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

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James P. Walsh, Acting Administrator

National Ocean Survey
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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

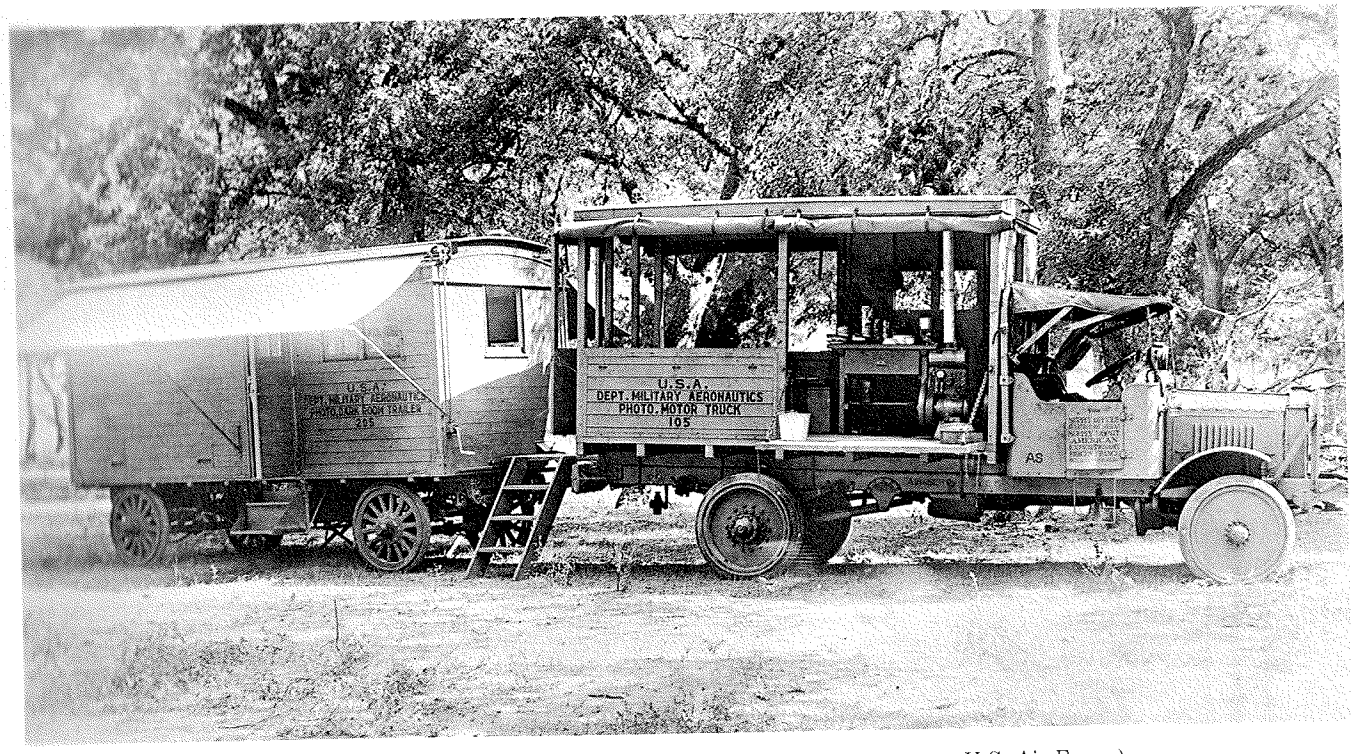

FIGURE 8.—Photographic trailer and truck, 1919. (Photograph courtesy U.S. Air Force.)

