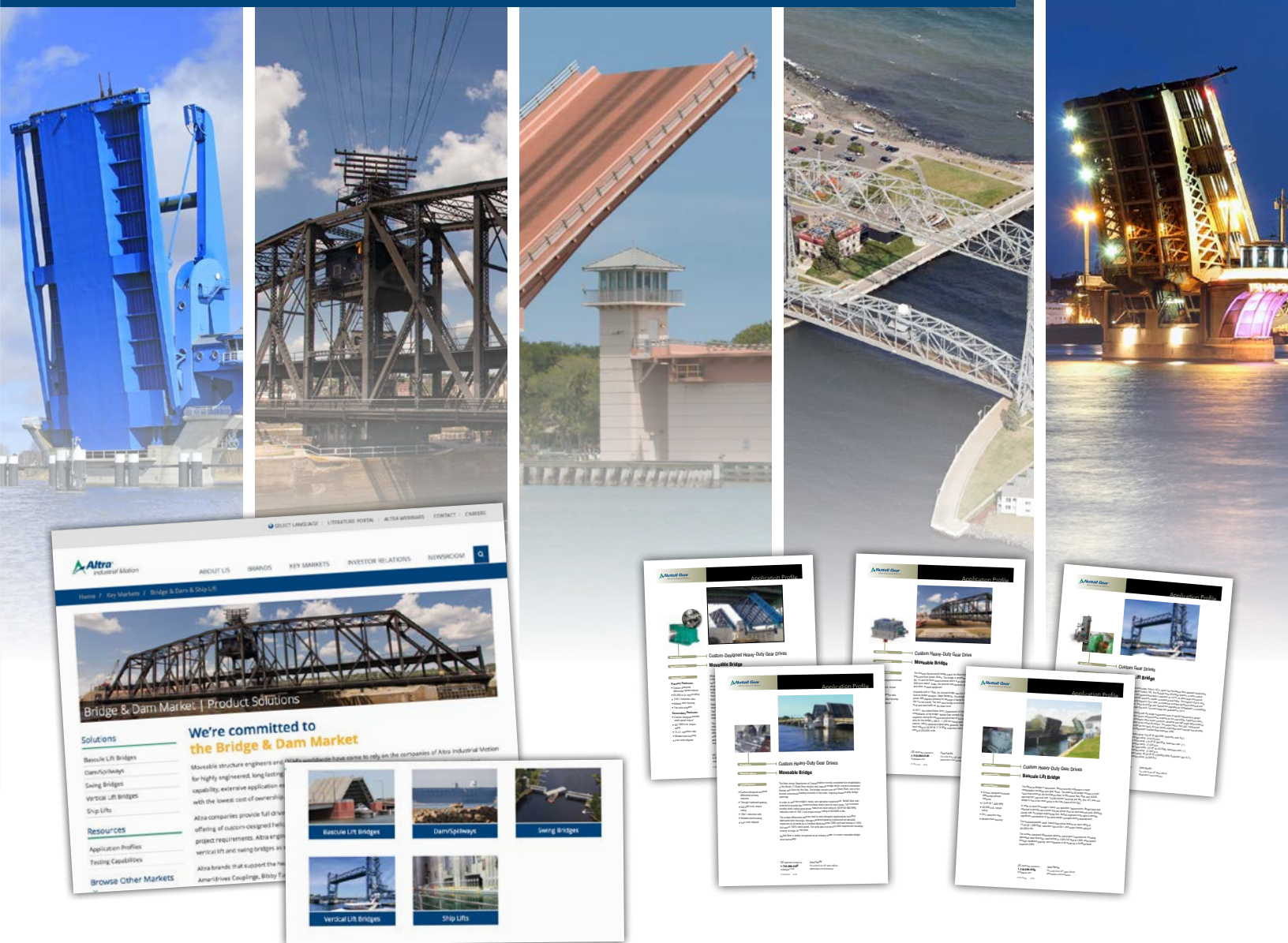


# Application Profiles

Custom Engineered and Manufactured Gearbox Solutions for Bridge Applications



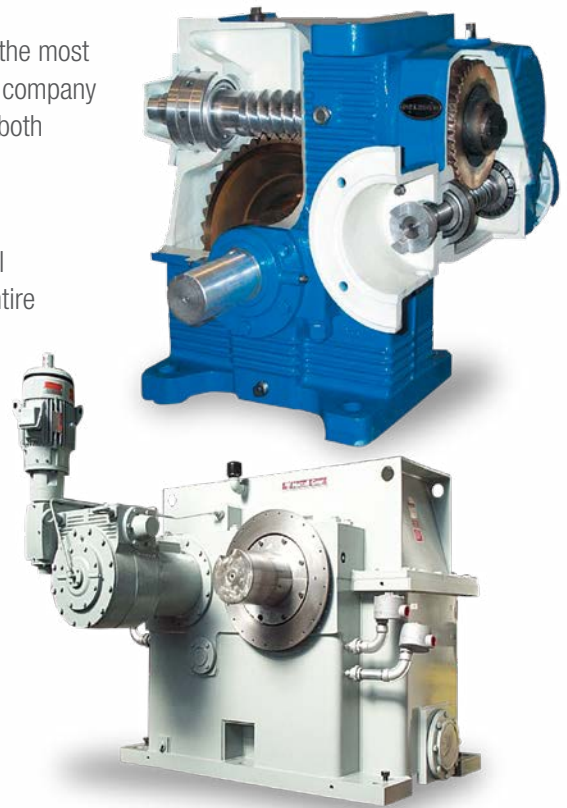
# Nuttall Gear

Founded in 1887, Nuttall Gear developed and introduced single helical gears, one of the most significant contributions to the field of gear engineering. Today, Nuttall is the premier company that specializes in providing complete custom packaged drive assemblies combining both mechanical and electrical components to meet specific customer requirements.

Nuttall designs and manufactures a variety of gearing solutions including vertical and horizontal drives, speed reducers and speed increasers, cast iron and fabricated steel housings and flange mounted and scoop mounted gearmotors. Nuttall can provide entire drive packages including reducer, motor mounted on a bedplate with couplings, coupling guards, backstops, chain and/or belt drives, clutches, shoe or disc brakes and auxiliary lubrication consoles.

Custom, heavy-duty Nuttall drives are utilized in a range of key markets including metals, pulp & paper, mining, textile, oil & gas on applications such as extruders, crushers, elevators, water screens, briquetting machines, de-barkers, conveyors, drawworks, recoilers/uncoilers and dredges.

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# Altra Industrial Motion

Altra is a leading global designer and manufacturer of quality power transmission and motion control products utilized on a wide variety of industrial drivetrain applications. Altra clutches and brakes, couplings, gearing and PT component product lines are marketed under the industries most well known manufacturing brands. Each brand is committed to the guiding principles of operational excellence, continuous improvement and customer satisfaction. Highly-engineered Altra solutions are sold in over 70 countries and utilized in a variety of major industrial markets, including food processing, material handling, packaging machinery, mining, energy, automotive, primary metals, turf and garden and many others.

Altra's leading brands include **Ameridrives**, **Bauer** Gear Motor, **Bibby** Turboflex, **Boston** Gear, **Delroyd** Worm Gear, **Formsprag** Clutch, **Guardian** Couplings, **Huco**, **Industrial** Clutch, **Inertia** Dynamics, **Kilian**, **Lamiflex** Couplings, **Marland** Clutch, **Matrix**, **Nuttall** Gear, **Stieber**, **Stromag**, **Svendborg** Brakes, **TB Wood's**, **Twiflex**, **Warner** Electric, **Warner** Linear and **Wichita** Clutch.

