TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 289

TWO-SEAT LIGHT AIRPLANES

Which Participated in Contest Held at Lympne, England, Week of September 29 to October 4, 1924.

Taken from "Flight," Sept. 25, Oct. 2 and 9, and from "Aeroplane," Sept. 24, Oct. 1, 8 and 15, 1924.

Compiled by the National Advisory Committee for Aeronautics.

November, 1924.

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Which Participated in Contest Held at Lympne, England, Week of September 29 to October 4, 1924.*

The object of this competition was to produce an airplane suitable for school work.

Various prizes were awarded for the following qualifications:

Entry Qualifications

The airplane was first presented to the officials completely erected. It was then disassembled or folded in such a manner as to permit of it being completely transported in one journey over a distance of not more than 75 feet and placed in a shed 10 feet wide. The airplane was then removed from the shed and re-erected by two persons only, within a period of two hours.

A demonstration of dual control was then made. The pilot was required to make two flights, one from each seat, following the course of a figure eight, flown within the boundaries of the airport.

Speed Range

The greater portion of the prizes were awarded for this qualification, which was determined by the following formula:-

$$\text{Speed range } \% = \frac{\text{High speed} - \text{Low speed}}{\text{Low speed}} 100$$

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High speed not to be less than 60 M.P.H. and low speed not to exceed 45 M.P.H.

Take Off

This test required starting from a position of complete rest and clearing a barrier 25 feet high in the shortest possible distance, one award being made for every yard by which the distance was less than 450 yards,

Landing

In this test the airplane was required to cross a barrier 6 feet high and come to rest in the shortest distance from the barrier, one award being made for every yard less than 150 yards.

Reliability

Awards in this test were made to the airplanes flying the greatest number of circuits during the period of the competitions, the total mileage to be not less than 400. A further stipulation required that an airplane fly at least 10 hours during that period.

High and Low Speed

The high-speed test was conducted over a 12.5 mile triangular course in two separate flights of 75 miles each or 6 laps. An interval was allowed between the two flights for the taking on of gasoline and oil only.

The low-speed test was carried out over a straight course about 500 yards in length, and 25 yards in width, with red flags placed at intervals on both sides. The course was covered twice in each

direction at a constant height of not more than 20 feet; the average for the four flights represents the speed flown.

From an aerodynamical and structural point of view a majority of the airplanes were reasonably successful, most failures being chargeable to the engine; therefore, as a matter of due consideration there is given in this memorandum, data concerning all airplanes which made a favorable impression structurally and also as fliers.

The requirements of the engine, it developed, were rather severe, the "Cherub" being the only one to pass the gruelling test with any degree of satisfaction. It is predicted, however, that with another year of development an engine will be produced which may reasonably be expected to meet the requirements of the two-seat light airplane.

The official figures as to the success of the various airplanes, for the purpose of preliminary training or school work, are given individually preceding the structural description of the airplane.

Another Technical Memorandum is being prepared concerning low-powered or light airplanes of other European countries.

"Wee Bee I" Monoplane.

The "Wee Bee I" light airplane (two-seat high-wing monoplane) designed by Mr. W. S. Shackleton, after joining the W. Beardmore & Co., Ltd., is quite naturally similar to the A.N.E.C. monoplanes also designed by him. There are, however, some features which produce a very clean design, every effort having been made to eliminate, to a minimum, all projections which might adversely affect its performance.

The performance of this airplane given in the official statement is:

High speed 70.11 M.P.H.; Low speed 39.66 M.P.H.;

Speed range 76.77%; Take off 235 yards; Landing 124 yards;

Miles flown 737.5; Hours flown 11.

It is regarded as astonishingly efficient for a two-seater with an engine of 1096 cm^3 (66.88 cu.in.) displacement. Furthermore, the construction is simple, sturdy and comparatively inexpensive.

It is not strictly a cantilever monoplane as the wing is divided in the center with each wing braced by two parallel diagonal struts running from the lower longerons of the fuselage. Apart from this there is no external bracing anywhere, either for the tail plane or landing gear.

The cross-section of the fuselage has been reduced to the minimum and altogether a very effective attempt has been made to reach an aerodynamical perfection.

The fuselage is built of six spruce longerons with formers or bulkheads of spruce and three-ply, the whole being covered with a 1/16 inch birch three-ply. The deck, in cross-section, conforms approximately to the shape of a man's head and shoulders. The controls and instruments are of the usual type, and flying can be done from either seat.

The wings are of fairly orthodox construction in that they have two box-shape spars with three-ply walls. There is no internal nor external drag bracing of the usual type, this being accomplished by the three-ply covering which extends from the leading edge, back to the rear spar, in the length from the fuselage to the strut attachments and from the leading edge to the front spar in the length from attachments to wing tip.

The ailerons are of large aspect ratio and are hinged to a false spar or stringer. They are operated by cables to a T shape lever from which a push-pull rod runs to the aileron. The usual control pulleys are not employed.

The elevator is in one piece and is hinged at its upper edge. The central portion of its under surface is so shaped as to continue the streamline form of the fuselage at that point. A further advantage in this construction is that the elevator can be operated without the usual external crank lever or horn, there being a layshaft near the stern of the fuselage carrying crank arms, from one of which a push-and-pull tube runs to the projected under surface or edge of the elevator. Cables run from the cranks on the lay-

shaft to the controls in the cockpit. The triangular gap between the elevator and fuselage is covered with a duralumin flap making the under surface of the horizontal tail unit continuous.

The landing gear is of the simplest construction. The axle is of chrome nickel steel, designed for sufficient flexibility to absorb landing shocks. It is supported in trunnions, which allow it to bend freely. One trunnion is rigidly fixed to the axle so as to resist torque loads and to hold the axle in place laterally. The other trunnion takes "up" loads only and allows the axle to slide through laterally, thus providing the required freedom for spring action.

The mounting of the engine is rather ingenious. The top support consists of a pyramidal projecting frame of sheet duralumin while the bottom support consists of two longitudinal duralumin struts from which diagonal steel tube braces are run to the lower corners of the engine bulkhead. The engine can be removed by undoing four bolts and the fuel and oil connections.

See Fig. 1 for outline drawings, dimensions, areas and displacement of engine.

"Brownie" Monoplane.

The "Brownie" light airplane (two-seat, low-wing monoplane) was designed by Captain F. S. Barnwell, and two were entered by the Bristol Airplane Company, Ltd., known as Nos. 1 and 2. No. 2 is the first light airplane having an all-metal framework throughout.

No. 1 has a fuselage framework of metal, while the wings are of the usual wood construction. The construction of No. 2 is described, in detail, in this memorandum, being a departure from the usual method and perhaps a little more interesting at this time.

The airplane No. 1, however, with the usual wood and fabric structure, was the more successful, its performance, according to the official statement being:

High speed 65.19 M.P.H.; Low speed 38.73 M.P.H.; Speed range 68.33%; Take off 215 yards; Landing 102.6 yards; Miles flown 512.5; Time flown 10 hrs. 23 min. 40 sec. It is regarded as remarkably efficient and from the take-off and landing tests it is evident that the airplane can be operated from a very small field.

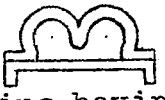
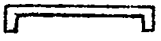
The longerons and struts of the fuselage structure consist of steel tubing, braced with piano wire and turnbuckles. Simple sleeves are sweated to the longerons and drilled through to receive the strut-end-fitting screws, the latter also passing through the eye-plate fittings for the brace wires.

The seats are of somewhat novel construction. A sheet of laterally corrugated duralumin is swung - hammock fashion - between the opposite sides of a rectangular light-gage, steel-tube frame. This frame is installed in an inclined position, one of the opposite sides being raised to form a back rest. The structure complete is held in shape by bearers constructed of three-ply with a spruce frame. The corrugated seat is equipped with an air cushion.

At the point of attachment for the wings, wood bulkheads, con-

sisting of three-ply sides mounted on a frame, are used with a plain pin joint at the bottom and an adjustable joint at the top of each spar. The fork-head bolt of the latter screws into a castellated nut which in turn screws into a heavy steel fitting. The threads of the nut are of different pitch, thus affording a very fine adjustment for the dihedral angle.

The wings of No. 1 airplane are built of spruce and plywood box spars with spruce girder-type ribs. The compression ribs are reinforced by a built-up structure with the stays running horizontally and vertically. The drag bracing is doubled in each bay, one set of wires being at the top and the other at the bottom of the spars.

The wings of No. 2 have steel spars and duralumin ribs. The flanges of the spars are uniform in cross-section  for the main portion of the span, the approach to the tips having the bottom  section only.

The web of the spar consists of a continuous length of steel tubing (approx. 1 3/4" dia.) bent in the form of a Warren truss and flattened at the bends, at which point it is riveted to the flanges. The ribs are a very simple truss girder built of duralumin channel sections.

Fabric is used as the covering throughout for both airplanes.

Instead of the usual positive controls, the ailerons are held down by rubber cords with the proper tension, the object being to obtain an automatic variable camber which will approach, and finally

coincide with the normal camber as the airspeed increases.

The stabilizer, elevator, fin and rudder have a metal framework, with the more orthodox shape. The elevator is operated through a layshaft, the cranks of which can be seen projecting above the fuselage deck. The inclined position of the rudder post places the pull on the rudder cables at right angles to the post, thus avoiding a sidewise pull on the horns.

The engine is mounted on four steel struts projecting from the front bulkhead of the fuselage. These struts are unbraced and the somewhat lack of rigidity protects the fuselage from engine vibrations. The engine is very accessible and easily removed.

The gasoline and oil tanks are installed above and behind the front bulkhead, giving sufficient head for a gravity feed.

Fig. 2 contains the outline drawings with dimensions, areas and displacement of engine.

"Cygnet" Biplanes.

The "Cygnet" light airplanes (two-seat biplane) two in number designated Nos. 1 and 2, were built and entered by the H. G. Hawker Engineering Co., Ltd., and were received with a great deal of interest. Their performance, according to the official figures, using the best result attained by either airplane, was:

Low speed 37.42 M.P.H.; Take off 250 yards; Landing 66.7 yards; Miles flown 475; Time flown 10 hrs. 24 min. 40 sec.

An unofficial figure credits No. 2 with a high speed of 75 M.P.H.

The take off and landing performances were probably the best of the meeting. The efficiency of the controls was excellent, as shown in the exhibition of "crazy" flying while the surplus power was very much in evidence.

In the design and construction of these airplanes every effort was made to attain extreme lightness. Literally, not one ounce of unnecessary weight was allowed to remain in the structure and as a result they were the lightest of all the airplanes at the meeting.

The weight empty, i.e., complete with engine, but without pilot, passenger, gasoline and oil is only 373 lb. Without the engine the structure weighs about 270 lb. The total weight loaded is only 730 lb.

A girder construction is followed in the fuselage structure, consisting of four longerons routed out to an X section and braced in the form of a Warren truss with diagonal struts of the same cross-section. The struts are attached to the longerons by three-ply gusset plates, partly riveted through and partly screwed, instead of the usual metal fittings. This structure eliminates distortion and the necessary re-truing-up.

The deck is cambered and consists of thin stringers of wedge-shape cross-section supported by a light arch-shape former of three-ply. The covering is of fabric.

The wings are built of box spars of the usual construction with spruce ribs, the latter being of a Warren truss construction similar to the fuselage, except that the flanges and ties are of square in-

stead of X cross-section. The box spars are wrapped with fabric. The central section of the top wing is supported on four steel struts with wood fairing, while the bottom wings are attached to short wing roots built from the bottom edge of the fuselage.

In the provisions made for the folding of the wings, a light temporary strut is fitted between the front spars of the top and bottom wings.

The inter-plane struts are of spruce, and are of the I shape design. They are installed at a considerable incline as seen in the front view.

In order to attain a low landing speed, a variable camber wing flap adjustment is used. The ailerons run the whole length of the wing and are pulled down simultaneously, the differential action still being retained. This is accomplished in the support of the longitudinal rocking shaft bearings, the support for the fore end bearing being hinged, while that for the aft bearing is mounted at the top of a worm gear and can be raised or lowered.

In the raising, the lower cables are pulled in while the upper are paid out, the ailerons thus being pulled down simultaneously.

The landing gear is of the simple vee construction, with plain rubber cord shock absorbers.

The tail unit consists of a stabilizer, elevator and balanced rudder.

The engine is mounted on very light supports extending from the bulkhead installed about a foot back of the nose of the stream-

lined cowling.

The gasoline and oil tanks are installed in the deck fairing immediately back of the engine bulkhead.

The workmanship evidenced in this airplane is of a very high order of excellence.

The outline drawings, dimensions, areas and engine capacity are given in Fig. 3.

"Avis" Biplane.

