R.A.A.F. PUBLICATION No. 76

THE "WIRRAWAY" OVERHAUL AND REPAIR MANUAL

PART 1.—SERVICE AND MAINTENANCE

PART 2.—INSPECTION

PART 3.—REPAIRS

ENGINEERING DEPARTMENT
AIRCRAFT DIVISION
COMMONWEALTH AIRCRAFT CORPORATION PTY. LTD.

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WIRRAWAY AIRCRAFT

FOREWORD

The purpose of this Manual is to furnish information on the maintenance, servicing and general repairs of the "Wirraway" type of aircraft.

This service Manual is grouped into three parts namely—Service and Maintenance, Inspection, and Repairs. Each division is divided into various chapters and again into sections. A comprehensive Index covers all sections.

Individual sheets will be issued from time to time and amendments will be incorporated as "Amendment Lists." The amendments should be recorded in the Manual as they are made.

Detailed information regarding the operation of this aircraft will be found in the Handbooks "Wirraway Operating Instructions" (for the aircraft) and "Wasp Operating Instructions" (for the engine). These are intended to be used as the pilot's handbooks for this aircraft.

WIRRAWAY OVERHAUL AND REPAIR MANUAL

AMENDMENT CERTIFICATE

CERTIFIED that the amendments promulgated in the under-mentioned AMENDMENTS LISTS have been made in this publication :—

AMENDMENT LIST		AMENDMENT MADE BY	DATE	AMENDMENT LIST		AMENDMENT MADE BY	DATE
NO.	DATED			NO.	DATED		

CHAPTER 1.—GENERAL DATA

Section A.—TABLE OF CHARACTERISTICS

Normal Gross Weight	5,575 lb.
Maximum Gross Weight	6,450 lb.
Fuel Capacity (total)	92 gals.
Reserve Fuel (included in total)	16 gals.
Wing Area	256 sq. ft.
Wing Span	43 ft.
Rated Power of Engine—	
Normal	600 h.p. at 7,000 ft. at 2,300 r.p.m.
Take-off	650 h.p. at 2,300 r.p.m.
Wing Loading (normal)	21.8 lb. per sq. ft.
Power Loading (normal)	9.3 lb. per h.p.
Top Speed at Critical Altitude (8,600 ft.)	220 m.p.h.
Operating Speeds (2,100 r.p.m. and 28 ins. manifold pressure)—	
At Sea Level	177 m.p.h.
At 9,000 ft.	199 m.p.h.
At 13,000 ft. (critical altitude)	209 m.p.h.
Landing Speed (at normal weight)—	
Flaps Down	65 m.p.h.
Flaps Up	70 m.p.h.
Maximum Rate of Climb	1,950 ft. per min.
Endurance at Operating Speed (at 450 h.p.)	3.07 hours
Range at Operating Speed (at 450 h.p. at critical altitude)	640 miles
Range at Economical Speed	850 miles

Section B.—WEIGHT SUMMARY

	Item Weight		Total Weight	
				lb.
(*a*) TARE WEIGHT				3,895
(*b*) FIXED MILITARY EQUIPMENT—			lb.	oz.
Radio R 1082–A.T. 10—				
Stowage for Transmitter and Oscillator Coils	3	12		
Crate	3	08		
Morse Keys		08		
Trailing Aerial Winch	2	08		
TOTAL RADIO R 1082–A.T. 10			10	04
Radio TR 11b—				
Remote Control	2	00		
Fixed Aerial and Mast complete	5	08		
Crate	2	08		
TOTAL RADIO TR 11b			10	00
Front Guns—				
Gun Trunnions	4	04		
C.C. Gear	15	08		
Chutes and Top Slide of Ammunition Box	10	00		
TOTAL FRONT GUNS			29	12
Rear Gun—				
Gun Track, Truck, and Hoist	22	00		
TOTAL REAR GUN			22	00
Bomb Gear—				
Light Series Slips with Steadies	10	08		
Mechanical Bomb Releases	6	00		
E.M. Release—4 Universal Carriers	5	00		
6 Light Series Carriers	4	08		
Bomb Selector Switches (12)	1	08		
Fusing and Firing Switches		02		
Firing Switch		06		
Jettison Switches (2)		12		
Nose and Tail Fusing Selector Switches		11		
TOTAL BOMB GEAR			29	07
Pyrotechnics—				
Signal Gun Mounting	1	00		
Parachute Flare Containers and Controls	12	00		
TOTAL PYROTECHNICS			13	00
Electrical—				
Identification Key	1	08		
Identification Lights	1	00		
TOTAL ELECTRICAL			2	08
TOTAL FIXED MILITARY EQUIPMENT			116	15
			lb.	
(*c*) NORMAL GROSS WEIGHT			5,575	
(*d*) MAXIMUM GROSS WEIGHT			6,595	

ISSUED WITH A.L. No. 1

Section C.—TYPICAL LOADINGS

(*a*) DAY FIGHTER—

		lb.
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Signal Pistol and cartridges	6	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT		286
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		5,640

(*b*) NIGHT FIGHTER—

		lb.
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Signal Pistol and cartridges	6	
2 Landing Flares	37	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT		323
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		5,677

(*c*) DAY RECONNAISSANCE—

		lb.
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Radio—R 1082–A.T. 10 (including A.T. 10 Vibrator Unit—29 lbs.)	70	
Camera F. 24	37	
Signal Pistol and cartridges	6	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT	——	393
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		5,747

(*d*) NIGHT RECONNAISSANCE—

Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Radio—R 1082–A.T. 10 (including A.T. 10 Vibrator Unit—29 lbs.)	70	
Camera F. 24	37	
Signal Pistol and cartridges	6	
2 Landing Flares	37	
2 Reconnaissance Flares	45	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT	——	475
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		5,829

		lb.
(*e*) DAY BOMBER—		
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Radio—R 1082–A.T. 10 (including A.T. 10 Vibrator Unit—29 lbs.)	70	
Signal Pistol and cartridges	6	
Bomb Sight	15	
Bomb steadies + 4 nose and tail fusing units	13	
Bombs	500	
Bomb Distributor	1	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT		885
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		6,239
(*f*) DAY BOMBER (OVERLOAD)—		
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
1 Vickers fixed gun, Mk. V., complete with loading handle and trigger motor	31	
600 rounds .303 ammunition in belt	43	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Signal Pistol and cartridges	6	
Bomb Sight	15	
Bomb steadies + 8 nose and tail fusing units	15	
Bombs	1,000	
Bomb Distributor	1	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT		1,243
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		6,595

		lb.
(*g*) NIGHT BOMBER—		
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	lb. 61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Radio—R 1082–A.T. 10 (including A.T. 10 Vibrator Unit—29 lbs.)	70	
Signal Pistol and cartridges	6	
2 Landing Flares	37	
2 Reconnaissance Flares	45	
Bomb Sight	15	
Bomb steadies + 4 nose and tail fusing units	13	
Bombs	500	
Bomb Distributor	1	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT	——	967
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		6,321
(*h*) DIVE BOMBER—		
Weight empty + fixed equipment		4,068
Fixed military equipment		117
Crew at 200 lb. each, parachute inclusive		400
Removable Equipment—		
2 Vickers fixed guns, Mk. V., complete with loading handles and trigger motors	61	
1,200 rounds .303 ammunition in belt	87	
1 Vickers Gun, G.O., No. 1, Mk. I.	25	
8 Drums .303 ammunition (60 rounds per drum)	67	
Radio—T.R. 11b	32	
Signal Pistol and cartridges	6	
Bomb steadies + 4 nose and tail fusing units	13	
Bombs	500	
Bomb Distributor	1	
Fire Extinguisher	5	
First-aid equipment	3	
TOTAL REMOVABLE EQUIPMENT	——	800
Fuel—92 gallons		690
Oil—8¾ gallons		79
TOTAL		6,154

Section D.–POWER PLANT: WASP H. GEARED RADIAL ENGINE

1. General Data.

The aircraft is fitted with a C.A.C. Wasp H. geared radial engine of the following rating:—

Take off	-	650 B.H.P. at 2,300 R.P.M. with 38″ Hg. Manifold Pressure.
Normal	-	600 B.H.P. at 7,000 feet at 2,300 R.P.M. with 34″ Hg. Manifold Pressure.
Cruising	-	2,100 R.P.M. with 28″ Hg. Manifold Pressure.
Fuel	-	87 Octane Rating.

2. Operation of Engine.

For instructions relative to the operation of the engine refer to Chapter 2, Section A, of this Manual.

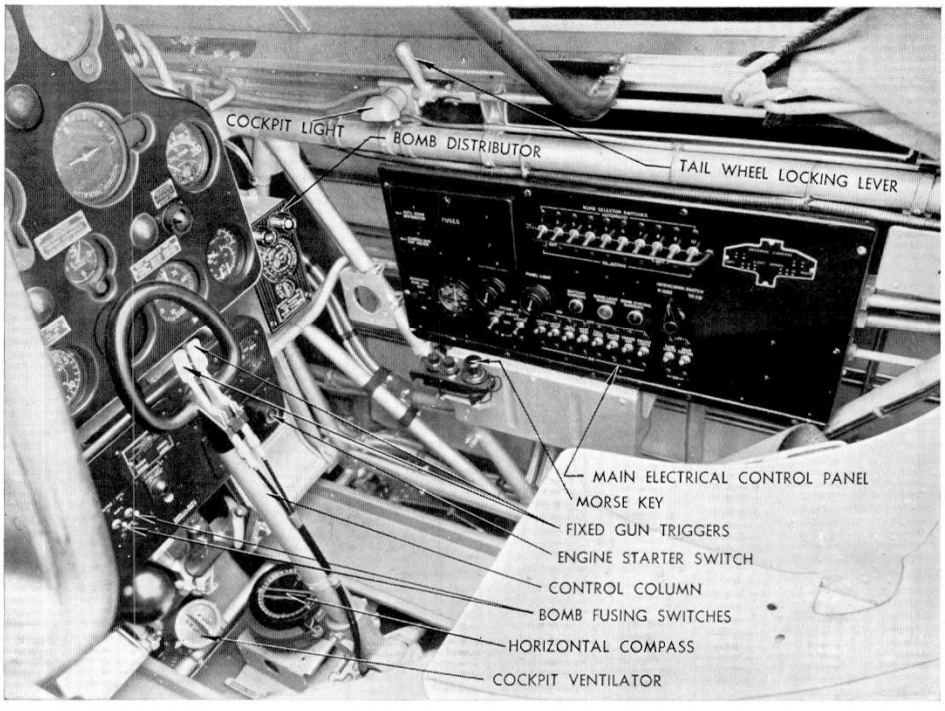
3. General Service and Maintenance.

Instructions for the maintenance and servicing of the engine are contained in the "Manual of Operating Instructions for Wasp Aircraft Engine." (R.A.A.F. Publication No. 71.)

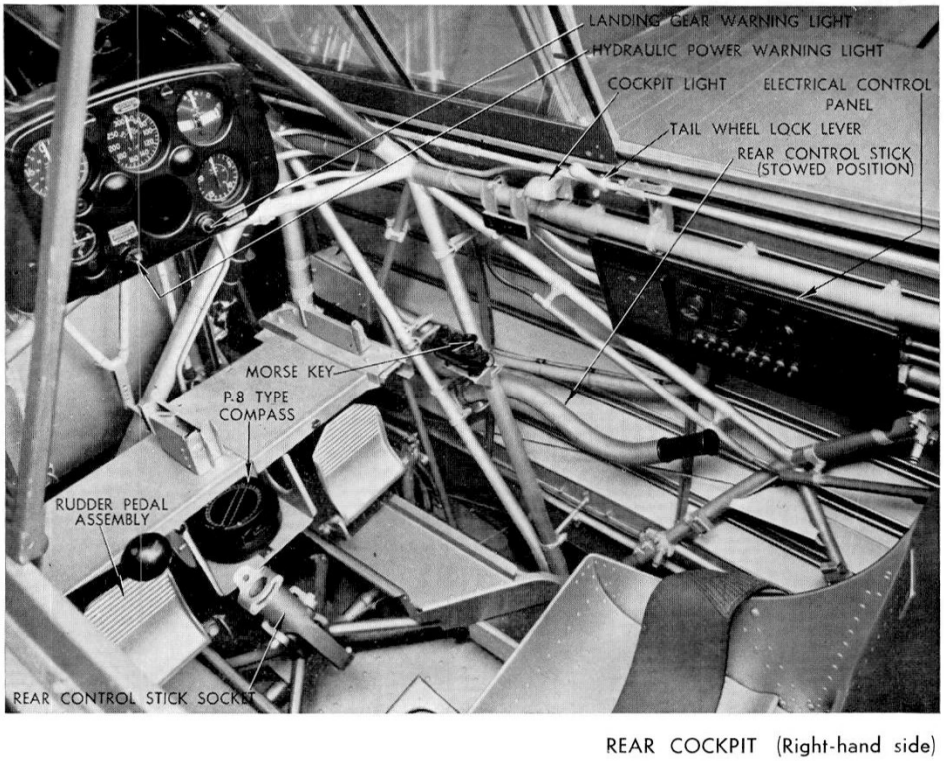
Section E.–AIRCRAFT MODEL IDENTIFICATION

For the purpose of identification of the aircraft to the manufacturing contracts the following list of aircraft is given for reference:—

Model No.	Manufacturer's Serial No.	R.A.A.F. Identification No.
CA 1 -	1 to 40 inclusive	A20– 3 to A20– 42 inclusive
CA 3 -	41 ,, 100 ,,	A20– 43 ,, A20–102 ,,
CA 5 -	103 ,, 134 ,,	A20–103 ,, A20–134 ,,
CA 7 -	135 ,, 234 ,,	A20–135 ,, A20–234 ,,
CA 8 -	436 ,, 635 ,,	A20–235 ,, A20–434 ,,



FRONT COCKPIT (Right-hand side)



REAR COCKPIT (Right-hand side)

CHAPTER 2.—OPERATION AND HANDLING OF ENGINE AND AIRCRAFT

Section A.—OPERATION OF ENGINE

1. Starting the Engine.

The following procedure should be followed when starting the engine:—

(1) Check level in fuel and oil tanks.
(2) When starting from cold, pull airscrew through several turns to ensure engine is free and that cylinders are free of excess oil.
(3) Put parking brakes on.
(4) Fuel—"LEFT" tank "ON."
(5) Carburettor heat—Full "COLD" position.
(6) Propeller control—Low R.P.M. (Coarse Pitch).
(7) Mixture Control—Place mixture control in full "LEAN" (Priming) position. Prime engine with 4 to 6 steady strokes of the throttle lever. Return mixture control to full "RICH" position.
(8) Throttle Control—Lever approximately half-inch open.
(9) Hand Fuel Pump—Operate until pressure on gauge is approximately 3 to 4 lbs. per sq. inch.
(10) Isolating Battery Switch (on front of battery housing)—Make sure the switch is "ON."
(11) Ignition Switch—Both "ON."
(12) Starter Switch—Push switch to energise starter.

Caution.—During the starting period, DO NOT pump throttle when engine is cold as this may cause backfiring with the accompanying risk of fire.

2. Warming-up Engine.

The following procedure is recommended for warming-up the engine:—

(1) When engine starts, manipulate the throttle to obtain 500 to 600 R.P.M. as quickly as possible, and hold this speed for approximately one minute, or until the oil pressure reaches 50 lb. per sq. inch.
(2) Place propeller control in full high R.P.M. position (Fine Pitch) as soon as oil pressure reaches normal and engine is running smoothly.
(3) Advance throttle to increase R.P.M. to 1,000 for warm-up.
(4) Check mixture control for full "RICH" position, and leave in this position during warming-up period.
(5) Oil temperature should be 60°C. minimum for take-off.
(6) Maximum permissible cylinder head temperature is 260°C. on ground.

3. Stopping Engine.

The following method should be adopted for stopping the engine:—

(1) Set airscrew control for full low R.P.M. (Coarse Pitch), in which position the airscrew cylinder covers and protects the piston.
(2) Idle engine to approximately 600 R.P.M.
(3) Set mixture control to full "LEAN" position.
(4) Turn ignition switch to "OFF" position AFTER engine ceases to fire.

Note.—The carburettor is equipped with an idle cut-off device, which is operated by the mixture control in the full "LEAN" position.

4. Limiting Operating Conditions.

The following table gives the limiting conditions of operation of the engine:—

MAXIMUM PERMISSIBLE POWER OPERATION.

CONDITION	Maximum Manifold Pressure (ins. Hg.)	Maximum R. P. M.	Minimum Fuel-air Ratio
Take-off (at sea level)	38.0	2,300	Full "RICH"
Climb	34.0	2,300	.084
Level Flight	34.0	2,300	.084

MAXIMUM DIVING CONDITIONS.

The maximum R.P.M. in a dive is not to exceed 2,650 R.P.M. The manifold pressure under these conditions should be not less than 20 inches and should not exceed 25 inches.

Cylinder Temperatures.

Operation of the engine must always be such as to maintain cylinder head temperatures within the following limits:—

(1) Take-off and short climbs—Maximum allowable for five minutes, 290 degrees Centigrade.

(2) Continuous operation—Maximum allowable, 260 degrees Centigrade.

(3) Cruising—Maximum recommended, 235 degrees Centigrade.

Prolonged steep climbing may result in high cylinder head temperatures; under severe operating conditions, therefore, it will be found desirable to climb at air speeds somewhat in excess of the best climb speed (approximately 120 M.P.H.) so as to obtain adequate cooling. An increase in air speed of 5 to 10 M.P.H. will considerably reduce cylinder head temperatures with very little sacrifice in rate of climb.

5. Hand Starting.

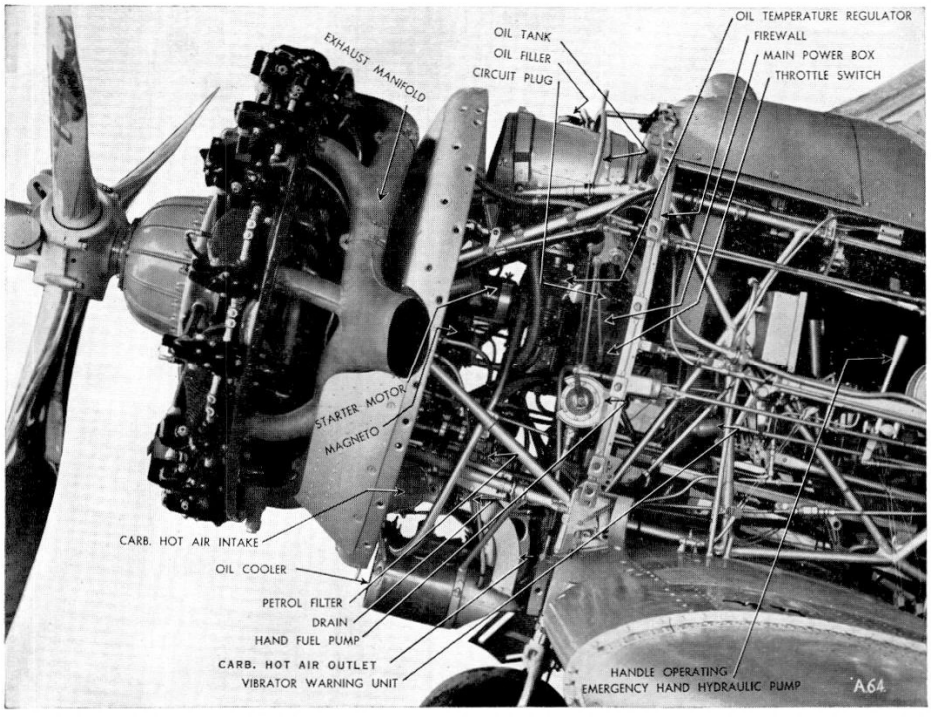
The engine may be turned with a hand starting crank which is stowed inside the fuselage side access door. The starting handle should be engaged with the extension shaft from the starter, the end of which projects beyond the engine cowling on the right-hand side of the aircraft.

When starting by hand, the engine will probably not start without the aid of the booster coil. In this case, the left-hand side removable engine cowl should be removed, and the starter disconnected by disconnecting the cannon plug on the main electrical power supply box on the firewall (the starter connection is the larger of the two cannon plugs, the smaller one connects the generator). The cowl should then be replaced.

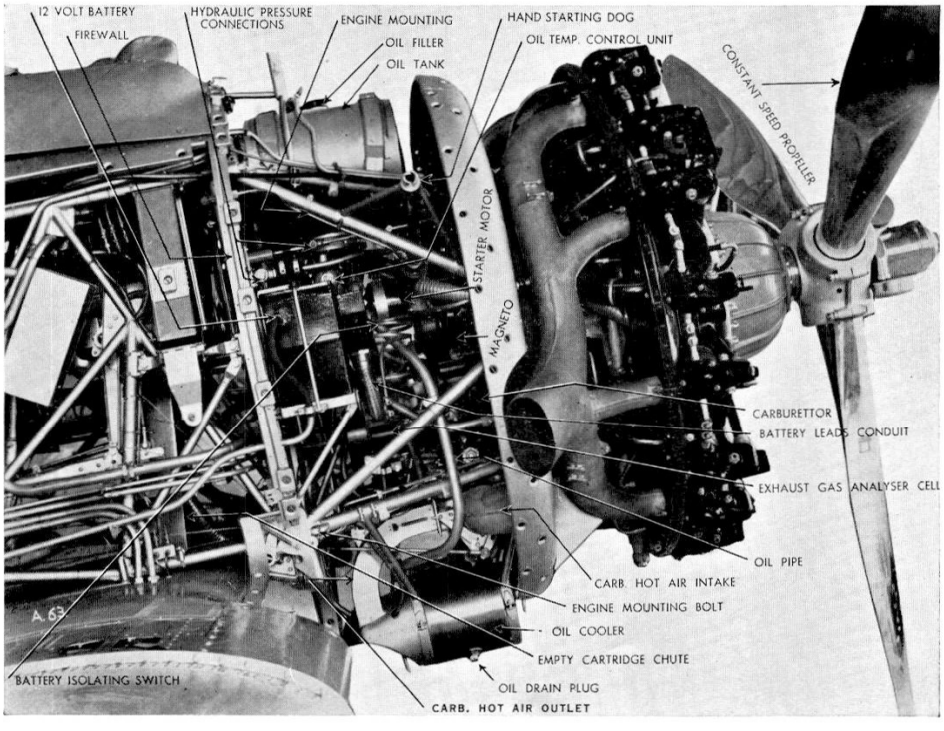
As the booster coil is energised by the starter switch, this switch should be pushed by the occupant of the front cockpit while the engine is being turned by the starting handle.

6. Operation in Flight.

For information regarding the operation of the engine during flight, refer to the "Manual of Operating Instructions for the Wirraway Aircraft." (R.A.A.F. Publication No. 71.)



ENGINE AND MOUNTING (Left Side)



ENGINE AND MOUNTING (Right Side)

Section B.—POWER PLANT INSTALLATION—GENERAL

1. Removal of Power Plant.

The entire power plant from firewall forward can be removed as a unit. Lifting eyes are located at the engine base between cylinders No. 1 and No. 2 and cylinders No. 1 and No. 9. Hoisting lugs are located on the engine mount at the two upper points of attachment to the fuselage.

Warning.—Do not use these lugs to hoist the aircraft.

The sequence of operations necessary to dismantle the power unit at the firewall is as follows:—

(1) Remove airscrew. A special hub nut wrench is provided with each aircraft.
(2) Remove engine ring cowl and engine compartment cowling.
(3) Disconnect exhaust gas analyser cell wire and conduit at analyser.
(4) Disconnect starter and generator circuit plugs at junction box on firewall.
(5) Disconnect magneto wiring and conduit at firewall.
(6) Disconnect carburettor air temperature bulb.
(7) Disconnect the following control rods at their respective bellcranks at the firewall:—
    Throttle.
    Mixture.
    Carburettor Air Heat.
    Airscrew Control.
(8) Disconnect the following pipes, &c., as noted:—
    (*a*) Remove oil temperature bulb.
    (*b*) Disconnect vacuum line, petrol pressure line, oil pressure line, manifold pressure line at right-hand corner of firewall, and hydraulic pump line at top of firewall.
    (*c*) Disconnect fuel lines.
    (*d*) Disconnect thermocouple lead from No. 1 cylinder.
(9) Disconnect two cowl fasteners attaching oil cooler duct to firewall.
(10) Detach gun sight support from top of firewall.
(11) Make certain that all pipes, rods, wiring, &c., have been disconnected at firewall, and that nothing will interfere with the removal of the power plant.
(12) Attach engine sling to lifting eyes on engine and attach hoisting chain to hoisting lugs at rear of engine mount.

    Note.—Maintain ample chain clearances in order to avoid damage to equipment.

(13) Take up slack in chain fall or hoist.
(14) Remove nuts from bolts at points of attachment of engine mount to fuselage.
(15) Hoist power plant clear.

    Caution.—Care should be exercised in handling so that rear of mount does not drop down, which is the tendency, as this would result in damage to the oil tank and fixtures on the firewall.

(16) Attach power plant to stand, using four 7/16" diameter bolts.

2. Replacement of Power Plant.

The power plant may be installed in the aircraft by reversing the above procedure. It is recommended that upon re-assembly of the engine to the fuselage, the holes in the engine mount terminal fittings be coated with graphited cup grease.

Section C.—GROUND HANDLING

1. Towing and Jacking.

Provisions are made for towing and jacking the aircraft by means of a combination towing ring and jacking point located on the inboard side of each main landing wheel. Jacking points are also installed on the outer wing panels at a position 30 inches outboard of the wing joints. A tail jacking point is installed on the fuselage monocoque bottom structure, just ahead of the tail wheel.

Warning.—DO NOT jack the aircraft by means of the outer wing panel jacking points when the lower detachable skin of the centre section is not installed.

2. Lifting of Tail.

A self-contained sliding type of lift tube is installed in the aft portion of the fuselage for the purpose of lifting the tail of the aircraft. The lift tubes are retained in the stowed position by a bayonet fitting.

3. Hoisting.

The aircraft may be hoisted by inserting hoisting shackles in sockets provided on the upper surface of the wing centre section, at the under-carriage down lock position. Care should be taken when inserting the shackle to ensure that the thread of the shackle is in **full engagement** with the socket.

Warning.—DO NOT hoist the aircraft by means of the two lugs welded to the engine mount at the two upper points of attachment to the fuselage. These lugs are for hoisting the power plant assembly only.

4. Lashing Down.

Provisions for lashing down aircraft are made by the incorporation of inverted U-shaped castings, which are built into the outer wing panels near the outboard ends.

5. Steering Tail Wheel.

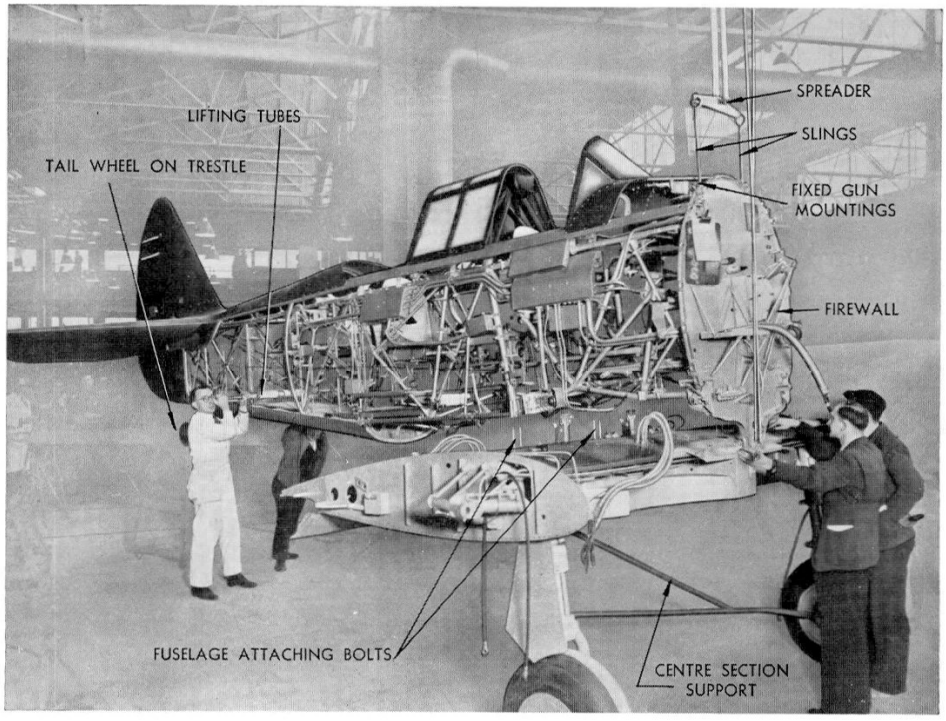
A socket is provided in the tail-wheel fork assembly for the insertion of a steering arm for ease of ground handling the aircraft.

Caution.—Care must be taken to see that the tail-wheel lock is in the "UNLOCKED" position before attempting to handle the aircraft in the above position.

6. Slinging.

When removing fuselage installation, complete, from centre section, the following method of slinging MUST be observed:—

(1) Place the aircraft in flying position, supporting the tail on a trestle.
(2) Prepare for removal. Refer to Chapter 4, Section B, Paragraph 3.
(3) Remove cowling behind firewall.
(4) Using a spreader and a suitable sling, take the lift on the two front gun mountings; at the same time (if the engine is installed), take the weight of the engine on the lifting lugs provided.
(5) Lift evenly on both forward tackles.
(6) During the lift, steady the rear end of the fuselage at the lifting tube, and also at the bottom of the firewall.
(7) After removal, support fuselage at tail-wheel and at centre attachment points.



SLINGING OF AIRCRAFT

CHAPTER 3.—CONTROL SYSTEM

Section A.—FLYING CONTROLS

1. Description.

The flying controls consist of those controls operating the rudder, elevators, ailerons and trim tabs. They can be operated from either cockpit. Smooth and effective operation is assured by use of sealed type ball bearings at all pulleys, bellcranks and control surface hinge points. A complete set of flying controls is installed in each cockpit.

2. Rudder Controls.

Rudder control is effected by means of rudder pedals in each cockpit. They are interconnected by means of connecting tubes to which, in turn, are attached the cables which operate the rudder. The rudder pedals are adjustable to suit pilot's leg length and brake control pedals are incorporated in the rudder pedal assemblies. Stops are provided on the lower extension of the vertical stabilizer rear spar to limit the rudder movement. The rudder pedals also provide steerable control for the tail wheel.

3. Adjustment of Rudder Controls.

(1) Set front pedals in second hole from rear on the pedal connecting tube assembly and disconnect tail wheel control cable springs.
(2) Line up port and starboard pedals either by sighting or by using a straight edge.
(3) Adjust rear rudder cable turnbuckles to bring rudder into central position.
(4) Attach tail wheel springs, set to a tension of 60 lb.
(5) Re-check adjustment of rudder cable turnbuckles.
(6) Lock all turnbuckles, spread all split pins, &c.
(7) Adjust travel of rudder by means of adjusting screws on rear spar of vertical stabilizer, to 32-1/2° port and 32-1/2° starboard.

4. Elevator Controls.

The control sticks, located in the conventional position in each cockpit are ball-bearing mounted to an aluminium alloy torque tube. Stops are provided on the horn assembly of the torque tube to limit the amount of transverse movement of the sticks to 17-1/2° either side of the control position. Fore and aft movement of the control sticks is limited to 19° 50′ forwards and 24° 50′ back by means of adjustable stops located on the control stick fitting at either end of the torque tube. The torque tube carries an arm to which are attached the aileron control cables. The rear control stick is removable and provisions are made for stowing on the starboard side of the rear cockpit. Make certain control stick is in stowed position when not in use. Incorporated in the front control stick are the gun triggers for the two forward fixed guns.

5. Adjustment of Elevator Controls.

(1) Set front control stick to 2-1/2° behind vertical position, with aircraft in rigging position.
(2) Adjust elevator control cable turnbuckles on starboard side of aircraft until elevator is in neutral position—*i.e.*, in line with horizontal stabilizer.
(3) Set adjusting screws on control stick fittings, to give elevator travel of 30° upward and 20° downward.
(4) Lock turnbuckles, spread all split pins, &c.

6. Aileron Controls.

Control of the ailerons is provided by the transverse movement of the control sticks, the control cables being attached to the torque tube. The aileron wires are lead to a bell-crank in the outer wing which is connected to the aileron by a push-pull rod.

7. Adjustment of Aileron Controls.

(1) Set front control stick in central position.
(2) Adjust ailerons to neutral position by means of turnbuckles. These turnbuckles are located to the rear of the first bay in each wing and are accessible by means of an inspection door in the under surface of the wing.
(3) Check travel of ailerons on each side of the aircraft. The travel should be 30° upwards and 15° downwards.
(4) If ailerons have not correct travel disconnect aileron connecting rod and rotate fork-end, increasing or decreasing travel as required.
(5) Set stick in neutral position and re-adjust turnbuckles to bring ailerons into neutral position again.
(6) Check travel again. Repeat until correct travel is obtained.
(7) Lock all turnbuckles, spread all split pins, &c.
(8) Adjust aileron tab to neutral with aileron in neutral position, by means of rotating forked end of aileron tab connecting rod.

8. Trim Tabs.

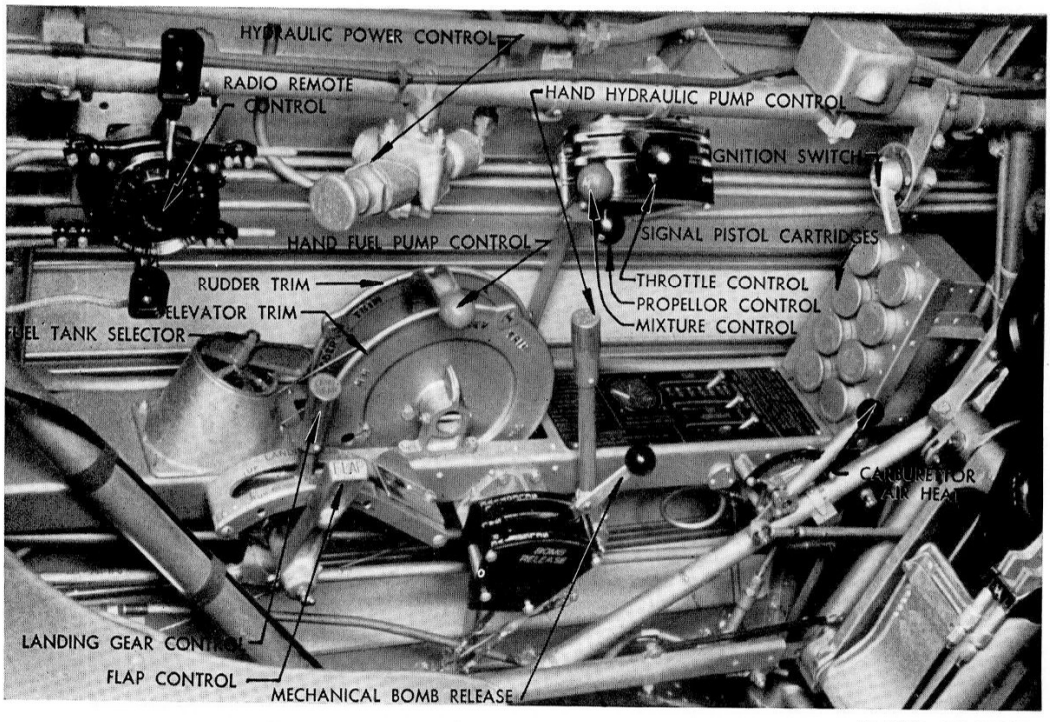
Longitudinal trim of the aircraft is maintained by means of elevator trim tabs, whilst directional trim is given by trim tab on rudder. The trim tabs are controlled by means of cables secured to grooved wheels located on the control shelf on the left-hand side of each cockpit.

9. Adjustment of Elevator Trim Tab Controls.

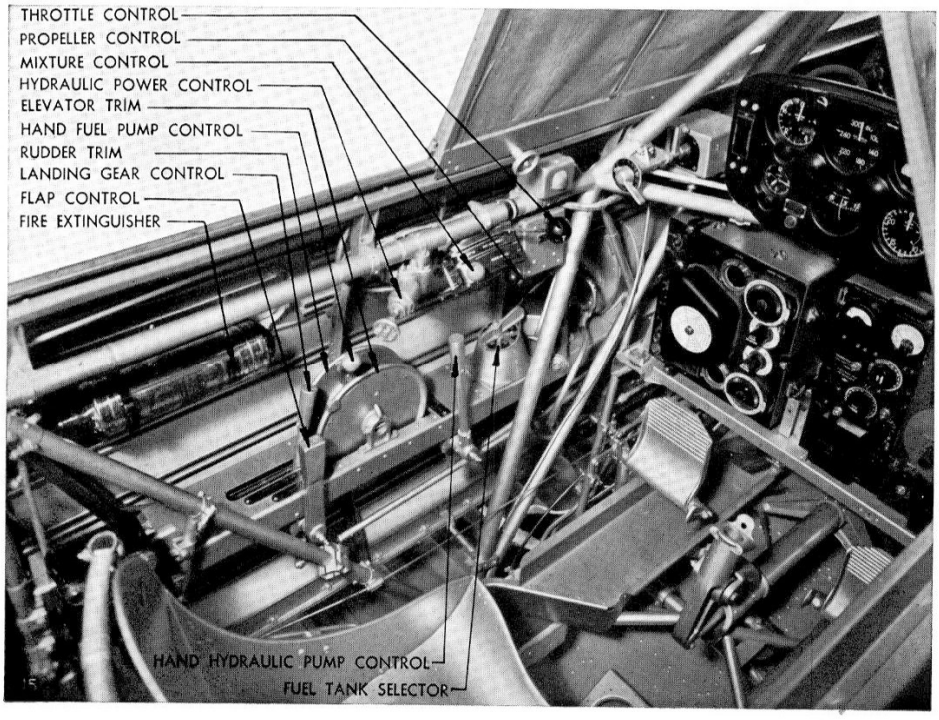
(1) Set elevator in neutral position.
(2) Adjust cables to correct tension by means of turnbuckles.
(3) Wind wheel marked elevator trim tab clockwise to its full forward position. This raises elevator trim tab.
(4) Adjust upward travel of tab to 5°. This adjustment is carried out by disconnecting rod and screwing forked end in or out as required.
(5) Wind wheel in anti-clockwise direction and check for downward travel, this should be 19° from the neutral position.
(6) Lock turnbuckles, &c.

10. Adjustment of Rudder Trim Tab Controls.

(1) Adjust cables to correct tension by means of turnbuckles.
(2) With rudder in neutral position wind wheel marked "Rudder Trim" in clockwise direction to full forward position. This swings trim tab to port.
(3) Adjust port travel to 11° by disconnecting rod and screwing forked end as required.
(4) Check for starboard travel, this should be 2° from neutral position.
(5) Lock turnbuckles, &c.



FRONT COCKPIT



REAR COCKPIT

11. General Rigging Notes.

(1) Before adjusting surface controls raise ship to rigging position. Levelling lugs are supplied for this purpose.

(2) Turnbuckles are made more accessible by the removal of the rear deck cowling.

(3) All turnbuckles should be assembled so as to have an equal amount of thread available for adjustment at each end.

(4) After adjustment check all cables for free movement and see that all turnbuckles are in safety. Check that all turnbuckles are lock-wired, split pins spread, &c.

12. Surface Control Lock.

A surface control lock is provided in the front cockpit directly foward of the control stick socket. To lock the entire surface control system, place rudder pedals in neutral, push control stick forward, centreing it laterally and pull upward on the lock handle until the lock recess engages with the control stick socket. A plunger incorporated in the lock mechanism prevents the system from disengaging other than by release of the control column lock.

The rudder pedal balance cable is supplied with two stops. These are soldered to the cable after installation, their positions being such that they engage with a lever on the control lock mechanism when it is in the locked position.

Section B.—ENGINE CONTROLS

1. Throttle, Mixture and Airscrew Controls.

The throttle, mixture and airscrew control handles are all assembled in a single quadrant located on the left side of each cockpit, and are interconnected by means of rods. The function of the controls are as follow:—

Control	Rearward Position	Forward Position
Throttle	Closed	Open
Mixture	Rich	Lean
Airscrew	Coarse Pitch	Fine Pitch

The full lean of the mixture control provides for positive stoppage of the engine through an idle cut-off device incorporated in the carburettor.

Forward travel of the airscrew control lever decreases the airscrew pitch with a resulting increase in engine R.P.M. Travel of the lever towards the rear increases the airscrew pitch with a resulting decrease in engine R.P.M. For take-off, climb and landing, set the control for high R.P.M. ("FINE PITCH"). For cruising and high speed, set lever for desired R.P.M.

2. Carburettor Air Heat Control.

Hot air from the exhaust manifold shroud may be taken into the carburettor through a valve in the air mixture chamber below the carburettor. The control, incorporating notches to provide for vernier adjustment, is mounted on the control shelf in the left-hand front corner of the front cockpit. The control handle is pulled back to increase the carburettor air temperature and the extreme forward position admits cold air only, to the carburettor. The temperature of the air in the mixing chamber is indicated by the air temperature thermometer on the instrument sub-panel in the front cockpit when the two-position switch is turned to position 1. This instrument records the free air temperature when the selector switch is in position 2.

3. Hand Fuel Pump Control.

The hand fuel pump handle is located on the left side of each cockpit, between the rudder and elevator trim tab control wheels.

4. Fuel Selector Valves.

Fuel tank selector valve controls are mounted on the control shelf at the left side of each cockpit, and are directly connected to a gear-box that is common to both.

5. Starter Control.

The starter is controlled by means of a push button located on the instrument sub-panel in the front cockpit. A guard is provided to prevent the starter being inadvertently energised.

6. Ignition Switch.

The ignition switch is located on the left side of the aircraft ahead of the rear cockpit. The switch is operated by a mechanical linkage from either cockpit, the lever being located in the front left-hand corner of each cockpit, ahead of the throttle controls.

Section C.—CABLE CONTROLS

General.

Non-corrodible flexible steel cables are used for the operation of the various control surfaces and to the auxiliary units as set out:—

(1) Rudder.
(2) Rudder Balance.
(3) Rudder Trim Tab.
(4) Tail Wheel.
(5) Elevator.
(6) Elevator Trim Tab.
(7) Ailerons.
(8) Brake Operation.
(9) Indicators, Landing Gear and Flaps.
(10) Bomb Release.
(11) Parachute Flares.
(12) Parking Brake Cables.
(13) Wireless Aerials.
(14) Tail Wheel Lock.

Details of all Cables.

Full details of all lengths of cables and the end fittings are set out in the following tables.

RUDDER, RUDDER BALANCE, TAIL WHEEL AND TRIM TAB CONTROL CABLES.

Part No.	Weight.	DTD Spec.	Length.	Cut.	Location.	Commences at	Connects to
33-52459-2	15 cwt.	181A/6	153⅞"	174"	Rudder Front, Left hand side.	Clamp under front of Rudder Bar.	Link on Tail Wheel Control Arm.
19-52460 -	15 cwt.	181A/6	63"	75"	Rudder Rear, Left hand side.	Turnbuckle on Link.	Rudder Horn Assembly. Left hand side.
33-52459-3	15 cwt.	181A/6	154¼"	170"	Rudder Front, Right hand side.	Clamp under front of Rudder Bar.	Link on Tail Wheel Control Arm.
19-52460 -	15 cwt.	181A/6	63"	75"	Rudder Rear, Right hand side.	Turnbuckle on Link.	Rudder Horn Assembly. Right hand side.
19-52461 -	10 cwt.	181A/5	118½"	132"	Rudder Balance.	Clamp under rear of Rudder Bar on Left hand side, passes to front around Pulleys.	Similar Clamp on Right hand side of Rudder Bar.
19-34012 -	10 cwt.	181A/5	39⅞"	54"	Tail Wheel Control, 2 off, R. & L. hand, both sides the same length.	Turnbuckle, Spring and Link on Tail Wheel Control Arm.	Tail Wheel Pivot Arm.
26-52537 -	5 cwt.	181A/4	Taken on job.	390"	Rudder Trim, Front.	Top Turnbuckle passes forward around both Quadrant Assemblies and returns to bottom Turnbuckle.	Turnbuckles at both ends.
26-52538 -	5 cwt.	181A/4	Taken on job.	183"	Rudder Trim, Rear.	Turnbuckle passes rearward to Rudder Tab Control and returns to Turnbuckle.	Turnbuckles at both ends.

ELEVATOR AND ELEVATOR TRIM TAB CONTROL CABLES.

19-52217 -	15 cwt.	181A/6	169½"	184"	Front Upper.	Rear and bottom of Control Stick passes across Fuselage rearward.	Turnbuckle.
19-52219 -	15 cwt.	181A/6	44⅝"	57"	Rear Upper.	Turnbuckle.	Top Arm of Horn Assembly.

ELEVATOR AND ELEVATOR TRIM TAB CONTROL CABLES—*Continued*

Part No.	Weight.	DTD Spec.	Length.	Cut.	Location.	Commences at	Connects to
19-52218 -	15 cwt.	181A/6	196¾"	210"	Front Rear.	Front and bottom of Control Stick passes forward around Pulley and rearwards.	Turnbuckle.
19-2220 -	15 cwt.	181A/6	61¾"	75"	Rear Lower.	Turnbuckle.	Bottom Arm of Horn Assembly.
26-52528 -	5 cwt.	181A/4	Taken on job	360"	Elevator Trim Tabs, Front.	Top Link and passes forward around both Quadrant Assemblies and returns to bottom Link.	Links at both ends.
19-52527 -	5 cwt.	181A/4	Taken on job	206"	Elevator Trim Tabs, Rear.	Top Link and Turnbuckle passes rearward through Elevator to Right hand Trim Tab, thence back to bottom Turnbuckle and Link.	Turnbuckles and Links at both ends.
19-52527 -	5 cwt.	181A/4	Taken on job	206"	Elevator Trim Tabs, Rear.	Top Link and Turnbuckle passes rearward through Elevator to Left hand Trim Tab, thence back to bottom Turnbuckle and Link.	Turnbuckles and Links at both ends

AILERON CONTROL CABLES.

01-52316 -	15 cwt.	181A/6	75"	87"	Centre Section.	1 attached to Righ hand Horn of Control Stick Assembly, crosses to Left hand Pulley.	To Left hand Aileron Control Cable Turnbuckle.
					2 off, 1 for Right hand, 1 for Left hand.	1 attached to Left hand Horn of Control Stick Assembly, crosses to Right hand Pulley.	To Right hand Aileron Control Cable Turnbuckle.
26-52313 -	15 cwt.	181A/6	75⅛"	80"	Centre Section.	1 attached to Right hand Horn of Control Stick Assembly.	To Right hand Aileron Control Cable Turnbuckle.
					2 off, 1 Right hand, 1 Left hand.	1 attached to Left hand Horn of Control Stick Assembly.	To Left hand Aileron Control Cable Turnbuckle.

AILERON CONTROL CABLES—*Continued*

Part No.	Weight.	DTD Spec.	Length.	Cut.	Location.	Commences at	Connects to
19-52309	15 cwt.	181A/6	120¾"	132"	Outer Wing.	1 attached to Right hand Aileron Control Cable Turnbuckle.	Aileron Bellcrank Right hand Rear Arm.
					2 off, 1 Right hand, 1 Left hand.	1 attached to Left hand Aileron Control Cable Turnbuckle.	Aileron Bellcrank Left hand Rear Arm.
01-52317	15 cwt.	181A/6	120¾"	132"	Outer Wing.	Same as 19-52309.	Aileron Bellcrank Front Right Arm.

BRAKE OPERATING CABLES.

19-33451	10 cwt.	181A/5	28⅝"	40"	Front Cockpit, 2 off, Right and Left hand sides the same.	Fulcrum Plate and Link on front Pedal Assembly.	Link and Bolt on Master Cylinder.
01-33475	10 cwt.	181A/5	66¼"	80"	Rear Cockpit, 2 off, as above.	Fulcrum Plate and Turnbuckle on rear Pedal Assembly.	Link and Bolt on Master Cylinder.
01-33466	Bowdenite	—	—	—	Front Cockpit.	Control Handle at Left hand side of Instrument Panel.	Master Brake Cylinder Control Valves.

INDICATOR CABLES FOR FLAPS AND LANDING GEAR. FLAPS.

01-52668	5 cwt.	181A/4	80"	80" cut casing 34"	Indicator, Left hand side of Front Cockpit.	Fork end on Indicator Assembly, passes through Bowdenite casing.	To Flap Connection.

LANDING GEAR.

01-33534	5 cwt.	181A/4	63"	63" cut casting 36"	Indicator, Left hand side of Front Cockpit.	Fork end on Indicator Assembly passes through Bowdenite casing.	To Port side Leg Fitting.
01-33535	5 cwt.	181A/4	90"	90" cut casting 75"	As above.	As above.	To Starboard Leg Fitting.

BOMB RELEASE MECHANICAL.

Part No.	Weight.	DTD Spec.	Length.	Cut.	Location.	Commences at	Connects to
01-63141 -	5 cwt.	181A/4	65¼"	80"	Mechanical Bomb Release, on Left hand side of Front Cockpit.	Centre Lever of Control, passes into Centre section.	Salvo Release Mechanism in Centre section.
01-63136-2	5 cwt.	181A/4	61¼"	80"	As above.	Left hand Lever and Turnbuckle passes into Centre section.	Port side Bomb Release.
01-63136-3	5 cwt.	181A/4	59 15/16"	80"	As above.	Right hand Lever and Turnbuckle passes into Centre section.	Starboard side Bomb Release.

PARACHUTE FLARES

01-65001AC	5 cwt.	181A/2	163⅜"	178"	Right hand side of Fuselage.	Rear Handle of Flare Release on Right hand side of Front Cockpit.	Turnbuckle on Rear Flare Release Cable.
01-65001BC	5 cwt.	181A/2	164⅞"	178"	As above.	Front Handle of Flare Release on Righ hand side of Front Cockpit.	Turnbuckle on Front Flare Release Cable.
28-65016 -	5 cwt.	181A/2	14¾"	18"	Flare Release Doors, 2 off.	Turnbuckle on Flare Cable Release.	Release Door Latch Pin.

PARKING BRAKE CABLE.

19-33450 -	5 cwt.	181A/2	45½"	Cut Cable 60" cut 41¼"	Left side of Front Cockpit Instrument Panel.	Through Bowdenite casing forward.	Master Brake Cylinder Control Valves.