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# Table of Contents

## Nuttall Gear

Custom Heavy-Duty Gear Drives for the Hamilton Ave. Bridge.....	P-1934-NG
Custom Heavy-Duty Gear Drives for the Arsenal Bridge.....	P-7331-NG
Custom Heavy-Duty Gear Drives for the Route 71 Shark River Bridge .....	P-7332-NG
Custom Heavy-Duty Speed Reducers for the Bascule Lift Bridge .....	P-7517-NG
Custom Heavy-Duty Gear Drives for the Bascule Lift Bridge .....	P-7518-NG
Custom Speed Reducers for Swing Bridges .....	P-7519-NG
Custom Gear Drives for Vertical Lift Bridge.....	P-7634-NG
Hines Memorial Swing Bridge .....	P-7635-NG
Custom Reducers for Single Leaf Bascule Lift Bridge.....	P-7642-NG
Custom Heavy-Duty Speed Reducers for the Fort Street Bridge .....	P-7700-NG
Custom Gear Drives for the Park Boulevard Double-Leaf, Bascule Bridge.....	P-7701-NG
Custom Gearbox for Single-Leaf Bascule Bridge in South Bristol, Maine .....	P-8107-NG
Custom Gear Drive for the Robert Mathis Double-Leaf Bascule Bridge.....	P-8108-NG
Custom Gearboxes for the Sarah Mildred Long Vertical Lift Bridge .....	P-8572-NG
Custom Gearboxes for the Burlington Canal Vertical Lift Bridge .....	P-8574-NG
Custom Heavy-Duty Gearboxes for the Lindsey Warren Swing Bridge .....	P-8576-NG
Custom Gear Drives for Vertical Lift Rail Bridge .....	P-8577-NG

## Corporate

Folsom Lake Spillway Flood Gates.....	P-7644-C
Custom Gear Drives for Rail Swing Bridges .....	P-8578-C

## Nuttall Gear | Delroyd Worm Gear

Nuttall and Delroyd Line Card.....	P-1723-16-ND
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## Product

## Custom-Designed Heavy-Duty Gear Drives

## Application

## Moveable Bridge

### Highlights

#### Primary Reducer:

- Custom-designed differential speed reducer
- 65,000 in.lb. torque rating
- 19.8:1 reduction ratio
- Welded steel housing
- Two units shipped

#### Secondary Reducer:

- Custom-designed parallel shaft speed reducer
- 497,000 in.lb. torque rating
- 15.3:1 reduction ratio
- Welded steel housing
- Four units shipped

When replacing the Hamilton Avenue moveable bascule bridge over the Gowanus Canal in New York City, project engineers required a reliable, heavy-duty gear drive solution to function as the primary differential speed reducer and secondary reducers for the bridge drivetrains. There were many challenges associated with the complex skewed bascule bridge, all compounded by the fact that an eight-lane elevated expressway is located 30m over the bridge. Consisting of two single leaf, four-lane bascule bridges, the Hamilton Ave. bridge carries approximately 55,000 vehicles a day and opens around 900 times per year for marine traffic.

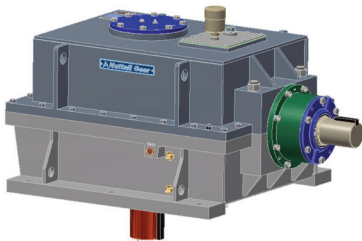
Nuttall engineers relied on their extensive application knowledge and experience to develop a custom gear drive solution that met the project specification requirements. The Nuttall enclosed parallel shaft helical gear drives feature welded steel housings for strength and durability. Units incorporate spiral bevel/helical gear combinations, custom shafts, special seals, and long-life bearings.

The two main drivetrains (one for each span), which included one primary differential reducer driving two secondary reducers, were shop-assembled, tested and delivered to the site as complete units. Power is provided by two electrical motors driving each differential (one of two operating at a time) which are coupled to the input shafts of the reducers. Torque of the reducer is equalized to two output shafts by internal differential gearing. Each shaft drives a secondary reducer. Auxiliary backup motors were also coupled to the reducers through a helical bevel right angle input.

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## Product

## Custom Heavy-Duty Gear Drive

## Application

## Moveable Bridge

### Highlights

- Custom-designed enclosed reducer
- 295,000 in.lb. torque rating
- 1.86:1 reduction ratio
- Fabricated steel housing
- One unit shipped

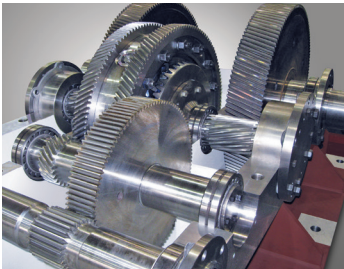
The Arsenal (Government) bridge spans the Mississippi River connecting Davenport, Iowa and Rock Island, Illinois. The bridge is positioned adjacent to Lock and Dam No. 15 and the Rock Island Arsenal which is an active US Army facility located on a 946-acre island. Today, the arsenal manufactures gun mounts, artillery carriages and other combat equipment.

Originally built in 1896, the Arsenal bridge was the first project engineered by world famous bridge designer, Ralph Modjeski. The bridge features a swing section that pivots 360 degrees allowing for passage of barge/boat river traffic (only one of two like it in the world). The twin-deck bridge accommodates two rail lines on the top level and road traffic on the lower level.

In 2011, the United States Army, Department of Defense completed an extensive rehabilitation of the bridge. Nuttall Gear worked closely with Modjeski & Masters engineers during the design/concept phase of the project to provide the custom gear drive for the bridge's 360 ft., 1,250 ton swing span. The unique Nuttall enclosed reducer, which replaced original open gearsets, features a fabricated steel housing, input rating of 30 HP @ 17.8 RPM, reduction ratio of 1.86:1 and output torque rating of 295,000 in.lbs.

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## Product

## Custom Heavy-Duty Gear Drives

## Application

## Moveable Bridge

### Highlights

- Custom-designed enclosed differential primary reducers
- Through-hardened gearing
- 504,000 in.lb. torque rating
- 160:1 reduction ratio
- Welded steel housing
- Two units shipped

The New Jersey Department of Transportation recently completed the rehabilitation of the Route 71 Shark River double-leaf, bascule bridge which connects downtown Belmar with Avon-by-the-Sea. The bridge crosses over the Shark River, one of the busiest commercial boating channels in the state, requiring frequent daily bridge openings.

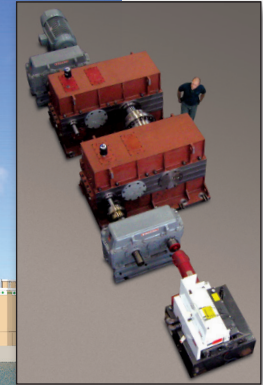
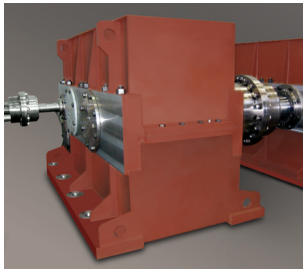
In order to meet the bridge's heavy-use operation requirements, Nuttall Gear was selected to provide two custom primary drives (one for each span). The enclosed parallel-shaft, helical gear drives feature an input rating of 30 HP @ 900 RPM, reduction ratio of 160:1 and output torque rating of 504,000 in.lbs.

