AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 120

THE CIERVA "AUTOGIRO" MARK III (BRITISH)

Armstrong-Siddeley "Genet Major" Engine

Washington
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The autogiro illustrated in the photographs of this circular is known as the type C.19, Mark IIa (Figs. 2, 3, and 4) and is, with minor exceptions, identical with the type that is being put into production, and which will be known as the Mark III (Fig. 1).

In the performance test conducted at the old Avro airport near Southampton it was demonstrated that the aircraft could be banked steeply like an ordinary airplane, and could glide either in a fairly flat glide, or in a very steep one. The "zooms" were quite impressive, and the climbing angle was very good (Fig. 5). However, its rate of climb was not as good as that of an airplane.

When some fifty or sixty yards from the hangar, the pilot pulled the stick back, the aircraft tilted backward and settled down into a very steep path, touching the ground and coming to a standstill after something like two revolutions of the landing wheels. By gently applying the brake with which the latest type is provided, the rotor was soon stopped, and the flight was ended. The pilot had taken off with the rotor doing 85 r.p.m.

*From Flight, May 9, 1930.

Constructional Features

In the notes which follow, the production type, C.19, Mark III, may be assumed to be referred to, except when otherwise stated. The fuselage is a welded steel tube structure of normal welded construction. The forward end terminates in an engine plate for the "Genet Major" 105 hp engine, while at the rear is carried the biplane tail (Fig. 6). This consists of two vertical fins of welded steel tube, two rudders of duralumin, and two tail planes, also of duralumin construction, to which are hinged the duralumin elevator flaps (Fig. 7). The control of the tail surfaces is accomplished as shown in Figure 8.

The rotor blades are of mixed construction in that the single spars of the rotor blades are circular section steel tubes, 1-3/4 inches in diameter and 20 S.W.G., of high-tensile (T.5) steel and the rotor blade ribs are of wood in the Mark IIa (experimental) aircraft, but it is likely that in the production type they will be of duralumin. The covering of the blades is fabric, but the leading edge is covered with plywood, up to the spar (Fig. 9). The ribs are very closely spaced (3 in.) and all ribs are provided with metal flanges sweated to the tubular spar. In addition every third rib is bolted to the spar (Fig. 10). Owing to the close spacing of the ribs, the load to be carried by each rib is very small, and the factor of safety provided by the bolting of every third rib is in the neighborhood of 20.

In the experimental aircraft (Mark IIa), the rotor spars are attached to the hinges of the rotor head by flanged couplings.

These are incorporated in order to permit the blades to be set at various angles of incidence so as to determine the best angle. When that angle has been ascertained in the Mark IIa aircraft, the rotors for the Mark III will have their spars joined direct to the hinged joints on the rotor head.

It may be recollected that in his lecture to the Royal Aeronautical Society, recently, Senor de la Cierva referred to the addition of another hinge, perpendicular to the first, allowing the blades to "overtake" each other, and that the freedom thus given was the maximum which the blades could have without becoming unstable. This hinging of the blades is shown in Figure 11. It will be seen that the new rotor head consists of a hollow steel cone, to the top of which the check cables are attached, and of the rotor head proper, which is a forging, running on ball bearings, carrying the four lugs to which the spars of the rotor blades are hinged. Each spar has a double hinge of which the inner is horizontal and permits the blade to rise under the action of the lift, while the outer hinge pin is vertical and permits the blade to swing slightly fore and aft in the plane of the blades. The moving parts of the rotor head are lubricated by oil from the conical top, which forms the oil tank, and in the side of which is the oil filler cap.

Those who had an opportunity to examine closely the first autogiro built in England may remember that cables, joining one blade to the blades on each side of it, were fitted, and that small lead bobbins were placed in the centers of these cables, centrifugal force swinging the bobbins outward and thereby putting a certain amount of tension on the cables. In the latest version the lead bobbins have been replaced by crank-armed dampers mounted on the wing spars (Fig. 10). These dampers work somewhat on the principle of the shock absorbers used on motor cars, and the friction between their steel plates and cork discs can be adjusted to give whatever stiffness is required. The crank arms of the dampers are so designed as to have a certain degree of free movement in a vertical plane, thus enabling them to adjust themselves to the rising and falling of the blades.

