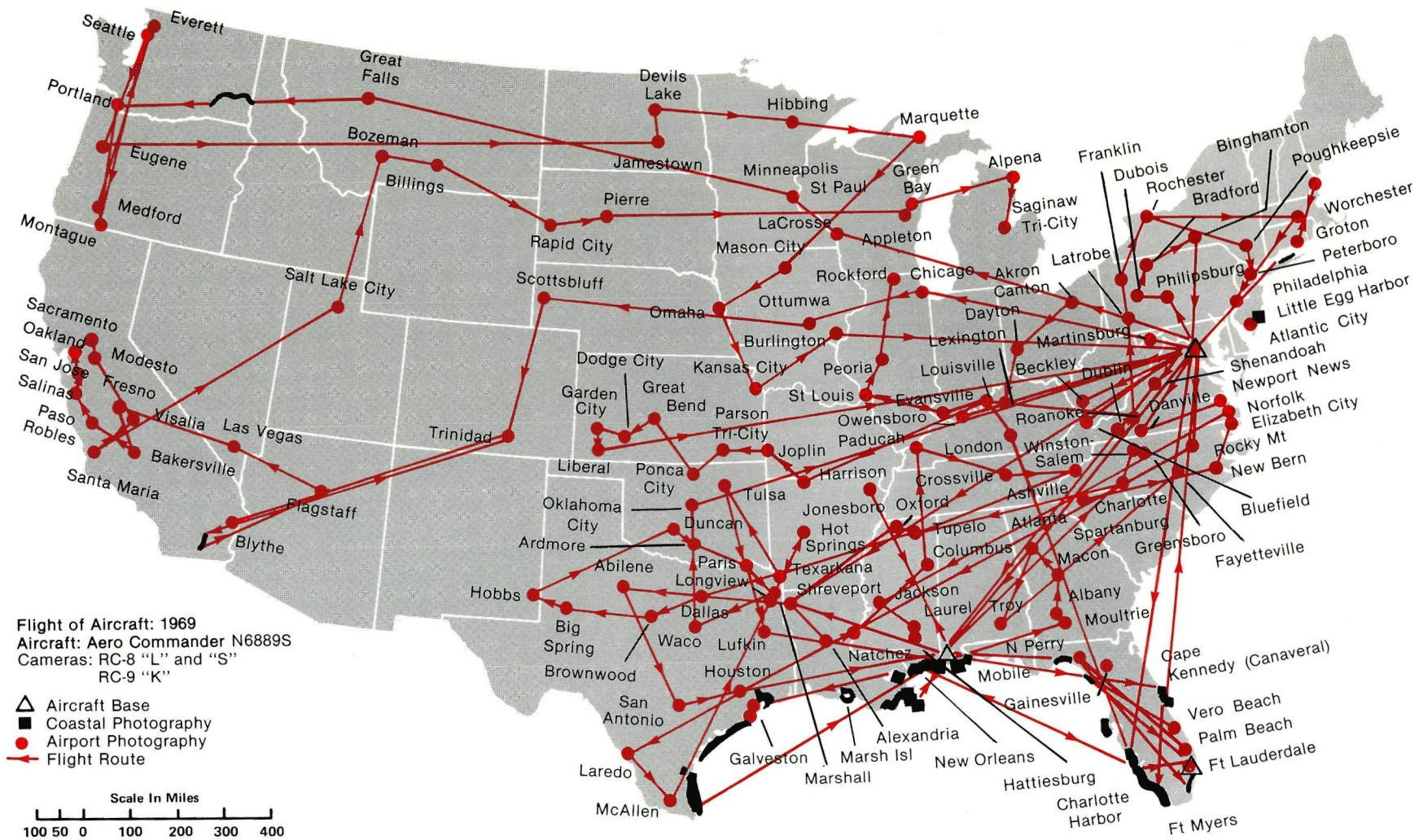
Tacoma
Moses Lake
Tillamock Bay
Hoquiam
Pullman
Lewistown
Yaquina Bay
Salem
Lewiston
Bismark
Coos Bay
Corvallis
West Yellowstone
Miles City
Boise
Powell
Cody
Wausau
Klamath Falls
Riverton
Martinsburg
Johnstown
Pittsburgh
Morgantown
Chadron
Ogden
Rock Springs
Massena
Saranac Lake
Watertown
Westfield
Boston
Ithaca
Bradford
Dubois
McArthur Airport
New York
Philadelphia
Atlantic City
Chincoteague Island
Dulles Apt.
Grand Bland
Columbus
Hastings
Wheeling
Clarysburg
Elkins
Cincinnati
Portsmouth
Staunton
Hot Springs
Richmond
Greensboro
Hickery
Marysville
Broomfield
Kansas City
Las Vegas
Lake Mead
San Diego
Greenwood
Tuscaloosa
Meridian
Charleston
Savanah
Brunswick
St. Augustine
Daytona Bch
Cape Canaveral
Pompano Bch
Hollywood
Miami
Key West
Ft. Myer
Sarasota
Tampa
Jacksonville
Pensacola
Gulf Port
Baton Rouge
New Orleans
Port Arthur
Galveston
Corpus Christi
Sabine Lake
Baffin Bay
Flight of Aircraft: 1968
Aircraft: Aero Commander N6375U
Camera: RC-8 "E" RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Everett
Coeur D'Alene
Kalispell
Williston
Thief River Falls
Grand Forks
Bemiosi
Duluth
Ironwood
Marquette
Brainerd
Aberdeen
Watertown
Huron
Mitchell
Minn. St. Paul
Wausau
Clintonville
Appleton
Grand Rapids
Benton Harbor
Winona
La Crosse
Oshkosh
Ann Arbor
Detroit
Fairmont
Yankton
Milwaukee
Chicago
Toledo
Cleveland
Moline
Jackson
Youngstown
Iowa City
Lafayette
Marion
Zanesville
Galesburg
Danville
Springfield
Lima
Kokomo
Columbia
Muncie
Terre Haute
Covington
Decatur
Alton
Bloomington
Cape Girardeau
Marion
Indianapolis
Nashville
Hickery
Clemson
Goldsboro
Chattanooga
Greer
Atlanta
Columbia
Glenn Falls
Auburn
Augusta
Portland
Keene
Laconia
Hagerstown
San Francisco
Elko
Ely
Cheyenne
Sidney
Stockton
San Jose
Monterey
Montrose
Moab
Broomfield
Colorado Springs
Durango
Alamosa
Farmington
Los Angeles
Palm Springs
Ontario
San Diego
Amarillo
Stillwater
Tulsa
McAlester
Silver City
Lubbock
Texarkanna
Carlsbad
Dallas
Ft. Worth
Monroe
Longview
Temple
Austin
San Antonio
Victoria
West Bay
Flight of Aircraft: 1968
Aircraft: Aero Commander N6889S
Cameras: RC-8 "E" and "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


To Alaska
From Alaska
Seattle
Snake River
The Noalles
San Francisco
Lake Tahoe
Los Angeles
Oxnard
Tulsa
Ft. Sill
N.Y. & N.J Coast
Delaware Bay
Chesapeake Bay
Kinston
N.C. & S.C. Coast
Charleston
Florida Coast
Palatak
Cape Kennedy
Melbourne
Tampa
Ft. Myers
Louisiana Coast
Flight of Aircraft: 1969
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: RC-8 "E" RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1969
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: RC-8 "E" and "K"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Kotzebue
Bettles
Ft. Yukon
Nome
McGrath
Anchorage
Cordoua
Juneau
Cook Inlet
Homer
Seward
Petersburg
King Salmon
Afognak Island
Ketchikan
Annette Island
Kodiak Island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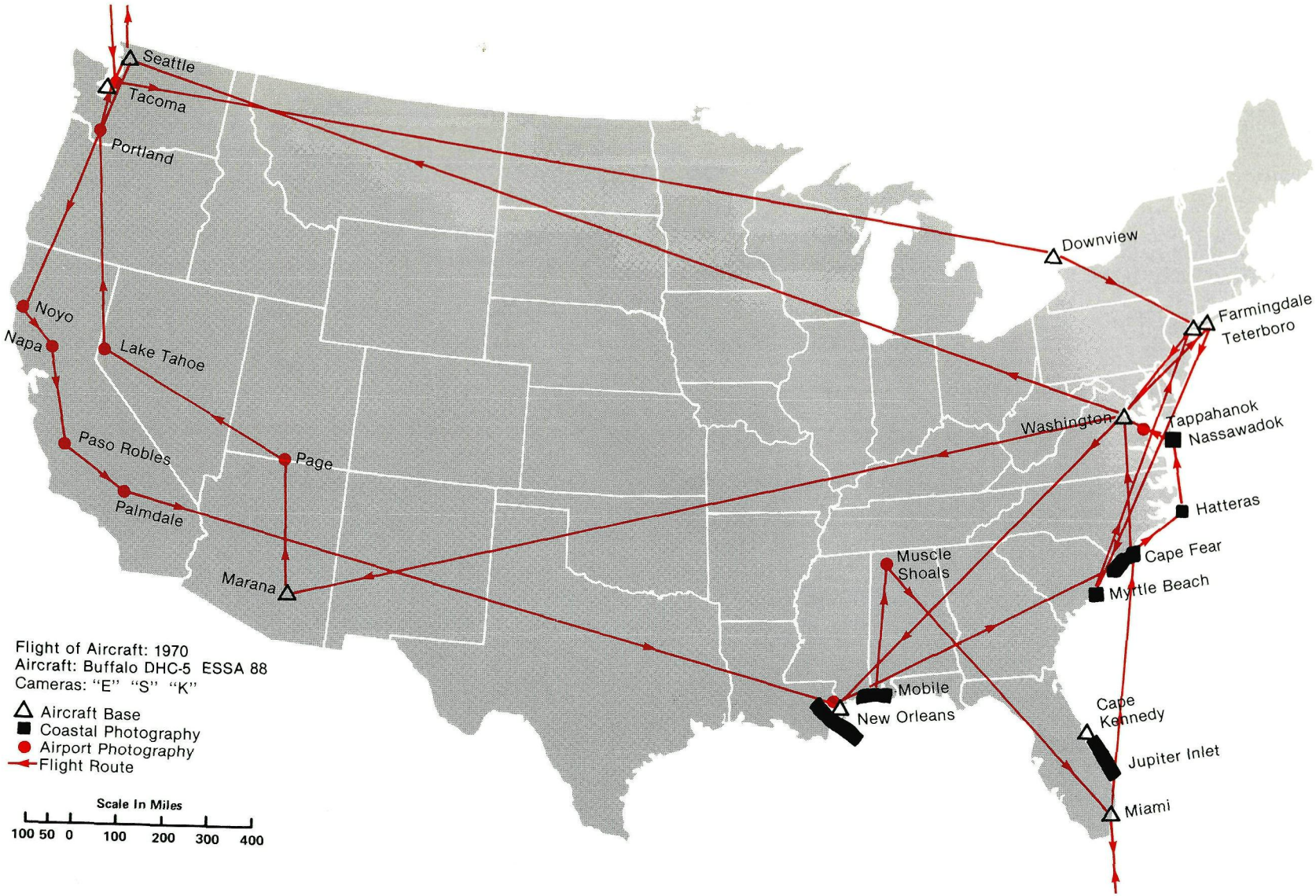
Portland
Great Falls
Devils Lake
Hibbing
Marquette
Bozeman
Eugene
Jamestown
Minneapolis
St Paul
Green Bay
Alpena
Billings
Medford
Pierre
LaCrosse
Saginaw
Tri-City
Montague
Rapid City
Mason City
Appleton
Salt Lake City
Scottsbluff
Rockford
Chicago
Akron
Canton
Latrobe
Omaha
Ottumwa
Dayton
Sacramento
Oakland
Burlington
Lexington
Martinsburg
Modesto
San Jose
Fresno
Salinas
Dodge City
Kansas City
Peoria
Louisville
Beckley
Garden City
Great Bend
St Louis
Evansville
Parson
Owensboro
Roanoke
Danville
Visalia
Las Vegas
Tri-City
Paso Robles
Trinidad
Joplin
Paducah
London
Winston-Salem
Bakersville
Liberal
Ponca City
Harrison
Crossville
Santa Maria
Tulsa
Ashville
Oklahoma City
Jonesboro
Oxford
Charlotte
Flagstaff
Duncan
Hot Springs
Tupelo
Atlanta
Spartanburg
Blythe
Ardmore
Columbus
Greensboro
Abilene
Paris
Texarkana
Macon
Longview
Shreveport
Jackson
Albany
Hobbs
Dallas
Laurel
Troy
Moultrie
Big Spring
Waco
Lufkin
Natchez
N Perry
Brownwood
Houston
Mobile
Cape Kennedy (Canaveral)
San Antonio
Gainesville
Vero Beach
Palm Beach
Alexandria
Galveston
Marsh Isl
New Orleans
Ft Lauderdale
Laredo
Marshall
Hattiesburg
Charlotte Harbor
McAllen
Ft Myers
Franklin
Dubois
Binghamton
Poughkeepsie
Rochester
Bradford
Worchester
Groton
Philipsburg
Peterboro
Philadelphia
Little Egg Harbor
Atlantic City
Shenandoah
Newport News
Norfolk
Elizabeth City
Rocky Mt
New Bern
Bluefield
Fayetteville
