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THE JAPANESE ZERO FIGHTER

TYPE ZERO MARK I, CARRIER FIGHTER, MODEL 2.

This is a compilation of information currently available on late-type Zero carrier-borne fighters, based on examinations of crashed aircraft. Models bearing dates as late as the early part of 1942 have served as a basis for this work.

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For sometime past, incomplete, confusing and occasionally conflicting information has prevailed regarding the Japanese Zero Fighter. During recent weeks, examinations and investigations of crashed Zeros in various parts of the world have clarified the situation. For this reason, it is believed that the following detailed summary will prove of interest.

DESIGNATION: Some confusion has existed in the designation of Japanese aircraft, due to varying translations of the characters for type, mark, model, series, etc. To reach a common standard, use by us of the following phraseology usually found in Japanese characters on the airplane nameplate, is suggested:

Type Zero Mark I, Carrier Fighter, Model 2.

In the case of land-based airplanes, the designation is varied as required. For example:

Type 99 Mark I Army Bomber, Model 3.

GENERAL DESCRIPTION: The carrier-borne Zero fighter is a low-wing, cantilever monoplane of welded tube and stressed alloy skin construction. No fabric is employed except to cover the movable control surfaces.

Landing gear retracts inward hydraulically and is smoothly streamlined into the lower wing and fuselage when in the retracted position.

The double-row radial motor is enclosed within a long-chord cowling with adjustable cooling flaps attached to the after edge.

The silhouette of the airplane is marked by double taper wings, rounded wing tips and an inset rudder which terminates approximately at the elevator surfaces.

A radio mast is usually mounted behind the cockpit enclosure.

COMMENTS: While these late model Zeros are of pre-determined light design, they do not give an impression of flimsiness, nor does their construction appear skimped any more than necessary to obtain the desired lightness. Workmanship is of excellent quality. The outside color-finish of the fuselage and wings is well done, and the blue enamel protective coating on interior metal surfaces is thoroughly and carefully applied. There is some indication that these late models of the Zero may be stronger than earlier versions. This can be determined only when direct comparisons are possible.

It is considered unlikely that the late models are unduly weak in wing structure. They should, therefore, be able to enter an extended dive and pull out without too much difficulty.

While the airplane is well-made and well-designed, the complete absence of armor and lack of self-sealing construction in fuel and oil tanks make it vulnerable to a high degree. Earlier reports have failed to mention the fuselage fuel tank. While this tank is protected by the engine from forward attack, it is nevertheless, open to beam and deflection shots and considerably increases the vulnerable area of the airplane.

CHARACTERISTICS: Attached, as the final page of this summary, is a standard sheet of characteristics as applicable to the Type Zero Mark I, Carrier Fighter, Model 2. This sheet, which is numbered page 40 in the upper right-hand corner, is intended to replace the present page 40 in Informational Intelligence Summary No. 41, issued by Headquarters, Army Air Forces, Director of Intelligence Service, in July 1942.

On the following pages will be found a detailed description of the more recent version of the TYPE ZERO MARK I, CARRIER FIGHTER, MODEL 2.

I N D E X

TYPE ZERO MARK I, CARRIER FIGHTER, MODEL 2,

1. FUSELAGE: The over-all length from tip of tail light to forward end of spinner i 30'-3". With the spinner removed, the length to the front of the propeller control cylinder in the extended, low-pitch position is 29'-4½". Construction throughout is welded steel tubing with flush-riveted aluminum alloy skin. The only fabric employed is on the control surfaces--ailerons, elevators and rudder.

   A large yellow rubber bag is suspended by tapes in the interior of the after part of the fuselage, apparently as a flotation gear. It is connected by a metal pipe of about 1" diameter to the inner compartment formed in each wing by the main and after spar, outboard of the 20 mm. gun bay. From a "T" joint behind the cockpit wall, a short pipe of the same diameter projects into the left side of the cockpit, ending in a hand-controlled valve, opening directly into the cockpit.

