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No. 103

THE BRISTOL "BULLDOG" (BRITISH)

A Single-Seat All-Steel Fighter

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THE BRISTOL "BULLDOG" (BRITISH)* - A Single-Seat All-Steel Fighter.

The Bristol "Bulldog" was designed on the Bristol principles of metal construction by The Bristol Aeroplane Co., Ltd. The entire structural portion is of high tensile steel (Figs. 1, 2, and 3). The airplane is powered with the "Bristol" Jupiter radial air-cooled engine, either the "Bristol" Jupiter Series VII supercharged engine, when exceptional speed and performance at high altitudes are especially required, or the "Bristol" Jupiter Series VI.A engine when the normal operating area of the airplane is not expected to exceed, say, 15,000 feet. The two types of engine are entirely interchangeable when desired. The speeds maintained at altitudes with the rate of climb and the ceiling are given in tables at conclusion of this Circular.

F u s e l a g e

The fuselage structure comprises three main parts, the front and rear portions and the stern frame. Of these, the front portion and the stern frame are constructed of high tensile tubes and the rear portion of members built up of high tensile steel strip in special "Bristol" sections.

Front end.- This portion extends from the front bulkhead

*From circular issued by The Bristol Aeroplane Co., Ltd., England.

to the end of the tubular longerons, and accommodates the pilot's seat, controls and most of the military equipment, etc. No bracing wires are fitted in the side frames and transverse bracing is fitted only in the foremost panel. The side struts are attached to the longerons by side plates which are bolted both to the side struts and the longerons. Short tube sleeve pieces are used on the strut ends and longerons at these joints.

The side frames are connected to each other by cross tubes braced by crossed tie rods except in the case of the cockpit panel. To the front fuselage joint is attached the engine mounting top tube and side bracing wire, the top center section front strut and bracing wire and the Oleo leg.

All the tubes are of the same diameter and specification. The sleeve pieces are not sweated or brazed to the tubes or longerons and they have small flat areas pressed out from the inside to form bearing areas for the side plates. The main fitting for the Oleo leg attachment may be detached by removing the six bolts through the side struts (Fig. 4).

Rear end.- Rear longerons and strips are made of two rolled steel strips interlocked, forming a circular cross section. The members form structures of the Warren girder type rigidly held together at these joints, and only the transverse tie rod bracing is adjustable.

Attachment of the rear to the front portion is made by single lug sockets on the rear longerons engaging with and bolted to forked sockets on the front longerons. The sockets fit inside the longerons and are secured by taper pins through the rear and bolts through the front longerons.

The bottom cross strut about which the tail skid arm pivots is a length of high tensile steel tube, braced by steel tubes to the port and starboard joints of the cross members immediately in front of and above it. The whole of the tail skid and its bracing members can be quickly detached from the fuselage (Fig. 5).

Stern frame.- The stern frame comprises the stern post and six other tubular bracing members. The bracing tubes are attached to the stern post by double bolted sockets to brackets welded on sleeves which are bolted to the post. The stabilizer actuating gear has a guide sleeve working on the stern post tube, extreme positions of which are located by the bottom edge of the fixed top sleeve and the top edge of the central fixed sleeve (Figs. 6 and 7). On the bottom sleeve is welded a pad used as a stop to prevent damage to the rudder and fuselage in the event of tail skid failure, and to rest the aircraft on when checking rigging or inspection purposes.

Small brackets on the rear of the top and bottom sleeves hold the rudder hinges. Other brackets are mounted on all the sleeves to carry the fairing fasteners.

Fairing formers and stringers.- With the exception of the fairing panels and doors, the remainder of the covering is doped fabric, the "after" detachable panels underneath the stabilizer are made of fabric stretched on a light tubular framework welded together.

The formers and stringers are of steel strip rolled in a  section and bolted together. The formers are secured to the longerons by bolts to bridge pieces which are bolted to the longerons (Fig. 4).

