AIRCORPS AVIATION

DOCUMENT
AC.A. 01-151-L2
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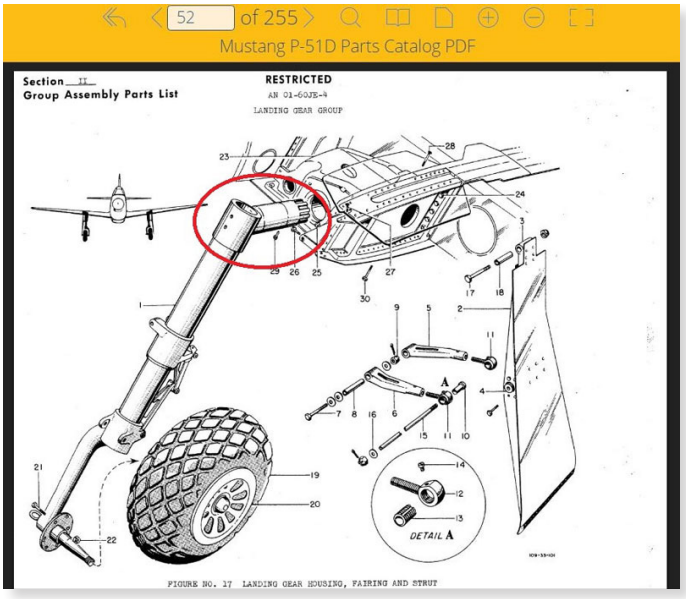
P-51 Landing Gear Pivot Shafts

All P-51 Mustang Variants

Manufacturer	Manufacturer - North American Aviation
Aircraft	P-51 Mustang
NAA Part Number	73-33112
Bendix Part Numbers	66584 & 161271
Proper Description	Landing Gear Pivot Shaft and Ring Assembly
Location	One assembly is located at the top of each P-51 Landing Gear Assembly (P/N 73-33102)
Nickname	Pivot Shaft



Digital drawing of NAA pivot shaft on AirCorps Library

OVERVIEW / EXECUTIVE SUMMARY

Nobody wants to witness, participate in, or collapse a landing gear on a Mustang. It is a costly and intensive repair resulting in damage to wing, fuselage, and major components. While the most common reason a Mustang ends up on its belly is pilot error, another factor can be the failure of a landing gear pivot shaft. Fortunately, there are inspections, preventative measures and solutions that almost eliminate the likelihood of this failure mode. AirCorps Aviation in Bemidji MN has compiled a comprehensive explanation of the failure modes of this critical component, with the belief that it is something every pilot and mechanic involved with a Mustang should thoroughly understand.

Read on to learn why...

LOCATION/FUNCTION

Pivot shaft is an abbreviated description from the actual component properly named Landing Gear Pivot Shaft and Ring Assembly. This critical component can be described as the point at which the gear leg attaches and rotates for retraction of landing gear into the wing. It also bears the stress of attachment of a landing gear to wing and absorbs the impact of the main wheel tires making contact with the ground upon landing.

COMPONENT BACKGROUND

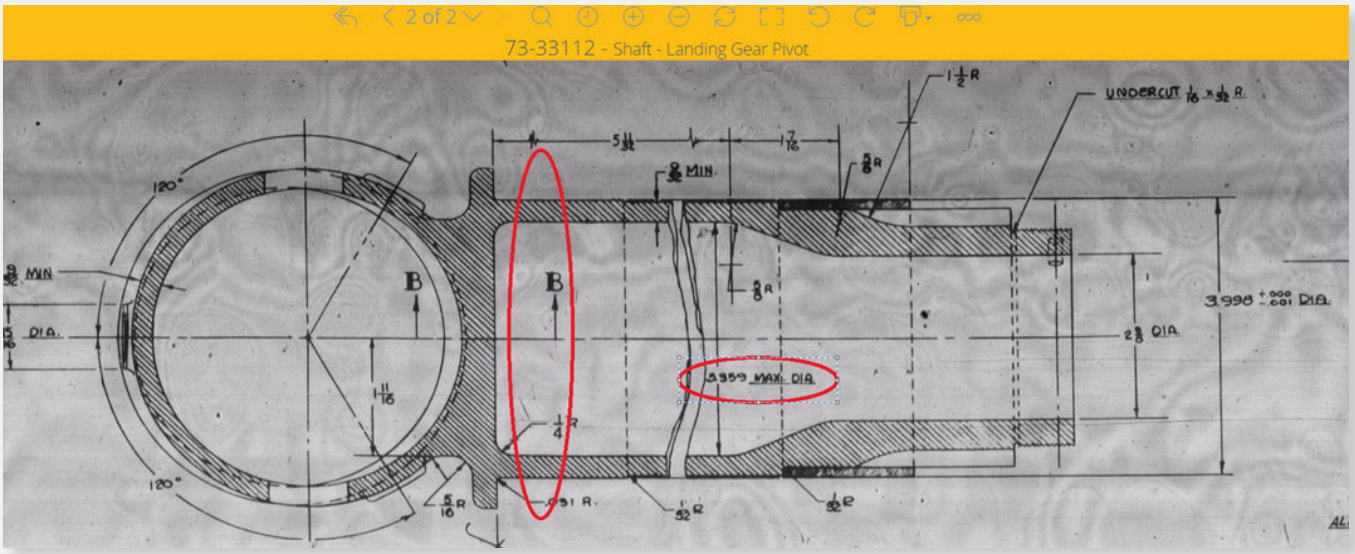
The pivot shaft was designed and engineered by North American as P/N 73-33112 on July 5, 1940 and checked / approved about a month later. The NAA drawing identifies two were used per ship on on all P-51 variants, F-51 & A-36 Series aircraft A thru K. On June 6, 1943 the drawing was made inactive and production was handed over to Bendix who produced the part as part number 66584 – a "light shaft" and as 161271 – a "heavy shaft" subsequently discussed.

