The Latest in No-maintenance Trailer Axles

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ROR Merator

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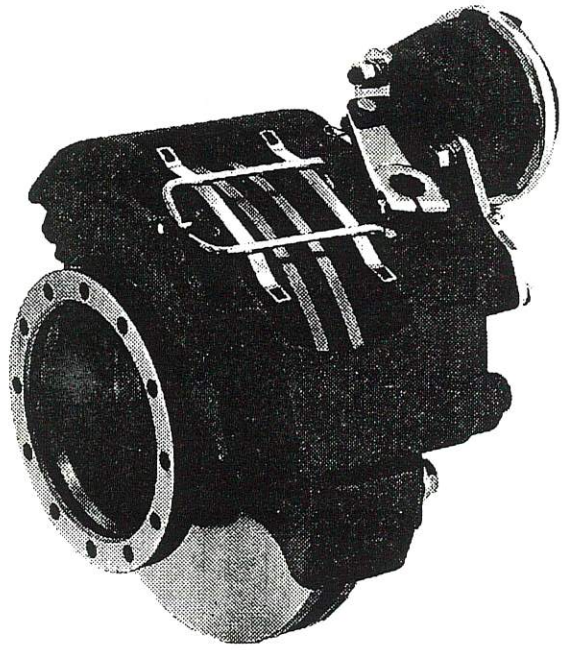
A Heritage of Rockwell Technology

DX SERIES
AIR DISC BRAKE

- Why Disc Brakes
- Technical Benefits
- Practical Benefits
- Background & Design Features
- Testing and ROR's Influence
- Applications on Trailer Axles



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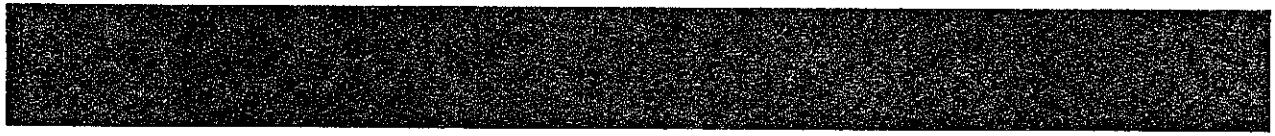
Why Air Disc Brakes?

- Improved truck aerodynamics & reduced rolling resistance mean more kinetic energy transfer into the brake system
- Higher power to weight ratios give higher average speeds & significant increase in braking load
- With test speed raised from 40-60 kph, kinetic energy increases by 125%
- Operators expect:
  - better brake stability
  - good brake feel (modulation)
  - reduced stop fade



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BENEFITS TO CUSTOMER

- TECHNICAL PERFORMANCE

  - **Reduced stopping distances**
  - **Advanced abs performance**
  - **EBS compatibility**
  - **Low air consumption**
  - **Short bedding period**
  - **Low fade characteristic**
  - **Optimum brake performance**

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BENEFITS TO CUSTOMER

- TECHNICAL PERFORMANCE

  - **Light weight axle**
  - **No auto lubrication**
  - **Extended service intervals**
  - **Max. suspension spring centres**
  - **Offset rotor- low tyre temperatures**
  - **Greased filled hub**
  - **Cartridge bearing option**

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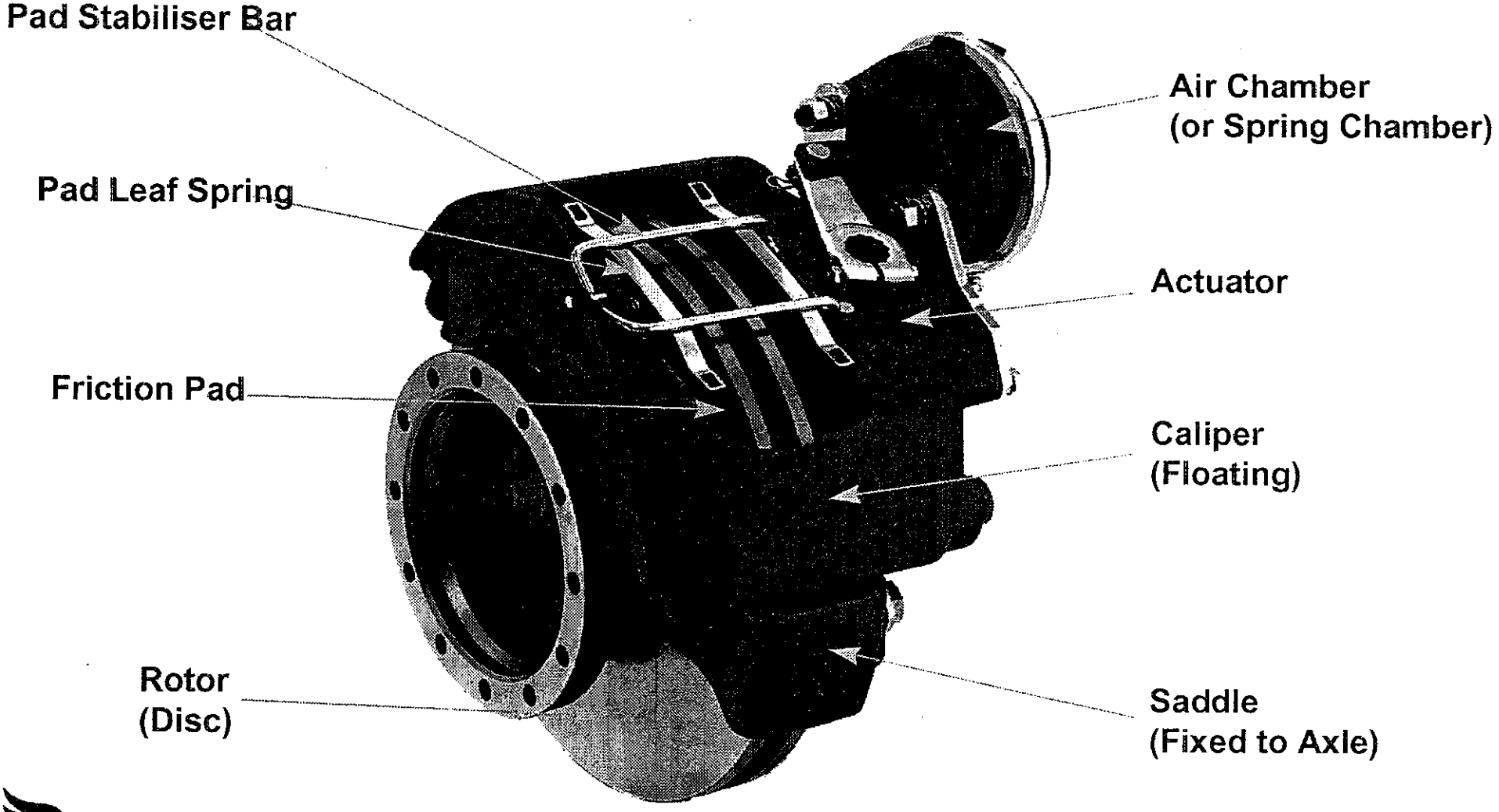
Terminology



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Air Disc Brake Benefits

- **Brake Performance - can vary due to:**
  - Temperature Fade
  - Speed Fade
  - Pressure Sensitivity of the lining
  - Deflection of brake components
- **Temperature and speed fade - all brakes suffer, but:**
  - Disc brakes are least sensitive to speed fade
- **Pressure sensitivity - not a problem with disc brakes with stiff pad supports**
- **Structural Deflections: Drum brakes suffer from drum deflection and incomplete lining contact**
  - Disc rotor is incompressible - and full pad contact is ensured

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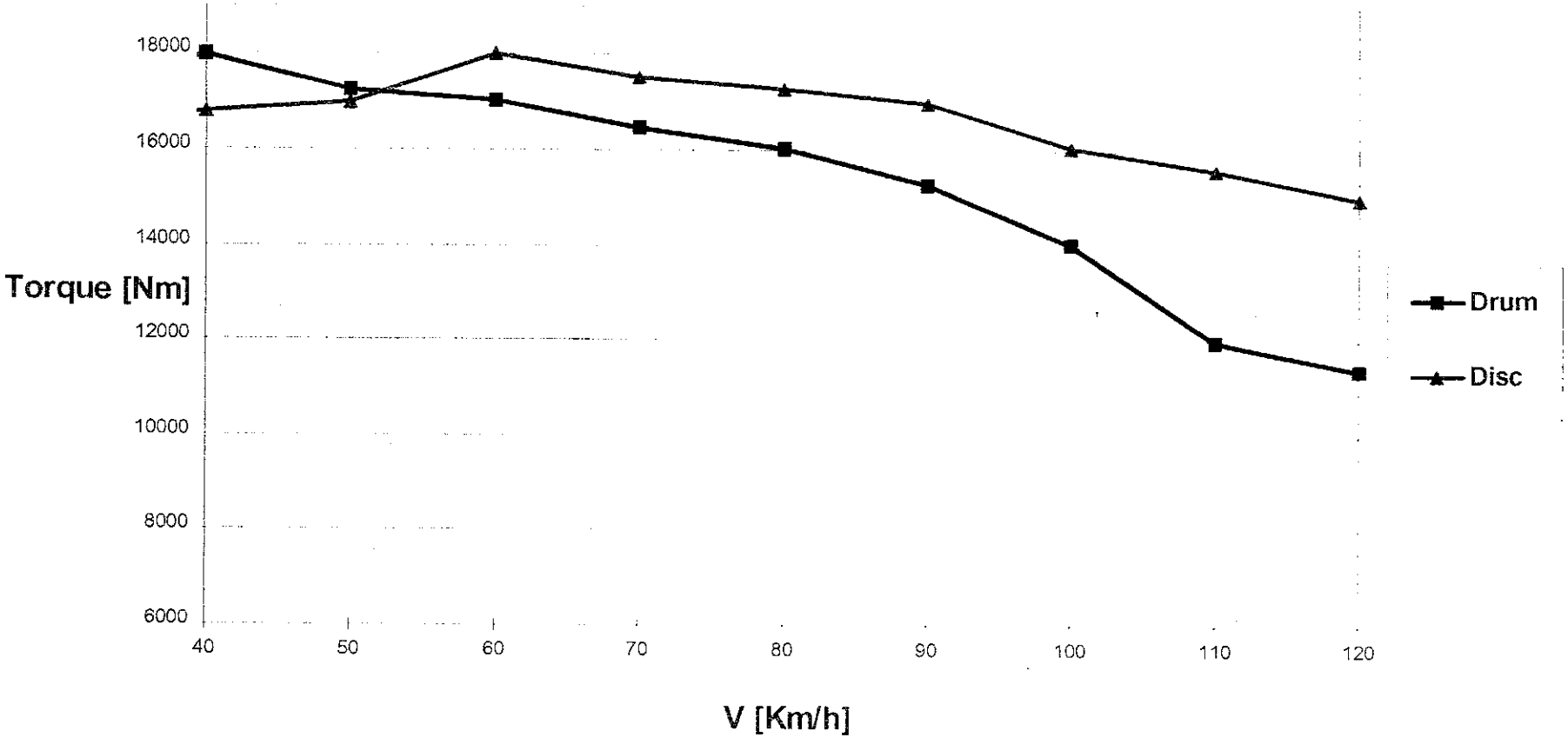
Speed sensitivity
Drum vs. Disc



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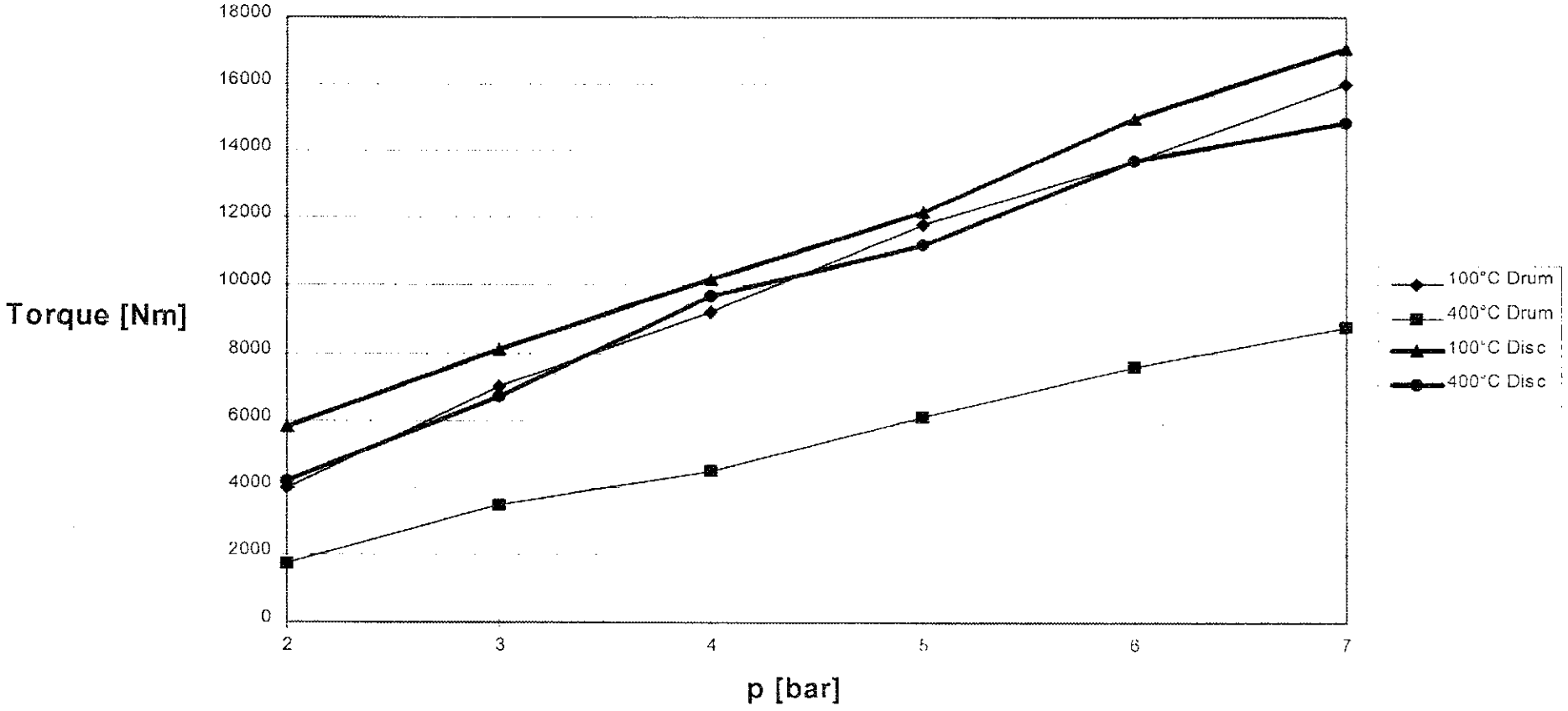
Temperature sensitivity
Drum vs. Disc



