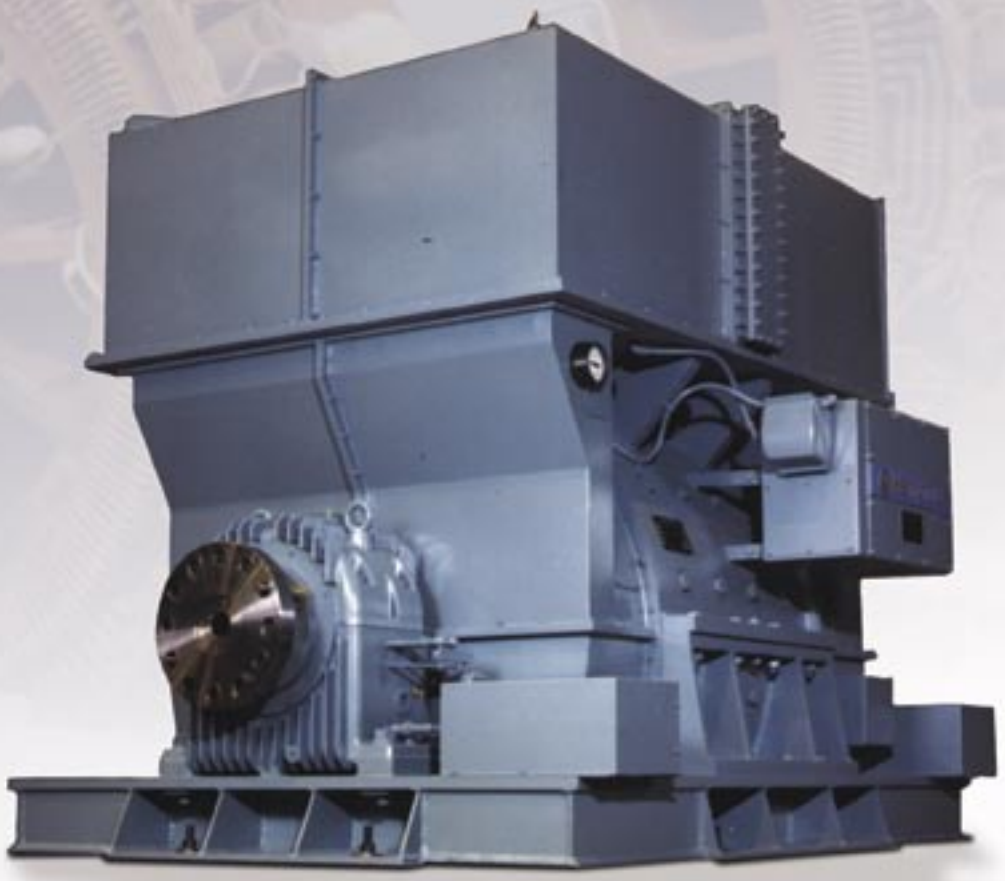
DC MOTORS



TECO Westinghouse

ANSI-RAB QMS ACCREDITED

SYSTEM CERTIFICATION ISO 9001:2000 SGS

TECO-Westinghouse Motor Company DC Motors

TECO-Westinghouse Experience: A Legacy of Leadership

The TECO-Westinghouse legacy of innovation and quality in the design and production of electric motors spans more than a century. Since 1888, when Westinghouse first manufactured direct-current motors, we have led the industry in pioneering new applications and technologies. The company's advances in the field of DC motors can be traced through the parallel growth of the nation's steel manufacturing, mining and shipbuilding industries, which require the benefits of large-scale motors with high torque and variable speed. **TECO-Westinghouse Motor Company** DC motors and generators combine time-tested performance with superior features that satisfy the demanding needs of these industries today. Building on the achievements of George Westinghouse at the turn of the century, we continue to set the standard for engineering excellence, technological innovation and product reliability.

1 First reversing electric mill motor

Westinghouse Innovation: A History of Firsts

Our presence as a world leader in the engineering and production of DC motors is built upon a distinguished record of pioneering achievements in the steel and mining industries.