Flight of Aircraft: 1969
Aircraft: Aero Commander N6889S
Cameras: RC-8 "L" and "S"
RC-9 "K"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Seattle
Tacoma
Portland
Noyo
Napa
Lake Tahoe
Paso Robles
Palmdale
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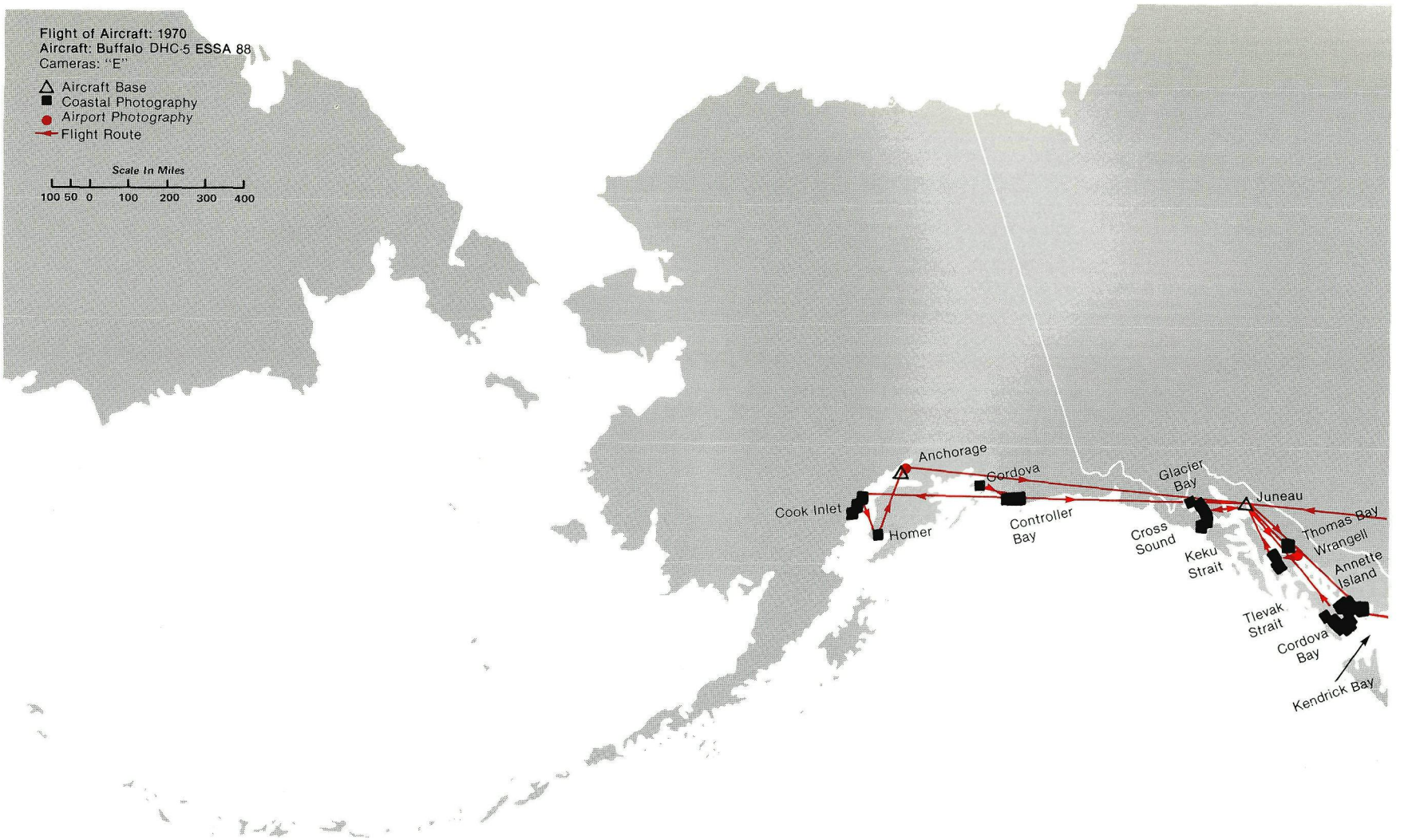
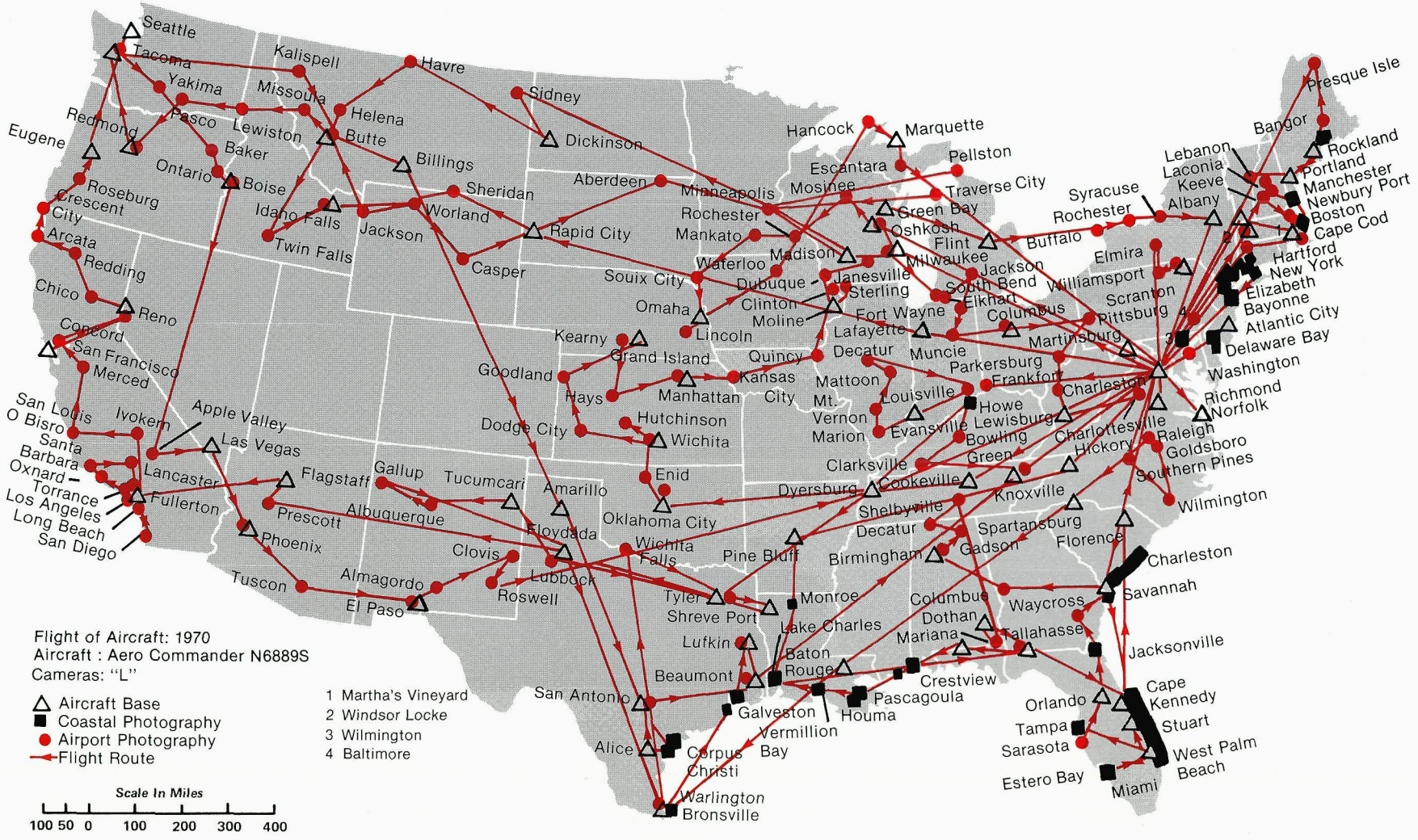
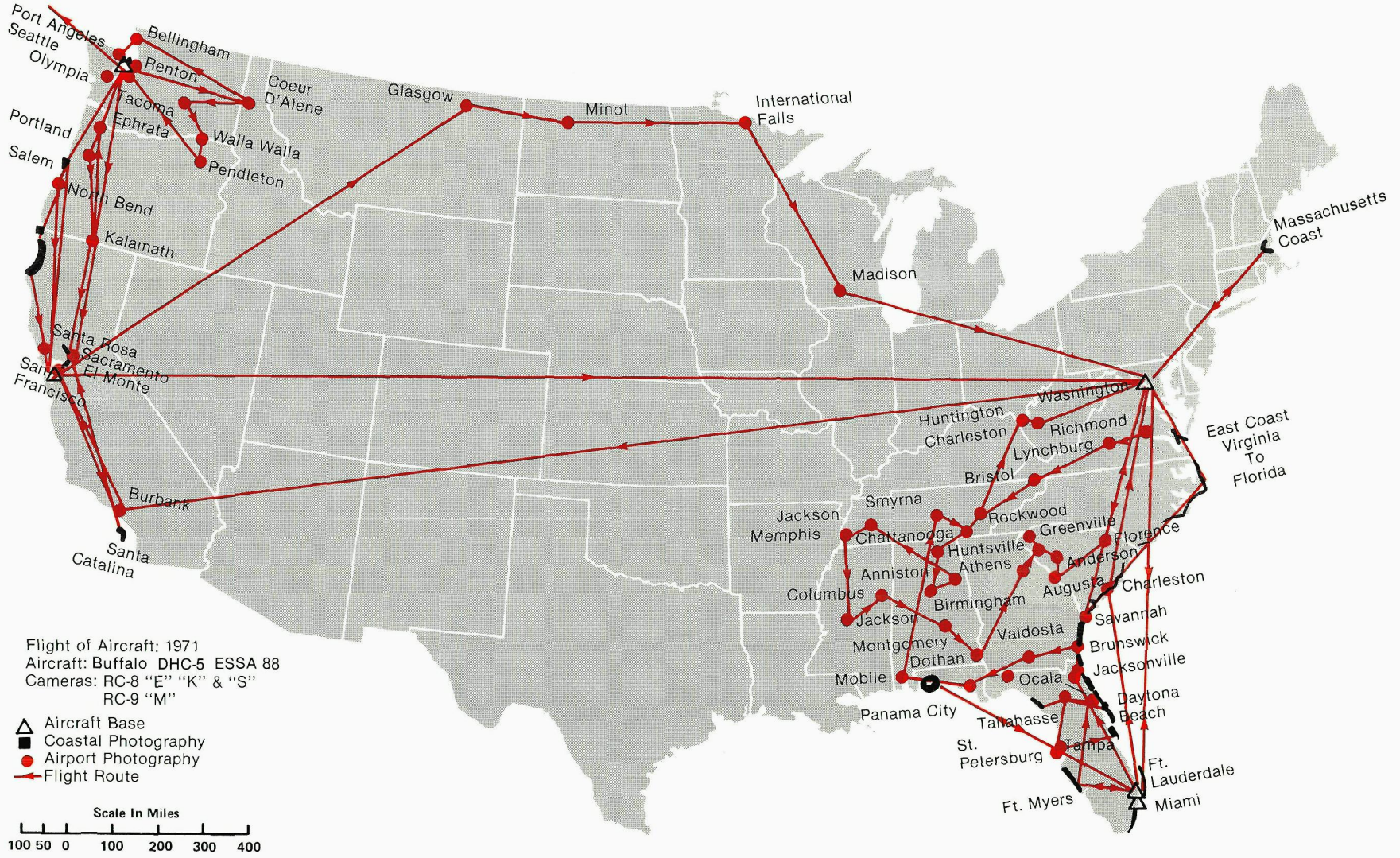
Marana
Downview
Farmingdale
Teterboro
Washington
Tappahanok
Nassawadok
Hatteras
Cape Fear
Myrtle Beach
Muscle Shoals
Mobile
New Orleans
Cape Kennedy
Jupiter Inlet
Miami
Flight of Aircraft: 1970
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: "E" "S" "K"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1970
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: "E"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Sordova
Glacier Bay
Juneau
Cook Inlet
Homer
Controller Bay
Cross Sound
Keku Strait
Thomas Bay
Wrangell
Annette Island
Tlevak Strait
Cordova Bay
Kendrick Bay


Flight of Aircraft: 1970
Aircraft : Aero Commander N6889S
Cameras: "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
1 Martha's Vineyard
2 Windsor Locke
3 Wilmington
4 Baltimore
Scale In Miles
100 50 0 100 200 300 400
Seattle
Tacoma
Yakima
Pasco
Lewiston
Kalispell
Missoula
Helena
Butte
Havre
Sidney
Dickinson
Billings
Sheridan
Worland
Casper
Rapid City
Aberdeen
Minneapolis
Rochester
Mankato
Waterloo
Souix City
Omaha
Lincoln
Kearny
Grand Island
Goodland
Hays
Manhattan
Kansas City
Dodge City
Hutchinson
Wichita
Enid
Oklahoma City
Amarillo
Floydada
Wichita Falls
Tucumcari
Gallup
Albuquerque
Clovis
Lubbock
Roswell
Almagordo
El Paso
Tuscon
Phoenix
Prescott
Flagstaff
Las Vegas
Apple Valley
Ivokern
Lancaster
Fullerton
Santa Barbara
Oxnard
Torrance
Los Angeles
Long Beach
San Diego
San Louis O Bisro
Redmond
Eugene
Roseburg
Crescent City
Arcata
Redding
Chico
Reno
Concord
San Francisco
Merced
Ontario
Baker
Boise
Idaho Falls
Twin Falls
Jackson
Hancock
Marquette
Escantara
Pellston
Mosinee
Traverse City
Green Bay
Oshkosh
Flint
Madison
Milwaukee
Janesville
Dubuque
Sterling
Clinton
Moline
Fort Wayne
Lafayette
Decatur
Quincy
Mattoon
Mt. Vernon
Marion
Louisville
Evansville
Clarksville
Dyersburg
Cookeville
Shelbyville
Decatur
Birmingham
Gadson
Pine Bluff
Monroe
Tyler
Shreve Port
Lake Charles
Lufkin
Beaumont
Baton Rouge
Galveston
Houma
Vermillion Bay
Pascagoula
Crestview
Mariana
Dothan
Columbus
Tallahasse
Waycross
Savannah
Charleston
Florence
Spartansburg
Knoxville
Hickory
Charlottesville
Raleigh
Goldsboro
Southern Pines
Wilmington
Richmond
Norfolk
Washington
Delaware Bay
Atlantic City
Bayonne
Elizabeth
New York
Hartford
Cape Cod
Boston
Newbury Port
Manchester
Portland
Rockland
Bangor
Presque Isle
Lebanon
Laconia
Keeve
Albany
Syracuse
Rochester
Buffalo
Elmira
Williamsport
Scranton
Pittsburg
Martinsburg
Columbus
Muncie
Parkersburg
Frankfort
Charleston
Howe
Lewisburg
Bowling Green
Jackson
South Bend
Elkhart
Jacksonville
Cape Kennedy
Stuart
West Palm Beach
Miami
Estero Bay
Sarasota
Tampa
Orlando
Alice
Corpus Christi
Warlington
Bronsville
San Antonio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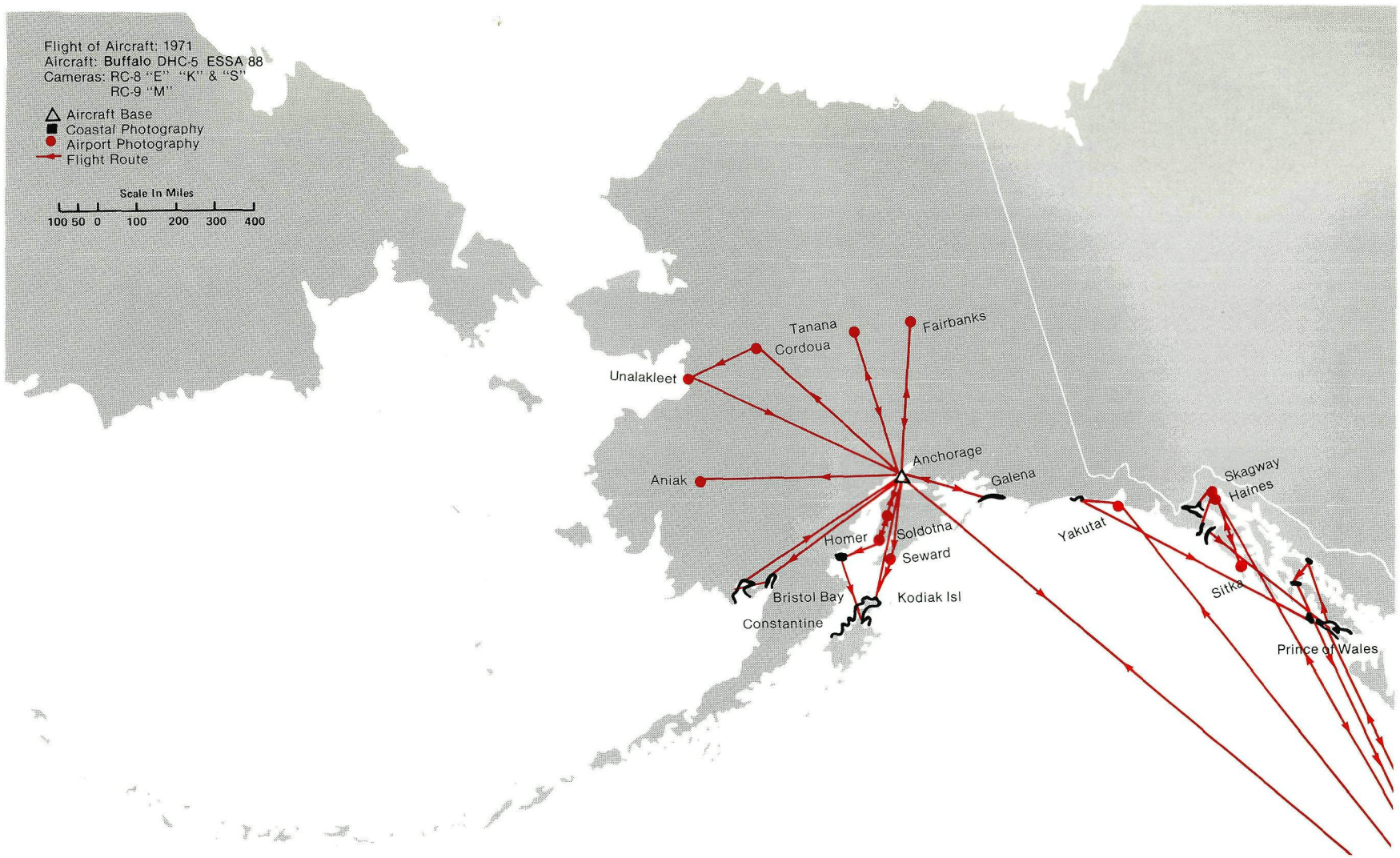
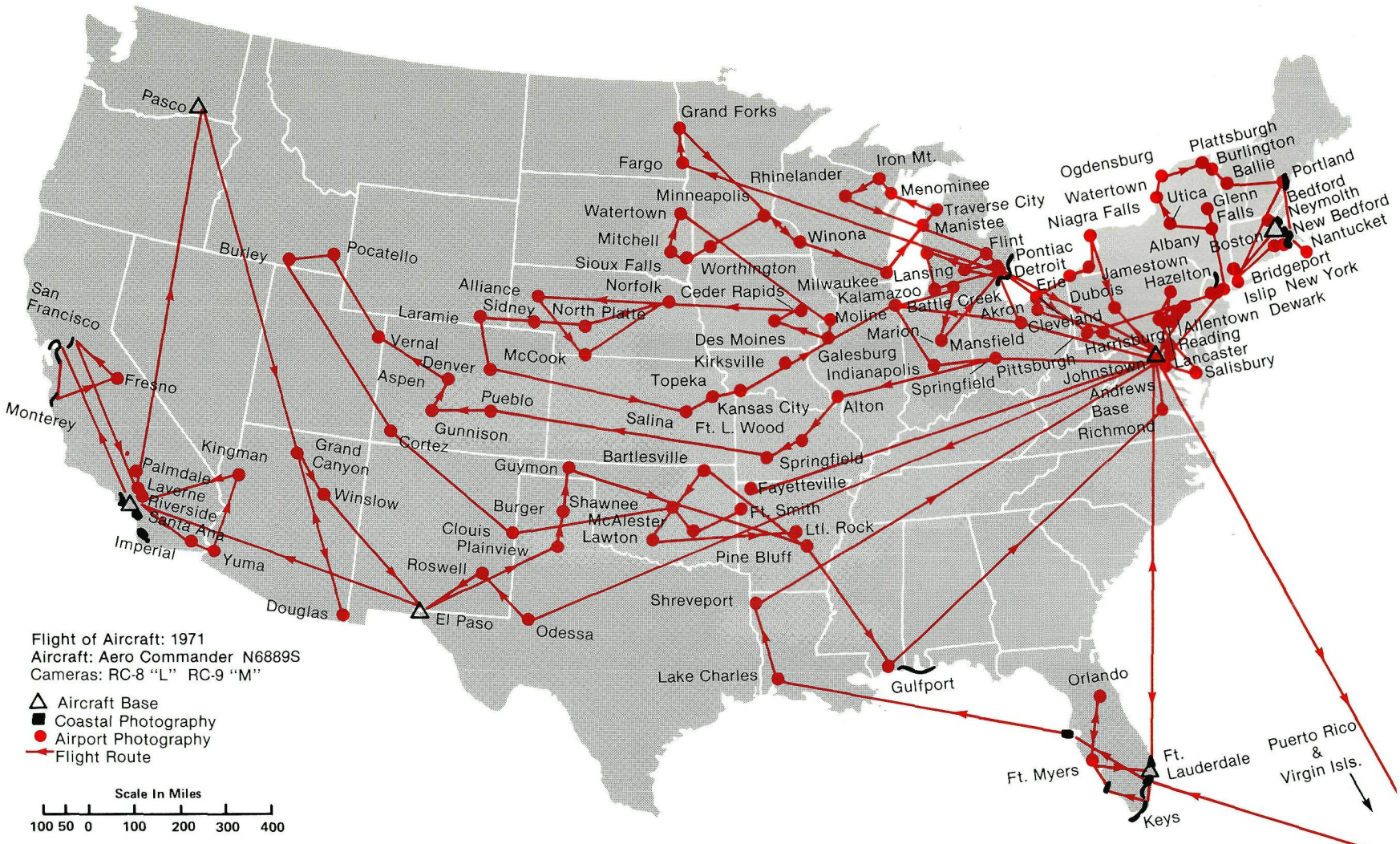
Bellingham
Renton
Tacoma
Ephrata
Coeur D'Alene
Walla Walla
Pendleton
Portland
Salem
North Bend
Kalamath
Glasgow
Minot
International Falls
Madison
Massachusetts Coast
Santa Rosa
Sacramento
El Monte
San Francisco
Burbank
Santa Catalina
Washington
Huntington
Charleston
Richmond
Lynchburg
Bristol
East Coast Virginia To Florida
Smyrna
Jackson
Memphis
Chattanooga
Rockwood
Greenville
Florence
Huntsville
Athens
Anderson
Anniston
Augusta
Charleston
Columbus
Birmingham
Savannah
Jackson
Valdosta
Montgomery
Brunswick
Dothan
Jacksonville
Mobile
Ocala
Daytona Beach
Panama City
Tallahasse
St. Petersburg
Tampa
Ft. Lauderdale
Ft. Myers
Miami
Flight of Aircraft: 1971
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: RC-8 "E" "K" & "S"
RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1971
Aircraft: Buffalo DHC-5 ESSA 88
Cameras: RC-8 "E" "K" & "S"
RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Tanana
Cordoua
Fairbanks
Unalakleet
Anchorage
Aniak
Galena
Skagway
Haines
Yakutat
Homer
Soldotna
Seward
Sitka
Bristol Bay
Kodiak Isl
Constantine
Prince of Wales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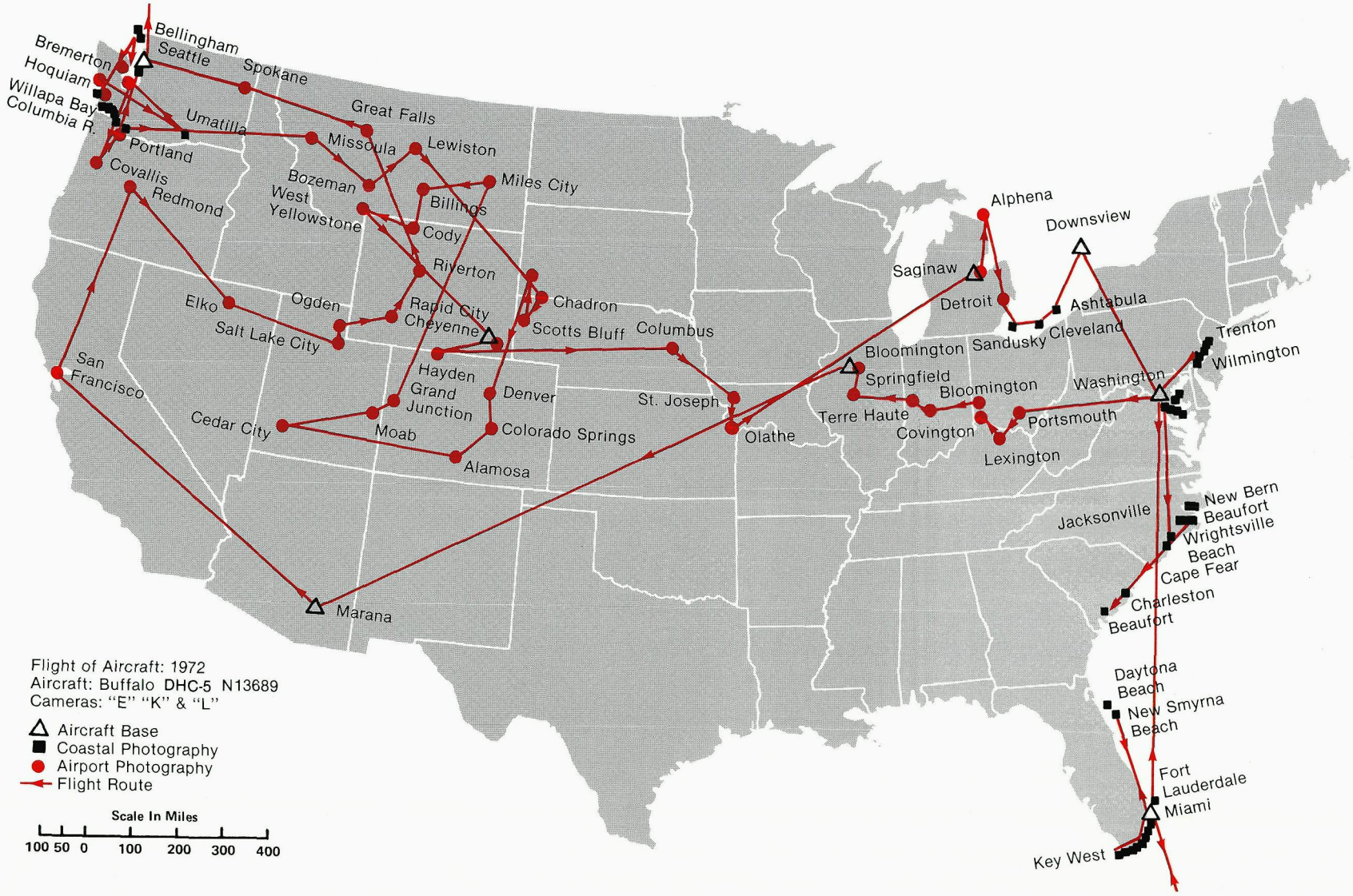
Fargo
Rhinelander
Iron Mt.
