



EMEA Aftermarket Press Event  
June 17, 2009

**Insist on Genuine**

**Honeywell**

## Agenda

- Comparison between a Genuine Garrett® VNT™ Turbo and a Remanufactured VNT™ Turbo
  - Case Study
  - Visual Analysis
  - Components Comparison
  - Display
- Comparison between a Genuine Garrett® Turbo and Copy/Counterfeit Turbos
  - What is the difference between copy and counterfeit turbos ?
  - Visual Analysis
  - Components Comparison
- Impact on Engine Performance

## Part 1

### Comparison between a Genuine Garrett® VNT™ Turbo and a Remanufactured VNT™ Turbo

**Garrett®**  
by Honeywell

**VNT™**  
**Remanufactured**  
**Turbo**



## Comparison Case Study

- Customer ordered replacement of Garrett® part number **454232-0005**

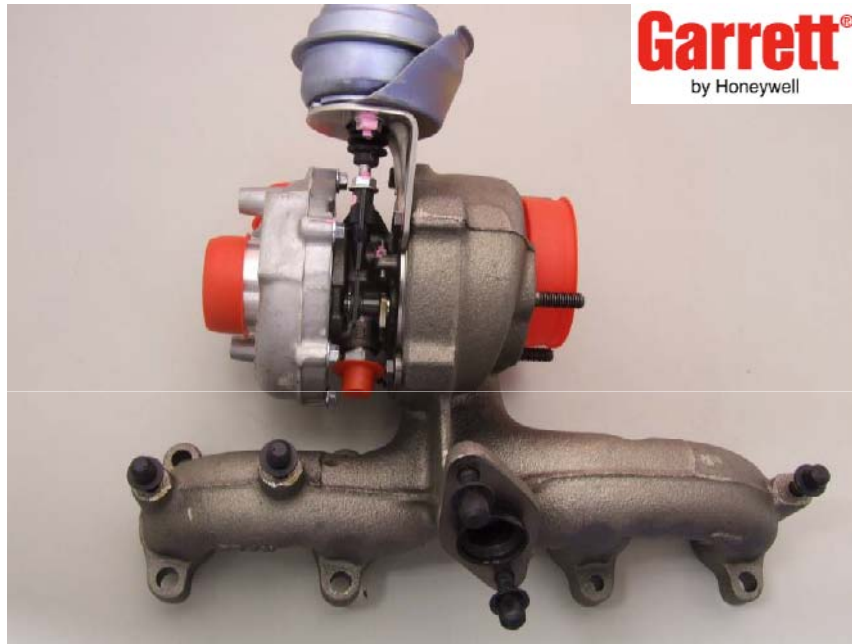
### Honeywell

- Customer received Garrett® product referenced **768329-0001** as a direct service replacement of **454232-0005** which Honeywell no longer supplies.
- Authorized Garrett® distributors have latest information on part number changes.
- Customer received a turbo to the latest specification with any enhancements made during engine/turbo production life.

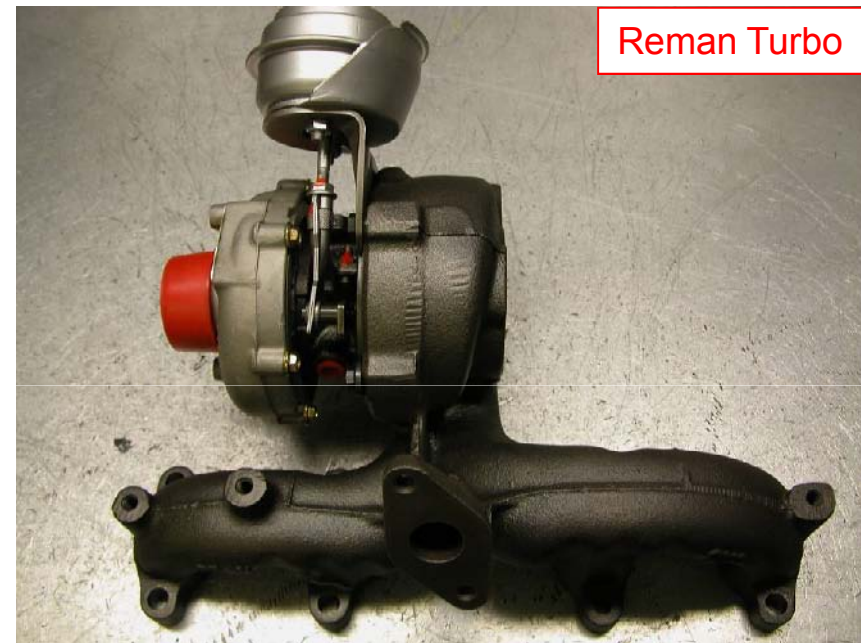
### Remanufacturer

- Customer received remanufactured product referenced **454232-Unknown**
- Remanufacturers are not up-to-date on Honeywell product upgrades and part number changes.
- Customer received a turbo which does not feature the latest upgrades.

## Visual Analysis



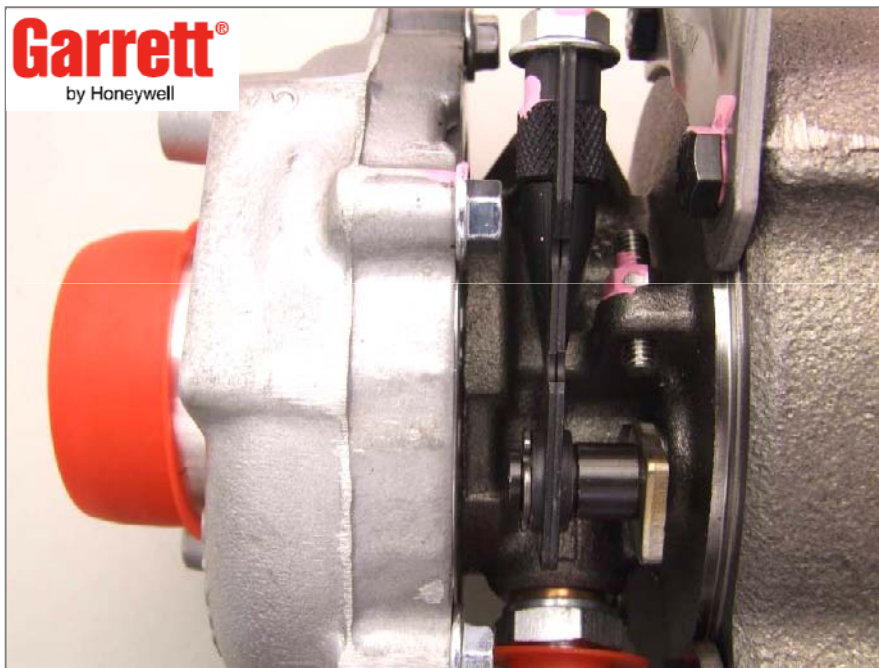
- Appearance as expected by customer
- Plating complies with ELV Directive Annex II



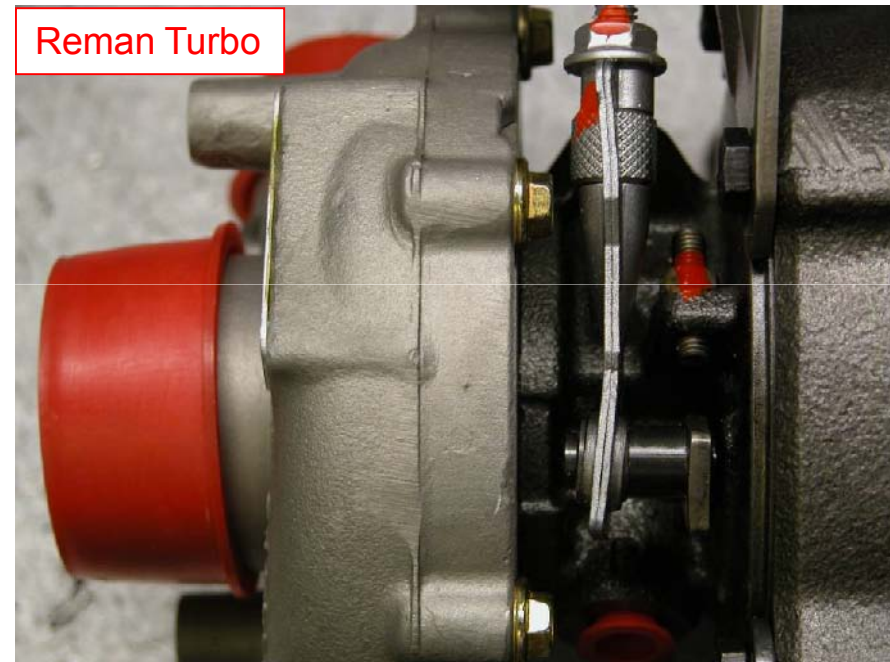
- Typical appearance from used, cleaned housings
- Blast cleaned, re-painted actuator

## Actuator Rod End

- It controls the movement of the variable nozzle assembly
  - Critical to correct turbo and engine performance



