PHOTOGRAPHIC MAPPING OF ALASKA FROM THE AIR

Extract from an Article

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Aerial photographs are particularly valuable in regions such as Southeastern Alaska where there is a heavy mantle of timber, which makes surveying by the usual methods very costly. Photographs furnish a means of identifying readily the myriads of lakes, and the details of drainage, shore lines, mountain crests, glaciers, roads, trails, houses, etc. They may be utilized to advantage in supplementing the regular planetable surveys; thus greatly enhancing their accuracy and decreasing their cost.

Accordingly, in the early spring of 1929, the Geological Survey and the Forest Service, through the Interior and the Agricultural Departments respectively, requested the Navy Department to continue the photographing during the summer of 1929.

The equipment consisted of the aeroplane tender *Gannet* and a converted 100-foot ammunition barge, and four Loening amphibian planes.

The *Gannet* furnished motor power and light for the barge, towing it to Alaska and back and moving it from place to place while in Alaskan waters. Water which was consumed in large quantities because of the photographic work in the dark rooms usually came from the local water supply of the towns at which we based. This year, the great value of the long 54-foot boom of the *Gannet* was realised, for it was extensively used in hoisting the planes from the water to the docks where they were kept, and back to the water again.

The barge was a most comfortable and convenient home for the forty men who made up the photographic and aviation units. The barge contained a galley, mess hall, space for the yeomen, rooms for the commanding officer and the Interior Department representative, and quarters for twelve chief petty officers, and twenty-seven enlisted men. There were also two dark rooms and a drying room for the photographic work, a sick bay, carpenter shop, store room, barber shop, and a radio room.

This method of taking care of the personnel and of supplying workshops for the photographic activities proved most satisfactory. Such quarters far excel any which could be built on land within the required time and cost. The barge was mobile, and being close to the planes, greatly expedited the photographic operations. Similar quarters, known as "wannigans", are used by lumbering and surveying parties in Alaska. They are usually built upon a raft of logs and are by no means as well equipped as this barge.

Four Loening amphibian planes of the latest model, OL-8A, were used. All Loening planes are now equipped with camera hatches in the bottom of the fuselage and are supplied with water-tight hatch covers which may be removed easily when the planes are in the air.

The camera is swung in a huge gimbal ring just as a mariner's compass is swung, in order that it may be levelled each time a picture is taken.

Plane Number 1, the *Juneau*, the plane of the Commanding Officer, was equipped with an excellent radio for both sending and receiving. This radio was invaluable. In long flights, especially in Southeastern Alaska where weather conditions are so changeable, it is extremely helpful for the commanding officer to be advised as to the weather conditions ahead, and this is made possible through the radio.

In the cooperative scheme, the Navy furnished the personnel, equipment, and all expenses usually incurred in the functioning of such a unit. The civil bureaus vitally interested, *i.e.* the Geological Survey of the Interior Department; the Forest Service and the Bureau of Public Roads of the Agricultural Department; and the Federal Power Commission, etc., supplied the

funds necessary for securing the photographs, which included films, paper and chemicals; gas and oil for the planes while on photographic flights; the expenses of the crews when away from the ship; and other incidental expenses.

The organization and equipment of the expedition was augmented by a trained meteorologist and the necessary equipment for observing and correlating all available data for forecasting weather conditions. Temperature, atmosphere pressure, humidity and wind conditions were observed at the base.

Balloon "hops" or balloon soundings were made twice a day when weather permitted. These balloons were about 3 feet in diameter and were filled with hydrogen gas which was carried in tanks on the barge. The speed and direction of drift of the released balloons were observed by means of a theodolite. Frequently these balloons rose to heights of 15,000 or 20,000 feet or more before they burst or were lost to view. Occasionally a balloon was destroyed in a burst of flames.

The information gained from these balloons was of value in forecasting weather and was also used by the navigators of the mapping planes in judging the probable drift of the planes.