Menominee
Minneapolis
Traverse City
Watertown
Manistee
Mitchell
Winona
Flint
Pontiac
Detroit
Sioux Falls
Worthington
Lansing
Norfolk
Ceder Rapids
Milwaukee
Kalamazoo
Battle Creek
Akron
Cleveland
Marion
Mansfield
Moline
Galesburg
Indianapolis
Springfield
Pittsburgh
Johnstown
Harrisburg
Allentown
Dewark
Reading
Lancaster
Salisbury
Andrews
Base
Richmond
Ogdensburg
Watertown
Niagara Falls
Plattsburgh
Burlington
Ballie
Utica
Glenn
Falls
Albany
Boston
Portland
Bedford
Neymolth
New Bedford
Nantucket
Bridgeport
Islip
New York
Jamestown
Hazelton
Dubois
Erie
Burley
Pocatello
Alliance
Sidney
North Platte
Laramie
Vernal
Denver
McCook
Aspen
Pueblo
Gunnison
Cortez
Des Moines
Kirksville
Topeka
Kansas City
Salina
Ft. L. Wood
Springfield
Alton
Bartlesville
Guymon
Fayetteville
Ft. Smith
Ltl. Rock
Pine Bluff
Shawnee
McAlester
Lawton
Burger
Clouis
Plainview
Roswell
Odessa
Shreveport
Lake Charles
Gulfport
Orlando
Ft. Myers
Ft. Lauderdale
Keys
Puerto Rico
&
Virgin Isls.
San
Francisco
Fresno
Monterey
Kingman
Grand
Canyon
Winslow
Palmdale
Laverne
Riverside
Santa Ana
Imperial
Yuma
Douglas
El Paso
Flight of Aircraft: 1971
Aircraft: Aero Commander N6889S
Cameras: RC-8 "L" RC-9 "M"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400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Seattle
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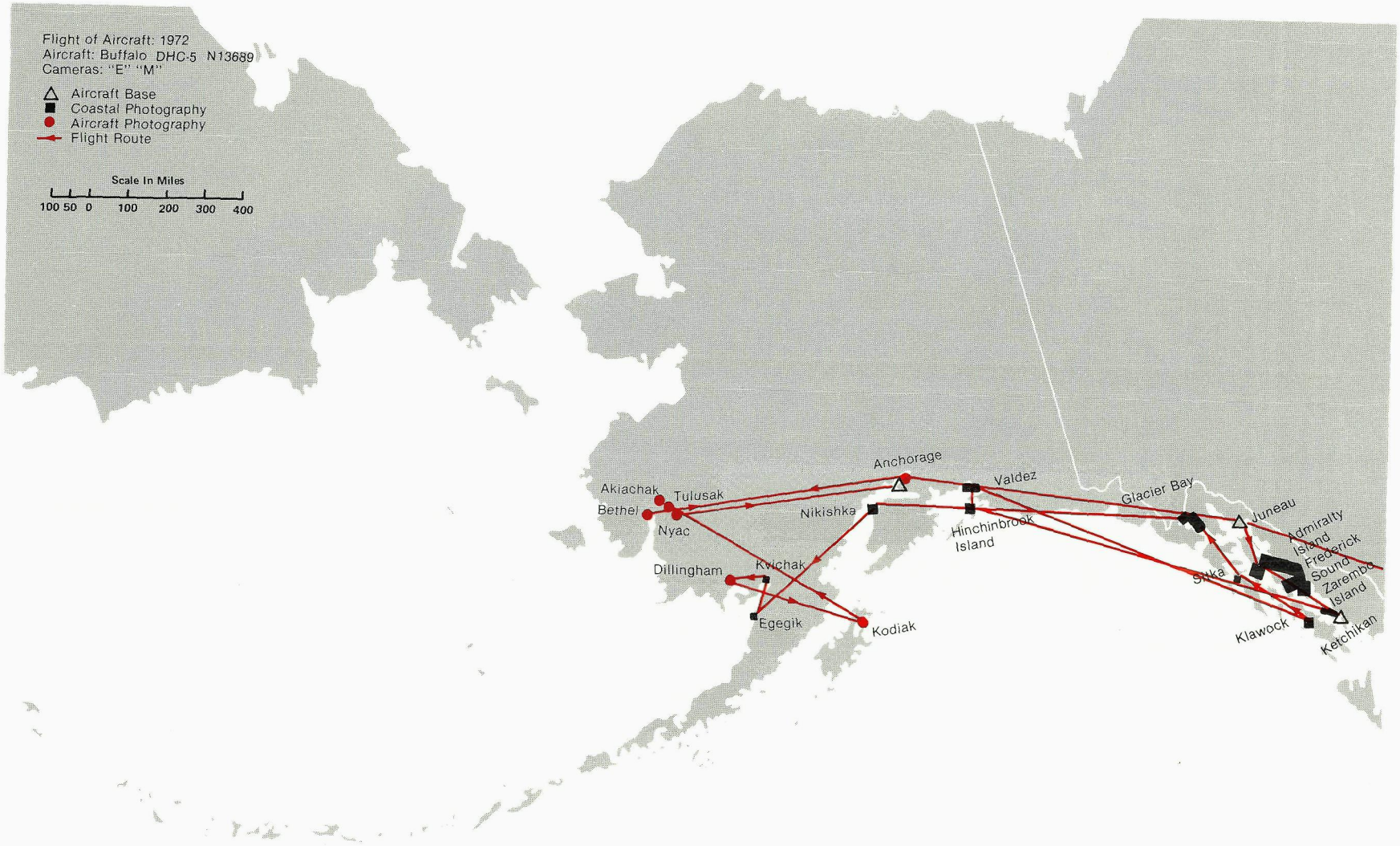
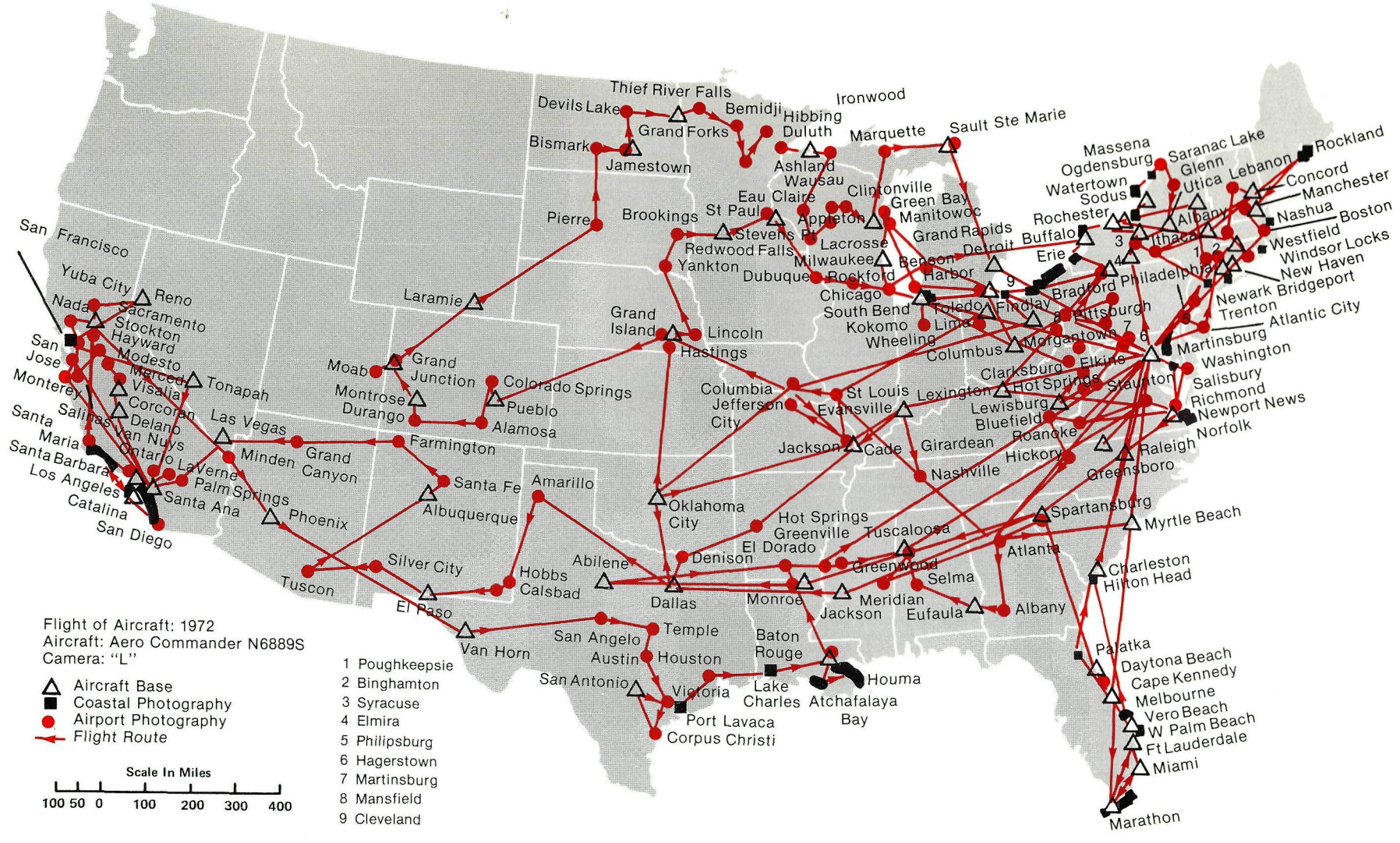
Columbia R.
Great Falls
Umatilla
Missoula
Lewiston
Portland
Covallis
Redmond
Bozeman
West Yellowstone
Miles City
Billings
Cody
Riverton
Elko
Ogden
Rapid City
Cheyenne
Chadron
Scotts Bluff
Columbus
Salt Lake City
San Francisco
Hayden
Grand Junction
Denver
St. Joseph
Cedar City
Moab
Colorado Springs
Alamosa
Olathe
Marana
Alphena
Downsview
Saginaw
Detroit
Ashtabula
Cleveland
Sandusky
Bloomington
Springfield
Terre Haute
Bloomington
Covington
Lexington
Portsmouth
Washington
Trenton
Wilmington
Jacksonville
New Bern
Beaufort
Wrightsville Beach
Cape Fear
Charleston
Beaufort
Daytona Beach
New Smyrna Beach
Fort Lauderdale
Miami
Key West
Flight of Aircraft: 1972
Aircraft: Buffalo DHC-5 N13689
Cameras: "E" "K" & "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1972
Aircraft: Buffalo DHC-5 N13689
Cameras: "E" "M"
Aircraft Base
Coastal Photography
Aircraft Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Anchorage
Akiachak
Tulusak
Bethel
Nyac
Nikishka
Valdez
Glacier Bay
Hinchinbrook Island
Juneau
Admiralty Island
Frederick Sound
Zarembo Island
Ketchikan
Klawock
Sitka
Dillingham
Kvichak
Egegik
Kodiak


Flight of Aircraft: 1972
Aircraft: Aero Commander N6889S
Camera: "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Poughkeepsie
2 Binghamton
3 Syracuse
4 Elmira
5 Philipsburg
6 Hagerstown
7 Martinsburg
8 Mansfield
9 Cleveland
San Francisco
Yuba City
Reno
Nada
Sacramento
Stockton
Hayward
San Jose
Modesto
Merced
Tonapah
Monterey
Visalia
Corcoran
Delano
Salinas
Santa Maria
Van Nuys
Ontario
Santa Barbara
LaVerne
Los Angeles
Palm Springs
Santa Ana
Catalina
San Diego
Las Vegas
Minden
Grand Canyon
Phoenix
Tuscon
Silver City
El Paso
Van Horn
Laramie
Moab
Grand Junction
Montrose
Durango
Colorado Springs
Pueblo
Alamosa
Farmington
Santa Fe
Albuquerque
Amarillo
Hobbs
Calsbad
Abilene
Dallas
San Angelo
Austin
Temple
Houston
San Antonio
Victoria
Port Lavaca
Corpus Christi
Baton Rouge
Lake Charles
Atchafalaya Bay
Houma
Jackson
Meridian
Monroe
Denison
El Dorado
Greenville
Hot Springs
Oklahoma City
Columbia
Jefferson City
Jackson
Cade
Evansville
St Louis
Lexington
Girardean
Nashville
Tuscaloosa
Greenwood
Selma
Eufaula
Albany
Atlanta
Spartansburg
Myrtle Beach
Charleston
Hilton Head
Palatka
Daytona Beach
Cape Kennedy
Melbourne
Vero Beach
W Palm Beach
Ft Lauderdale
Miami
Marathon
Raleigh
Greensboro
Norfolk
Newport News
Richmond
Salisbury
Washington
Staunton
Martinsburg
Atlantic City
Trenton
Newark
Bridgeport
New Haven
Windsor Locks
Westfield
Boston
Nashua
Manchester
Concord
Rockland
Lebanon
Albany
Utica
Glenn
Saranac Lake
Massena
Ogdensburg
Watertown
Sodus
Rochester
Buffalo
Erie
Philadelphia
Bradford
Pittsburgh
Morgantown