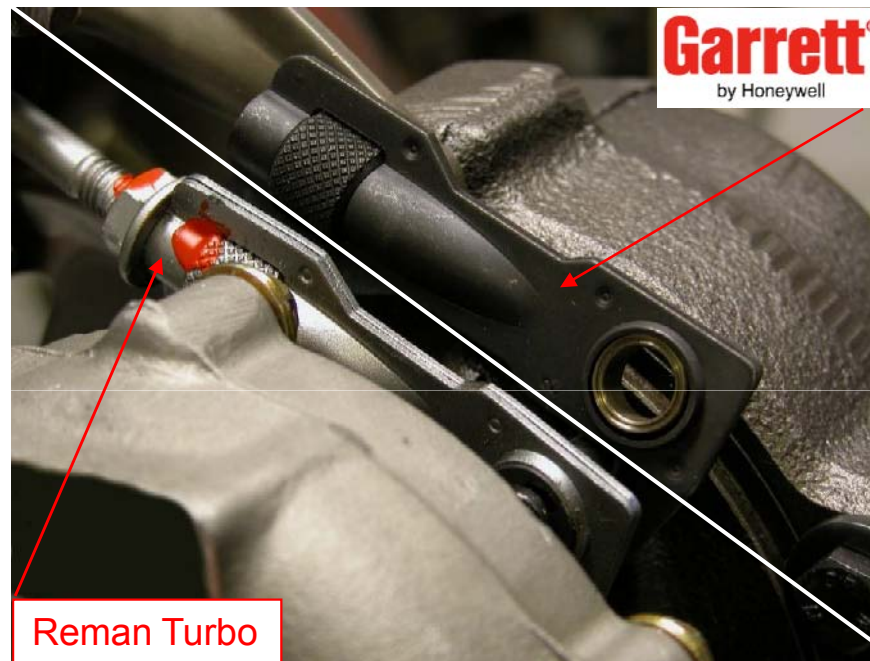
- Special tool used during assembly to prevent twisting and bending
  - Smooth operation



- Twisted and bent
  - Sideloads of crank and pin
  - When tested, erratic operation



## Actuator Rod End Surface Finish



- Surface finish removed during cleaning process
  - May rapidly corrode and restrict movement.
- Corrosion resistant Nitro-Carburised finish
  - Salt bath tested
  - Durability tested

## Actuator Water/Dust Seal



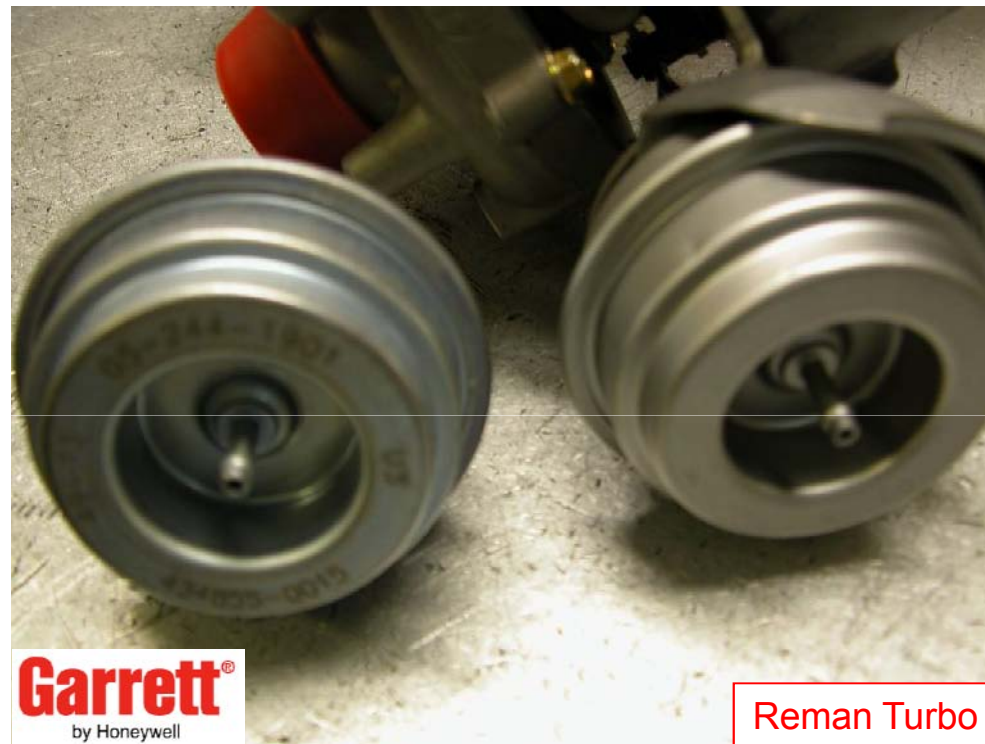
- Actuator mounted in inverted position on engine
- Later turbos all fitted with seal



- No seal fitted
  - May allow water/dust ingress



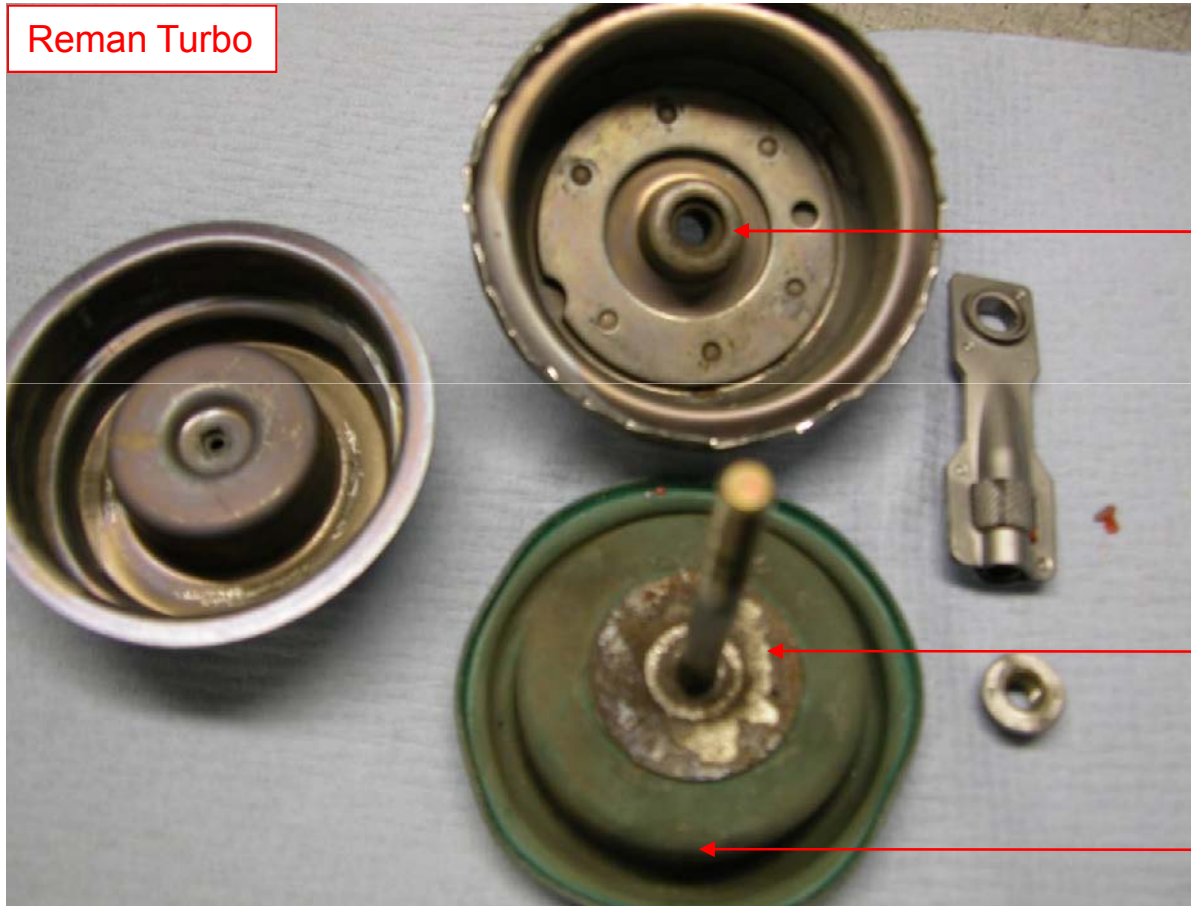
## Actuator Surface Finish



- Corrosion resistant finish
  - Salt bath tested
- Tested over 1,000,000 cycles
- Leak tested
- Surface finish removed during cleaning process
  - May corrode rapidly
- Testing unknown

