Twin Wasp D Series Engines
(R-2000)
Model Differences

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SERVICE SCHOOL

East Hartford, Connecticut

January, 1946

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Since its inception in 1942, the R-2000 has been produced as a military engine for use in the C-54 airplane. Just as the C-54 airplane designations have changed for varying configurations of the airplane, the R-2000 designations have changed from the original model R-2000-3, to R-2000-7, -11, -9, and 2SD13G.

The change in engine designation, implies either a change in rating or sufficient change in structure to warrant a separate bill of materials. The largest designation number does not necessarily indicate the latest model, and in the case of the R-2000, the -9 is a later model than the -11.

The R-2000-3 was superseded by the R-2000-7 to introduce some mechanical and operating improvements. While continuing with development, we were asked by the Army to increase the ratings and at the same time, increase the high blower critical altitude. This brought forth the R-2000-9 model which contained extensive design changes to improve mechanical strength, and to overcome other weaknesses causing service difficulties in the older models. A new supercharger achieved an appreciable gain in high blower critical altitude.

The Army, due to the immediate necessity of improving the altitude performance of the C-54 for certain ATC requirements, requested that we build an intermediate model utilizing, in effect, the new supercharger on the R-2000-7 in order to get a limited quantity of high altitude engines in service before the rather completely changed R-2000-9's could be produced. This resulted in the R-2000-11 model.

Outlined herein is a summary of the improvements and design changes which appear in the 2SD13G engine now in production. The reasons for making these changes are, in most cases, indicated in the text. From constant study of service troubles experienced in earlier models have come new ideas and techniques designed to minimize service failures and to facilitate overhaul. The new features incorporated in this engine do not come as radical changes but rather as forward steps in the process of continuous development of Pratt and Whitney engines.

A. NOSE SECTION

1. Front Reduction Drive Coupling

Pitting and spalling of the splines on the reduction drive couplings, which is caused by high localized pressures, is being alleviated by Parko-Lubrize.

2. Intermediate Reduction Drive Coupling

The Parko-Lubrize process is also employed on the intermediate reduction drive coupling to provide protection from pitting and spalling. Furthermore, this coupling is smaller and lighter than in some earlier models.

3. Reduction Drive Rear Coupling

The reduction drive rear coupling in the 2SD13G engine is mated to internal splines in the crankshaft rather than to external splines as used in the -7 engine. This change has been dictated by the use of plain crankshaft main bearings. It further makes possible a simpler design for the reduction couplings as a unit.

4. Propeller Shaft Rear Bearing

The rear support bearing for the propeller shaft is incorporated in the reduction drive front coupling. It is a steel-backed silver-loaded bearing and was adopted because of its greater durability. It has greater bearing surface than the roller type, resulting in better load distribution.

5. Propeller Shaft

Splines on the propeller shaft (propeller end) are now being shot peened to give increased durability.

6. Ignition System

The 2SD13G uses either the same type of filled harness and rigid high tension leads as the R-2000-9 or a cadmium plated tubular harness with flexible high tension leads.

Radio noises which frequently were cuased by improperly mated surfaces are being minimized by increasing contact areas, and, on the distributor housing by a braided wire loop in the cover which fits into a groove in the housing when the cover is in place. In addition, the number of securing screws at these surfaces has been increased.

To reduce condensation of moisture inside magnetos, a new ventilating system has been developed. It is expected to appear soon on production engines. This system passes cold air from outside the nose section through the magnetos and vents it through pipes leading to outside the accessory section. The direct flow of ventilating air from front to rear greatly facilitates drainage of moisture from the ignition system.

7. Automatic Spark Advance System

The 2SD13G engine is equipped with a mechanism which automatically shifts the spark advance from 25 degrees to 37 degrees before piston top center when the engine is operated in the cruising range. At the same time the mechanism leans the fuel-air mixture through a two-position automatic lean valve unit. This provides for an increase of approximately four to seven per cent in cruise economy.

This equipment has not yet been released for use pending the results of service tests.

