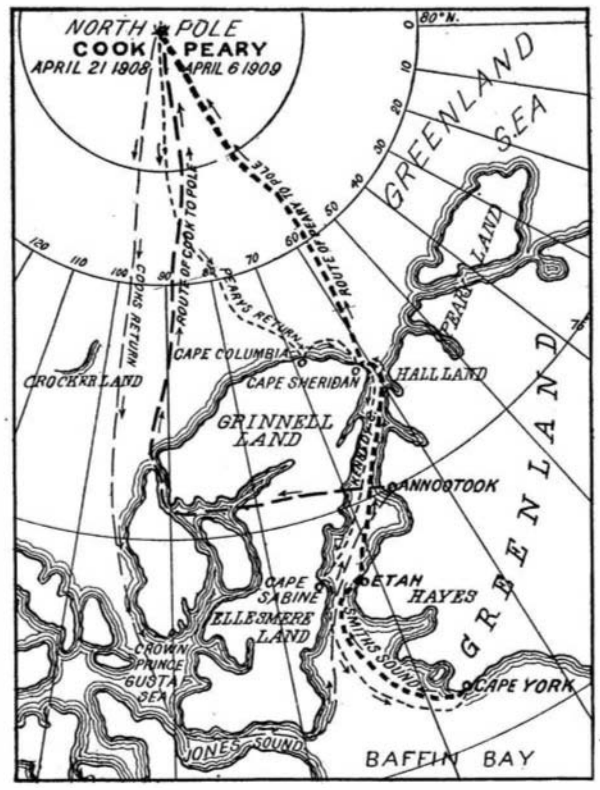
day the rest of the expedition caught up Bartlett, who had been stopped by open water, which delayed the entire party till March 11th.

On the 5th of March the sun appeared for a few minutes at noon for the first time after the long winter night. On March 11th the lead was sufficiently frozen over to be crossed, and another start was made. Borup and Marvin, who had gone back for alcohol and oil from Bartlett's third camp, had not yet come up with the expedition in spite of the delay, causing some anxiety, but a note was left for them, and three days later they caught up the main party at the end of its sixth march. The latter in the meantime had been traversing alternately floating solid ice and newly-frozen leads, and had just crossed the 84th parallel. From that camp Dr. Goodsell turned back by pre-arrangement, and McMillan accompanied him reluctantly, owing to a badly-frozen foot, which he had been concealing for three days, much to the regret of Peary, who had counted on his enthusiasm and physical powers.

The best dogs and sledges were selected for the northward journey, the party now consisting of 16 men, 12 sledges, and 100 dogs. At the end of the tenth march, at latitude 85 deg. 23 min., Borup turned back in charge of the second supporting party. The traveling rather improved, and Commander Peary and Marvin waited twenty hours after the start of the advance party, in order to overtake them as they broke camp after the next halt, thus using the same camp and keeping in touch with the advance party once in every twenty-four hours. After two more marches the sun began to get high enough for observations to be made, 85 deg. 48 min. being recorded, and, the going continuing to improve, 50 minutes was covered in the next three marches, including 20 miles on the third day, bringing the party to 86 deg. 38 min. At this point Marvin turned back with the third supporting party. The next day's march was good, but after that came the deepest snow encountered, accompanied by haze which made a short and exhausting journey. At the end of the succeeding day the ice parted exactly where the party was encamped, nearly causing the loss of dogs and sledges, but after an exciting period dashing from one moving floe to another, better going was reached. Then came Capt. Bartlett's last day, another long march with fair going, camp being made at 87 deg. 48 min., as shown by observation of the sun next day. The sturdy navigator of the "Roosevelt," who had borne the brunt of the pioneering work, walked several miles north in the morning to be sure that he crossed the 88th parallel, and then turned reluctantly back with the two Esquimaux of the last supporting party, the provisions carried being insufficient to last more than 6 men and 40 dogs for the week or more estimated to be required to reach the Pole as well as for the return journey.

