AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 4

GERMAN TRAINING AIRPLANE, ARADO "Ar. S.I."

By G. Manigold

From "Zeitschrift für Flugtechnik und Motorluftschiffahrt,"
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The "Ar. S.I.," built by the Arado Company at Warnemünde, Germany, is a wireless biplane of pleasing shape. The slender fuselage and staggered wings, with their peculiar bracing, give it a character of its own. The khaki paint on fuselage and fabric and the special varnish on the wings make an agreeable impression. On closer examination, we quickly reach the conclusion that it is not simply a beautifully finished "exhibition piece," but that every detail is scientifically worked out.

The wooden wings have box spars of American spruce with their tension and compression members specially glued, so as to prevent the development of any weakness from possible slight defects in the wood. The under surface of the wings consists of birch wood, which gives it the necessary resistance to the diagonal stresses. Fabric is employed, however, on the upper surface of the wings. This afforded the opportunity to remedy an oft-experienced defect, namely, inaccessibility for thorough inspection without sacrificing any of the covering. The wing covering is not sewed directly to the rib wrappings, but

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is held by bands which are attached to the ribs by special devices. No loosening is possible, even in long use, though the covering can be removed at any time without damaging it. Nothing therefore interferes with the inspection of the wings, which is a great advantage for much-abused training planes. The continuous upper wing is cantilever and is attached to the fuselage by a cabane in such a way as to avoid all undesirable stresses. The upper wing carries the long narrow ailerons which extend nearly to the middle and have various deflection angles. The lower wing is similar to the upper one, but has a shorter span and consists of two parts attached to the bottom of the fuselage. It is connected with the cabane by a pair of struts in the form of an inverted V. The cabane itself consists, on each side, of an outwardly inclined N set of struts connected by two struts with the lower edge of the fuselage. At each end of the lower wing there is a V strut to take up the torsion of the upper wing.

The two sheet-brass gasoline tanks are suspended by straps within the upper wing, in order to avoid their being disturbed by stresses in any flight position. For a training plane, it is important to use gravity tanks instead of those requiring an internal pressure for delivering the fuel, because there is danger of leaks being started in the latter by hard landings. The quantity of fuel in the tanks is shown by two gasoline gauges of special Arado design and plainly visible from both seats.

The fuselage framework (Fig. 3) is made of steel tubing very carefully welded so as to cause no weakening of the metal at the joints. Steel is used on account of its greater security against rupture and the greater facility in replacing damaged parts and in making repairs. The steel frame is covered with easily removable fabric, so applied as not to rub through at any point. The top can be removed in one piece (Fig. 4) for inspecting the steering controls and the whole inside of the fuselage without loss of time.

The simple landing gear consists of four struts and one axle. Each pair of struts forms a V in which the rear strut is provided with a rubber shock absorber. The simple winding of the rubber cords and the possibility of immediately discovering any wear, as also the easy exchangeability and the good shock absorption, fulfill the most essential conditions for an airplane. The cost of the whole training process depends largely on the excellence of the landing gear, because a poor landing gear may easily entail the high expense of a new airplane.

The tail skid is rendered flexible by a rubber cord so wound as to distribute the landing stresses evenly between the different strands. Provision is made, however, for easy exchangeability, even of the broad skid shoe. The customary safety cables are also provided against the possibility of the rubber cords being damaged by friction.

Especial care was devoted to the installation of the engine. Since radial engines (either the 120 HP. Bristol "Lucifer" or the 100 HP. Siemens) are used, special provisions are necessary to afford accessibility from all sides. This is accomplished by tilting the whole mounting, without disconnecting any pipe or rod. All the instruments, as well as the aluminum oil tank are rigidly connected with the engine (Figs. 5-6).

In order to facilitate communication between instructor and pupil, both seats are placed in a sort of "tub" behind the engine. All the instruments, including the compass in the wing cut-out above the fuselage, are clearly visible from both seats. The fuel delivery and ignition are regulated by levers. The fuel cock can be easily reached from either seat, but the starter and switch are in the instructor's compartment. The cockpit is separated from the engine by the customary fire-wall.

The steering gear consists of a control stick for the elevator and ailerons and an oscillating bar for the rudder. The whole steering gear in the student's compartment can be thrown in or out by a single motion during flight. On the control stick there are two convenient hand grips. The seat can be shifted both horizontally and vertically, so as to fit the occupant and lessen the fatigue of flying. The safety belt, which also serves as a shoulder strap, can be easily and surely detached by a single pressure. A parachute serves as a back cushion.

The stabilizer can be easily adjusted by a lever during flight. Although such adjustment of the trim is perhaps hardly necessary on a training plane, it is very convenient for showing the pupil the difference between nose and tail heaviness. The divided elevator is connected with the control stick by rods, while the rudder is connected with the rudder bar by cables. Neither elevator nor rudder is balanced, which is entirely justifiable on a training plane. The pupil must be able to feel the steering pressure, even for slight deflections, so that he will not be so liable to move the controls too far. After he has acquired the requisite sensitiveness of feeling for the correct deflection, he can fly with balanced rudders.

