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No. 197

THE DE HAVILLAND "COMET" LONG-RANGE AIRPLANE (BRITISH)
A Low-Wing Cantilever Monoplane

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THE DE HAVILLAND "COMET" LONG-RANGE AIRPLANE (BRITISH)*

A Low-Wing Cantilever Monoplane

Stressed-skin construction has been used extensively in the new De Havilland airplanes specially designed and built for the England-Australia race. (See figs. 1, 2, 3, and 4.)

It may be pointed out that the expression "stressed skin" is applied to a form of wing or fuselage covering, which, in addition to giving the component the desired external form, helps also to give it strength. In an ordinary biplane wing, the strength is provided by the primary structure, spars and ribs; the doped fabric is not taken into account, although it may under certain conditions contribute something to the strength. The stressed-skin covering may, of course, be of any material capable of resisting compressive loads, such as wood or metal. When metal is used, it is of necessity applied in very thin panels in order to reduce weight. This means that unless stiffened by some internal framework of stringers or the like, the metal skin will crinkle. When wood is used for the skin, less stiffening is usually necessary because the wood, being much lighter than metal, can be and is used in much greater thicknesses.

In the case of the De Havilland "Comet" the use of a stressed skin was, once wooden construction had been decided upon, forced upon the designers by the fact that two spars of a size which could be housed in the thin wing section employed would not have provided sufficient strength, even if they were of solid wood. To obtain the requisite strength the wing covering had to be made of a form which would reinforce the spars (figs. 5, 6, 7, 8, and 9). The system finally adopted was one in which certain members having the appearance of orthodox wing spars, and of similar construction, i. e., box section, are used for taking the shear loads and for transmitting the loads to the covering. Bending and torsional loads are taken by the skin, which is in the form of a spruce planking laid

*From Flight, September 20, 1934.

on after the manner of "double-diagonal" planking of many lifeboats. That is to say, there is an inner and an outer layer, each composed of spruce strips some 2 inches wide, the strips of inner and outer layers crossing each other at approximately right angles (fig. 10). The thickness of this skin or planking is reinforced where the stresses are high, such as on the upper surface near the root of the wing, by a third and even a fourth layer, reaching in places a thickness of more than half an inch. At other places, such as at the tips where the loads are small, the planking is only about one eighth of an inch thick.

FUSELAGE CONSTRUCTION

For the fuselage a somewhat similar construction has been adopted (fig. 11). The shape is almost a perfect streamline, but not quite. The sides, which are not of great depth, are flat, and there would be no point in using the double-diagonal type of planking for them. Consequently, they are covered with plywood in the ordinary way. The top and bottom of the fuselage, however, have a double curvature, and are planked with spruce strip in the same manner as the wing. This is necessitated by the fact that sheet material cannot be bent to a double curvature. It can, to put it in a different way, be bent into the form of a cylinder or cone, but not into the shape of a barrel. The use of diagonal-strip planking makes it easy to get a smooth double curvature. The nose and tail fairings of the fuselage are of beaten elektron sheet.

From an aerodynamic point of view the De Havilland "Comet" is interesting on account of the trouble taken to reduce drag to a minimum. The fuselage is, as already mentioned, of nearly perfect streamline form. Its maximum cross-sectional area has been kept down to the minimum which would house the crew, and by placing the cockpit well aft, increasing the fuselage depth slightly behind the cockpit, and using a flatly sloping windshield, the break in the air flow caused by this necessary excrescence has probably been reduced to a minimum. The view obviously cannot be as good as if the cockpit were in the nose of the fuselage, but in a racing airplane something must always be sacrificed for speed.

THE RETRACTING LANDING GEAR

The fact that the airplane is a twin-engine monoplane, has brought with it the almost inevitable use of retractable landing gears, the wheels of which draw up into the tail fairings behind the engines (figs. 9, 12, 13, and 14). A mud guard over the front of each wheel prevents stones, etc., from being flung into the propeller, and when the wheels are raised this same mud guard forms part of the bottom of the engine nacelle, leaving merely an opening large enough to let the air escape from inside the engine cowling.