Peary then determined to try and reach the Pole in five forced marches, allowing less than a day for each, extending the last one, if necessary, to complete the distance lacking. His cabled narrative speaks of "five marches of fifteen miles each"; but as he was then south of the 88th parallel, this is an obvious mistake for 25 miles, to which distance he refers as having accomplished his intention on his next, the twenty-first, march. After a few hours' sleep good going was found, and twenty miles were covered on the twenty-second march before an open lead delayed the journey. Another brief halt and even better weather and smoother ice enabled another twenty miles to be made on the next march, including a dash across 100 yards of ice newly formed over a lead, which buckled under the sledges and broke as the last one left it. Again a short sleep, and twenty-five miles were made on the twenty-fourth march. Although the temperature was not so low as had been experienced, even the Esquimaux complained of the bitter cold. Much-needed sleep was taken for a little longer, and then the party dashed forward, dreading that each rise in the ice marked an open lead, but always finding continued going. The haze was thicker, but an observation was possible at noon, showing 89 deg. 25 m. A rise in temperature to 15 deg. below zero encouraged the dogs, and forty miles was covered in twelve hours. An observation at noon on April 6th, at the end of the twenty-sixth march, showed latitude 89 deg. 57 m. to have been reached, only three minutes or a little over three miles from the Pole, so the remaining distance was apparently covered before a rest was taken.



Map showing the routes taken by Peary and Cook on their expeditions.

The first thirty hours at the Pole was spent in making observations and taking photographs. Ten hours after arrival the weather cleared, and the afternoon of April 7th was cloudless. A crack in the ice five miles from the Pole was found, and a sounding was made, 1,500 fathoms of wire finding no bottom, and the wire being broken and lost in withdrawing it.

Speed was just as urgent on the return as on the upward journey, every day gained lessening the chance of a gale opening leads and destroying the track. Every march back lessened the chance of provisions running short before the base was reached, so the equipment could be lightened to facilitate speed. Peary therefore determined, in spite of the records for Arctic travel made on the advance, to try to *double* the daily journey on the return, covering two of the northward marches on each march south, and making use of the same "igloos"—the ice huts made in camping—and so saving time at each halt. This he very nearly accomplished, regularly covering five outward marches in each three of the return journey. He was singularly fortunate in escaping open leads in the ice, which had delayed the return of the supporting parties, down to lat. 85 deg. 23 m., the camp at the end of the tenth outward march, where a lead five miles wide was encountered. By good luck Bartlett's trail was found again at the other side, and by continued rapid traveling Cape Columbia was reached on the 23rd of April after fifteen marches. The "Roosevelt" was reached in two more marches, and found unharmed. Nearly two months were spent in additional geodetic observations and in bringing back remaining supplies from the outlying *cachés* until on July 18th the ice was sufficiently open for the ship to be removed from her berth. She fought her way south to Cape Sabine by August 8th, picked up Whitney and the stores at Etah, coaled from the "Jeanie," and cleared from Cape York August 26th, and reached Indian Harbor September 5th to send the now historic telegram: "Stars and Stripes nailed to North Pole."

How the sextant is manipulated in measuring the sun's altitude.

HOW COOK MADE HIS LATITUDE OBSERVATIONS.

So much doubt seems to have been engendered in the public mind by a certain portion of the press, regarding the validity of Dr. Cook's observations, that it may not be amiss to describe briefly the methods which, in common with every other explorer, he would necessarily adopt in determining his latitude. The actual determination of latitude, although it is one of the most important practical questions in astronomy, is also one of the most elementary, for which reason we fail to understand why so much ado should have been made.

