The original configuration of the "HUMMINGBIRD" consisted of a side-by-side seating arrangement and featured a tricycle retractable landing gear. The engine was retracted and extended manually by a hand crank in the cockpit. The fuselage was modified from that of a "DRAGONFLY" and considerable amount of time was thus saved in reaching a flight test date. As was anticipated, the high speed performance was poor due to the large fuselage cross-section, but the model proved the feasibility of the idea. The tricycle gear was deleted in the final configuration in the interests of weight economy and design simplicity.

Description

The "HUMMINGBIRD" is classified under CAR 05 Glider Airworthiness (Ref. 1) as a two-place class I high-performance glider with auxiliary power. The aircraft meets current CAR 05 and applicable parts of CAR 03 (Ref. 2) covering power-plant installation and power-on flight characteristics. The configuration follows conventional high performance sailplane design with the exception of the retractable powerplant and the bicycle type landing gear. Figure 3 shows a three-view drawing. The aircraft is shown in power-on flight in Figure 2 and in gliding flight in Figure 1. The location of the powerplant was dictated by weight and balance considerations and airframe geometry. By locating the engine aft of the wing beam carry-through structure it was possible to take advantage of an unused volume of the fuselage for retraction purposes. It was also possible to locate both occupants ahead of the leading edge of the wing, thus providing excellent visibility.

The following are some of the more important design criteria:

Total Wing Area....	185.5	Ft^2
Span	54.0	Ft
Gross Weight	1200.0	Lbs
Aspect Ratio	15.73	
Wing Loading (Gross Wt.)	6.48	Lbs/Ft^2
Limit Positive Load Factor	5.43	g's
Limit Negative Load Factor	—3.43	g's
Design Gliding Speed	155.0	MPH
Power Loading	30.0	Lbs/BHP

Figure 4 shows the V-n diagram. The spanwise lift distribution was determined by methods outlined in ANC-1. The wing loading conditions were ascertained according to CAAM 05. The critical loading conditions for the wing are Condition I (positive high angle of attack) and Condition IV (negative low angle of attack). These points are shown on Figure 4. A number of loading conditions are critical for the fuselage. They are the wing load reactions, horizontal and vertical tail maneuvering loads, three landing load conditions and four tow load conditions. (An emergency tow-hook is provided.)

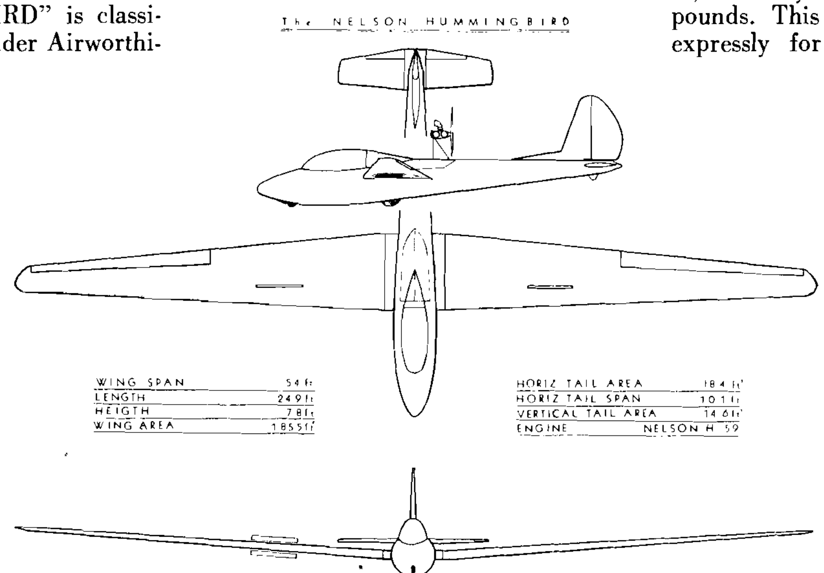

Fig. 3

Component Design

I. *Propulsion Unit*

The design of a powered sailplane is dictated to a large degree by the selection of the propulsion source. This unit was chosen for the "HUMMINGBIRD" on the basis of the following considerations:

A. Availability, cost and replacability.
B. Net thrust at design climb speed.
C. Acceleration factor for take-off at design gross weight.
D. Physical dimensions.
E. Type, availability and cost of fuel required.
F. Fuel consumption at design climb speed.

At the time of design only the reciprocating piston engine and propeller combination satisfied all of the above points. There have been some developments since, using small turbo-jet engines and also solid-propellant type rocket engines. Very little data or information has been made available on these experiments. High developmental costs have undoubtedly been a factor for lack of further progress. References 3 and 4 give performance criteria and information on these units.

The powerplant used in the "HUMMINGBIRD" is a Nelson H-59 four cylinder two-stroke cycle engine developing 40 hp at 4200 RPM. (Fig. 5.) The dry weight of the unit is 42 pounds. This engine was developed expressly for use in powered sailplanes and was designed and built by Ted Nelson. At the time of design no engines of this type were commercially available. The standard engine-propeller configuration uses a fixed pitch wood propeller forty-two inches in diameter. The small diameter propeller is necessitated by aircraft dimensions, the vertical location of the thrust line, and powerplant installation requirements. A considerable amount of investigation as to the performance of this small propeller was undertaken to find the optimum design for the design climb speed of the aircraft. Unfortunately, most of the standard charts, correction factors, equations and design parameters for standard aircraft propellers do not include data covering this category. Extrapolation of such data has been found to be unrealistic and unreliable.

A mobile test stand (Fig. 6) was constructed in order to establish some criteria for design purposes. The engine was attached to a parallelogram mounting to which was attached a flexure bar. Baldwin SR-4 type strain gauges were mounted in pairs on opposite faces of the flexure bar forming a Wheatstone bridge circuit. A standard slide-wire galvanometer was used for measuring thrust forces. The test procedure consisted of making test runs of approximately three miles under conditions of zero wind. A calibrated helicopter-type airspeed indi-

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