2. WINGS: Span is 39'-5". Wings are tapered in plan and thickness, and have a pronounced dihedral. Taper is less on the leading edge than on the trailing edge. Wing tips are rounded and hinged about two feet from the outer end to permit folding. When the tips are horizontal, but not locked, a red tab projects through the upper surface to warn the pilot. The folding feature is controllable from the ground, but not from the cockpit. It is believed that it has been provided to permit the use of the Zero Plane on carrier elevators, since the wing is longer than that employed on some earlier carrier-borne fighter models. Ailerons are mechanically controlled and taper in plan with the outer edge projecting about 5" past the hinge into the folding wing tip. They are 10'-10" long, 16½" wide at inner end and 8" at outer end. Split-type, trailing edge flaps are provided inboard of the ailerons and are operated hydraulically. They are 5'-4" long and taper from 18" wide at the inboard end to 15" at the outer end. Wings are riveted to the fuselage and form a continuous structure with the lower side flush with the bottom of the fuselage. A large rearward flaring fillet covers the wing root at the fuselage. The wing is 8'-3½" wide at the outer edge of the fillet and is 4'-1" wide at the wing tip hinge.

3. WEIGHTS AND WING LOADING: Wing area measured to the outer end of the fillets totals 212 square feet. Weights of the airplane are given as follows:

Empty - - - - - - - - - - - - - - - -	3,781 pounds
Normal (combat) weight - - - - - -	5,214 pounds
Maximum weight with detachable belly tank - - - - -	5,689 pounds (estimated)

Based on these weights and 212 square feet wing area, wing loading in the empty condition is 17.8 pounds per square foot; with combat loading, 24.6 pounds per square foot; with full belly tank, (estimated) maximum loading 26.8 pounds per square

foot. The comparatively light weight of this airplane appears to be obtained entirely through lightening structural members and by the entire omission of protective armor. Otherwise, this model contains equipment and accessories closely similar to those commonly employed by other nations. The relatively light wing loading explains the high rate of climb and quick manoeuverability obtainable with this airplane.

4. TAIL GROUP: The horizontal stabilizer has straight taper on the leading edge with rounded tips. Its span is 15'-5". No negative dihedral has been observed on those aircraft examined. Divided tapered elevators are cable-controlled and are provided with trimming tabs on each elevator. The rudder is balanced and contains a heavy counterweight in the upper section which projects forward of the upper hinge. A solid tab adjustable on the ground is riveted to the outer edge. A cone-shape tail-piece is fitted to the fuselage below the rudder, and ends in a rounded tip housing the tail light. The lower portion is open to receive the retractable tail wheel and has a canvas and metal cover to fair it in when the wheel is retracted.

5. LANDING GEAR: The main landing gear consists of two hydraulically-controlled single struts for the main wheels. They fold inward into recesses in the lower part of the wing; metal covers attached to the outer part of the strut, together with folding metal covers over the wheel, entirely enclose the members when in the retracted position. Wheel pockets come into the fuselage and are separated by only about 6" at the center. Each strut contains a hydraulic shock absorber. It is simple and apparently well made. The weak point appears to be at the junction of the upper end of the strut with the hinged member, as a number have broken at this fitting. The tail wheel is provided with a solid flat-surfaced rubber tire, and is retracted hydraulically into the recess in the rear fuselage. The retracting mechanism also provides a hydraulic shock absorber for the tail wheel. Springs hold the wheel in the fore and aft position, and a spring-loaded clutch, which is pushed out of contact by a cam after an angle of 45° is reached, permits full swivelling. Each brake on the two main wheels is hydraulically operated by a single-acting piston; each contains two brake shoes 9" in diameter and 2" wide. Brakes are well made and are very similar to the Bendix type.