The "Avis" light airplane (two-seat biplane) entered by A. V. Roe & Co., Ltd., as two separate airplanes, was in reality but one airplane, designed for either the "Cherub" or the "Blackburn" radial engines. The Avro style is generally apparent, while many novel and interesting features occur, especially in the wing bracing structure.

As to its performance, the only figure available refers to the 100 mile race, at which time it is said to have reached a speed of 65 M.P.H.

In design and performance it is probably similar to the Cygnet. Its maneuverability is unquestionably good and there is little doubt as to its practical utility, if sufficiently powered.

The fuselage structure is similar to that of last year's Avro, the longerons being square in cross-section with Warren girder strut bracing, secured by three-ply gusset plates. This form of construction seems to be growing popular for light airplanes, as it avoids the necessity of truing up after hard usage. The deck is

made of three-ply and the entire fuselage is covered with fabric.

The wings, in profile, are thin and are constructed of I section spars and Warren girder ribs. The drag bracing is of piano wire, but an unusual feature is found in this bracing close to the I strut attachment. From about the center of the strut, or rather the special rib under the foot of the strut, diagonal stays are run to both front and rear spars. Where the struts meet the spars, a fore-and-aft tie rod is installed in the position usually occupied by the compression member of the drag bracing. The stresses are transmitted evenly to the front and rear spars and the result is extra stiffness in the structure.

The lift wires are attached to the fuselage at a point between the spar attachments. The inner rib is also attached at this point, thus providing three instead of two supports for the rib. The lift and drag wires are in duplicate placed very closely together. The peculiar bracing arrangement, while making folding a little more difficult on account of the extra supporting wire needed in the folded position, should save a fair amount of head resistance and aside from the monoplane or cantilever construction it would be difficult to imagine a cleaner design.

The top center section has tubular spars and struts and the usual wood ribs. In order to give access to the front cockpit the struts are arranged in two vees as shown in the drawing.

The ailerons run the entire length of the wings, and have a large duralumin tube, in the leading edge, which serves as a torque

tube operated by cranks at the inner end. Differential action is provided for the ailerons with an additional feature for depressing all ailerons simultaneously. The control-shaft ball bearing, near the aileron hinge, is mounted at the top of a worm gear which is turned by a sprocket chain from the cockpit thereby raising both aileron levers, which action depresses the ailerons. The differential action is still retained. The ailerons in the top wing are operated by struts from the lower ailerons.

The controls are of the usual type, but owing to the great angle at which a short foot bar, of a narrow fuselage, must be operated the stirrup mechanism is such as to keep the stirrups at right angles to the center line of the fuselage.

The landing gear provides ample deflection, the front diagonal struts acting as radii rods for the axle. The lateral bracing occurs between these struts only.

The outline drawings, dimensions, areas and engine capacity are given in Fig. 4.

"Pixie IIIa" Biplane.

The "Pixie IIIa" light airplanes (two-seat biplane) two in number, entered by George Parnall & Co., are identical except that by removing the top wing one becomes a monoplane. This is very easily done.

The performance of the biplane is given in the official figures as:

Low speed 37.22 M.P.H.; Take off 301 yards; Landing 70 yards;

Miles flown 450; Time flown 10 hrs. 4 min. 38 sec.

This airplane is also considered very efficient, the monoplane however, appearing to be the better all-round airplane. Engine trouble, no doubt, interfered with the biplanes showing their real capabilities, but there seems to be no question as to controllability or reserve power while the engines are functioning properly.

The monoplane (III) seems to be a little too fast and lively on controls for elementary training.

The fuselage consists of four longerons braced by triangulating struts attached by three-ply gusset plates. This provides a very light structure and one that does not require truing up once it has left the stocks. The stern of the fuselage terminates in a vertical knife-edge formed by a channel-section metal strip. The short elevator control tube passes through an opening in this strip, from the arms of the short layshaft inside the fuselage.

The spars of the bottom wing are of box section with narrow strips screwed to the outside of the flanges, on which rest the three-ply webs of the ribs, thus relieving the flanges of shear loads.

The spars run parallel from the fuselage to the ailerons at which point the rear spar is equipped with a pin-joint which permits it to turn abruptly and approach the front spar joining it at the wing tip. This was a feature in last year's single-seat monoplane and was chosen as giving a torsionally stiff structure.

The rib flanges, incidentally, are of the divided type over the

leading edge, the webs rising to the full depth of the wing section. Tie-rod drag bracing is employed, and the lift struts are attached to the tubular drag struts instead of to the spar flanges as is usually done. This method avoids all torsional stresses on the spars and since the lift strut fittings are placed close to the spars the tubular drag struts are not subjected to bending loads but merely to shear.

The pin joints at the wing roots are placed on the lower flanges of the spars instead of at the neutral axis. The front joint is universal and permits the folding of the wings along the fuselage with the trailing edge in an upward direction.

The landing gear consists of two legs of steel tubing which run through the floor and up to the top longerons, where their ends are securely anchored. There are no lateral or fore and aft bracing, the legs and axle being all cantilever. Steel springs and a pneumatic shock absorber is installed, providing a fair amount of travel, so that with the telescopic movement of the tubes the required deflection is obtained.

The tail skid consists simply of three pieces of Malacca cane, each forming a 120 degree sector, glued and taped together. It is extremely light and should be very durable.

Most of the foregoing description applies equally well to the biplane which is practically a monoplane with a smaller top wing added. This additional structure consists of a cabane of steel tubing and two inclined N struts to which the top wing is attached.

As will be seen from the drawings this wing is of smaller span than the bottom and is without ailerons. It is also thinner and tapers both in chord and ordinate from the plane of symmetry toward the tip. It has two I section spars of spruce with three-ply webs and the ribs generally are similar in construction to those of the lower wing.

Fig. 5 contains the outline drawings, dimensions, areas and engine displacements.

"Wood Pigeon" Biplane.

The "Wood Pigeon" light airplane (two-seat biplane) built and entered by the Westland Aircraft Works, is in outward appearance a normal single-bay tractor biplane but when observed closely in detail, many new and valuable features are found in the structure.

The extent of its success in the competition is given in the official figures as:

Miles flown 125; Time flown 2 hrs. 31 min. 37 sec.

It is beautifully built and finished and if either lightened or equipped with a little more wing surface should perform very well.

The fuselage is of the normal type with wire bracing in the rear portion, but with triangulated construction in front.

Access to the cockpit is facilitated by the special strut arrangement and the hinging of the rear portion of the upper wing. There is no fixed center wing section.

The wings are of the usual construction as regards the spars and ribs, but a very unusual attachment is provided at the fuselage,

where the front strut, adjacent to the fuselage, meets the front spar of the bottom wing. At this junction a special rack and pinion is used by which the spar, strut and fuselage are all united or by which, when folding the wings, the spar alone is disconnected from the fuselage. The top end of the strut is equipped with a plain forked end for the eye-bolt attachment. All struts are of steel tubing with suitable fairing.

The ailerons are equipped with mechanism which can function as an automatic or as a mechanically operated variable camber device. In normal flight the movement of the ailerons is automatic, but should flight conditions require a greater camber than is automatically provided, it could be obtained quickly through the use of the mechanically, or hand-operated mechanism. A description or sketching of this device is not permissible at this time.

Two types of landing gears were designed for this airplane, one having frictional devices incorporated in telescopic legs and the other a pneumatic type shock absorber. The latter was used in the competing airplane.

The engine is mounted on a frame-like structure consisting of steel tubing and gusset plates. The ends of the tubes are filled with aluminum, and are slotted to receive the plates which are attached with bolts and rivets, thus providing a very rigid structure.

The outline drawings with dimensions, areas, and engine capacity are given in Fig. 6.

"A.N.E.C. II" Monoplane.

The "A.N.E.C. II" light airplane (two-seat high-wing monoplane) designed by Mr. W. S. Shackleton, was built and entered by the Air Navigation and Engineering Co., Ltd.

The failure of this airplane to qualify in the elimination tests was entirely due to the fact that it was equipped with a propeller unsuited for taking off under unfavorable conditions with full load. It flew excellently after the propeller had been changed and its lack of success reflects no discredit on either the design or the construction.

This airplane is similar to last year's single-seat monoplane which made such a remarkable showing in the single-seat competition.

The same form of fuselage construction has been employed and the general shape of the fuselage is also very similar. The pilot's view, however, has been improved, partly by making the deck of the fuselage narrower and also by using a different arrangement of the wing attachment. A slender framework of spruce forms the fuselage skeleton and a three-ply covering provides the bracing.

The wing structure differs from last year's single-seater, in that the orthodox two-box spar with spruce flanges and three-ply walls have been used instead of one triangular-shaped box spar. Lattice ribs of spruce and three-ply are used, and the structure is further strengthened against torsion by being covered with three-ply from the leading edge back to the rear spar on the lower sur-

face and back to the front spar on the top. The fabric is put on at an angle of 45 degrees in order to further stiffen the wing against twisting loads.

The wing is in halves, the roots being bolted to strong bulkheads in the fuselage, and is braced by a pair of diagonal struts on each side, one of each pair being provided with an incidence adjustment.

The ailerons are hinged at their lower edge, with the return cable passing direct from the upper edge of the aileron, avoiding the use of external cranks or horns on the upper surface of the wing.

The stabilizer and fin are of somewhat unusual design, the former being built into the end of the fuselage rather than resting on top of it, while the latter is in two pieces joined with dowel pins which serve to bring alignment and support against shearing loads.

The elevator is in one piece and is hinged at its upper edge only. The central portion of its under surface is so shaped as to continue the streamline form of the fuselage at that point. A further advantage in this feature is that the elevator can be operated without an external crank lever or horn, there being a layshaft near the stern of the fuselage carrying the usual crank arms, from one of which a push-and-pull tube runs to the central lowered surface of the elevator. Cables run from the cranks on the layshaft to the controls in the cockpit.

The landing gear is of the simplest construction, consisting

of a single high-tension steel tube, so mounted on the lower longerons that it cannot turn or twist. It is bent in the middle and extends slightly downward as it projects from the fuselage sides. The flexure of the tube axle and the tires provide the only spring action.

The fuel tank is installed under the deck fairing immediately aft of the fireproof bulkhead.

Fig. 7 contains the outline drawings, dimensions, areas and engine data.

"Cranwell II" Biplane.

The "Cranwell II" light airplane (two seat biplane) designed by Lieut. Comper and entered by the Cranwell Light Aeroplane Club, represents a very successful effort on the part of a number of enthusiastic amateurs to produce an airplane, at a low cost, which will meet the requirements for school work.

Its success in the competition is shown in the official figures as: Time in the air 17 hrs. 53 min. 18 sec.; Miles flown 762.5. Winner of the prize for distance flown. In the landing test it ranked next to the "Brownie."

This airplane as seen from the outline drawings is a typical biplane and the only unusual feature, in an airplane of its size, is found in the side-by-side seating of the occupants. This arrangement, although necessitating a rather wide fuselage, which has a detrimental effect on the airplane's performance by increasing the drag or head resistance, is considered very suitable for the giving

of preliminary instructions in school work.

The fuselage is the usual wood-girder structure, with wire bracing, flat sides and bottom but with a cambered deck of thin stringers on built-up formers.

The cockpit is fairly roomy. The two foot bars are side by side and have a connecting cable going over a pulley and kept taut by a spring. Two control sticks are provided and are connected together by a transverse bar above the forked ends.

The struts of the landing gear on each side are made in one piece from multi-ply wood in the form of a complete V with its apex so shaped as to give the required support for the rubber cords and freedom for the axle.

The wings are of the usual design with I section spruce spars. No provision has been made for the folding of the wings, the designer intending that the wings should be hung at the fuselage side in the transportation tests. The assembling is a comparatively simple process.

The engine is mounted on a very small engine bulkhead, the four longerons converging rather sharply toward the front, with about two feet of the nose of fuselage butt-jointed to the main portion so in case a more powerful engine is required later, a stronger nose structure could be installed.

The gasoline tank is mounted in the central section of the upper wing, thus providing ample head for direct gravity feed.

The outline drawings with dimensions, areas, and engine displacement are given in Fig. 8.

"Sparrow" Biplane.

The "Sparrow" light airplane (two-seat biplane) designed by Mr. Mitchell and entered by the Supermarine Aviation Works, was forced to make about nineteen landings on account of the engine before the competition began and possibly an equal number during the meeting but at no time did any damage occur to the airplane. This speaks well for its robustness and its controllability.

It did not participate in the contest, no doubt on account of this handicap but, according to accounts, it responded to controls and flew excellently. In one landing with its engine stopped, it is reported to have literally maneuvered between other airplanes in a pronounced zigzag flight and yet made a perfect landing.

