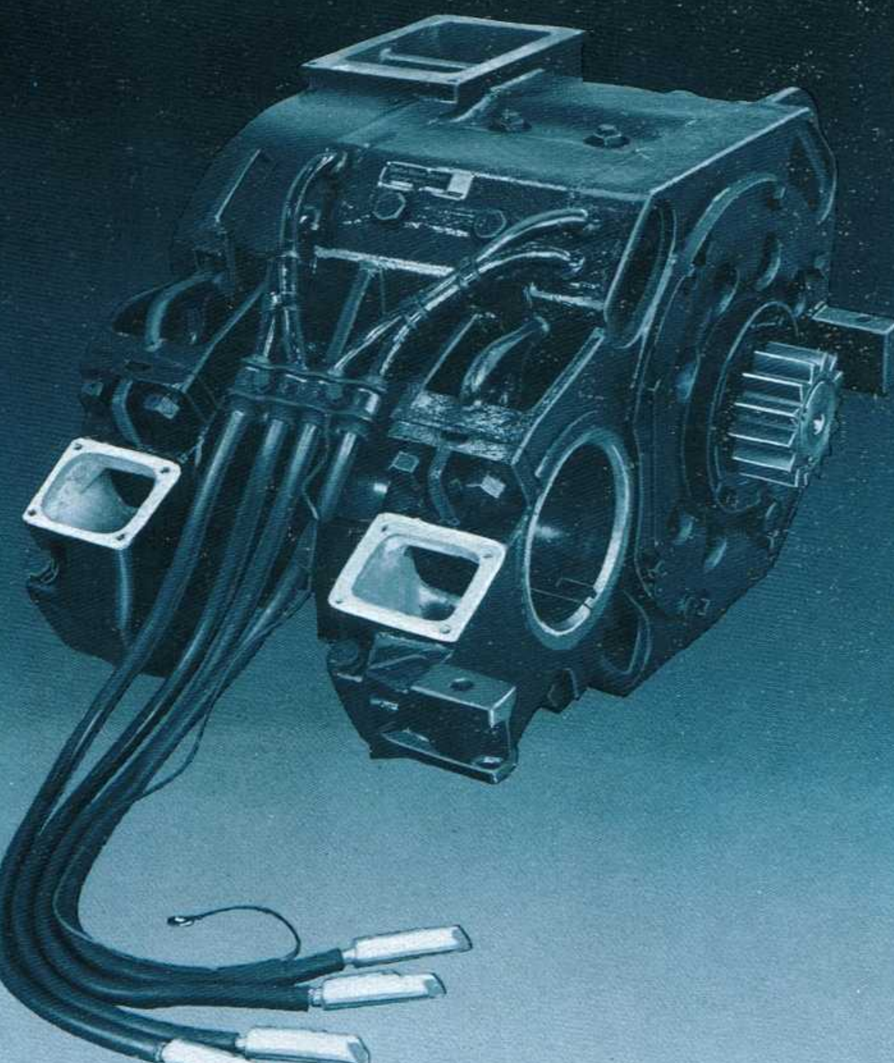
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS

D29 TRACTION MOTOR



- Rugged Construction
- Long Service Life
- Minimum Maintenance
- High Reliability
- Axle Hung
- TIG Welded Commutator Riser
- Long Life, Three-Wafer Brushes
- Inorganic Bonded Mica Commutator Insulation

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General

The Electro-Motive Division of General Motors Corporation offers the D29 traction motor for use in locomotive models requiring either a narrow gauge truck or low axle loading on standard or broad gauge applications.

Suitable for one meter gauge and wider, the D29 is designed and manufactured to handle all operating conditions – from light yard duty to high speed passenger and heavy duty freight service. The rugged design of the D29 has been proven through years of reliable, trouble-free service.

The D19 traction motor, installed in locomotives in 1954 and rated at 154 kW was the predecessor to the D29. As the need for higher horsepower locomotives arose, Electro-Motive developed and produced these locomotives. The increase in locomotive horsepower created the demand for higher capacity traction motors. Today's D29 motor is rated at 320 kW, more than double that of the early D19 traction motor.

Design

The D29 traction motor is a direct current machine used to convert the electrical energy from the locomotive main generator to mechanical energy in the form of rotational torque.

