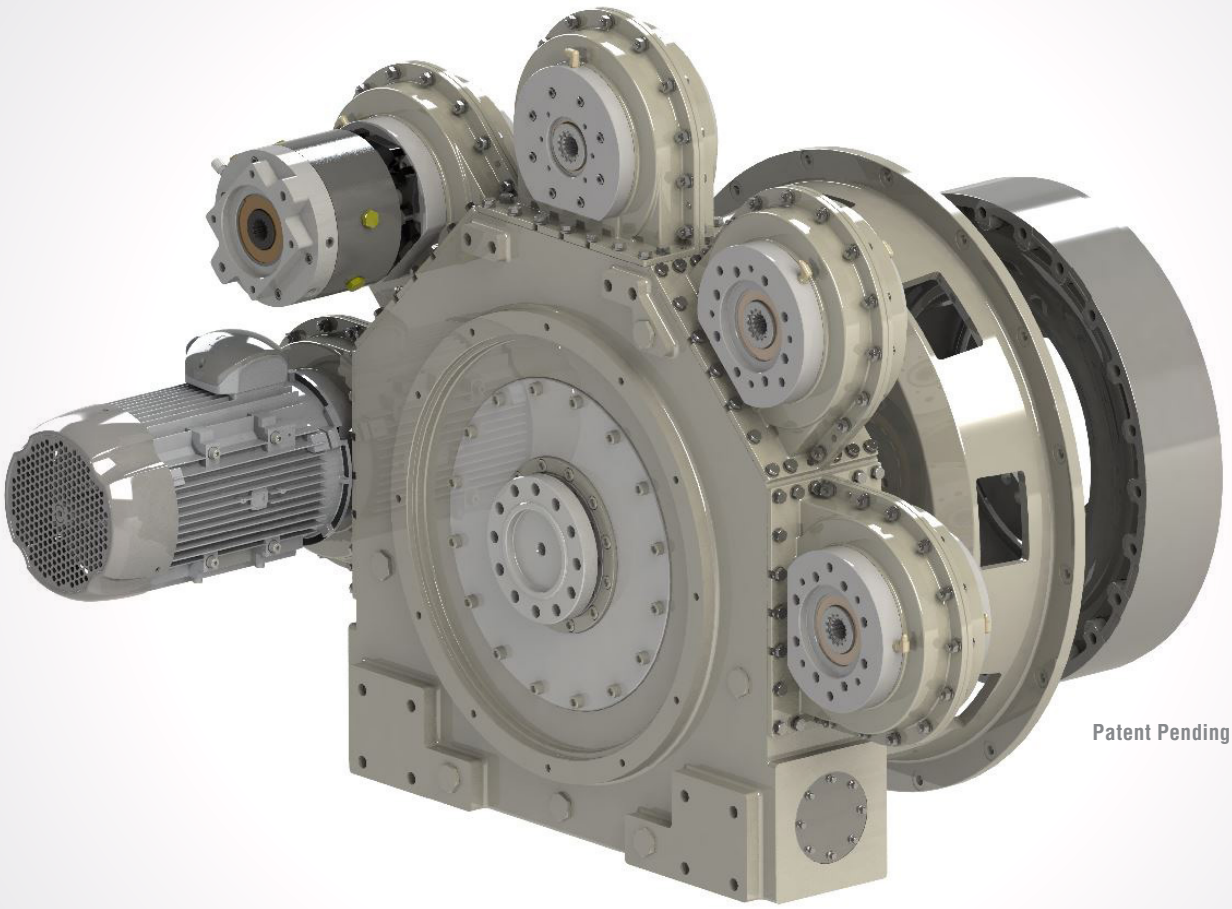
NEW! Logan FlexaDrive™

MULTIPLE PUMP DRIVE SYSTEM



Patent Pending

- Industrial
- Marine
- Agriculture
- Off-Road
- Mobile Equipment
- Hybrid Vehicles

Logan Clutch Corporation®

manufacturers of clutches and brake products

Family owned and operated since 1975, Logan offers a complete line of fluid / air actuated multiple disc clutches, brakes, PTO Clutches and clutch discs for a variety of wet and dry clutch and brake applications.