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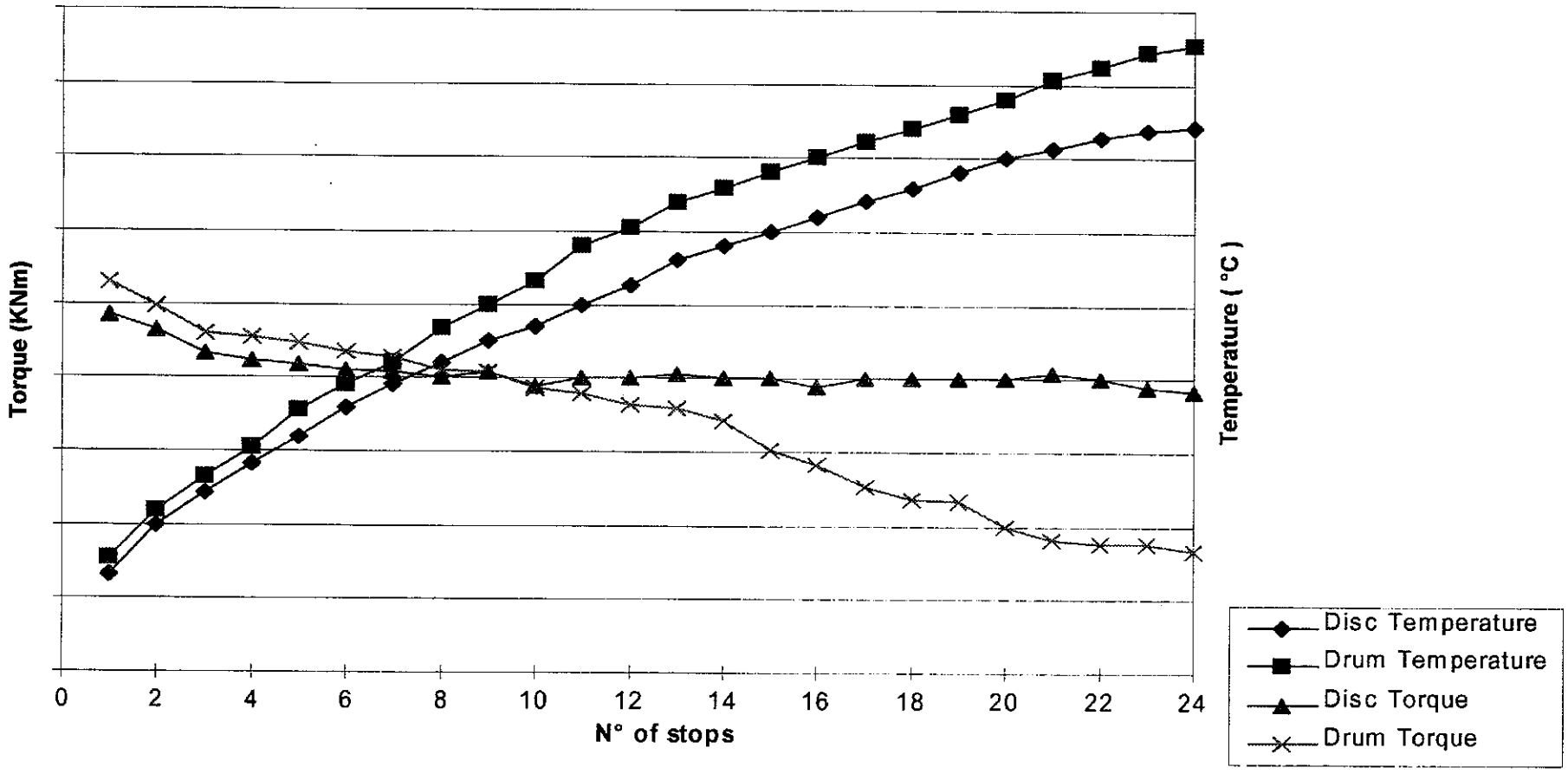
Temperature and Fade
Drum vs Disc



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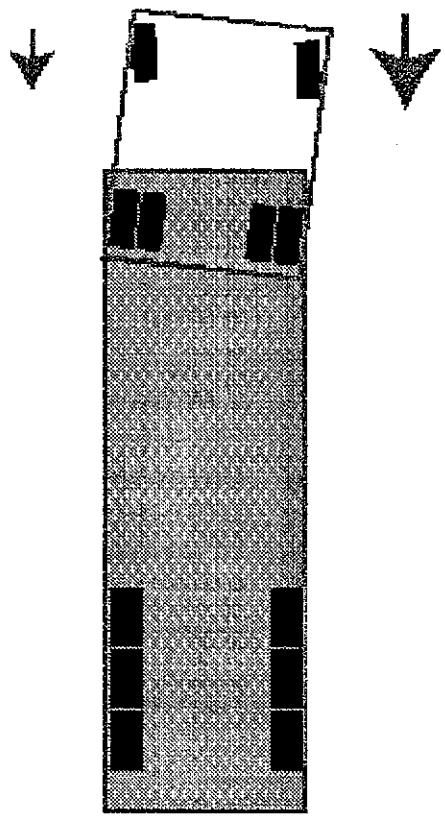
Stability

- **Brake pull is caused by uneven braking torques developing between LH and RH brakes**
  - **Directional change is compensated by driver steering**
- **Drum Brakes have built-in mechanical advantage (brake factor) due to self energisation of the leading shoe(s)**
  - **Unequal torque is the result of variation in the self energisation as a result of friction level variation due to fade**



Problem is proportional to brake factor

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Brake Factor

- **Drum Brakes are used almost exclusively today**
- **Typical Brake Factors:**
  - **Cam** **C* = 1.8**
  - **Wedge Simplex** **C* = 2.5**
  - **Wedge Duo Duplex** **C* = 4.0**
- **For comparison the disc brake has:**

C* = 0.76 (μ=0.38)

The disc brake offers the optimum stability solution

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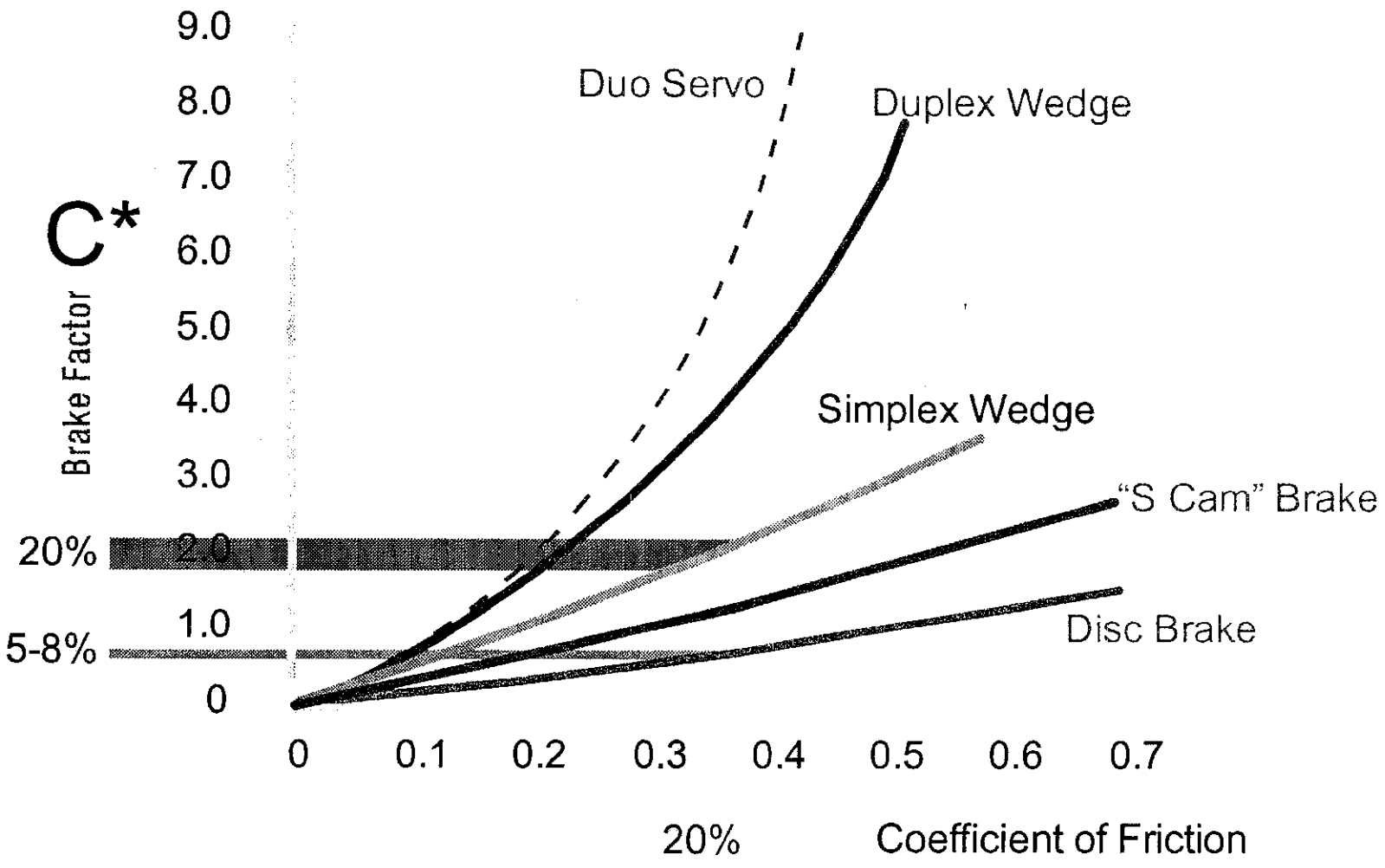
Brake Factor vs. Friction



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Summary of Disc Brake Benefits

Improved Braking

- Optimum Stability
  - Low sensitivity to friction variation
  - Constant performance new to worn
- Resistance to fade
- Speed sensitivity effects reduced
- Low hysteresis
  - High mechanical efficiency
  - ABS compatibility
- Lower judder and vibration
- More resistant to dirt and water ingress

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BENEFITS TO FLEET CONTROL

- **MODULAR CONCEPT**

  - **Modular Components**
    - **Brake unit (caliper and saddle assembly)**
    - **Hub**
    - **Rotor**
    - **Pads**
    - **Air chamber**
  - **Consistent service cost and quality**
    - **Precise fault diagnosis**
  - **Reduced, precise service time**

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LINING REPLACEMENT TIMES

DX195 (Axle Jacked up) Pad Replacement	Time Min
Break torque's on wheel nuts	2.0
Air gun off wheel nuts, and remove wheel	2.0
Release parking brake	1.0
Remove adjustment plug	0.5
Back off brake	0.5
Remove retaining pin	1.0
Remove old pads	1.0
Fit new pads	1.0
Fit retaining pin	1.0
Adjust brake fit plug	1.0
Fit wheel and nuts	2.0
Drop Jack	0.5
Torque wheel nuts	2.0
(With the modular concept of parts replacement no spare components other than the pads and retaining springs should be necessary).	**15.5**

DRUM BRAKE (Axle Jacked Up) Shoe Replacement LM Cart.	Time Min
Remove hub cap	2.0
Release parking brake	1.0
Undo axle end nuts	3.0
Fit hub puller	2.0
Pull wheel assembly	2.0
Release brake retainer springs	1.0
Lift off shoes	1.0
Re grease pins (anchor)	2.0
Swap and re grease rollers onto new shoe	2.0
Grease cam head bearing	1.0
Fit shoes back on with springs	3.0
Fit wheel assembly on spindle	2.0
Torque axle end nuts	3.0
Refit hub cap	2.0
Re adjust brake	1.0
Drop Jack	0.5
(No account has been made to replace seals and wearing components).	**29.5**

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ADVANTAGES OF DX195

- Weight 294 kg LM separate
- Weight 299 kg LM cartridge
- Self steer version LM
- Standard 22.5" 335 pcd wheel - no offset.
- Weight 310 kg TM
- Standard 19.5" 275 pcd 8 stud wheel
- Compatibility
- Grease filled hubs.
- Modular concept.
- Precise fault diagnosis
- Total meritor ownership.
- Control of on going improvement.

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DX Brake
Design Parameters

- User friendly / packageability
- Standard Air Chambers / Spring brakes
  - No sealing to caliper
- Full family for all 3 major wheel sizes
  - Global programme
- Very high efficiency (95% achieved to date)
  - Low hysteresis
- Lighter weight
- Optimised Pad-load distribution
- Adjuster - not based on friction
- Higher torque capabilities
- Integrated Rotor programme
- Competitive market prices - comparable to OE manufactured cam brakes

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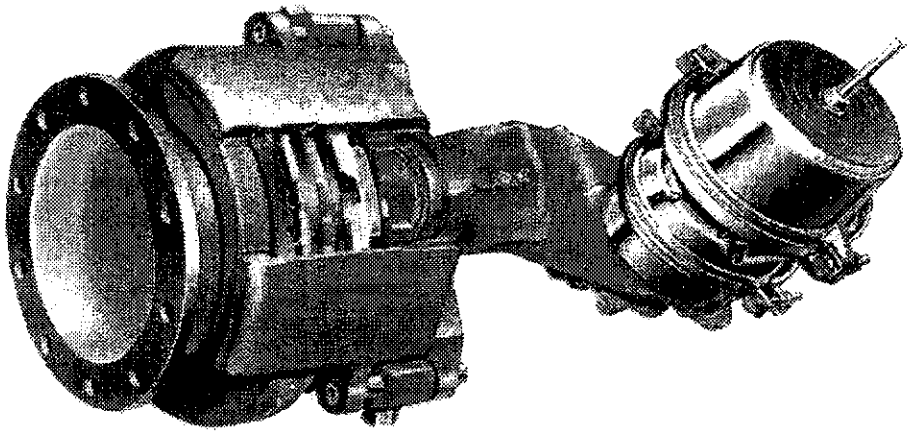
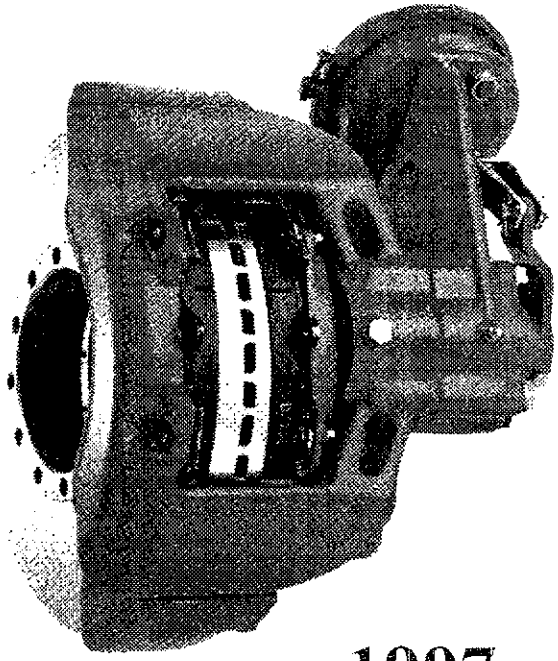
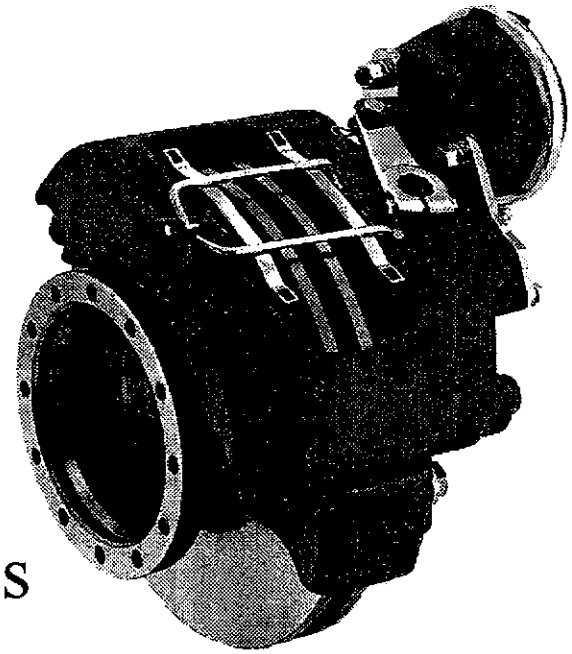
AIR DISC BRAKE HISTORY