Sheet-metal fillets are used where the wing joins the fuselage in order to reduce interference and keep the air flow as smooth as possible. The same system has been employed on the tail, fillets being used to run the fin surface gradually into that of the fuselage and stabilizer. The rudder extends down to the top of the fuselage only so that in straight flight and for small rudder movements, there is an easy path for the air to follow and eddying is reduced to a minimum. By giving wings and fuselage several coats of paint, rubbing down between coats, and repeating the process, a remarkably smooth surface has been obtained which, by reducing skin friction in such a fast airplane, should add materially to the speed.

An airplane with the aerodynamic "cleanness" of the "Comet" will obviously have a very flat gliding angle, and when most of the fuel has been consumed, so that the wing loading is reduced, it might be a matter of some difficulty to bring the airplane into a small airport. In order to make this possible, air-brake flaps have been fitted. These take the form of split trailing-edge flaps over the central portion of the wing, extending from one engine nacelle to the other (figs. 14 and 15). When closed, the flaps lie snugly against the main wing surface. They are operated by a simple torque tube and levers.

Designed for long-range flying (the distance from London to Baghdad is about 2,550 miles), the "Comet" is provided with very large fuel capacity. The three tanks are all carried in the fuselage; one of 128 gallons capacity in the nose, another of 110 gallons capacity approximately, over the center of gravity, and a third, of 20 gallons, just aft of the cockpit. The latter tank is used for trimming purposes. As fuel is consumed the forward

tank begins to empty, and to keep the airplane from being tailheavy a small quantity is taken from the rear tank, which is farther from the c.g., and therefore works on a longer leverage. In addition, the elevators are provided with a spring-loading device for trimming purposes. The stabilizer itself cannot be adjusted for incidence.

Accommodation is provided in the cockpit for a crew of two. They are seated one behind the other, and have dual controls so that they can take turns at piloting. A well-equipped instrument board is placed in front of the forward seat, and can be seen by craning slightly from the back seat also. The flying controls are of the usual type, with a plain "stick" for elevator and ailerons. A large wheel to the right of the front seat operates the landing gear retracting mechanism. On the left is a lever which operates the air-brake flaps fitted under the central trailing-edge portion of the wing. Wheel brakes are connected to the rudder bar for steering on the ground. A transparent roof over the cockpit encloses the occupants.

Flying-control surfaces are of usual type, with a form of Frise aileron operated by the patented De Havilland differential method. The ailerons are mass-balanced by lead distributed along the leading edge of the aileron. Rudder and elevators have the usual bob-weight mass balances. In the rudder and elevator controls a mechanism has been inserted to give a very low gear ratio at small angles of movement of the control surfaces and an increasingly greater ratio for larger movements (fig. 16). This has, of course, been done in order to provide lightness of control and eliminate violent response to small movements of the controls at high speed.

Engine mountings and landing-gear attachments form almost the only metal parts in the "Comet". Welded steel tube construction is used for the engine supports, and the landing-gear wheels are carried on steel forks with telescopic limbs. The wheels are raised and lowered by a worm gear, or rather by the use of "overgrown" bolts and nuts, the nuts forming cable drums for the operation of the gear. Thus when the nuts are rotated by cables from the cockpit, they draw the bolts upward, shorten one member, which forms one side of a triangle, and thereby raise the triangle and with it the wheel. The movement is explained in two diagrams (figs. 12 and 13). As the worm gear is self-locking, no danger arises if the airplane should land with the wheels not quite in the "fully down" position.

The Dunlop wheels are provided with brakes which can, as already mentioned, be operated separately via the foot bar. They can be locked on together for parking. Instead of a tail wheel there is the usual tail skid, which is thought to offer less air resistance and which helps to pull the airplane up when landing (fig. 17).