## Actuator Internals

Reman Turbo



Worn gimble

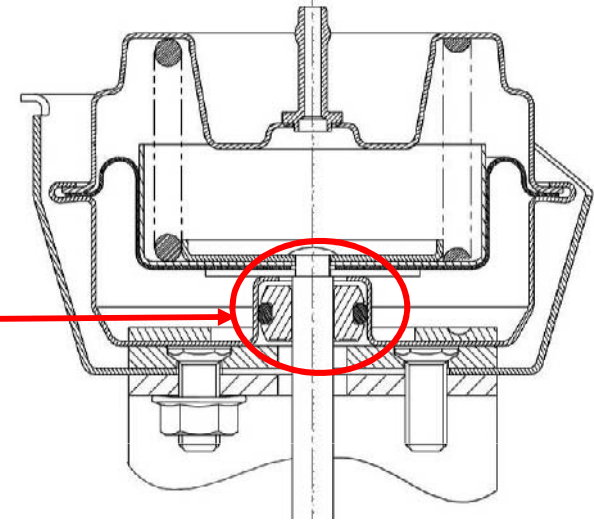
Badly corroded piston components

Worn and damaged diaphragm

## Actuator Internals

- Badly worn gimble
- Gimble is both linear bearing and seal
  - Poor control of actuator rod
  - Allows water/dirt ingress

Gimble is glass fibre reinforced polyamide resin with Viton "O" ring seal



**Garrett®**  
by Honeywell



Reman Turbo

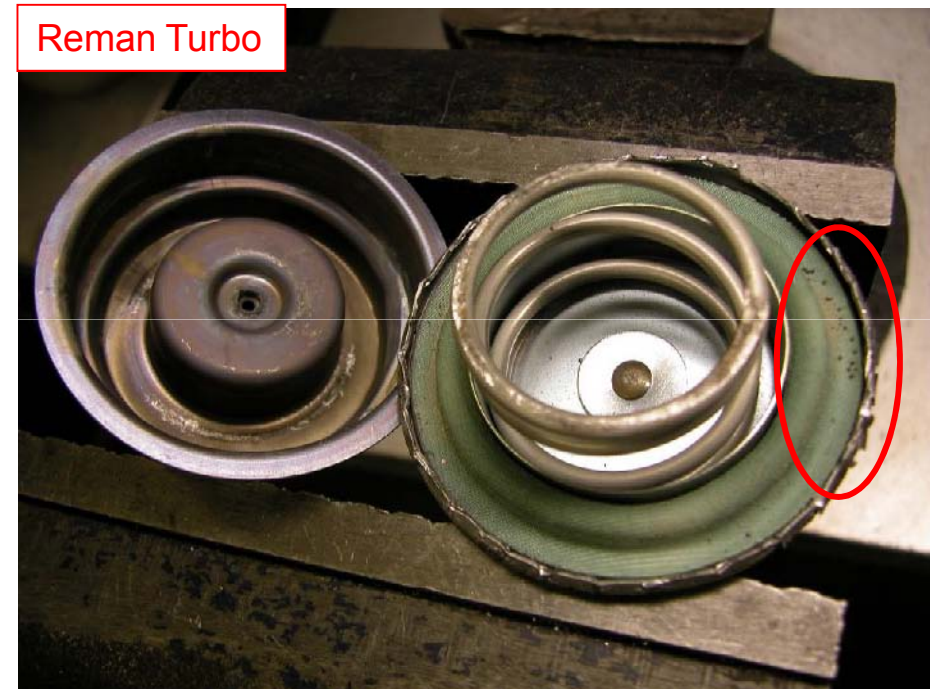




## Actuator Internals



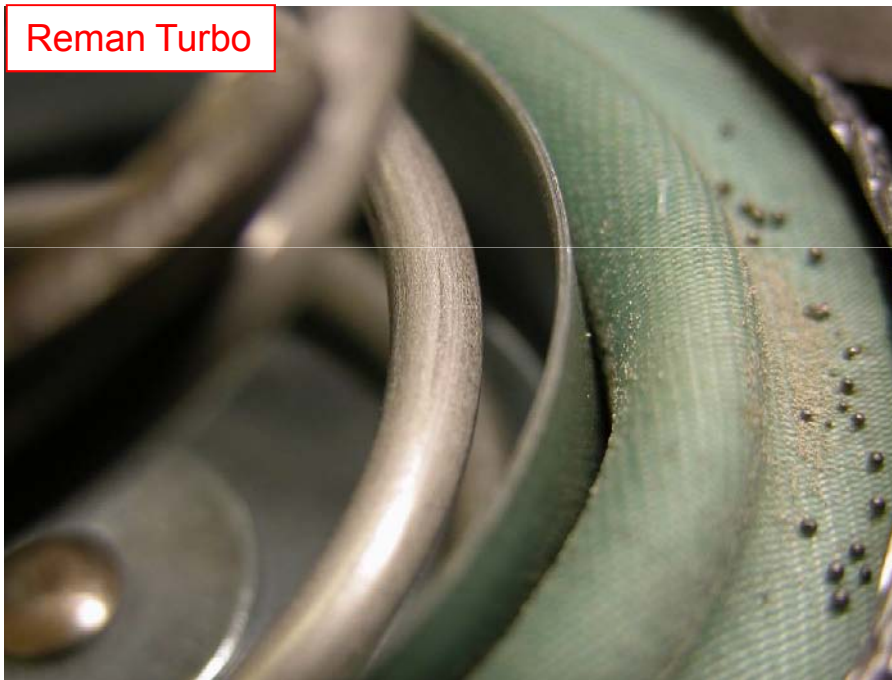
– Bent actuator rod



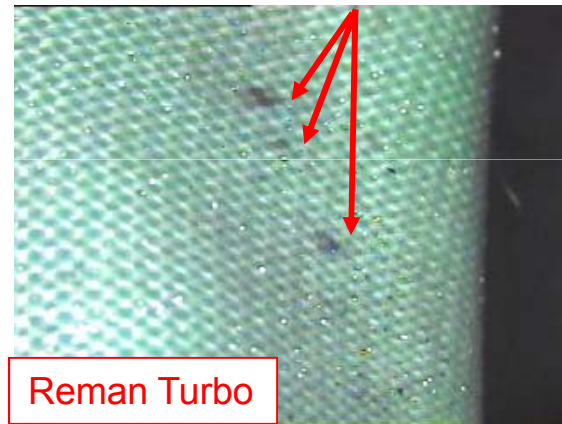
– Steel shot inside actuator

## Actuator Internals

- Steel shot had entered actuator during reman cleaning process



- Diaphragm reinforcing fibers worn
- Steel shot damage to diaphragm
  - Almost perforated