1981
ADB 1560/1540



1992
RADB2000



1997
DX Series

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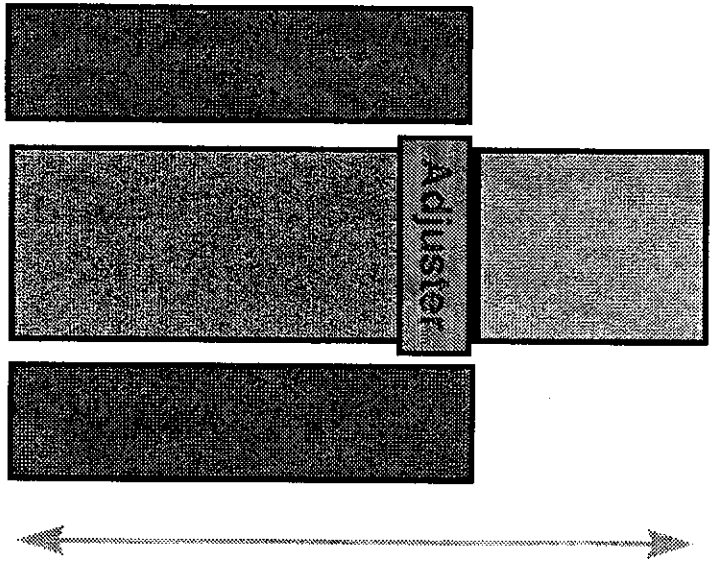
Introduction to Third Generation Design

Shorter standout dimension is achievable by twin piston design

- Allows Pistons - Actuator - Adjuster - to be positioned in parallel



Basic principle adopted by other Brake suppliers

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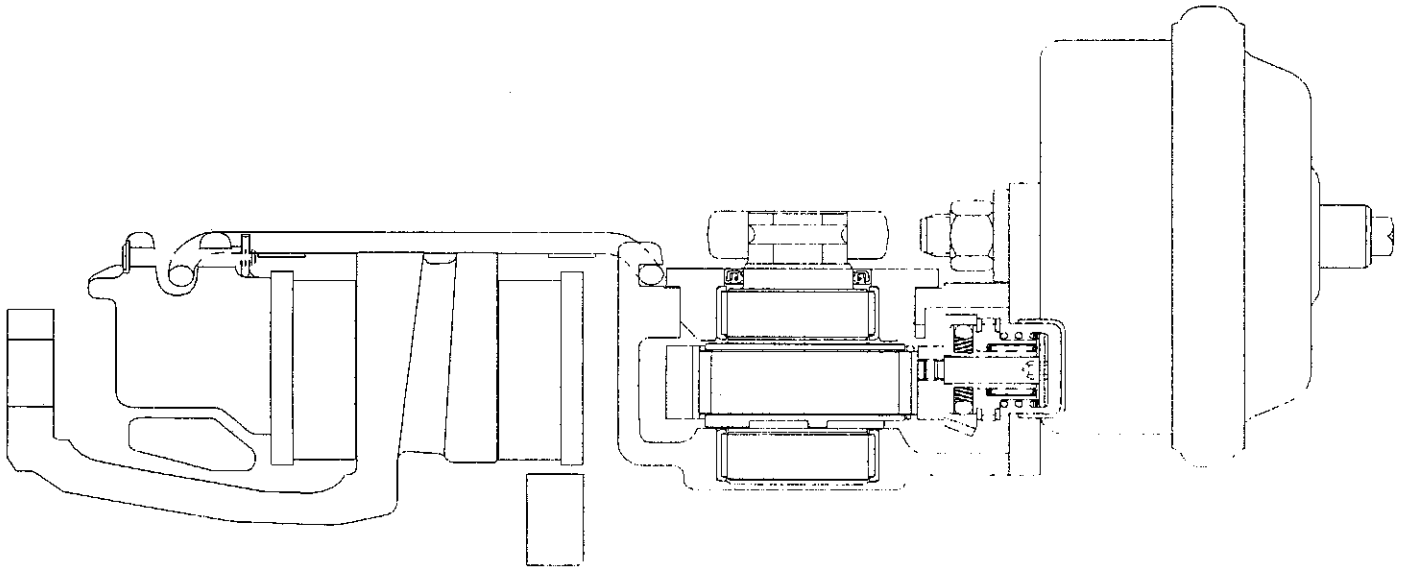
Actuation Mechanism



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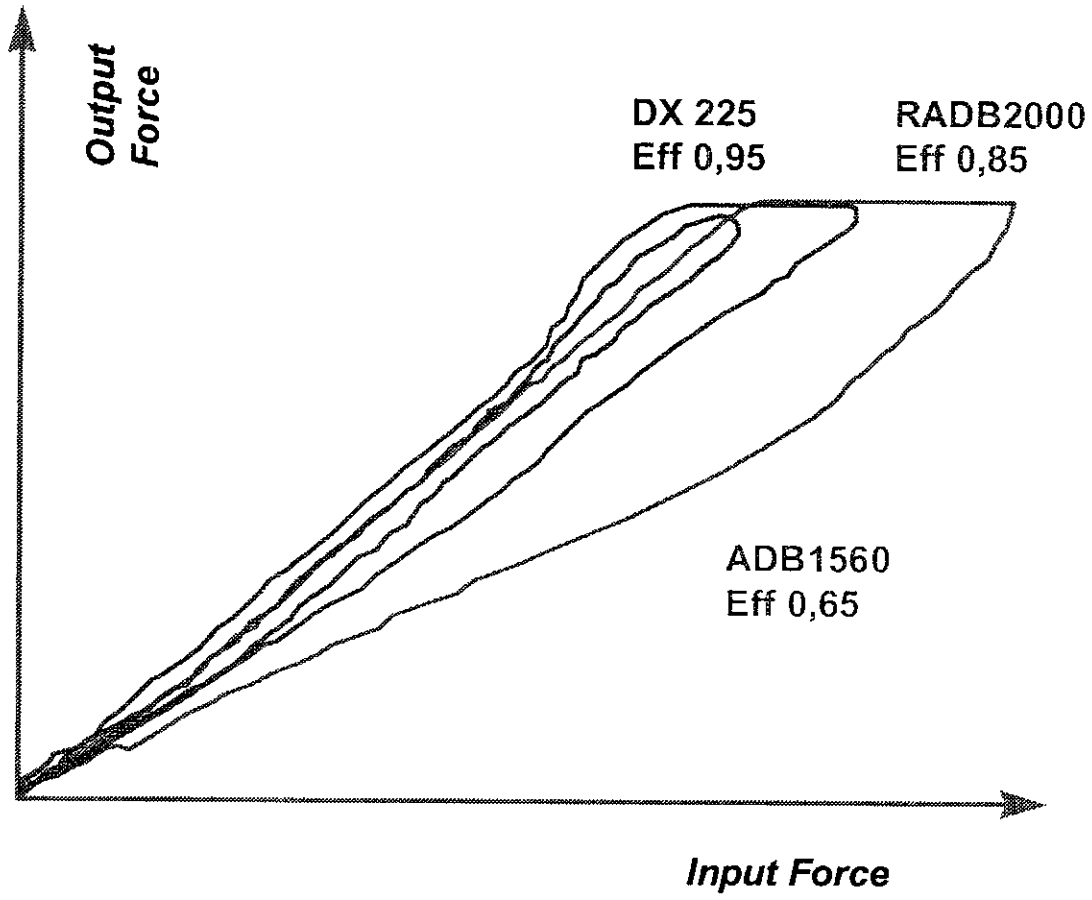
High Efficiency

The actuation is ultra - efficient consisting of a shallow throw eccentric supported in roller bearings throughout - giving pure rolling motion and minimal hysteresis



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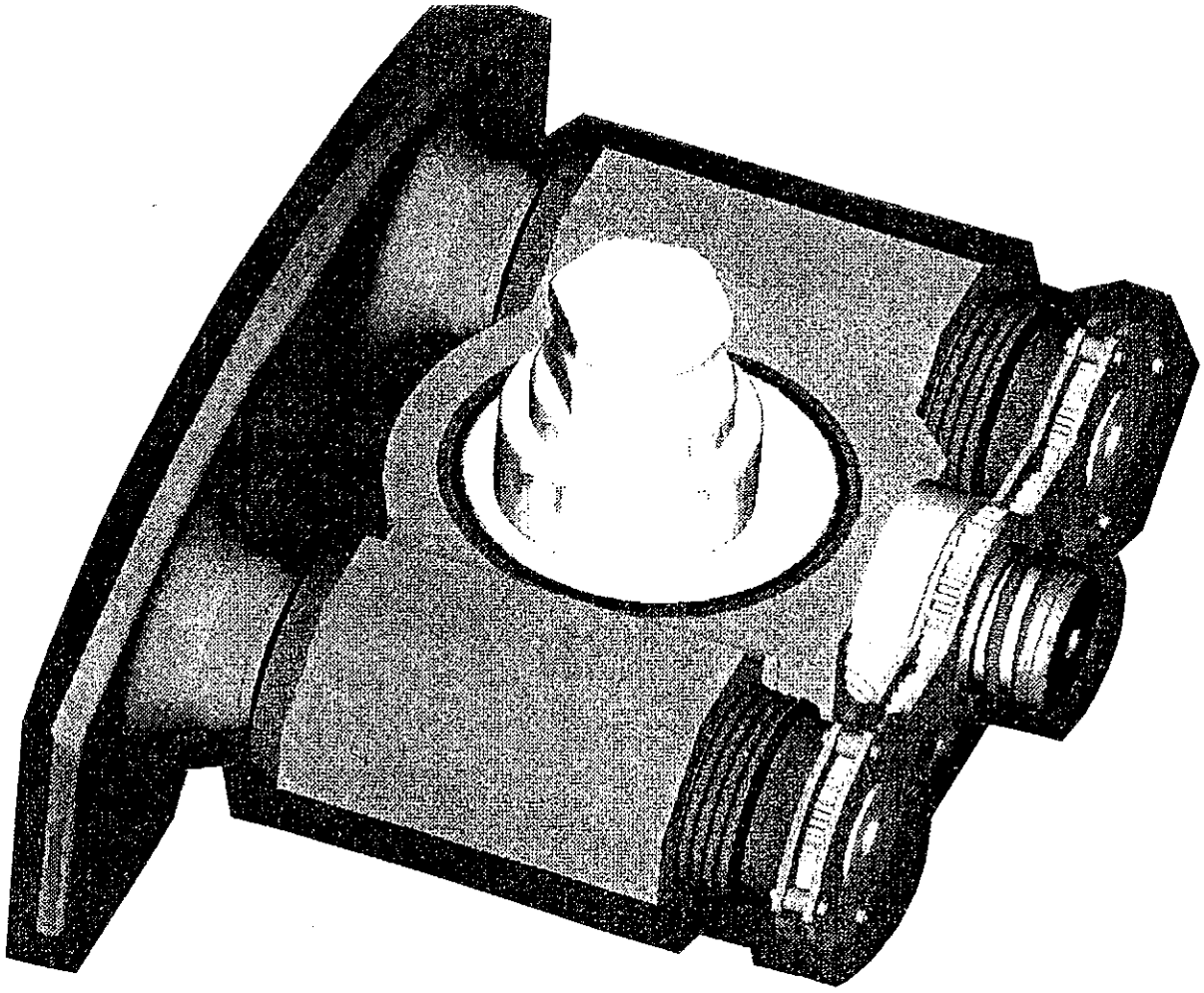
Air Suspension & Adjustment Arrangements



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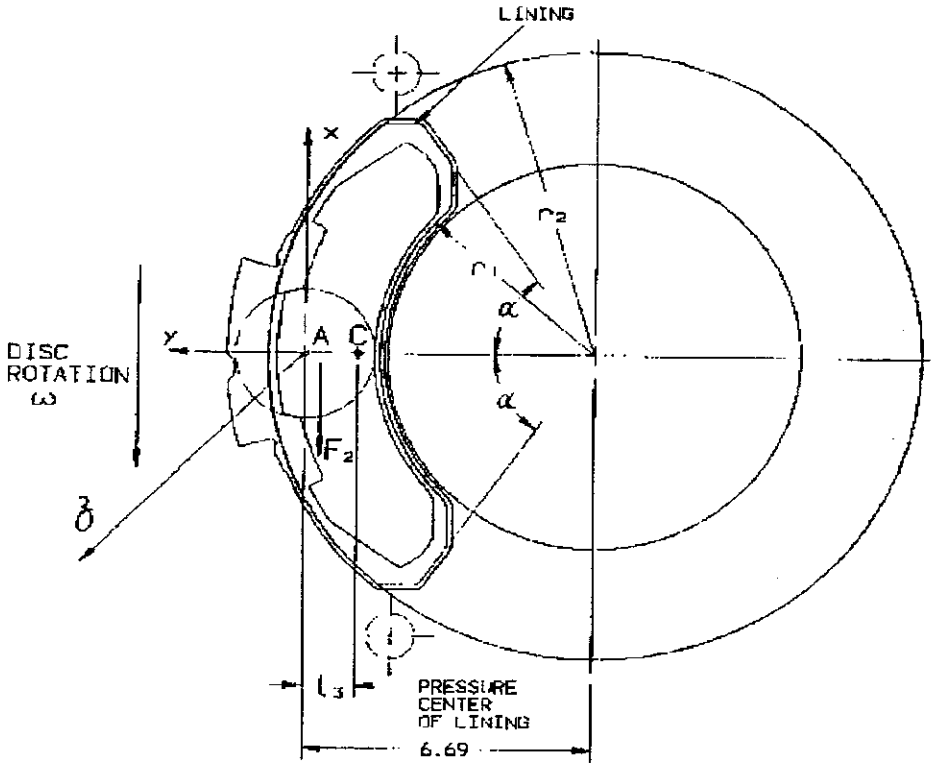
Ideal Load Centre

(Single Piston design)

- For uniform pressure distribution - the load centre needs to be on the lining centroid
- For uniform heat generation and wear the load centre requires to be re-positioned
- With a single piston design it is impossible to achieve this position due to physical constraints



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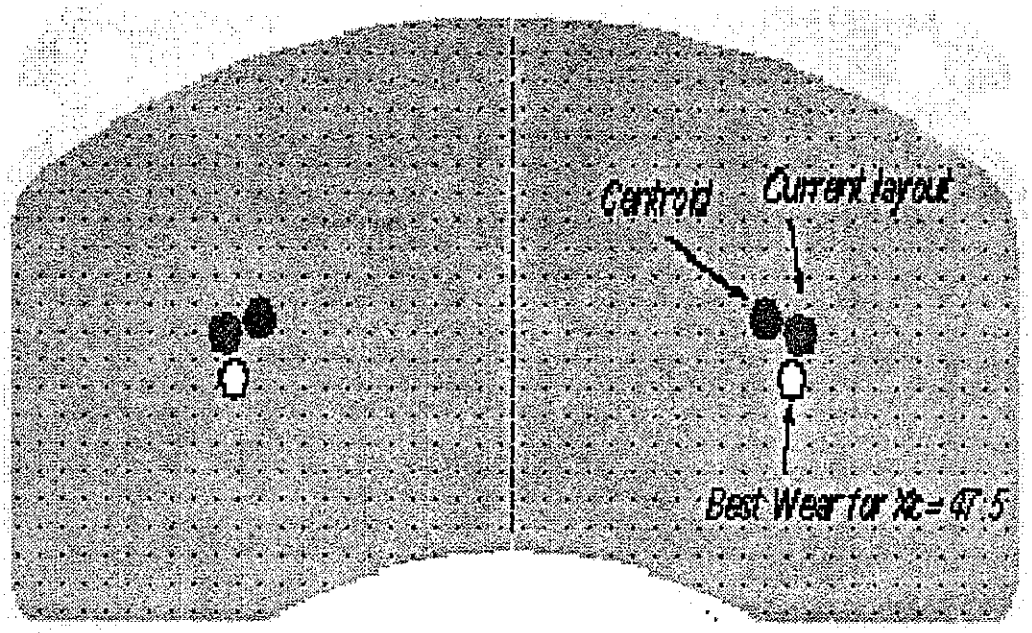
Idealised Load Centre Positions (Twin Piston)