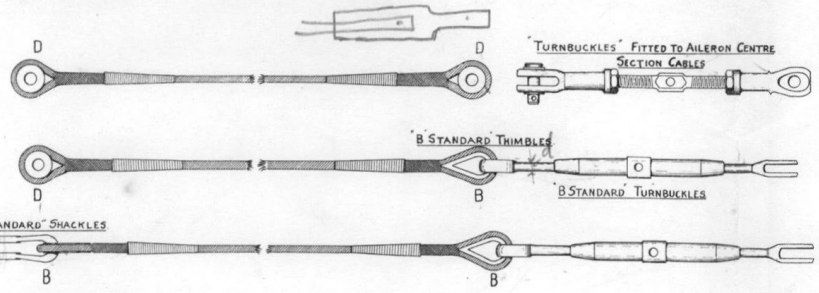
WIRELESS AERIALS.

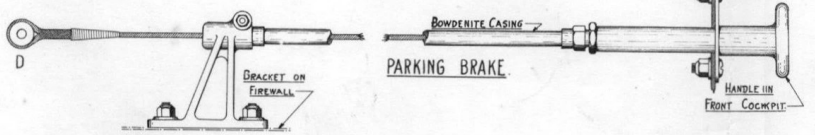
01-71059 -	7 strand		235' 0"		Trailing Aerial.	Aerial Winch Drum.	Eye of Weights.
01-71058 -	7 strand		234"		Fixed Aerial.	Mast.	Insulator on Fin.
	7 strand		41¼"		Dropper.	On Fixed Aerial 77" from Rear Insulator.	Lead in Insulator on Cowling.

END FITTINGS ON ALL CONTROL CABLES.

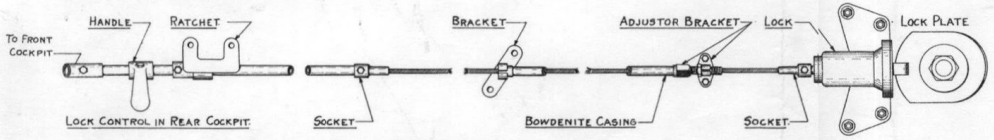
Part No.	Cable.	Type of End.	Standards.	Turnbuckles, &c.
19-52217 -	Elevator, Front Upper - - -	D	B-425-5	
		D	B-425-4	
19-52218 -	Elevator, Front Lower - - -	D	B-425-5	
		D	B-425-4	
19-52219 -	Elevator, Rear Upper - - -	B	B-432-B	B426-20
		D	B-425-5	
19-52220 -	Elevator, Rear Lower - - -	B	B-432-B	B426-20
		D	B-425-5	
19-52309 -	Aileron, Outer Wing - - -	D	B-424-4	
		D	B-424-4	
19-52313 -	Aileron, Centre Section - - -	D	B-424-4	
		D	B-424-4	
01-52316 -	Aileron, Centre Section - - -	D	B-424-4	
		D	B-424-4	
01-52317 -	Aileron, Outer Wing - - -	D	B-424-4	
		D	B-424-4	
33-52459-2 -	Rudder, Front - - - -	D	B-424-4	
		D	B-424-4	
33-52459-3 -	Rudder, Front - - - -	D	B-424-4	
		D	B-424-4	
19-52460 -	Rudder, Rear—2 off - - -	B	B-432-B	B426-20
		D	B-425-5	
19-52461 -	Rudder, Balance - - - -	D	B-424-4	Catches
		D	B-424-4	19-52453
19-34012 -	Tail Wheel—2 off - - - -	B	B-432-A	B426-20
		C	B432-A	B435-C*
19-33451 -	Front Cockpit Brake—2 off - -	D	B-425-4	
		D	B-425-4	
01-33475 -	Rear Cockpit Brake—2 off - -	B	B-432-A	B426-10
		D	B-425-4	
26-52537 -	Rudder Trim Tabs, Front - -	D	B-425-2	
		D	B-425-2	
26-52538 -	Rudder Trim Tabs, Rear - - -	B	B-432-A	B426-5
		B	B432-A	B426-5
26-52528 -	Elevator Trim Tabs, Front - -	D	B-425-2	19-52532-2 & 3
		D	B-425-2	Links
19-52527 -	Elevator Trim Tabs, Rear - -	B	B-432-A	B426-10
		B	B432-A	B426-10
01-52668 -	Indicator Flaps - - - -	E	01-52670	
		E	B246	
01-33534 -	Indicator Landing Gear, Port Side -	E	01-33537	
		E	B246	
01-33535 -	Indicator Landing Gear, Starboard Side	E	01-33537	
		E	B246	
01-63141 -	Bomb Release—Salvos - - -	B	B-425-2	
		D	B-432-A	
01-63136-2 -	Bomb Release, Port Side - - -	B	B-432-A	B426-5
		D	B-425-2	
01-63136-3 -	Bomb Release, Starboard Side - -	B	B-432-A	B426-5
		D	B-425-2	
33-65023-2 -	Parachute Flares—Control, Rear -	B Handle	B-432-A	B426-5
33-65023-3 -	Parachute Flares—Control, Front -	B Handle	B-432-5	B426-5
28-65016 -	Parachute Doors - - - -	D Catch	B-425-2	
19-33450 -	Parking Brake - - - -	D Handle	B-425-4	

*NOTE.—Shackles worked into timble before splicing.

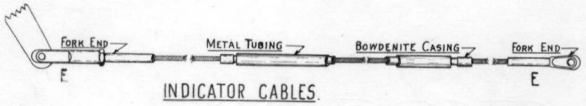




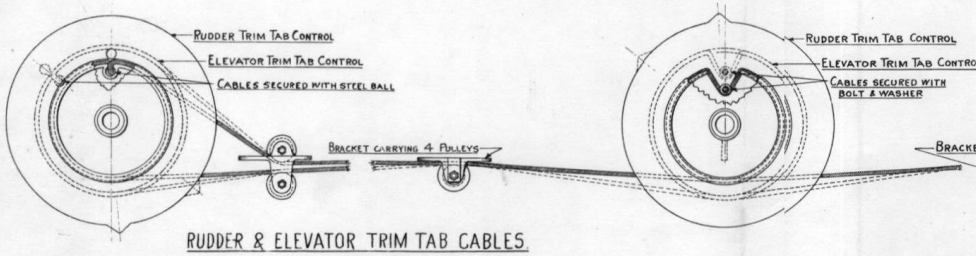
PARKING BRAKE.



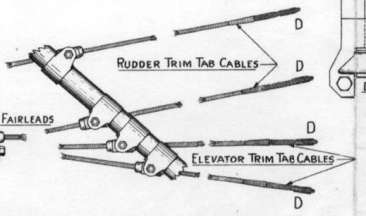
TAIL WHEEL LOCK.

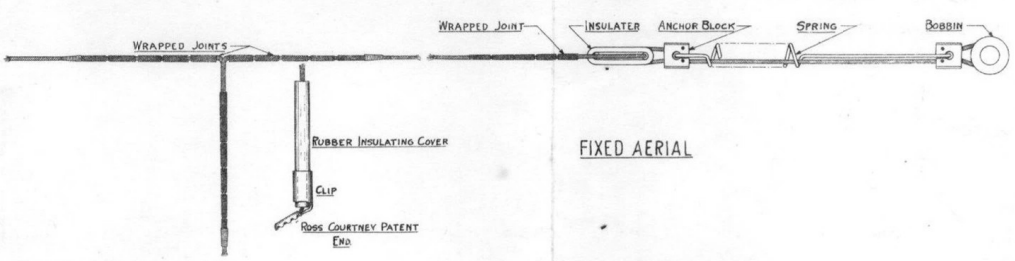


INDICATOR CABLES.



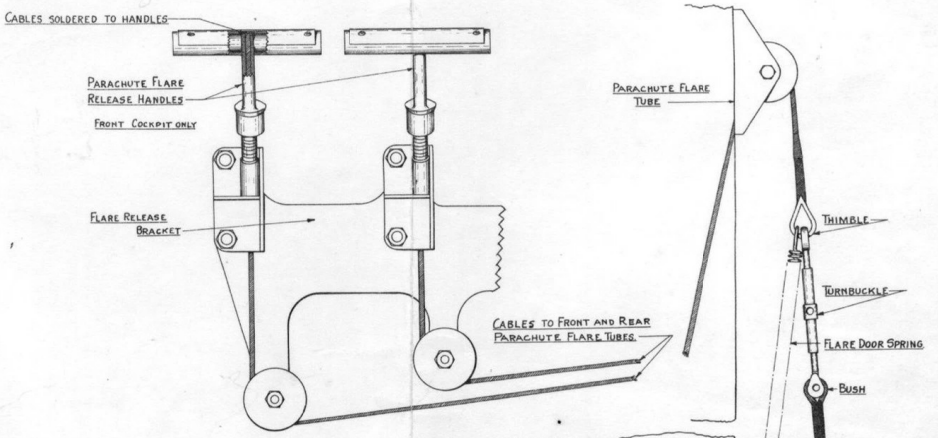
RUDDER & ELEVATOR TRIM TAB CABLES.





FIXED AERIAL

TRAILING AERIAL



PARACHUTE FLARE RELEASE CABLES.

CABLE CONTROLS DIAGRAM

CHAPTER 4.—WING INSTALLATION

Section A.—DESCRIPTION

1. Description.

The wing assembly consists essentially of a centre section, two outer panels, two wing tips, two ailerons, two aileron booster tabs and five flap panels. The centre section is of constant chord design and is set at a 2° angle of incidence. Each outer panel is twisted 2°, thus resulting in an angle of 0° at the tips. The outer panels have a sweep back of 12° 51′ at their leading edges and have, relative to the centre section, a dihedral angle of 5° measured along the upper surface. The entire trailing edge of the wing is straight.

2. Centre Section.

The wing centre section is of aluminium alloy construction consisting of two spars with channel type flanges and flat sheet webs, flanged chanel type intermediate ribs between the spars, two end plates and a corrugated sheet riveted to the spar flanges and intermediate ribs between the spars at the top. The entire assembly is covered with aluminium alloy sheet, with access doors and openings provided in the upper surface to accomodate the fuel cock extension shaft, aileron control cables, flap and hydraulic brake pipes, fuel tank filler necks, &c. A large door, extending the whole length of the centre section between the spars, gives access to the fuel tanks. When bolted into position between the outer wing panels this door forms an integral part of the wing centre section. Incorporated in the assembly of this fuel tank cover is the manual bomb release mechanism. The removal of this cover gives access to both fuel tanks.

The landing gear supports and lock-pin mechanisms are installed at the outboard ends of the centre section on the front spar. Wheel wells are provided in the leading edge to accommodate the landing gear wheels in the fully retracted position. On the rear bottom surface of the centre section are installed electro-magnetic bomb release mechanisms.

3. Outer Panels.

A twist of 2° (wash-out) is incorporated in each outer wing panel, which is of aluminium alloy construction throughout. The basic construction of each outer panel consists of a single spar, pressed flanged ribs and aluminium alloy sheet covering. Access doors are provided on the upper and lower surfaces to facilitate inspection, servicing, replacement, &c.

The outer panels are attached to the centre section by means of eight (8) bolts through angles riveted to end plates of the centre section and screwing into anchor nuts on the spar of the outer panel, also by numerous bolts through bolt angles which are riveted to the centre section and outer panels about their respective root profiles.

Two universal type bomb carriers are built into each wing panel. These carriers are so arranged that the slip and electro-magnetic releases are entirely within the wing. The necessary bomb steadies and rails for the fusing units are incorporated as part of the wing assembly.

A landing light is installed in the leading edge of each outer panel.

4. Wing Tips.

Each wing tip is of aluminium alloy construction consisting of two ribs, two intercostals and top and bottom covering. The complete tip assembly is readily detachable, being fastened to the outer wing by means of 37 screws.

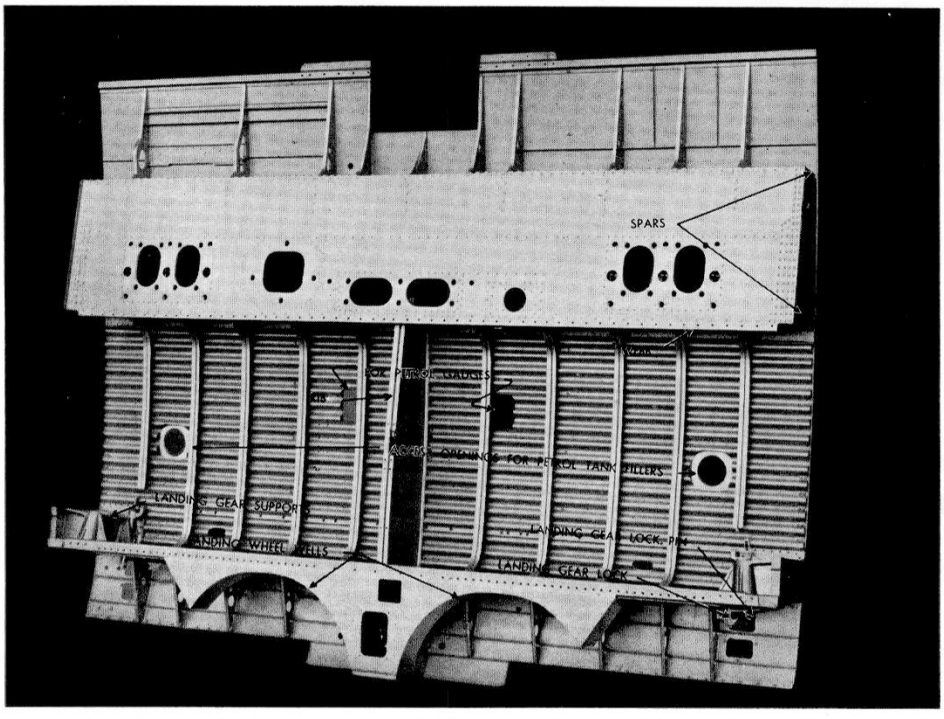
5. Ailerons.

The ailerons are differentially controlled and are limited in movement to 30° upward and 15° downward, by stops located on the horn of the aileron torque tube. The aileron frame is constructed of aluminium alloy, employing pressed flanged ribs, a channel type spar and a trailing edge. A balancing cast lead counterweight is attached inside the nose skin at the outboard end, which in addition to forming the leading edge also takes torsional loads. The complete aileron frame is covered with fabric and attached to hinge fittings, located on a sub-spar of the wing, by means of three ball-bearing eyebolts. A control rod link is located on the upper side of each aileron. The ailerons are twisted to conform with the 2° twist in the outer wing panel, and are equipped with booster tabs.

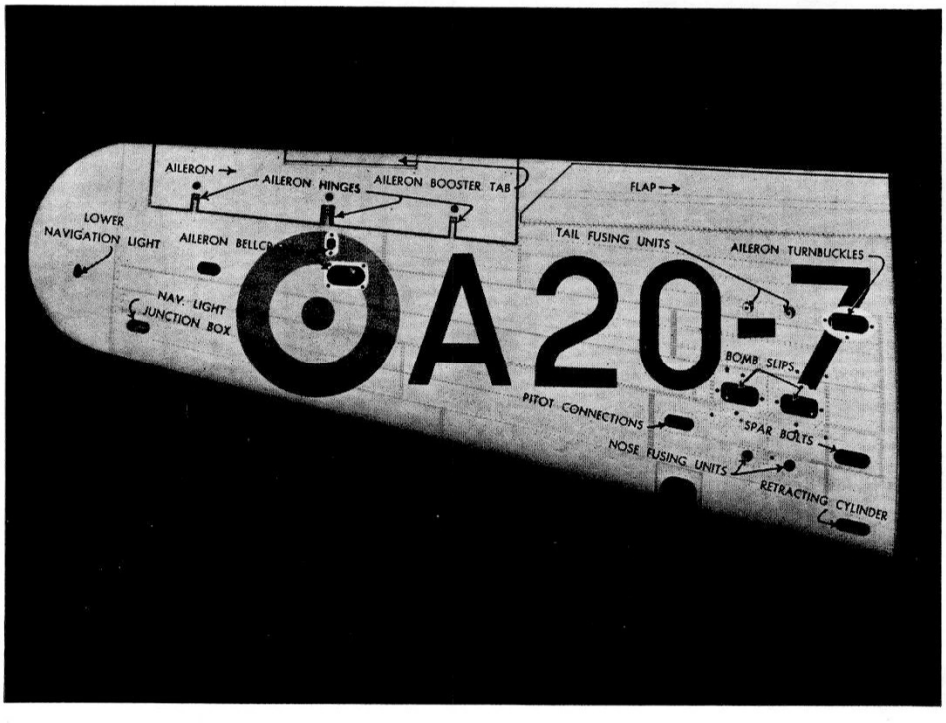
6. Flaps.

Landing flaps are incorporated in the lower surface of the wing trailing edge extending between the inboard ends of the ailerons. The landing flap assembly consists of two outer wing and two centre section flap panels, and a special centre flap assembly which is arranged to hinge upward, when the bomb sighting doors are open, to provide a good forward view from the prone bombing position.

The panels are constructed of aluminium alloy with pressed flanged ribs, a "hat" section spar located down the centre and a trailing edge member. The leading edge consists of a section to which is attached a continuous type hinge. The metal covering is of .020 gauge aluminium alloy sheet on the bottom face of the frame assembly.



WING CENTRE SECTION



COMPLETE WING (Underside)

Section B.—REPLACEMENTS

1. Description.

The major sub-assemblies of the complete wing assembly may be removed individually or the complete wing assembly may be removed from the fuselage as one unit. Removal of complete wing assembly or centre section assembly can be accomplished with landing gear installed on centre section and locked in extended position. The hydraulic system and brake system should be drained prior to the removal of wing centre section. When disconnecting hydraulic pipes, plug ends to prevent loss of fluid and entrance of foreign matter.

2. Outer Panel Removal.

To remove the outer panel from the centre section proceed as follows:—

(1) Support panel at tip and rear bolt angles at the inboard end, or preferably by a special wing trolley.
(2) Remove bolt angle fairings and necessary access doors.
(3) Disconnect aileron control cables through access door located on the lower surface to the rear of the inboard end of the panel near the bolt angle.

Caution.—Cables should be labelled for convenience of re-assembly and their ends lashed together to prevent their slipping into the wing sections.

(4) Remove one bolt from flap push-pull rod universal joint immediately outboard from the wing bolt angle.
(5) Support and/or tape ailerons in neutral position and flaps in "up" position.
(6) Disconnect outer wing bomb slip cables by means of two pin connectors to junction box on end plate of centre section. These are accessible through inspection door located near bolt angle on lower surface.
(7) Disconnect cable for outer wing lighting at landing gear warning switch box.
(8) Disconnect pitot tube static and pressure pipes located in starboard panel only. These pipes are accessible through the centre one of the three inspection doors located on the inboard lower surface.
(9) Remove eight bolts connecting spar of outer panel to angle on end plate of centre section. Access is gained through centre one of the three inspection doors on the inboard lower surface.
(10) Remove bolts from wing joint bolt angle starting from trailing edge on lower surface and working forward; then from the trailing edge on the upper surface and working forward.
(11) Pull panel clear, exercising care in guiding landing gear retracting mechanism through outer panel and in guiding flap push-pull rod through hole in trailing edge end rib.

3. Centre Section Removal.

To remove centre section from fuselage proceed as follows:—

(1) Remove all wing to fuselage fairings, fillets and front fuselage side panels.
(2) Detach fresh air duct flexible tubing at ventilator control neck; located above centre section, just aft of firewall.
(3) Disconnect fuel gauge lights and bonding braids by extracting two bolts at each assembly. Remove clip holding conduit to starboard gauge allowing light assemblies to remain with fuselage.

3. Centre Section Removal *(Continued)*

(4) Turn fuel tank selector valve "OFF." Remove cotter pin from lower universal on each control drive shaft on starboard side.

(5) Disconnect main fuel pipe line at lower forward side of firewall and remove connecting elbow.

(6) Disconnect two hydraulic pipes to flap operating cylinder at unions above port rear top surface.

(7) Disconnect two hydraulic pipes from brake operating cylinder.

Caution.—Before disconnecting hydraulic pipes from brake, make certain parking brakes are disengaged.

(8) Disconnect pitot tube static and pressure pipes at connector box located on bottom longeron above starboard leading edge of centre section.

(9) Disconnect two mechanical landing gear position indicator cables at bellcranks situated beneath the control shelf. Undo clip attaching conduit to fairing bracket.

(10) Disconnect flap position indicator cable at point of attachment to the left centre section flap panel, free outer casing from conduit and pass cable through top surface of centre section.

(11) Disconnect three mechanical bomb release cables from selector quadrant on hydraulic shelf.

(12) Disconnect aileron control cables from arm on torque tube. Label cables and lash together to prevent slipping into centre section.

(13) Cut lashings securing two camera gun operating cables to fuselage on port side of aircraft.

(14) Disconnect landing gear lock pin operating rod from upper bellcrank to centre bellcrank at the latter bellcrank on the port leading upper surface.

(15) Remove two bolts securing bombsight door assembly to trailing edge of centre section. Disconnect operating rod to hinged portion of centre section at trailing edge.

(16) Disconnect electric wiring in junction box located on bottom longeron on starboard side above centre section, and detach four flexible conduits from box.

(17) Disconnect wiring for lighting in outer panels in front cockpit and detach two flexible conduits from bottom of box.

(18) Remove plug to free air bulb at port nose rib. Remove plug from cable. Disconnect conduit at leading edge upper surface and draw cable through.

(19) Before removing centre section from fuselage see that it is well supported.

(20) Remove nuts from eight bolts atttaching centre section to fuselage and hoist fuselage clear.

Caution.

(1) Maintain proper hoisting chain clearances in order to avoid damage to the fuselage assembly or installed equipment. Care must be exercised when raising fuselage to see that all fittings, rods, wires, pipes are either supported or guided clear as required.

(2) Before disconnecting hydraulic pipes drain hydraulic fluid from system.

(3) Plug ends of pipes after disconnecting to avoid entry of any foreign matter.

(4) After disconnecting any cable or electric lead, label and coil to prevent damage during hoisting operations and to simplify re-assembly.

4. Wing Tip Removal.

To remove wing tip, disconnect electrical wiring and conduit at the junction box located in the outer panel near the wing tip, and remove the thirty-seven attaching screws.

5. Aileron Removal.

To remove an aileron, disconnect the aileron booster tab push-pull rod at the stationary bracket end. Remove the aileron hinge nuts from three small apertures on the lower surface of the aileron near the hinges. Lift the aileron clear, allowing the hinges to remain with the wings and the tab rod with the aileron.

6. Aileron Booster Tab Removal.

The removal of an aileron booster tab is accomplished by disconnecting the booster tab push-pull rod at either end and removing the screws securing the continuous type hinge to the aileron.

7. Flap Panel Removal.

To remove any desired wing or centre section flap panel, disconnect the small actuating rods at the push-pull rod, allowing the actuating rod to remain with the flaps. Disconnect position indicator cable at point of attachment to left inboard flap panel. Withdraw the hinge wire from the continuous type hinge and lift the flap clear.

8. To Remove Fuel Tank Cover.

To remove tank cover from wing assembly, proceed as follows:—

(1) Support weight of wings at jacking point or sling aircraft (see Chapter 2, Section C).

(2) Remove bolt angle fairings on bottom surface.

(3) Disconnect bomb release cables. One cable is accessible through inspection door No. 14 and two through inspection door No. 11.

(4) Remove bolt securing tank cover to outer wing panels.

(5) Remove eight screws from centre rib.

(6) Remove screws securing cover to rear and front spars of centre section.

Caution.—Suitable preparations should be made to support weight of fuel tank cover for removal.

Note.—When re-assembling tank cover, the eight screws securing to centre rib of centre section should be screwed into position first.

To simplify the placing of the cover into position between the outer panel bolt angles, the outer panels should be lifted slightly at the tips.

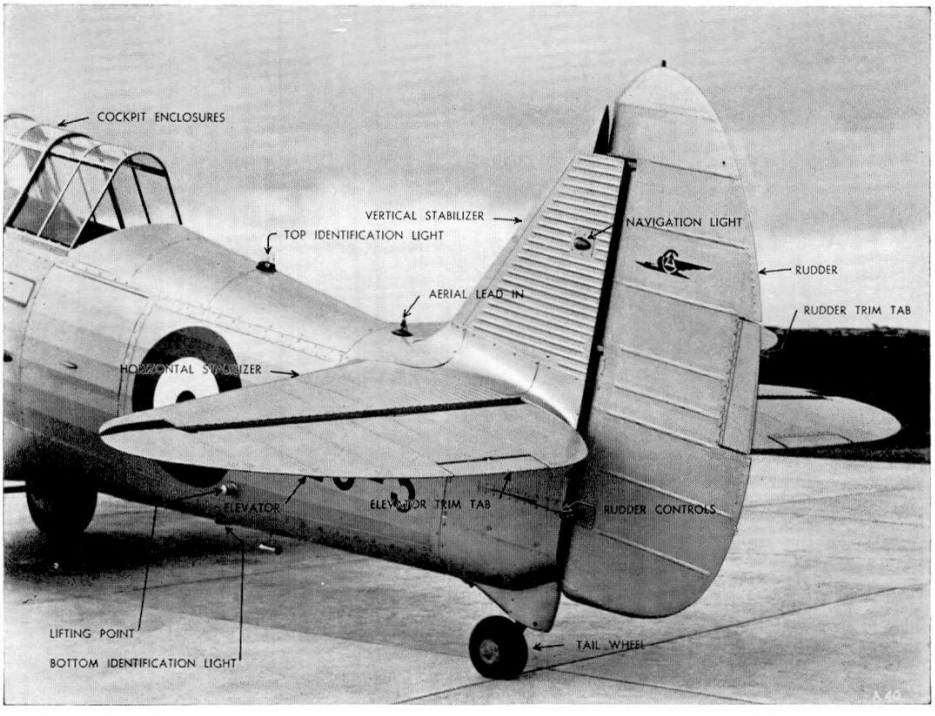
9. Installation of Components.

For installation instructions reverse the procedures outlined for removal. In the event that any of the hinge brackets have been replaced, check for proper alignment of hinge point centres prior to installation of ailerons. When installing the wing centre section make certain that all fittings, rods, wires, pipes, &c., are either supported clear or guided into their proper places as required, when the two assemblies are brought together. Check all piping and electrical circuits for correctness of assembly.

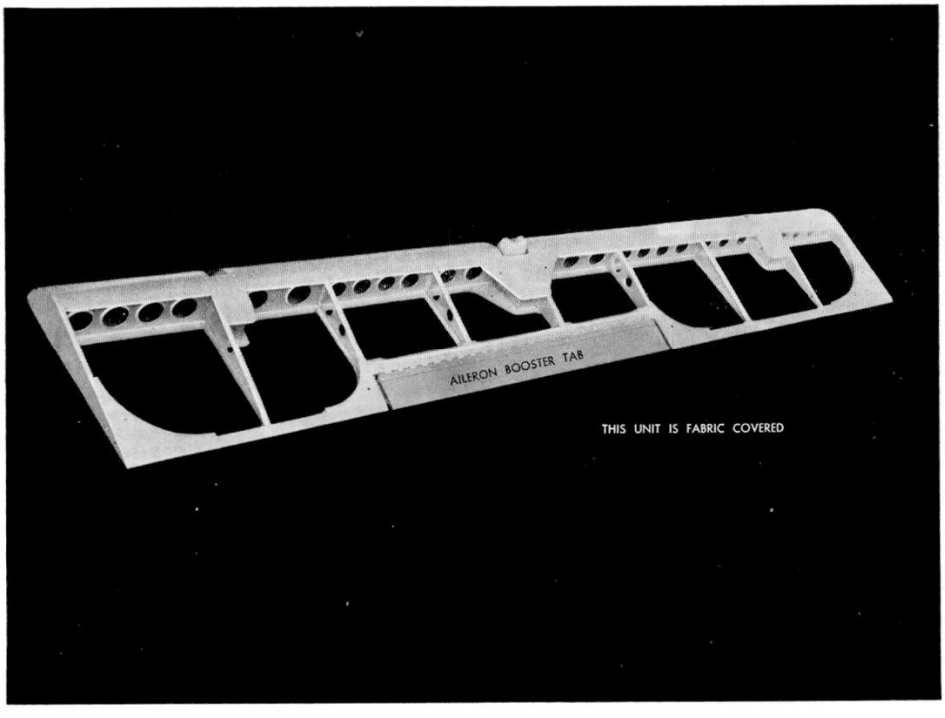
10. Adjustment of Landing Flap Panels.

Limit the travel of the flap panels to 60°. Each flap panel should be adjusted individually by lengthening or shortening the actuating rods as required. In order to avoid warping, make certain that the rods attached to an individual panel are adjusted to the same length. The travel of the two groups of flap panels should be equalised, by adjusting the lengths of the two rods connecting the flap hydraulic operating cylinder push-pull rods to the equaliser rocker arm, located below the cylinder. Adjustable rod ends are provided for this purpose.

Check operation of flaps to ensure that the flaps lie true with the trailing edge of the wing when in the full up position, and that no flap connecting rods are so shortened as to cause the flaps to warp or bind in this position.



EMPENNAGE



AILERON (Uncovered)

CHAPTER 5.—EMPENNAGE INSTALLATION

Section A.—DESCRIPTION

1. Description.

The empennage consists of rudder and rudder trim tab, elevators and elevator trim tabs, vertical stabilizer and horizontal stabilizer.

2. Rudder.

The rudder is statically and dynamically balanced. The frame is of aluminium alloy construction consisting essentially of a torque tube, pressed flanged ribs, a channel trailing edge and metal covered leading edge. A balancing cast lead counterweight is built into the leading edge of the balance portion. The frame assembly is fabric covered. The rudder assembly is provided with an aluminium alloy trim tab, which is controlled from either cockpit.

3. Elevator.

The elevator assembly consists of two interchangeable sections, which are balanced statically and dynamically. Each elevator frame assembly is of aluminium alloy construction consisting essentially of a torque tube, pressed flanged ribs, a channel trailing edge and a metal covered leading edge; in addition to forming the leading edge contour the metal covering also resists torsional loads. A balancing cast lead counterweight is built into the outboard end of the leading edge of each section. The frame assemblies are fabric covered and each section of the elevator is provided with an aluminium alloy trim tab, controllable from either cockpit. The two sections are attached to a control horn assembly by means of flanges located at the ends of the torque tubes on the frame and horn assemblies. The horn assembly is ball-bearing mounted to the rear spar of the horizontal stabilizer. The elevator is attached to hinge brackets mounted on the rear spar of the horizontal stabilizer, at four points, by means of ball-bearing eyebolts.

4. Vertical Stabilizer.

The vertical stabilizer is a full cantilever non-adjustable structure of aluminium alloy construction. The assembly consists of a front and rear spar, pressed flanged ribs, stiffening intercostals and metal covering. The leading edge covering is of heavier gauge metal than the other surface covering in order to provide for leading edge protection. Navigation lights are incorporated in the assembly.

5. Horizontal Stabilizer.

The horizontal stabilizer is a full cantilever non-adjustable structure consisting of two interchangeable sections. Each section is of aluminium alloy construction consisting of a front and rear spar, pressed flanged ribs, stiffening intercostals and metal covering.

Section B.—DISMANTLING

1. To Remove Rudder.

(1) Disconnect wireless aerial from top of rudder.

(2) Remove rear upper deck cover.

(3) Slacken off one turnbuckle on rudder control cable.

(4) Disconnect rudder control cables at horn.

(5) Disconnect trim tab control cables in fuselage.

Caution.—After the trim tab control cables are disconnected they should be taped in place in the grooves on the trim tab drum for convenience on re-assembly.

(6) Remove fairleads for trim tab cables in rear fuselage.

(7) Remove bonding braids.

(8) Remove hinge bolt and nut from two lower hinge points; these are made more accessible by swinging rudder to one side.

(9) Remove nut from eyebolt at top hinge point and lift rudder free.

2. To Remove Vertical Stabilizer.

(1) Remove all fairings and fillets.

(2) Remove rear upper deck cover to gain access to junction box.

(3) Disconnect navigation light wiring in junction box in rear fuselage and disconnect flexible conduit at box.

(4) Remove three bolts securing stabilizer to fuselage and lift free.

Note.—The vertical stabilizer can be removed with or without the rudder attached.

3. To Remove Elevators.

(1) Remove vertical stabilizer.

(2) Slacken off one turnbuckle on elevator control cable in fuselage.

(3) Disconnect control cables at horn.

(4) Disconnect trim tab cables in fuselage.

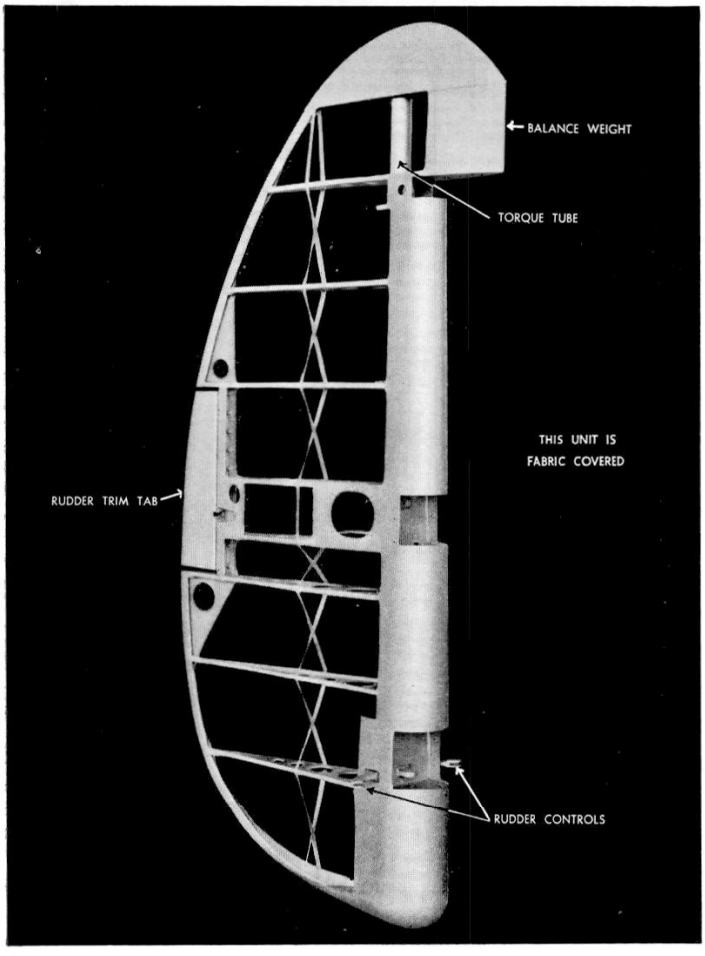
(5) Remove four trim tab control cable pulleys.

(6) Tape trim tab cables so as to prevent crossing inside elevator assemblies.

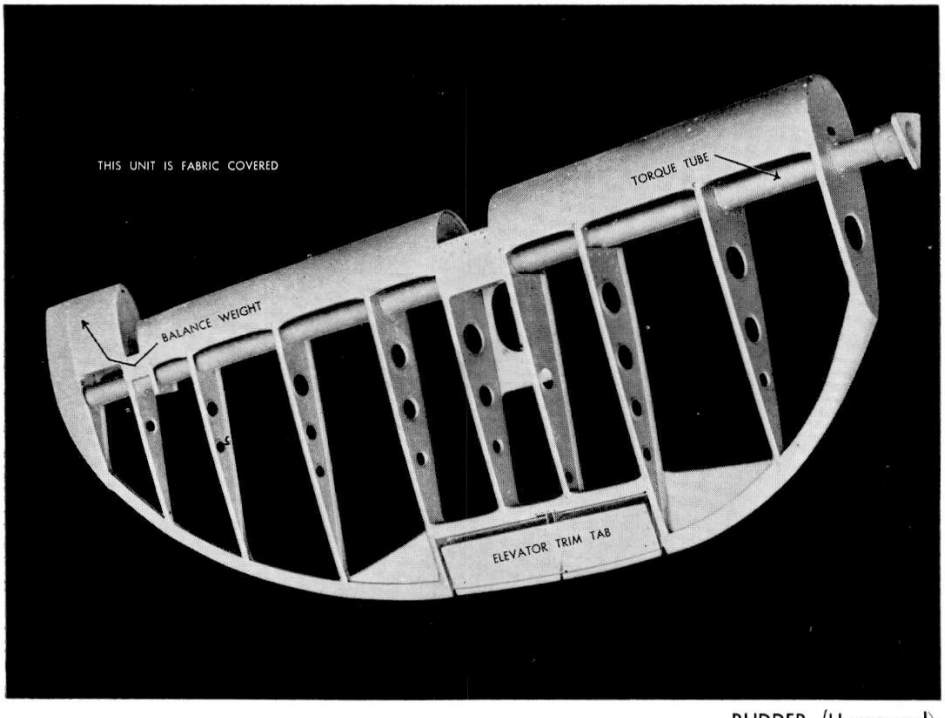
(7) Remove nuts from eyebolts at hinge points.

(8) Disconnect bonding braids.

(9) Remove two hinge bolts from horn assembly. Pull elevators free, allowing hinges to remain with horizontal stabilizer.



ELEVATOR
(Uncovered)



RUDDER (Uncovered)

4. To Remove Horizontal Stabilizer.

(1) Remove all fairings and fillets.

(2) Loosen rear fairing former at rear connection to fuselage to gain access to bolts securing stabilizer at rear attachment fitting.

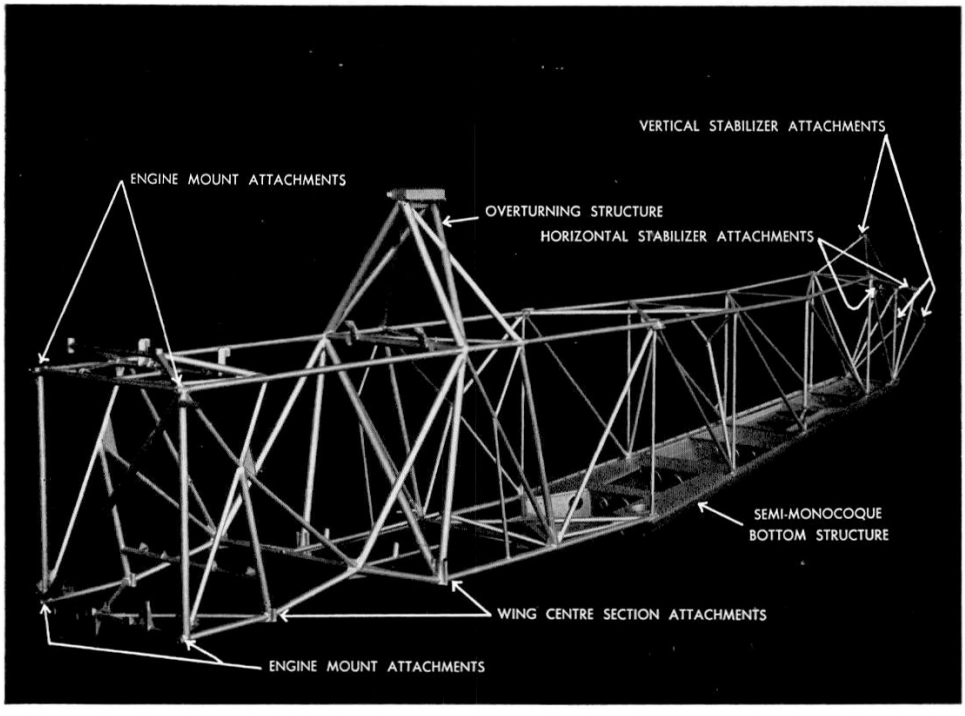
(3) Remove nuts from four bolts (two on either side of fuselage) securing rear spar to fuselage.

(4) Extract two bolts, one in front spar, attaching front spars to fuselage.

Lift stabilizer clear, taking care to support the structure at the ends of the two front spars. The elevators and horizontal stabilizer can be removed as one complete unit after the removal of the vertical stabilizer. If it is necessary to remove only one section of the elevator essembly, remove rear assembly fillet from the required side of the fuselage. After having disconnected trim tab cables in the fuselage remove two guide pulleys and tape cables to prevent crossing inside elevator assembly. Now remove three bolts securing elevator torque tube to flange on horn assembly. Remove nuts from two eyebolts at hinge points and lift elevator free, allowing hinges to remain with stabilizer.

5. Installation.

For installation instructions reverse the procedures outlined for the removal of the rudder, elevator, vertical stabilizer and horizontal stabilizer. The port and starboard sections of the horizontal stabilizer and elevator are interchangeable. After interchanging the elevator sections or installing a spare section make certain that drain holes locating on upper surface are covered and that new drain holes are added to the lower surface. In the event of having replaced any hinge bracket, check for proper alignment of hinge point centres prior to installation of rudder and elevator. For rigging and alignment of surfaces refer to Chapter 3, Section A.



FUSELAGE FRAME ASSEMBLY

FUSELAGE COVERING AND COWLING

CHAPTER 6.—FUSELAGE INSTALLATION

Section A.—DESCRIPTION

1. Fuselage Frame Assembly.

The fuselage frame assembly consists of forward and aft sections of welded chrome-molybdenum steel tubing and steel fitting construction, with the exception of the bottom portion of the aft section, which is of aluminium alloy semi-monocoque construction. An auxiliary tail skid and jack pad are riveted to the reinforced aft end of the monocoque bottom. An overturning structure is incorporated in the forward section of the fuselage frame, behind the front cockpit, for the protection of the pilot in event of a nose-over of the aircraft. Provisions are made in the forward section for the installation of the wing centre section, engine mount, firewall, furnishings, equipment, seats and controls. Transverse and longitudinal levelling lugs are also provided in the front section. The rear section provides for the installation of forced landing flare containers, empennage and tail-wheel. Forced landing flare doors, camera doors and a downward identification light are incorporated in the monocoque bottom structure. On either side of the top forward section provisions are made for the mounting of the two forward guns.

2. Firewall.

The firewall consists of a single thickness of .040 aluminium alloy sheet and is provided with reinforcing angles about its circumference. It is secured to the forward end of the fuselage frame assembly by means of the engine mount attaching bolts and by numerous brackets and clamps.

3. Fuselage Covering and Cowling.

The side panels are of fabric covered aluminium alloy frame construction and are readily detachable, being secured to the fuselage by means of screws. There are two fabric covered panels on each side of the aircraft, whilst on the port side a centre hinged access panel of aluminium alloy sheet construction is provided. The upper surface of the fuselage fore and aft of the cockpit enclosure consists of removable aluminium alloy cowling panels. Fuselage former channels are provided for attaching the side panels and cowling panels. These channels are attached to the fuselage by means of brackets, U-bolts and clamps.

The front cowling installation includes three fuselage cowl panels, one extending forward from the lower edge of the centre windshield panel (this panel incorporates two hinged panels secured by cowl fasteners to the top fuselage former channel on both sides of the aircraft), and the other two extending downward from the lower edge of the side panels.

4. Cockpit Enclosures.

The two tandem cockpits are under one enclosure, which incorporates individual manually operated sliding sections at each cockpit for entrance and exit of the crew. The sliding sections operate on channel tracks which are attached to the fixed section. A handle and lever locking arrangement is provided at the left-hand side of the front sliding section to provide a means of controlling the enclosure lock plunger from either inside or outside. The rear section is controlled by pulling a knurled knob on the inside of the left-hand side of the enclosure. Both front and rear sections may be locked closed or in several intermediate positions.

5. Emergency Exit.

Latch assemblies are located between the side panels of the sliding sections for the purpose of releasing the panels and thereby providing an emergency exit for the crew. Pulling downward on the latch assembly extracts the plungers which secure the panel frame at the top and bottom, after which the panel may be pushed outward.

6. Seats.

The seats are arranged in tandem and are mounted on chrome molybdenum steel tubes, which are chromium plated. Both seats are adjustable to selective vertical positions by means of shock absorber cords and release mechanism. The release mechanism is operated by a lever which actuates the locking pins, and which is situated on the right-hand side of each seat. This lever should not be operated unless the operator is sitting on the seat to balance the load of the shock cord. On either side of each seat provisions are made for the installation of safety belts, while clips are provided on either side of the seat backs on which to stow the harness when not in use. The seats are constructed of riveted aluminium alloy sheet and are designed to accommodate seat type parachutes. A relief tube is clipped under each seat on the left-hand side.

The rear seat is mounted on a chrome-molybdenum steel tube frame and is reversible, being pivoted on a bearing incorporated on the fuselage frame assembly. It is locked in the normal or forward position by a spring loaded catch at the front of the seat pivot, and convenient to the observer's heel. To fix in the reverse position a rod, held in a clip and pivoted to the right-hand side of the seat, is clipped into a catch provided on the port side of the aircraft.

7. Instrument Flying Hood.

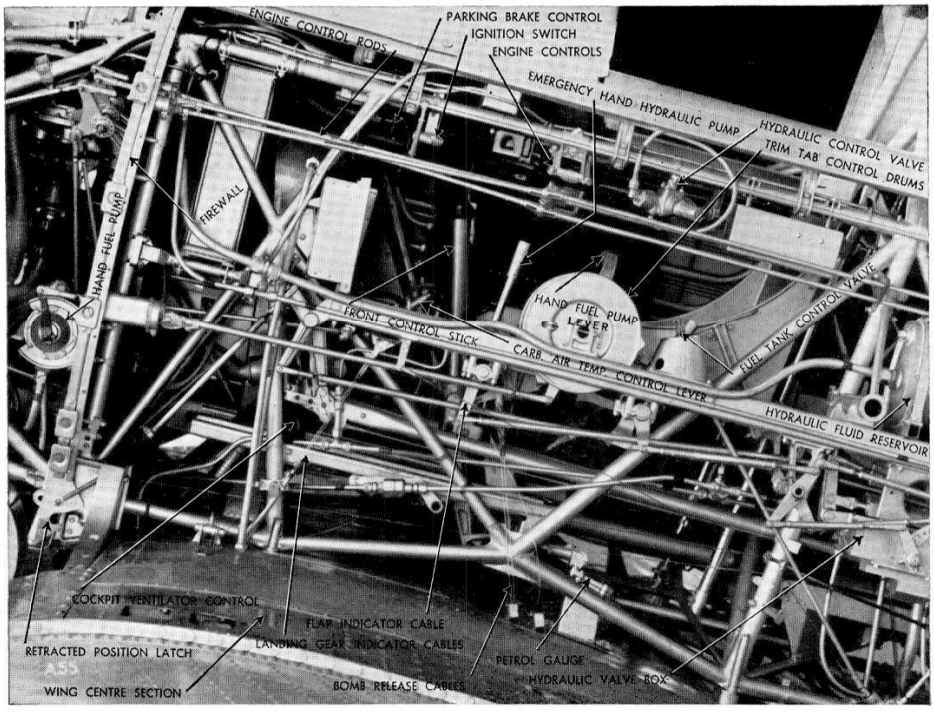
An instrument flying hood to be used for the training in instrument flying is provided in the front cockpit. It consists essentially of three aluminium alloy tubular bows, the lower ends of which pivot at a common point at each side of the fuselage. The bows are covered with artificial leather to form the top, sides and back. The forward bow conforms in shape to the instrument panel shield. To lock the hood in the closed position, pull the hood forward and engage the catch on the lug attached to the front bow of the hood. The hood may be released from the front cockpit by pulling the knob of the catch assembly, which is located under the cowl above the instrument panel. The release, installed in the rear cockpit, at longeron level on the left-hand side, releases the hood by means of a bowdenite cable. When not in use the hood is folded back and is held down by means of a clamp arrangement attached to the fuselage aft of the front seat.

8. Ventilation.

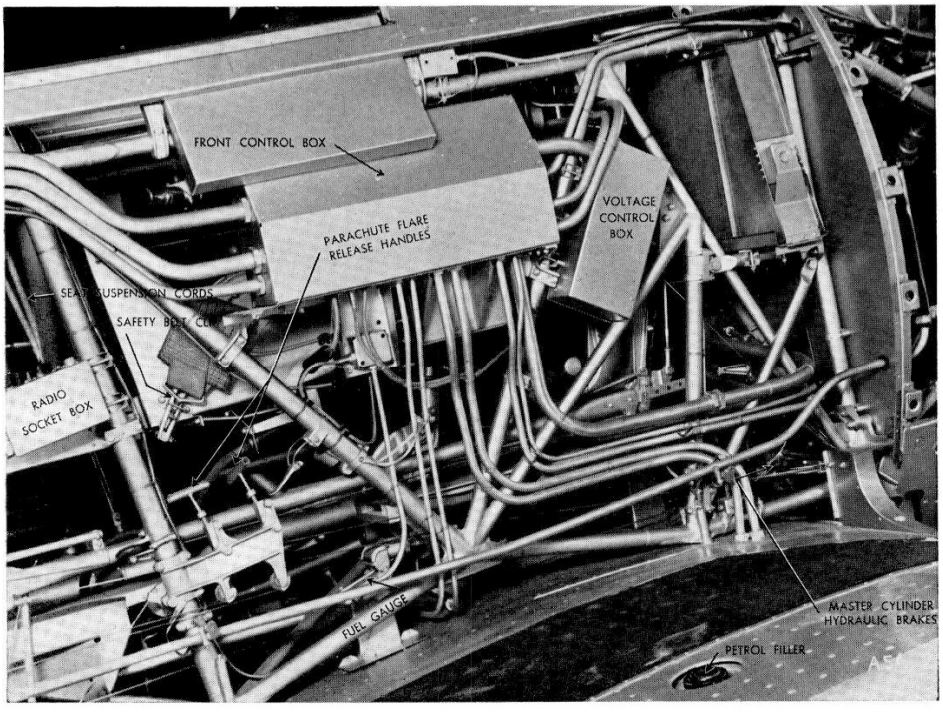
Fresh air is supplied to the cockpit by means of a flexible pipe leading from the port side of the leading edge of the wing centre section. It is regulated by means of a valve, operated with the foot by rotating a notched control wheel located between the rudder pedals in the front cockpit.

9. Urinary Equipment.

A horn and stowage bracket are provided at the bottom of each seat. Rubber tubes lead from each horn to a "tee" fitting located below the rear seat at the bottom of the fuselage frame. From the "tee" fitting a tube terminates at a venturi fitting mounted on the lower left side of the semi-monocoque bottom at the forward end.



WING TO FUSELAGE (Left Side)



WING TO FUSELAGE (Right Side)

10. Map Case.

A map case of aluminium alloy construction is located on the starboard side of the front cockpit, attached to the top fuselage former channel.

11. Radio Installation.

A shelf located between the front and rear cockpits provides for the radio receiving and transmitting installation. Incorporated in this shelf is a sliding panel which acts as a writing shelf for the operator. A further shelf located aft of the rear cockpit carries an emergency receiving and transmitting set which can be controlled from the front cockpit. Stowage for radio transmitter coils is provided beneath the rear seat.

12. Fire Extinguisher.

A hand operated carbon-tetrachloride fire extinguisher is secured to the inner side of a hinged door located at the left side of the rear cockpit. The fire extinguisher is readily accessible from the ground, as well as from the rear cockpit, by opening the hinged door. To remove extinguisher open quick release clip located near handle of extinguisher, grasp handle and pull directly out. Operation instructions are attached to the extinguisher.

