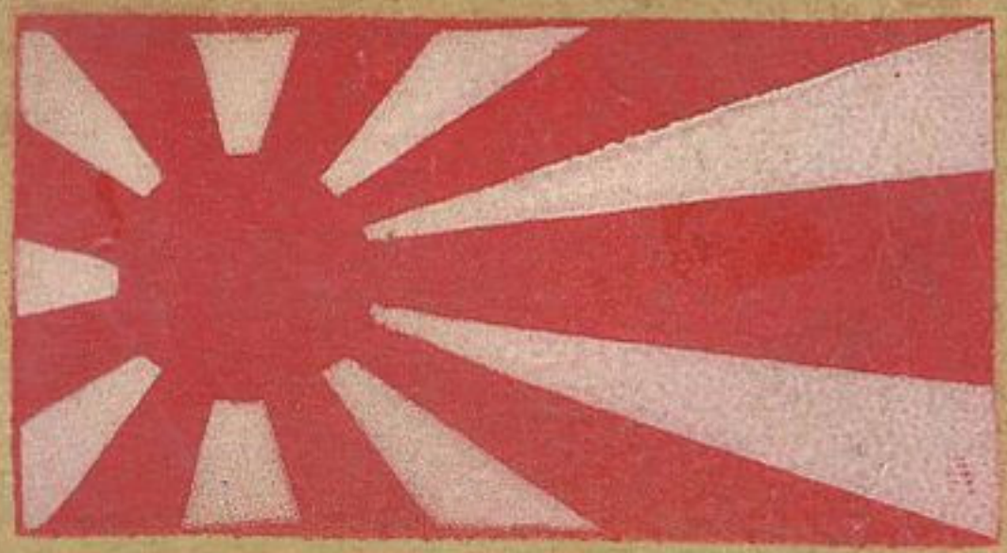

FRANK I
T2-301





TECHNICAL MANUAL

THE INFORMATION CONTAINED IN THIS MANUAL WAS COLLECTED AND COMPILED AT MIDDLETOWN AIR TECHNICAL SERVICE COMMAND BY INTELLIGENCE DIVISION (T-2) AIR MATERIEL COMMAND, WRIGHT FIELD, DAYTON, OHIO.

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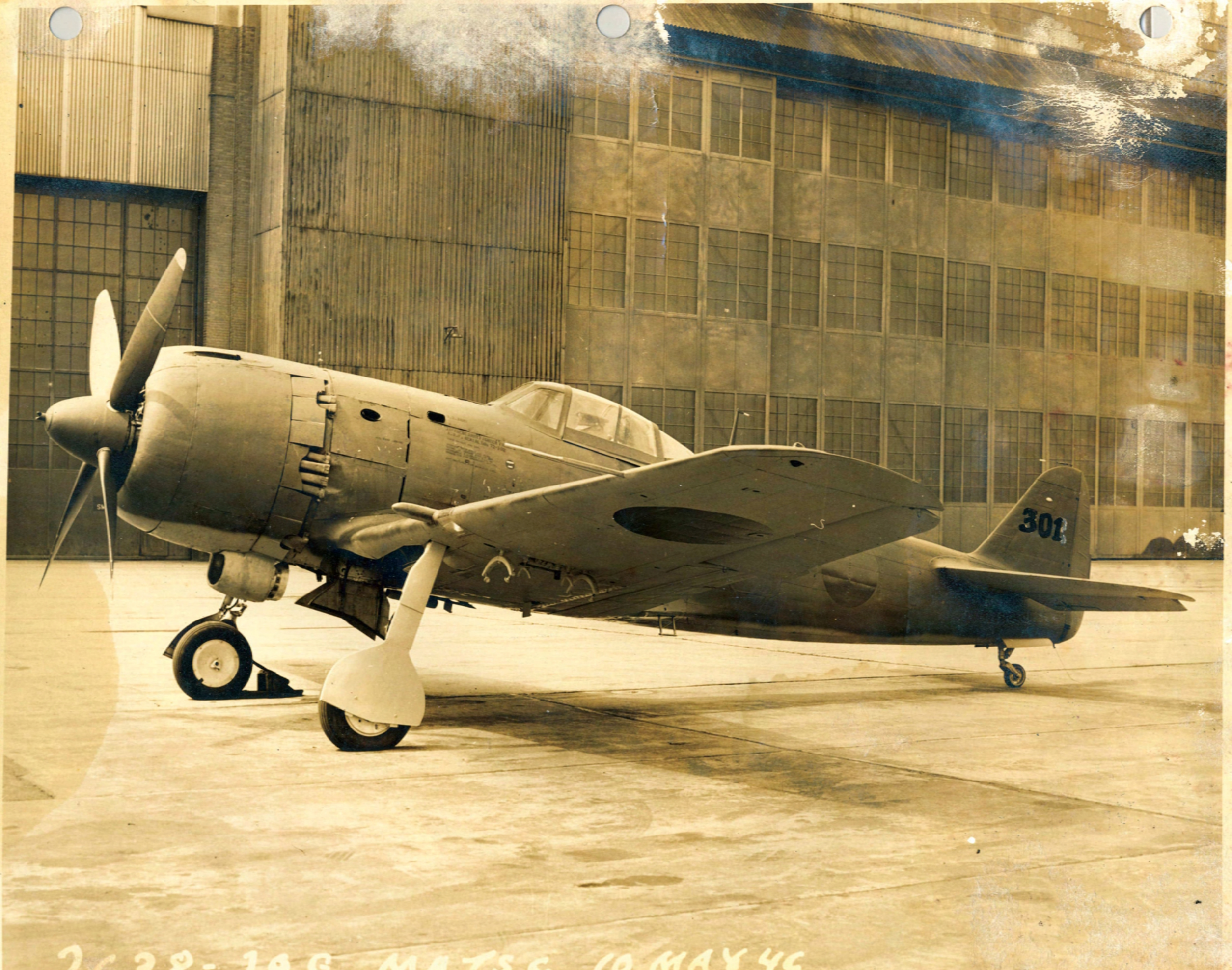

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Left Front, Three Quarter View of the Frank I

INTRODUCTION

In the Frank I T2-301, Model - Type 99 Nakajima engine, serial number 123041, as well as all component parts and accessories were completely disassembled, repaired, reassembled and tested by the Maintenance Division of Middletown Air Technical Service Command, Olmsted Field, Middletown, Pa.

Except where units or assemblies were completely replaced by American installations as indicated in Part I of this manual, the original parts were repaired, secured from spare aircraft or reproduced by the Maintenance Division of Middletown Air Technical Service Command and installed, using fits, clearances and arrangements originally used in the aircraft, where available. When not available, tolerances were established which were arrived at by compromising the tolerances recommended by manufacturers of similar American built equipment.

In comparing the entire Japanese Frank I to American aircraft of similar type, there are many interesting features of aircraft design.

The Frank I T2-301, Model - Type 99 is comparable to our R-2800 Pratt & Whitney engine, except that it uses a carburetor bowl prime and carburetor priming system instead of priming the cylinders.

The power of the Model - Type 99 engine in the Frank I is increased by using the injection of 50% water and 50% methanol as a supplement to the ninety-two (92) octane gasoline, which is automatically controlled with the manifold pressure of the engine. This injection allows the use of lower octane fuel, but still maintains the necessary power, thereby creating more economy in the operation of the engine.

The engine magnetos employ the distributors separate of the magnetos which are mounted on the front case of the engine and the magnetos on the rear accessory case.

A two wire electrical system is used throughout the airplane because of the airplane construction; using plywood and non-conductive materials and causing a poor ground. The electrical equipment such as relays, solenoids, control boxes, etc. are of fine workmanship and material, indicating that more handwork was involved and less production tendencies. All

wires are shielded or in metal conduits and are marked very clear to facilitate continuity check, and trouble shooting of the various electrical systems. All bonding connections, on all moving parts, are bonded in more detail, proving that either the radio reception was clearer or that trouble was encountered in the reception of the Japanese installed radio.

The tires and tubes are of the high pressure type and the Japanese tend to use high pressure equipment on all their aircraft. The construction is pure rubber and good anti-slippage design on the beading of the tire. Although the wheel castings are made of soft material and look similar to AAF wheels, they are approximately three times heavier.

Comparing the general aircraft aluminum alloy metals, the Japanese metal is less ductile or more brittle. The use of soft aluminum alloy is employed on most surfaces using extreme bends and curves and left in its natural state. A tendency to use lighter gauge material is also evident in the Japanese aircraft construction, decreasing the final weight of the airplane, and decreasing also the weight per horsepower ratio. The aluminum alloy of the Japanese is more corrosive resistant and does not employ a pure aluminum coating as does the alclad used in American aircraft. The steel in Japanese aircraft is cheap and of low carbon content. Cadmium plating is not used for protection, but the metal is allowed to be installed without protection against rust or corrosion.

The Frank I contains very few devices to protect the pilot's safety. The use of fire extinguisher systems for the engines and airplane are not provided for. Emergency systems for use in case of failure of the hydraulic system, escape of the pilot and gunner or other important safety features are not provided for the pilot. Remote control or automatic equipment is held to a minimum.

This manual is divided into three parts, each part covering the information as outlined below.

Part I - Changes, Modifications and Depot Workmanship.

Part II - Maintenance.

A. General.

B. Specific Maintenance Instructions.

C. Engines.

Part III - Operation.

Whenever practical in the description of the aircraft, the part being described is compared to an accepted American design. This is done for two reasons; first, to facilitate explanations, second, to provide a reference for more specific and detailed information.



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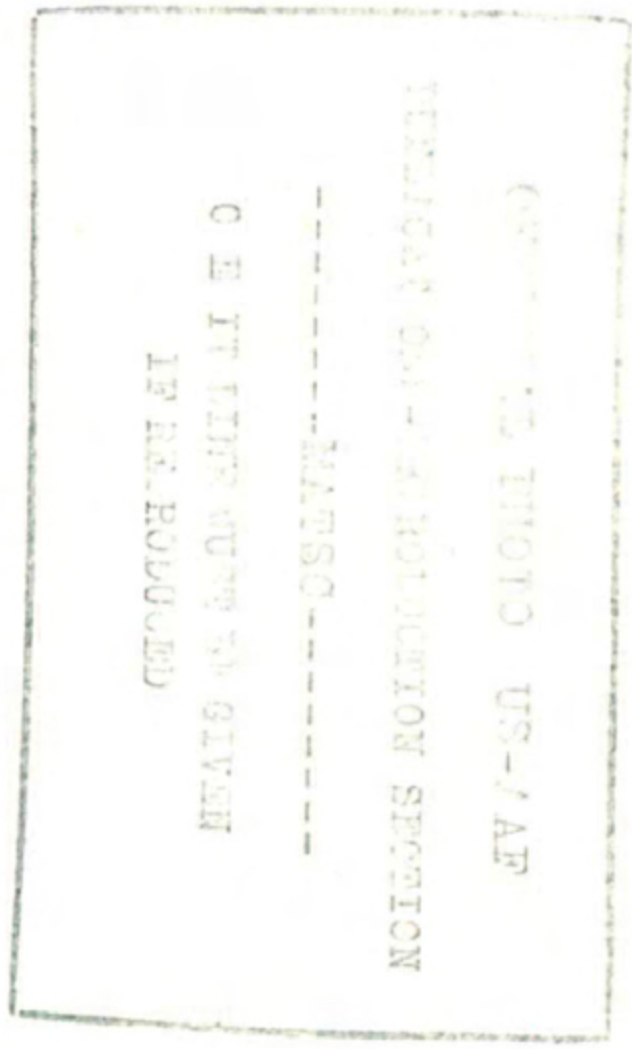

Right Front, Three Quarter View of the Frank I

TABLE OF SPECIFICATIONS

Principal Dimensions

Span	37.1'
Length	32.3'
Height	11.2'

Settings and Ranges of Movement of Control Surfaces

Aileron (up)	17°
Aileron (down)	14°
Flaps (total down)	30°
Elevator (up)	4 1/2"
Elevator (down)	3"
Rudder (right)	14"
Rudder (left)	14"
Trim Tabs	
Elevator (up)	1"
Elevator (down)	1"
Rudder	Fixed
Ailerons	Fixed

NOTE: Tolerances on all control surface movements ±2°.

Wheel Type Alighting Gear

Type - Hydraulically retracted.
Tread 131.3"
Shock Struts
Type - Combination air and oil.
Fluid required - AN-VV-O-366.
Approximate Maximum Air Pressure - Inflate shock strut until 3" of piston shows.
Tire - International Rubber Company of Japan 650 x 170 mm.

Tail Wheel Unit

Type - Hydraulically operated.
Shock Struts
Type - Combination air and oil.
Fluid Required - AN-VV-O-366.
Air Pressure - Inflate shock strut until 3" of piston shows.
Tire - International Rubber Company of Japan. A tubeless, solid rubber tire.

Circumference - 25" - Thickness - 1"
Diameter - 7 1/2"

Engines

Number - One (1)
Designation - (Nakajima) Model - Type 99
Type - Air-cooled 18 cylinder radial engine.
Gear Ratio - .5 : 1
Fuel - AN-F-26 Grade 91/96 and Alcohol Specification No. AN-A-24.
Oil - AN-VV-446A, Grade 1120

Tank Capacities

Fuel
Fuselage, Main (1) - 57.28 U.S. Gallons
Left Wing, Main (1)
Left Wing, Reserve (1)
Total - 45 U.S. Gallons
Right Wing, Main (1)
Right Wing, Reserve (1)
Total - 45 U.S. Gallons
External Tanks (2) - 53 U.S. Gallons each
A.D.I. System Tank (1) - 35 U.S. Gallons

Oil
Tank (1) - 24.3 U.S. Gallons

Weight and Balance Data

Location of Reference Datum - Rear of Propeller Spinner.
Net Weight - 6638 lbs.
Reference Datum Line to center of main wheel axle 64.8".
Reference Datum Line to center of tail wheel axle 329.2".
Reference Datum Line to wing jack point 91.2".
Reference Datum Line to tail lift point 271.9".
Reference Datum Line to leading edge of wing 67.8".
Wheel Base - 264.4"
Length of Mean Aerodynamic Chord 76.7"
Location of Center of Gravity - 84.6".



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Left Rear, Three Quarter View of the Frank I

PART I

CHANGES, MODIFICATIONS AND DEPOT WORKMANSHIP

Oxygen Equipment---All high pressure equipment has been removed and replaced with AAF low pressure demand oxygen system. The low pressure tank is installed behind the pilot's seat on the right hand side of the fuselage. The regulator is located on the right side of the cockpit and the oxygen pressure gage and blinker flow indicator are located above and on the same side. A standard filler connection has been fitted to the system and located forward of and above the fuselage access door. For detailed information concerning the installed system, refer to the Technical Order pertaining to the section of the system in question.

Radio---All foreign radio equipment has been replaced with AAF equipment. The Frank I T2-301 has a SCR-274-N transmitter receiver installed. An audio control box for headset volume control and a hand microphone have also been installed. An antenna wire from the radio in rear compartment of the fuselage is connected to an antenna wire running from the right wing tip to the vertical stabilizer.

Instruments---The following standard AAF instruments have been installed on the pilot's instrument panel, replacing the foreign equipment; airspeed indicator, rate of climb indicator, altimeter, artificial horizon and clock. Refer to applicable Technical Order when further information concerning this equipment is required.

Electrical---The electrical equipment has been modified only to the extent necessitated by the unavailability of replacement parts. The replacements in which standard AAF equipment were used include the battery, landing gear, warning horn, ignition switch and miscellaneous lights. An AAF type automatic propeller control switch incorporating an "off" position has been installed in the instrument panel replacing the Japanese switch. The generator switch has been moved from the rear compartment to the left side of the pilot's seat aft of the throttle quadrant.

Engines---The engine, number 123041 was removed from the airplane, disassembled, overhauled, tested and reinstalled. Dis-

assembly inspection revealed very little wear and from general appearance the engine had very few hours operating time since last overhaul. All parts required to rebuild the engine were manufactured locally or secured from spare engines. For further information refer to Part II, Paragraph C, of this manual.

Surfaces---All fabric on the fabric covered surfaces was replaced in accordance with AAF regulations.

Fittings---All Japanese grease fittings were replaced with American Zerk fittings. Air and oil servicing fittings were replaced and reinstalled.

Landing Gear---The landing gear assembly was removed, overhauled and reinstalled.

Starter---It was intended to install an electric inertia starter on this aircraft, however, due to the limited space it was impossible to make this installation.

Fuel System---A drain cock was installed on each fuel tank.



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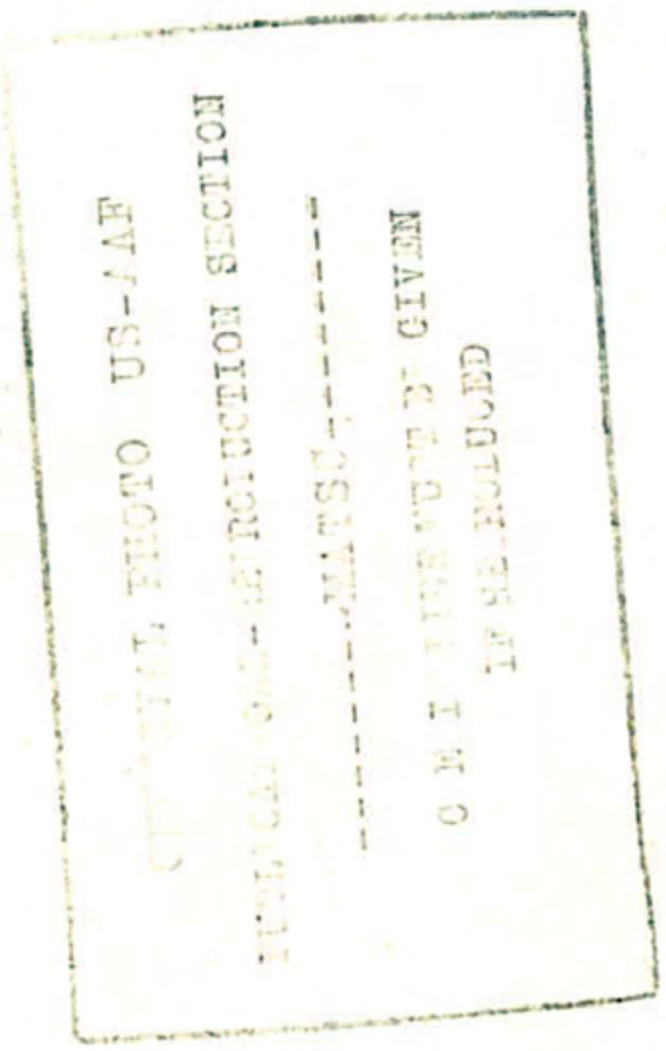

Front View of the Frank I

PART II

MAINTENANCE

(A) DESCRIPTION

General---The Frank I, a Japanese single engine fighter is a low wing land monoplane of all metal construction. It is powered with a radial, air cooled, eighteen cylinder, Nakajima manufactured engine. The engine drives a ten foot, four blade, constant speed electrical propeller, similar to the Curtiss Electric Propeller, but considerably lighter in the construction of the power motor unit.

The landing gear and tail wheel are hydraulically operated.

The Frank I is a single seat army fighter.

Approximate over-all dimensions of the airplane are:

Length 32.3'
Height 11.2'
Span 37.1'

Fuel and Oil---Fuel - Specification No. AN-F-26, Gr. 91/96.
Oil - Specification No. AN-VV0-446A, Gr. 1120.
Anti-Detonation Fuel - 50% water, plus 50% alcohol, Specification No. AN-A-24.

Armament---The pilot is protected by armor plate to the rear of the pilot's seat. The rear protection plate is 13mm thick and covers the pilot's shoulders to the lower part of the waist. Provisions are made for the installation of bullet resistant glass (not installed) 65mm thick aft of the front windshield. An optical gun sight, similar to the AAF-N3S is installed forward of the pilot.

Two fixed type 12.7mm guns are engine synchronized and mounted in the fuselage on each side forward of the cockpit. Approximately 350 rounds of ammunition is carried for each gun, located in ammunition cans below each gun. Two 20mm guns, free firing, are installed, one in each wing just outboard of the landing gear assembly. Approximately 150 rounds of ammunition


NOT SUITABLE FOR AROMATIC FUEL
NOT SUITABLE FOR AROMATIC FUEL
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20 Millimeter Wing Gun Installation, Left Wing

is carried for each gun, located in ammunition cans on the outboard side of each gun. All guns are hydraulically charged and electrically fired. Two hydraulic charging handles are located at the lower center of the main instrument panel. The left handle operates the charging of the wing guns and the right handle charges the front fuselage synchronized guns. The armament breaker switch is located on the main electrical control panel at the right forward side of the cockpit next to the pilot's right leg. Under a hinged guard on top of the control stick is a red firing button for the fuselage synchronized guns. When the hinged guard is moved to the rear of the control stick, it contacts the firing button of the wing guns. Depression of the guard fires the wing guns. There are two bomb racks, one under each wing, outboard of the landing gear, for carrying light bombs or external drop tanks. The bomb racks may be operated manually or electrically. The manual control release is on the left side of the pilot on the floor. The electrical release is on the throttle lever. A junction box located on the right side of the cockpit has three control switches, two are bomb selective switches, left and right, and a third is for the "safe" or armament position.

Baggage---No provisions are made for baggage.

Power Plant---The Nakajima manufactured T2-301, Model - Type 99, is an eighteen cylinder, air cooled, radial type engine having a propeller reduction gear ratio of .5:1. The engine has a normal rated and take-off power at sea level of 1970 horsepower at 3000 R.P.M. and 49.6" Hg. The engine has a single stage two speed integral supercharger manually controlled by a selector valve. The impeller ratio is 5.81:1 and 7.95:1. For further information concerning the engine, refer to Part II, Section C, of the Engine Section in this manual.

Propeller---The propeller is similar to the Curtiss Electric, four bladed constant speed type. It is non-feathering and is controlled by a governor which maintains constant propeller speed by regulating the electric motor in the propeller hub assembly. The governor may be adjusted to desired engine power and speed by a propeller control lever in the pilot's compartment. The propeller is equipped with a spinner assembly.

Flight Controls---Conventional stick and rudder bar control is provided for the pilot. The rudder bar has a toe pedal type brake which provides the necessary brakes for controlling the aircraft in ground movements. The rudder bar may be adjusted


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Engine Installation, Right Side

fore and aft by use of a screw jack type adjuster to accommodate the pilot's stature.

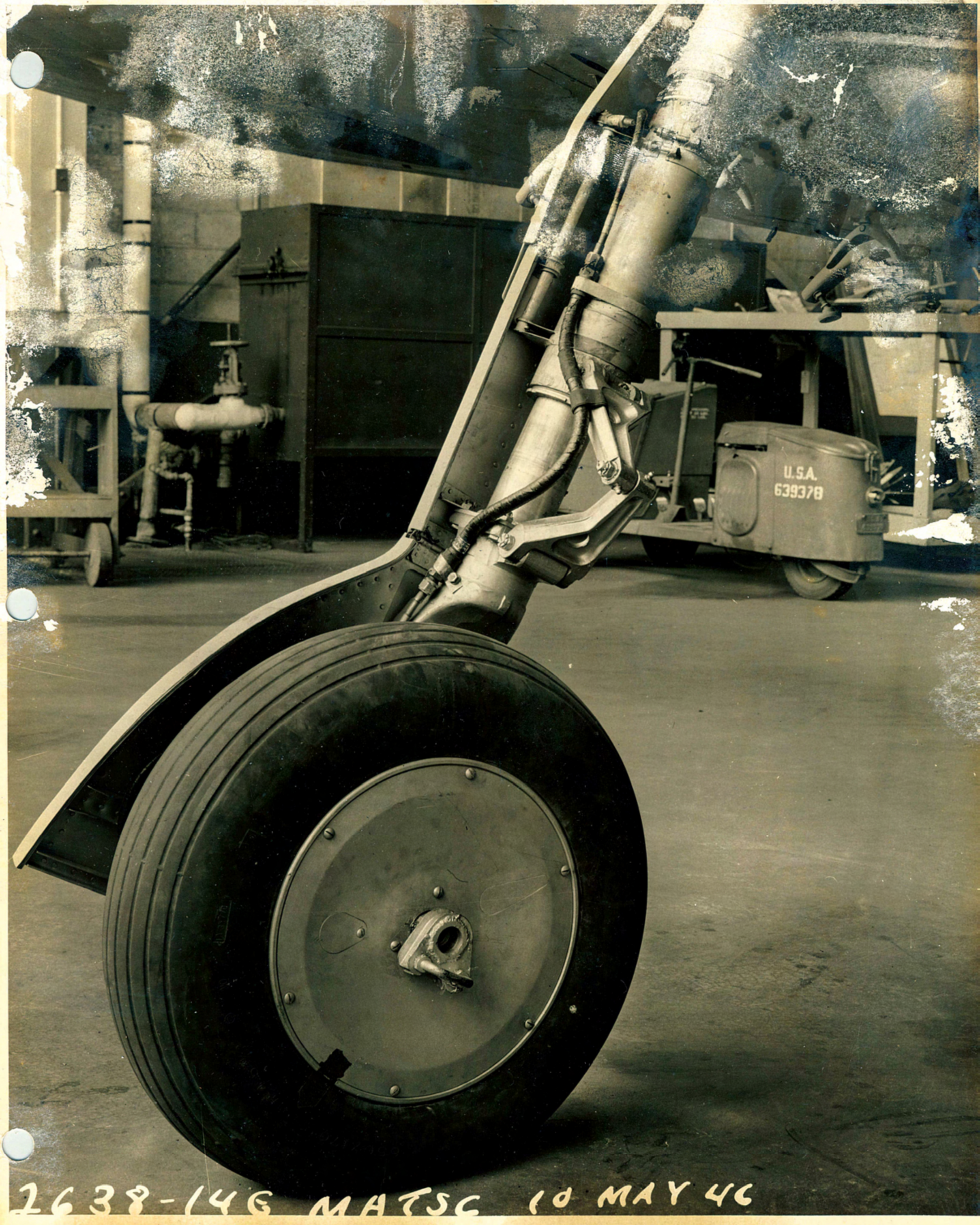
Elevator Trim Tab Control---Elevator trim tabs may be adjusted in flight by a wheel mounted just to the left of the pilot. Turn wheel forward for nose down position and backward for nose up position. An elevator trim tab position indicator is located just outboard of the tab control.

Rudder Trim Tab Control---The rudder trim tab is of the fixed type and may be adjusted on the ground only.

Aileron Trim Tab Control---The aileron trim tab is of the fixed type and may be adjusted on the ground only.

Main Landing Gear---For normal operation of the landing gear, put dump valve in "pressure" position (rear) and place the landing gear selector control to "down" position to extend the gear; to "up" position to retract it. The dump valve is located on the cockpit floor near the left front side of the pilot's seat. The landing gear selector control is located on the lower left side of the cockpit. When pressure is not required for the operation of any hydraulic system unit, place dump valve in "dump" position (forward). (NOTE: FOR PROLONGED OPERATIONS OF AROUND 1000 R.P.M. DUMP VALVE SHOULD BE IN "DUMP" POSITION TO PREVENT WEAR OF THE HYDRAULIC SYSTEM.) The landing gear selector control does not have a "neutral" position, preventing the landing gear from being stopped in any intermediate position. In any emergency, if the gear is being lowered it can be quickly retracted without fully extending the gear and then retracting it. (NOTE: WITH GEAR FULLY EXTENDED, THE GREEN WARNING LIGHT ON THE PILOT'S INSTRUMENT PANEL AND THE POP-UP INDICATORS ON THE WING WILL SHOW GEAR IS EXTENDED AND LOCKED. WITH GEAR FULLY RETRACTED, THE RED WARNING LIGHT WILL LIGHT.) An added precaution to prevent the airplane from landing with the landing gear retracted, or in an unlocked position, is the addition of a landing gear warning horn controlled by micro-switches on the landing gear locking links will cause the warning horn to blow when the landing gear is unlocked. A micro-switch is attached to the flap selector handle which will cause the warning horn to blow if the flaps are lowered to 30° and the landing gear is not extended and locked.

To operate by the auxiliary or hand pump method, place



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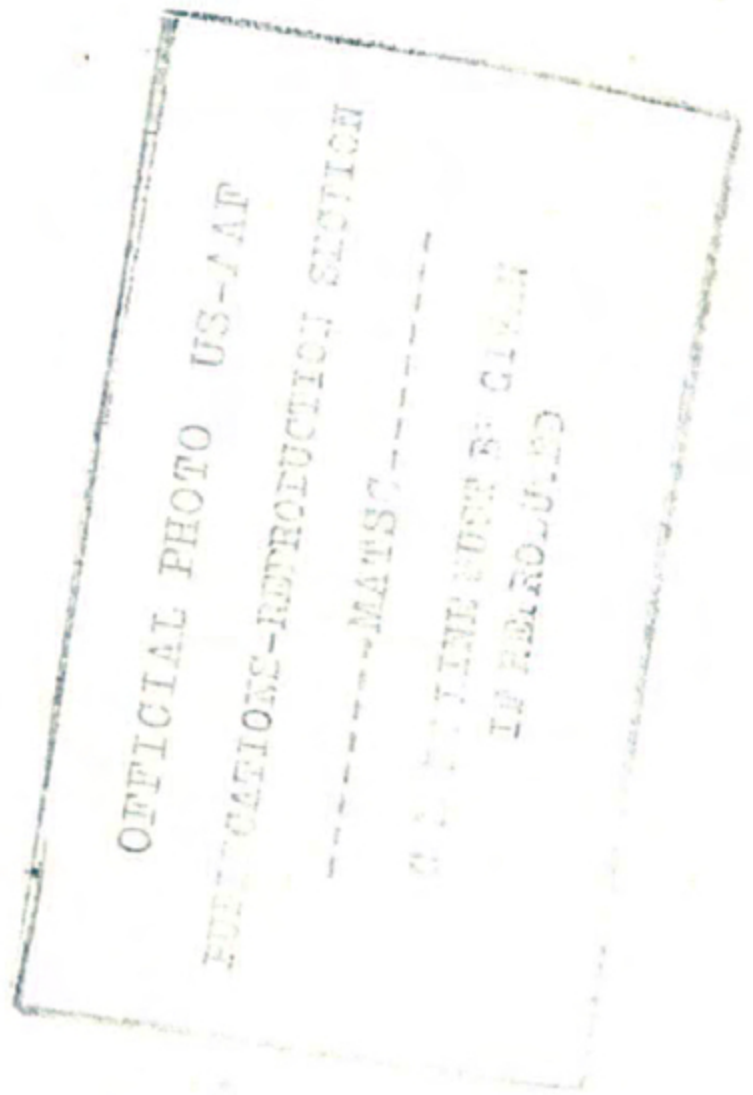
Right Landing Gear Assembly, Extended





Tail Wheel Assembly, Extended

dump valve in the "pressure" position (rear) and landing gear selector handle to the desired position. Pump hydraulic pressure by use of the hand pump, on the right side of cockpit floor just forward of pilot's seat, until the gear is locked in position. Check position indicator lights and return dump valve to "dump" (forward) position. There is an emergency way of lowering the gear in case of complete loss of hydraulic fluid. The "up locks" and "down locks", are actuated mechanically by coil springs and are released by a cable connected directly to each lock, and also to the landing gear selector handle. For further information of the landing gear refer to the Hydraulic Section in this manual on Page 37.

Tail Wheel Controls---Tail gear retraction is simultaneous with that of the main gear. The tail wheel is full swiveling and may be locked in a forward position for take-off and landing. The tail wheel lock control is located on the left side of the cockpit aft of the pilot's seat.

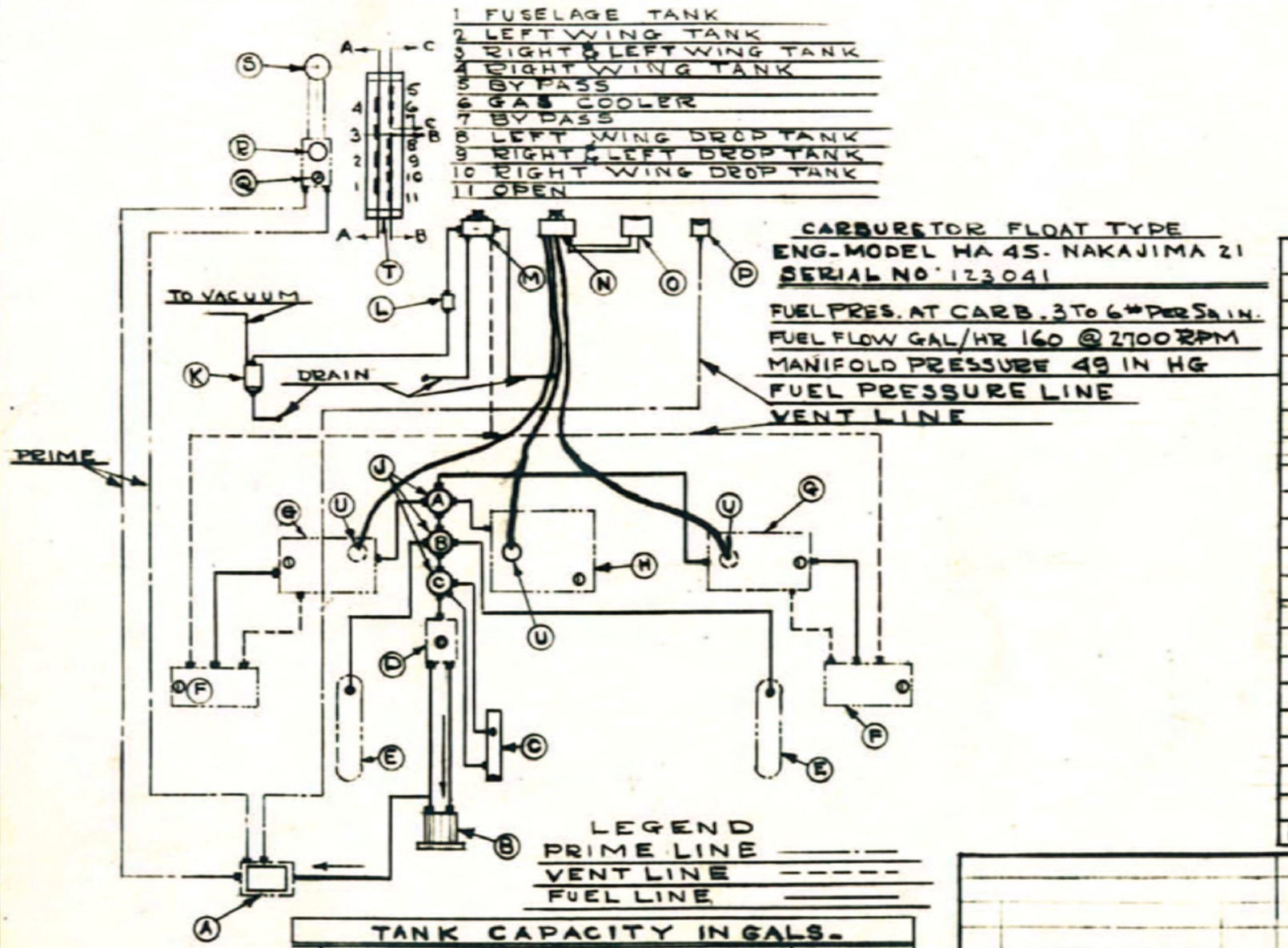
Parking Brakes---No provisions are made for parking brakes.