6. WHEELS: The main landing gear wheels are of aluminum alloy construction and are provided with double roller bearings. Each contains within the outer flange, two notches about an inch long and a quarter inch deep, set 180° apart. These notches receive lugs moulded into one flange of the tire casing, apparently to prevent creeping. Size of tires is 600mm. x 175mm., approximately 23.6" x 6.9".

7. ARRESTING GEAR: The hook at the end of the arrestor arm is hinged to permit quick release after landing. The locking pawl is controllable through a wire cable from the cockpit, and a spring on the arrestor arm returns the hook to normal locked

position. The entire arm is retractable into the lower part of the fuselage by a cable from the pilot's compartment.

8. MOTOR: These are usually manufactured by Nakajima and are 14-cylinder, double-row, air-cooled radials, marked "Series 12." Although apparently an original Japanese product, they follow closely many features of both Pratt & Whitney and Wright design. The horsepower is often rated at 840, but it is believed that a considerably higher horsepower is available for take-off. The motor is fastened to its mount by four bolts, permitting quick change of power plant assembly. Valves are automatically lubricated. Pistons contain five rings, four at the top and one at the bottom, and are light and well made. A single-stage supercharger is built into the crankcase, driven at a ratio of 127 + 17, approximately 7.5 : 1. Bore is 130 mm., stroke 150 mm., or approximately 5-1/8" x 5-7/8". A planetary propeller reduction gear is fitted into the nose of the crankcase and operates at a speed reduction of 16 : 11. Spark plugs, two to each cylinder, are of the radio-shielded type very similar to BG's. Many are marked T 1 B in English letters and figures. Dual magnetos are mounted and a 12 v. generator is built into the engine, but no electric starter is fitted, although a hand inertia starter is provided.

9. PROPELLER: The propeller is a 3-blade constant-speed Sumitomo of the hydraulic type, and apparently is identical with the Hamilton model. The hub is enclosed with a large bullet-nosed spinner, well fitted.

10. PIPE MARKINGS: The following colors to indicate various pipe connections and power controls are believed to be standard Japanese practice:-

Engine fuel - - - - - - -	red
Engine oil- - - - - - - -	yellow
Hydraulic fluid - - - - -	green
Oxygen - - -- - - - - - -	blue (and sometimes, white)

11. FUEL TANKS: The following tanks are fitted:-

In each wing there is a flat riveted aluminum alloy tank of 53.4 U. S. gallons capacity. A third tank containing 38.3 U. S. gallons is mounted crosswise of the fuselage in the forward end of the cockpit directly behind the fire wall, and is filled through an opening of the upper fuselage in front of the windshield. Detachable belly tanks probably vary in capacity. Some contain approximately 75 U. S. gallons. Built-in fuel capacity, therefore, is 145 U. S. gallons, and maximum capacity, including the detachable tank is a total of 220 U. S. gallons. If an estimated consumption of 45 gallons per hour at a cruising speed of 250 m.p.h. is accepted, ranges would be as follows (in still air):-

Built-in capacity 3.2 hours at 250 m.p.h.	=	805 miles
Maximum capacity 4.9 hours at 250 m.p.h.	=	1225 miles

A jettisonable, streamlined, plywood belly tank approximately 6' long and 18" in diameter appears to be used on the more recent models. A heavy cylindrical plunger is riveted to a collar on the upper part of the tank at a forward angle of about 15°. This plunger fits into a cylinder in the bottom of the fuselage just behind the wheel housings. Small rollers in the walls of both plunger and cylinder assure non-jamming release. A notched lug at the top of the plunger is the retaining device, and permits release from the cockpit by the pilot. The fuel line is joined to the fuselage through a flexible rubber connection just behind the detaching device. Slightly to the rear of the fuel line, a braced metal tube contains a heavy coiled, kickaway spring to assist in forcing the tank away from the fuselage when dropped. The plywood tank itself is estimated to weigh about 75 pounds; if filled with 75 U. S. gallons of fuel weighing 450 pounds, the total weight of tank and fuel would be approximately 525 pounds.

