THE *Fleet* BIPLANE

(MODELS 1 AND 2)

By Leslie E. Neville

THE FLEET BIPLANE, which is at present manufactured by the Consolidated Aircraft Corp., Buffalo, N. Y., for Fleet Aircraft, Inc., is a two place, single bay type having seats in tandem in a single cockpit cutout, and designed for engines in the 60-150 hp. range of radial air cooled types. It was intended originally for the seven-cylinder Warner "Scarab" engine which develops 110 hp. at 1,850 r.p.m. and more recently has been offered with the five-cylinder Kinner K-5 power plant which is rated 100 hp. at 1,850 r.p.m. The Scarab powered plane is designated Fleet Model 1 and the Kinner powered craft, Model 2. Other installations will be offered when thoroughly tested.

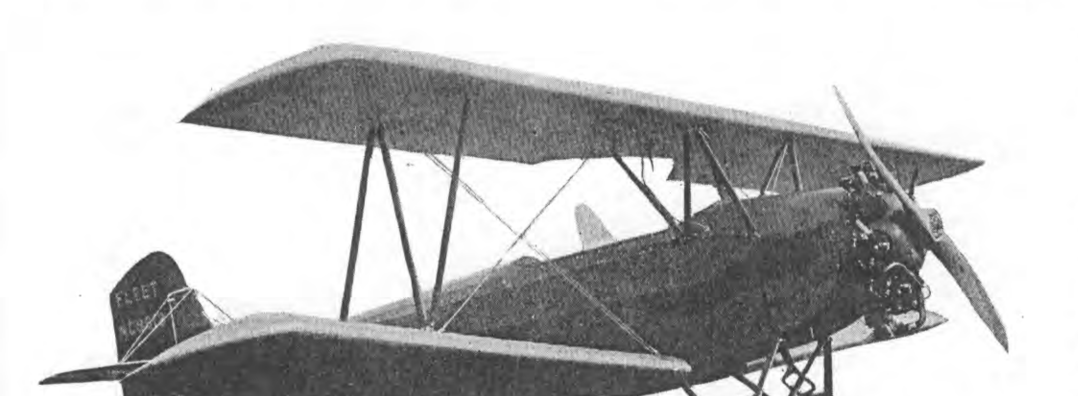
The Model 2 has a high speed (sea level) of 113.5 m.p.h. at 1,900 r.p.m., a minimum speed of flight of 40 m.p.h., a rate of climb at the ground (full load) of 930 ft. per min. and a ceiling of 16,000 ft. The high speed of the Model 1 is 111 m.p.h.

The weight of the Model 1 empty with wooden propeller and without starter, is 976 lb. The disposable load is 554 lb. and the gross weight is 1,530 lb. The weight of the Model 2 empty, with metal propeller and starter, is 1,022 lb. disposable load 560 lb. and gross weight 1,582 lb. Model 1 is manufactured under approved type certificate No. 122 and Model 2 under approved type certificate No. 131.

The plane has a wing span of 28 ft., a length of 20 ft. 9 in. The height of the Fleet Biplane is 7 ft. 10 in.

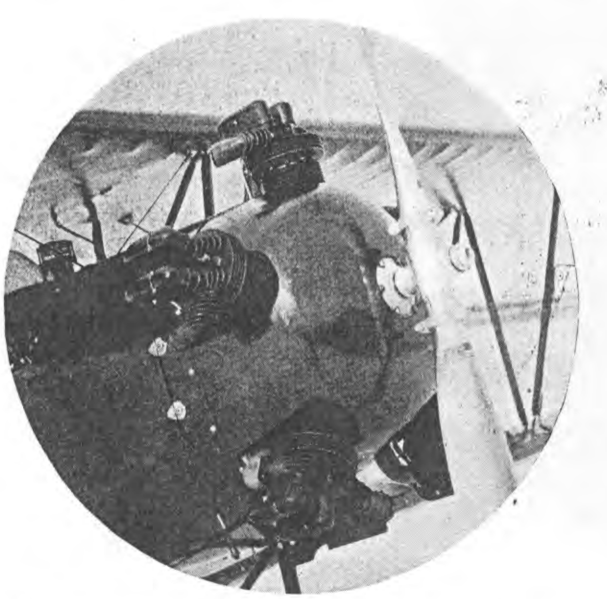
Wings are rectangular in plan form and set at an angle of incidence of 0 deg. for both. The lower wing is set at a dihedral of 4 deg. while the upper wing is flat. The cellule comprises one upper and two lower panels, a center section cut-out being provided in the upper panel to improve visibility and facilitate parachute exit. The upper wing has an area of 99.7 sq.ft. and the lower panels each have an area of 47.35 sq. ft. A Clark "Y" airfoil section, expanded to 15 per cent, is employed.