For the purposes of astronomical measurement, the celestial sphere is divided as indicated in Fig. 1. Assuming that the observer is placed at *O*, his celestial horizon will be *H E S W*. The axis of the heavens will be *P p*, *P* being the elevated pole, and *p* the depressed pole; *Z* will be the zenith of the observer, and *N* his

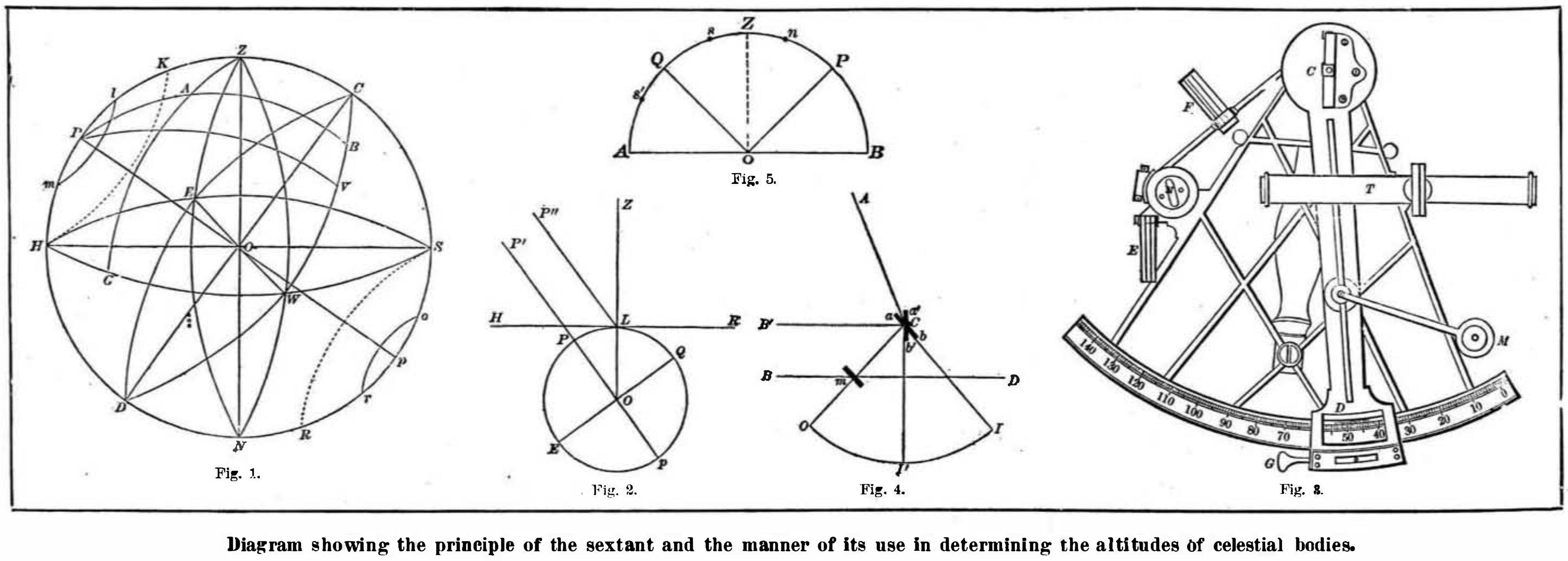


Diagram showing the principle of the sextant and the manner of its use in determining the altitudes of celestial bodies.

HOW COOK MADE HIS LATITUDE OBSERVATIONS.

nadir. The great circle $HZSN$ will be the observer's celestial meridian; like all great circles passing through the celestial poles, it is an hour circle or circle of declination. The circle $ECWD$ is the equinoctial (the celestial equator), and the circle $EZWN$ perpendicular to the meridian is the prime vertical, cutting the horizon at E and W, respectively the east and west points. The north pole of the heavens is P, and is marked by the Pole Star or North Star.

The latitude of any place on the earth is equal to the altitude of the elevated pole at that place. Hence by measuring the altitude of the Pole Star, the north latitude of a place above the equator is directly obtained. This follows from a consideration of Fig. 2, in which Pp is the earth's axis, and EQ the equator. The line HR tangent to the earth's surface at L is the horizon, and the point Z the zenith of L. Assume that the earth's axis and the line LP'' parallel to the earth's axis to be both indefinitely prolonged. Because of the immensity of the celestial sphere as compared with the earth, these two lines will sensibly meet at a common point on the surface of the celestial sphere, and this common point is the elevated pole. To an observer L this elevated pole will therefore lie in the direction LP'', and $P''LH$ will be its altitude. From Euclidian geometry we know that the angle HLZ is equal to the angle POQ, and the angle ZLP'' equal to ZOP'. Hence the angle $P''LH$ (the altitude of the pole) is equal to LOQ, the observer's latitude.