The power plants fitted in the "Comet" are De Havilland Gipsy Six engines, specially modified for the purpose of the MacRobertson Race. By using a modified cylinder head, valve rocker gear and piston, the over-all height of the engine has been slightly reduced, the compression has been raised from 5.25 to 6.5, and the engine works satisfactorily on standard service fuel to D.T.D. 224 specification.

In order to take advantage of the use of the Hamilton controllable pitch propellers fitted, the normal speed of the engine has been increased to 2,350 r.p.m. At the maximum of 2,400 r.p.m., the engine develops 224 b.hp. on the bench. In the air this is slightly increased owing to the small degree of boost obtained by the high forward speed of the airplane. A new crankshaft has had to be made to get an appropriate hub fixing for the Hamilton propeller. The high pressure required (about 100 lb./sq.in.) to operate the pitch control of the propeller is obtained from the usual engine pumps through duplicate oil relief valves. It does not affect in any way the normal lubrication system. The standard arrangement of alternative hot or cold air supply for the carburetors has been retained in case adverse weather conditions are encountered during the race. Warm air, if required, is taken from the vicinity of the cylinders through a flame trap.

A special coupling is provided on the rear end of the crankshaft for driving a rotary vacuum pump used to operate the Sperry gyro-compass.

But few data relating to the "Comet" are available. The dimensions and areas are shown on the general arrangement drawings and under the characteristics given below. The gross weight is in the neighborhood of 5,250 pounds. As the quantity of fuel carried is 258 gallons, a little guessing puts the tare weight, fully equipped, at something like 3,000 pounds. Should this be approximately correct, the ratio of gross to tare weight is 1.75. In other words, the airplane carries 75 percent of its own weight.

CHARACTERISTICS

Dimensions:

Length 29 ft.

Wing span 44 "

Areas:

Total wing 212.5 sq.ft.

Ailerons 24.2 "

Stabilizer 11.3 "

Elevators 14.6 "

Fin 7.3 "

Rudder 9.6 "

Weights and Loading:

Gross weight, about 5,250 lb.

Tare weight, about 3,000 "

*Wing loading 24.7 lb./sq.ft.

*Power loading 11.8 lb./hp.

*Taken from The Aeroplane, September 19, 1934.