Working with the steel industry, Westinghouse developed and installed the:

- first electric motors in an American steel mill (1891)
- first electric drive for main rolls
- first reversing mill drive
- first large twin-motor reversing mill drive

Some of our significant achievements in the mining industry include the:

- first application of separately excited shunt-wound DC motors
- first Ward Leonard dragline system
- first vertical swing motors
- first laminated frame generators
- first dual circuit generator system

Perpetuating a proud tradition, **TECO-Westinghouse** has continued through the years to refine our DC motor product lines with quality-enhancing features that secure our position of leadership within the market.

Experience-Based, Computer-Aided Precision

A key to **TECO-Westinghouse Motor Company's** distinguished record of innovation in design engineering is our Engineering Department's use of sophisticated computer equipment and design tools. Our programs draw upon four decades of computer-aided design and analysis, allowing our engineers to quickly optimize the design of every motor or generator for the highest operating efficiency. This depth of engineering expertise, coupled with advanced computer technology, accounts for the high levels of performance and precision for which our DC machines are known today.

Commitment to Quality

TECO-Westinghouse Motor Company's position of industry leadership comes from an uncompromising commitment to quality manufacturing and customer service. At our U.S. headquarters in Round Rock, Texas, electrical and mechanical engineering teams develop precision design and manufacturing specifications for each order. Our DC motors are then manufactured in total compliance with these exact requirements. Thorough testing of every DC motor we build is conducted at our manufacturing plant in Round Rock. Our test facility is one of the most advanced in the world. The result is a high standard of quality control that reinforces our manufacturing excellence.

1 Small motor test facility

2 Large motor test facility

DC Motors Designed for Your Application

DC Motor Applications

TECO-Westinghouse Motor Company DC motors are ideally suited to a multitude of industrial and marine applications in which high torque and variable speed are required. These applications include ship propulsion, mine hoists and steel rolling mills. They also drive many other types of industrial equipment such as fan drives, Banbury mixers and extruders.

To meet the needs of a broad range of applications, our rugged DC motors are available in sizes ranging from 12-inch to 12-foot armature diameters, with available power ratings up to approximately 35,000 horsepower.

