TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 250

MAGNAN GLIDER M-2.

By M. André Lesage.

From "L'Air," January 1, 1924.

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MAGNAN GLIDER M-2.*

By M. André Lesage.

This glider was designed by Dr. Magnan to fly in so-called horizontal winds.

The author, in his studies on bird flight, has shown that there are certain gliders such as birds of prey which, in gliding, utilize, preferably, ascending currents of dynamic origin furnished by horizontal currents encountering a slope, cliff, mountain, forest or ascending currents of thermic origin which exist in warm regions and particularly in deserts. He has also shown that sea birds, if they are capable of utilizing ascending currents caused by cliffs or waves, are also capable of flying over the sea using the energy contained in so-called horizontal winds.

Dr. Magnan, when describing the maneuvers executed by different birds during the course of their evolutions, noted the considerable differences which exist in the characteristics of these birds.

The birds of prey have long, thick and wide wings, an aspect ratio of 5 to 6 and a very well developed tail. The angle of incidence of their wings, when spread out but at rest, that is,

* Translated from "L'Air," January 1, 1924.

not influenced by any external influence, is at a maximum of 11° near the body. Web-footed birds on the other hand have long, thick and narrow wings, an aspect ratio of from 9 to 15 and a short tail. The angle of incidence of their wings when spread out at rest reaches for special species 23° near the body.

The marine type glider which Dr. Magnan has designed and constructed possesses the same characteristics as the web-footed bird gliders and has thick, long and narrow wings having variable camber and incidence and elastically warped like the wings of birds.

Wings.- Each wing of this glider includes a single box type spar which runs from the fuselage to the wing tip diminishing in height. The spar carries the flexible ribs. Each of these ribs is composed of two ash strips, one passing above and the other below the spar. The lower strip running from the leading to the trailing edge is glued and screwed to the lower face of the spar. The upper strip terminates at a point about 2/3 of the chord from the leading edge where it is fixed to the lower strip. It is connected to the spar by means of a special device composed of a ball and cup bearing.

Thanks to this device the upper strip cannot spread from the spar but glides without effort forward and aft and thus permits the flexure of the rib under the action of gravity and wind.

The radii of curvature of the various ribs increase regularly from the fuselage to the wing tip. In addition, the ribs are so arranged as to have different angles of incidence to one another, the greatest incidence being near the fuselage.

The outer end of the wing is composed of a series of ribs made out of two wood strips fixed to the upper and lower faces of the spars. These ribs are arranged in fan form in order to give a pointed shape to the end of the wing and to copy exactly the wing of a sea bird.

The leading edge of the wing is composed of very flexible curved strips.

The angle between the two wings is about 170° (a 5° dihedral). There is a horizontal cabane placed on the top of the fuselage and attached to each wing where it dips downward near the fuselage.

Dr. Magnan has thus produced a wing easily twisted, flexed and vibrated under the combined action of gravity and the wind, in other words, a wing with variable camber and incidence.

The wing covering accomplished in a special manner permits the cloth to follow the deformation of the wings without causing folds.

Fuselage.- The body of the glider is composed of a series of bulkheads in wood and inclined alternately with reference to the longitudinal axis of the glider; these bulkheads are connected at their bases and summits so as to form a series of contiguous V's in the longitudinal plane. The whole is cross braced by piano wire. In addition, these bulkheads serve to carry four longerons and the longitudinal stringers composing the assembly to which is applied the cloth covering.

The two center bulkheads which are much strengthened serve as the points of attachment of the cabane and carry the transverses to which the wing spars are attached. These two frames are connected at the bottom by a member to which is fixed the axle of the landing gear. Between these two bulkheads is an open space in the body of the airplane utilized as the pilot's cockpit.

Tail Surfaces.- The tail of the glider includes a fin and a rudder pivoted around a vertical axis, and a fixed horizontal plane and an elevator pivoted around the horizontal axis. This assembly is carried by a very light duralumin girder attached to the fuselage.

Controls.- The warping and elevator deflection is accomplished through a control stick. This stick is connected by a rod pivoted to the pilot's seat; the seat is carried by four rollers on two rails mounted in the body parallel to the longitudinal axis of the glider. This arrangement permits the pilot to alter the center of gravity of the glider towards the front or rear. Steering in a lateral direction is by means of a rudder bar.

Landing Gear.- The landing gear includes two wheels mounted on a streamlined duralumin axle which projects only 15 cm (5.91 in) on each side of the fuselage. This axle is supported by a member connecting the two central bulkheads and is fixed to it by a rubber shock absorbing gear.

General Characteristics.

Span,	11.50 m	37.7 ft.
Length,	4.95 m	16.2 ft.
Height,	1.10 m	3.6 ft.
Chord at middle of wings,	1.30 m	4.3 ft.
Wing area,	10.25 m^2	110.3 sq.ft.
Weight of wings,	60.00 kg	132.3 lb.
Weight of glider empty,	130.00 kg	286.6 lb.
Total weight loaded,	200.00 kg	440.9 lb.
Wing loading,	19.00 kg/m^2	3.9 lb./sq.ft.

Operation of the Glider.