- With twin pistons some of the constraints are removed and load can be positioned to achieve best wear condition
- Pressure distribution is a function of the elastic deformation of the total system
  - Pad - backplate - piston
- Without a load plate, system stiffness is severely compromised
- Analysis shows profiled load plate with pad backplate can optimise system for uniform heat and wear



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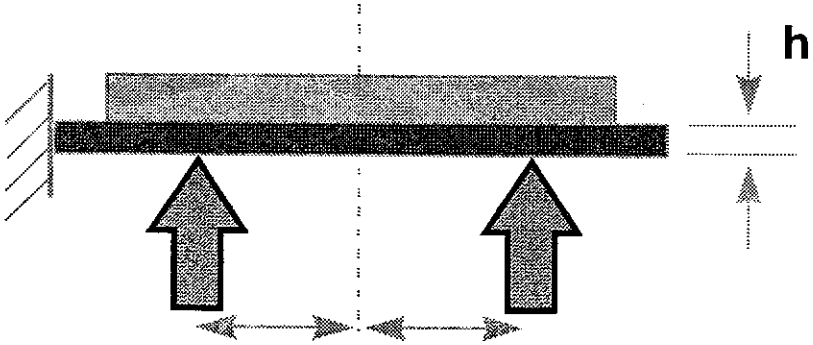
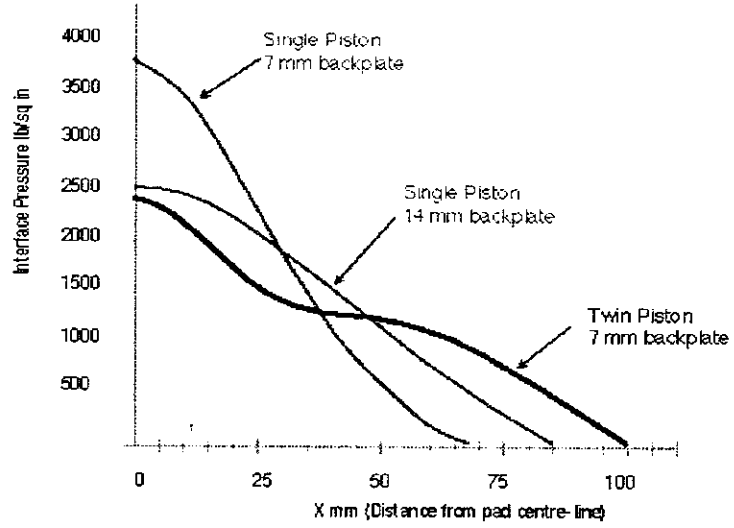
Influence of Back Plate in Load System

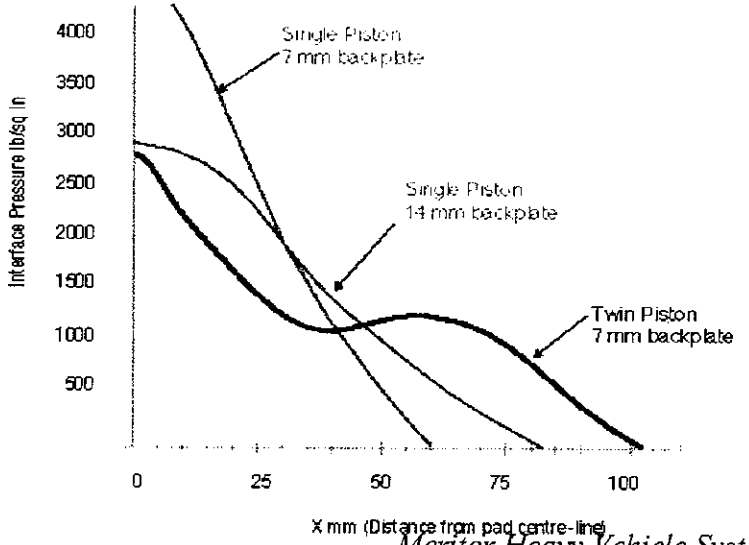


- **Analysis shows that single piston brake requires significantly thicker back plate to approach twin piston load uniformity**
- **Piston position X from pad centre-line for twin piston gives essentially common pressure distribution in both new and worn pad conditions**

Lining Disc Interface Pressure - New linings (23.2 mm)



Lining Disc Interface Pressure - 53% Worn linings (11 mm)



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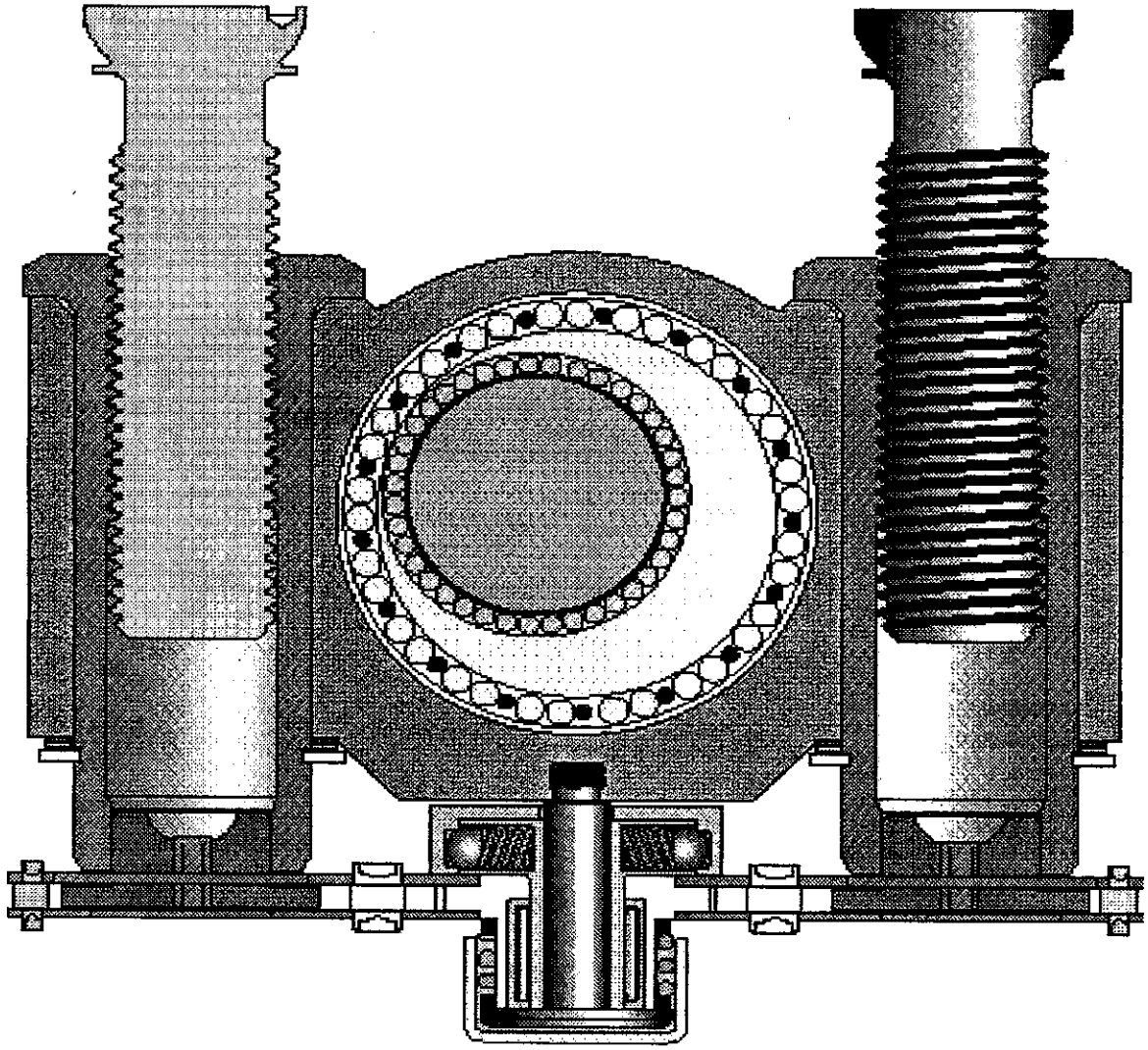
Load Beam & Plungers



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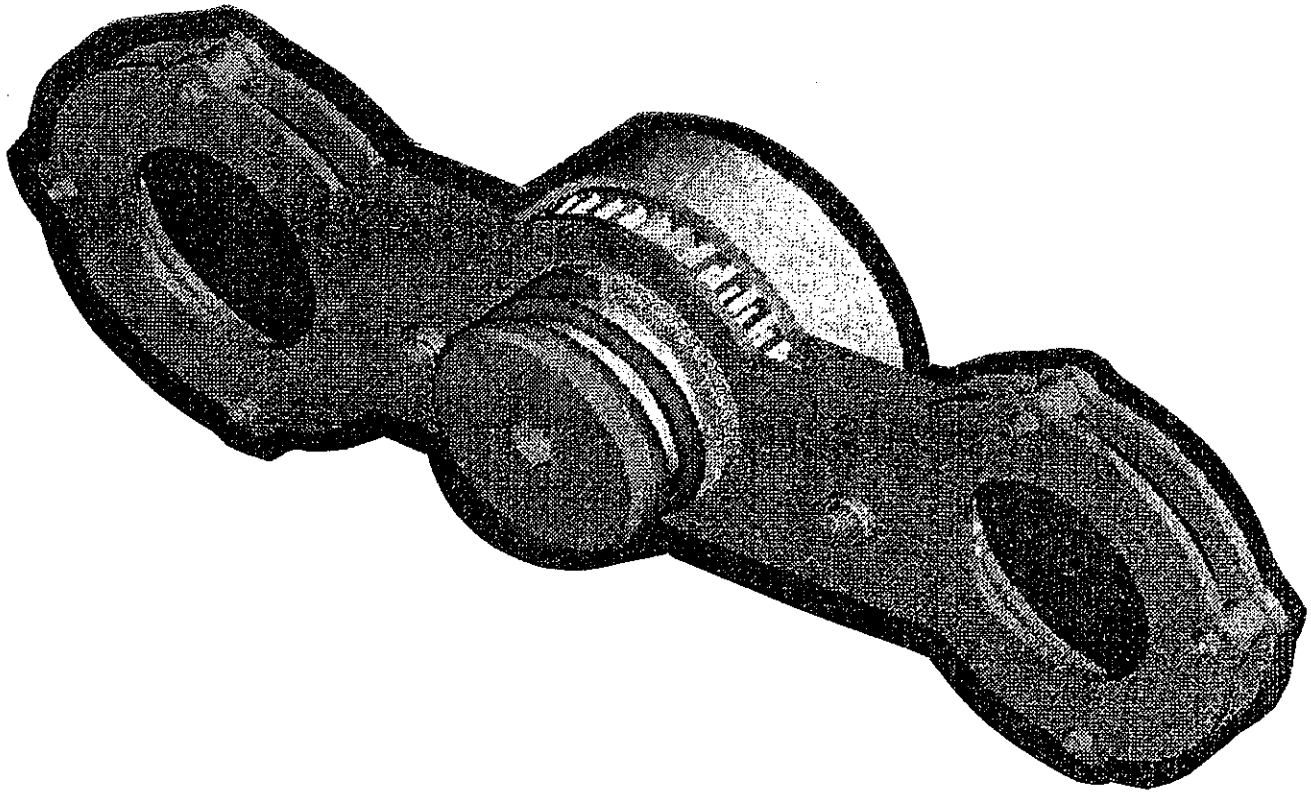

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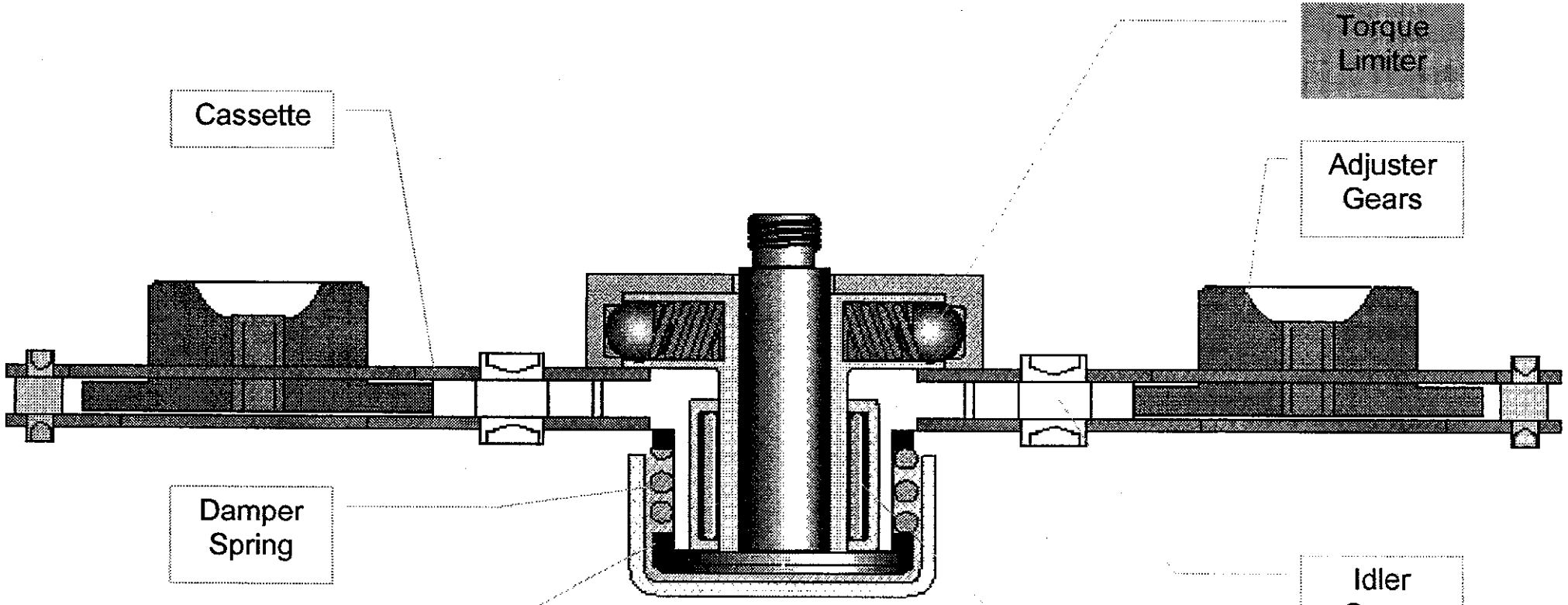
Adjuster Mechanism