The fuselage has a flat bottom and sides of plywood with a cambered deck. The longerons are not horizontal throughout but take an upward direction beginning abruptly at a point behind the rear cockpit and extending to the stern post, the purpose being, of course, to give the wings a greater angle of attack in the take-off. This feature with the variable camber furnished by the aileron gear adjustment enabled this airplane to take off, fly and land at low speed very successfully during the meet. Except for the shape of the longerons the fuselage structure conforms to the usual type.

The wing structure is also quite in accordance with the usual construction. The spruce spars are of I section, and the ribs of standard design. The drag bracing consists of piano wire with compression ribs of special reinforced construction. Both wings have

wing-length ailerons. Those of the lower wings are operated by cables and cranks direct, this operation being transmitted to the ailerons of the upper wings by struts. The ailerons, as previously referred to, are used for varying the wing camber, the method of operation being very simple. A short column, similar to the control stick, is mounted on the longitudinal rocking shaft carrying the latter. The cockpit ends of the control cables are attached to a short vertically movable yoke on the short column. This yoke has an internal thread engaging with a vertical worm which terminates on the top of this column, at which point a hand wheel is provided. By turning this wheel the yoke is raised or lowered, thereby drawing in or paying out the cables. A link of shock-absorber cord provides the required flexibility in the cable necessary on account of variation in length.

The landing gear consists of the usual struts in V formation, the front struts being telescopic while its lower tube is slotted to permit movement of the crutches at the end of the upper tubes. The crutches are covered with leather gaiters over which is wound the rubber shock-absorber cord. The axle is enclosed in a streamline fairing.

The gasoline tank is installed in the deck fairing and provides direct gravity feed.

The three-cylinder engine is cowled-in very neatly with the tops of the cylinders projecting in the usual way.

This airplane generally is a substantial straightforward struc-

ture with several very sound ideas and but few experimental features.

The view from the cockpit is exceptionally good.

Fig. 9 contains the outline drawings, dimensions, areas and engine displacement.

"Vagabond" Biplane.

The "Vagabond" light airplane (two-seat biplane) designed by Mr. Rex Pierson and entered by the Vickers Ltd., is distinct from other competing airplanes in the construction of the fuselage.

The entire airplane is exceptionally well made but the construction and design is probably too expensive and perhaps impractical for preliminary training purposes.

Engine mounting difficulties interfered with its participation in the competition to any extent but it was quite obvious that its performance would have been satisfactory.

No data is available as to its characteristics or success in any of the entries.

The construction of the fuselage, as referred to, is a peculiar feature. The main framework consists of solid spruce longerons and struts, of cruciform section, braced by tie-rods from duralumin fittings which straddle the longerons, the fittings being held in place by wood screws. This framework, in both width and height, is smaller than the fuselage outline, therefore in order to obtain the pleasing shape, as shown in the drawing, the top and bottom is built up separately of light material and, in width, extends beyond

the vertical sides of the frame so that the fabric does not touch the longerons. This method provides a particularly smooth surface but necessitates considerable care in handling on the ground, to avoid damage, as the usual substantial hand-holds of the longerons are not provided.

A most unusual construction occurs in the same structure. The rear portion of the fuselage telescopes slightly into the central or cockpit portion and is hinged at the lower longerons. The top longerons are equipped with worm gears which can be operated from either cockpit, the effect of which is to shorten the top longerons, bending the fuselage, thereby raising the tail unit in relation to the wings. This operation, it will be readily seen, gives the wings a greater angle of attack for taking off or landing and provides another method by which trimming and the effect of variable camber is accomplished.

The wings are of normal construction with spruce I section spars and N formation ribs. Drag bracing is done with tie-rods. The interplane struts are of spruce with steel-end fittings. The angular elevation of the wings, in the folded position, has been reduced by hinging the top wing some distance aft of the rear spar by using a specially reinforced three-ply box extension. The bottom wing is hinged at the rear spar.

In the process of folding, a small portion of the trailing edge of the top wing is first raised while the wing flaps and ailerons of the lower wings are folded, in order to provide the necessary clearance.

The landing gear is of the plain V type with rubber cord shock absorbers. The wheels have ash rims and double-diagonal-grain mahogany sides which are so shaped as to offer the least possible head resistance or drag.

The usual outline drawings with dimensions, areas and engine displacement are given in Fig. 10.

"Satellite" Monoplane.

The "Satellite" light airplane (two-seat monoplane) an exceptionally pretty design entered by the Short Brothers, is neither a high nor a low wing type, the wings being considered perhaps, as in a neutral position.

In regard to its performance, an unofficial figure concerning the 100-mile race, places it as seventh.

Lightly loaded it flew and responded to controls excellently but with the load required under the regular two-seater competition it was found to be hopelessly under-powered, the excessive weight occasioned by the use of all metal in the fuselage structure being too great a handicap.

The fuselage structure follows the principles now being used in boat hull construction, the skin or covering serving as part of the stress-resisting structure. Duralumin is used as the covering and is attached in short panels which are wrapped around the elliptically shaped fuselage, and attached to L section rings or formers placed in a transverse vertical plane. At the nose of the fuselage where

the shape approaches a spherical form the panels of duralumin are narrower as shown in the drawing. In order to stiffen the panels against compression loads V section stringers are riveted to the skin between the rings or formers. These stringers are not continuous as in a boat but are separated at the formers, which interruption, contrary to expectations, does not diminish the stiffness of the structure, the curvature of the fuselage, no doubt, contributing in this respect.

The external surface of this fuselage is exceptionally free from projections and bracing and although the structure is not as light as it might be, the system is probably worth considering in future developments concerning larger airplanes.

The wings have wood spars with laminated flanges and three-ply webs. The ribs are made of duralumin built in the form of a Warren girder. Strong frames are built in the fuselage for supporting the wings which are attached by fish plates and large-diameter hinge pins, the latter also serving to facilitate dismantling.

The ailerons extend the whole length of the wing and are operated by torsional tubes and rods. Mechanism for depressing the ailerons and imparting a differential action, is also provided.

The landing gear is the usual vee type with rubber shock absorbers, in the form of compression blocks installed in the front legs. These legs and the axle are enclosed in streamlined casings.

The engine mounting is particularly neat and light, consisting of an aluminum alloy casting to which the engine is bolted, and

which also provides a structure for resisting torque loads. Four diagonal tubes are run from the crown of the casting to the rim of the fireproof bulkhead, serving as a support for direct loads.

The gasoline tanks are mounted aft of the bulkhead in such a position as to provide a gravity feed.

An excellent view is afforded from the front cockpit.

Fig. 11 contains the outline drawings, dimensions, areas and engine displacement.

The following two light airplanes made a very favorable impression at the meet but did not take part in the contests, one having failed to arrive on time on account of engine troubles, while the other was compelled to withdraw on account of damage resulting from a crash in its first flight.

Both were regarded as of excellent design and construction and it was generally regretted that their elimination was caused in this way.

As a matter of interest or possible benefit to designers a detail description of these airplanes is given herein.

"Bluebird" Biplane.

The "Bluebird" light airplane (two-seat biplane) built and entered by the Blackburn Aeroplane & Motor Co., Ltd., represents an effort to provide an airplane containing such features as are considered desirable for school work. The side-by-side seating of the occupants is certainly convenient for this purpose and furthermore,

as a private "fly-about" this arrangement would greatly facilitate conversation. Moreover, trimming is not necessary when making solo flights. Unfortunately, the occasioned width of the fuselage, with the consequent increase in cross-section, increases the drag considerably in this case.

This airplane also has a very pleasing appearance and a substantial structure.

The fuselage is built in two separate sections, the front portion being plywood covered with rounded corners, while the rear has the usual longerons, stays and wire bracing.

The cockpit is provided with a door on each side, made necessary by the continuation of a narrow strip of the deck fairing across the top of the cockpit. A small wind shield is placed in front of each occupant.

The wings are of orthodox construction with spruce spars and ribs, the latter being of the Warren girder type and very light (5 oz. each). The drag struts are of duralumin tubing and the drag bracing of tie-rods.

The interplane struts are also of duralumin tubing, fitted into duralumin sockets and taper pins.

All central surfaces are of large area, giving good maneuverability, a very necessary feature when close to a stalling angle or when flying at low speed near the ground.

Dual controls are fitted, the rudder operating foot-bars having a parallel movement but the elevator and ailerons are operated

by a single control stick centrally located. This stick can be readily adapted to either branch control or plain knob.

The landing gear is the simple V type, the struts being vertical in the front view, made possible by the wide fuselage. The shock absorbing gear consists of telescoping tubes, containing rubber blocks which work in compression, with mechanism for snubbing.

The engine is mounted on triangulating tubes with a fireproof bulkhead between the engine and the cockpit.

It might be mentioned that a more powerful engine can be used in this airplane since the structure has been designed to sustain larger engine vibrations.

The gasoline tank is installed in the central portion of the top wing conforming to the wing profile.

Fig. 12 contains the outline drawing, dimensions, areas and engine displacement.

"Widgeon" Monoplane.

The "Widgeon" light airplane (two-seat parasol monoplane) built and entered by the Westland Aircraft Works, was received with a great deal of interest. In appearance it was distinctly pleasing and the favorable report from the pilot regarding its performance leads to the conclusion that this type of construction may merit further consideration.

In comparison with other airplanes, it is very unorthodox, not only structurally but aerodynamically.

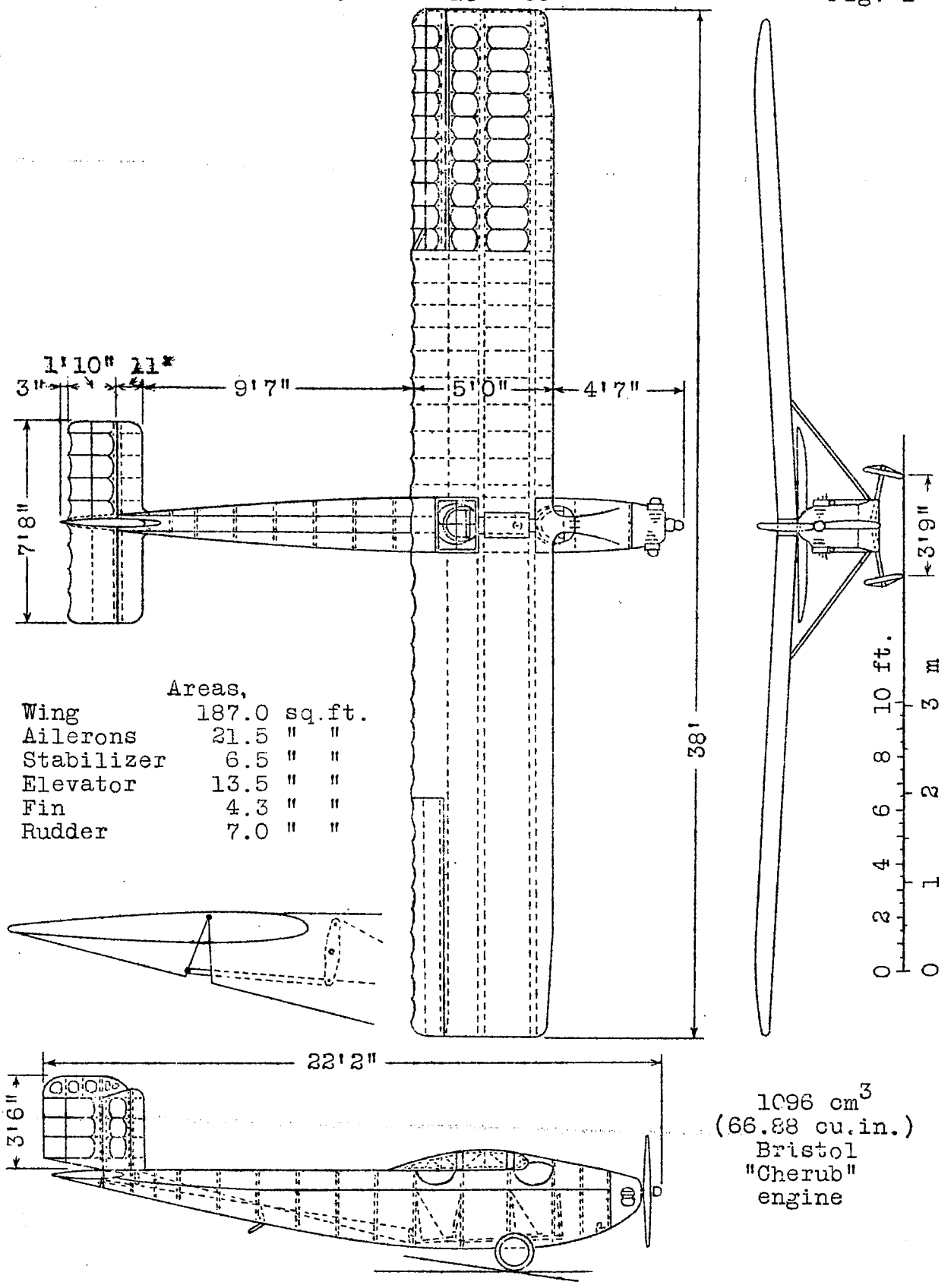
The fuselage structure is similar to that of the "Wood Pigeon," the usual girder, braced by piano wire and tightened with turnbuckles, being used. The sides and bottom are flat but the deck is cambered.