Dr. Magnan has shown that gliding birds always possess at the instant when they face the wind a certain speed which they have acquired by running along the surface of the waves, launching themselves from a rock or after having executed a more or less rapid descent in the direction of the wind or into the wind but during a relative calm. To facilitate the take-off, Dr. Magnan makes use of an arrangement of rubber cords and tackles to permit the glider to be launched at the required moment and to give it the necessary speed. As soon as the glider is launched, the pilot should pull on the control stick to raise the elevator in order to assist the climb. The greater the wind the smaller is the movement necessary. As soon as the glider is in line of flight, the maneuvers to give it a horizontal trajectory are as follows: On the arrival of a gust the pilot must pull on the control stick and keep it in this position so as to maintain the glider slightly tail down so long as the force of the wind is increasing. As soon as the force commences to diminish it is necessary at once to bring the control stick forward to lower the elevator and cause the glider to dive, otherwise it would rapidly lose speed. This maneuver is easily executed on account of the movement of the seat following the fore and aft displacements of the control stick. Drawing back the seat (together with the pilot's body) with the control stick at the beginning of a gust moves the center of gravity of the glider to the rear and facilitates putting the tail down and ascending into the wind. Advancing the seat at the maximum moment of a gust brings the center of gravity forward. In these conditions moving the seat assists in tilting the glider around its transverse axis, commences the gliding descent and permits the avoidance of accidents due to loss of speed.

As soon as the glider is diving and has reached a certain speed the pilot, during the entire time that the wind is decreasing, should execute a gliding flight and endeavor to lose as little height as possible. These maneuvers should be repeated at each passage of a gust so as to cause the glider to describe in space a trajectory composed of successive ascents and descents the control of which must be learned in order to preserve a sufficient speed of flight.

This type of gliding flight can be practiced also in describing circles but experience proves that this is more difficult. It is, in fact, very easy to turn at the maximum moment of the gust so as to have the wind astern while planing. It is, on the other hand, difficult to make in time the turn necessary in order to face the wind at the next gust. This result can be obtained, however, by using properly designed gust indicators.

All winds and consequently all gusts are not good for gliding flight. The gusts as Dr. Magnan has indicated, possess an energy which varies with the speed of the wind. In light winds the gusts have smaller amplitude than in high winds. Gusts of light winds cannot be utilized by gliders as by sail boats, for example, as they do not contain sufficient energy. The gusts of winds in great storms are also useless and are even dangerous on account of the excess of energy which they contain.

According to Dr. Magnan, strong gusty winds are the most favorable on condition that their mean speed is not greater than 20 m (65.6 ft.) per second, as these gusts have a duration long enough for the pilot to maneuver. The pulsations of the wind are of no immediate interest to the pilot for they are too rapid to use but they are not without their effect. They have a definite action on the wing but this action is automatic.

Finally, it is best to fly at a height of 50 m (164 ft.) above land or water, neither too low nor too high, in other words, in a zone where the gusts of wind have their greatest amplitude.

At the present time, gliding flight with ascending wind, such as is practiced by eagles in the mountains or by gulls along cliffs, has been realized by man while the gliding flight of sea birds has not as yet been made the object of real tests, except as, apparently, by the Germans. No positive results have in any case as yet been published.

The tests carried on by Dr. Magnan have already permitted him to state certain principles regarding the realization of gliding flight in horizontal winds.

The Magnan glider was piloted in recent tests by Mr. André Canivet who has succeeded in applying certain of the maneuvers of gliding birds observed during their evolutions.

The following results have already been obtained:

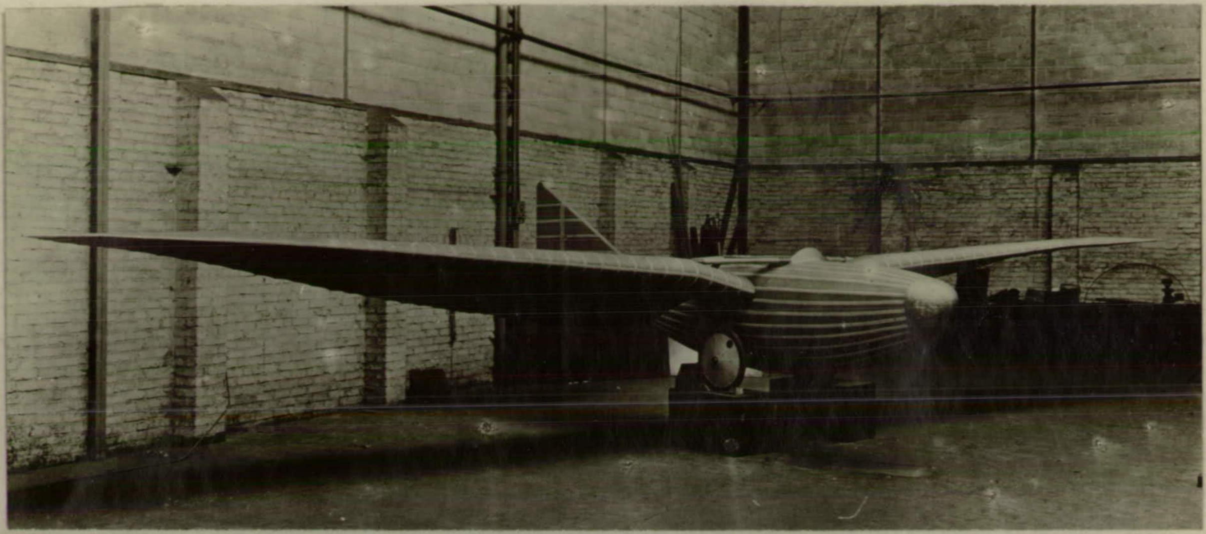
The glider heavily loaded placed on flat ground and facing the wind outside of the influence of any ascending current and drawn by a rubber cord 18 mm (.709 in.) in diameter elongated 100% does not take off when there is no wind. It rolls along the ground but does not leave it.