Elkins
Clarksburg
Hot Springs
Lewisburg
Bluefield
Roanoke
Hickory
Columbus
Lima
Toledo
Findlay
Harbor
Benson
Detroit
Grand Rapids
Manitowoc
Green Bay
Clintonville
Appleton
Lacrosse
Milwaukee
Rockford
Chicago
South Bend
Kokomo
Wheeling
Dubuque
Yankton
Redwood Falls
Stevens Pt
St Paul
Eau Claire
Wausau
Ashland
Hibbing
Duluth
Ironwood
Marquette
Sault Ste Marie
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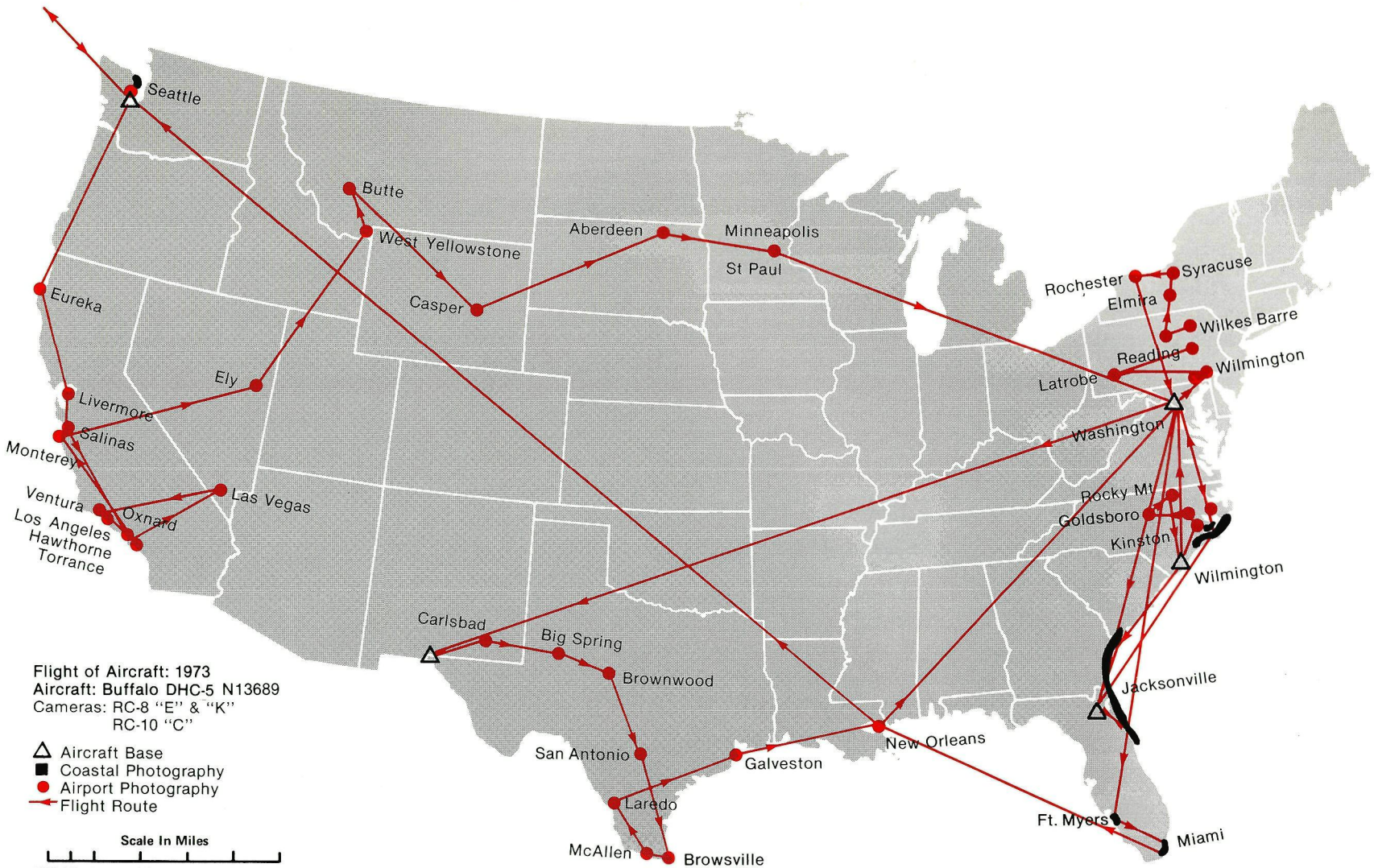
Grand Forks
Thief River Falls
Devils Lake
Bismark
Jamestown
Pierre
Brookings
Grand Island
Lincoln
Hastings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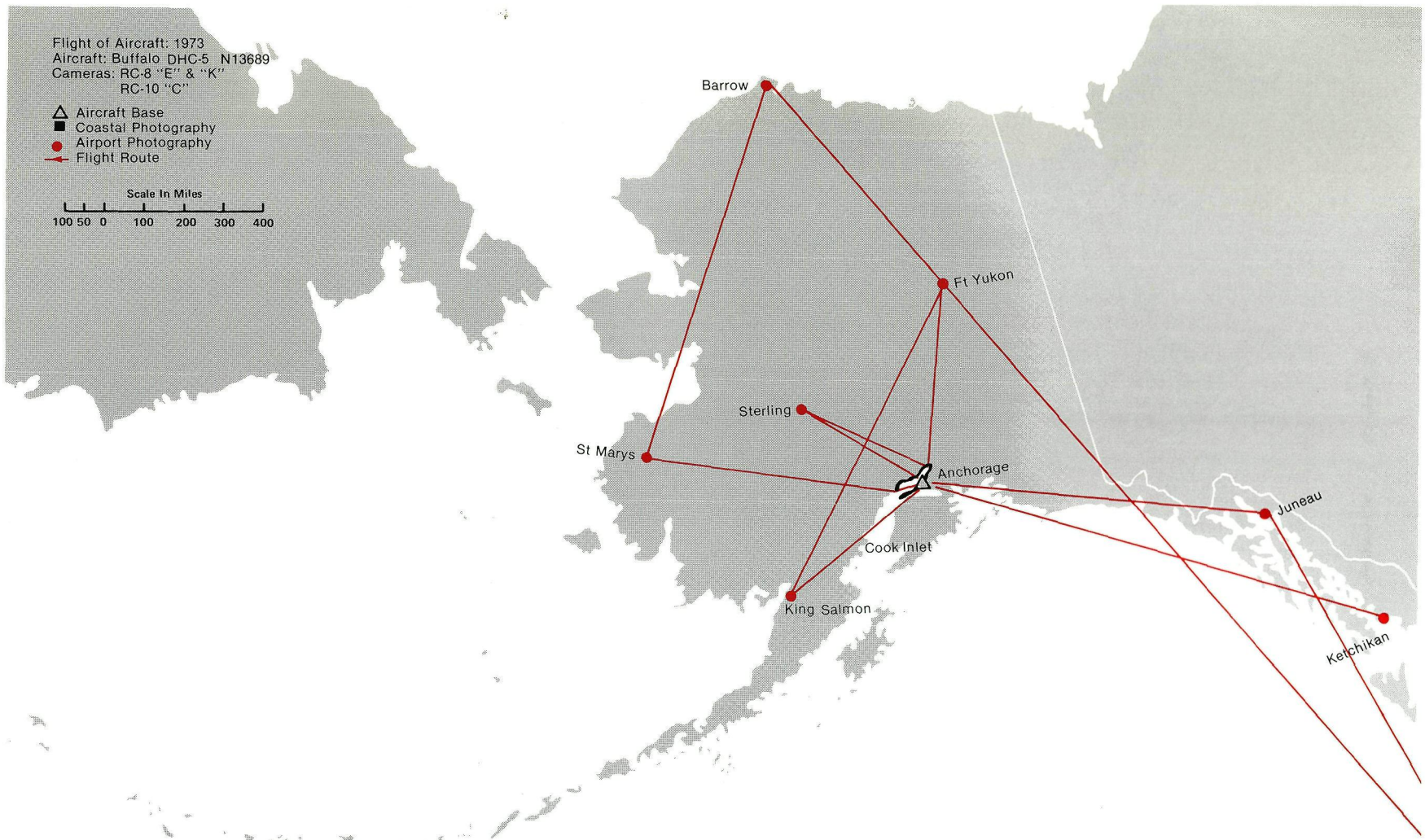
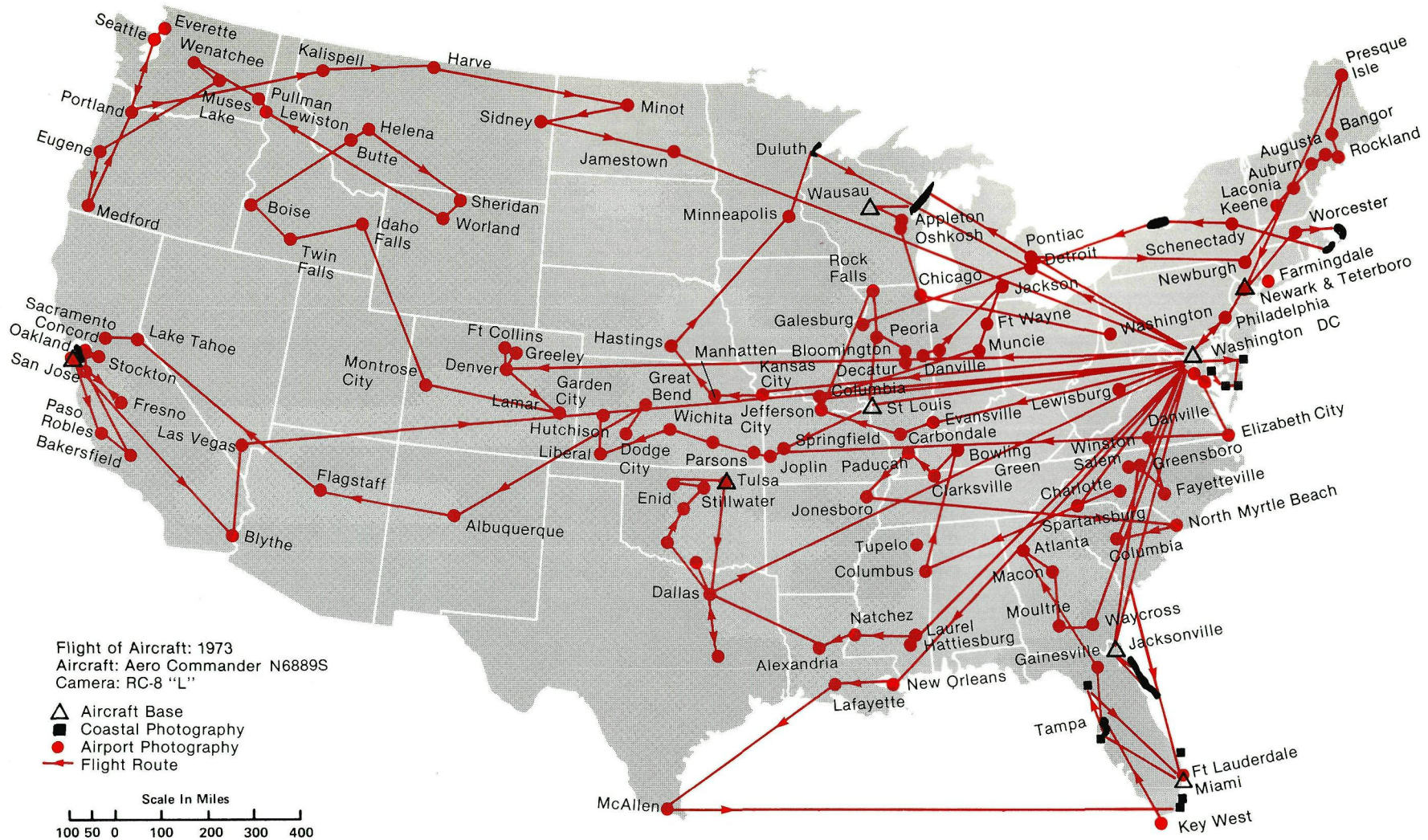
Butte
West Yellowstone
Aberdeen
Minneapolis
St Paul
Casper
Eureka
Ely
Livermore
Salinas
Monterey
Ventura
Oxnard
Los Angeles
Hawthorne
Torrance
Las Vegas
Carlsbad
Big Spring
Brownwood
San Antonio
Galveston
Laredo
McAllen
Browsville
New Orleans
Rochester
Syracuse
Elmira
Wilkes Barre
Reading
Wilmington
Latrobe
Washington
Rocky Mt
Goldsboro
Kinston
Wilmington
Jacksonville
Ft. Myers
Miami
Flight of Aircraft: 1973
Aircraft: Buffalo DHC-5 N13689
Cameras: RC-8 "E" & "K"
RC-10 "C"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1973
Aircraft: Buffalo DHC-5 N13689
Cameras: RC-8 "E" & "K"
RC-10 "C"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Barrow
Ft Yukon
Sterling
St Marys
Anchorage
Juneau
Cook Inlet
King Salmon
Ketchikan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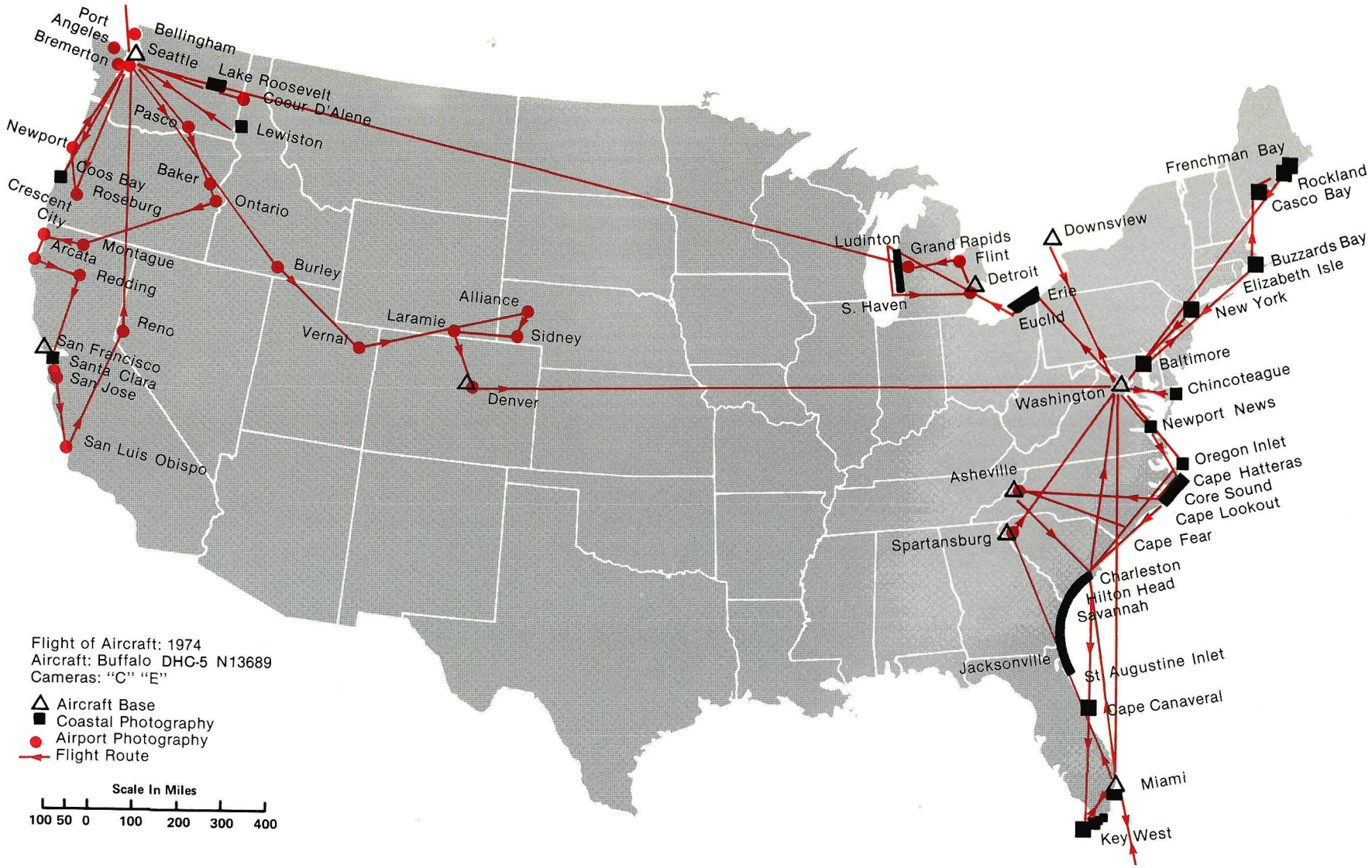
Wenatchee
Kalispell
Harve
Portland
Muses Lake
Pullman
Lewiston
Helena
Sidney
Minot
Eugene
Butte
Jamestown
Duluth
Medford
Boise
Idaho Falls
Sheridan
Worland
Twin Falls
Minneapolis
Wausau
Appleton
Oshkosh
Presque Isle
Bangor
Augusta
Auburn
Rockland
Laconia
Keene
Worcester
Pontiac
Detroit
Schenectady
Newburgh
Farmingdale
Newark & Teterboro
Rock Falls
Chicago
Jackson
Philadelphia
Washington DC
Galesburg
Peoria
Ft Wayne
Washington
Sacramento
Concord
Oakland
Lake Tahoe
Ft Collins
Greeley
Hastings
Manhatten
Bloomington
Muncie
San Jose
Stockton
Denver
Montrose City
Kansas City
Decatur
Danville
Columbia
Garden City
Great Bend
Lamar
Wichita
Jefferson City
St Louis
Evansville
Lewisburg
Danville
Elizabeth City
Paso Robles
Fresno
Las Vegas
Hutchison
Springfield
Carbondale
Winston Salem
Greensboro
Bakersfield
Liberal
Dodge City
Parsons
Joplin
Paducah
Bowling Green
Fayetteville
Flagstaff
Tulsa
Clarksville
Charlotte
Enid
Stillwater
Jonesboro
Spartansburg
North Myrtle Beach
Albuquerque
Tupelo
Atlanta
Columbia
Blythe
Columbus
Macon
Dallas
Natchez
Moultrie
Waycross
Laurel
Hattiesburg
Jacksonville
Alexandria
Gainesville
New Orleans
Lafayette
Tampa
Ft Lauderdale
Miami
McAllen
Key West
Flight of Aircraft: 1973
Aircraft: Aero Commander N6889S
Camera: RC-8 "L"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400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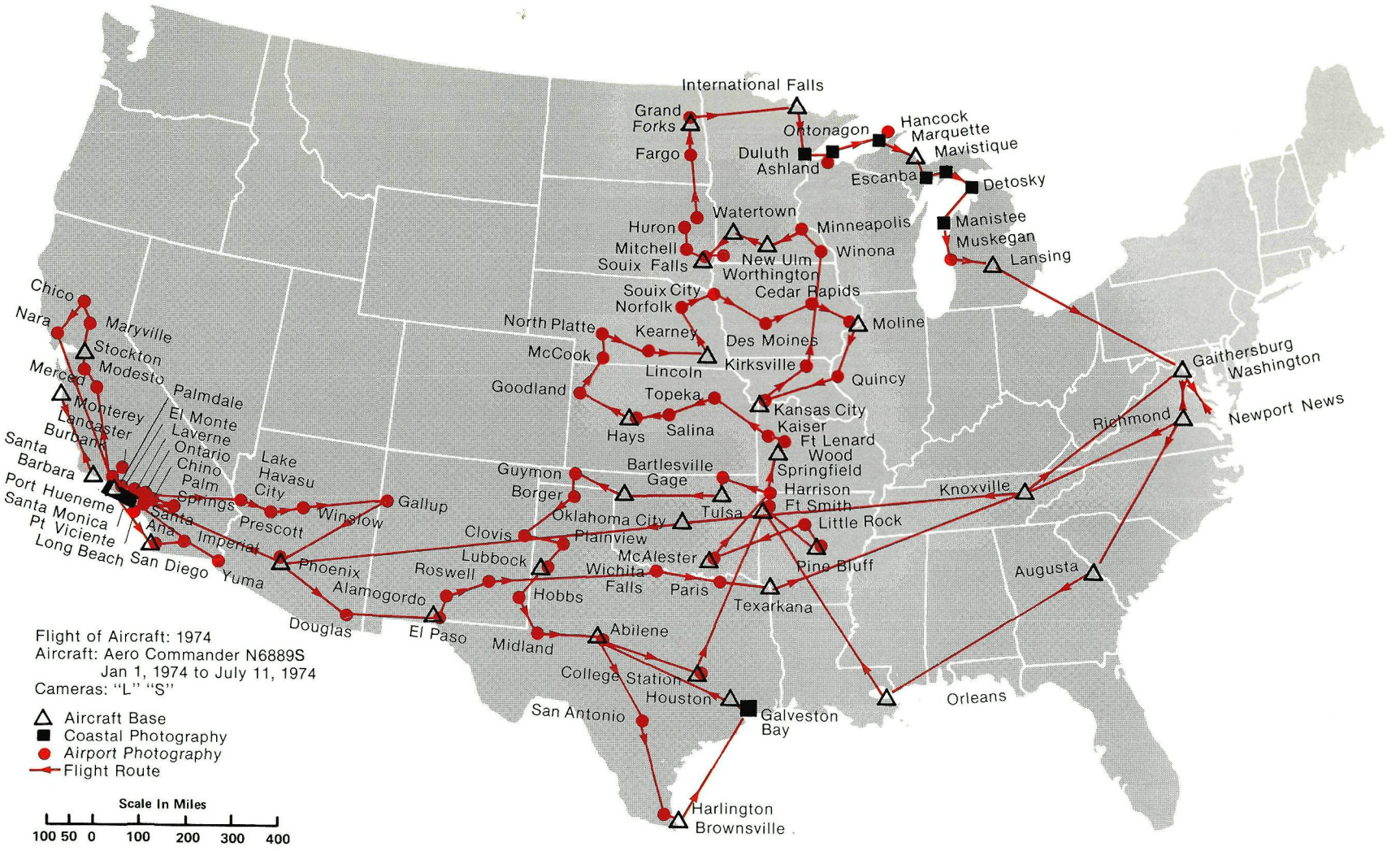
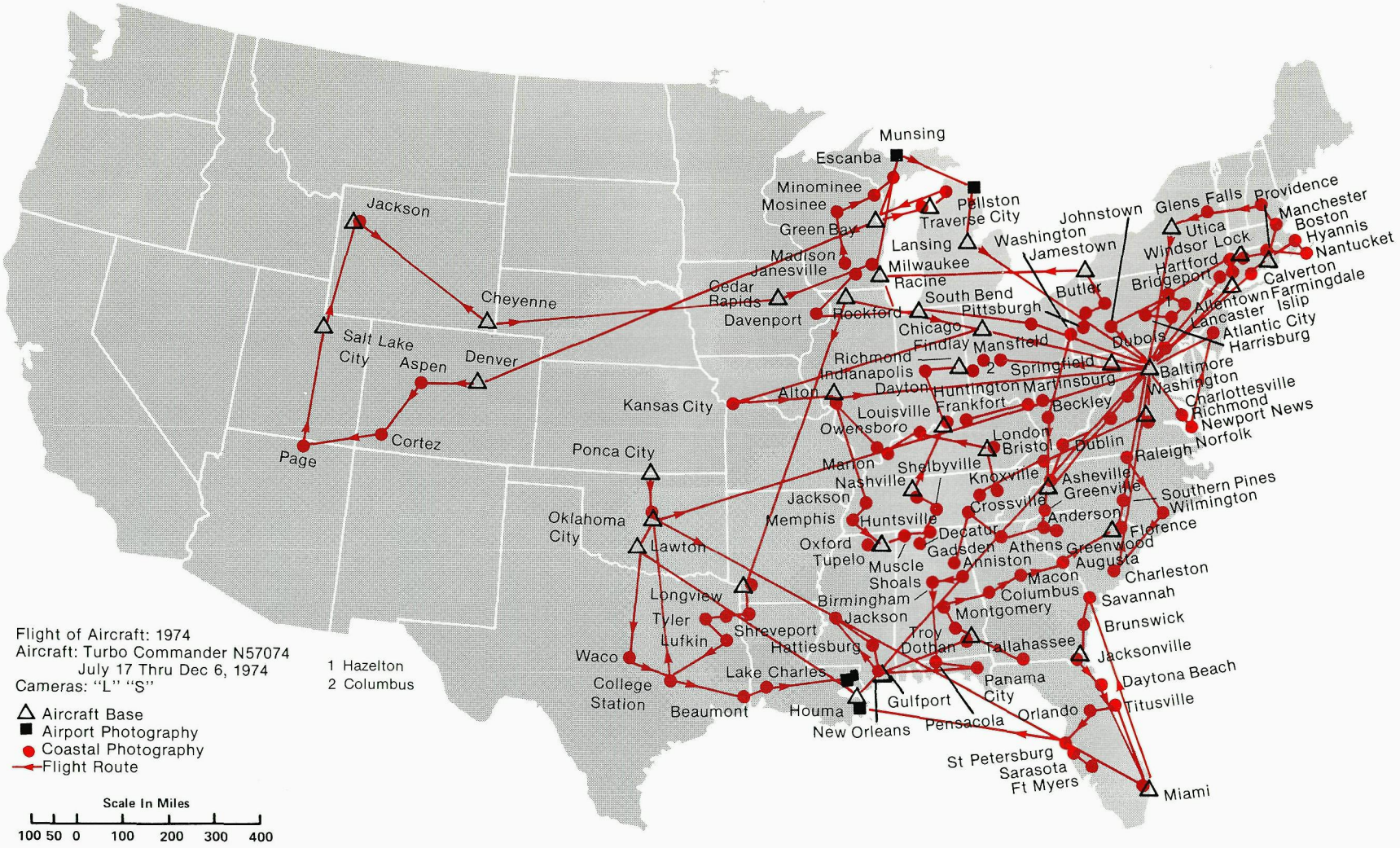
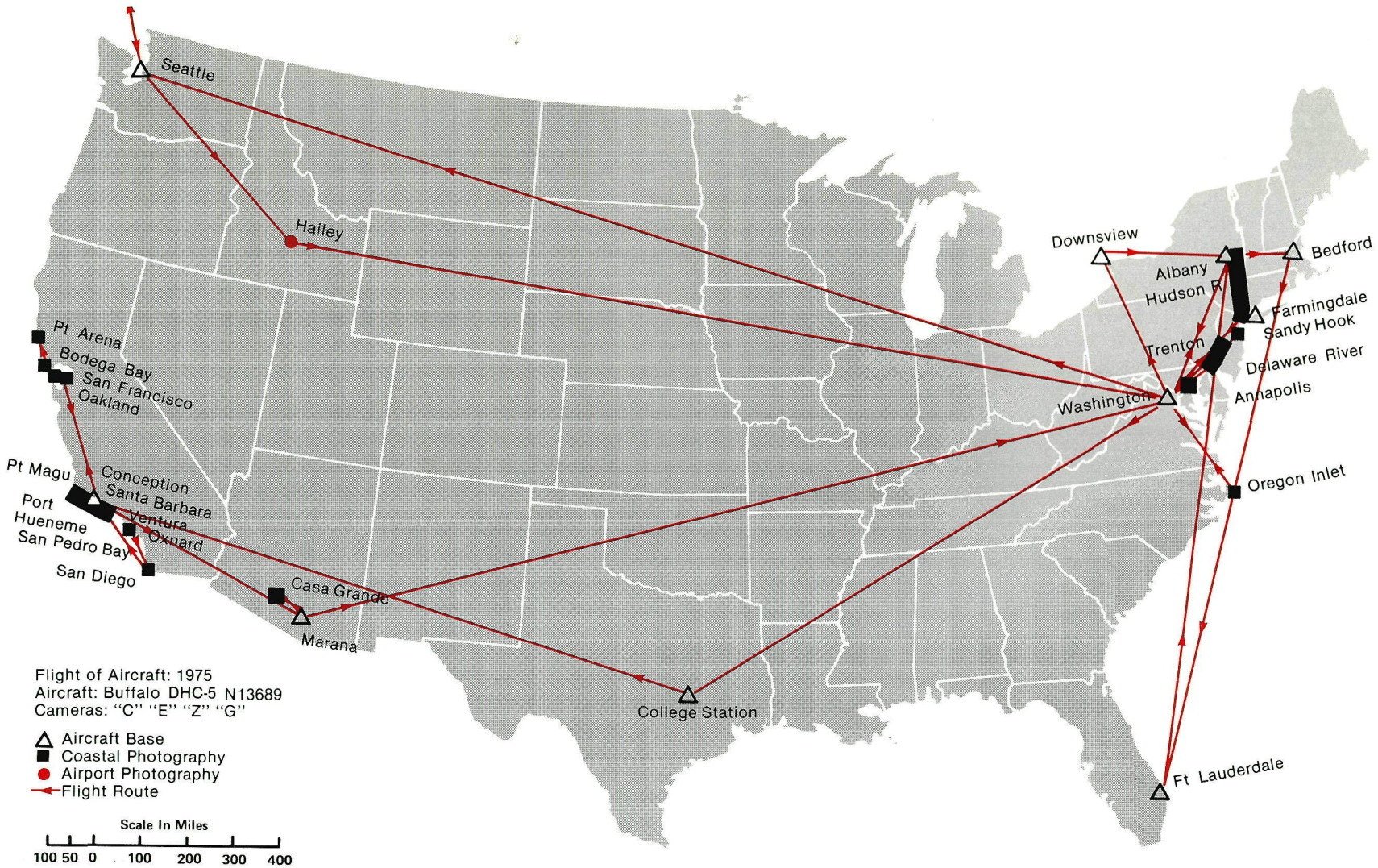
Bellingham
Bremerton
Seattle
Lake Roosevelt
Coeur D'Alene
Pasco
Lewiston
Newport
Coos Bay
Baker
Roseburg
Ontario
Crescent City
Arcata
Montague
Redding
Burley
Reno
Alliance
Laramie
Vernal
Sidney
San Francisco
Santa Clara
San Jose
Denver
San Luis Obispo
Ludington
Grand Rapids
Flint
Detroit
S. Haven
Erie
Euclid
Downsview
Frenchman Bay
Rockland
Casco Bay
Buzzards Bay
Elizabeth Isle
New York
Baltimore
Chincoteague
Washington
Newport News
Oregon Inlet
Cape Hatteras
Core Sound
Cape Lookout
Asheville
Cape Fear
Spartansburg
Charleston
Hilton Head
Savannah
Jacksonville
St Augustine Inlet
Cape Canaveral
Miami
Key West
Flight of Aircraft: 1974
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1974
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Haines
Juneau
Petersburg
Wrangell


International Falls
Grand Forks
Fargo
Ontonagon
Hancock
Marquette
Mavistique
Duluth
Ashland
Escanba
Detosky
Manistee
Muskegan
Lansing
Watertown
Huron
Minneapolis
Mitchell
Souix Falls
New Ulm
Worthington
Winona
Souix City
Norfolk
Cedar Rapids
Moline
North Platte