Spruce spars and aluminum alloy ribs are used in the wing structure. The ribs are built of heat-treated duralumin stampings .014 in. in thickness excepting those whose extended cap strips carry the aileron hinges, these being of .045 in. stock. A flanged "U" section is employed in the cap strip while the vertical members are of channel section. The cap strip section is 1 in. in overall width, including the two $\frac{1}{4}$ in. flanges, and $\frac{21}{32}$ in. deep. The channel section is $\frac{1}{2}$ in. wide by $\frac{5}{8}$ in. deep. Duralumin rivets $\frac{1}{16}$ in. in diameter are used in fabricating the ribs which weigh approximately 5 oz. each. Nose ribs of curvature different from the former ribs to prevent fabric sag are inserted between the former ribs. Cement coated nails are used to attach all ribs to the top and bottom of the spars. These nails merely locate the ribs as the upper and lower cap strips are tied to the spars. In order to avoid the difficult nose curvature of the ribs, upper and lower cap strips are made separately and riveted to the .030 duralumin leading edge. Trailing edge, center section cut-out and wing end bows also are of .030 duralumin, heat-treated. Walkboards are of .065 duralumin and will support a man at the trailing edge with a safety factor of three.



A front quarter view of the Warner powered Model 1 Fleet biplane showing the landing gear and cowling

The aluminum alloy used in the wing structure is of high tensile strength and is of the same composition as that used on the first 50 PT models built by the Consolidated Aircraft Corporation and which have been in service for four years. A special heat-treating furnace has been developed and is installed close to the stamping press to insure a continuous flow of materials to the press.



A view of the nose of the Fleet Model 2, showing the Kinner engine installation

A selected grade of airplane spruce is used in the wing spars, which are rectangular in section. The upper wing spars are built up of three laminations and are $1\frac{3}{16}$ in. wide, the front being $4\frac{1}{8}$ in. deep and the rear $3\frac{7}{8}$ in. deep. The spars of the lower wing panel structure are of the same dimensions as those of the upper wing but are solid.

Six bays are made in the drag bracing of each lower wing panel and eight are provided in the upper wing exclusive of the center section. The single, unswedged tie-rods, employed for rigidity rather than strength, are set at an angle of 45 deg. This setting has been found by experience to give the greatest rigidity in this type of bracing. Compression struts are $\frac{9}{16}$ x .028 in. chrome molybdenum steel tubes, cut off squarely in a lathe and set over the heads of the drag wire fitting bolts.

Each drag fitting is attached to the spar by a single bolt through a Bakelite spool inserted in a reamed hole, and large duralumin disks $\frac{1}{8}$ in. thick are placed on the faces of the spars. This makes attachment a rigid assembly and prevents washers from embedding themselves in the spars.