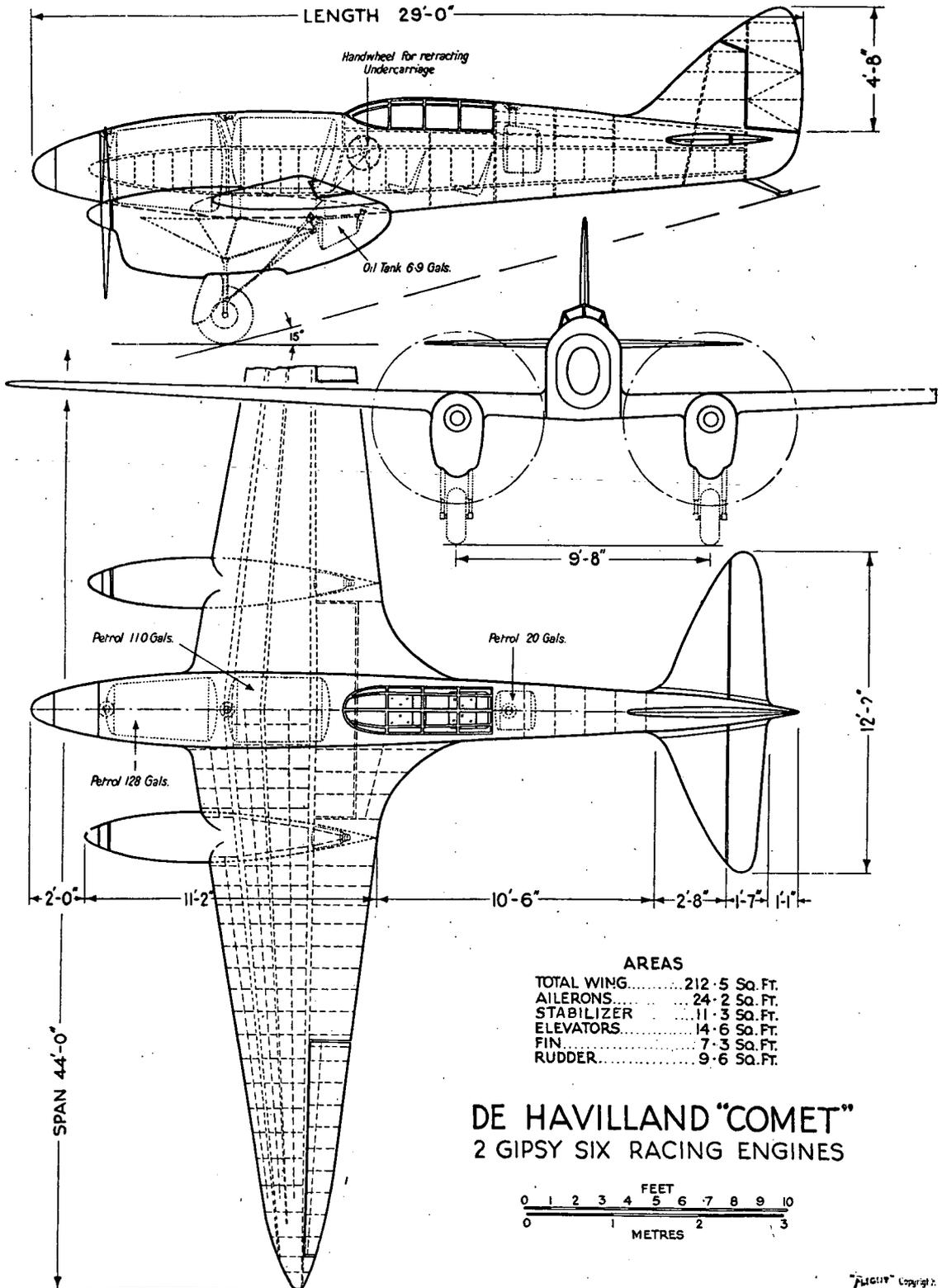


Figure 1.- General arrangement drawing of the DeHavilland Comet airplane.

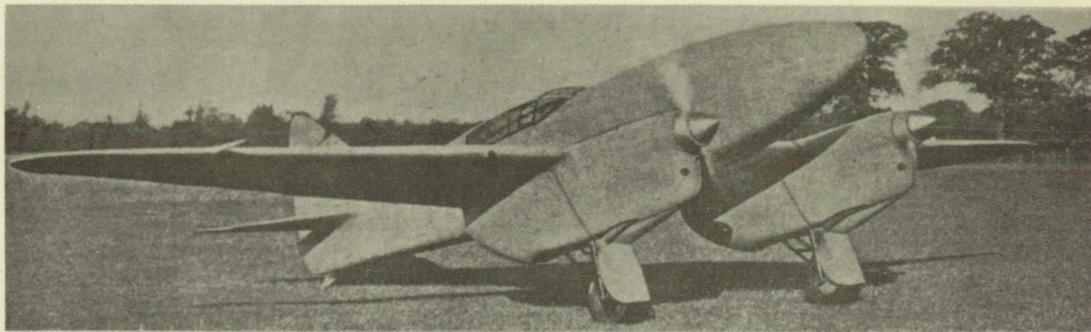


Figure 2.- Three-quarter front view of the DeHavilland Comet airplane. *"The Aeroplane"*