12. OIL TANK: The engine oil tank is mounted forward of the fire wall and contains 15.86 U. S. gallons (60 litres).

13. COCKPIT: Although perhaps somewhat smaller than average, the cockpit provides ample room for a pilot of normal size. Instruments are conveniently arranged and visibility is good. No automatic flight control apparatus is installed, but the instrument panel contains practically all other flight and navigational instruments found in modern fighters, including artificial horizon, radio compass dial and bank-and-turn indicator. A rudder bar is provided rather than individual rudder pedals. Metal stirrup loops in hinged toe plates mounted at each end of the bar provide individual brake control, which is obtained through built-in Bowden wire connections to two hydraulic cylinders mounted on the cockpit floor just in front of the rudder bar. The entire rudder bar and fittings are manually adjustable fore and aft by means of a screw to accommodate pilots of different length of leg. The control stick is of normal design, but contains neither trigger nor gun selector switches. These are found upon the throttle handle on the left side of the cockpit. A small rocking-thumb lever in the tops of the throttle handle selects in the forward position the 7.7 mm. nose guns, and in the rearward position both the 7.7's and the 20 mm. wing guns. A long, curved trigger is fitted to the forward side of the throttle handle. On the next inner quadrant, slightly below the throttle, a supercharger control lever is mounted. Inboard and slightly below the supercharger handle is the handle for the propeller pitch control. Mixture control handle is mounted on a separate quadrant, slightly higher and forward of the other group.

The air speed indicator is calibrated in knots and reads through a double scale from 40 to 160 and from 160 to 300 knots, equivalent to a range of 46 to 345 statute miles per hour.

The altimeter is of somewhat unusual calibration and reads from 0 to 8 through a double circular scale with a single hand indicator. The unit of measurement, although not as yet definitely determined, is presumably kilometers.

The manifold pressure gauge is designed in a manner unusual to western practice. A circular dial reads from 0 at the top, anti-clockwise to -45, at a position equivalent to 5 o'clock. From the zero position the single hand can move in a clockwise manner to a reading of +25 at a position equivalent to 4 o'clock. This plus quadrant is colored red.

The compass is of the normal liquid-filled flush-mounting type, and is positioned in the center of the instrument panel. Around the dial is mounted a rotatable ring calibrated from 0 to 360 degrees, permitting a simplified course setting against the lubber line.

14. COCKPIT VENTILATION: A tube coming from the leading edge of the right wing enters the cockpit on the lower right side ending in a flexible, ball-socketed tip, containing a hand-operated closure valve. No provision has been noted for bringing heat to the cockpit, but an electrical connection has been found indicating the use of electrically heated clothing for the pilot. Oxygen mountings for several oxygen bottles are usually found in the fuselage just behind the pilot's seat.

15. ARMAMENT: Normal armament consists of two 20 mm. guns, one in each wing with about 60 rounds of ammunition for each. Guns are air-cooled and are operated by the Oerlikon method based on the blow-back principle. Compared to our usual 20 mm. Oerlikon, the Japanese gun is shorter and lighter. It has a 30" barrel, pneumatic cocking device, pneumatic trigger motor, sturdy 3-point suspension and a flash hider constructed as part of the barrel and ending almost flush with the leading edge of the wing. The estimated muzzle velocity is 1800 f/s. Ammunition is stored in a 60-round drum. The cartridge case is shorter than with our standard Oerlikon 20 mm. H.E., A.P. and incendiary types are known to be used. The guns are well made and give every indication of precise workmanship and good design.

Two 7.7 mm. recoil-operated guns, synchronized to fire through the propeller disk, are mounted to fire through tunnels in the upper fuselage. Five hundred rounds are provided for each gun, and the usual equipment seems to be three sizes and shapes of 7.7. ammunition loaded in the following manner: 1 tracer, 1 armor-piercing, 1 incendiary, 1 armor-piercing, 1 tracer. The tracer is semi-boat tailed. Others have square bases but are not of the same size or shape.