Basically, the motor consists of an armature (rotor) centered inside four radially supported field poles and four interpoles. The interpoles, also known as commutating poles, are physically smaller than, and are located between, the main field poles. Electrically, the interpole windings are connected in series with the armature; thus the electromagnetic effect of the interpole is in direct proportion to armature current.

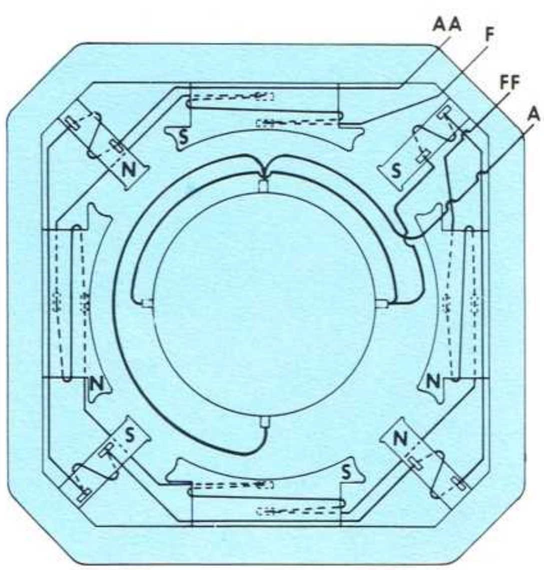
Locomotive control devices are utilized to connect the low resistance armature and field windings in series. This series type motor operation provides the high starting torque required for locomotive service. The direction of motor rotation can be reversed by reversing current flow through the field winding. This switching is also accomplished by the locomotive control devices.

The main field poles are constructed of a laminated steel core surrounded by copper coils. The face of the steel core has a larger cross-sectional area. This spread-out portion, or shoe, permits the magnetic flux to cover a wider area of the armature core. The armature windings are also wound on a laminated steel core.

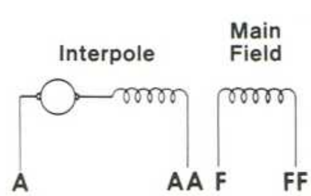
The function of the interpoles is to insure that, during commutation, the generated voltage and likewise, the current in the commutated coil is very nearly zero. If the generated voltage is not zero, the current passing through the coil, brush, and air gaps will cause excessive arcing and resultant commutator burning.

The axle-hung D29 motor is geared directly to the axle and thus, a pair of driving wheels. Additionally, a rubber nose suspension is provided to dampen the torque shock.

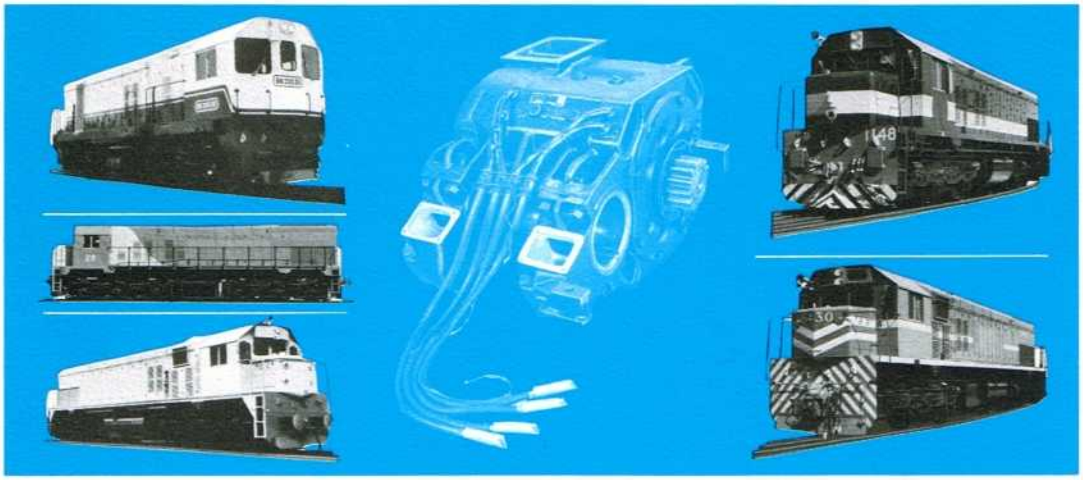
Lifting eyes on the stator frame provide a convenient means of lifting the motor.