Kearney
Des Moines
McCook
Lincoln
Kirksville
Quincy
Goodland
Topeka
Kansas City
Hays
Salina
Kaiser
Ft Lenard Wood
Springfield
Bartlesville
Gage
Guymon
Borger
Harrison
Ft Smith
Oklahoma City
Tulsa
Little Rock
Clovis
Plainview
Lubbock
McAlester
Pine Bluff
Roswell
Wichita Falls
Paris
Texarkana
Hobbs
Abilene
Midland
College Station
Houston
Galveston Bay
San Antonio
Harlington
Brownsville
Orleans
Augusta
Knoxville
Richmond
Gaithersburg
Washington
Newport News
Chico
Nara
Maryville
Stockton
Modesto
Merced
Palmdale
Monterey
El Monte
Lancaster
Laverne
Burbank
Ontario
Santa Barbara
Chino
Palm Springs
Lake Havasu City
Port Hueneme
Santa Monica
Pt Viciente
Long Beach
Santa Ana
San Diego
Imperial
Yuma
Prescott
Winslow
Gallup
Phoenix
Alamogordo
Douglas
El Paso
Flight of Aircraft: 1974
Aircraft: Aero Commander N6889S
Jan 1, 1974 to July 11, 1974
Cameras: "L" "S"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Munsing
Escanba
Minominee
Mosinee
Green Bay
Pellston
Traverse City
Lansing
Madison
Janesville
Milwaukee
Racine
Cedar Rapids
Davenport
Rockford
Chicago
South Bend
Pittsburgh
Findlay
Mansfield
Richmond
Indianapolis
Springfield
Dayton
Huntington
Marinsburg
Alton
Kansas City
Louisville
Frankfort
Beckley
Owensboro
London
Bristol
Dublin
Ponca City
Marion
Nashville
Sheibyville
Knoxville
Asheville
Greenville
Jackson
Crossville
Memphis
Huntsville
Anderson
Oklahoma City
Lawton
Decatur
Oxford
Tupelo
Gadsden
Athens
Greenwood
Muscle Shoals
Anniston
Augusta
Macon
Charleston
Longview
Birmingham
Columbus
Savannah
Tyler
Jackson
Montgomery
Brunswick
Shreveport
Lufkin
Hattiesburg
Troy
Dothan
Tallahassee
Jacksonville
Waco
Lake Charles
Panama City
Daytona Beach
College Station
Beaumont
Houma
Gulfport
Orlando
Titusville
New Orleans
Pensacola
St Petersburg
Sarasota
Ft Myers
Miami
Jackson
Cheyenne
Salt Lake City
Aspen
Denver
Page
Cortez
Johnstown
Washington
Jamestown
Butler
Glens Falls
Utica
Windsor Lock
Hartford
Bridgeport
Providence
Manchester
Boston
Hyannis
Nantucket
Calverton
Farmingdale
Islip
Allentown
Lancaster
Atlantic City
Harrisburg
Dubois
Baltimore
Washington
Charlottesville
Richmond
Newport News
Raleigh
Norfolk
Southern Pines
Wilmington
Florence
Beckley
Flight of Aircraft: 1974
Aircraft: Turbo Commander N57074
July 17 Thru Dec 6, 1974
Cameras: "L" "S"
Aircraft Base
Airport Photography
Coastal Photography
Flight Route
1 Hazelton
2 Columbus
Scale In Miles
100 50 0 100 200 300 400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Hailey
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Bodega Bay
San Francisco
Oakland
Pt Magu
Conception
Santa Barbara
Port Hueneme
Ventura
Oxnard
San Pedro Bay
San Diego
Casa Grande
Marana
College Station
Washington
Downsview
Albany
Hudson R.
Bedford
Farmingdale
Sandy Hook
Trenton
Delaware River
Annapolis
Oregon Inlet
Ft Lauderdale
Flight of Aircraft: 1975
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E" "Z" "G"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
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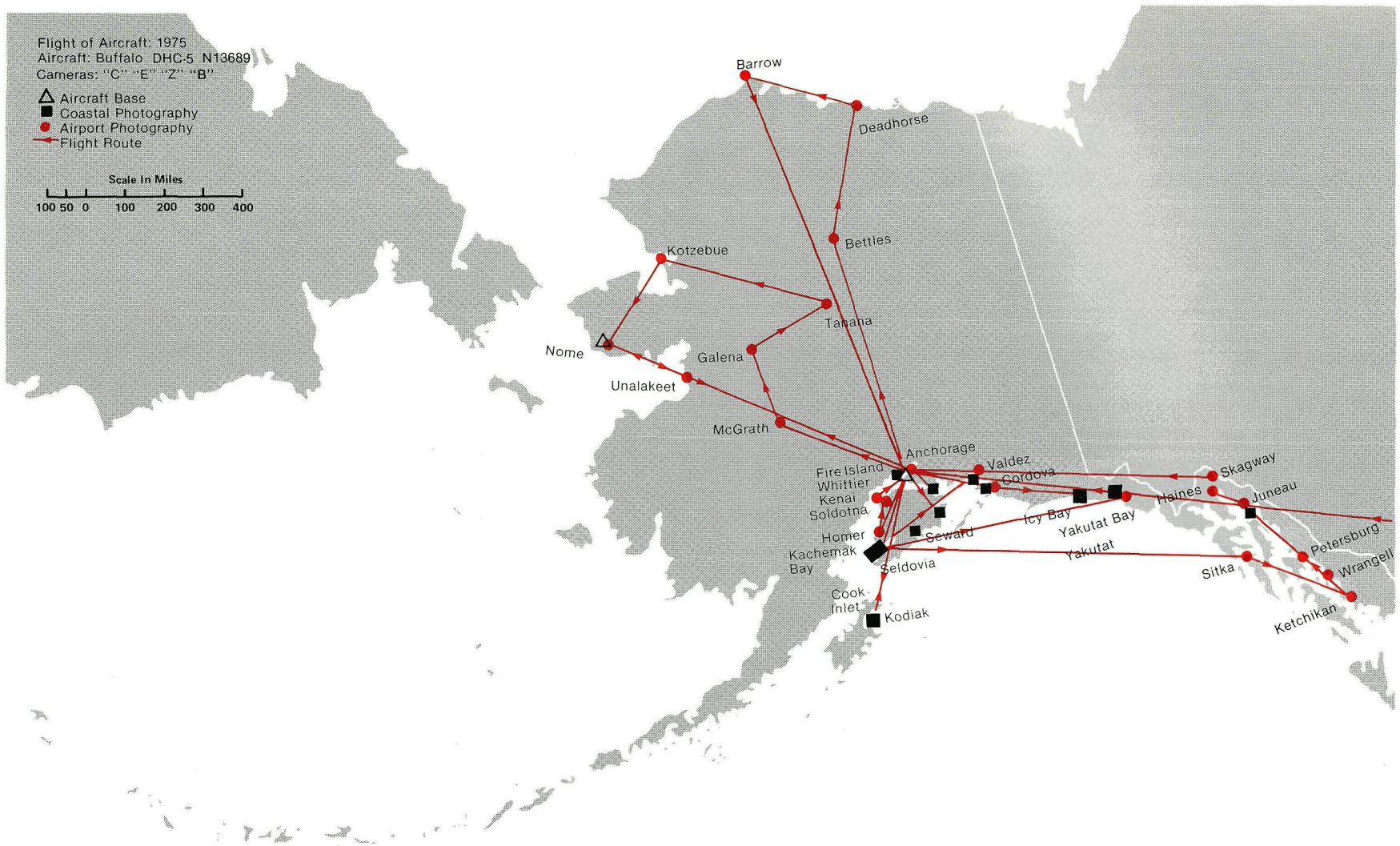
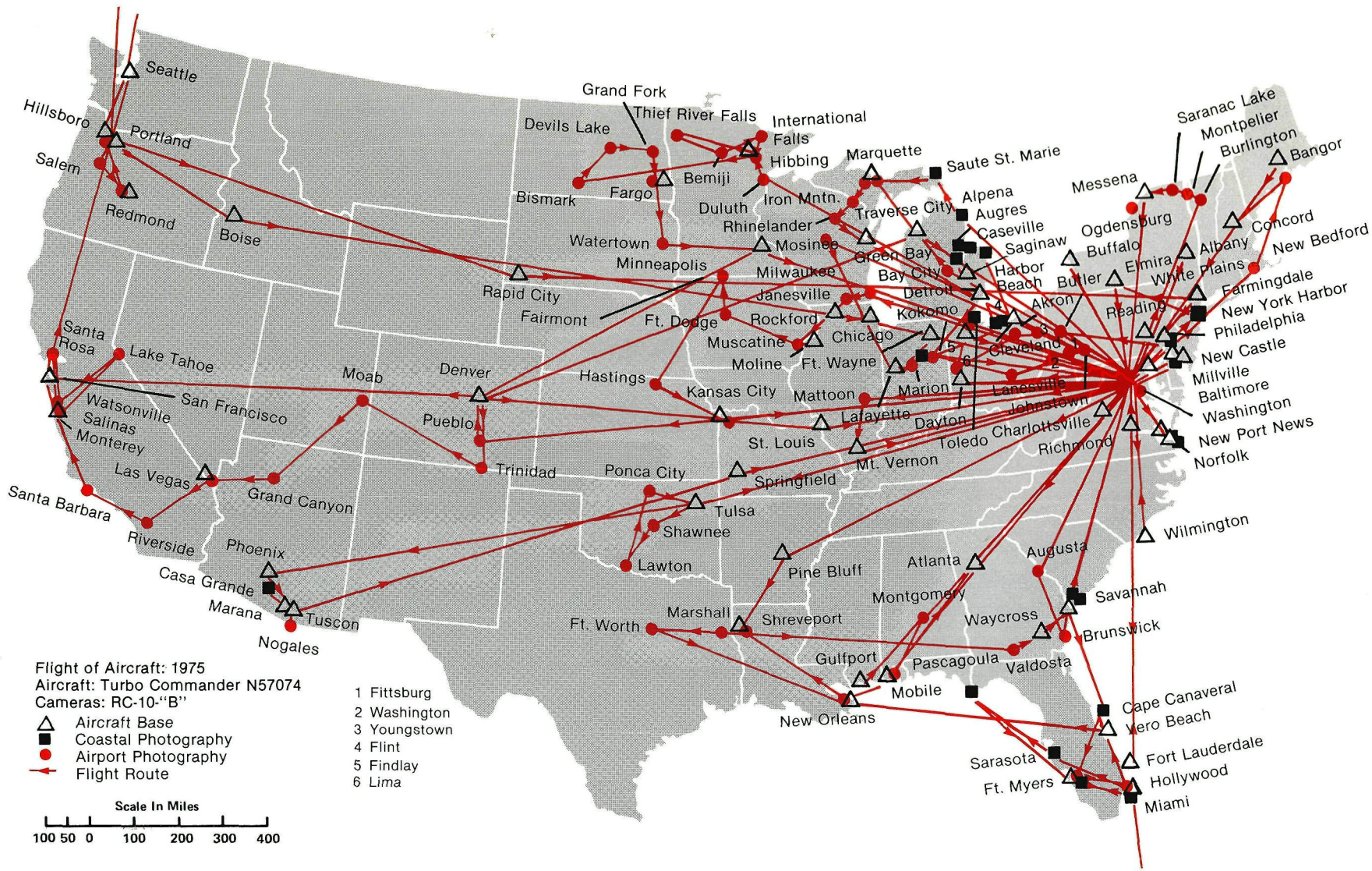

Flight of Aircraft: 1975
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E" "Z" "B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Barrow
Deadhorse
Bettles
Kotzebue
Tanana
Nome
Galena
Unalakeet
McGrath
Anchorage
Valdez
Cordova
Fire Island
Whittier
Kenai
Soldotna
Homer
Kachemak Bay
Seward
Seldovia
Cook Inlet
Kodiak
Icy Bay
Yakutat Bay
Yakutat
Skagway
Haines
Juneau
Petersburg
Wrangell
Sitka
Ketchikan


Seattle
Hillsboro
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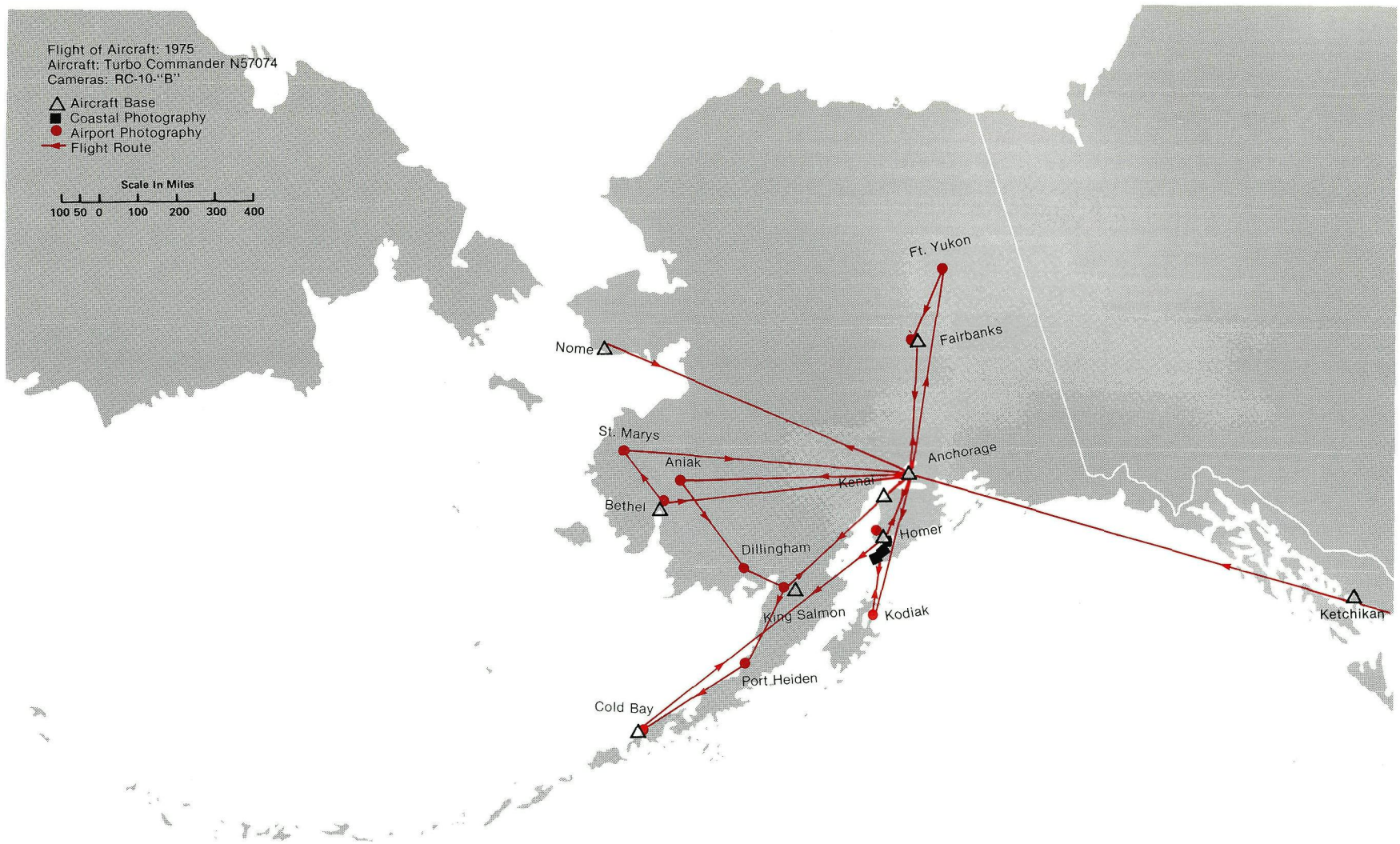
Salem
Redmond
Boise
Santa Rosa
Lake Tahoe
San Francisco
Watsonville
Salinas
Monterey
Santa Barbara
Riverside
Las Vegas
Grand Canyon
Moab
Denver
Pueblo
Trinidad
Phoenix
Casa Grande
Marana
Tuscon
Nogales
Rapid City
Fairmont
Grand Fork
Thief River Falls
Devils Lake
Bismark
Fargo
Watertown
Minneapolis
Ft. Dodge
Hastings
Kansas City
Ponca City
Tulsa
Shawnee
Lawton
Ft. Worth
Marshall
Shreveport
Pine Bluff
St. Louis
International Falls
Hibbing
Bemiji
Duluth
Iron Mntn.