Wing Flap Controls---For normal operation of wing flap, put dump valve handle in "pressure"(rear) position and wing flap selector handle in "down" position to lower flaps and "up" position to raise flaps. Flaps may be stopped in any intermediate position by returning the handle to neutral. Maximum deflection of flaps is 30°. A flap position indicator is not installed.

Flaps may be operated manually by placing dump valve in the "pressure" (rear) position and with flap selector handle in desired position, pump the hydraulic hand pump to desired position. Return flap control selector handle to neutral position.

Heating and Ventilation---Control for cold air supply to the pilot's compartment is on the left front edge of cockpit above the instrument panel. A small ventilator just below the front windshield is the only means of admitting cold air into the cockpit. No provisions are made for heating the cockpit.

Lights---The master battery switch must be turned on before any lights can be operated by their individual switches. The master battery switch is located on the electrical panel, right side of the cockpit just aft of the instrument panel.



V	DRAIN-FUEL TANK
U	TRANSMITTER-LIQUIDOMETER
T	QUADRANT-FUEL VALVE SELECTOR
S	TANK-FUEL PRIMING
R	PUMP-HAND PRIMING
Q	VALVE-PRIMING
P	GAGE-FUEL PRESSURE
O	GAGE-LIQUIDOMETER
N	SWITCH. LIQUIDOMETER
M	VALVE SELECTOR DRAIN OR VENT
L	VALVE-RELIEF
K	DRAIN-SUMP
J	VALVE SELECTOR
I	FILLER NECK-TANK
H	TANK-FUEL FUSELAGE
G	TANK-FUEL WING
F	TANK-FUEL LEADING EDGE
E	TANK-FUEL DROP
D	PUMP-HAND FUEL PRESSURE
C	COOLER-GAS
B	PUMP-FUEL
A	CARBURETOR

TANK CAPACITY IN GALS.				
		U.S.	IMPERIAL	LITERS
E	AUX DROP			
F	LEADING EDGE			
G	WING			
H	FUSELAGE			
	TOTAL			

METHODS [illegible] MAINTENANCE DIVISION MATSU [illegible] ARMY AIR FORCES

DIAGRAM-T2-301 & 302 FRANK AIRPLANE-FUEL SYSTEM-SCHEMATIC

LET	REVISIONS	BY	DATE

CHIEF MAINT DIV — CHIEF M & P SECT — MATERIAL — SCALE

W J LONG 4-29-46 — PYLE 26 APRIL 1946 — MAD 46-600

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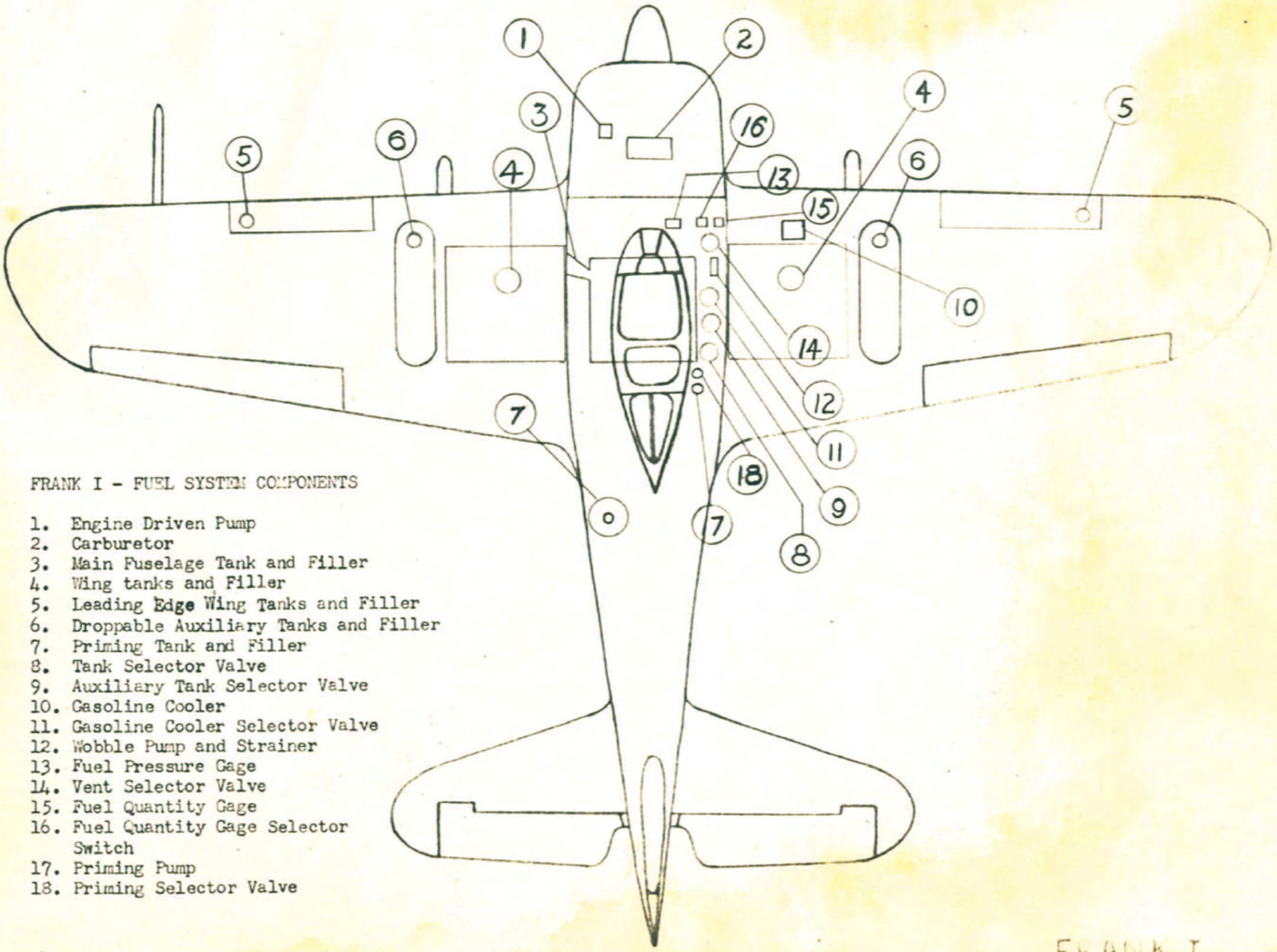
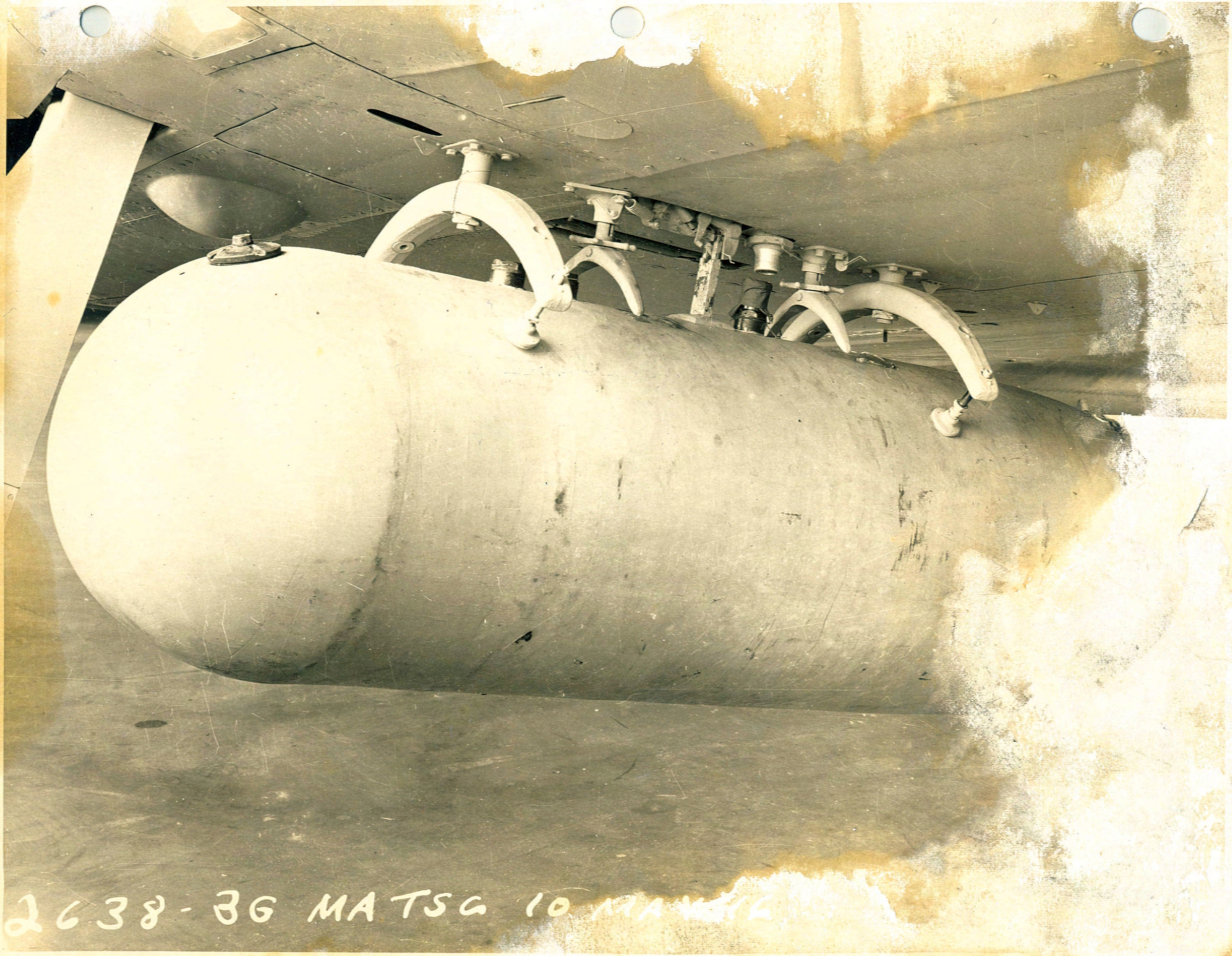


FRANK I - FUEL SYSTEM COMPONENTS

1. Engine Driven Pump
2. Carburetor
3. Main Fuselage Tank and Filler
4. Wing tanks and Filler
5. Leading Edge Wing Tanks and Filler
6. Droppable Auxiliary Tanks and Filler
7. Priming Tank and Filler
8. Tank Selector Valve
9. Auxiliary Tank Selector Valve
10. Gasoline Cooler
11. Gasoline Cooler Selector Valve
12. Wobble Pump and Strainer
13. Fuel Pressure Gage
14. Vent Selector Valve
15. Fuel Quantity Gage
16. Fuel Quantity Gage Selector Switch
17. Priming Pump
18. Priming Selector Valve

FRANK I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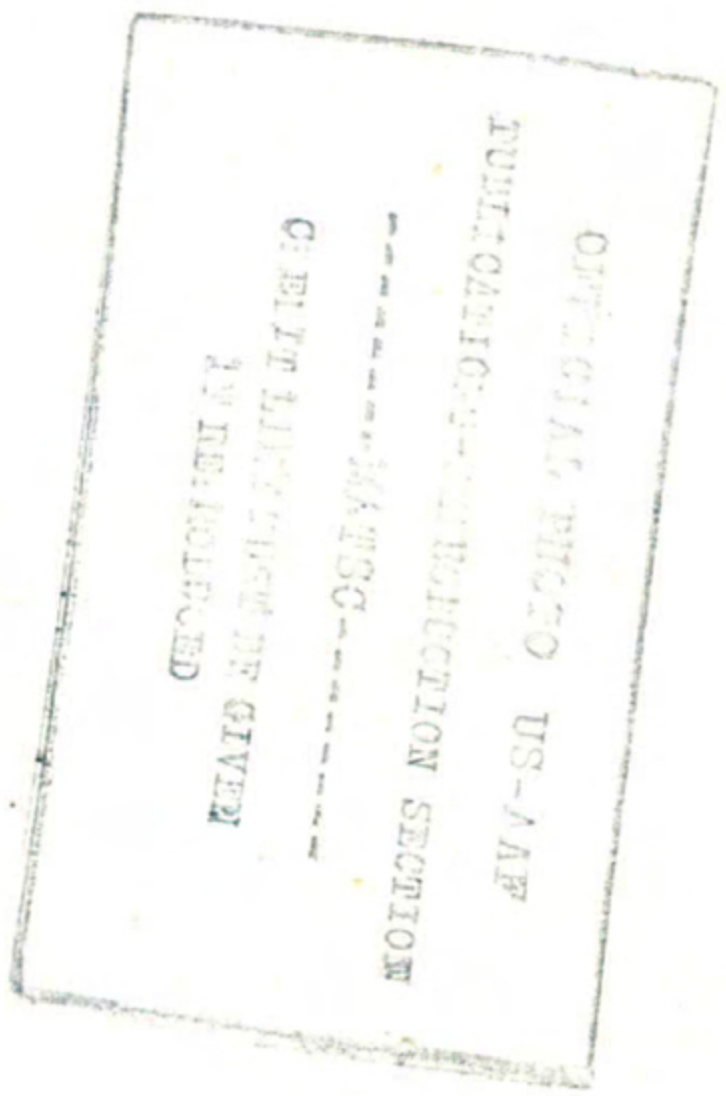


Left Drop Tank Assembly Installed

One cockpit light (AAF) is located on the right side of the cockpit. The switch is on the lower right side of the electrical switch panel.

The instrument panel lights are of the AAF fluorescent type and are controlled by a switch located on the right side of the cockpit aft of the electrical switch panel.

Fuel System---Fuel is supplied to the engine from seven (7) supply tanks. The fuselage tank of 57.28 U.S. gallons (217 liters) capacity is located beneath the pilot's compartment. A wing tank is located at the butt end of each wing and a leading edge reserve tank is located in the leading edge of each wing just outboard of the wing guns. The corresponding wing tanks and leading edge reserve tanks are connected and each set of tanks has a total capacity of 45 U.S. gallons (173 liters). The fuel flows from the leading edge tanks to the wing tanks by gravity and by the aid of the vent pressure. Two droppable tanks (jettisonable) may be attached to bomb racks beneath the wings. Each auxiliary tank has a capacity of 53 U.S. gallons (200 liters).

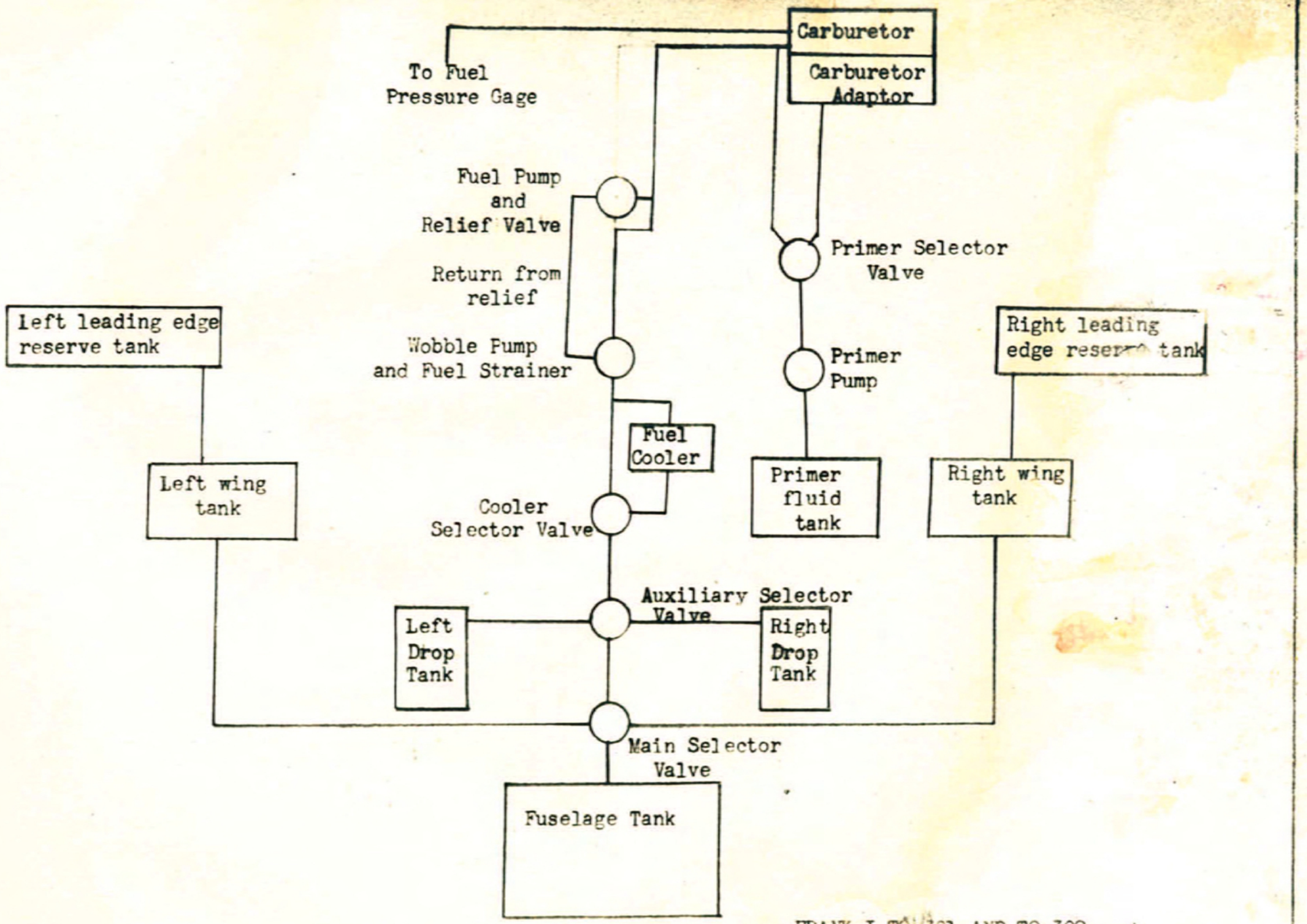
Fuel is directed from the desired tank by a series of two fuel tanks selector valves to a third selector valve, the fuel cooler selector valve which either diverts the fuel through the fuel cooler or by-passes the cooler. The fuel cooler is suspended under the right wing close to the fuselage. The three selector valves are controlled from a quadrant on the floor to the right of the pilot's seat.

The positions of the first selector valve are as follows:

1. Fuselage
2. Left wing
3. Right and left wing
4. Right wing

The positions of the second selector valve are as follows:

1. Open
2. Right drop tank
3. Right and left drop tank
4. Left



FRANK I T2-301 AND T2-302

FUEL AND PRIMER SYSTEMS

The positions on the quadrant are from the front to the rear in the order listed above. From the fuel cooler the fuel passes on to the wobble pump which incorporates the fuel strainer and then to the engine driven fuel pump which includes the fuel pressure to the wobble pump. The fuel strainer is accessible through the long inspection cover under the right side of the fuselage just aft of the firewall. The engine driven fuel pump is mounted on the lower left side of the engine accessory case. The desired fuel pressure is 3.5 lbs. per sq. inch ±.5 lb. (0.25 Kg. per sq. cm.). The fuel is pumped from the engine driven fuel pump directly to the carburetor. The fuel pressure gage line is connected to the carburetor.

Fuel Tank Vent System---All the fuel tanks except the drop tanks may be vented to either atmospheric pressure or pressure from the pressure side of the vacuum pump.

The fuselage tank is vented to a vent pressure selector valve located on the right side of the instrument panel. The leading edge reserve tanks are vented to the fuselage tank vent line and the corresponding wing and leading edge reserve tanks are vented together.

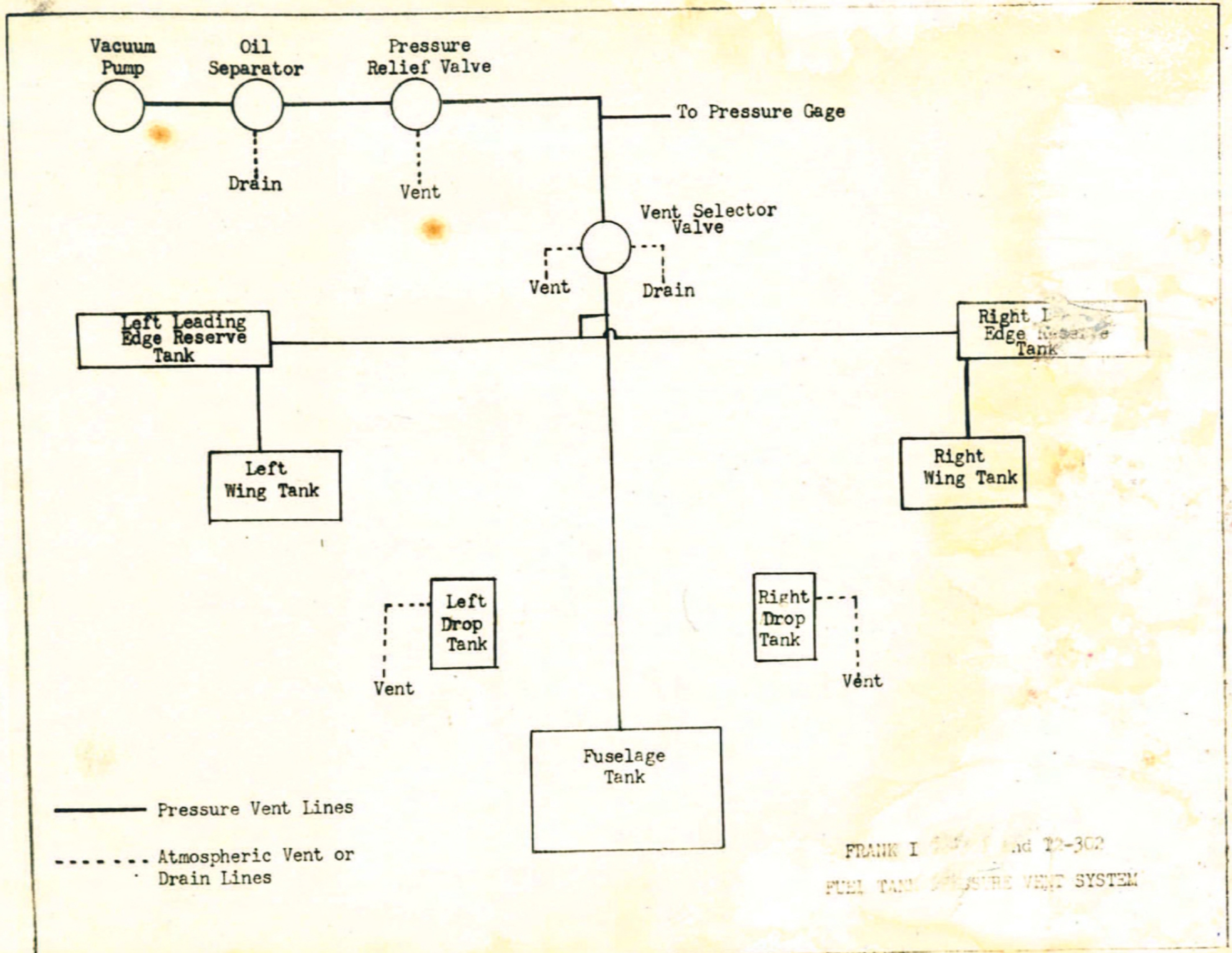
There are two drain lines from the vent pressure selector valve to atmospheric pressure and one line to the pressure side of the vacuum pump. Incorporated in the vacuum pump line is an oil separator located at the base of the firewall and an air pressure relief valve located on the right side of the engine mount. The relief valve limits the amount of air pressure from the vacuum pump to the fuel tanks to 0.25 Kg./cm^2 (3.5 lbs. per sq. inch).

There are two positions on the vent pressure selector valve:

1. "Pressure" - at which time pressure from the vacuum pump is vented to the fuel tanks.
2. "Drain" - at which time the fuel tanks and the vacuum pump pressure are vented to atmospheric pressure.

The drop tanks are always vented to atmospheric pressure. (NOTE: AIRPLANE MAY BE FLOWN WITH THE PRESSURE VENT SYSTEM IN THE "OFF" OR "DRAIN" POSITION.)

Engine Priming System---A small hand pump for priming the



FRANK I [illegible] and 22-302

FUEL TANK [illegible] PRESSURE VENT SYSTEM

engine is located on the right side of the airplane cockpit. Primer fluid is supplied to the pump from a tank of two (2) U.S. gallons capacity located on the left side of the fuselage aft of the cockpit and just forward of the fuselage access door. The primer fluid is directed from the primer pump by a selector valve to the primer discharge nozzle in the carburetor adapter or the fuel inlet to the carburetor. Since the engine priming system is entirely independent of the main fuel system, a higher octane fuel is used for starting the engine, especially in cold weather. (NOTE: DO NOT USE CARBURETOR PRIMER EXCEPT IN EXTREME COLD CONDITIONS.)

Fuel Quantity Indicator---The quantity of fuel in the tank is indicated by an electric gage in liters on the right side of the instrument panel. Selection of the tank to be indicated is made by a selector switch to the left of the indicator. There are three positions on the selector switch:

1. Fuselage tank 57.28 U.S. gallons
2. Left wing tank 45 U.S. gallons
3. Right wing tank 45 U.S. gallons

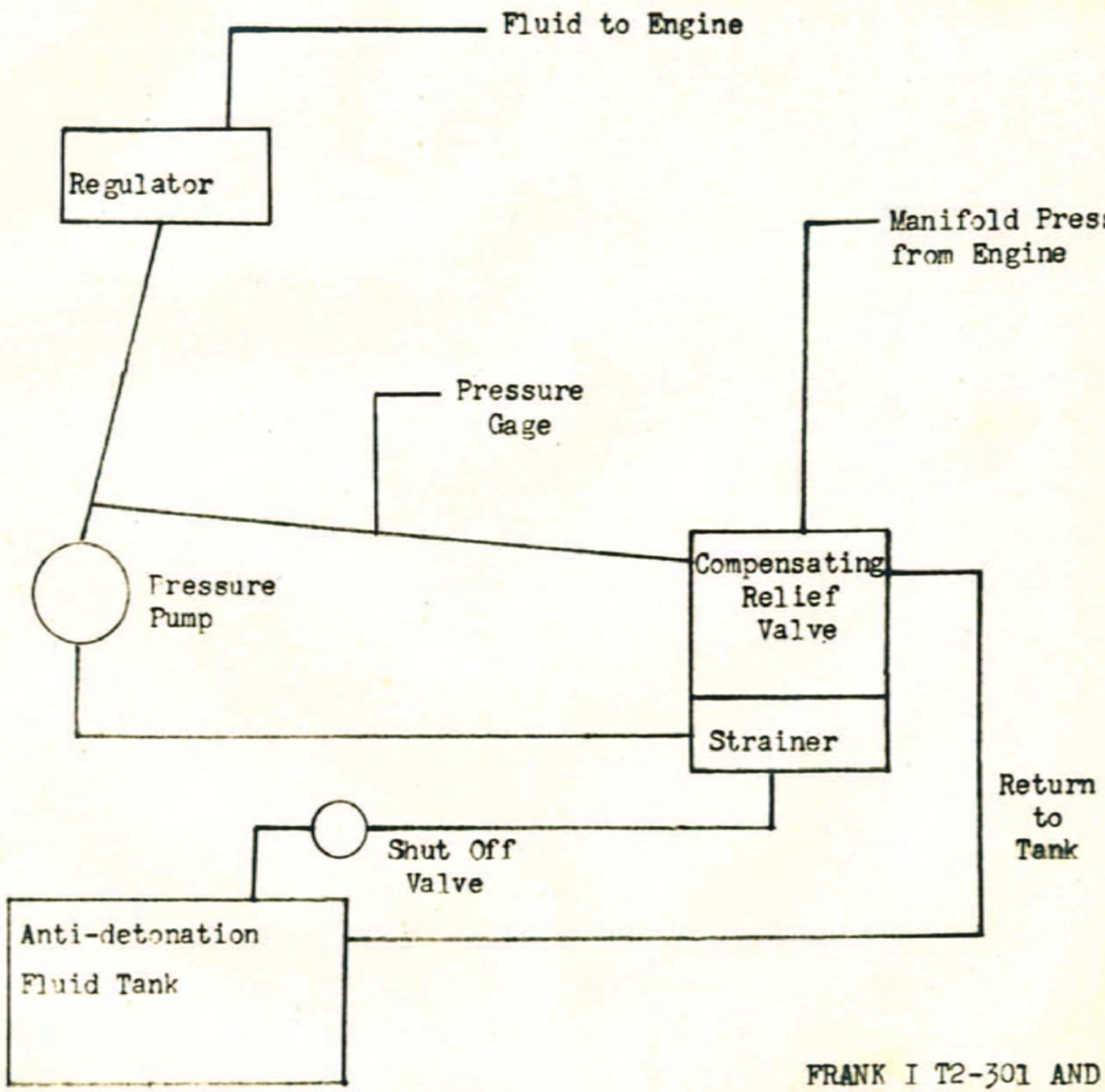
Indication of the amount of fuel in the wing tanks also includes the leading edge reserve tanks since the corresponding wing and reserve tanks are connected.

When the quantity of fuel in the tank being indicated drops below three (3) gallons, a red light flashes in the indicator.

The fuel quantity indicator does not indicate the amount of fuel being carried in the drop tanks. The fuel pressure may be increased or decreased by the adjustment of the relief valve which is located directly on the engine fuel pump. By screwing the adjustment screw in or clockwise the fuel pressure is increased and counterclockwise decreases the fuel pressure. A lock nut is incorporated on the adjusting screw which should be loosened before adjustment and tightened after adjustment to prevent the adjustment from changing.

Anti-Detonation Injection System---The anti-detonation injection system consists of the following units:

1. Anti-detonation fluid tank.



FRANK I T2-301 AND T2-302

ANTI-DETONATION INJECTION SYSTEM

2. Shut-off valve (manually operated from the ground and not used during operation).
3. Compensating pressure relief valve and strainer unit.
4. Engine driven pressure pump.
5. Regulator unit.
6. Pressure gage.

The anti-detonation fluid tank is located near the top of the fuselage just aft of the firewall and its capacity is 35 U.S. gallons. The tank is vented to atmospheric pressure.

The shut-off valve is a manually operated, two position valve located in the anti-detonation fluid tank out-line close to the tank. The valve can only be operated from outside the airplane and cannot be controlled during flight.

The compensating relief valve and strainer unit is mounted on the right side of the engine mounting. The strainer is a conventional fine mesh wire screen. The compensating relief valve consists of a poppet valve, a bellows which is controlled by manifold pressure, and a spring and spring adjusting screw.

The purpose of the relief valve is to maintain pressure on the anti-detonation injection system without permitting it to become excessive. The pressure valve on this ship is set so that there will be a pressure of approximately thirteen (13) pounds when the regulator opens allowing the anti-detonation injection fluid to start entering the induction system at 37" Hg. manifold pressure. When the regulator valve opens, the pressure will, in spite of the increase in pressure on the spring exerted by the manifold pressure, start falling off and will continue decreasing until at 49" manifold pressure the anti-detonation injection pressure gauge will indicate a pressure of approximately 4.5 pounds. Since there is no anti-detonation injection flow gauge installed a drop in pressure may be used as an indication of whether or not anti-detonation fluid is being injected.