The unique differential reducers had to meet stringent requirements including fabricated steel housings, through-hardened gearing (carburized not allowed), inspection of all welds by a Certified Weld Inspector (CWI) and load testing to 150% full load at 100% rated speed. The units also met the buy USA requirement including country of origin for the steel.

Nuttall Gear is widely recognized as an industry leader in custom moveable bridge drive technology.

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Reducers shown  
on test stand

## Product

## Custom Heavy-Duty Speed Reducers

## Application

## Bascule Lift Bridge

## Highlights

- Enclosed differential primary drives with a reduction ratio of 12.25:1
- Secondary parallel-shaft drives with a reduction ratio of 48.5:1
- Through-hardened gearing
- Fabricated steel housing
- All welds CWI inspected

Work is nearing completion on the new Ocean Ave. bridge that spans the intercoastal waterway in Lantana, Florida (West Palm Beach County). The bridge replaces the original span, built in 1950, which had reached the end of its service life with over 20,000 daily vehicle crossings. The bridge features a double-leaf bascule center span which opens to accommodate larger boats.

The bridge's center span will be 21 feet high (11 feet higher than the old bridge). This new height is projected to reduce the number of openings required for larger watercraft by nearly 40 percent. The 52" wide deck features two lanes for vehicular traffic as well as dual pedestrian walkways and cycle lanes.

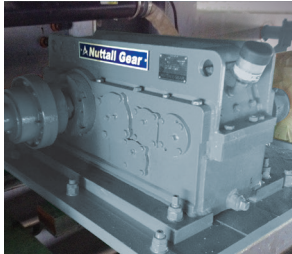
Nuttall Gear was chosen to provide custom primary drives (one for each leaf). The enclosed helical gear differential drives, with right-angle input shafts, feature input rating of 75 HP @ 1200 RPM, reduction ratio of 12.25:1 and output torque rating of 2,080 ft.lbs. Secondary, parallel-shaft reducers were also supplied with input rating of 37.5 HP @ 98 RPM, reduction ratio of 48.5:1 and output torque rating of 101,000 ft.lbs.

All the reducers feature fabricated steel housings, through-hardened gearing (carburized not allowed), inspection of all welds by a Certified Weld Inspector (CWI) and load testing to 200% full load at 100% rated speed. The units also met a "Buy USA" requirement including country of origin for the steel.

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## Product

## Custom Heavy-Duty Gear Drives

## Application

## Bascule Lift Bridge

### Highlights

- Custom-designed enclosed differential primary reducers
- 15 HP @ 1,800 RPM
- 40,000 in.lb. torque rating
- 50:1 reduction ratio
- Welded steel housing

The Blynman Bridge in Gloucester, Maine recently underwent a major rehabilitation including new gear drives. The bascule lift bridge crosses a small canal that connects the Annisquam River to Gloucester Bay. With over 8,000 openings per year and over 14,000 vehicle crossings per day, this 107-year-old bridge is one of the most active in the East Coast of the USA.

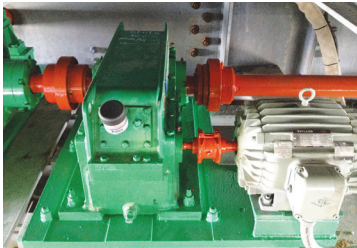
In order to meet the bridge's heavy-use operation requirements, Nuttall Gear was selected to provide two custom primary drives (one for each bascule leaf). Working closely with the bridge engineering firm, Nuttall engineers were able to provide significant contributions to the drive design concepts during development.

The enclosed parallel-shaft, helical gear drives feature an input rating of 15 HP @ 1,800 RPM, reduction ratio of 50:1 and output torque rating of 40,000 in.lbs.

The custom-designed differential reducers met project requirements including fabricated steel housings, load testing to 150% full load at 100% rated speed, through-hardened gearing, and inspection of all welds by a Certified Weld Inspector (CWI).

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## Product

## Custom Speed Reducers

## Application

## Swing Bridge

### Highlights

- Custom-designed enclosed reducers
- Four different drives were manufactured
- Fabricated steel housings

The Court Street bridge, built in 1908, spans the Hackensack River between Hackensack and Bogota and is one of the oldest bridges in Bergen County, New Jersey. A comprehensive 26-month rehabilitation of the vehicular two-lane, swing-style moveable bridge was completed in 2011. The bridge's swing-span section pivots 360 degrees allowing for passage of large barge and boat river traffic.

Nuttall Gear worked closely with the moveable bridge engineering team at Stafford Bandlow to design and manufacture four different enclosed drives for the bridge. The project had a "Buy USA" requirement (including country of origin for the steel). All units feature fabricated steel housings and all welds were inspected by an Independent Certified Weld Inspector (CWI).

- Span Drive Reducer: Input rating: 10 HP @ 870 RPM, Reduction ratio: 76.5:1, Output torque rating: 83,000 lb.in.
- End Wedge Reducer: Input rating: 7.5 HP @ 870 RPM, Reduction ratio: 450:1, Output torque rating: 367,000 lb.in.
- Center Wedge Assembly: Input rating: 1.5 HP @ 2.8 RPM, Reduction ratio: 1:1, Output torque rating: 51,000 lb.in.
- Center Wedge Reducer: Input rating: 1.5 HP @ 870 RPM, Reduction ratio: 309:1, Output torque rating: 51,000 lb.in.

Nuttall Gear was called to recondition and rehabilitate these gearboxes in the aftermath of Hurricane Sandy as the bridge drive mechanism was submerged due to flooding.

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## Product

## Custom Gear Drives

## Application

## Vertical Lift Bridge

### Highlights

- Custom-designed enclosed reducers
- Two duplicate sets of drives were required. Each set featured a primary, offsetting and right angle reducer
- Fabricated steel housings

The World War Memorial bridge, built in 1922, spans the Piscataqua River between Portsmouth, NH and Badger's Island in Kittery, ME. The through-truss lift bridge features a center vertical lift span that can be fully opened (providing a clearance of 130 ft.) to allow large commercial vessels to pass or partially raised for smaller recreational boat traffic. The original 1200 ft. long bridge was permanently closed in 2011 after an inspection revealed significant structural and mechanical problems. Since the bridge was deemed too degraded for rehabilitation, a completely new replacement bridge was built. The new bridge was dedicated in 2013.

Nuttall Gear worked closely with the bridge engineering team at HNTB Engineering to design and manufacture all the various enclosed drives required for the new bridge. Equipment rooms, containing matching drivetrains (each house a primary, offsetting and right angle speed reducer), are located on both sides of the center lift section. The project had a "Buy USA" requirement (including country of origin for the steel). All units feature fabricated steel housings and all welds were inspected by an Independent Certified Weld Inspector (CWI).

- Primary Reducers: Input rating: 250 HP @ 900 RPM, Reduction ratio: 60:1, Output torque rating: 819,230 lb.in.
- Offsetting Reducers: Input rating: 125 HP @ 900 RPM, Reduction ratio: 2:1, Output torque rating: 27,000 lb.in.
- Right Angle Reducers: Input rating: 125 HP @ 450 RPM, Reduction ratio: 1:1, Output torque rating: 27,000 lb.in.
- Auxiliary Reducer: Input rating: 40/20 HP @ 1200/600 RPM, Reduction ratio: 6.2:1, Output torque rating: 20,566 lb.in.