The monoplane wing is tapered in both chord and thickness toward the tips and plane of symmetry, beginning at the strut attachments. Structurally, the wings are of interest on account of the unusual spar construction.

Instead of I section or box spars, the web of the spars is of three-ply wood, cut out to form a succession of X's and reinforced with strips of rectangular cross-section. In conforming to the letter X one strip runs with constant cross-section from one flange of the spar to the other, while the other strip is in two pieces. This arrangement is reversed on the other side of the three-ply web. The flanges are in halves attached on each side of the web, the latter extending from top to bottom of spar.

The outline drawing, dimensions, areas and engine displacement is given in Fig. 13.

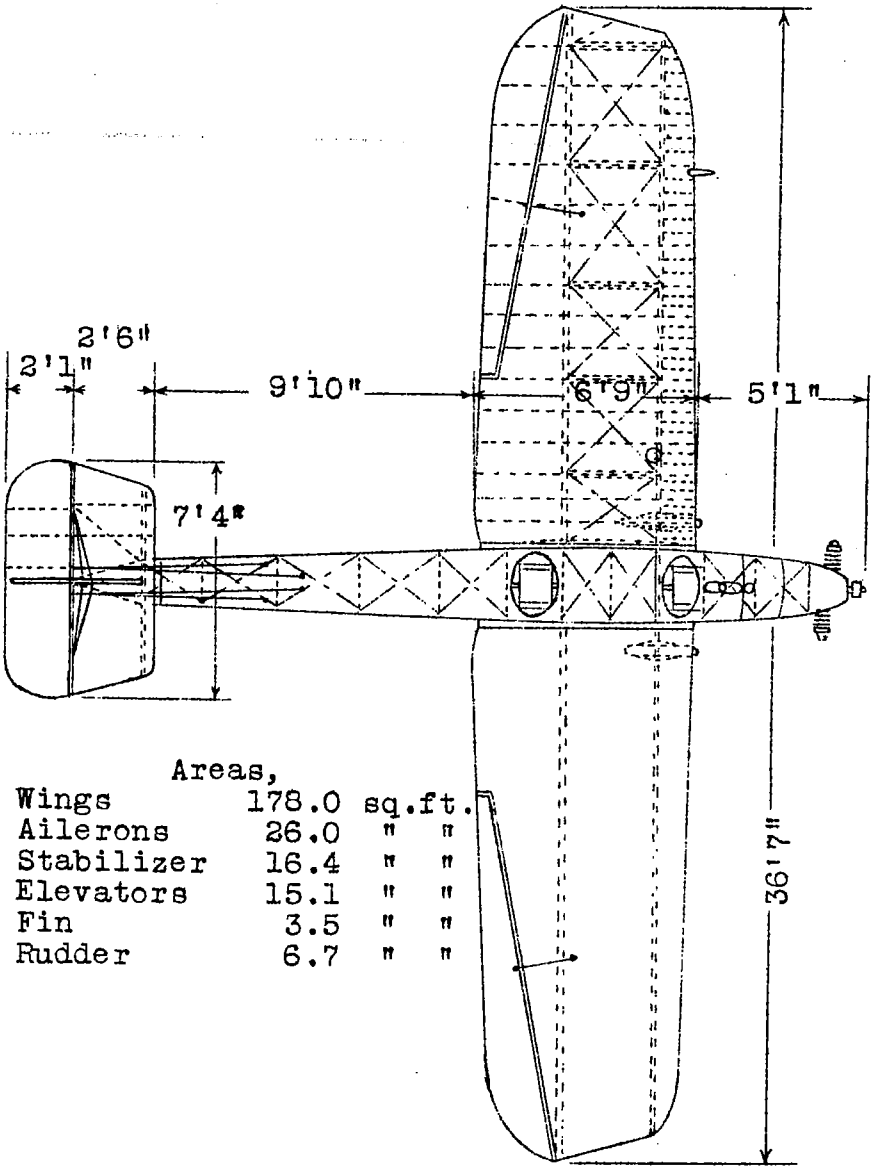
The relative sizes of the thirteen airplanes in plan outline is given in Fig. 14, followed by a tabular presentation (Fig. 15) showing the relative efficiencies in the various contests.



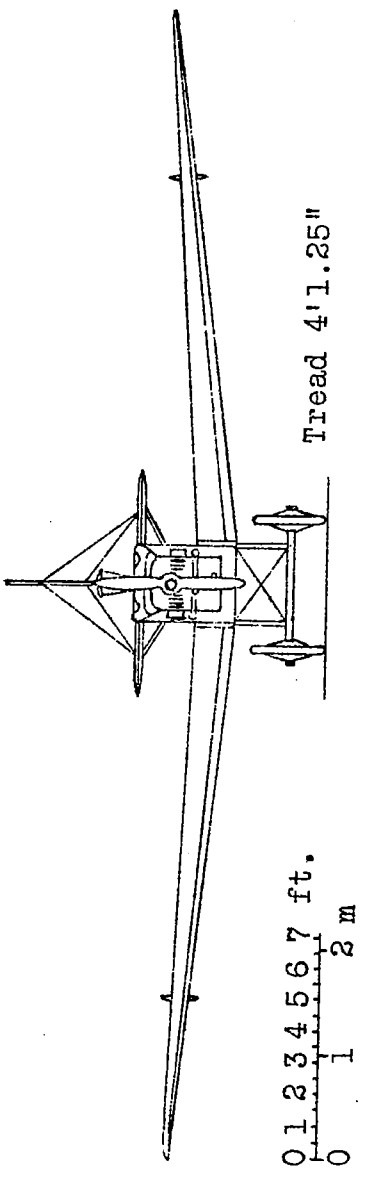
Areas,	
Wing	187.0 sq.ft.
Ailerons	21.5 " "
Stabilizer	6.5 " "
Elevator	13.5 " "
Fin	4.3 " "
Rudder	7.0 " "

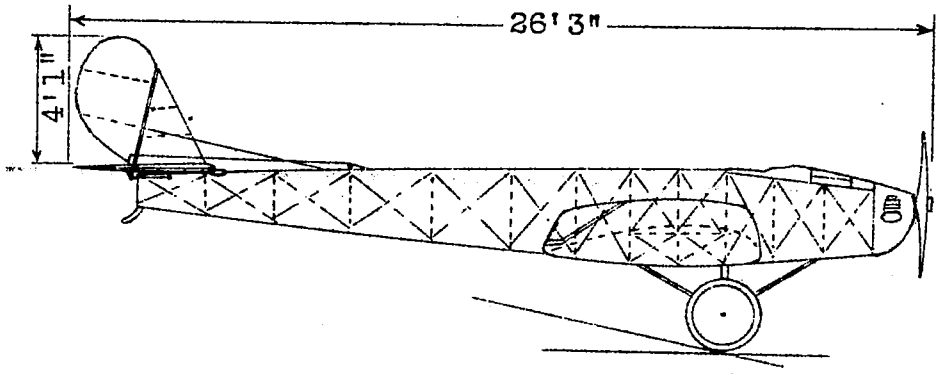
1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Fig. 1 The "Wee Bee I" two-seat light airplane



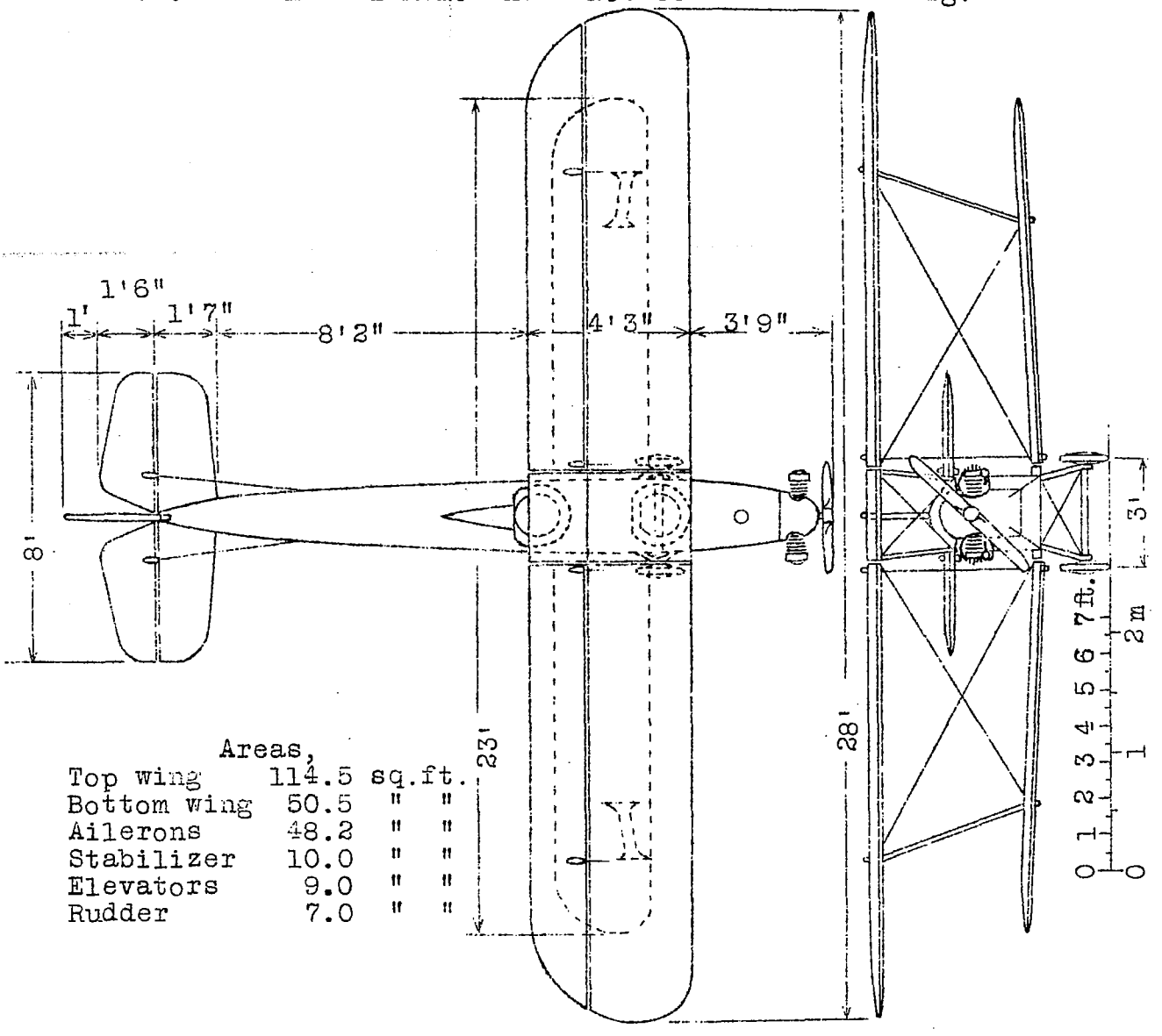
Areas,		
Wings	178.0	sq.ft.
Ailerons	26.0	" "
Stabilizer	16.4	" "
Elevators	15.1	" "
Fin	3.5	" "
Rudder	6.7	" "



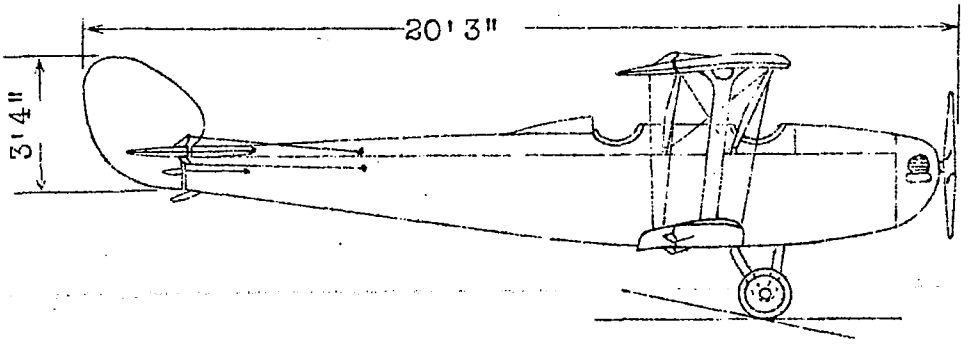


1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Fig.2 The "Brownie" two-seat light airplane.