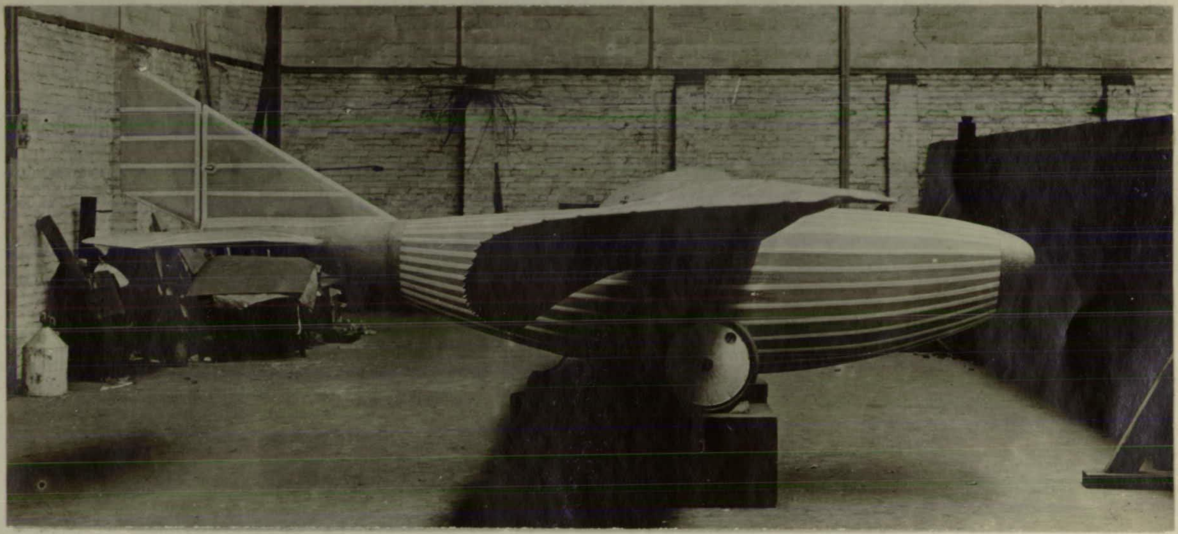
When the mean speed of the wind reaches 6 m (19.7 ft.) per second the glider placed and towed in the same condition as above rolls along the ground for about 10 m (32.8 ft.), then rises and executes a gliding flight of a length according to circumstances. It has even been possible for Mr. Canivet by proper manipulation of the elevator to attain in full flight a slight increase of height at the moment of the passage of a gust.

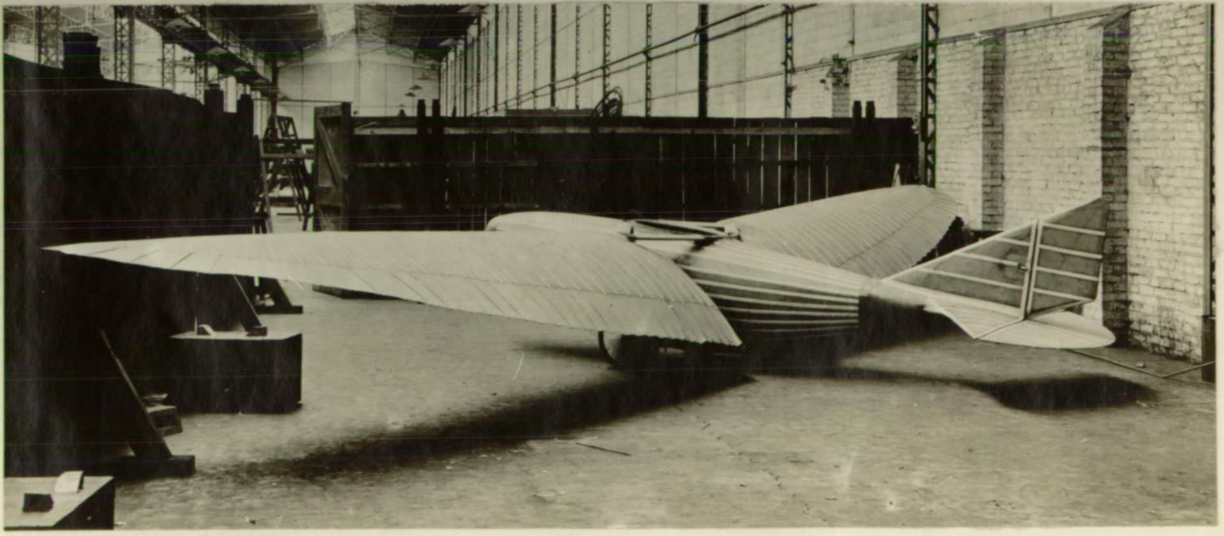
When the speed of the wind attains 12 m (39.4 ft.) a second, the taking off of the glider is more rapid even if the rubber cord is elongated only 50%.