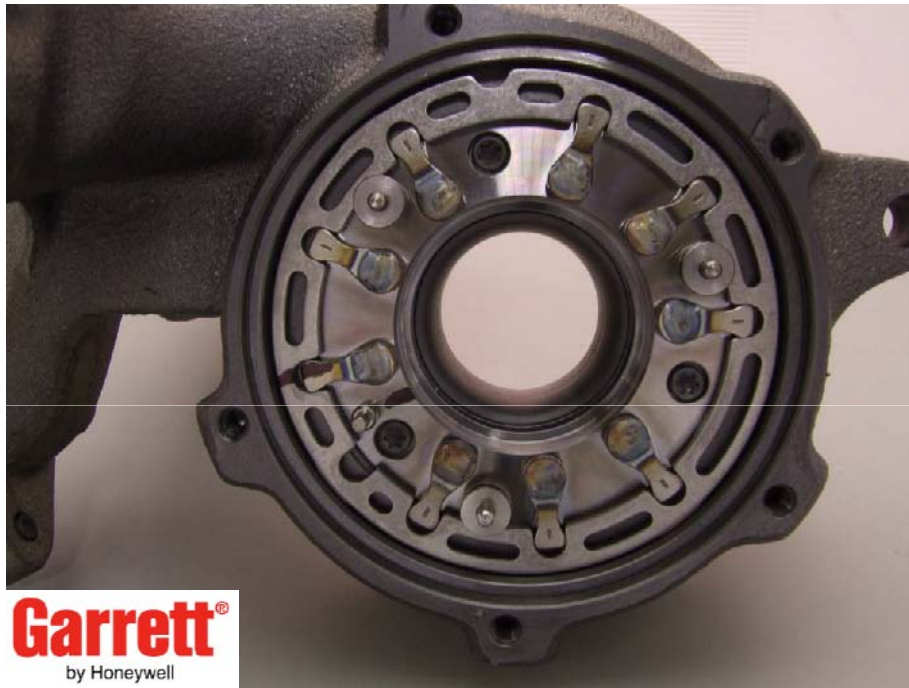


## Remanufactured Actuator – Potential Risks

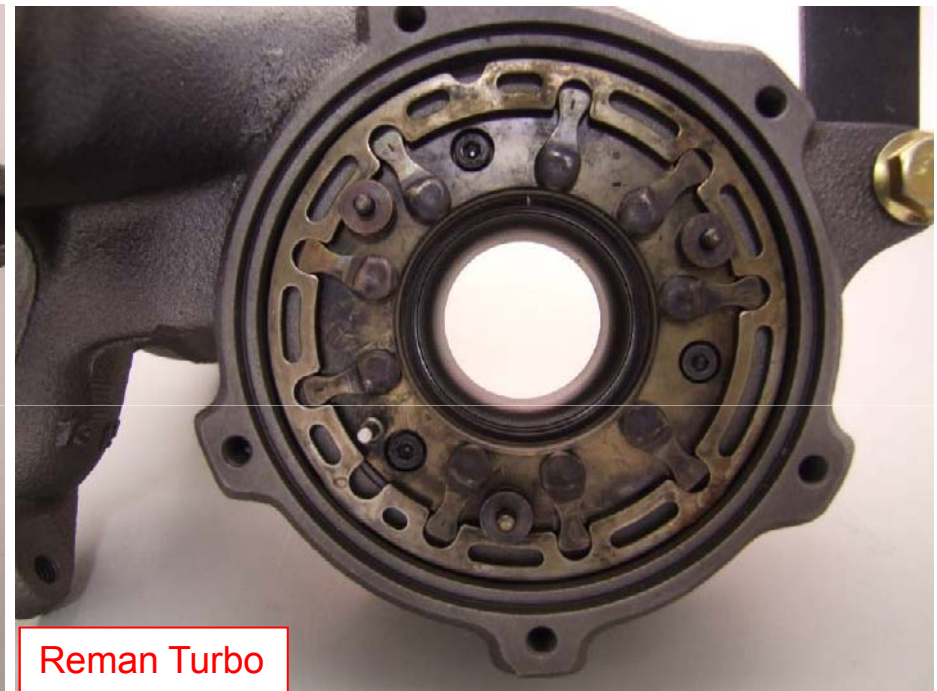
- Sticking of vane control mechanism and premature wear
  - Rapid corrosion and failure of internal components
  - Total failure of diaphragm in very short time
    - No control of VNT™ mechanism
      - Poor engine performance
      - Excess exhaust emissions
      - Excessive exhaust gas temperature
      - Engine damage
  - Broken spring
    - Possible overspeeding of turbo
      - Total turbo failure and possible engine damage
- Impossible to assess future service life

***A New Genuine Garrett® Actuator  
Offers Guaranteed Performance***

## Turbine Housing - Nozzle Assembly



- New parts. Free movement.

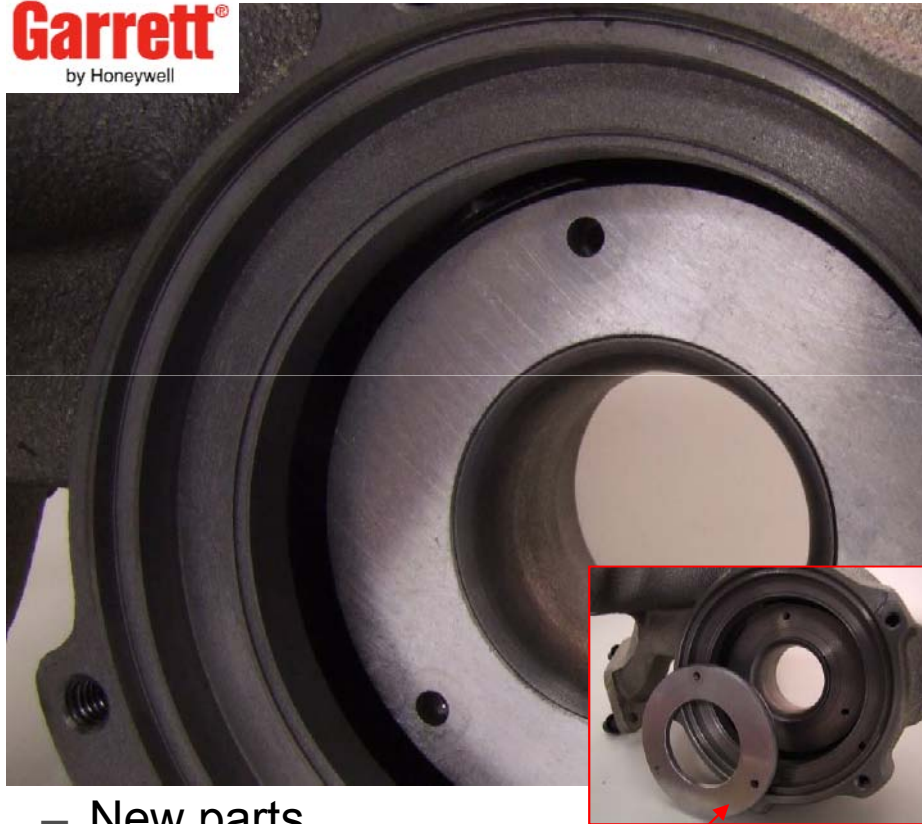


- Sticky and oily deposits on nozzle assembly and control mechanism
  - May burn on engine start up, carbon build-up may restrict movement

## Turbine Housing Gas Flow Surface

- adjacent to vanes

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- New parts
- Gas nitrided insert fitted
  - Part of product improvement process

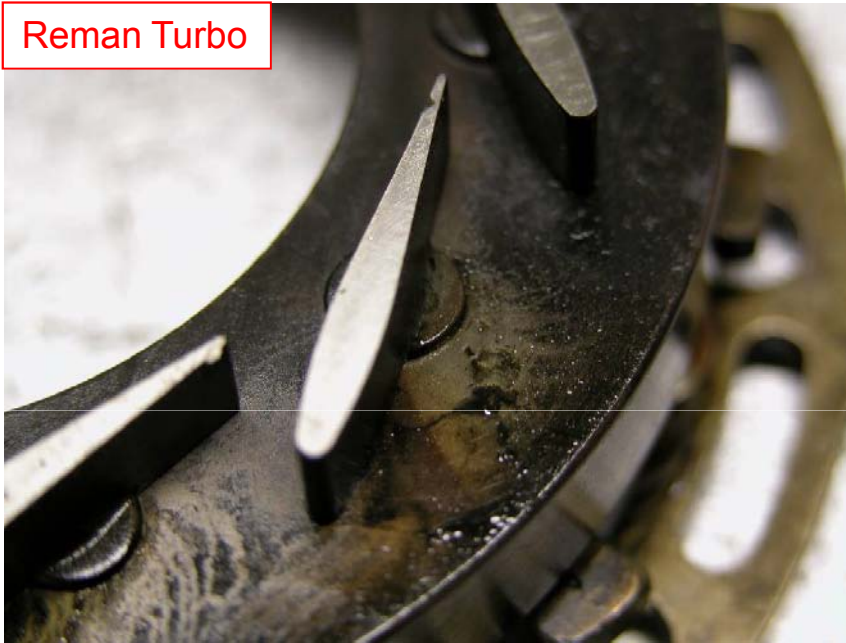
Reman Turbo



- Roughly machined face, uneven surface
- Poor surface finish
- No insert fitted

# Nozzle Assembly

Reman Turbo



- Badly ground ends
  - Outside of tolerance
- 7 out of 9 vanes
  - Outside of tolerance
- Uneven dimensions
  - Outside of tolerance
- Tapered vane faces from leading edge to trailing edge
  - Outside of tolerance

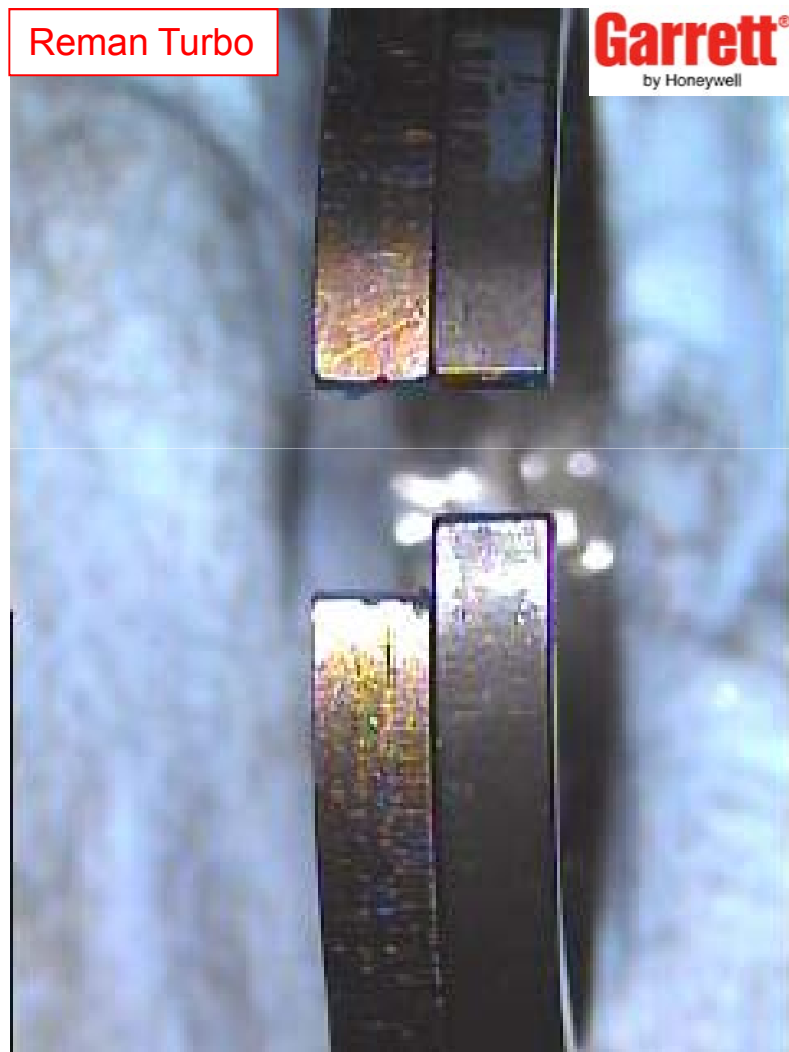
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## POTENTIAL RISKS

- Restricted movement of nozzle assembly may cause permanent contamination of nozzle assembly, so reducing performance.
- Impact on low rpm efficiency of the turbine, with a reduction in engine performance at low speed.