Areas,		
Top wing	114.5	sq.ft.
Bottom wing	50.5	" "
Ailerons	48.2	" "
Stabilizer	10.0	" "
Elevators	9.0	" "
Rudder	7.0	" "



1100 cm^3
(67.13 cu.in.)
A.B.C.
"Scorpion"
engine

Fig.3 The "Cygnet" two-seat light airplane.

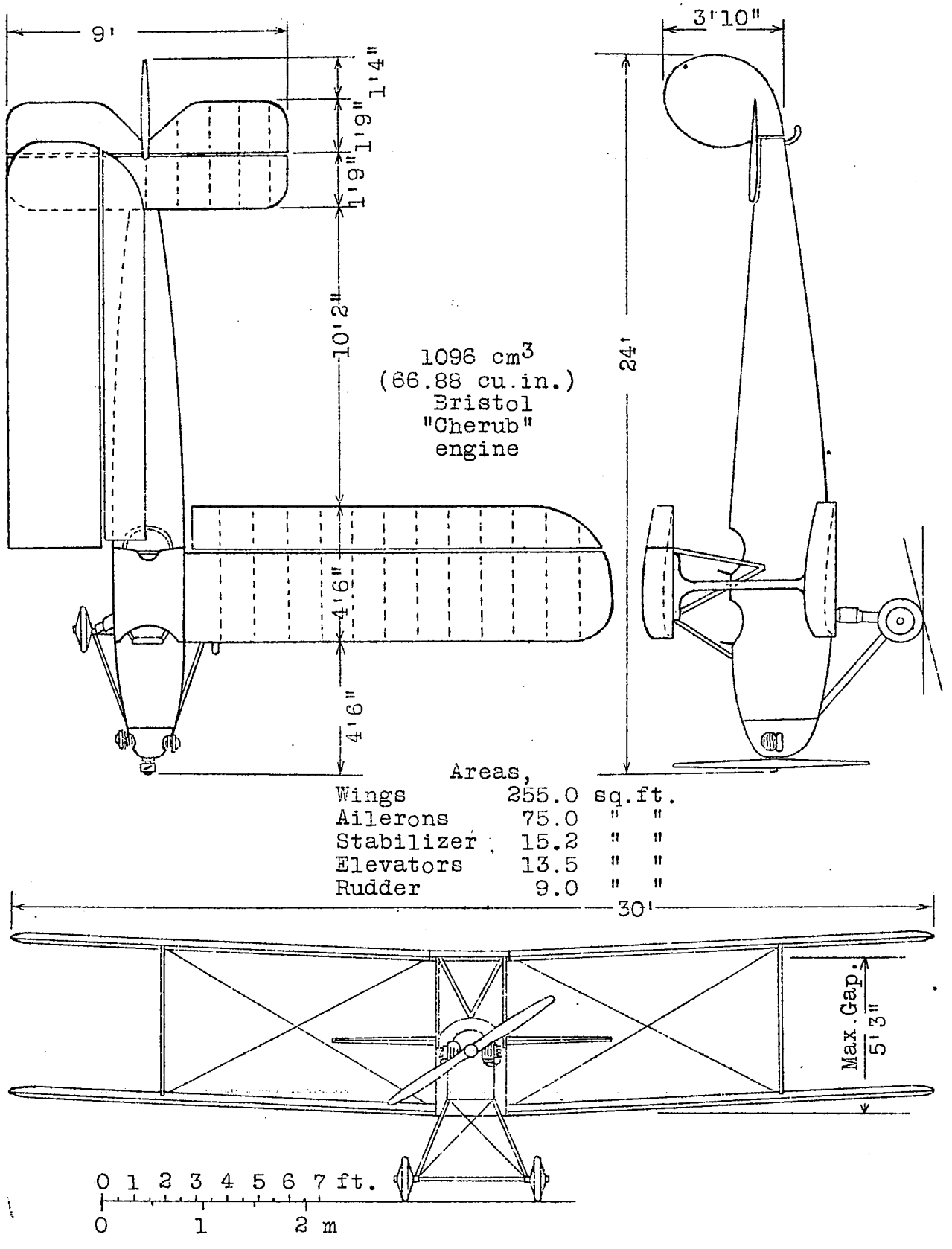
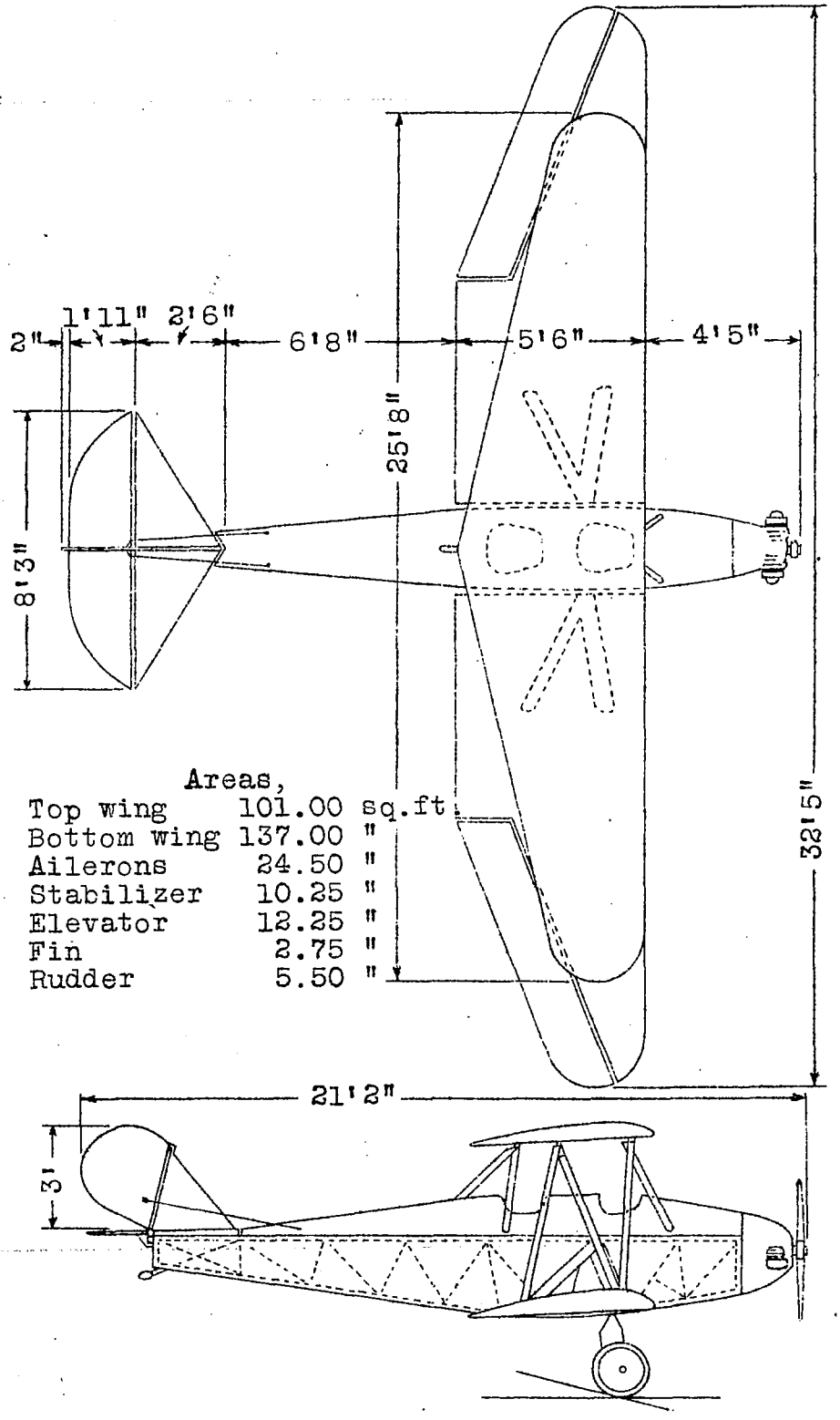
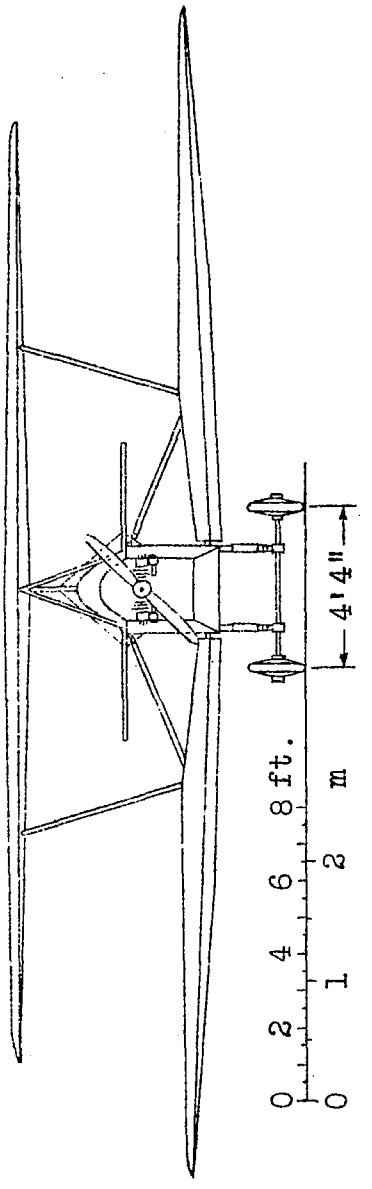


Fig.4 "Avis" two-seat light airplane.



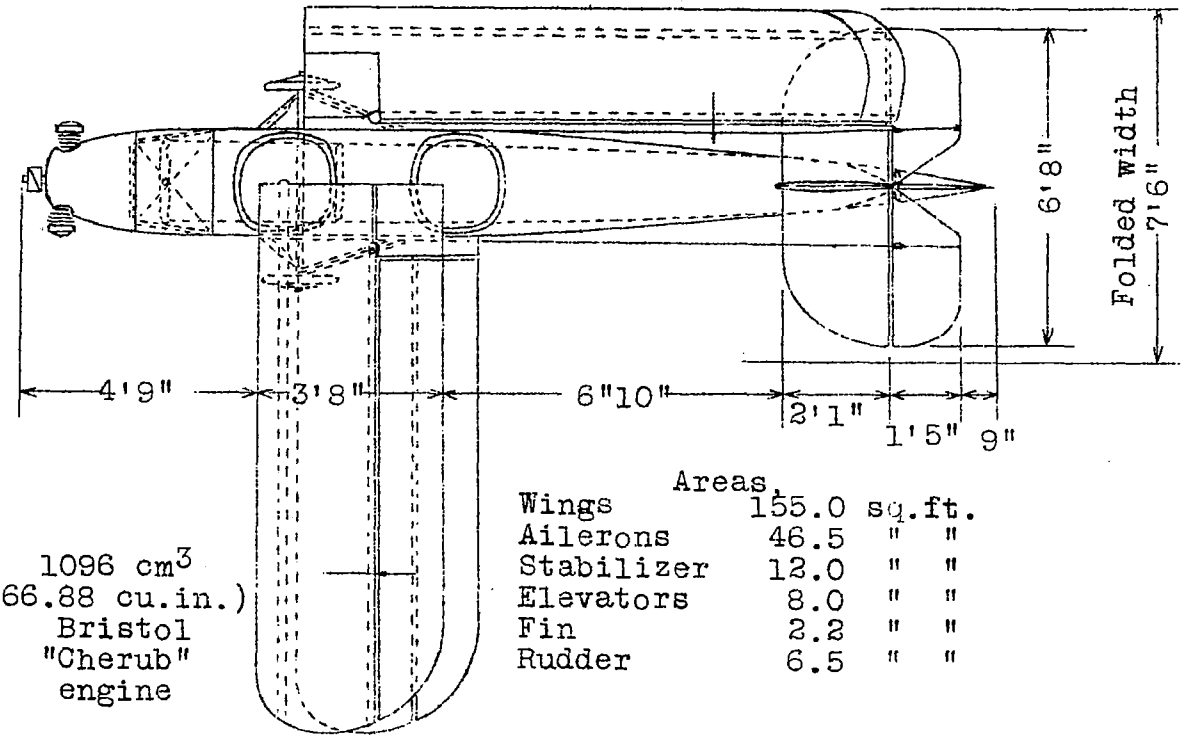
Areas,

Top wing	101.00	sq.ft.
Bottom wing	137.00	"
Ailerons	24.50	"
Stabilizer	10.25	"
Elevator	12.25	"
Fin	2.75	"
Rudder	5.50	"



1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Fig. 5 "Pixie IIIa" two-seat light airplane



1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Areas.		
Wings	155.0	sq.ft.
Ailerons	46.5	" "
Stabilizer	12.0	" "
Elevators	8.0	" "
Fin	2.2	" "
Rudder	6.5	" "