13. Access Doors.

To facilitate servicing of the hydraulic control box, an access door is provided on the port side, front fuselage side panel.

The hydraulic reservoir may be filled through a small sliding door located above the hydraulic control box access door.

A fuselage access door is located on the port side of the rear fuselage side panel, just aft of the rear cockpit enclosure. A handle, which may be locked, opens this door from the outside.

Access to the battery isolating switch is provided by a hinged door, secured by Dzus fasteners, located on the starboard side of the engine cowling.

Two small access doors are provided on either side of the fuselage fairing, just aft of the firewall, for servicing master brake cylinder, &c.

Section B.—REMOVALS AND REPLACEMENTS

1. Cockpit Enclosure, Dismantling.

Removal of the windshield assembly, including fuselage cowling panels and instrument panel shield, can readily be accomplished by removing the screws attaching the cowl panels and shield to fuselage formers. To remove rear sliding section, detach cowling panel aft of rear cockpit. Remove stops from channel tracks and slide rear cockpit enclosure out. To remove front sliding section, remove stops at rear of channel tracks and slide out. The fixed centre section can be removed by removing four screws holding it to channel tracks.

2. Enclosure Panel Replacement.

To replace a panel in the windshield assembly, remove screws attaching windshield frame to cowl panels. Detach windshield frame and panels from cowl and remove defective panel from frame and slide new panel into position. The panels are of 3/16" thick "Perspex." To replace a panel in the fixed centre portion of the enclosure it is necessary to remove this section. The defective panel can then be taken out by sliding it from the bottom of the framework and a new one fitted in its place. The side panels of the two sliding sections can be removed by pulling the emergency panel release latch and pushing panel outward. The curved top panels are removed by removing all bolts securing them to the framework. The new panel should be drilled to suit framework, and bolted into position. Seal rubber channels in windshield with an elastic caulking compound. No sealing compound is required for the panels on the enclosure sections. Before replacing a damaged panel make certain that all rubber channels and strips are in good condition and replace if necessary.

3. Seat Removal.

To remove front seat proceed as follows:—

(1) Raise seat to its uppermost position.
(2) Detach shock cords from metal securing hooks at rear lower edges of seat.
(3) Loosen two bolts securing support tubes at bottom.
(4) Remove two bolts securing support tubes at top to support brackets.
(5) Remove relief tube horn from stowage clips beneath seat.
(6) Remove seat and support tubes as a unit.

To remove rear seat:—

(1) Raise seat to uppermost position.
(2) Remove relief tube horn from stowage clips beneath seat.
(3) Remove nut from pivot arm at bottom of supporting frame.
(4) Depress lock pin lever and remove seat and framework as complete unit.

To re-install seats reverse procedure outlined above.

4. Instrument Flying Hood Installation.

To instal instrument flying hood in front cockpit proceed as follows:—

(1) Lower seat to provide ample head clearance when hood is open or in effective position.
(2) Engage pivot arms on ends of bows in holes in brackets attached to fuselage former channels on either side of the cockpit. Secure with split pins.
(3) Secure straps located on rear bow to clips located on cross tube of fuselage frame just aft of front cockpit.
(4) Open hood and fasten by means of catch located on instrument panel shield.
(5) Button sides to press studs located on fuselage former channel.

To remove instrument flying hood reverse above procedure.

5. Monocoque Bottom Removal.

To remove monocoque bottom proceed as follows:—

(1) Remove side panels, and all fairings and fillets relative to tail wheel installation.
(2) Remove vertical fuselage former channels from rear frame assembly.
(3) Disconnect relief tube at venturi and remove clips attaching to bottom of monocoque.
(4) Disconnect wiring for navigation light and detach conduit from junction box.
(5) Remove landing flare containers.
(6) Remove two screws securing bomb sight door assembly to monocoque.
(7) Disconnect tail wheel control cables at tail wheel horn and remove shackles. Draw cable back through roller guides and tie to fuselage.
(8) Remove bolt securing tail wheel strut to fuselage.
(9) Remove tail wheel casting and tail wheel assembly as a single unit by removing two 7/16" bolts securing to end of monocoque.
(10) Remove two tail wheel cable guide brackets.
(11) Remove 12 screws securing monocoque to fuselage attachment plates at Stations 8 and 9.
(12) Remove 12 bolts holding monocoque to fuselage and lift monocoque clear.

6. Installation of Monocoque Bottom.

Spare fuselage monocoque bottom structures are not provided with certain attachment holes for installation, and these holes should be drilled on assembly as follows:—

(1) Instal monocoque bottom to aft section of fuselage frame, utilizing holes drilled at Stations 7, 8, 9, and 10.
(2) Using holes in fuselage attachment plates as drill guides, drill No. 12 (.189) through flanges of monocoque bottom formers at Stations 8 and 9; twelve holes required.
(3) Secure attachment plates to formers with B331-5 screws and B151-C nuts; twelve of each required.
(4) Utilizing attachment holes in front fuselage section as drill guides, drill two No. 0 (.316) holes and two No. V (.377) holes in forward end of monocoque bottom at Station No. 6. Secure with one B201-G17 bolt and one B201-G33 at forward side of attachment point, and with two B201-J16 bolts at rear end of attachment fitting. (Refer to Drg. No. 01-31102).
(5) For further assembly reverse proceedings outlined in preceding paragraph dealing with removal of monocoque.

7. Fuselage Rear Frame Removal.

To remove fuselage rear frame it is necessary to proceed as follows:—

(1) Remove all side panels, cowlings, fairings and fillets.
(2) Remove empennage. (Refer to Chapter 5, Section B.)
(3) Remove monocoque bottom. (Refer Paragraph 5 of this sheet.)
(4) Remove four bolts securing rear frame to front section.

8. Installation of Fuselage Rear Frame and Monocoque.

When replacing rear end of fuselage care must be taken to ensure that correct alignment with the centre line of the aircraft is obtained.

(1) Secure rear frame to monocoque bottom, utilizing holes already drilled and anchor nuts located on monocoque at Stations 7, 8, 9, and 10.

(2) Using pilot holes in fuselage attachment plates at Stations 8 and 9, drill No. 12 (.189) twelve holes through flanges of monocoque bottom formers. Secure monocoque to attachment plates. (Refer paragraph No. 6 dealing with installation of monocoque.

(3) Secure upper longerons of front and rear sections of fuselage by means of four bolts. (Refer Drg. No. 01-31102.)

(4) Secure a plumbing line through centre line of front section of fuselage and extending aft but attached to some point independent of rear section and further aft.

(5) Check rear section for alignment with this centre line. Vertical alignment is given by dimension of 13″ from top of outside tailplane attachment tube on either side of fuselage to centre line of aircraft as represented by plumbing line. Horizontal alignment is given by locating the centre line of the forward vertical stabilizer attachment tube 3/16″ to port of centre line of the aircraft. (Refer Drg. No. 01-31151.) If necessary steel shims may be used between attachment fittings on top longerons of front and rear sections to obtain correct alignment.

(6) Drill and attach forward end of monocoque to front section at Station 6. (Refer Paragraph 6.)

For further re-assembly reverse procedures outlined for various units in previous sections.

CHAPTER 7.—HYDRAULIC BRAKE SYSTEM

Section A.—DESCRIPTION

1. Master Brake Cylinder.

The master brake cylinder constitutes the main hydraulic unit from which the brakes are operated. The assembly consists of two cylinders and pistons, one for each wheel brake assembly and a reservoir built as an integral part of the unit. The cylinder is located on the lower fuselage cross tube immediately aft of the firewall and is operated by foot pressure applied to the brake pedals incorporated in the rudder pedal assemblies of either cockpit. A leakage and temperature compensating unit, parking brake control, and a vent pipe are incorporated in the master brake cylinder assembly. The brake pedals and parking brake control handle are interconnected with the cylinder by means of linkage, cables and pulleys. The master brake is interconnected with the wheel and brake assemblies by means of rigid and flexible hydraulic pipes.

2. Operation of Brake System.

Depressing the brake pedals develops pressure which is routed to a small hydraulic cylinder located in each wheel. The hydraulic fluid causes the wheel hydraulic cylinders to operate, forcing the brake shoes and bands against the inner rim of the wheel. The amount of braking action is governed by the amount of foot pressure applied. Releasing the brake pedals causes a spring on the master brake cylinder to draw the actuating pistons back into their respective cylinders, with the result that the hydraulic pressure diminishes and the brakes disengage. To set the parking brakes, first apply pressure on the brakes with the pedals and while holding the pressure, pull out the parking brake control. This holds the parking valves down on their seats thereby locking the brakes. To release simply press on the brake pedals, this removes all hydraulic pressure and frees the brakes.

3. Brake Shoes.

The brake shoes are of the self-energizing type, being continuous around the inside of each brake drum. They are pivoted at one end by a pin and actuated from the other end by the small hydraulic cylinder and piston. A spring forces the shoe away from the drum when the brake is inoperative.

Section B.—MAINTENANCE

1. Filling of Master Brake Cylinder.

A filler plug for the master brake cylinder is located on the forward side of the firewall. The filler plug assembly incorporates a vent pipe. The master brake cylinder should be topped up every 20-hour inspection, whenever the system is bled or brake adjustments made. Fill cylinder to overflowing with hydraulic fluid to Specification CA 411 or use a mixture of equal parts of diacetone alcohol and castor oil.* This should be done with aircraft in the tail down position and with parking brake released.

***Important.**—Under no circumstances may hydraulic fluids of different specifications be mixed. If a change has to be made the unit or system must be drained.

2. Bleeding Brake System.

A "spongy" feel in the brake system is positive indication of the presence of air in the system, in which case it should be bled. Bleeding of the brake system should also be accomplished after cleaning or after any assembly operation. Bleeding consists of forcing more hydraulic fluid through the system to pick up any air present and replace the fluid containing air bubbles. The fluid may be forced through without the application of pressure at the fluid reservoir. During bleeding operations the fluid reservoir of the master brake cylinder should be kept full.

The brake system may be bled without the use of compressed air. Proceed as follows:—

Fill reservoir of master brake cylinder to capacity. Remove bleeder plug from hydraulic cylinder of the brake assembly and connect a hose to this outlet. Place the free end of the hose in a clean glass receptacle. Gravity will force the fluid through the pipes instead of air pressure. As the fluid flows into the glass receptacle, depress the brake pedals rapidly, shut off the bleeder outlet, and allow the pedals to slowly return to the released position. This will allow new fluid to be drawn into the system. Repeat this operation until air bubbles cease to appear in the fluid entering the glass receptacle. After bleeding system, replace bleeder plug and refill the reservoir of the master brake cylinder.

3. Cleaning Brake System.

The hydraulic brake system should be cleaned every 120 hours inspection. The system should be drained at the bleeding valve on the wheel hub and flushed with alcohol. Internal operating parts of the master brake cylinder and wheel brake cylinder should be inspected for wear, leaks and deterioration of packings, &c. On re-assembly the master brake cylinder should be pressure tested at 1,200 lb./sq. in.

4. Replacement of Hydraulic Cups.

Moulded rubber cups are utilized in the units of the brake system as packing glands. Replacement of these cups is necessary in the event of excessive leakage occurring. If replacement is accomplished without removal of the unit, particular care must be taken to ensure that the cylinders, pistons and glands are kept free of foreign matter. The hydraulic master brake cylinder requires a total of eight packing cups. Two B1121 cups are required for each of the two pistons located in the lower portion of the cylinder. One B1117 cup is required behind each of the two brake compensator units located in the upper portion of the cylinder ends. One B1117 cup is required for each of the two parking brake valve stems, below the operating arms at the upper side of the cylinder.

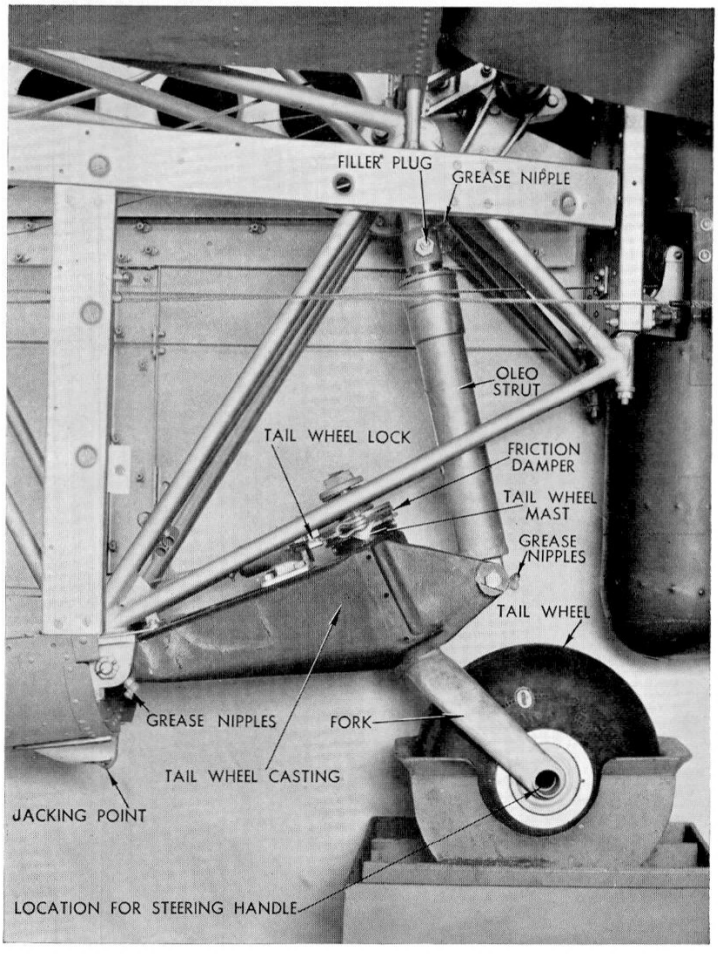
The piston seal in each of the wheel brake cylinders is a B843 cup, and a B842 dust cap is used over the end of the cylinder as a dust seal.

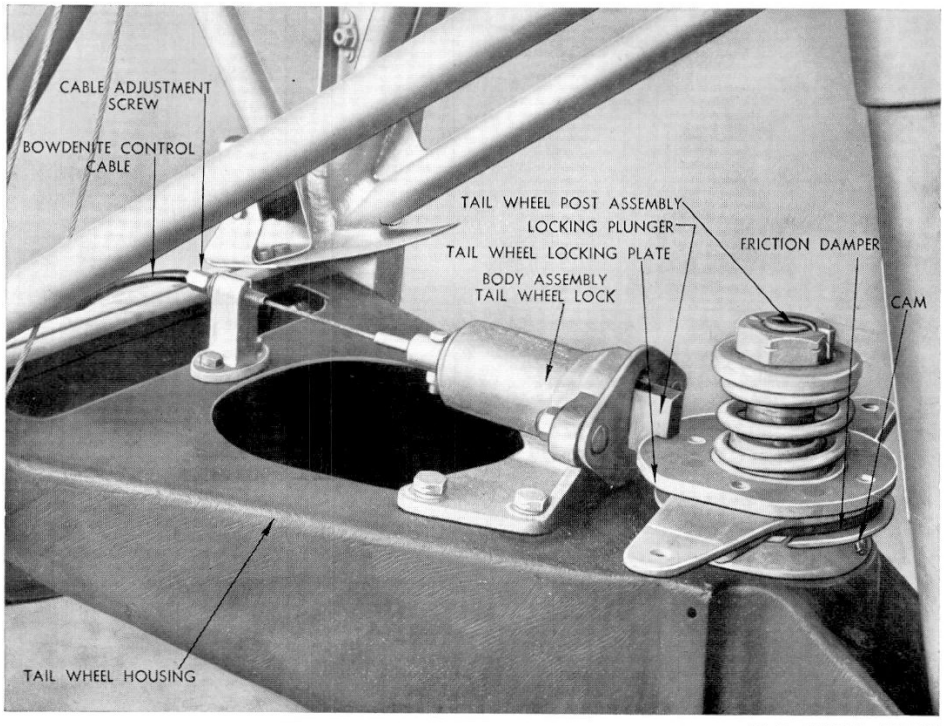
5. Brake Adjustment.

Brakes should be adjusted with equal tension, so as to hold the aeroplane at full throttle, and be entirely free of dragging when released.

To adjust the brakes the wheels have been provided, on their inboard side, with three adjusting screws and three feeler gauge openings. Adjust each screw until a .010 feeler gauge fits snugly between the brake band and the drum. After all three points have been separately adjusted, a re-check should be made to see that one adjustment has not changed another. If it is found that the clearance is greater than .010 of an inch after adjusting screw has been screwed all the way, the brake bands must be replaced. To do this, wheels must be removed. The part number of the brake lining is D18117. Brake shoes and linings should be inspected for alignment and wear each 30-hour inspection.

TAIL WHEEL ASSEMBLY





TAIL WHEEL LOCK

CHAPTER 8.—TAIL WHEEL INSTALLATION

Section A.—DESCRIPTION

Description.

The tail wheel assembly consists of an aluminium alloy tail wheel support attached at two points to the fuselage, swivel post assembly and fork mounted on roller bearings at the rearmost portion of the support, and a pneudraulic shock strut. The lower end of the shock strut is mounted on the tail wheel support, the upper end being attached to the fuselage. A 10-1/2 inch diameter wheel and tyre is mounted on the axle at the lower end of the tail wheel swivel post.

The tail wheel is steerable and is controlled with the rudder pedals by means of cables incorporated in the rudder control system. The cables are attached to a control horn on the tail wheel swivel post and incorporate springs to absorb pedal shock due to taxying. Normally, the tail wheel is locked in alignment with the landing gear by means of a cam and spring mechanism. This mechanism is released by application of full rudder to permit the tail wheel to swivel freely through 360°.

A tail wheel lock is fitted to the aircraft. This consists of a locking plate riveted to the tail wheel mast. This plate is slotted to accommodate a spring-loaded plunger, housed in a casting bolted to the main tail wheel casting.

The lock is controllable from either cockpit by means of a Bowden cable and locking levers. When locked, the tail wheel is held in the neutral position.

To adjust tension on the cable, an adjusting screw is provided.

Section B.—MAINTENANCE

1. Refilling of Oleo Strut.

In order to refill the oleo strut, the air in the strut should be released through the valve located near the top of the strut on the left-hand side. The hexagonal plug containing the air valve should be removed and the strut filled to the level of the filler plug, with the strut fully compressed. Use hydraulic fluid to Specification CA 411 or a mixture of equal parts of diacetone alcohol and castor oil.* Re-install hexagonal plug and air valve assembly, and inflate the strut with air until the red line painted on the oleo piston is 3 inches maximum with light load, and 2-1/2 inches with full load, measured from the end of the strut cylinder with the aircraft in the tail down position.

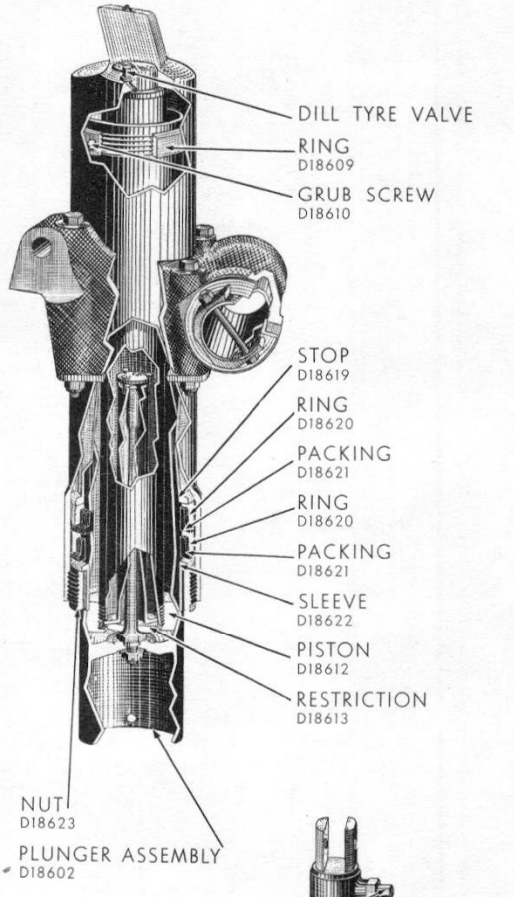
***Important.**—Under no circumstances may hydraulic fluids of different specifications be mixed. If a change has to be made the unit or system must be drained.

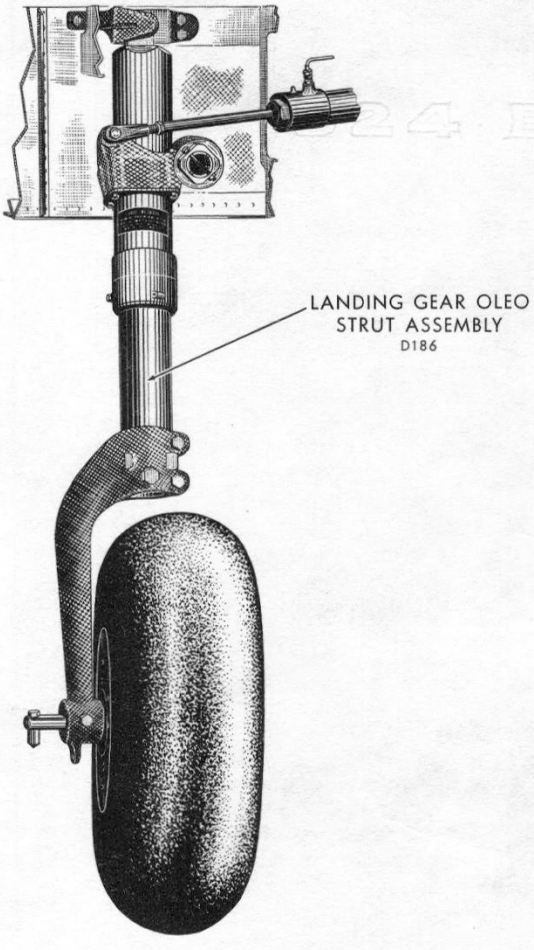
2. Tyre Maintenance.

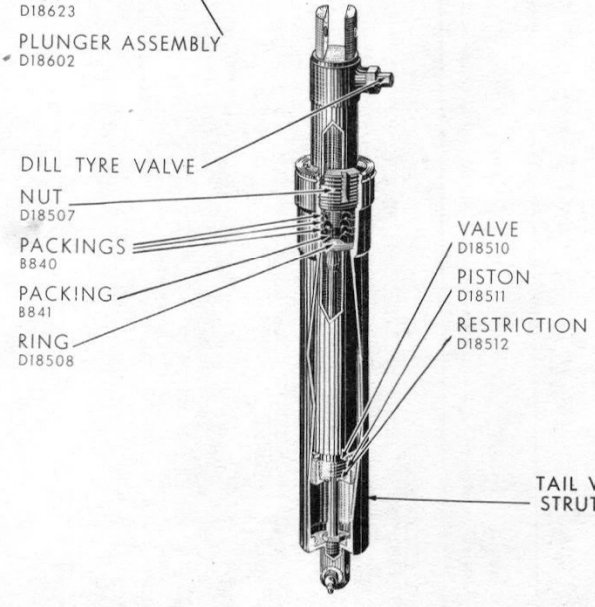
The tail wheel tyre pressure should be such that the inflation ribs moulded on the sides of the tyres just meet the ground when the aircraft is on level ground and with the aircraft loaded as for flight.

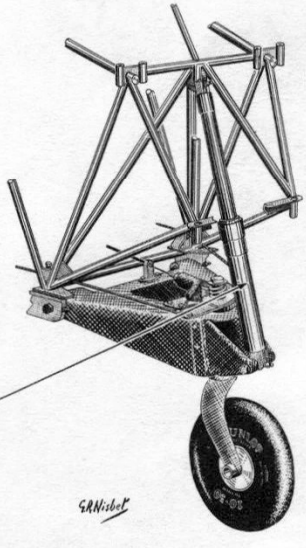
3. Adjustment of Bearings.

The axle nut should be adjusted so that all appreciable side play or shake is eliminated. Care must be taken that the bearings are not drawn up too tightly and the wheels should revolve true and freely after adjustment. The aircraft should be supported on the jacking point just ahead of the tail wheel.









LANDING GEAR ASSEMBLY

ISSUED WITH A.L. No. 1

CHAPTER 9.—MAIN LANDING GEAR

Section A.—DESCRIPTION

1. Description.

The main landing gear of the Wirraway aircraft is fully retractable inboard and forward of the wing centre section front spar. It is hydraulically operated, normally by means of an engine driven pump, and in emergency by means of a hand operated pump. The operation of the landing gear is controlled by a lever located in each cockpit. Positive mechanical latches and lock pins are provided for the retracted and extended positions, respectively. Mechanical landing gear position indicators, operated by bowden wires with spring returns, are provided, together with an electrical warning device. This device operates an electric horn located on the over-turning truss behind the pilot's head, if the locking pins have not travelled at least half-way into the locked position when the wheels are down. It is interlocked with the lock pin operating mechanism, the operating switches and a switch connected to the throttle control. The operating switches are enclosed in boxes in the centre section just inboard of each landing gear down position locks.

2. Shock Absorber Strut.

The shock absorber strut constitutes, with a heat treated steel fork, the main leg of the landing gear unit. The shock absorber is of the smooth bore type, employing the principle of air and oil shock absorption. The maximum amount of travel of the piston into the cylinder is 7½ inches. Torsional resistance is provided by two torsion links connecting the piston and the cylinder of each unit . Each shock strut assembly is pivoted on a heavy steel pin pressed into an aluminium alloy support riveted to the front spar and end plate of the wing centre section.

3. Wheels.

The main landing gear wheels are of the drop centre type. They are heat treated aluminium alloy castings and incorporate pressed steel brake drums.

4. Tyres.

The tyres used are 27-inch smooth contour, six-ply covers. Small raised inflation ribs are provided on each tyre to aid in maintaining proper inflation. The tyres should be inflated so that these ribs are just in contact with the ground with the aircraft loaded as for flight.

5. Brake System.

The brake system is a self-contained hydraulic system operated by the rudder pedals. For information relative to maintenance of the brake system, refer to the Maintenance Instruction Sheet, Chapter 8, dealing with that subject.

6. Landing Gear Retracting Cylinders.

A landing gear hydraulic operating cylinder is mounted, at each end of the wing centre section, by means of a steel tubing support assembly. These cylinders are the points of energy from which the landing gear is operated. Extending inboard from each cylinder is a piston rod, one end of which consists of a lug attachment to the strut, the other end forming the piston of the hydraulic cylinder. When operating the landing gear, hydraulic fluid is forced to one side of the piston or the other, actuating the piston and rod, causing the landing gear strut to swing up or down, as required, about its pivot point.

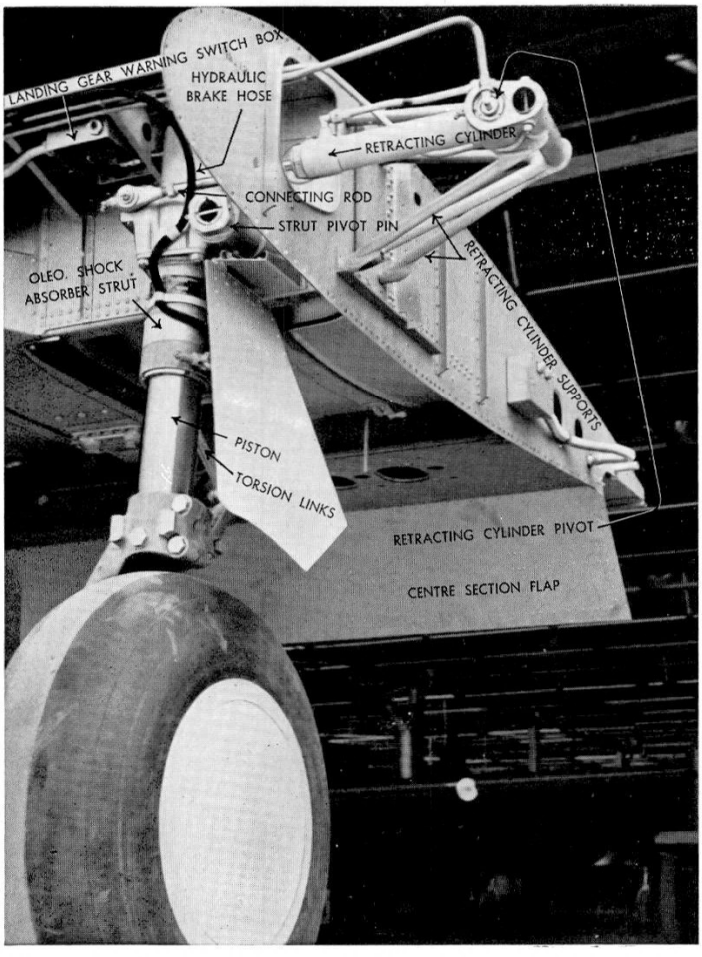
7. Retracted Position Latches.

A spring loaded steel latch, triangular in shape, is pivoted at one end to a retainer support assembly, which is clamped to the lower fuselage longeron at each side of the fuselage at the firewall. This latch is designed and located so that the moment the landing gear reaches the fully retracted position it becomes engaged with a bolt and roller extending from the inboard side of each strut at the wheel axle.

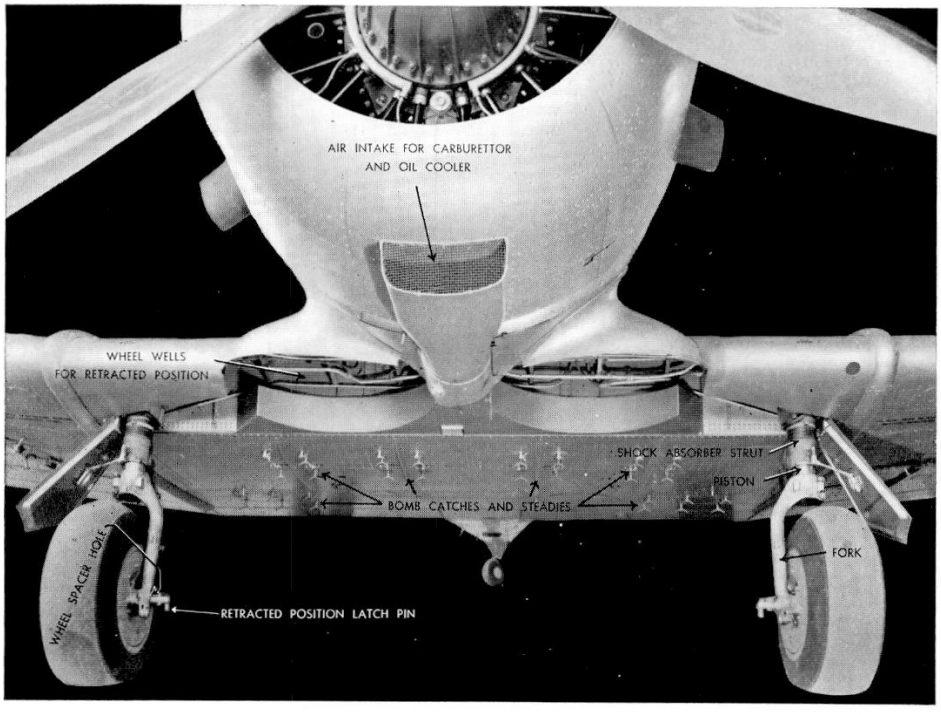
The retracted position latches may be released from either cockpit by means of the landing gear control handles.

8. Extended Position Lock Mechanism.

As the landing gear swings downward toward the extended position, a boss at the upper end of the shock strut moves into the slot of a steel fitting bolted to the landing gear support. The movement of the boss into the slot presses a bevelled lock pin back into the support. As the landing gear reaches the fully extended position, the lock pin snaps into place behind the boss, thus securely locking the strut. In the event of spring failure the lock pins may be forced into place behind the shock strut boss by moving aside the emergency plate, on the landing gear selector valve control handle quadrant, and moving the handle to the extreme forward position.



RETRACTING MECHANISM



MAIN LANDING GEAR

Section B.—MAINTENANCE

1. Filling of Shock Absorber.

Instructions for filling the shock absorber are engraved on a metal plate attached to the shock absorber assembly. To fill either strut, proceed as follows:—

Remove the access cover located on the upper surface of the wing centre section immediately above the strut. Release the air in the shock absorber through the valve at the top of the strut and remove the filler plug. Fill strut to overflowing with hydraulic fluid to C.A.C. Specification CA 411 (or a mixture of equal parts of diacetone alcohol and castor oil*). When filling the shock absorber, the strut MUST be fully compressed. Replace filler plug and inflate the strut with air until the piston moves outward 1-1/2 inches (measured between the lower end of the shock absorber cylinder gland nut and the upper collar of the fork) with the aircraft in the TAIL DOWN position and loaded as for flight. Under normal loading conditions this pressure will be approximately 220 lb. per sq. inch.

***Important.**—Under no circumstances may hydraulic fluids of different specifications be mixed. If a change is to be made the unit or system must be drained.

2. Removal of Shock Absorber Strut.

The sequence of operations necessary to remove the landing gear shock absorber strut assembly without removing the oleo attachment fitting at the pivot pin is as follows:—

(1) Jack aircraft approximately 12 inches by means of outer wing jacking points or lift by means of lifting shackles. (Refer to Chapter 2, Section C.)
(2) Release air in strut to completely deflate shock absorber.
(3) Detach bleeder plug at wheel and drain hydraulic hose. Plug end of hose.
(4) Disconnect flexible hydraulic hose at connection to non-flexible pipe. Plug end of pipe.
(5) Detach flexible hose from securing clips.
(6) Detach landing gear fairing turnbuckle from strut assembly.
(7) Remove air valve assembly from top of strut.
(8) Remove four nuts from bolts securing the strut to the oleo attachment fitting at the strut pivot pin.
(9) Lower strut through oleo attachment fitting.

Re-installation of strut may be made by reversing the sequence of operations and refilling and bleeding the brake system.

3. Removal of Oleo Attachment Fitting.

The sequence of operations necessary to remove the oleo attaching fitting is as follows:—

(1) Detach the position indicator cables.
(2) Detach the cockpit ventilator duct and air temperature resistance bulb connections from the leading edge assembly.
(3) Remove wing joint fairing by disconnecting at trailing edge of wing.
(4) Remove bolts, screws and cowl fasteners as required, to remove the leading edge assembly from centre section.
(5) Loosen the lock nut on the landing gear operating strut piston rod and rotate rod until it becomes disengaged from the oleo attachment fitting. Care should be exercised to prevent marring the polished surface of the piston rod.
(6) Remove the locking bolt and pivot pin nut, and slip the oleo attachment fitting from the pivot pin. Save shims for re-installation.

To re-install the oleo attachment fitting, reverse the above procedure. Make certain that the pivot pin is properly shimmed to provide ample clearance for operation between the landing gear strut and the extended position lock fitting.

Section C.—ADJUSTMENT OF RETRACTING MECHANISM

1. Landing Gear Lock Pin.

Adjustment of landing gear lock pin push rod should be such that the total travel (C) of the pin is 3/4″ minimum to 13/16″ maximum. The pin in the retracted position must not be less than 1/16″ underflush (A) with the lock fitting, and the maximum projection should not exceed 3/4″ in the locked position (B).

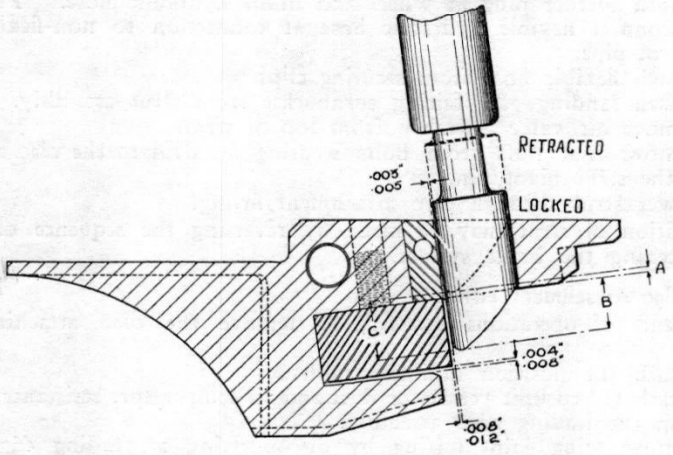
To obtain the correct travel of the pin, rotate lock pin push rod as required.

In the "DOWN" position the landing gear is held in position by means of a boss on the upper end of the shock strut. When in this position and secured by the locking pin, the following clearances are allowable:—

(D) With the boss held tight against the locking pin the clearance at the opposite end of the boss should be within .008″ minimum to .012″ maximum.

(E) A side clearance of .004″ minimum to .008″ maximum is permissible.

(F) The clearance between the locking pin and the removable locking pin block should be from .003″ to .005″.



2. Landing Gear Lock Pin Operating Mechanism.

Landing gear lock pin operating linkage must be carefully adjusted in order to obtain the correct operation of lock pins. Adjustment of rods is accomplished by detaching rods from corresponding bellcranks; loosening lock nuts and rotating rod ends until required adjustment is obtained. With landing gear lever in neutral position, a preliminary set up of linkage should be made with bellcranks arranged as shown in Diagram. The lengths of the operating rods should then be adjusted to suit.

3. Checking of Landing Gear Lock Pin Mechanism.

(1) Disconnect rods from undercarriage lever to upper arm on valve box.
(2) Push arm on valve box back until stop is reached.
(3) Disconnect operating rods from upper bellcrank (Part No. 01-58010) to centre bellcrank (01-33736), and from upper bellcrank to latch arm assembly (01-33706).
(4) Bring undercarriage lever to "UP" position on quadrant, allowing a maximum of 1/8" clearance before reaching end of travel. Without changing position, adjust rods linking undercarriage lever to upper arm on valve box, which should still be pushed back against stop.
(5) Place a suitable lever in centre bellcrank (01-33736) and manipulate until one lock pin is in correct retracted position—*i.e.*, 1/16 underflush. Holding bellcrank in this position, check lock pin on other side of aircraft. Bring to same position by adjusting length of transverse operating rod.
(6) Check for "emergency" position of undercarriage lever in similar manner. While manual pressure is still applied to centre bellcrank, check lock pins for slack by pressing on ends.
(7) Finally, adjust length of rod connecting upper and centre bellcranks to give desired retraction of lock pins when undercarriage lever is in "UP" position.

4. Electrical Warning Device.

The length of the rod connecting the switch to the lock pin mechanism must be such that the warning horn will operate if the lock pin has not travelled at least 11/32" or half way into locked position when landing wheels have been lowered.

The length of this rod can be adjusted by turning the nut which acts as a striker for the momentary contact switch. Care must be taken to prevent this nut from fouling the top or sides of the switch box when coming into operation, and also that the rod exerts no strain on the switch when in the off or down position.

5. Latching Gear Rod Adjustment.

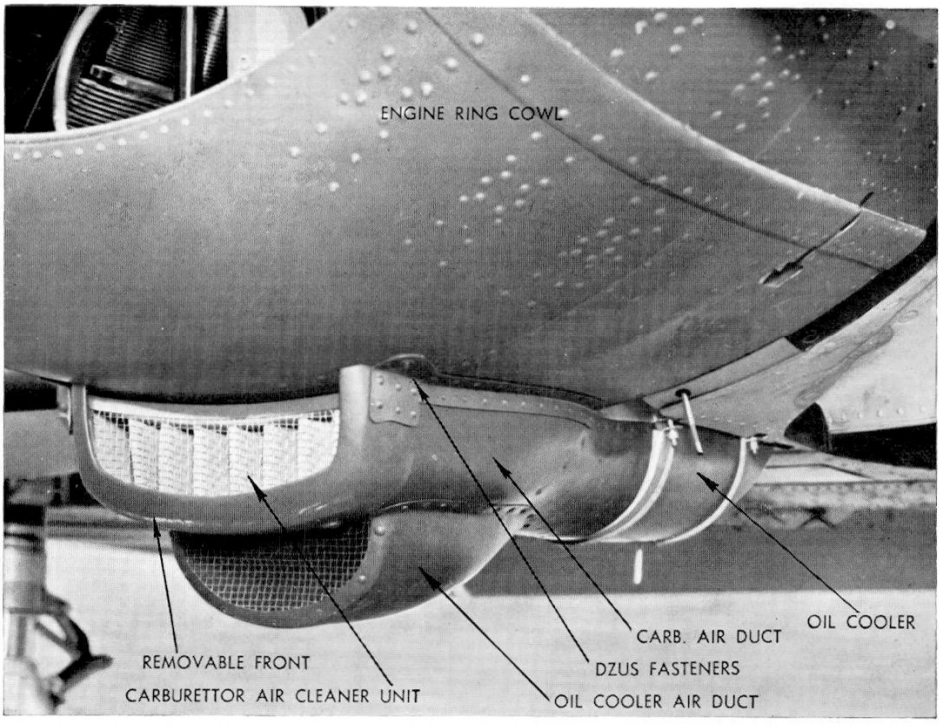
(1) Raise aircraft, by hoisting or jacking, until main landing wheels are off the ground. (Chapter 2, Section C, Ground Handling).
(2) By means of hand pump raise wheels until up position latch engages.
(3) Adjust rod connecting latching lever to upper bellcrank so that both wheels fall away simultaneously when undercarriage lever is approximately half-way between neutral position and "DOWN" on the quadrant.

6. Re-check of Operating Mechanism.

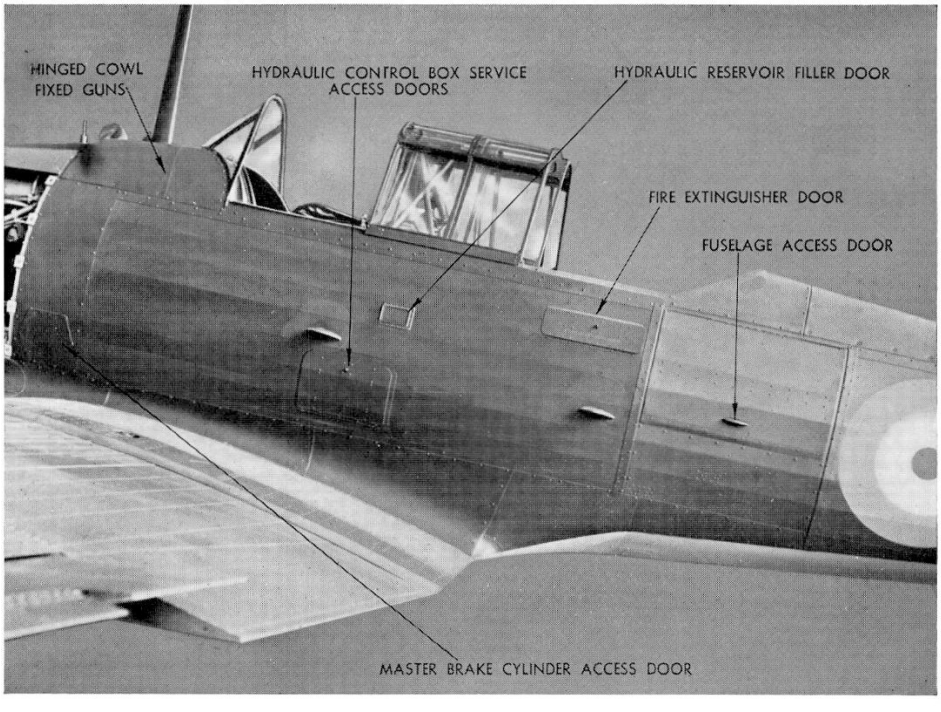
With all rods adjusted, the following points should be carefully re-checked:—

(1) With undercarriage lever in the "UP" position, the stop should be obtained in the valve box and not on the quadrant; or by the starboard bellcrank striking the starboard transverse operating rod.
(2) With undercarriage lever in the "EMERGENCY" position, stop should be obtained at end of slot in lock pin push rod and not on quadrant.
(3) With undercarriage lever in both the "UP" and "EMERGENCY" positions, all bellcranks, operating rods, fork ends, &c., should be carefully examined for fouling.

Should fuel tanks be removed, special care must be taken on replacement to see that they do not foul lock pin mechanism.

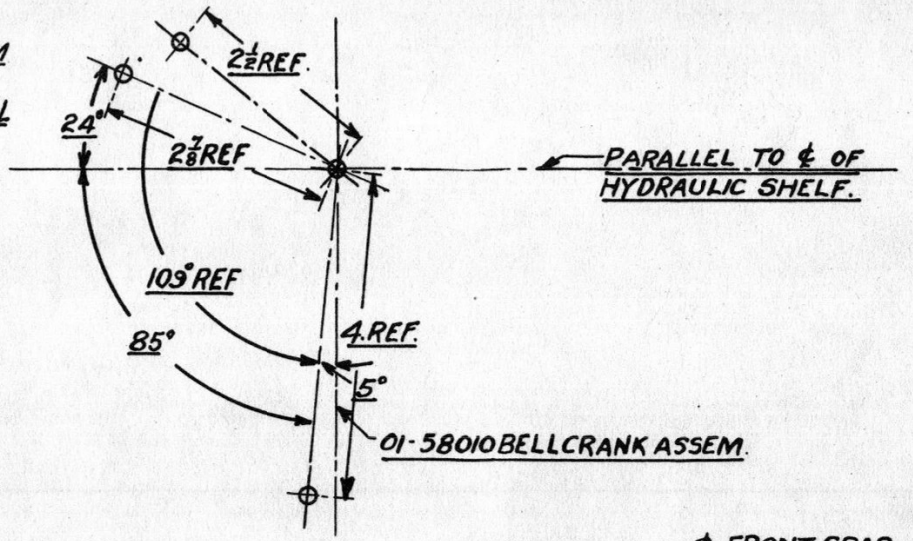


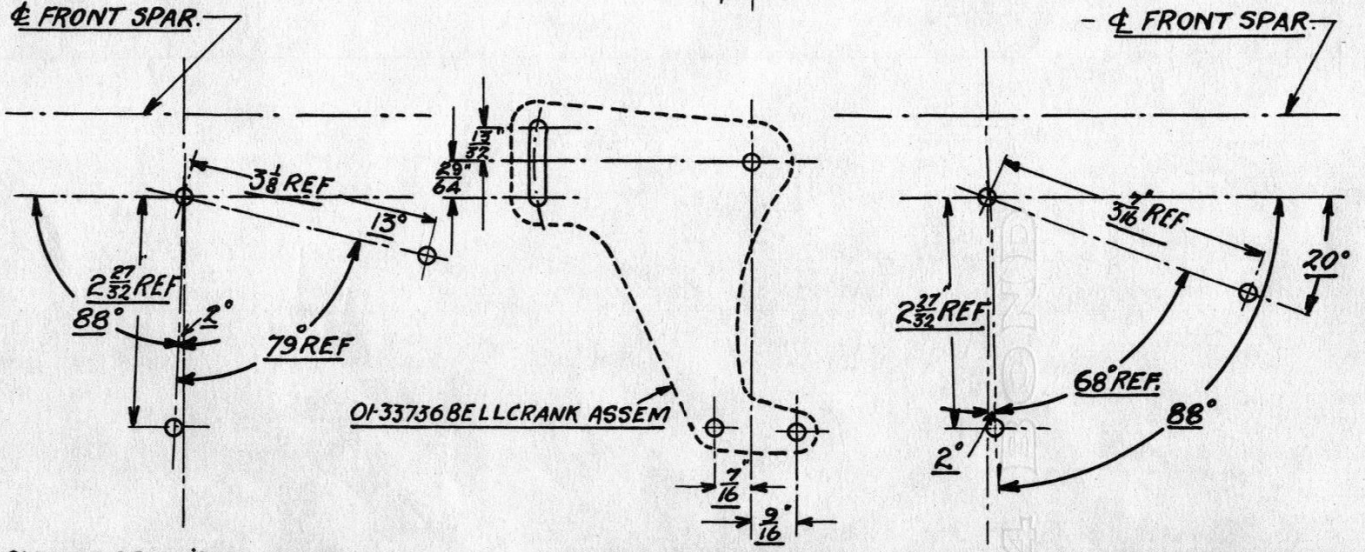
CARBURETTOR AIR CLEANER

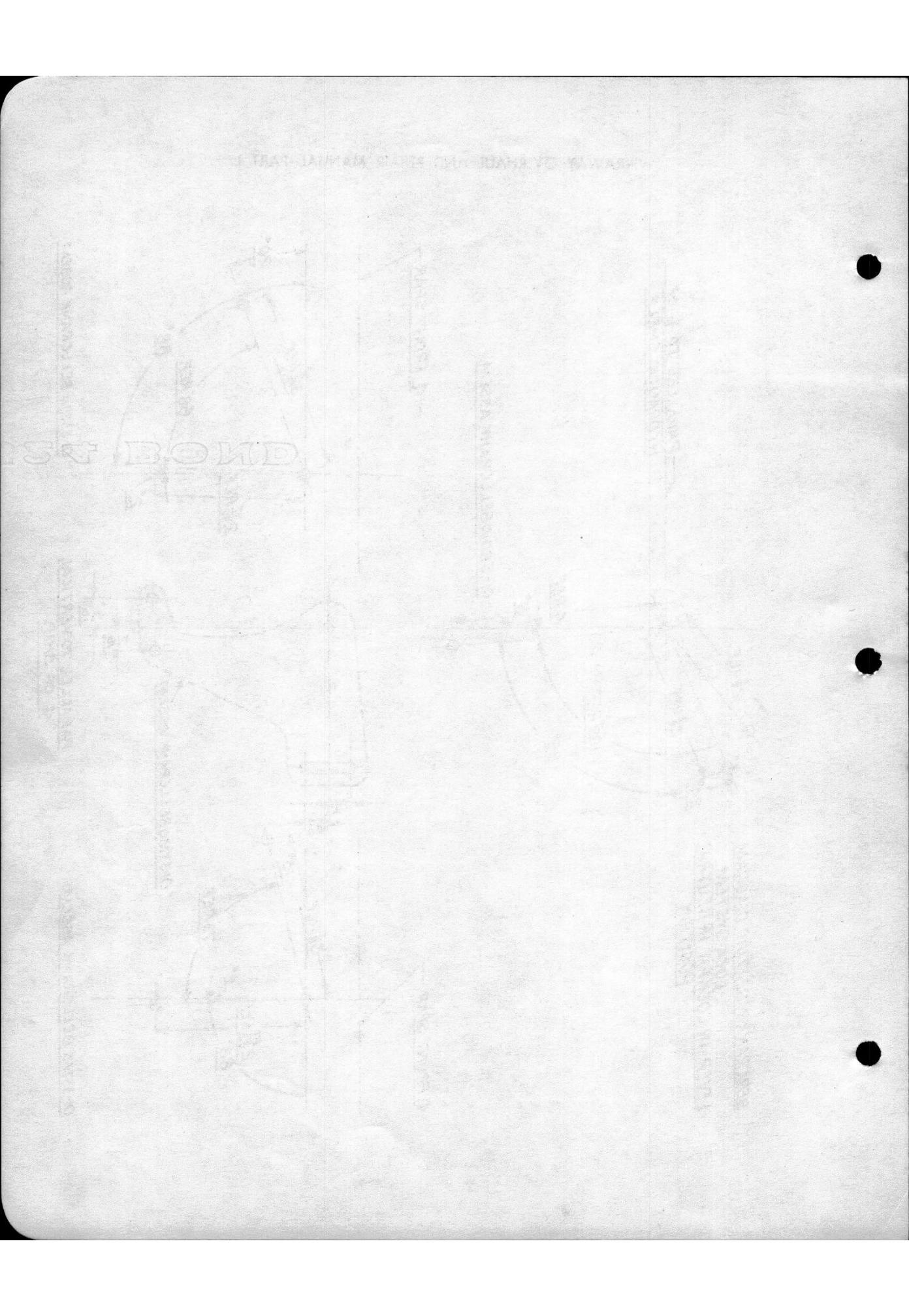


FUSELAGE ACCESS DOORS

BELLCRANKS SETTING DIAGRAM LOCK SYSTEM. LEVER IN COCKPIT IN NEUTRAL POSITION.