Owing to its ability to land very nearly vertically, the autogiro calls for a rather exceptional landing gear, with a travel long enough to absorb the shock. The telescopic legs are attached to the lower spar of the fixed wing, and two struts above the wing brace the latter to the fuselage (Figs. 1 & 12). The landing gear has a very wide track, and the wheels are fitted with Bendix brakes, so that the aircraft can be brought to a standstill with almost no run at all.

Hitherto one of the arguments against the autogiro has been that, owing to the fact that the rotor continues to run and to give lift after the aircraft has come to a standstill, there is risk of turning over on the ground. In fact, this has happened on more than one occasion. A brake has now, however, been fitted by means of which the rotor can be stopped in a very short time, and thus the risk of turning over should be materially decreased.

The Mark III autogiro has a tare weight of 930 pounds and the C. of A. covers a gross weight of 1400 pounds. The gasoline capacity is 18 gallons and the oil, 2½ gallons. Cruising at a speed of 75 m.p.h., the consumption is approximately 6 gallons per hour, so that the still air range is approximately 225 miles.

As regards performance, the top speed of the Mark IIa is approximately 90 m.p.h., but by "cleaning up" the production aircraft it is estimated that this figure will be increased to at least 95 m.p.h. The aircraft is able to maintain horizontal flight at 25 m.p.h., and the vertical descent reduces the landing run to practically nothing. The take-off can be accomplished in about 30 yards, and the climbing angle is 12 degrees. The initial rate of climb is 750 feet per minute. With pilot only on board, the ceiling is 17,000 feet, and with full load the ceiling is still 13,000 feet.

Characteristics

Diameter of rotors at rest	35 ft. 0 in.
Diagonal span of rotors at rest	25 " 0 "
Span of fixed planes	20 " 6 "
Chord of fixed "	2 " 9 "
Length from propeller to fins	18 " 3 "

Areas in square feet:

Four rotor blades	89.52
Two fixed planes	42.00
Ailerons	12.68
Oblique fins	7.92
Vertical fins	26.64
Rudders	16.12
Stabilizer	14.98
Elevator	15.37