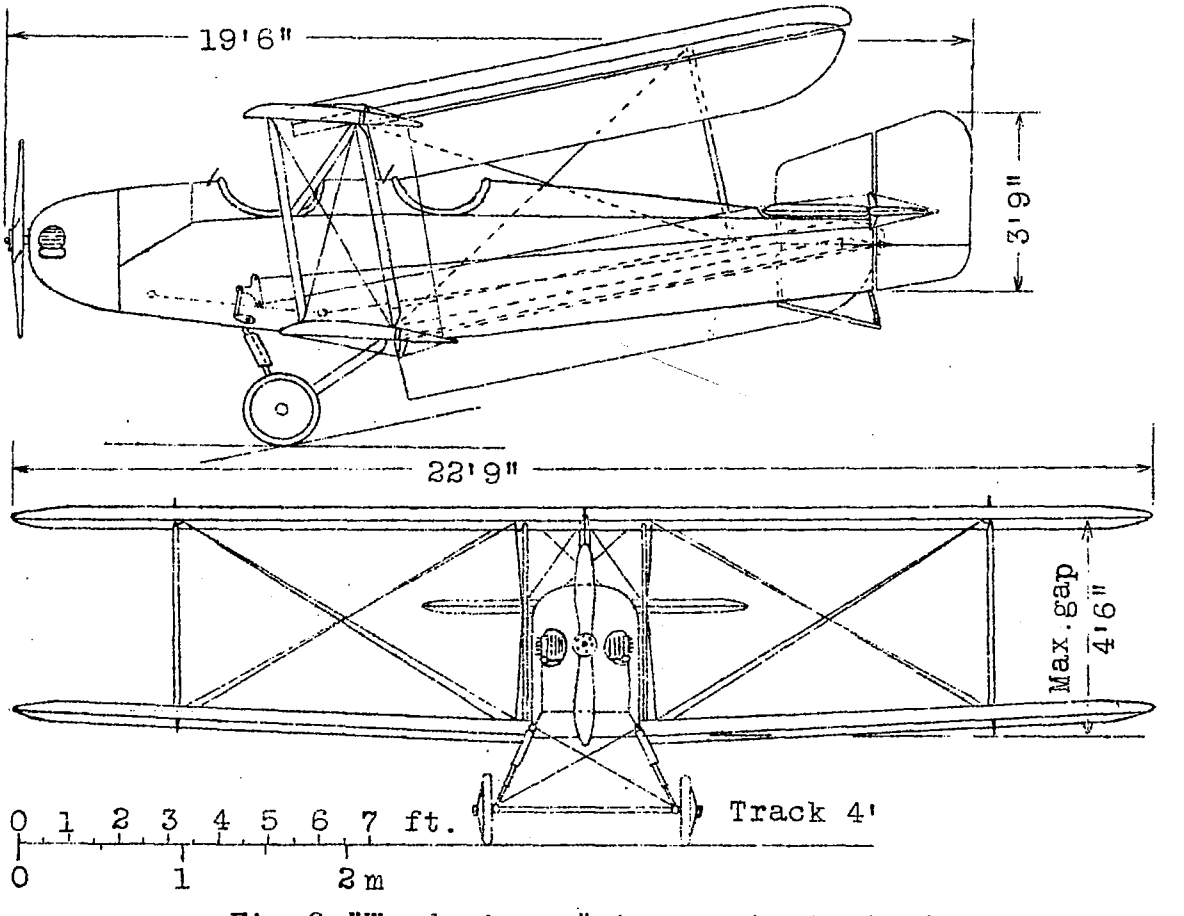


Fig.6 "Wood pigeon" two-seat light airplane.

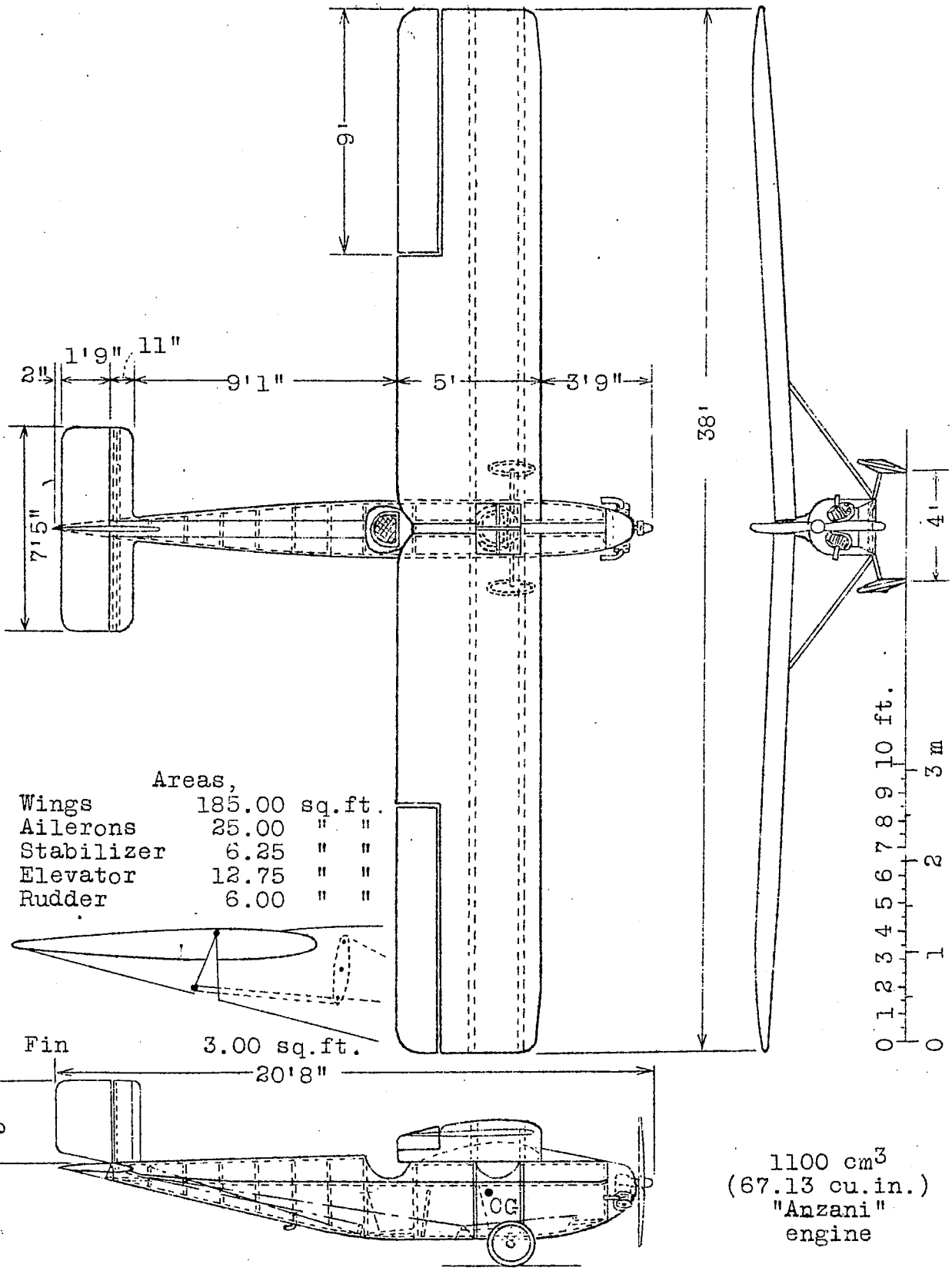
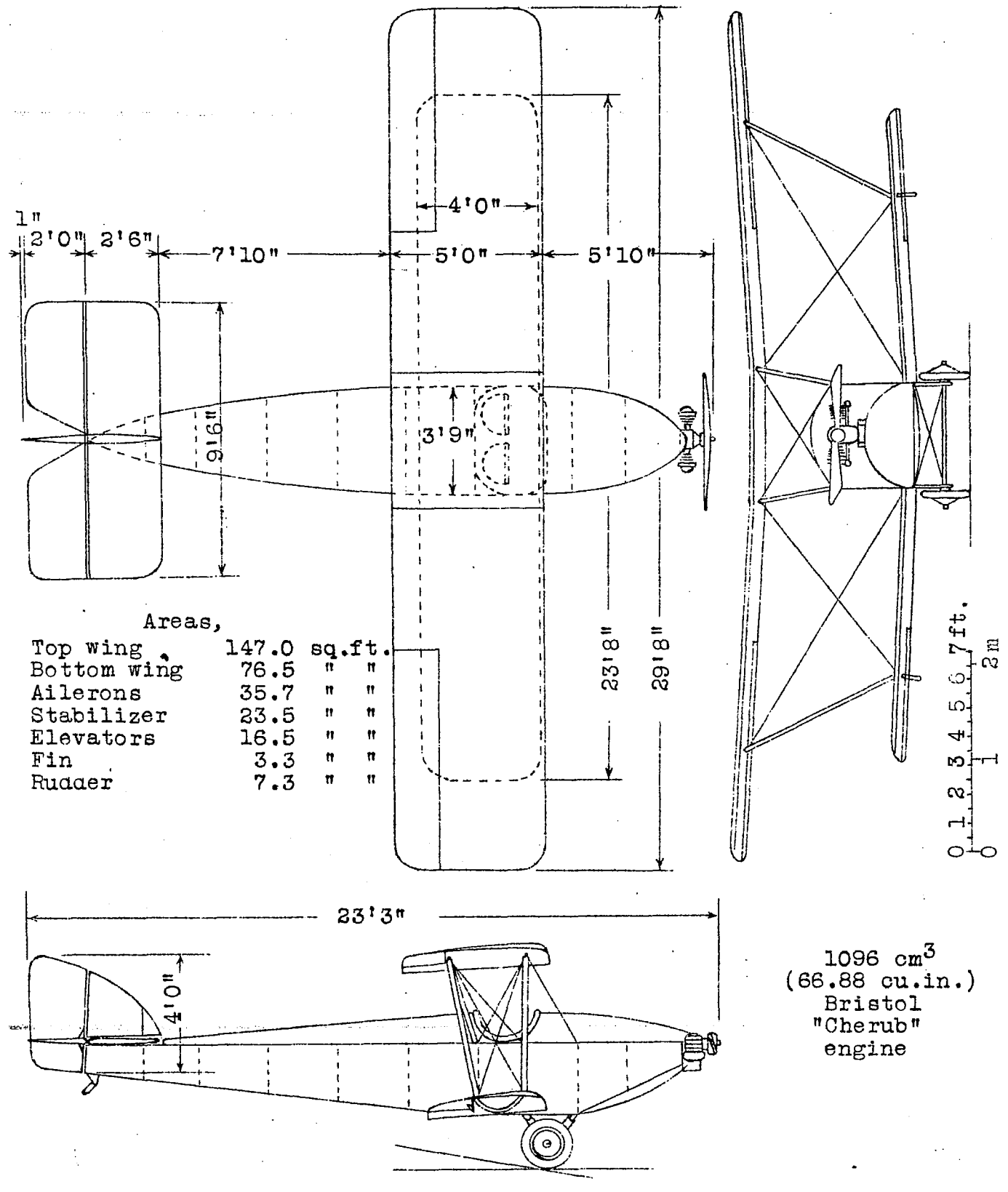


Fig.7 "A.N.E.C. II" two-seat light airplane.