The regulator unit is mounted on the left side of the carburetor. It consists of a metering valve which is operated through suitable linkage by a bellows controlled by engine manifold pressure. The metering valve is set by an adjustment on the valve to begin opening at 37" Hg. manifold pressure. The adjustment of the valve can be reached by removing a cap from the outside of the regulator units. As

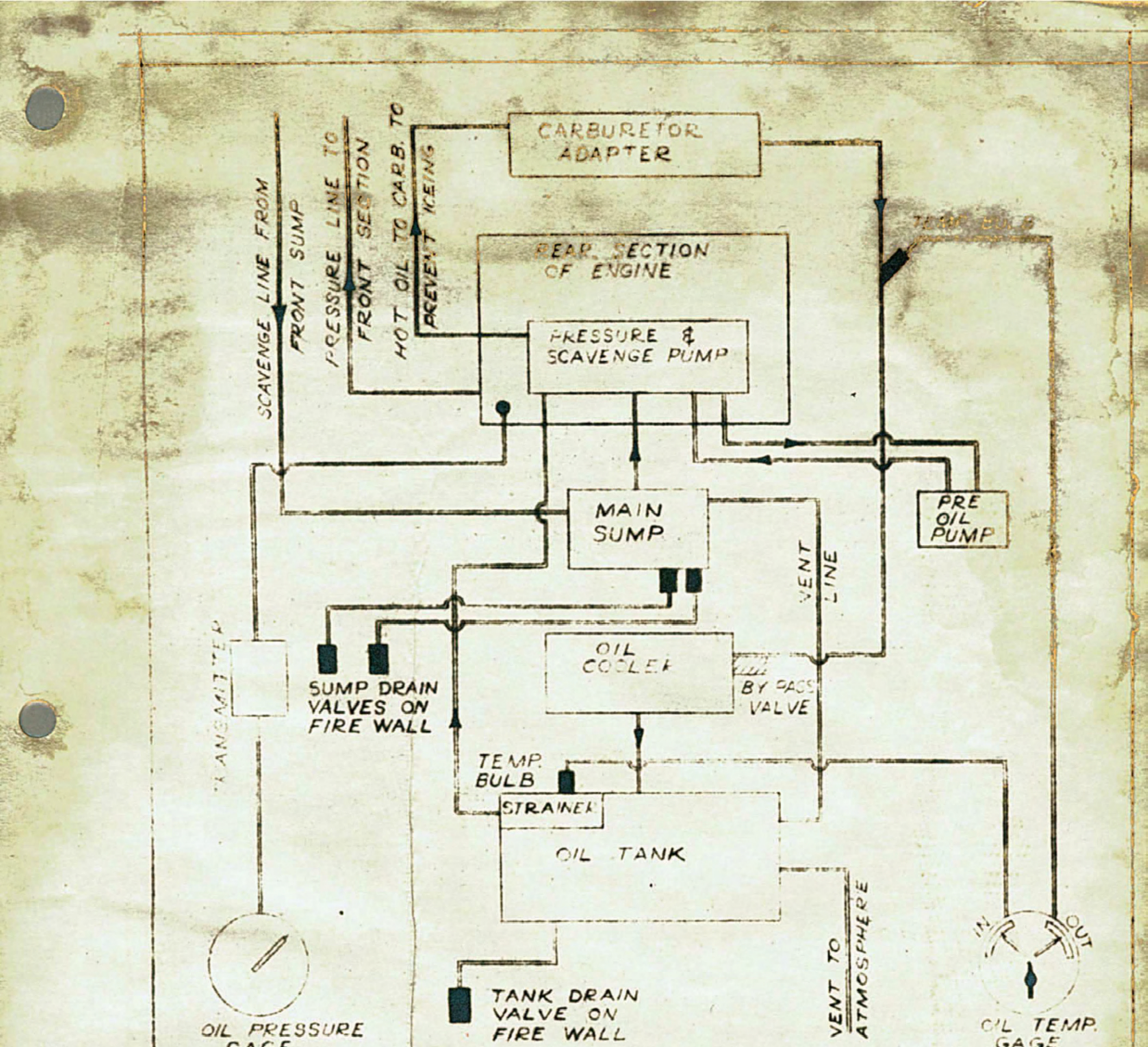


DIAGRAM - JAPANESE AIRPLANES
FRANK-T2-301 SCHEMATIC
OIL SYSTEM

TBM

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5-7-46
JND

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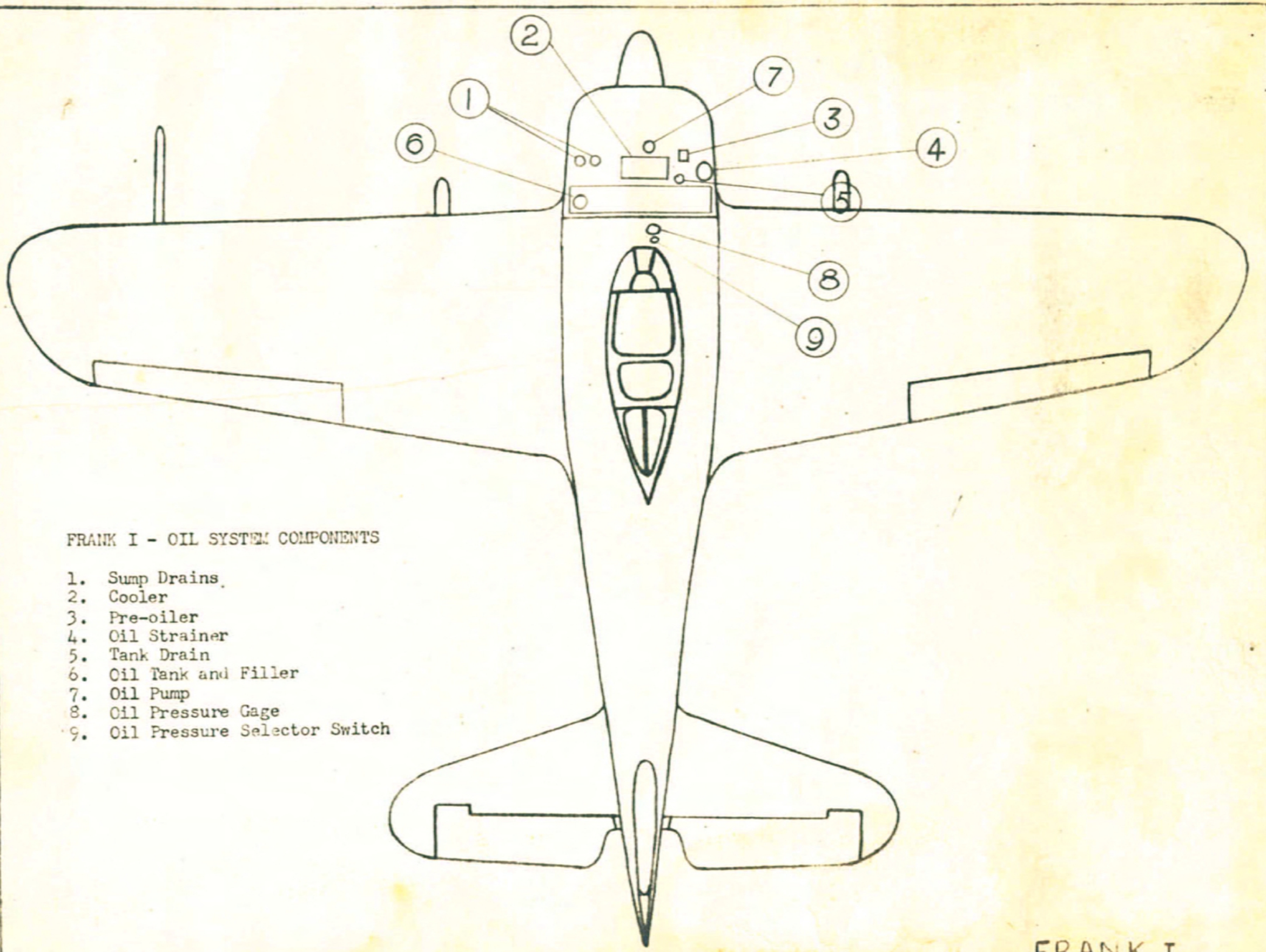


FRANK I - OIL SYSTEM COMPONENTS

1. Sump Drains
2. Cooler
3. Pre-oiler
4. Oil Strainer
5. Tank Drain
6. Oil Tank and Filler
7. Oil Pump
8. Oil Pressure Gage
9. Oil Pressure Selector Switch

FRANK I

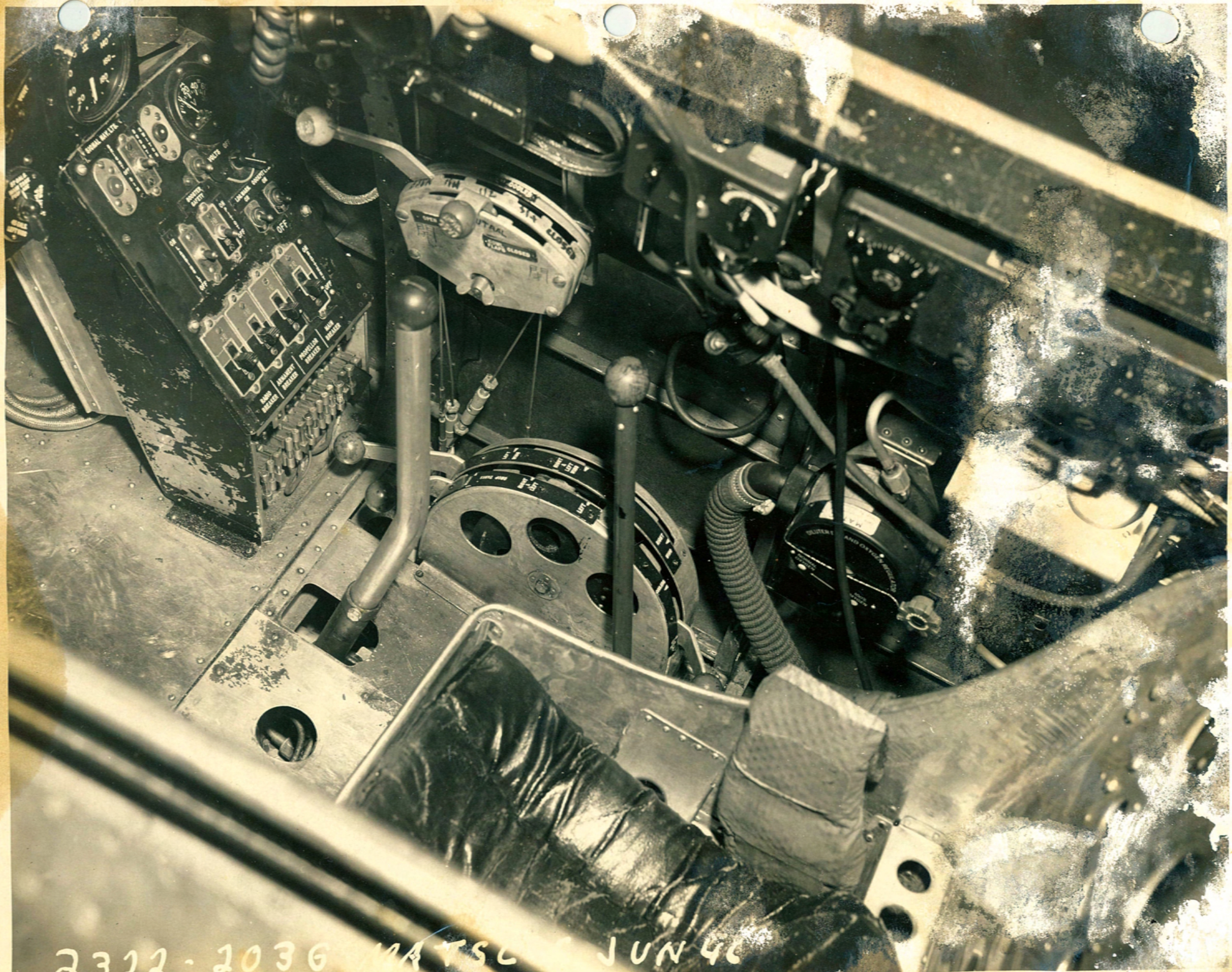
the engine manifold pressure increases above 37" Hg. the bellows in turn increases the opening of the metering valve increasing the amount of anti-detonation injection to the engine. When the manifold pressure is decreased the metering valve closes at 35" Hg. manifold pressure. Incorporated in the anti-detonation regulator unit is a fuel derichment valve. The derichment valve is operated by a bellows which is controlled by the pressure of the fluid in the anti-detonation injection system. As the pressure of the anti-detonation system increases the derichment valve decreases the amount of fuel that is delivered to the engine by the carburetor power enrichment valve.

The engine driven pressure pump is a vane type pump and is mounted on the engine near the center of the accessory section housing.

The pressure gage is a Bourdon type gage and is calibrated in Kg/cm^2.

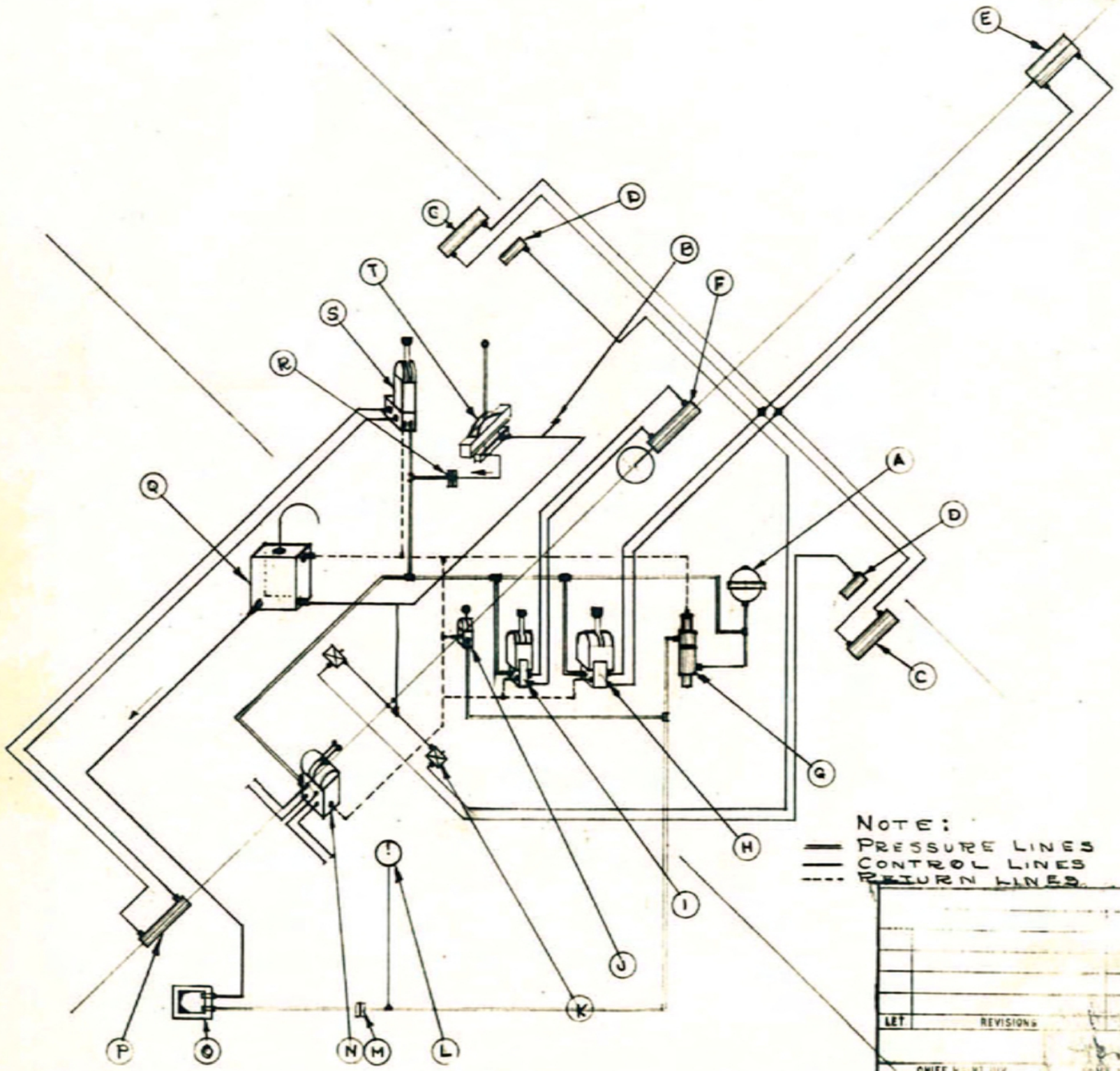
Oil System---The oil system's main supply is an oil tank centrally located just forward of the firewall. Its capacity is 24.3 U.S. gallons or 92 liters. The oil outlet from the tank goes to an oil strainer located on the forward side of the left wheel well. From there the line leads to the oil pump located on the lower center of the accessory drive of the engine. In this line is included an oil "in" temperature bulb. The oil "out" line of the scavenge pump leads from the pump to the carburetor adapter. From the carburetor adapter the line leads to the oil cooler located under the engine. Included in the cooler is a spring loaded temperature by-pass valve that permits the oil to by-pass the cooler core when the oil is below the proper temperature. The cooler is equipped with an airscoop in the propeller slip stream, and also cooler shutters behind the cooler. The oil shutters are controlled by a lever control in the cockpit located in the right side of the cockpit on the same quadrant as the cowl flap control. From the outlet of the cooler the line leads back to the tank. An oil "out" temperature bulb is located in the line where it comes out of the carburetor adapter.

A hand cranked pre-oiler is incorporated in the system and is located on the forward side of the right wheel well.


SIGNAL MASTER
OFF
OFF
OFF



Electrical Control Panel, Cowl
and Oil Cooler Flap Controls



NOTE:
— PRESSURE LINES
— CONTROL LINES
---- RETURN LINES

AE	
AD	
AC	
AB	
AA	
Z	
Y	
X	
W	
V	
U	
T	PUMP HAND
S	VALVE COWL FLAP
R	VALVE CHECK
Q	RESERVOIR
P	COWL FLAP CYL.
O	PUMP ENGINE DRIVEN
N	VALVE GUN CHARGING
M	DISCONNECT & TEST
L	GAGE MAIN HYD SYSTEM
K	BRAKE TOTAL COL
J	VALVE DUMP
I	VALVE WING FLAP
H	VALVE LANDING GEAR
G	REGULATOR
F	WING FLAP CYL
E	TAIL WHEEL CYL.
D	BRAKE CYL.
C	LANDING GEAR CYL
B	PLUG LINE
A	ACCUMULATOR

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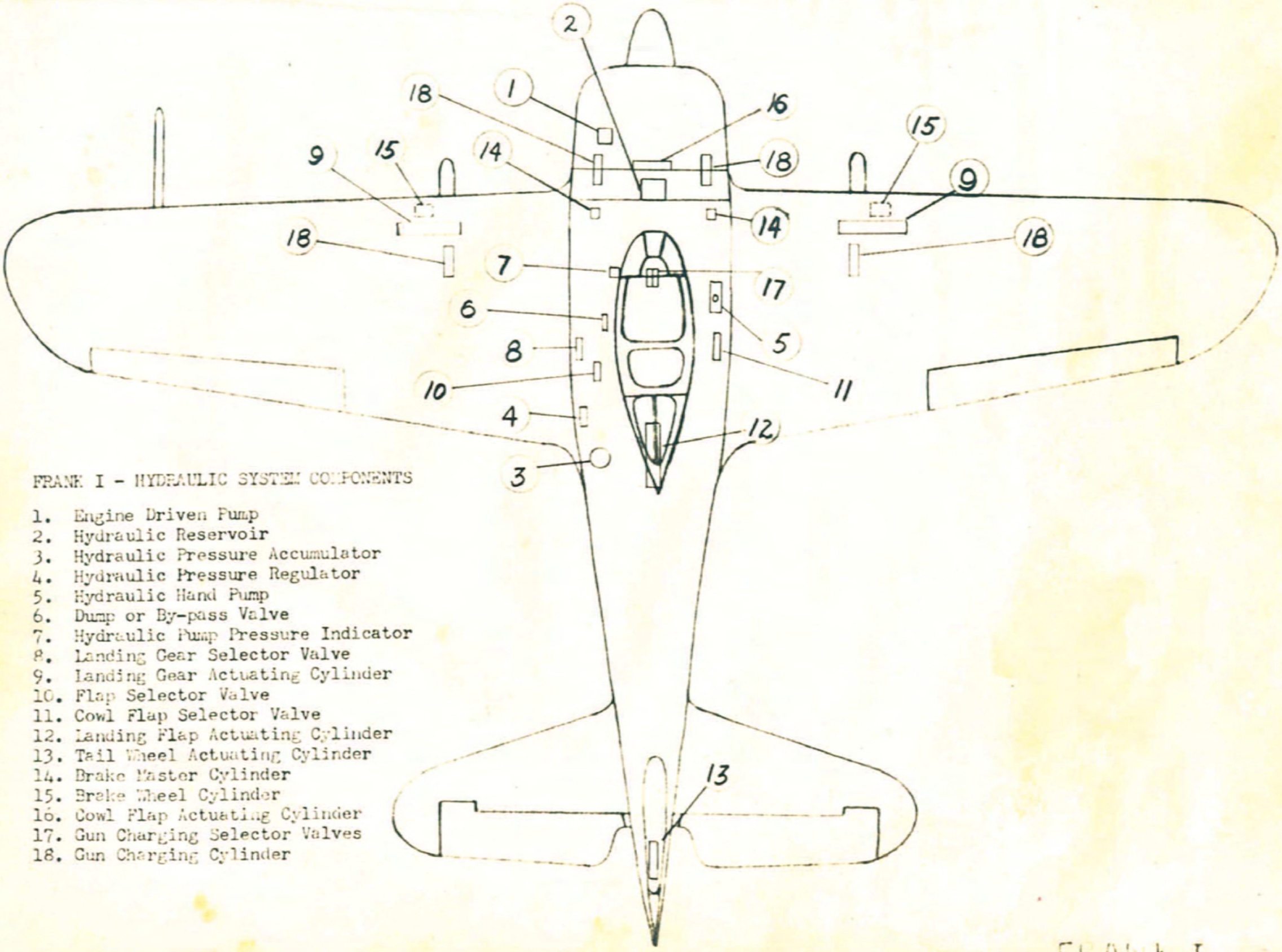


FRANK I - HYDRAULIC SYSTEM COMPONENTS

1. Engine Driven Pump
2. Hydraulic Reservoir
3. Hydraulic Pressure Accumulator
4. Hydraulic Pressure Regulator
5. Hydraulic Hand Pump
6. Dump or By-pass Valve
7. Hydraulic Pump Pressure Indicator
8. Landing Gear Selector Valve
9. Landing Gear Actuating Cylinder
10. Flap Selector Valve
11. Cowl Flap Selector Valve
12. Landing Flap Actuating Cylinder
13. Tail Wheel Actuating Cylinder
14. Brake Master Cylinder
15. Brake Wheel Cylinder
16. Cowl Flap Actuating Cylinder
17. Gun Charging Selector Valves
18. Gun Charging Cylinder

FRANK I

The lines are connected to the engine driven pump. It is operated by a small hand crank that is stowed in the right wheel well.

The oil tank filler is on the left side of the engine mount, midway up. There is an oil tank drain between the wheel wells. There are two engine sump drains equipped with quick disconnect plugs on the forward side of the left wheel well. There are also small spring loaded drains in two of the lowest cylinder intake pipes. They are drained by simply pulling on the rings attached to the valves.

The engine rear case is vented to the top of the oil tank, which is in turn vented out to the atmosphere through a large vent line that comes out between the wheel wells.

The oil pressure is registered on a gage on the lower center of the pilot's instrument panel. The oil pressure line is connected into the oil line in the cover of the accessory section on the lower left side. The oil temperature gage is equipped with a two way switch to facilitate the selecting of oil "in" or oil "out" temperature.

There is no means of diluting the engine oil for cold weather operation.

Cowl Flap Controls---The cowl flap control is located on the right side of the pilot's cockpit below and on the same quadrant as the oil cooler shutter control. A three position control is used for the cowl flaps; move control handle forward to open cowl flaps and back to close cowl flaps and center for neutral.

Throttle Control---The throttle control is conventional and is located on the left side of the cockpit.

Mixture Controls---Two mixture controls, one automatic and the other manual, are located on the main control quadrant on the left side of the pilot's cockpit. The automatic mixture control is located on the top inboard side of the quadrant and has three positions; normal, cruising and lean.

The manual mixture control is located on rear outboard end of the quadrant and idle cut-off is in the down position. The quadrant is graduated in positions from idle-cut-off to ten (full rich).

Friction Adjustment---Friction adjustment thumb screws are located on the inboard side of the main control quadrant for the throttle (red), propeller (yellow) and automatic mixture controls (black). Turn thumb screw clockwise to tighten the control handles.

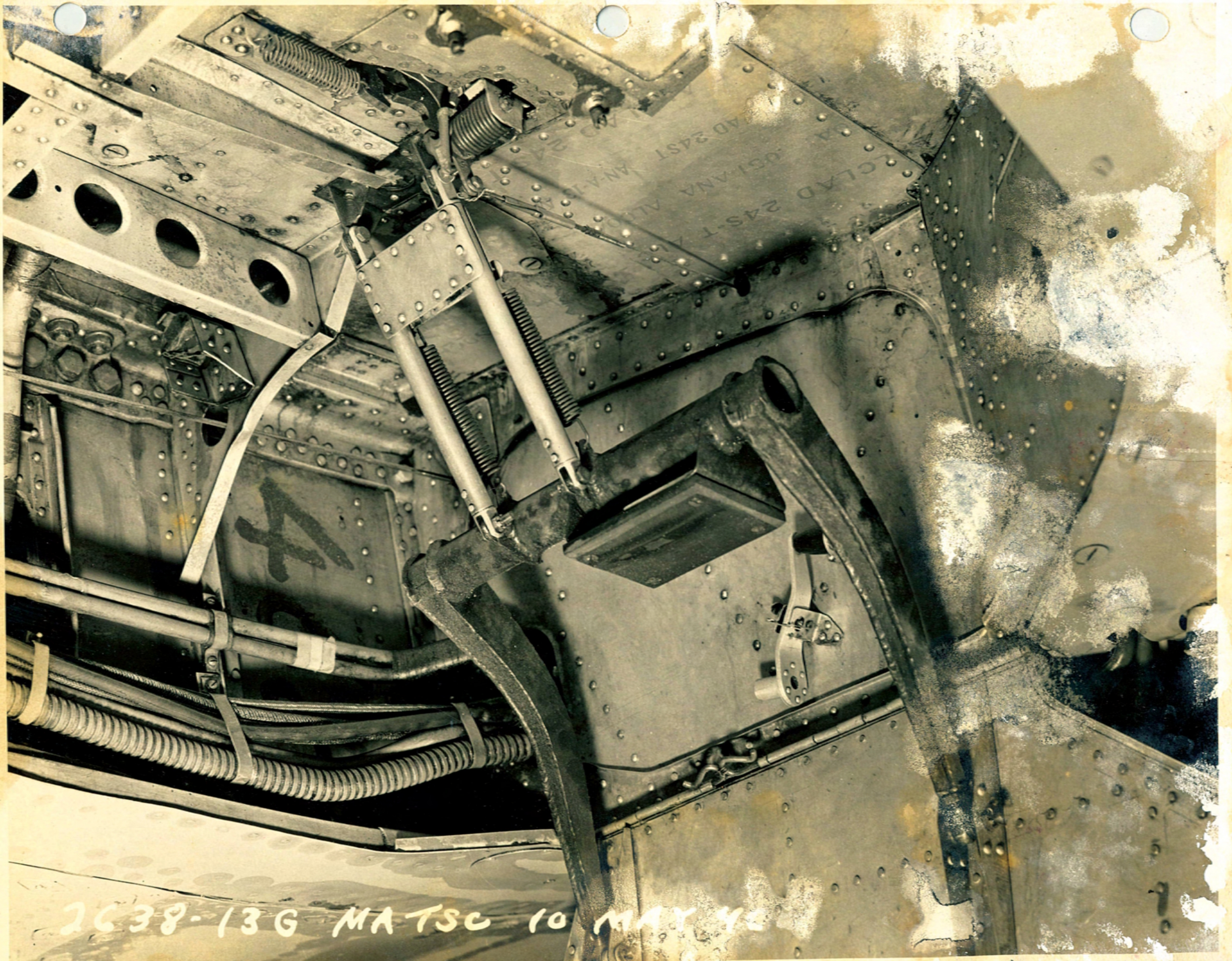
Ice-Eliminating Equipment---No provisions are made for de-icing equipment.

Pilot's Seat---The pilot's seat is adjustable up and down to accommodate the pilot's stature. By means of a handle on the left side of the seat, it may be raised or lowered.

Hydraulic System---The main supply of the hydraulic system fluid is carried in a hydraulic reservoir located just aft of the firewall on the top centerline of the fuselage. The fluid Specification No. is AN-VV-O-366. The filler is accessible through an inspection cover just aft of the firewall, on the upper side of the fuselage. The capacity of the tank is approximately 1.5 gallons or 6 liters.

The pressure for the system is supplied by the engine driven pump, located on the accessory section of the engine. The line from the tank to the pump leads behind the firewall to a disconnect fitting on the lower right side of the firewall. The pressure line from the pump leads through the lower left side of the firewall through a disconnect filling, then along the lower left side of the fuselage, to the pressure regulator.

The pressure regulator is located below, to the left and just aft of the pilot's seat. The pressure accumulator is located just aft and below the pressure regulator. The pressure regulator is set to regulate system pressure to 1000 lbs.


2C38-13G MATSC 10 MAY 44

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PUBLICATIONS-REPRODUCTION SECTION
---------MATSC---------
CREDIT LINE MUST BE GIVEN
IF RE-RODUCED.

Right Landing Gear Fairing, Latch Mechanism

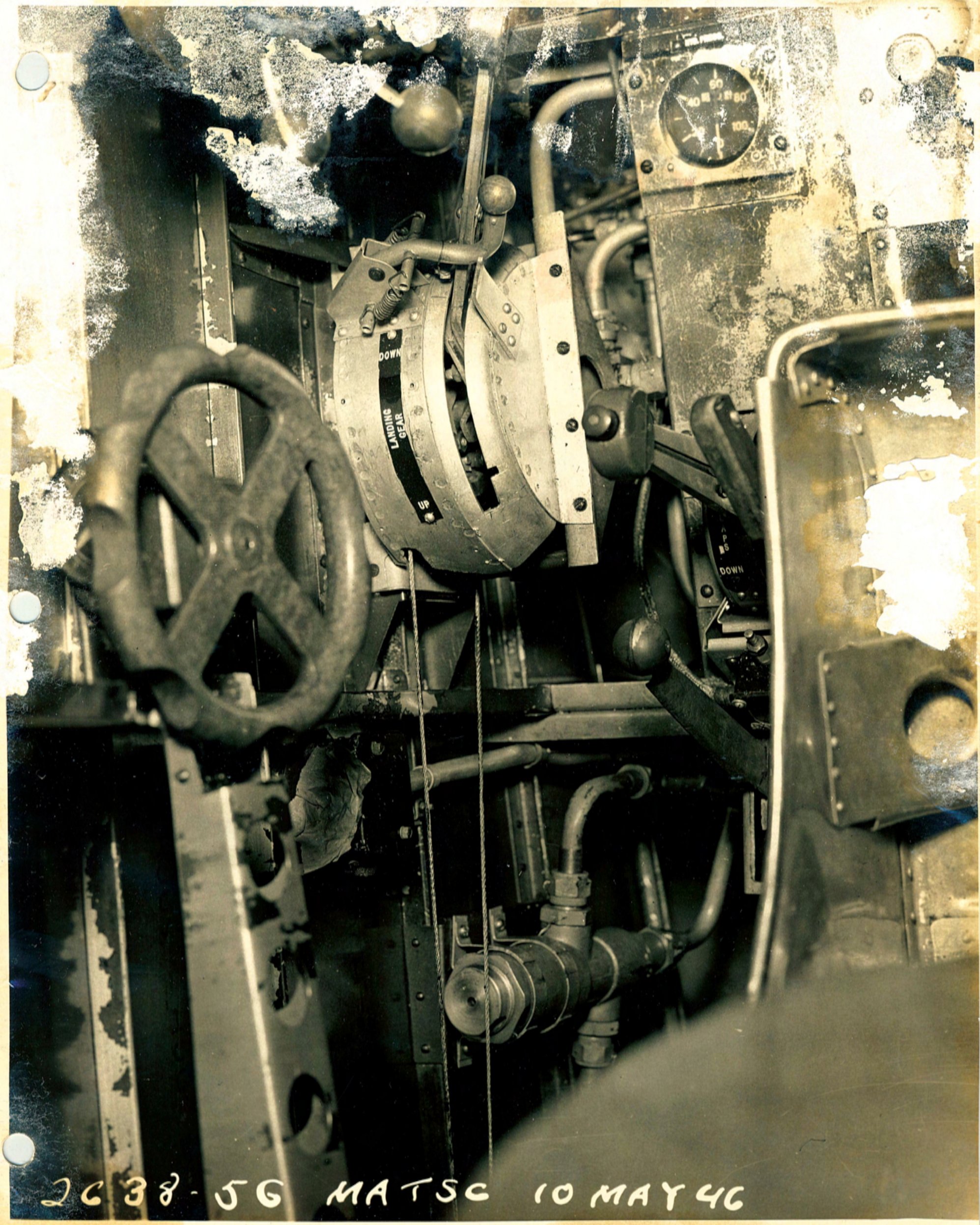
per sq. inch or 70 Kg. per sq. cm. The accumulator is preloaded to a pressure of 400 lbs. per sq. in. or 30 Kg. per sq. cm.

A manual dump or by-pass valve is incorporated in the system to by-pass or relieve the pressure on the pressure regulator when the system is not in use. It is located on the floor of the pilot's compartment near the left front side of the pilot's seat. The rear position of the dump valve operates the system and the forward position by-passes the pressure.

A pressure gage is connected to the pump pressure line to indicate engine pump pressure and system pressure when operated by the engine pump. It does not indicate pressures built up by the hand pump, or the accumulator pressure.

The hand pump is incorporated in the system as an auxiliary method of operating the system. The hand pump is located on the right side of the pilot's seat and actuated by fore and aft movement of the pump handle. Any part of the system may be actuated by operating the hand pump, the dump valve in pressure position and appropriate selection of the selector valves. The intake of the hand pump is a line from a lower point in the reservoir than the main supply, thereby providing a reserve of fluid for hand pump operation of the system. The line leads from the fluid tank aft along the upper part of the fuselage on the right hand side, down to the lower side of the fuselage just forward of the instrument panel, and then aft to the hand pump. There is a check valve in the pressure line from the hand pump to prevent a back-up of pressure when the system is being operated normally by the engine driven pump.