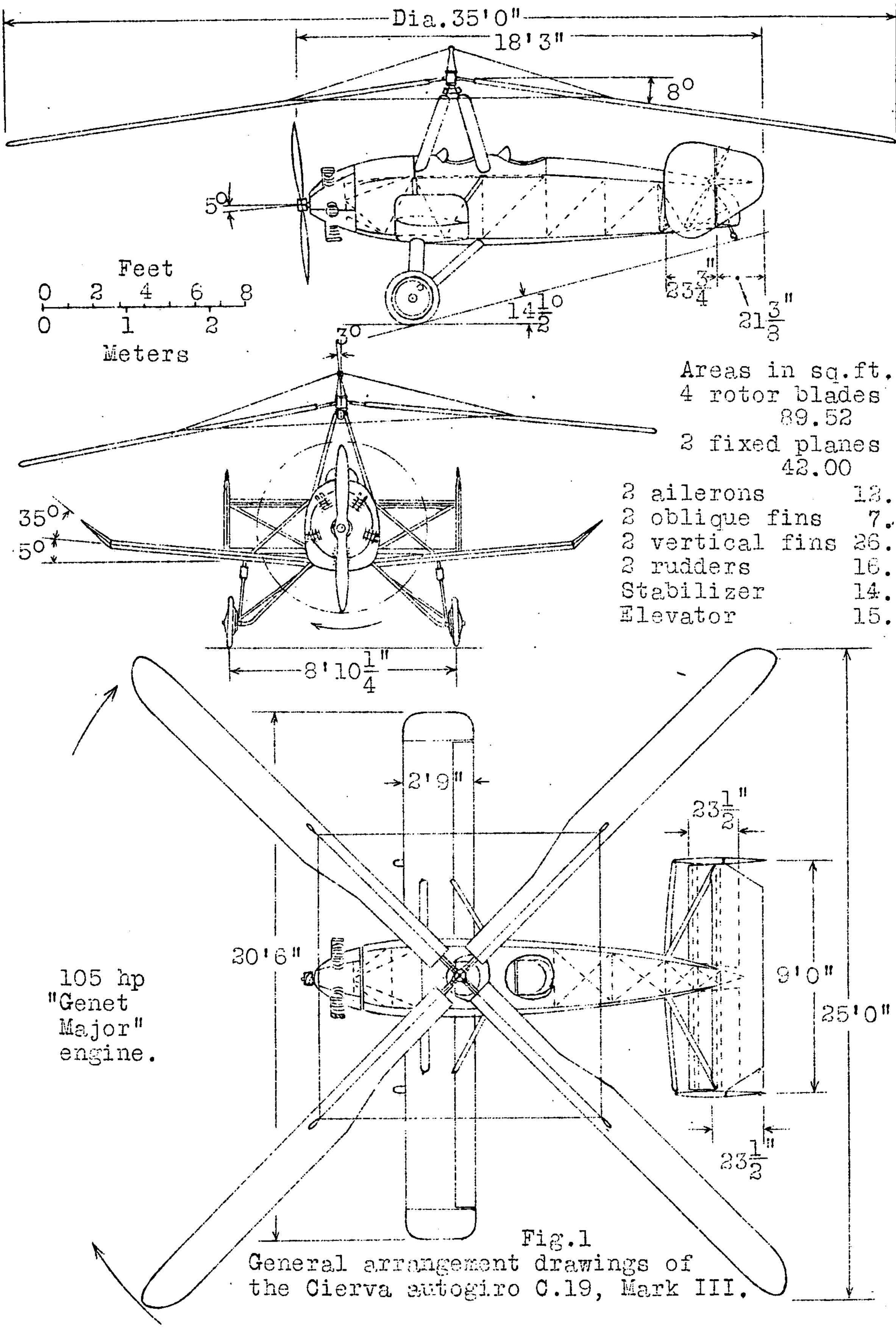

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Fig.1
General arrangement drawings of the Cierva autogiro C.19, Mark III.

Fig.2 Three-quarter front view of the autogiro, type C.19 Mark IIa. The engine is an Armstrong Siddeley "Genet Major".

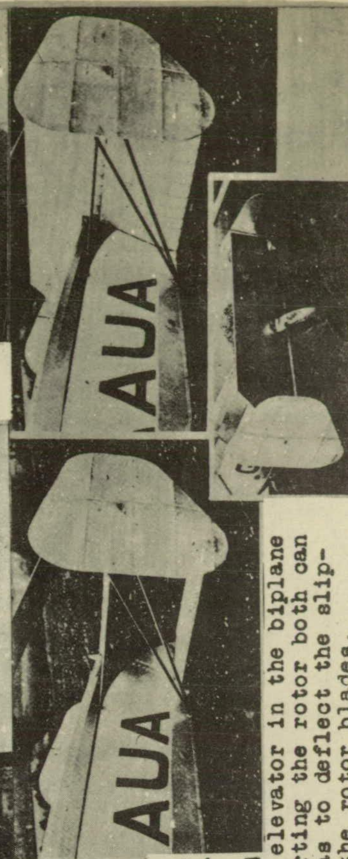


Fig.7 The trimming tail: The lower surface is the stabilizer and the upper the elevator in the biplane tail. For starting the rotor both can be tilted so as to deflect the slipstream on to the rotor blades.

Fig.3 The autogiro landing without a run. Note that the aircraft is heading for the hangar. It pulled up a few feet from the position in which it is shown in the photograph, and still some 20 yards or so from the hangar.