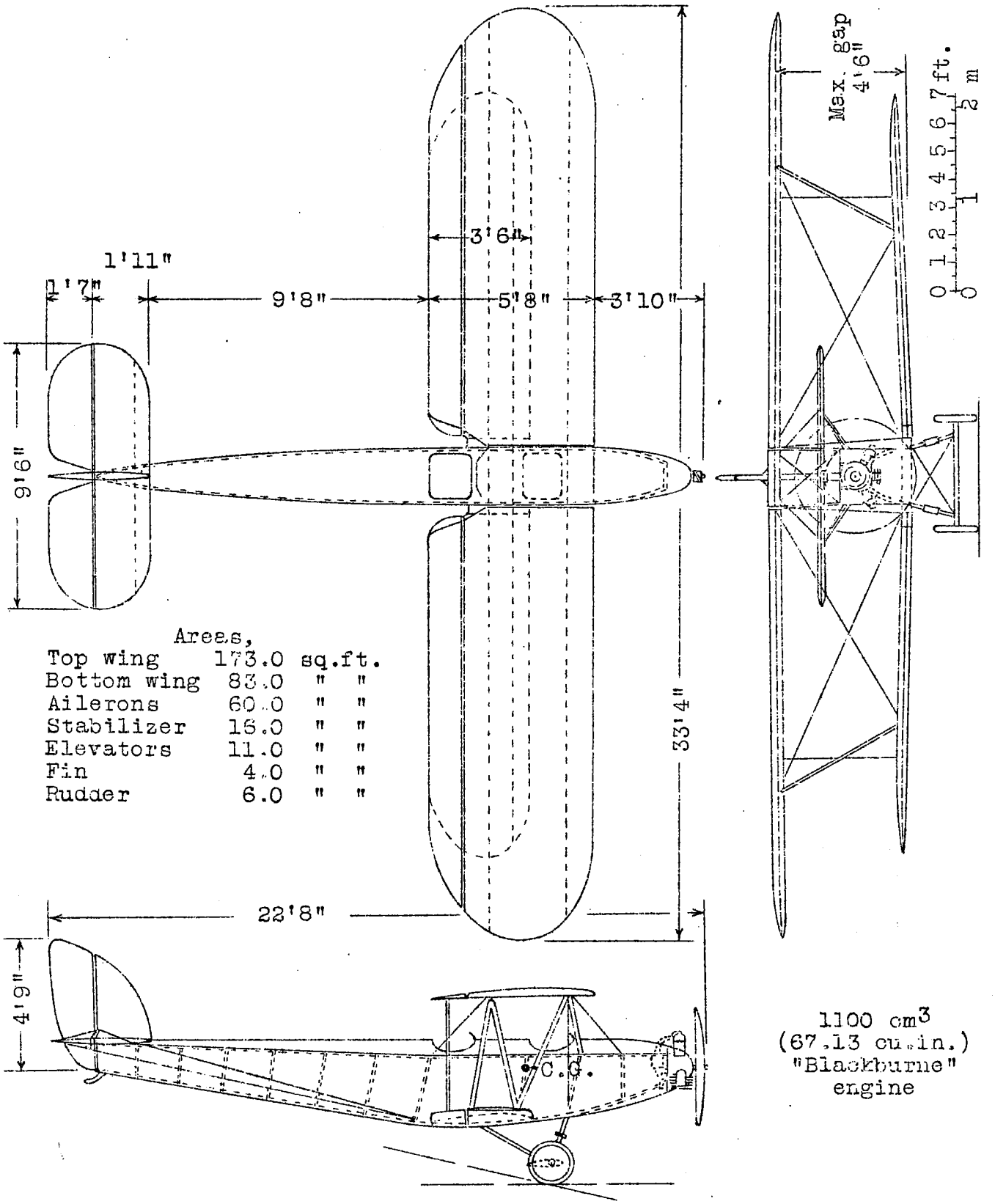


Areas,

Top wing	147.0	sq.ft.
Bottom wing	76.5	" "
Ailerons	35.7	" "
Stabilizer	23.5	" "
Elevators	16.5	" "
Fin	3.3	" "
Rudder	7.3	" "

1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

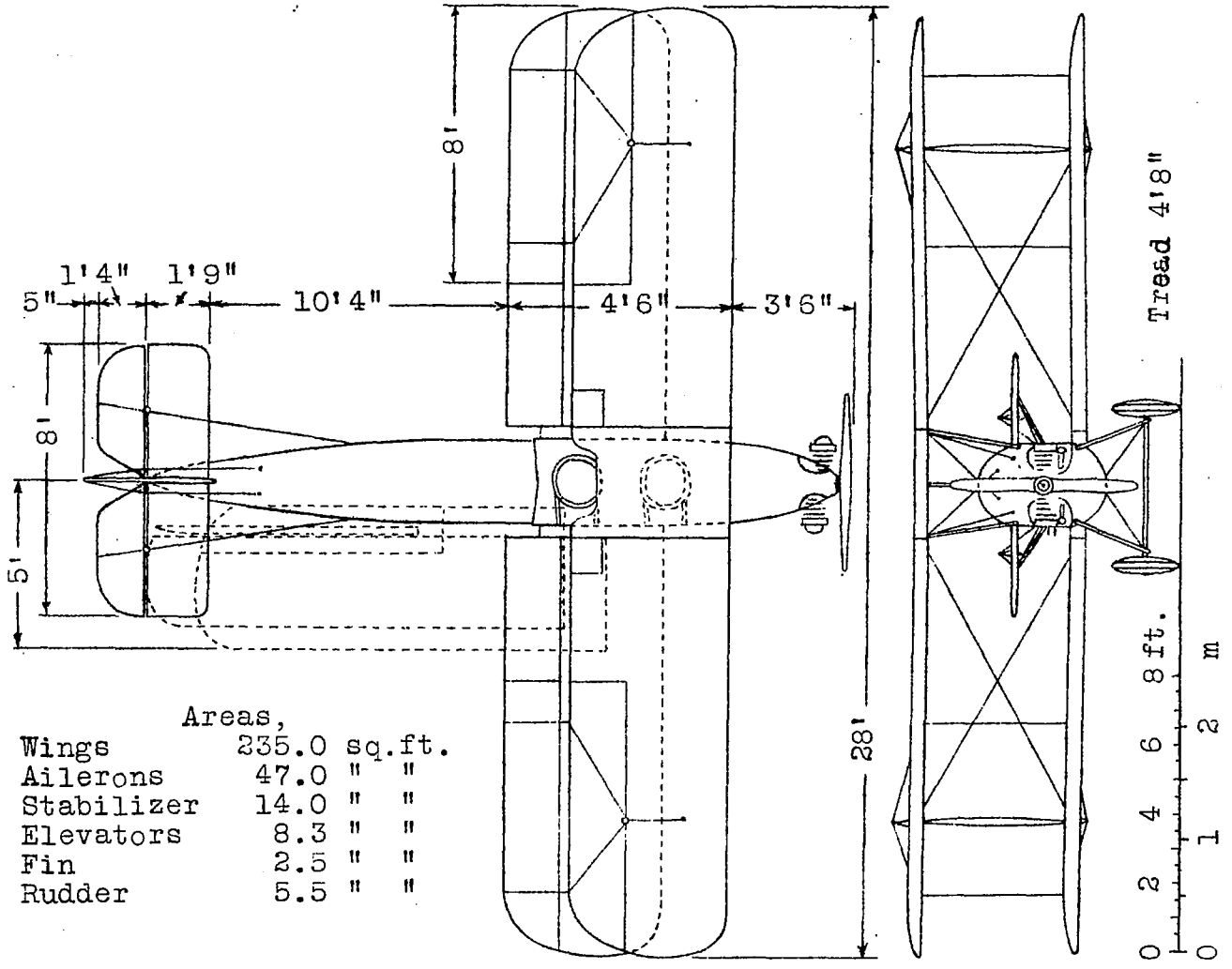
Fig.8 The "Cranwell II" two-seat light airplane.



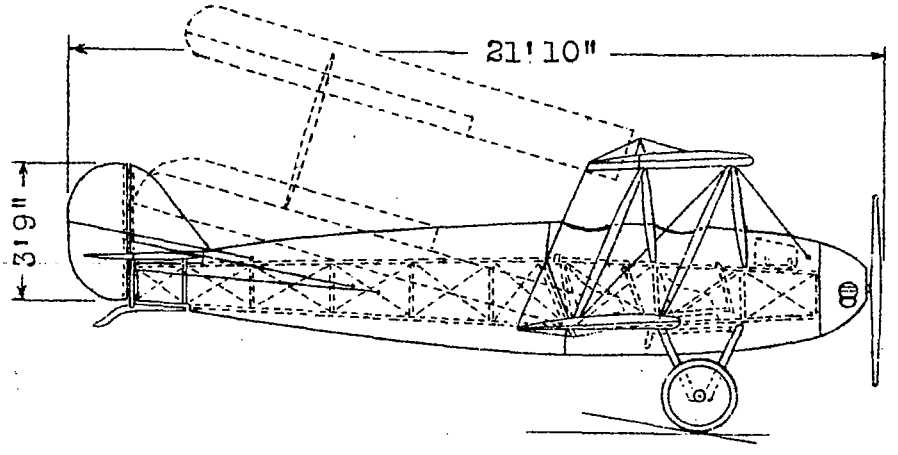
Areas,

Top wing	173.0	sq.ft.
Bottom wing	83.0	" "
Ailerons	60.0	" "
Stabilizer	16.0	" "
Elevators	11.0	" "
Fin	4.0	" "
Rudder	6.0	" "

Fig.9 The "Sparrow" two-seat light airplane.

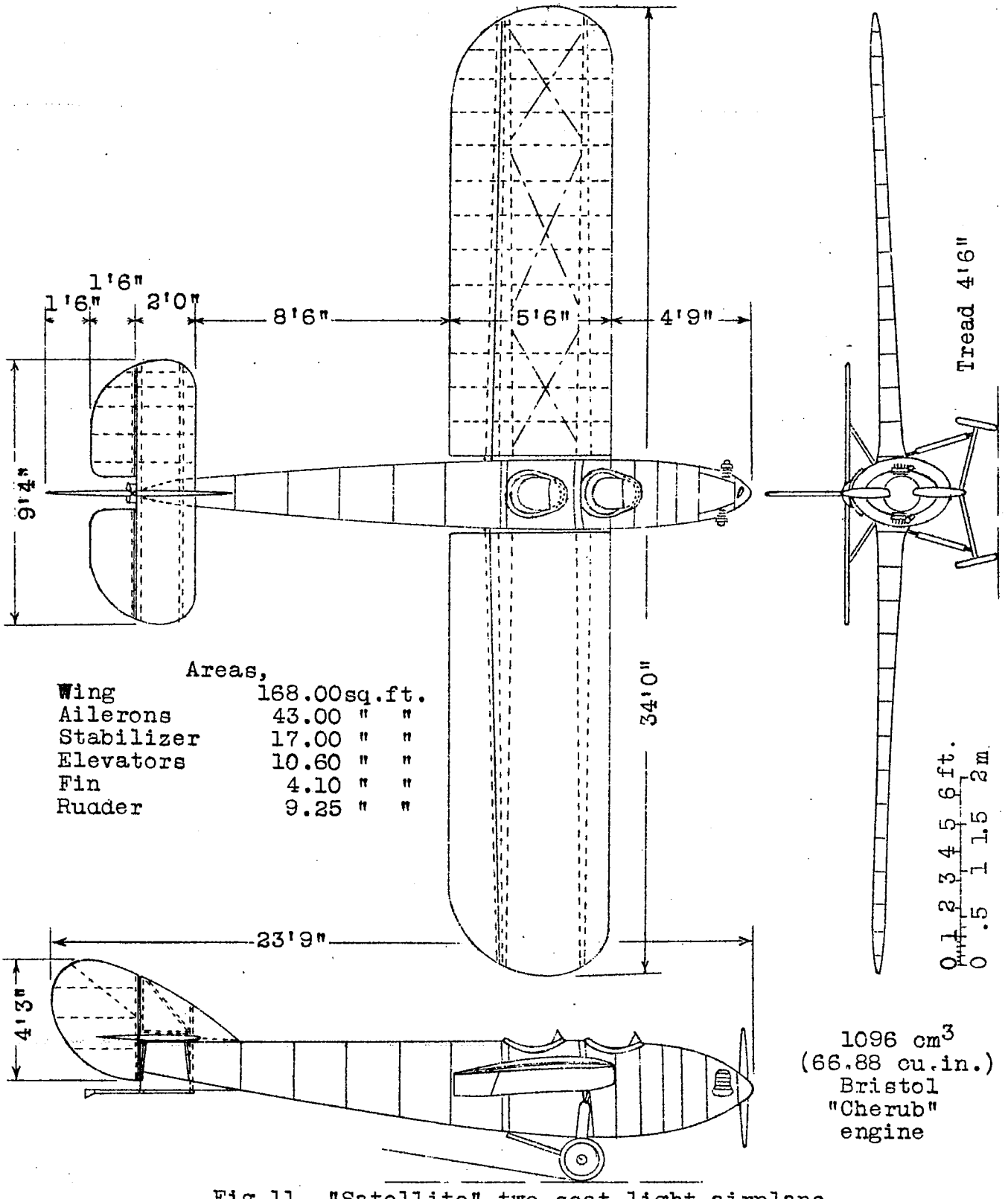


Areas,	
Wings	235.0 sq.ft.
Ailerons	47.0 " "
Stabilizer	14.0 " "
Elevators	8.3 " "
Fin	2.5 " "
Rudder	5.5 " "



1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Fig. 10 "Vagabond" two-seat light airplane



Areas,

Wing	168.00	sq.ft.
Ailerons	43.00	" "
Stabilizer	17.00	" "
Elevators	10.60	" "
Fin	4.10	" "
Rudder	9.25	" "

1096 cm^3
(66.88 cu.in.)
Bristol
"Cherub"
engine

Fig.11 "Satellite" two-seat light airplane.