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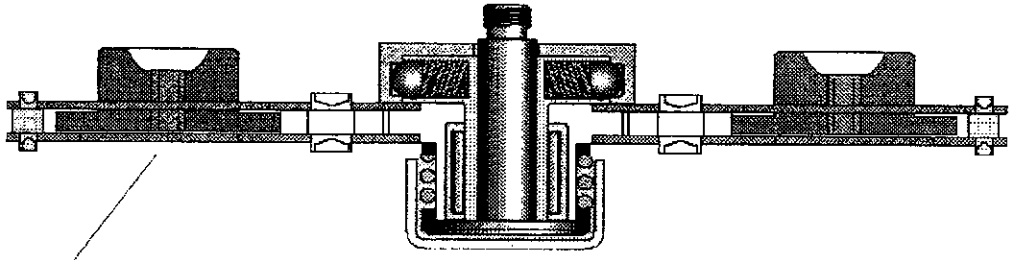
Adjuster Mechanism

- Clearance Sensing
- No Friction plates to wear and affect operation over time or temperature
- Easy access for resetting for pad replacement
- Mounted on-load beam - thereby following movement of actuating mechanism
- Compact and light weight



Manual
Adjustment Port

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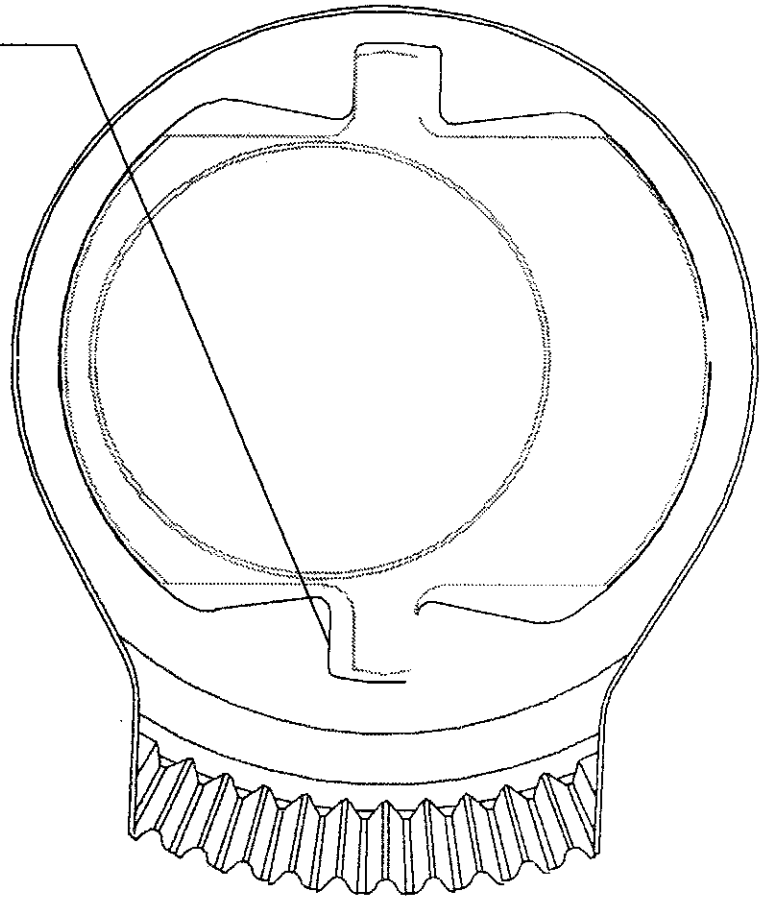
SECTOR GEAR

Gap Controls Pad running clearance



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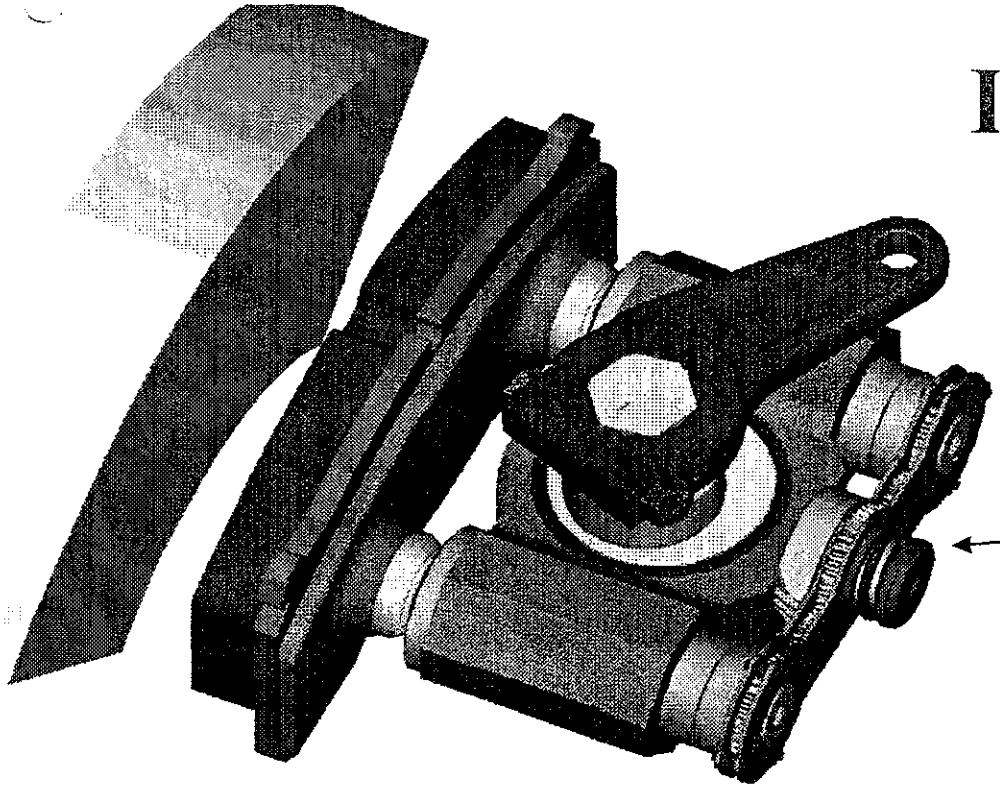
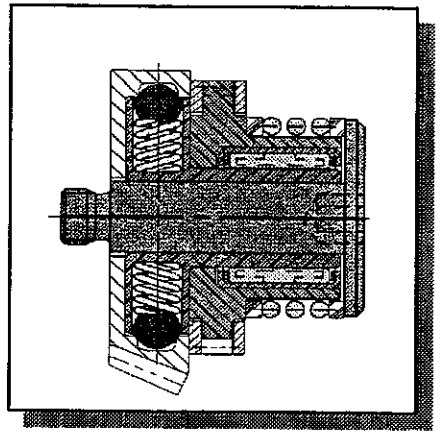
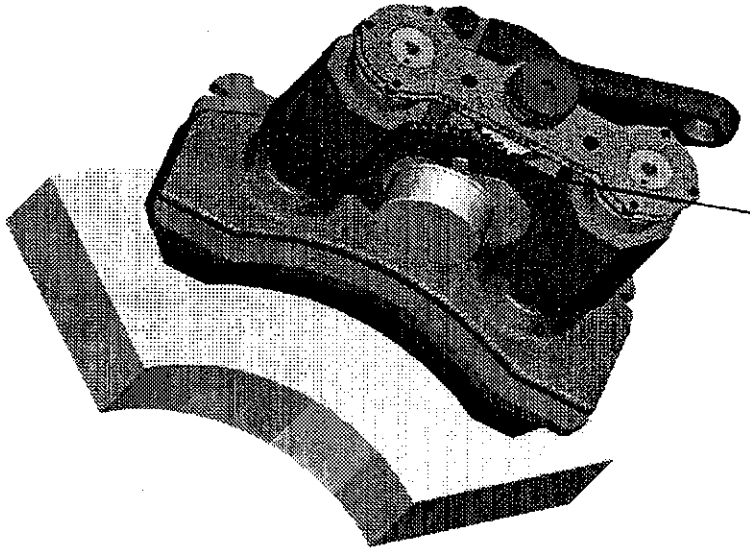
Initial condition

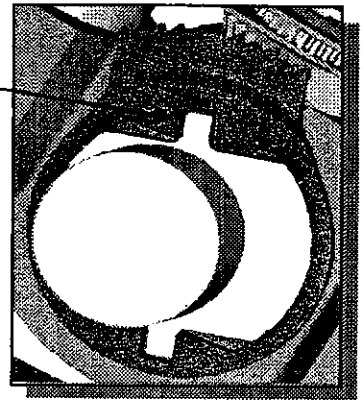


Adjuster mechanism section





Contact between sector and eccentric



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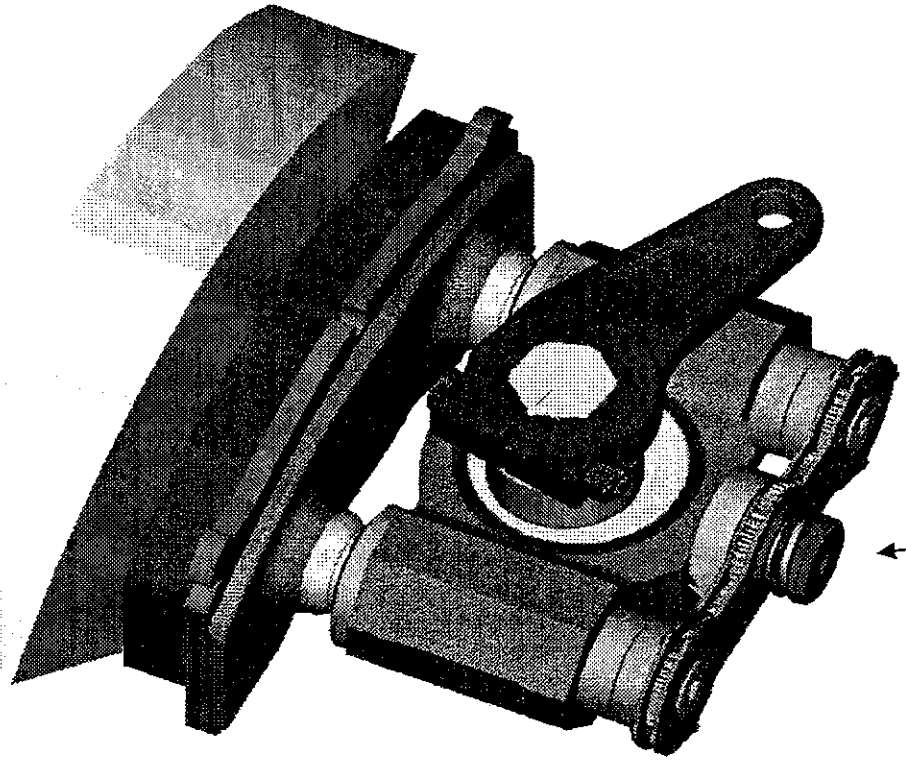
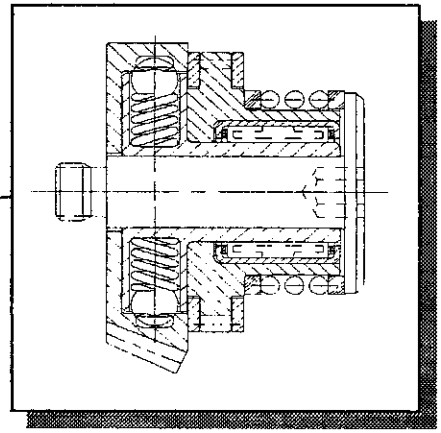
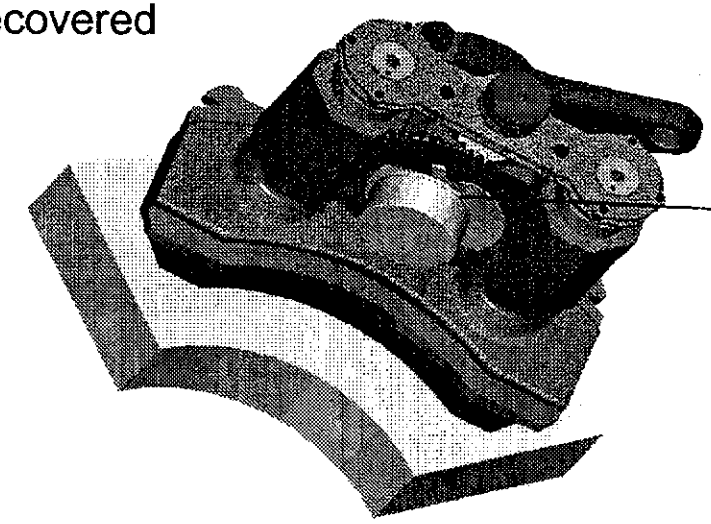
Lever rotation without adjustment



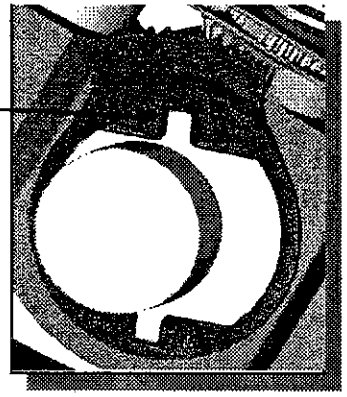
Adjuster mechanism section



0.7mm load plate movement
Clearance recovered



Eccentric rotates until gap is closed



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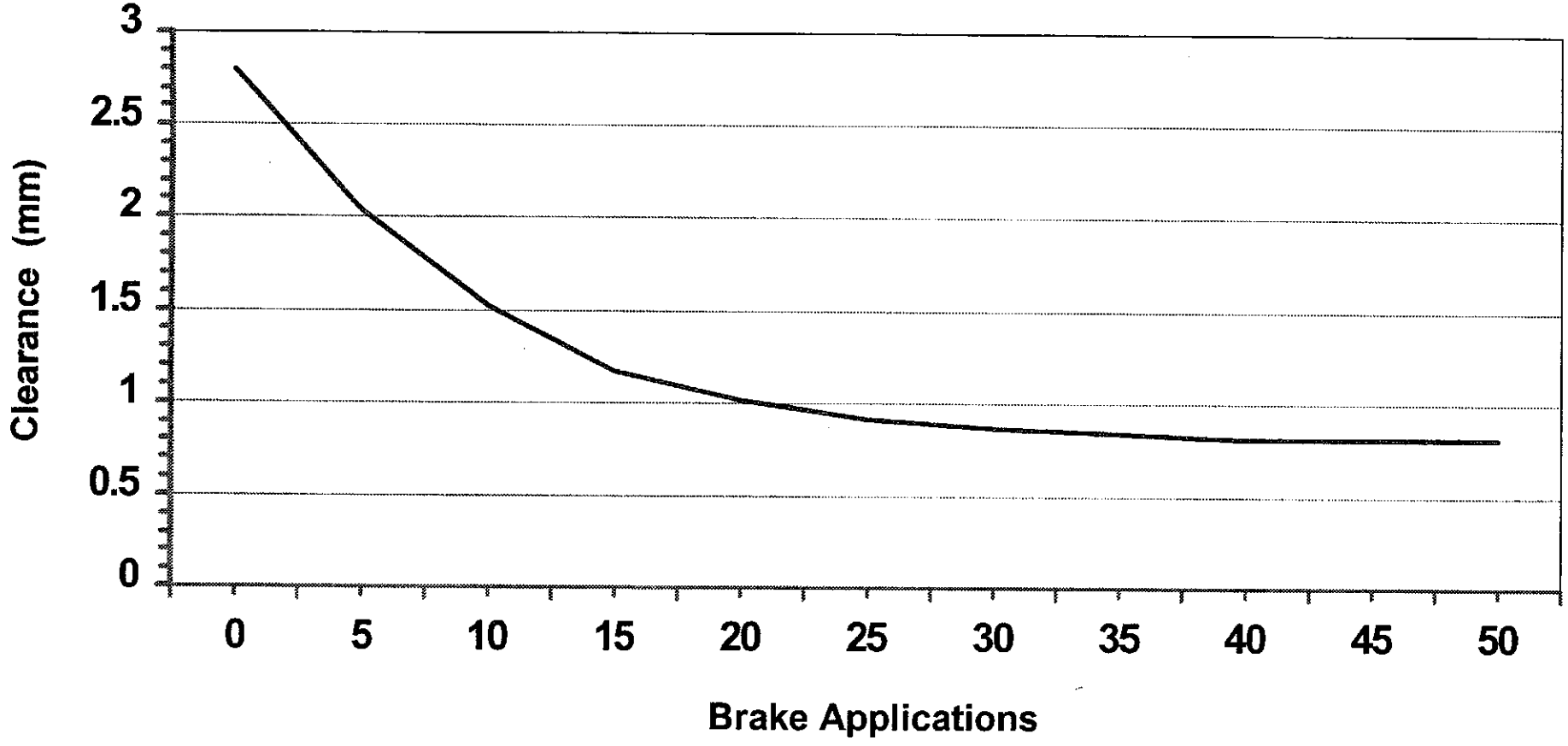
Adjuster Rate Curve