Rhinelander
Mosinee
Milwaukee
Janesville
Rockford
Muscatine
Moline
Chicago
Ft. Wayne
Mattoon
Lafayette
Springfield
Mt. Vernon
Marquette
Saute St. Marie
Traverse City
Alpena
Augres
Caseville
Saginaw
Green Bay
Bay City
Harbor Beach
Detroit
Kokomo
Akron
Cleveland
Marion
Dayton
Toledo
Lancaster
Johnstown
Charlottsville
Richmond
Mobile
Gulfport
Pascagoula
New Orleans
Atlanta
Montgomery
Waycross
Augusta
Savannah
Brunswick
Valdosta
Wilmington
Cape Canaveral
Vero Beach
Fort Lauderdale
Hollywood
Miami
Sarasota
Ft. Myers
Saranac Lake
Montpelier
Burlington
Bangor
Messena
Ogdensburg
Buffalo
Elmira
Albany
Concord
New Bedford
White Plains
Farmingdale
New York Harbor
Philadelphia
Reading
Butler
New Castle
Millville
Baltimore
Washington
New Port News
Norfolk
Flight of Aircraft: 1975
Aircraft: Turbo Commander N57074
Cameras: RC-10-"B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Fittsburg
2 Washington
3 Youngstown
4 Flint
5 Findlay
6 Lima


Flight of Aircraft: 1975
Aircraft: Turbo Commander N57074
Cameras: RC-10-"B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
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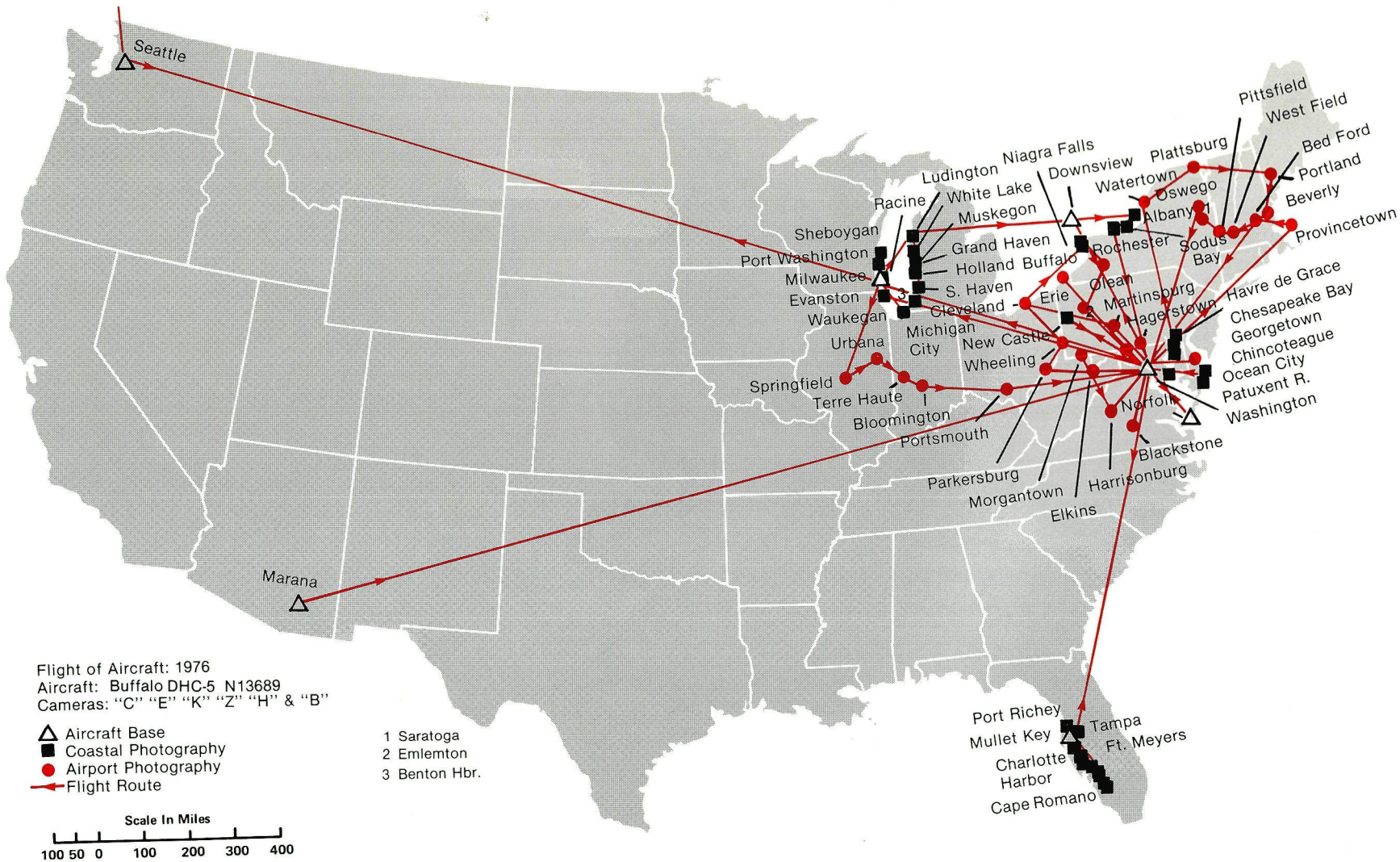
Ft. Yukon
Fairbanks
Nome
St. Marys
Aniak
Anchorage
Kenai
Bethel
Homer
Dillingham
King Salmon
Kodiak
Ketchikan
Port Heiden
Cold Bay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Holland
S. Haven
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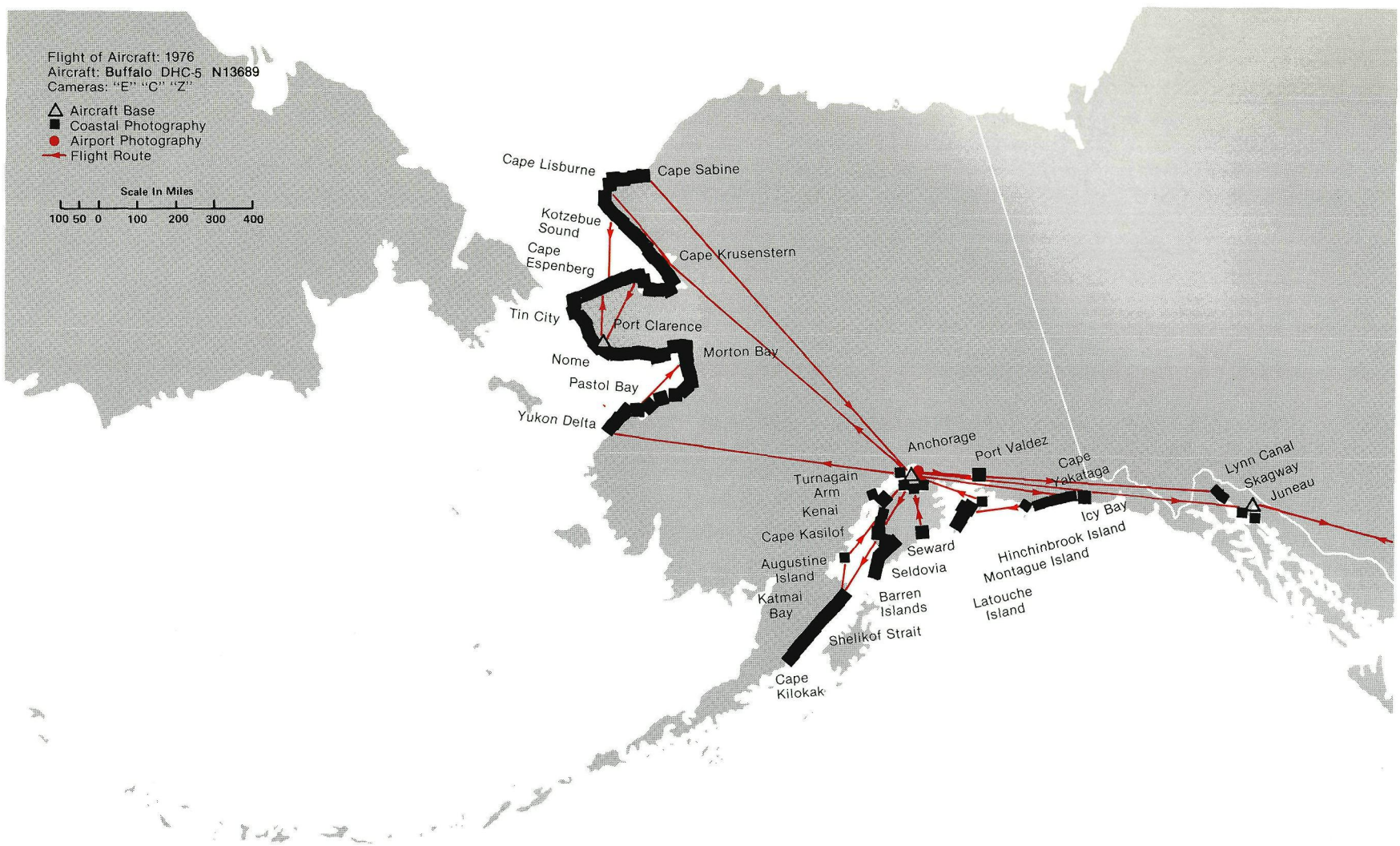
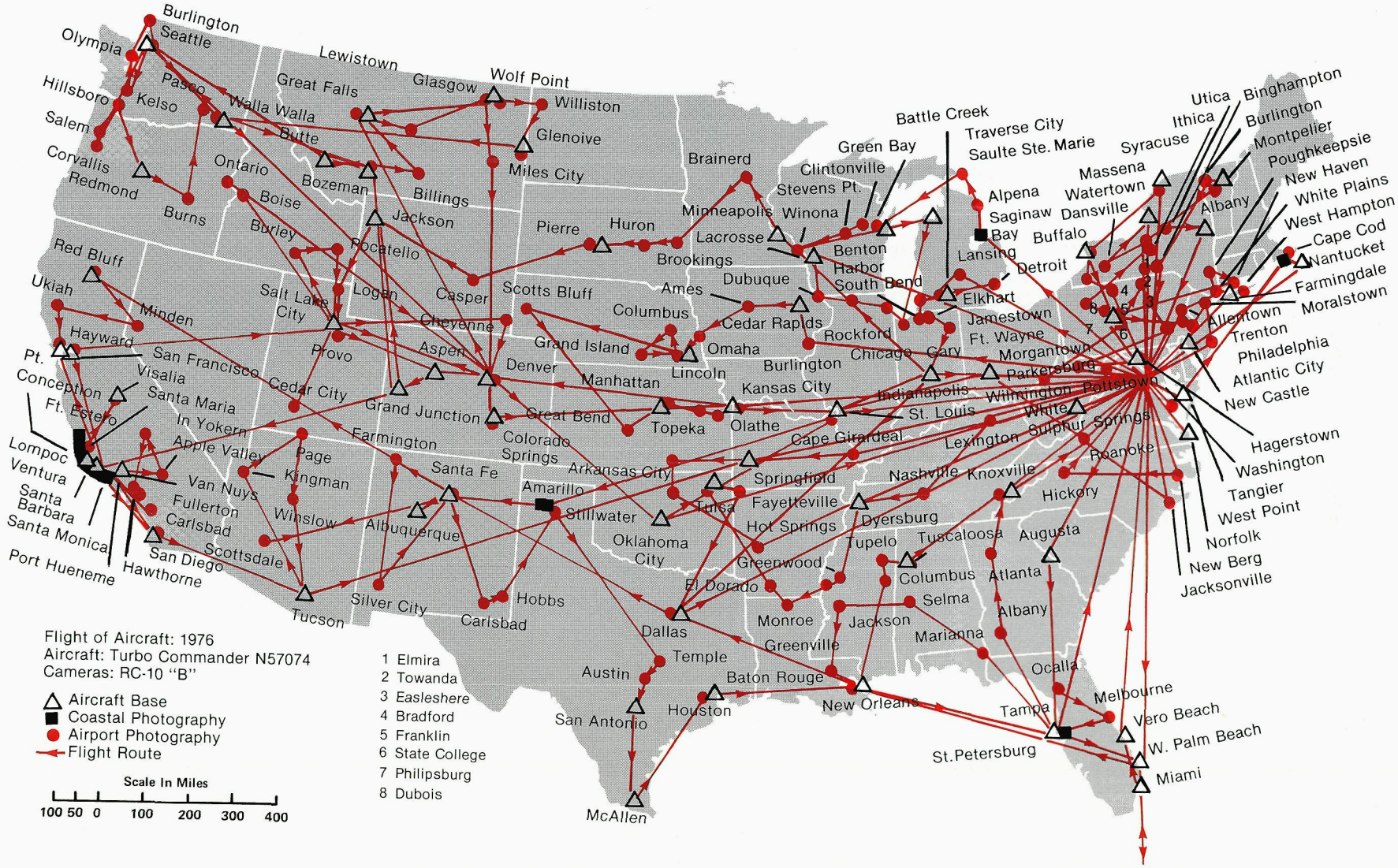
Michigan City
Evanston
Waukegan
Urbana
Springfield
Terre Haute
Bloomington
Portsmouth
Parkersburg
Morgantown
Elkins
Harrisonburg
Blackstone
Norfolk
Wheeling
New Castle
Erie
Olean
Buffalo
Rochester
Niagra Falls
Downsview
Watertown
Oswego
Albany
Plattsburg
Pittsfield
West Field
Bed Ford
Portland
Beverly
Provincetown
Sodus Bay
Martinsburg
Hagerstown
Havre de Grace
Chesapeake Bay
Georgetown
Chincoteague
Ocean City
Patuxent R.
Washington
Port Richey
Mullet Key
Tampa
Ft. Meyers
Charlotte Harbor
Cape Romano
1 Saratoga
2 Emlemton
3 Benton Hbr.
Flight of Aircraft: 1976
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E" "K" "Z" "H" & "B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1976
Aircraft: Buffalo DHC-5 N13689
Cameras: "E" "C" "Z"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Cape Lisburne
Cape Sabine
Kotzebue Sound
Cape Espenberg
Cape Krusenstern
Tin City
Port Clarence
Morton Bay
Nome
Pastol Bay
Yukon Delta
Anchorage
Port Valdez
Cape Yakataga
Lynn Canal
Skagway
Juneau
Turnagain Arm
Kenai
Icy Bay
Cape Kasilof
Seward
Hinchinbrook Island
Montague Island
Augustine Island
Seldovia
Katmai Bay
Barren Islands
Latouche Island
Shelikof Strait
Cape Kilokak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Kelso
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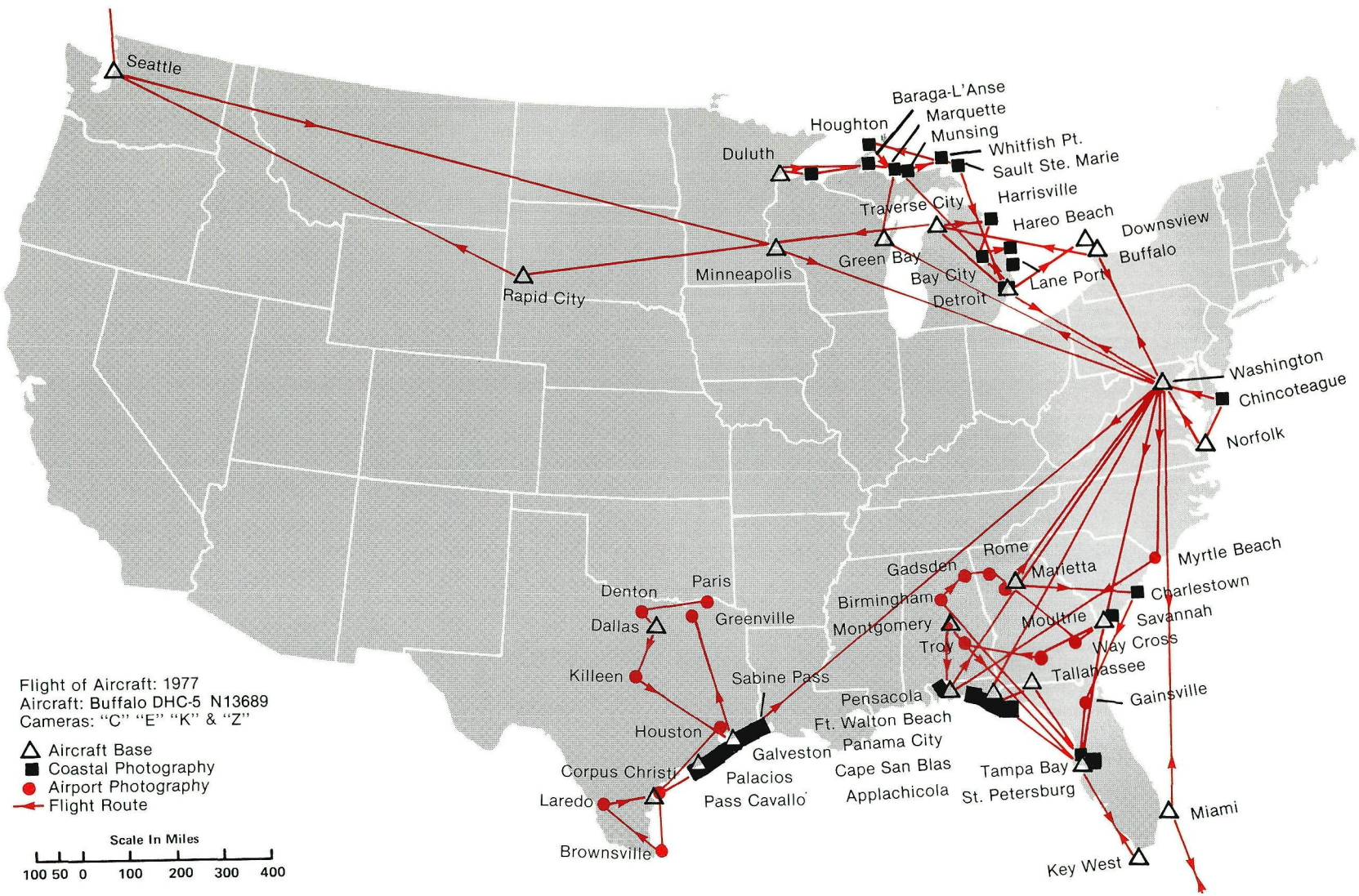
Butte
Burns
Ontario
Boise
Burley
Lewistown
Great Falls
Glasgow
Wolf Point
Williston
Glenoive
Miles City
Billings
Bozeman
Jackson
Pocatello
Casper
Pierre
Huron
Brainerd
Minneapolis
Lacrosse
Brookings
Winona
Stevens Pt.