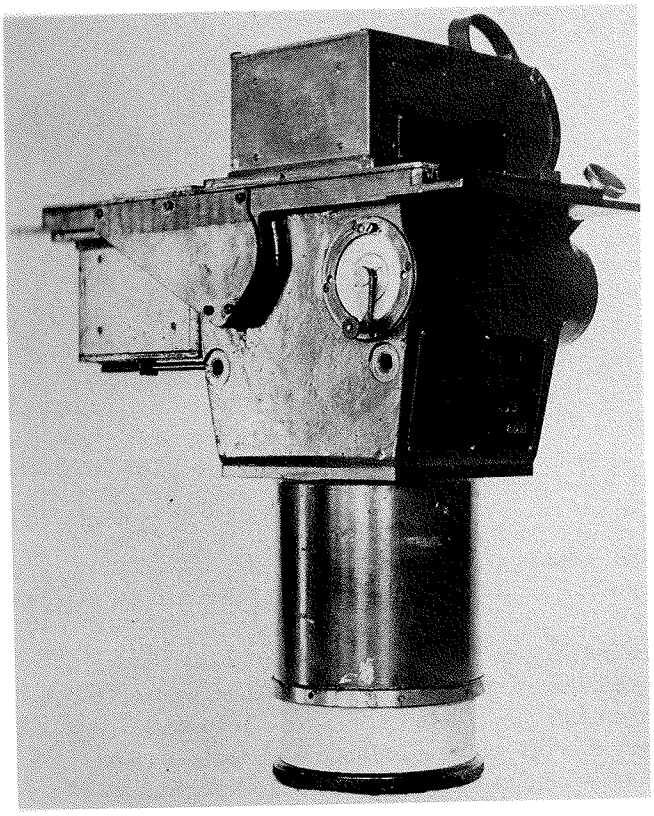

FIGURE 9.—U.S. Army Air Service L Type camera. This view shows the shutter release handle and the lever for moving plates from one magazine to the other. The camera weighed 125 pounds when loaded and it had to be loaded in a darkroom because the plate magazines did not have a dark slide. The photographer 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.)

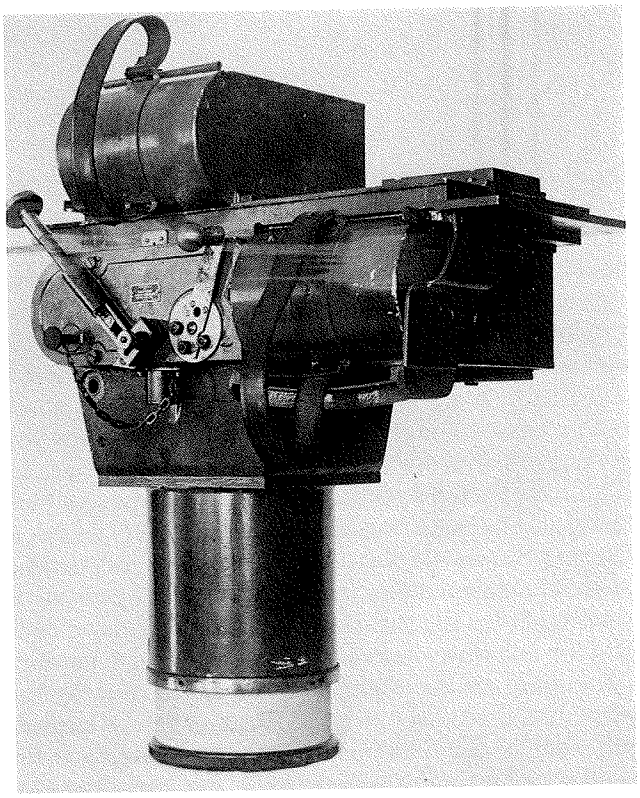

FIGURE 10.—U.S. Army Air Service L Type Aerial Camera. The focal length of the lens is 10⅛ inches. Twenty-five plates were loaded into the magazine on top of the camera and each was moved to the magazine at the rear of the camera after exposure. (Photograph courtesy U.S. Army Air Service.)