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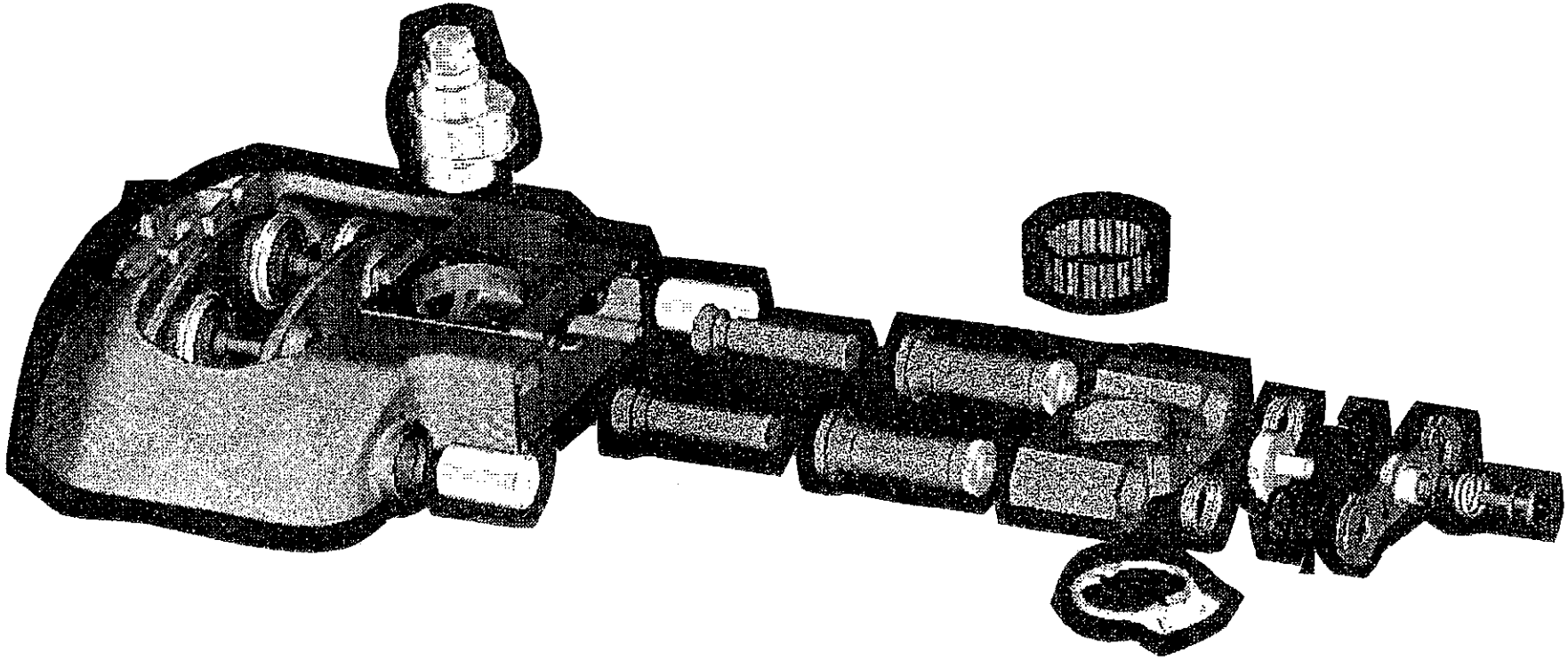

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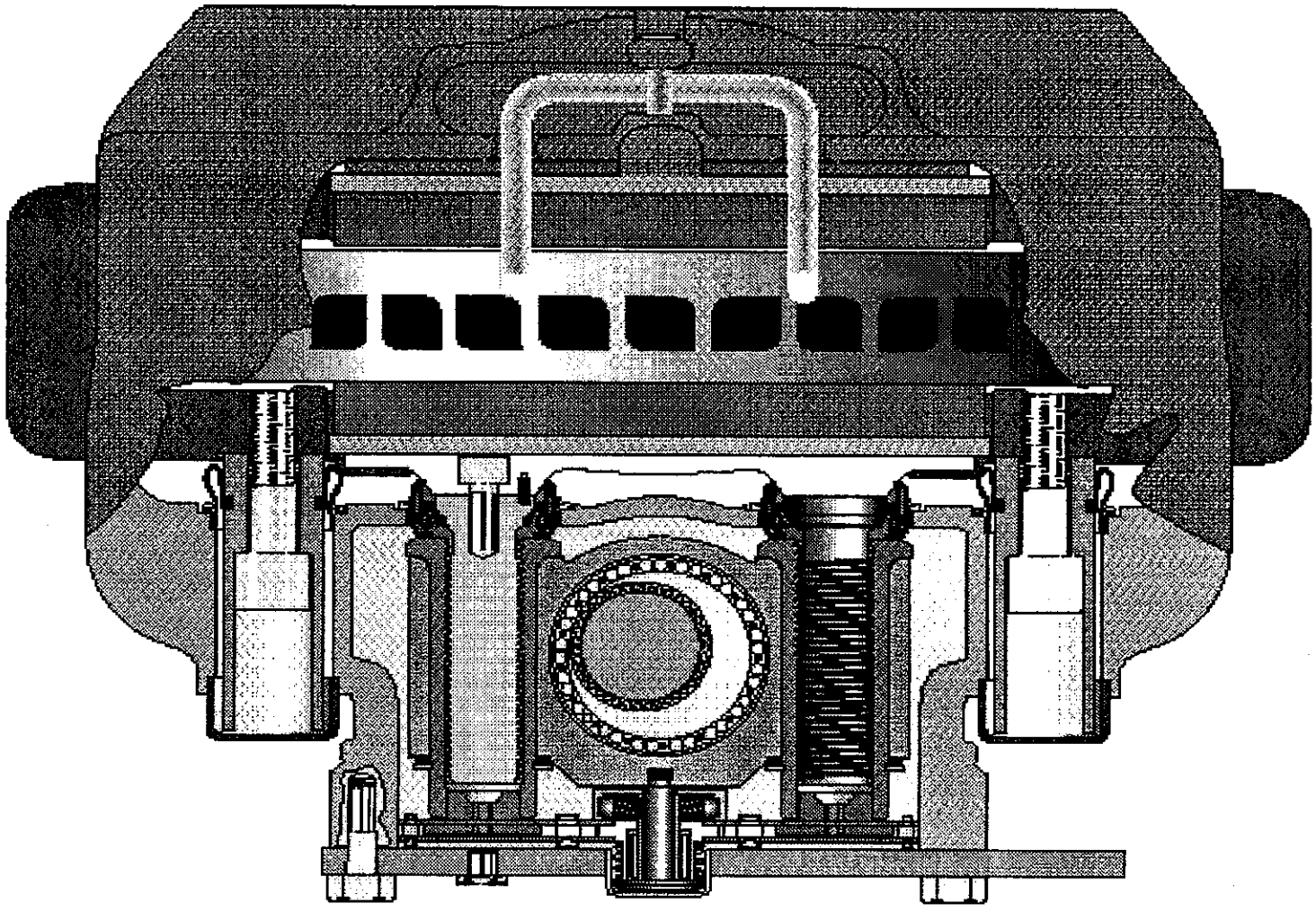
New Pads



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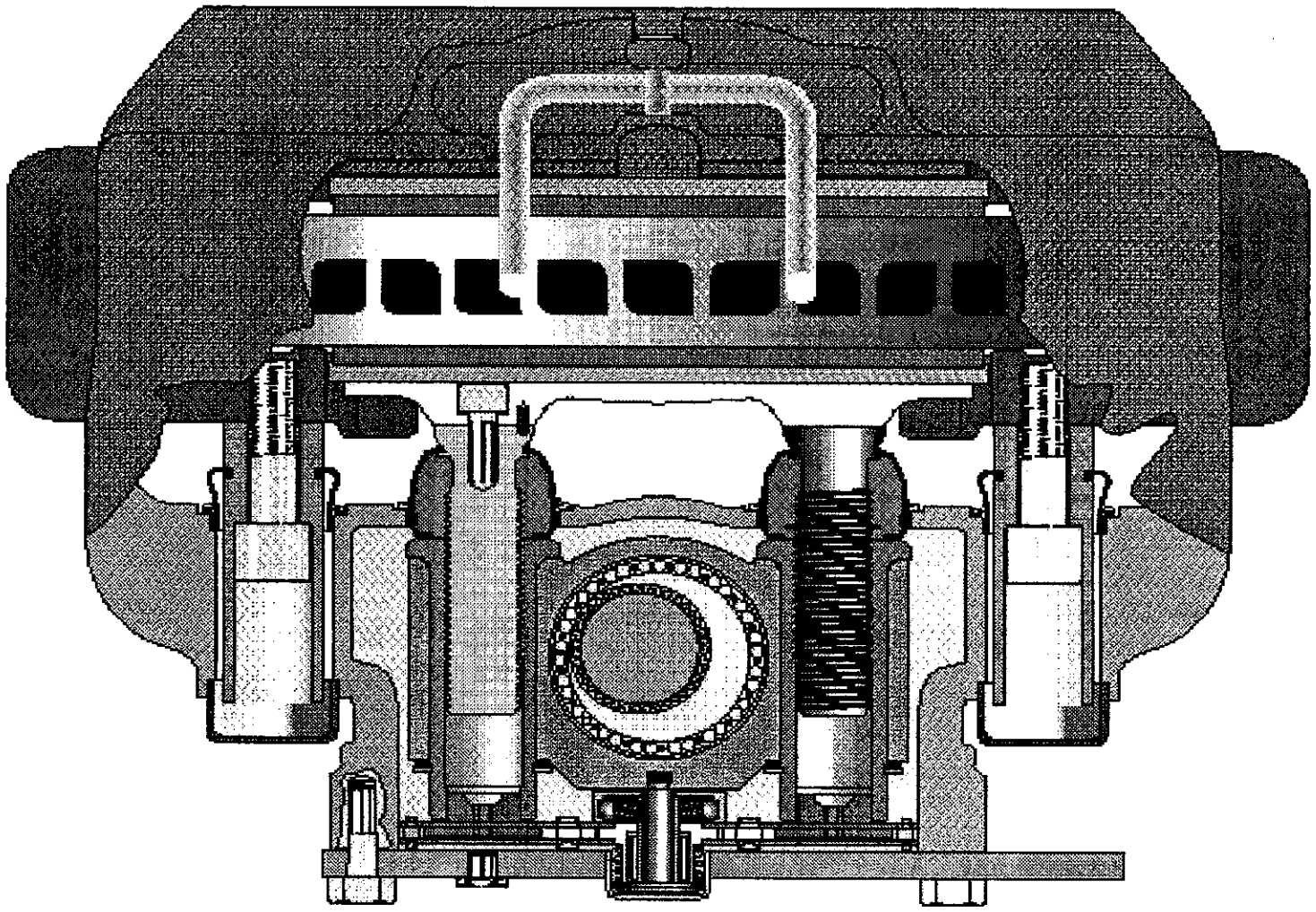
Worn Pads



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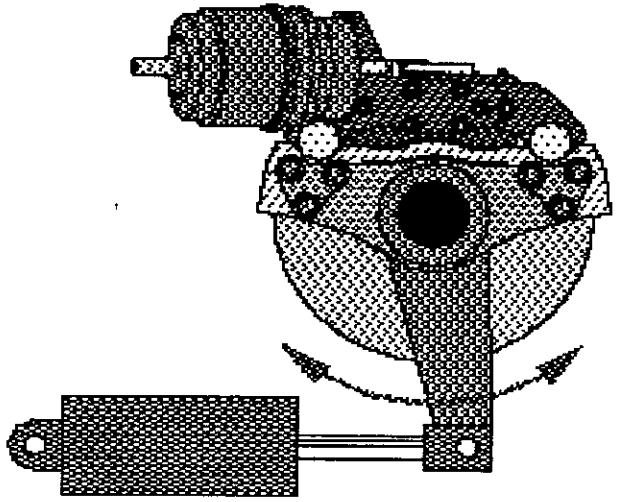
Principle Bench Tests

- Dynamometer
  - Brake Performance
  - Wear Test
  - Rotor Test
- Chucker
  - Structural Integrity of entire assembly
  - Dynamic Deflection
- U.B.T.
  - Durability
  - Static Deflection
  - Hysteresis/Efficiency
- Shaker
  - Structural
  - Adjuster Function



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Standard Structural Test

- Chucker Testing
  - Bogey 20,000 x 3 cycles
  - Dynamic Deflection/Strain Gauges
- UBT Fatigue Testing
  - 8 bar A/C pressure, A/C size for rated torque
  - Bogey 100,000 cycles (variable temperature)
  - Hysteresis/Efficiency
  - Static Deflection

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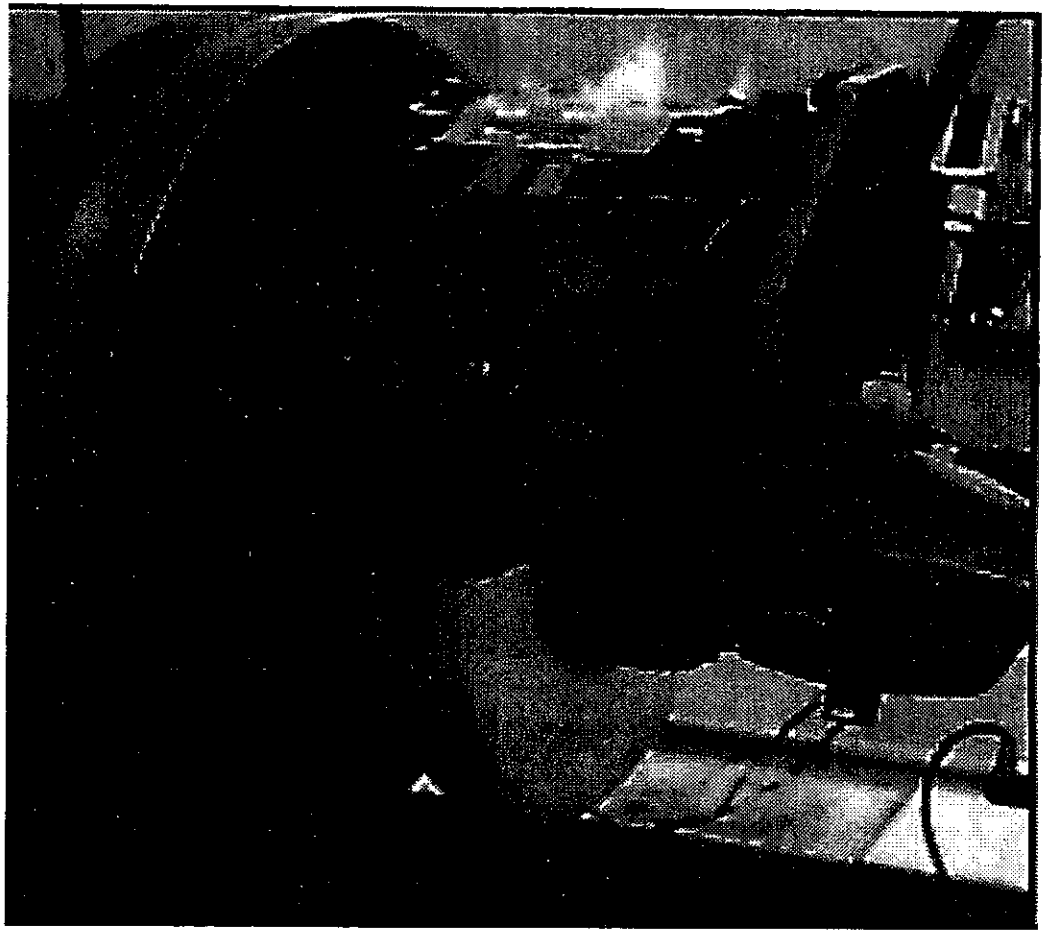
Dynamometer