CHAPTER 10.—FUEL AND OIL SYSTEMS

Section A.—FUEL SYSTEM

1. Description.

A Romec Type F-4A engine driven fuel pump or equivalent is installed directly on to the engine. Its capacity at 1,750 R.P.M. is 150 gallons per hour. An auxiliary hand fuel pump is mounted on the forward port side of the firewall, and this can be operated from either cockpit. It is used to apply fuel pressure to the carburettor before starting, and in the event of engine driven pump failure may be used to provide emergency supply of fuel to the carburettor.

A relief valve and fuel filter is mounted on the engine mount ring on the lower port side of the engine compartment.

All fuel pipes are of aluminium alloy tubing and are identified by a **red band** painted near either end. Compression type fittings are employed at all connections excepting those subject to extreme vibration. These latter connections are comprised of a pipe line, synthetic rubber hose connection and clamps. The fuel level in each tank is indicated by a float type gauge incorporated in each tank and situated one on either side of the aircraft above the top of the wing centre section. The gauges are visible from either cockpit and each are illuminated for night flying. A fuel pressure indicator is mounted on the front instrument panel.

2. Tanks.

The fuel tanks are constructed of aluminium and are welded round the seams. The tanks are well baffled to prevent the surging of the fuel; are highly crowned at the ends, and are of elliptical form in cross section. They are located in the wing centre section, being separated by the intermediate rib located on the longitudinal centre line of the aircraft. A filler neck, extending through the upper surface of the wing centre section on either side of the aircraft, is incorporated in each tank. The tanks provide for a total fuel capacity of 92 imperial gallons. The right-hand tank has a capacity of 46 imperial gallons. The left-hand tank has a main supply of 30 imperial gallons, and a stand pipe incorporated in this tank provides for a reserve of 16 gallons. The tanks are not directly connected together, a three-way fuel cock mounted in the rear of the wing centre section and controlled from the control shelf in either cockpit, must be operated, switching from one tank to the other and then to reserve to give maximum continuous operation.

3. Carburettor Air Intake.

Cold air is forced into the carburettor air mixing chamber by means of a duct. The duct is built as an integral part of the engine ring cowl. Hot air is supplied to the carburettor air mixing chamber by two ducts leading from the engine compartment, and secured to the fixed engine cowl. The air is heated by the exhaust collector ring and routed to the carburettor by the two ducts.

4. Carburettor Air Cleaner.

Riveted to the lower half of the engine ring cowl are two air ducts, one of which incorporates an air cleaning unit and supplies air direct to carburettor air mixing chamber. The lower duct supplies air to the oil cooler.

The two ducts are inter-connected by means of a spring-loaded flap, which allows any excessive pressure, brought about by a backfire, to escape through the oil cooler, without damage to the air cleaner element.

The air cleaner element consists of two layers of "stockinette" held between fine brass wire gauze and assembled to form a readily removable unit.

Section B.—OIL SYSTEM

1. Description.

All oil system pipes are identified by **a 3/4" yellow band** painted approximately 3" from each end. The oil system can be drained at a tee fitting located in the pipe leading from the oil cooler to the oil tank. This fitting does not drain the oil cooler; an individual plug located at the bottom of the cooler being provided for this purpose. All pipes are secured to fittings by means of flexible hose connections.

2. Tank.

The oil tank is located in an accessible position on top of the engine mount. It is of aluminium construction and has a service capacity of 8-3/4 gallons, ample foaming space being provided. An accelerated warming compartment is provided in the oil tank. It consists essentially of a cylinderical hopper which permits only a small amount of the total oil capacity to circulate through the engine. As this oil is circulated by the engine, relatively new oil flows into the hopper from the oil tank. In this manner only a small amount of the oil is heated during the engine warming period, making it unnecessary to wait for long periods for the entire oil capacity to become heated for satisfactory engine performance.

3. Oil Cooler.

An oil cooler is installed at the bottom of the engine compartment. This cooler is 8" in diameter and consists of a brass shell, which houses a honeycomb radiator. Air is lead into the radiator by means of an air scoop attached to the forward end of the cooler. The operation of the cooler depends upon a spring-loaded pressure relief valve which allows the oil when cold to by-pass through the outside jacket of the cooler. When the oil becomes hot, however, the valve closes and the oil is diverted through the oil cooler radiator and back to the oil tank, where it reduces the temperature of the oil in the tank.

4. Automatic Oil Temperature Control and Check Valve.

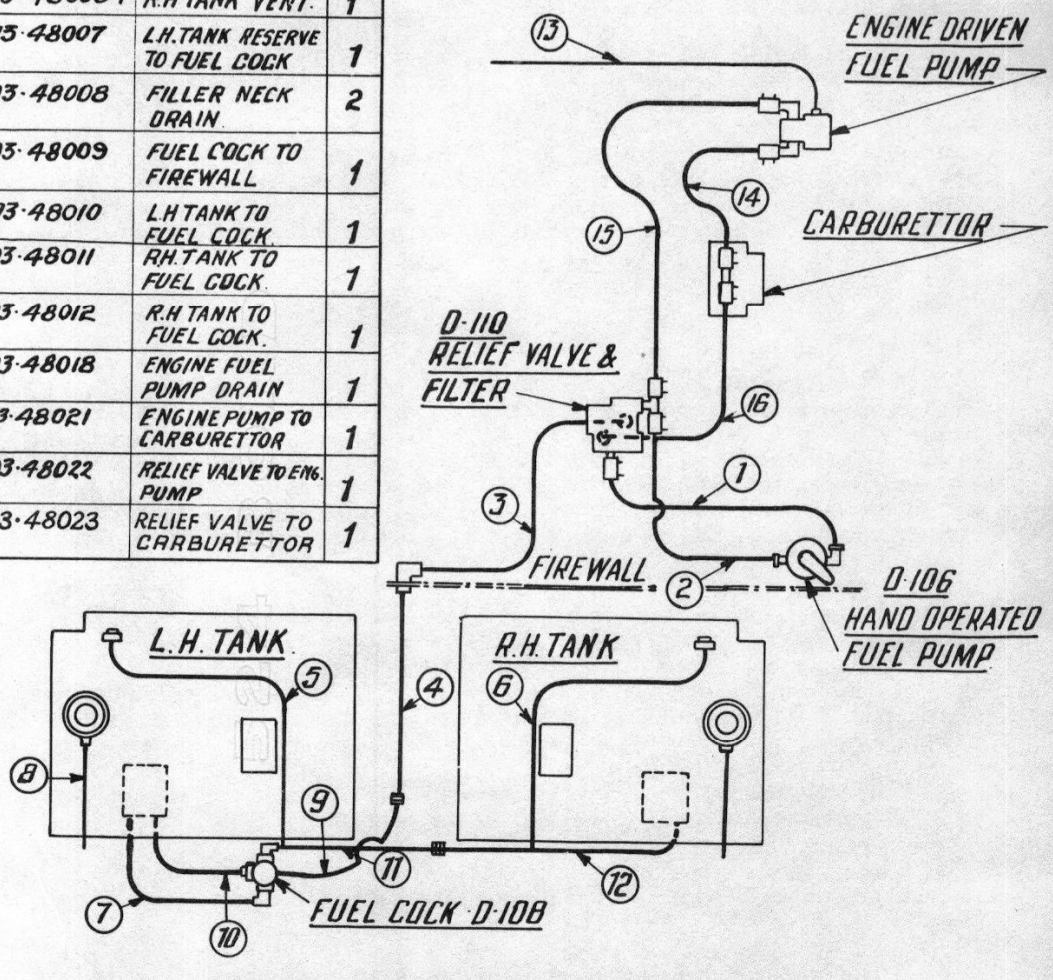
An automatic oil temperature control and check valve is secured to the bottom of the oil tank. The operation of this valve depends upon a thermostatic spring adjusted to open a valve which diverts the oil through the oil cooler at a temperature of 155° F.

Until this temperature is reached, however, the oil does not pass through the oil cooler, but returns direct from the engine to the oil tank.

The oil in the system passes from this valve to the engine pump. After circulating through the engine a scavenger pump forces the oil back to the oil tank through the oil cooler.

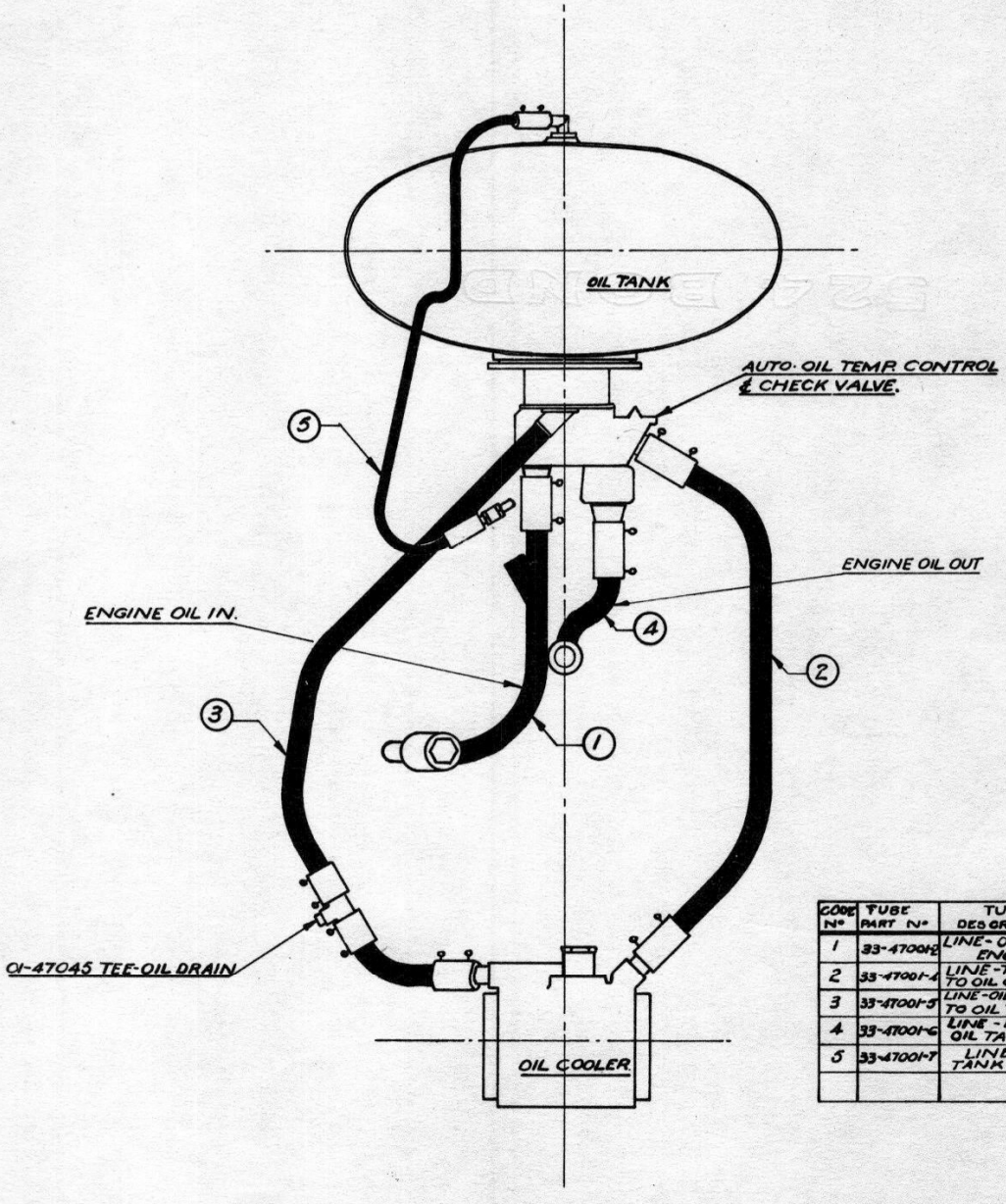
A temperature bulb is incorporated in the engine supply pipe.

CODE Nº	TUBE ASSEM PART Nº	TUBE DESCRIPTION	Nº REQ.
1	03-48002	HAND PUMP TO RELIEF VALVE	1
2	03-48003	RELIEF VALVE TO HAND PUMP	1
3	03-48004	FIREWALL TO RELIEF VALVE	1
4	03-48005	FUEL COCK TO FIREWALL	1
5	03-48006	L.H. TANK VENT	1
6	03-48006-1	R.H TANK VENT.	1
7	03-48007	L.H. TANK RESERVE TO FUEL COCK	1
8	03-48008	FILLER NECK DRAIN	2
9	03-48009	FUEL COCK TO FIREWALL	1
10	03-48010	L.H TANK TO FUEL COCK.	1
11	03-48011	RH. TANK TO FUEL COCK.	1
12	03-48012	R.H TANK TO FUEL COCK.	1
13	03-48018	ENGINE FUEL PUMP DRAIN	1
14	03-48021	ENGINE PUMP TO CARBURETTOR	1
15	03-48022	RELIEF VALVE TO ENG. PUMP	1
16	03-48023	RELIEF VALVE TO CARBURETTOR	1



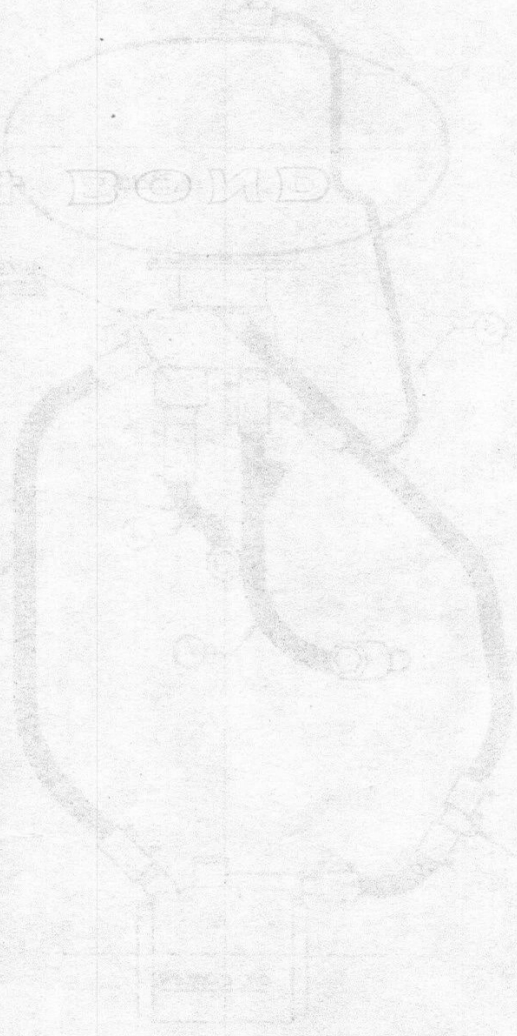
FUEL SYSTEM PIPE DIAGRAM

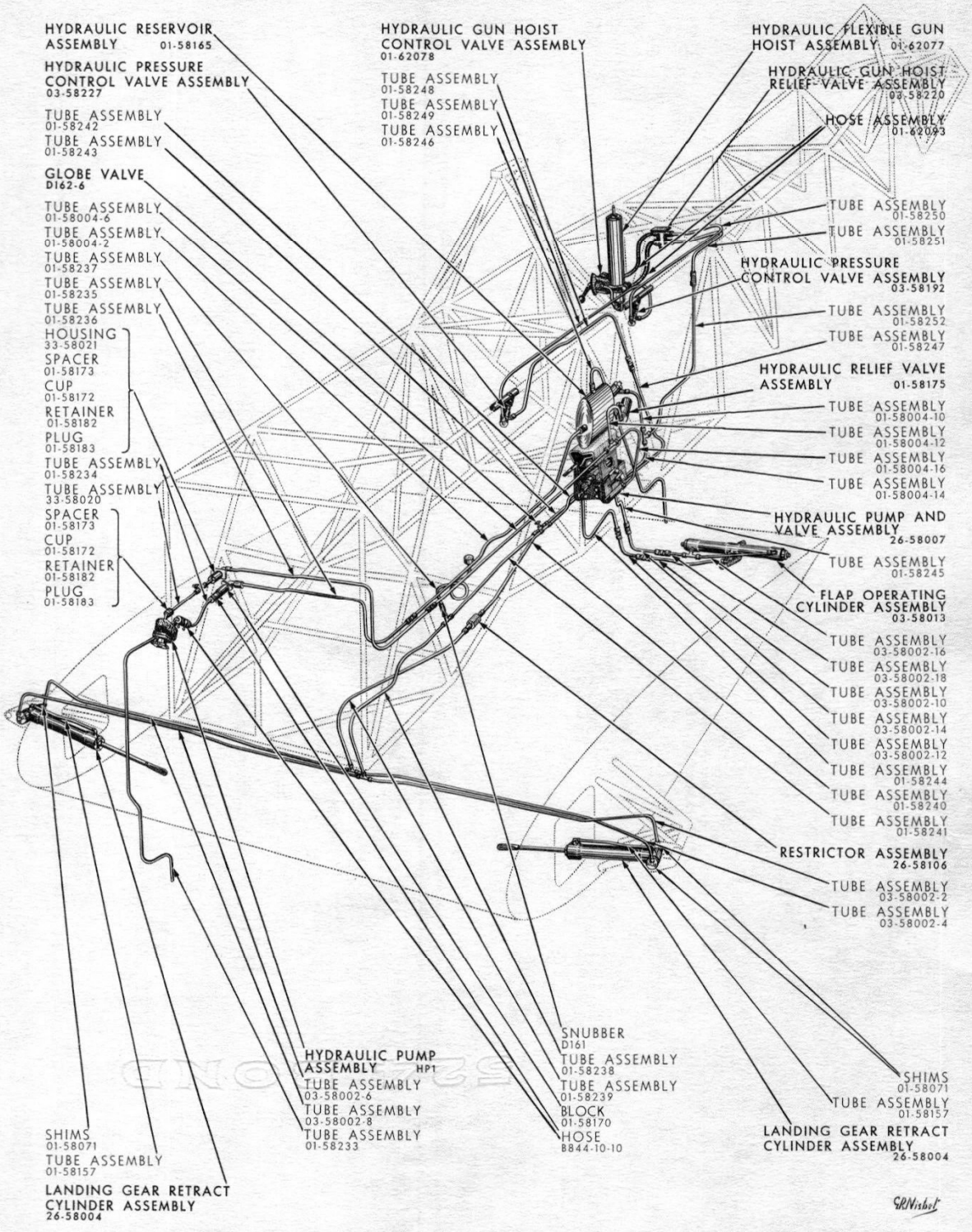
REFERENCE NOTE:
PAINT ¾ WIDE YELLOW BAND APPROX. 3 IN FROM END OF TUBES. STENCIL PART N°. ON EACH TUBE



CODE N°	TUBE PART N°	TUBE DESCRIPTION	N°REQ SHIP
1	33-47001-2	LINE - OIL TANK TO ENGINE.	1
2	33-47001-4	LINE - TEMP. CONT. TO OIL COOLER.	1
3	33-47001-5	LINE - OIL COOLER TO OIL TANK	1
4	33-47001-6	LINE - ENGINE TO OIL TANK.	1
5	33-47001-7	LINE - OIL TANK VENT	1

OIL SYSTEM PIPE DIAGRAM





INSTALLATION OF HYDRAULIC SYSTEM 03-58001

ISSUED WITH A.L. No. 1

Section C.—REMOVALS

1. Removal of Fuel Tank.

The sequence of operations necessary for the removal of either the right or left hand fuel tank is as follows:—

(1) Drain fuel.
(2) Remove fuel tank door.
(3) Disconnect bonding braids from tank.
(4) On removing the left tank, it will be necessary to entirely remove the two fuel pipes leading from the fuel tank sump to the fuel cock.
(5) On removing the right tank, it will be necessary to disconnect the single fuel pipe leading from the fuel tank sump at the sump, and loosen the pipe connection at the fuel cock. Rotate the pipe downwards to provide clearance for the tank.
(6) Disconnect the vent pipes through the access holes provided on the upper surface of the wing centre section, just aft of the front spar, and near the longitudinal centre of the aircraft.
(7) Disconnect fuel gauge lights, allowing them to remain with the centre section.
(8) Remove wing centre section fuel gauge opening covers.
(9) Detach tank support straps and lower tank from centre section.

Warning.—Before removal of the fuel tanks from the centre section it is necessary to remove the tank cover assembly. This must not be done when the aircraft is standing on its wheels, and the aircraft should therefore be jacked up or lifted before commencing to remove the tank cover. (Refer to Chapter 4, Section B, Paragraph 8 of this publication for instructions relating to the removal of the tank cover assembly.)

2. Removal of Oil Tank.

To remove oil tank proceed as follows:—

(1) Drain oil from oil tank by means of drain plug situated in the return line from oil cooler on starboard side of aircraft.
(2) Remove gun sight support from engine mount ring.
(3) Disconnect breather pipe at top of tank.
(4) Disconnect return pipe from oil cooler at sump on bottom of tank.
(5) Disconnect three pipes from oil temperature regulator.
(6) Disconnect tank bonding braid.
(7) Remove locking wires from turnbuckle arrangement on tank straps and unscrew turnbuckles. Hinge tank straps outward and raise tank from lower support straps and pads. The oil temperature regulator should remain attached to the tank.

CHAPTER 11.—HYDRAULIC SYSTEMS

Section A.—DESCRIPTION

1. Description.

The hydraulic system is provided for the operation of the retractable undercarriage, landing flaps, and also for the operation of flexible gun hydraulic hoist. Pressure for the system is supplied by an engine driven hydraulic pump. An auxiliary hand operated hydraulic pump is provided, to be used in case of the failure of the engine driven pump. This hand pump can be operated from either cockpit. On the control shelf (Part No. 01-58004) on the left-hand side of the aircraft is mounted a fluid reservoir which supplies the hydraulic fluid for the operation of both engine and hand pumps.

All hydraulic pipes are marked with a **blue band** near either end.

The undercarriage levers and flap control handles are interconnected with the selector valve box situated beneath the hydraulic shelf. When operating the system by means of the engine driven pump the fluid is directed to the selector valve by means of a hydraulic power valve situated on the top longeron on the left-hand side of the aircraft. This valve is connected in series to another control valve in the rear cockpit, thus enabling the system to be controlled from both cockpits. The hydraulic power valve situated in the front cockpit is fully balanced and will remain closed until the valve spindle is pulled out by the operator. The valve in the rear cockpit, however, is unbalanced and will only remain closed while the operator exerts pressure upon the valve spindle.

2. Pressure Relief Valve.

A spring loaded relief valve is placed in the pressure line just behind the fluid reservoir. The function of this valve is to limit the maximum pressure in the system. Should the hydraulic power valve be inadvertently left closed, or if for any other reason the pressure should reach the maximum allowable (850 lb./sq. in.), a trigger operated by the relief valve engages a switch, which in turn causes a warning light to glow on the instrument panel in both cockpits.

3. Rear Gun Hoist Connection.

A connector block carrying a ball relief valve is installed in the fuselage to the rear of the rear cockpit. This block serves as a connection between the metal pipe line and the flexible hoses leading to the rear gun hoist control valve. The relief valve is adjusted to 100 lbs. per sq. inch and limits the pressure applied to the ram of the gun hoist. The hydraulic fluid circulates through the connector block and gun hoist valve until it is diverted into the gun hoist barrel by the operation of the gun hoist control valve lever.

Originally the relief valve was set to operate at a pressure of 800 lbs. sq. inch. and no means were provided for adjusting the tension on the relief valve spring. A new design of relief valve is now fitted whereby the tension of this spring may be adjusted.

4. Non-Return Valve.

A non-return valve is incorporated in the selector valve box to prevent the fluid being forced from the hand pump back into the engine pump system.

5. Restrictor Valves.

A restrictor valve is incorporated in the "down" line of the main landing gear to prevent the wheels from dropping too rapidly. A restrictor is placed in the "up" line of the flap operating system to prevent the pressure of the wind on the flaps in the down position forcing the flap up quickly if the hydraulic pressure is relieved by withdrawing the power control without returning the flap control lever to the centre or "LOCK" position.

6. Pressure Gauge.

A pressure gauge is mounted on the hydraulic shield in the front cockpit. It is connected by means of an expansion tube to a snubber (D. 161) plaecd in the "DOWN" line of the landing gear operating system.

The snubber restricts the flow of fluid to the gauge, thereby reducing wear on the gauge and preventing excessive oscillation of the gauge pointer. This is accomplished by absorbing excessive surges of hydraulic pressure due to pulsations from the engine pump, or from the completion of a given movement of the landing gear operation.

Section B.—OPERATION

1. Description.

The retractable landing gear and the landing flaps are hydraulically operated, either by engine driven pump or by hand pump. The normal operation is by engine driven pump, and after the control handles are set at the desired positions, the hydraulic power control knob should be pushed. An instruction plate for the operation of the hydraulic system is located at the forward end of the control shelf, on the left-hand side of the front cockpit.

2. Operation of Landing Gear.

The landing gear is operated by double-acting hydraulic rams, with mechanically-operated spring loaded latches at the limiting upward and downward positions. The landing gear may be lowered from either cockpit, but as a safety catch is incorporated in the front cockpit quadrant, the landing gear cannot be raised by the rear cockpit controls. Mechanical indicators and warning devices are provided for the pilot's information in the front cockpit.

The operation of the landing gear is as follows:—

Place undercarriage lever in either the "UP" or "DOWN" position as required. This operates the lever arm on the selector valve box, which opens the valve directing the circulating hydraulic fluid into the operating cylinders. Now push the spindle of the hydraulic control valve right in. The front cockpit control valve being fully balanced will remain in engagement, but when operating from the control in the rear cockpit, it is necessary to hold this control in until the desired operation is completed. The closing of the control valve diverts the hydraulic fluid through the selector valves, and pressure builds up in the system operating the piston of the retracting cylinder. The landing gear control handle in the cockpit is inter-connected with the mechanical latches, and these are released when the control is moved to the desired setting. When the operation is completed, the hydraulic pressure continues to build up until the relief valve opens and operates the switch controlling the red warning indicator on each instrument panel. This, together with the mechanical indicators showing the position of the landing gear, serves as an indication that the operation is completed and the hydraulic control valve should then be withdrawn, and the landing gear control handle returned to the centre position.

3. Landing Gear Warning.

The landing gear warning indicator consists of a warning horn attached to the over-turning truss behind the pilot's head. This acts as a warning in case of unsafe landing conditions. The unit is inter-connected electrically with the "DOWN" position latch pins and the throttle control in such a manner that, when the throttle is closed to an extent resulting in engine speeds under 1,000 R.P.M., the horn will sound if either "DOWN" position latch pin is not in place.

4. Operation of Landing Flaps.

The hydraulically operated landing flaps are controlled in a similar manner to the retractable landing gear. A calibrated indicator adjacent to the landing gear position indicator in the front cockpit shows the position of the landing flaps from the "UP" position (0°) to the "DOWN" position (60°). When it is desired to stop the flaps at an intermediate position, the flap control handle should be moved to the "LOCK" position, when the flap indicator shows the flap extension desired. The flaps MUST NOT be lowered when flying at indicated air speeds in excess of 125 miles per hour. The landing flap control handle should always be returned to the "LOCK" position as soon as the desired extension is completed, as the air pressure on the flaps tends to return the flaps slowly to the upward position, although a restrictor is incorporated in the flap circuit tc ensure that reasonable time is available to lock the flaps down.

5. Operation of Rear Gun Hoist.

The raising or lowering of the gun is effected by means of a three-position valve at the side of the hydraulic hoist. The upward and downward positions of this valve raise and lower the gun respectively. The hoist may be locked in any position by merely returning the valve to the neutral or central position. The hydraulic power for the operation of the hoist is derived from the engine driven hydraulic pump, but in case of failure of this supply, the hoist may be operated by setting the valve in the desired position and operating the hand hydraulic pump.

To relieve the loads on the control valve, the ball relief valve in the gun hoist system is set to open at approximately 100 lb. per sq. inch.

Warning.—When the rear gun is not actually in operation, the control valve should be locked in the central position by inserting the locking pin, which is attached to the valve by a short length of chain. This will avoid accidental raising or lowering of the gun hoist should the valve be inadvertently knocked.

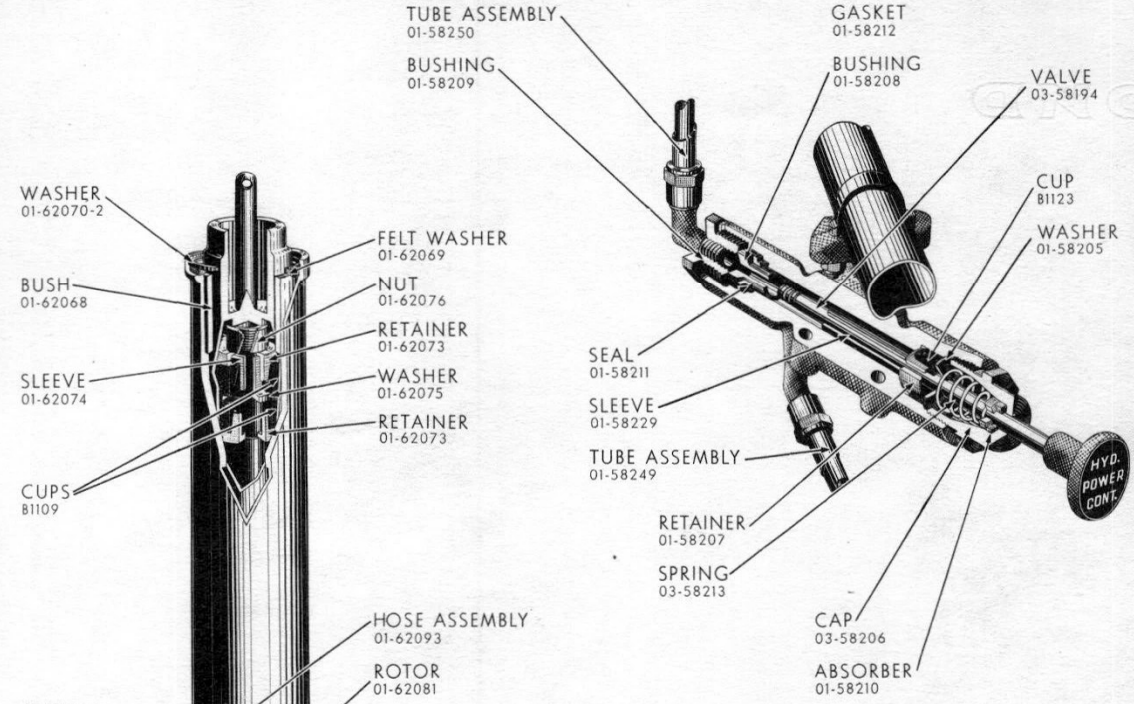
6. Emergency Operation.

In the event of failure of the engine driven pump or its connections, the hand pump should be used for the operation of the landing gear and flaps. The reservoir in the hydraulic system is so arranged that, even in the event of failure of the pressure line from the engine driven pump, with the consequent loss of hydraulic fluid, sufficient will always remain in the system to provide fluid for the operation of the emergency hand pump. Should complete failure of the hydraulic system occur—*i.e.*, failure of both engine driven pump and hand pump, the landing gear will fall to the extended position when the control handle is set for the "DOWN" position and the emergency valve, located to the left of the pilot's seat in the front cockpit, is opened. This valve is of the needle type and the handle is painted red and the valve suitably labelled. After the landing gear has reached the down position during this emergency operation, without the use of either hydraulic pump, the latches may not positively engage unless the aircraft is rocked to and fro about the rolling axis to throw the landing gear into place. The safe landing condition is indicated if, on closing the throttle, the landing gear warning horn, at the pilot's head, does not operate.

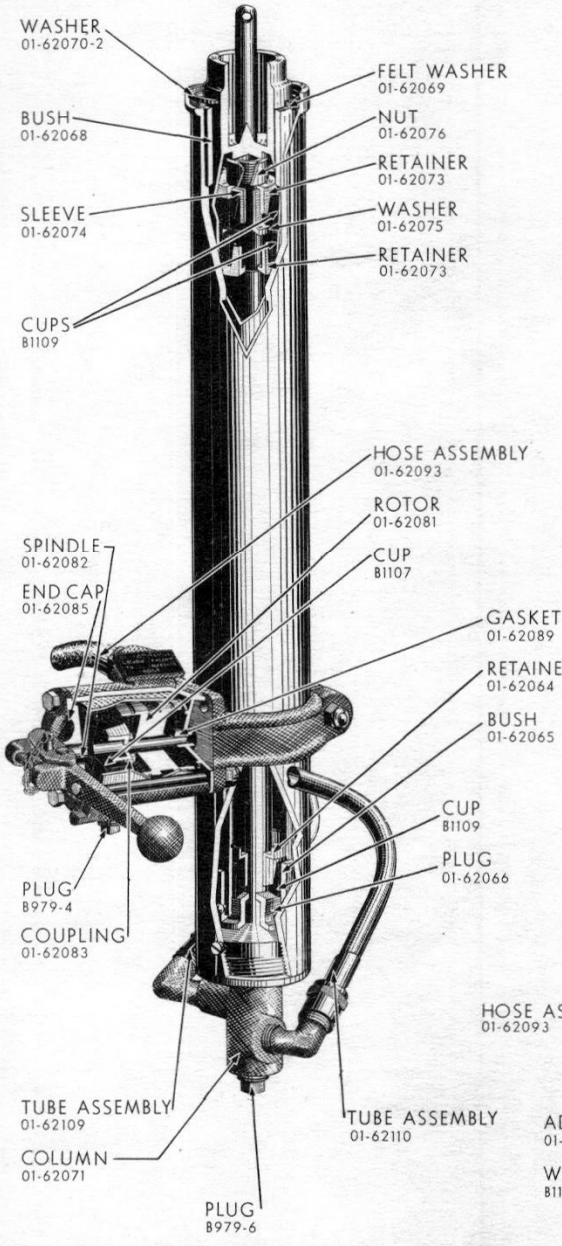
7. Landing Gear Latch Failure.

The landing gear is held in the "DOWN" position by a spring loaded latch, and failure of the spring may prevent the latch pin from going into place. This condition will be indicated when the electric horn sounds a warning of an unsafe landing condition when the landing gear has otherwise functioned normally.

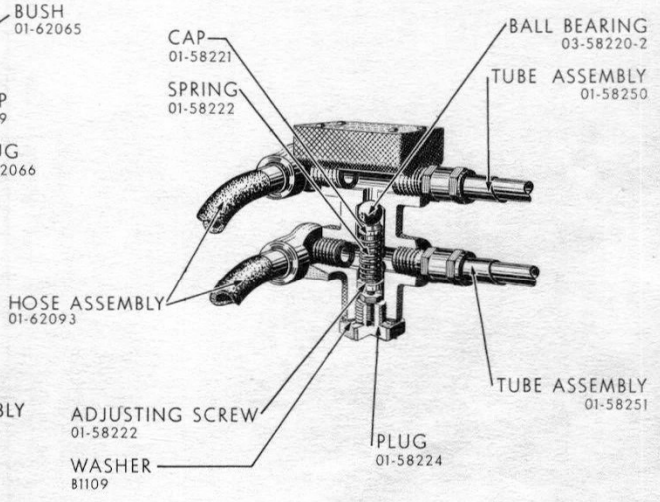
The "DOWN" position latch pin may then be operated by a mechanical over-ride, which is actuated by the landing gear control handle in the front cockpit. In order to do this, it is necessary to move aside the lock plate marked "EMERGENCY" — "This portion of **Handle Travel Pushes Latch Pins in Place,**" which normally limits the forward travel of the landing gear control lever; the control handle should then be pushed forward as far as it will go. Safe landing condition is then, as usual, indicated when, with the throttle closed, the warning horn ceases to sound. It should be noted that this extra portion of the landing gear control handle travel is to be used only in this emergency and not for normal operation.



HYDRAULIC PRESSURE CONTROL VALVE ASSEMBLY
03-58192



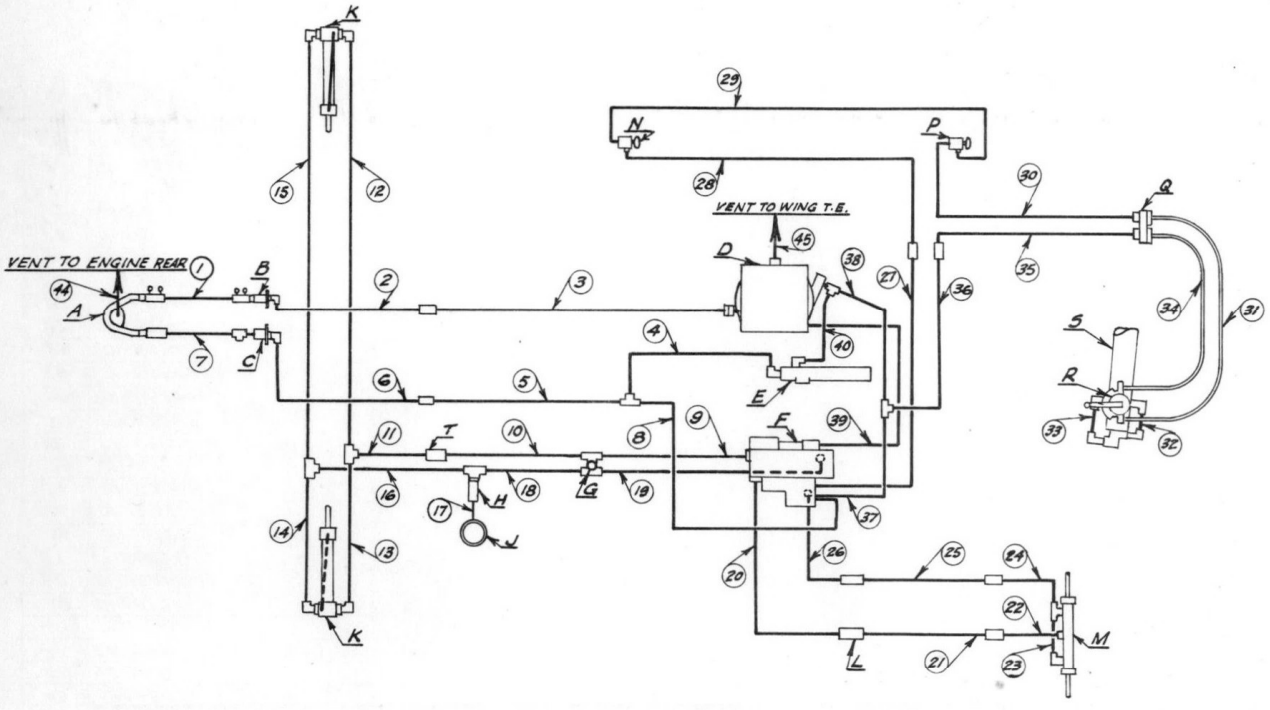
HYDRAULIC GUN HOIST ASSEMBLY
01-62077



HYDRAULIC GUN HOIST RELIEF VALVE ASSEMBLY
03-58220

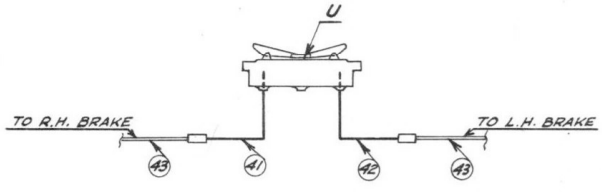
CONTROL VALVE AND GUN HOIST ASSEMBLIES

ISSUED WITH A.L. No. 1



HYDRAULIC SYSTEM PIPE DIAGRAM

CODE NUMBER	PART No.	No. REQ.	PART NAME
45	01-58246	1	TUBE ASSEM.
44	01-58233	1	" "
43	03-33406	2	" "
42	26-33401-2	1	" "
41	26-33401-3	1	" "
40	01-58004-8	1	" "
39	01-58004-4	1	" "
38	01-58004-10	1	" "
37	01-58004-14	1	" "
36	01-58252	1	" "
35	01-58251	1	" "
34	01-62093	1	" "
33	01-62110	1	" "
32	01-62109	1	" "
31	01-62093	1	" "
30	01-58250	1	" "
29	01-58249	1	" "
28	01-58248	1	" "
27	01-58247	1	" "
26	01-58245	1	" "
25	01-58002-14	1	" "
24	01-58002-18	1	" "
23	01-58002-16	1	" "
22	01-58002-10	1	" "
21	01-58002-12	1	" "
20	01-58244	1	" "
19	01-58243	1	" "
18	01-58241	1	" "
17	01-58237	1	" "
16	01-58238	1	" "
15	01-58002-6	1	" "
14	01-58002-2	1	" "
13	01-58002-4	1	" "
12	01-58002-8	1	" "
11	01-58239	1	" "
10	01-58240	1	" "
9	01-58242	1	" "
8	01-58004-16	1	" "
7	33-58020	1	" "
6	01-58236	1	" "
5	01-58004-6	1	" "
4	01-58004-12	1	" "
3	01-58004-2	1	" "
2	01-58235	1	" "
1	01-58234	1	TUBE



BRAKE SYSTEM

ITEM LETTER	PART No.	No. REQ.	PART NAME
U	19-33402	1	CYLINDER ASSEMBLY BRAKE
T	26-58106	1	RESTRICTOR ASSEM.
S	01-62077	1	HOIST ASSEM. FLEXIBLE GUN
R	01-62078	1	VALVE ASSEM.
* Q	01-58220	1	VALVE ASSEM.
P	03-58192	1	VALVE ASSEM.
N	03-58227	1	VALVE ASSEM.
M	03-58013	1	CYLINDER ASSEM. FLAP OPER'G.
L	01-58232	1	RESTRICTOR ASSEM.
K	26-58004	2	CYLINDER ASSEM. LAND. GEAR
J		1	PRESSURE GAUGE "KOLLSMAN OR PIONEER"
H	D161	1	SNUBBER
G	D162-6	1	GLOBE VALVE
F	26-58007	1	PUMP AND VALVE ASSEM.
E	01-58175	1	RELIEF VALVE ASSEM.
D	01-58165	1	RESERVOIR ASSEM.
C	33-58021	1	HOUSING
B	01-58170	1	BLOCK
A		1	ENGINE DRIVEN HYD. PUMP

* THIS PART USED ON CA-1 ONLY. FOR CA-3 & CA-5 USE 03-58220

Section C.—MAINTENANCE

1. Hydraulic Fluid.

The hydraulic fluid used for servicing throughout the aircraft is to C.A.C. specification CA 411 (or a mixture of equal parts of diacetone alcohol and castor oil may be used*). Care should be taken to prevent any foreign matter getting into the fluid. If dirt or any foreign substance should get into the systems there is a possibility that small particles may destroy the complete seal of the rubber hydraulic cups, which would cause loss of fluid and interfere with the efficiency of the system.

***Important.**—Under no circumstances may hydraulic fluids of different specifications be mixed. If a change has to be made the unit or system must be drained.

2. Filling Hydraulic Systems.

Access to the hydraulic reservoir is gained through a small door located on the port side of the aircraft between the cockpits. The fluid level in the reservoir should be checked daily and fluid added if necessary. The normal capacity in the system is obtained with the aircraft in the tail down position and the reservoir filled to overflowing. In cases where the system has been drained, the following operations should be carried out to ensure complete filling of the system.

(1) With the aircraft in the normal tail down position, fill the reservoir by means of the filler pipe to overflowing. This is necessary, because the inspection of the level of the fluid in the reservoir through the filler opening is misleading. The total fluid capacity of the reservoir in this position is .625 imp. gallons. The relative positions of the engine pump suction pipe and that of the hand pump are such that there is always a sufficient supply of fluid in the reservoir with which to operate the hand pump in case of failure of the engine pump.

(2) Place landing flap control handle in "DOWN" position and push spindle of hydraulic control valve in. Now operate the hand pump until flaps are in the down position. This operation pumps fluid into the hydraulic pipes to the flap.

(3) Remove filler cap from reservoir and bring flaps to the "UP" position, at the same time placing a cloth over the filler opening and allowing the air which is being expelled from the pipe line to escape, but taking care that the fluid in the reservoir is not forced out.

(4) Add fluid to the reservoir until it overflows, and operate flaps by means of the hand pump until all air bubbles disappear. The air has now been expelled from the flap operating system.

(5) With the landing wheels down and chocked to prevent inward movement, force the fluid into the system as shown above by operating the undercarriage lever and control valve.

(6) Raise aircraft by hoisting or jacking until main landing wheels are off the ground (refer to Chapter 2, Section C—Ground Handling), and with the filler cap still removed from the reservoir, raise and lower wheels several times (refer to Operation Hydraulic System—To raise or lower the wheels, Chapter 11, Section B).

(7) Bring level of fluid in reservoir to overflowing point and screw on cap.

(8) Expel air from the hydraulic gun hoist system in the same manner.

3. Priming of Engine Driven Hydraulic Pump.

When the pipes of the engine driven hydraulic pump have been drained and the reservoir refilled, some difficulty may be experienced in getting the pump to prime. To check for satisfactory operation of the engine pump, start the engine and operate the wing flap control handle and hydraulic control valve as required for the raising and lowering of the flaps. If satisfactory operation of the flaps is obtained, the engine driven pump is functioning correctly. If, however, the flaps do not function correctly, proceed as follows:—

(1) Stop engine and connect a globe valve to pressure pipe tee connector fitting located on forward side of firewall.
(2) Close globe valve and re-start engine.
(3) Open globe valve slightly, allowing a small leakage of fluid.
(4) Close globe valve and test for proper functioning of engine pump by again operating landing flaps.
(5) Allow leakage from globe valve until engine pump has primed itself.
(6) Stop engine, remove globe valve and plug tee fitting.

4. Dismantling and Adjusting Hydraulic Units.

A visual inspection of some units of the hydraulic system will readily determine the procedure for dis-assembly; therefore instructions for the dis-assembly of those parts are omitted. When the disconnection of any hydraulic pipe is involved plug the ends of the pipe to prevent loss of fluid and entry of any foreign matter.

Packing cups, gaskets, absorbers, &c., should be inspected for deterioration, wear and damage. Replacement of gaskets is not necessary unless they are in poor condition. Before installing any part, it should be thoroughly cleaned and coated with hydraulic fluid. Do not use petrol to clean hydraulic cups, as when they are placed in petrol they swell considerably. Methylated spirits can be used however.

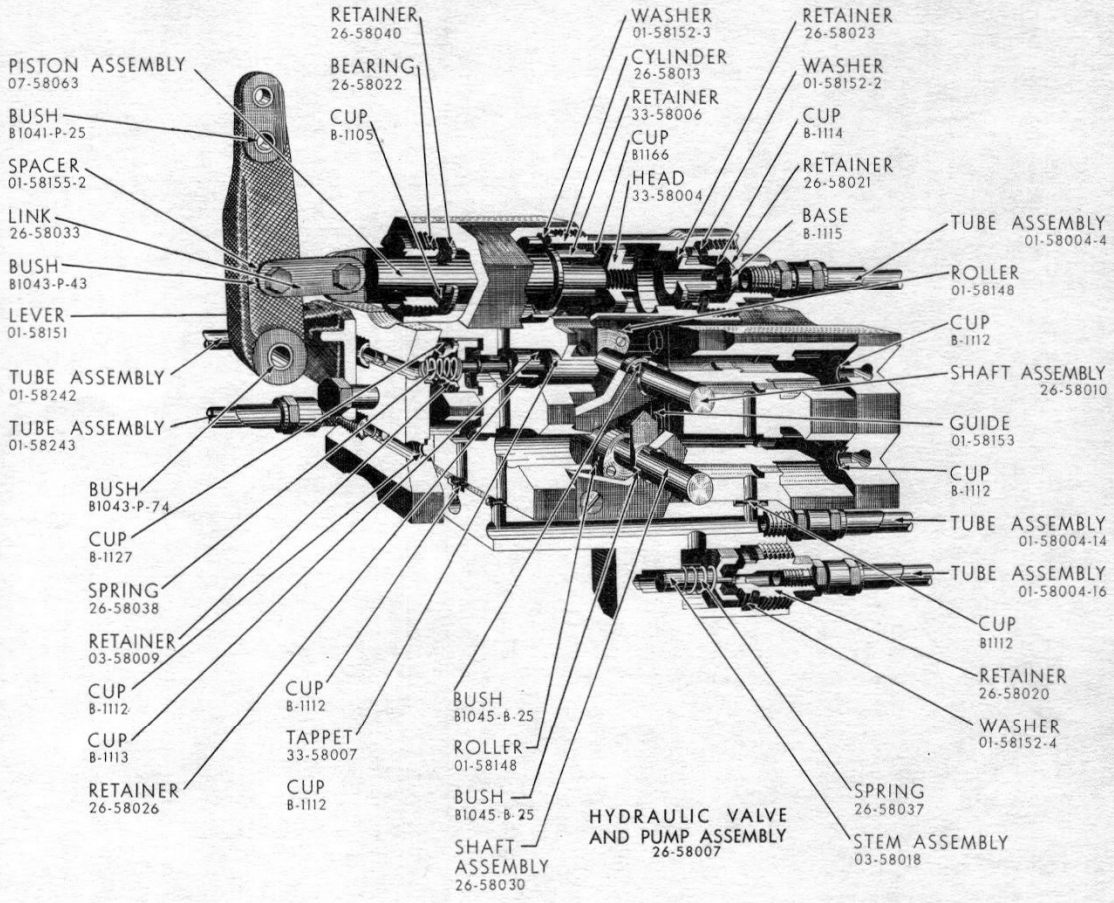
During assembly make certain that all cups, retainers, guides, pins, washers, gaskets, &c., are properly installed and locked as required. For assembly and installation instructions, reverse procedure oulined for removal and dis-assembly of the various units.