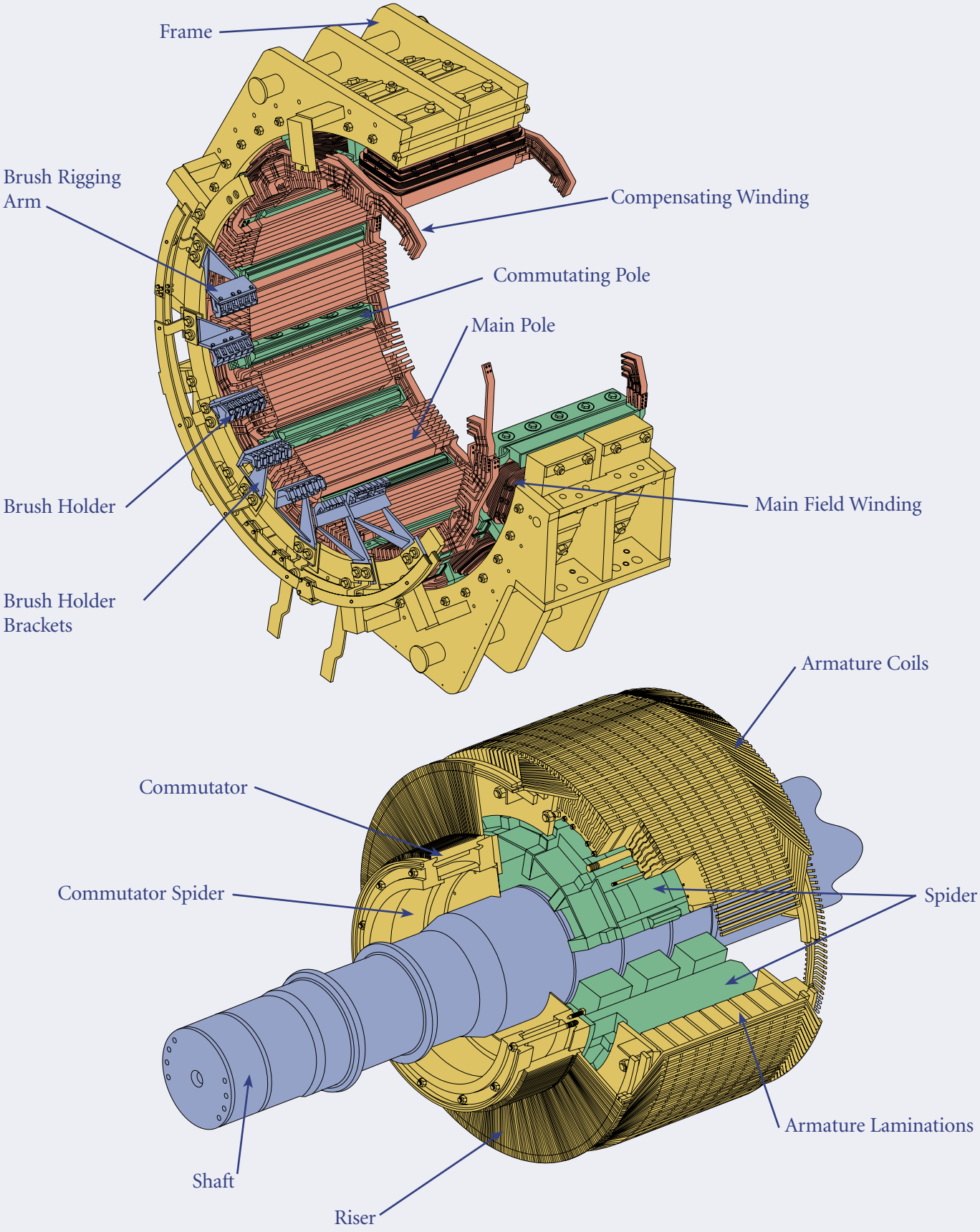
Custom Designs as a Standard Feature

TECO-Westinghouse Motor Company DC motors are designed and built for long life and minimum maintenance. Over 100 years of motor industry experience has yielded design features that add up to precision, performance and reliability.

TECO-Westinghouse Motor Company offers drop-in-replacements, uprate motors, as well as universal replacement motors with multiple ratings that can be used at various locations in the same mill.

TECO-Westinghouse Motor Company has over 400,000 **Westinghouse** and **TECO-Westinghouse** motor designs on file. We have the information to design and manufacture armature and stator replacements for your TWMC motors, and motors from other manufacturers as well.

Our DC motors and generators are custom designed to meet your specific needs. We can incorporate existing foundations, space limitations, service conditions and enhanced sparing capabilities into our motor and generator designs. In addition, TWMC DC machines can be applied to any quality brand of controls with total confidence.


Frame
Brush Rigging Arm
Compensating Winding
Commutating Pole
Main Pole
Brush Holder
Main Field Winding
Brush Holder Brackets
Armature Coils
Commutator
Commutator Spider
Spider
Armature Laminations
Shaft
Riser

Motor Configurations

Bracket-Type

Bracket-type motors have their bearings mounted in a bracket that is attached to the motor frame. These primarily employ grease lubricated cylindrical roller bearings and do not require bedplates. The end covers are removable for easy access.

Pedestal-Type

Most large DC motors use the pedestal type of construction, which includes a bedplate on which the stator frame and bearing pedestals are mounted. The bedplate maintains the alignment between the armature and stator. A portion of the motor frame extends below the bedplate, and therefore, requires a pit under the motor. Removable end covers allow easier access than bracket-type configurations.

1 Heavy duty stator components

Technical Features

Proven Features that Provide Impressive Performance

All **TECO-Westinghouse Motor Company** DC Motors incorporate features that distinguish them from competing products and set the standards by which other motors are measured:

Heavy-Duty Stator Components

TECO-Westinghouse Motor Company stators are designed and built to provide exceptional performance and outstanding reliability. The main poles and commutating poles are all laminated to assure quick response to speed and load changes. Our full-length commutating poles lower the reactance voltage, and compensating windings provide proper compensation for armature reaction. Stator end connection joints are TIG-welded together for maximum strength. Compensating winding straps are individually bolted at the centerline split to allow quick removal of the top half of the stator. All stator electrical conductors are made from copper.

Armature Coils

Laminated, rectangular copper conductors are individually insulated and bonded together with separators. The formed, full coils are wrapped and taped with ground wall insulation. A protective binding of tape then covers the complete coil. After winding, multiple coats of insulating resin are applied to create a smooth surface that resists rust, moisture, chemical contamination and heat.