Clintonville
Green Bay
Battle Creek
Traverse City
Saulte Ste. Marie
Alpena
Saginaw Bay
Lansing
Detroit
Benton Harbor
South Bend
Elkhart
Jamestown
Ft. Wayne
Gary
Chicago
Rockford
Dubuque
Ames
Cedar Rapids
Columbus
Omaha
Lincoln
Burlington
Kansas City
Indianapolis
St. Louis
Cape Girardeal
Springfield
Fayetteville
Tulsa
Hot Springs
Greenwood
El Dorado
Monroe
Greenville
Jackson
Dyersburg
Tupelo
Tuscaloosa
Columbus
Selma
Marianna
Nashville
Knoxville
Lexington
Sulphur Springs
White
Wilmington
Pottstown
Morgantown
Parkersburg
Roanoke
Hickory
Augusta
Atlanta
Albany
Ocalla
Tampa
St. Petersburg
Melbourne
Vero Beach
W. Palm Beach
Miami
Buffalo
Massena
Watertown
Dansville
Syracuse
Ithica
Utica
Binghampton
Burlington
Montpelier
Poughkeepsie
New Haven
White Plains
West Hampton
Cape Cod
Nantucket
Farmingdale
Moralstown
Allentown
Trenton
Philadelphia
Atlantic City
New Castle
Hagerstown
Washington
Tangier
West Point
Norfolk
New Berg
Jacksonville
Red Bluff
Ukiah
Minden
Hayward
Pt. Conception
Ft. Estero
Lompoc
Ventura
Santa Barbara
Santa Monica
Port Hueneme
San Francisco
Visalia
Santa Maria
In Yokern
Apple Valley
Van Nuys
Fullerton
Carlsbad
San Diego
Hawthorne
Scottsdale
Tucson
Salt Lake City
Logan
Provo
Cedar City
Page
Kingman
Winslow
Silver City
Cheyenne
Aspen
Grand Junction
Farmington
Albuquerque
Santa Fe
Denver
Colorado Springs
Great Bend
Manhattan
Grand Island
Scotts Bluff
Amarillo
Stillwater
Hobbs
Carlsbad
Austin
San Antonio
McAllen
Houston
Baton Rouge
New Orleans
Dallas
Temple
Oklahoma City
Arkansas City
Topeka
Olathe
Tulsa
Flight of Aircraft: 1976
Aircraft: Turbo Commander N57074
Cameras: RC-10 "B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Elmira
2 Towanda
3 Easleshere
4 Bradford
5 Franklin
6 State College
7 Philipsburg
8 Dubois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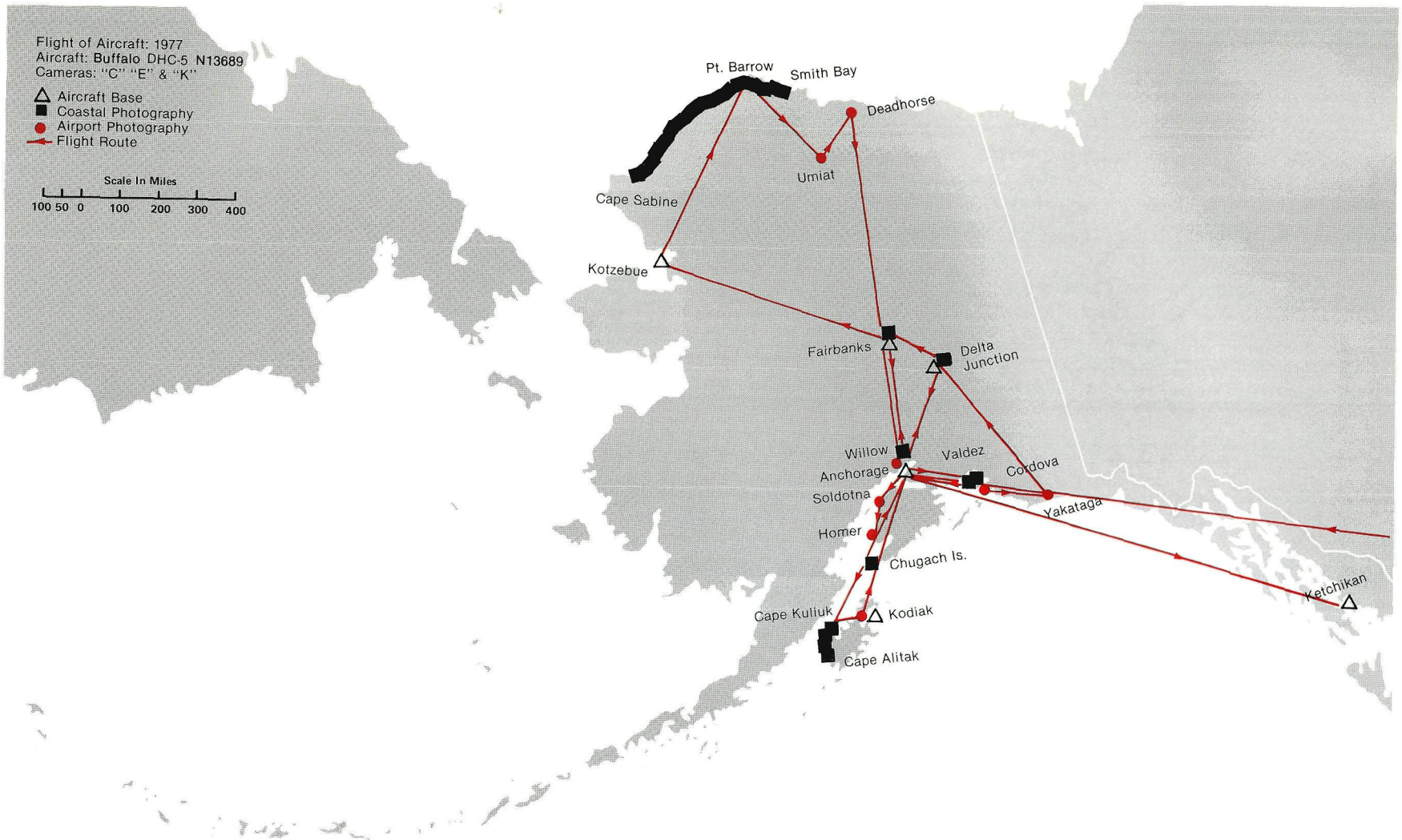
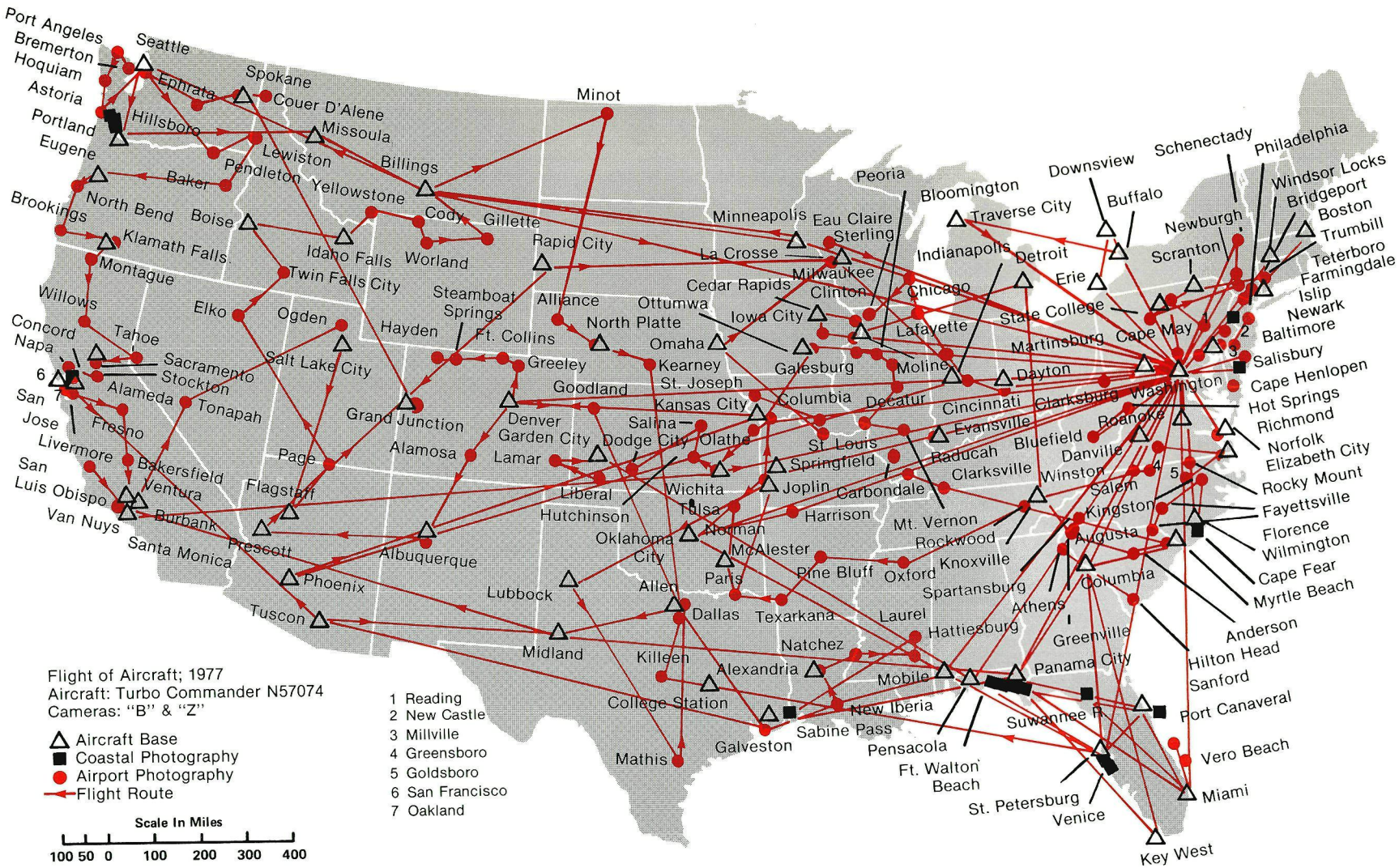
Rapid City
Minneapolis
Duluth
Houghton
Baraga-L'Anse
Marquette
Munsing
Whitfish Pt.
Sault Ste. Marie
Harrisville
Traverse City
Hareo Beach
Green Bay
Bay City
Detroit
Lane Port
Downsview
Buffalo
Washington
Chincoteague
Norfolk
Denton
Paris
Dallas
Greenville
Killeen
Sabine Pass
Houston
Galveston
Palacios
Corpus Christi
Pass Cavallo
Laredo
Brownsville
Gadsden
Rome
Marietta
Myrtle Beach
Birmingham
Charlestown
Montgomery
Moultrie
Savannah
Troy
Way Cross
Tallahassee
Pensacola
Gainsville
Ft. Walton Beach
Panama City
Cape San Blas
Applachicola
Tampa Bay
St. Petersburg
Miami
Key West
Flight of Aircraft: 1977
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E" "K" & "Z"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1977
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "E" & "K"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
Pt. Barrow
Smith Bay
Deadhorse
Umiat
Cape Sabine
Kotzebue
Fairbanks
Delta Junction
Willow
Anchorage
Valdez
Cordova
Soldotna
Yakataga
Homer
Chugach Is.
Ketchikan
Cape Kuliuk
Kodiak
Cape Alitak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Hoquiam
Astoria
Portland
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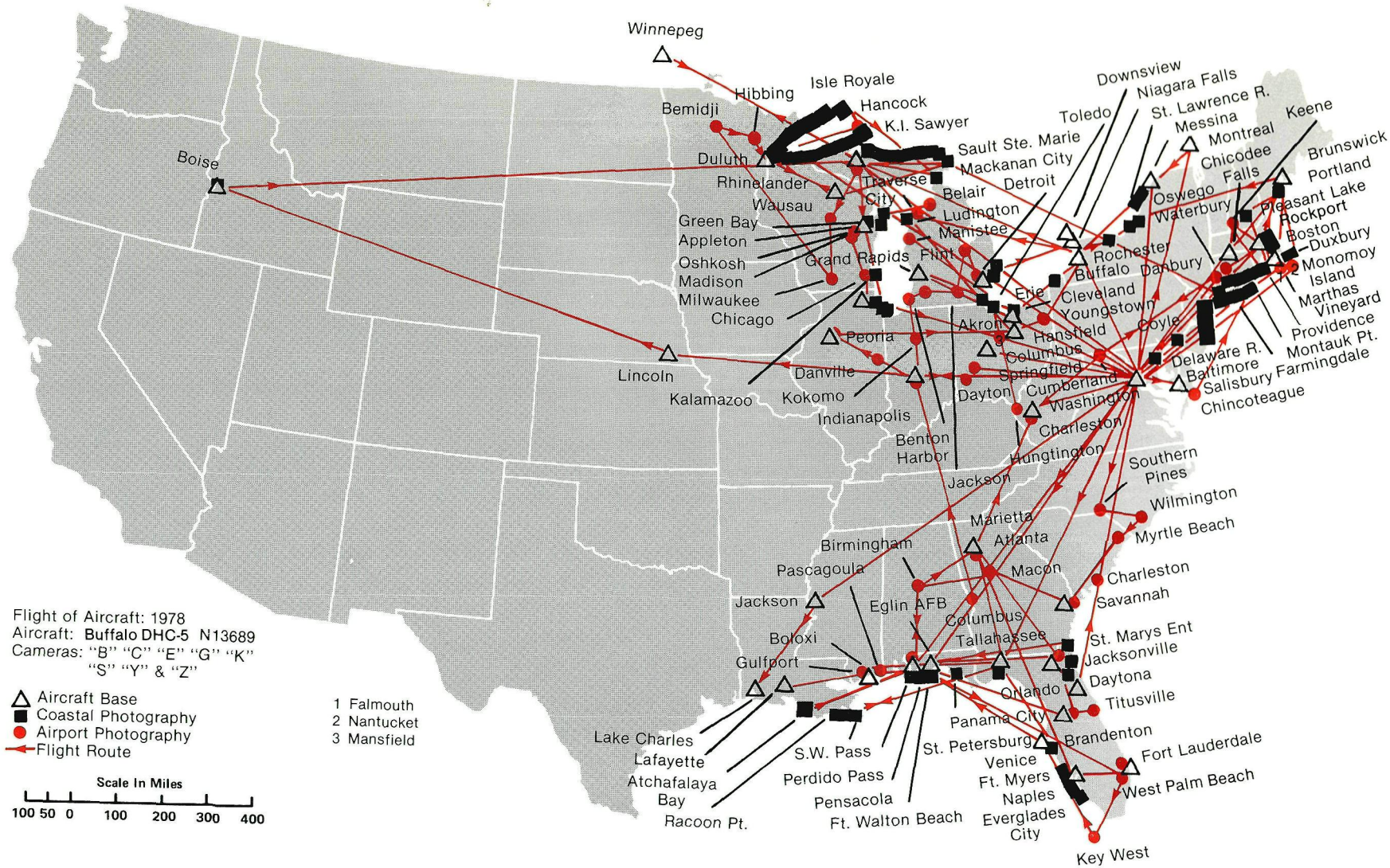
Seattle
Ephrata
Spokane
Couer D'Alene
Missoula
Hillsboro
Lewiston
Pendleton
Baker
Billings
Yellowstone
Minot
Brookings
North Bend
Boise
Klamath Falls
Montague
Idaho Falls
Worland
Cody
Gillette
Rapid City
Twin Falls City
Willows
Elko
Ogden
Steamboat Springs
Hayden
Ft. Collins
Alliance
North Platte
Ottumwa
Concord
Napa
Tahoe
Sacramento
Stockton
Salt Lake City
Greeley
Omaha
Kearney
St. Joseph
Goodland
Kansas City
Salina
Dodge City
Olathe
Denver
Garden City
Lamar
Alamosa
Grand Junction
Page
Flagstaff
Liberal
Hutchinson
Wichita
Tulsa
Norman
Oklahoma City
McAlester
Paris
Allen
Dallas
Texarkana
Lubbock
Midland
Killeen
Alexandria
Natchez
College Station
Galveston
Sabine Pass
Mathis
Minneapolis
La Crosse
Eau Claire
Sterling
Milwaukee
Cedar Rapids
Clinton
Iowa City
Galesburg
Columbia
Decatur
St. Louis
Springfield
Joplin
Carbondale
Harrison
Pine Bluff
Oxford
Laurel
Hattiesburg
Mobile
New Iberia
Pensacola
Ft. Walton Beach
St. Petersburg
Venice
Key West
Miami
Vero Beach
Port Canaveral
Sanford
Hilton Head
Anderson
Myrtle Beach
Cape Fear
Wilmington
Florence
Fayettsville
Rocky Mount
Elizabeth City
Norfolk
Richmond
Hot Springs
Cape Henlopen
Salisbury
Baltimore
Newark
Islip
Farmingdale
Teterboro
Trumbill
Boston
Bridgeport
Windsor Locks
Philadelphia
Schenectady
Newburgh
Scranton
Downsview
Buffalo
Erie
Detroit
Indianapolis
Chicago
Lafayette
Moline
Dayton
Cincinnati
Evansville
Raducah
Clarksville
Mt. Vernon
Rockwood
Knoxville
Spartansburg
Athens
Greenville
Panama City
Suwannee R.
Columbia
Augusta
Kingston
Salem
Winston
Danville
Roanoke
Bluefield
Clarksburg
Washington
Cape May
Martinsburg
State College
Lafayette
Peoria
Bloomington
Traverse City
Albuquerque
Phoenix
Tuscon
Prescott
Santa Monica
Burbank
Ventura
Bakersfield
Livermore
San Jose
Fresno
Alameda
Tonapah
San Luis Obispo
Van Nuys
Flight of Aircraft; 1977
Aircraft: Turbo Commander N57074
Cameras: "B" & "Z"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Reading
2 New Castle
3 Millville
4 Greensboro
5 Goldsboro
6 San Francisco
7 Oakland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Isle Royale
Bemidji
Hancock
K.I. Sawyer
Boise
Duluth
Sault Ste. Marie
Mackanan City
Rhinelander
Traverse City
Detroit
Wausau
Belair
Ludington
Green Bay
Manistee
Appleton
Grand Rapids
Flint
Oshkosh
Madison
Milwaukee
Chicago
Lincoln
Kalamazoo
Peoria
Danville
Kokomo
Indianapolis
Benton Harbor
Akron
Erie
Cleveland
Youngstown
Hansfield
Columbus
Springfield
Dayton
Cumberland
Washington
Charleston
Hungtington
Jackson
Marietta
Atlanta
Birmingham
Pascagoula
Macon
Jackson
Eglin AFB
Columbus
Tallahassee
Biloxi
Gulfport
Lake Charles
Lafayette
Atchafalaya Bay
Racoon Pt.
S.W. Pass
Perdido Pass
Pensacola
Ft. Walton Beach
Panama City
St. Petersburg
Orlando
Venice
Ft. Myers
Naples
Everglades City
Key West
Downsview
Niagara Falls
Toledo
St. Lawrence R.
Messina
Montreal
Keene
Chicodee Falls
Brunswick
Portland
Oswego
Waterbury
Pleasant Lake
Rockport
Boston
Duxbury
Rochester
Buffalo
Danbury
Monomoy Island
Marthas Vineyard
Providence
Montauk Pt.