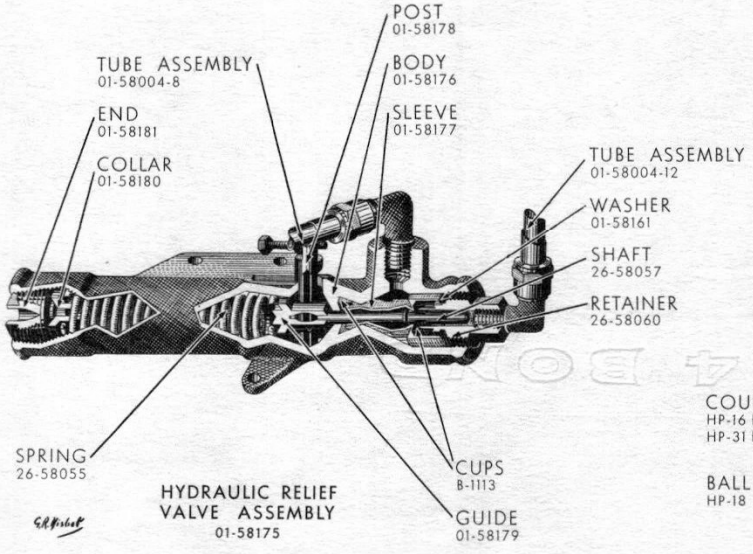
5. Valve and Pump Assembly (26-58007).

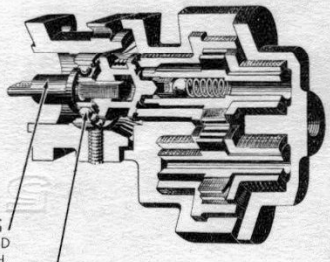
To inspect and repair valve and pump assembly (Part No. 26-58007) it is necessary to remove the assembly from its position beneath the control shelf. To do this it is necessary to remove the front L.H. side fairing from the fuselage and to drain the hydraulic system. Disconnect all pipes and connecting links from the assembly. Remove securing bolts and lift clear. Plug ends of pipes to ensure that no foreign matter enters the system. To dismantle proceed as follows:—

(1) Remove end blocks (Part No. 26-58012), taking care not to damage sealing cups (B 1127).
(2) Remove side plates (Part No. 26-58143) and cam gear.
(3) Remove head (Part No. 26-58009).
(4) Remove valves. This can be accomplished by removing fibre strip and turning tappet through 90°, so that hole in tappet lines up with hole drilled through body. Locking pin (26-58039) can then be shaken out, allowing tappet to be screwed from valve spindle.
(5) Remove cylinder of hydraulic pump (Part No. 26-58013) by screwing from valve body. The piston (26-58063) can then be withdrawn.

Thoroughly inspect each part of the assembly to determine the condition of gaskets, cups, retainers, springs, &c. Make certain that the piston bearing (Part No. 26-58022) is not excessively worn. Replace all cups and retainers that have deteriorated to such an extent as to cause leakage of fluid and subsequent incorrect functioning of the system. When replacing tappets on valve pistons, see that the locking pin is an easy fit in locating hole to facilitate dis-assembly.







HYDRAULIC POWER UNITS

ISSUED WITH A.L. No. 1

6. Pressure Relief Valve Assembly (01-58175).

The hydraulic pressure relief valve assembly is mounted on the control shelf just aft of the hydraulic fluid reservoir. To remove assembly, disconnect the two hydraulic pipes at fittings on assembly. Disconnect wiring in switch box and detach conduit. Remove three bolts securing assembly to control shelf and lift clear. Completely dis-assemble valve and thoroughly inspect each part for signs of damage and wear. When re-assembling, adjust the spring loaded relief valve (Part No. 01-58185) to function at 850 lbs. per sq. inch. This may be adjusted by removing lockwire from locking nut at end of valve and turning nut to increase or decrease the pressure on the spring as required. This adjustment should be made with the engine running. The pressure should be adjusted to 850 lbs. per sq. inch with the engine running at 2,100 R.P.M. Test the functioning of the relief valve by lowering landing gear and holding pressure control valve in until the relief valve operates. Note pressure reading on pressure gauge, and adjust until correct reading is obtained. Operate several times before finally locking adjustment screw. Care should be taken to see that the trigger incorporated in the valve assembly engages the switch operating the warning light, and also that there is no excessive load on switch when relief valve is open.

7. Hydraulic Control Valves (03-58227 and 03-58192).

The hydraulic control valves are mounted, one in each cockpit, on the top longeron on the port side of the aircraft. To remove, disconnect two hydraulic pipes and remove U-bolt securing to longeron. Completely dis-assemble and thoroughly inspect each part for signs of wear or damage. Replace any damaged part or cup that has deteriorated. When re-installing control valves care must be taken to see that the balanced valve (Part No. 03-58227) is placed in the front cockpit and that the unbalanced valve (Part No. 03-58129) is in the rear cockpit.

8. Landing Gear Operating Strut (26-58004).

The landing gear hydraulic operating struts are supported at the outboard ends of the wing centre section front spar. To remove strut, disconnect two hydraulic pipes from strut, loosen locknut at end of retracting piston and turn piston until eye-end is free.

Remove bolt securing steel collar over the forward bearing on retracting cylinder and over shaft at the outboard end of cylinder support structure. The collar may then be pulled off and the cylinder removed, leaving the retracting piston eye-end attached to the oleo attaching fitting.

Dis-assemble strut and examine cups, gaskets, bearings, &c., for deterioration and wear. Replace any faulty part. On re-assembly, all parts should be thoroughly cleaned and coated with hydraulic fluid. The maximum length of piston stroke is 7-1/2", but the adjusted stroke should be 7", allowing 1/4" overstroke at each end. After assembly, check for correct adjustment by raising and lowering landing wheels.

9. Flap Operating Cylinder (03-58013).

The flap hydraulic cylinder is supported by means of two bolts securing cylinder to brackets attached to upper surface of the centre section trailing edge on the port side. To remove, disconnect two hydraulic pipes at fittings attached to cylinder. Extract bolts securing push-pull rod at either end. Disconnect two equalising rods at rocker arm located on the cylinder and at fittings on the push-pull rod. Remove two bolts supporting cylinder and remove assembly.

9. Flap Operating Cylinder (03-58013) *(Continued)*

Completely dis-assemble operating cylinder and inspect for deterioration and wear. Replace any faulty part. When adjusting flaps for 60° travel, care should be taken to adjust travel of piston so as to give clearance in cylinder at each end of stroke.

10. Replacement of Hydraulic Cups.

Moulded rubber cups are ultilised in various units of the hydraulic systems, as packing glands. Service replacement of cups is necessary in the event of excessive leakage occuring. Leakage of internal cups is indicated by slow action or complete malfunctioning. Cups to be replaced may be determined by location of the leakage. A visual inspection of the location of the cups to be replaced and of attaching and surrounding parts will readily determine to what extent dis-assembly is necessary in order to accomplish replacement.

If replacements are accomplished without removal of the unit, care should be taken to see that the mechanism is kept clean and free of foreign matter. After the replacement of a cup or cups in a unit, that unit should be bench tested if dis-assembled from the aircraft, to withstand 1,200 lb. per sq. in. In cases where replacements are made on the aircraft, the unit may be tested to 850 lb. per sq. in. by utilising the hand or engine driven hydraulic pump.

The following are the requirements for moulded parts used in the various units:—

(1) *Valve and Pump Assembly.*—The valve and pump assembly requires eight B 1113 cups at back of tappets, eight B 1127 cups sealing end blocks to valve body, four B 1112 cups sealing distributor head to valve body, one B 1105 sealing piston bearing, and one B 1114 at non-return valve seat. One B 1166 cup is required for piston assembly (Part No. 26-58063).

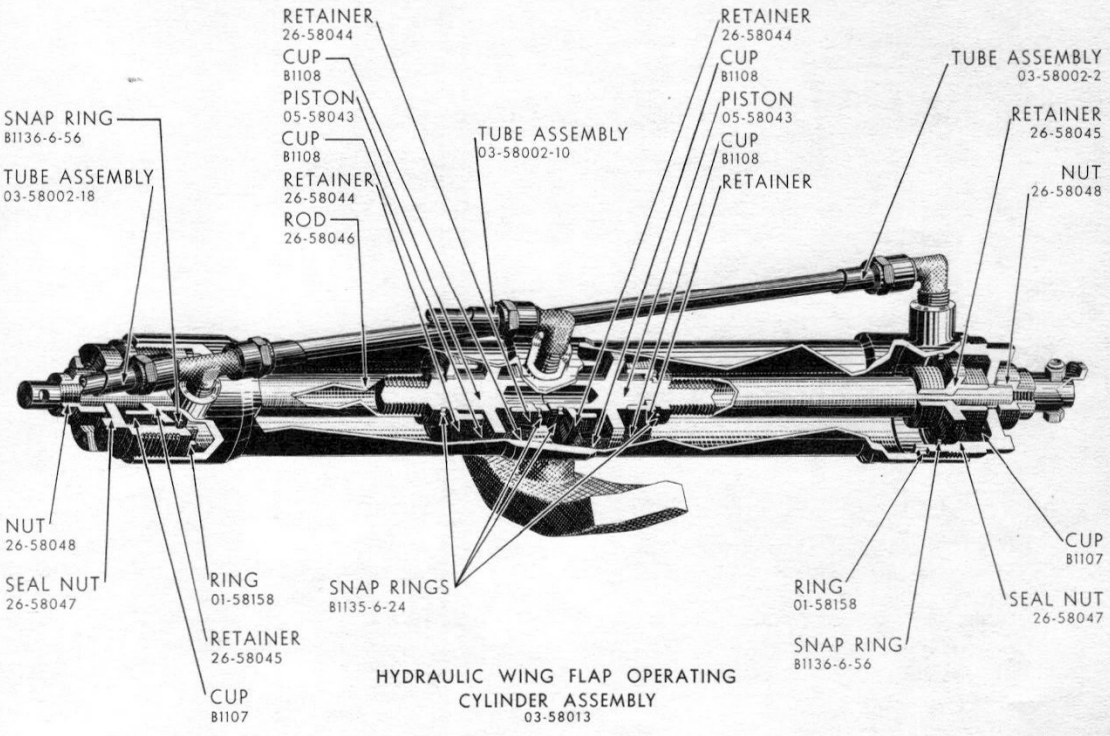
(2) *Hydraulic Control Valve.*—The hydraulic control valve requires only one B 1123 cup for the control valve.

(3) *Landing Gear Operating Strut.*—Each hydraulic strut for retracting and lowering the landing gear requires five B 1105 cups for the swivel head, two B 1108 cups sealing piston head, and one B 1107 cup sealing piston rod bearing.

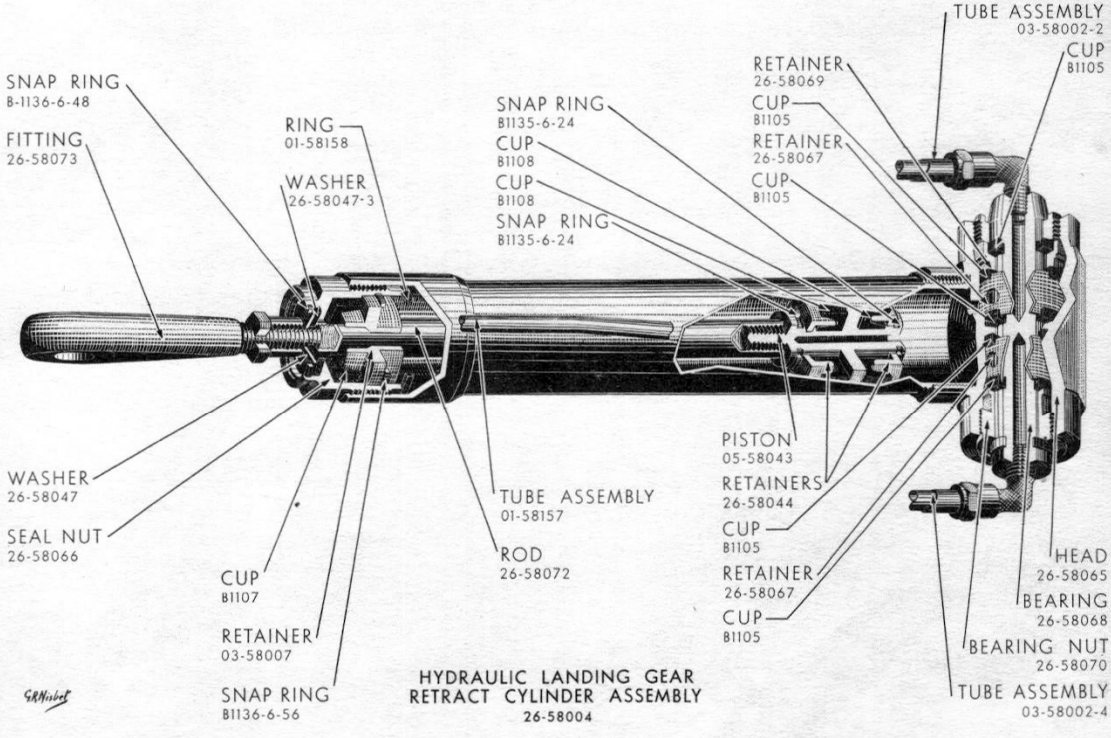
(4) *Flap Operating Cylinder.*—The flap operating cylinder requires four B 1108 cups for sealing piston heads and two B 1107 cups for piston bearings.

11. Hydraulic Gun Hoist Relief Valve (01-58220).

The hydraulic gun hoist relief valve mounted on the fuselage aft of the rear cockpit can be removed by disconnecting two hydraulic pipes, two flexible hose couplings, and removing securing bolts. When not connected to rear gun hydraulic hoist by means of the flexible hose, the circulating block (01-58189) must be secured into position with plugs (01-58188). To connect to rear gun, remove circulating block and attach flexible hose from gun hoist with plugs. Adjust spring to relieve at 100 lb. per sq. in. pressure. This adjustment can be made by removing plug (01-58224) and turning adjusting screw (01-58223) in the required direction to either increase or decrease the tension on the spring holding the ball valve on its seat.



HYDRAULIC WING FLAP OPERATING CYLINDER ASSEMBLY
03-58013



HYDRAULIC LANDING GEAR RETRACT CYLINDER ASSEMBLY
26-58004

ISSUED WITH A.L. No. 1

CHAPTER 12.—INSTRUMENTS

Section A.—DESCRIPTION

1. Description.

Instrument panels are installed in the conventional position in each cockpit. The panels are mounted on shock absorbers to prevent damage to the instruments due to engine vibration. A sub-panel is also fitted in the front cockpit below the main instrument panel, and a small instrument panel is installed aft of the rear cockpit on the port side at the prone bombing position. The main panels are directly lighted by lamps located behind a hinged reflector covering each panel. The intensity of illumination is governed by a rheostat control located on the electrical control panel of either cockpit. In addition the ground compass and gas analyser instruments have built-in lights, which are also controlled by rheostats.

The following instruments are installed:—

2. Front Cockpit Instrument Panel.

Air Speed Indicator.
Bank and Turn Indicator.
Rate of Climb Indicator.
Directional Gyro.
Gyro Horizon.
Altimeter.
Compass.
Clock.
Exhaust Gas Analyser.
Tachometer.
Manifold Pressure Gauge.
Engine Gauge Unit.
Engine Cylinder Head Temperature Indicator.

3. Front Cockpit Sub-Panel.

Air Temperature Indicator (Carburettor and Free Air).
Suction Gauge.
Connections for Camera Gun and Camera.
Engine Starter Switch.
Bomb Jettison Switch.

4. Rear Cockpit Instrument Panel.

Altimeter.
Air Speed Indicator.
Turn and Bank Indicator.
Clock.
Compass.
Tachometer.

5. Bomb Aimer's Instrument Panel.

Air Speed Indicator.
Altimeter.

A pressure gauge is mounted on the control shelf in the front cockpit and connected to the hydraulic system. The pressure gauge does not register until the hydraulic control valves are operated to put the landing gear in the "DOWN" position.

6. Gyroscopically Controlled Instruments.

Artificial horizon, directional gyro and turn and bank indicators are normally operated by an engine driven vacuum pump through a vacuum relief valve set to approximately five inches of mercury at cruising R.P.M. Two venturis are provided in case of failure of the engine pump. A selector valve is located in the front cockpit at the right-hand side of the main instrument panel, and, if desired, both pump and venturis may be connected to the instruments at the same time.

(1) *The Directional Gyro* indicates to the pilot all turns and the amount of the turn in degrees. The instrument has no time lag, being dead beat, and therefore by using it as a turn indicator, the pilot can change his heading by any predetermined number of degrees.

(2) *The Gyro Horizon* indicates to the pilot his relative position to the real horizon. It has no time lag, being dead beat, and the position of the aircraft is given by the relationship of the miniature aeroplane, which is fixed in the dial, to the horizon bar which moves over the dial.

(3) *The Turn and Bank Indicators* show the degrees of the bank, and extremely accurate lateral control can be maintained by watching the pointer. This indicator, being dead beat, has no time lag.

7. The Suction Gauge.

The suction gauge on the sub-panel in the front cockpit is provided to indicate the amount of suction in inches of mercury obtained by the engine driven pump and the venturis.

8. Pitot Static Head.

The altimeters, airspeed indicators, and rate of climb indicator are operated by the flow of air on the electrically heated pitot head. The connection of the altimeters and rate of climb indicator to the static side of the unit makes these instruments independent of air pressure conditions inside the cockpit.

9. Compass.

Horizontal compasses, Type P8, are fitted in the front and rear cockpits.

10. Clock.

The sweep second hand clocks are of the eight-day type, although a margin of two days is normally achieved to eliminate the necessity of re-winding precisely on the eighth day.

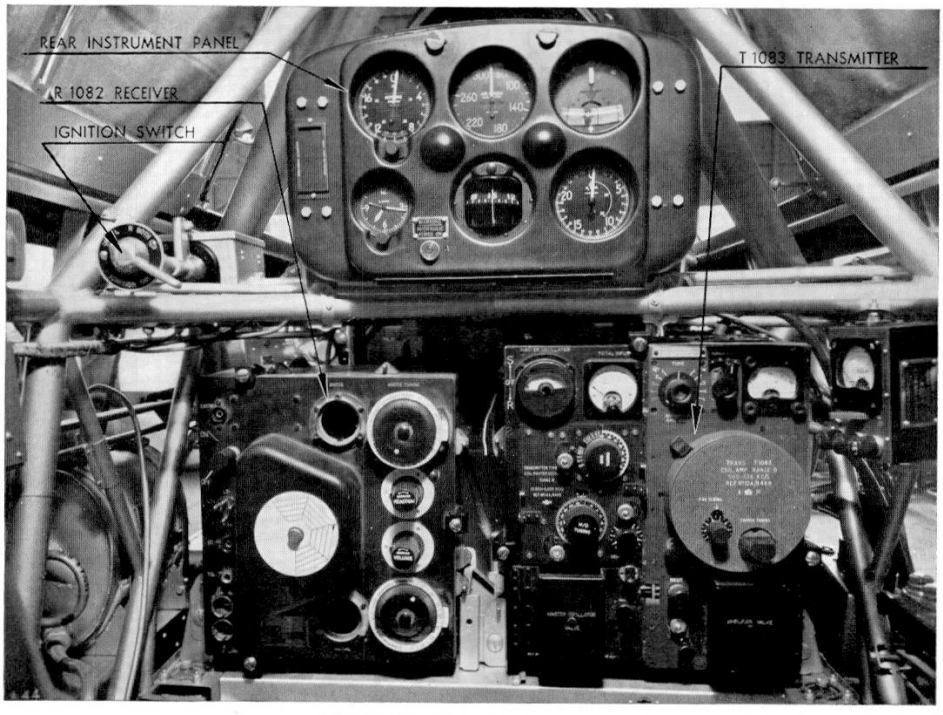
11. Air Temperature Indicator.

The temperature of the carburettor air and the outside air temperature is taken from two resistance bulbs; one in the mixing chamber below the carburettor, and the other in the port leading edge of the centre section, at the point where the ventilating air for the cockpit enters.

12. Engine Gauge Unit.

The engine gauge unit consists of three instruments built into one case. They are: oil temperature indicator, oil pressure indicator, and fuel pressure gauge. The oil temperature is taken from a capillary bulb in the oil inlet pipe to the engine.

INSTRUMENT PANEL
(Front Cockpit)



INSTRUMENT PANEL & RADIO INSTALLATION (Rear Cockpit)

13. Manifold Pressure Gauge.

The manifold pressure gauge indicates the pressure of the fuel mixture as its enters the engine. The instrument is calibrated in absolute pressures in inches of mercury, and a red danger zone indicator forms part of the instrument face.

14. Exhaust Gas Analyser.

The exhaust gas analyser measures the fuel-air ratio of the mixture entering the engine by electrically analysing a sample of the exhaust gas.

15. Tachometer.

The tachometers indicate the number of revolutions of the engine per minute. The drive from the engine is by means of flexible drive shafts.

Note.—The gear ratio between the engine and the propeller is three to two.

16. Engine Cylinder Temperature Indicator.

The temperature of the hottest cylinder head under normal operating conditions (in this case, No. 1 cylinder) is indicated by a thermocouple indicator unit by means of copper constantin wires leading from the rear spark plug gasket.

Section B.—MAINTENANCE

1. Service and Maintenance.

For detailed information pertinent to service and maintenance of the instruments used in the Wirraway aircraft, consult the publications and data supplied by their respective manufacturers.

2. Vacuum Relief Valve.

In order to avoid overloading the gyro instruments, the suction of the vacuum pump should be adjusted so that the suction gauge will indicate five inches of mercury at cruising engine R.P.M. Adjustment may be accomplished at the vacuum relief valve, located near the bottom of the firewall on the right-hand side, by loosening the lock nut and screwing the adjusting screw in or out as required. Tighten lock nut after adjustment has been made.

3. Sperry Gyro Horizon.

It is essential to operate the instrument at a suction value of not less than 3½" or more than 5" of mercury.

At less than 3½" the movement of the bar becomes sluggish, or it may not respond at all to changes in altitude of the aircraft. Should this occur, proceed as follows:—

(1) Check the vacuum pump and relief valve by means of a gauge fitted on a "tee" close to the instrument.

(2) Examine the filter at back of instrument; clean if necessary.

(3) Make sure that all screws in the case are in position and tight. The proper functioning of the instrument requires the case to be airtight, and this also applies to the connections.

(4) The actual vacuum in the instrument may be determined, at any time, by removing a plug, of which there are two, from the back of the case, and inserting a gauge.

To high a vacuum, that is more than 5" of mercury causes increased sensitivity, and shortens the life of the instrument.

Oscillation of the bar may be caused by undue vibration of the panel. Check shock mountings for broken or perished rubbers.

This may also result in the horizon bar failing to take up a perfectly level position.

Note.—This instrument and the Sperry Directional Gyro should be handled with particular care when not in the panel, as the heavy weight of the gyro wheel, together with its high operating speed, make the instrument susceptible to damage by shock.

To Cage Horizon.—The horizon should be caged when landing or performing aerobatics, and when in transit out of panel.

(1) *To Cage.*—Pull out caging knob, turn anti-clockwise 90 degrees, push knob in and release. A spring returns the arrow to vertical.

(2) *To Uncage.*—Turn knob anti-clockwise 90 degrees, pull out, turn 90 degrees clockwise, push in.

Note.—When the instrument is caged, the knob may be turned before pulling out. When the instrument is free, the knob may not be turned until pulled out.

(3) *Tests.*—The instrument should be tested at the bench at intervals of 180 hours and overhauled at 800 hours.

4. Sperry Directional Gyro.

General remarks in reference to the Gyro Horizon also apply to the directional gyro.

Undue vibration of the panel may cause the card to continuously rotate in one direction, or to show excessive drift in either direction. The latter may also be caused by insufficient or excessive vacuum.

To Cage.—Push knob in.

5. Compass.

A horizontal compass, Type P8, is installed in each cockpit. The front cockpit compass is located on a bracket between the pilot's feet forward of the control column. The rear cockpit compass is carried on a bracket situated beneath the centre of the radio shelf.

Lights are provided for illumination during night flying.

6. Engine Gauge Units.

Either of the pressure assemblies may be removed from the unit without removing the instrument from the aircraft.

7. Manifold Pressure Gauge.

Kollsman Type 296-01 was fitted on aircraft up to A 20-39. Subsequent aircraft are fitted with Pioneer Type 1911-1 B-A 1.

To Adjust Warning Mark.

(1) *Kollsman.*—Remove glass and slacken screw in dial marked "Sector Lock." Push sector around arc and tighten locking screw.

(2) *Pioneer.*—Remove large flat-headed screw at back of case. The small screw—then accessible—may be turned to adjust the warning line.

8. Exhaust Gas Analyser.

To adjust, proceed as follows:—

(1) With the current off, move the pointer to "A" by turning the zero adjustment screw on the instrument front.

(2) Wet the wick in the vapour plug (marked 6) of the analysis cell.

(3) Remove cover and steel wool from filter chamber of the analysis cell, allowing time for any residual gas to be displaced by fresh air. Then place in this chamber a clean, wet rag, which has been slightly wrung out, and replace cover.

(4) With the current on, allow the instrument to stand about 30 minutes, at the end of which time the pointer should stand at "A" on the scale. If it does not, adjust this position by means of the rheostat screw (3) in the analysis cell. The rag should then be removed and the steel wool replaced. Push wool in sufficiently to clear the opening of the inlet pipe.

Service.—The following service is required at approximately 180 hours:—

(1) The sampling nipples should be cleaned out, also the gas lines, and all joints tightened where necessary.

(2) Inspect rubber mountings.

(3) Remove filter wool, wash with gasoline or replace with new wool. Clean out filter chamber.

8. Exhaust Gas Analyser *(Continued)*

(4) Test the indicator unit for pointer striction by noting the pointer position with the current off. Turn the current on and off to cause movement of the pointer. It may be necessary to have gas in the cell to cause this movement. If the pointer does not return to within .002 fuel-air ratio of its original position, the instrument requires overhauling.

(5) Wet the wick in the vapour plug, make sure the breather hole (size 80 drill) is clear, and replace.

(6) Check the mechanical and electrical adjustments, reset if necessary.

The instrument may be relied upon for accuracy with the mixture leaned out to a maximum of .068 fuel ratio. When leaning out, should the pointer in approximately this range reverse and move back towards the "A," it is an indication that the mixture is lean beyond the range of the instrument.

Should detonation occur, the pointer will move erratically, generally toward the rich end of the scale.

1. If no response of the pointer when the current is switched on there may be:—

   (*a*) An open circuit in the current supply or indicator wires.

   (*b*) Ballast tube may be burned out.

2. If the pointer deflects violently to one end of the scale when the current is switched on:—

   (*a*) The connections may be wrong, or there may be a ground. Check all connections, and if in doubt "ring out" all wires between cell and indicator. Make sure no wires are touching adjoining terminals. Disconnect battery leads, and test for grounds. If no ground is found in the wiring between the cell and indicator, disconnect each in turn and check.

   (*b*) There may be an open circuit in the bridge spirals. To verify that the trouble is in the cell, a spare cell should be installed and the instrument checked.

(7) If the instrument does not respond to a change of mixture:—

1. The cell may not be getting a sample of the exhaust gas. There may be water in the sampling system, the gas line filter may be clogged or the outlet may be also clogged.

2. The indicator wires may be reversed where connected to the cell. This would cause the pointer to move in the wrong direction.

3. There may be a pointer striction.

4. The mechanical or electrical zero may be off. Check as previously directed.

9. Turn and Bank Indicator.

Aircraft up to A 20-98 are fitted with Hughes T & B Indicators.

(1) Operating suction is 3 inches of mercury. This may be adjusted by means of two needle valves in the suction distribution manifold. This manifold block is mounted immediately behind the firewall. All gyro instruments and suction gauge are supplied from here.

(2) To level inclinometer tube, level aircraft on jacks, using straight edge and spirit level on the levelling pegs behind the pilot's seat. Slacken four holding screws in panel. The body of the instrument may then be turned to bring the black ball to the centre of the glass tube. Tighten the screws in panel.

Aircraft from A 20-98 are fitted with Pioneer T & B Indicators.

(1) Operating suction is 2 inches of mercury.

(2) Levelling inclinometer. No adjustment is provided, except by turning the instrument bodily in slightly slotted holes in the panel.

10. Engine Temperature Indicator.

The temperature of the hottest cylinder head under normal working conditions (in this case, No. 1 cylinder) is indicated by means of a thermocouple attached to a washer, which is substituted for the rear spark plug gasket. The indicator on the front panel is a millivoltmeter, calibrated in degrees Centigrade.

Three types of leads are fitted:—

(*a*) A yellow and black, in which yellow is negative on instrument.

(*b*) A red and black, in which red goes to positive on instrument.

(*c*) A red and blue, in which red goes to positive on instrument.

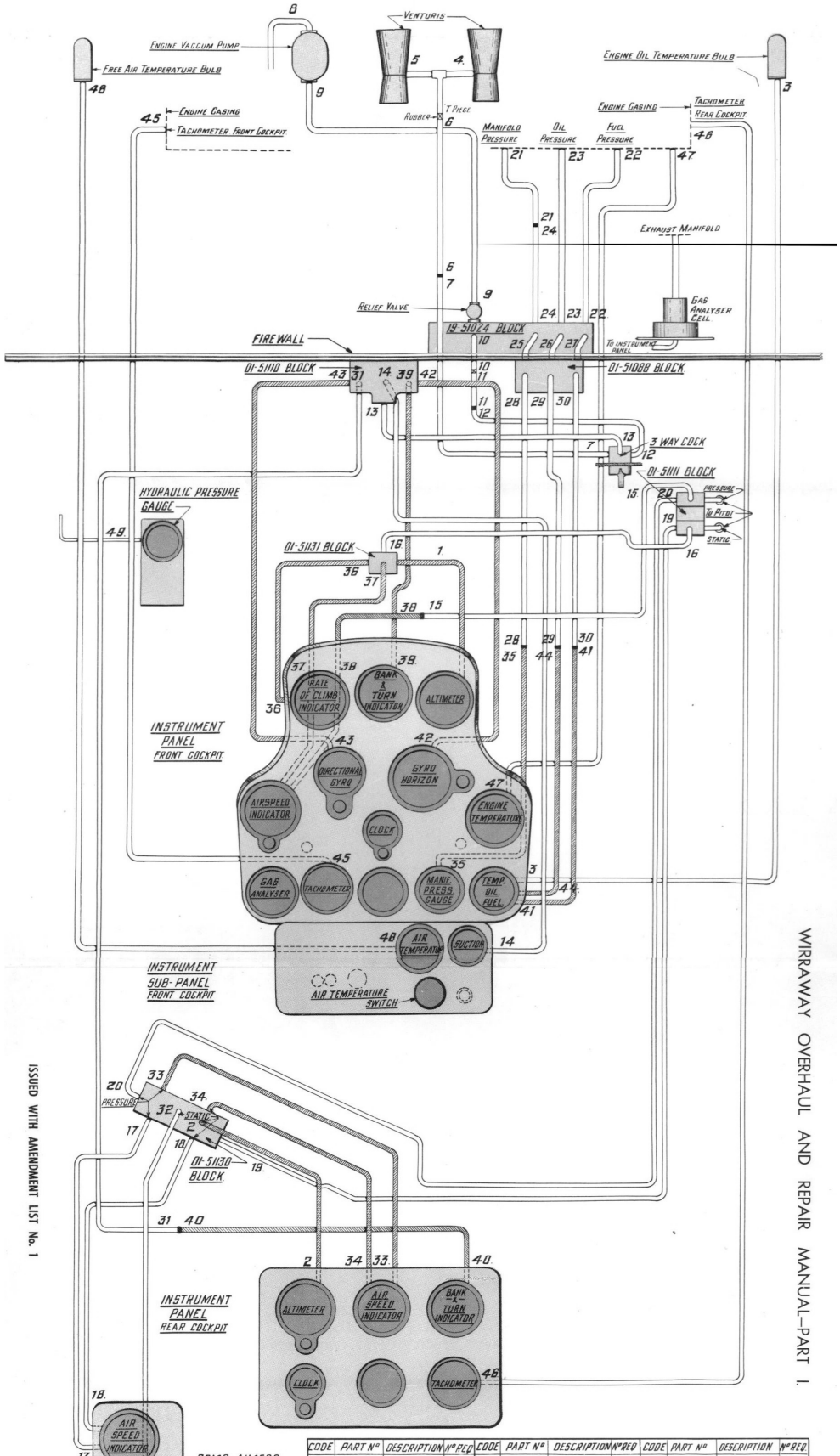
The resistance through the thermocouple of any lead is 2 ohms—*i.e.*, 1.75 for the compensating leads, and .25 for the gasket.

11. Tachometer.

The tachometer will sometimes come to rest with the pointer indicating two-three hundred R.P.M. This is peculiar to the design, and does not mean that the instrument is faulty.

12. Pitot Static Head.

Provision is made for the drainage of both the static and pressure lines by means of drain plugs, located at the lowest point of the system. Access to these drain plugs is obtained through a hand-hole situated on the underside of the starboard wing, just aft of the landing light.



NOTE.
FLEXIBLE HOSES SHOWN THUS—

CODE	PART Nº	DESCRIPTION	Nº REQ	CODE	PART Nº	DESCRIPTION	Nº REQ	CODE	PART Nº	DESCRIPTION	Nº REQ
1	01-51135	Hose Assem.	1	18	01-51171	TUBE ASSEM	1	35	H950-14	HOSE ASSEM	1
2	H950-14	HOSE ASSEM	1	19	01-51173	" "	1	36	H950-14	" "	1
3		CAPILLARY	1	20	01-51172	" "	1	37	H950-14	" "	1
4	01-51153	TUBE ASSEM	1	21	01-51174	" "	1	38	H950-14	" "	1
5	01-51156	" "	1	22	01-51175	" "	1	39	H951-14	" "	1
6	01-51158	" "	1	23	01-51176	" "	1	40	H951-18	" "	1
7	01-51160	" "	1	24	01-51177	" "	1	41	H951-14	" "	1
8	01-51161	TUBE		25	01-51176	" "	1	42	H952-18	" "	1
9	01-51162	TUBE	1	26	01-51178	" "	1	43	H952-18	" "	1
10	01-51163	TUBE	1	27	01-51178	" "	1	44	H861-14	" "	1
11	01-51164	TUBE ASSEM	1	28	01-51179	" "	1	45	TACHOMETER DRIVE CABLE		1
12	01-51165	" "	1	29	01-51178	" "	1	46	TACHOMETER DRIVE CABLE		1
13	01-51166	" "	1	30	01-51179	" "	1	47	THERMO COUPLE LEAD		1
14	01-51167	" "	1	31	01-51180	" "	1	48	THERMO COUPLE LEAD		1
15	01-51169	" "	1	32	01-51170	" "	1	49	01-50237	TUBE ASSEM	1
16	01-51168	" "	1	33	H950-14	HOSE ASSEM	1				
18	01-51182	" "	1	34	H950-14	" "	1				

INSTRUMENT SYSTEM - PIPE DIAGRAM

CHAPTER 13.—ELECTRICAL SYSTEM

Section A.—DESCRIPTION

1. Description.

While the electrical system of the aircraft, in general, is of the single wire type, the majority of the equipment is, however, of the two wire type, the negative terminal being earthed at the nearest convenient point in each case. All wiring, with the exception of the high tension wires, is of the glazed cotton braided type, with metal terminal lugs pressed and soldered into place. Each wire is numbered or coded with a colour designation to correspond with the wiring diagram. A wiring diagram is incorporated in this manual.

The aircraft is completely bonded and shielded. Insulation test to a minimum of 2 megohms per circuit at 500 volts D.C. are standard.

Condensers should be disconnected before making megohm test as they are only 100 volts working voltage.

All electrical equipment and wiring is adequately protected by fuses of sufficient capacity to prevent damage in the event of a short circuit.

2. Battery.

The battery (C.A.C. Specification CA 402A) is mounted on a shelf at the right-hand side of the firewall below the oil tank. The battery has a capacity of 68 ampere-hours at a five-hour rate. A forced air inlet and outlet are provided to thoroughly ventilate and cool the battery and to carry away acid fumes. A main supply switch is incorporated with the battery terminal shield. This switch is accessible through a small hinged door in the removable cowling on the right-hand side of the engine. When operations with the aircraft are completed this switch should be turned to the "OFF" to avoid possibility of accidental discharge of the battery.

3. Spare Lamps and Fuses.

In the Model CA-1 the spare lamps and fuses box in the front cockpit is accessible on the right-hand side at the level of the top longeron. In the Model CA-3 the spare lamps box only is retained in the same position, the spare fuses being incorporated in the control box behind a hinged cover on the lower right side. The spare generator fuse is carried on the underneath side of the generator control panel cover. In both models a spare fuse box is also located in the rear cockpit on the hydraulic shelf inboard side.

4. Control Panel—Front Cockpit.

The main electrical control panel in the front cockpit is arranged along the right-hand side of the cockpit. A hinged cover gives access to the fuse panel behind the top left corner of the main panel. The fuses on this panel cover all circuits except those under the immediate control of the occupant of the rear cockpit. In model CA-1, switches are arranged on this panel controlling the following:—

Generator.
Landing Light—Left.
Landing Light—Right.
Navigation Lights.
Pitot Heating.
Fuel Gauge Lights.
Cockpit Lights (Front Cockpit).
Bomb Loading Lights in Wing.
Bomb Main Power Control (Master Switch).

4. Control Panel—Front Cockpit—*Continued*

Two rheostats are provided to control the intensity of illumination of the instrument panel lights and the self-contained lights built into the compass and the gas analyser instrument respectively. Two warning lights are also fitted, an amber light which glows when the bomb loading power is on and a red light which gives warning when the bomb control master switch is on. The panel also carries the inter-communication change-over switch, and the bomb selector switches for the pilot's use. A voltammeter is fitted to indicate charge and discharge rate, also battery voltage when small plunger at bottom of voltammeter is pressed.

Model CA-3 has the same control panel as CA-1, with the addition of two switches, one for the camera power and the other for the camera gun, also a socket is fitted on the forward side top for the camera gun footage meter.

5. Sub-Panel—Front Cockpit.

This sub-panel is mounted beneath the control panel and carries the following components:—

Air Temperature Gauge (Carburettor and Free Air).
Suction Gauge.
Control Switch for Air Temperature Gauge.
Engine Starter Switch.
Bomb Jettison Switch.
Nose and Tail Fusing Switches.
Firing Switch (on CA-1 only).

Also socket outlets for:—

Camera Gun.
Camera Power.

6. Control Panel—Rear Cockpit.

As in the case of the front cockpit control panel, the fuses are carried on an enclosed panel behind a hinged cover. The following switches are fitted to the panel:—

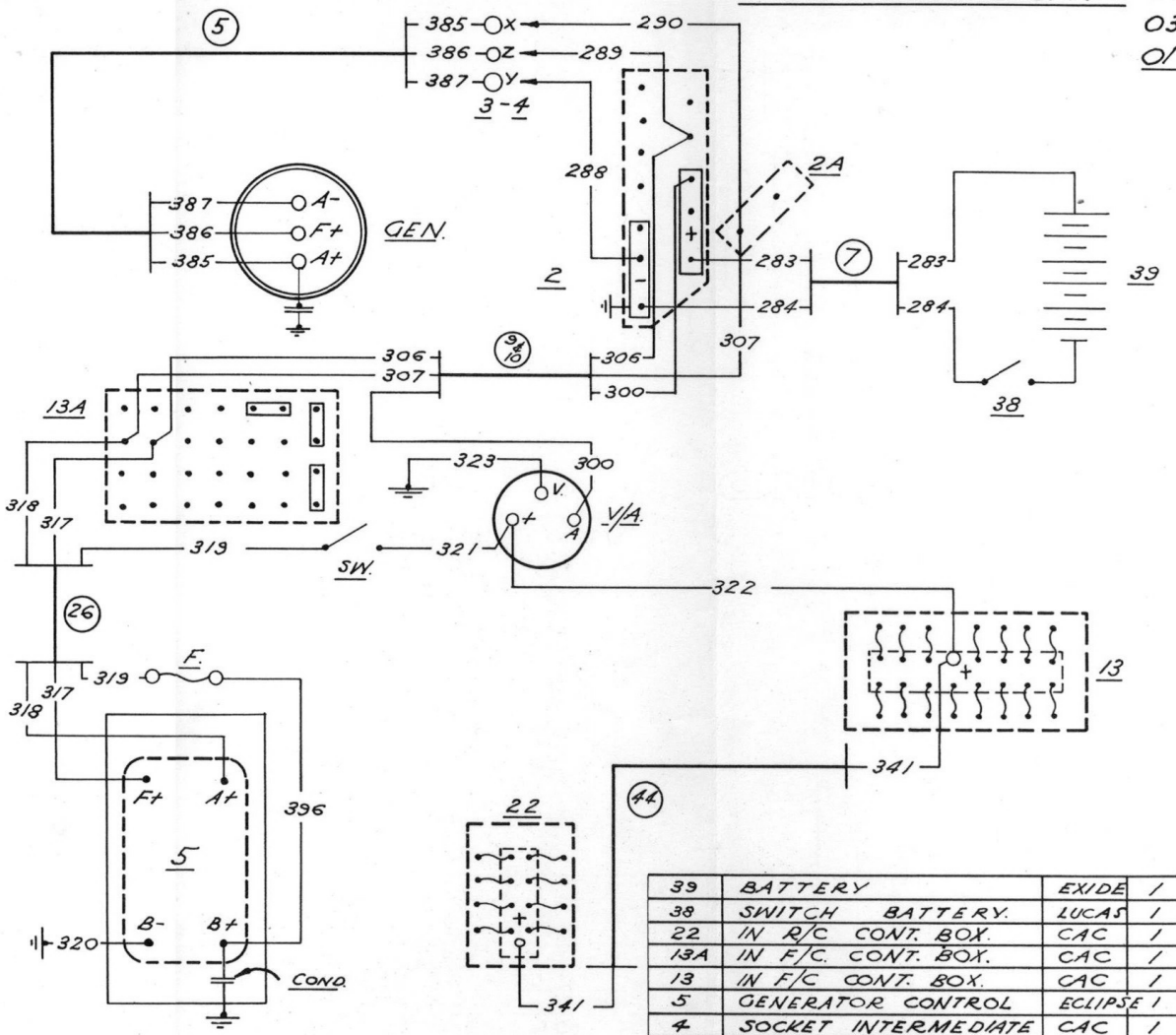
Cockpit Lights—Upper.
Cockpit Lights—Lower (Bomb Aimer's Light)
TR. 11b Radio Power Supply.
R. 1082 Radio Power Supply
Camera Power Supply.
Camera Gun.
Aldis Lamp.

Two rheostats are provided to control the intensity of illumination of the rear instrument panel lights and the compass lights respectively.

Alongside the two rheostats is the inter-communication change-over switch for R.1082 and TR. 11b.

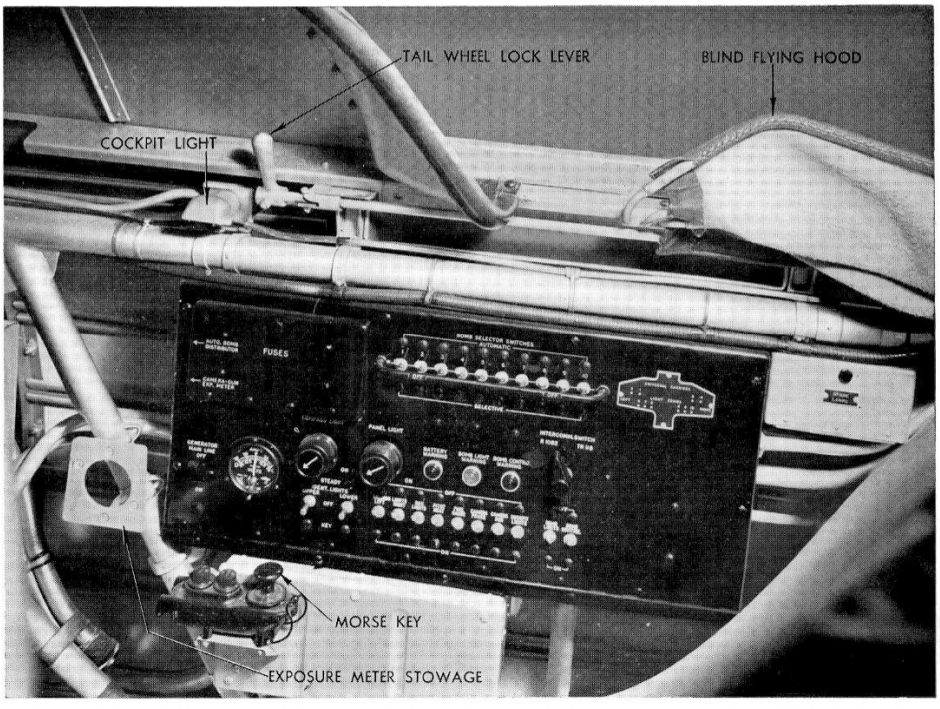
CIRCUIT DIAG. Nº 23.

ELECT. WIRING DIAG. Nºs. 03-00541
03-54026
01-54112.

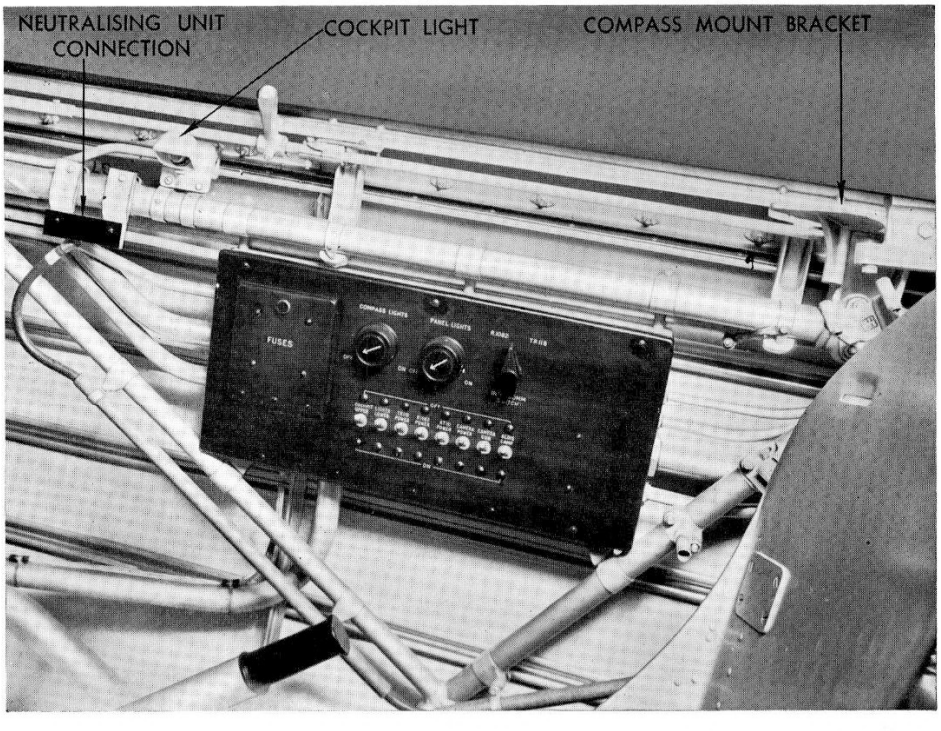


GENERATOR CONTROL CIRCUIT

Nº.	DESCRIPTION	TYPE	Nº. REQ	PART Nº.
39	BATTERY	EXIDE	1	6-TAS-17
38	SWITCH BATTERY.	LUCAS	1	ST 330
22	IN R/C CONT. BOX.	CAC	1	01-54083
13A	IN F/C. CONT. BOX.	CAC	1	03-54267
13	IN F/C CONT. BOX.	CAC	1	03-54245
5	GENERATOR CONTROL	ECLIPSE	1	CB-84-1
4	SOCKET INTERMEDIATE	CAC	1	D129
3	PLUG INTERMEDIATE	CAC	1	D122
2A	IN MAIN POWER BOX	CAC	1	01-54191.
2	IN MAIN POWER BOX	CAC	1	23-54074
V/A	VOLT/AMMETER	WESTON	1	506
GEN.	GENERATOR	ETC.	1	E 5
COND.	CONDENSER 100V 5 MFD.	COMM.	2	
SW.	SWITCH GEN. MAIN LINE	WESTINGHOUSE	1	NJP 70403
F.	FUSE 120 AMP.	CAC	1	B372



MAIN ELECTRICAL CONTROL PANEL (FRONT COCKPIT)



ELECTRICAL CONTROL PANEL (REAR COCKPIT)

7. Lights.

Two 240-watt landing lights fitted to the aircraft are built into the leading edge of the wing. A hinged door with an inset transparent sheet cover is provided over each light to give access to the lamp. This door lies flush with the outside contour of the wing.

Navigation lights, controlled from the front control panel are built into the wing tip and fin. The wing tip lamps are 12 V. 6 cp., and the fin 12 V. 3 cp.

Upward and downward identification lights are installed in the rear fuselage on the top and bottom respectively. These lights are CAC Standard Fittings and are controlled by a CAC Identification Keying Switch, which is fitted on the right side of the front cockpit.

Models CA-1, 3 and 5 are fitted with R.A.A.F. Type 2 Lights and a No. 2, Mark III., Keying Switch.

Models CA 7 onwards are not fitted with a Keying Switch. The upward and downward identification light switches are so arranged that, when the switches are placed in the "upward" position, the identification lights are held "ON," while if used in the "downward" position they may be used as "Morse Keying Switches."

On Model CA 7, these switches were located on a small panel beneath the main electrical control panel.

On Models CA 8 and subsequent aircraft, these switches are incorporated on the main electrical control panel.

Lighting of the cockpits is effected by two lights in each cockpit at the level of the top longeron. In addition, a further light is provided to illuminate the prone bombing position. Lamps for these lights are 12 volt 3 watt.

The fuel gauges are lit by two 3-watt lamps enclosed in a fitting incorporated with the fuel gauge.

All warning indicator lamps are of 6 watts.

The front instrument panel is floodlit by means of four 3-watt lamps, and the rear instrument panel by two 3-watt lamps.

The compass and gas analyser instruments which are built integral with the instruments are of the extra small type and are not carried on the aircraft.

The light for the horizontal compass is attached to the cross member behind the compass mounting.

8. Pitot Heating.

The heating element of the pitot static head is a wire wound resistance unit built into the pitot head. The power supply is controlled by a switch on the front cockpit control panel and should not be switched on, with the ship on the ground, except for a short period.