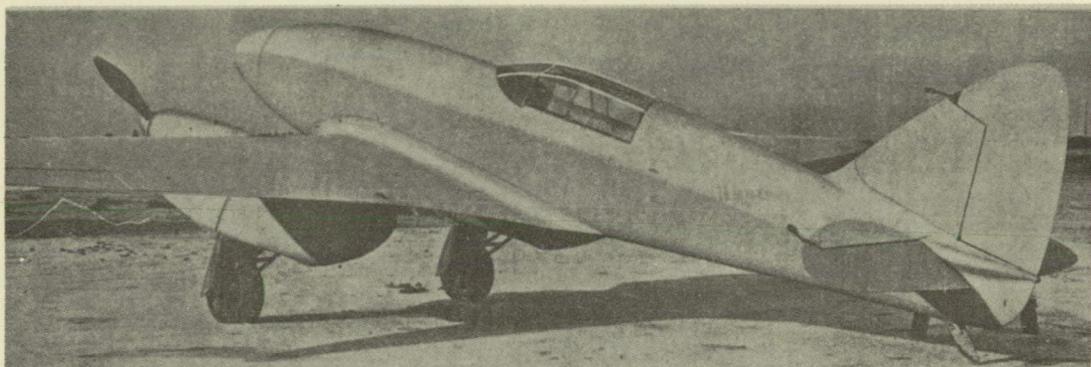


Figure 3.- Three-quarter rear view of the Comet. *"The Aeroplane"*

Figure 15.- The trailing edge flap air brake extending from one engine nacelle to the other in two halves. *"Flight"*

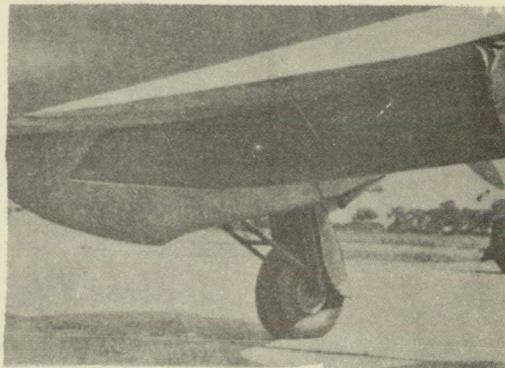


Figure 4.-

Close-up front view of the Comet showing the mud guards which form a part of the cowling. *"Flight"*

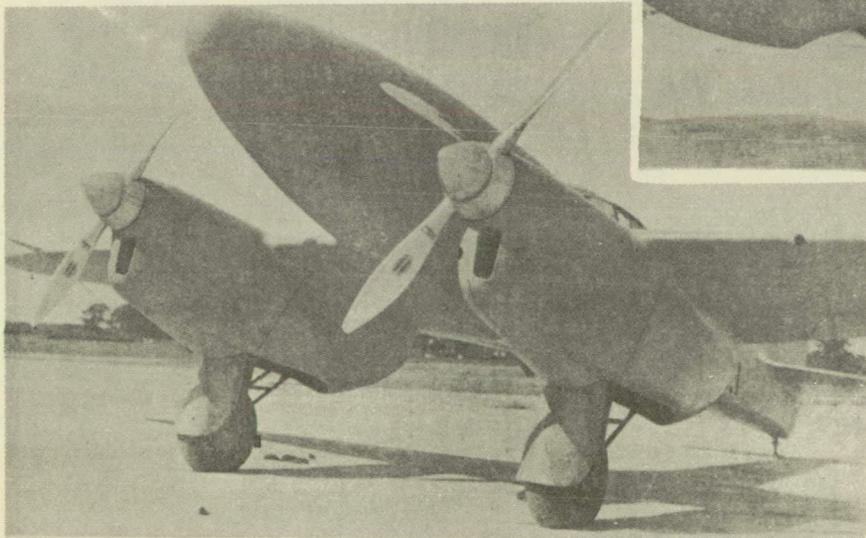


Figure 7.- Sectional assembly of the Comet
"Flight"