- **Dynamometer test**
  - Performance
  - Torque/pressure
  - Fade/Recovery
  - Speed Sensitivity
  - Temperature Sensitivity
  - Adjuster Verification test
- **Lining Wear test**
- **Rotor Durability**
  - Performance
  - Wear test
  - Rotor Cracking test
  - Rotor Mechanical Stress
  - Rotor Thermal Stress



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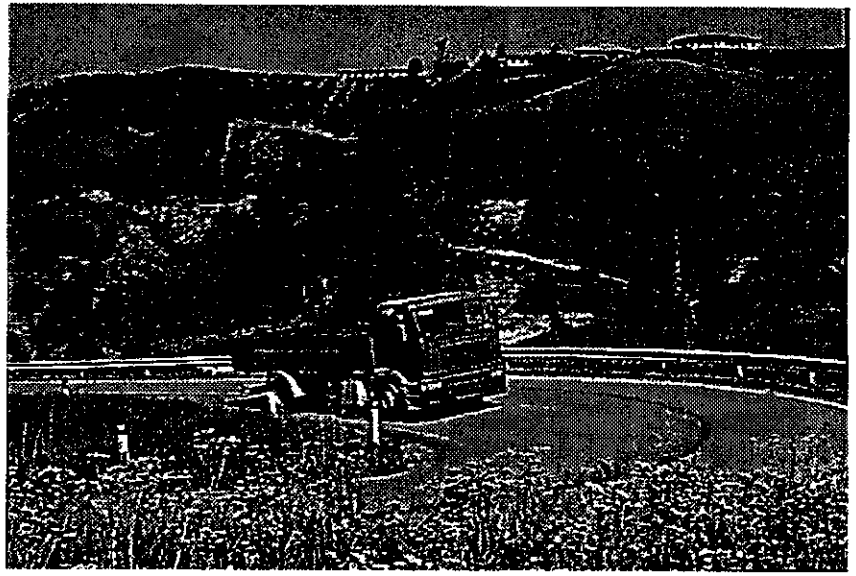
Supplementary Tests

- **Cold Box Test**
  - **8 hour soak at -40°C with spring brake on**
    - Check release
- **Corrosion Test**
  - **Salt Spray/Mud Test**
    - 200 hours

Vehicle Durability

Vehicle Testing commenced in Mid '95 - to evaluate:

- Performance
- Fade Testing
- Rossfelt (Mountain)
- Durability
  - UK, Italy, USA, Germany
- Fleet Testing



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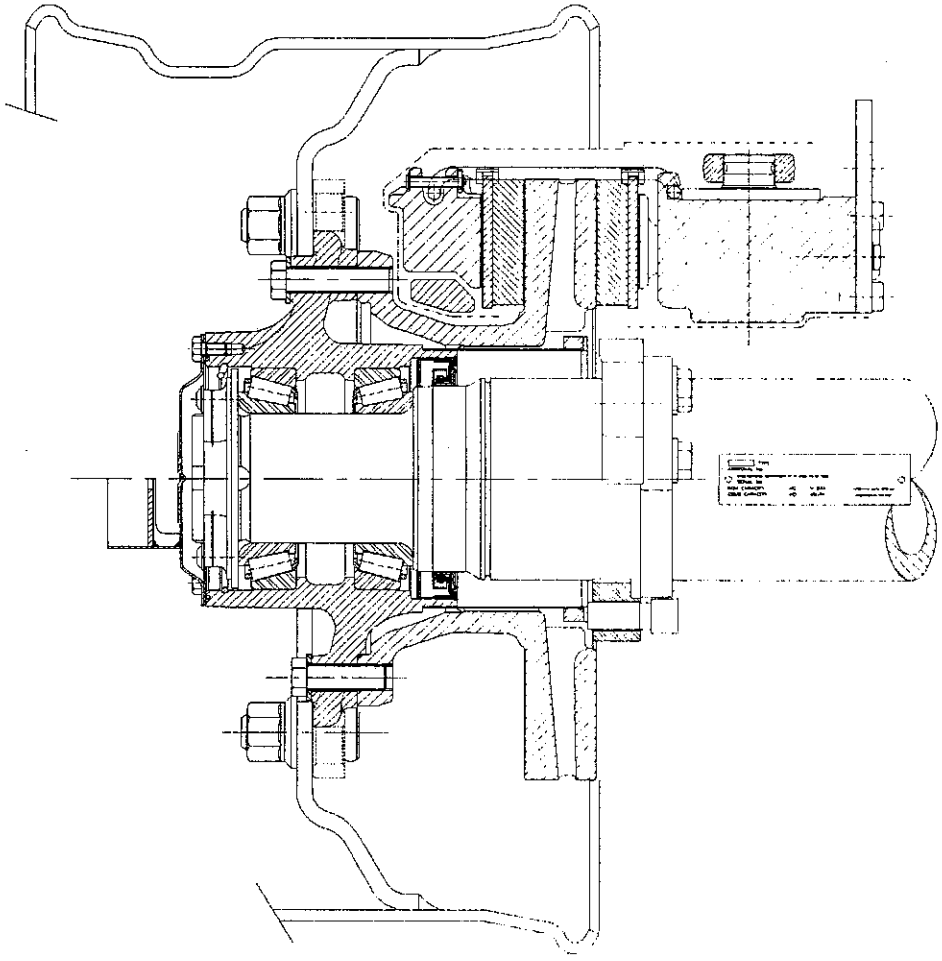
LM AXLE / DX 195 DISC BRAKE EUROPEAN TRAILER APPLICATION



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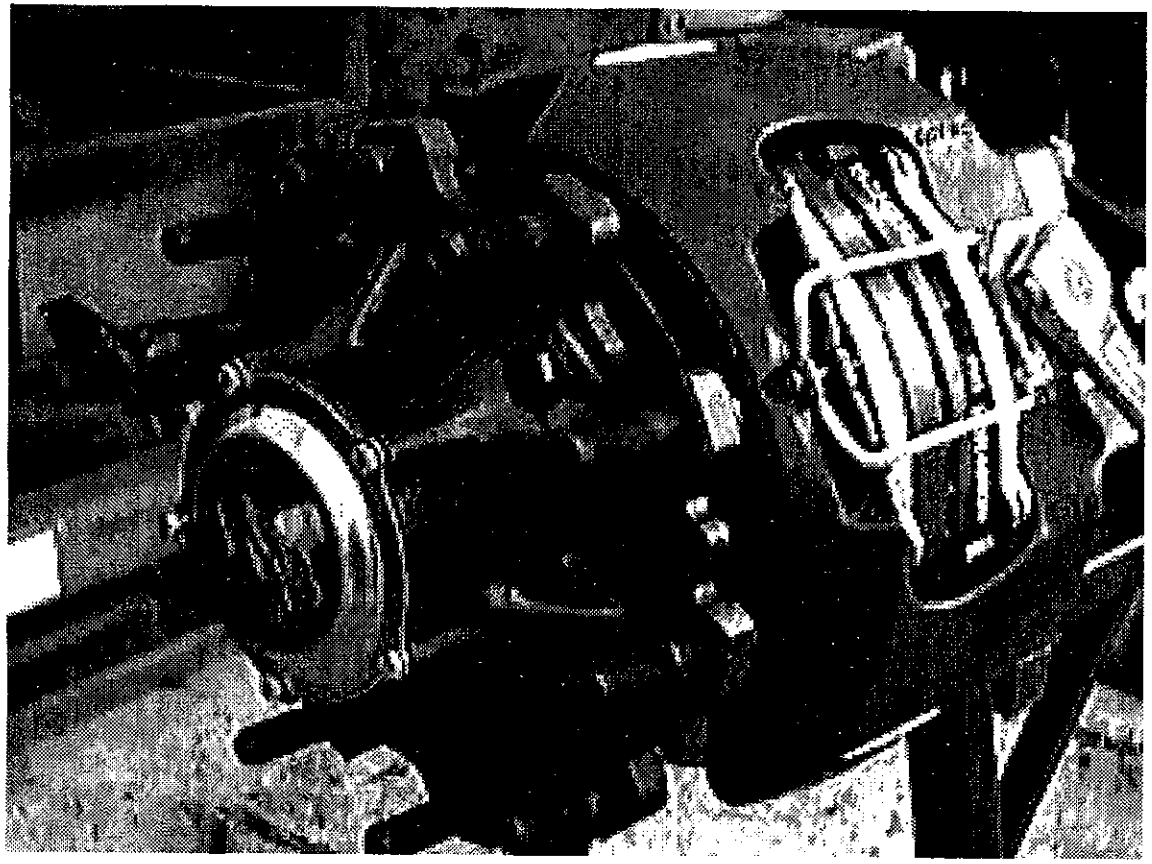
DISC BRAKE DEVELOPMENT



LM DX 195 TRAILER AXLE

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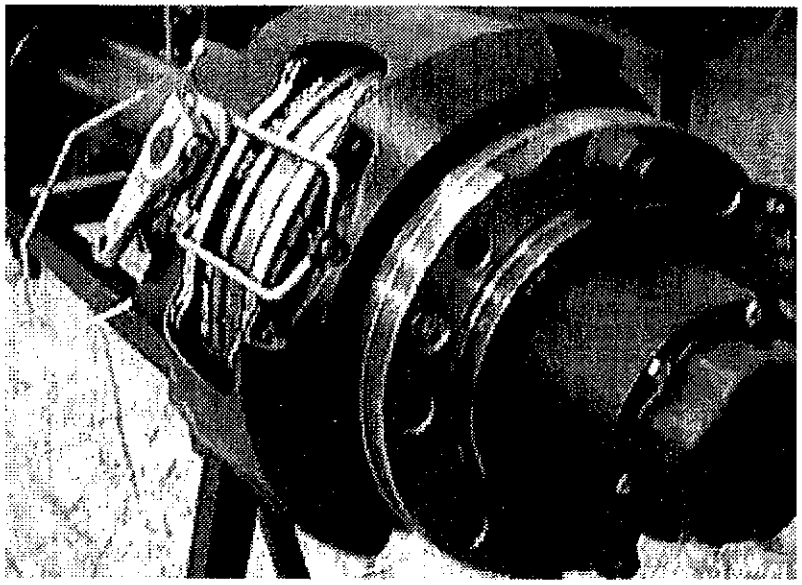
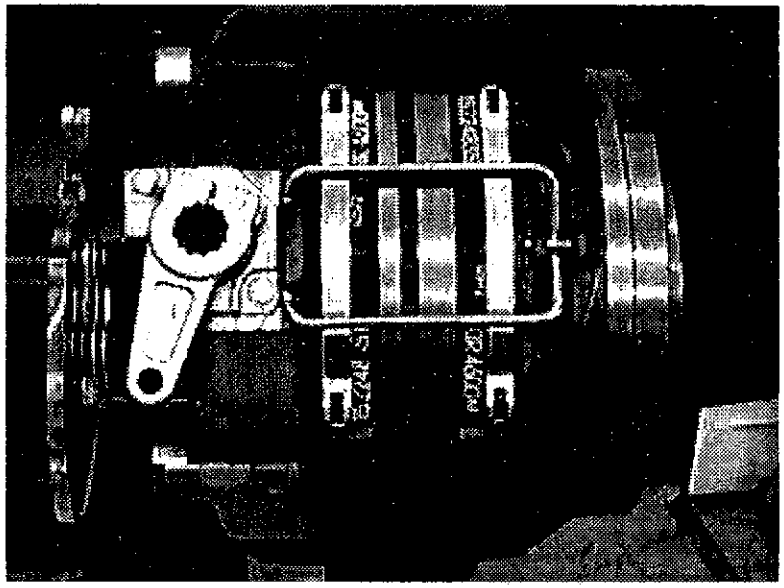
TM DISC FOR 19.5" WHEEL





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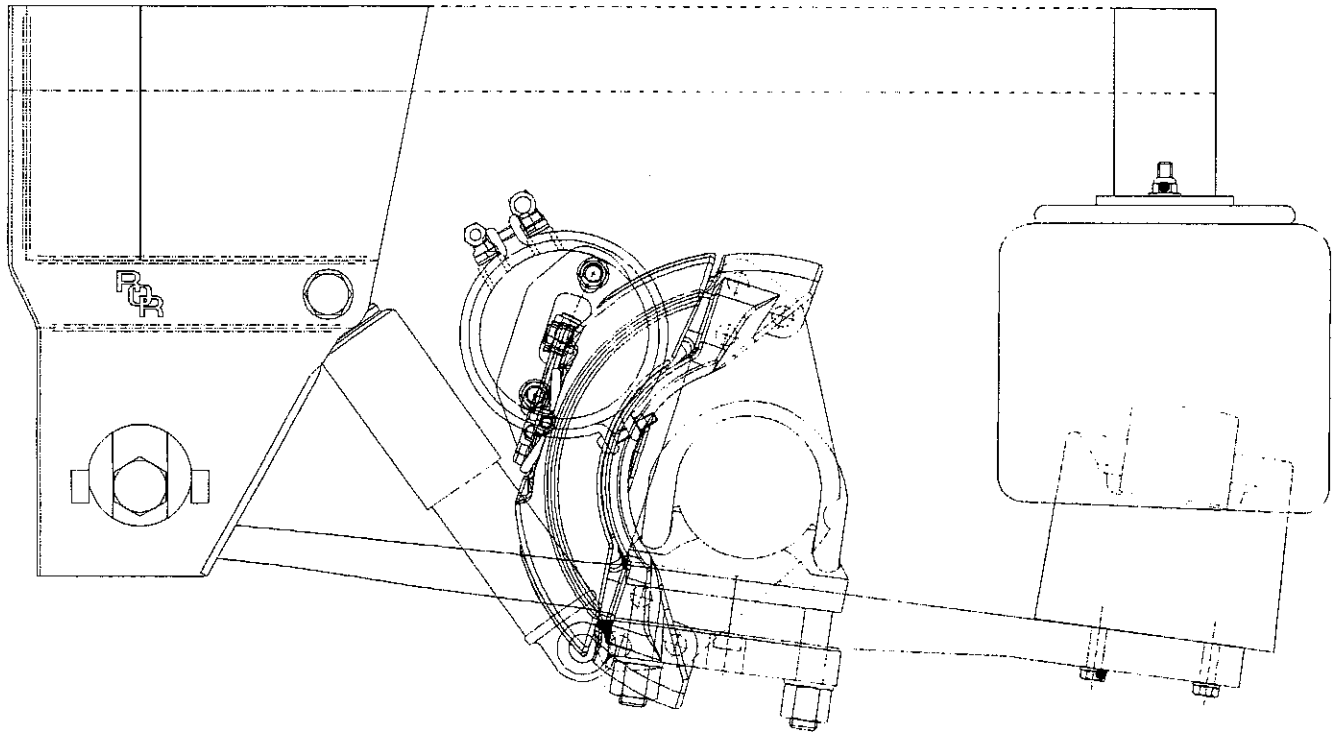
FL9000X