W i n g s

Each wing structure is of the usual bispar type, with the spars connected by steel tube compression members braced by tie rods. A 35-gallon gasoline tank is carried between the front and rear spar of each wing, supported in each case by a single diagonal steel tube which constitutes the only bracing in the tank bay.

Ailerons of the patented "Bristol" Frise type are fitted on the top wing only; the control cables passing from the fuselage through the bottom wings, behind the rear spar thence to the aileron lever by streamline wires.

Spars.- High tensile steel strip drawn in special "Bristol" sections is used in the manufacture of the wing spars (Fig. 6). The sections are assembled in "box" form with the edges flanged and interlocked. Extension pieces of flat strip riveted together, also in "box" section, are attached to the outer spar ends to carry the wing tip edges.

Rib posts made of steel channel are riveted to the spar flanges and to the ribs. Plates of nickel chrome steel are fitted against the spar sides and are riveted to the spar flanges where the compression member joints are made.

Compression members and ribs.- Lengths of steel tube form the compression members, attached to the spars by forked sockets pinned to eyebolts which pass through distance tubes in the spars. One compression member in both top and bottom wings passes through both wing spars to receive the interplane strut fittings. In the top wing this tube is extended behind the rear spar to carry the central hinge of the aileron.

Ribs are constructed of steel strip drawn in special channel sections riveted together. They are riveted to the leading edge and trailing edge as well as to the rib posts. In front and behind the fuel tank the nose ribs and trailing ribs are of deeper section and are secured to the spars by steel bridge pieces riveted to the spar flanges.

Spar end fittings.- In the case of the wing spar end fittings, the spar end jaw bolt is screwed through a trunnion passing through the spar sides and the side plates which are riveted to the spar. A steel block connects each wing spar to the corresponding center plane spar, the block being held between the jaws of wing fitting by a vertical bolt screwed into the lower fork of the jaw, and by a bolt fitted horizontally through the center plane fitting.

Tank bay.- No crossed tie-rod bracing is used in the tank bay, but a steel tube which carries the gasoline tank is fitted diagonally across the bay and this acts as drag bracing. The ends of the tube are connected to eyebolts which pass through the spars by special tapered bolts. These tapered bolts are clamped firmly to the spar eyebolts and extend to the under surface of the wing, to facilitate the placing or removal of long-collared nuts, the ends of which fit between the jaws of the sockets on the tank bearer tube, engage the threads of the vertical bolts. The top ends of the nut collars are tapered to fit the bolt and upon the nuts being tightened or slackened the bearer tube sockets are forced on or drawn off the taper.

Stabilizer

The stabilizer comprises two separate cantilever structures bolted to a center beam which is adjustable by the stabilizer actuating gear (Figs. 7 and 8). Short cross tubes are mounted on the main fore and aft tube at right angles; these receive the spar ends of the port and starboard stabilizer, and are rigidly welded in place.

Stabilizer spars are made of high tensile steel tubing flattened at the outer ends. Sleeve pieces are fitted on the inner ends of the spars and these fit closely into the cross tubes of the center portion; a single bolt holds each spar end in position.

Brackets riveted to vertical fuselage struts carry the bushings in which the front cross tube of the center beam pivots. The stabilizer actuating gear is bolted to the fork end of the fore and aft center tube, and a link from the same socket is bolted to a guide sleeve working on the stern post. By operation of the stabilizer actuating gear the stabilizer incidence angle is adjusted within the fixed limits afforded by stops on the sternpost.

E l e v a t o r s

Aft of the stabilizer, a short tube of smaller diameter than those carrying the stabilizer spars, is welded on the main beam. This smaller tube receives the spar ends of port and starboard elevators which are free to rotate inside, the spars being also of steel tube. Levers are attached to the inner ends of the spars and straddle the stabilizer center beam, being connected by two bolts which pass through distance pieces around which are spliced the control cables.

Hinges are fitted at the outer end of each elevator spar. Each hinge is in two pieces bolted together over a sleeve on the spar and between the jaws of a bracket secured to the rear spar of the stabilizer. The bolt through this bracket supplies oil to the bearing and is fitted with a standard grease gun connection which extends to the top surface of the stabilizer profile.