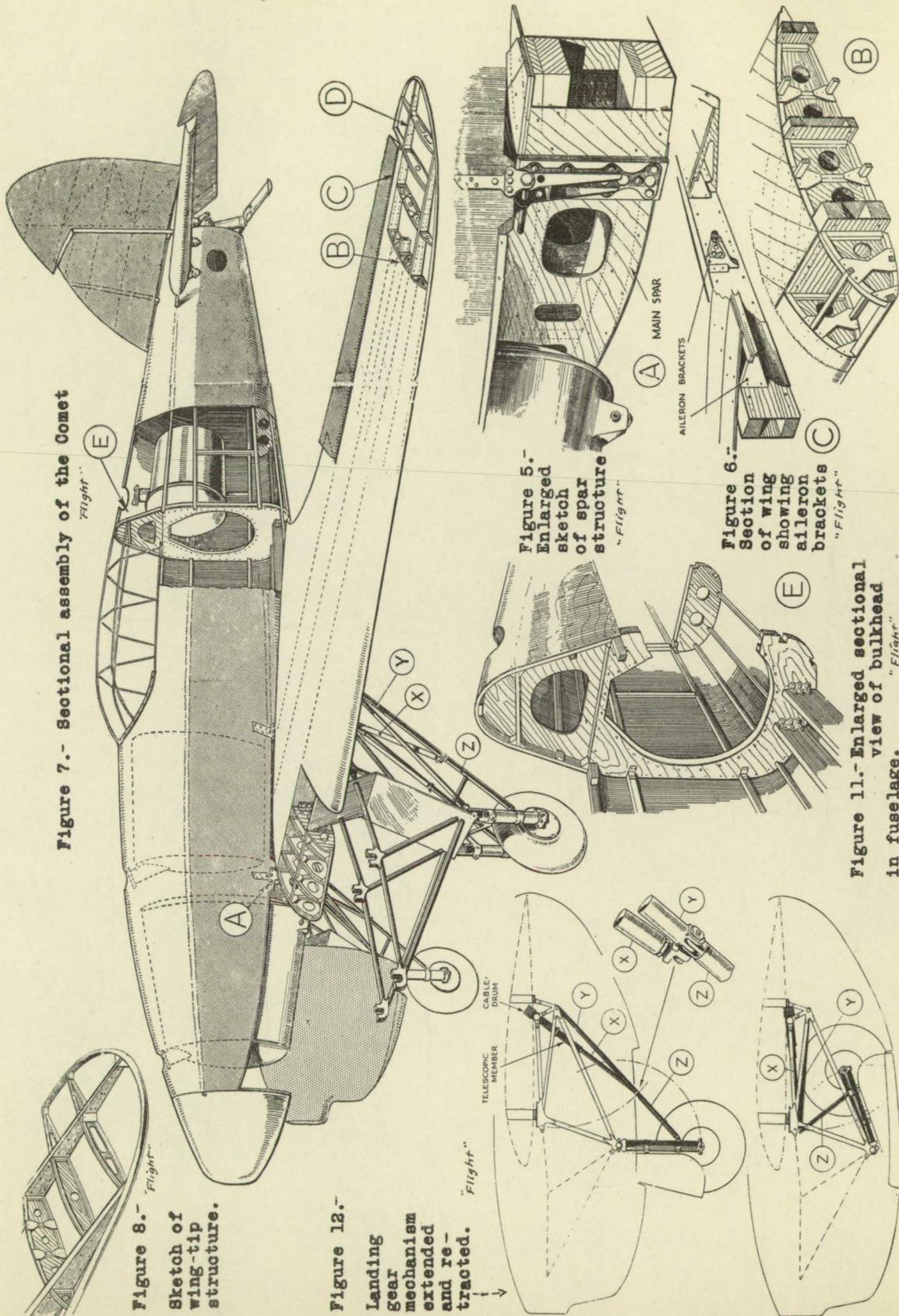


Figure 8.-
"Flight"
Sketch of wing-tip structure.

Figure 12.-
Landing gear mechanism extended and retracted.