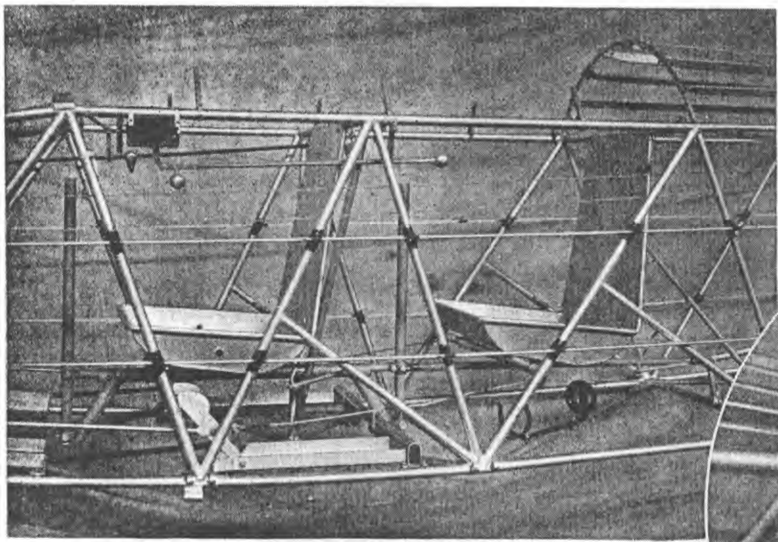
The main wing fittings are of one-piece design, the single welds being under practically no stress. They are bolted to the spars through Bakelite spools inserted in reamed holes, increasing the bearing area in the wood by 150 per cent and eliminating the trouble caused by bolts embedding in the spar. The layout of the position of these bolts is such that the centroid of the bearing area in the wood coincides with the truss center line. This eliminates rotating tendency between the fittings and spar and prevents one bolt from taking more than its proper share of the load. This is quite important as a small shift in the location of one bolt will add 25 to 50 per cent to its load and cause premature embedding in the spars.

It is possible to replace either front or rear spar in either upper or lower wing panels without destroying or losing a single rib or fitting, a point of great advantage in training operations where minor crashes are frequent.

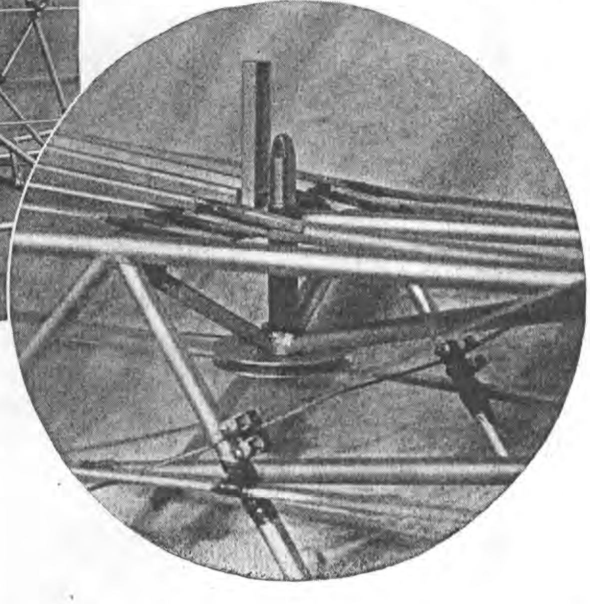
Ailerons are provided on lower wings only as the upper wing reaches the burble point 8 deg. earlier than the lower. The aileron structure is of wood, the leading edge is a fairing of .014 duralumin. Ailerons are balanced by locating the hinges behind their leading edges and the hinge fittings on the wing structure are riveted into the ends of the previously mentioned extended cap strips of the ribs. A single long hinge pin is provided for each aileron and is inserted through a hole in the wing end bow, engaging all hinges when they are in alignment. The end of the pin is bent, flattened and fastened to the tip bow by two screws.

One of the most interesting features of the Fleet airplane is the patented aileron control system. The system is extremely simple and consists essentially of a push-pull tube in each wing connected directly to the stick and attached to a lever pivoted to the aileron on an axis inclined in both front and side elevation. Motion of this lever transversely moves the aileron up and down with a differential action. As the operating lever attached to the aileron is telescoped, assembly of the aileron to the wing is a simple matter. The wing structure is protected by three coats of spar varnish.

An original feature in the production of the plane is the patented method of attaching the fabric to the wings. Holes .05 in. in diameter are punched into the cap strips of the ribs and a tapered end punch and die is then run through each, producing bell mouth holes .089 in. in diameter. The fabric is next applied to the structure and a $\frac{3}{8}$ x .020 in. duralumin washer is laid on the fabric over each hole. Attachment is made by the use of No. 4x$\frac{1}{4}$ in. Parker-Kalon sheet metal screws, having special heads. These screws, when used in this size and type of hole, will not come out even if the thread is damaged. Round fabric patches, one inch in diameter and stamped out in large quantities at the factory, are doped on to the fabric to cover the screwheads.