Markets include: Machine Tool, Industrial, Marine, Irrigation, Rail, Oil Field, and Off-Highway industries.

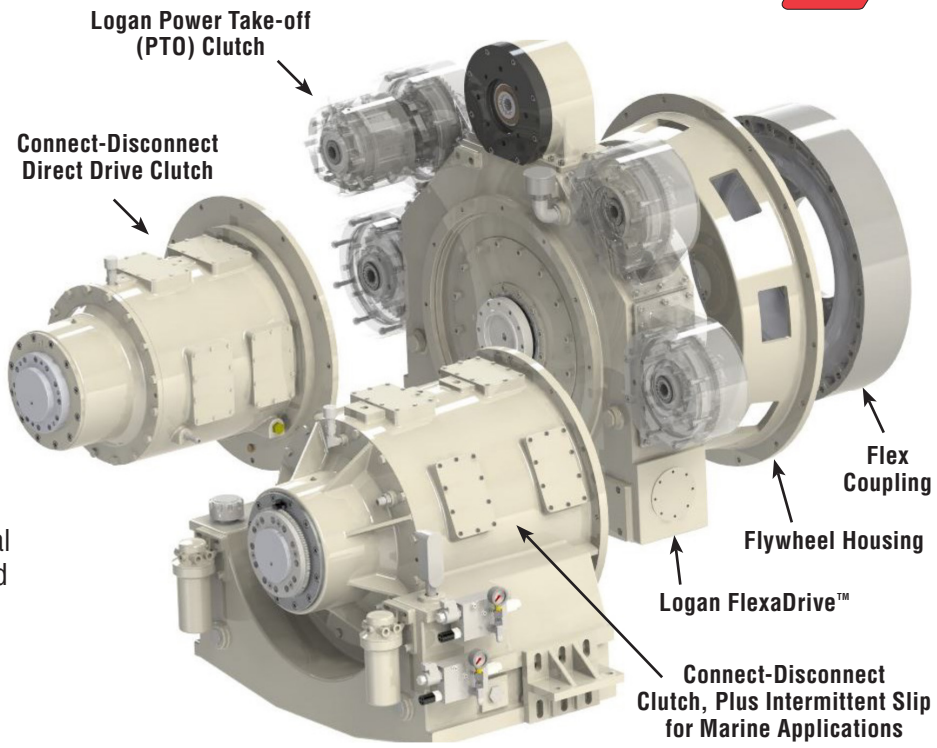
Applications include: Pump Drives, Trenchers, Tunnel Boring and Snow Removal Equipment, Single and Multi-Speed Transmissions, Marine Transmissions, Work Boats, Escort Vessels, Marine Z-drives, Machine Tools, Screw Machines, Conventional and High Performance friction and steel clutch discs.

Logan Sales, Engineering and Customer service personnel are available to answer questions regarding catalog specs, parts and service details, and inquiries regarding your specific design requirements. We certainly thank you for your interest, and look forward to being of further service.

NEW! Logan FlexaDrive™ Pump Drive Gearbox

Logan FlexaDrive™ Multiple Pump Drive Gearbox Series Description:

The Logan FlexaDrive multiple pump drive system is a self-contained gearbox with integral flexible coupling, providing full engine power between engine (power take-off) and transmission. Three different models, with up to Five (5) pump drive towers offer up to (10) PTO/PTI pump pads with bi-directional rotation for engines ranging from 200 HP (150 kW) to 3000 HP (2237 kW) at a maximum of 2600 RPM. Various step-up gear ratios are available for direct drive PTO's. An integral Flexible coupling is part of the system to dampen torsional vibration. Logan FlexaDrives mount to all standard SAE flywheel housings ranging from No. 3 to 00.