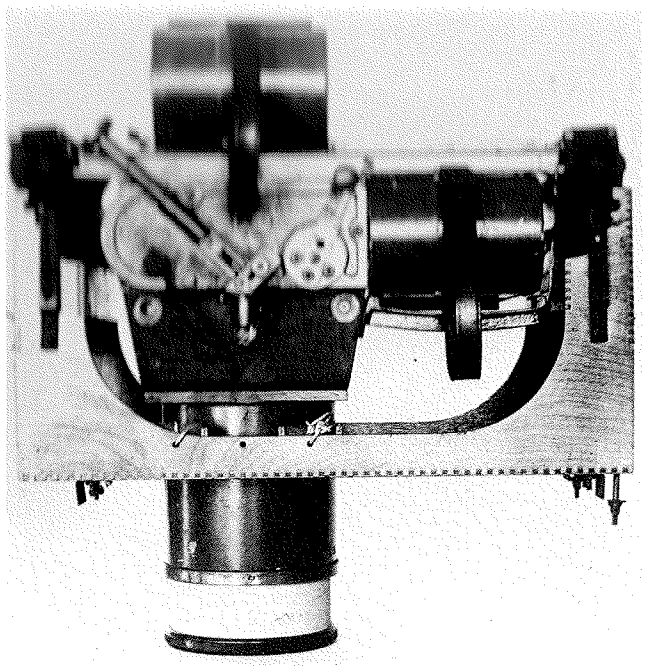

FIGURE 11.—U.S. Army L Type Camera and mount. The mount was bolted directly to the floor of the aircraft; rubber sponges were used at each end to absorb aircraft vibrations. (Photograph courtesy U.S. Army Air Service.)

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

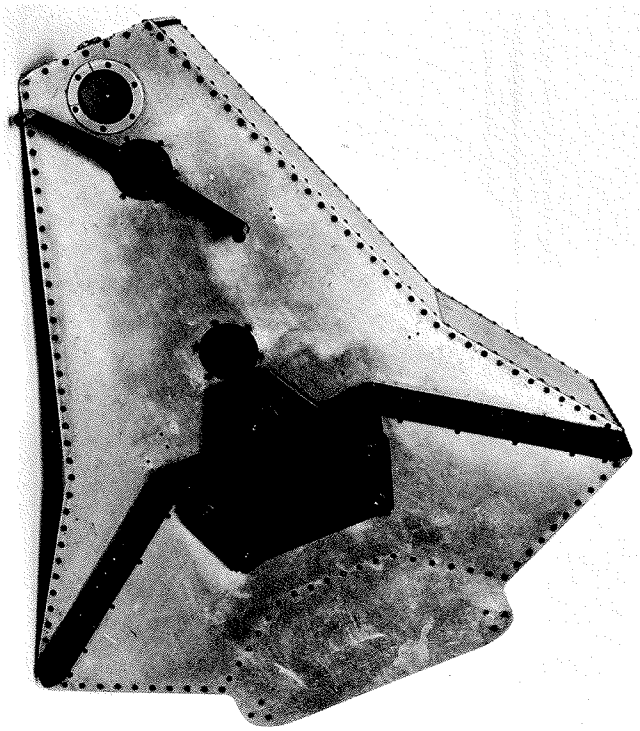

FIGURE 12.—The 3-lens Bagley camera. Major J. W. Bagley of the Corps of Engineers designed the 3-lens camera based on the principle advanced by Capt. Theodore Scheimpflug, an Austrian Army engineering officer. This view of the camera shows the film advance mechanism. (Photograph courtesy Curator of Photography,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