An electric reflector gun sight of Japanese manufacture is provided.

16. BOMB LOAD: Strong points are provided for a bomb rack under each wing, and two bomb release levers are mounted in the cockpit at the left side of the pilot's seat. Since the weight of the detachable belly tank with its fuel totals approximately

525 pounds, it is thought that a 250 pound bomb might be carried under each wing when the detachable belly tank is not in use.

17. ARMOR: On recent models, no armor has been found in any part of the airplane. The front windshield is made of glass approximately 3/32" thick and is not shatterproof. Cockpit cover is made of a material resembling plexiglass and is also approximately 3/32" thick.

18. RADIO: Late-model Zeros have been found to contain 2-way radio with a radio mast mounted just aft of the cockpit. The usual equipment seems to consist of a transmitter for both voice and Morse code, together with a crystal-controlled receiver and a radio compass of the Fairchild type. The loop for the latter is located in the cockpit enclosure, just back of the pilot's seat. Frequency range for the radio compass is in two bands ranging from 170 to 460 kc. and from 450 to 1200 kc.

The radio receiver is of superheterodyne type, crystal-controlled and has a beat oscillator for CW reception. Frequency can be changed only by changing the crystal which plugs into the front panel. A commonly used crystal is marked 4145 kc.

The radio transmitter has a power output of about 10 watts, is crystal-controlled and is arranged for voice or CW. Frequency range is approximately 2000 kc. to 6000 kc. and can be changed only by inserting a new crystal. A neon bulb is provided in the plate circuit to indicate resonance, and an antenna meter provides a maximum reading up to .8 of an ampere. Radio tubes are of Japanese manufacture and appear similar to those employed by western nations.

Power is provided by three dynamotors--one for the transmitter, one for the receiver and one for the radio compass--operating through a 12 v. non-spillable storage battery of small capacity.

19. PARACHUTE: A quick detachable seat-type parachute has been noted. It is of Japanese manufacture, made of silk and well-designed.

20. INSIGNIA: The usual Japanese recognition insignia consists of a large red circle on the top and bottom of each wing with the outer edge about 8" inboard of the hinge of the folding wing tip. Similar red circles are painted on each side of the fuselage about a foot aft of the trailing edge of the wing, although it is understood that these fuselage circles have been omitted on aircraft operating in Burma and China. Bands, sometimes of a yellow or red color, and at various angles, frequently are painted around the fuselage to the rear of the red circle. In some cases, they form an oblique angle; at other times they make a right angle to the fore and aft line of the fuselage. Their width is about 7".

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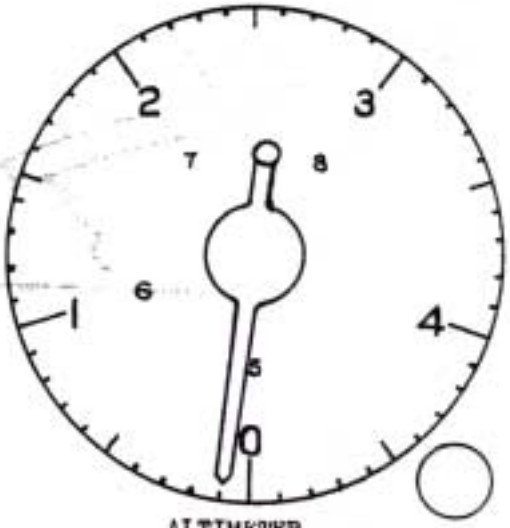
AIR SPEED INDICATOR
Knots x 10



