FRONTISPIECE.—"Shooting the sun."

AIR NAVIGATION

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In Fig. 69, A and B are two objects which are separated by 10 miles and the bearing of B from A is found to be 159° true. An aircraft flying from A to B for the purpose of determining the wind, takes 8 min. to make the distance and this requires a heading of 181° true, at an air speed of 70 knots. In this case, since the rate of passage over 10 miles is 8 min., the ground speed is 75 knots per hour. Therefore, the track is extended from A through B to P, the distance AP being 75 knots. The heading AC is drawn, of course, 181° and 70 knots. The line CP indicates the force and direction of the wind. It may be reasoned in arriving at this result that the aircraft starting from A along the heading AC at the end of an hour will not be at C but rather at P, hence it was "blown" from C to P in that hour; hence, CP is the force and direction of the wind, which in this case is 28 knots from 270°.

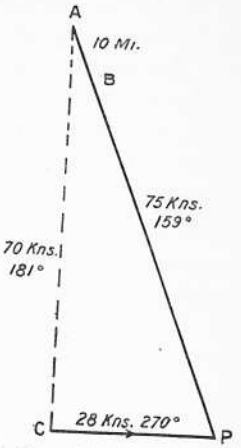

FIG. 69.—Obtaining force and direction of wind from known run.

THE RADIUS OF ACTION OF AIRCRAFT

Operations from a Fixed Base.—From the point of view of the pilot or navigator of an aircraft engaged in scouting operations, the work to be performed divides itself into two classes. When the operations are so conducted that the aircraft is given specific directions as to the area to be covered and the courses to follow, nothing remains for the navigator but to insure that the fuel and oil supply of the aircraft is amply sufficient to cover the proposed route under the conditions likely to be encountered. A fairly safe-working rule is to allow 25 per cent of the cruising radius of the aircraft for a margin of safety. The trip may then be undertaken without requiring anything of the navigator but the computation of various headings to be steered in making the patrol.

On the other hand, the orders for search may merely indicate the direction in which search is to be made and require the craft to cover as much distance as possible in that direction. It is then necessary for the navigator to determine how far he can venture out on this course, considering the wind conditions at

the time. It may also be ordered that the plane remain out on the patrol for a certain number of hours; it is then the work of the navigator to determine how far out he may go in order that the return may be made on time.

The extent of the operations of the second class depends entirely upon the force and direction of the wind; it is necessary to remark that before undertaking the mission the aerologist should be called upon for comment, and the navigator must determine the wind at the outset with as much accuracy as possible.

Let it be assumed that a plane with a definite range of action is called to leave a fixed base, A, then to scout along the course AB and return at the expiration of T hr. (Fig. 70). The wind is

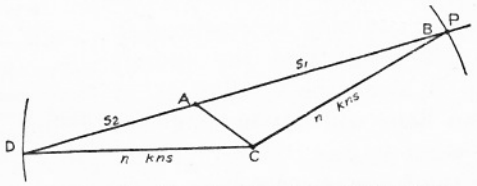

FIG. 70.—Radius of action from a fixed base.

represented by AC in the figure. Obviously the heading to be steered from the base A, assuming the air speed equal to S knots, is CB. At the end of an hour the plane is at B; the distance AB represents the rate of departure from the base. Call this S_1. Similarly, the heading to be steered back, the wind remaining the same (an assumption necessary at this point in the demonstration), is CD. AD is the ground speed back, and in the case of a fixed base it is also equal to the rate of return, S_2. Now let t equal the time which the craft will travel away from the base before turning back, and t_1 the time returning. Obviously, $T = t + t_1$; also, calling R the distance from base at time of returning, it follows that

$$\frac{R}{S_1} = t \text{ and } \frac{R}{S_2} = t_1$$

and hence,

$$T = \frac{R}{S_1} + \frac{R}{S_2} = R\frac{(S_1 + S_2)}{(S_1 \times S_2)}$$

whence

$$R(S_1 + S_2) = T(S_1 \times S_2).$$

From which, solving the equation for R,

$$R = \frac{T(S_1 \times S_2)}{S_1 + S_2}$$

but R is equal to $t \times S_1$, and substituting this value in equation, we get

$$t = \frac{T \times S_2}{S_1 + S_2}$$

which gives the time before turning. R, it will be n distance from the base at the time of turning. It is customary to call this the *radius of action*. In the abo it is equal to the distance traveled out before turn not true, however, with a moving base, as will be see all cases, however, t multiplied by the ground speed will give the distance to go before turning back.

To recapitulate:

R = distance from base at time of turning b
t = time out;
T = total time of patrol;
S_1 = rate of departure;
S_2 = rate of return;
g = ground speed out.

$$R = \frac{T(S_1 \times S_2)}{S_1 + S_2}; t = \frac{T \times S_2}{S_1 + S_2} \text{ and}$$

Distance out before turning $= g \times t$.

2. *Operations from a Moving Base.*—Operations of this are undertaken from a carrier or other ship wh position while the aircraft is absent on patrol. orders for patrol are so worded that the pilot is left as to the ground to be covered—*i.e.*, when the cou are definitely prescribed—there is nothing invol navigation of the patrol except to follow the track When, however, the navigator is allowed to de himself the extent of his patrol the solution is diff with the latter class of scouting problem that we a here. The caution concerning a 25 per cent fue safety, which was given above, applies with even g in patrols from a carrier, where the base to which t on return is subject to the unknown variations of w

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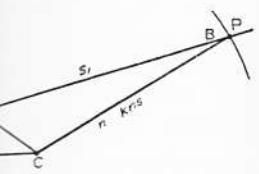

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which gives the time before turning. R, it will be noted, is the distance from the base at the time of turning. It is sometimes customary to call this the *radius of action*. In the above example it is equal to the distance traveled out before turning; this is not true, however, with a moving base, as will be seen later. In all cases, however, t multiplied by the ground speed out, or AB, will give the distance to go before turning back.

To recapitulate:

R = distance from base at time of turning back;
t = time out;
T = total time of patrol;
S_1 = rate of departure;
S_2 = rate of return;
g = ground speed out.

$$R = \frac{T(S_1 \times S_2)}{S_1 + S_2}; t = \frac{T \times S_2}{S_1 + S_2} \text{ and}$$

Distance out before turning $= g \times t$.

2. *Operations from a Moving Base.*—Operations of this character are undertaken from a carrier or other ship which changes position while the aircraft is absent on patrol. When the orders for patrol are so worded that the pilot is left no decision as to the ground to be covered—*i.e.*, when the courses for him are definitely prescribed—there is nothing involved in the navigation of the patrol except to follow the track laid down. When, however, the navigator is allowed to determine for himself the extent of his patrol the solution is different. It is with the latter class of scouting problem that we are concerned here. The caution concerning a 25 per cent fuel margin of safety, which was given above, applies with even greater force to patrols from a carrier, where the base to which the aircraft is to return is subject to the unknown variations of wind and sea.