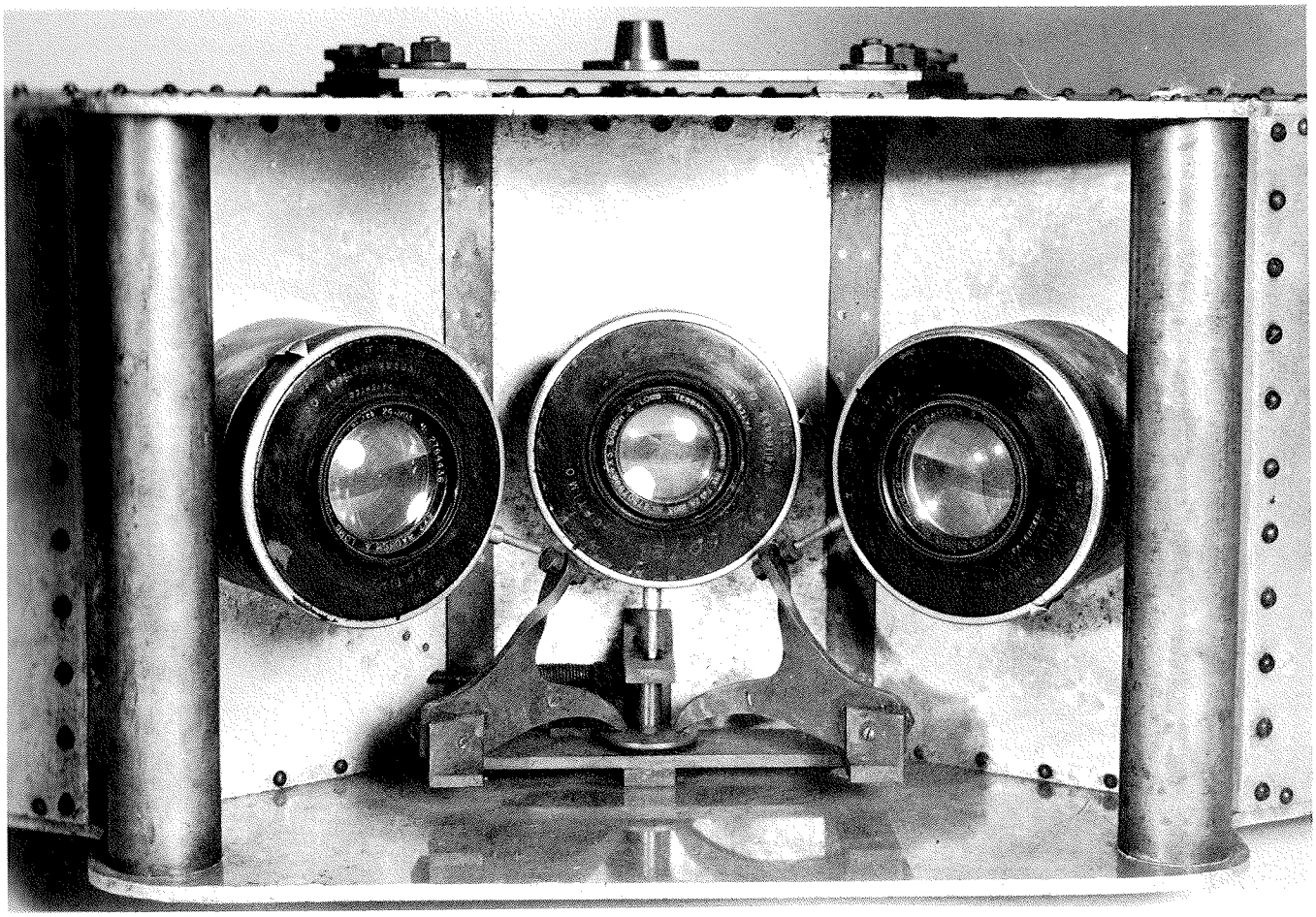

FIGURE 13.—Lenses on the Bagley 3-lens camera were manufactured by Bausch and Lomb. The focal length is 5 inches for the center lens and 7 inches for the two wing lenses. The ingenious trigger mechanism for tripping all three shutters simultaneously is under the center lens. (Photograph courtesy Curator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

"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.