It is obvious from all these structural details that much care and thought were expended on the construction of the "Ar.S.I." and it is gratifying that even the flight characteristics of the airplane are so excellent. A distance of only about 55 m (180.4 ft.) is required for taking off with full load. Its stability and manageability are equally remarkable. Stalled flight or too flat gliding flight are without harmful results and involuntary slipping or rolling is not to be feared. By adjusting the stabilizer, unsteered flight is possible at any altitude. Stunts of every kind can be easily and safely performed.

Characteristics

Span of upper wing	11.5 m	37.73 ft.
" " lower "	8.5 "	27.89 "
Length	7.35"	24.11 "
Height	2.65"	8.69 "
Wing area	26.5 m²	285.24 sq.ft.
Dead weight	600.0 kg	1322.77 lb.
Gasoline for 4 hours	115.0 "	253.53 "
Oil	30 "	66.14 "
Pilot	80 "	176.37 "
Pupil	80 "	176.37 "
Parachutes (2)	10 "	22.05 "
Total weight	915 kg	2017.23 lb.
Wing loading	34.5 kg/m²	7.07 lb./sq.ft.
Load per HP. (120)	7.65 kg/HP.	16.83 lb./HP.
Climbing time to 1000 m (3281 ft.)	7 minutes	
Ceiling	4000 m	13123.00 ft.
Maximum speed	147 km/h	91.34 M.P.H.
Landing "	55 "	34.18 "
Take-off run	55 m	180.4 ft.
Landing run	57 "	187.0 "

Translation by Dwight M. Miner,
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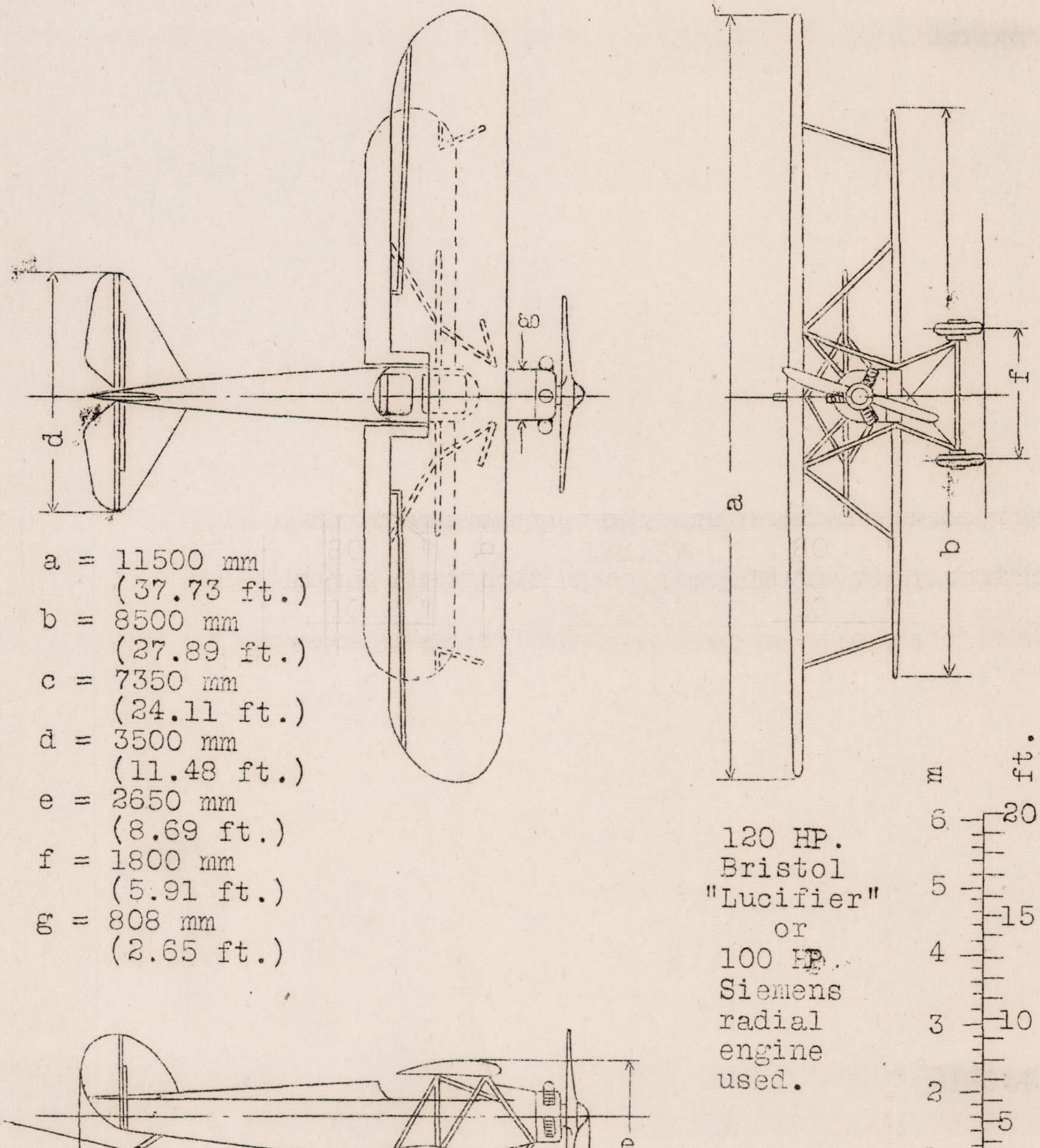

Fig.1 German training airplane Ar.S.I.