Wiring Diagram



Electrical Schematic



Stator

The welded stator frame is fabricated from high quality magnetic steel. To minimize any power loss caused by eddy currents, the main field poles are made of steel laminations.

After a glass reinforced silicone rubber ground insulation is applied to the stator coils, the coils are flash "vulcanized" while pressure is applied to them. The "vulcanizing" process consists of passing a high level of electrical current through the coil which generates sufficient heat to vulcanize the class "H" silicone rubber to the copper and to itself. This forms an excellent insulation system with good heat transfer properties, insuring cooler operation and moisture sealing.

To provide additional protection against moisture grounds, the coils are dipped in silicone varnish and then baked in a convection oven. This varnish also provides a smooth, dirt-repelling surface.

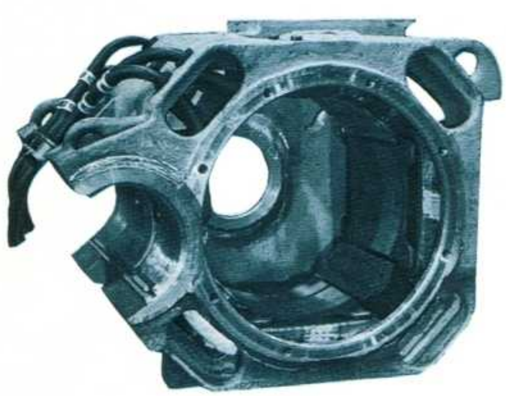
To verify the integrity of the insulation system, each coil undergoes a 6000-volt high potential test prior to being installed in the stator. This test is performed while the coil is pressed together under very high pressure, simulating actual motor installation conditions.

To insure good commutation and minimize arcing at the brushes, the main field and interpole coils must be accurately spaced and positioned in the stator frame. To accomplish this, one field coil is pre-set in the frame and precision gauges are then used to locate the other poles with respect to it. The poles are then bolted to the frame clamping the coil with sufficient pressure to prevent any movement due to mechanical vibrations or magnetic forces.

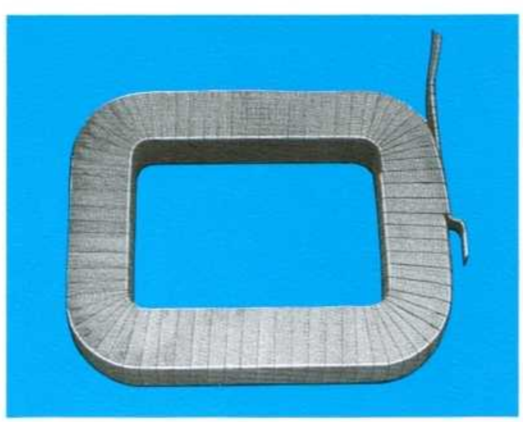
Electrical connections within the stator are brazed to provide both good electrical contact and mechanical strength.

The installation of full length extruded baffles in the stator directs the cooling air over the main field and interpole coils allowing motor operation at higher continuous ratings with low temperatures.

Interpole Coil



Stator



Main Field Coil

Armature

The armature core is constructed of laminated electrical grade silicon sheet steel. The main winding of the armature consists of 67 coils. Each coil is made up of three conductor straps. The manner in which the D29 armature coils are installed and electrically interconnected is commonly known as a wave winding. The advantage of the wave type of coil winding is that it effectively eliminates circulating currents and, consequently, excessive sparking at the commutator brushes.

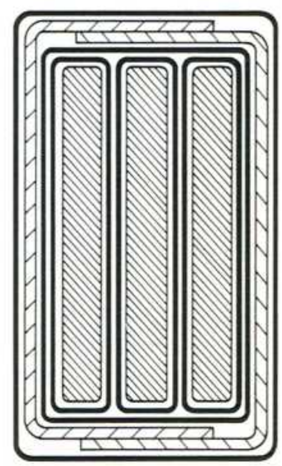
Prior to installation in the armature, each coil undergoes a comprehensive insulation sequence, consisting of the following processes. First, each individual copper strap is taped with silicone-bonded glass and mica tape and then coated with modified silicone varnish. The three conductor straps are then taped together, again using the silicone-bonded glass and mica tape. Two tight-fitting interlocking Nomex* channels are placed over the core slot section of the coil. The final step in the coil insulation process is the application of fiberglass tape over the entire coil length. Polyester varnish is applied over this tape to seal the laps and the coil is then hot and cold pressed to produce a tough, moisture proof jacket with maximum insulating quality, heat transfer, stability and life.