Landing Gear---The landing gear is actuated hydraulically by means of an actuating cylinder in each wing just aft of the landing strut well, and one in the tail wheel well. The landing gear selector valve is located to the left of the pilot's seat. Forward position selecting pressure to the "down" side of each actuating cylinder and the rear position is the "up" position. The lines lead to the main gear cylinders from the selector valve forward along the lower left side of the fuselage to the left wheel well. From there the lines are "T'd" and go out along a wing spar to the actuating cylinders. The lines lead to the tail



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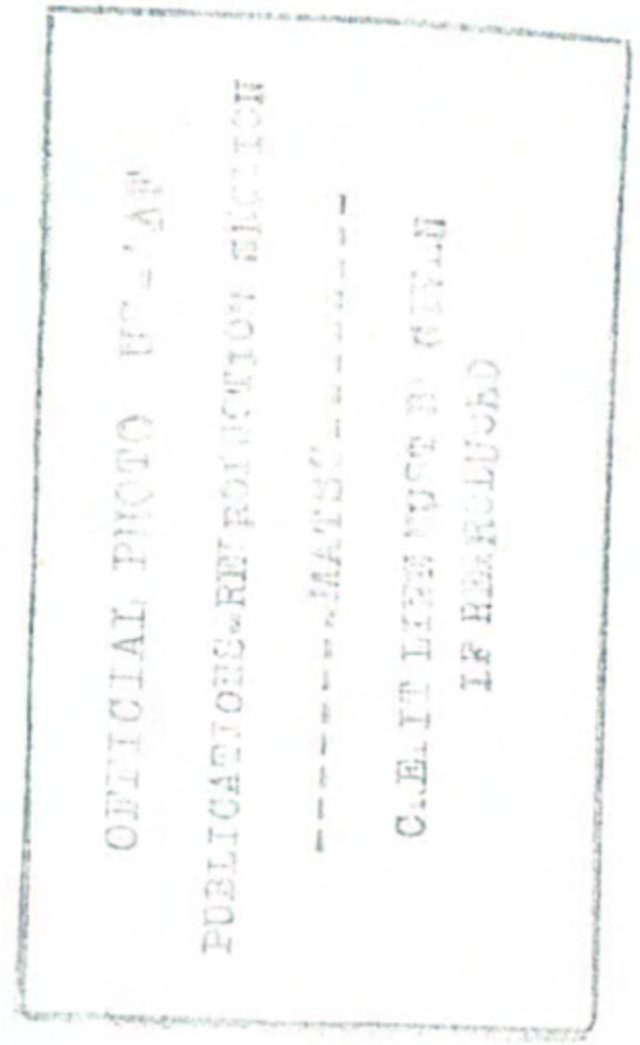
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PUBLICATIONS REPRODUCTION SECTION
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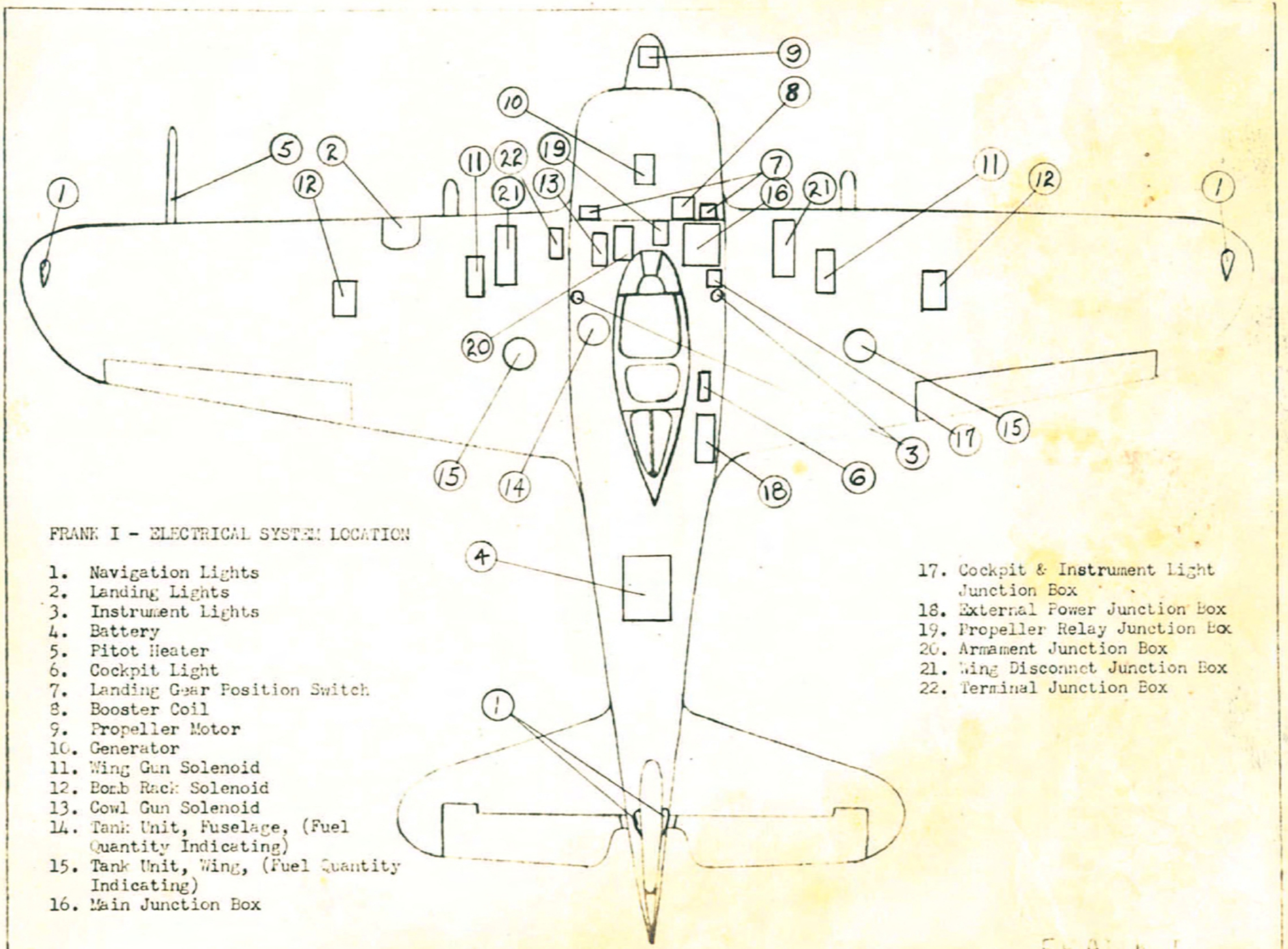

FRANK I - ELECTRICAL SYSTEM LOCATION

1. Navigation Lights
2. Landing Lights
3. Instrument Lights
4. Battery
5. Pitot Heater
6. Cockpit Light
7. Landing Gear Position Switch
8. Booster Coil
9. Propeller Motor
10. Generator
11. Wing Gun Solenoid
12. Bomb Rack Solenoid
13. Cowl Gun Solenoid
14. Tank Unit, Fuselage, (Fuel Quantity Indicating)
15. Tank Unit, Wing, (Fuel Quantity Indicating)
16. Main Junction Box
17. Cockpit & Instrument Light Junction Box
18. External Power Junction Box
19. Propeller Relay Junction Box
20. Armament Junction Box
21. Wing Disconnct Junction Box
22. Terminal Junction Box

FRANK I



2C38-1G MATSC 10 MAY 46

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DUPLICATION-REPRODUCTION SECTION
=======MATSU=======
C.E. IT LINE MUST BE GIVEN
IF REPRODUCED

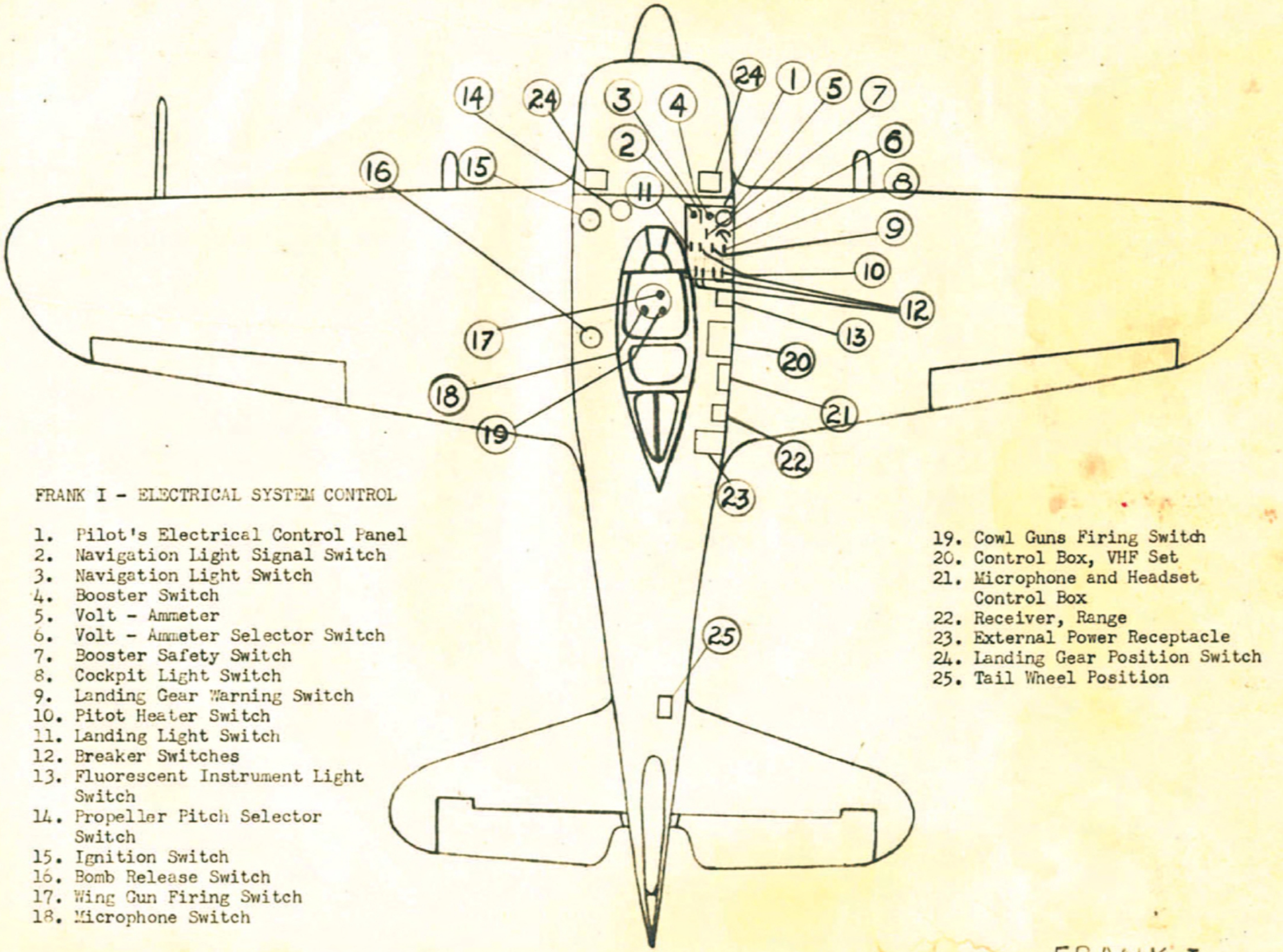
Battery Box, Installed

wheel cylinder from the selector valve and along the lower part of the fuselage. The locks are actuated mechanically by springs, and are released by a cable connected directly to each lock and also to the landing gear selector handle. There are four landing gear indicator lights and two pop-ups; two, indicating the up and locked position (red); and two, the down and locked position (green). The micro-switches that control these lights are located as follows: The main landing gear up switches are on the forward lower side of the firewall, just above the "up lock" latches. The "up locks" latch onto the towing lugs on the main landing gear. The "down locks" are on a linkage forward of the actuating cylinder, and are controlled by a spring and cam mechanism. The cam forcing the lock unlocked against spring pressure which holds the lock in place when the handle is in the "down" position. The cam also controls the "down" light switch. The switch that operates the "up lock" light for the tail wheel is located forward of the "up lock" latch, just above and to the left of the tail wheel strut. The "down" light switch is mounted on the retracting link and operated in conjunction with the lock.

The main landing gear cylinders are contracted when the main gear is down or extended, and the tail wheel cylinder is extended, when the tail wheel is down.

Flaps---The flaps are actuated hydraulically by one cylinder located just aft of the pilot's seat in the lower part of the fuselage. The landing flap selector valve is located to the left of the pilot's seat just aft and inboard of the landing gear selector valve. This valve has a neutral position to facilitate stopping the flaps in any position.

Cowl Flaps---The cowl flaps are actuated by means of hydraulic pressure. The selector valve is to the right and under the cockpit floor. The selector valve is controlled by a lever to the right of the pilot's cockpit and is connected to the selector valve by means of a cable. The cowl flap



FRANK I - ELECTRICAL SYSTEM CONTROL

1. Pilot's Electrical Control Panel
2. Navigation Light Signal Switch
3. Navigation Light Switch
4. Booster Switch
5. Volt - Ammeter
6. Volt - Ammeter Selector Switch
7. Booster Safety Switch
8. Cockpit Light Switch
9. Landing Gear Warning Switch
10. Pitot Heater Switch
11. Landing Light Switch
12. Breaker Switches
13. Fluorescent Instrument Light Switch
14. Propeller Pitch Selector Switch
15. Ignition Switch
16. Bomb Release Switch
17. Wing Gun Firing Switch
18. Microphone Switch
19. Cowl Guns Firing Switch
20. Control Box, VHF Set
21. Microphone and Headset Control Box
22. Receiver, Range
23. External Power Receptacle
24. Landing Gear Position Switch
25. Tail Wheel Position

FRANK I

actuating cylinder is located on the lower center of the engine mount.

Brakes---The brakes are hydraulic and operated independently of each other and of the power hydraulic system. The fluid is supplied from the same tank, and goes to each of two smaller master cylinders on the end of the rudder bar. Each cylinder is actuated by a linkage from the toe pedal on each rudder. The line from each cylinder passes out through the cockpit floor, forward along the lower side of the fuselage and along the front spar to the oleo strut, from there down along the strut to the brake actuating cylinder in each wheel.

Hydraulic Gun Chargers---Gun charging cylinders are located on each gun (inoperative). The control valves are located centrally and just beneath the pilot's instrument panel. The left valve or handle charges the wing guns, and the right one the nose guns.

Electrical System---The electrical system in this plane is the conventional 24 volt type with the storage battery located behind the pilot and accessible thru a door on the left side of the fuselage and to the rear of the cockpit. The external power receptacle is located on the right side of the fuselage below and in line with pilot's head rest. There are no external power switches or relays, a mechanical switch being incorporated into the receptacle which automatically disconnects the plane's battery when the external power plug is inserted into the receptacle. The main circuit breaker is located on the electrical control sub-panel to the right and below the main instrument panel.

The generator is 27 volt 56 amp. model and is located on the left side of the engine accessory section. The control panel is AAF equipment and is mounted on the left side of the cockpit aft of the throttle quadrant. A volt-ammeter is mounted in the electrical sub-panel and is equipped with a selector switch to read in voltage and amperage.

The starter is an inertia type, hand cranked and hand meshed. The pilot has no control over it since the system is ground crew operated.

The propeller may be compared to the electric four (4) bladed constant speed controllable pitch prop manufactured by Curtiss.

The governor also is very similar in operation to Curtiss Model 100002 although it differs slightly in construction. The main propeller breaker switch is located on the electrical control sub-panel beside the main breaker switch. The propeller pitch control switch is located on the main instrument panel at the extreme left above the landing gear indicator. This is a selector type switch with four positions. The center position is automatic, the left of center position is manual decrease R.P.M., and the right of center position is manual increase R.P.M. and down is "off". In addition to the electrical control there is a manual governor control located on the throttle quadrant.

There are several electrical indicating systems on the Frank. One of them is the landing gear and tail wheel position indicating system. The indicator is mounted on the main instrument panel in the lower left corner. The landing gear "up" switches are mounted on the lower right and left corners of the firewall just about the top of the wing panel. The landing gear "down" warning light switches are located on the gear locking link. The tail wheel position switches are located on the tail wheel gear assembly. The oil temperature indicating system consists of two bulbs and one indicator with a built-in selector switch. The instrument is mounted in the bottom row on the main panel, a little left of center. One bulb is located in the engine oil "in" line and the other in the "out" line which connects on the carburetor adapter. These two are similar to AAF equipment.

The last system is the fuel quantity indicating system. The indicator is located in the bottom row of instruments to the extreme right. This instrument also contains a selector switch for the separate tanks. The tank unit for the fuselage tank is mounted in the top of the tank and those for the wing tanks are mounted in the bottom of the tanks.

There are no lights installed in this airplane that are not absolutely essential. The landing light is built into the left wing and the control switch is mounted on the electrical control sub-panel. The navigation lights are mounted on each wing tip and the vertical stabilizer. The control switch is located on the electrical sub-panel also and in addition there is a push button switch inserted in the circuit to permit signaling. There are AAF fluorescent instrument lights mounted on each side of the fuselage and directed onto the instrument panel. The control switch is mounted in

a junction box on the right fuselage wall just above the electrical sub-panel. The AAF cockpit light is the conventional incandescent variety and is mounted on the right side of the fuselage below the pilot's seat level. The control switch for this light is located on the electrical control panel just above and to the right of the main circuit breaker switch.

The armament consists of two wing guns, two cowl guns and two external bomb racks. The guns are charged hydraulically and fired electrically. The switches for firing the machine guns are located in the control stick grip. The button under the guard fires the cowl guns and the guard itself when flipped back serves as a trigger to fire the wing guns. The bomb selector control box is located on the right fuselage wall at approximately knee heights. The bomb release switch is mounted on the end of the throttle control handle which is part of the throttle quadrant of the left fuselage wall.

Ignition System---The ignition switch is located on the left side fuselage wall forward of the throttle quadrant. The engine mounts a dual type magneto somewhat similar to our DF-18. The magneto, however, is located on the accessory section to the right and above the starter. This magneto incorporates no distributor as the distributors are a separate unit mounted on the engine nose section.

Radio---The radio equipment in this plane has been replaced completely throughout. For two way communication a SCR-274-N transmitter receiver was installed on the right fuselage wall, together with a control box which was also mounted on the fuselage right wall forward of the range receiver. A microphone and head-set control box is mounted between the range receiver and the set control box. The microphone switch is part of the microphone grip. The SCR-274-N is installed with a one wire hook-up, grounding the negative wire at the battery. For information concerning this sytem, refer to Technical Order No. 16-10-50.

Wing Group---The wings are built integral with the fuselage by riveted assemblies employing some bolted sections. The wing tips are detachable. A full cantilever wing is used.

Wing panels are constructed with double, load carrying, front spar and aluminum alloy sheets, and the rear spar transfers shear loads between upper and lower skin coverings. The remaining structures consist of ribs and stringers covered by a smooth dural skin,

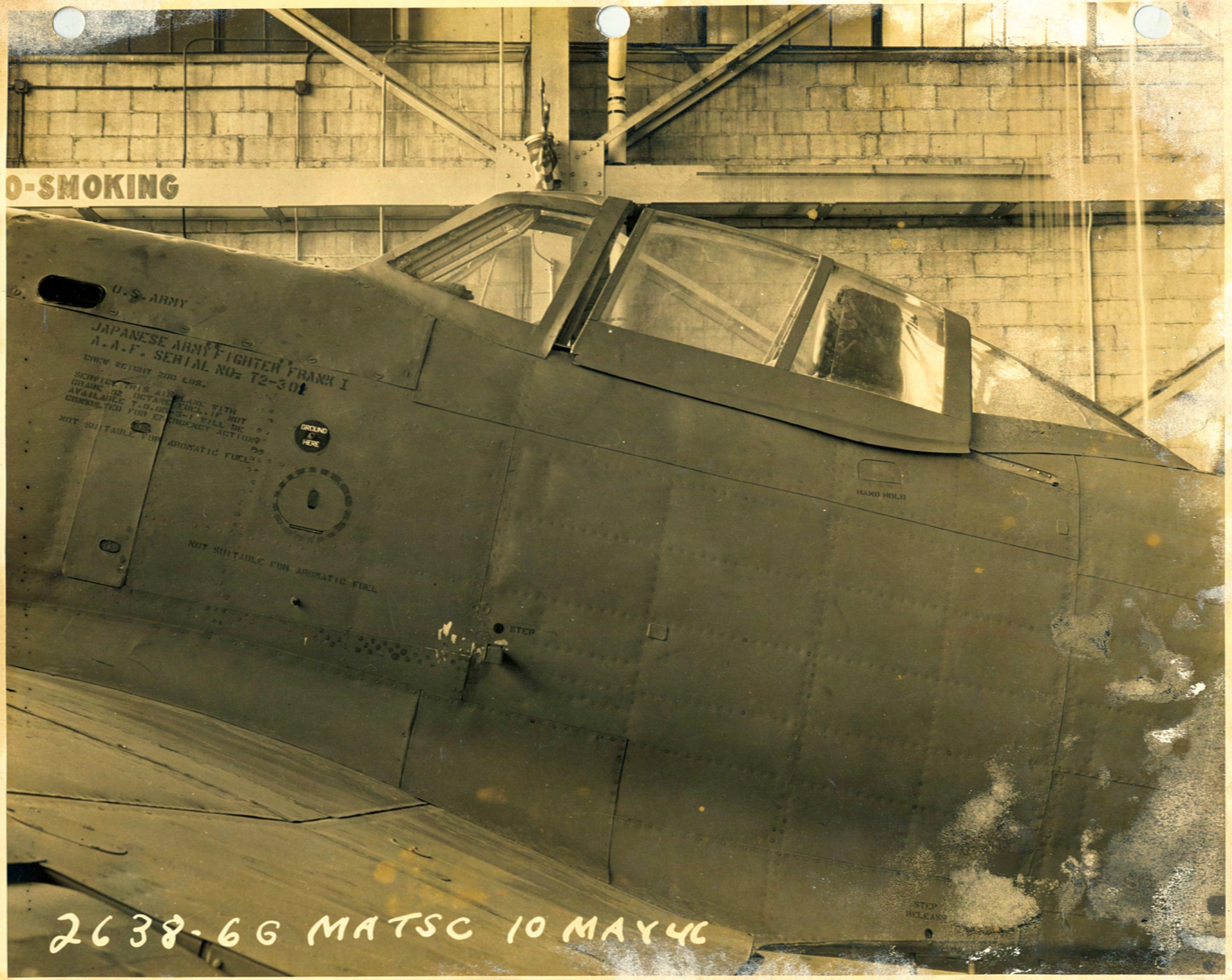
similar to our metal. The wing panels are riveted into the main fuselage members and the metal fairing is attached to the wing and fuselage permamently with rivets.

The main landing gear is attached to the front spar and a small false spar forward of the main spar. A rear false spar aft of the rear spar, is a shear beam and supports the wing flap hinges and aileron hinges. Wing tips are of the same fundamental construction as the wing panel but constructed entirely of plywood. They are attached to the wings by machine screws through skin coverings of wing panel and tip. Ailerons are constructed of dural metal with a single spar and ribs, covered with fabric. These surfaces are hinged to the wing panel with fittings containing self aligning bearings. Fixed trim tabs of metal are installed on each aileron.

The wing flaps are similar to the Fowler flap construction and are constructed of dural sheet metal, ribs and stiffeners covered with dural metal on both sides.

Tail Group---The horizontal stabilizer is of aluminum alloy construction. It has two spars, with the elevator hinges attaching into the rear spar. Dural skin is riveted to the ribs and stringers. The stabilizer is attached to the fuselage at eight points using aircraft bolts. The leading edge of the stabilizer as well as the tip are removable and constructed of metal. Fairing, attached by machine screws and nutplates, are used on all openings around the vertical and horizontal stabilizer.

The elevator construction is of dual construction with a single main spar, formed dural ribs and fabric covered. It is attached to the horizontal stabilizer with four fabricated dural fittings employing self aligning bearings. The trimming tabs are located on the inboard trailing edges of the elevators and are of all metal construction. The rudder is constructed similar to the elevators. The rudder is attached to the vertical stabilizer by three cast dural fittings containing self aligning bearings. The lower part of the rudder is covered with metal and the rest is fabric covered. A trim tab of metal is



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Fuselage Left Side, Canopy & Gas Tank Filler

located on the center of the trailing edge and is of the fixed type.

Body Group---The fuselage is of semi-monocoque construction and is constructed of dural metal throughout. The body is divided into three sections; namely, the engine nacelle, pilot's compartment and the tail.

The Engine Nacelle---The engine nacelle extends from the front of the engine cowling to the firewall and is attached to the firewall by the engine mount and accessory cowling.

Pilot's Compartment---The pilot's compartment is located from the firewall to a point just aft of the pilot's seat. Entrance to the pilot's cockpit is from the left side of the fuselage and trailing edge of the left wing by a series of steps and hand grips. A sliding canopy opened by sliding to the rear is the means of access to the cockpit.

Tail Compartment---The tail compartment extends from just aft of the pilot's seat to the extreme end of the vertical stabilizer. It is attached to the pilot's compartment by 72 one-quarter inch aircraft bolts and stop nuts. The oxygen equipment is located in this compartment as well as the radio. A fuel primer tank is located on the left side of this fuselage compartment. An access door on the left side of this compartment allows access to the interior of the formerly named equipment.

Movable Surfaces

General---The aileron, rudder and elevators are fabric covered. The movable elevator trim tabs and fixed aileron and rudder tabs are metal.

Ailerons---Ailerons are attached to wings by a center hinge and two end supports. A series of torque tubes connects ailerons to bottom of control stick. Adjustment is made at torque tube forward of ailerons; access door is underneath the wing. Each aileron has a fixed trim tab.

Rudder---Two cables, one from each end of a metal plate attached to the center of the rudder bar, travels under pulleys below the pilot's seat. Each cable is attached to two cables directly behind the pilot. In the tail section, the

double cables connect to a single cable which is connected to each end of a bellcrank. Adjustment is made at turn-buckles directly behind the pilot. The rudder has a fixed trim tab. Adjustment of rudder pedals is made at the center of the rudder bar.

Elevators---A torque tube from the control stick connects to the bellcrank behind the pilot. Cables connect the forward bellcrank with the rear bellcrank. Adjustable trim tabs are on each elevator, they are connected to the trim tab control on the left of the cockpit by cable and chain. A trim tab indicator is located behind the trim tab control.

Wing Flaps---The wing flap selector handle is located on the floor to the left of the pilot. Move forward to open and rearward to close. The flaps are cable connected to a drum which is actuated by movement of the hydraulic piston. The gear teeth on the piston contacts the gear teeth of the drum which winds cable on drum to close flaps and unwinds cable to open flaps. The cylinder and drum are located beneath the floor under the pilot's seat. The cables from the drum for each flap travel through pulleys located to rear of the pilot on the floor of the fuselage. From there, they attach to an arm fastened to flaps on the inboard side and wind on a drum outboard of the flaps. Gear teeth on drum contact the gear teeth on an arm which is attached to the flaps. Flaps move rearward and down on rollers, similar in action to the Fowler flaps.

Rudder - 14" R - L
Tension 100 lbs.

Elevator - 4-1/2" UP - 3" DOWN
Two center cables from the front bellcrank to bottom of the rear bellcrank have a tension of 75 lbs. Two outer cables to top of rear bellcrank have a tension of 100 lbs.

Elevator Tab - 1" UP - DOWN
Tension 20 lbs.

Aileron - 17° UP - 14° DOWN

Flap cable tension 300 lbs.
Flaps travel approximately 30°. Travel is limited to length of hydraulic piston movement.

Landing Gear---The landing gear is hydraulically operated. To operate, place control handle in desired position. Mechanical locks are cable connected to the landing gear control handle in the cockpit. The main gear retracts inward and up; it is streamlined by two sections of fairing. One section is attached to outboard side of landing gear; the other section is attached to inboard side of wheel well and actuated to open and closed position by the gear. Landing gear position switches are actuated by "up" and "down" locks. Position light indicators are located at the lower left of the control panel, two green lights for "down" and "locked" and two red lights for "up" and "locked". The landing gear control handle is located on the left side of cockpit; it has a hinged guard to prevent accidental movement from the "down" position. High pressure, treaded tires are installed on main landing gear and a solid rubber (no inner tube) tire is on the tail wheel. Air pressure for main gear tires is 4.5 Kg. per sq. cm. or 64 lbs. Expander tube brakes are installed (clearance of .005" to .006"). Brakes are actuated by the pressure on rudder pedals.

Engine and Propeller Controls---The throttle, automatic mixture and manual mixture controls, propeller and supercharger controls are grouped on one quadrant at the left of cockpit. Manually adjusted friction brakes hold controls in any desired position. The oil shutter control and cowl flap control are located on a quadrant at the right side of the cockpit. The oil shutter control has five positions, ranging from open to closed position giving a fine control adjustment to maintain desired oil temperature. The cowl flap control is a three position control; forward for "full open" and back for "full closed" and center for "neutral". The throttle, automatic mixture control and the propeller control are of the rigid tubing, push-pull type with bellcranks to actuate controls forward of the firewall. All other engine controls are of the cable and pulley type. On the right side of the instrument panel, under the cowl gun is the carburetor filter and carburetor heat control. Pull out and turn one-quarter turn clockwise for "on" position for both controls.

Engine Instruments---The engine instruments include the tachometer, cylinder temperature, exhaust temperature, oil temperature, oil pressure, fuel pressure, water pressure and hydraulic pressure gages.

The tachometer system is the electric type similar in operation to our Weston E-12, although it is of much simpler

construction. The generator is mounted on the upper right structural member of the engine mount and is connected to the engine pad by means of a flexible shaft.

The cylinder head temperature and exhaust temperature are both thermocouple type instruments. The cylinder head temperature thermocouples are placed in No. 4F and No. 4R cylinders (master rod cylinders). The instrument is calibrated in hundreds of degrees centigrade. The two positions, #1 and #2, on the cylinder head temperature gage indicate the front and rear head temperatures respectively. The thermocouple for the exhaust temperature indicator is situated in the exhaust stack of No. 16 cylinder and the exhaust indicator is also calibrated in hundreds of degrees centigrade. The range of this instrument is from 500° to 900° C.

The pressure instruments, oil pressure, fuel pressure, water pressure, and hydraulic pressure, are all Bourdon tube type instruments. All of these are calibrated to Kilograms per squdre centimeter.

Manifold Pressure Instrument---The manifold pressure indicator is essentially the same as AAF standard. It contains an aneroid type bellows or diaphragm assembly and the instrument itself is calibrated to indicate pressure in terms of centimeters of Mercury.

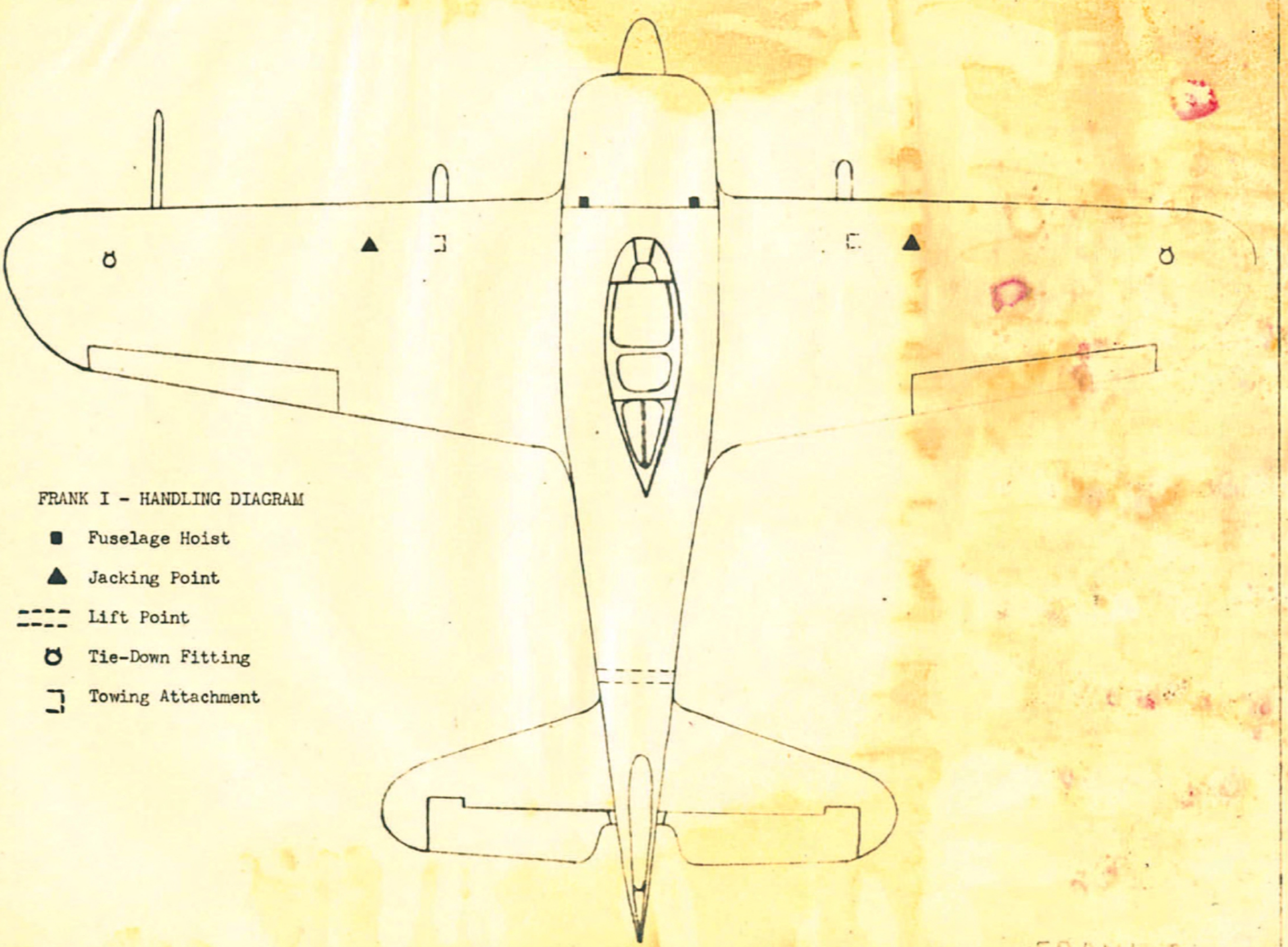
The oil temperature instrument is also very similar to a standard AAF model. It is connected to two temperature bulbs in this installation and a selector switch is used to select either one or the other. Switch selector to the left for oil temperature inlet and to the right for oil temperature outlet. The principle of operation is the same as that of a wheatstone bridge. The temperature bulbs are located in the oil lines to and from the engine.

The fuel quantity indicating system is electrically operated and consists of an indicator, tank units, and a selector switch to select the tank in which quantity is to be read. This instrument is different in principle and operation from U.S. types. This system utilizes a rotary type switch in the tank unit to vary the impressed

voltage across a series of coils which in turn exert a varying force on a permament magnet which is free to turn and to which the indicator pointer is fastened. This plane has three tank units and a three position selector switch. The selector switch is mounted in the instrument panel beside the indicator. A fuel warning light is also built into the indicator to indicate when the fuel quantity in the particular tank is below three gallons.

Flight Instruments---The flight instruments in the Frank are all U.S. manufacture with the exception of the bank and turn indicator and the compass. These two instruments are very similar to AAF types and are identical in operation.

Oxygen Flow and Pressure Gages---Standard AAF types.


FRANK I - HANDLING DIAGRAM
Fuselage Hoist
Jacking Point
Lift Point
Tie-Down Fitting
Towing Attachment
FRANK I

PART II

B. SPECIFIC MAINTENANCE INSTRUCTIONS

SECTION I

HANDLING AND GENERAL MAINTENANCE - INSTRUCTIONS

Hoisting---No provisions are made for hoisting.

Jacking---An aft jack point is installed just forward of the tail gear. Remove the smaller front bomb support under each wing and use fitting attached to wing as a jack point.

WARNING: WHEN USING WING JACKS CARE MUST BE EXERCISED TO PREVENT AIRPLANE FROM FALLING OFF JACKS. BOTH SIDES SHOULD BE RAISED SIMULTANEOUSLY. ALWAYS WEIGHT TAIL WHEN AIRPLANE IS ON JACKS. WHEN OPERATING LANDING GEAR WITH AIRPLANE ON JACKS, TAIL MUST ALSO BE JACKED BECAUSE THE TAIL WHEEL WORKS IN CONJUNCTION WITH THE MAIN GEAR RETRACTING SYSTEM.

Leveling---A leveling lug is under each side of canopy and painted red. Move canopy forward until lug lines up with red mark on top side of cockpit. Two lugs are for lateral leveling.

As a support for longitudinal leveling, place a piece of metal or flat board across the cockpit.

Towing---Lugs used for towing airplane are located inboard of each main wheel. Unlock tail wheel before towing airplane.

Lifting---Insert a lift tube or bar through the hole in rear of fuselage below leading edge of horizontal stabilizer. Lift airplane onto a solid support or use a hoist attached to each end of bar.

Mooring---Mooring brackets are installed under each wing approximately two feet from each wing tip. A small door with two dzus fasteners provides access to mooring brackets. The tail can be secured by attaching a rope to the lift bar or tail gear assembly.

Parking---No parking brakes are provided.

Surface Control Locks---No internal control locks are provided, but external locks may be installed.

Filling Fuel and Oil Tanks---There are five fuel tanks, fuel tank openings and drain plugs. The fuselage tank filler cap is on the left side of fuselage forward of cockpit, capacity of 57. 28 gallons. The filler caps for wing reserve tanks are outboard of guns. The main wing tank fillers are inboard of guns. Combined capacity of reserve and wing tanks is 45 gallons. The drain plugs for each wing tank are accessible through inspection doors fore and aft of bomb support assemblies. The drain sump for the fuselage tank is underneath the fuselage. The oil tank has a capacity of 24.3 gallons and is mounted on the forward side of the firewall. Remove piece of fairing on top left to fill tank. Use AN-VV-O-446 (1120 viscosity).