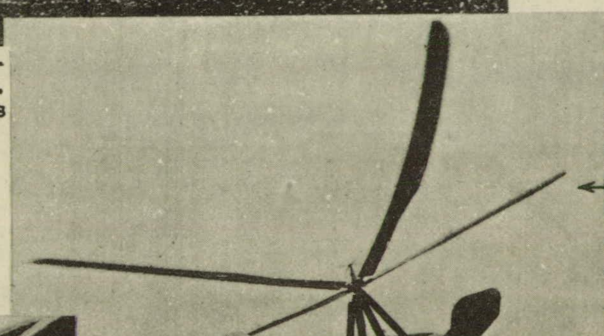


Fig.4 In full flight. Note the coning angle of the rotor blades.

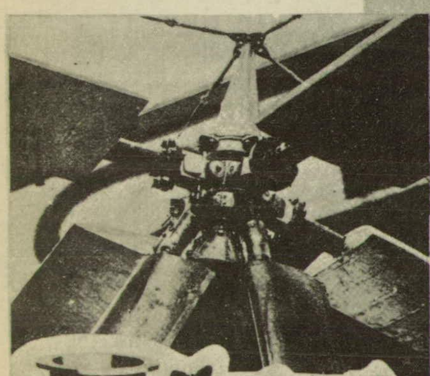
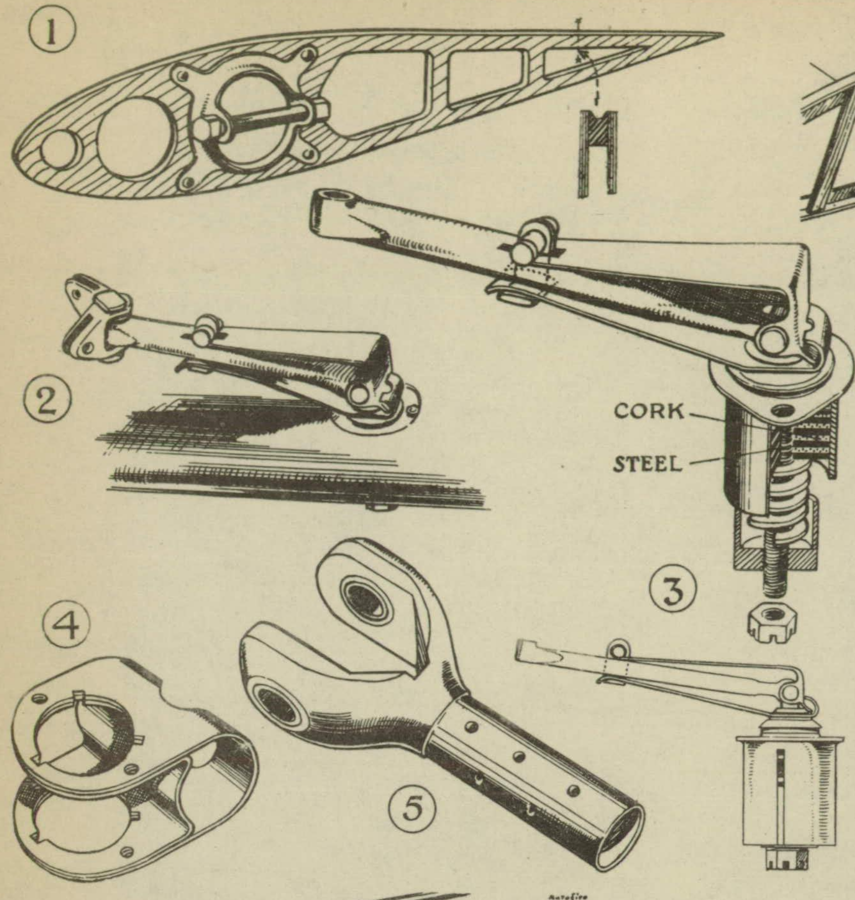


Fig.11 The rotor head. The flange couplings of the spars will not be incorporated in the production type. Below is the conical top of the head. This serves as an oil tank. Note the filler cap on the side. On the left, the blank for the rotor head.