After the insulation process is complete, the coils are installed in the armature core and electrical connections made by TIG welding at the commutator riser.

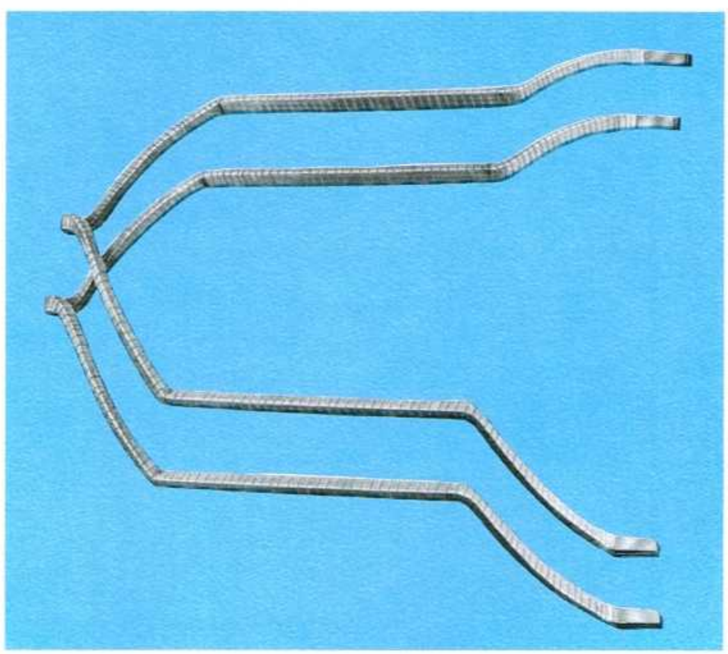
Each armature is dynamically balanced to provide a vibration-free operation and, therefore, increased motor life. With vibration-free operation, the bearings will last longer and the insulation used in the motor is subjected to a reduced level of chafing.

The D29 traction motor is designed to operate at a relatively low armature speed – approximately 2260 rpm. This low armature speed operation results in less brush wear, reduced risk of flashover and maximum bearing life.

Armature



Coil Insulation Cross-Section



Armature Coils

*DuPont Registered Trademark

Commutator

The commutator assembly is made up of copper bars separated by segments of inorganic bonded mica. These commutator bars and insulating segments are held firmly in place by pressure V-rings bolted together.

Insulating Nomex V-rings are installed between the steel V-rings and the commutator bars. The Nomex V-ring is made of paper-like sheets of many small aramid fibers, bonded together with polyimide varnish. The outstanding characteristic of this material is its uniform density which not only loads the commutator bars more evenly but does not compress under pressure. The resulting commutator surface is extremely stable providing both excellent commutation and a long service life.

A glass string band is applied over the Nomex V-ring to add mechanical strength to the retention of the Nomex V-ring.

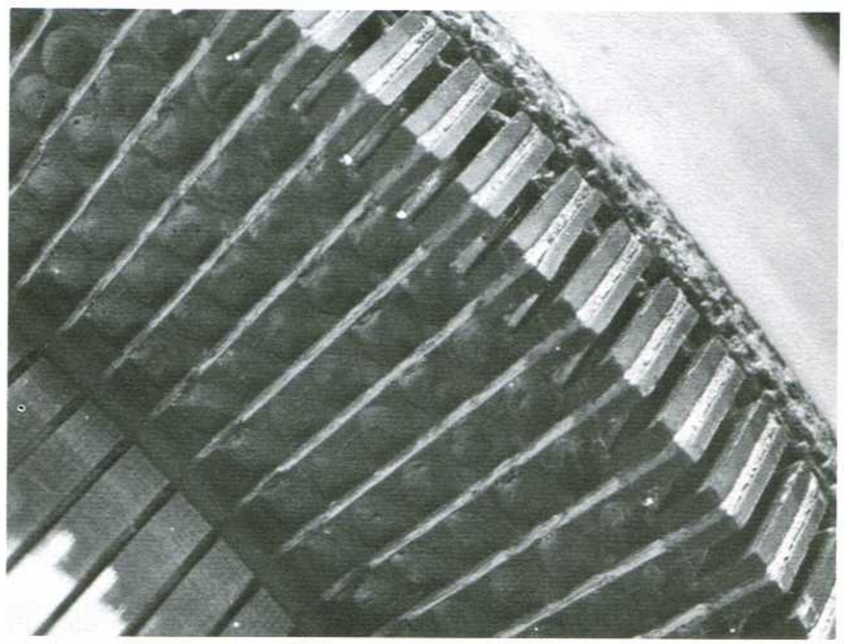
Each commutator is press-tightened and then subjected to an oven "seasoning" process. The temperature of the commutator is cycled up and down to cause the copper bars to seat securely and provide a stable commutator profile. As a part of the "seasoning" process, the commutator is also carefully diamond turned to provide a smooth brush riding surface eliminating the deteriorating effects of brush bounce and maximizing brush life.