Rudder

The balanced rudder has a main post of steel tubing to which is riveted the ribs of duralumin channel section. The edge tube is held in the rib ends. Split duralumin bearings fit over the rudder post and are bolted to the sternpost of the fuselage and to the fin post. The top bearing, situated at the top of the fin post locates the rudder vertically, being held between two collars secured to the rudder post.

The rudder lever is made of sheet steel and attached to a fixed flange on the rudder post. It may be removed without disturbing the fabric cover, thus facilitating the packing or storage of the rudder.

Fin

The fin post is a length of steel tubing which fits into the top of the sternpost. The leading edge of the fin is located by bolts welded to a bracket which is riveted to the rearmost top cross member of the fuselage.

Landing Gear

Two Palmer wheels are mounted on a straight single axle of steel tube. Landing and taxying loads are absorbed by "rubber-Oleo" legs which are attached to the axle end fittings and to the front top fuselage joints.(Fig. 9). From the same axle fittings, radius rods are attached and are connected to the bottom center wing rear spar end fittings by ball joints. Cables are used for cross bracing in the radius rod plane. The Oleo legs have a total travel of about 7 inches, $2\frac{1}{2}$ inches of which are taken on oil only and the remainder taken on a series of compression rubbers held in the top chamber. The oil piston has a constant leak, therefore the leg stroke is "damped" in both directions.

Tail Skid

The tail skid arm pivots about the rearmost fuselage bottom cross strut, the shock being absorbed by two sets of compression rubbers attached to the top end of the arm and to the port and starboard fuselage top joints (Fig. 5).

The two shock absorbers are each built up of ten pieces of rubber separated from each other by thin duralumin disks. They are held in place by steel channel pieces at each end and connected to each other by tie rods. Passing through the center of the rubbers and the bottom channel pieces runs a steel rod which is bolted to the top channel. Skid loads are transmitted by this rod to the rubbers through a shackle acting over a trunnion nut screwed on the lower end of the central rod, the shackles of the two shock absorbers being pinned to the fitting on the top of the skid arm.

Elevator and Aileron Controls

Both elevator and aileron control surfaces are balanced, and the controls are of the standard universally mounted type. Ailerons are fitted to the top wings only and are of the "Bristol" Frise type (Fig. 10).

The control column pivots fore and aft about the front end of a short steel rockshaft to the rear end of which is attached the aileron control lever. By sidewise movement of the control column this tubular rockshaft rotates in bearings attached to the fuselage structure. To the bottom of the column is attached an intermediate elevator control tube, which is connected at the rear end to a lever pivoted on a fuselage bottom cross strut; the attachment to this lever is made by a screwed fork. Both fore and aft joints on the intermediate tube are of the universal type and the rear screwed fork allows of slight rotation of this tube when the control column is moved sidewise. The elevator control cables are attached at the front to the fuselage lever and at the rear to central double elevator lever, and are therefore completely within the fuselage.

Aileron control cables are attached to the lever on the rear end of the control rockshaft. Short lengths of chain secured to the cable lengths, pass round sprockets attached to the center section rear spar, thence by cable to other chain lengths passing round sprockets attached to the bottom wing rear spar. The external connection between these wing chain lengths and the aileron lever is made by streamline wires.

The rudder bar is adjustable in flight over a range, fore and aft, of about 4 inches. A square lead screw engages in a boss on a cast aluminum crosshead which carries the rudder bar. Two other bosses, one on each side of the center threaded one, slide over guide tubes held rigidly in a cradle with the center lead screw. The cradle is riveted to a flange on the top of a vertical spindle tube, to the bottom of which is riveted the rudder control lever. Rudder bar adjustment is effected by turning a four-spoke star wheel secured to the rear end of the lead screw, and does not affect the fore and aft position of the vertical spindle or bottom lever and cables. Control cables are attached to the rudder control lever and pass aft to the rudder lever as shown in the diagram of the controls (Fig. 11).