The latitude of a place on the earth is also equal to the declination of the zenith at that place. The declination of a body or point is its angular distance from the plane of the celestial equator, and hence ZOQ in Fig. 2 is the declination of the zenith or latitude of L in Fig. 2.

In order to calculate his latitude, the navigator or explorer employs a sextant, which is an instrument by means of which the angular distance between two visible objects can be measured. Since Pole Star observations cannot always be taken, because the horizon is not always visible at dusk or at night time, the navigator is generally compelled to measure the sun's altitude, and to use that as the basis of latitude calculations. As shown in Fig. 3, the sextant is a sector of a circle, whose arc measures 60 deg. A movable radius, called the index bar, CD, revolves about the center of the sector. At its lower extremity the bar carries a vernier D. At the upper extremity of the index bar is a silvered mirror C, the surface of which is perpendicular to the plane of the instrument. Another glass N, called the horizon glass, is rigidly attached to the frame of the instrument, the upper half of which glass is transparent and the lower half silvered. The surface of the horizon glass must also be perpendicular to the plane of the instrument. A telescope T is directed toward the horizon glass, with its optical axis parallel to the plane of the instrument. Two sets of colored glasses F and E are usually provided for the protection of the eye when the sun is observed. The sextant is constructed on the principle that the angle between the first and last direction of a ray which has been reflected twice in the same plane is equal to twice the angle which the two reflecting surfaces make with each other.

Suppose that we wish to measure the angular distance between the sun A and some distant object B on the horizon (Fig. 4). The object B is distinctly visible at D in the telescope through the upper, transparent half of the horizon glass m. The object B is so distant that the rays $B'C$ and BM coming from it may be regarded as sensibly parallel. If ab and CI are the positions of the index glass and index bar when both glasses are parallel, the ray $B'C$ will be reflected by the two glasses in a direction parallel to itself, and the observer, whose eye is at D, will see both the direct and the reflected image of B in coincidence. If the index bar be moved to some new position CI', so that the ray from the sun, A, is finally reflected in the direction mD, then the observer will see the direct image of B and the reflected image of A in coincidence. The angular distance between the two bodies is evidently equal to the angle between the first and the last direction of the ray AC, which angle is equal to twice the angle made by the two glasses with each other, or twice the angle ICI'. If then we know the point I on the gradient arc at which the index bar stands when the glasses are parallel, twice the difference between the reading of that point and that of the point I' will be the angular distance of the two bodies. To avoid this doubling of the angle, every half degree on the arc is marked as a whole degree.