These first results already show the reproduction of the fundamental maneuvers of gliding birds flying in horizontal winds.

Translated by
Paris Office,
National Advisory Committee
for Aeronautics.







MAGNAN
GLIDER
M—2

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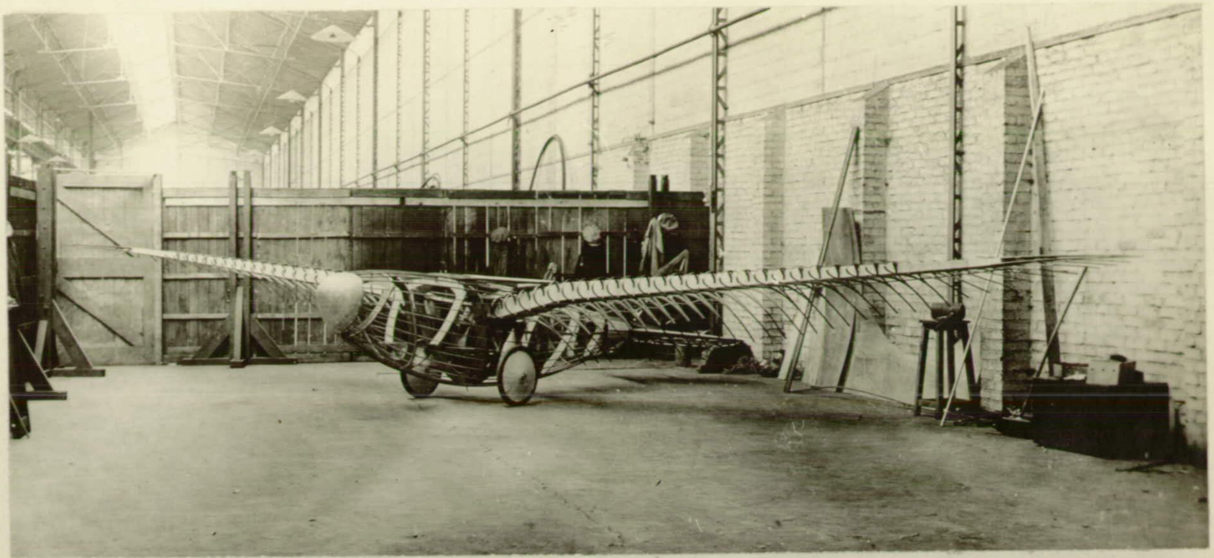