Stabilizer Actuating Gear

Bolted to a bracket on the sternpost, and immediately in front of it, is a housing carrying the bottom attachment of the stabilizer actuating gear. This is a spindle with a square thread cut on it engaging in a sleeve to the top of which is a fork bolted to the rear end of the stabilizer center beam. As previously explained, this beam carries the stabilizer and elevators and may be adjusted by the movement of the thread (Figs. 7 and 8).

A control wheel is fitted in the pilot's cockpit, and to this is attached a sprocket wheel engaging a chain length. From the ends of the chain length are two lengths of cable spliced at the rear end to another chain which engaged in a sprocket wheel attached to the bottom of the square thread mentioned above.

Although the stabilizer actuating gear aft and the stabilizer center beam are entirely enclosed in the fuselage fairing, access is afforded by a removable panel on each side of the fuselage under surface. The top fabric at this point is laced in position.

Engine Controls

The engine control levers are fitted on the port side of the pilot's cockpit and comprise throttle lever, with gate fixed at approximately half throttle, altitude lever, and ignition lever. The arrangement is such that while the throttle lever may be independently operated, the ignition lever cannot be advanced ahead of the throttle. Upon closing the throttle, ignition is automatically retarded by the enforced backward movement of the ignition lever.

Fuel System

Gasoline is supplied to the carburetors by a simple gravity feed system. Two tinned steel wing tanks, each of 35 gallons capacity, are mounted in the top wings. Steel tubes lead from the tank sumps to each side of the fuselage; these fuel pipes are streamlined by the addition of fairing pieces, taped and glued on. Cocks are fitted beneath the tank sumps and have control rods extended to the wing trailing edges, where levers are fitted which are clearly marked and within easy reach of the pilot. The tanks are fitted with a magnetic-float type of fuel level indicator, this arrangement rotates a multicolored disk clearly visible from the cockpit; a corresponding color chart is fitted in a convenient position in front of the pilot. The gasoline gauge and float may be detached from the tank by breaking a joint on the sump.

Oil System

The oil tank which incorporates the oil cooling device is made of thin sheet steel, and is suspended from the fuselage bottom longerons immediately aft of the fireproof bulkhead.

The cooling space is the space between the outer shell and an inner skin secured in position by the rivets holding the external cooling fins and the internal spacing channels. Oil enters this space and, under normal running conditions, is forced up the inner sides of the tank to empty into the main body. Should the oil be congealed when starting the engine, warm oil is forced along the inlet tube and through a spring loaded bypass valve which is held in the end of the tube. Passing the relief valve oil is free to flow into the main body of tank until such time as the cooling space is free and the passage of oil through it is moving at the normal speed.

Equipment

Two Vickers guns are fitted, one on either side, in a position that is impossible to improve upon from the point of view of accessibility in the air. It is quite possible in flight to open the lid of the gun, which is automatically held up until released; and if necessary to remove and replace the lock or any part of the gun requiring attention. The loading handles are in the best position for working and belt box feed chutes can be opened and examined with ease. The belt boxes can be loaded in position through the hinged lids, although it is a simple matter to withdraw them complete through the side doors of the fuselage. The gun mountings are fitted with a patented device for lining up. By means of two knurled screws, the rear of the gun may be adjusted vertically or horizontally and instantly locked in any position by a locking nut.

The gun sights are rigidly mounted on a fore and aft member independently of the fairing. The external brackets are quickly detached by means of wing bolts to leave a clean exterior when not in use.

All radio services are grouped on the port side of the airplane and all electrical wiring and apparatus on the starboard side. All wiring is run in aluminum conduits for protection. These conduits are open channels and the wires are held in by spring clips so that the inspection or removal of any wire is a simple matter.

The oxygen installation is grouped to starboard, and the bottle is held in a quick release cradle; it is easily withdrawn through one of the side doors. The bayonet attachment for the mask is mounted on the starboard longeron and the flow meter in the fairing directly in front of the pilot.