9. Ignition Switch.

The ignition switch is located on the left-hand side of the aircraft ahead of the rear cockpit. The switch is operated by mechanical linkage from either cockpit, the lever being located in the front left-hand corner of each cockpit, ahead of the throttle controls.

10. Temperature Indicators.

Two electric temperature indicators are installed, a thermocouple type cylinder head temperature indicator on the front cockpit main instrument panel, and an air temperature indicator with a two-position switch for reading carburettor and free air temperatures on the instrument sub-panel in the front cockpit. The air temperature thermometer is of the resistance bulb type, connected through a two-position selector switch to the two thermo-couple units, one of which is fitted in the air mixing chamber of the carburettor and the other in a chamber in the wing centre section leading edge on port side.

11. Exhaust Gas Analyser.

The exhaust gas analyser indicates the fuel-air ratio of the mixture after combustion, by measuring the variation in electrical resistance provided by a change in the thermal conductivity of that half of the Wheatstone Bridge over which the exhaust gas passes, compared with the remaining half of the Bridge maintained at fully saturated atmosphere. The analysis cell is located in the engine bay on the right side of the aircraft. The indicator is installed on the front main instrument panel, and is connected to the 12-volt supply through the air temperature switch. The gas analyser does not function, therefore, until the air temperature instrument is switched on, either to the carburettor or free air temperature units.

12. Warning Indicators.

The operation of the landing gear warning indicator is explained in Chapter 9, Section A.

A red warning light is fitted to the main instrument panel in each cockpit to indicate when the main hydraulic relief valve is operating. This will occur when the hydraulic power control valves are engaged and the desired operation of the landing gear and/or flaps has been completed.

Five other warning lights are fitted, as follow:—

On Front Instrument Panel—
Camera Signal (Green).

On Front Cockpit Electrical Control Panel—
Bomb Light Warning (Amber).
Bomb Power Warning (Red).

On Prone Bombing Position Control Panel—
Selective Bombing Control (Red).
Automatic Bombing Control (Amber).

13. Condensers.

Two condensers, 100 v., 0.5 mfd. each, are installed, one in the generator control panel and the other one at the generator. These units function to absorb any electrical disturbances from commutation and relay contacts that might cause interference in radio or inter-cockpit communication.

14. Booster Coil.

A booster coil installed inside the main power box on the front face of the firewall is automatically set in operation through the starter switch, which is mounted on the front cockpit sub-panel. The function of the booster coil is to supply a high voltage spark through the left magneto until the engine, which is being operated by the starter, has rotated the magnetos to a speed that will cause them to maintain a spark of sufficient intensity to operate the engine.

15. Radio Power Supply.

TR. 11b Transmitter and Receiver.—Low tension and high tension power supply for TR. 11b set is obtained from a Vibrator Unit, which is incorporated within the power crate inside the set.

A.T. 10 Transmitter.—Low tension and high tension power is supplied to A.T. 10 transmitter by means of an A.T. 10 Vibrator Unit, which is mounted on the fuselage cross brace, just aft of the flexible gun track. It is controlled by a switch located on the rear cockpit control panel. (See Paragraph 6.)

R. 1082 Receiver.—Low tension and high tension power is obtained from a Vibrator Unit installed on the starboard side of the rear cockpit. A socket for the gunner's sight light is located on the A.T. 10 Vibrator Junction Box. No. 1 pin is grounded, and No. 3 pin is positive.

16. Electro-Magnetic Bomb Control.

Ten electro-magnetic bomb slips are fitted to the aircraft. Four are universal release units, and have steadies attached, together with electro-magnetic fusing units. The other six are of the light series. The slips are built into the wing and centre section. Switches controlling the release of the bombs are installed both in the front cockpit and at the prone bombing position. In the front cockpit selector switches are situated at the top of the main control panel, with the fusing and jettison switch located on the instrument sub-panel. The jettison switch on this panel is also connected to a specially designed solenoid operated switch at the rear bomb control box; this enables the bombs to be jettisoned regardless of what position the bomb selector switches may be in.

The firing switch in the front cockpit is located at the top left longeron. At the prone bombing position all switches are located on the left side, except the automatic bomb distributor box, which, when fitted, is installed on the right-hand side of the bomb aimer. The jettison switch in front cockpit may also be used as a bomb loading indicator by first switching the Main Bomb Power Control Switch "ON," and then alternately depressing each bomb selector switch. Each loaded bomb slip will be indicated by the glowing of the jettison lamp.

17. Bomb Control—Rear Cockpit.

The rear bomb control panel is mounted on the left-hand side of the aircraft in a position convenient, when in the prone bombing position. On this panel is located:—

(*a*) The ten bomb selector switches.
(*b*) Nose and tail fusing switches.
(*c*) The selector switch, for selective or automatic firing.
(*d*) The jettison switch.
(*e*) The selective and automatic warning lights. Right-hand side.

On A20-235 and subsequent aircraft the above panel has been deleted and replaced by:—

(*a*) Selective and automatic warning lights.
(*b*) Bomb-firing switch.

These units are located on the lower right-hand side of the fuselage.

18. Automatic Bombing Control Box.

This box is mounted on the right-hand side of the aircraft near floor level. Its action is such that it will automatically release the bombs as selected by the selector switches in the top of the box.

19. Automatic Bomb Distributor.

Provision is made for the installation of a J.127 type Automatic Bomb Distributor at the right-hand side of the front cockpit instrument sub-panel. This distributor automatically releases the bombs, previously selected by means of the switches located on the main electrical control panel, at intervals desired by the pilot.

Section B.—ENGINE DRIVEN GENERATOR AND CONTROL PANEL

1. Description.

The generator is an engine driven, shunt wound generator of the voltage controlled type. It is installed on the engine accessory section, directly aft of the engine mounting ring. The output of the generator is controlled by a voltage regulator on a control panel in the front cockpit.

2. Generator.

The generator operates in connection with the control panel and has an output capacity of 50 amperes, and under normal conditions a maximum charging rate of from 25 to 35 amperes. Normal charging rate may, however, be as low as 5-10 amperes, depending on the condition of the battery.

The generator consists of the following major parts:—

(1) *Front Head Assembly.*—The front head assembly is bolted to the yoke assembly and serves as a support for the ball-bearing mounted armature shaft. The generator brush rigging and terminal posts are also contained in this assembly. A removable window strap, clamped to the outside diameter of the front head, provides access to the brush rigging and commutator.

(2) *Yoke Assembly.*—The yoke assembly consists of a yoke in which the field coils and pole shoes are mounted.

(3) *Armature Assembly.*—The armature assembly consists of a splined shaft on which are mounted the armature winding, core laminations and commutator.

(4) *Intermediate Head.*—The intermediate head serves as a pilot for the mounting head, which is attached to the drive end of the yoke by means of screws passing through the intermediate head. A felt seal ball-bearing, mounted in the intermediate head, serves as a support for the drive end of the armature shaft.

(5) *Flexible Drive Coupling.*—Incorporated on the generator armature assembly and located between the splined driving shaft and the armature windings is a flexible rubber coupling, which absorbs any torsional vibration that may exist in the engine drive shaft.

The flexible rubber coupling consists of a splined drive shaft and housing assembly and a drive plate member, which is splined to the armature shaft. The four driving pins of the drive plate assembly engage with the eight driving rubbers contained in the housing assembly, thereby affording flexibility between the engine drive member and the generator armature.

(6) *Mounting Head.*—The mounting head contains the flexible drive coupling, and is designed for mounting on a standard 5" SAE flange. A felt oil seal is incorporated in the mounting head to prevent oil leakage from the engine into the generator interior.

3. Control Panel.

The control panel (CB. 84-1 Eclipse) contains the voltage regulator, reverse current relay and resistance units mounted as a complete assembly on a shock mounted bakelite panel. The heel iron of the reverse current relay is stamped for proper identification.

4. Reverse Current Relay.

The reverse current relay, sometimes termed cutout or main switch, is required to prevent the discharging of the battery through the generator when at rest or operating at a speed below that required for battery charging.

The cutout or relay consists of a magnetic core having two windings thereon, a stationary contact, a moving armature with contact and a spring for retracting the moving contact away from the fixed contact. One of the windings is a shunt coil consisting of many turns of fine wire, and is connected across the generator terminals in series with a 40 ohm resistor (part of CB. 84-1, regulator panel) so as to receive the voltage developed. The other winding consists of a few turns of comparatively heavy wire, and is connected in series with the generator battery circuit when the contacts are closed.

The operation of the cutout is as follows: When the generator is at rest, the contacts are held apart by the retracting spring, which is fastened to one end of the cutout armature. After the generator has attained a speed sufficient to develop a D.C. voltage of 13-1/2 volts, the shunt winding is sufficiently energised to attract the armature carrying the movable contact, thereby closing the circuit between the generator and battery. With the latter closed, a current flows in the series winding energising the same. The pull due to the series winding, reinforces the pull of the shunt winding and holds the armature of the cutout in its closed position. When the speed of the generator is decreased to a value at which its generated voltage is lower than that of the battery, or when the generator is at rest, a momentary discharge of the battery through the series winding takes place, the flow of the current being reversed, the magnetic pull of the series coil now acts against the pull of the shunt coil. The total magnetic pull is decreased and the tension spring attached to the cutout armature pulls it away from the core and opens the circuit between the generator and the battery.

5. Voltage Regulator.

The voltage regulator consists primarily of a frame on which is mounted a core having a shunt winding, connected across the generator terminals in series with a 40 ohm resistor (part of CB. 84-1, regulator panel). A fixed contact is mounted on the frame and a movable contact fastened to the armature. An adjustable retracting spring holds the armature closed against the fixed contact and, at the same time, holds the armature away from the core, thereby short circuiting the resistor unit connected across the fixed and movable contacts. The position of the fixed contact may be adjusted by means of the screw on which it is mounted.

The cycle of operation is as follows: The current in the winding and resultant magnetic pull on the armature is dependent upon the voltage developed by the generator. With increasing generator speed the voltage increases until it reaches the normal value for which the regulator is adjusted. With a further increase in generator speed the voltage will tend to rise above the normal value. When, however, this value is exceeded by a very small amount, the increased pull, exerted on the armature carrying the moving contact, overcomes the tension of the spring and the armature will be drawn towards the core, thus opening the contacts and inserting the resistance in the generator field circuit.

The added resistance in the field circuit decreases the exciting current in the generator field winding and the voltage generated tends to drop below its normal value. The decrease in generated voltage causes the magnetic pull between the core and the movable armature to be reduced. This decrease in magnetic pull allows the tension spring to pull the movable contact back against the fixed contact, thereby short circuiting the resistor and increasing the flow of current through the generator field.

The opening and closing of the contacts take place so rapidly that the change in generated voltage is not noticeable as the cycle is repeated.

Section C.—CHECKING OF ENGINE DRIVEN GENERATOR AND CONTROL PANEL

1. Check for Operation in Aircraft.

Operation of the generator and control box is entirely automatic upon starting the engine with the generator main line switch in the closed position. The operation of the generator should be checked before each flight by speeding up the engine to at least 1,600 R.P.M.

If the ammeter fails to show a charge with engine speed of 1,600 R.P.M. with no large external electrical loads (landing lights, &c.), the operation of the control box and generator should be checked.

2. Replacement of Generator Brushes.

When replacing a worn brush, it should be properly seated by inserting a strip of No. 000 sandpaper between the brush and commutator, with sanded side next to the brush and pull in the direction of rotation, being careful that the sandpaper is kept in the same contour as the commutator. This operation should be repeated until the brush is completely seated. Binding brushes should be wiped clean with a petrol moistened cloth.

Caution.—Do not use coarse sandpaper or emery cloth. Remove sand or metal particles with compressed air.

The maximum permissable wear of the generator brushes is 5/16" from a new length of 7/8", or when the amount of brush remaining is 9/16". However, brushes should have sufficient length so that wear before the next 30-hours inspection will not exceed the maximum wear limit.

3. Maintenance of Control Panel.

The control panel should not be tampered with unless the procedure set out for control panel adjustment is thoroughly understood. If the battery remains in a well charged condition it would indicate that the generator and control box are functioning properly. At every 30-hours inspection, the control box cover should be removed and the voltage regulator and reverse current relay contacts cleaned and set in accordance with the procedure set out in Paragraphs 4 and 5.

4. Inspection and Cleaning of Contacts.

The interior of the control box must be kept clean. This is particularly important in order to avoid a deposit of dirt between the contacts of the voltage regulator and the reverse current relay. All wiring contacts must be tight. Dirty contacts should be cleaned by inserting a piece of clean paper between them, pressing the contacts together and pulling out the paper. However, if the contacts are pitted their faces should first be cleaned off by the use of a fine carborundum stone, such as a Norton No. 220, followed by fine crocus cloth, and finally cleaned with carbon tetra-chloride. Whenever the contact faces have been cleaned the regulator must then be adjusted in accordance with Paragraph 5.

5. Adjustment in Aircraft of 2-Unit Generator Control Panel.

This instruction covers the following types of control panel units:—

Eclipse Type CB.84 (Eclipse and E.T.C. manufacture).
Eclipse Type CB.84-1 (Eclipse manufacture).
C.A.C. Type D.154 (D.C.L. manufacture).

5.—Adjustment in Aircraft of 2-Unit Generator Control Panel—*Continued*

Preliminary to Adjustment.

(1) Open generator main line switch to isolate the battery from the generator and generator control panel. Remove control box cover.

(2) Inspect the voltage regulator contact for signs of pitting. If the contacts are not pitted, check the air gap between the regulator armature and core. This should be between .053 and .063. If not, adjust the gap between these limits so that the regulator armature will be approximately parallel with the core face. Clean the contact surfaces with unglazed writing paper dipped in carbon tetra-chloride (or tri-chlor-ethylene), finally drawing a strip of clean dry paper between the contacts.

If the contacts surfaces are appreciably pitted, remove the screw contact, the fulcrum pin retainer and fulcrum pin, and lift the armature sufficiently to expose the contact surface. BE CAREFUL NOT TO INJURE THE TENSION SPRING BY BENDING OR STRETCHING. Dress both contact surfaces, first with a fine "India" oilstone, and finish with a hard "Arkansas" slip. (Fine "Carborundum" paper, Nos. 280 and 400 respectively, may be used instead of the oilstones mentioned. The paper should be supported by wood or metal.) If possible, dress the armature contact in position—*i.e.*, without removing the fulcrum pin—and thus avoid the risk of distorting the tension spring. The armature contact should be finished flat, and the screw contact should have a slightly convex surface. Replace the cleaned contact in the regulator, resetting the armature-core air-gap and cleaning the surfaces with carbon tetra-chloride as described above. TIGHTEN THE LOCKNUT AFTER ADJUSTING THE CONTACT SCREW.

(3) Inspect the reverse current relay contacts for signs of pitting and check the air-gap between the armature and the core. This should be .045 ± .005 when the contacts are open, and .025 ± .005 when the contacts are closed. (By the application of light pressure over the armament contact.) If the reverse current relay contacts appear satisfactory and the armature-core air-gaps are within the specified tolerances, clean the contact surfaces with paper and carbon tetra-chloride.

If the reverse current relay contacts are excessively pitted or the armature core air-gaps are incorrect, the control panel should be removed from the aircraft for servicing.

(4) Connect a voltmeter between A+ and B− terminals of the control panel (voltmeter should be of 0—20v. range, calibrated accurately between 12 and 16 volts, in which range all adjustments are made).

Note.—The voltammeter in the aircraft cannot be used for this purpose.

Adjustment of Voltage Regulator in Aircraft.

(1) With the generator line switch open, run the engine at 1,500 R.P.M. (generator 2,250 R.P.M.), observing the voltage on the run up. If the voltage exceeds 14.6 volts, turn the regulator adjusting knob anti-clockwise, and if less than 13.8 volts, turn clockwise until the voltage is within these limits.

(This is only a preliminary adjustment.)

5.—Adjustment in Aircraft of 2-Unit Generator Control Panel—*Continued*

Adjustment of Voltage Regulator in Aircraft—Continued.

(2) Leaving the generator line switch open, run the engine at 1,400-1,500 R.P.M. for 15 minutes. This will allow the regulator to reach operating temperature, and the regulator contacts to bed in before the final adjustment.

(3) Immediately after the warm-up period, adjust the engine speed to 1,900 R.P.M. (generator 2,850 R.P.M.), observing the generator voltage. Adjust the voltage by means of the regulator adjusting knob to 14.5 ± .1 volts.

Note.—It is imperative that the generator line switch be open throughout the above adjustments.

(The regulator has now been finally adjusted and must not be altered.)

If the regulator fails to maintain the voltage at 1,900 R.P.M. to within 14.5 ± .2 volts, the control panel should be removed from the aircraft for servicing.

Adjustment of Reverse Current Relay in Aircraft.

It is assumed that the voltage regulator has been adjusted and that the unit is still at operating temperature.

(1) With the generator line switch open and the engine running at idling speed, note whether the reverse current relay contacts are open. If they are not, turn the adjusting nut to the right to increase the control spring tension until the contacts separate.

(2) Increase the engine speed to 1,600 R.P.M. (generator 2,400 R.P.M.) and close the generator line switch. Reduce the engine speed slowly until the reverse current relay contacts open.

If the discharge current (indicated on the aircraft voltammeter) exceeds 10 amps, increase the engine speed, turn the adjusting nut to the right and repeat the test.

(3) Raise the engine speed slowly until the reverse current relay contacts close. This should be at 13.5 ± .2 volts, and will correspond to an engine speed between 800 and 1,400 R.P.M. If the contacts close at less than 13.3 volts, turn the adjustor to the right, and if at more than 13.7 volts, turn to the left. After obtaining the correct setting, repeat the test three times to check.

Note.— The closing voltage should be found by watching the aircraft voltammeter, not by observation of the contacts.

The direction of the current flow when the contacts close will depend upon whether the generator voltage at that instant is greater or less than that of the battery.

(4) Increase engine speed to 2,000 R.P.M. (generator 3,000 R.P.M.) for a few seconds, and then reduce the speed slowly until the reverse current relay operates. If the reverse current (indicated as discharge on the aircraft voltammeter) is less than 10 amps, the relay may be considered as finally adjusted, and care should be taken not to touch the flexible leads to the armature, as this will upset the adjustment. If the reverse current, prior to the opening of the relay contacts, exceeds 10 amps, the control panel should be removed from the aircraft for servicing.

5.—Adjustment in Aircraft of 2-Unit Generator Control Panel—*Continued*

Service Note.

A common misunderstanding regarding the operation of the generator and control box is that the system is not functioning properly when the ammeter shows little or no charging current. This may or may not be true. Since the generator is of the constant voltage type, the current output depends entirely upon the condition of the battery and the amount of external load. Therefore, when the battery is fully charged and there is no load on the system, the difference in voltage between the generator and the battery is so small that little or no current will flow between them.

DO NOT ATTEMPT TO RAISE CHARGING CURRENT BY INCREASING VOLTAGE OUTPUT ABOVE THE SPECIFIED FIGURE, AS DAMAGE WILL RESULT.

6. Battery.

The condition of the battery should be checked with a hydrometer at least every seven days. If the hydrometer reading is below 1.150 to 1.200, the cell is partially discharged or medium, and if the reading is from 1.275 to 1.285, the cell is high (fully charged). If any cell is low, or if any cell is too high, the battery is developing trouble and should be removed from the aircraft and thoroughly checked, and repaired if necessary. Add distilled water to the cells of the battery if the electrolyte is low. Never add electrolyte or acid. If the battery terminals are dirty or shows signs of corrosion, disconnect terminals, wipe clean and then apply a coat of vaseline over the metal surfaces. If the battery indicates signs of leakage, remove battery and replace with another. Examine aircraft structure in the vicinity of the defective battery and wash those areas with a 10 % solution of caustic soda to neutralise the sulphuric acid, and then wash thoroughly with clean water. Check with litmus paper. To avoid the possibilities of fire, open the main battery isolating switch on the front of the battery housing, prior to using any inflammable solvent for cleaning the aircraft. If the aircraft is not to be operated for a **period of two weeks or more, the battery should be removed** and maintained in a serviceable condition.

Conical vent plugs are provided to prevent spilling of the electrolyte during aerobatics. To obviate sticking, these plugs are recessed on the base, thus giving a narrow contact surface.

It is necessary to keep vents and plugs free from dirt by washing with petrol.

Warning.—Do not use methylated spirits or alcohol, which are harmful to the battery.

7. Replacement of Battery.

The battery may be easily removed by undoing the two holding down bolts, disconnecting the inlet and outlet ventilating tubes and removing the positive and negative connections from the battery terminals. The battery terminal shield is left connected with the flexible conduit to the main power box. The battery may then be lifted out from the right side of the aircraft.

8. Booster Coil.

Access to the booster coil is obtained by removing the cover over the main power box on the firewall. Contact points should be cleaned when necessary and adjusted so that the D.C. current passing through the primary winding, with a spark plug in the H.T. circuit, is 1.25 to 1.5 amperes.

8. Booster Coil—Continued.

Do not use emery cloth or sandpaper to clean booster coil points. To clean the points use a fine carborundum stone, such as a Norton No. 220, followed by a fine crocus paper and clean with carbon tetra-chloride.

9. Landing Lamps.

To gain access to the landing lamps, extract the screws securing the hinged leading edge cover to the lower surface of the outer wing panel, and hinge the assembly upwards. Remove the locking wire and the screw from the lamp glass retaining rim and remove the glass. Further access to the lamp may be gained through an access door on the lower surface of the panel, just aft of the landing lamp.

10. Replacement of Condensers.

A defective generator condenser may be replaced by loosening the screw clamping the condenser to the generator, removing two screws securing the generator terminal housing to the generator body and disconnecting the wires therein. The condenser may then be removed. The generator control box condenser may be replaced by first removing the box cover, then loosening the holding screw and disconnecting the wire.

Section D.–STARTING MOTOR

1. Description.

The starting motor is installed on the engine accessory section, directly aft of the engine mounting ring. It is energised by means of a solenoid starting switch attached to the front of the firewall and operated from a starter switch located on the instrument sub-panel in the front cockpit.

2. Starting Motor.

The starting motor consists of the following major parts:—

(1) A series wound electric motor, the body of which is bolted to the reduction gear housing. It also forms the support for the hand-starting drive. The windings of the motor are protected from oil by an oil seal assembly installed between the motor and the reduction gears.

(2) A reduction gear consisting of a train of gears having a total reduction ratio of 90 to 1 between the starting motor and the starter jaws.

(3) An adjustable torque overload release, contained in a rotating barrel shaped housing. The torque is transmitted through this housing to a spring loaded multiple disc clutch. Adjustment is obtained by altering the tension of the clutch springs.

(4) An automatic meshing and de-meshing device, which is also located in the rotating housing, and is driven through the multiple disc clutch. It transmits the torque to a screw shaft by means of an internally threaded spline nut. The starter jaw is splined to the screw shaft and equipped with a friction ring which causes the screw shaft to advance, before starting to rotate, to a point where the starter jaw engages with the engine jaw on the engine starter shaft. The starter jaw is faced in such a manner that disengagement occurs the instant that the engine starts. A baffle plate oil seal assembly, completely covering the portion of the starter protruding into the engine crankcase, is incorporated in the starter to prevent leakage of engine oil into the starter housing.

(5) The hand crank assembly which consists of two units, a removable crank handle and the extension assembly which is fastened to the starter crankshaft. The crankshaft of the starter is fitted with an internally tapered bore at its outer end to permit of the attachment of the extension assembly. The extension assembly is made from heat treated steel tubing, tapered at the drive end and reinforced with a hardened steel plug. The drive end of the assembly is secured to the starter crankshaft with a 1/4" diameter bolt, nut and cotter pin. The bolt is snug fit in the crankshaft and a clearance fit in the extension assembly, thereby permitting a universal action between the two, should a slight mis-alignment of the extension occur. The crank end of the tubing is permanently pinned to a hardened steel dog which engages with the hand crank by means of spiral slots. The spiral slots automatically disengage the hand crank when the operator ceases cranking.

Section E.—MAINTENANCE OF STARTING MOTOR

1. Operation of Starter.

For the best results in starting, prepare the engine in accordance with the instructions contained in Chapter 2, Section A, of this manual and also the Wasp Operating Instruction Manual.

Caution.—If the engine fails to start readily, the cause should be ascertained to avoid running down the battery. Unless the engine starts the starter jaws will still be in engagement, and to free them it is necessary to turn the propeller a 1/2 revolution in its normal direction (first making sure that the ignition switches are "OFF") so as to disengage the starter jaws. Under no circumstances may the propeller be turned in the reverse direction unless the starter has first been disengaged.

2. Maintenance of Starter.

The starter when properly installed and operated should not require attention between major overhaul periods, except when it is recommended that after every 180 hours of engine operation the window strap of the motor be removed and the motor inspected for:—

(*a*) Loose connections.

(*b*) Worn or binding brushes.

3. Commutator.

If the commutator is rough or dirty it should be smoothed and polished with No. 000 sandpaper. If it is extremely rough or burned the armature should be removed and the commutator re-faced, with a light cut, in a lathe. The minimum diameter to which it may be turned is 1 5/16". Smooth and polish the commutator after turning.

Note.—Brushes must be re-seated whenever the commutator has been turned.

4. Brushes.

When replacing a worn brush, it is necessary to set the brush properly by inserting a strip of No. 000 sandpaper between the brush and the commutator with the sanded side next to the brush and pull in the direction of rotation. The operation should be repeated until the brush is completely seated. Binding brushes and brush boxes should be wiped clean with a petrol moistened cloth. Brushes should be a free fit without excessive side play in the brush boxes.

Caution.—Do NOT USE coarse sandpaper or emery cloth. Remove sand and metal particles with compressed air.

5. Brush Springs.

Brush springs should be replaced if the tension is less than 20 ounces as measured when the spring leaves the top of a new brush.

6. Starter Jaws.

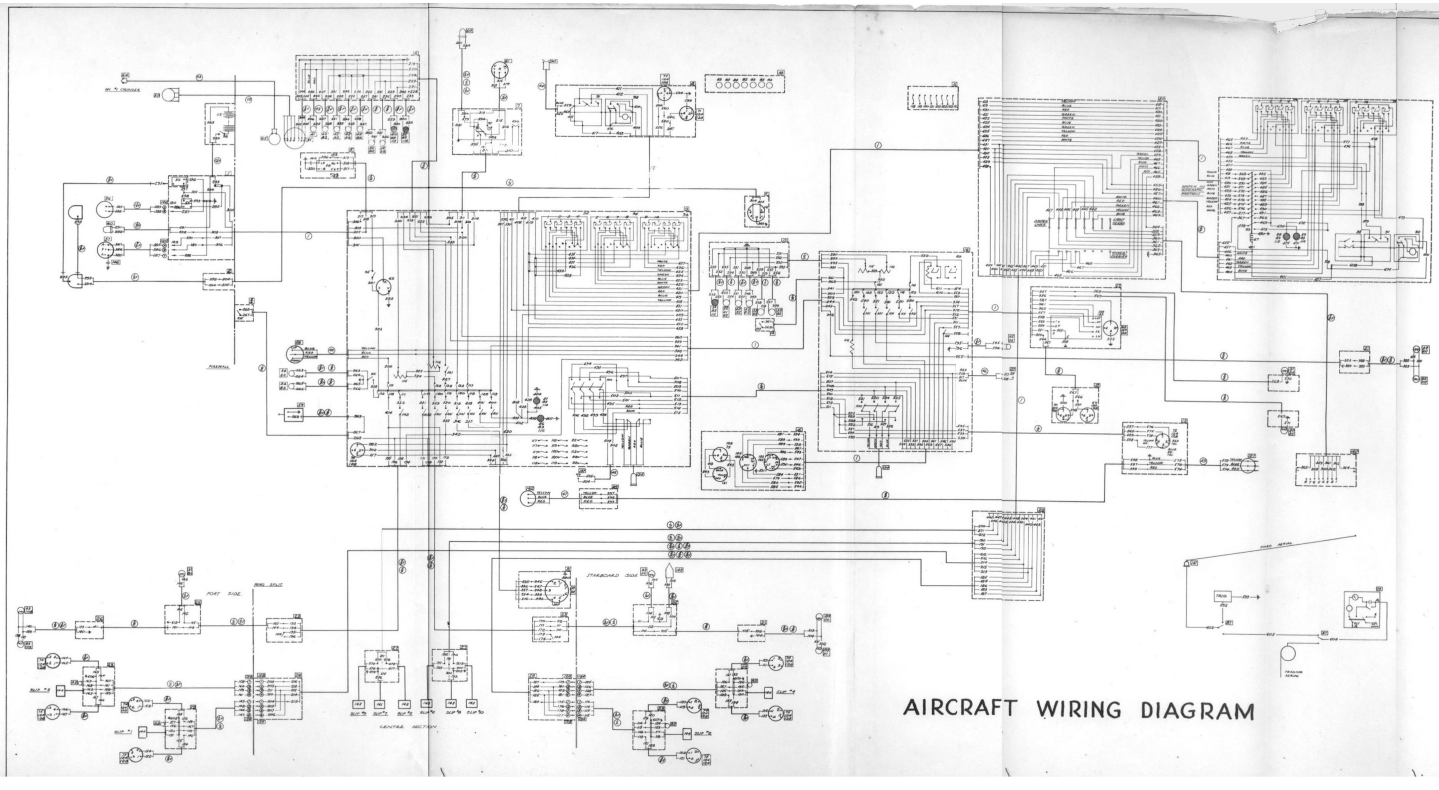
With the jaws fully retracted, the travel to the full advanced position should be 11/32".

7. Friction Ring.

Check the friction ring assembly on the baffle plate to ascertain if the spring has sufficient tension to hold the starter jaw in position so that it will advance full forward to mesh with the engine jaw before starting to rotate. If the jaw fails to advance the friction spring should be replaced.

8. Solenoid Starting Switch.

Examine contacts, both movable and stationary, and if dirty clean with No. 000 sandpaper. If badly burnt or pitted, replacement should be made. The movable switch blade may be replaced in service by removing the pin through the shaft near the switch blade. The plug holding the blade on the shaft will then lift out and the blade may be removed. Do NOT attempt to remove the studs from the cover plate. In order to replace the stud contacts a complete cover plate assembly should be obtained.



AIRCRAFT WIRING DIAGRAM

CHAPTER 14.—GUN ARMAMENT

Section A.—FIXED GUNS INSTALLATION

1. Description.

The fixed gun installation consists of two .303 calibre Vickers Mark V. machine guns, fitted one on either side of the front instrument panel, and firing forward in a line outside the engine ring cowl. The left-hand gun is fitted with a left-hand feed block, and the right-hand gun has a right-hand feed block.

The guns are covered by a hinged section of cowling, which may be readily opened for accessibility when the aircraft is on the ground.

2. Gun Synchronising Gear.

Synchronisation of the guns with the movement of the propeller blades is achieved by means of a standard type generator for each gun. These are actuated by cams on the vertical accessory drive shafts at the rear of the engine. A standard type reservoir is fitted in the front cockpit between the rudder pedals, and the guns are fired by bowden controls from triggers built into the control column handgrip. Air release valves are incorporated in the system, and are fitted one on either side of the main instrument panel, below the guns.

3. Gun Mountings.

The guns are mounted on a rigid tubular mounting formed as part of the welded structure of the fuselage. The gun trunnions are of forged steel, and alignment of the guns is effected by adjustment vertically of the rear trunnion and by horizontal adjustment of the screw through the top of the trunnion.

4. Gun Sight.

The gun is sighted by means of a standard type ring and bead sight. The bead is supported by a tubular structure over the oil tank, and the ring is fitted to the cowling behind the windscreen.

5. Ammunition Box.

Ammunition for the two front guns is carried in a two-compartment ammunition box of spot welded stainless steel construction. The box is designed to provide stowage for two 600 round belts, or a total of 1,200 rounds.

The ammunition box is a removable unit fitted with rollers, which engage on a track support extending across the aircraft. Access is provided by means of a hinged portion of cowling on the right-hand side of the aircraft, and the box must be removed from the aircraft for charging.

6. Feed and Ejection Chutes.

The feed chutes are readily detachable from the gun to facilitate loading of the belt. A hinged cover in the top of the chutes also aids in this operation. The rounds ejection chutes meet in a Y at the centre of the aircraft, and the link ejection chutes are joined to the Y chute, so that all spent rounds and links are ejected through a central chute leading vertically through the wing centre section leading edge.

For the purpose of salvaging empty links and cases, the main ejection chute leads to a box structure in the centre section ahead of the front spar, and a removable cover is provided in the bottom skin of the centre section at this position.

Warning.—Owing to the proximity of the guns to the front instrument panel, the compass in the front cockpit MUST be re-swung and corrected whenever any changes of guns are effected, or whenever any gun is removed or re-installed.

7. Fixed Camera Gun.

Provision is made for the mounting of a Type G.42.B camera gun on the starboard wing centre section.

The camera is operated electrically, and wiring installations are provided. Sockets are located on the main control panel and junction box on the front spar of the centre section, above the starboard landing wheel well.

Provision for mounting an exposure meter are made on the forward end of the front control box.

Section B.—REAR GUN INSTALLATION

1. Description.

The rear gun is a Vickers G.O. No. 1, Mark I., machine gun of .303 calibre. It is carried on a hydraulically controlled hoist arranged to move on a track in the form of a circular arc. The ball-bearing truck which mounts the hoist unit may be locked at any position along the track by means of a locking handle actuating a cam operated lock.

2. Gun Hoist.

The raising or lowering of the gun is effected by means of a three-position valve at the side of the hydraulic hoist. The upward and downward positions of this valve raise and lower the gun respectively. The hoist may be locked in any position by merely returning the valve to the neutral or central position. The hydraulic power for the operation of the hoist is derived from the engine driven hydraulic pump, but in case of failure of this supply, the hoist may be operated by setting the valve in the desired position and operating the hand hydraulic pump.

Warning.—When the rear gun is not actually in operation, the control valve should be locked in the central position by inserting the locking pin, which is attached to the valve by a short length of chain. This will avoid accidental raising or lowering of the gun hoist should the valve be inadvertently knocked.

The gun hoist may be removed from the aircraft by disconnecting the flexible high-pressure hoses at the after end, leaving the hoses with the hoist. When this is done, the hydraulic circuit must be closed by installing the special block (Part No. 01-58189) provided with each aircraft for this purpose. The copper sealing washers and drilled bolts should be retained with the aircraft for attaching the special block. It is necessary to unbolt the track from its supports in order to remove the hoist.

Whenever the gun hoist is removed or re-installed, the level of the hydraulic fluid in the reservoir should be checked, and in the case of installation of the hoist, the hoist should be operated several times by means of the hand pump in order to fully prime the complete system before checking the fluid level.

3. Ammunition.

Ammunition for the rear gun is carried in magazines, each holding sixty rounds. Stowage is provided for eight magazines, or a total of 480 rounds.

4. Flexible Camera Gun.

Provision is made for mounting a G.42.B camera gun on the flexible gun hoist by means of a casting (J.140), which is interchangeable with the flexible gun.

Power supply for the camera is provided by a breeze plug located on the A.T. 10 Vibrator Junction Box, situated on the top fuselage cross bracing, aft of the flexible gun track.

The current is controlled by a switch marked "Camera Gun," located on the rear control panel.

CHAPTER 15.—BOMBING ARMAMENT

Section A.—DESCRIPTION

1. Description.

A total of eighteen bomb-slips are built into the aircraft. These are as follow:—

4 Universal carriers on the outer wings two each side.

6 Light series carriers in the wing centre section.

8 Mechanically-controlled carriers in the centre section.

2. Universal Carriers.

The universal carriers in the outer wings consist of single claw release slips and electro-magnetic release units built inside the wings. Access doors are provided at each bomb position to enable removal of the units for servicing and to facilitate loading of the bombs.

The bombs are fused by E.M. fusing units, and for this purpose, channel members are fitted into which the fusing units may be inserted. Electrical connection of the units is made by a cannon plug fitted at each nose and tail fusing positions.

Bomb steadies consist of screwed strut members with a knurled head piece and locking nut. The bombs should be lined up fore and aft with the fusing unit channels, taking care to keep the tail of the bomb well down in order to clear the tail fusing unit. The steadies should be drawn up hand tight only and locked by means of a spanner on the locking nuts.

The total normal load of bombs to be carried on these slips is 500 lb., but for the overload case, 1,000 lb. of bombs may be carried. The universal carriers are designed for use with any of the undermentioned bombs:—

100 lb. A.S.

112 lb. H.E.

120 lb. G.P.

250 lb. G.P., S.A.P., A.S. or R.L.

Note.—Aircraft bearing manufacturers' serial numbers CA1-30 and subsequent numbers have strengthened carriers at Nos. 1 and 2 universal carrier positions (inboard universal carriers) to which 500 lb. S.A.P. bombs may be loaded.

3. Light Series Carriers.

The six light series carriers are electro-magnetically controlled release units built into the trailing edge portion of the wing centre section, just ahead of the landing flaps. Access doors are provided for servicing and removal of the units.

The rear steady is adjusted to a fixed length and should not require further setting. Steadying of the bombs should be effected by the adjustable nose steady, which incorporates a lock nut and splint cone locking arrangement. The steady should be drawn down on to the bomb, and held firmly in position with the fingers while the lock nut is tightened with a spanner.

Each light series carrier is designed to carry one of the following bombs:—

8-1/2 lb. Practice Bomb, Mk I.

11-1/2 lb. Practice Bomb, Mk. I.

4. Mechanical Releases.

Eight mechanically-controlled release slips, arranged in two groups of four slips each, are installed in the lower panel of the centre section. These slips are intended primarily for the carriage of pyrotechnics.

The slips are actuated by a cam bar and pawl mechanism operated by a release lever in the front cockpit. Pyrotechnics from the left-hand or right-hand group of slips may be released individually by successive strokes of the release lever in the left-hand or right-hand slot of the release quadrant respectively. In addition, all four slips of the left-hand group may be released simultaneously by operating the release lever in the centre or SALVO slot of the quadrant.

The front and rear steadies are adjustable and are of the same type as the adjustable steadies of the light series E.M. carriers. A removable fuse safety bracket is provided for each release for use when required.

5. Bombsight.

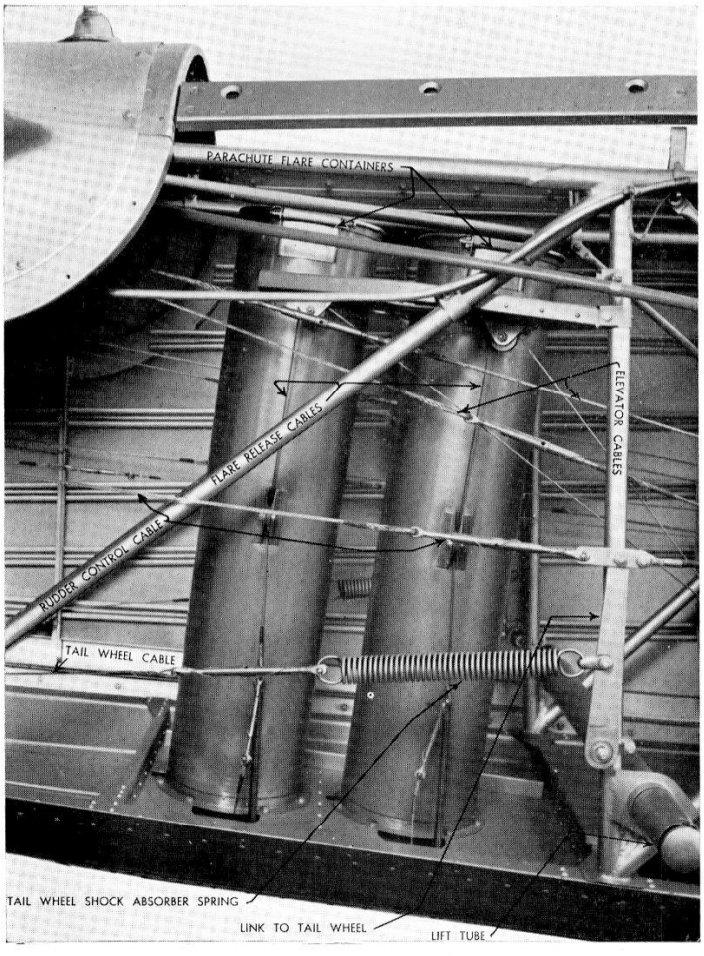
Provision is made for the fitting of a Course Setting Bombsight, Mark VII. or Mark IX., on a mounting below the floor in the rear cockpit. The part of the floor covering the bombsight position is arranged as a double-hinged door, which folds against the left-hand side of the aircraft when the rotatable seat is locked in the rearward facing position. Bomb sighting doors are arranged in the fuselage bottom, actuated by a lever to the right of the bombsight position. To permit a flat sighting angle from the prone bombing position, these doors are interconnected with a section of the centre section landing flaps, which is arranged so as to swing upward as the bomb sight doors are opened.

6. Automatic Bombing.

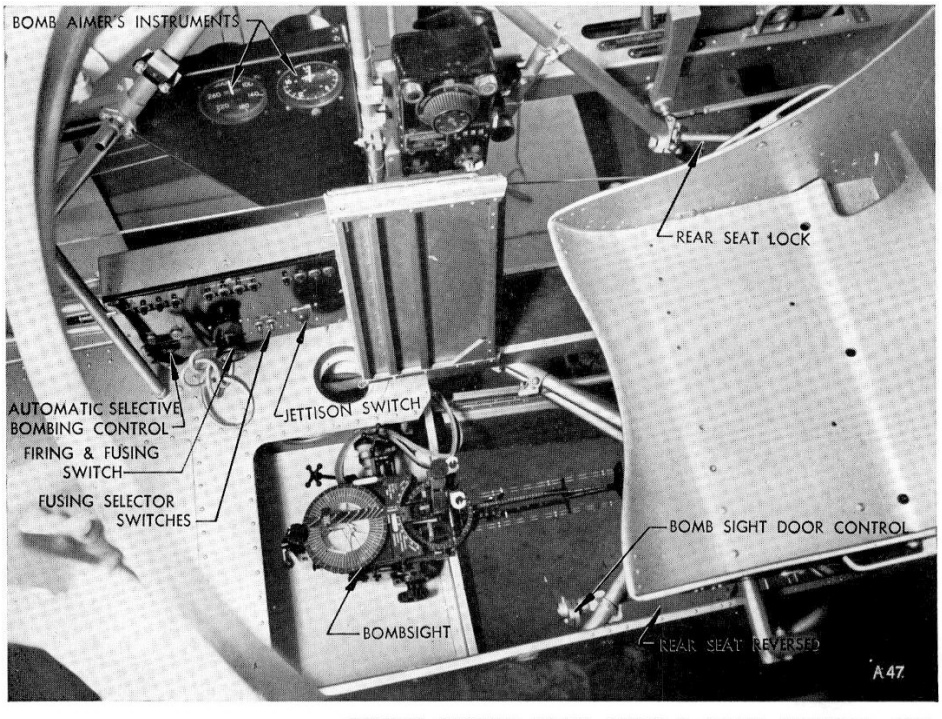
For the purpose of dropping bombs to a pre-determined pattern, a Bomb Distributor Box, Type A, is fitted to the aircraft in the right-hand side of the prone bombing position. The box should be connected to the group of terminals provided in the main bomb circuit junction box, which is situated just aft of the electrical control panel in the rear cockpit. Selection of the bombs to be connected to the distributor, either light series or universal carriers, is made by plug-in type bridges in this box; the selection of bombs to be fired is, however, made in the usual way by means of the selector switches incorporated in the distributor box.

To operate the distributor, a manual control is fitted to the solenoid multipole switch in the bomb control box to the left of the bombing position. This switch connects the bomb-firing circuits to the distributor box and at the same time connects the power supply and the amber-coloured indicator light.

The multipole switch is solenoid operated by the jettison switch in the front cockpit to enable the pilot to jettison all bombs in an emergency, even though they may have been selected for automatic bomb dropping by the prone bomber.



PARACHUTE FLARES



COURSE SETTING BOMB SIGHT & BOMB CONTROL BOX

CHAPTER 16.—PYROTECHNICS

Section A.—DESCRIPTION

1. Forced Landing Flares.

Two four-inch reconnaissance training flare launching tubes are installed in the rear section of the fuselage. They are of spot welded stainless steel construction and are mounted by means of a bolted flange to the monocoque. Two doors through which the flares are dropped are hinged to the bottom of the tubes. The monocoque is cut away to give sufficient clearance for the doors to operate. These doors are controlled by means of cables attached to two handles of the toggle type, carried on a bracket on the right-hand side of the front cockpit.

2. Reconnaissance Flares.

Reconnaissance flares when used may be carried on the centre section mechanical bomb carriers, and released by means of the bomb release mechanism and controls.

3. Signal Flares.

A bracket secured to the fuselage on the right-hand side of the front cockpit provides for the stowage of a Verey Pistol. A signal pistol cartridge rack for eight cartridges is installed at the forward end of the control shelf on the left-hand side of the front cockpit.

4. Installation of Forced Landing Flares.

To instal the flares remove the top cowling directly above the launching tubes. The removal of the cover on each tube allows the flare to be placed in position. The bomb carrier band lug and lock pin must be removed from the flares to permit entry into the tube. Instal flare and connect mechanism. Do not connect operating cord on flare until installation has been checked as outlined below.

When installing the flares in the flare launching tubes, the operation of the tube and release mechanism should be checked by installing the flares without connecting the operating cord on flare, and then operating the release mechanism. While this check is being made someone should be stationed beneath the aircraft to catch the flare before it strikes the ground. When desired this test may be accomplished by substituting a dummy flare of the same approximate size and weight as that of the flare actually used. Following this test, however, the actual flare must be tried in the launching tube to make certain that no binding occurs at any point.

CHAPTER 17.—CAMERA INSTALLATION

Section A.—F. 24 TYPE CAMERA

1. Description.

Provisions are made for the fitting of a Type F. 24 Camera, together with a Camera Mounting Type 25. The camera may be installed through the fuselage side access door. An Aldis Camera Aiming Sight may be installed on a wedge-plate mounting fixed to the panel which mounts the bomb aimer's instruments . The camera may be installed only when it is not desired to use the prone bombing position.

2. Installation of Camera.

The camera and its mounting are carried by supports which are not normally fitted to the aircraft. The necessary parts are, however, supplied with each aircraft and brackets for their attachment are provided. The following parts are required for installing the camera:—

Part No.	Part Name	No. Req'd.
01-73104	Front Rail Assembly	1
01-73104-2	Rear Rail Assembly	1
01-73106	Pin Assembly	4
01-73112	Front Post	2
01-73113	Rear Post	2

Before installing the camera, the door in the inner skin of the fuselage bottom structure must be opened and folded back. The camera doors in the bottom skin of the fuselage may be opened in flight.

3. Installation of Camera Sight.

The mounting ring for the Camera Aiming Sight is a permanent installation in the aircraft. Before fitting the camera sight, it is necessary to move the cover plate which is normally over the sighting hole in the fuselage bottom. To effect this, remove the forward attaching screw of the cover, loosen the rear screw and rotate the cover through 180° about the rear screw. The cover may then be secured by the first screw, through the additional hole provided.

4. Camera Control and Motor.

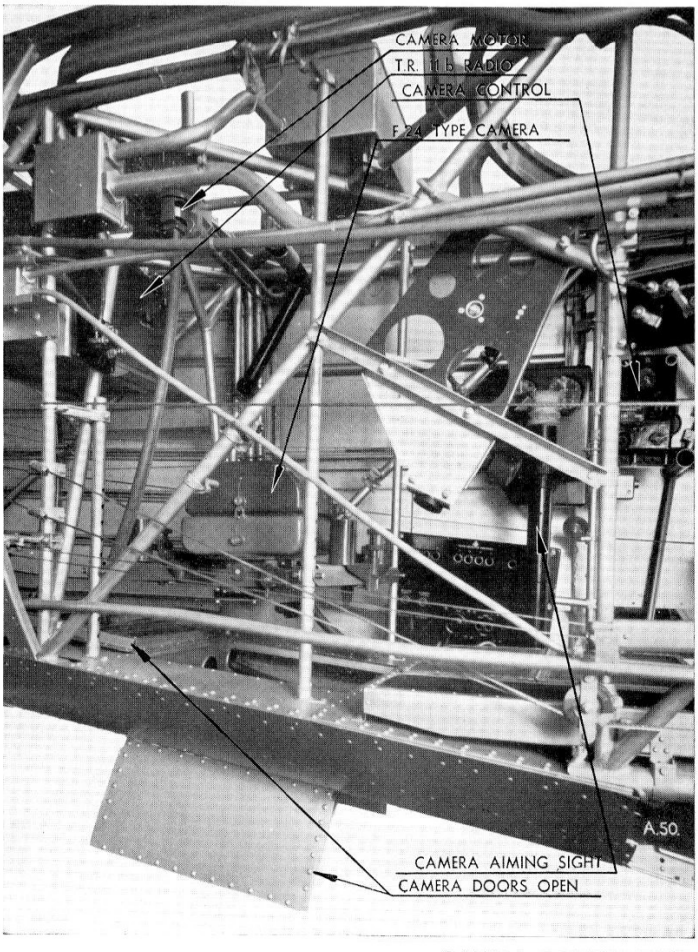
Wedge-plate mountings are provided for the installation of a camera motor and control unit. The motor may be fitted to the wedge-plate, which is fixed to the top of the fuselage frame, at the bulkhead station immediately aft of the camera mounting position. The wedge-plate for the camera control is fixed to the fuselage structure on the left side of the rear cockpit. Electrical power connection of the camera equipment is made by means of four-pin cannon plugs. The sockets are located adjacent to the camera wedge-plate fitting. The camera is intended to be operated by the occupant of the rear cockpit with the rotating seat fixed in the rearward-facing position.

5. Removal of Photographic Equipment.

The camera installation may be removed from the aircraft by reversing the above procedure. When the camera is removed, the parts detailed above should also be removed from the aircraft.

6. Pilot's Warning Indicator.

A green camera light is permanently fixed on the front cockpit instrument panel.



CAMERA INSTALLATION

CHAPTER 18.—LUBRICATION

Section A.—DAILY

Lubricate Daily.

The accompanying description and lubrication diagram illustrates the general system of lubrication, the lubricants and the points of lubrication on the aircraft.

1. Fill the hydraulic fluid reservoir with hydraulic brake fluid to C.A.C. Specification CA 411 or equivalent.

Section B.—30 HOURS

Lubricate every 30 hours.