Brush wear results in carbon dust deposits which tend to collect at the end of the commutator bars. Should any substantial quantity of these deposits exist, electrical bar-to-bar shorts can result. To prevent the collection of these deposits, the glass string band is coated with epoxy providing a smooth, arc-resistant and dirt-resistant surface. This also provides an effective seal at the string band to bar junction.

Since the connection between the armature coil lead and the commutator riser is a critical area in a traction motor, this connection is TIG (Tungsten Inert Gas) welded. In the past, when solder was used to make this connection, the motor rating was dependent on the melting point of solder since short time overloads could cause solder melting and shorts. The TIG welding process not only eliminates this problem, but also provides a strong, low-resistance connection.

Because TIG welding involves fusion of the copper in the coils and the commutator bars, the connections have the same electrical characteristics as the coil straps themselves. The heat of fusion is created by an electric arc between a Tungsten electrode and the copper bars under cover of an inert gas envelope to exclude oxygen.

Commutator



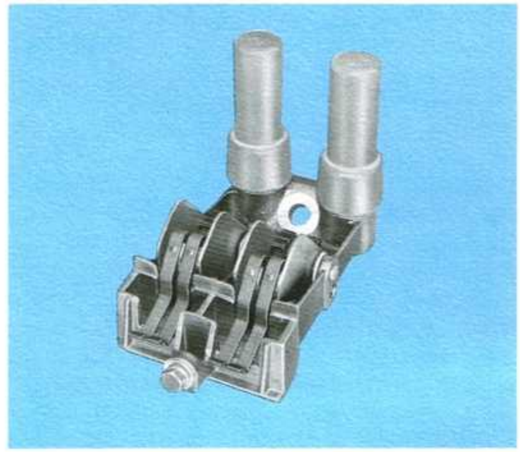
TIG Welding

Brushgear

Brushes

Four brush holders are bolted to the stator housing at 90° intervals around the commutator. Two brushes are installed in each holder. The polyester insulated brush holder studs are covered with a silicone rubber boot and are unusually resistant to flashover damage. Constant pressure throughout the brush life, resulting in a smooth brush ride, is provided by the constant pressure spring cell.

The flexibility of the resilient-pad, three-wafer, rubber-topped carbon brush allows the brush to follow the commutator more closely with minimum sparking. In addition, the extra wafer space of the three wafer brush aids commutation by minimizing brush circulating currents.