Dimensions*

Span	34 ft. 0 in.	Area, top wing	193 sq.ft.
Length	24 " 9 "	" bottom wing	115 "

Total wing area, 308 sq.ft.

Weights

Total weight empty, Jupiter VI	1947 lb.	883 kg
" " " Jupiter VII	1997 "	906 "

Military load:	lb.	kg		lb.	kg
Pilot	180	82	Oil (8 gal.)	80	36
Gasoline (70 gal.)	532	241	Guns, sights, instruments, equipment, etc.	164	361

Total load, 1153 lb. 523 kg

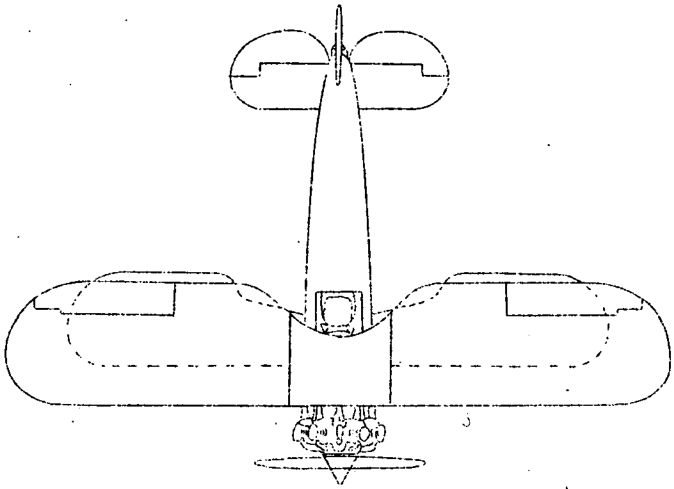
Weight fully loaded, Jupiter VI	3100 lb.	1406 kg
" " " Jupiter VII	3150 "	1429 "

Performances

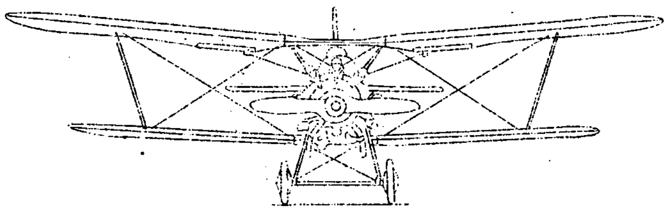
		Fitted with Jupiter VI, total loaded weight of 3100 lb. (1406 kg)	Fitted with Jupiter VII, total loaded weight of 3150 lb. (1429 kg)
Speed at ground level,		168 m.p.h. 270 km/h	-
" "	1000 m 3250 ft.	167 m.p.h. 269 km/h	-
" "	2000 m 6500 ft.	166 m.p.h. 268 km/h	-
" "	3000 m 10000 ft.	165 m.p.h. 266 km/h	177 m.p.h. 285 km/h
" "	4000 m 13000 ft.	163 m.p.h. 262 km/h	175 m.p.h. 281.5 km/h
" "	5000 m 16500 ft.	159 m.p.h. 256 km/h	172 m.p.h. 277.5 km/h
Climb to	1000 m 3250 ft.	2.1 min.	2.2 min.
" "	2000 m 6500 ft.	4.5 "	4.1 "
" "	3000 m 10000 ft.	6.9 "	6.2 "
" "	4000 m 13000 ft.	9.5 "	8.1 "
" "	5000 m 16500 ft.	12.5 "	10.5 "

Ceiling, fully loaded 9500 m 31200 ft.

*From Flight, July 11, 1929.



Drawing taken from "Flight" July 11 1929



Span 34'0"
Length 24'9"
Wing area 308 sq.ft.

Bristol
"Jupiter VII "
engine.