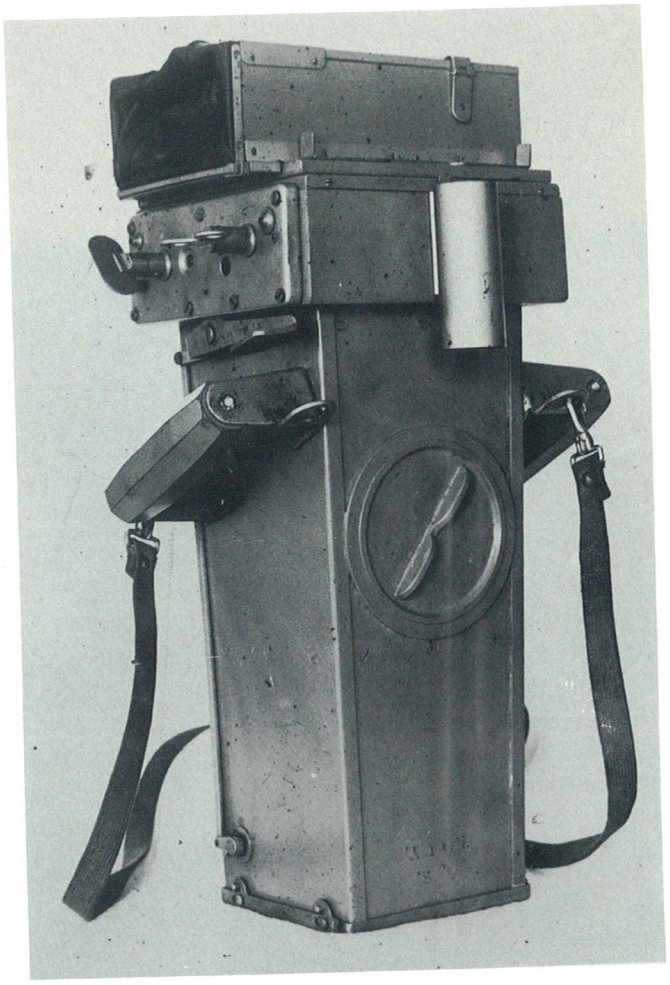

FIGURE 18.—The U.S. Navy Multipurpose camera. Although this camera was designed primarily for hand-held photographs it could be mounted in the aircraft much like the Army model L, but it was only capable of holding eight 4- by 5-inch glass plates. The plates were moved from the focal plane to the top 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