Fig.12 The starboard half of the landing gear. Note the Bendix wheel brakes.



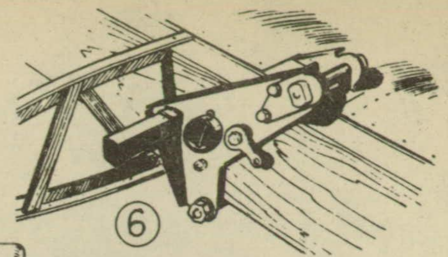
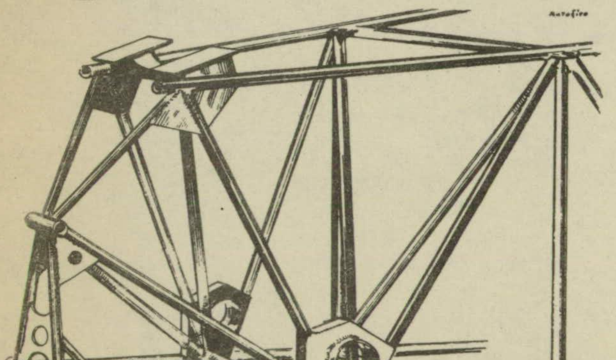


Fig.10 Some constructional details of the autogiro: 1, a wooden rib and its attachment to tubular spar of rotor blade. 2, one of the dampers which check the movement of the rotor vanes in a horizontal plane. Details of the damper are shown in 3, and the method of mounting the damper on the spar is shown in 4. Details of the forkends of the rotor spars are illustrated in 5. 6, shows the strut fitting on the fixed wing.

Fig.9 The fixed wing is of wood construction. Details of wing spar, wing ribs and dihedral wing tip are shown.



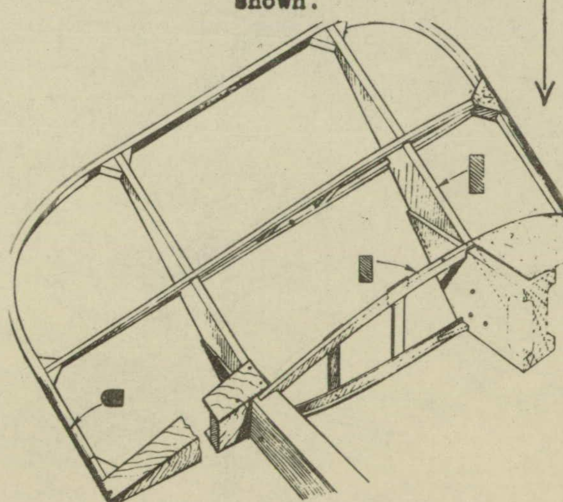


Fig.6
Sketch of fuselage constructional details showing mounting for the biplane tail.

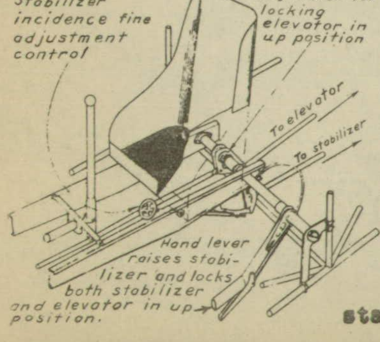
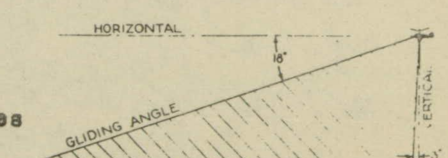


Fig.8 How the tail surfaces are controlled. The lower plane is the stabilizer and the upper the elevator. The lever on the left-hand side of the cockpit controls the tilting for starting the rotor.

Fig.5



This diagram illustrates the range of gliding angles claimed for the autogiro, which gives a wide choice of landing grounds from any particular point. The nearly vertical descent (indicated on the right of the diagram) is particularly interesting.