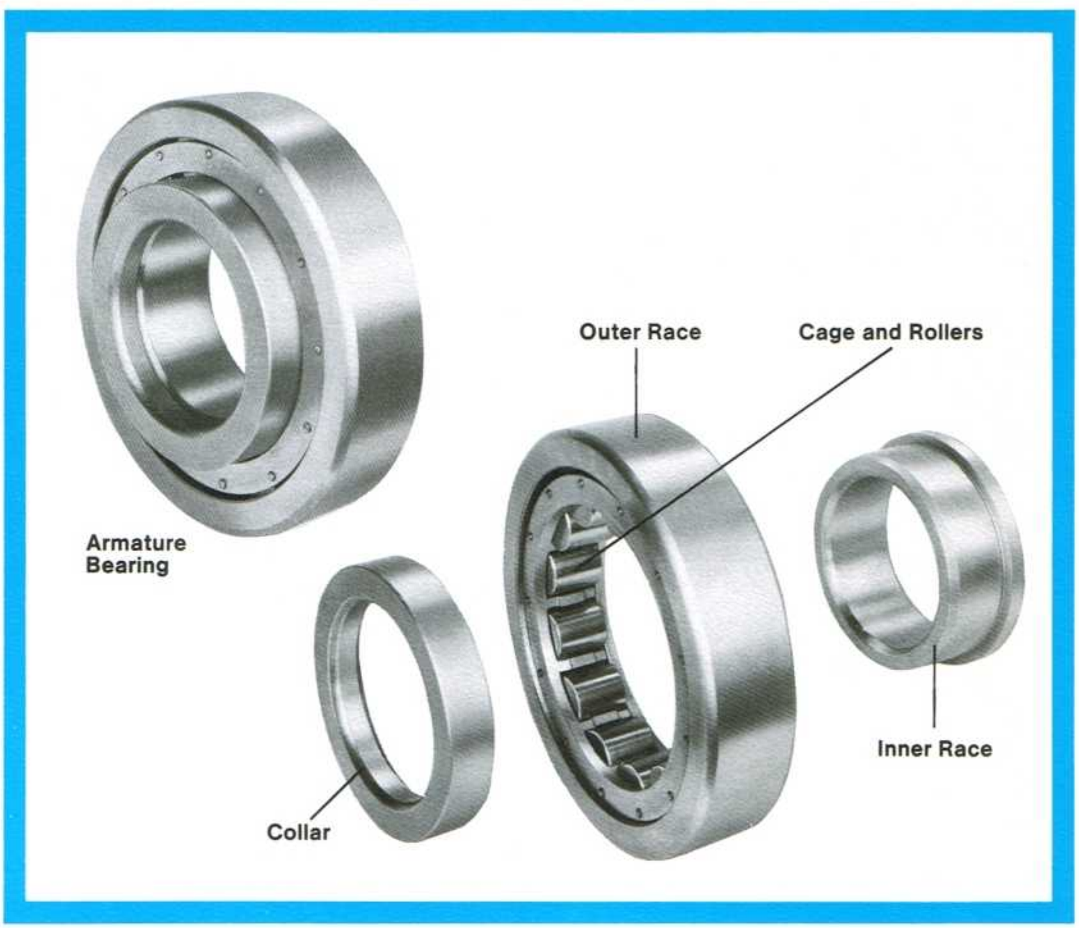


Brush Holder

Bearings

Electro-Motive's design engineers selected precision, proven-design, roller bearings to provide the critical function of armature support. A cylindrical roller bearing is used at both the pinion end and the commutator end of the D29. These high quality bearings consist of an inner race, an outer race, and crowned rollers mounted in a roller-riding riveted brass cage. Sized for long fatigue life, these bearings have experienced years of dependable performance.

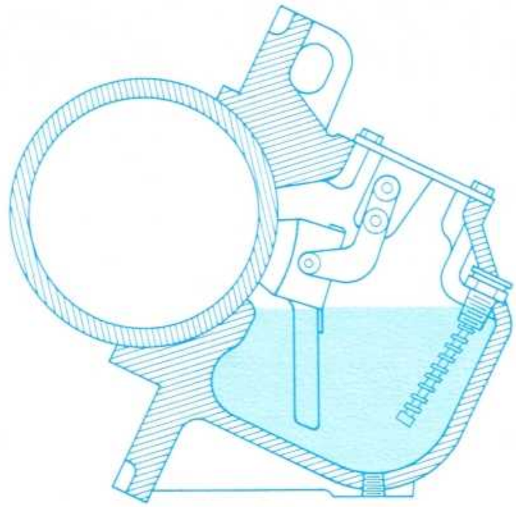
An important factor to determining bearing life is lubrication. To obtain the maximum bearing life, the D29 traction motor employs a sealed grease lubrication system utilizing a lithium-base grease which exhibits a high temperature capability and is highly resistant to both softening and water dilution.