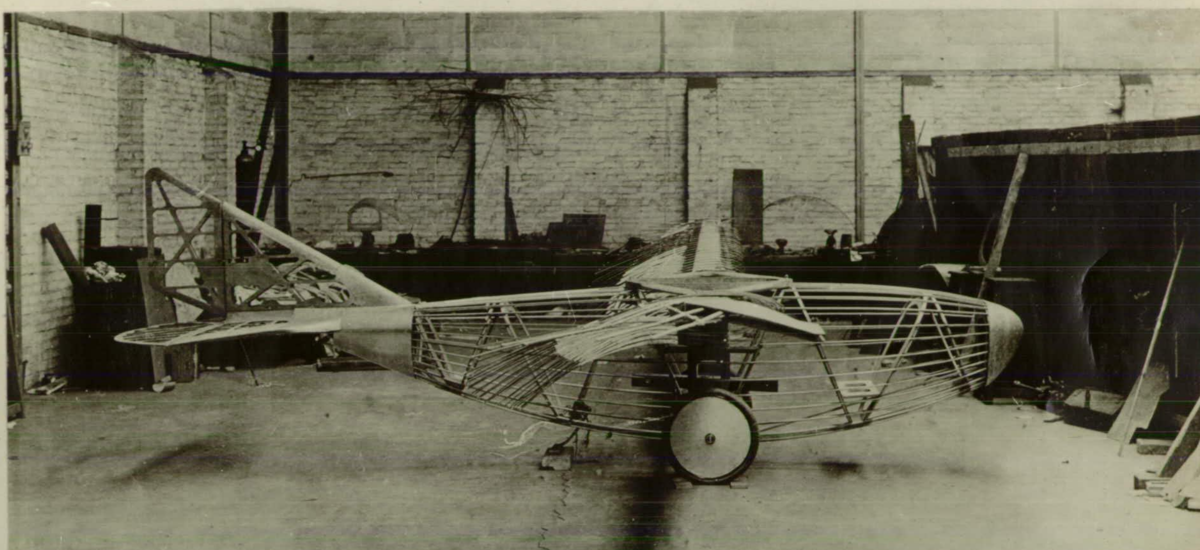

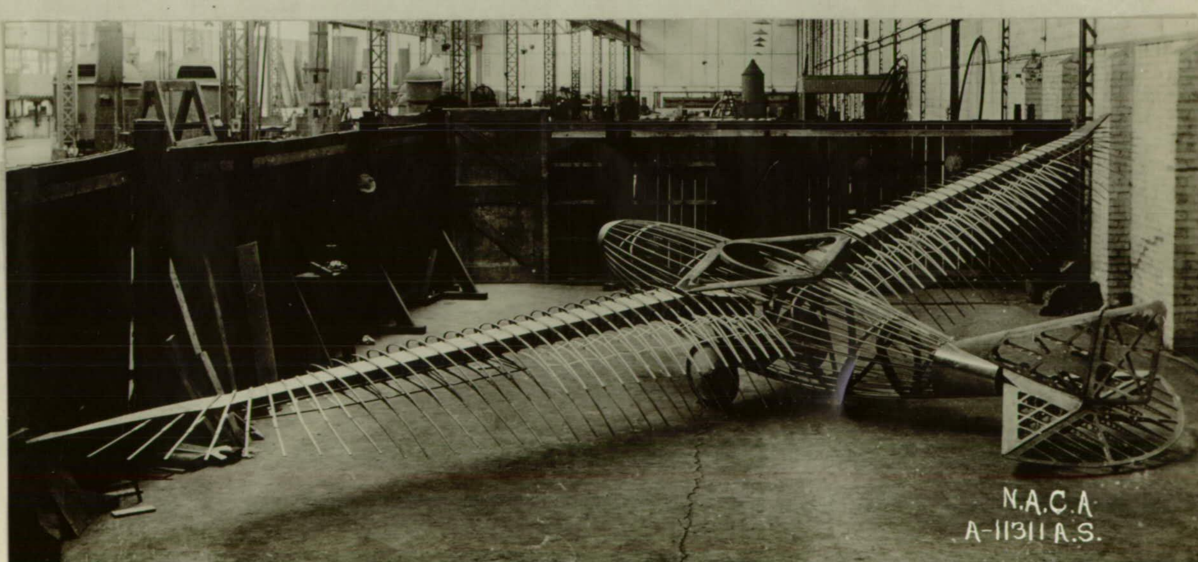
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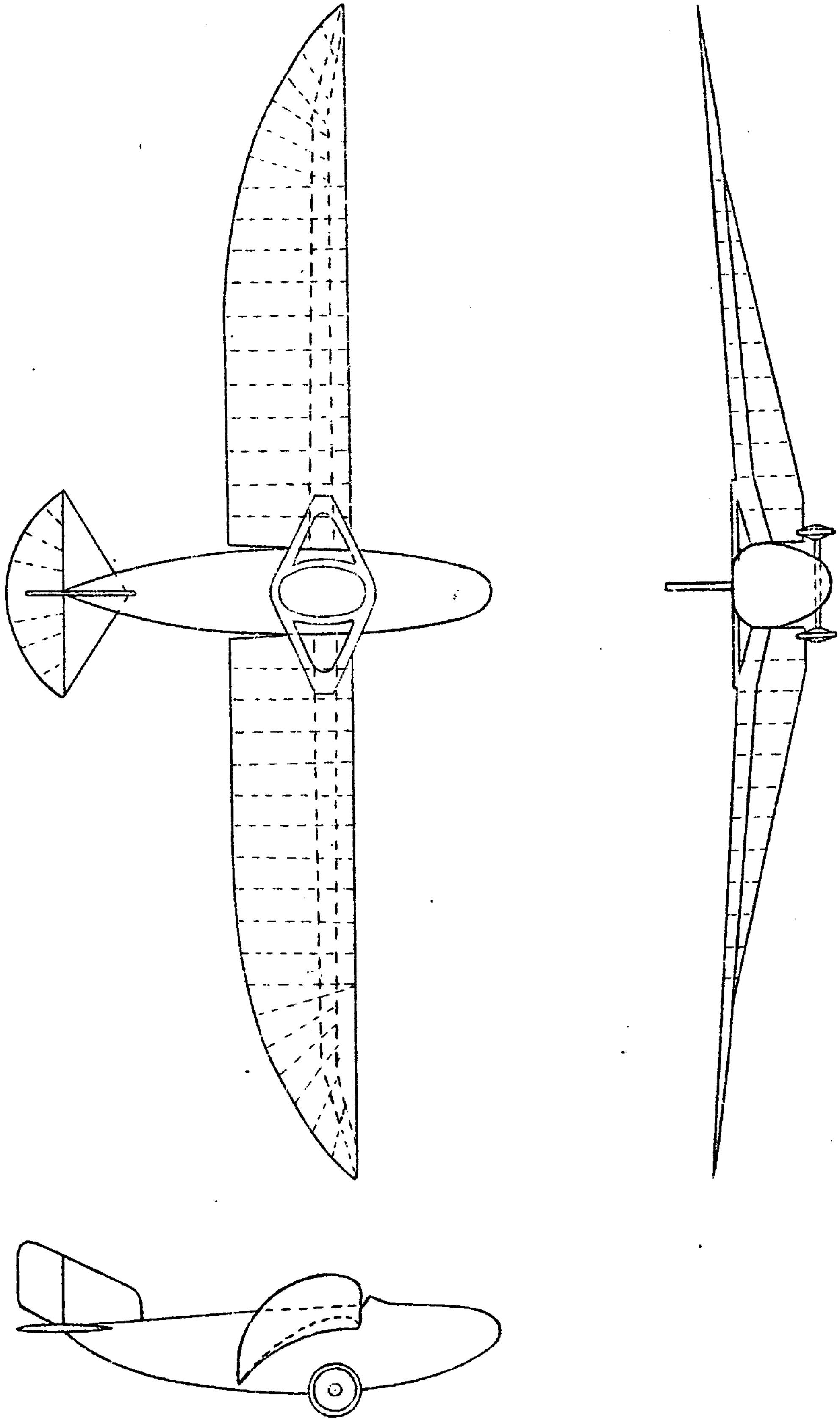