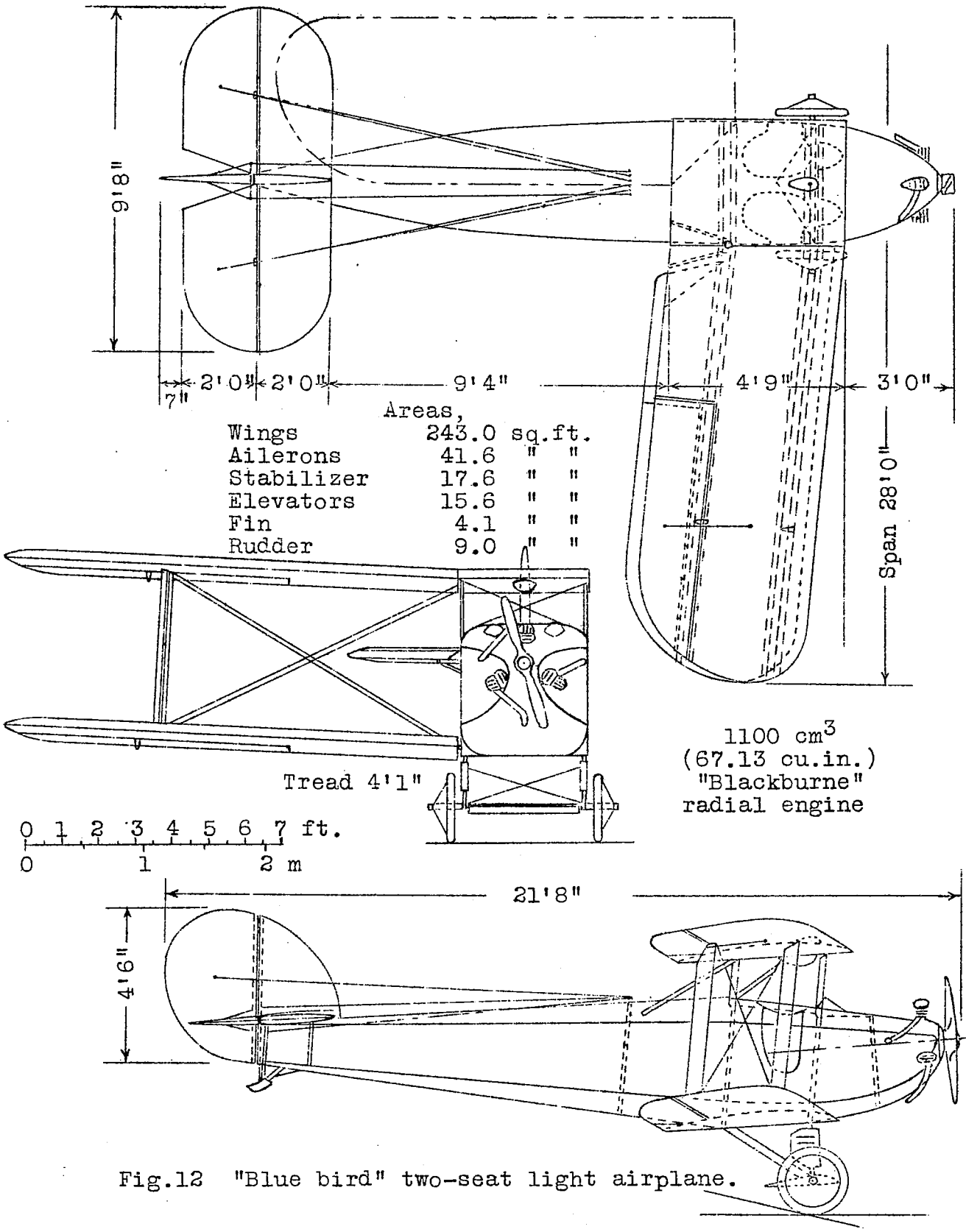


Fig.12 "Blue bird" two-seat light airplane.

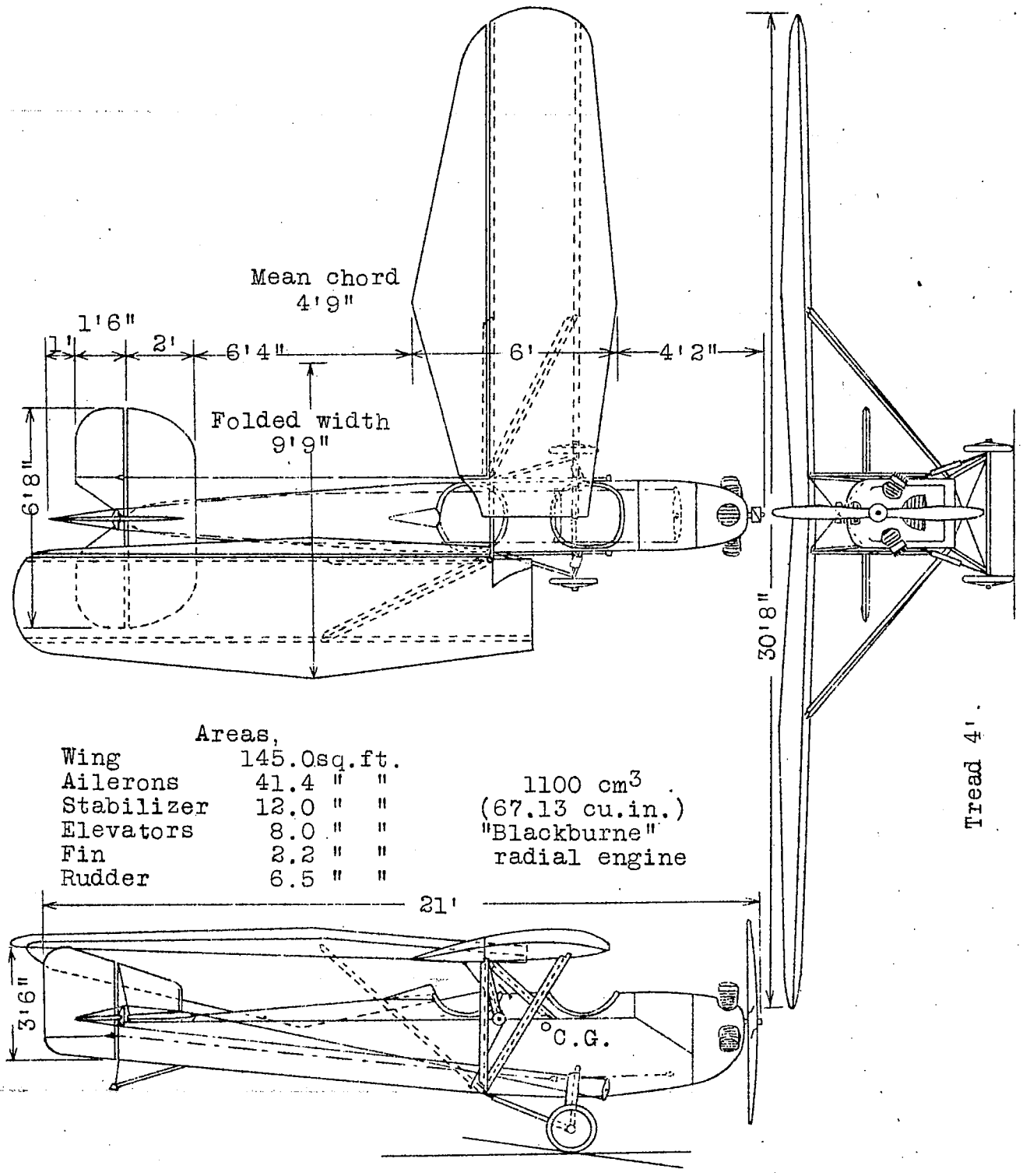


Fig.13 "Widgeon" two-seat light airplane.

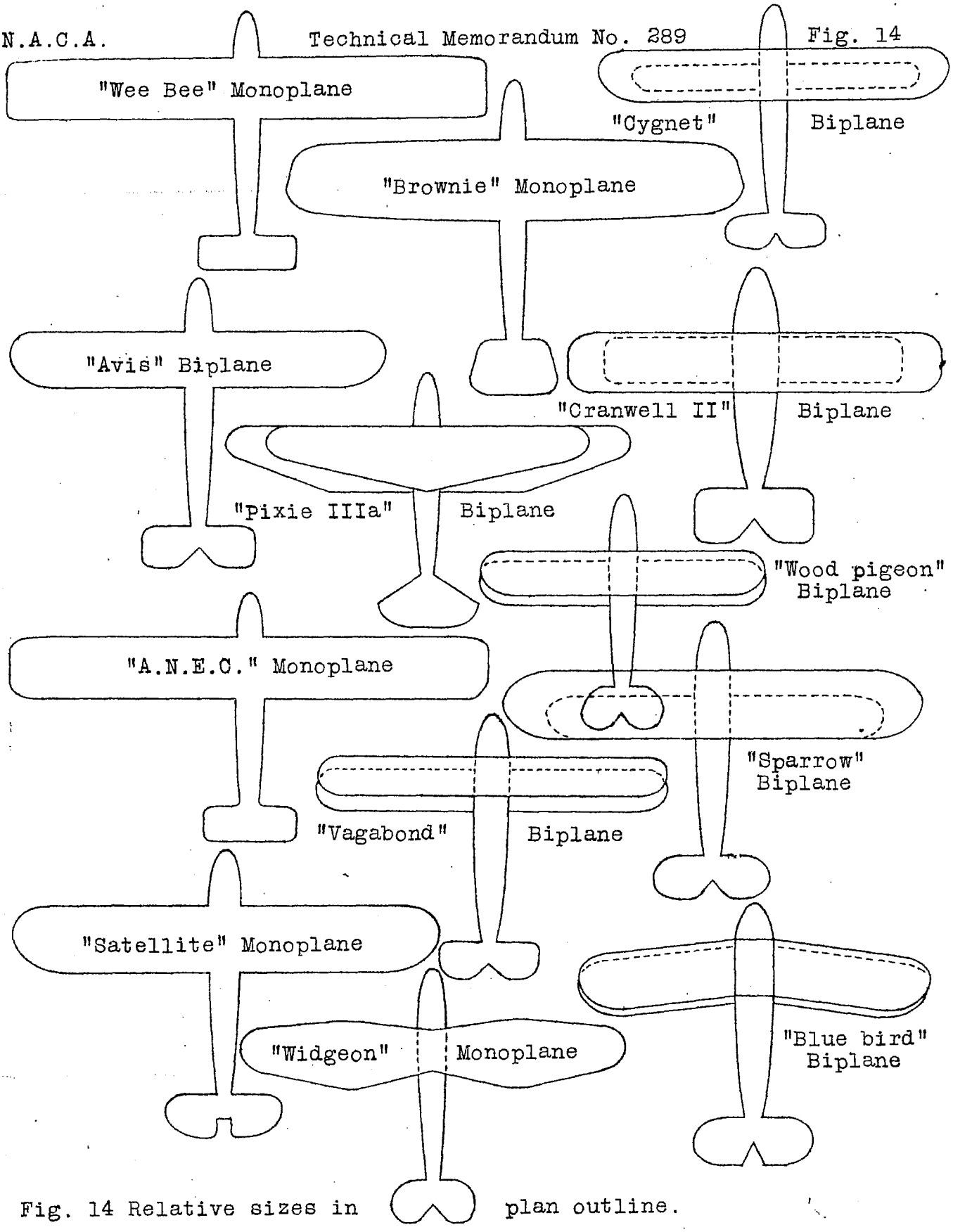


Fig. 14 Relative sizes in plan outline.

Reliability:-
Distance.

1	Cranwell	762.5 miles
2	Wee Bee	737.5 "
3	Brownie	513.5 "
4	Cygnet	475.0 "
5	Pixie IIIa	450.0 "
6	Wood pigeon	125.0 "

Time in air

		hr.	min.	sec.
1	Cranwell	17	53	18
2	Wee Bee	11	54	41
3	Cygnet	10	24	40
4	Brownie	10	33	40
5	Pixie IIIa	10	4	38
6	Wood pigeon	2	31	37

High speed

1	Wee Bee	70.11 M.P.H.
2	Brownie	65.19 "

Low speed

1	Pixie IIIa	37.22 M.P.H.
2	Cygnet	37.42 "
3	Brownie	38.73 "
4	Wee Bee	39.66 "

Speed range

1	Wee Bee	76.77 %
2	Brownie	68.33 %

Take off

1	Brownie	215 yd.
2	Wee Bee	235 "
3	Cygnet	250 "
4	Pixie IIIa	301 "

Landing

1	Cygnet	66.7 yd.**
2	Pixie IIIa	70.0 "
3	Brownie	102.6 "
4	Wee Bee	124.0 "

100 mile
handicap race
(unofficial rating)

1	Avis
2	Wood pigeon
3	Brownie
4	Sparrow
5	Pixie III (2 seat)
6	*Pixie II (1 seat)
7	Satellite
8	*DH-53

*These light airplanes, it will be remembered, took part very successfully in last years competition.
**Airplane with "Anzani" engine.

Fig. 15 Relative efficiencies.