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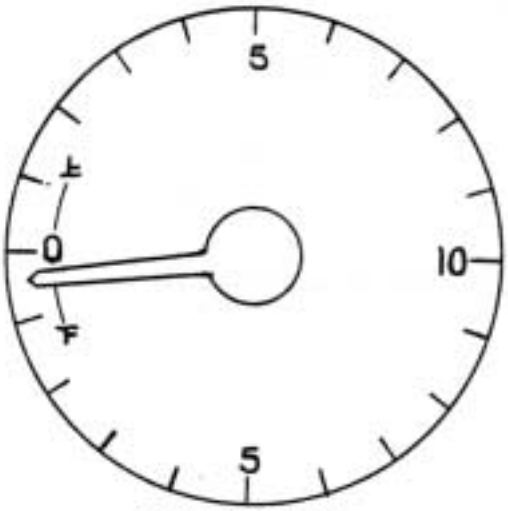
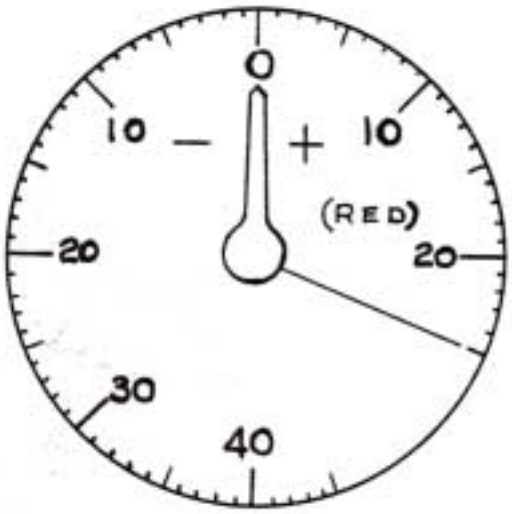
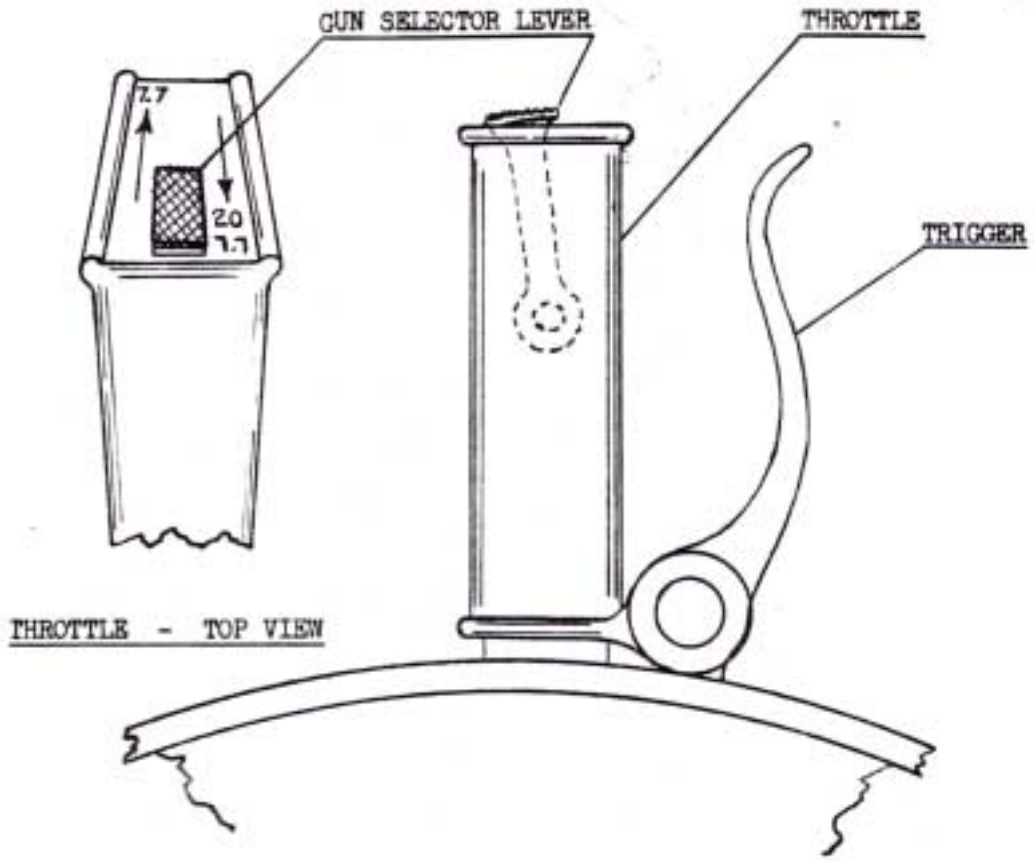


