UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

ATBG-DT-AVN-1460

3 SEP 1959

SUBJECT: Report of Evaluation of the Kellett KD-1A Autogyro,

12 5 P.

TO: Commanding General
United States Continental Army Command
Fort Monroe, Virginia
ATTN: ATDEV

1. PURPOSE. To evaluate the Kellett KD-1A Autogyro to determine the potential of the autogyro concept for Army use.

2. SCOPE. The Kellett KD-1A was evaluated at Kellett Aircraft Corporation, Willowgrove, Pa. Flight maneuvers to include takeoffs, landings (power-on and power-off), climbs, descents, steep turns, and slow flight were performed during the 3¼-hour flight test. The performance, flight characteristics, and handling qualities of the machine were evaluated.

3. BACKGROUND.

a. Kellett has proposed "A New Observation and Liaison Aircraft" utilizing autogyro principles. On 28 May 1959, Kellett held a symposium at Willow Grove to familiarize interested agencies with the autogyro concept and to demonstrate the Model KD-1A Autogyro. Board personnel attending this symposium considered that further Army evaluation was warranted.

b. The KD-1A Autogyro has been rebuilt from old parts and, in order to avoid recertification, was not modernized during rebuild. The basic aircraft design is dated 1928. The aircraft is presently flying on a CAA Type certificate issued in 1941.

c. A jump-takeoff feature is proposed for future autogyros but was not incorporated in the KD-1A.

4. DESCRIPTION OF MATERIEL.

a. General.

(1) The Kellett KD-1A is a composite fixed- and rotary-wing aircraft powered by a 225-horsepower radial engine driving a fixed-pitch propeller. The fuselage is of fabric-covered, welded-tube construction and provides two open cockpits. An airplane-type rudder is used for yaw control. The horizontal tail surfaces are fixed, and pitch and roll control is achieved through control of the rotor as in a helicopter.

(2) The engine accessory section is modified to provide a power takeoff for "rotor starting." The power takeoff is coupled to the rotor by a conical clutch with provisions for manual engaging and disengaging through a lever in the pilot's cockpit.

(3) Pilot's controls consist of rudder pedals with toe brakes, cyclic stick and lock, airplane-type throttle quadrant, clutch lever, and rotor brake.

(4) The three-bladed rotor system is fully articulated and designed for easy access and quick folding. Blade-centering devices imbedded in the blade roots extend into a cam-type fitting on the rotor head. Lead, lag, and centering of the individual blades are permitted by the cam arrangement. No friction devices are provided. The rotor blades are of fabric-covered plywood construction over a steel spar.

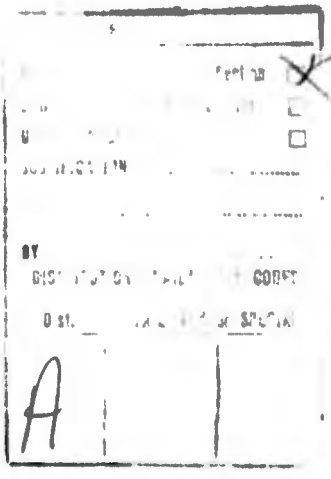
b. Operational Techniques.

(1) To start a takeoff, the rotor starting clutch is engaged and the rotor accelerated to approximately 180 r.p.m. As the desired r.p.m. is reached, the clutch is disengaged and full power is applied to the propeller to start the takeoff roll. From this point, the rotor operates independently of engine power.

(2) Maintaining a three-point attitude throughout the takeoff roll results in becoming airborne in approximately 150 feet at an indicated airspeed of 20 knots.

c. Manufacturer's Specifications.

Gross weight	2400 lb.
Empty weight	1664 lb.
Useful load	736 lb.
Maximum speed	126 m.p.h.
Minimum speed	25 m.p.h.
Landing speed	0 m.p.h.
Takeoff (no wind)	200 ft. max.
Rate of climb	1060 ft./min.
Service ceiling	14,000 ft.
Rotor diameter	40 ft.



Length - blades folded. . . . . 26 ft.

Width - blades folded . . . . . 10 ft.

Height. . . . . 10 ft.

Engine. . . . . 225 hp. Jacob

5. EVALUATION. Since the purpose of this evaluation was to determine the potential of the autogyro concept, the configuration, controls, rotor system, and handling qualities were accepted as reflecting the state of the art at the time the machine was originally certificated by CAA (FAA).

a. Controls. When compared to today's rotary-wing aircraft, the control system of the KD-1A is crude, cyclic forces are high, and some cyclic feedback is encountered in all phases of flight. A mechanical lock is employed to hold the cyclic control in place during rotor acceleration and immediately after landing. Feedback reached its maximum during rotor acceleration and deceleration. Adjustable bungees are used to provide pitch and roll trim and to reduce control forces in the cyclic control system. Cyclic control is maintained through direct mechanical linkage. Incorporation of features presently within the state of the art could greatly enhance handling qualities. The rudders and rudder controls are similar to those of a conventional airplane and are adequate for all maneuvers performed except power-off descents at airspeeds below 15 knots. At slow speeds with power off, a left-turning tendency was encountered.

b. Takeoffs and Climbs.