PART II

B. SPECIFIC MAINTENANCE INSTRUCTIONS

SECTION II

SERVICE INSTRUCTIONS

To Fill The Fuel Tanks---The fuselage tank is filled through an inspection hole cover over the filler neck on the left hand side of the fuselage, and forward of the cockpit. The capacity of the tank is 55 U. S. gallons.

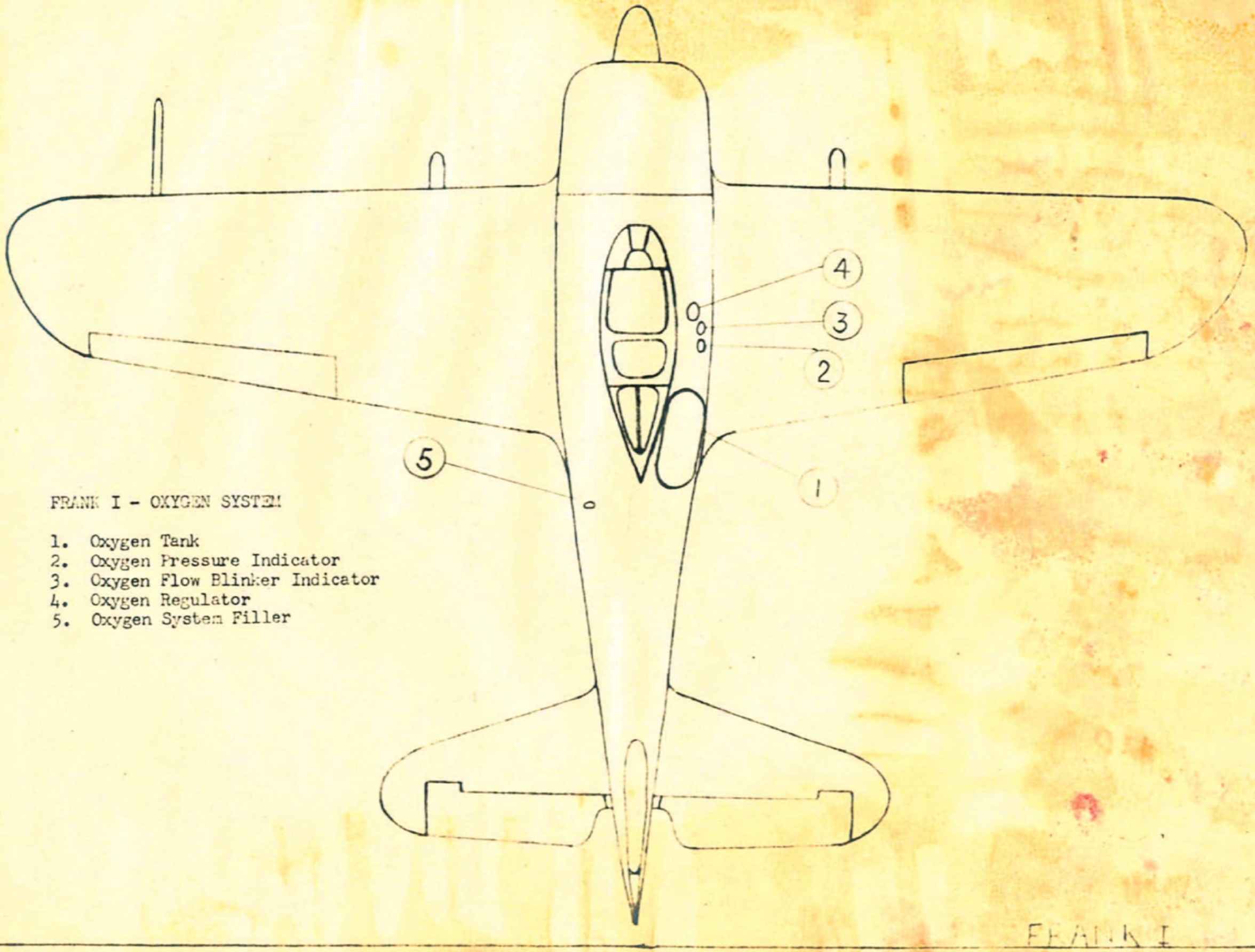
The main wing tank fillers are accessible through covers on each wing. The main wing tanks should be filled first, then the leading edge tanks should be filled. The leading edge tanks being filled through the fillers in the outboard end of the tank.

The anti-detonation injector tank is filled through a filler neck that is made accessible by removing the inspection cover between the two synchronized guns on the upper forward part of the fuselage. This tank has a capacity of 35 U.S. gallons. Use 50% water and 50% alcohol, Specification No. AN-A-24 composed of half ethyl and half methyl alcohol.

The priming tank is accessible through the fuselage access door on the left hand side of the fuselage. Its capacity is approximately two (2) gallons.

To Fill The Oil Tank---The oil tank filler is available through the left side of the cowling midway up. The filler cap is a conventional screw type cap. The capacity of the tank is approximately 24.3 U.S. gallons.

To Fill The Hydraulic Tank---The hydraulic reservoir is just ahead of the anti-detonation injector tank and is accessible through the same inspection cover. Its capacity is 1.5 gallon or 6 liters. Correct fluid is AN-VV-O-366. It should be filled to within two inches of the lower end of the filler neck. If the hydraulic system has become air bound caused by replacing lines, actuating cylinders, etc. the airplane should be placed on stands and all hydraulic equipment operated through several cycles to force out the trapped air. Then recheck the supply and replenish if necessary.



FRANK I - OXYGEN SYSTEM

1. Oxygen Tank
2. Oxygen Pressure Indicator
3. Oxygen Flow Blinker Indicator
4. Oxygen Regulator
5. Oxygen System Filler

FRANK I

To Charge The Accumulator---Release all hydraulic system pressure by means of the dump valve. Inflate the accumulator through the high pressure fitting on the top of the accumulator to a pressure of 400 lbs. per sq. inch.

To Inflate The Pneumatic Equipment---The main landing gear tires should be inflated to a pressure of 64 lbs. per sq. inch. To inflate the landing gear shock strut remove the cap from the air valve and use a high pressure air pump to inflate. The strut should be inflated so it is extended approximately three (3) inches with the airplane at the normal load condition. (NOTE: AAF high pressure valve chuck was installed.) While inflating the shock strut, rock the ship alternately, extend and compress the strut to overcome packing friction. After inflating, check the air valve and filler cap for air leaks with soapy water. Fill the tail wheel strut through the air filler plug located on the strut, so the strut will be extended three (3) inches with tail of aircraft in the normal load condition.

Filling Shock Struts---The shock struts should be filled with Hyd. Fluid Spec. No. AN-VV-O-366 Red, through the filler hole until the fluid is level with the filler hole. Insert the plug loosely and rock the ship causing extension and compression of the strut several times to eliminate air traps. Remove plug and check level again. If more fluid is added, repeat the process, replace and tighten plugs.

Armament Loading Instructions---For further armament information see the Armament Section, Page No. 12.

To Fill The Oxygen System---The oxygen filler for the low pressure AAF system is located just forward of the fuselage access door near the top of the door. The system should be filled to a pressure of 400 lbs. per sq. inch with aviator's breathing oxygen.

PART II

SECTION III

INSPECTION SCHEDULE

(All inspections will be accomplished in accordance with Technical Order No. 00-20A.)

Preflight and Daily

a. General -

(1) Check for correct oil and fuel quantities and enter on Form 1A.
(2) Make all entries necessary on Form 1A.
(3) Fire extinguisher nearby before starting engines.
(4) Flight controls unlocked if ship is to be flown.

b. Wing and Empennage Group - Fixed Surfaces -

(1) Check horizontal and vertical stabilizers for damage and obvious defects.
(2) Surfaces checked for cranks, loose rivets or screws, evidence of structural failure and obvious defects.
(3) Check fairing for cracks, dents and security of attachment.
(4) Inspection doors and covers checked for condition and security.

c. Movable Surfaces and Surface Controls -

(1) Check rudder, ailerons, elevators and trim tabs for breaks, wear, tear, distortion or other damage.
(2) Check all controls for full travel and free movement.
(3) Check flaps for full travel and free movement of rollers on tracks.
(4) Check for security of attachment of all control

surfaces.

(5) Check alignment of movable surfaces when controls are in neutral position.
(6) Inspect controls for interference with other assemblies or structures.
(7) Inspect all cables and rods for security and proper safetying.

d. Engine Cowling and Nacelle -

(1) Check cowling for damage or obvious defects.
(2) Check all cowling for security.
(3) Cowl flaps checked for loose rivets, chafing and excessive looseness.
(4) Supports checked for cracks or other defects.

e. Fuselage -

(1) Clean cockpit and windshield.
(2) All articles that could foul or jam controls will be properly attached, stowed or removed.
(3) Check security of all inspection doors and covers.
(4) Check for deep scratches, dents, cracks, and bulges in fuselage skin.
(5) Inspect canopy for general condition, security and functioning.
(6) Check fire extinguisher for contents, security of mounting brackets, opening unobstructed, tag intact, security in bracket yet easily removable.
(7) Oxygen cylinder checked for proper pressure.
(8) Check fuel tanks and lines for evidence of leaks and security.
(9) Check safety belt for cuts, fraying, cleanliness and latching device for proper operation.

f. Hydraulic System -

(1) Check fluid level in hydraulic reservoir.
(2) Check visible lines and hydraulic units for leaks.
(3) Check hand pump operation.
(4) Check accumulator pressure.
(5) Brakes checked for proper operation.

g. Landing Gear -

(1) Check landing gear strut for proper oil level, fluid leaks and proper extension.
(2) Clean exposed part of piston tube with cloth saturated with same hydraulic fluid used in struts.
(3) Check tires for wear, breaks, cuts, chafing and proper inflation (64 lbs.).
(4) Check wheels for distorted rim flanges, security of retaining nut, bolts and cotter pins.
(5) Inspect complete landing gear for general condition of struts, braces, fittings and cylinders.
(6) Check security and safety of fairing.
(7) Check brake pressure.

h. Oxygen System -

(1) Oxygen supply checked (400 lbs. per sq. inch).
(2) Check lines for damage.
(3) Check regulator for proper functioning.
(4) Emergency valve safetied.
(5) Collar on regulator and hose clamp checked for security.
(6) Regulator diaphragm checked for leaks.

i. Fuel System -

(1) Check fuel quantity and safetying of filler.
(2) Inspect surrounding structure of tanks for leaks.
(3) Check fuel selector valves for proper operation.
(4) During engine run-up check fuel and water pressure gages for correct readings.
(5) Drain strainer in wobble pump body.
(6) Check wobble pump for proper operation.
(7) Check air filter.

j. General Power Plant -

(1) Remove sufficient cowling to completely check engine visually.
(2) Check intake pipes for looseness.

(3) Check exhaust manifold and clamps for excessive looseness and security.
(4) Check for evidence of excessive oil leaks.
(5) Check for evidence of fuel leaks.
(6) Check drain plugs for security and safetying.
(7) Check all connections for tightness and condition.
(8) Check engine cowling for defects and security of attachment.

k. Instruments -

(1) Pitot heating unit tested for proper operation.
(2) Cover glasses checked for breaks, looseness, proper operating limits, etc.
(3) Cover glasses cleaned with a soft, dry cloth.
(4) Instruments checked for correct pointer position.
(5) Compass inspected for discoloration of liquid and bubbles.
(6) Clock wound and set to Operation Office time.
(7) Free air thermometer indication checked against known temperature.
(8) Altimeter set to station altitude or as directed by pilot.
(9) Rate of climb indicator set to zero.
(10) Air speed indicator pointer indicates zero or value of wind velocity component.
(11) Mounting panel checked for proper movement.
(12) Manifold pressure gage reading checked with station barometer.
(13) Pointer tolerances checked at zero.
(14) Flexible shafts checked for whipping, kinks and bends.
(15) Warning signals checked for proper functioning.
(16) Operating range markers on tachometer checked for location and condition.

l. Oil System -

(1) Check oil quantity in tanks.
(2) Check and clean oil sump screens.
(3) Check oil cooler shutter for proper operation.
(4) On engine run-up check pressure and temperature gages.

m. Propellers and Accessories -

(1) Clean propeller and examine blades for bends, dents, cracks or nicks.
(2) Clean spinner and check for security and damage.
(3) Check governor control for proper operation.
(4) Check governor and connections for security of attachment.
(5) Pull propeller through ten revolutions.

n. Ignition and Electrical -

(1) Generator inspected for cracked housing or flanges and security of mounting.
(2) Starter inspected for evidence of oil in gear case or flywheel housing.
(3) Starter inspected for cracked housing or flanges and security of mounting.
(4) Starter housing bolts checked for tightness and safetying.
(5) Coils and solenoids checked for security of all attaching bolts, connections, etc.
(6) Magneto checked for cracked housing and security of mounting.
(7) Specific gravity reading of two battery cells checked.
(8) Battery vent and overflow lines checked for condition.
(9) Battery terminals and boxes checked for corrosion and leaks.
(10) Operation of all lights checked.
(11) All lamps checked for proper functioning, lenses checked for security.
(12) Fluorescent and other bulbs checked for ample supply.

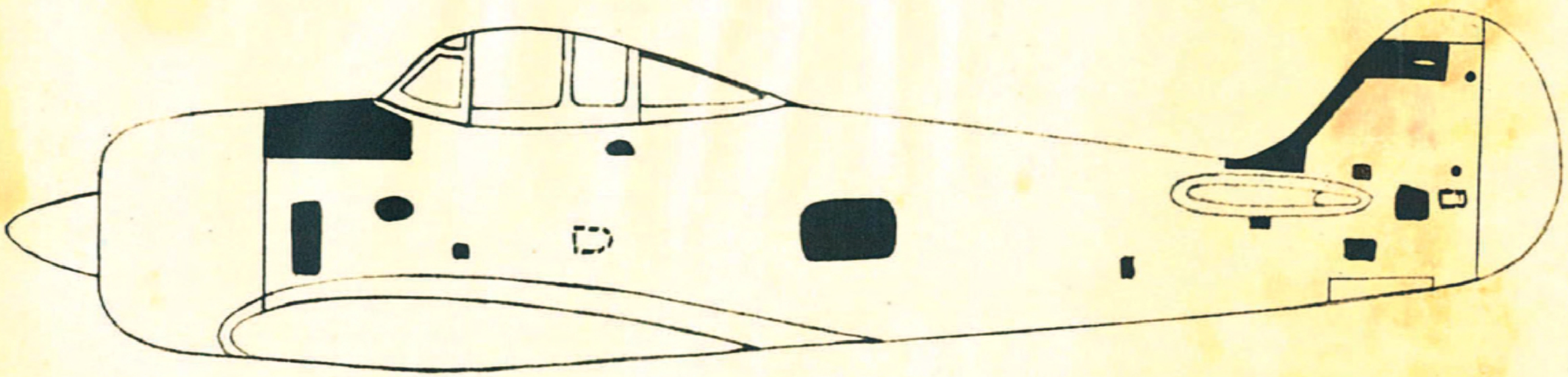
o. Armament -

(1) Check operation of bomb racks electrically and manually.
(2) Check ammunition for burrs, short or bent rounds and other defects.
(3) Check alignment of feed and ejection chutes.
(4) Check hydraulic charging units for leaks and operation.

(5) Check operation of sight.
(6) Check internal mechanism of gun for wear, burrs and smoothness of operation.

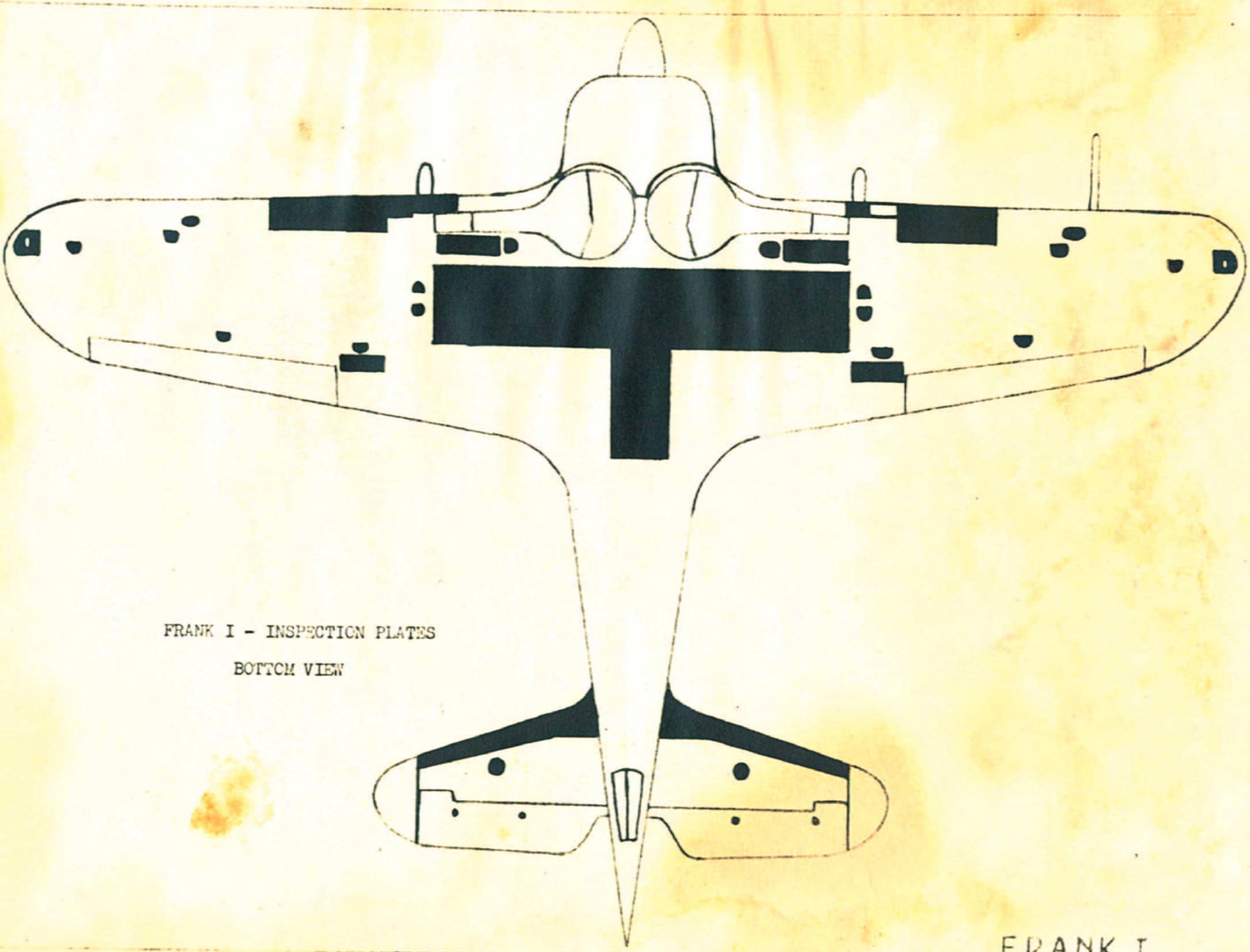
p. Operational Check During Warm-Up -

(1) Engine controls checked for proper functioning.
(2) Engine instruments checked for readings consistent with stage of warm-up.
(3) Oil pressure gage checked.
(4) Oil pressure checked.
(5) Oil temperature checked. (NOTE: Selector switch for oil "in" and oil "out".)
(6) Fuel pressure checked.
(7) Water pressure checked.
(8) Hydraulic system pressure checked.
(9) Ammeter and voltmeter checked for charge and voltage.
(10) Propeller operation checked.
(11) Propeller selective fixed pitch and automatic operation checked.
(12) Magnetos checked. Swing ignition from "BOTH" to "L" to "BOTH" to "R". (NOTE: Maximum permissible drop on one magneto is 75 R.P.M.)
(13) Ignition system checked.
(14) Engine cowl flaps checked for proper operation.
(15) Oil cooler shutter checked.
(16) All surface controls checked for full travel and free movement.
(17) Position indicators checked for proper indication.
(18) Fuel pressure gage checked for proper indication.
(19) Cylinder head temperature checked.
(20) Vacuum gage checked with engine operating at 1000 R.P.M. or more.
(21.) Check vacuum pump operation.
(22) Check carburetor air temperature control.



FRANK I - INSPECTION PLATES

SIDE VIEW



FRANK I - INSPECTION PLATES

BOTTOM VIEW

Twenty-five (25) Hour Inspection

a. Wing and Empennage Group - Fixed Surfaces -

(1) Same as Preflight and Daily Inspection.

b. Movable Surfaces and Surface Controls -

(1) Complete Preflight and Daily Inspection.
(2) Inspect all cables at drum assemblies for security of attachment.
(3) Check movable surfaces for signs of failure at hinge points.
(4) Inspect fabric for tears or wear.

c. Engine Cowling and Nacelle -

(1) Same as Preflight and Daily Inspection.

d. Fuselage -

(1) Complete Preflight and Daily Inspection.
(2) Check first aid kit for broken seal and proper installation.
(3) Check seat for security of attachment, condition and functioning of adjusting mechanism, breaks or cracks in seat.
(4) Check date of last inspection on safety belt.

e. Hydraulic System -

(1) Accomplish daily inspection.
(2) Check lines and connections for leaks.
(3) Check selector valves for proper operation.
(4) Check flexible hoses for deterioration.
(5) Check cylinders for proper operation and leaks.
(6) Pressure regulator checked for proper operation.
(7) Accumulator checked for proper operation.
(8) Brake master cylinders and brake lines checked for leaks.

f. Landing Gear -

(1) Complete Preflight and Daily Inspection.
(2) Lubricate zerk fittings.

(3) Check brakes for fluid leakage and entrapped air. Bleed brakes if necessary.
(4) Check brake lines for wear or chafing and security of connection.
(5) Check clearance of brakes (.005 - .006 inches).

g. Oxygen System -

(1) Accomplish Preflight and Daily Inspection.
(2) Check cylinder, regulator, tubing for security of mounting, leaks, dents, corrosion and loose clamps or connections.

h. Fuel System -

(1) Accomplish Daily Inspection.
(2) Check engine driven pumps for security of mounting and all lines for security, chafing and deterioration.
(3) Open fuel cooler selector and check cooler for leaks.
(4) Check tank caps for proper sealing.
(5) Check all vents and drains for kinks, stoppage.
(6) Clean strainer in water line.
(7) Check carburetor heater for proper operation.

i. General Power Plant -

(1) Complete Preflight and Daily Inspection.
(2) Check cylinders for damaged or broken fins.
(3) Inspect entire engine control installation from levers in pilot's compartment to engine for free movement, bent rods, frayed cables, loose or broken pulleys.
(4) Clean oil screens.

j. Instruments -

(1) Complete Daily and Preflight Inspection.
(2) Thermometer bulbs checked for proper tightness.
(3) Thermometer electrical connectors checked for looseness.

k. Oil System -

(1) Previous inspection accomplished.

(2) Check lines for leaks, dents, cracks, chafing and security.
(3) Check cooler for security and obstruction.
(4) Check and clean oil screen.

l. Propellers and Accessories -

(1) Complete Preflight and Daily Inspection.
(2) Remove spinner and check tightness of bolts, nuts and screws.
(3) Check power unit for evidence of leaks.

m. Ignition and Electrical -

(1) Complete Daily and Preflight Inspection.
(2) Landing lights checked for operation and reflectors and sealing strips checked for general condition.
(3) Signal and running lights checked for condition and operation.
(4) Generator external connections checked for cleanliness and tightness.
(5) Spark plugs checked for security of shielding elbow nuts, general condition.
(6) Specific gravity reading of all battery cells checked.
(7) Battery vent sump checked and pads treated with solution of sodium bicarbonate and water.
(8) Battery mounting bolts checked for snug condition to prevent shifting.
(9) Voltage regulator checked for tightness of connections, condition of leads.
(10) Voltage regulator checked for proper volt setting of 28.0 volts, adjust if necessary.
(11) Voltage regulators checked for excessive dirt or grease, clean with clean dry cloth.

n. Armament -

(1) Complete Preflight and Daily Inspection.
(2) Check bomb racks for cracks, corrosion and attachment.
(3) Check guns and mounts for defects and security of mounting.
(4) Check feed and ejection chutes for alignment and defects.
(5) Check electrical connections for wear & attachment.

Fifty (50) Hour Inspection

a. Wing and Empennage Group - Fixed Surfaces -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check security of attachment of wing tips.
(3) Check wings for broken ribs, corrosion, open grommet drains and missing rivets.
(4) Check attachment fittings for defects, security and elongated bolt holes.

b. Movable Surfaces and Surface Controls -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check cables for fraying.
(3) Check hydraulic flap cylinder for leaks.
(4) Check elevator tab control for play or looseness.
(5) Check pulleys and fairleads for excessive wear, looseness and security of attachment.
(6) Check all torque rods for wear, security and safetying.
(7) Inspect control assemblies in cockpit for wear, cracks, rubbing against other assemblies and security of attachment.

c. Engine Cowling and Nacelle -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check engine mount for cracks, corrosion, signs of failure and security of mounting.

d. Fuselage -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check fuselage for general condition, corrosion, loose bolts or rivets, bent or cracked longerons and braces. Check security of inspection doors.
(3) Check windshield and sliding enclosure for condition of frame and security of attachment, breaks or cracks in glass, condition and operation of mechanism for opening and closing enclosure.
(4) Fire extinguisher removed and inspected for leakage.

e. Hydraulic System -

(1) Twenty-five (25) Hour Inspection accomplished.
(2) Engine driven pump checked for security and safetying.

f. Landing Gear -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Support airplane on jacks. Test functioning of retracting and extending mechanism. Inspect all moving parts for wear.
(3) Check fairing doors for correct adjustment, freedom of movement and security of attachment.
(4) Check operation of hand pump, selector handle and condition of hydraulic lines.
(5) Check operation and security of attachment of locks.
(6) Check condition and security of attachment of lock control cables and pulleys.
(7) Remove tires and inspect for breaks, cuts, blisters or other damage to inside or outside of tire.
(8) Remove tubes, inspect for wrinkles, cuts, creases, thin spots and attachment of valve to tube.
(9) Check functioning of indicator lights and warning horn.
(10) Check brake discs for cleanliness.

g. Oxygen System -

(1) Accomplish Preflight and Daily Inspection.
(2) Check cylinder, regulator, tubing, for security of mounting, leaks, dents, corrosion and loose clamps or connections.

h. Fuel System -

(1) Accomplish previous inspection.
(2) Check fuel quantity gage for correct calibration.
(3) Check priming system for leaks, loose lines.
(4) Check all carburetor controls for security and proper operation.

i. General Power Plant -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check push rod tubes for security.
(3) Check propeller governor and engine accessories for mounting.
(4) Inspect all lines for proper connection and chafing.
(5) Check cylinders for security of attachment.

j. Instruments -

(1) Complete Daily and Preflight and Twenty-five (25) Hour Inspections.
(2) Instruments inspected for chipped markings and security of mounting.
(3) Mounting panel vibration absorbers inspected for general condition, deterioration, etc.
(4) Panel, lines and instruments checked for proper bonding.
(5) Rate of climb indicator checked for security of attachment and tightness of connections.
(6) Bank and turn, gyro horizon indicator screens and filters cleaned.
(7) Air speed lines checked for security and tightness and drained.
(8) Air speed tube secure, holes cleaned.
(9) Air speed tube drain plug removed and water drained.
(10) Thermocouple thermometers checked as to "zero" positions.
(11) Tachometer indicator and generator checked for security of mounting and satisfactory leads.
(12) Thermocouple leads checked for cleanliness and tightness.
(13) Thermocouple connectors checked for proper anchorage, condition of tape and clamps.
(14) Tachometer generator checked for security of mounting and tight electrical connections.

k. Oil System -

(1) Accomplish Twenty-five (25) Hour Inspection.
(2) Check oil tank for leakage security of mounting, padding, deterioration.

(3) Check tension on tank support straps.

l. Propellers and Accessories -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check control rods for wear, condition and security.
(3) Governor contact assemblies checked for cleanliness, wires for condition.
(4) Slip rings and brushes checked for condition and wear.

m. Ignition and Electrical -

(1) Complete Daily and Preflight and Twenty-five (25) Hour Inspection.
(2) Generator checked for presence of oil in generator.
(3) Generator inspected for dirty or loose connections and conditions of terminals.
(4) Generator checked for worn or sticking brushes and loose connections.
(5) Generator commutator checked for cleanliness, pitting, wear or scoring.
(6) Magneto breaker covers removed, condition and adjustment of contact points checked.
(7) Magneto distributor inspected for proper condition of parts and functioning.
(8) Ignition harness shielding inspected for condition, proper anchorage, security of union nuts.
(9) Generator cable connector nuts checked for proper safetied condition.
(10) Voltage regulator checked for condition of contact points, condition of wiring, terminals, insulation, signs of overheating, general condition.
(11) Voltage regulator checked for proper voltage setting of 27.5 to 28.5 volts with no load.
(12) Instrument wiring checked for security of anchorage, condition of insulation.
(13) All switches, rheostats and position indicators checked for condition, security of mounting and proper operation.

n. Armament -

(1) Complete preceding inspections.
(2) Disassemble guns, clean and check for burrs, cracks, wear and smoothness of operation.
(3) Reassemble and lubricate parts.

One Hundred (100) Hour Inspection

a. Wing and Empennage Group - Fixed Surfaces -

(1) Same as Fifty (50) Hour Inspection.

b. Movable Surfaces and Surface Controls -

(1) Complete Fifty (50) Hour Inspection.
(2) Check tension of control cables.

c. Engine Cowling and Nacelle -

(1) Same as Fifty (50) Hour Inspection.

d. Fuselage -

(1) Complete Twenty-five (25) Hour Inspection.
(2) Check fuselage for general condition, corrosion, loose bolts or rivets, bent or cracked longerons and braces. Check security of inspection doors.
(3) Check windshield and sliding enclosure of condition of frame and security of attachment, breaks or cracks in glass, condition and operation of mechanism for opening and closing enclosure.
(4) Fire extinguisher removed and inspected for leakage.

e. Hydraulic System -

(1) Include previous inspections.
(2) Pump lines checked for security, chafing and deterioration.
(3) Pressure gage checked for proper indication.

f. Landing Gear -

(1) Complete Fifty (50) Hour Inspection.
(2) Grease bearings.

g. Oxygen System -

(1) Accomplish Fifty (50) Hour Inspection.
(2) Emergency valve safety removed and regulator checked for emergency flow.

h. Fuel System -

(1) Include previous inspection in One Hundred (100) Hour Inspection.
(2) Check operation of water relief valve.
(3) Tighten all hose connections and check all lines for tightness, safetying, deterioration.

i. General Power Plant -

(1) Complete Fifty (50) Hour Inspection.
(2) Check cowl flaps, cowling and fairing for general condition.

j. Instruments -

(1) Complete Preflight and Daily, Twenty-five (25) Hour and Fifty (50) Hour Inspections.
(2) Compass swung and compensated per T.O. 03-15-3.
(3) Air speed tube installation checked for voltage drop and for leaks.
(4) Bank and turn indicator lubricated.

k. Oil System -

(1) Accomplish previous inspection.
(2) Oil changed unless clarified every Twenty-five (25) Hours.
(3) Dirt and sludge removed from vent lines.

l. Propellers and Accessories -

(1) Complete Fifty (50) Hour Inspection.
(2) Power unit removed and adjusted for proper brake clearance.
(3) Inspect power unit for seal damage, condition of hub and power unit contacts.
(4) Propeller shaft nut checked for tightness.
(5) Relay box checked for security of mounting and cracks in supports.
(6) Relay contact points checked for condition and proper clearance, terminals, and wire connections checked for tightness.
(7) Lubricate hub with grease.

m. Ignition and Electrical -

(1) Complete Daily and Preflight, Twenty-five (25) Hour and Fifty (50) Hour Inspections.
(2) Magneto cam oiler pushed ONCE as far as it will go.
(3) Spark plugs replaced with serviceable plugs of an approved type.
* (4) All wiring inspected for chafing, proper installation, security of anchorage.
* (5) All wiring inspected for proper installation of grommets, electric plastic tubing, adapters and proper taping.
* (6) Junction boxes checked for drain holes at lowest point.
* (7) Junction boxes checked for condition of connections.
* (8) All electrical connections inspected for solder deterioration, corrosion, misaligned terminals which indicate excessive vibration.
* (9) Terminal strips checked for cracks, breaks and tightness.
* (10) Bonding and grounding jumpers checked for breakage, deterioration and fraying.
x (11) Battery tested per procedure in T.O. 03-5B-1.
* (12) Fuse clips checked for proper tension. Should hold fuse securely.
(13) Instrument electrical connections checked for cleanliness and lightness.
° (14) Fluorescent lamps and switches tested. Darkened lamps replaced.

n. Armament -

(1) Complete preceding inspections.

* First One Hundred (100) Hours and every Two Hundred (200) Hours thereafter. T.O. 01-1-68.
x Two Hundred (200) Hours or Thirty (30) Days (whichever comes first).
° Two Hundred (200) Hours. T.O. 03-5G-1.

PART II

B. SPECIFIC MAINTENANCE INSTRUCTIONS

SECTION IV

ENGINE CHANGE

A. Removal from Aircraft

1. Remove propeller spinner and propeller.
2. Remove cowling.
3. Remove synchronized guns.
4. Remove synchronized gun housings.
5. Drain oil tank and sumps.
6. Disconnect all electrical plugs and fittings.
7. Disconnect all fuel and oil lines.
8. Disconnect all hydraulic and vacuum lines.
9. Remove carburetor air filter and scoop.
10. Remove oil tank.
11. Disconnect oil cooler, air filter, carburetor and prop controls.
12. Attach sling to lifting lugs on engine, and hoist engine and engine nut assembly.
13. Remove engine mount nuts.
14. Remove engine and mount from aircraft.
15. Remove cowling ring and cowl flap assembly.
16. Remove engine from mount.
17. Remove accessories to be replaced on new engine.

B. Engine Installation

1. Install accessories on new engine.
2. Install engine in mount.
3. Install cowling ring and cowl flap assembly.
4. Hoist engine assembly in place on firewall.
5. Replace engine mount nuts and safety.
6. Reconnect fuel, hydraulic and vacuum lines.
7. Reconnect electrical connections.
8. Install oil tank and oil lines.
9. Install carburetor air filter and scoop.
10. Connect carburetor, propeller, air filter and oil cooler controls.
11. Replace synchronized gun housings.

12. Replace synchronized guns.
13. Check all connections for tightness and safetying.
14. Install propeller and propeller spinner.
15. Install cowling.
16. Fill oil tank.