## Turbine End Piston Ring



- Piston ring is gas/oil seal
- Reman turbo contains piston ring with incorrect end gap
  - Outside of specification
- Unknown material

### POTENTIAL RISKS

- Dependent on running conditions:
  - Increased gas leakage into center housing
    - Increased oil drain/crankcase pressure
  - Increased oil leakage into turbine housing
- Possible risk from wrong material
  - Distortion/buckling of ring
  - Contact with rotating assembly



## Backplate



- Retaining bolts overtightened

- Oil sealing area damaged

### Notes:

- Honeywell backplate holes have flat surface
- Honeywell backplate bolts have raised steel sealing bead which “bites” into aluminium backplate creating a very positive seal

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## POTENTIAL RISKS

- Oil leakage from center housing into compressor
- Oil contamination of air pressure hoses and intercooler
- Oil burned during combustion process
- Emissions out of specification



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## Part 2

### Comparison between Genuine Garrett® Turbos and Copy/Counterfeit Turbos



**Copy &  
Counterfeit  
Turbos**



## Copy and Counterfeit Turbos

### What is the difference?

- A **counterfeit** is designed to make the purchaser believe that they have bought the genuine original product.
- A counterfeit may use:
  - Original manufacturer's names, models and logos
  - Original manufacturer's part numbers
  - Original casting marks on parts
  - Copy of original packaging
  - Copy of original documentation
- A **copy** aims to replicate the look and performance of the original product.
- A copy may use:
  - Original manufacturer's part numbers and models
  - Copy manufacturers own packaging and documentation
  - Copy manufacturers name and logo

## Visual Analysis

- Compressor and turbine housing castings appear well finished
- Logo of Honeywell's supplier has been copied on compressor housing
- Garrett® logo not shown on housings
- Actuator plating does not appear to latest specification (EU legislation)
- Actuator hose made of very soft material



***Copy is visually good***



# Actuator Calibration

- Results
  - Specification = 1.240 – 1.309 Bar = 0.380mm of rod end movement
  - Actual result averaged over three tests = 1.130Bar = 0.380mm of rod end movement
- Conclusion
  - Calibration outside of specification
  - Possible effects:
    - Poor performance
    - Increased emissions
    - Reduced airflow to engine = fuel rich mixture = excessive combustion temperature = excess thermal loading on engine components, possible damage to turbine side of turbocharger and engine damage



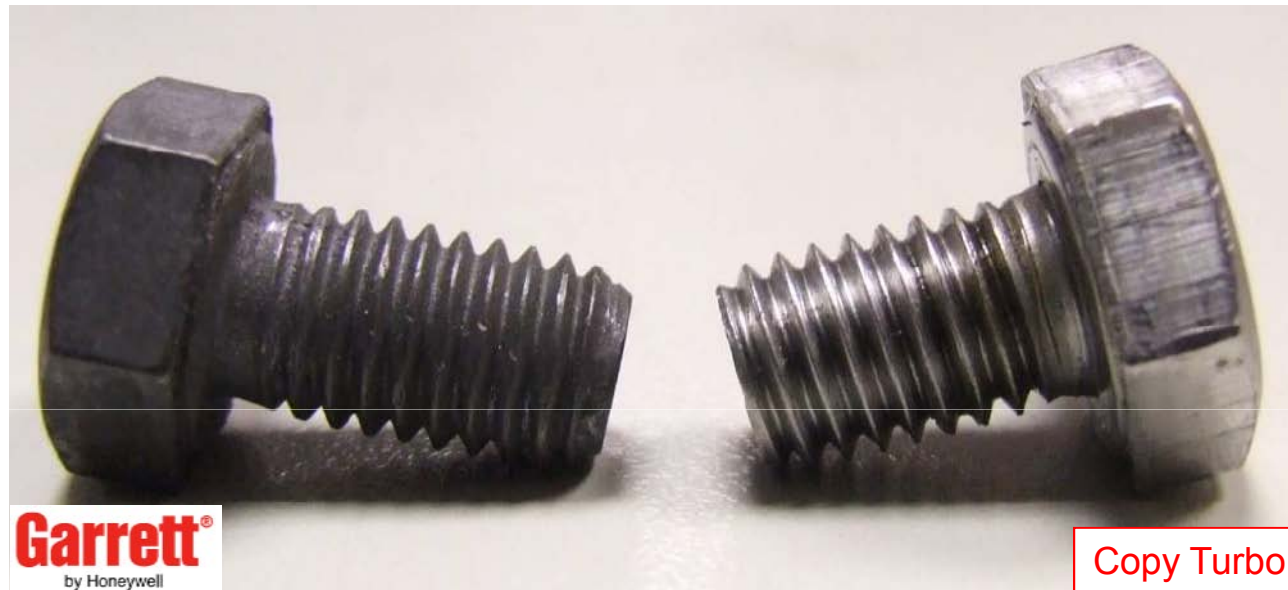
# Turbine End Bolts



- Garrett uses B16 High temperature bolts for elevated temperatures (540°C at joint) - Tensile Strength  $\geq 1000$  Mpa
- Chromium, Molybdenum, Vanadium
- Copy uses 4.8 grade low temperature bolts approx (300°C) - Tensile Strength  $\geq 340$  Mpa
- Low or medium carbon steel, fully or partially annealed

***Very high risk of bolts “relaxing” and center housing to turbine housing joint loosening***

# Turbine End Bolts



- Garrett B16 turbine bolts are pre-coated with low friction compound to ensure that tightening torque is not overcoming thread friction
- Copy bolt has no coating

***Part of tightening torque lost due to thread friction.  
High risk of gas leakage and joint loosening***

## Turbine End Bolts

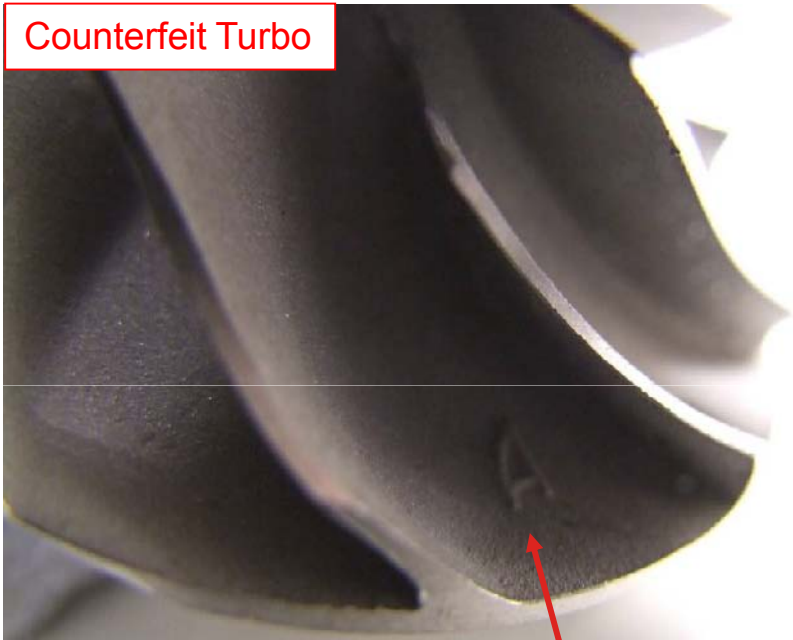


- Garrett bolt is **14 mm long** to give correct clamping force to critical joint and correct load distribution across full thread helix
- Copy bolt is **12 mm long**