The following components are to be lubricated with the lubricants stated:—

1. Nine grease nipples located on the **Landing Gear Struts and Retracting Mechanism** on both sides of the aircraft.
2. One grease nipple on both sides of the aircraft located on the **Landing Gear Retracted Position Latch Assembly.**
3. One grease nipple on the **Centre Bellcrank Bracket** located near leading edge of centre section on port side.
4. One grease nipple on each **Flap Control Handle Assembly.**
5. Seven grease nipples on **Flap Operating Yoke,** located on the wing centre section trailing edge below the hydraulic operating cylinder.
6. Four grease nipples on **Tail Wheel Strut and Tail Wheel Support Attachment.** The nipples are located one at each of the attachment points of the tail wheel support fitting, and one at each end of the oleo strut.
7. Three grease nipples located on each **Rudder Pedal Assembly.**
8. One grease nipple for the **Rudder Trim Tab.** Access to this nipple is gained through an inspection cover in the leading edge of the rudder directly forward of the trim tab.
9. Two grease nipples for **Elevator Trim Tabs** located in the port and starboard elevators. Access is gained in similar manner to the rudder trim tabs.
10. Two grease nipples on **Remote Control Cable** located on the port side of the aircraft, just aft of the rear cockpit. Access to it is gained through side panel.
11. Lubricate **Travel Contacting Lock Mechanism** on the rudder balance cable. No grease nipple provided.
12. Lubricate **Surface Control Lock Plunger.** No grease nipple provided.
13. Lubricate **Undercarriage Lock Pins.** No grease nipples provided.

Lubricate every 30 hours with LIGHT LUBRICATING OIL.

14. Clean and lubricate sparingly **Rudder and Elevator Trim Tab Control Screws.** Access to these screws is gained through inspection covers located on the surface just aft of the trim tab drum locations.
15. Lubricate all **Pins, Shackles, and Moving Joints of Brake System** and **Landing Gear Retracting Mechanism.**
16. Lubricate sparingly **Booster Tab Control Rod Connections and Hinges.**
17. Lubricate the **Carburettor Throttle Shaft Bearings** and exposed **Economiser and Accelerating Pump** parts.
18. Lubricate **Pins and Shackles** in the **Engine Control System.**
19. Moisten the **Wick** of the **Magneto Contact Breaker Tension Spring.**
20. Fill with **Hydraulic Brake Fluid,** C.A.C. Specification CA 411, the **Master Cylinder.**

Section C.—60 HOURS

Lubricate every 60 hours, with the Lubricant stated.

1. One grease nipple on each **Hydraulic Hand Pump Assembly.**
2. Pack **Main Landing Wheels and Tail Wheel Bearings,** using a medium grade aluminium soap or a soft or medium grade wheel bearing grease. Only the bearings or the bearing cavities should be packed with the lubricant, and no grease should be applied to the centre of the hub between the bearings or in the dust cap. Old grease should be removed with a suitable grease solvent, and all bearings properly cleaned.
3. Lubricate the **Seat Operating Mechanism** with a light lubricating oil.
4. Lubricate the **Safety Harness Release Mechanism** with a light lubricating oil.

Section D.—GENERAL INSTRUCTIONS

1. Cockpit Enclosure Tracts.

Do NOT LUBRICATE the cockpit tracts, as the lubricant would attract foreign matter, with the resultant tendency to cause incorrect functioning and to increase wear.

2. Rocker Arm Bearings.

The rocker arm bearings of the engine are automatically lubricated by a pressure system, utilising oil from the engine. They need no further lubrication.

3. Ball Bearings.

All control rod ends and bell cranks are fitted with ball bearings of the sealed type, packed with lubricant at assembly, and also require no further lubrication.

4. Location of Grease Nipples.

Greasing points are provided for the lubrication of various moving parts of the aircraft, and these are located as follow:—

2 (1 each side) on retracted latch cross shaft.
8 (4 each side) torsion links of main oleo strut.
4 (2 each side) outboard end of retracting cylinder.
2 (1 each side) retracting piston rod connecting fitting.
2 (1 each side) on top of oleo strut (accessible through cover plate).
2 (1 each side) on main pivot pin through oleo attachment fitting.
6 (3 on each) front rudder pedals.
6 (3 on each) rear rudder pedals.
2 (1 on each) on flap control handle.
2 (1 on each) on hydraulic hand pump assembly.
2 (1 each side) on elevator trim tabs.
1 on rudder trim tab.
1 on centre bellcrank bracket on port side.
7 on flap operating mechanism.
4 on tail wheel strut and tail wheel support attachment.
2 on remote control cables on port side.

53 total points

Section E.—APPROVED LUBRICANTS

The following lubricants are satisfactory for the use in servicing Wirraway aircraft:—

1. General lubrication of controls, landing gear mechanisms, &c., at all **Grease Nipples.**
   (1) Mobilgrease 2B.

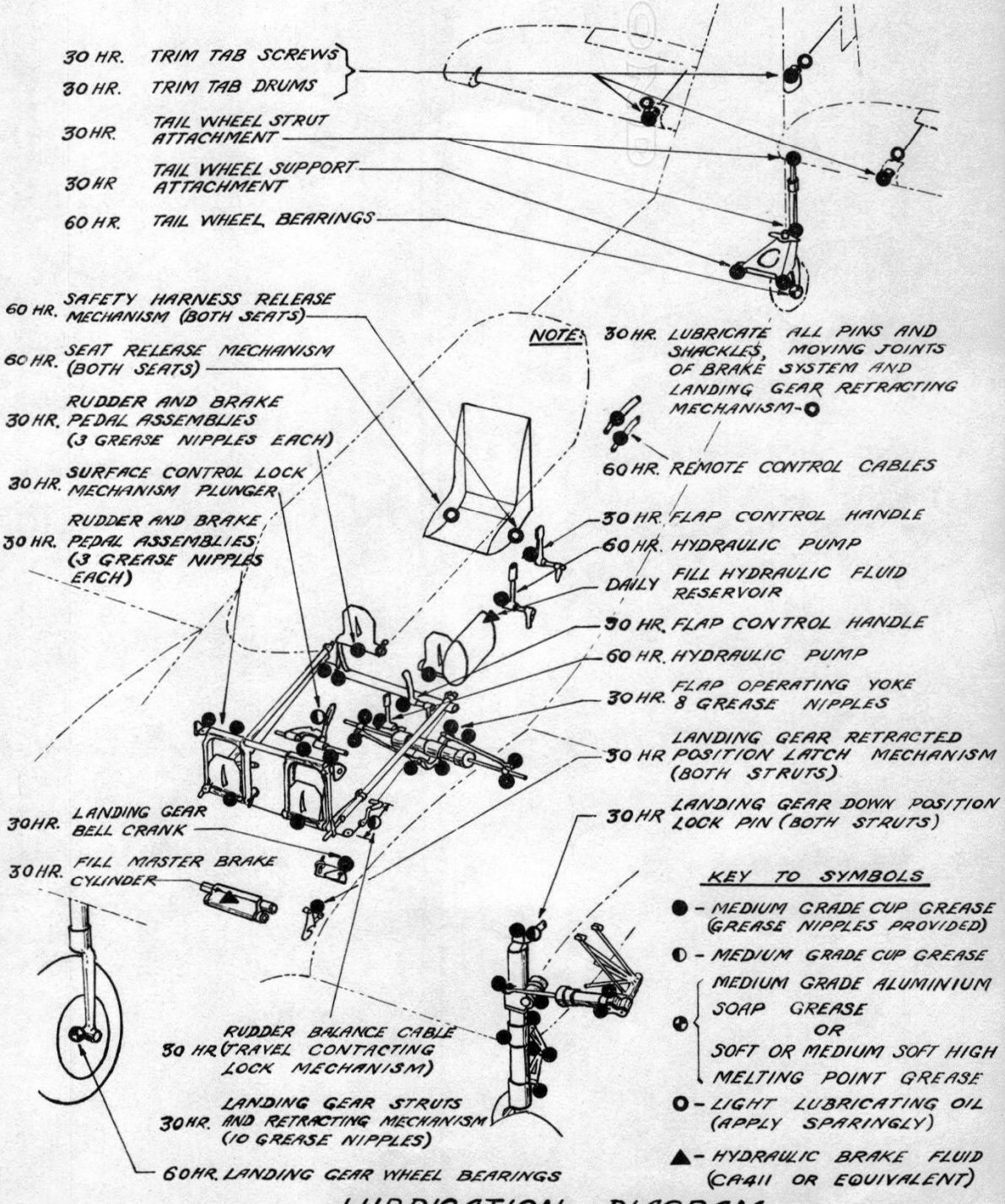
2. Lubrication of parts specified on lubrication chart where **No Grease Nipples** are provided.
   (1) Mobilgrease 2B.

3. Lubrication of **Wheel Bearings** on main landing gear and tail wheel.
   (1) Mobilgrease 2X.

4. The following **Hydraulic Fluids** are satisfactory for use in the hydraulic system, brake system, main landing gear oleos and tail wheel shock absorber.
   (1) Hydraulic Fluid CA 411.
   (2) Lockheed No. 21.
   (3) A mixture of equal parts of Diacetone alcohol and castor oil.

Caution.—Under no circumstances may hydraulic fluids of different specifications be mixed. If a change is to be made the unit or system must be drained.

5. Lubrication of **Airscrews.**
   (1) Intava A.



LUBRICATION DIAGRAM

"WIRRAWAY"
OVERHAUL AND REPAIR
MANUAL

PART II.

INSPECTION

CHAPTER 1.—INSPECTION

Section A.—BETWEEN FLIGHT INSPECTION

1. Uc. Main Landing Gear.

(1) Inspect the undercarriage and tyres for damage and see that the tyre pressures and shock absorber struts appear normal.

(2) See that tyres and fairings are free from mud.

(3) Examine tail wheel and tyres for damage and correct inflation.

(4) See that all loose articles are secured.

(5) Check position of landing gear and flap controls.

2. As. Airscrew.

(1) Inspect the airscrew hub and blades for visible damage, such as cracks or dents.

(2) Check the airscrew pitch change mechanism during the "running up" period of the engine to see that the operation of pitch changing is normal.

Important.—This check **is not to be made** by manually operating the airscrew blades with the engine at rest.

3. Ol. Oil and Fuel Tanks.
Pe.

(1) Replenish the fuel and oil tanks if necessary and see that the filler caps are securely replaced.

4. Ig. Ignition.

(1) See that the ignition switches are in the "OFF" position.

(2) See that the pilot tests the ignition by running on each magneto alone. (The drop should not exceed 100 R.P.M.)

5. Pp. Engine Test.

(1) See that the engine will run up to its usual R.P.M. and that the correct fuel and oil pressures show on the gauges. Refer to the Wasp Operating Instructions Manual, R.A.A.F. Publication No. 71.

6. Pp. Engine-Driven Generator.

(1) During the engine tests see that the generator is charging correctly. See Part I., Chapter 13, Section B.

7. Co. Aerials.

(1) Examine the last 20 feet of the trailing aerial for cleanliness and fraying and the weight attachment for security. See that the trailing aerial is secured by insertion of winch plunger between the beads of the weight.

8. Co. Switches.

(1) See that all electrical and W/T spares are stowed securely and that spare fuses, filament lamps, &c., used on previous flights are replaced.

9. Ge. Electrical System, General.

(1) During night flying check all lamps for correct functioning.

Section B.—DAILY INSPECTION

1. Uc. Main Landing Gear.

(1) Check wheels and fairings for security of attachment and wheels for distortion of rim flanges.

(2) Check tyres for cuts and damage. See that tyre pressures are normal. Inflation ribs should just touch the ground when the aircraft is standing on a firm level surface.

(3) Check the operation of the brakes—a spongy feel on the pedals indicates trapped air necessitating bleeding of the brake system. Refer to Chapter 7, Section B of Part I., covering this operation. See that the "Parking" release frees the brakes.

(4) See that the shock absorber struts appear normal. Refer to Part I., Chapter 9, Paragraph 1, for details.

(5) Inspect the operating mechanism generally for condition of struts, braces and fittings. Ascertain that no leakage is taking place in the operating cylinders.

(6) Inspect and check the retracting lock mechanism in accordance with instruction in Part I., Chapter 9, Section C.

2. Cn. Control System.

(1) Check flaps for full and free movement. See that the flaps open and close simultaneously and that the position indicator agrees with the actual movement. Top hydraulic fluid reservoir. For adjustment of flaps see Part I., Chapter 4, Section B.

(2) Check elevator and rudder trim tab controls for correct, full and free movement.

3. Fu. Fuselage.
Co.

(1) Check the condition and functioning of the sliding segments of the cockpit enclosure frame and release mechanism.

(2) See that the windscreens are clean and secure. See that the cockpit is clean and free from loose articles.

(3) See that the fire extinguisher is full, nozzle clear, and that the attachments to the fuselage are in good condition and also that the access door operates freely.

(4) Inspect the seats for security of attachment and proper functioning of the adjusting mechanism.

(5) Inspect the safety belts and anchorages for security, operation and general condition.

(6) Check fabric covering, cowling and fairings for condition and security of attachment.

4. Ta. Empennage.

(1) Inspect tail plane, fin, elevator, rudder and trimming tabs for external damage.

(2) See that the fairing and access covers are securely attached.

(3) See that all drain holes are open.

(4) Check rudder for full and correct movement.

(5) Check all hinges for security of attachment, bonding, freedom of movement and general condition.

5. Ta. Tail Wheel.

(1) Examine tail wheel assembly for security and see that the compression strut inflation appears normal. Refer to Part I., Chapter 8, Section B, dealing with maintenance. Check tyre for pressure by means of the inflation ribs on the tyre. Examine for cuts or other damage.

6. Pl. Wing Installation.

(1) Inspect the wing installation and ailerons for damage and general condition. See that the wing tip attachment screws are tight and that all drain holes are open.

(2) See that the aileron hinge nut access covers are tight. Inspect aileron hinges for security and any sign of excessive play.

(3) Inspect flaps for damage or distortion.

(4) Ascertain that no leakage is taking place in the flap operating cylinders, tubing or connections.

(5) Check access covers and fuel tank doors for security of attachment.

7. Ge. General.

(1) Keep aircraft clean both internally and externally.

(2) See that all access covers are properly closed and all cowling properly fastened.

(3) Remove wheel spreader and pitot flag before flight and replace on cessation of flying.

8. As. Airscrew.

(1) Inspect all external locking on the airscrew for security.

(2) After the first flight of an aircraft with a newly installed airscrew, check for correct tightness of the airscrew on the airscrew shaft with spanner.

(3) Examine the blades for shake.

(4) Examine blades for nicks and sharp dents on the leading edges and gashes on the blade faces.

(5) Coat counterweight bearing assemblies with lubricant.

(6) Check cylinder assembly and external oil lines for leaks.

(7) If the airscrew has been subjected to salt air or spray carefully wash with soap and fresh water or thoroughly clean with kerosene after the final flight for the day. A coating of engine oil is then applied for protection.

(8) See that the engine is stopped with the airscrew in the high pitch position.

9. Pp. Power Plant.

For power plant inspection see Wasp Operating Instructions Manual, R.A.A.F. Publication No. 71.

10. Ig. Ignition.

Inspect the ignition switches for correct mechanical functioning and see that they are all in the "OFF" position.

11. Pe. Petrol System.

(1) Drain any water from the fuel strainers and safety drain cock and see that they are locked.
(2) Check operation of hand fuel pump against the fuel pressure gauge, with the fuel valve at the "ON" position.
(3) Check the fuel system for leaks.
(4) Check the taper pins securing the stop lever assembly to the throttle shaft for security.
(5) Remove air cleaner unit. Wash in petrol, re-oil, and drain surplus oil.

12. Ol. Oil System.

(1) Remove and clean the oil screen in the base of the sump after approximately five hours of service of a new or overhauled engine. Examine the deposit in the recess of the drain plug for signs of metal which would indicate excessive wear or scoring of engine parts. Do NOT use rag or waste for cleaning oil screens.
(2) Check oil system for leaks.

13. Cn. Engine Controls.

(1) Check all engine controls for condition and proper functioning.

14. Co. Instruments.

(1) Set the altimeter at "zero."
(2) Inspect the instruments for broken glasses, loose dials or indicator pointers.
(3) With the engine running observe the operation of:—
(*a*) Fuel pressure gauge. Pressure should be 3½ lbs. at full throttle. Check for excessive oscillation of the pointer. See that the pointer registers "zero" when the engine is stopped.
(*b*) Oil pressure gauge. Pressure should register 80 lbs. at full throttle. See that the pointer registers "zero" when the engine is stopped.
(*c*) Tachometers. Check for steady readings at the indicated speeds and the return of the pointer to "zero" when the engine is stopped, except as stated in Part I., Chapter 13, Section B, Paragraph 11.
(*d*) Thermometers. See that the temperature reading increases as the engine is warmed up.
(*e*) Test gas analyser for operation and see that the pointer returns to "zero" when the current is switched off.
(*f*) Inspect all navigation instruments for broken glasses, loose dials and pointers, also for security of mounting.
(*g*) See that the rate of climb indicator is at "zero." If not, adjust by means of the adjusting screw on the back of the case.
(*h*) Wind the clock and set to the correct time.
(*i*) See that the compass deviation cards are legible and secure.

15. Electrical Equipment.

(1) Pp. Power Plant. See that all conduit nuts between the generator, the starter motor, and the main distribution box are secure.
(2) Check the operation of the voltammeter and the voltage on the load of the battery by switching on the navigation lights and reading the voltage shown on the voltammeter.
(3) Remove the cover of the battery box and remove all surplus electrolyte. Check the level of the electrolyte in each cell and top up with distilled water as required. Replace cover and see that the battery is securely mounted.
(4) Inspect the aerial fairlead and attachments for security and cleanliness. See that the aerial is free in the fairlead and the weight is securely attached.
(5) Clean the plunger block on the aerial winch. Inspect the other parts of the winch for security and adequate lubrication.
(6) See that all electrical and W/T spares are serviceable and securely stowed.
(7) Conduct a ground test of the W/T equipment.
(8) Test morse keys for correct functioning.
(9) Inspect and test the armament electrical equipment.
(10) Examine the fixed aerial attachments and lead-in for security.
(11) See that the aerial insulators and lead-in insulators are clean, secure and not damaged.
(12) Examine and test all navigation, identification, instrument, landing, cockpit, petrol gauge and warning lamps for security, cleanliness and correct functioning.
(13) Test the pitot heater for correct functioning.

Warning.—The heating element of the pitot static head is a wire wound resistance unit built into the pitot head. The power supply is controlled by a switch on the front cockpit control panel and should not be switched on, with the ship on the ground, except for a short period.

(14) See that all W/T equipment is mounted securely and that the rubber suspension on W/T crates, power supply units for R.1082 and neutralizing unit is functioning correctly.

16. Fixed Guns—Group A.

(1) Examine muzzle attachments for security and locking.
(2) Clean and lubricate the Vickers guns as required.
(3) Examine service and spare locks; oil lightly.
(4) Inspect the Vickers gun mountings for security.
(5) Test operation of loading mechanism.
(6) Inspect the ammunition boxes and empty cartridge case and link chutes for security and damage.

17. Synchronising Gear—Group B.

(1) Inspect the synchronising gear generators for security.
(2) Inspect the synchronising gear pipe lines and unions for security and damage.
(3) Inspect the trigger motors for security and damage.
(4) Inspect the synchronising reservoir for security; replenish as required. Expel air and test for faults. Leave H.P.P.R. one inch from bottom.
(5) Inspect the firing levers and bowden controls of the synchronising gear for security and damage. Ensure the bowden controls do not foul or limit the movement of the control column.
(6) Check the timing of the synchronising gear as laid down in Air Force Publication 1242, Volume 1, Part I., Chapter 9, Paragraph 31 (ii.).

18. Free Gun—Group C.

(1) Inspect the Vickers G.O. gun mounting for security and free operation. Lubricate as necessary in accordance with Armament Order No. 1/6.
(2) See that the stowage clip for the Vickers G.O. gun is secure.
(3) Ensure that the lever for the gun hoist is in the "neutral" position.

19. Gun Sights—Group D.

(1) Check the fixed gun sight and attachment brackets for security and damage.
(2) Inspect the sights on the free gun (if fitted) for security and damage.
(3) If reflector sight is fitted to free gun, carry out inspection as laid down in Armament Order No. 6/7, Paragraph 9 (*a*).
(4) See that the serviceable spare lamp is in its appropriate stowage.

20. Bomb Carriers—Group E.

(1) Examine the E.M. release units for security.
(2) See that the release slips are clean and correctly lubricated.
(3) Examine the steadies for freedom of movement and leave them securely locked.
(4) Examine the fusing units for security and damage.
(5) Carry out the mechanical tests as laid down in Armament Order Nos. 36/5 [Paragraph 5 (*b*)] and 36/6 [Paragraph 4 (*b*)].
(6) Examine and test the manually operated carrier for correct functioning.

21. Bomb Aiming Equipment—Group F.

(1) Examine the cross levelling bracket for security and damage.
(2) Examine the course setting bomb sight for security and damage.
(3) Carry out the test as laid down in Armament Order No. 37/3, Paragraph 5.

22. Miscellaneous Equipment—Group G.

(1) See that the signal pistol and cartridges are properly stowed.
(3) Check the training flare containers for security, damage and correct functioning.
(3) Check the camera gun for security. See that it is free from dust and grit and replace canvas cover.

Section C.—30 HOUR INSPECTION

1. Uc. Main Landing Gear.

(1) Lubricate the landing gear at the 20 lubrication points provided (10 each side) with the pressure gun. Lubricate the retracted position latch mechanism and the down position lock pins.

(2) Lubricate with the pressure gun at lubrication point on each landing gear bell-crank.

(3) Lubricate all pins, shackles and moving joints of the brake system and retracting mechanism with anti-freezing oil.

Note.—Refer to Part I., Chapter 18, for full instructions regarding lubrication.

(4) Deflate and fully compress shock absorber struts and check fluid level, which should be at the point of overflowing. If necessary top up with the hydraulic fluid. It is essential not to mix different hydraulic fluids, therefore, if another fluid is to be used the system, or unit, must be first drained. Re-inflate until piston moves outward $1\frac{1}{2}$ inches (measured between the lower end of the cylinder gland nut and the upper collar of the fork) with the aircraft in the tail down position and loaded as for flight. Pressure under normal loading conditions will be approximately 220 lbs. per square inch.

(5) Inspect the hydraulic retracting cylinders, pipe lines and connections for leaks, damage and security of attachment.

2. Fu. Fuselage. Co.

(1) Inspect all transparent panels and framework of the cockpit enclosure for cracks and general security.

(2) Lubricate the lock plungers with anti-freezing oil.

(3) See that the map case is in good condition and securely fastened.

(4) Inspect the condition and attachment of head rest in the front cockpit.

(5) Lubricate with the pressure gun at the three lubrication points on each rudder bar pedal in front and rear cockpits.

(6) Lubricate the travel contacting lock mechanism on rudder balance cable.

(7) Check the operation of the control surface lock mechanism and lubricate plunger.

(8) In both cockpits, check the rudder bar pedal length adjusting mechanism for operation and the operating springs for condition and tension.

(9) Lubricate with pressure gun at lubrication point on flap control lever.

3. Cn. Control System.

(1) Check cable control fairleads and pulleys for security of attachment and for broken, seized or misaligned pulleys.

(2) Inspect the full run of the control cables to the rudder, elevator and their respective trimming tab controls for wear, fraying or fouling. See that cables are correctly tensioned and that all turnbuckles are in safety and locked.

(3) Lubricate the control cable attachment pins at elevator and rudder control levers, trimming tab screws and drums with anti-freezing oil.

4. Ta. Empennage.

(1) Inspect the control levers on the elevator and rudder for cracks, bends and security.

(2) Lubricate with pressure gun at the lubrication points on the leading edge of the rudder and elevator.

(3) Inspect the rudder trimming tab cables on rear drum and ascertain that they are riding in their correct grooves.

(4) Remove the access covers on the elevator and rudder and check the trimming mechanism for correct functioning.

(5) Inspect the fin and tail plane for security of attachment, condition of rivets and signs of corrosion.

5. Ta. Tail Wheel.

(1) Check the entire tail wheel assembly for cracks, breaks, or bends in the attachment fittings and brace members.

(2) Inspect the tail wheel swivel release mechanism for correct operation.

(3) Lubricate with the pressure gun at the four lubrication points on the tail wheel assembly—see Lubrication Diagram in Part I., Chapter 18.

(4) Deflate and fully compress the tail wheel compression strut. Check fluid level and fill, if necessary, to plug level with hydraulic fluid. Under no circumstances may hydraulic fluids of different specifications be mixed. If a change has to be made the system or unit must be drained.

(5) Raise tail wheel so that the tail wheel may be twisted to fully castored position. Grease the splines, ensuring that no surplus grease will effect the action of the friction plate.

6. Pl. Wing Installation.

(1) Check the aileron hinge bearings for tightness and hinge brackets for security of mounting.

(2) Check the full run of the aileron control cables for wear, fraying, fouling and proper tensioning. Check turnbuckles for safety and locking. Examine for broken or misaligned pulleys and proper alignment of all moving parts.

(3) Inspect the aileron booster tab operating rods for bends or misalignment and check attachment brackets for cracks or distortion.

(4) Lubricate the pins at the ends of the operating rods for the aileron booster tabs with anti-freezing oil.

(5) Check the wing flaps for warping and rivets for looseness and corrosion.

(6) Lubricate flap operating yoke with pressure gun at the lubrication points provided.

(7) Lubricate all pins and shackles with anti-freezing oil.

7. Ge. General.

(1) Lubricate with pressure gun all lubrication points in accordance with the instructions issued in Part I., Chapter 18, Section D.

(2) Keep oil and grease away from tyres.

(3) Do not use oil or grease excessively.

8. As. Airscrew.

(1) Check for correct tightness of airscrew on airscrew shaft with spanner.
(2) Lubricate blade bushings with pressure gun at lubrication points provided.

Caution.—The use of excessive pressure when the blade bushings are fully charged may cause the blade plugs to buckle under the pressure allowing grease to flow out in the hollow portion of the blade, thus causing unbalance.

9. Pp. Power Plant.

(1) For Power Plant inspection see Wasp Operating Instructions Manual, R.A.A.F. Publication No. 71.

10. Ig. Ignition.

(1) Inspect ignition switches for correct mechanical functioning.
(2) Inspect the distributor rotor for cleanliness, broken bushes and signs of arcing.

11. Pe. Petrol System.

(1) With the fuel "ON" and pressure "UP" inspect the fuel lines for leaks. This inspection should be made with the engine cowling removed and the hand fuel pump in operation.
(2) Inspect the fuel lines for security, damage or chafing and the fuel drain line for plugging.

12. Ol. Oil System.

(1) Remove and clean pressure filter.

Note.—Rags or waste should not be used for cleaning oil screens.

(2) Remove and clean oil screen in base of sump. Examine the recess in the drain plug for signs of metal which would indicate excessive wear or scoring of engine parts.
(3) Inspect all oil pipe lines for security, leaks and for wear due to vibration or chafing.

13. Cn. Engine Controls.

(1) Inspect the entire engine control assembly, from the levers in the rear cockpit, through all rods and their linkage for full and free movement, lost motion, bent rods and correct locking.
(2) Check the "throttle closed" adjustable stop screws (one on each side) for even adjustment.

Note.—The throttle shaft may become twisted if one stop screw only is bearing when the throttle is closed, thereby causing unequal opening of the two carburettor butterflies.

14. Engine-Driven Generator.

(1) Remove the generator window strap and inspect for loose connections and visual check of brushes and commutator.
(3) Inspect generator for oil leaks from engine. Should oil be noticed, remove generator and check engine oil seal for breakage.

15. Battery.

(1) Remove 12-volt battery, check the level and the specific gravity of the electrolyte and examine the case and lid for condition. Clean off any moisture and re-grease the terminals. Replace the battery in the aircraft, ensuring that the mounting is secure and that there are no traces of corrosion on the aircraft structure adjacent to the battery.

16. Aerials.

(1) Run the trailing aerial out to its full length and inspect the aerial for kinking and fraying. Replace the aerial if the total length is less than 200 feet.
(2) Test the aerial winch for freedom of movement. Clean and grease as necessary.
(3) Test the insulation between the aerial systems and earth.

17. Electrical System, General.

(1) Inspect the W/T earthing system for continuity.
(2) Inspect and test the armament electrical system.
(3) Inspect the whole of the electrical conduit system for security and replace any defective flexible bonding strips.
(4) Inspect all fuses and fuse clips for cleanliness and security. See that all fuses and spare fuses are serviceable and of the correct value.
(5) See that all lamp glasses are clean and secure.

18. Motor Generator.

(1) Remove motor generator from its mounting, remove any carbon dust and inspect the commutators for cleanliness. Inspect the brushes for wear and freedom of movement in their holders and replace worn brushes as necessary. Replace the motor generator, ensuring that the mounting and all cable connections are secure.
(2) Check the accuracy of the voltammeter readings, using a meter and multi-test (Y10A/55240) as the standard.

19. Synchronising Gear—Group B.

(1) Examine reservoir for leaks.
(2) Examine trigger motor push rod for chips on face.
(3) Check trigger motor push rod clearance as laid down in Air Force Publication 1242, Chapter 9, Paragraph 56, and Armament Order No. 4/6.

20. Free Gun—Group C.

(1) See that magazine pegs are secure.

21. Gun Sights—Group D.

(1) Check harmonisation of sights.

22. Bomb Carriers—Group E.

(1) Clean lubricant from nose and tail crutches and replace with fresh lubricant as laid down in Armament Order Nos. 36/5 [Paragraph 10 (*b*)] and 36/11.

23. Bomb Aiming Equipment—Group F.

(1) When the Course Setting Bomb Sight is in constant use, carry out the detail inspection as laid down in Armament Order No. 37/4.

Note.—This inspection is to be carried out by the Unit Armament W.O. or N.C.O.

(2) Check installation of Course Setting Bomb Sight.
(3) Clean and lightly oil cross levelling bracket spigot.

24. Miscellaneous Equipment—Group G.

(1) Check harmonisation of camera gun.

Section D.—60 HOUR INSPECTION

1. Uc. Main Landing Gear.

(1) Jack up or hoist aircraft. (The aircraft may be hoisted by inserting hoisting shackles in the sockets provided on the upper surface of the wing centre section at the undercarriage lock position. See that the shackle threads are in full engagement with the socket before hoisting. **Warning.**—Do not jack up aircraft by means of the outer wing panel jacking points when the outer detachable skin of the centre section is removed.)

(2) Check the operation of the landing gear retracting mechanism by using the emergency hand pump in the cockpit or by external hydraulic power supply. (Connections are provided ahead of the fireproof bulkhead for external power supply.) Check operation of undercarriage down and retracted position latches. Inspect landing gear controls. Make any necessary adjustments or replacements.

(3) Check operation of undercarriage position indicator, and, in co-operation with the W/T operator, the electrically operated foot vibrator and horn warning devices.

(4) Check operation of landing gear emergency valve.

(5) Examine the locking device roller on the wheel axle extension for wear.

(6) Remove wheels, clean old grease from bearings with cleaning petrol, examine bearings and re-grease (only the bearings and the bearing cavities should be packed with lubricant, none should be applied to the centre of the hub.) Refer to Part I., Chapter 18, dealing with Lubrication.

(7) Inspect brake drums for cracks, looseness and scoring. Check brake shoes for alignment and brake linings for condition and loose rivets. Inspect the felt grease retainer and if grease soaked replace. Inspect the brake cylinder and joints for leaks.

(8) Replace wheels, adjust bearings and lock.

(9) Adjust the brake clearances of each wheel by means of the three adjusting screws provided, until a .010″ feeler gauge fits snugly between the brake band and the drum at the three feeler gauge openings. If it is found that the clearance is greater than .010″ after the adjusting screws have been moved to the limits, the brake must then be replaced.

(10) The operation of the excess pressure red jewel light and landing gear pressure gauge are to be checked when the engine is running.

2. Cn. Control System.

(1) Check cable control fairleads and pulleys for security of attachment and for broken, seized or misaligned pulleys.

(2) Inspect the full run of control cables to rudder and elevators, also to their respective trimming tabs for corrosion, wear, fraying and fouling. See that all cables are correctly tensioned and that all turnbuckles are in safety and locked.

3. Fu. Fuselage. Co.

(1) In both cockpits lubricate the hydraulic pump operating lever with pressure gun at points provided. Refer to Part I., Chapter 18, dealing with Lubrication.

(2) Lubricate the release mechanism of front and rear seats with anti-freezing oil.

(3) Lubricate the safety harness release mechanism of front and rear seats with anti-freezing oil.

(4) Check all accessible parts of the exterior and interior of the fuselage for bent longerons, breaks, cracks in tubing and loose members. Check for loose rivets and bolts, also the attachment bolts of wing to fuselage. Inspect for proper attachment all removable parts.

(5) Inspect the engine ring cowling screws and draw up so that the cowling is snug but not tight when the engine is cold.

4. Ta. Empennage.

(1) Support the tail of the aircraft at the jacking point just ahead of the tail wheel and remove the tail wheel. Clean hub and bearings with cleaning petrol and inspect for wear and condition, re-grease and replace. (Only bearing cavities and bearings should be packed with grease, none being applied to the centre of the hub or in the outer dust cap.)

(2) Clean and inspect tail wheel swivel mechanism and lubricate.

5. Pl. Wing Installation.

(1) Check the wing tip for corrosion and loose rivets.

(2) Inspect the interior and exterior of the outer wing sections for corrosion, loose nuts or rivets or for rivets pulling through the metal.

(3) Check wing joint bolt angle bolts, including the eight interior bolts connecting spar to end plate for security of attachment.

(4) Remove ailerons, then very carefully examine aileron hinge brackets and the spar in the vicinity of the hinge attachments for signs of looseness, cracks or other damage.

6. Ge. General.

(1) Lubricate with pressure gun all lubrication points in accordance with the instructions issued for Lubrication in Part I., Chapter 18, Section C.

7. Pe. Petrol System.

(1) Check all connections, locking, &c., of the carburettor for leakage, tightness and safety.

(2) Check hose connections for condition.

(3) Check fuel cock control for excessive "drag" or "back-lash." See that the pointer registers the cock position properly.

(4) Check bonding.

(5) Drain carburettor by removing the drain plug.

8. Ol. Oil System.

(1) Drain and flush the oil system, including tank, oil sump, cooler and pipe lines. Check for clogging of the oil cooler. Clean pressure and scavange screens. Refill with fresh oil.
(2) Check condition of hose connections.
(3) Check oil tank for leakage and security.
(4) Check all oil connections for tightness, locking and condition of packings.

9. Ig. Ignition System.

(1) Check switch and earthing wires for loose terminals and condition of wire ends.
(2) Examine the ignition harness for chafing, condition and security. Examine H.T. end assemblies at spark plugs for broken springs or wire ends and for signs of arcing.
(3) Inspect ignition booster for security of attachment and proper adjustment of engaging cable.
(4) Inspect contact breaker points for condition and freedom of oil. If necessary face points with fine stone—see Part I., Chapter 13, Section C.

Caution.—When inspecting pivotless contact breaker points it is imperative that the main spring should not be raised beyond the point giving 1/16" clearance between the movable and stationary contact points. Further tension on the main spring beyond this point may cause it to be weakened.

10. Pp. Power Plant.

(1) Inspect the engine generally for loose nuts or broken locking wires. Check all accessories for security and locking.
(2) Check the exhaust system for looseness and wear in the brackets, heater pipes and slip joints.
(3) Check the engine mounting brackets for general condition and security of attachment.
(4) Inspect the engine mounting assembly for cracks, particularly at the welds, and for tightness of the mounting bolts.

11. Co. Instruments.

(1) Compass.—Check the compass for the following conditions:—
(*a*) Clouded or discoloured liquid impairing visibility.
(*b*) Illegibility of luminous markings in the darkness.
(*c*) Illegibility of card markings due to discolouration or fading.
(*d*) Card rotation for smoothness when the aircraft is in the normal flying position.
(*e*) Leakage of fluid from bowl.
(*f*) Cracked panel glass.
(*g*) Cracked or badly dented bowl or compensating chamber.
(*h*) Broken mounting frame or lugs.
(*i*) Loose or misplaced lubber line.
(*j*) See that compass bowl is completely filled.
(2) Exhaust Gas Analyser.—Wet the wick in the vapour plug. Make sure the breather hole in the plug is open.

Note.—When an aircraft is operating in hot climates or is not in constant use it may be found necessary to wet the vapour wick more frequently.

12. Pp. Engine-Driven Generator.

(1) Inspect the generator and associated control equipment.

13. Co. Motor Generator.

(1) Remove motor generator from its mounting, remove any carbon dust and inspect the commutators for cleanliness. Inspect the brushes for wear and freedom of movement in their holders and replace worn brushes as necessary. Replace the motor generator, ensuring that the mounting and all cable connections are secure.

(2) Check the accuracy of the voltammeter, using a meter, multi-test (Y10A-5540) as the standard.

14. Co. Warning Indicator.

(1) In co-operation with the rigger, test the undercarriage vibrator and audible warning indicators for correct functioning.

15. Ge. Electrical System, General.

(1) See that all lamp glasses are clean and secure.

(2) Inspect and test the armament electrical installation.

16. Fixed Guns—Group A.

(1) Remove Vickers guns from aircraft, clean and carry out inspection as laid down in Air Force Publication 1242, Chapter 1, Paragraph 54.

17. Miscellaneous Equipment—Group G.

(1) Remove training flares and examine flare chutes.

Section E.—180 HOUR INSPECTION

1. Uc. Main Landing Gear.

(1) Jack or hoist up aircraft, remove shock absorber struts, release air, dismantle and clean. Inspect interior parts and glands for wear or damage. See Part I., Chapter 9, Section B.
(2) Remove shock absorber strut attachment fittings and examine for wear, damage and cracks. See Part I., Chapter 9, Section B.
(3) Remove hydraulic retracting cylinders, dismantle, clean and inspect. See Part I., Chapter 9, Section B.
(4) Inspect extended position latches and latch plungers for wear, damage and cracks.
(5) When re-assembling, check clearance of lug on top of the shock absorber strut and lock fitting, and, if necessary, adjust with shims to provide ample clearance for operation between the shock absorber strut and the extended position lock fitting. See Part I., Chapter 9, Section C.
(6) Remove tyres and examine rims of wheels for cracks, buckling, corrosion or chipping of the protective coating. Examine tyres internally and externally for damage.
(7) Remove master brake cylinder, dismantle and clean. Inspect glands, packings and parts for wear, damage or deterioration.
(8) Remove and dismantle operating cylinders and inspect for condition. Replace glands and dust caps if worn or deteriorated.

Note.—Do not use petrol or kerosene for cleaning of rubber glands or packings of the hydraulic system.

(9) Flush the remainder of the brake system with methylated spirit.
(10) Re-assemble and test brake system at 1,200 lbs. per square inch.
(11) Check complete operation of undercarriage controls, retracting and locking mechanism, position indicators and brakes. Make any adjustments necessary.

2. Fu. Fuselage.

(1) Nothing additional to that laid down for previous inspection periods is normally necessary.

3. Ta. Empennage.

(1) Remove tail wheel shock absorber strut, release air, dismantle and clean. Examine for worn or deteriorated glands, and replace if necessary.
(2) Remove swivel post and fork assembly, clean and examine. Repack bearings with grease. Refer to Part I., Chapter 18, dealing with Lubrication.
(3) Remove tail wheel tyre and examine for internal or external damage.
(4) Examine tail wheel for damage, corrosion and condition of protective covering. See Part I., Chapter 9, Section B.

4. Pl. Wing Installation.

(1) Remove fuel tank door and inspect and cones for galling, also splines for wear. security.

5. As. Airscrew.

(1) Remove airscrew and examine shaft and cones for galling, also splines for wear.

Note.—Subject to satisfactory operation of the airscrew the complete overhaul period is to coincide with that of the engine (420-480 hours).

6. Pp. Power Plant.

(1) Refer to The Wasp Operating Instructions Manual, R.A.A.F. Publication No. 71, for inspection instructions.

7. Ig. Ignition.

(1) Inspect the pivotless contact breaker mechanism for loose or misaligned breaker points, damaged or worn cam follower, worn or loose cams, deteriorated or damaged breaker arm cushions, weak or corroded breaker springs.

(2) Re-adjust contact points if the gaps have been reduced to .005" or less.

(3) Check the position of opening of contact breaker points with a straight edge across the step of the cam. Re-adjust if the straight edge fails to line up with the breaker housing rim marks by more than 1/8" with the points just opening.

(4) See that the cam follower felt is just slightly damp with oil—if necessary lubricate sparingly. Excessive oil may interfere with the functioning of the breaker points.

(5) Lubricate magneto at oil hole provided.

8. Pe. Petrol System.

(1) Drain petrol tanks and clean internally, examine tanks for corrosion or damage to fittings.

9. Ol. Oil System.

(1) No further inspection is necessary in addition to those previously detailed.

10. Co. Instruments.

The following inspection and checking is to be carried out:—

(1) Remove the altimeters for calibration and test.

(2) Check the calibration and examine airspeed indicators for defects.

(3) Disconnect the pipes from the altimeters, bank and turn indicator, airspeed indicators and rate of climb indicator, then blow through the pipe lines to remove dust and moisture. Re-connect the pipes and check the system for leaks.

(4) Remove the rate of climb indicator for calibration, check and test.

(5) Remove the direction indicator for test, and examine for defects.

(6) Check the calibration and examine the fuel gauges for defects.

(7) Clean the filters over the air jets of the direction indicator and artificial horizon by brushing the outer gauze with a clean tooth brush or watchmaker's brush.

(8) Check calibration and examine oil pressure and temperature gauges, also pipe lines for leaks.

(9) See that compass corrector is properly aligned and secured.

(10) Check calibration of engine speed indicator and examine for visual defects and security.

(11) Check calibration of gauge for hydraulic system.

(12) Service the exhaust gas analyser as set out in Part I., Chapter 13, Section B, Paragraph 8.

(13) Check the calibration of the manifold pressure gauge against the barometric scale of the altimeter.

Note.—Full details for the servicing of all instruments will be found in Part I., Chapter 13, and Section B of this manual.

11. Pp. Engine-Driven Generator.

(1) Inspect the 12-volt engine-driven generator and its associated control equipment.

12. Co. Motor Generator.

(1) Inspect the bearings of the motor generator for wear and lubrication; carry out the necessary functional tests.

13. Ge. Electrical System, General.

(1) Test all electrical circuits with 500-volt megger for effective insulation.

Note.—Condensers should be disconnected before making the megohm test, as they are only 100-volts working voltage.

(2) Inspect the bonding and screening throughout the aircraft for security and test the bonding with an "Aircraft Bonding Tester."

(3) Remove the covers of all distribution boxes and inspect the terminals for security and cleanliness.

(4) Disconnect all plug and socket connectors and inspect for security and cleanliness.

14. Synchronising Gear—Group B.

(1) Remove synchronising gear reservoir and thoroughly clean. Renew washers as necessary.

15. Bomb Releases—Group E.

(1) Remove the E.M. release units from the aircraft, thoroughly clean, and hand to Unit Signals Section for inspection.

(2) Type A release units are to be inspected in accordance with Armament Order No. 36/24, Paragraph 5 (*b*).

(3) Remove fusing units (if fitted) and hand to Unit Signals Section for inspection.

"WIRRAWAY"
OVERHAUL AND REPAIR
MANUAL

PART III.

REPAIRS

CHAPTER 1.—GENERAL REPAIRS

Section A.—ALUMINIUM ALLOY STRUCTURES

1. General Instructions.

On the repair of any component part of the Wirraway aircraft care should be exercised to use materials having a quality, a type and a specification at least equal to that originally used.

2. Aluminium Alloy Structures.

In the repair of any aluminium alloy structures care must be exercised to use the same type of rivets (same head and same material) as those originally used. All aluminium alloy rivets used are heat treated rivets to C.A.C. Specification CA 216 and are identified by an identification dimple on the head. These rivets do not harden to any great extent and therefore they do not require to be driven immediately after heat treatment nor is there any need for refrigeration prior to forming.

In the repair of any non-structural parts, such as junction boxes, &c., aluminium rivets may be used. These rivets have no identification dimple.

The following points should be avoided:—

(1) Quenching of aluminium alloys in hot water or air after heat treating.

(2) Insufficiently rapid transfer of alloys from heat treatment medium to the quenching tank. An elapsed time of 10 to 15 seconds will, in most cases, result in noticeably impaired corrosion resisting properties.

(3) Painting after assembly (without prior surface protection) of structures which are to be subjected to severe corrosion conditions. Whenever possible such parts should be anodised and primed before assembly.

(4) Re-heating at temperatures above that of boiling water of aluminium alloys after heat treatment, and baking of all primers above the temperature of boiling water.

(5) The use of annealed aluminium alloys in parts subjected to severe corrosive conditions.

(6) The use of paint removers which contain strong caustic compounds and of very thin paint removers which have a tendency to run into joints. Those that have a jelly-like consistency are preferable.

(7) The leaving of any trace of welding flux after welding. This is most readily prevented by washing in a warm solution of 5 per cent. sulphuric acid, rinsing in clear warm water, scrubbing accessible welds with a stiff wire brush and giving a final rinse.

Surfaces which have undergone fabrication and for assembly after application of primer coat and before application of the final colour coat should be cleaned with petrol or other de-greasing agent. Bare spots, scratches and rivet heads should be re-touched with a thin coat of primer. Fuel tanks with inaccessible interior welds should be immersed in a tank containing a warm solution of 5 per cent. sulphuric acid, carefully rising in clear warm water and afterwards dried. Wing ribs should be made from the drawings supplied, unless the rib to be replaced is only sightly damaged, in which case the rib may be utilised as a pattern.

3. Covering.

The methods as outlined below are applicable to stress skin covering and fuselage cowling only, not for engine cowling and fairing panels.

For emergency repair of a buckled or wrinkled skin panel, smooth out the panel and rivet a reinforcing plate of one gauge thicker over the panel. If possible, rivet a stiffening section to the inner side. In either case the reinforcing plate or stiffening section should extend and be riveted well beyond the damaged area. In the event of it becoming necessary to replace an entire metal panel on the outer wing panel, it will be necessary to remove the wing tip and the narrow closing strip running spanwise along the lower surface of the wing panel, just aft of the spar, to give access to the rivets securing the damaged metal panel.

To rivet the closing strip, start at the inboard end of the outer panel and finish through an access door at the outboard end of the strip. To replace a damaged panel, drill out the rivets securing the panel to the assembly, remove the panel and using it as a pattern prepare another panel. Rivet the new panel in place, making certain that it is placed relative to the surrounding panels, in the same position as that of the one removed. Repair of holes greater than one inch diameter in any direction should be accomplished by cutting the edges of the hole clean and straight. Refer to the diagram "B." Reinforce hole with plate at least one gauge thicker and of the same material as the original sheet. Thickness of reinforcing plate is contingent upon size of hole and stresses to which panel is subjected.

In repairing small cracks, drill a hole at each end of the crack to prevent it from flowing and rivet a reinforcing plate in position over the crack. See diagram "A." The reinforcing plate must be of the same material and at least one gauge thicker than the original plate.

When rivetting a reinforcing plate the rivets must be spaced in accordance with diagrams "A" and "B."

Small holes up to approximately one inch in diameter can usually be repaired by cutting the edge of the hole clean and round, and rivetting a washer of the same material and one gauge thicker to one or both sides of the hole. Refer to diagram "C."

4. Fuel and Oil Tanks.

Fuel and oil tank leakages may be repaired by welding.

Caution.—Care must be taken to see that all fumes are removed from the interior of the tank either by steaming for two hours or by thoroughly flushing with fire extinguisher fluid (Carbon Tetrachloride). Use CA.234-2 or equivalent 2S½H material for repairs. After repair of leaks, test the tank with air pressure of 1½ lbs. per sq. inch. Make certain that the interior of the tank is clean and free of welding flux before refilling with fuel or oil.

5. Repairs to Wing.

To facilitate repairs to wings, inspection holes, reinforced and fitted with cover plates, may be incorporated when required at the locations shown in diagrams 1, 2 and 3.

6. Repairs to Brake Drum.

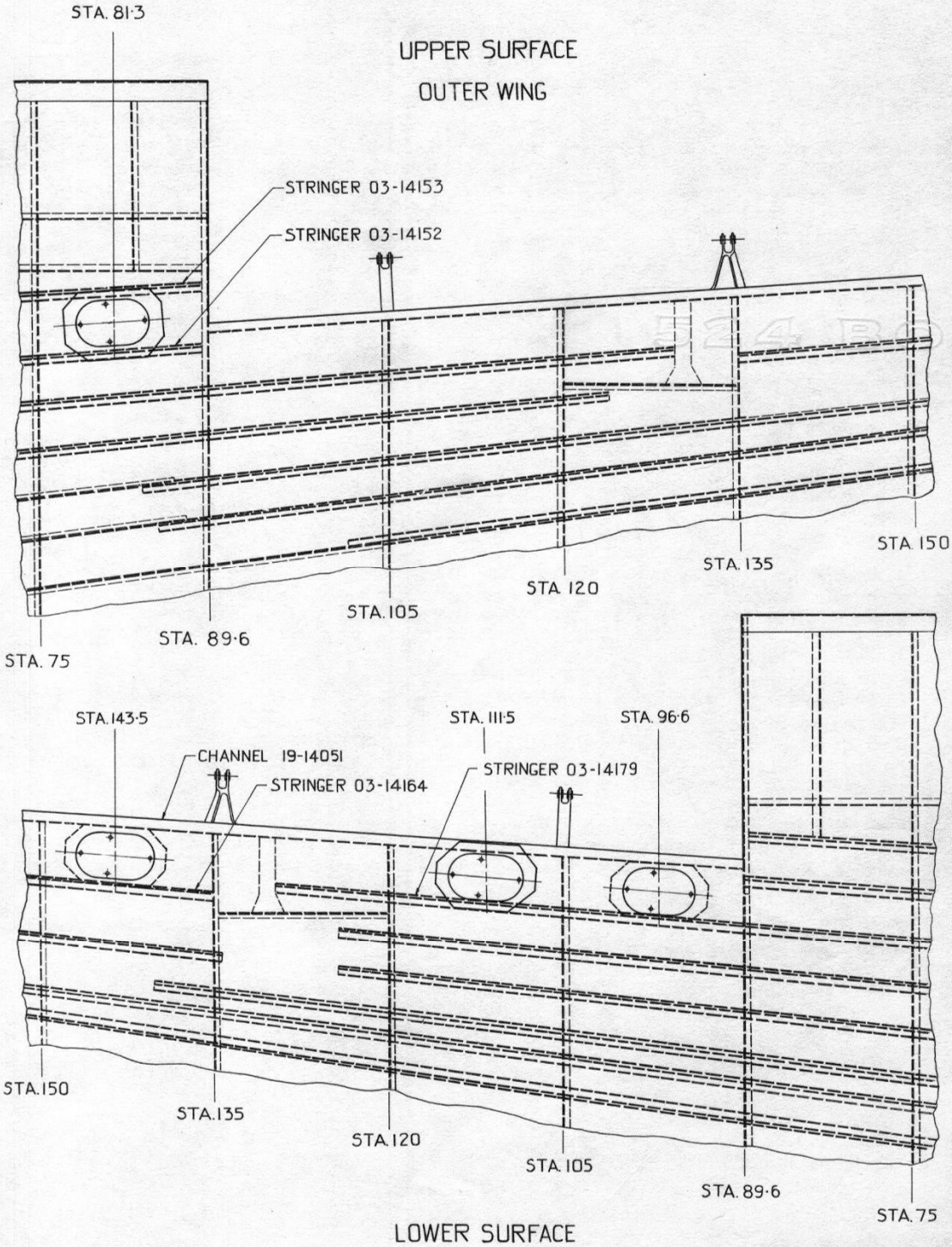
The internal diameter of the brake drum may be ground out to a maximum of .064" above the original diameter. After grinding, the inner surface must be re-chrome plated to a minimum thickness of .001 and buffed. The drum must be removed from the wheel casting before re-working.