NOTE: It is recommended that the engine in this airplane be changed after four hundred (400) hours normal operation.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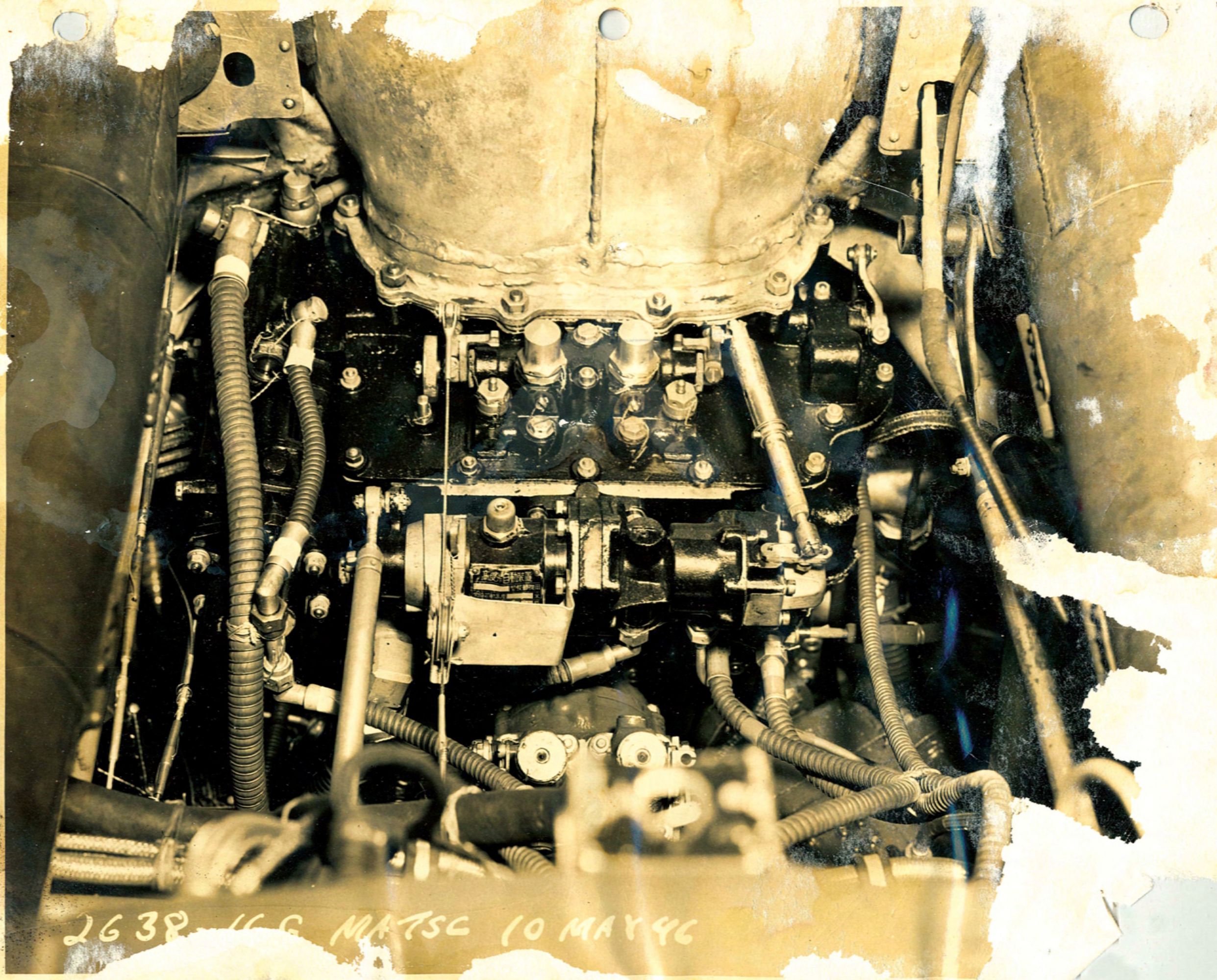
C.E. IT LINE MUST BE GIVEN
IF RE-ROLUCED

Engine Installation, Left Side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---------MATSC---------
CREDIT LINE MUST BE GIVEN
IF REPRODUCED

Engine, Installation, Top View Showing Carburetor

PART II

C. ENGINES

ENGINE MANUFACTURER

MANUFACTURED BY - NAKAJIMA

ENGINE NUMBER - 123041

MODEL - TYPE 99

REMOVED FROM FRANK I FE-301

ENGINE OVERHAULED 25 MARCH 1946

TABLE OF SPECIFICATIONS

Type	Two row, radial air-cooled
Number of cylinders	18
Bore	5.12"
Stroke	5.91"
Piston displacement	2185 cu. in.
Compression ratio	8 : 1
Impeller ratio	
Low speed	5.81 : 1
High speed	7.95 : 1
Impeller diameter	12.6"
Crankshaft rotation (viewed from cockpit)	Clockwise
Propeller reduction gear ratio	.5 : 1
Number of mounting bolts	9
Average weight of engine	1800 lbs.
Diameter	46.5"
Magneto type	Dual flange mounted
Distributor type	18CF2R, Dual type
Magneto drive	Clockwise, 1 1/8 : 1
Distributor	Anti-clockwise, .5 : 1

Ignition timing accomplished on No. 4 rear cylinder.

Spark advance	
Rear plugs	22°
Front plugs	22°

Valve timing	
Intake opens	40° BTC
Exhaust closes	50° ATC
Valve rocker clearances	
Timing (cold)	.010"
Adjusting (cold)	.010"
Fuel system	
Carburetor	2 Barrel, downdraft
Fuel	91
Priming inlet	in carburetor adapter
Accessory drives	
Starter	Clockwise, 3 Jaw, 1 : 1
Generator	Clockwise, 2 : 1
Tachometer	Clockwise, .5 : 1
Oil pressure pump	Anti-clockwise
Cylinder numbering (viewed from cockpit)	
Front row	Clockwise, 1 thru 9 starting with bottom cylinder
Rear row	Clockwise, 1 thru 9 starting with top cylinder
Master rod locations	Cylinders No. 4 front and 4 rear
Firing order	4r, 5f, 6r, 7f, 8r, 9f, 1r, 2f, 3r, 4f, 5r, 6f, 7r, 8f, 9r, 1f, 2r, 3f
Performance	
Take-off	1970 Hp at 3000 RPM, 49.6" manifold pressure at sea level
W.E.P.	1970 Hp at 3000 RPM, 49.6" manifold pressure at sea level
W.E.P.	2050 Hp at 3000 RPM, 49.6" manifold pressure at 2500'

TABLE OF SPECIFICATIONS CONT'D

W.E.P.	1850 Hp at 3000 RPM, 49.6" manifold pressure at 17,600'
Military	1765 Hp at 3000 RPM, 43.7" manifold pressure at sea level
Military	1865 Hp at 3000 RPM, 43.7" manifold pressure at 5900'
Military	1695 Hp a t 3000 RPM, 43.7" manifold pressure at 21000'

DESCRIPTION OF ENGINE

General---This engine is of the eighteen cylinder, radial air-cooled type, incorporating a single stage, two-speed integral supercharger which is manually controlled by a selector valve. The construction and operation is conventional although there are several details such as preoiling provisions, carburetor rather than cylinder priming, restricted intake pipes and various gear trains that vary from the conventional. The differences will be described in the section of this book giving the detailed description of the section in which they occur.

For the purposes of description, the engine will be divided into seven major groups. The reduction gear housing assembly (nose section), the main crankcase assembly, cylinders and pistons, the blower section, the intermediate rear section, the rear section and accessories.

SECTION I

PROPELLER REDUCTION DRIVE GEAR HOUSING

Reduction Gear Housing---The reduction gear housing houses the propeller reduction gear assembly. It has provision for mounting a twin ignition distributor on the top side, an oil scavenge sump on the outer side and eighteen valve tappet guide assemblies.

The ignition distributor driven shaft turns on a bushing mounted in the housing. The distributor drive shaft turns on two bushings mounted in bosses integral with the case. A gear mounted on the rear end of the drive shaft meshes with a spur gear mounted on the forward end of the cam reduction drive shaft.

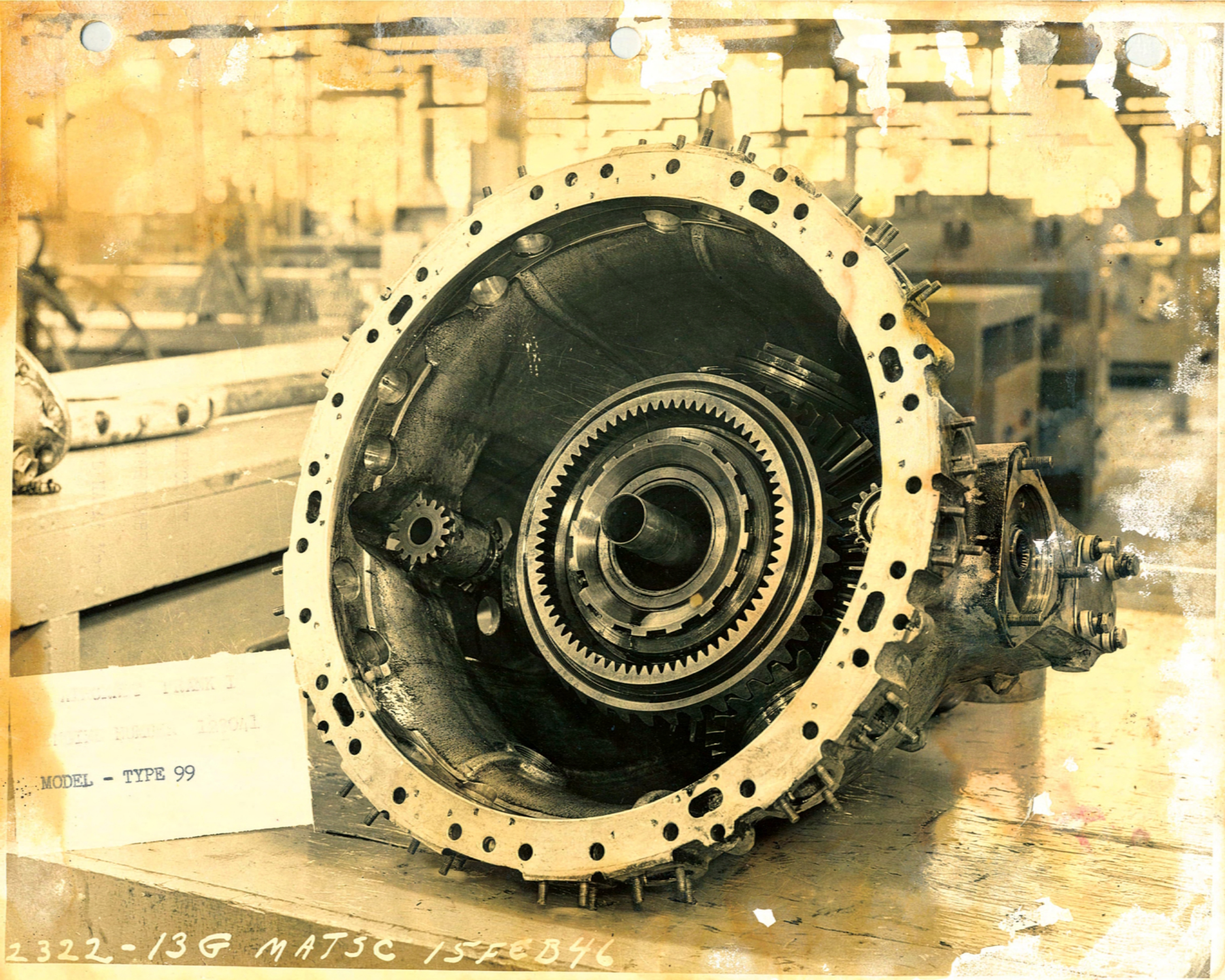
An oil scavenge pump mounted within the front oil sump is driven by an intermediate drive shaft that turns in a bushing mounted in an integral boss on the inner side directly under the propeller shaft. The intermediate drive shaft gear meshes with a spur gear mounted on the lower edge of the front cam intermediate drive gear support, which in turn meshes with the cam ring gear. A deep groove ball bearing is mounted in the front end of the reduction gear housing to transmit the thrust from the propeller shaft to the reduction gear housing. A threaded opening to the left of the distributor pad is provided for viewing the timing disc.

Reduction Drive Gearing---The gearing assembly consists chiefly of three beveled pinions, a drive gear, a fixed gear and a stationary gear. The reduction gear pinions, having pressed in bronze bushings, turn on shafts forged integrally with the propeller shaft. The reduction drive gear meshes with the pinions and turns on a spherical thrust washer mounted on the rear end of the propeller shaft and is splined to a coupling, mounted on the front of the crankshaft. The reduction drive fixed gear meshes on the opposite side of the pinions and is splined to a stationary gear anchored to the front of the housing. The rotation of the drive gear turns the propeller shaft .500 to 1 crankshaft speed. This type reduction gearing is identical to that formerly used on some early American radial engines and is known as the "Farman" type reduction gearing. Two steel-backed bronze bearings pressed in the bore of the propeller shaft turn on journals machined on the front extension of the crankshaft. A main crankcase breather tube assembly is mounted in the front end of the propeller shaft and is of sufficient length to take bearing in a support mounted in the front cheek of the crankshaft.

The following is a table of fits and clearances for the propeller reduction drive gear housing

Governor drive gear backlash	.005"
Governor drive gear end clearance	.0045"
Distributor drive gear backlash	.007"
Distributor drive gear end clearance	.0045"
Oil scavenge pump drive gear backlash	.021"
Oil scavenge pump drive gear end clearance	.005"
Oil scavenge pump driven gear end clearance	.006"
Governor and distributor internal drive shaft to bushing clearance	
Front	.002"
Rear	.006"
Drive pinions fit to intermediate drive shaft	
Front	.0015"L
Rear	.002"L

Reduction drive gear backlash			.017"
Reduction drive gear end clearance			.018"
Reduction fixed gear backlash			.012"
Reduction fixed gear end clearance			.013"
Pinion gear to shaft clearance (3 each)	.0015"	to	.002"
Propeller nut oil seal ring side clearances	.005"	to	.007"
Propeller nut oil seal ring gap clearances	.008"	to	.010"
Propeller shaft spacer oil transfer ring side clearances			.004"
Propeller shaft spacer oil transfer ring gap clearances	.005"	to	.020"



MODEL - TYPE 99

2322-13G MATSC 15FEB46

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WRIGHT-PATTERSON AIR FORCE BASE

Reduction Gear Assembly

SECTION II

MAIN CRANKCASE SECTION

The main crankcase is composed of three forged steel sections; front, center and rear, held together by through bolts inserted through integral lugs located on the inner side of the cylinder pads. Sixteen studs, approximately 3/8" in diameter hold each cylinder to its pad.

One-piece steel crankshaft bearing liners are pressed into each section and each is locked with three steel pins. A steel liner, drilled for transferring pressure oil from the crankshaft to cam bearing and cam reduction drive gears is also installed in the inner bore of the front and rear sections. A steel cam bearing liner is pressed over the outside diameter of an integral boss on the front and rear section for supporting the cams.

A double track four lobe cam assembly actuates the valves in each row of cylinders. The cams rotate on a steel-backed tin bearing pressed into and pinned to an aluminum hub. A cam ring attached by twenty-four bolts, completes the assembly.

Both cams are driven counterclockwise to the crankshaft rotation, at 1/8 crankshaft speed by cam reduction gears located above the crankshaft. The cam reduction gears mesh with the cam drive gear mounted on the crankshaft and with the internal gear of the cam. The front cam drive gear is splined to the crankshaft and the rear drive gear is keyed and secured by a nut turned on the rear end of the crankshaft. The cam reduction gears are supported by and turn in bronze bushings pressed into supports, which are bolted to the cam bearing bosses.

Crankshaft---The two-throw crankshaft is machined from three steel forgings and is almost identical to that of the Wright R-2600 series engines, with the exception of the manner is which the three sections are machined for joining. This is accomplished by splining rather than clamping. A crankpin journal integral with the front and rear section is splined to the inner bore. The center section consists mainly of a large diameter bearing journal having a splined crank on opposite sides which are a tight fit in the splines inside the crankpins. After assembly the sections are locked by a bolt installed through each crankpin.

A counterweight attached to the outer cheek of the front and rear section incorporates dynamic dampening, which consists of supporting a slotted steel counterweight from the crankcheek which extends into the slot, by means of two spool shaped steel pins passing through oversize holes in both the weight and crankcheek. The difference in diameter between the pins and holes, besides giving two-point suspension, permits the counterweight to swing when moving through the same arc of rotation as if bolted to the crankcheek. The swing or movement of the front counterweights is less than that of the rear due to the counterweight pins being of larger diameter than the pins installed in the rear.

The crankshaft is supported in the main crankcase by three roller bearings. The center bearing is mounted on the shaft by means of two steel liners pressed between the inner race and center bearing journal. The outer race of the same bearing is caged in by the use of two circular steel plates on either side that are bolted to the crankcase center section by through bolts, thus preventing any end movement of the crankshaft other than the clearance between the plates and the outer race.

A coupling, reduction gear driven, is mounted to the front crankshaft section. A timing disc, pressed from heavy steel is attached to the coupling with fourteen bolts. A steel coupling is splined into the rear end of the shaft to accommodate and drive the main accessory drive shaft.

Master and Articulated Rods---The two master rod assemblies are located in the No. 4 front and No. 4 rear cylinders. The master rods are of the one piece type and are each provided with a one-piece steel-backed bronze bearing. The bearings are shrunk into position. Types of plating applied to this bearing by American manufacturers have not been resorted to. A splined flange on one end of the bearing controls the depth of entry and provides facilities for locking.

Eight "I" section articulated rods are attached to each master rod by non-plated steel knuckle pins. The articulated rods are provided with a pressed-in bronze piston and knuckle pin bushing. The knuckle pins are drilled and tapped on the small diameter end for installation of an oil feed plate with cap screws. The opposite end of the pins are machined to accommodate a locking plate which prevents their backing out or rotating. This plate is also splined to mate with the splined flange of the master rod bearing. Upon its installation to the master rod the master rod bearing and knuckle pins are held in position.

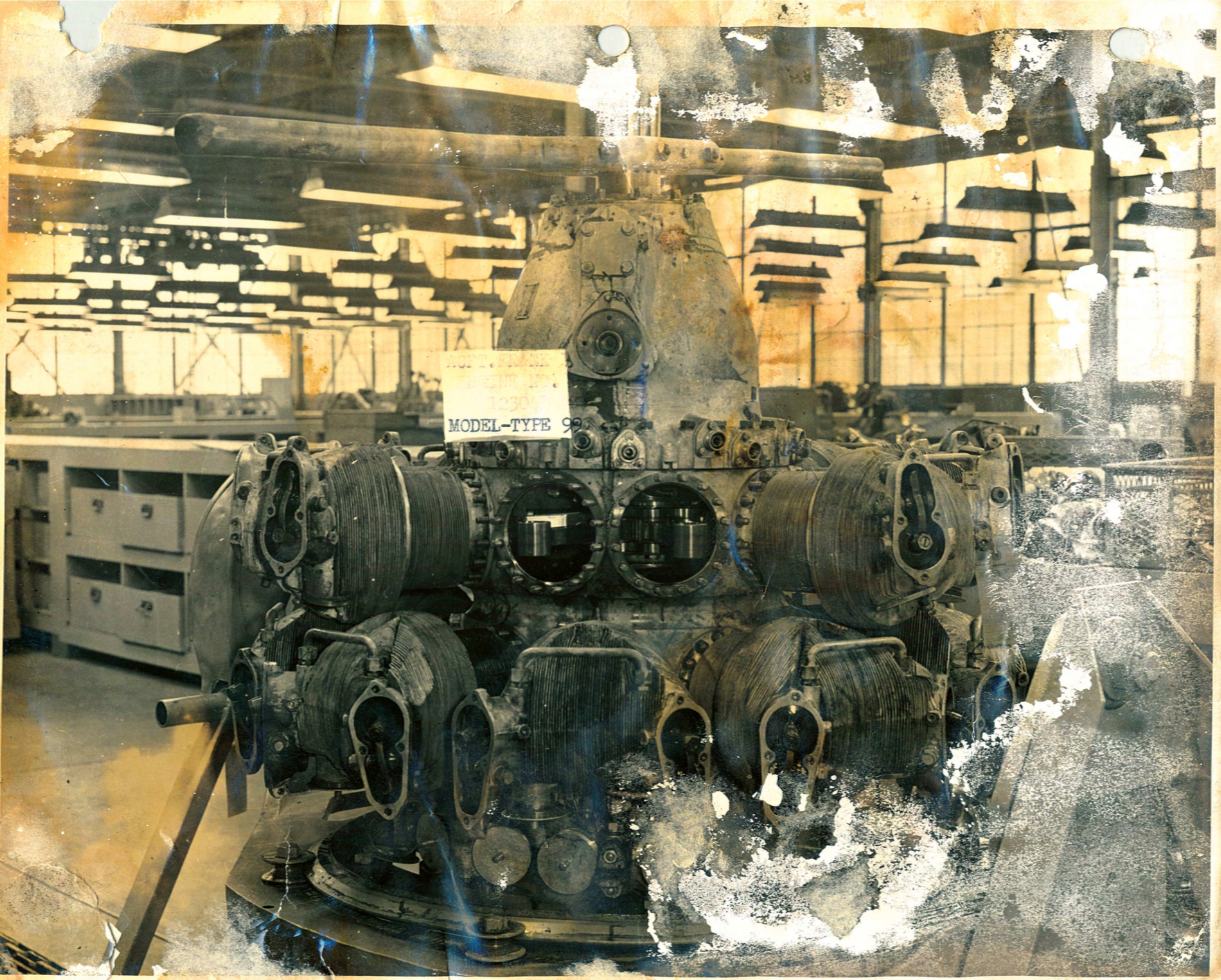
Following is a list of fits and clearances for the Main Crankcase Section:

Rear roller bearing to crankshaft	.0002"T
Rear roller bearing to crankcase	.005"L
Center roller bearing to crankcase	.005"L
Center roller bearing to liner	.001"T
Front roller bearing to crankshaft	.002"T
Front roller bearing to crankcase	.005"L

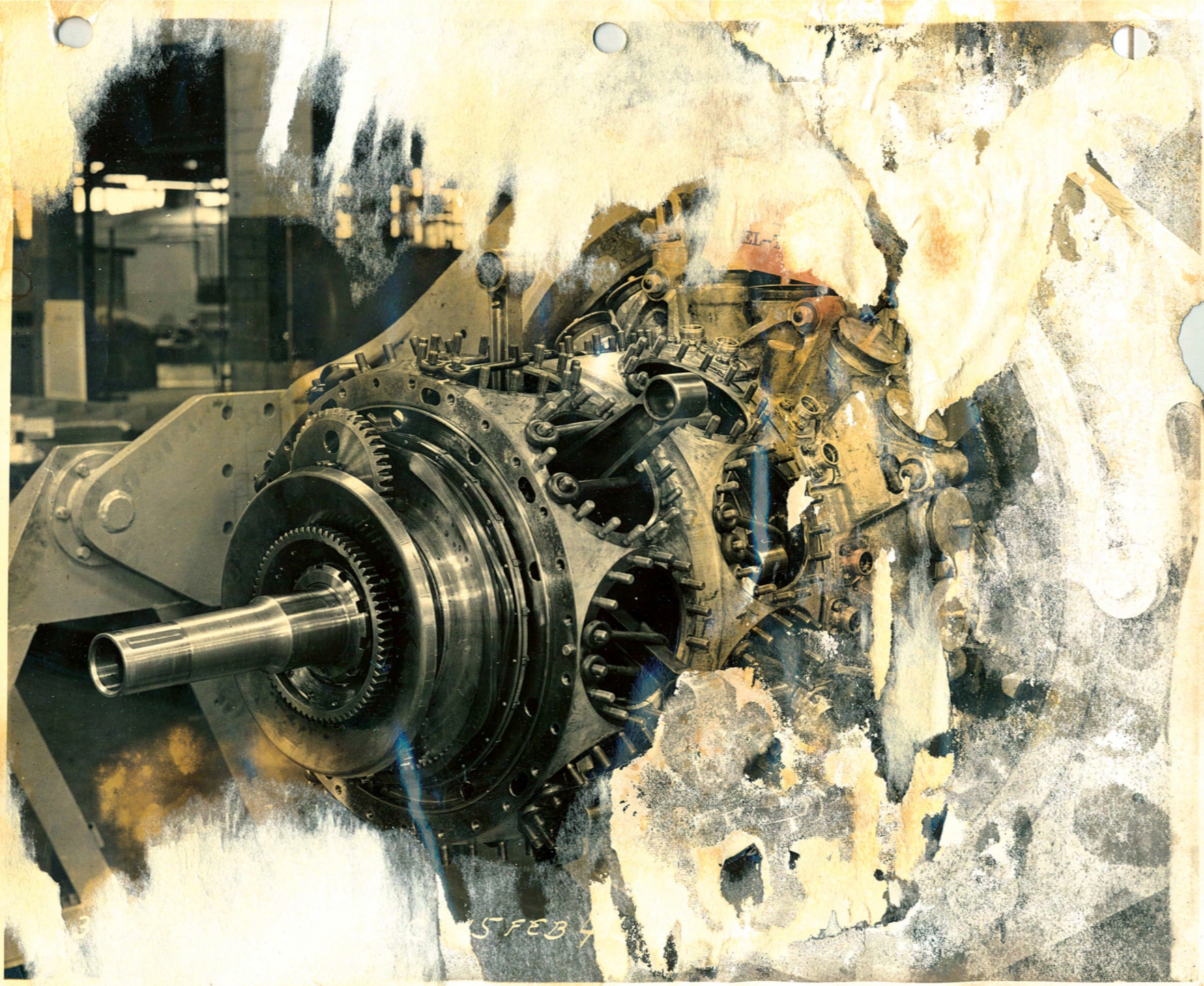
Crankshaft to cam oil transfer ring gap clearance			
Front	.004"	to	.006"
Rear	.006"	to	.010"
Crankshaft to cam oil transfer ring side clearance			
Front	.006"	to	.010"
Rear	.005"	to	.007"

Front cam diametrical clearance	.004"
Front cam end clearance	.013"
Rear cam diametrical clearance	.004"
Rear cam end clearance	.016"
Cam reduction gear to bushing (front)	.003"L
Cam reduction gear end clearance (front)	.010"
Cam reduction gear to bushing (rear)	.003"L
Cam reduction gear end clearance (rear)	.011"
Front scavenge pump drive gear to bushing	.002"L
Front scavenge pump drive gear end clearance	.008"
Crankshaft end clearance	.001"

Master rod bearing to crankshaft clearance	
Front	.008"
Rear	.008"
Master rod bearing end clearance	
Front	.009"
Rear	.009"
Knuckle pins to bushings	.0025"L to .003"L
Piston pins to bushings	.0025"L to .003"L
Articulated rods side clearance	.010" to .021"


MODEL-TYPE 99

Main Crankcase Assy., Two Cylinders Removed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PUBLICATIONS-REPRODUCTION SECTION
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CREDIT LINE MUST BE GIVEN
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Main Crankcase Section

SECTION III

CYLINDERS AND PISTONS

Cylinders---The cylinders are of steel and aluminum construction. The barrels are machined from steel forgings and the heads are aluminum alloy castings with integrally cast cooling fins and rocker housings that have full openings parallel to their base. Each cylinder has one inlet and one exhaust valve seat of steel alloy material shrunk into the head, also bronze inlet and exhaust valve guides and bushings for two spark plugs. The cylinder bore is choked at the head, the amount of choke ranging from -.012" to -.016". The cylinder mounting flange and cooling fins are machined integrally with the barrel.

The cylinders are similar to American made radial engine cylinders of equivalent cubic-inch displacement, the cooling fins being of the same design and approximately the same dimensions. In this respect this engine is different from the Frank I, previously overhauled at this Depot, since the fins of that engine were designed to provide a greater cooling area.

Pistons---The pistons are machined from aluminum alloy forgings. Each piston has four straight side ring grooves and two rows of holes for oil return. The two pistons installed on the master rods in No. 4 front and No. 4 rear cylinders have four less oil return holes per piston. Rings are installed in all pistons as follows: Chrome plate compression rings having about 2° taper on the face, in No. 1 groove. Unplated taper compression rings in No. 2 groove. Two each, dual oil control rings in No. 3 groove. Bevel face oil scraper rings in No. 4 groove. All rings have the gap cut on an angle. The piston pins have aluminum alloy plugs installed in the ends, each plug having one lobe about 1/8" in diameter to permit drainage of any oil that may accumulate.

Valve Mechanism---All valve operating parts are enclosed. The rocker arms are supported on bronze bushings and acutated through tubular steel push rods which have steel ball ends. One piece, oil tight cover tubes, held in place by a packing nut at each end enclose the push rods.

There is one intake and one exhaust valve in each cylinder. The exhaust valves are of hollow head and stem design to provide

for carrying some cooling agent and are faced with a steel alloy similar to stellite. Three concentric valve springs are secured to the stems by the conventional type split cone locks and retaining washers.

Valve Tappet Assemblies---The valve tappet guides are of aluminum alloy having a loose fit in their respective bosses. The guides that house the tappet assemblies for rocker arms above the horizontal center line are not interchangeable with those installed below the horizontal center line since two oil passages are machined in the outer wall to permit scavenge oil to drain from the rocker boxes into the crankcase via the push rod cover tubes rather than through inter-cylinder drain tubes, which is the method used for draining rocker boxes located below the horizontal center line.

To prevent erroneous installation of guides for the rocker arms above the horizontal center line, which are those of cylinders Nos. 4, 5, 6, 7 front and Nos. 1, 2, 8, 9, 3 intake and 7 exhaust rear row. A dowel pin is installed in each guide mount pad corresponding to above numbers. A dowel hole drilled through the mounting flanges of guides that incorporate oil return passages, prevents installation of guides other than the proper type above the horizontal center line.

The valve tappets have loose fitting push rod ball sockets to permit installation of a coil spring within the tappet for the purpose of keeping the tappet rollers constantly in contact with the cam periphery.

The tappet rollers have a pressed in bronze hub and turn on a floating type steel pin.

The following are fits and clearances of the tappet assemblies:

Tappet to tappet guide	.0015"L	to	.003"L
Tappet roller to tappet side clearance	.010"	to	.016"
Tappet roller pin to tappet	.0015"L	to	.003"L
Tappet roller pin to roller	.002"L	to	.004"L

Cylinder Deflectors---The cylinder deflectors are made from sheet aluminum alloy and are of the pressure design. Each cylinder has inter-cylinder and head deflectors. The head deflectors are provided with tubes through their center for cooling the rear spark plugs. Inter-cylinder deflectors follow the contour of the barrel fins closely which produces a pressure differential between the front and rear surfaces of the cylinder. Blast tubes for cooling the magnetos and generator are incorporated in the inter-cylinder deflectors.

Intake Pipe Assemblies---The intake pipes were apparently manufactured by reshaping heavy wall aluminum tubing and each one is attached to the engine by two aluminum packing gland nuts. A simple strap clamp having a lug that meshes in a wrench slot of the nut is used as a locking device for each nut.

Intake pipes Nos. 1 front and 6 rear have built-up bosses near the cylinder end which are drilled and tapped to permit installation of a drain valve. The drain valve is a poppet type and is spring loaded to hold the valve in a closed position. A small metal ring installed in the outer end of the valve stem is provided for manually operating the valve. Draining to the outside of the cowl is accomplished by connecting a hose to a nipple installed in the mounting base of each drain valve assembly.

Rocker Box Drain Sump---A small cast type drain sump, located between the rocker arm housings of No. 1 front cylinder, collects the drain oil from the rocker boxes through a series of inter-cylinder drain pipes.

Following is a table of fits and clearances for the cylinders and pistons:

Piston ring side clearance			
No. 1 ring	.004"	to	.007"
No. 2 ring	.002"	to	.005"
No. 3 & 4 rings	.003"	to	.007"
No. 5 ring	.0015"	to	.004"
Piston ring gap clearance			
No. 1 ring	.065"	to	.073"
No. 2 ring	.047"	to	.069"
Nos. 3 & 4 rings	.049"	to	.070"
No. 5 ring	.025"	to	.035"

Rocker shaft nut torque	250 inch pounds
Rocker arm side clearance	
Intake	.008" to .011"
Exhaust	.006" to .014"
Piston pin to piston clearance	.0015" to .003"
Piston pin to connecting rod bushing	.002"L to .003"L
Valve stem to valve guide	
Intake	.002"L to .003"L
Exhaust	.0025"L to .004"L
Valve spring tension (compressed to length of 1-1/2")	
Inner spring	42 to 46 lbs.
Intermediate spring	77 to 85 lbs.
Outer spring	125 to 136 lbs.

MODEL - TYPE 99

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MAXWELL AFB, ALABAMA

Cylinder

101

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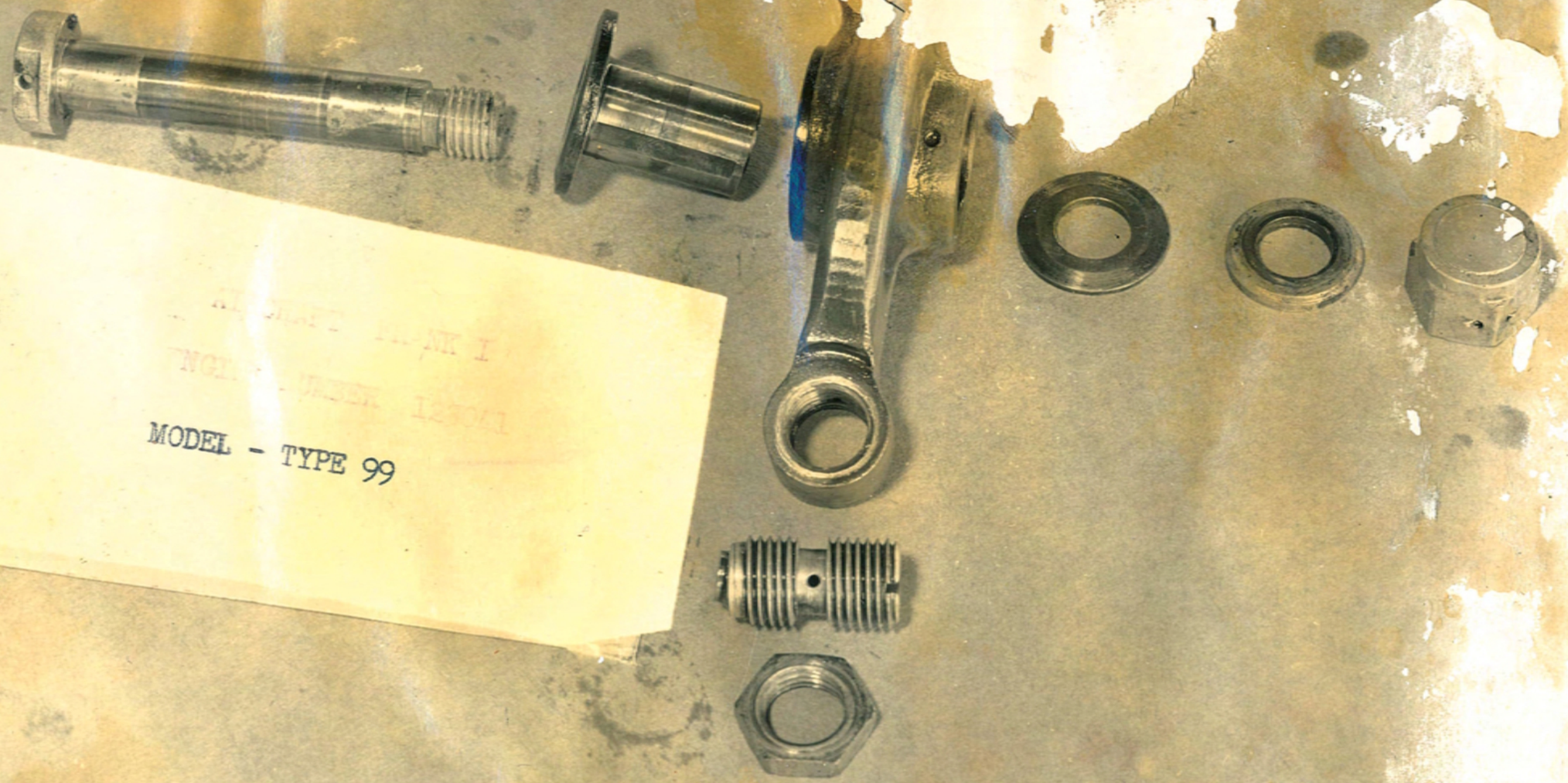

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Rocker Arm Assy., Exploded View

SECTION IV

CRANKCASE BLOWER SECTION

Blower Crankcase---The blower crankcase is an aluminum alloy casting which houses the impeller and incorporates the front diffuser plate. A steel impeller shaft front oil seal liner is pressed into the center of the diffuser plate and the plate is mounted to the crankcase with twenty-seven screws. Nine engine mounting bracket pads are cast integral with the crankcase blower section housing. A steel coupling threaded externally at each end for installing the intake pipes, is installed in each intake port and locked by two steel pins. Provisions are made for mounting eighteen valve tappet guide assemblies for actuating the valves of the rear row cylinders. A steel lifting eye is mounted on a boss located on the top center of the case. A breather passage leading to the intermediate rear case is cored in the outer wall on the left side and an oil passage for supplying pressure oil to the valve tappet pads is cored in the outer wall on the right side. An oil scavenge passage at the bottom connects with a similar size passage in the intermediate rear case. Nine elongated breather holes equally spaced around the front mating surface align with similar holes in the mating surface of the rear crankcase main section.