A portion of the uncovered fuselage of the Fleet biplane showing construction and installations



The screw type stabilizer adjusting mechanism of the Fleet plane. Several of the standard attachment clips also are shown

Single streamline wire trusses are used in the external bracing and consist of two flying wires and one landing wire. The flying wires are $\frac{5}{16}$-24-6100 and the landing wire is $\frac{1}{4}$-28-3400. The stagger is 23 in. and the bracing wires are in the plane determined by the rear upper and front lower spars. The center of the lift forces in flight comes very close to the plane of this vertical truss, resulting in very little torsional stress on the wings and great rigidity. Wing heaviness can be corrected in the air by adjustment of the left diagonal center section strut, the adjustment nut being located within easy reach of the pilot.

THE STATIC TESTS with balanced and unbalanced loads, conducted on the wing cellule, indicated load factors of four for inverted flight, six for low incidence and 11 for high incidence conditions. In the inverted flight test, sand bags were piled on the upper surface of the wing to a load factor of four and the load was then unbalanced by removing one load factor from the right wing. In the low incidence test, sand bags were piled on the lower surface of the wing to a load factor of six and the load factor was unbalanced by removing 1.5 load factors from the left wing. In the high incidence test, the load was carried to a factor of eight and unbalanced by removing 30 per cent of the load from the left wing. These tests were all successfully carried out without signs of failure though with some permanent deformation.

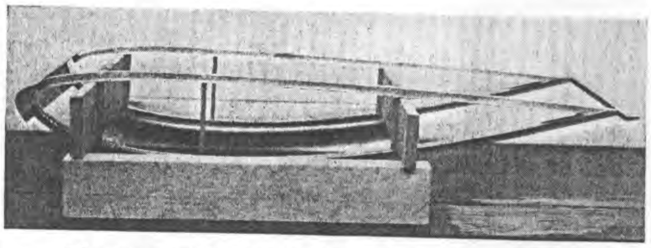
Loading was resumed after the high incidence unbalanced test and carried to a factor of 10 where some bending of the interplane struts was observed. Some of the sand load was piled against these strips for the following loads to retard their failure. The struts held a load factor of 11 for about 10 sec. after releasing all jacks before the left wing failed through the buckling of the interplane struts. Subsequent inspection of wings showed only minor elongation of holes. As no flight load of so great intensity lasts as long as 10 seconds it is assumed that the structure will carry a load of 11 factors under actual flight conditions.

The welded chrome molybdenum steel tube fuselage is designed primarily to protect the occupants in the event of a crash and weighs 87 lb. The construction is such that the least possible number of members are welded at each joint and the bracing members are so placed that shrinkage is neutralized and at inclination determined after careful investigation. Special tubes are incorporated in the structure for no other purpose than to anchor the safety belt triangles. A Warren truss is provided in the plane of the front seatback and welded to a cross in the bottom of the structure. Parachute seats are provided and all supporting members are designed to withstand severe impact. The standardized type of detatchable clip, used to make attachments to the fuselage structure, has been employed for a number of years by the Consolidated Company. This clip is fitted around the tubes and permits attachment without welding to the structure. Wood fairing strips, attached to curved cross members by standard clips, constitute the turtle back. The engine mount, having a patented three point support for the mounting ring, is designed to eliminate all internal stress due to welding shrinkage. Many failures in multi-membered engine mounts are attributable to these shrinkage stresses. The method of attaching the engine with self-adjusting clips further reduces the initial stresses in the mounting.

A divided axle type of landing gear having a 64 in. tread and oleo and spring shock absorbers is provided. The landing angle is 15 deg. 20 min. The oleo cylinder design is such that all oil leaking out at the upper gland is trapped and fed back into the chamber. It therefore can be manufactured without oil tight joints. The oleo action has a seven-in. effective stroke at the wheel and the spring action, intended for taxiing, has a four-in. effective stroke at the wheel. The oleo element can be easily detached and filled from the outside and, after being detached, can be disassembled by the removal of one nut.