Thermalastic® Insulation

Used in thousands of **TECO-Westinghouse** motors in the field since its introduction, Thermalastic® Insulation has proven to be the industry's premier insulation system. Due to its unique structure, the dielectric material is locked in a stable elastic bond to form a barrier that withstands prolonged voltage stress, moisture, abrasion, dirt and thermal cycling. Thermalastic® Insulation is chemically stable in the most severe environments, making it well suited for the most rigorous applications of our DC motor coil insulation. For less demanding DC applications, other insulation systems are available.

Superior Banding and Wedging

In a unique **TECO-Westinghouse**-developed glass banding process, polyester-treated glass tape is applied to the armature coil end-turns under controlled tension and temperature. This process creates solid, high-strength, pre-tensioned bands that restrict coil movement under the forces encountered in service.

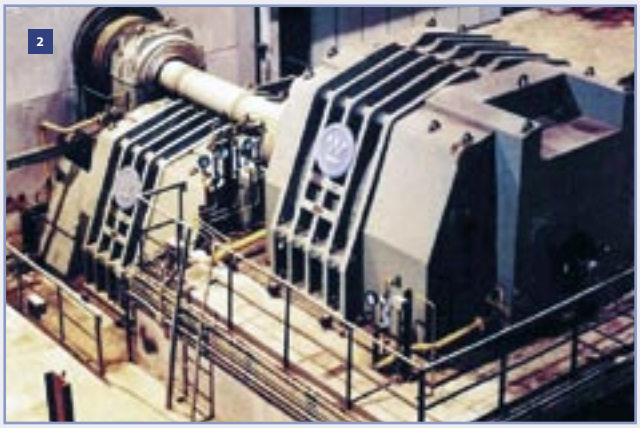
TECO-Westinghouse armature wedge designs prevent coil movement in the core and assure excellent coil heat transfer. Narrow, flush wedges allow unimpeded airflow along the air gap, and wedging eliminates the reduction of rotor heat dissipating surfaces that would normally be associated with core banding.

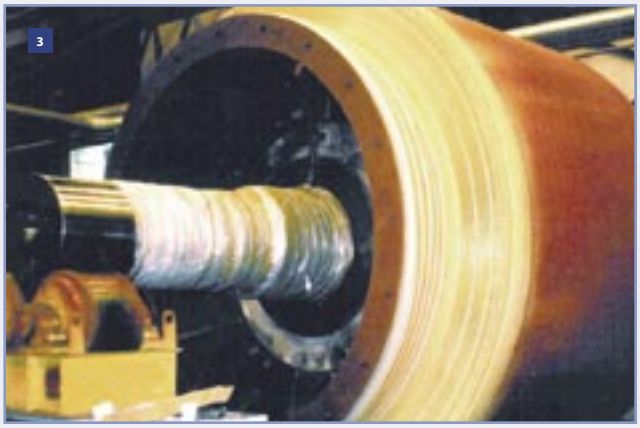
Multiple Armatures

Depending upon your specific application, **TECO-Westinghouse Motor Company** can provide double, or even triple, armature motors designed to deliver the required torque while minimizing the inertia of the drive train. A special two bearing, double armature is available in some sizes that offers low inertia while being very compact. Also available are twin drive configurations.

TIG Welded Connections

Tungsten inert gas (TIG) welding is used to connect armature coils to the commutator risers and the inner pole and pole face winding connections. This method of joining copper to copper produces a connection that has high strength, is low in resistance and is free of oxides, thereby assuring electrical, mechanical and thermal superiority.





1 Four two-bearing, tandem mill motors in the various stages of manufacturing

2 Twin drive configuration

3 Exclusive (Digard®) insulation

High Fatigue Strength Risers

Today's **TECO-Westinghouse** DC motor line features a special copper alloy riser that has superior fatigue strength as compared to conventional copper. Each riser is fitted with several rows of glass-fiber vibration dampers. These special features, along with the overhung commutator design, virtually eliminate riser failures.