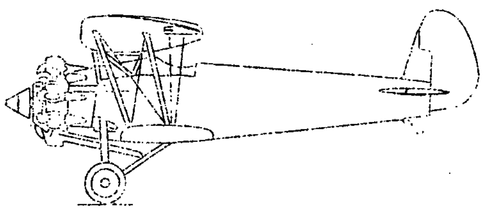
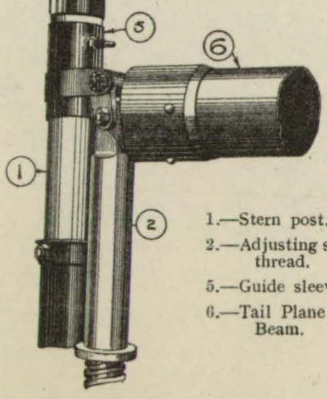


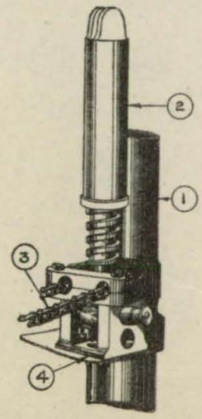
Fig.1 Bristol "Bulldog" single-seat fighter airplane.

Figs. 2 & 3 Views of the Bristol "Bulldog" airplane



1.—Stern post.
2.—Adjusting sleeve and thread.
5.—Guide sleeve.
6.—Tail Plane Centre Beam.

Fig. 7 Attachment of adjusting sleeve to stabilizer center beam



1.—Stern post.
2.—Adjusting sleeve and thread.
3.—Chain working on sprocket.
4.—Base of adjusting thread secured to bracket on the stern post.

Fig.8 Attachment of base of stabilizer adjusting gear to stearn post.

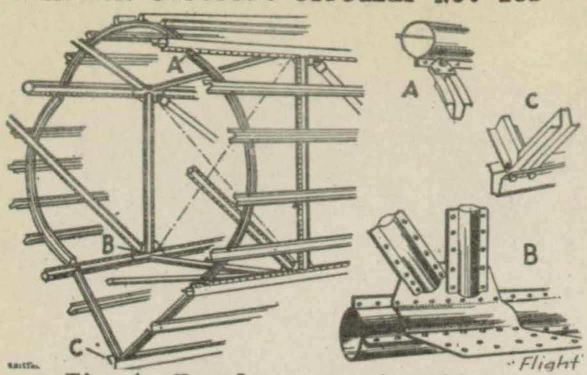


Fig.4 Fuselage construction

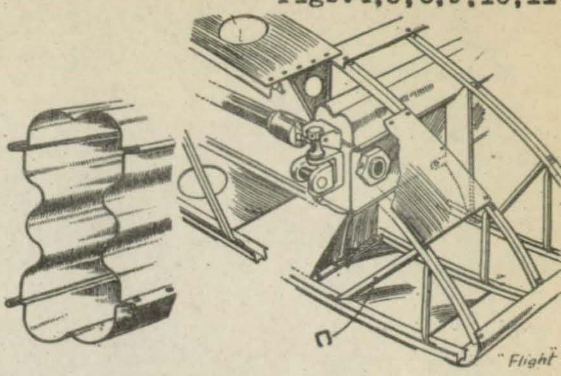


Fig.6 Main spar (steel) and other wing details.

Details of the Bristol" Bulldog" airplane

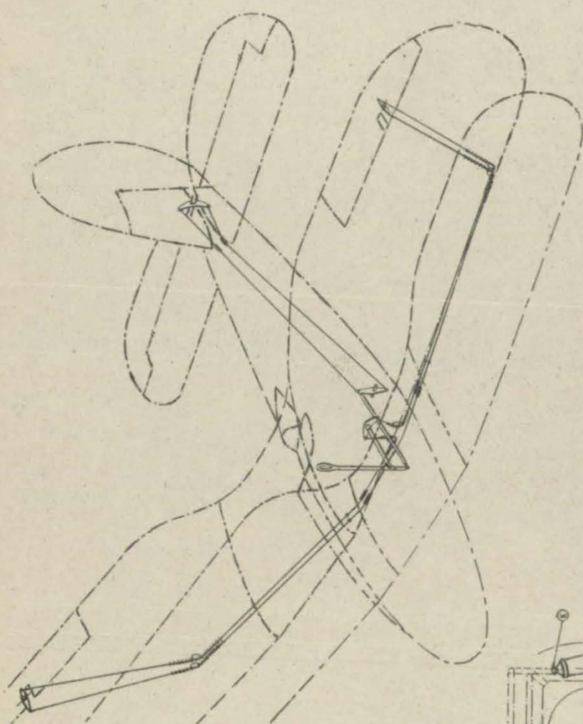


Fig. 10 Diagram of aileron and elevator controls.