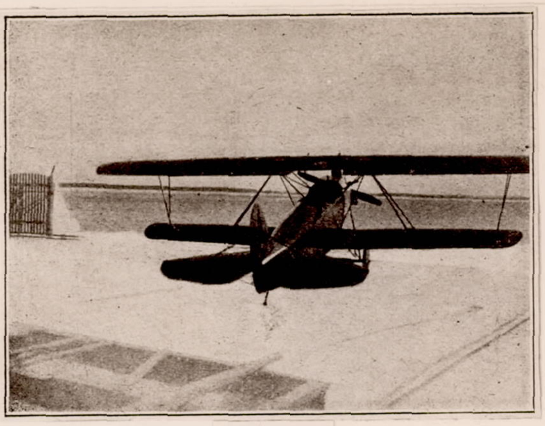

Fig.2

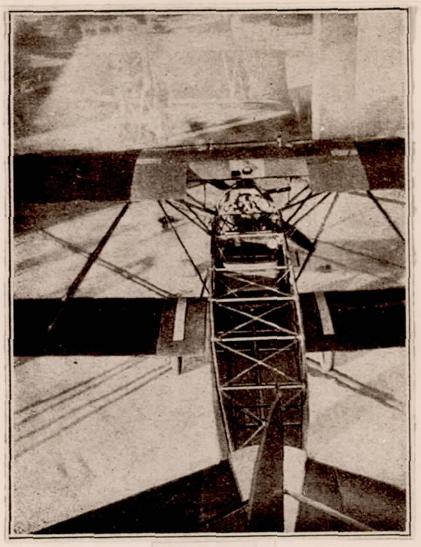

Fig.3

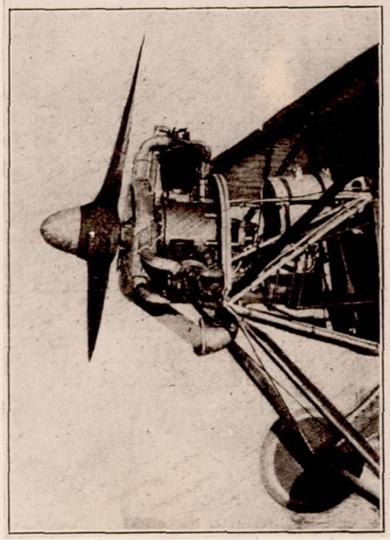

Fig.5

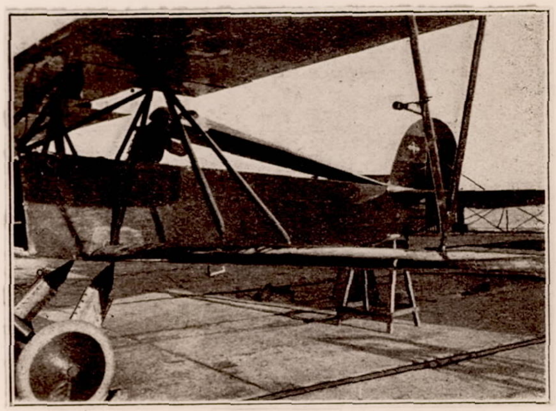

Fig.4

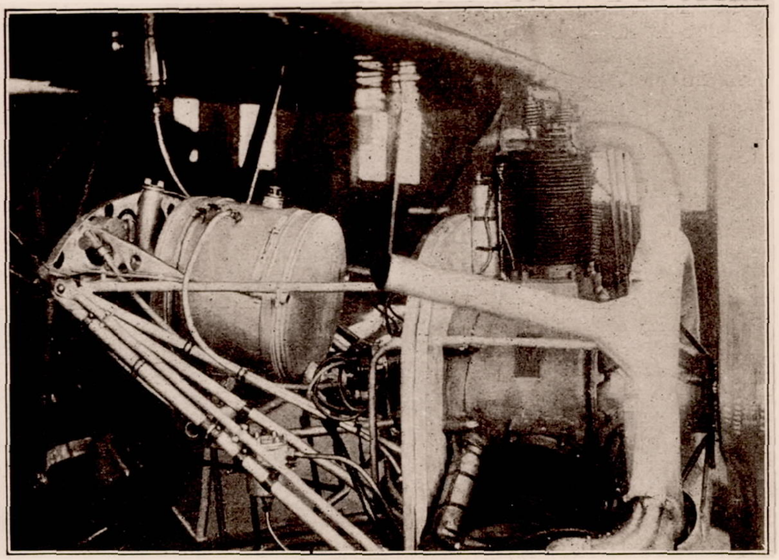

Fig.6