SECTION V

INTERMEDIATE REAR SECTION

General---The intermediate rear section is a magnesium alloy casting which houses the blower drive gear train. It also supports a vaned diffuser plate on it's front face. A flange at the top of the intermediate rear section provides a mounting surface for a downdraft carburetor. Leading from the flange is a duct which carries the intake air to the impeller. An automatic fuel drain valve in the bottom of the intermediate rear section housing leads into the blower section to allow any raw fuel which may accumulate to drain from the engine.

A steel liner is pressed into the center rear face of the intermediate rear section to accommodate the impeller shaft oil seal ring carrier and a bearing pressed into the housing directly below the impeller shaft oil seal ring carrier lines provides a support for the front end of the high and low ratio impeller clutch assembly shaft.

A support plate bolted to a recessed shelf on the inside periphery of the intermediate rear section provides a means of support for the main accessory spring drive gear shaft, left accessory secondary idler gear shaft, left accessory primary idler gear shaft, right intermediate accessory idler gear shaft, right intermediate accessory drive gear shaft, oil pump intermediate drive and idler gear shaft and the oil pump drive gear shaft.

Dual Ratio Clutches and Selector Valve---A high and low ratio clutch are mounted on a common shaft the front end of which is supported in the intermediate rear section housing and the rear end in the support plate. The clutches are driven by the accessory spring drive gear through a pinion on the high and low ratio clutch shaft. The clutches are of the plate disc type incorporating a five pinion planetary reduction gear assembly in the low ratio clutch housing to obtain the desired reduction in impeller speed when the low ratio clutch is engaged.

A two position blower ratio selector valve is mounted on the intermediate rear section housing in such a manner that it protrudes into the splined opening provided for it in the anchor

plate. Manual operation of the control lever will cause the valve to move into one of two positions, the high ratio position or the low ratio position. If for example, the valve is moved into the high ratio position, the pressure oil will be directed to the rear of the high ratio clutch piston engaging the high ratio clutch assembly. The high ratio clutch gear will then drive the impeller at high speed. Should the valve be moved to the low ratio position, pressure oil will be directed to the rear of the low ratio clutch assembly piston engaging the low ratio clutch. The clutch shaft will then be driven through the planetary reduction gearing and since the clutch shaft is splined to the low ratio clutch gear the impeller will then be driven at a reduced speed.

Following is a list of fits and clearances for the intermediate rear section:

Impeller shaft oil seal rings gap clearance	.012" to .016"
Impeller shaft oil seal rings to liner	.003"L to .007"L
Impeller shaft thrust plate oil seal ring	
Gap clearance	.007" to .008"
Side clearance	.004"
Impeller shaft end clearance	.010"
Impeller shaft to throat clearance	.057"
Impeller shaft to front diffuser plate clearance	.042"
Starter shaft to bushing clearance	.004"
Starter shaft end clearance	.017"
Starter shaft to clutch drive adapter backlash	.010"
Left accessory primary idler to main accessory drive gear backlash	.006"
Right intermediate accessory idler gear to accessory drive backlash	.008"

Left accessory secondary idler to primary idler backlash	.007"
Left accessory primary idler to oil pump intermediate idler backlash	.009"
Oil pump drive gear to intermediate idler backlash	.008"
Oil pump intermediate drive gear end clearance	.019"
Low clutch pinion bushing to shaft	.002"L to .003"L
Low clutch pinion bushing to gear	.004"L
Low clutch pinion gear end clearance	.005" to .007"
Low clutch piston oil seal ring gap	.012"
High clutch piston oil seal ring gap clearance	.044"
High clutch piston oil seal ring side clearance	.088"
Impeller shaft drive clutch gear to bushing	.003"L
Intermediate impeller drive shaft to intermediate gear bushing	.003"L
Intermediate impeller drive sun gear to bushing	.004"L
Impeller drive clutch gear to main accessory drive gear backlash	.013"


MODEL - TYPE 9

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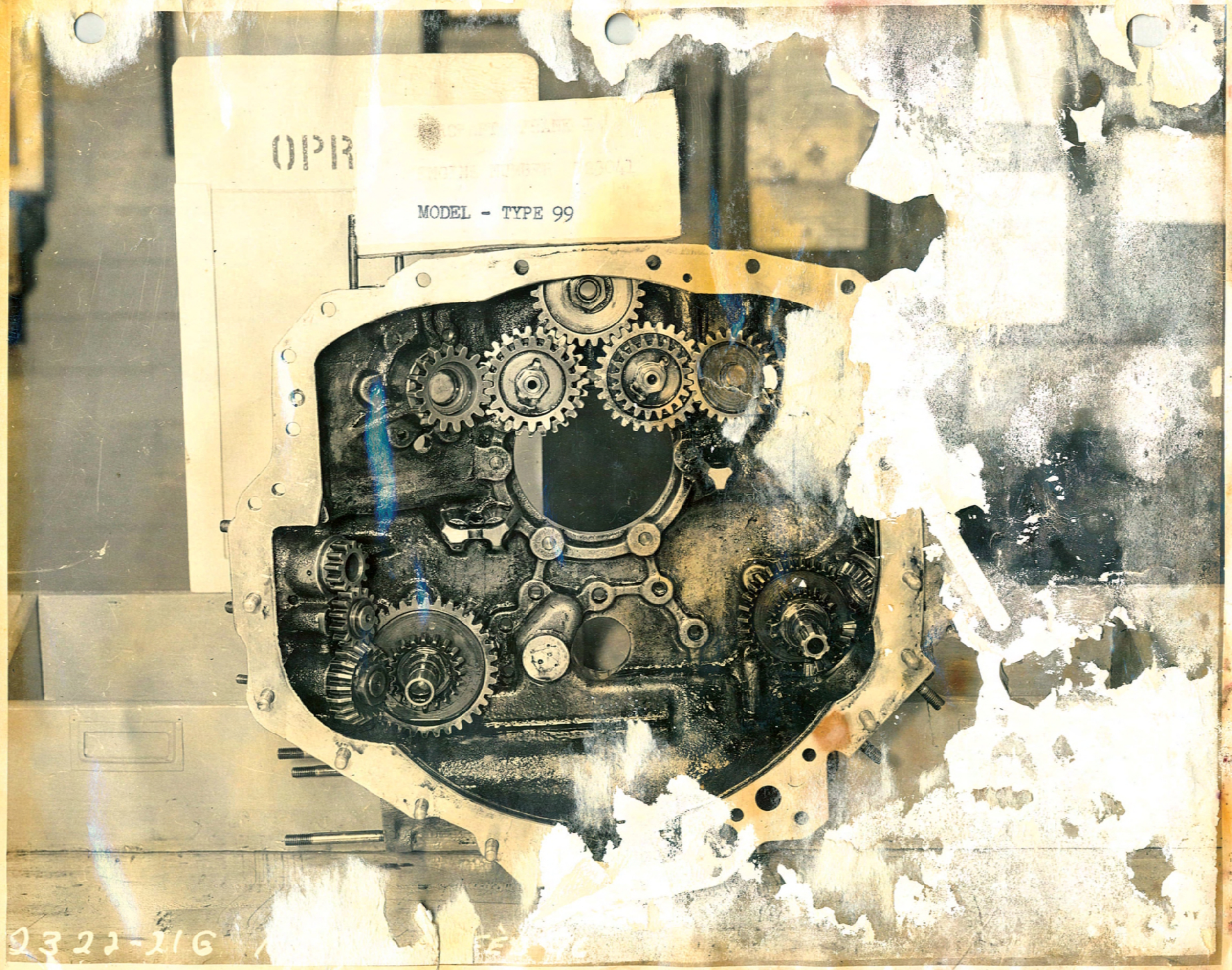
Intermediate Case, Rear View Showing Accessory Drive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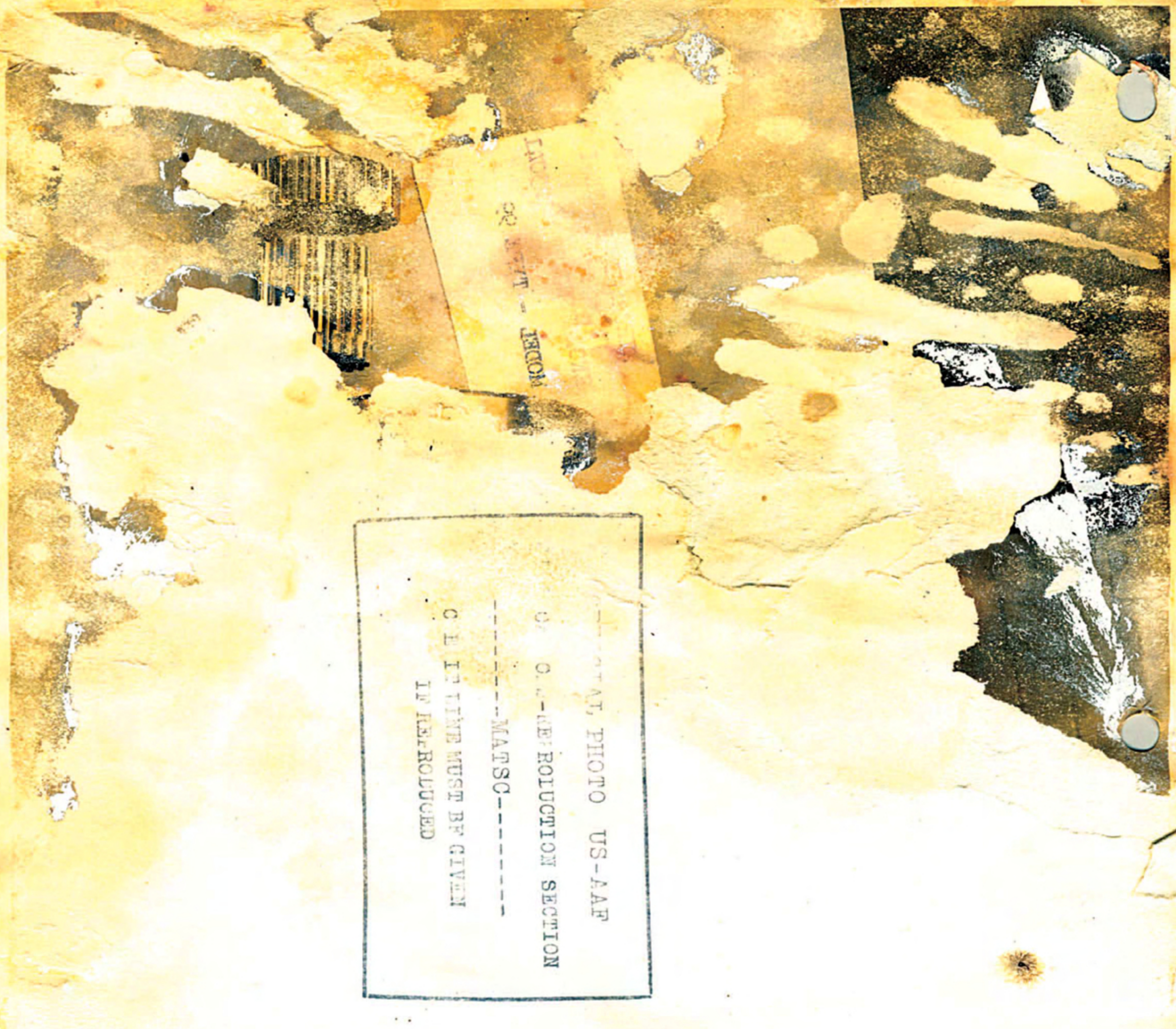
WRIGHT FIELD
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Rear Case, Front View


MODEL - TYPE 99
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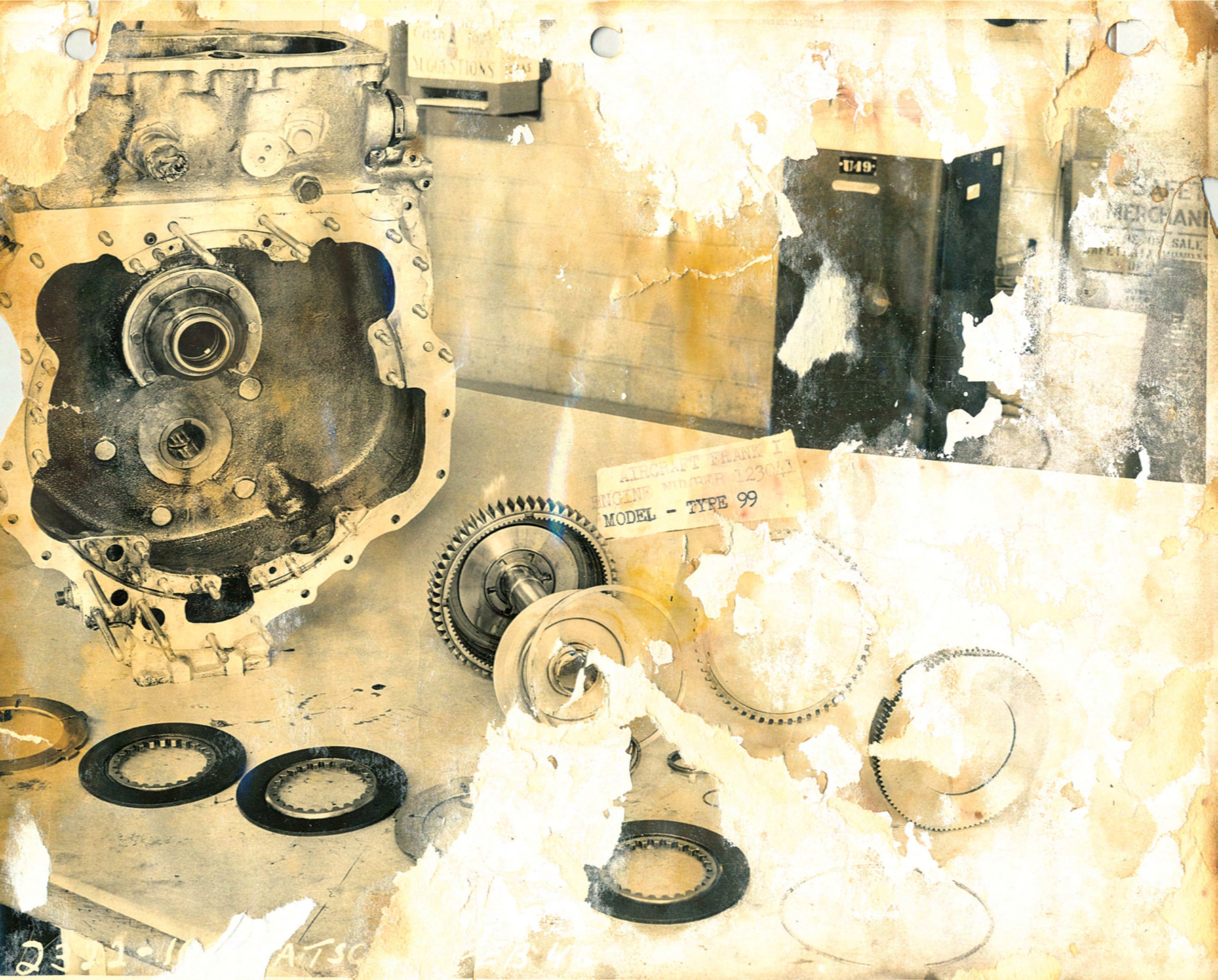
Accessory Drive Support Plate
Showing Clutch Assembly, Exploded View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MODEL - TYPE 99

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Intermediate Rear Case & Clutch Assembly, Exploded View

SECTION VI

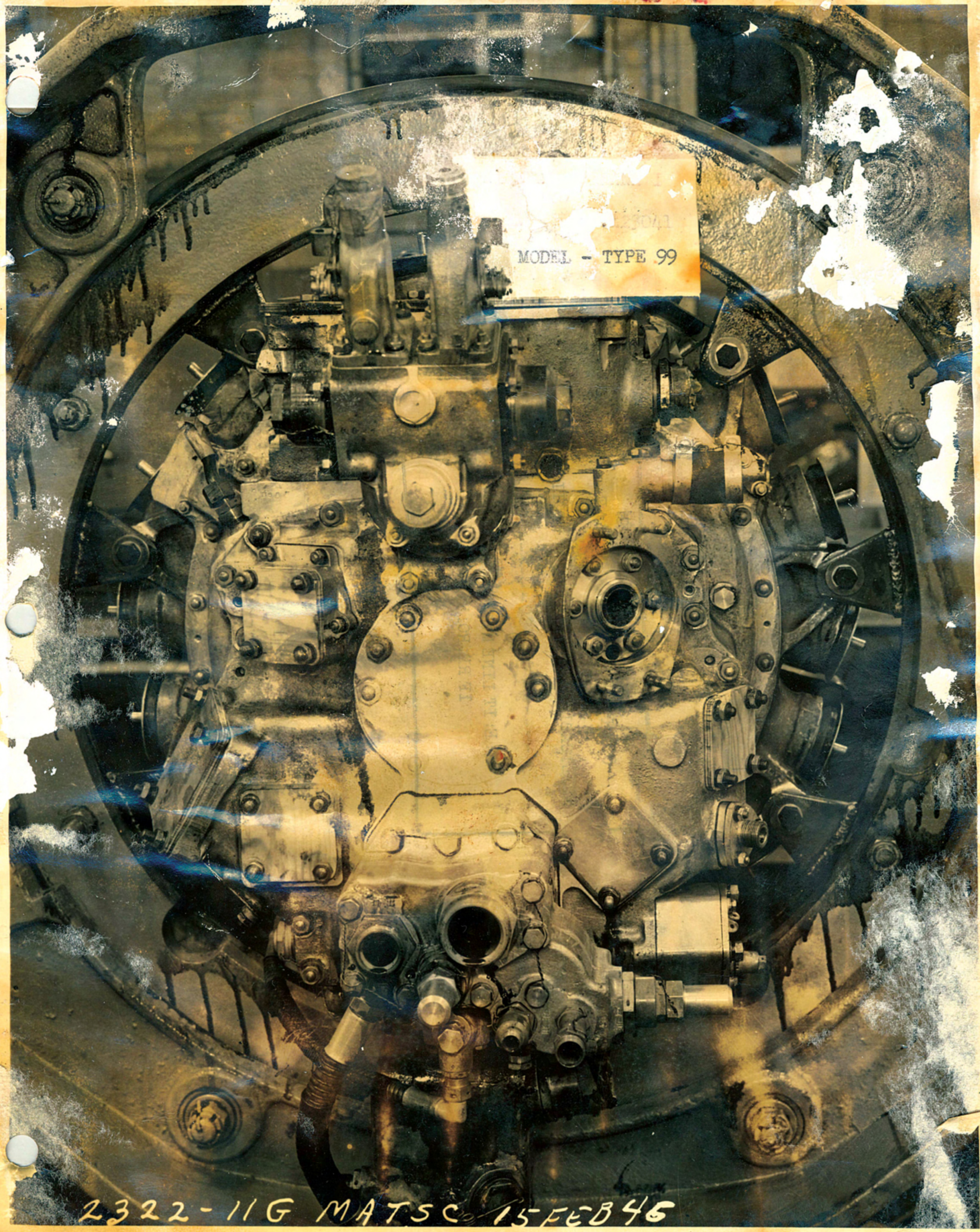
REAR SECTION

The rear section is a magnesium alloy casting incorporating pressed in aluminum bearings which support the magneto drive gear shaft, the upper and lower right and upper left intermediate idler gear shafts, the upper right and left and lower intermediate drive, the upper left and lower right accessory idler gear shafts, the upper left and lower right accessory drive shafts, the generator drive gear shaft, the intermediate tachometer drive gear shaft and the tachometer drive gear shaft. An opening in the lower rear of the rear section housing is equipped with a mounting pad for installing an automatic type cuno. Provision is made for mounting the three stage pressure and scavenge oil pump on the lower side of the rear face of the rear section housing. A starter mounting pad directly above the oil pump provides for the mounting of a starter. Directly above the starter provision is made for the mounting of a gun synchronizer. The magneto mounting pad is on the rear case, to the right of the starter mounting pad, on a 45° angle to the longitudinal axis of the engine. The generator mounting pad on the lower left hand side of the rear section housing provides for mounting the generator at an angle of 45° to the vertical axis of the engine and approximately 20° to the longitudinal axis of the engine. A tachometer drive pad on the lower right hand side of the rear section housing provides for the mounting of a tachometer drive adapter at an angle of 45° to the longitudinal axis of the engine.

Table of fits and clearances for the crankcase rear section:

Magneto drive gear to upper R. intermediate idler gear backlash	.016"
Main accessory idler gear to upper R. intermediate idler gear backlash	.011"
Main accessory idler gear to upper L. intermediate idler gear backlash	.007"
Upper left accessory drive gear to intermediate drive gear backlash	.009"

Generator drive gear to intermediate drive gear backlash	.008"
Angular accessory drive gear lower L. to intermediate drive gear backlash	.008"
Tachometer drive gear to intermediate drive gear backlash	.018"
Angular accessory drive gear lower R. to idler gear backlash	.006"
Clearances for all gear and shaft bushings in this section are	.002" to .003"
Main oil pressure pump gear to body	.002"L
Main oil pressure pump gear side clearance	.003"
Main oil moderate pressure gear to body	.0015"L
Main oil moderate pressure gear side clearance	.004"
Main oil scavenge gear to body	.0015"L
Main oil scavenge gear side clearance	.003"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Engine, Rear View Mounted In Engi.

Rear and Intermediate Rear Case
Assembled on Work Bench

SECTION VII

ACCESSORIES

Ignition System---Ignition is furnished by a dual type flange mounted magneto, having one 8-pole magneto and four breaker assemblies. It is mounted to the right of the starter pad, at an angle of approximately 45° to the longitudinal axis of the engine. The magneto is equipped with two each 9 lobe fiber cams, each cam operates two breaker assemblies through steel breaker arms. The two breakers on the left side of the magneto supplies high tension current for the front spark plugs of all cylinders and the two breakers on the right side supply high tension current for all rear plugs. A wire leading from each set of two breakers to the distributor is enclosed in braided shields.

The distributor assembly is mounted on the top side of the propeller reduction gear housing and consists mainly of two distributor blocks, two distributor fingers and an aluminum housing. The distributor fingers are located in the center of the distributor assembly, one above or over the other. Each distributor block has eighteen segments molded in the block to conduct the current from the distributor finger to an outlet. The bottom distributor finger receives the high tension current from the set of two breakers on the left side of the magneto and delivers it to nine of the eighteen segments in each distributor block. The top distributor finger functions are the same, except it is connected to the set of two breakers on the right side of the magneto.

The ignition manifold is mounted on the front of the engine and is of the tubular type with braided shield, each having a spark plug elbow attached. The distributor end of the spark plug lead wires pass through holes in two fiber block, each hole has a number corresponding to that of a spark plug, thus each block serves as a multiple plug for connecting the manifold to the distributor. In making this connection the spark plug lead wires will contact the segments in the distributor in a sequence corresponding to the firing order of the engine. The firing order starts with the cylinder having the rear master rod installed and is as follows: 4r 5f, 6r, 7f, 8r, 9f, 1r, 2f, 3r, 4f, 5r, 6f, 7r, 8f, 9r, 1f, 2r, 3f.

Carburetor and Fuel Distribution---The carburetor is of the two barrel down draft float type. Two float chambers equipped with treated cork floats maintain a constant supply of fuel for the

metering system of the carburetor. A piston type accelerating pump located in the throttle body housing and operated by the throttle shaft, provides a positive charge of fuel for accelerating the engine whenever the throttle is suddenly advanced.

A manifold boost control regulator attached to the carburetor and connected to the throttle shaft thru a differential maintains, during normal cruising operation of the engine, a given pre-determined manifold pressure. An enrichment valve incorporated in the regulator unit is operated by manifold pressure in such a manner that the mixture is gradually enrichened as the throttle opening approaches its maximum.

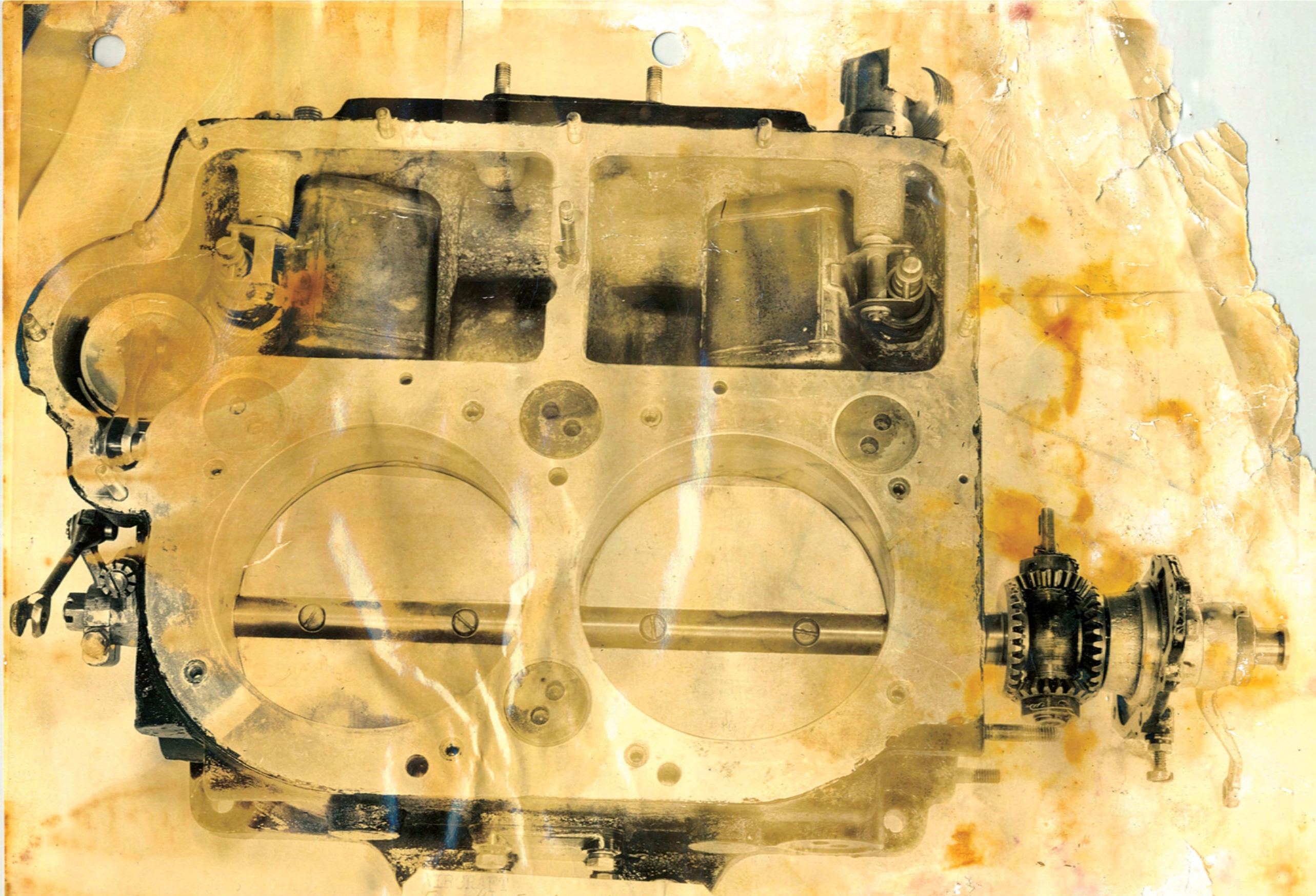
An automatic mixture control unit attached to the throttle body unit is controlled by an aneroid and operates hydraulically through the manual mixture control shaft to restrict the flow of gasoline to compensate for changes in atmospheric pressure and temperature. The manual mixture control provides a means for manually controlling the mixture from the cockpit. It, like the automatic mixture control, leans the mixture by restricting the fuel passage and may be set in any position desirable from full-rich to idle cut-off.

Fuel is metered into the stream of incoming air by the differential in pressure resulting from the venturi effect in the throat of the carburetor. The mixture enters the blower section where it is compressed by one of the two speeds of the impeller to maintain a given manifold pressure. A vaned diffuser distributes the mixture to the intake pipes leading to the top of the intake valve in each cylinder. A restriction in the form of a metal collar that decreases the inside diameter of the intake pipe was found in the number 3 front intake pipe. This restriction was apparently made to improve the distribution of the mixture.

The carburetor is equipped with an anti-detonation injector. This injector automatically cuts-in anti-detonant fluid (half water and half alcohol, Spec. AN-A-24) for power ranges above high cruising. The purpose of the injected fluid is to maintain normal cylinder head temperatures at maximum power ranges and also to suppress detonation when using gasoline with average (grade 92) octane rating.

Engine priming connections are installed in the carburetor adapter and carburetor main body. They prime independently by use of a control lever in the pilot's cockpit. The priming fluid is contained in a separate tank. To prime the engine thru the

adapter connection turn the lever in the cockpit to "prime" and charge the adapter by using a hand pump in the line for this purpose. To prime the engine thru the carburetor main body first drain the gasoline from the main body by means of a drain cock at that location. Close the drain cock and turn the lever in the cockpit to "carburetor prime", and by the use of the hand priming pump fill the main body of the carburetor with priming fluid. Then by operating the carburetor accelerating pump the engine will be primed thru the carburetor. This method is only recommended for extreme cold weather starting.



FRANK. ENGINE No 123041

MODEL - TYPE 99

CARBURETOR MAIN Body

ASSY

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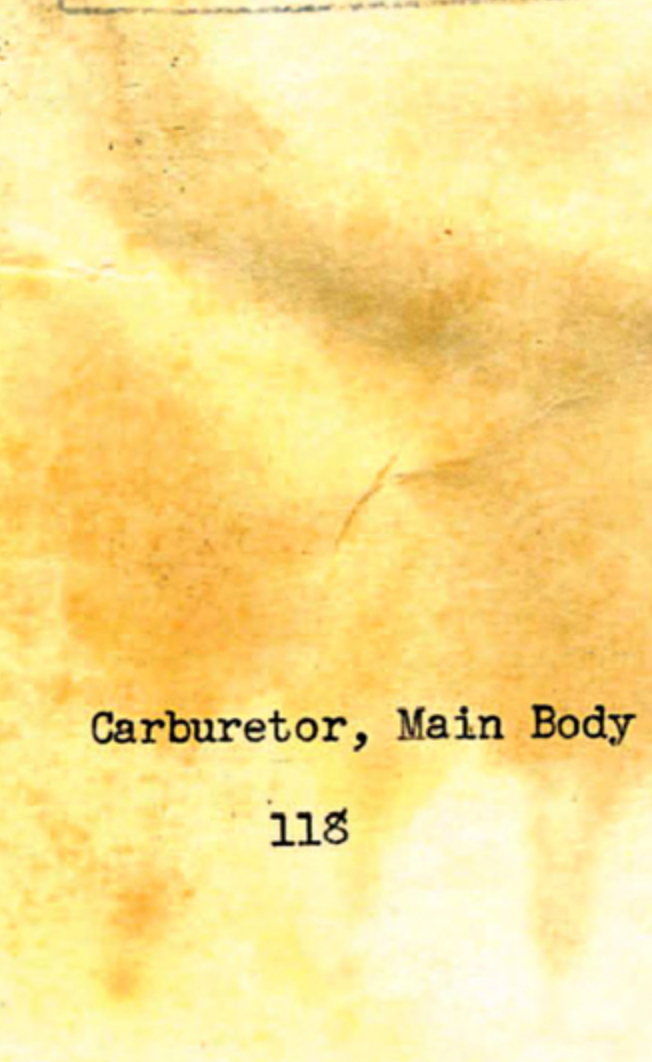

Carburetor, Main Body



AIRCRAFT

FRANK I ENGINE # 123041

MODEL - TYPE 99

CARBURETOR PRESSURE,

ENRICHMENT VALVE AND

WATER INJECTION REGULATOR

2322-87

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Carburetor Pressure Enrichment
Valve & Water Injection Regulator

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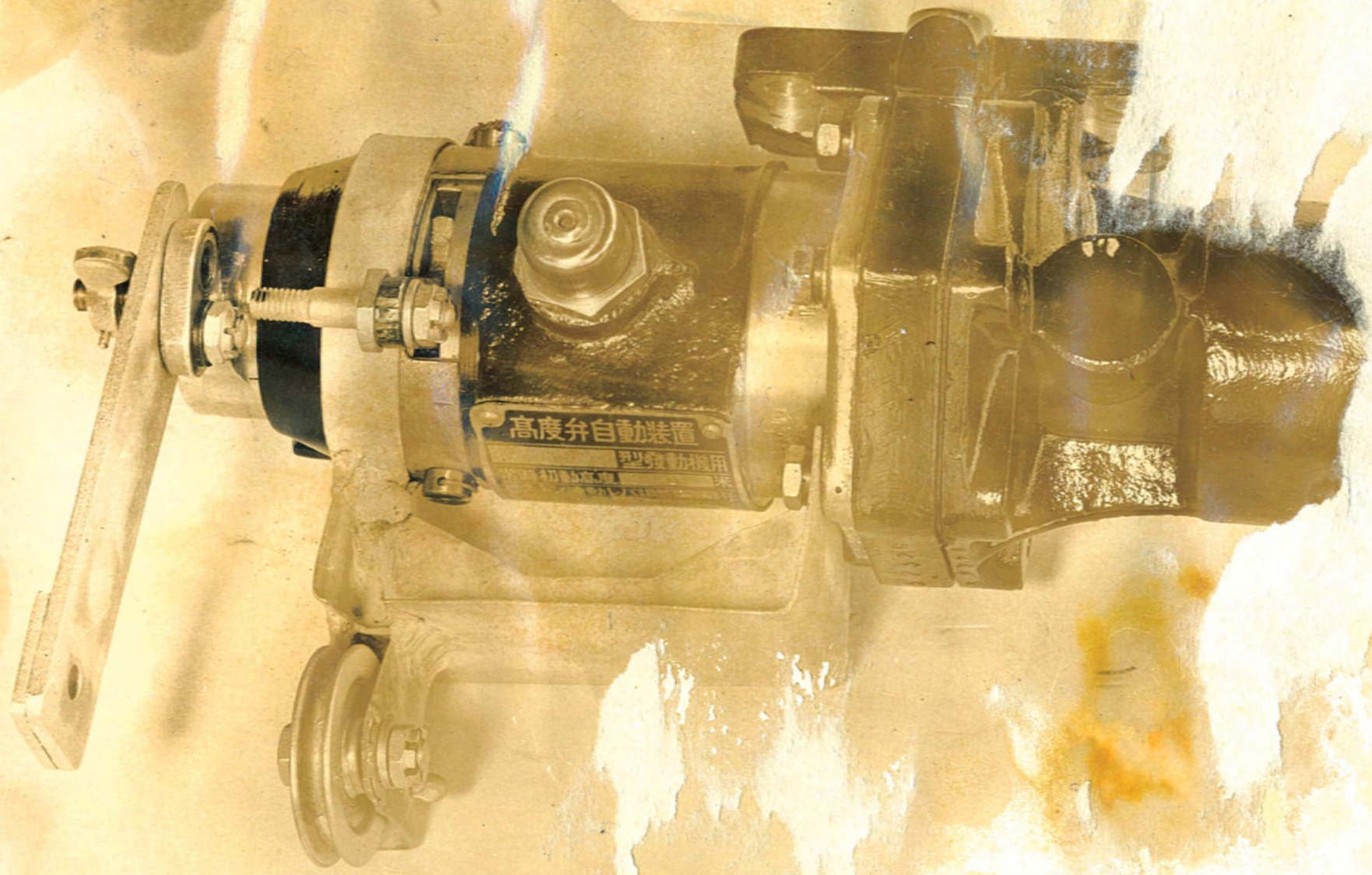
MODEL - TYPE 99

CARBURETOR Mixt

CONTROL ASSY



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Carburetor Mixture Control Assembly

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GENERAL MOTORS SALES CORPORATION
DETROIT, MICHIGAN

Carburetor Assembly

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LUBRICATION

Pressure oil is circulated through the engine by a three section gear pump of the pressure and scavenging type located on the lower central part of the rear section.