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## Product



## Application

## Custom-Designed Gear Drives

## Highlights

- Custom-designed enclosed reducers
- Four different drives were manufactured
- Fabricated steel housings

## Swing Bridge

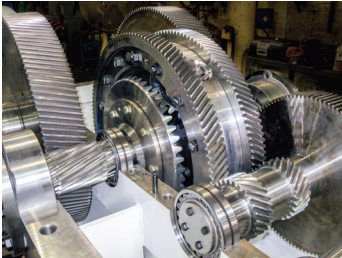
Originally built in 1882, the Hines Memorial bridge crosses over the Merrimack River between Amesbury and Salisbury, MA. The bridge features a swing span section which pivots to allow passage of barge and boat river traffic. The Massachusetts Dept. of Transportation commissioned a comprehensive redesign and rebuild of the bridge which was completed in 2012. The project included the replacement of two approach spans and the center swing span superstructures as well as the electrical and mechanical systems.

Nuttall Gear worked with BRH Engineering to develop conceptual designs for bridge's new gearboxes. Once approved, Nuttall manufactured four different enclosed drives. All units featured fabricated steel housings and all welds were inspected by an Independent Certified Weld Inspector (CWI).

- Primary Drive Reducer: Input rating: 7.5 HP @ 1170 RPM, Reduction ratio: 175:1, Output torque rating: 103,000 lb.in.
- Auxiliary Reducer: Input rating: 1.5 HP @ 1200 RPM, Reduction ratio: 5.06:1, Output torque rating: 562 lb.in.
- End Lift and Center Wedge Reducers: Input rating: 3 HP @ 1725 RPM, Reduction ratio: 536:1, Output torque rating: 88,000 lb.in.

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## Product

## Custom Reducers

## Application

## Single Leaf Bascule Lift Bridge

### Highlights

- Custom-designed enclosed reducers
- One large single leaf bascule design replaced the original double leaf bascule configuration
- Three different drives were manufactured
- Fabricated steel housings
- 150% load test requirement

The 17th Street double leaf bascule lift bridge in Two Rivers, Wisconsin has been in operation since 1949, allowing the local commercial fishing fleet access to Lake Michigan via the East Twin River.

After over 60 years of service, the Wisconsin Dept. of Transportation commissioned a comprehensive rehabilitation of the bridge which was completed in 2014. The project included the replacement of the two approach spans and a redesigned single leaf bascule center span as well as all mechanical systems.

Working closely with the bridge engineering team, Nuttall Gear contributed to the development of the bridge's gearboxes which needed to drive the new larger single leaf bascule lift vs. the original double leaf configuration. Nuttall manufactured three enclosed drives which rotate 70 degrees with the bascule leaf. All units featured fabricated steel housings. Per specification, all steel materials were of USA origin. The drives met a 150% load test requirement and all welds were inspected by an Independent Certified Weld Inspector (CWI).

- Primary Reducer (WD15DIFF Differential Reducer):  
Input rating: 120 HP @ 1170 RPM, Reduction ratio: 11.39:1,  
Output torque rating: 74,000 lb.in.
- Secondary Reducers (WT30):  
Input rating: 60 HP @ 103 RPM, Reduction ratio: 63.82:1,  
Output torque rating: 2,343,000 lb.in.

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## Product



Photos courtesy of the Michigan Department of Transportation

## Application

## Custom Heavy-Duty Speed Reducers

## Single-Leaf Bascule Lift Bridge

### Highlights

- Massive single-leaf bascule design replaced original double-leaf configuration
- Custom-designed gearboxes to meet specifications
- Three different drives were manufactured
- 150% load testing required at 75-degree incline for all reducers
- All manufacturing and testing performed in-house

Originally built in 1922, the Fort Street fixed-trunnion bascule bridge in Detroit, Michigan allows large cargo ships to travel the Rouge River while transporting material to the nearby Ford Motor plant. The double-leaf bascule design utilized below-deck counterweights to raise and lower the two roadway leaf/sections.

The busy 278 ft. long, five-lane bridge carries approximately 10,500 vehicles per day and averages eight to ten daily openings to accommodate marine traffic. After more than 90 years of service, the Michigan Dept. of Transportation approved the construction of an entirely new bridge, which was completed in 2016.

The new bridge design replaced the original double-leaf configuration with a massive single-leaf bascule (the largest in the U.S.) that included an overhead counterweight. Working closely with the bridge's engineering team and mechanical contractor, Nuttall Gear contributed to the development of the bridge's gearboxes, which needed to drive the new single-leaf bascule lift. Nuttall manufactured three enclosed drives featuring custom lubrication systems to ensure gearing immersion during the 75-degree rotation of the bascule leaf. Per specification, all steel materials were of U.S. origin. All units featured fabricated steel housings.

The drives met a 150% load test requirement, and all welds were inspected by an Independent Certified Weld Inspector (CWI).

- Primary Reducer (WDSC13-SPC):  
Input rating: 300 HP @ 875 RPM, Reduction ratio: 7.57:1,  
Output torque rating: 246,000 lb.in.
- Secondary Reducers (WDSC28-SPC):  
Input rating: 150 HP @ 115 RPM, Reduction ratio: 15:1,  
Output torque rating: 1,840,000 lb.in.

*See back for more details.*





Photos show Nuttall's massive in-house custom-built test stand with two of the 15,000 lb. Fort Street bridge reducers mounted and being tested on a 75-degree incline per specification.



## In-house Testing

To meet demanding moveable bridge drive customer load-test requirements, Nuttall Gear has invested in the expansion of its in-house gearbox testing capabilities. As the recognized leader in moveable bridge drives, Nuttall provides comprehensive, cost-effective and convenient load testing in-house.

Moveable bridge reducers can be quite large and need to be tested to very high torque loads. The bridges also have differential style gearboxes that require load equalizing on each output shaft.

Nuttall technicians utilize the latest testing techniques and technology, including laser alignment of all drivetrain components, twin dynamometers, and massive, custom-built test stands which allow two 15,000 lb. gearboxes to be mounted and tested back-to-back on inclines up to 75-degrees. The rotating stand tests for proper gearing lubrication while reducers are inclined.

*Nuttall customers enjoy significant benefits with its in-house testing capability including:*

- Complete control of the test schedule.
- Elimination of transportation costs to an outside test facility (which can be significant for a 15,000 lb. gearbox).
- Initial run and diagnostic challenges can be quickly overcome by Nuttall gear technicians without having to remove the gearbox from the test floor, saving considerable setup time.
- Nuttall Gear can be significantly more cost-effective vs. competitors that outsource testing at an off-site facility.

### **In-house testing capabilities include:**

- Test loads up to 500 HP
- Test loads up to 6 million lb.in.
- Differential gearbox testing
- Incline testing (up to 75-degrees)
- Temperature monitoring
- Sound monitoring
- Vibration monitoring
- Comprehensive test reports to customer specifications
- Many customized testing options available

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**Product**



**Application**

## Custom Gear Drives

## Double-Leaf Bascule Bridge

### Highlights

- Custom-designed enclosed parallel-shaft reducers with carburized and ground gearing
- Two identical primary drives manufactured
- Fabricated steel housings
- All required testing performed in-house

The Pinellas County Department of Transportation in Florida recently completed upgrades to the Park Boulevard double-leaf, bascule bridge. The bridge opened in 1981 and spans the intracoastal waterway to connect Seminole with Indian Shores on the barrier islands. The bridge opens on demand for larger boats that sound their horn or radio the bridge tender.