***Very high risk of center housing and turbine housing joint loosening***

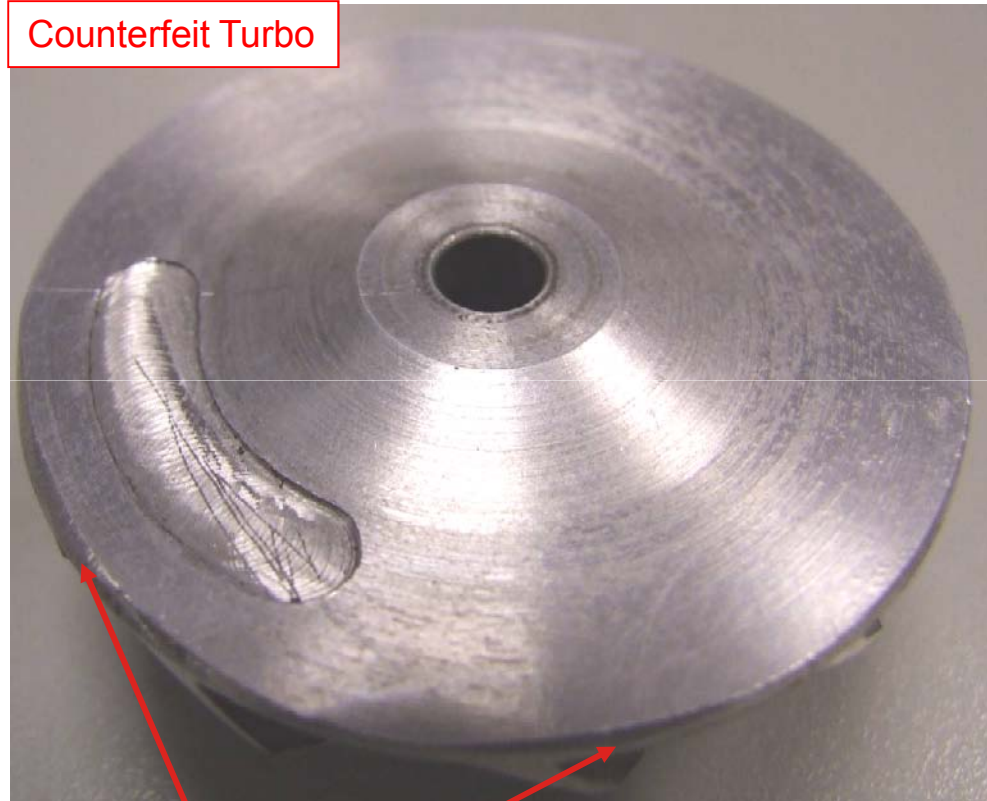
## Compressor Wheel

Counterfeit Turbo



Wheel uses Honeywell's registered trademark "A" originating from Garrett AiResearch, which makes this a counterfeit

Counterfeit Turbo



Machined edge appears to be roughly hand finished

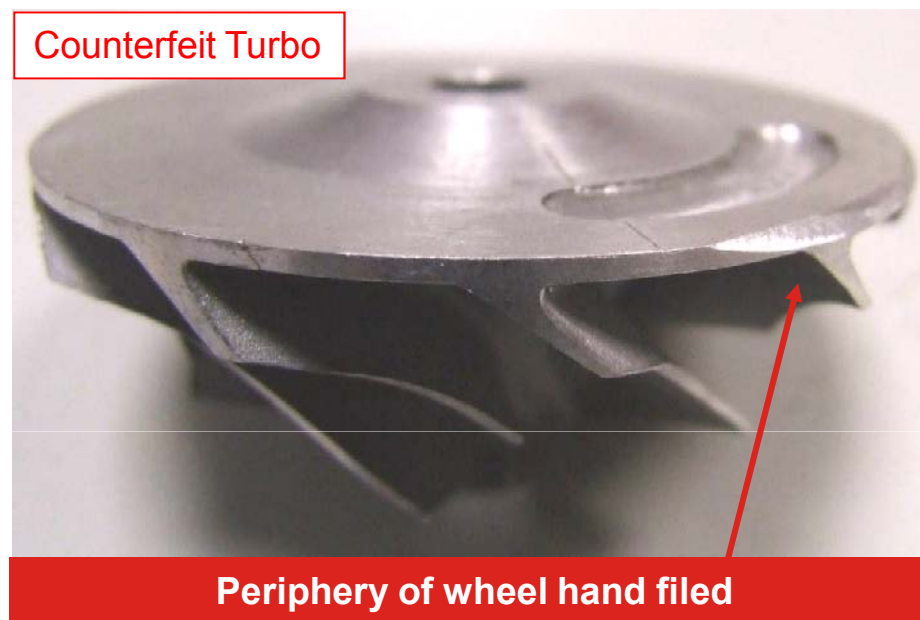


## Compressor Wheel

Counterfeit Turbo



Counterfeit Turbo

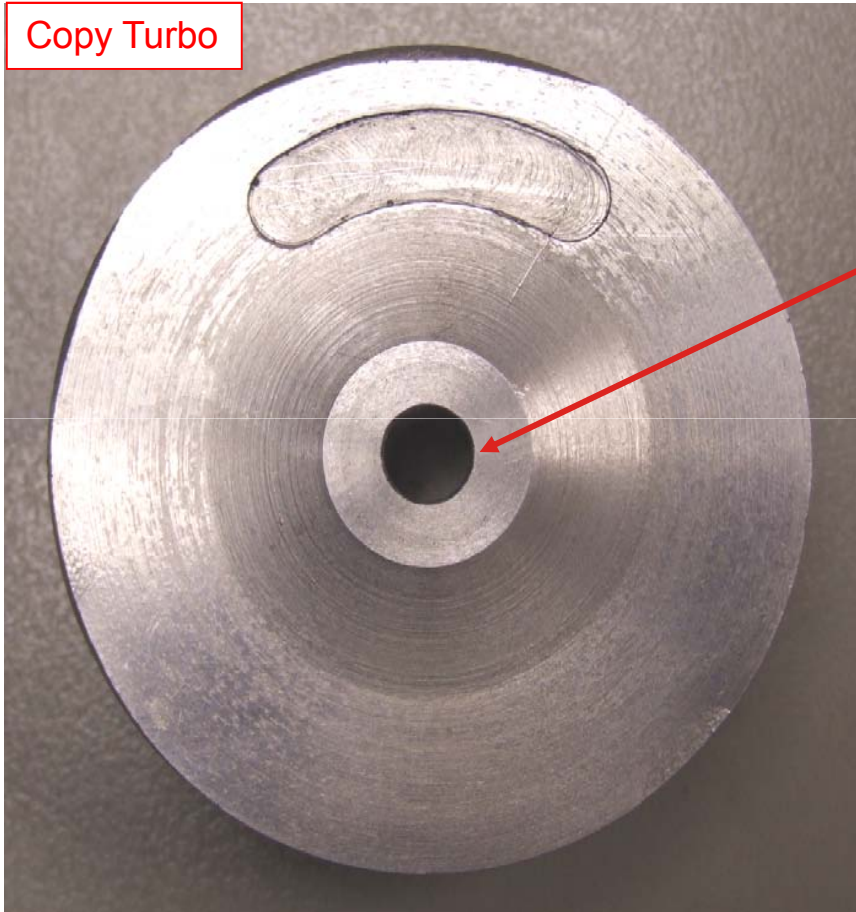


- Wheel rotates at up to 180,000rpm
- Tip speed up to 530 meters per second

***Implications for balance, noise and reliability***

# Compressor Wheel

Copy Turbo



Oversized compressor wheel bore by 0.016mm over top limit and 0.024mm over bottom limit

Critical joint surfaces on the turbocharger

The clearance between this compressor wheel and its pilot shaft could be easily detected by hand, without even needing measuring instruments!

- Most Garrett® turbos use “interference fit” where the compressor wheel has to be heated and then shrinks onto the shaft during cooling.

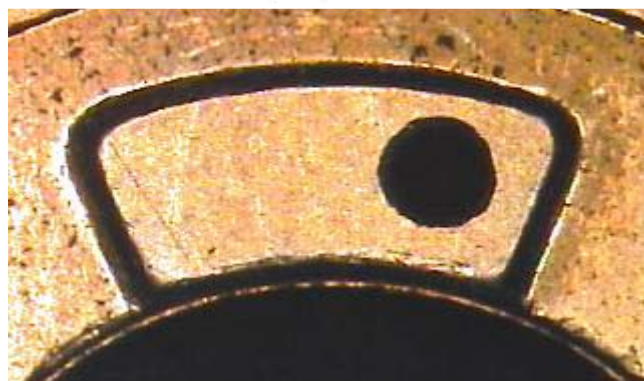
***Implications for wheel location, balance, noise and reliability***

## Thrust Bearing

- Controls axial movement of high speed rotating assembly



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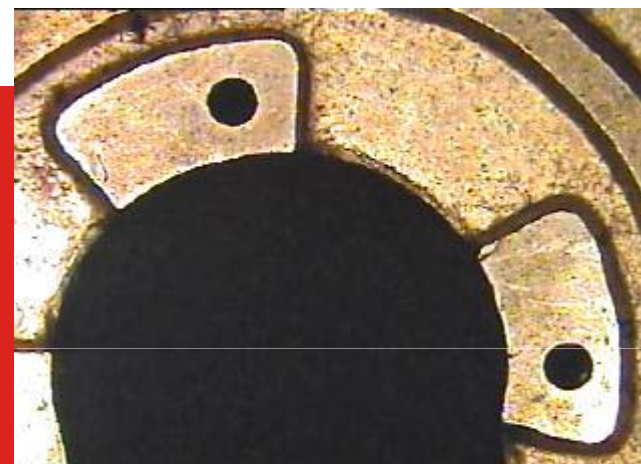
Incorrect oil feed hole positions

PCD of holes outside of specification

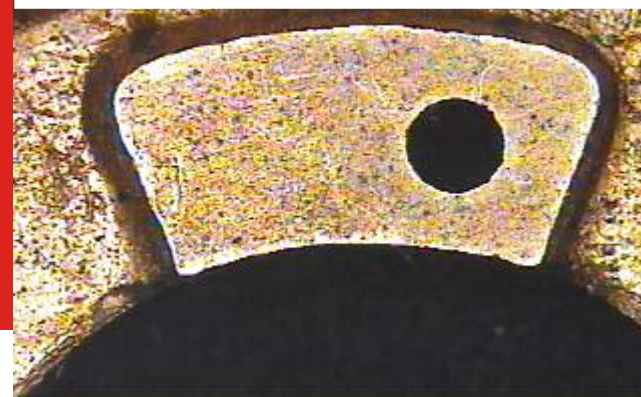
Flatness of critical  
"A" face

(mating surface with  
center housing)

almost double Garrett  
tolerance!