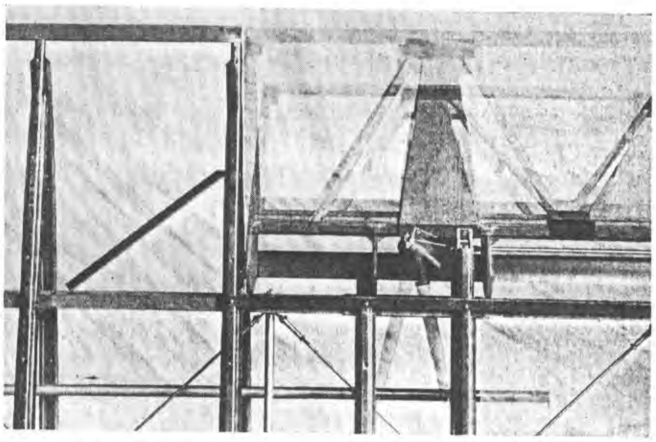
Axles are heat-treated streamline tubes. The loop joint of the landing gear is so designed that there is no sudden change in section, eliminating the possibility of fatigue failure. Drop tests were conducted on the landing gear with 20x4 in. wheels under a 1,680 lb. load and later the same fuselage and landing gear was drop tested with 24x4 in. wheels. Landing gear attachment fittings are drop forgings welded on in such a manner that they can be replaced at major overhaul without damage to the fuselage structure. The lower wing hinge attachment fittings are also drop forgings and can be replaced at overhaul. Center section strut attachment fittings are of laminated chrome molybdenum steel.

The tail skid is also fitted with an oleo cylinder of the same type as that of the landing gear but having a six-in. oleo and spring stroke. A quickly detachable manganese steel shoe is furnished and dovetails into a fitting on the end of the shock absorber plunger. The shoe is locked in place by a wire. This type of tail skid has been in long service over frozen fields and has given proof of its efficiency.



The stamped duralumin ribs set up preparatory to static testing

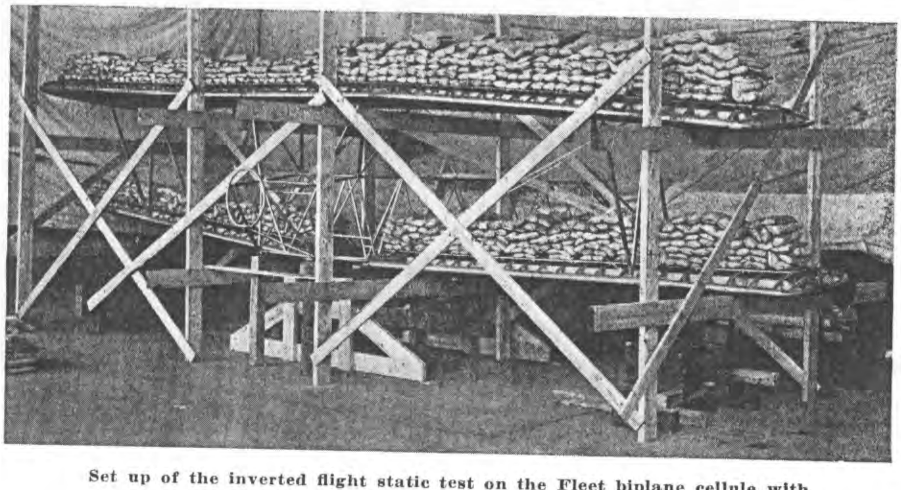
Tail unit structures are built up of chrome molybdenum steel tube spars with sheet steel channel ribs, sheet steel trailing edges and tubular leading edges. A special hinge arrangement which is a development of the hinge used on all Consolidated army PT models, is employed for the elevators. A feature of this hinge, which is attached by two bolts, is that it provides that no wear take place on the elevator or rudder torque tubes as there are shouldered bushings around these tubes which take the wear from the hinge straps. All steel tubing is protected against corrosion and hermetically sealed and other steel parts where possible are cadmium plated. Both fuselage and tail surfaces are covered with fabric and doped. The fin is adjustable on the ground and the stabilizer is adjustable in flight.