Digard® Insulation

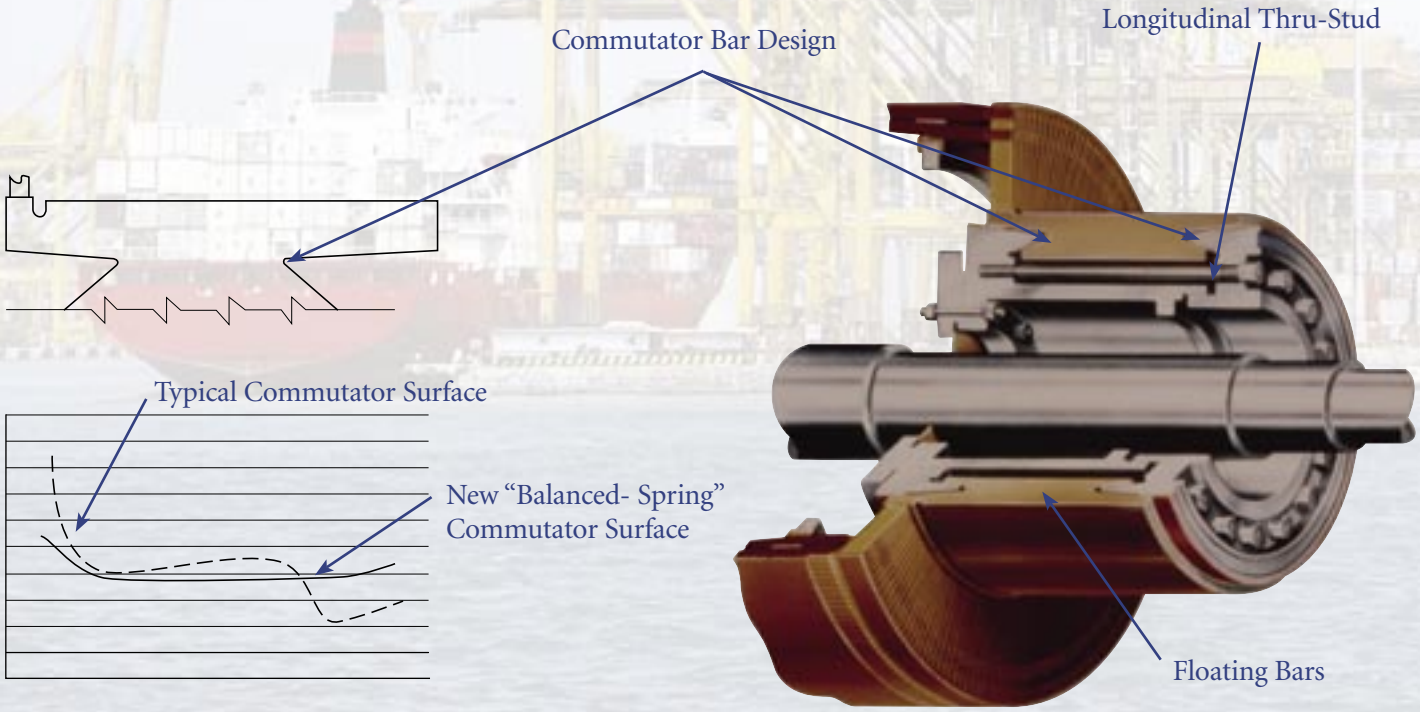
Digard® is a specially developed epoxy powder used on the commutator. The electrostatically applied powder is preferentially attracted to the riser edges. As a result, the insulating material is actually thicker at critical edge areas. This coating is applied to all the critical areas when the armature is hot, allowing the powder to melt and flow. This smooth, void-free surface provides long creepage paths and prevents carbon dust from adhering, thus eliminating the major cause of low insulation resistance in DC machines.

High-Efficiency Brush Holders

Massive reaction-type brush holders assure constant tension over the life of the brush with the use of a negator-type spring. The holders also include quick disconnect shunts and a brush wear indicator. The brushes used in these holders are multi-wafered and feature special vibration damping pads to provide optimum commutation even under the most severe operating conditions. Radial brush holders with the same features are used on reversing motors.

Arch-Bound, V-Ring, "Balanced Spring" Commutators

Our V-ring commutators feature true arch-bound construction with fully centered "floating" bars to ensure concentricity and eliminate distortion. The major "spring-like" commutator components, such as V-rings, copper overhangs and underhangs and thru-studs are specifically designed to assure pure uniform radial motion of the commutator bars at operating speed and temperature. This "balanced-spring" feature provides a smooth, brush-riding surface under thermal and centrifugal forces, thus assuring maximum brush life. Longitudinal thru-studs permit a convenient check for commutator tightness. All commutators are fully seasoned at rotational speeds.