Magnan glider M-2

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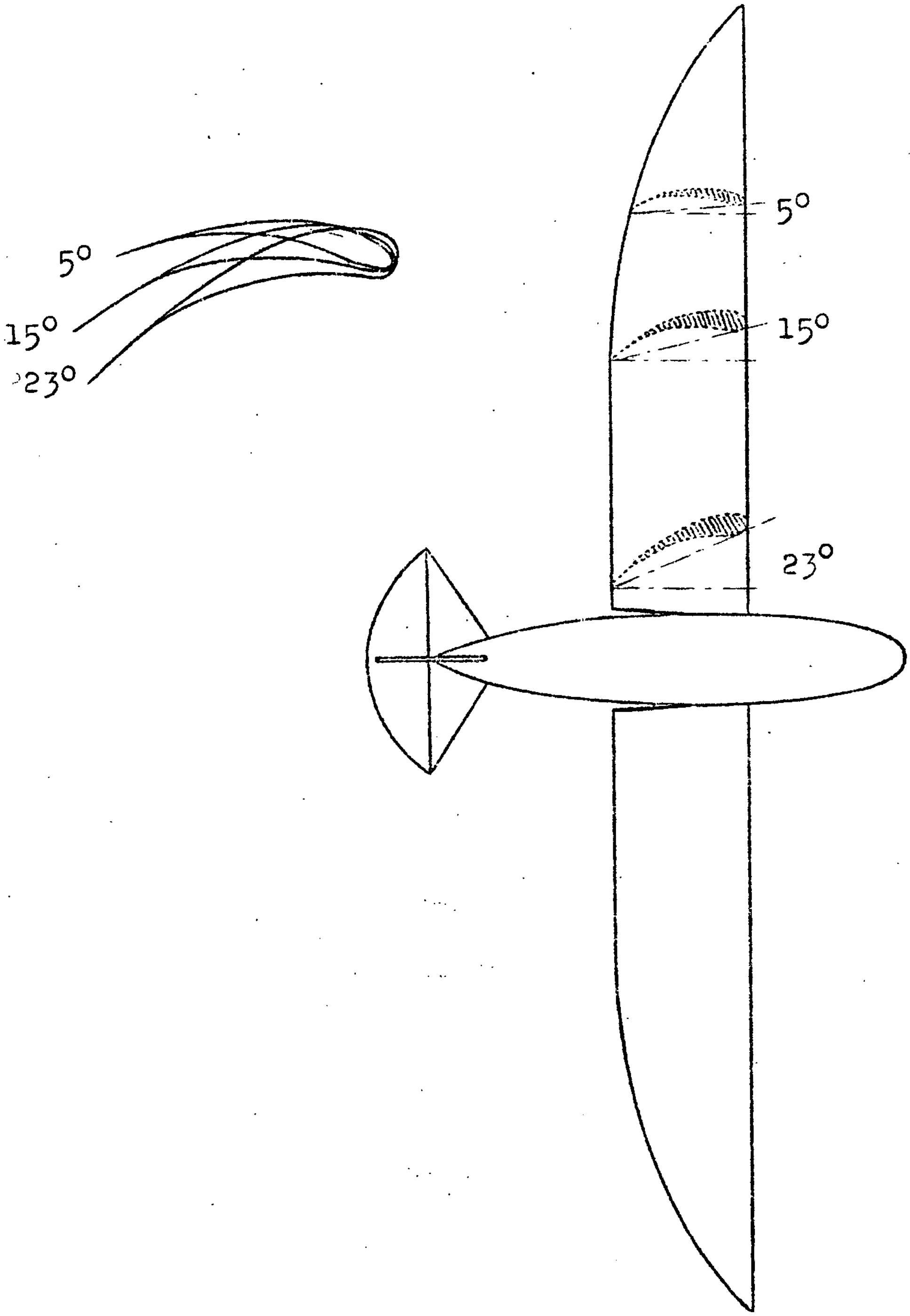
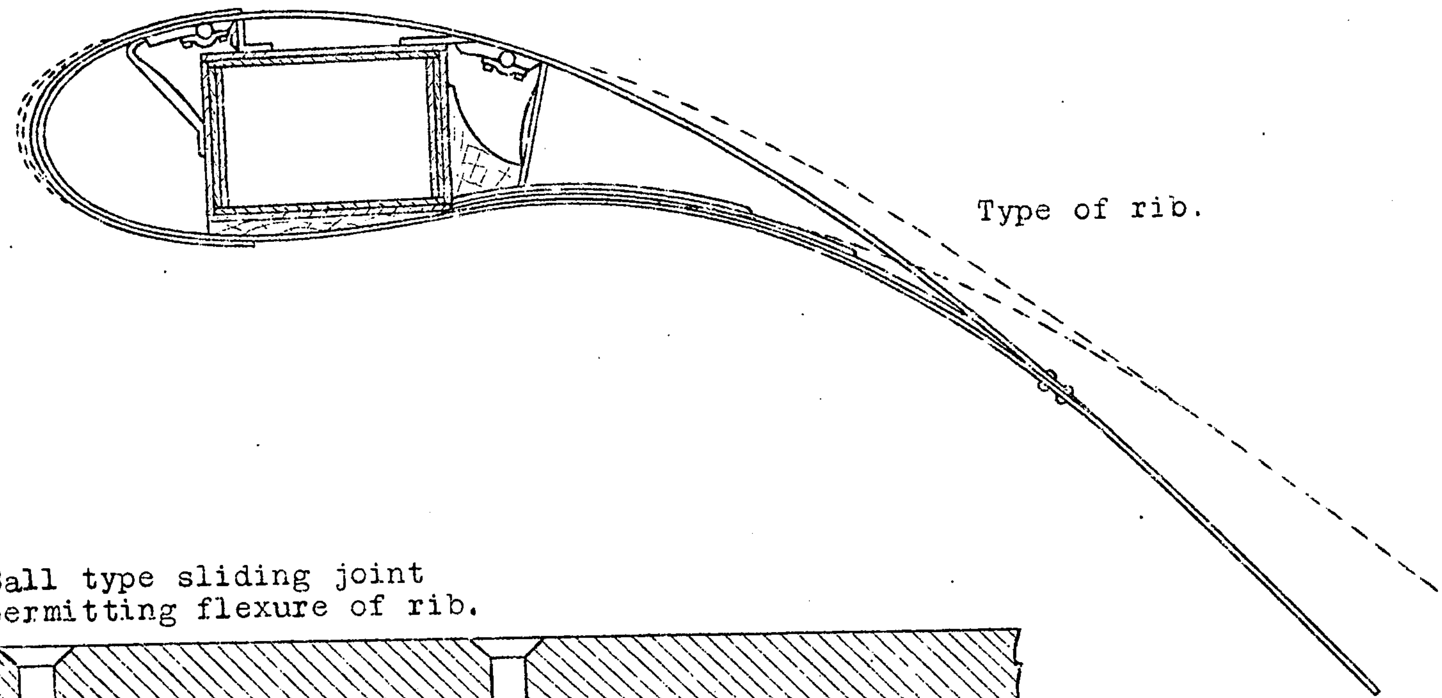