Phantom view showing operation of the aileron control mechanism

Dual control is provided for the stabilizer adjustment which is simple self-locking and weatherproof. Removal of a single bolt completely disassembles this control. The vertical guide just forward of the adjusting post takes side forces out of the front of the stabilizer eliminating any chance of binding the adjusting screw.

THE ADJUSTING mechanism consists essentially of a vertical screw actuated by a deep groove aluminum pulley which is itself operated by a $\frac{3}{32}$ in. endless spliced cable. The cable runs along the left side of the plane to a point forward of the cockpit and adjustments are made by pulling the cable in the desired direction. The design of the pulley is such that the cable cannot slip and the arrangement eliminates a number of parts used in the conventional types of stabilizer adjusting mechanism. Its simplicity makes it readily adaptable to production. Zippers are provided in the fuselage covering for inspection of the stabilizer adjusting mechanism. Simplicity is characteristic of the dual control system. The bolts at the lower end of control sticks are ground bolts and run in steel bearings. It has been found that bronze bushings are unable to stand the high bearing pressures at a joint of this character. All of the bearings in the control system are die cast, oil-less bronze bushings and are designed to a bearing stress of 700 to 800 lb. per sq.in. Stamped brass bearings are used for the interstick torque tubes. Push-pull tubes are employed in aileron and elevator control and cables with spring

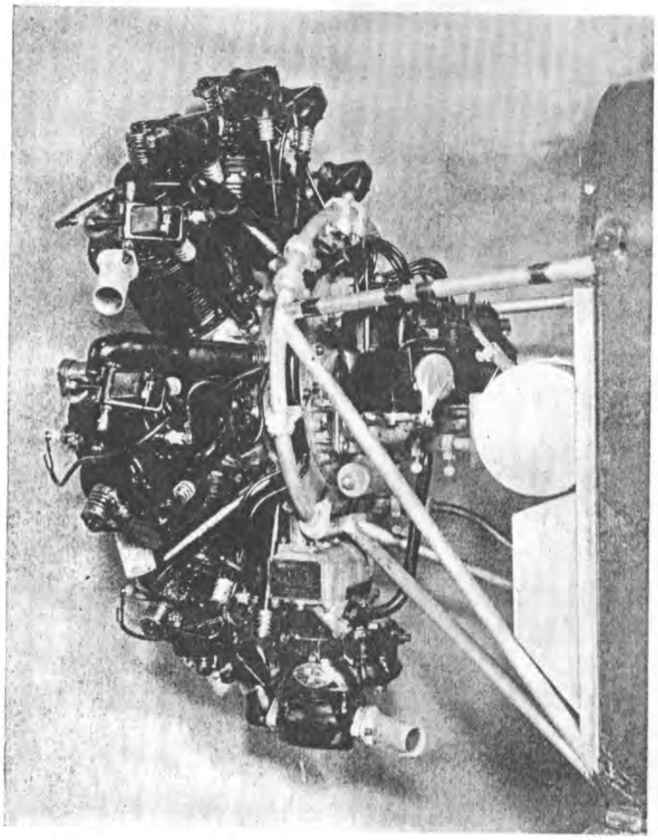


Set up of the inverted flight static test on the Fleet biplane cellule with unbalanced load factors four and three

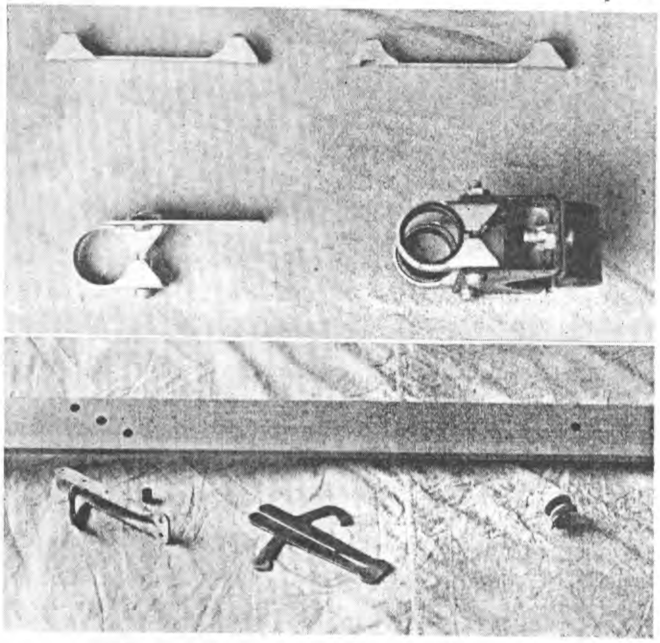
return are used for the rudder pedals. The dual controls can be disconnected easily if desired.