After over 30 years of service, the bridge's original primary gearbox, which was undersized, started to fail causing maintenance issues. The bridge upgrade included replacement of the primary reducer, motor brakes and adjustment of air buffer mechanisms.

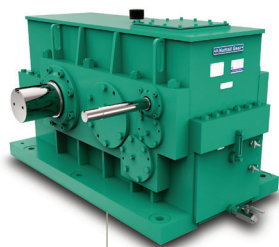
Nuttall Gear designed and manufactured new, larger primary gearboxes to drive both bascule leaves. The drives featured fabricated steel housings. Per specification, all steel materials were of USA origin and all welds were inspected by an Independent Certified Weld Inspector (CWI).

Required no load, 150% load, and 200% load tests (in horizontal orientation), where performed in-house. Nuttall technicians utilize the latest testing techniques and technology including laser alignment of all drivetrain components, twin dynamometers and massive custom-built test stands.

- Primary Differential Reducers:  
Input rating: 120 HP @ 1171 RPM, Reduction ratio: 17.1:1,  
Output torque rating: 74,000 lb.in.

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## Product

## Application

## Highlights

- Custom-designed parallel-shaft reducer with through-hardened gearing
- Fabricated steel housings
- All required testing performed in-house



## Custom Gearbox

## Single-Leaf Bascule Bridge

A new bridge that spans “The Gut” channel in South Bristol, Maine was recently opened to vehicle and boat traffic. The original, historic 82-year-old swing bridge had reached the end of its useful life as it occasionally got stuck in the open or closed position.

The Maine Department of Transportation approved the new single-leaf bascule bridge design that utilizes counterweights for easier raising and lowering of the bridge deck. The 20 ft. wide leaf spans 78 ft. to allow commercial fishing and recreational boats to transit the Gut channel as they move between John’s Bay and the Damariscotta River. The bridge also allows drivers to access Rutherford Island, a popular vacation destination.

Nuttall Gear designed and manufactured the new gearbox that drives the single bascule leaf. The splash-lubricated, custom parallel shaft gearbox features an input rating of 10 HP @ 333 RPM, a 278:1 reduction ratio, and a torque rating of 790,000 lb.in.

The drive features through-hardened gearing, a fabricated steel housing, and bearing L10 life 40,000 at rated load. Per specification, all steel materials were of USA origin and all welds were inspected by an Independent Certified Weld Inspector (CWI).

150% load testing was performed in-house. Nuttall technicians utilize the latest testing techniques and technology, including laser alignment of all drivetrain components, twin dynamometers and massive custom-built test stands.

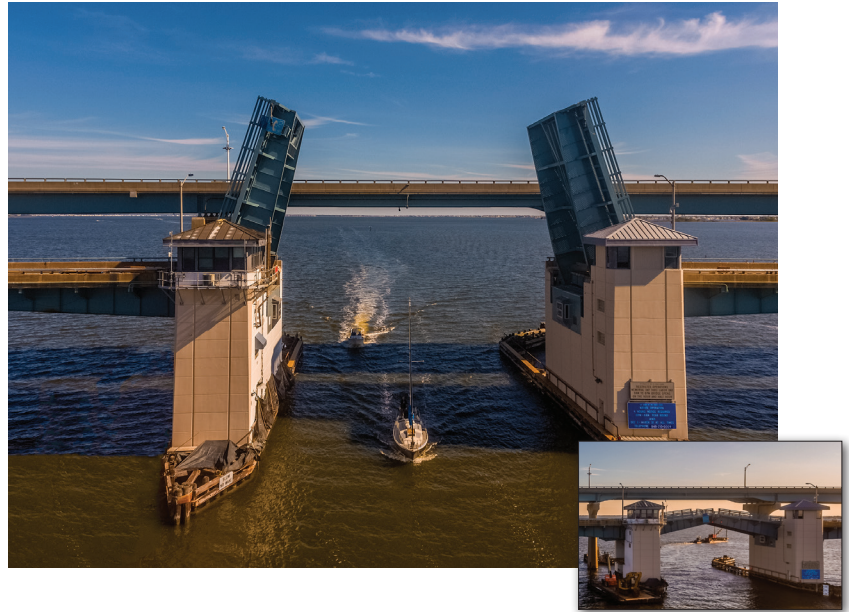
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**Product**



## Custom Gear Drive

**Application**

## Double-Leaf Bascule Bridge

### Highlights

- Custom-designed enclosed parallel-shaft reducer with through hardened gearing
- Input rating: 120 HP @ 1171 RPM
- Fabricated steel housing
- All required testing performed in-house

Due in part to damage sustained during Hurricane Sandy, the New Jersey Department of Transportation awarded contracts in 2015 for improvements to the mile-long Robert Mathis double-leaf, bascule bridge. Opened in 1950, the bridge spans Barnegat Bay to connect Toms River on the mainland and Pelican Island at Seaside Heights. The bridge carries three 10 ft. wide lanes of eastbound traffic while the adjacent, taller Tunny bridge, carries westbound traffic. The Mathis bridge's double-leaf bascule center span routinely opens on demand to allow clear passage of taller vessels.

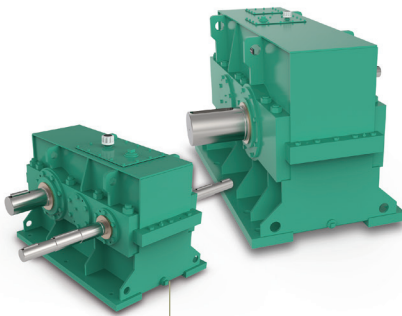
The bridge upgrade included structural and substructure repairs, replacement of various deck sections, and replacement of the auxiliary reversing gearbox along with other machinery and controls. The reversing gearbox is positioned between a diesel engine drive and a larger, primary gearbox. The diesel engine is utilized as a back up to the primary electric drive motor when there is a power outage. The reversing gearbox is required since the diesel engine only turns in a single direction while the bridge moves up and down.

Nuttall Gear designed and manufactured a new custom parallel shaft auxiliary reversing gearbox with a 3:1 ratio (Forward/Neutral/Reverse). The drive featured a fabricated steel housing. All welds were inspected by an Independent Certified Weld Inspector (CWI) and all steel materials were of USA origin per specification.

A required spin test was performed in-house utilizing the latest testing techniques and witnessed by the customer.

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## Product



## Application

## Custom Gearboxes

## Vertical Lift Bridge

### Highlights

- Custom-designed enclosed parallel-shaft reducers with carburized and ground gearing
- Two duplicate sets of drives were supplied; each set featured a primary and two secondary reducers
- All required testing performed in-house
- Fabricated steel housings

Originally opened in 1940, the Sarah Mildred Long bridge spans the Piscataqua River connecting Kittery, Maine to Portsmouth, New Hampshire. The vertical lift bridge allows passage of large ships to the Atlantic Ocean. In 2016, the Maine-New Hampshire Interstate Bridge Authority determined that the original twin deck truss bridge had reached the end of its useful life after a series of mechanical and maintenance issues caused repeated closures. A completely new bridge design was approved.

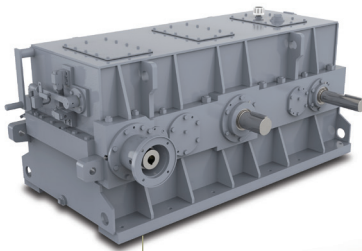
The new replacement bridge features a single-deck center lift span that carries two lanes of vehicle traffic as well as an integrated set of train tracks. When fully raised, the 300 ft. (91 m) long center span provides 134.5 ft. (41 m) of clearance to accommodate large, modern cargo ships. While typically positioned at the road bed height for vehicle traffic, the center span can also be lowered to align with the railroad tracks on the twin-deck side spans of the bridge. Approximately 4000 vehicles cross the bridge on a daily basis.