Ruggedly Built Spiders

The spider structure, which transmits torque from the armature laminations to the shaft, is offered in a number of different configurations.

Welded arm shafts, with laminations and end plates shrunk onto the spider arms, are used for the smaller machines. Hub-type spiders with ring-type laminations are employed in the medium sized machines. In all cases, spider arms are secured to the hub rings with a fail-safe weld that penetrates the surface of the hub at the spider arm interface.

Larger hub-type assemblies use segmental punchings and armature cores built on thru-studs. Dovetail-type spiders, used in the largest DC motors, feature dovetail slots machined into the hub and reinforced by heavy steel gussets. All of the spider designs can be supplied with a special hydraulic shaft removal and installation feature.

Precision-Machined Shafts

Our motor shafts are designed and machined for unsurpassed precision and reliability. They are forged out of low or medium carbon steel to meet a full spectrum of loading conditions and feature a smooth finish and contours to ensure minimum stress concentration.

Self-Aligning Bearings

The self-aligning, spherical seat bearings utilized on **TECO-Westinghouse Motor Company** DC motors are designed and engineered for continuous, reliable performance and easy maintenance. The bearing caps are removable and the bearing is split for easy inspection. The bearing units provide excellent heat transfer from babbitt to oil and to the pedestal. Oil ring lubrication is simple, effective and trouble-free.

When required, these bearings are also offered with internal disc lubrication or forced lubrication. Where special low friction is required or for continuous operation at very low speeds, a hydrostatic lift can be supplied. A number of surface configurations are available depending on the magnitude of the thrust force.

Keyless Couplings

TECO-Westinghouse pioneered the use of keyless couplings, and thus, eliminated the problems of slippage under heavy torque, which is often associated with key-type couplings. Our keyless couplings are shrunk on the shaft with high-interference fits that provide a strong bond. Special fittings and grooves allow the couplings to be removed and even installed using hydraulic pressure. Key-type couplings can be designed where specific applications require them.

1 Rugged spider designs

2 Self-aligning bearings

Cross-Connections

With equalizer connections located at the rear of the armature, they are readily accessible and kept free from carbon dust generated at the commutator. This positioning also places connections in the most effective electrical location. Cross-connection conductors are fastened securely to an insulated steel rind, that holds the connections in place and prevents failure from fatigue or centrifugal force. TWMC also offer windings that are self-equalized without external connections.

Sturdy Frame Construction

Our large DC motors feature laminated steel frames for faster response and exceptional electrical performance. The commutation flux more easily follows the rapid changes in load current, resulting in better commutation. The lower frame time constant allows voltage changes to respond more quickly to regulator demands.

A variety of frame types are offered. Either bracket, stand-up solid, or stand-up laminated frame types are available depending on machine size and application. Each of these frame types is specifically engineered to ensure optimum flux carrying capability, while providing adequate strength to transfer torque to the foundation and to hold its shape under magnetic forces.

Split-frame construction enhances the maintainability of our DC machines. The top half of the frame can be removed for thorough cleaning, inspection, and quick access to all internal parts without disturbing motor alignment.

Integral Ventilation

In applications that require forced ventilation equipment constructed integrally with the DC motor, the **TECO-Westinghouse Motor Company** provides the integral ventilated motor system, which features a top-mounted, air-to-water heat exchanger along with a motor driven blower and filters. The system circulates cooling air at all times, independent of the motor's speed and load.

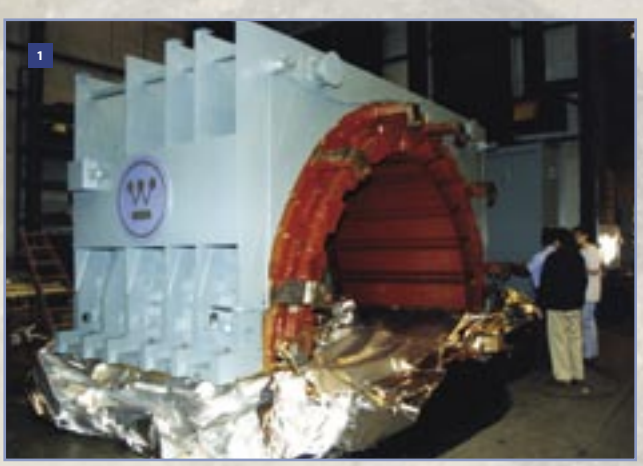
As in all **TECO-Westinghouse** DC motors, the air flow is directed from rear to front, blowing air over the commutator and carrying carbon dust from the brushes out of the motor.