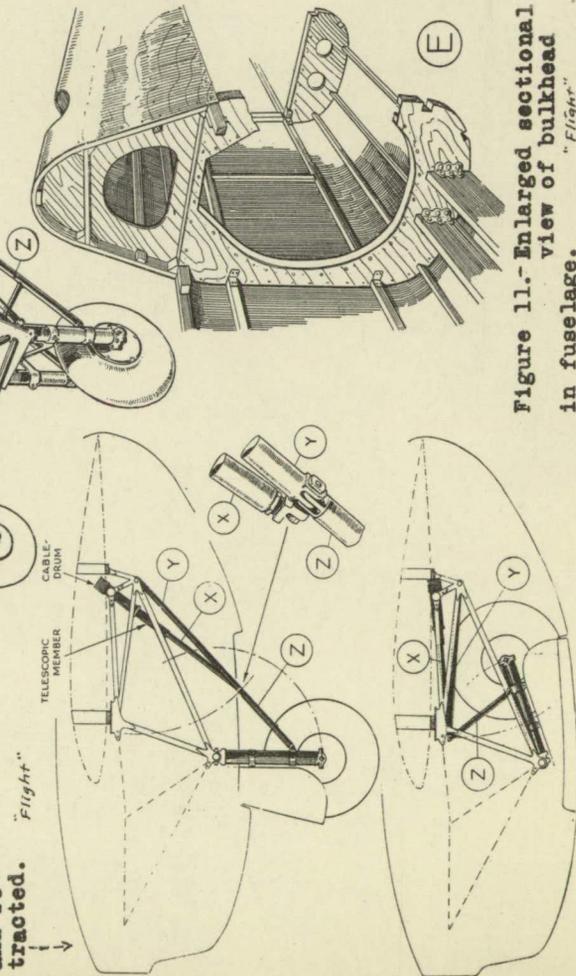


Figure 11.- Enlarged sectional view of bulkhead in fuselage.
"Flight"

Figure 5.-
Enlarged sketch of spar structure
"Flight"

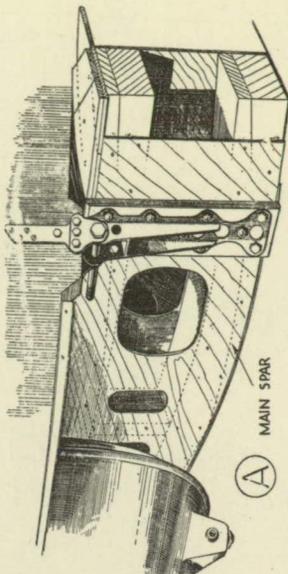
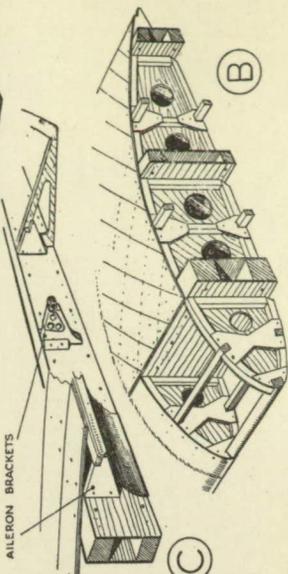


Figure 6.-
Section of wing showing aileron brackets
"Flight"



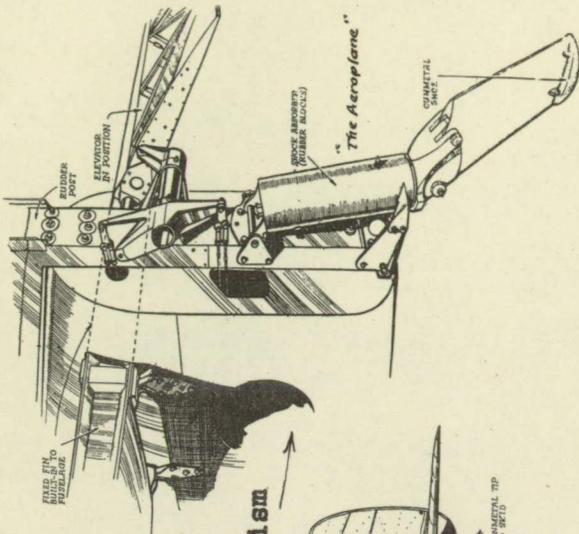


Figure 13.- The Landing gear structure. "The Aeroplane"