TYPES OF PIVOT SHAFTS

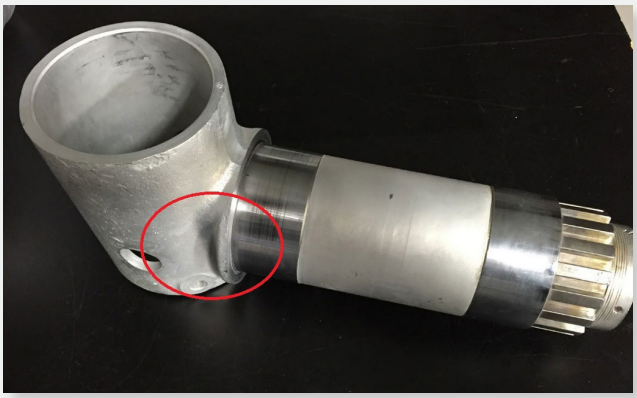
Mustang expert Mark Tisler explains the three generations of pivot shafts commonly referred to as light, light cut, and heavy.

A light landing gear pivot shaft (P/N – 73-33112 & 66584) has two different generations of production, both of which share a light wall on the interior of the shaft. The first generation "light" pivot shaft has a sharp radius on the thrust face anda 90 degree corner around the radius of the chrome bearing. The second generation "light cut" pivot shaft has had the 90 angle undercut to give it a radius and reduce stress concentration. Tech Order 01-60JE-47 outlines replacement of light shafts with heavy shafts.

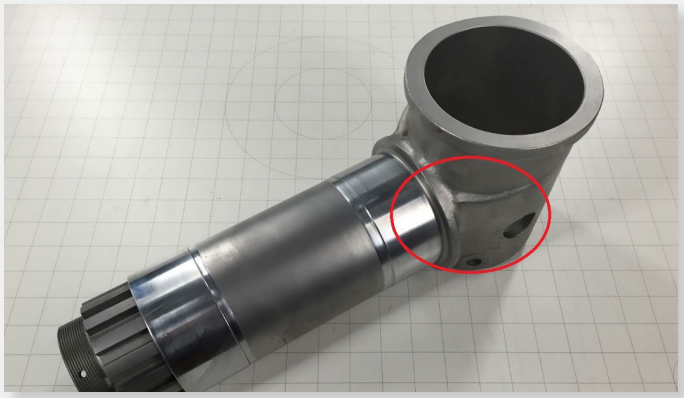
A heavy landing gear pivot shaft (P/N 161271) is machined differently on the inside bore of the pivot tube and has increased wall thickness. The pivot shaft thrust face has a large radius cut away to make a symmetrical sloping edge. There are also diagonal bands called "cheeks" on each side of the pivot shaft and an additional bead around the base to reduce the propensity to crack.



Light pivot shaft drawing 73-33112 - Notice the common cracking point on the left and how inner diameter 3.359" leaves a wall thickness of only 9/32".



Light pivot shaft - Notice lack of additional material in the cheeks area of the shaft. Only 3 of the 16 light pivot shafts inspected and tested by AirCorps have passed.



Heavy pivot shaft - Notice additional material through cheeks of shaft to strengthen area prone to cracking. Also the chamfered / symmetrical sloping edge is visible within the highlighted area where the upright portion makes the transition to the shaft.

INSPECTION

In overhauling 10 sets of landing gear over the past two years, AirCorps has established a standard process of handling these increasingly rare, high-value components. The importance of recording serial numbers, inspecting for airworthiness by checking for cracks, straightness, twist, and re-plating, if necessary, cannot be understated.

To ensure proper inspection, the pivot shaft must be removed from the aircraft to see cracks in the radius. Dye penetrant has been found to be insufficient in locating cracks meaning the pivot shaft must undergo magnetic particle inspection. A thorough dimensional analysis should be done to check the straightness and location of splines relative to the angle of the gear leg receptacle hole. Also measure for elongation of the top and bottom of the gear leg receptacle hole and the outer diameter (O.D.) of chromed surfaces, along with checking for flaking of chrome which is an indication of rust underneath.