The bridge operates by utilizing four sets of sheaves and cables, positioned in each of the bridge's four towers. Nuttall Gear worked with the bridge's engineers and mechanical contractor to design and manufacture the enclosed reducers required for the bridge's main drive assemblies.

Nuttall provided two sets of custom parallel shaft gearboxes. The two primary reducers had an input of 125 HP @ 1170 RPM, a 20:1 ratio, and a service factor of 1.5. The four secondary reducers had an input of 63 HP @ 58.5 RPM, a 23:1 ratio, and a service factor of 1.5. All the drives featured fabricated steel housings and all welds were inspected by an Independent Certified Weld Inspector (CWI). The drives met a "Buy USA" requirement and were subjected to 150% load tests performed in-house.

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## Product

## Application

## Highlights

- Two identical custom-designed enclosed reducers
- Locking mechanisms
- Fabricated steel housings
- Splash lubrication



## Custom Gearboxes

## Vertical Lift Bridge

The current version of the Burlington Canal lift bridge was built in 1962. Located between Hamilton and Burlington, Ontario, the bridge spans the Burlington Canal that was widened to allow ships to navigate between Hamilton Harbour and Lake Ontario. In 2017, the bridge underwent a major overall, including the replacement of the mechanical drive system components.

The bridge carries four lanes of vehicle traffic as well as a pedestrian walkway. A 380 ft. (116 m) long center lift span raises 118 ft. (36 m) to allow large marine vessels, including cargo ships, to pass. The busy bridge rises approximately 4,000 times during its operational season from March through December.

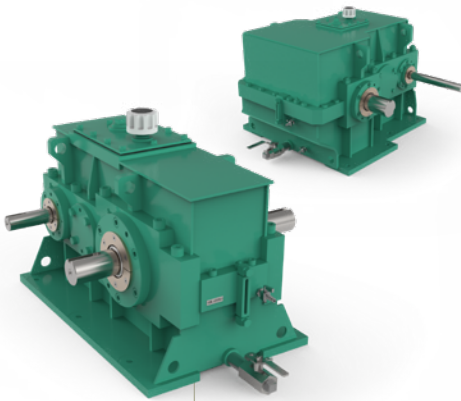
Synchronized 150 HP motors, positioned in each of the bridge's two towers, raise and lower the 1,996 ton center span. Nuttall Gear worked with the bridge's mechanical contractor to design and manufacture the enclosed reducers required for the bridge's main drive assemblies.

Two custom parallel shaft gearboxes with a main input of 150 HP @ 580 RPM, a 6.238:1 ratio, a service factor of 3.0 and an auxiliary input of 20 HP @ 1750 RPM with a 153:1 ratio were supplied. Dual manual shift locking mechanisms were included for operation with either the main input, the auxiliary input or hand crank input. The identical drives featured fabricated steel housings and all welds were inspected by an Independent Certified Weld Inspector (CWI). The drives utilize splash lubrication to prevent churning that occurs when the gears are fully submerged in oil.

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## Product

## Custom Heavy-Duty Gearboxes

## Application

## Swing Bridge

### Highlights

- Custom-designed enclosed reducers
- Special center distances
- Fabricated steel housings
- Load tested to 150%

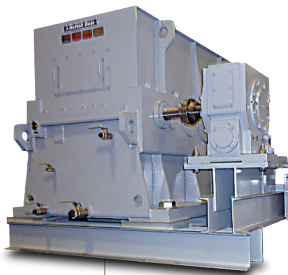
The Lindsey Warren bridge that spans 3 miles across the Alligator River in North Carolina recently underwent a major renovation. Originally built in 1962, the two-lane bridge carries U.S. 64 vehicular traffic between Tyrrell and Dare counties. The North Carolina Dept. of Transportation approved the renovation project that included the mechanical and electrical components positioned below the bridge's center swing span that allows marine traffic to pass through the bridge.

Nuttall Gear designed and manufactured two new enclosed gearboxes for the bridge. Both units featured fabricated steel housings and were load tested to 150%. All welds were inspected by an Independent Certified Weld Inspector (CWI). Special center distances were required.

- Primary Parallel Shaft Differential Reducer:  
Input rating: 25 HP @ 870 RPM, Reduction ratio: 30.41:1
- Wedge Machinery Parallel Shaft Reducer:  
Input rating: 7.5 HP @ 870 RPM, Reduction ratio: 28:1

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## Product

## Application

## Highlights

### **Nuttall Gear Custom Reducers**

feature carburized and ground gearing with CWI weld inspected, fabricated steel housings

### **Delroyd Worm Gear Custom Reducers**

feature a hardened, ground and polished alloy steel worm and bronze gear

### **Ameridrives Amerigear Couplings**

feature fully-crowned teeth for higher torque, higher speed and higher misalignment capacity



Artist rendering

## Custom Reducers and Gear Couplings

## Folsom Lake Spillway Flood Gates

In 2008, construction of an auxiliary spillway began at the Folsom Dam near Sacramento, CA. This Joint Federal Project (JFP) is managed by the U.S. Army Corps of Engineers, together with other Federal and state agencies. The new spillway will allow water to be released earlier and more safely from Folsom Lake during a high water event.

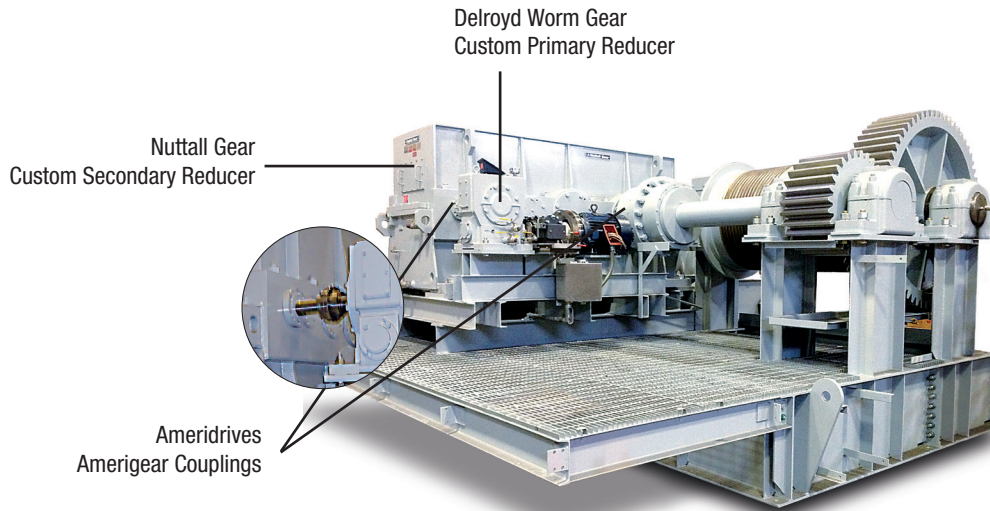
Granite Construction is the general contractor for the overall project which includes a control structure containing six submerged tainter gates and six bulkhead gates. The massive 45 ft. tall, 30 ft. wide curved tainter gates rotate in an arc and are hydraulically-operated to allow for precise water flow control. The new control structure's tainter gates will work in conjunction with the dam's main gates to release water from the lake and funnel it through 3,000 ft. long spillway into the American River below.