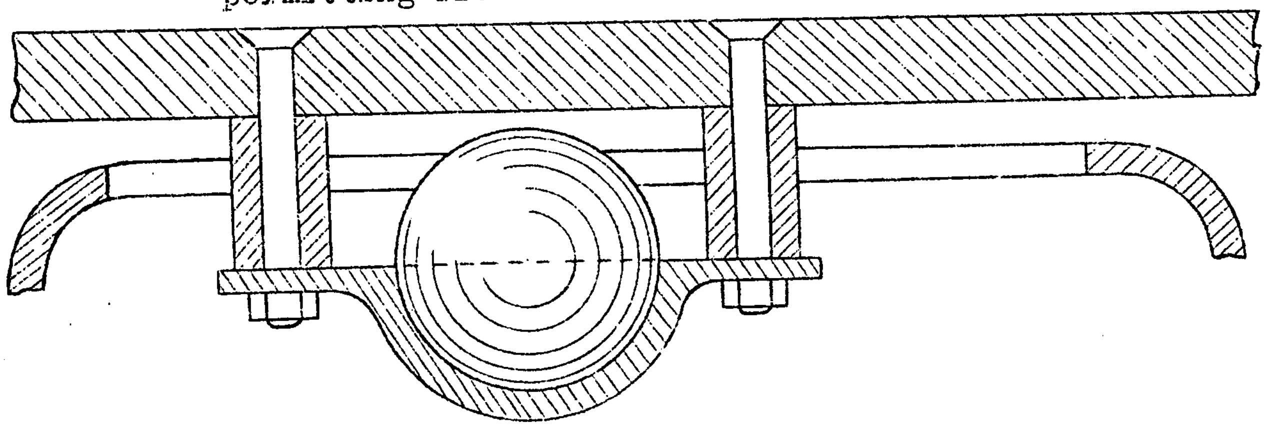


Plan showing angles of incident at three points of wing.



Type of rib.

Ball type sliding joint
permitting flexure of rib.