Coyle
Delaware R.
Baltimore
Salisbury
Farmingdale
Chincoteague
Southern Pines
Wilmington
Myrtle Beach
Charleston
Savannah
St. Marys Ent
Jacksonville
Daytona
Titusville
Brandenton
Fort Lauderdale
West Palm Beach
Flight of Aircraft: 1978
Aircraft: Buffalo DHC-5 N13689
Cameras: "B" "C" "E" "G" "K" "S" "Y" & "Z"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
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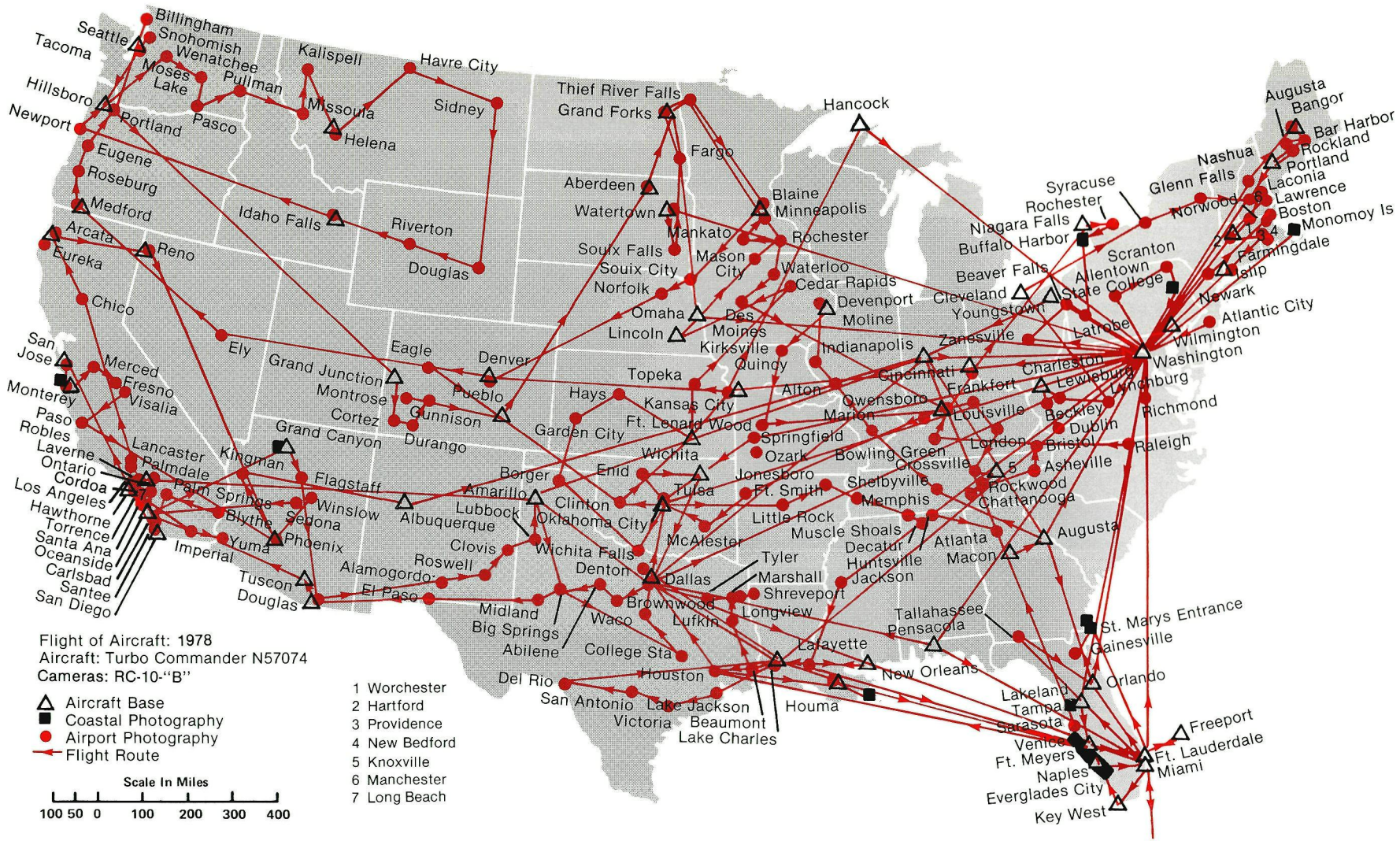
1 Falmouth
2 Nantucket
3 Mansfield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Hillsboro
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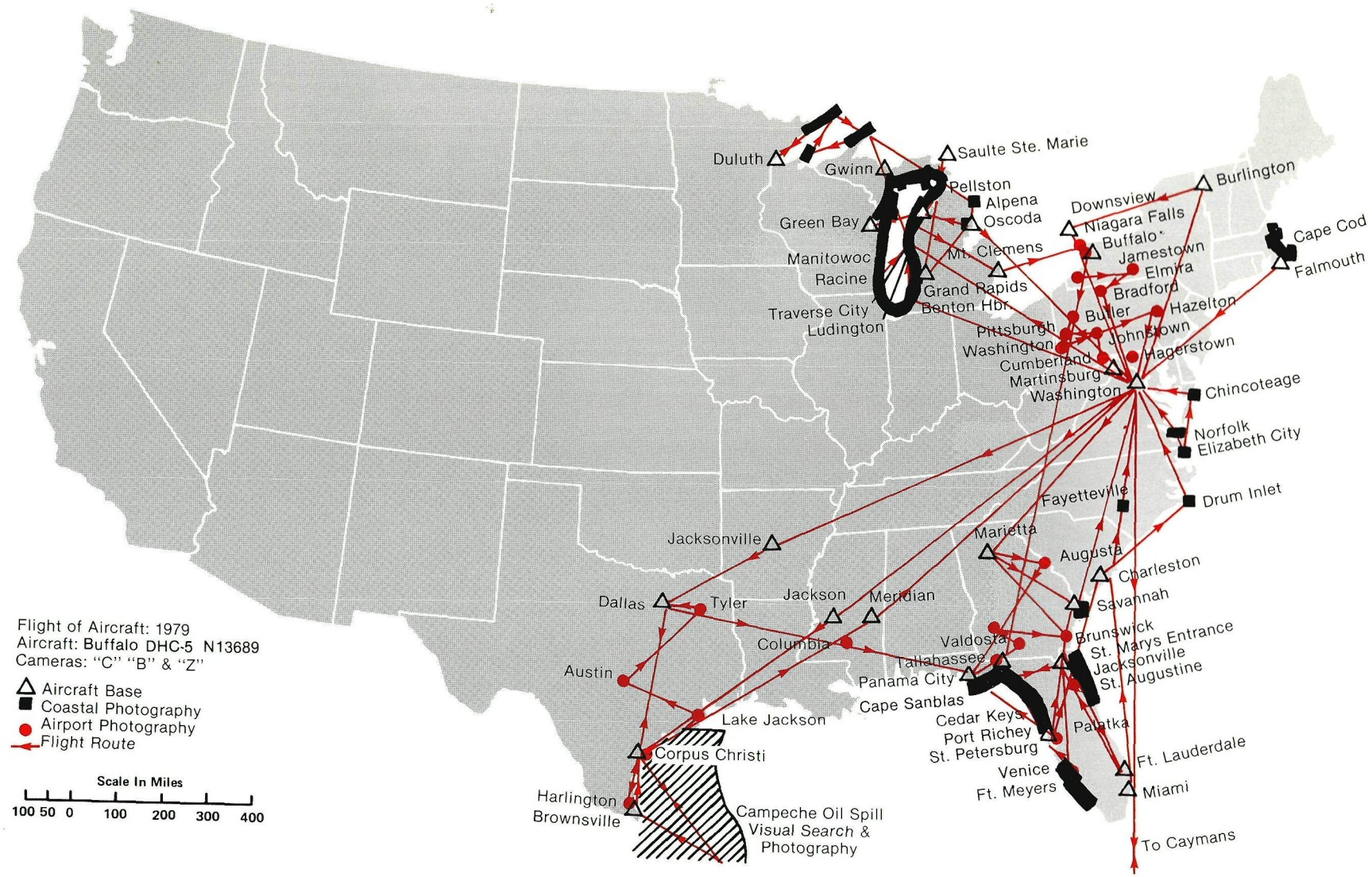
Missoula
Sidney
Newport
Helena
Eugene
Roseburg
Medford
Idaho Falls
Riverton
Arcata
Reno
Douglas
Eureka
Chico
Ely
San Jose
Merced
Grand Junction
Eagle
Denver
Fresno
Montrose
Pueblo
Monterey
Visalia
Gunnison
Hays
Paso Robles
Cortez
Grand Canyon
Durango
Garden City
Laverne
Lancaster
Kingman
Ontario
Palmdale
Flagstaff
Cordoa
Palm Springs
Winslow
Amarillo
Borger
Los Angeles
Blythe
Sedona
Albuquerque
Lubbock
Clinton
Hawthorne
Phoenix
Oklahoma City
Torrence
Yuma
Clovis
Wichita Falls
Santa Ana
Imperial
Roswell
Denton
Oceanside
Alamogordo
Dallas
Carlsbad
Tuscon
El Paso
Midland
Santee
Douglas
Big Springs
Waco
San Diego
Abilene
College Sta
Del Rio
Houston
San Antonio
Lake Jackson
Victoria
Beaumont
Lake Charles
Houma
Thief River Falls
Grand Forks
Fargo
Aberdeen
Watertown
Blaine
Minneapolis
Mankato
Rochester
Souix Falls
Mason City
Souix City
Waterloo
Norfolk
Cedar Rapids
Omaha
Des Moines
Devenport
Moline
Lincoln
Kirksville
Indianapolis
Quincy
Topeka
Kansas City
Ft. Lenard Wood
Springfield
Ozark
Wichita
Enid
Tulsa
Jonesboro
Ft. Smith
Little Rock
McAlester
Tyler
Marshall
Shreveport
Longview
Brownwood
Lufkin
Lafayette
Hancock
Syracuse
Rochester
Niagara Falls
Buffalo Harbor
Beaver Falls
Cleveland
Youngstown
Scranton
Allentown
State College
Zanesville
Latrobe
Cincinnati
Frankfort
Alton
Owensboro
Louisville
Marion
Lewisburg
Lynchburg
Charleston
Beckley
Dublin
Bristol
London
Crossville
Bowling Green
Shelbyville
Memphis
Muscle Shoals
Decatur
Huntsville
Jackson
Rockwood
Chattanooga
Asheville
Raleigh
Richmond
Washington
Wilmington
Atlantic City
Newark
Islip
Farmingdale
Nashua
Glenn Falls
Norwood
Augusta
Bangor
Bar Harbor
Rockland
Portland
Laconia
Lawrence
Boston
Monomoy Is
Atlanta
Macon
Augusta
Tallahassee
Pensacola
New Orleans
St. Marys Entrance
Gainesville
Orlando
Lakeland
Tampa
Sarasota
Venice
Ft. Meyers
Naples
Everglades City
Key West
Freeport
Ft. Lauderdale
Miami
Flight of Aircraft: 1978
Aircraft: Turbo Commander N57074
Cameras: RC-10-"B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Worchester
2 Hartford
3 Providence
4 New Bedford
5 Knoxville
6 Manchester
7 Long Beach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Gwinn
Saulte Ste. Marie
Pellston
Alpena
Oscoda
Green Bay
Manitowoc
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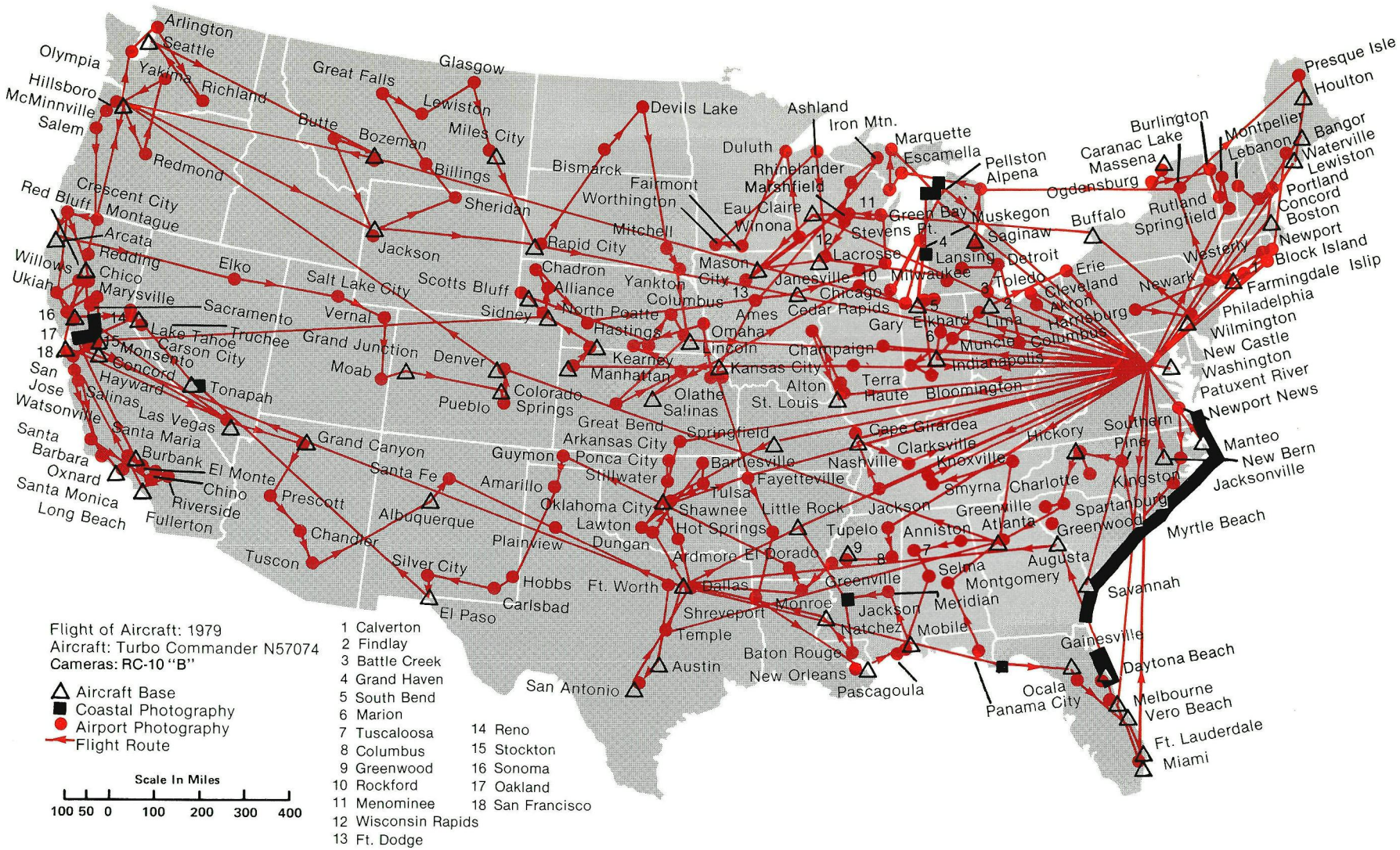
Mt. Clemens
Grand Rapids
Benton Hbr.
Traverse City
Ludington
Downsview
Niagara Falls
Buffalo
Burlington
Jamestown
Elmira
Bradford
Cape Cod
Falmouth
Butler
Hazelton
Pittsburgh
Johnstown
Washington
Hagerstown
Cumberland
Martinsburg
Washington
Chincoteage
Norfolk
Elizabeth City
Drum Inlet
Fayetteville
Jacksonville
Marietta
Augusta
Charleston
Savannah
Dallas
Tyler
Jackson
Meridian
Columbia
Valdosta
Brunswick
St. Marys Entrance
Jacksonville
St. Augustine
Tallahassee
Panama City
Cape Sanblas
Austin
Lake Jackson
Cedar Keys
Port Richey
St. Petersburg
Palatka
Corpus Christi
Venice
Ft. Meyers
Ft. Lauderdale
Miami
Harlington
Brownsville
Campeche Oil Spill
Visual Search &
Photography
To Caymans
Flight of Aircraft: 1979
Aircraft: Buffalo DHC-5 N13689
Cameras: "C" "B" & "Z"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400


Flight of Aircraft: 1979
Aircraft: Turbo Commander N57074
Cameras: RC-10 "B"
Aircraft Base
Coastal Photography
Airport Photography
Flight Route
Scale In Miles
100 50 0 100 200 300 400
1 Calverton
2 Findlay
3 Battle Creek
4 Grand Haven
5 South Bend
6 Marion
7 Tuscaloosa
8 Columbus
9 Greenwood
10 Rockford
11 Menominee
12 Wisconsin Rapids
13 Ft. Dodge
14 Reno
15 Stockton
16 Sonoma
17 Oakland
18 San Francisco
Olympia
Arlington
Seattle
Yakima
Richland
Hillsboro
McMinnville
Salem
Redmond
Red Bluff
Crescent City
Montague
Arcata
Redding
Willows
Chico
Ukiah
Marysville
Sacramento
Truchee
Lake Tahoe
Carson City
Monsento
Concord
Hayward
Tonapah
San Jose
Salinas
Watsonville
Las Vegas
Santa Maria
Santa Barbara
Burbank
El Monte
Oxnard
Chino
Santa Monica
Riverside
Long Beach
Fullerton
Great Falls
Glasgow
Lewiston
Butte
Bozeman
Miles City
Billings
Sheridan
Jackson
Elko
Salt Lake City
Vernal
Grand Junction
Moab
Denver
Pueblo
Colorado Springs
Grand Canyon
Santa Fe
Prescott
Albuquerque
Chandler
Tuscon
Silver City
El Paso
Hobbs
Carlsbad
Devils Lake
Bismarck
Fairmont
Worthington
Mitchell
Rapid City
Chadron
Alliance
Scotts Bluff
Sidney
North Peatte
Hastings
Kearney
Manhattan
Yankton
Columbus
Mason City
Omaha
Lincoln
Kansas City
Olathe
Salinas
Great Bend
Arkansas City
Guymon
Ponca City
Stillwater
Amarillo
Oklahoma City
Lawton
Dungan
Plainview
Ft. Worth
Dallas
Shreveport
Temple
Austin
San Antonio
Ashland
Iron Mtn.
Duluth
Rhinelander
Marshfield
Eau Claire
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Pellston
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Green Bay
Stevens Pt.
Lacrosse
Janesville
Chicago
Cedar Rapids
Ames
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St. Louis
Terra Haute
Bloomington
Springfield
Bartlesville
Fayetteville
Tulsa
Shawnee
Little Rock
Hot Springs
Ardmore
El Dorado
Monroe
Baton Rouge
New Orleans
Pascagoula
Jackson
Natchez
Greenville
Tupelo
Anniston
Selma
Montgomery
Meridian
Mobile
Cape Girardea
Clarksville
Nashville
Knoxville
Smyrna
Charlotte
Greenville
Atlanta
Augusta
Greenwood
Spartanburg
Kingston
Hickory
Southern Pine
Savannah
Gainesville
Daytona Beach
Ocala
Panama City
Melbourne
Vero Beach
Ft. Lauderdale
Miami
Caranac Lake
Massena
Burlington
Montpelier
Lebanon
Bangor
Waterville
Lewiston
Portland
Concord
Boston
Newport
Block Island
Farmingdale
Islip
Philadelphia
Wilmington
New Castle
Washington
Patuxent River
Newport News
Manteo
New Bern
Jacksonville
Myrtle Beach
Presque Isle
Houlton
Ogdensburg
Rutland
Springfield
Buffalo
Saginaw
Lansing
Detroit
Toledo
Erie
Cleveland
Akron
Harrisburg
Columbus
Lima
Muncie
Indianapolis
Elkhard
Gary
Milwaukee
Muskegon
Kalamazoo
Newark
Westerly