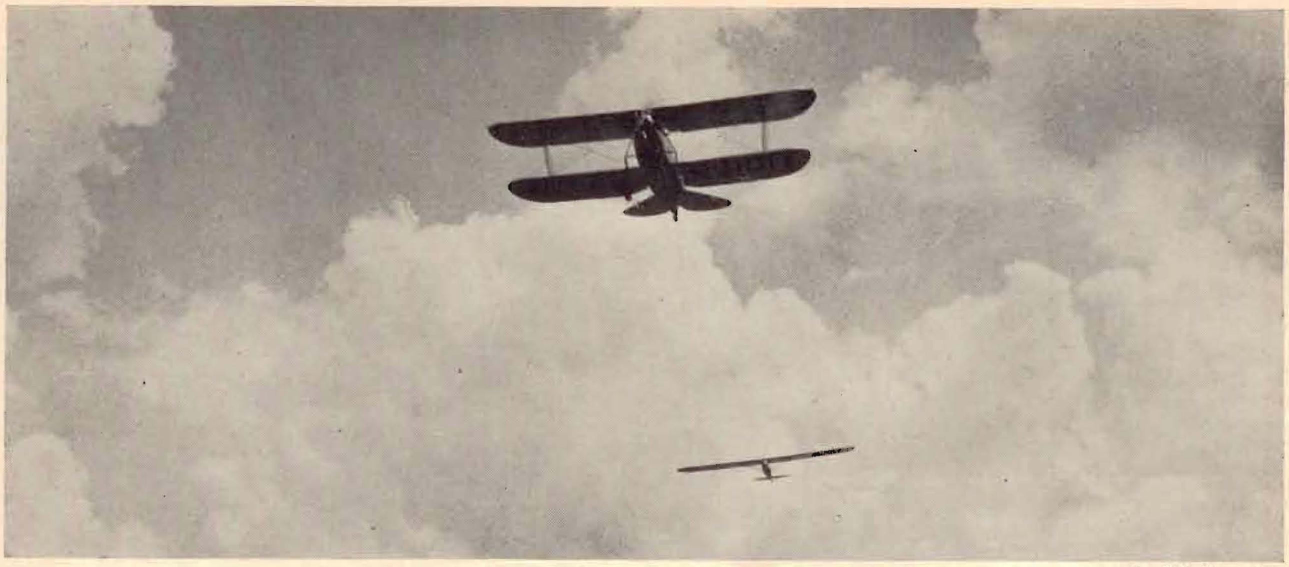

Fred T. Loomis

TUG AND TOWED GLIDER RATE OF CLIMB

By R. D. HISCOCKS

It is often asked whether a certain airplane will safely tow a certain glider. Two of the most critical points are the rate of climb and the angle of climb of the airplane when used as a tug. In the following paper Mr. R. D. Hiscocks, a member of the Technical Committee of the Soaring Association of Canada gives a method for checking these points, which should be useful to gliding groups. B. S. Shenstone, President, Soaring Association of Canada.

Ed: This paper represents a careful study of the physical requirements of aerotowing of gliders. It is most interesting to note that for a combination having a three to one ratio of gross weight of airplane to glider the maximum climb rate is reduced by only 30'/minute, from 750 to 720'/minute. Based on this study a revision and clarification of requirements for aerotow waivers appears to be in order.

The purpose of this article is to outline an elementary method of calculating the rate and angle of climb of an aeroplane towing a glider.

It is convenient to begin with a fictitious number Vcf which is defined as the rate of climb which would be obtained if all the available power were used to overcome the force of gravity on the two aircraft, therefore:

Vcf = 550 n b.h.p. ÷ W.
n = propeller efficiency.
b.h.p. = engine brake horsepower.
W = total weight of glider and tug (lb.).

In a steady glide at a sinking speed Vs the two aircraft lose potential energy at the rate WVs. Therefore the power required to maintain a fixed altitude is:

$$550 \text{ n b.h.p.} = \text{WVs} \qquad (2)$$

If V is the velocity of the tug and glider along the flight path in a glide and L/D is the lift: drag ratio of the combination then is:

$$\text{Vs} = \text{V} \div \text{L/D} \qquad (3)$$

Let the subscripts "a" and "g" refer to aeroplane and glider respectively, and Vsa and Vsg refer to the individual aeroplane and glider sinking speeds, then from Equation 3, by a little manipulation:

$$V_s = \frac{V}{W}\left(\frac{Wa}{(L/D)a} + \frac{Wg}{(L/D)g}\right) = \frac{Wa}{W}V_{s_a} + \frac{Wg}{W}V_{s_g} \quad (4)$$

If we define the aeroplane and glider fictitious sinking speeds as:

$$\text{Vsaf} = (\text{Wa} \div \text{W})\ \text{Vsa}$$
$$\text{Vsgf} = (\text{Wg} \div \text{W})\ \text{Vsg} \qquad (5)$$

Equation 4 becomes simply:

$$\text{Vs} = \text{Vsaf} + \text{Vsgf} \qquad (6)$$

and equation 2 becomes:

$$550 \text{ n b.h.p.} = \text{W (Vsaf + Vsgf)} \qquad (7)$$

When the engine delivers more power than is required for level flight, then the excess, which is available for climbing, is from Equation 7:

Excess Power = 550 n b.h.p. − W (Vsaf + Vsgf)

or, dividing by the total weight, we obtain as the true rate of climb of the combination:

$$\text{Vc} = (550 \text{ n b.h.p.} \div \text{W}) - (\text{Vsaf} + \text{Vsgf})$$

or, from Equation 1:

$$\text{Vc} = \text{Vcf} - (\text{Vsaf} + \text{Vsgf}) \qquad (8)$$

The calculation of Vcf from Equation 1 will usually present little difficulty and a "speed polar" curve giving Vsg in terms of forward speed will normally be available for the glider. The remaining task then, in order