Another interesting feature of the system is the dual throttle control which also is placed on the left side of the seats. This consists of a push-pull rod passing through both cockpits and having ball handles for both occupants. The motion of this rod is transformed into lateral motion to actuate the throttle rod by means of a third member which is pinned to the forward end of the push-pull rod and attached by a Cincinnati ball joint to the throttle rod. The push-pull rod passes through holes in the sides of two supporting channel members and is fitted with simple friction clips in each channel which hold it in position eliminating the use of a quadrant. Fixed spark is provided on all planes after the first twenty-five in which it was found that controlled spark was of no value. Dual switch and fuel shut-off control are provided. Consolidated and Pioneer instruments are furnished in the forward cockpit.

The fuel system consists mainly of the 24 gal. gasoline tank which is built into the center section, the $\frac{3}{8}$ in. x 0.032 in. copper tube fuel line and the primer and shut-off cock. An Army type C-1 strainer made with special size tapped holes to save bushings and fitted with a Parker $\frac{3}{8}$ in., drain cock also is included. Parker fittings are used throughout and several have been developed specially for various purposes. The tank is held in place by three straps and is fitted with two outlets to provide gravity feed in all attitudes of flight. An 0.018 in. terne plate fire wall separates the cockpit from the engine compartment and cowling of 0.050 and 0.035 in. aluminum is used to enclose the compartment. Attached to the firewall is a cylindrical oil tank of 0.018 terne plate. The tank has a capacity of $2\frac{1}{2}$ gals. and a filling mark at two gallons. Equipment includes a wooden propeller, but a metal adjustable propeller also can be provided. A Heywood air starter can be furnished as optional equipment.



The three point engine mounting of the Fleet Model 1 showing another use of the standard clips



Top—Torque tube bearing and adaptations of standard clip
Bottom—Wing and drag fittings and method of attachment

The specifications as furnished by the manufacturer are as follows:

Length overall	20 ft. 9 in.
Height overall	7 ft. 10 in.
Span, each wing	28 ft.
Chord, each wing	3 ft. 9 in.
Airfoil section	Clark Y expanded to 15 per cent
Gap (at C. S.)	54 in.
Stagger	23 in.
Angle of Incidence (Both wings)	0 deg.
Dihedral (Upper)	0 deg.
Dihedral (Lower)	4 deg.
Area of wings, total	194.4 sq. ft.
Area of horizontal tail sur.	23.4 sq. ft.
Area of vertical tail sur.	9.9 sq. ft.
Propeller clearance (8 ft. prop.)	10 in., flying position
Weight empty (Model 1)	976 lb.
Disposable load (Model 1)	554 lb.
Gross weight loaded (Model 1)	1,530 lb.
Weight empty (Model 2)	1,022 lb.
Disposable load (Model 2)	560 lb.
Gross weight (Model 2)	1,582 lb.
High speed (full load, sea level; Model 1)	111 m. p. h.
High speed (full load, sea level; Model 2)	113.5 m. p. h.
Cruising speed	90 m. p. h.
Minimum speed of flight	40 m. p. h.
Climb at sea level	930 ft. per min.
Ceiling	16,000 ft.
Gasoline capacity (normal)	24 gal.

The following features on this airplane are either patented or have patents applied for: aileron control mechanism, stabilizer adjusting mechanism, seat construction, engine mount construction, wing ribs, wing fittings, method of attaching fabric, oleo shock absorber, throttle control, method of adjusting lateral balance, standard clips used in supporting cowling, seats, flooring, etc.