As in 1925, the United States Signal Corps cooperated most heartily in receiving and delivering to the expedition the regular meteorological reports which were broadcasted for the entire United States, thus giving information for constructing the weather map of the entire country. These reports were received twice a day as were also reports from twelve local stations.

Since making mapping photographs was the prime object of the expedition and since absolutely cloudless skies are necessary for this work, the weather was watched with much eagerness by all the members of the expedition. Of the one hundred and five days during which the expedition was in Alaskan waters, there were eighteen days on which mapping flights could be and were made.

Frequently, while the weather is clear enough for mapping early in the day, clouds form by noon which prevent photographing. If the weather is unsuitable for mapping in the morning, it seldom clears sufficiently during the day to permit of mapping operations.

To the newcomer to the territory it is a novelty to be able to read a book by natural light at ten o'clock at night and to find it daylight at three o'clock in the morning. These long days are very advantageous for photographing.

During the time from May 25 to August 5 two flights per day were made on mapping days, but after August 5 only one flight was undertaken.

CAMERAS AND PHOTOGRAPHIC EQUIPMENT.

The mapping cameras used in 1926 are listed in the War Department as "T1 Cameras". This type is popularly known as the "Bagley Tri-lens Camera", after the inventor, Major J. W BAGLEY, now in the Corps of Engineers, United States Army. At the time he conceived the idea and commenced the development of this camera, Major BAGLEY was a member of the Alaskan Branch of the Geological Survey of the Interior Department.

This year, an improved camera of the same general type, but having four lenses instead of three and known as "T2", was used.

A detailed description of the three-lens camera was given in the May-June, 1928 issue, of "The Military Engineer". The camera is in reality three cameras in one large case about 28 inches high, 20 inches wide, and 7 inches thick, and weighs approximately 75 pounds. The four-lens camera is of the same general construction with a fourth lens added in a box attached to the rear.

The film for the three lenses in the main box is 380 feet long and 6 inches wide, and is wound on a huge spool, while the film for the fourth or "*D*" lens is on a smaller spool, and is approximately 130 feet long. Of the three lenses in the large box, the central one, called "*B*" lens, points directly downwards when the camera is in position, while the two side lenses, "*A*" and "*C*", are obliquely set at an angle of approximately 35 degrees to the axis of the "*B*" lens. The "*D*" lens is also obliquely set. The shutters of all four lenses are released simultaneously. The scale of the centre or "*B*" negative, is the same throughout. The negatives of the oblique lenses, "*A*" and "*C*" in the main box and "*D*" in the attached camera, are of the same size and shape as the "*B*" negative, but because of their obliquity, they cover a much larger area. The images, however, are distorted, thus making an infinite number of scales on these negatives.

These oblique negatives must be transformed or corrected to give the uniform scale of the "*B*" picture. This transformation is accomplished by printing them in a specially designed camera known as the "transformer printer".

The transforming camera or printer is complementary to this type of airplane camera and is essential to this method or airplane mapping. The optical principles that are involved in its design were first applied to aerial mapping by Major Theodore SCHEIMPFLUG, an Austrian army engineer, whose work was done before the airplane had reached a degree of perfection which made possible its use for mapping. These principles were employed in map work for the first time in this country in the transforming camera which was designed by Mr. Fred H. MOFFIT, of the United States Geological Survey, while he was collaborating with Major BAGLEY during the World War in the early stages of the development of the BAGLEY method of airplane mapping. The simplified form of the transforming camera, which is built for use with a definite airplane camera and which has been referred to as the transforming printer, was developed under Major BAGLEY'S direction in the shops of the Air Corps at McCook Field, Dayton, Ohio.

The result of these transformed negatives are keystone shaped prints which are of the same scale throughout as the "*B*" prints. The prints "*A*", "*B*", "*C*" and "*D*" are carefully joined together and mounted on a large card, 15 inches by 22 inches, thus making a photograph on a scale of approximately 1:20,000.