Positioned upstream from the tainter gates, the six 39 ft. long, 23 ft. wide and 3-1/2 ft. thick flat steel bulkhead gates are raised and lowered vertically to completely stop water flow in order to allow maintenance work on the tainter gates.

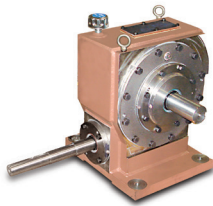
Engineering teams at Nuttall Gear and Delroyd Worm Gear worked closely with Linita Design and Manufacturing, the firm responsible for the design and assembly of the spillway's gate systems. Nuttall and Delroyd developed and manufactured heavy-duty, custom-designed primary and secondary reducers to meet the specific application requirements of the bulkhead gate drivetrains.

Ameridrives Couplings, also part of Altra Industrial Motion, was chosen to provide all the required gear couplings for all the bulkhead gate drivetrains based on their reputation for quality and reliability in tough industrial applications.

*See back for more details.*

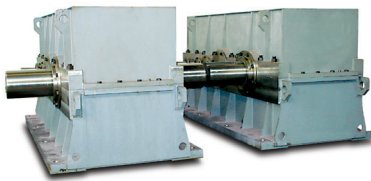


*A separate drivetrain assembly (above) was required to operate each of the spillway's six bulkhead gates.*



## Delroyd Worm Gear Custom Drives

Primary Drive Worm Gear Reducers: Input rating: 15 HP @ 1160 RPM, Reduction ratio: 11.4:1, Output torque rating: 18,750 lb.in. Delroyd helical worm gear drives feature a hardened, ground and polished alloy steel worm that develops a smooth, work-hardened surface on the bronze gear providing high efficiency and long service life.



## Nuttall Gear Custom Drives

Secondary Reducers (with double extended shafts): Input rating: 15 HP @ 102 RPM, Reduction ratio: 238:1, Output torque rating: 4,412,000 lb.in. All Nuttall drives are made in the USA and feature carburized and ground gearing with CWI weld inspected, fabricated steel housings.



## Ameridrives Amerigear Couplings

9.44" dia. gear couplings connect the primary gearbox with the secondary gearbox. 30.5" dia. gear couplings connect the primary gearbox with the open pinnion. Amerigear flexible couplings feature fully-crowned teeth for higher torque, higher speed and higher misalignment capacity (1.5° angular misalignment per gear mesh). Units also feature accurately machined, medium carbon steel hubs and sleeves. Positive-type O-ring seals keep lubricant in and contaminants out. Seals are enshrouded to prevent damage.

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### Contact Ameridrives Couplings

US (Application Assistance)  
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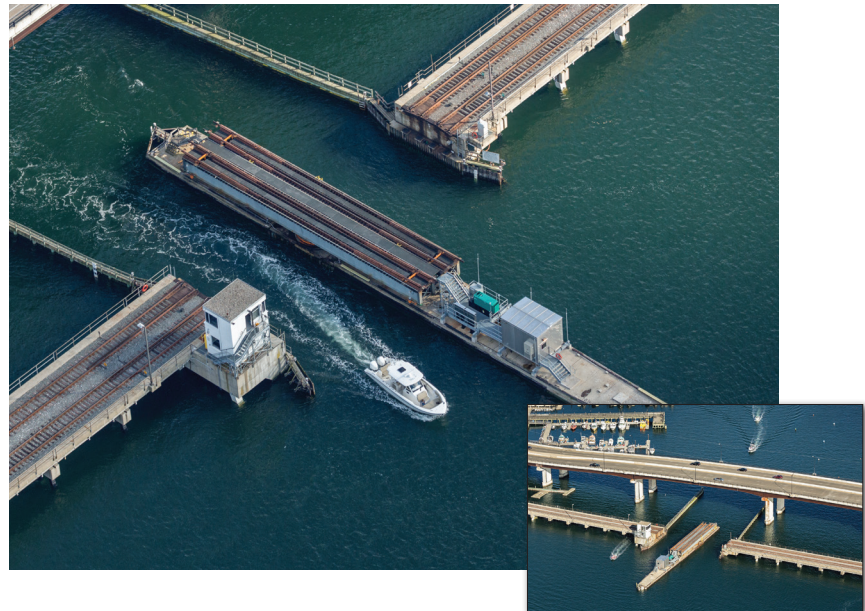
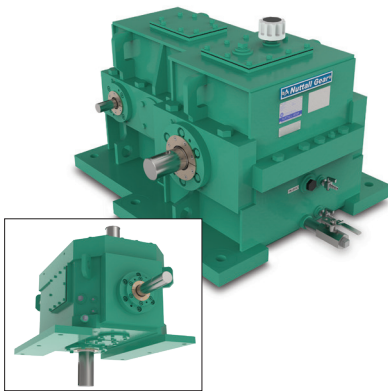
### Contact Delroyd Worm Gear

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## Product

## Custom Gear Drives

## Application

## Rail Swing Bridge

## Highlights

### Nuttall Gear Custom Reducers

feature through-hardened gearing with CWI weld inspected, fabricated steel housings

### Delroyd Worm Gear Custom Reducers

feature a hardened, ground and polished alloy steel worm and bronze gear

The Beverly Drawbridge spans the Danvers River, connecting Beverly and Salem, Massachusetts. The bridge is positioned adjacent to the Route 1A, Veterans Memorial Bridge. Originally built in 1885, the rail bridge currently carries the Massachusetts Bay Transportation Authority (MBTA) Newport/Rockport commuter line that originates in Boston.

The bridge's center swing section rotates approximately 5,000 times per year to allow passage of marine river traffic through two channels. More than 30 inbound and 30 outbound trains cross the busy bridge daily. In recent years, the bridge had begun to experience mechanical problems requiring expensive repairs while causing significant service interruptions and delays for thousands of daily commuters.

In 2017, the MTBA completed a major rehabilitation of the bridge that included a new swing span, mechanical components, bridge wedges, and drive motor. Nuttall Gear and Delroyd Worm Gear worked with project engineers at HNTB Corp., to design custom gear drives for the bridge's 104 ft. swing span.

The Nuttall and Delroyd splash-lubricated enclosed reducers featured fabricated steel housings and included inspections by an Independent Certified Weld Inspector (CWI). The project had a "Buy USA" requirement (including country of origin for the steel). Required no load and 150% load tests were performed in-house.

- Primary Differential Span Drive Reducer: Input rating: 15 HP @ 900 RPM, Reduction ratio: 2.53:1
- Secondary Span Drive Right Angle Reducers: Input rating: 7.5 HP @ 356 RPM, Reduction ratio: 48.11:1
- Wedge Drive Gearmotors w/Integral Brakes: Input rating: 10 HP @ 1750 RPM, Reduction ratio: 17.1:1
- Wedge Drive Right Angle Reducers: Input rating: 10 HP @ 104 RPM, Reduction ratio: 56.42:1
- Rail Lift Worm Gear Reducers: Input rating: 5 HP @ 1750 RPM, Reduction ratio: 450:1

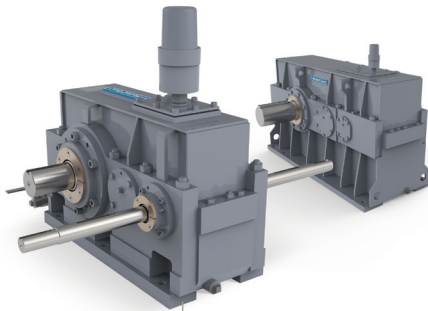
### Contact Nuttall Gear

### Contact Delroyd Worm Gear

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## Product



## Application

### Custom Gear Drives

### Vertical Lift Rail Bridge

#### Highlights

- Custom-designed enclosed reducers
- Fabricated steel housings
- Special center distances
- Load tested to 150%

In July of 2018, the Union Pacific Railroad replaced its aging 614 ft. long swing bridge over the San Bernard River near Angleton, Texas. The new bridge is a vertical lift design with a 114 ft. long center span that raises 56 ft. above the Mean High Water (MHW) level to allow marine river traffic to pass under. The busy bridge carries 19 trains per day (both commuter and freight).