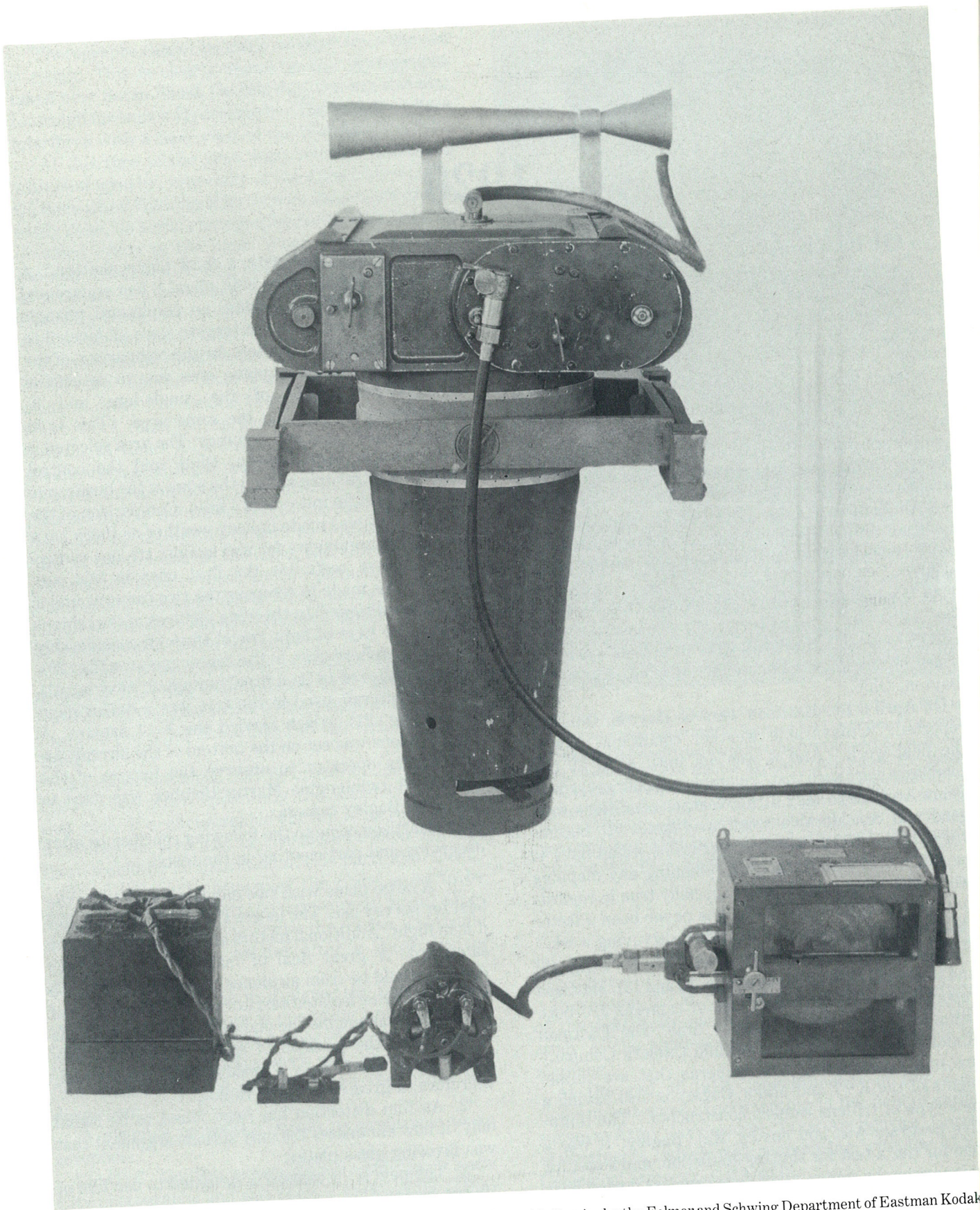

FIGURE 19.—The K–1 type camera was manufactured for the U.S. Army Air Service by the Folmer and Schwing Department of Eastman Kodak Company. The weight of the camera including film is 34 pounds. This does not include the venturi used as a vacuum system for flattening the film, the dry cell battery used 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

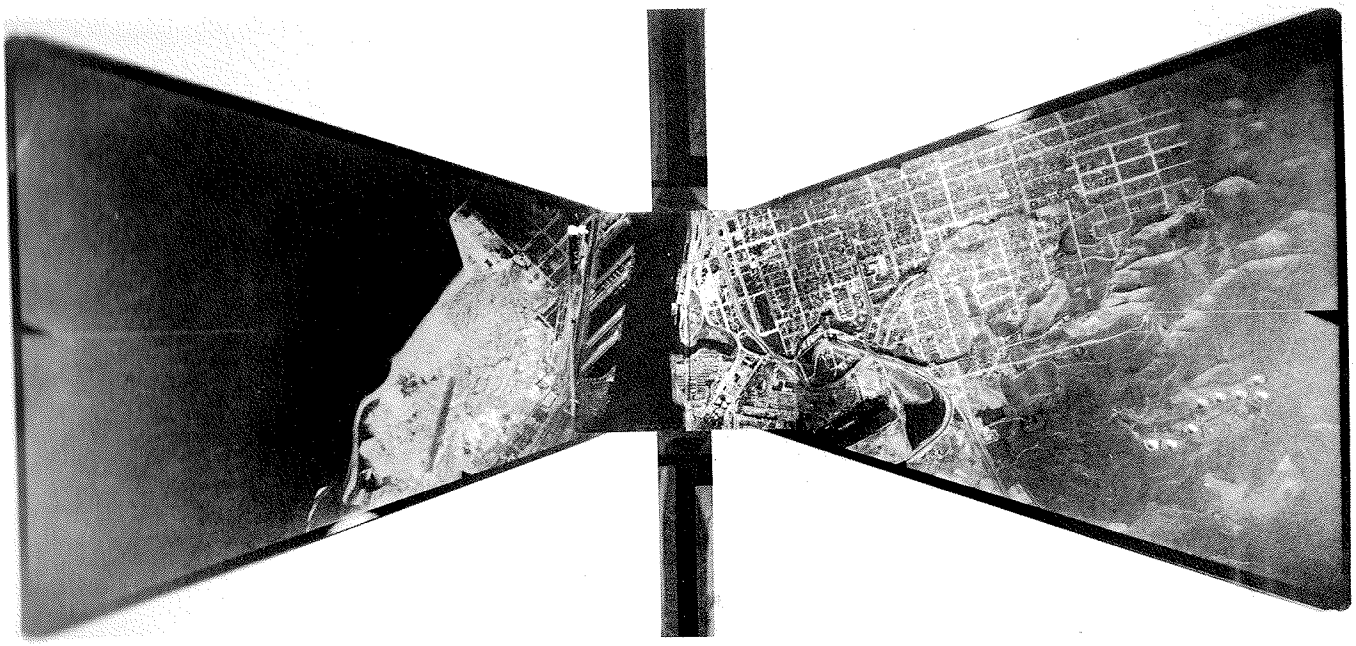

Figure 20.—Original Bagley 3-lens photograph on file at Photo Map and Imagery Information Section, Photogrammetry Division, NOS.

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 23.—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.)