To remove the drum, proceed as follows:—

1. Remove screws.
2. Immerse wheel in boiling water for ten minutes.
3. Remove from boiling water and run cold water on the inner surface of the brake drum for a few minutes. The drum may then be tapped or drawn out.

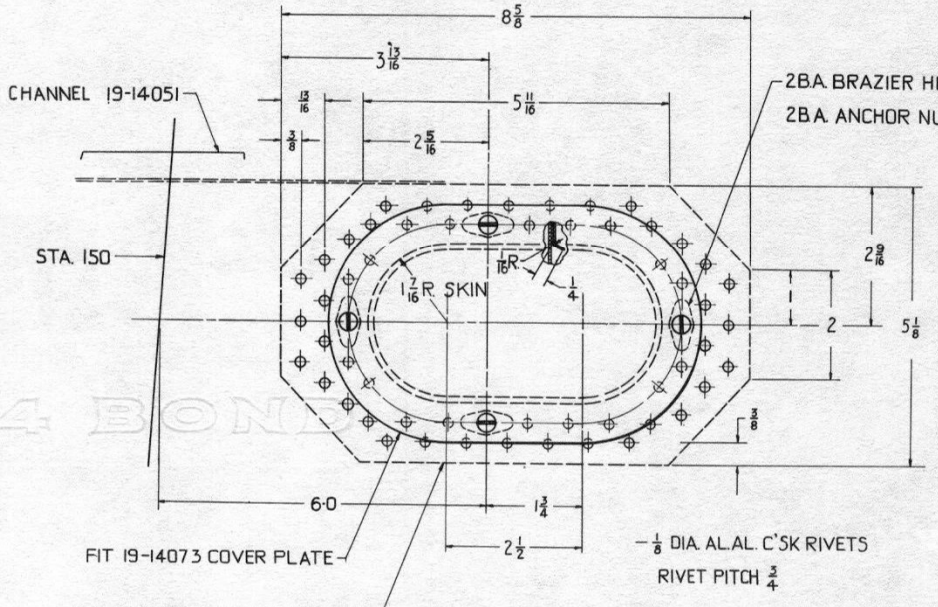
To replace drum after re-work, heat wheel casting in boiling water and chill drum, then press into position.

LOCATIONS OF HANDHOLES

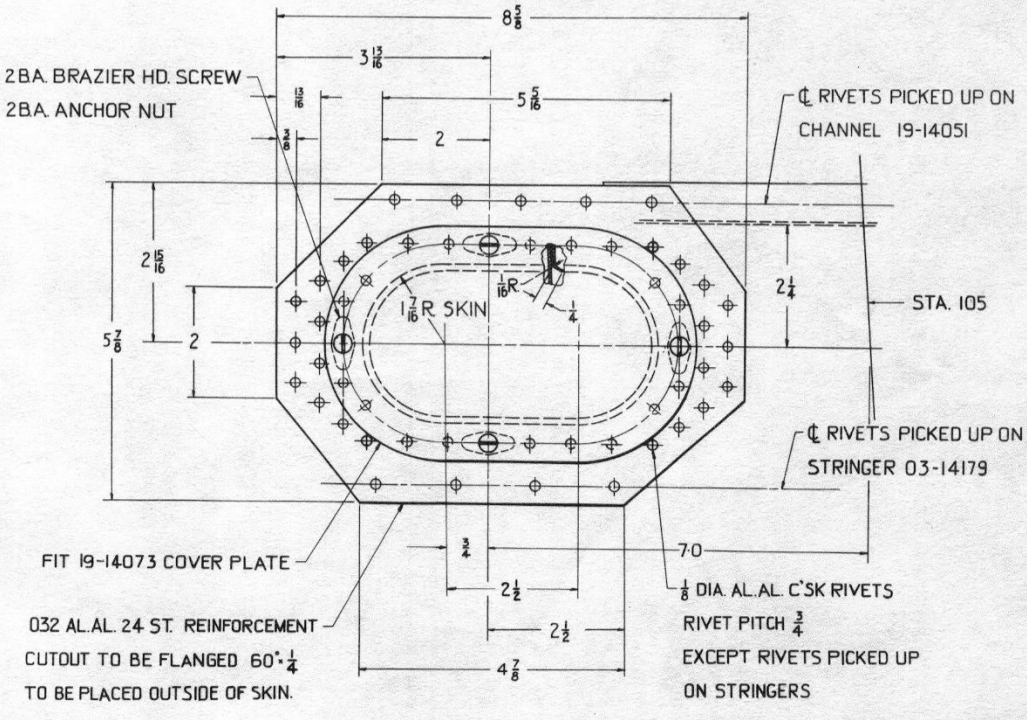


ISSUED WITH A.L. NO. 1

DETAILS OF HANDHOLES 1



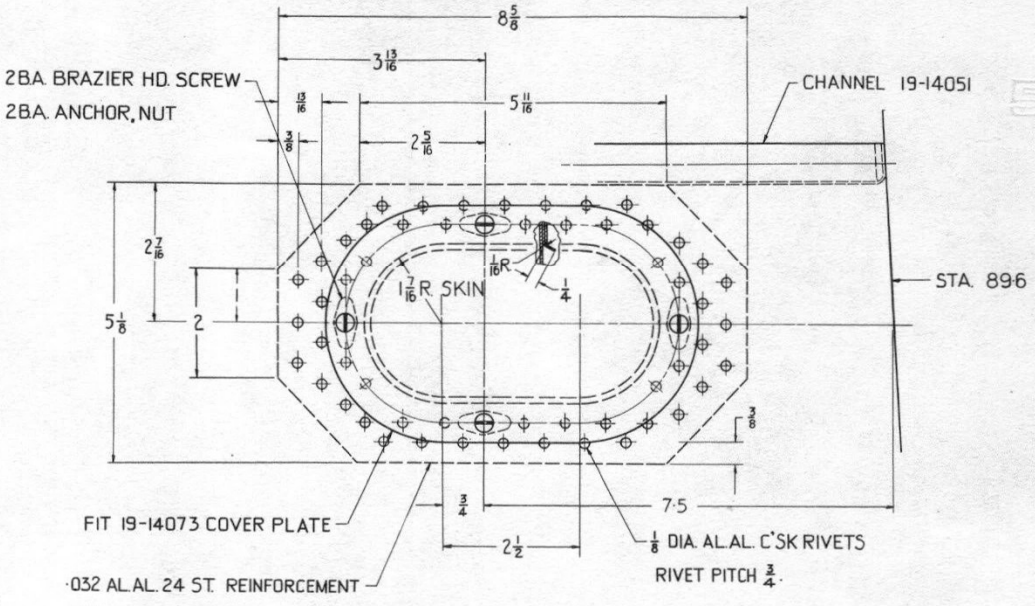
STA. 143·5
LOWER SURFACE



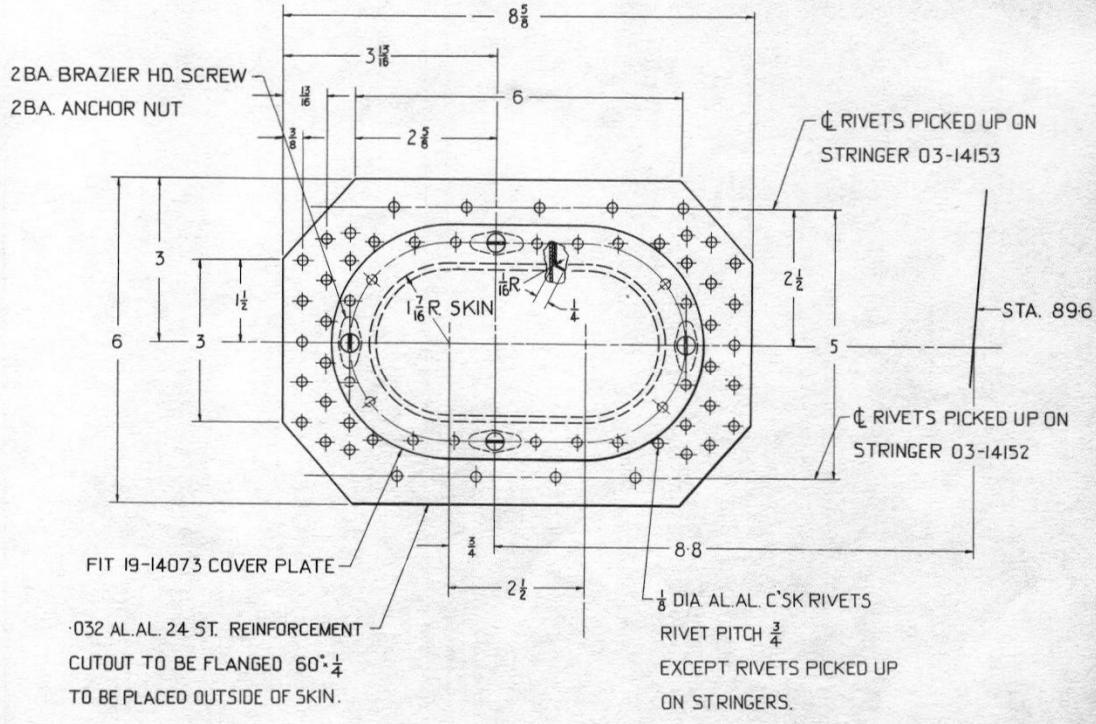
STA. 111·5
LOWER SURFACE

ISSUED WITH A.L. NO.1

DETAILS OF HANDHOLES 2



STA. 96·6
LOWER SURFACE



STA. 81·3
UPPER SURFACE

ISSUED WITH A.L. NO.1

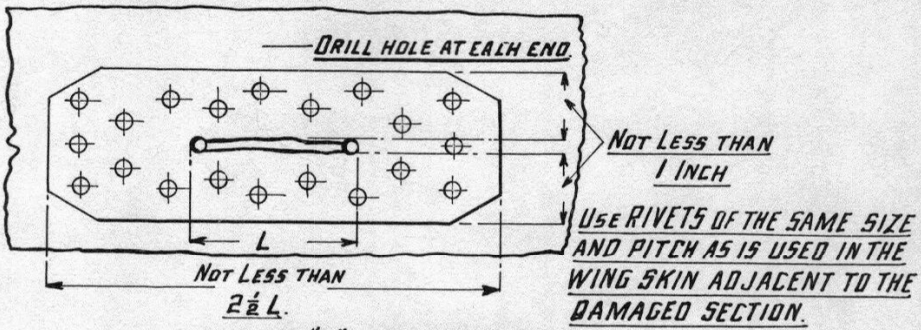


FIGURE "A" CRACK REPAIRS.

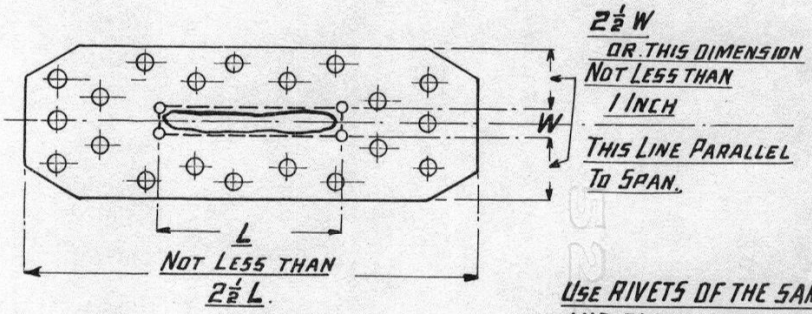


FIGURE "B" HOLE REPAIRS.
HOLE PARALLEL TO SPAN.

USE RIVETS OF THE SAME SIZE AND PITCH AS IS USED IN THE WING SKIN ADJACENT TO THE DAMAGED SECTION.

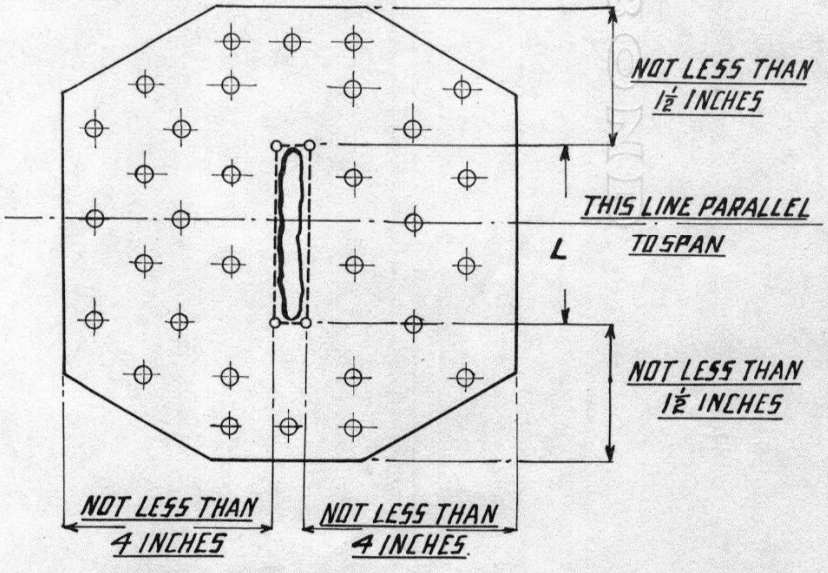


FIGURE "B" HOLE REPAIRS
HOLE ACROSS SPAN.

DWOM 4SJ

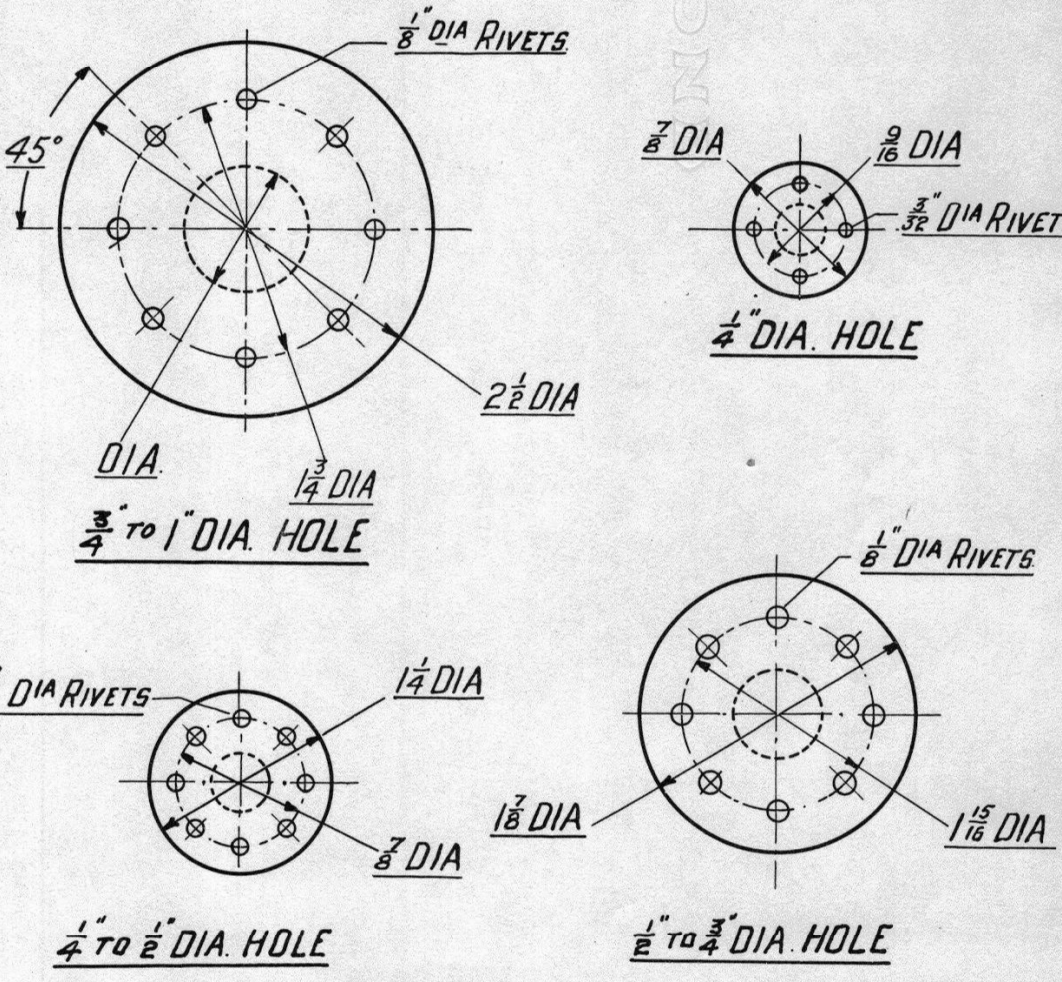


FIGURE "C" - ROUND HOLE REPAIR.

REFER TO PART III. CHAPTER I. SECTION A.

HWB

CHAPTER 2.—CABLE REPAIRS AND REPLACEMENTS

Section A.—GENERAL INSTRUCTIONS

1. General Instructions.

Aileron, elevator, rudder and tail wheel control cables should be spliced, not soldered. Use either a Clyde or Service splice, employing at least five full tucks.

Smaller cables, such as landing gear and flap mechanical position indicator and trim tab cables, may be sweat soldered into tinned terminals. Use silver solder and suitable soldering flux. Take special care to use a positive neutralising agent after the connection is completed. Wipe excess flux from terminal and coat lightly with oil. All cables are of stainless steel and need no further protection.

CHAPTER 3.—STEEL TUBING REPAIRS

Section A.—WELDING, SPLICING AND BENDING

1. Welding.

All tubing used in the construction of the fuselage and engine mount structure of the Wirraway aircraft is of Chrome-Molybdenum Steel, C.A.C. Specification CA 101. All repairs made thereto should be of the same material.

There are several precautions to be taken in the repair, by welding, of structural components:—

(1) Make no butt welded splices in structures subject to direct tension or bending stresses, unless they are amply reinforced in a manner at least equivalent to that illustrated in diagram "D."

(2) Welded joints should not be made to appear workmanlike by filing or filling of holes with molten welding wire, solder, brazing metal or other filler.

(3) Make no oxy-acetylene welds over a failure in an electric weld. The defective cast structure of the electric weld should be first chipped free and the joint re-welded by means of the oxy-acetylene. Electric welding only is used on engine attachment lugs, which are then oxy-acetylene welded to tubular engine mount ring.

(4) Before welding, thoroughly clean all components by sandpapering or by scrubbing with a wire brush.

(5) In the repair of any steel tube structure of the aircraft, use an oxy-acetylene welding torch and a mild steel welding wire.

(6) The size of the tip, the amount of heat applied and the size of the welding wire used are contingent upon the wall thickness of the tube. Recommended sizes for the tips and welding wire to be used in repair of tubes with various wall thicknesses are outlined below.

Wall Thickness of Tube	Welding Torch Tip	Welding Wire Size
Less than .031	No. 1	1/16" Dia.
,, .031	No. 2	1/16" ,,
,, .062	No. 3	1/16" ,,
,, .093	No. 4	1/16" ,,
,, .125	No. 5	1/8" ,,

2. Splicing.

Where practicable all splices made in tubing should be of the diagonal or of the "fish mouth" form of cut. This form prevents the localisation of heating at one point. The "fish mouth" splice should be used in preference to the straight diagonal type, as more welded area is obtained along the same lineal distance. In either case the splice should be reinforced as in diagrams "E" and "F." The length of the diagonal or "fish mouth" cut should preferably be at least equal to two outside diameters of the tube and, in no case, less than one diameter. The ends of the "fish mouth" cut should not be appreciably rounded or flattened. When replacing a length of tubing by splicing at either end, the splices should be as close as possible to the supported ends, in as much as the centre portion of the tube is under the greatest stress on application of the load.

3. Bending.

Minor mis-alignment of the tubular structure, due to stresses imposed by welding, can be remedied by applying heat to the outside at the point of maximum bend. The contraction of the metal on removal of the heat will force the tube into alignment. Structures incapable of being aligned by the above method, can be straightned by utilising three wooden blocks which have been machined to fit on the outside of the tube; a large "C" clamp and a short wooden beam. Arrange the wooden blocks, clamp and beam as shown in the diagram at "G," and tighten clamp until the desired result is obtained. Tubes which have been bent excessively, however, must be replaced. The original alignment of the structure must be maintained. This can be done by measuring the distance between the points of corresponding members that have not been distorted and by reference to drawings 01-31150 and 01-31151 if available.

STEEL TUBING REPAIR.

A. OUTER DIAMETER OF ORIGINAL TUBE.
B. OUTER DIAMETER OF REPLACEMENT TUBE [NOT LESS THAN A]
B' WALL THICKNESS OF REPLACEMENT TUBE [NOT LESS THAN A']
A' WALL THICKNESS OF ORIGINAL TUBE.
C' WALL THICKNESS OF INSIDE REINFORCEMENT
= A' OR ONE GAUGE LESS THAN A'.
D - RIVET - ¼ DIAMETER OF ORIGINAL TUBE. [MAX DIAMETER-¼ INCH]

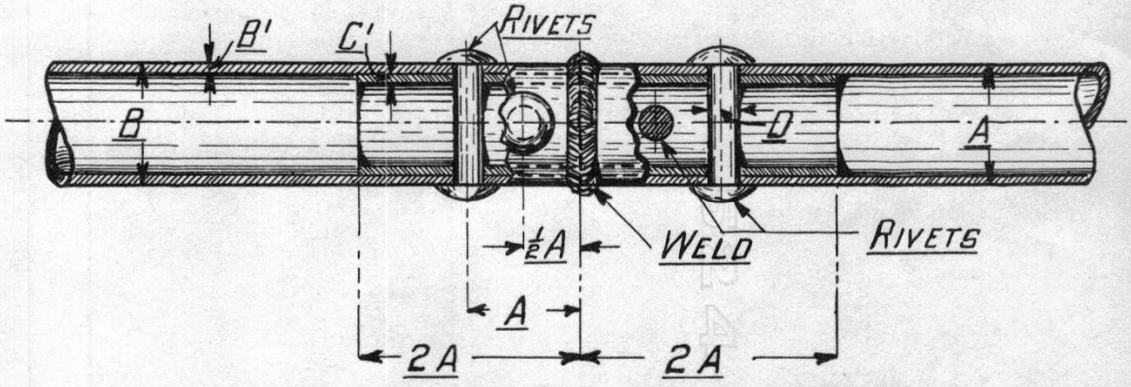


FIGURE "D" - BUTT WELD.

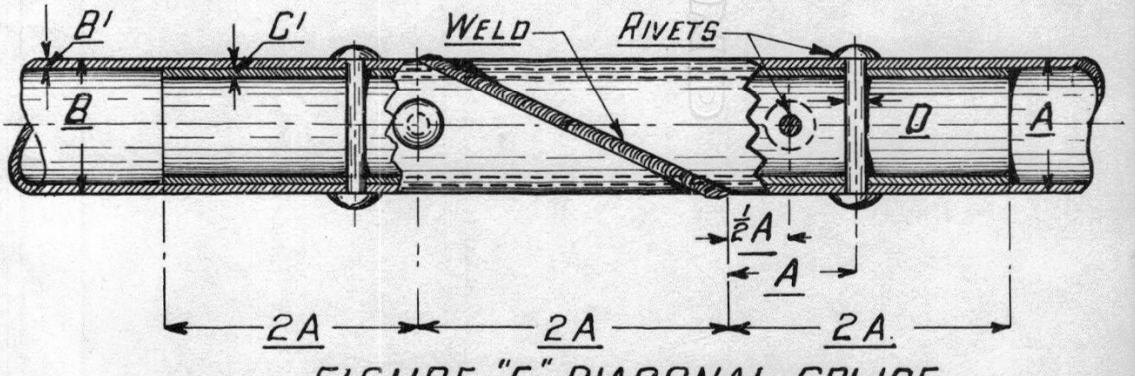


FIGURE "E" DIAGONAL SPLICE.

REFER TO PART III. CHAPTER 3 SECTION A.

END OF SECTION

STEEL TUBING REPAIR

FOR FORMULAE SEE FIGURE "D"

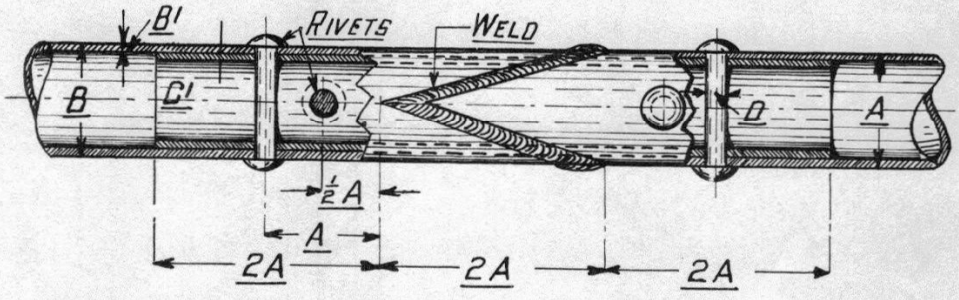


FIGURE "F" - FISH MOUTH SPLICE.

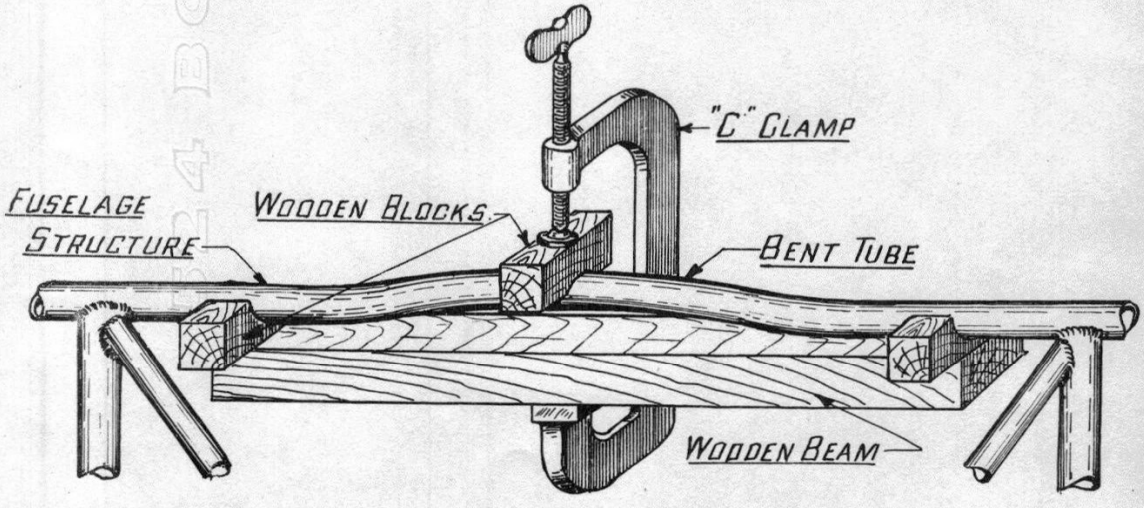


FIGURE "G" - JIG FOR STRAIGHTENING BENT TUBES

REFER TO PART III. CHAPTER 3 SECTION A.

HWB.

CHAPTER 4.—PIPE REPAIRS AND REPLACEMENTS

Section A.—JOINTS

1. Pipe Joints—General.

Three types of joints are used at pipe connections. The beaded type is only used in the oil system when hose connections are utilised. Metal liners are used at flexible hose connections of the fuel system. All other joints are of the flared type, to be used in conjunction with pipe connector fittings. Grip dies and flaring or beading tools are required to form flared and beaded type joints. Refer to diagrams.

2. Flared Joints.

The flared type grip die, consists of two steel blocks placed side by side and held in alignment by three steel pilot pins pressed into one block and allowed to extend into corresponding holes in the other. A number of countersunk holes are drilled along its length, the holes varying in size to correspond to the pipe sizes used. The grip die should be designed to grip the pipes tightly without damaging them. The flaring tool for this type of joint consists of punches, tapered at one end to correspond to the angles of the countersunk holes in the grip die.

Note.—It is advisable when using aluminium alloy tubing to make the grip die of hardwood, in place of steel to avoid cutting the underside of the flare.

To flare a pipe end, grip pipe in die, allowing the end of the pipe to project approximately one outside diameter of the pipe, and secure in the vice. Place the tapered end of the punch in the end of the pipe and tap lightly with a hammer until the walls of the pipe assume the shape of the countersunk hole in the die. See diagram.

3. Beaded Joints.

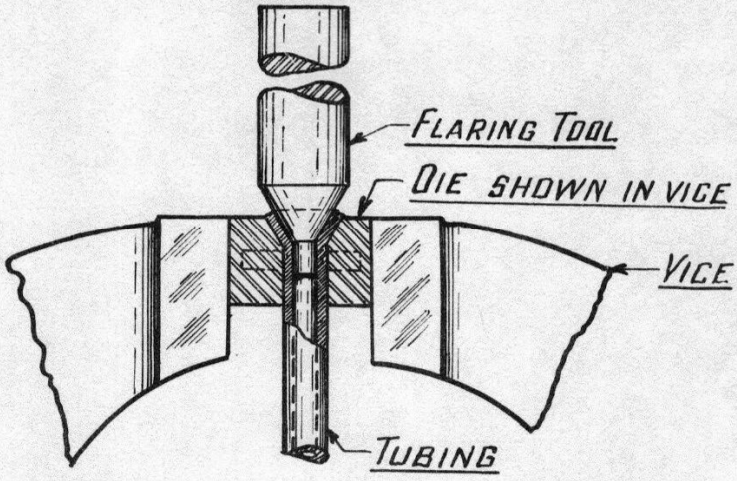
When making a beaded type joint, a separate grip die should be used for each size of pipe. It consists of two steel blocks placed side by side and held in alignment by locating pins. A hole equal to the outside diameter of the pipe and chamfered slightly around the top is drilled down the centre of the die. The beading tool consists of a cylinderical rod with a hole equal to the diameter of the pipe drilled approximately 1/4" deep in one end at the centre. A hole equal to the inside diameter of the pipe is drilled through the centre of the rod. A steel pilot pin is driven into this hole, and permitted to extend approximately one inch below the tool.

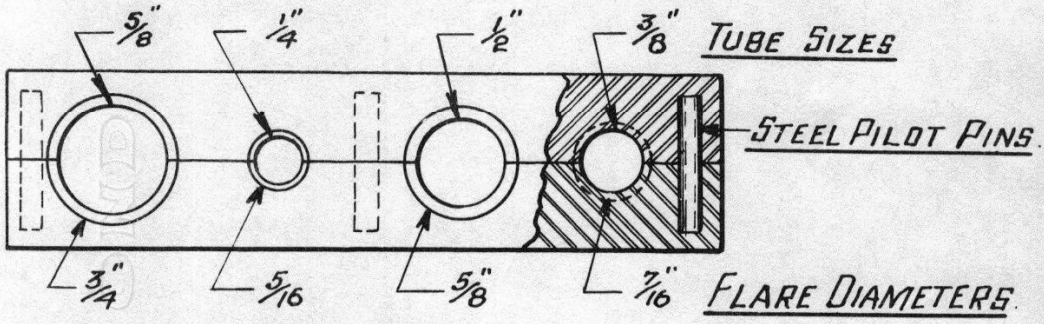
To make a beaded joint, clamp the pipe in the die, allowing end of pipe to project about one and one-half diameters. Secure die in vyce. Place the pilot pin of the beading tool into the end of the pipe and lightly tap until the required bead is formed. Refer to the diagram illustrating this die.

An alternative method of forming beaded ends is shown in figure 4. This tool consists of two separate parts—a beading tool to shape the inside of the pipe, and a forming tool to form the outside of the pipe to match the bead.

To make a bead the beading tool is held in the vice and the pipe pushed on vertically. The forming tool is held horizontally against the pipe in line with the inside bead and its end struck lightly with a hammer, at the same time the pipe is rotated. The bead is quickly formed and the pipe lifted off. A little pressure is required to free the pipe as its end has closed in around the bead.

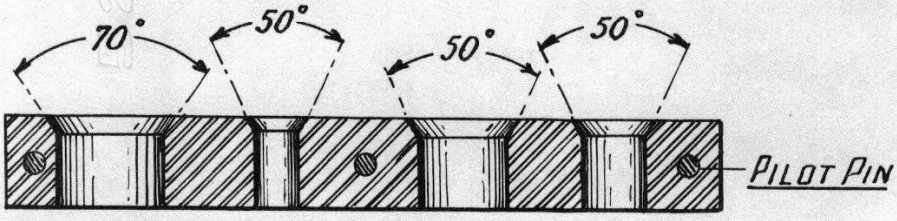
PIPE FLARING JIG





GRIP DIE

TOP VIEW.



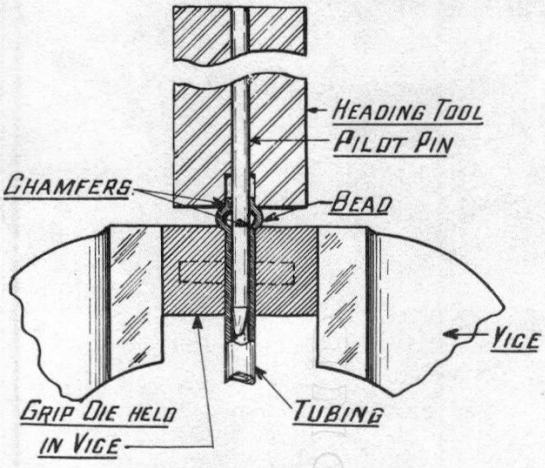
SECTIONAL VIEW OF ONE HALF OF BLOCK.

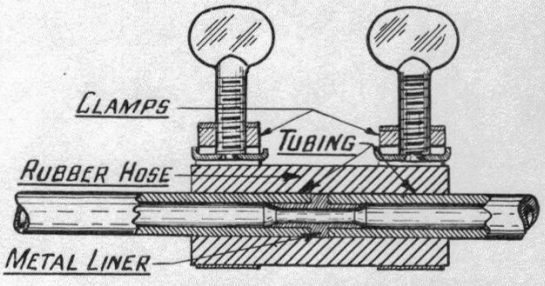
NOTE. USE HARDWOOD BLOCK FOR ALUMINIUM ALLOY TUBING.

REFER TO CHAPTER 4 SECTION 'A'

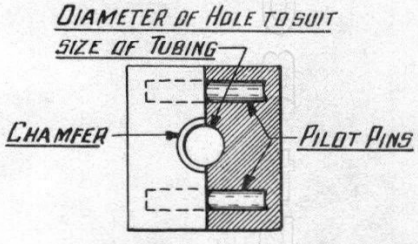
HW

PIPE BEADING JIG

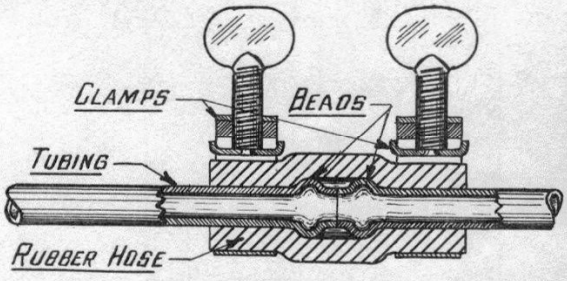




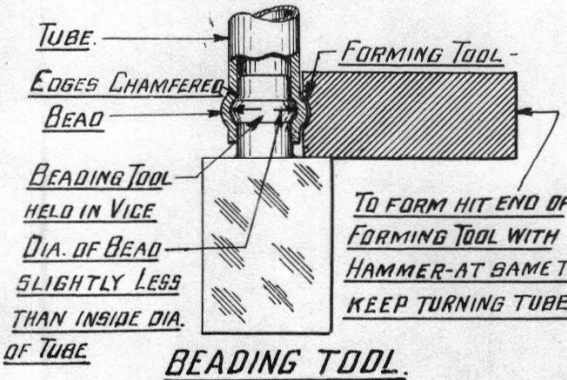
HOSE JOINT- FIGURE 2.



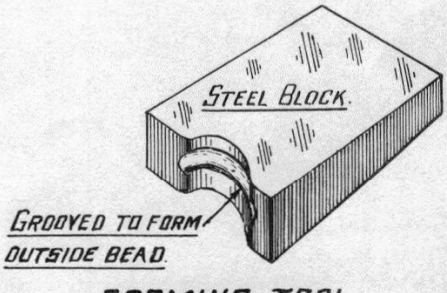
GRIP DIE. - FIGURE 1.



HOSE JOINT - FIGURE 3.



BEADING TOOL.



FORMING TOOL

FIGURE 4.

H.W.B.

CHAPTER 5.—BOLTS—HIGH TENSILE STEEL

Section A.—HIGH TENSILE STEEL BOLTS

1. General Information.

The use of high tensile bolts is general throughout the airframe. These bolts have a shorter length of thread than the corresponding AGS high tensile bolts because of the necessity of avoiding the threaded part being stressed in bearing.

2. Identification.

The bolts are made to C.A.C. standards and reference may be made to them as indicated in the following examples:—

B201—E16 Indicates a high tensile hexagon head bolt 1/4" BSF size, 1.6 inches long.

B203—C10 Indicates a high tensile brazier head bolt 2BA size, 1.0 inches long.

High tensile hexagon head bolts may be identified by a groove around the hexagon corners and a relief turned on the under side of the head.

High tensile brazier head bolts have mushroom heads with screw-driver slot and may be identified by a groove turned on the face of the head.

3. Replacement of Bolts.

Replacement of bolts should be made by bolts having the correct thread length, and it is, therefore, advisable to make replacements by using B201 or B203 bolts only. Should B201 bolts not be available, AGS high tensile bolts may be re-worked in accordance with B201 standards by turning the necessary relief under the head and cutting down bolts, running the thread down where required, to the proportions of the B201 standards. In doing this, particular care must be taken to chamfer off the bolt end and remove the sharp ends of the thread so that the fibre washer in the elastic stop nuts, in general use on the aircraft, is not rendered unserviceable.

The correct length of bolt should always be used and excess thread length projecting beyond the elastic stop nuts MUST NOT be cut off as the sharp edges remaining will destroy the fibre washer in the nut the next time it is taken off.

CHAPTER 6.—AIRCRAFT MATERIAL SPECIFICATIONS

Section A.—FERROUS ALLOYS

The following is a list of the C.A. Specifications for Aircraft Materials and their Approved Substitutes:—

		APPROVED SUBSTITUTE MATERIALS
CA 101	Chrome-Molybdenum Steel Tube - -	British Spec. D.T.D. 178 U.S. Navy Spec. 44 T 18 U.S. Air Corps Spec. 57-180-2
CA 102	Chrome-Molybdenum Steel Forgings - -	U.S. Navy Spec. 46 S 23 U.S. Air Corps Spec. 10083
CA 103	Chrome-Molybdenum Steel Bar - -	U.S. Navy Spec. 46 S 23 U.S. Air Corps Spec. 57-107-19
CA 104	Chrome-Molybdenum Steel Sheet - -	U.S. Navy Spec. 47 S 14 U.S. Air Corps Spec. 57-136-8
CA 107	3½ % Nickel Steel Bar - - - -	U.S. Navy Spec. 46 S 21 U.S. Air Corps Spec. 57-107-17
CA 108	Welding Wire—Corrosion Resistant Steels -	
CA 109	Free Cutting Steel Bar - - - -	
CA 110	3½ % Nickel Case Hardening Steel Bar -	British Spec. 3 S 15
CA 111	Corrosion Resistant Steel Tube - - -	
CA 113	Corrosion Resistant Steel Bar - - -	British Spec. S 80
CA 115	Corrosion Resistant Steel Bar—Free Machining	British Spec. S 61
CA 120	5 % Nickel Case Hardening Steel - -	
CA 121	18-8 Corrosion Resistant Steel Tube - -	U.S. Navy Spec. 44 T 25 U.S. Air Corps Spec. 57-180-3
CA 122	18-8 Corrosion Resistant Steel Forgings -	
CA 123	18-8 Corrosion Resistant Steel Sheet and Bar	U.S. Navy Spec. 46 S 18 U.S. Air Corps Spec. 10079
CA 124	18-8 Corrosion Resistant Steel Sheet and Strip	U.S. Navy Spec. 47 S 19 U.S. Air Corps Spec. 57-136-9B
CA 131	Low Carbon Steel Tubes - - -	

Section B.—ALUMINIUM ALLOYS

The following is a list of the C.A. Specifications for Aircraft Materials and their Approved Substitutes:—

		ALCOA REF.	APPROVED SUBSTITUTE MATERIALS
1. CASTINGS.			
CA 201	Aluminium Alloy Sand or Die Castings - - -	195-T4	U.S. Navy Spec. 46 A 1 U.S. Air Corps Spec. 57-72-5
CA 202	Aluminium Silicon Alloy Sand Castings - -	356-T6	U.S. Air Corps Spec. 11308-A
CA 203	Aluminium Alloy Castings (suitable for welding) -		U.S. Air Corps Spec. 57-72-1
CA 206	Aluminium Alloy Die Castings - - - - -		B.S.S. 3 L 5
CA 207	Aluminium Silicon Alloy Die Castings - - -		
2. WROUGHT ALLOYS.			
CA 210	Aluminium Alloy Sheet and Strip (Alum. covered) -	24S (Alclad)	U.S. Navy Spec. 47 A 8 U.S. Air Corps Spec. 11067 British Spec. D.T.D. 275
CA 210-2	Annealed		
CA 210-3	Heat treated		
CA 210-4	Heat treated and rolled		
CA 211	Aluminium Alloy Tube -	24S	British Spec. D.T.D. 273 U.S. Navy Spec. 44 T 28 U.S. Air Corps Spec. 10235
CA 211-2	Annealed		
CA 211-3	Heat treated		
CA 212	Aluminium Alloy Forgings -	14S	U.S. Navy Spec. M. 277 U.S. Air Corps Spec. 57-153 Grade 5 Federal Spec. QQ-A-367
CA 212-2	Annealed		
CA 212-3	Heat treated		
CA 213	Aluminium Alloy Bar - -	24S	U.S. Navy Spec. 46 A 9 U.S. Air Corps Spec. 11071
CA 213-2	Annealed		
CA 213-3	Heat treated		
CA 214	Aluminium Alloy Sheet and Strip - - - - -	24S	U.S. Navy Spec. 47 A 10 U.S. Air Corps Spec. 11066
CA 214-2	Annealed		
CA 214-3	Heat treated		
CA 214-4	Heat treated and rolled		
CA 215	Aluminium Alloy Sheet and Strip - - - - -	52S	U.S. Navy Spec. 47 A 11 U.S. Air Corps Spec. 11072
CA 215-1	Soft		
CA 215-2	1/2-Hard		
CA 215-3	3/4-Hard		
CA 215-4	Hard		

Section B.—ALUMINIUM ALLOYS *(Continued)*

2. WROUGHT ALLOYS—*(Continued)*.		ALCOA REF.	APPROVED SUBSTITUTE MATERIALS
CA 216	Aluminium Alloy Wire and Rivets - - - -	A 17ST	British Spec. D.T.D. 327
CA 217	Aluminium Welding Wire -		
CA 218	Aluminium Alloy (5 % Silicon) Welding Wire -		
CA 219	Aluminium Alloy Bars and Extruded Shapes - -	17S	British Spec. 6 L 1 U.S. Navy Spec. 46 A 4 U.S. Federal Spec. QQ-A-351
CA 219-2	Annealed		
CA 219-3	Heat treated		
CA 220	Aluminium Wire and Rivets -	2S	
CA 221	Aluminium Bars and Extrusions - - - -	2S	British Spec. L 34 U.S. Navy Spec. 46 A 3 U.S. Federal Spec. QQ-A-411
CA 221-1	Soft		
CA 221-2	1/2-Hard		
CA 221-3	3/4-Hard		
CA 221-4	Hard		
CA 223	Aluminium Tube - -	2S	British Spec. 4 T 9 U.S. Navy Spec. 44 T 19 U.S. Federal Spec. WW-T-783
CA 223-1	Soft		
CA 223-2	1/2-Hard		
CA 223-3	3/4-Hard		
CA 223-4	Hard		
CA 224	Aluminium Sheet and Strip -	2S	British Spec. 2 L 16 U.S. Navy Spec. 47 A 2 U.S. Air Corps Spec. 57-151-1
CA 224-1	Soft		
CA 224-2	1/2-Hard		
CA 224-3	3/4-Hard		
CA 224-4	Hard		
CA 225	Aluminium Alloy Tubes -	52S	U.S. Navy Spec. 44 T 32 U.S. Air Corps Spec. 57-187-3
CA 225-1	Soft		
CA 225-2	1/2-Hard		
CA 225-3	3/4-Hard		
CA 225-4	Hard		
CA 226	Aluminium Alloy Forgings and Bars and Billets for Forging - - -	17S	U.S. Navy Spec. 46 A 7a U.S. Air Corps Spec. 57-753 Gr. 1 U.S. Federal Spec. QQ-A-367
CA 227	Aluminium Alloy Sheet and Strip - - - -	17S	U.S. Navy Spec. 47 A 3 U.S. Federal Spec. QQ-A-353
CA 227-2	Annealed		
CA 227-3	Heat treated		
CA 227-4	Heat treated and rolled		

Section B.—ALUMINIUM ALLOYS *(Continued)*

2. WROUGHT ALLOYS—(*Continued*).		ALCOA REF.	APPROVED SUBSTITUTE MATERIALS
CA 231	Aluminium-Manganese Alloy Tubes - - - -	3S	U.S. Navy Spec. 44 T 20 U.S. Federal Spec. WW-T-788
CA 231-1	Soft		
CA 231-2	1/2-Hard		
CA 231-3	3/4-Hard		
CA 231-4	Hard		
CA 233	Aluminium-Manganese Alloy Bars and Extrusions -	3S	U.S. Navy Spec. 46 A 6 U.S. Federal Spec. QQ-A-356
CA 233-1	Soft		
CA 233-2	1/2-Hard		
CA 233-3	3/4-Hard		
CA 233-4	Hard		
CA 234	Aluminium-Manganese Alloy Sheet and Strip - -	3S	U.S. Navy Spec. 47 A 4 U.S. Federal Spec. QQ-A-359
CA 234-1	Soft		
CA 234-2	1/2-Hard		
CA 234-3	3/4-Hard		
CA 234-4	Hard		

Section C.—COPPER ALLOYS

The following is a list of the C.A. Specifications for Aircraft Materials and their Approved Substitutes:—

		APPROVED SUBSTITUTE MATERIALS
1. CASTINGS.		
CA 251	Phosphor Bronze Castings - - -	B.S. 2B8
CA 253	Aluminium Bronze Castings - - -	
CA 259	Gun Metal Castings - - - -	
2. WROUGHT ALLOYS.		
CA 252	Brass Bar Free Cutting - - - -	B.S. B13 U.S. Federal Spec. QQ-B-611
CA 254	Aluminium Bronze Bars - - - -	U.S. Federal Spec. QQ-B-746
CA 261	Brass Tube - - - - - -	
CA 264	Brass Sheet - - - - - -	
CA 271	Copper Tube - - - - -	U.S. Federal Spec. WW-T-799
CA 274	Copper Sheet - - - - -	

Section D.—MAGNESIUM ALLOYS

The following is a list of the C.A. Specifications for Aircraft Materials and their Approved Substitutes:—

1. CASTINGS.		APPROVED SUBSTITUTE MATERIALS
CA 291	Magnesium Alloy Sand or Die Castings (for general use) - - - - - -	ASTM. B80-38T Dow Chem. Co. H Amer. Magnesium Corp. AM. 265-T4
CA 292	Magnesium Alloy Sand or Die Castings (for shock resistance) - - - - -	Electron Alloy A8 (H.T.)
CA 293	Magnesium Alloy Sand or Die Castings (for pressure resistance) - - - - -	Electron Alloy AZ91 (H.T.)

Section E.—STANDARD MANUFACTURED PARTS

1. Standard Manufactured Parts.

The following are the Standard Manufactured Parts used in the aircraft:—

CA 301 High Tensile Bolts and Nuts.

Section F.–FABRICS

1. Fabrics.

The following Fabrics are used in the construction of the aircraft:—

CA 341 Cotton Fabric.

CA 342 Serrated Edge Cotton Tape.

Section G.—FINISHES

1. Finishes.

The following Finishes are used in the construction of the aircraft:—

CA 351 Zinc Chromate Primer Paint.

CA 252 Clear Nitro Cellulose Dope.

CA 353 Clear Nitro Cellulose Vehicle for Aluminium Covering.

CA 354 Clear Nitro Cellulose Vehicle for Aluminium Finish.

CA 355 Aluminium Paste.

Section H.—MISCELLANEOUS SUPPLIES, ELECTRICAL, Etc.

1. Miscellaneous Supplies, Electrical, &c.

The following Miscellaneous Supplies, Electrical, &c., are used on the aircraft:—

CA 401 Flexible Metal Conduit.

CA 402 Accumulators.

CA 411 Hydraulic Fluid.

Section 1.—TYRES AND TUBES

1. Tyres and Tubes.

The following Tyres and Tubes are used on the aircraft:—

CA 450 Smooth Contour Tyres.

CA 451 Inner Tube for Smooth Contour Tyres.

CA 452 Tailwheel Tyres, Steamline.

CA 453 Inner Tube for Steamline Tailwheel Tyres.

Section J.—RUBBER AND PLASTICS

1. Rubber and Plastics.

The following Rubber and Plastics are used in the construction of the aircraft:—

CA 469 Moulded Cable Pulleys.
CA 470 Tubing, Rubber.
CA 471 Rubber Sheet, Synthetic.
CA 472 Hose, Oil Resistant.
CA 473 Hose, Petrol Resistant.
CA 474 Rubber Mouldings.
CA 475 Synthetic Rubber Mouldings, Petrol and Oil Resistant.
CA 476 Rubber Sheet.
CA 477 Rubber Extrusions and Shapes.