Lift-Off End Covers

The end covers on **TECO-Westinghouse Motor Company** DC motors can be lifted completely away, allowing easy access for inspection, cleaning and maintenance. Guides are provided to insure proper fit and compression of the sealing gaskets between the end cover and the frame. Large doors are provided on the end covers for routine inspection and minor maintenance.

Rigid - Support Bedplates

Our DC motor bedplates are fabricated from H-beams and top plates, which offer significant rigidity and a smooth, machined surface to mount the motor. There is ample capacity available for grouting and heavy-duty foundation bolts are used to resist vibration.



1 Rugged split stator frame assembly

DC Motor applications

Rolling Mill Motors

Used in the steel and aluminum industries, rolling mill motors generally operate at low speeds and are designed for constant torque with a speed range of up to 4:1. Some applications include cold mills, hot strip mills, steckel mills, bar mills, rod mills, etc.

Mine Hoists

Mine Hoist transfer products and people from deep mines to the surface. They can be overhung from the hoist drum or fitted with supporting bearings.

Industrial Duty Motors

Industrial duty motors are typically used for fan drives, Banbury mixers, extruders and other applications that require high torque or speed variability.

Ship Propulsion

The demanding applications for **TECO-Westinghouse Motor Company** DC propulsion motors and generators include ice breakers, submarines, tugboats, mine sweepers, seagoing dredges and oceanographic vessels. Three classes of marine propulsion motors are offered. Our class one motors have many unique, heavy-duty features and provide special super-quite operation. These have been manufactured for use on Navy vessels and fisheries research vessels.

Special Applications

Special Applications include balance-machine drives, dynamic flight simulators, dynamometers or any application requiring high-torque, fast acceleration and low or variable speed.

1 Dynamic flight simulator

2 Propulsion motor

3 Cold mill motors

4 Marine applications

Compare the Quality Features and Time-Tested Performance of TECO-Westinghouse Motor Company DC Motors

- High Efficiency designs reduce life cycle costs
- Advanced insulation systems protect against moisture, dust, heat and contamination
- Critical area electrostatic coating provides long creepage paths
- High temperature rise capabilities offer cost economies
- V-ring, "balance spring," commutator ensures concentricity and prevents distortion
- High fatigue strength risers increase reliability
- Lift-away end covers improve accessibility
- Ruggedly built spiders smoothly transmit torque
- Integral ventilation package available to continuously circulate cooling air
- Keyless couplings eliminate inherent disadvantages of key ways
- Rigid-support, accurately machined bedplates ensure stability
- Armature wedges and banding assure excellent coil ventilation and accessibility
- Heavy-duty stators offer outstanding reliability
- Bearings with self-aligning, spherical seats provide excellent heat transfer
- Rear-mounted cross connections provide accessibility and mechanical stability
- Fully laminated coils reduce eddy current loss
- Removable shafts available for both continuous and rapid reversing operation
- Wound-on-pole shunt fields assure excellent heat transfer
- Sturdy frames provide optimum flux carrying configurations
- Rear to front ventilation system provides maximum heat dissipation
- Motor drop-in-replacements can be manufactured to increase efficiencies with minimal production loss

TECO-Westinghouse Motor Company DC Motors: Redefining the Standard of Excellence

In **TECO-Westinghouse Motor Company** DC motors, the best of both innovative and time-proven technologies are optimally combined to ensure the maximum in reliable performance and value. Backed by over 100 years of design and manufacturing experience, and a worldwide field service network, **TECO-Westinghouse** DC motors are the logical choice for mill, marine, mining and industrial applications anywhere in the world.

We urge you to compare the features and performance histories of **TECO-Westinghouse** DC motors with those of other manufacturers. We are confident you will choose **TECO-Westinghouse** quality as your standard in meeting the demands of your application. For more information on our line of DC motors, or if your are in the market for a proven upgraded universal spare, contact your local **TECO-Westinghouse** representative, visit our website at **www.tecowestinghouse.com** or call **TECO-Westinghouse Motor Company** direct at our Round Rock, Texas headquarters:

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