The three-lens pictures, when taken from an altitude of 10,900 feet (3,270 metres), span a distance from side to side of a little over 6 miles and cover about 2-½ miles in the direction in which the plane is flying. The "*D*" lens serves as a sort of rudder to assist in stronger control in compiling the information from them and covers about two exposures of the "*B*" lens.

These cameras are constructed with great accuracy, for they must not only have excellent optical properties but, more important still, the several lenses must be so placed within their respective mounts that the resulting photographs may have a uniform scale and an accurate alignment. The lenses are very carefully ground and, when completed, are tested at the United States Bureau of Standards to determine the exact focal length. Each lens is mounted in its appropriate setting after the camera is completed, and great care is taken in its correct calibration before any mapping is executed with it. The four-lens cameras which were used on this expedition are the property of the Navy Department but were designed and built under the direction of the Corps of Engineers of the United States Army.

At the beginning of this season, considerable difficulty was experienced with shutter failures. The difference of temperature experienced during flights was such as to cause friction between the steel plunger and the brass bushing through which shutter failures were caused.

In addition to the mapping photographs which were taken through the bottom of the plane, many photographs were taken over the side of the plane with a hand-held camera.

For these oblique pictures, Fairchild "K-3-A" cameras were used. These cameras weigh approximately 65 pounds. To hold one of these cameras over the side of the plane and secure just the picture which is desired, while the plane glides through the air at the rate of 90 miles an hour, is quite a task for the photographer.

The photographic quarters consisted of two dark rooms and one drying room. Tanks of sufficient size to develop and wash 125 feet of the 6-inch mapping film at one time were installed in one of the dark rooms. The other room was used for printing. In the drying room there was a huge drying reel, 7-½ feet in diameter by 12 feet long, on which 380 feet of the mapping film or 1,000 feet of movie film could be dried at one time.

There was also an enlarging camera in the equipment which was used in making enlargements as desired.

Three bases were used this year, Ketchikan, Petersburg, and Juneau. While the *Gannet* and barge were a mobile unit and could have been moved easily from place to place, yet the advantages of basing at a good sized town are great. Since the planes were compelled to fly a distance of from 50 to 75 miles in order to gain their altitude, little if anything was lost by remaining at these bases for usually the areas being mapped were within 75 miles of the base.

Every precaution was taken to insure the success of the flight and to aid a plane, should it be forced down. A relief plane equipped with radio was always ready for an emergency and the relief pilot was standing by for action. Every precaution was taken also against disaster, even to the carrying of emergency kits, Very pistols for signalling and emergency rations for food.

THE AMOUNT AND VALUE OF RESULTS.

A few figures taken from the report of Commander RADFORD shows something of the performance of the planes:

Hours in the air for all planes	677
Miles flown by all planes	54,182
Hours in the air for photographic mapping	243
Miles flown for photographic mapping	19,440
Hours in the air for oblique photography	96
Miles flown for oblique photography	7,750

Forty-two rolls of tri-lens mapping films, each 380 feet long and 6 inches wide; and nine rolls of films from the "*D*" lens or fourth lens were turned over to the Geological Survey. The films cover an area of approximately 12,750 square miles of country, much of which had never before been seen by the human eye. When transformed and printed there will be over twenty-five thousand prints, which, when combined, will make approximately seven thousand six hundred huge photographs. All of the developing of the films was done in the dark rooms on the barge, and when completed and dried, which done was within four hours of the time they came to the dark room, they were turned over to me to inspect, index and number.

The total of oblique photographs which were taken was six hundred and ninety-two. Of these, four hundred and sixty-nine were taken at the request of the several Civil Bureaus and two hundred and twenty-three were taken for the Bureau of Aeronautics. Moving pictures showing the work of the expedition were also taken.

A detailed discussion of the methods of office compilations was set forth in the May-June, 1928, issue of the *Military Engineer*.