8. Front Oil Pump

A new front oil pump having greater capacity has been developed and will appear in production models of the 2SD13G in the near future.

B. POWER SECTION

1. Valve Actuating Cams

The cam incorporated in the 2SD13G engine is an improvement over those used in some earlier models. It provides greater valve overlap, thus resulting in increased volumetric efficiency. As a further improvement, the contour of the ramp has been lengthened to provide smoother cam action. This in turn reduces flaking of the cam track. Furthermore, this cam has a greater number of driving teeth to eliminate tooth pitting on the driving pinion.

2. Front Valve Actuating Cam Bearing

A new type cam bearing is employed in this latest engine. Earlier engines were made with the front cam bearing integral with the front main bearing liner. It was supported by the cam bearing support which also, by means of splines, prevented the bearing from turning.

The latest engine is made with a boss which is integral with the front main crankcase section. This boss supports the cam bearing and is provided with studs to prevent the turning of the bearing. This change eliminates the cam bearing support.

3. Cylinders

The cylinder heads used on all R-2000 engines are basically the same as those used successfully on the R-2800-B engines.

a. Cylinder barrels

On the 2SD13G engine a new design of cylinder barrel is being used. This involves the use of an aluminum muff shrunk on the barrel. This muff, having greater fin area and better heat conductivity than steel, gives improved cooling characteristics and tends to reduce ring and piston wear.

Changing to muffed cylinders necessitated re-designing various parts of the engine that are on or adjacent to the cylinders. For this reason new deflectors, a new main oil sump with re-designed sump bracket screw, a new main oil pressure pipe, and a re-designed oil scavenge pipe are used on this engine. Cylinders are held on with 9/16" hexagon nuts and pal nuts. A revised method of clamping and routing primer lines has been developed to prevent breakage of these lines. This change is expected to appear on production engines in the near future.

b. Exhaust valves

In line with the changes made to improve cam action, an improvement has been made in the exhaust valves themselves. This improvement is one that proved successful in the R-2800-C engine and it should give good performance in the R-2000. It consists of making the valves thicker in the tulip section.

c. Exhaust valve guides

The exhaust valve guides in the 2SD13G engine are made of bronze and are provided with a steel flange at the lower end to prevent burning of the exhaust valve guide boss. This guide is safetied by a snap ring.

d. Valve tappets

The tappets are lighter in weight than those used on some earlier models, bringing about a total reduction of 4½ pounds in the weight of the twenty-eight tappets. Not only does this make a lighter engine, but it materially reduces inertia loads on the cams.

e. Spark plug inserts

Stainless steel helicoil spark plug inserts are used to prevent plug sticking, to strengthen the cylinder, and to reduce the corrosion which frequently occurred with bronze bushings.

f. Rocker box scavenging

In order to simplify the rocker box scavenging system and reduce engine weight, the rocker sump has been eliminated. Drain oil from the front and rear cylinder rocker boxes on the underside of the engine is brought to a small drain manifold on No. 8 cylinder head. This manifold is connected by a suction pipe to the front oil pump to provide for scavenging. This change results in a further weight saving amounting to approximately three pounds.

g. Rocker box covers

The material used in the 2SD13G rocker box covers is sand cast aluminum. The improved strength of this type of cover has materially reduced oil leakage.

h. Pistons and Piston Rings

A new design of piston used on the 2SD13G engine has a number one compression ring with a fifteen degree wedge angle and narrower faces on the second and third compression rings. In addition, the third compression ring has a three quarter degree scraper edge. All rings have increased gaps. These changes have been made to increase ring life.

4. Main Bearings

The 2SD13G engine incorporates steel-backed, silver-leaded main bearings of the type used on the R-2800-C engine. The front and rear bearings are pressure lubricated. The center bearing is a floating one having two bearing surfaces that are lubricated by splash oil. Plain bearings of the type used in this engine give a maximum of contact area for a minimum of space.