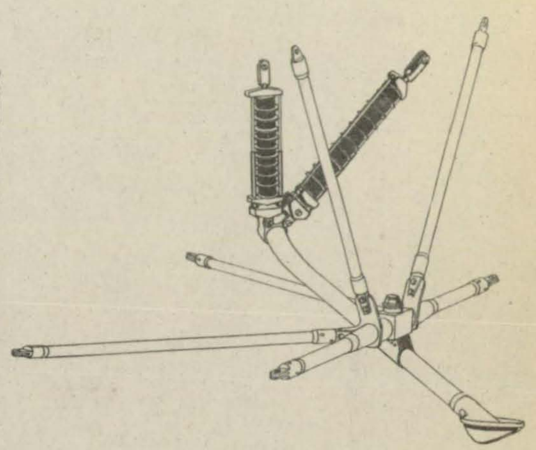
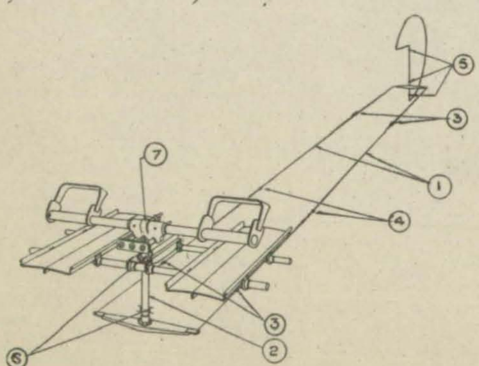
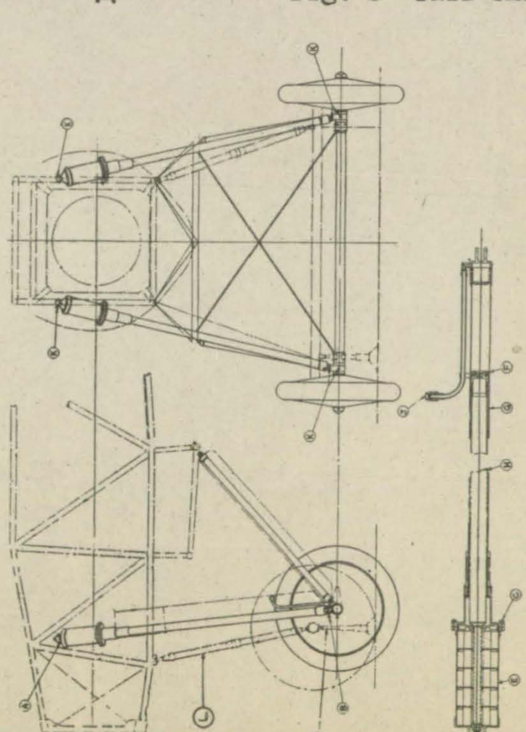


Fig. 5 Tail skid



(1) Cables
(2) Spindle tube
(3) Cable Guides
(4) Turnbuckles
(5) Oilers
(6) Grease gun connection
(7) Adjustable tiller bar

Fig. 11 Diagram of rudder controls



(a) Lower bolt in connecting block
(b) Grease gun connection.
(c) Studs securing flanges.
(d) Nut securing piston hub in top cap.
(e) Top cylinder holding compression rubbers.
(f) Cup leathers of piston.
(g) Outer tube or oil chamber.
(h) Inner tube or piston tube.
(k) Grease gun connection.
(j) Oil filler.
(l) Special jack for removing leg.
(m) Special jack for removing wheel.

Fig. 9 Diagram of landing gear