To diminish track outage time, engineers designed the new bridge's center vertical lift span to be fully constructed alongside the existing bridge and slid into position quickly once the old bridge's center swing section was removed. This radical approach to bridge construction had never been attempted before. The entire center section replacement process took only 80 hours to successfully complete.

Nuttall Gear worked with the bridge engineering team to design and manufacture the primary differential reducer and 4 secondary reducers required for the new vertical lift bridge. All the enclosed drives featured fabricated steel housings, and all welds were inspected by an Independent Certified Weld Inspector (CWI). The project had a US origin steel requirement.

- Primary Parallel Shaft Differential Reducer:  
Input rating: 20 HP @ 1170 RPM, Reduction ratio: 20.84:1
- Secondary Parallel Shaft Reducers:  
Input rating: 5 HP @ 56 RPM, Reduction ratio: 78.5:1

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Nuttall Gear and Delroyd Worm Gear provide vast experience in designing and manufacturing worm gears and worm gear drives as well as helical drive assemblies for a variety of mechanical equipment. Our in-house test facility allows us to expertly mount, align, and couple your reducer and motor. This allows us to deliver a fully tested and proven package that will integrate into your production system without any worries or surprises. Our mission is to provide solutions.

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Available in ratings up to 40,000 HP and output speeds up to 20,000 RPM or higher in ratios up to 9:1. Heavy cast iron or welded steel housings for strength and rigidity.



#### Custom Engineered Drives by Nuttall

Some of our most outstanding products cannot be found in a catalog because they were designed for a specific customer or application design.



#### Helical Worm Speed Reducer by Delroyd

Ratios 15:1 to 355:1. Hardened, and ground helical gears. Hollow and solid output shafts. Vertical and horizontal mountings. Fan cooled is standard. Motor mounts (C-Face adapters or scoops). Cast iron or steel housings



#### Type TDS/HPD Parallel Shaft Speed Reducer by Nuttall

Torque ratings up to 6,000,000 in.lb. and standard gear ratios up to 1500:1. TDS and HPD units incorporate precision helical gearing in single, double, triple, quadruple and quintuple reductions.



#### Worm-Gear Sets by Delroyd

The lowest cost and shortest delivery schedules are normally achieved through the use of standard worm and gear sets. Flanged rim design available for mounting on any adaptable center.



#### Single Worm Reducer by Delroyd

Ratios 5:1 to 70:1. Hollow & solid output shafts. Vertical & horizontal mounting. Fan cooled (standard). Motor mounts (C-Face Adapters or scoops). Cast iron or steel housings



#### Moduline® Integral Motors by Nuttall

Available in ratings from 1 to 200 HP and output speeds from 1.5 to 1430 RPM with AGMA Class I, II or III service factors. Fits many applications and provides total drive source responsibility.



#### BX Conveyor Drive Unit Series by Delroyd

Delroyd series BX Speed Reducers for conveyor drives feature exceptionally high overhung load capacity. This design advantage usually permits selection of a smaller drive unit for a given load. Drywell construction around the output shaft helps prevent leakage from above.



#### Double Worm Reducer by Delroyd

Ratios 75:1 – 4900:1. Right angle and parallel shaft arrangements. Hollow and solid output shafts. Vertical and horizontal mounting. Fan cooled is standard. Motor mounts (C-Face Adapters or scoops). Cast iron and steel housings





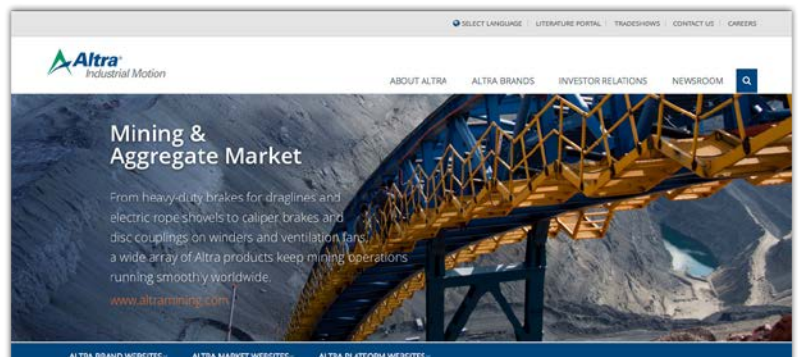
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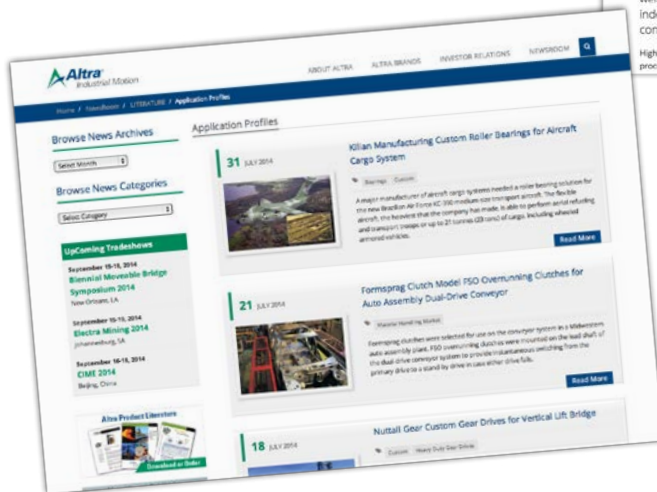
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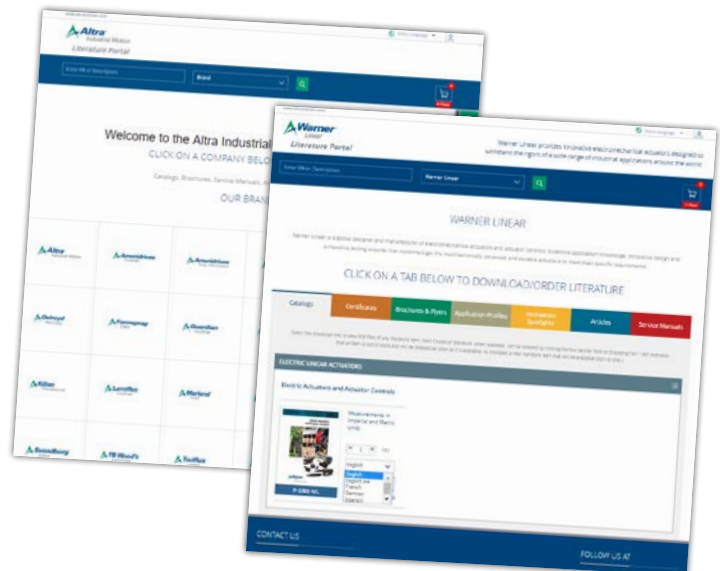
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