(1) Takeoff runs were started with the rotor turning at approximately 180 r.p.m. Takeoffs were accomplished by maintaining a three-point attitude. In light and variable winds, at a pressure altitude of 300 feet, and at takeoff gross weights of 2150 to 2250 pounds, takeoffs were accomplished from sod strips in 120 to 150 feet at indicated airspeeds of 18 to 20 knots.

(2) The best rate of climb was found to be 1100 f.p.m. at 45 knots IAS. Rate of climb decreased rapidly at speeds above 55 knots and below 30 knots. At airspeeds between 10 to 15 knots the aircraft was under positive control but would not climb.

c. Approaches and Landings. Approaches in the KD-1A could be made with or without power and were normally made in much the same manner as a power approach in a conventional airplane. The angle and rate of descent could be controlled by varying speed and power over a wide range. Although slow speed approaches (20 knots) were not performed, they are considered feasible. The approach is terminated in a cyclic flare near the ground, and the aircraft allowed to touch down three-point or tail-low with little or no forward speed. Zero groundspeed landings were gentle and seemed quite normal in this aircraft.

d. General Flight Characteristics.

(1) A comfortable slow flight speed of 20 knots is possible. At this speed the machine responded readily to control inputs and power changes.

(2) In flight the KD-1A was smooth and maneuverable. At high speeds (90 to 105 knots) cyclic forces and feedback increased, but the overall vibration level remained low.

(3) In light-to-moderate turbulence, single one-to-one vibrations were transmitted through the airframe and caused a circular motion of the cyclic control. It is assumed that these vibrations resulted from insufficient lead-lag damping of the rotor system.

(4) After takeoff, the rotor accelerated to approximately 200 r.p.m. and remained between 200 and 210 at all speeds and load conditions encountered.

(5) After landing, it was necessary to engage the cyclic lock, remain stationary, and apply the rotor brake to avoid resonance as rotor r.p.m. decayed. In this configuration, it was necessary to stop the rotor with one blade directly over the fuselage. This procedure positioned the forward blades sufficiently off center to prevent their striking the propeller in the event they flexed downward during taxiing.

(6) The maximum rate of climb of 1100 f.p.m. was achieved at 45 knots IAS. Maximum sustained rate of descent was 1100 f.p.m. at 10 knots IAS and 600 f.p.m. at 45 knots IAS, power off. When the nose was lowered to effect a recovery from slow speeds, the rate of descent temporarily exceeded 1100 f.p.m. When the nose was not lowered and power applied for recovery, high rates of descent were avoided.

e. Personnel. It is the opinion of Board personnel who flew the KD-1A Autogyro that transition for either fixed-wing or helicopter pilots could be accomplished in two to five hours of flying.

6. DISCUSSION - THE AUTOGYRO POTENTIAL. The KD-1A meets the accepted Army definition for V/STOL performance. If sustained hovering is not an Army requirement and forward speeds to 20 to 150 knots are acceptable, it appears that a simple, easy-to-maintain autogyro which will meet the requirement for an Army V/STOL observation aircraft is well within the state of the art today . In its present state of development, the KD-1A Autogyro is superior to present-day Army light airplanes as a V/STOL vehicle. The autogyro can give the Army a V/STOL takeoff and landing capability with less complexity than the helicopter and do virtually everything the helicopter does except sustain hovering flight.

7. SUMMARY.

a. The KD-1A Autogyro, an old machine, compares favorably in performance to today's light airplanes and has the added feature of zero groundspeed landings. The KD-1A Autogyro, however, is obsolete throughout and does not reflect the state of the art today.

b. The autogyro concept provides the Army the potential of developing a relatively simple, easy-to-maintain aircraft capable of meeting Army V/STOL performance requirements.

8. CONCLUSIONS.

a. The autogyro concept provides the Army the potential of developing a relatively simple, easy-to-maintain aircraft capable of meeting Army V/STOL performance requirements and warrants further Army interest.

b. Careful consideration should be given to the autogyro proposals which have been submitted to the Army, with a view towards accepting one for development for further investigation of the autogyro's ability to perform missions requiring V/STOL capabilities.

9. RECOMMENDATION. It is recommended that the Army consider acceptance of one of the autogyro proposals which have been submitted to the Army for further investigation of the autogyro's ability to perform missions requiring V/STOL capabilities.

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