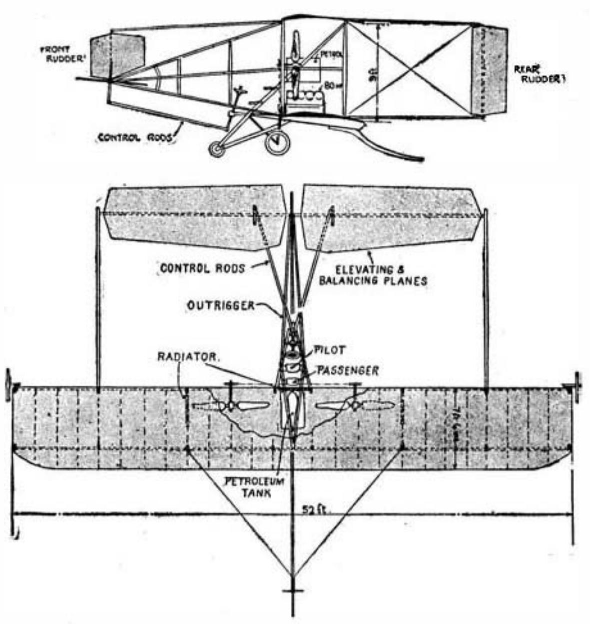
The sun is the body generally used by navigators in determining latitude. The time of noon being approximately known, the observer begins to measure the altitude of the lower limb of the sun a few minutes before noon, and continues to measure it until the sun ceases to rise, or "dips," as it is called. The greatest altitude attained by the sun is taken as the meridian altitude. Corrections are made for index error, dip, atmospheric refraction, parallax, and semi-diameter, and the result is the sun's true meridian altitude. Taking this from 90 deg. we obtain the sun's zenith distance. Looking in the Ephemeris or Nautical Almanac we find the sun's declination given for Greenwich (or Washington) noon of every day, with the hourly change, so that we can easily deduce the exact declination at the moment of observation. Then the observer's latitude is obtained, because the latitude of the observer equals the sun's zenith distance plus the sun's declination. This is apparent from a consideration of Fig. 5, in which the circle $AQPB$ is the meridian, Q and P the equator and the pole, and Z the zenith. QZ is the declination of the zenith, or the latitude of the observer. If the sun is observed at s, south of the zenith as it crosses the meridian, then Zs is its zenith distance and Qs its declination, which is known. Then QZ equals $Qs + sZ$; in other words, the latitude equals the declination of the sun plus its zenith distance.

The handling of the sextant is so simple a matter, and the application of corrections to its readings so easy, that we fail to understand how anyone can seriously doubt Dr. Cook's accuracy.

CAPT. CODY'S BRITISH ARMY AEROPLANE.

Following close upon the great exhibition of flying which was given recently at Rheims, Capt. S. F. Cody, who has been working for a number of years in the interests of the British government, has met with complete success with his aeroplane, and has succeeded in accomplishing a cross-country flight of one hour and three minutes' duration, in the course of which he rose to a height of about 400 feet, circled a church steeple, and traveled altogether about 47 miles. This is the first flight demonstration of any account which has been given in England, and the fact that it has been accomplished by an American after persistent experimenting puts another aviation record to the credit of the United States.

Capt. Cody has made a few minor changes in his machine since it was illustrated by us in our issue of January 30th last. Chief among these is the dividing of the single-surface horizontal rudder in front of the machine into two separate planes, or wings, placed side by side, and arranged so they can be worked together or separately and in opposite directions. This division of the horizontal rudder into two parts has been substituted for the separate wing tips, or balancing planes, which were formerly placed at each end of the single surface. By inclining the two wings of the present rudder in opposite directions, the machine can be righted when it tips to one side or the other, and this movement of the wings can also be used in steering the aeroplane to the right or the left. Steering in a horizontal plane is accomplished chiefly by means of two vertical rudders—one in front above the horizontal rudder, and one some distance at the rear of the planes.

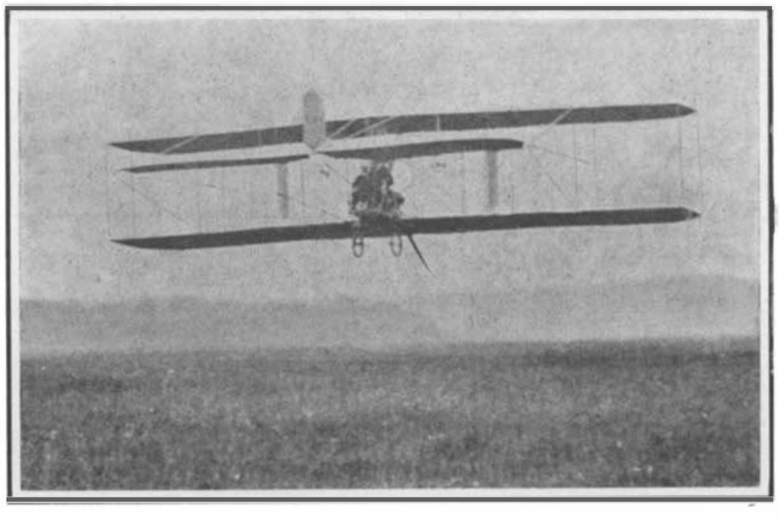


Plan and side elevation of Capt. Cody's biplane.