5. Crankcase and Crankshaft

The incorporation of plain bearings produces a stronger crankcase because the diameter of the main bearing hole is smaller than where the roller type is used. Likewise, the crankshaft has larger and stronger journals.

Further increase in the durability of both crankcase, (center section only) and crankshaft is provided by shot peening.

A front crankcase is used having the passages for the drainage of oil from the nose section at a higher level. This prevents abnormal amounts of oil from entering the power section.

Another crankshaft change consists of not having any squirt hole in the crankshaft-to-propeller-shaft oil transfer tube. This tends to reduce oil flow and permits better scavenging.

6. Master Rod Bearings

Master rod bearings have been strengthened by the use of nickel-chrome-molybdenum steel for backing. This tends to reduce the possibility of flange breakage which sometimes occurred in earlier models of the R-2000 engine.

C. BLOWER SECTION

1. Supercharger Efficiency

Supercharger efficiency has been improved through a re-design of the impeller to reduce heating of the fuel air charge. This was accomplished by reducing the height of the impeller blade tips. It results in a higher rate of flow for a given manifold pressure.

2. Impeller Shaft Oil Seal Rings

Because impeller shaft oil seal rings were occasionally wearing to the point of leakage in early R-2000 engines, it was decided to lead plate these rings. This is now standard practice for all R-2000 models in production.

D. INTERMEDIATE REAR SECTION

1. Supercharger Drive Clutch

Early models of the R-2000 engine (-3 and -7) incorporated clutches having sludge baffle plates secured by three screws. Ring liners were integral with clutch cones and sludge baffle plates acted as ring carriers.

The latest engines have clutches containing no baffle plates but incorporating ring carriers held in place by ten rivets to provide greater strength.

2. Clutch Desludging

Sludge collection in the clutches is reduced by a creeper gear which has given excellent service in R-2800 engines. This gear rotates at a different speed from that of the clutch gear. A bleed hole in the creeper gear aligns itself momentarily with each of the bleed holes in the clutch gear and the pressure oil within the clutch spurts out, carrying the sludge in the clutch with it.

3. Clutch Pinion Gear

The pinion gear, which on earlier engines was splined to the clutch shaft, has now been made integral with the shaft. This eliminates spline wear at this location.

4. Grooved Diffuser

In order to provide even better vaporization in the 2SD13G engine, annular grooves are machined in the internal surface of the diffuser insert. Unvaporized fuel running along the wall of the blower throat is picked up by these grooves and subjected to turbulent air, facilitating vaporization and distribution.

5. Fuel Feed Valve Spring

A heavier and longer fuel feed valve spring is being used on the 2SD13G engine to raise the opening pressure of the fuel feed valve and give greater freedom from vapor troubles in the fuel system.

E. REAR SECTION

Oil Pump

A higher speed oil pump is provided in the 2SD13G engine, to increase pump capacity and to relieve a marginal condition which existed in some earlier models in both the pressure and scavenging stages.

Twin Wasp D Series Engines

Summary of R-2000 Production Design Changes

Model Designations	-3	-7	-11	-9	2SD13G
Nose Section					
Front Reduction Drive Coupling Splines	Plain	Plain	Plain	Parko-Lub.	Parko-Lub.
Intermediate Reduction Drive Coupling	Plain	Plain	Plain	Parko-Lub.	Parko-Lub.
Crankshaft Driving Splines	External	External	External	Internal	Internal
Propeller Shaft Rear Bearing	Roller	Roller	Roller	Silver-leaded	Silver-leaded
Propeller Shaft Splines (Propeller End)	Plain	Plain	Plain	Plain	Shot-peened
Ignition Harness	Filled	Filled	Filled	New Filled	New Filled or Tubular
High Tension Leads	Flexible	Flexible	Flexible	Rigid	Rigid or Flexible
Magneto Vent System	Vented to Blower Throat	Vented to Blower Throat	Vented to Blower Throat	Vented to Blower Throat	Improved See Text
Automatic Spark Advance System	No	No	No	Yes, with super lean	Yes, with super lean
Front Oil Pump	Original Design	Original Design	Original Design	Original Design	Increased Capacity