FOR 19.5” & 22.5” SINGLE WHEEL
FROM 350mm TO 425mm RIDE HEIGHT



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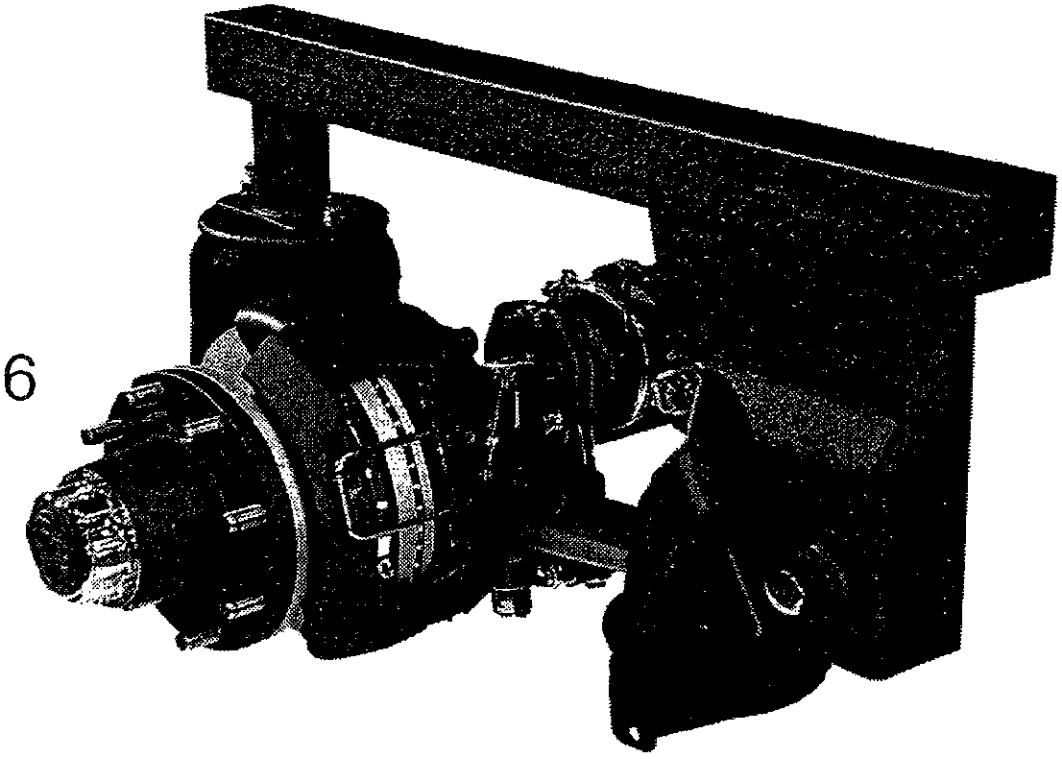
Trailer Installations

- Meritor Trailer axles at Llay
  - Vehicle Tests
    - Track tests October 95
    - Service vehicles April 96
  - Product Available
    - TM DX195 October 97
    - LM DX195 January 98



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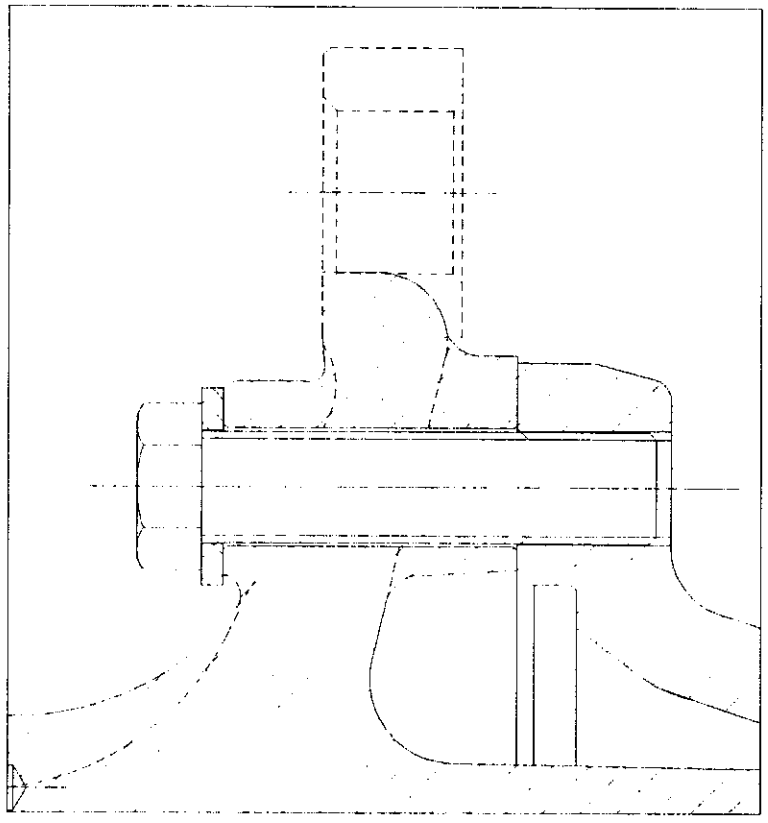
LM AXLE / DX 195 DISC BRAKE EUROPEAN TRAILER APPLICATION

- LIGHT WEIGHT HUB
  - **Proven LM design**
  - **TUV approved**
  - **Multi axis rig durability tested**
- PROVEN ROTOR MOUNTING
  - **Dynamometer tested (mechanical & thermal)**
  - **Meritor 'chucker' tested**
  - **Vehicle endurance tested**
  - **Salt spray tested**
  - **Side skid fatigue tested**



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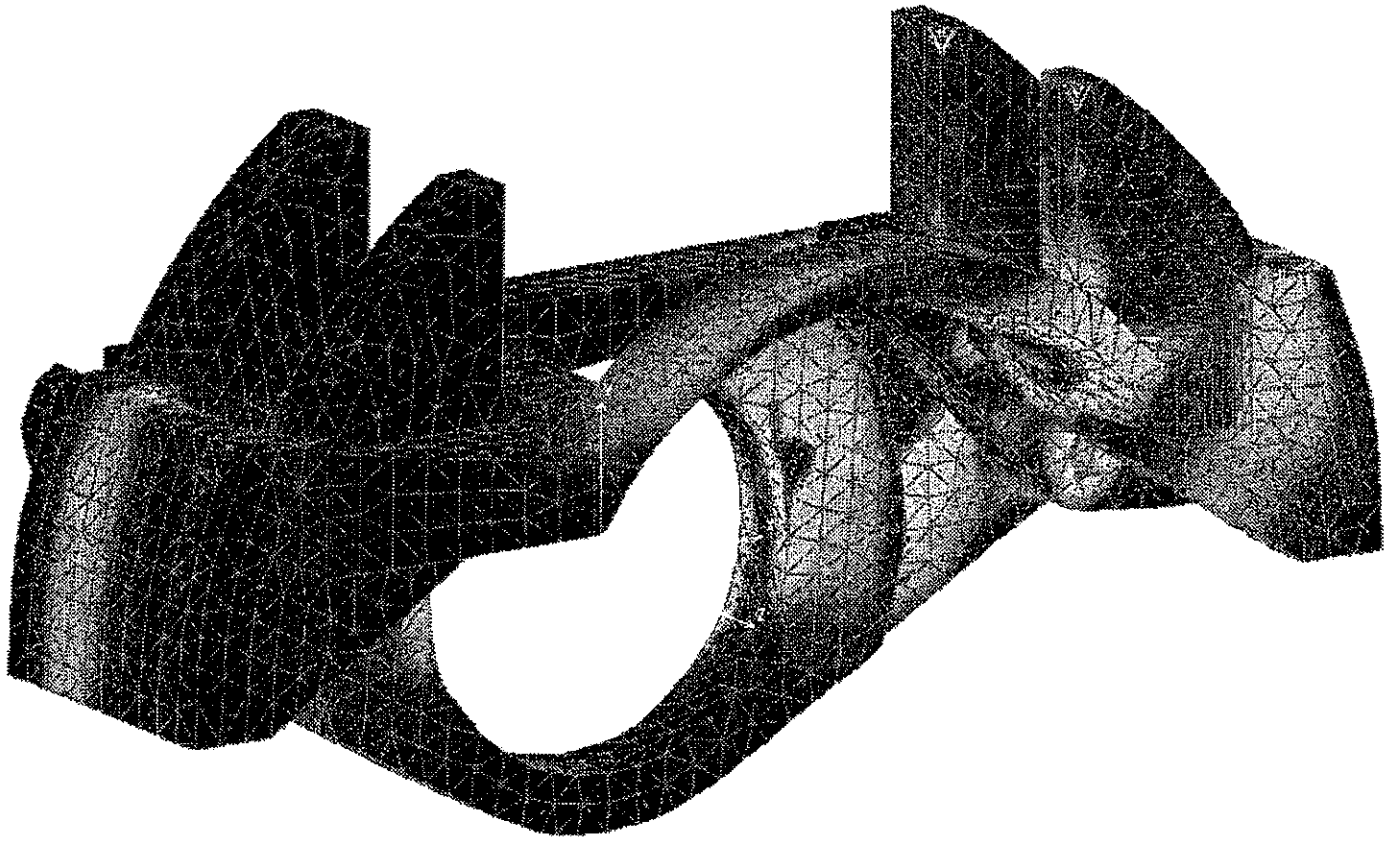
TORQUE PLATE & CALIPER MODEL



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New Developments

- 8 Stud 275 P.C.D. LM DX195
- TM DX225 for twin 22.5" wheels
- DX175 trailer axle

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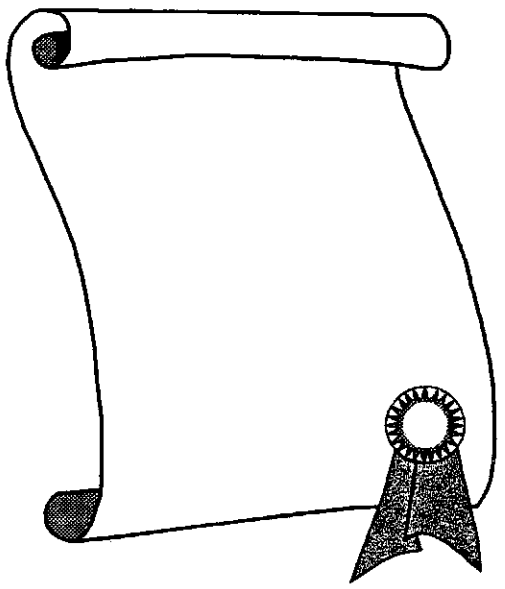
Legislation

Will continue to Impose higher performance requirements on brakes



- Higher tyre loadings
  - In smaller wheels = limited space for the foundation brake
- Higher Deceleration requirements
  - Reducing stopping distances
- Lower Maintenance
  - especially relining

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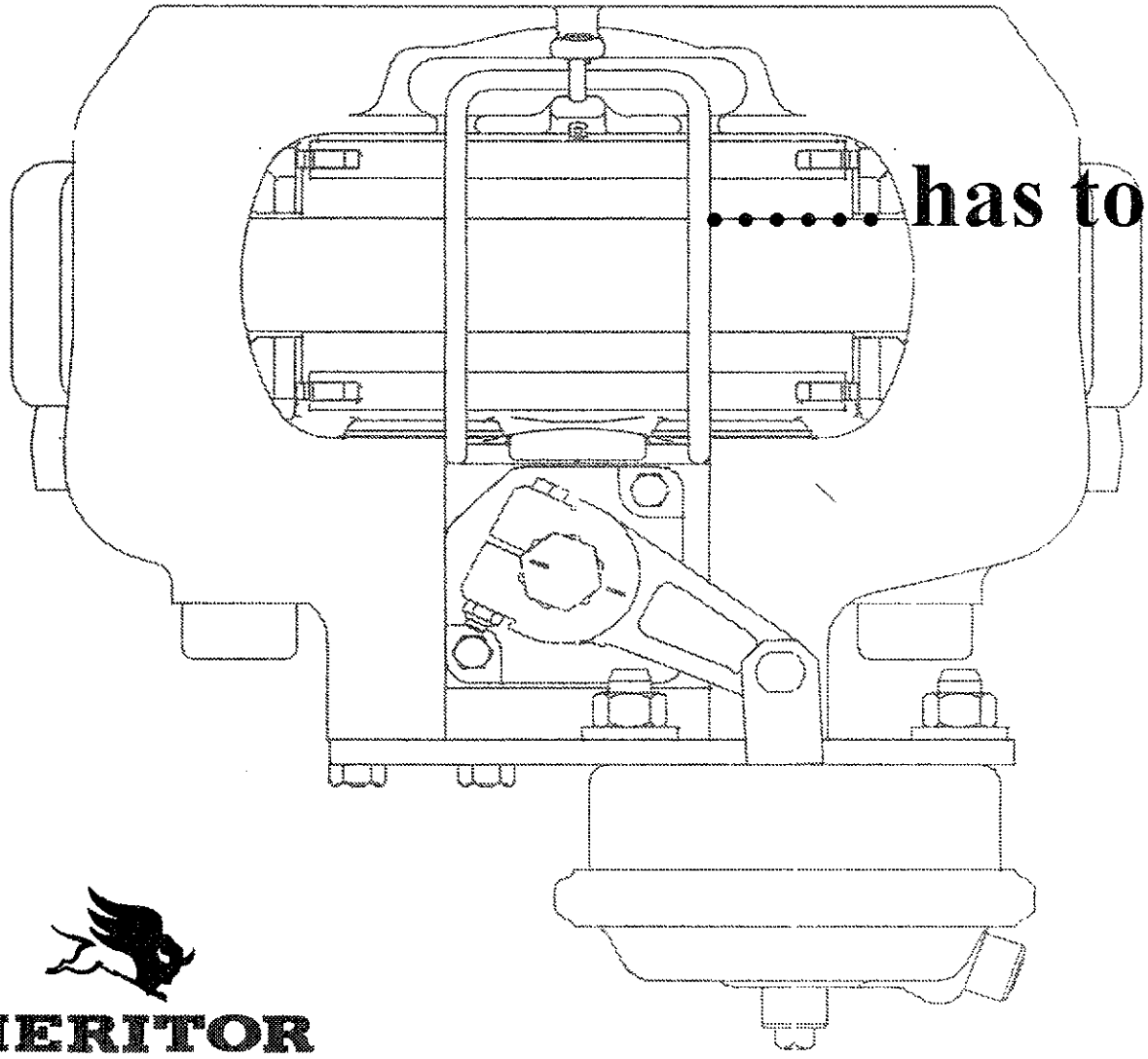
The Future



..... has to be based on Disc Technology

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