The Cody biplane is mounted upon three wheels and one skid. Two of the wheels, which are about 2 feet in diameter, are placed side by side just under the front edge of the lower plane, while the third one is located in advance of the other two, and at the intersection of two pairs of heavy inclined uprights extending downward from the rear longitudinal of the upper plane and from beneath the bed of the motor respectively. The former pair of inclined uprights carries seats for the aviator and his passenger, the latter seat being a foot or more above the aviator's seat and just in front of a radiator consisting of long thin tubes extending upward to the front edge of the top plane. A single skid extends backward from the rear edge of the lower plane on the center fore-and-aft line of the machine. Most of the weight of the aeroplane is carried upon the two large wheels placed beneath its front edge. Coiled-spring shock absorbers surround the upright rods extending from the axle of these wheels to the lower edge of the front plane. If the machine tips downward in front when running along the ground, the weight is taken by the small wheel in front, while if it tips upward the skid at the rear touches the ground. This skid also acts as a brake when alighting. The use of the inclined uprights extending out in front, and also the use of bamboo to support the rudders, makes Capt. Cody's biplane somewhat similar in construction to that of his fellow countryman, Mr. Curtiss.

The main planes of Capt. Cody's machine are 52 feet long by 7½ feet in a fore-and-aft direction. They are spaced 9 feet apart at the center, this distance gradually diminishing to 8 feet at the ends. Both planes are arched slightly in a transverse direction, the upper one being curved downward somewhat more than the lower one, in order to bring it nearer to the latter at the ends. The ends of both planes, moreover, are almost flat, although the other parts of the surfaces have the usual parabolic curve. In arching these surfaces downward, Capt. Cody has followed the idea of the Wright brothers, who claim that a slight downward curvature of the ends of the planes is preferable to an upward curvature of them. In the "June Bug" biplane of the Aerial Experiment Association, it will be remembered that the upper plane had its ends curved downward, while the ends of the lower plane were curved upward. This arching of the surfaces in opposite directions was, we believe, the idea of Lieut. Selfridge, and it was found to work very well.

The wings of the horizontal rudder are also arched slightly in a similar manner to the main planes. These are operated by a horizontal steering wheel mounted upon the end of a universally pivoted lever. Swaying the wheel from left to right or *vice versa* sets the wings of the horizontal rudder so as to right the machine when it tips, while turning the wheel moves the vertical rudders in front and behind and also inclines the wings of the horizontal rudder slightly in opposite directions, in order to tip the machine downward as it makes a turn; pushing forward the steering wheel or pulling it backward causes the two wings of the horizontal rudder to move together, and inclines them downward or upward, in order to direct the machine in either of these two directions. Capt. Cody has also provided for auxiliary balancing planes at the ends of the main planes. These can be attached to the uprights half way between the planes, if they are found necessary, in order to tip the machine in making abrupt turns. The inventor has also provided for warping the main surfaces if he finds this necessary. He has employed a system of warping the wing extensions of box kites for some time past with the man-lifting kites with which he has experimented. If it was found that the kite was not riding properly, by hauling it down and warping the wing extensions of the main box the trouble could be remedied.



Capt. Cody in flight in his latest biplane.

CAPT. CODY'S BRITISH ARMY AEROPLANE.

The power plant of the Cody machine now consists of an 8-cylinder E. N. V. gasoline motor capable of developing about 80 horse-power. This motor has replaced the 50-horse-power Antoinette which he used early in the year. It has been moved slightly back from the front edge of the lower plane, instead of being placed forward of the front edge as heretofore. In other words, the positions of the motor and the aviator have simply been reversed. The motor drives two

(Continued on page 200.)