RATE OF CLIMB



MANIFOLD PRESSURE GAGE



THROTTLE - TOP VIEW

COMPASS AND ADJUSTABLE COURSE INDICATOR

DESCRIPTION: Low-wing, single seat, cantilever monoplane. All metal construction except fabric covered control surfaces. Wings tapered in plan and thickness with sharp taper on trailing edge. Rounded wing tips, hinged about 2 feet from end. Landing gear retractable hydraulically, inward. Manufactured by Mitsubishi at Nagoya. Mentioned in FM 30-38 as the "Nagoya Zero." Elliptical winged model called Mitsubishi Zero in FM 30-38 not yet identified as such.

COUNTRY: JAPAN
TYPE: Carrier-borne Fighter
MODEL: Type Zero Mark 1, Model 2.
MFG.: Mitsubishi at Nagoya
MAX. SPEED: 310/345 mph (est.)
NO. OF MOTORS: 1
TOTAL H.P.: 840 @ ? altitude
TOTAL FIREPOWER: 2 x 7.7 & 2 x 20 mm
BOMB LOAD: Est. up to 500 lbs. max.
RANGE: Normal 805; max. 1225 mi.est.
CREW: 1

PERFORMANCE: - Speed at Sea level

Max. speed at ? ft. altitude 310/345 mph (est)

Cruising speed at ft. altitude

Landing speed m.p.h.; Climb: 26,000' in 15 min. Est. 3500 ft/min., or better.

Range: Est: Built in: 3.2 hrs @ 250 mph=805 mi; with belly tank: 4.9 hrs @ 250 mph=1225 mi.

Misc.: Tanks: 1 ea wing, 53.4 gals, fuselage 38.3, belly tank abt 75; total max. 220 US gals.
Service ceiling est. 36,000'

POWER PLANT - No. of motors 1 Rated H.P. each: 840 @ ? altitude

Description: Nakajima NK-1, series 12. 14 cyl. double-row radial, air cooled.

Propellers: Sumitomo; 3-blade, constant speed., hydr. control. Similar to Hamilton.

Superchargers: Single stage, built into crankcase. Ratio 127 : 17 (approx. 7.5 : 1).

Misc.: Bore 130 mm., stroke 150 mm. (approx. 5-1/8" x 5-7/8").
Propellor planetary reduction gear ratio, 16 : 11.

FIRE POWER: - Machine Guns 2 x 7.7 mm fixed, synchronized, 500 rnds ea, in belts; example of loading: 1 tracer, 1 A.P., 1 incendiary, 1 A.P., 1 tracer. Also 2 x 20 mm in wings forward outside prop. disk, 60 rnds ea, in drums; H.E., A.P., and incendiary.

Bombs: Strong points under each wing for bomb racks - Two bomb release levers in cockpit. Believed 2 x 250 lbs. may be carried.

Armor: None found in recent models

Misc.: Gun selector lever and trigger on throttle handle. Pneumatic control.

SPECIFICATIONS: - Materials All metal, stressed skin; fabric control surfaces.

Span: 39'-5" Length: 30'-3" Wing Area: Net 212; Gr. 256 sq.ft.(est)

Weight empty: 3,781 lbs. Full Load: Normal, 5214#; Max: 5689# (est)

Misc.: Net wing area is measured to the outer edge of the wing-fuselage fillets. Gross measurement is the projected plan area of entire wing through fuselage.

GENERAL REMARKS: - Light wing loading explains the high rate of climb and good maneuverability.