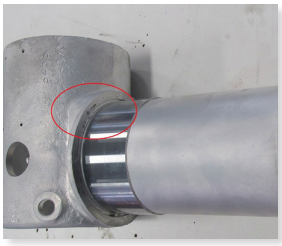
Therefore, AirCorps recommends, Following guidance given Military T.O. 01-60JE-47 to replace "light weight" shafts 73-33112 & 66584 as soon as possible or at next inspection. If "light weight" shafts are operated, we recommend immediate magnaflux inspection if not previously inspected by removal and magnaflux.

PIVOT SHAFT FAILURES

Pivot shafts are prone to cracks in a number of areas and require consistent inspection regardless of type. Experience in inspecting pivot shafts has identified the propensity for cracking in a few select areas:

CRACKING LOCATION #1

Exterior Corner at intersection of pivot and landing gear receptacle on both light and heavy pivot shafts.

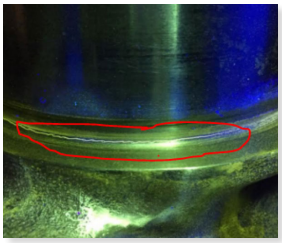


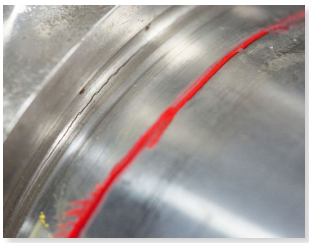
Location of external Pivot Shaft Cracking – photo – AirCorps Aviation

Heavy landing gear pivot shaft cracking circled in red. Photo: Gary Norville

CRACKING LOCATION #2

Radius of thrust face can be up to ¼" from face edge of internal radius.





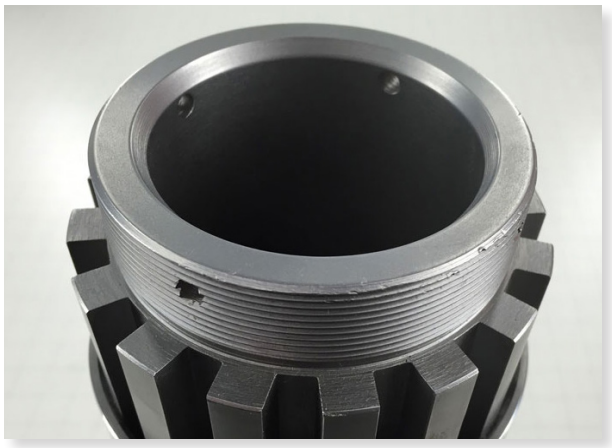
Cracking in Pivot Shaft under magnification - Photo AirCorps Aviation

Example of a light pivot shaft that failed on landing - damaging the airframe, prop, and engine. We appreciate photo contribution from Mike Vadeboncouer

DEFORMATION

To ensure the landing gear outer cylinder piston tube (Bendix Part numbers 67428 / 67427) will fit the pivot shaft landing gear leg receptacle hole, measure for elongation of the internal dimensions.

Twist of spline shafts is an often overlooked element of inspection that can affect the landing gear not properly engaging and uplocking when retracted. Splines will twist under 73-33116 bushing which is not visible without careful inspection.



Heavy pivot shaft - Notice additional material through cheeks of shaft to strengthen area prone to cracking. Also the chamfered / symmetrical sloping edge is visible within the highlighted area where the upright portion makes the transition to the shaft.

INTERCHANGEABILITY

Heavy shafts are interchangeable with lights, but the bearings in the gear casting in the wing need to be chamfered to accept heavy shafts. Heavy pivot shafts (161271) require the use of bushing 122-33109 in the landing gear casting in wing. Damage to casting and shaft will occur if a 161271 shaft is installed in a casting with 73-33109 bushing.

WHEN PURCHASING

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If you're looking for replacement shafts, prior to purchasing any original Bendix components ensure airworthiness by inspecting for cracks, straightness, and that the bore for the gear leg is not out of round. While original pivot shafts are quite difficult source right now, Roush Aviation has completed PMA approval and production of replacement pivot shafts that have improvements in failure areas.

AirCorps is available to perform inspections, answer questions, and perform modifications and services related to pivot shafts and landing gear. AirCorps has overhauled countless sets of P-51 landing gear and has the P-51 Landing gear on its Repair Station Capabilities list.

ADDITIONAL RELEVANT ELECTRICAL TECH ORDERS & INFORMATION:

AirCorps Library – P-51 Mustang Resources

Aircraft Inspection & Maintenance Guide – P-51, 00-20A-2-P-51, 7-Nov-1947

T.O. 01-60JE-2, Maintenance Instructions for F-51D, F-51M, ZF-51K, and TF-51D, T.O. No. 1F-51D-2 (AN 01-60JE-2), 30-Nov-1956)

Maintenance Instructions – Cavalier Mustang – F-51D, T.0. 1F-51D-2, 27-Sept-1968

Inspection and Replacement Main Landing Gear Pivot Shaft Ring Assembly - F-51D, T.O. No. 01-60JE-47, 26-Feb-1953

P-51 Landing Gear Drawing 73-33102 - Strut Assembly - Landing Gear Shock

P-51 Landing Gear Retraction Rod End Failure Safety Spring Installation