Copy Turbo





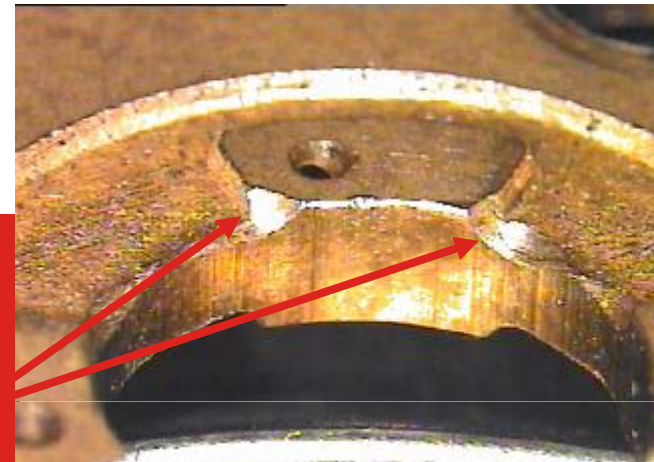
## Thrust Bearing



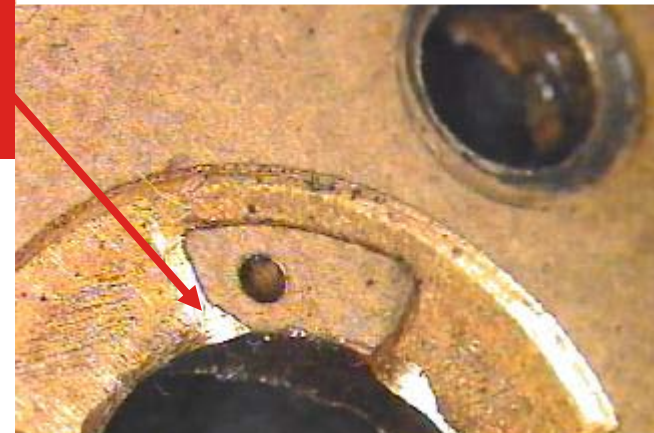
**Garrett®**  
by Honeywell



Poor finishing of thrust pads on copy reduces thrust pad area and weakens bearing



Copy Turbo



## Thrust Bearing



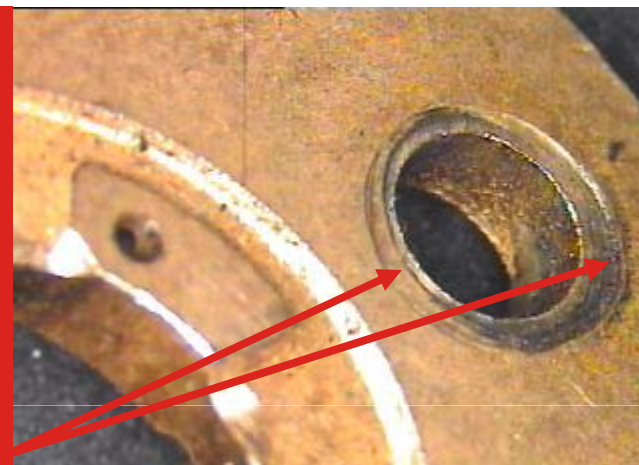
**Garrett®**  
by Honeywell

Genuine bearing has location diameter for bolt plus larger relief diameter to prevent bolt head distorting bearing during tightening

Copy bearing already distorted:

Flatness is almost double correct specification (distortion)

Witness marks show how the (incorrect specification) bolts have bitten into the surface of the bearing unevenly



Copy Turbo





## Thrust Assembly

### Bolt quality:

Material to be confirmed, but appears to be low quality, non high tensile bolts.

Uneven marking around bolt holes is consistent with poor surface flatness results



Garrett bolts are high tensile material.

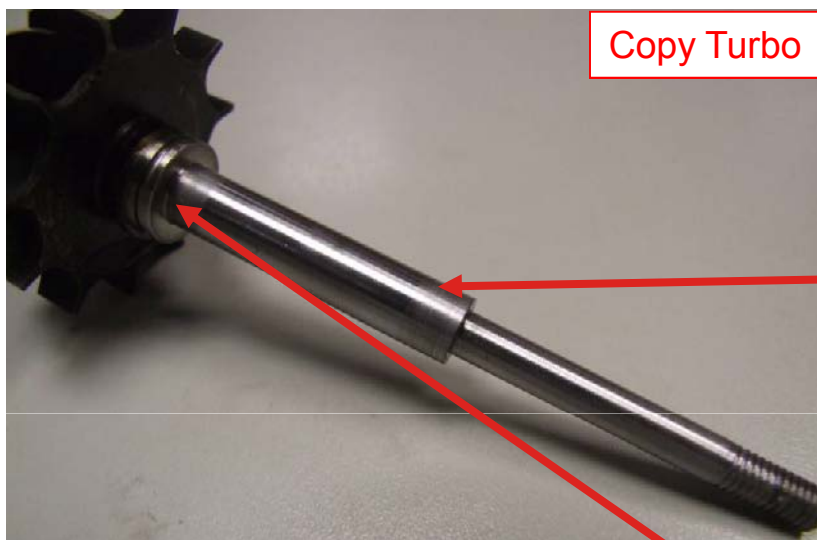
Head has large diameter flat clamping area to reduce distortion of bearing.

Thread is micro - encapsulated to eliminate the possibility of loosening due to vibration in service



***Bolts not to Honeywell specifications***

## Shaft Bearing Journals



Copy Turbo



Turbine  
end  
journal  
scored

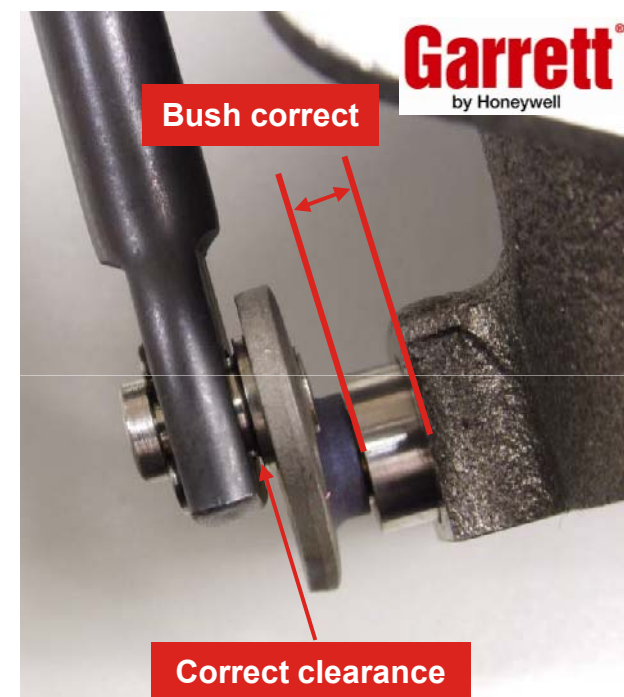
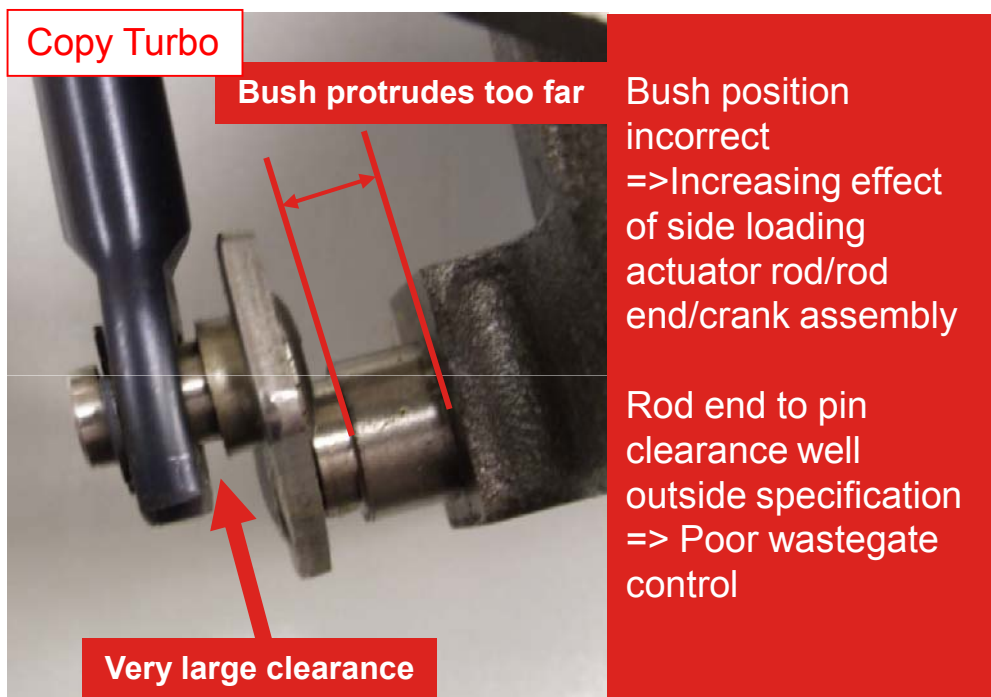