Oil from the tank enters the pump through an inlet port in the rear of the pump body and is directed to the two pressure stages of the oil pump. From the first stage (the larger stage located in the rear of the pump body) the oil contacts a pressure relief valve which maintains a given predetermined pressure by by-passing excesssive oil to the inlet side of the pressure pump. An oil outlet connection on the inlet side of the first stage of the pressure pump and an oil inlet on the pressure side equipped with one way check valves are incorporated in the pump to provide a means for pre-oiling the engine. The main pressure oil then is directed through a drilled passage through the automatically operated cuno into a drilled passage in which it flows in two directions. Traveling in one direction it passes via an outside line to the reduction gear housing section where it will be picked up in a later paragraph. Traveling in the other direction it goes, through drilled passages, through the intermediate rear section housing into an annulus around the main accessory drive shaft bushing in the support plate. Branches from this passage provide lubrication for the left and right accessory primary and secondary idler gear shaft bushings. Some of the oil from the accessory drive gear shaft annulus travels through two drilled passages in the support to two holes in the top of the housing of the intermediate rear section. One of these holes directs oil through drilled passages in the rear section to lubricate all the accessory shaft bushings in the rear section. The other hole directs oil through drilled passages in the carburetor adapter and carburetor to the manifold pressure regulator on the carburetor. A branch from this line directs pressure oil through drilled passages to the forward end of the blower section. A drilled passage around the circumference of the blower section housing carries the oil which through branching drilled passages provides lubrication for the rear valve tappet and guide assemblies. Through drilled holes the oil then enters the hollow valve tappets and through the hollow push rod tubes and drilled rocker arms provides lubrication for the rocker arm bearings. Scavenge oil from the manifold pressure regulator drains into the intermediate rear section through two passages, one a drilled passage through the carburetor adapter and intermediate rear section housing and the other an outside line leading to a hole drilled through the intermediate rear section housing.

The remainder of the oil entering the annulus around the main accessory shaft bushing enters the main accessory drive shaft, through a series of drilled holes, and is directed forward in the shaft. A hole in the main accessory drive shaft provides a means of lubrication for the impeller shaft bushings. Oil from the main accessory drive shaft passes into the hollow crankshaft, from here through drilled passages and holes, it lubricates the master rod bearings and knuckle pin bushings. Splash oil from the rotating parts provides lubrication for the pistons, piston rings, piston pins, cylinder walls and main bearings. The oil then drains to the bottom of the main crankcase section as scavenge oil. Pressure oil continues forward in the crankshaft to the forward end of the crankshaft extension where it passes between the crankshaft extension to propeller shaft bearings.

Pressure oil in the outside line from the cuno enters the reduction gear housing at the lower right side of the reduction gear housing. It then is directed through a drilled passage in the reduction gear housing. A branch from this passage provides lubrication for the scavenger drive gear shaft bushing and intermediate drive gear shaft bushing. The main passage directs oil into two oil lines in the stationary gear on the lower side of the reduction gear assembly. The oil entering the lower right hand line goes through the transfer bearing and enters an oil passage on the upper right hand side of the reduction gear housing assembly. Through drilled passages in the reduction gear housing the governor, distributor drive and distributor drive driven gear shaft bushings are lubricated. This drilled passage continues around the reduction gear housing and branch lines from this passage allow oil to pass to each of the valve tappets. Holes in the hollow valve tappets allow oil to enter the tappets from where it travels through the hollow push rods and drilled rocker arms to lubricate the rocker arm bearings. A drilled passage, branching off from the passage leading to the governor drive shaft bushing, directs oil through a drilled passage on the right hand side of the governor drive mounting pad, to the governor, which on this particular engine was plugged since an electrically controlled propeller was used.

The oil that enters the oil passage on the lower left hand side of the stationary gear goes through the transfer bearing and into the hollow propeller shaft by means of drilled holes. Holes drilled through the propeller shaft provide oil for the propeller reduction fixed gear and drive gearing pinion bearings and thrust washers by two drilled holes in each of the hollow pinion shafts. Oil from the reduction gearing assembly rotating parts provide splash lubrication for the gears in the reduction gear assembly and the front main bearing.

Pressure oil from the second stage of the pressure pump (the smaller pressure gears) is directed through an outside line from the oil pump to a drilled passage in the intermediate rear section through which it travels to the two position clutch selector valve. From the clutch selector valve one drilled passage leads to the back of the high ratio clutch piston and one to the back of the low ratio clutch piston. Only one of these two passges is open at any one time providing a means of changing from one blower speed to the other.

Scavenge Oil---Scavenge oil from the main crankcase section, rear section and intermediate rear section flows through cored passages into the main sump located on the bottom of the rear section. A scavenge pump located in the reduction gearing housing sump picks up scavenge oil from the rocker box sump and the reduction gearing housing and forces it, through an outside line, into the cored passages from the main sump carrying the main sump scavenge oil. From here all the scavenge oil is drawn into the 3 gear, scavenge section of the oil scavenge and pressure pump. Some of the oil is forced around each of the two pumping gears into a common outlet which, through an outside line, directs the warm scavenge oil through a jacket around the carburetor adapter for carburetor air heating and as an anti-icing precaution. From this jacket the oil travels through the oil cooling system and back to the oil tanks.

ENGINE TEST

Upon completion of overhaul the engine was mounted on a rigid, drum type, test stand equipped with a shroud and located in a "U" type cell which is equipped with Minneapolis-Honeywell automatic fuel and oil system.

Instructions contained in Technical Order No. 02-1-1, dated 5 November 1945, were followed from time of readying the engine for test, through to preparation for storage in every instance possible. A.T.S.C. Form No. 66-523, "Overhauled Engine Block Test Report", was used to record all necessary information and readings. Engine speed per test period, time off and number of periods operated were the same as those used for block testing the R-2000-11 series engines.

The principal changes required to accommodate the engine on the test stand were; relocating carburetor controls in the drums, modifying oil inlet and outlet hose connections and calibrating a four (4) bladed wooden test club. The test club was reworked from a standard club used in testing R-2000 series engines. The hub was furnished with the Japanese equipment.

The following is data taken from the A.T.S.C. Form No. 66-523:

During the last 15 minute test period at 2500 RPM; fuel consumption 590 lbs. per hour, oil consumption 12 lbs. per hour, oil flow 84 lbs. per minute, main oil pressure 85 psi, oil-out temperature 105°C, manifold pressure 36.0" Hg, cylinder head temperature 375°F.

During the 3 minute test run at 2900 RPM; fuel consumption 1280 lbs. per hour, manifold pressure 48.5" Hg, cylinder head temperature 385°C, fuel pressure 5 psi, carburetor air temperature 22°C., anti-detonant consumption 230 lbs. per hour.

Magneto check at 2000 RPM revealed 50 RPM drop while operating on the front or rear spark plugs. The manifold pressure at 2200 RPM in low ratio clutch was 28.5" Hg, and in high ratio clutch 31.5" Hg. Clutch oil pressure was 144 psi.

Equipment and material used for testing were: Oil grade 120, specification AN-VV-O-446A. Fuel grade 91, specification AN-F-26. Anti-detonant fluid, half water and half alcohol, specification AN-A-24 (50% Ethyl and 50% Methyl). Spark plugs type LS-88. Four (4) blade wood propeller type 41K3929 with blade angle of 40° and diameter of 92".

Station weather data was: True barometer 29.95" Hg. Dry bulb 65.2°F. Wet bulb 47.0°F. Vapor pressure .124 psi. Dry air pressure .24 psi and test cell temperature 24°C.

The anti-detonant injector was set to cut-in at 37" Hg. The RPM at this point was between 2500 and 2600. The anti-detonant flow from cutting-in speed to power take-off was from 95 to 230 lbs. per hour. The by-pass valve on the anti-detonant pump was set at 13 lbs. pressure. This pressure is exerted on the anti-detonant injector and governs the flow of anti-detonant fluid. There is a tube from the engine supercharger housing to the by-pass valve. The purpose of this connection is to exert supercharger pressure (30" Hg and above) on the by-pass thereby imposing additional pressure (approx. 4 to 5 psi) on the anti-detonant injector and consequently causing increased flow of anti-detonant fluid at higher engine speeds. The flow is directly proportional to the manifold pressure.

Prior to the initial starting of the engine priming was accomplished by rapidly advancing the throttle lever twice (2) to eject fuel out of the carburetor accelerating pump. The engine started operating on the first attempt without back-firing, smoking or irregular running. It was especially noted that the engine was very easy to start and that it idled very smoothly. Vibration of the engine, which was minor, occurred at the following speeds: 1800 RPM, 2150 RPM and 2400 RPM. The performance in general was very good and passed all the requirements as that for an A.A.F. engine of similar power without any adjustments or corrections to the engine as assembled.

PART III

OPERATIONS

Pilot's Operating Instructions

a. Flight Restrictions---The limited diving speed of the airplane is 460 I.A.S. The maximum permissible R.P.M. in diving is 3060 and should not exceed 30 seconds duration. The cowl flaps should be closed during a dive. The wing flaps should not be lowered in any dives. Avoid violent rise of the throttle or propeller controls in a dive as the engines will over-rev considerably.

b. Before Entering Pilot's Compartment -

(1) Visually check external parts of the aircraft.
(2) Check Form I and "Status Today".
(3) See that chocks are in place.
(4) See that no loose equipment is in the cockpit.
(5) Remove control locks.
(6) Remove pitot cover.

c. On Entering Pilot's Compartment -

(1) Ignition switch in the "off" position.
(2) Check Form IA.
(3) Supercharger in low blower.
(4) Propeller control in increase R.P.M., - switch in automatic.
(5) Tail wheel unlocked.
(6) Trim tab in neutral position.
(7) Check hand pump by exercising wing flaps.
(8) Air filter "off", position "in".
(9) Carburetor heat in the "off" position.
(10) Oil cooler shutters open.
(11) Fuel selector turned to "fuselage" - second selector "open".
(12) Check flight controls.

d. Starting Engine -

(1) Wheel chocks set.



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Pilot's Instrument Panel

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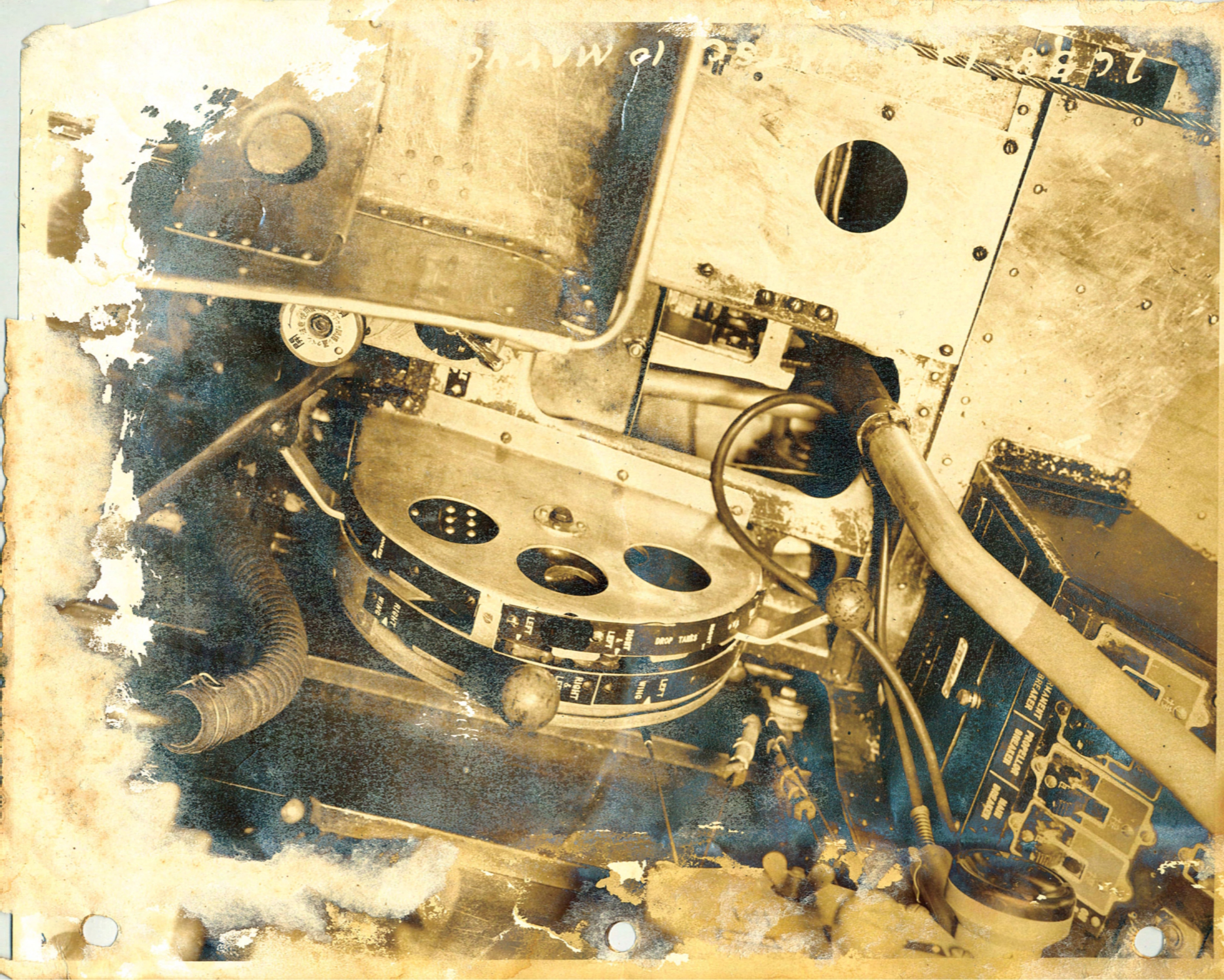
(2) Mixture control full rich, automatic mixture control at "normal".
(3) Crack throttle to 1/4 open.
(4) Turn primer selector to carburetor adapter (one stroke).
(5) Battery switch "on".
(6) Operate wobble pump so that fuel pressure is .3 kg/cm^2 (4.0 lbs.).
(7) Ignition switch "on".
(8) Have ground crew mechanics energize and engage starter.
(9) Turn on booster coil switch and press button to assist the start.
(10) Check oil pressure if less then 1.5 kg/cm^2 (20 lbs./sq. inch) after 30 seconds, cut engine.

e. Engine Warm Up -

(1) Warm up the engine at 800 - 1000 R.P.M.
(2) Check oil temperature at cruising limits (max. 108°C).
(3) Check oil pressure at cruising limits 6-8 kg/cm^2 (85-115 lbs. per sq. inch).
(4) Fuel pressure checked .3 kg/cm^2 (4.0 lbs. per sq. inch).

f. Engine and Accessory Check -

(1) After engine warm up check each magneto at 2000-2200 R.P.M. with maximum allowable drop of 75 R.P.M. for each magneto.
(2) Check propeller operation.
(3) Check operation of low and high blower (2200 R.P.M.).
(4) Check generator for amperage and voltages (59 amps., 27.5 - 28.5 volts).
(5) Check hydraulic pressure 70 kg/cm^2 (1000 lbs. per sq. inch).
(6) Check operation of wing and cowl flaps.
(7) Check operation of radio.
(8) If night flight is anticipated, check navigation and instrument lights.


DROP TANKS
RIGHT
MAIN
LEFT
WING
LEFT
MAIN
LEFT

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Fuel Selector Controls and Primer Installation

g. EMERGENCY INSTRUCTIONS

(1) LANDING GEAR---FOR FAILURE OF THE HYDRAULIC ENGINE DRIVEN PUMP OR THE COMPLETE LOSS OF HYDRAULIC FLUID RELEASE THE LANDING GEAR "UP" LOCKS BY PLACING THE LANDING GEAR SELECTOR CONTROL IN "DOWN" POSITION, WHICH AUTOMATICALLY BREAKS THE "UP" LOCKS. YAW THE AIRPLANE FROM LEFT TO RIGHT UNTIL THE LANDING GEAR IS LOWERED TO THE "DOWN" LOCKED POSITION. CHECK POSITION LIGHT INDICATOR FOR THE GREEN LIGHT TO PROVE LANDING GEAR IS LOCKED.

(2) CANOPY---THERE IS NO EMERGENCY PROCEDURE FOR OPENING THE CANOPY.

(3) FIRE---A PORTABLE FIRE EXTINGUISHER HAS BEEN INSTALLED IN THE PILOT'S COMPARTMENT ON THE RIGHT SIDE OF THE PILOT'S SEAT AFT.

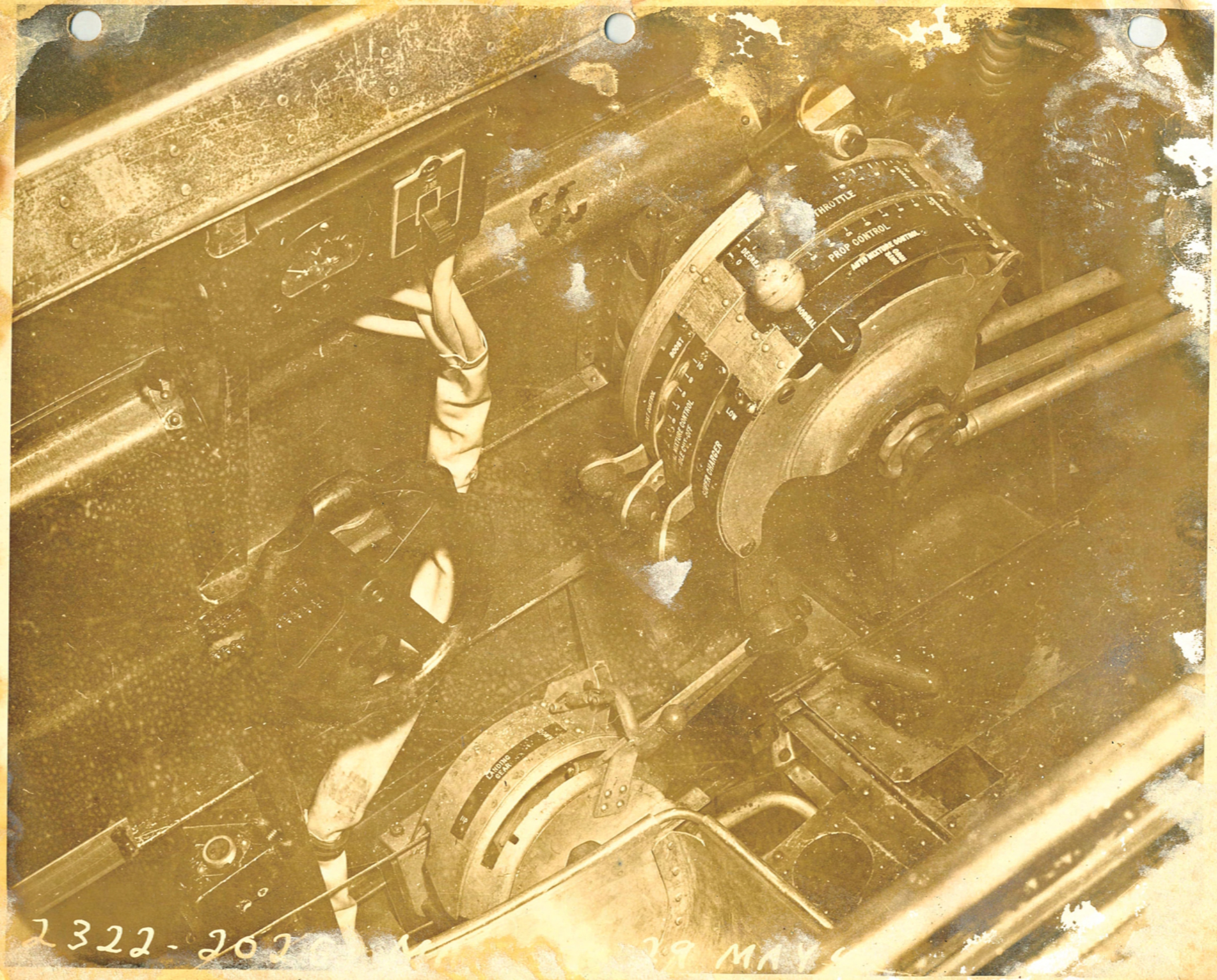
Flight Characteristics

a. Sensitiveness---At low speeds below 300 I.A.S. the Frank I has good handling characteristics. Above 300 I.A.S. the control surfaces stiffen considerably.

b. Taxing---Taxi and ground handling in general is poor due to poor brakes and difficulty in getting tail wheel to castor. It taxis well in a straight line with no tendency for the tail to come up. Vision on the ground is poor. The toe brakes on the British type rudder bar are more difficult to operate than the AAF type. The brake assembly is inadequate for the airplane necessitating cautious handling by the pilot. Use the brakes as little as possible in taxing and landing to prevent overheating and undue wear of the brakes. Unlock the tail wheel to allow wheel to castor.

c. Take-Off -

(1) Cowl flaps 1/4 open.
(2) Adjust propeller increase R.P.M. (3000 R.P.M.).
(3) Lock tail wheel.
(4) Gradually open throttle and increase to + 34 cm. (43.7 hg.).


THROTTLE
PROP CONTROL
AUTO MIXTURE CONTROL
NORMAL
BOOST
SUPER CHARGER
LANDING GEAR
2322-202
29 MAY

Pilot's Control Quadrant and Ignition Switch

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PUBLICATIONS-REPRODUCTION SECTION

MATSC

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IF NOT RETURNED BY GIVEN

(5) As momentum increases, raise tail and hold.
(6) When speed of 100 I.A.S. is reached slowly pull back the control stick and take off.
(7) After take-off, when a speed of 150 I.A.S. is reached, raise landing gear.

d. Landing -

(1) Extend gear at a sufficient altitude to allow time for the retraction. Do not lower landing gear above 160 I.A.S.
(2) Lower wing flap to the full deflection angle of 30°. Do not lower flaps above 130 I.A.S.
(3) Set propeller pitch lever for 2600 R.P.M.
(4) A smooth long glide, maintaining 120 I.A.S. on the final glide is recommended.
(5) The Frank I has good landing characteristics and a three point landing is recommended.
(6) Landing speed is 105 I.A.S.

e. Maneuverability---The maneuverability of the Frank I is very good at all speeds and is typical of all Japanese built fighters.

f. Dive Characteristics---Do not exceed 460 I.A.S. above 5000 feet in a dive. Should the airplane vibrate during a dive, close throttle and slowly reopen. Vertical dives should be exercised with the same care as a regular dive using a long gradual pull out of up to 4G. Control surfaces stiffen above 300 I.A.S. and will necessitate using the elevator trim tabs in dive pull outs.

Operational Limits

a. Rate of Climb---Rate of climb with maximum power up to 20,000 feet is approximately 3000 feet per minute.

Instrument Reading

a. Pitot Electric Heater---When there is a possibility of the pitot tube icing up, turn on the pitot electric heater switch.

b. Generator Switch---A generator switch is located on the

left side of the cockpit aft of the throttle quadrant. Turn "on" before flight.

c. Fuel Gage -

(1) Switch from wing tanks to fuselage tank and vice versa by means of the selector switch.
(2) The fuselage tank indicator is calibrated in liters of the quantity as is the wing tanks.
(3) When the amount remaining in each tank is three (3) gallons or less (11.35 liters) a red light on the fuel gage will go on.

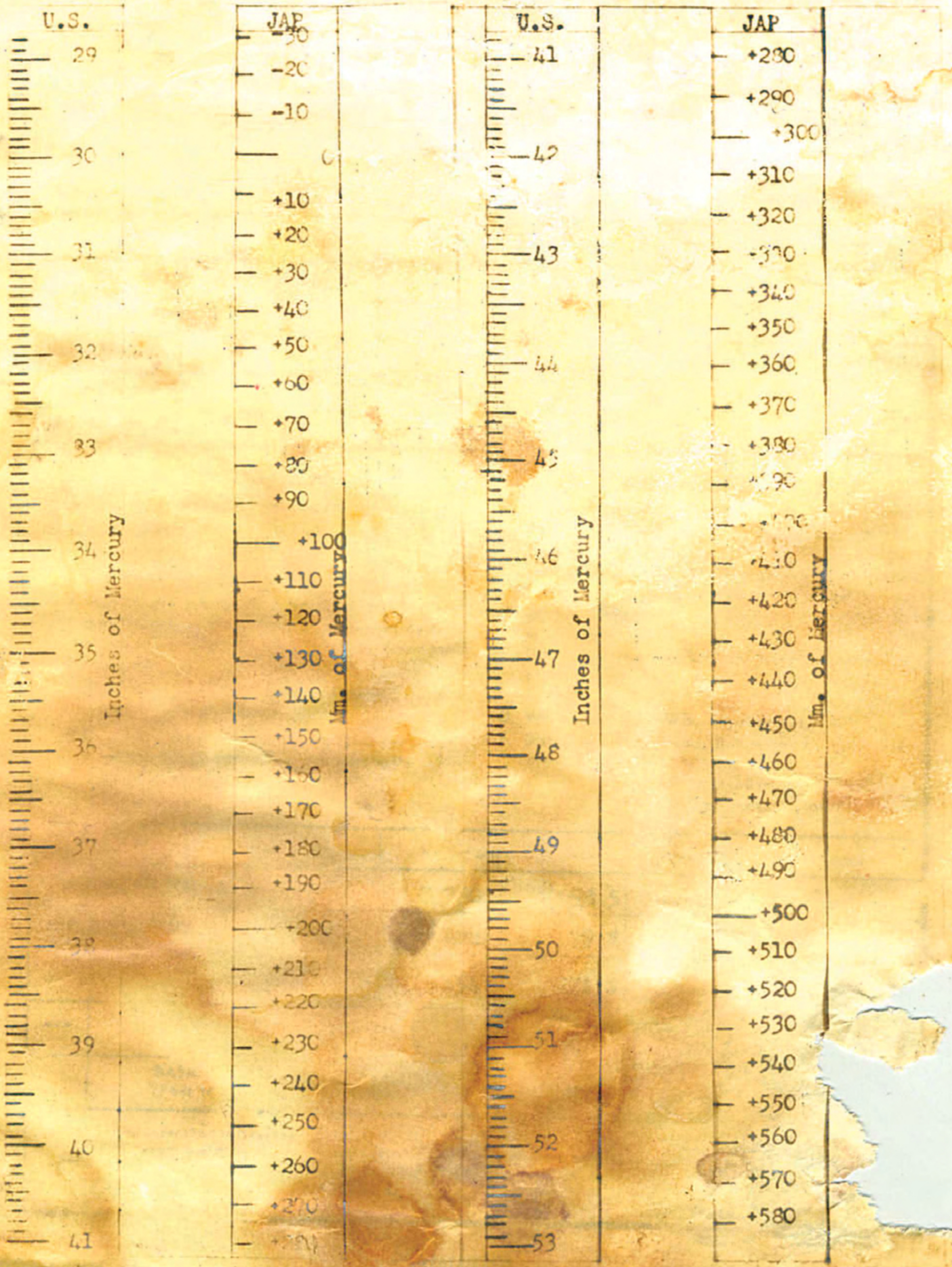
d. Oil Temperature Gage -

(1) Oil temperature is taken at the engine inlet and outlet. Switch left for oil inlet - switch right for oil outlet.
(2) A selector switch on the gage allows selection of either temperatures and when the battery switch is in the "off" position the gage reads 90°C.

e. Cylinder Temperature Gage---The number one gage shows the temperature of the fourth cylinder in the front row (master rod) and the number two gage shows the temperature of the fourth cylinder in the rear row (master rod).

The five (5) flight instruments, altimeter, clock, artificial horizon, airspeed and rate of climb, have been removed and replaced with standard AAF equipment.

EQUIVALENT BOOST PRESSURE



5-15-43

AIRPLANE WEIGHING FORM

DATE WEIGHED 7 May 1945 MODEL Frank I SERIAL No. T2-301

PLACE WEIGHED Olmsted Field, MATSC [illegible] G.L. Term, Capt., AC

WHEEL	SCALE READING	TARE	NET WEIGHT	ARM	MOMENT
LEFT MAIN	3,595		3,595		
RIGHT MAIN	3,545		3,545		
SUB-TOTAL (Both Main)	7,140		7,140	91.2 E	651,168
NOSE OR TAIL	240		240	315.6 F	75,744
TOTAL (As Weighed)	7,380		7,380	98.5 H	726,912

INSTRUCTIONS

1. Enter scale readings in first column.
2. Subtract tare, if any, from scale reading to obtain net weight.
3. Determine the arms, E and F.
4. Multiply the sub-total net weight of main wheels, and the net weight of nose or tail wheel by their respective arms (dimensions E and F) to obtain their moments.
5. Add net weights and moments of the main wheels and nose or tail wheel.
6. Divide the total moment by the total net weight to obtain the cg position in inches from the reference datum line (H).

MEASUREMENTS

E Distance from the jig point or frame to the center line of the main wheels. Obtained by measurements.

I. Distance from reference datum line to some accessible exterior jig point or frame of the airplane from which a plumb bob can be dropped to the ground. Obtained from diagram on balance computer or from Chart E.

E Distance from reference datum line to center line of main wheels.

D [illegible] 1

F Distance [illegible] reference datum line to center line of [illegible]

[illegible] (nose wheel airplane)
[illegible] (tail-wheel airplane)

	DESCRIPTION	NET WEIGHT	ARM	MOMENT/INDEX
*	TOTAL (As Weighed)	7,380	98.5	726,912
**	25 Gal. OIL IN AIRPLANE	188	79.8	15,002
**	Total of Items Weighed but Not Part of Basic Weight	554	271.9	150,633
***	Total of Basic Items Not in Airplane when Weighed			
	AIRPLANE (See Chart C)	6,638	84.6	561,277

*Post [illegible]
**Subtract [illegible] ment in accordance with actual weighing instructions in the title
***Be absolutely sure these items are subsequently installed and the [illegible] Applicable to the load adjusting computer.

TECHNICAL ORDER REFERENCE LIST

Airplane

00-20A	Visual Inspection of System for Aircraft
01-1-1	Cleaning of Aeronautical Equipment
01-1-2	Corrosion - Treatment for Aircraft
01-1-7	Storage of Aircraft
01-1-8	Ventilation of Aircraft in Hot Weather
01-1-26	Control Cables - Frayed
01-1-50	Towing - Ground Handling Parking
01-1-50A	Towing - Ground Handling Parking
01-1-68	Inspection of Electric Wiring & Junction Boxes
01-1-117	Kits - First Aid
01-1-123	Static Ground
01-1-130	Fuel Nozzle - Ground Receptacle
01-1-210	First Aid Kits - Identification & Marking
01-1-240	Wheels Alignment
01-1B-40	Handbook of Weight & Balance Data
01-1B-46	Load Adjuster - Installation of Placard
00-25-6	Take-off & Landing Precautions
06-10-1	Aircraft Engine Lubricating Oils
06-10-4	General Aircraft Use
06-1-2	Fluids for Hydraulic Equipment
06-1-2A	Fluids for Hydraulic Equipment
04-10-1	Aircraft Tires & Tubes - Information & Use
04-1-17	Installation of Hose Clamps
06-5-1	Fuel and Uses
02-1-1	Corrosion Control of Aircraft Engines
02-1-4	Block - Ground & Flight Test Instructions - Aircraft Engines
02-1-6	Valve Mechanism - Periodic Inspection & Adjustment
02-1-7	Engine Detonation
02-1-8	Restrictions on Removal of Engines.
02-1-22	Preoiling of Aircraft Engines
02-1-28	Intake Pipe Packing Nut - Inspection & Tightening
02-1-29	Ground Operating Instructions - Aircraft Engines
02-1-33	Stamping of Overhaul & Flying Time
02-1-38	Specified & Alternate Grade of Fuel
02-1-55	Cylinder Hold-Down Nut & Cap Screw