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Power Section					
Cams	Original Design	Original Design	Improved lobes and timing	Same as -11 but with more teeth	Same as -9
Cam Reduction Gears	Single	Dual	Dual	Dual with added teeth	Dual with added teeth
Front Cam Bearing Support	Supported by Main Bearing Support Plate	Supported by Main Bearing Support Plate	Supported by Main Bearing Support Plate	Integral with Crankcase	Integral with Crankcase
Cylinder Barrel	Steel fins	Steel fins	Steel fins	Steel fins	Aluminum muff
Cylinder Hold down Nut	Internal Spline Nut	Internal Spline Nut	Internal Spline Nut	Internal Spline Nut	9/16" Hex. with Pal Nut
Cylinder Deflectors	Original Design	Original Design	Original Design	Original Design	Clamped to Flange
Main Oil Sump	Fabricated	Fabricated	Fabricated	Cast	Fabricated
Sump Vent Pipe	Original Design	Original Design	Original Design	Special to go with cast sump	Original Design

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Sump Bracket Screw	Original Design	Original Design	Original Design	Original Design	Changed to fit muffed cylinder
Main Oil Pressure Pipe	Original Design	Original Design	Original Design	Original Design	Changed to fit muffed cylinder
Oil Scavenge Pipe	Original Design	Original Design	Original Design	Original Design	Changed to fit muffed cylinder
Primer Tube Clamps	Original Design	Original Design	Original Design	Original Design	Strengthened
Exhaust Valves	Original Design	Original Design	Same as R-2800-C	Same as R-2800-C	Same as R-2800-C
Exhaust Valve Guide	Bronze	Bronze	Bronze	Steel with bronze lining	Bronze with steel flange
Valve Tappets	Heavy wall	Heavy wall	Heavy wall	Light wall	Light wall
Spark Plug Inserts	Bronze	Bronze	Bronze	Helicoil	Helicoil

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Rocker box Scavenging	Rocker box Sump	Rocker box Sump	Rocker box Sump	Manifold	Manifold
Rocker box Covers	Magnesium	Magnesium	Magnesium	Aluminum	Aluminum
Piston and Rings	Original Design	Original Design	Original Design	Original Design	New Design
Main Bearings	Roller	Roller	Roller	Silver-leaded	Silver-leaded
Crankcase	Original Design	Original Design	Original Design	Strengthened	Strengthened See text
Front Crankcase Section	Drain from nose	Drain from nose	Drain from nose	Drain from nose	Higher Drain from nose
Crankshaft	Original	Same as -3	Same as -3	Improved	Improved See text
Crankshaft-to-propeller shaft oil transfer tube	Has squirt hole	Has squirt hole	Has squirt hole	Has squirt hole	No squirt hole
Master Rod Bearings	Steel backed	Steel backed	Steel backed	Ni-Cr-Mo Steel backed	Ni-Cr-Mo Steel backed

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Blower Section					
Impeller	High blade tip	High blade tip	Height of blade tip reduced	Same as -11	Same as -11
Impeller Shaft Oil Seal Rings	Plain bronze	Plain bronze	Plain bronze	Lead plated bronze	Lead plated bronze
Intermediate Rear Section					
Clutch	Baffle Plates held by screws	Baffle Plates held by screws	Ring Carriers riveted	Ring Carriers riveted	Ring Carriers riveted
Clutch Desludging Creeping Gear	No	No	Used on later -11	Yes	Yes
Clutch Pinion Gear	Splined	Splined	Splined	Integral with shaft	Integral with shaft
Diffuser	Smooth	Smooth	Grooved	Grooved	Grooved
Fuel Feed Valve Spring	5 pound	5 pound	5 pound	5 pound	10 pound
Rear Section					
Oil Pump to Crankshaft Ratio	.875:1	.875:1	.875:1	1.2 :1	1.2 :1