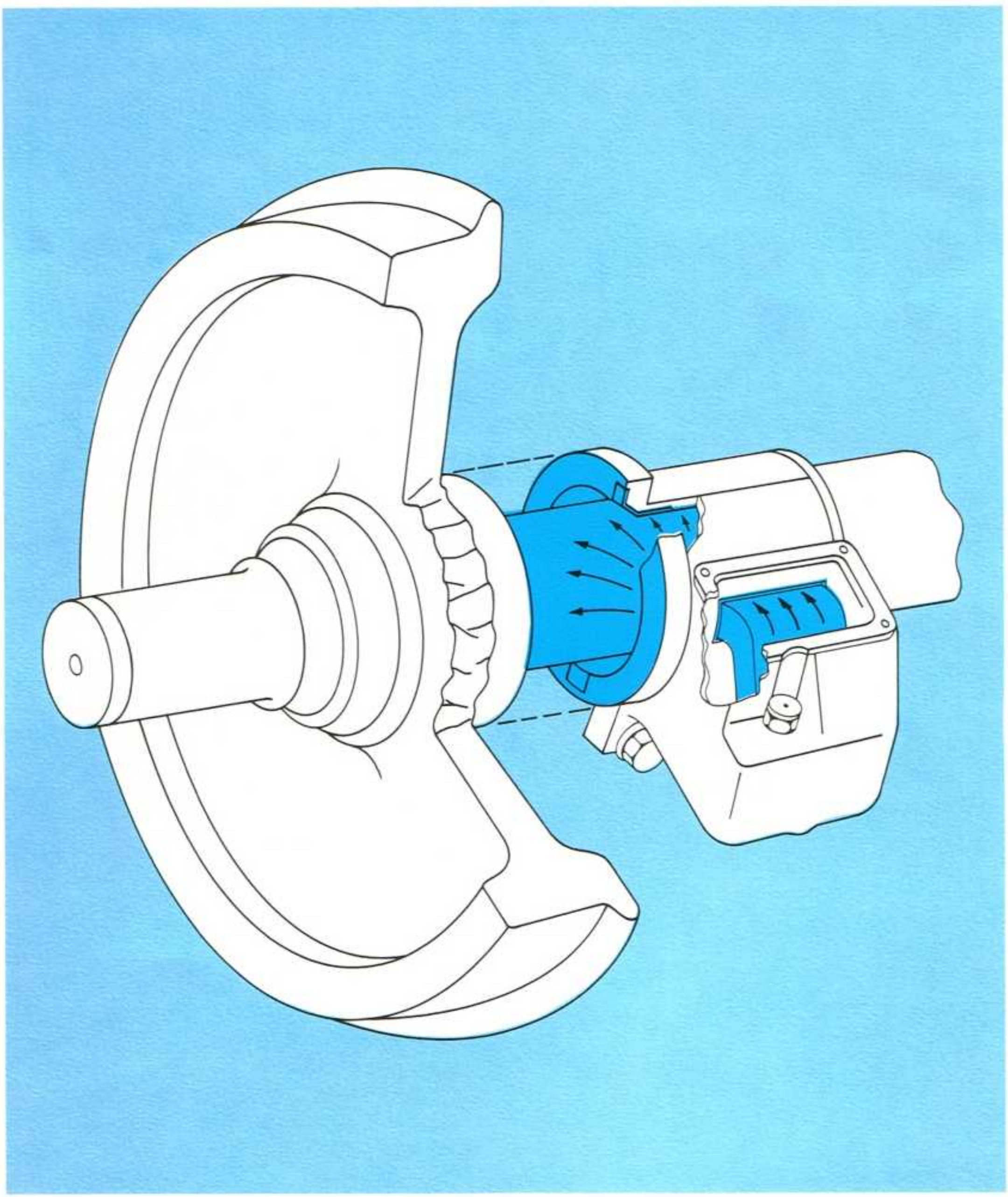


Support Bearings

The critical feature of the traction motor support bearing is lubrication. A long life wick type oil lubricator using high capillary action felt provides this critical lubrication. The brass support bearing has a window allowing a generous wick contact area while at the same time providing the necessary support bearing surface area. In addition, the support bearing contains felt flange lubricators to extend flange life.

The lubricating oil well is part of the axle cap itself. An oil filler for the well is located on the side of the axle cap. The hingeless oil filler cap is made of high impact polycarbonate. A positive, leakproof seal between the O-ring and the filler neck is provided by the snap-back action of the spring-loaded cap.





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