Compressor  
end journal  
scored

- Heavily loaded bearings due to component imbalance

***Serious damage for a turbo which has only run briefly!***

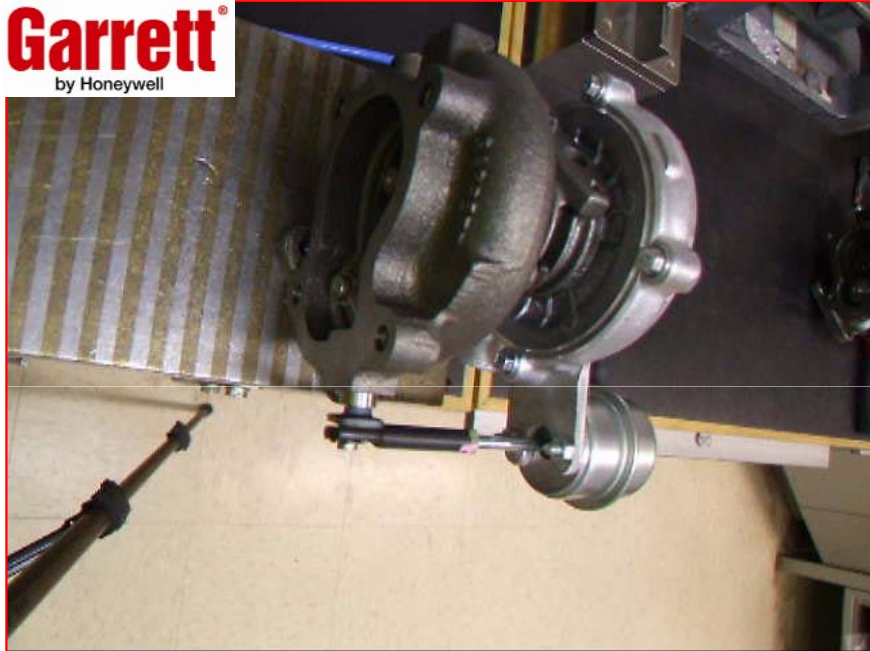
## Rod End and Bush Piston



***Implications for performance and reliability....***

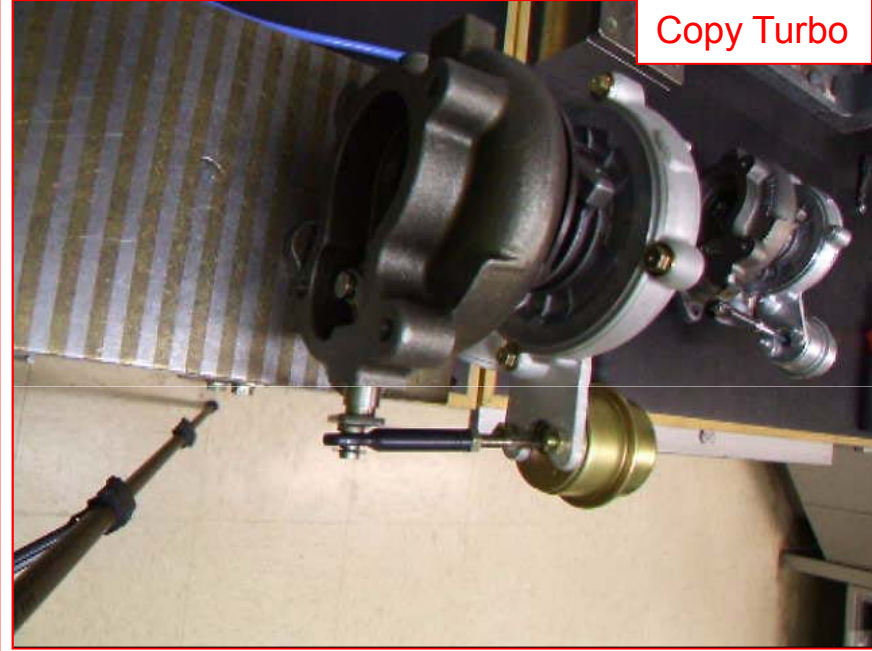
## Actuator and Wastegate

**Garrett®**  
by Honeywell



- Smooth and controlled

Copy Turbo



- Erractic motion
  - High wear rate to rod end/crank pin
  - Wastegate control deteriorate rapidly

***Garrett® actuator motion tested  
over 1,000,000 cycles***

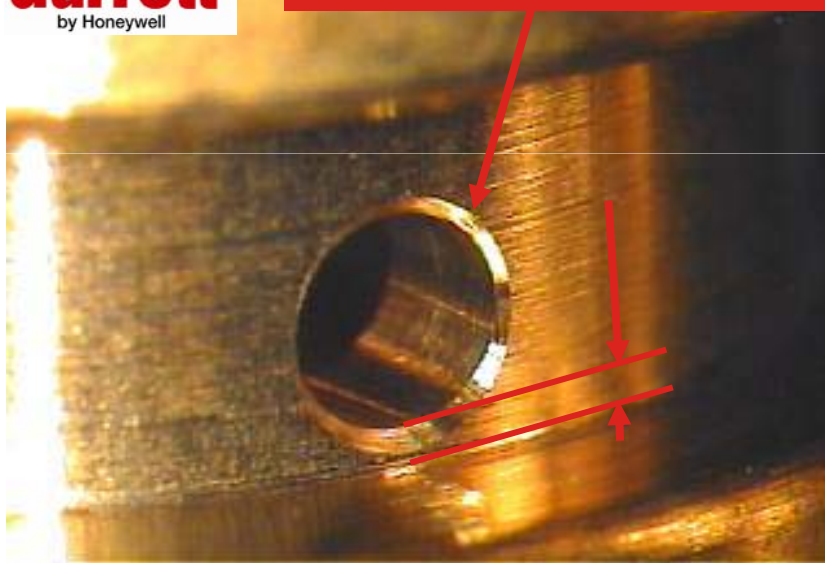


## Oil Supply Holes

- Oil supply holes to journal bearings
  - Incorrect location
  - Poor finish: Hanging burrs – material will break away due to normal vibration

**Garrett**  
by Honeywell

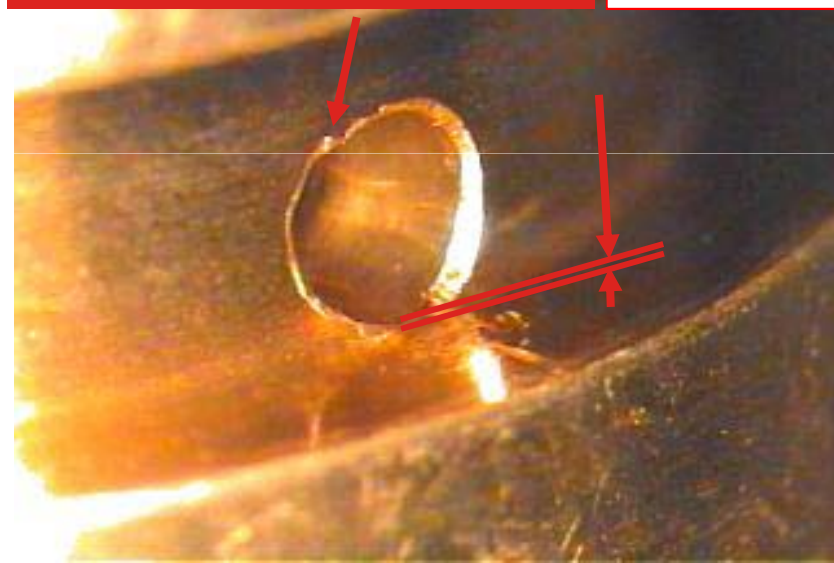
Correctly de-burred oil hole



Correct oil hole position

Poor de-burring, rough edges

Copy Turbo



Incorrect oil hole position

***Lubrication and shaft motion control rely on 8 tiny holes!***



## Part 3

### Impact on Engine Performance

**Garrett®**  
by Honeywell

**VNT™**  
**Remanufactured,**  
**Copy and**  
**Counterfeit**  
**Turbos**



## Impact on Engine Performance

### *Potential Risks*



**Reduced Performance** – leading to lower vehicle value and poor driveability on the road.



**Increased Fuel Consumption** – leading to higher running costs and greatly increased whole-life expenditure.



**Increased Emissions** – leading to higher CO<sub>2</sub> and NO<sub>x</sub> output, which could mean vehicles being identified as un-roadworthy at statutory inspections.



**Conflict with the engine management system** – leading to vehicles running in reduced power safety mode and creating immediate conflict with ECU on engine start-up.

# Insist on Genuine

**Garrett**  
by Honeywell



# Best-in-Class Products