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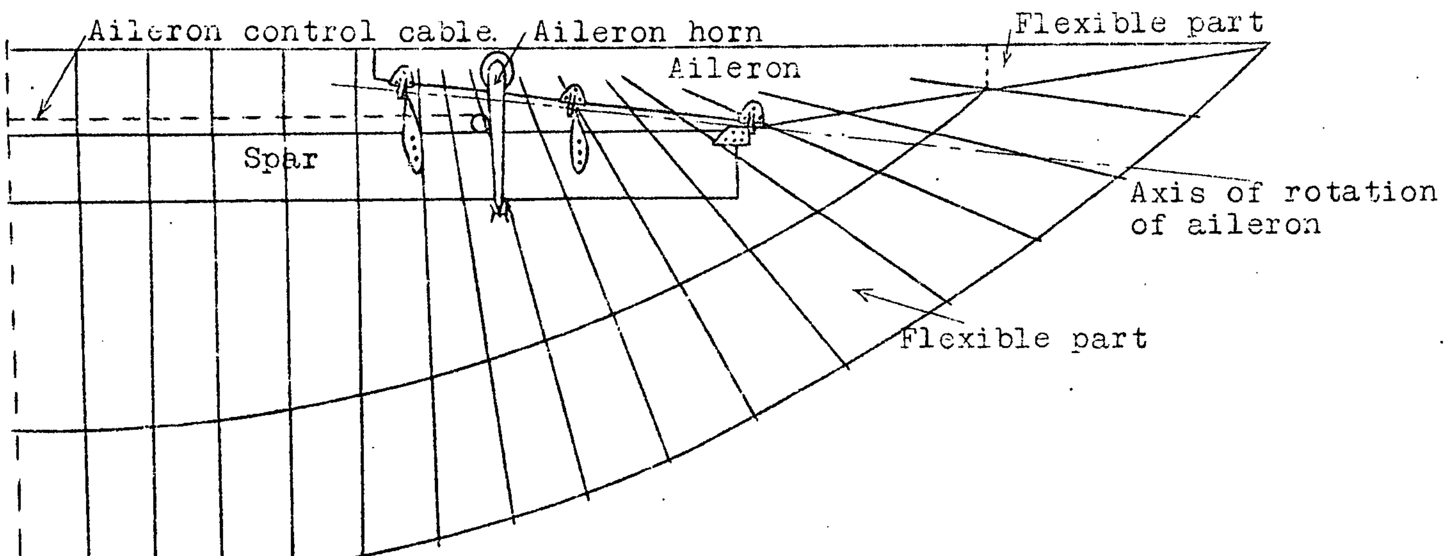
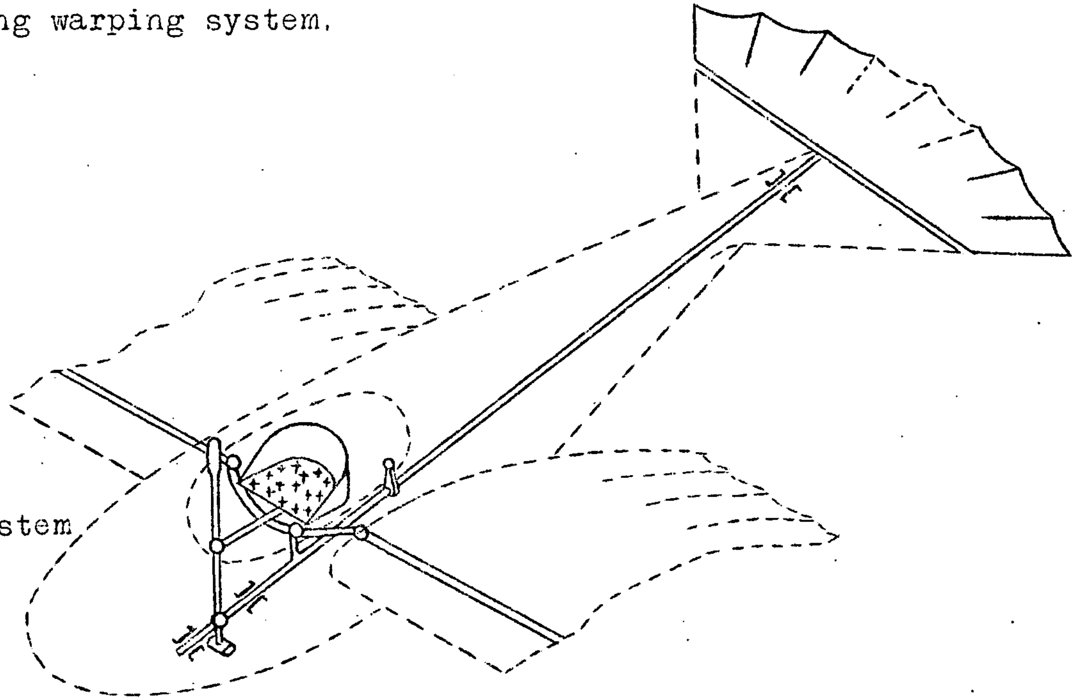


Wing warping system.



Control system