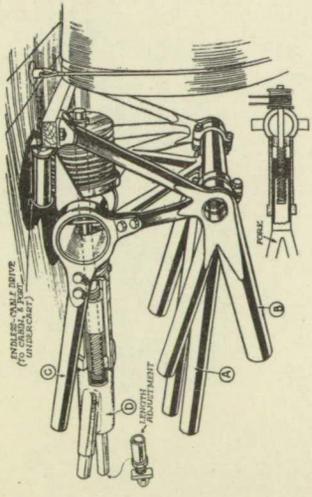


Figure 14.- Sketch showing gear and landing gear retracted. "The Aeroplane"

Figure 17.- Tail skid mechanism

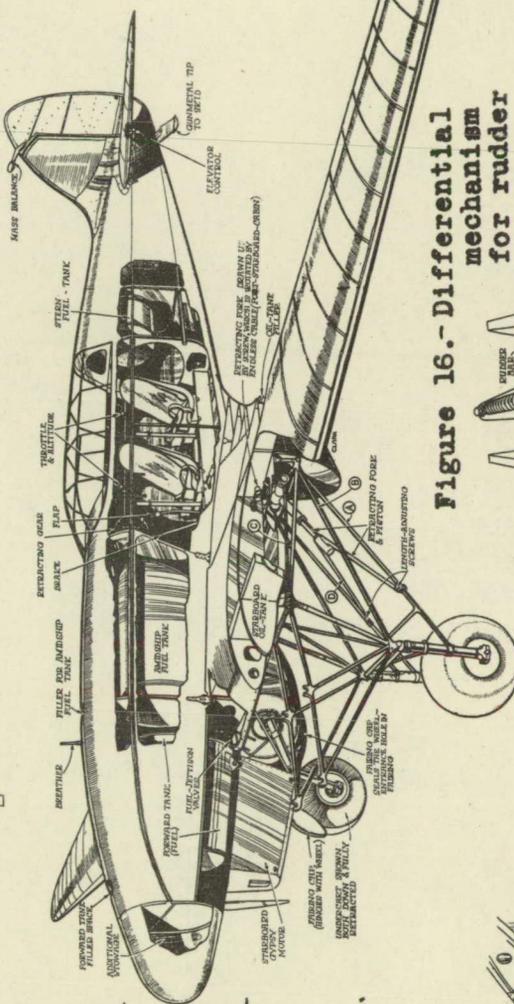


Figure 9.- Detailed sectional and interior view of the Comet. "The Aeroplane"

Figure 16.- Differential mechanism for rudder bar. "The Aeroplane"

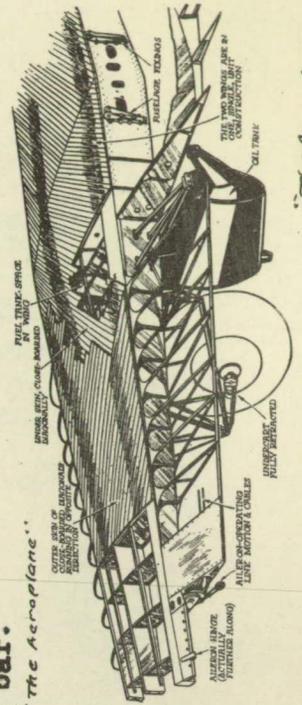
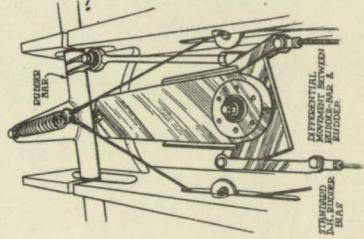


Figure 10.- Detail of wing structure showing diagonal planking. "The Aeroplane"