Multiple Disc Friction Clutch:

The Logan FlexaDrive™ System design mounts to of a wide range of Logan Bell Housing PTO's, and Logan LSC Series clutches, as well as any marine transmission for direct torque transmission. Clutch housings can be mounted rigidly or through soft mounts to the engine base frame or engine foundation.

Up to (10) Auxiliary Direct Drive Pads:

A range of output options are available to suit any desired output configuration: clutchable, pulley, SAE PTO / hydraulic pump output, drive shaft flange, or shaft and key. The Logan FlexaDrive modular concept allows installation of a wide range of hydraulic pumps with SAE or other standard input shafts and mounting flanges. Up to (5) Pump drive towers and (10) PTO pads are available in combinations of SAE A, B, B-B, C, C-C and D input shafts and SAE A, B, C and D flanges.

Flexible Coupling / Flywheel sizes:

The Logan FlexaDrive modular concept allows the use of a wide selection of flexible coupling designs suitable for flywheel mounting. Coupling Housings provide direct engine mounting and are available in SAE 1,2,3 as well as 0 and 00 Bell Housing sizes; and in SAE No. 3 (11.5" flywheel), SAE no. 1 (14" Flywheel), SAE No. 0 (18" flywheel) and SAE No. 00 (21" flywheel) sizes.

Benefits: Flexibility and Scalability

The FlexaDrive's patent pending design, provides OEM's the Flexibility to design in or install later, up to 5 PTO / PTI drives (up to 200 HP/150 KW each) simply by removing a plate and bolting a drive tower into position. PTO drives, such as hydraulically driven attachments can be engaged independently, and on demand by incorporating a Logan Direct Drive PTO.

Standard Specifications and options:

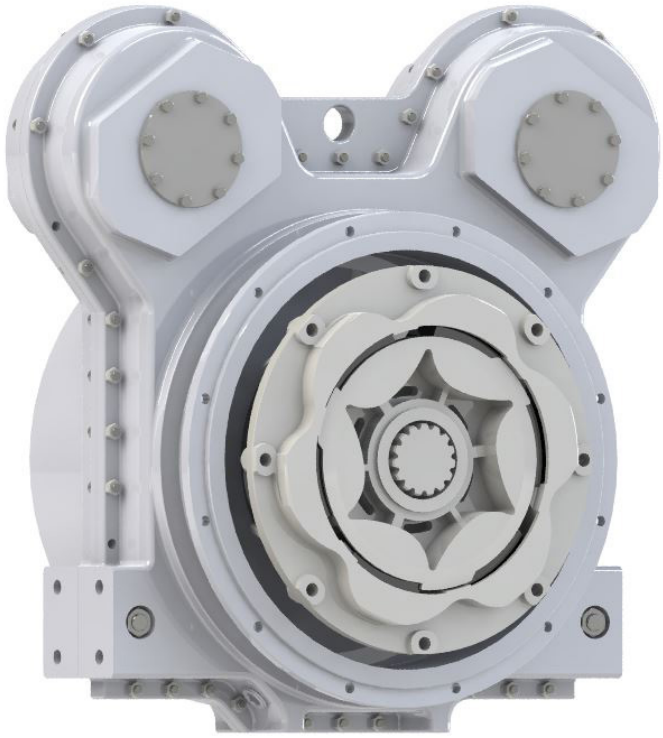
- For Engine Capacities from 200 HP (150 kW) to 5000 HP (3700 kW) 2600 Max. RPM
- (5) Pump Drive Towers and (10) pump pads; (2) per tower
- Up to (5) PTI/PTO drives (up to 200 HP/150 kw each)
- Integral Flexible Coupling to Dampen Torsional Vibration
- 3 Sizes: (2) Towers 300 HP, (5) Towers 300 HP, and (5) Towers 600 HP in Total Pads Capacity

Where Used:

- Hybrid Drive Systems
- Marine Propulsion
- Mobile Equipment
- Industrial Skid Mounted Systems and Gensets
- Front of Marine Engines

Logan FlexaDrive™ 2-position Pump Drive System 300 HP

For engines up to 730 HP / 554 kW



FlexaDrive 2-position pump drive - Input Side

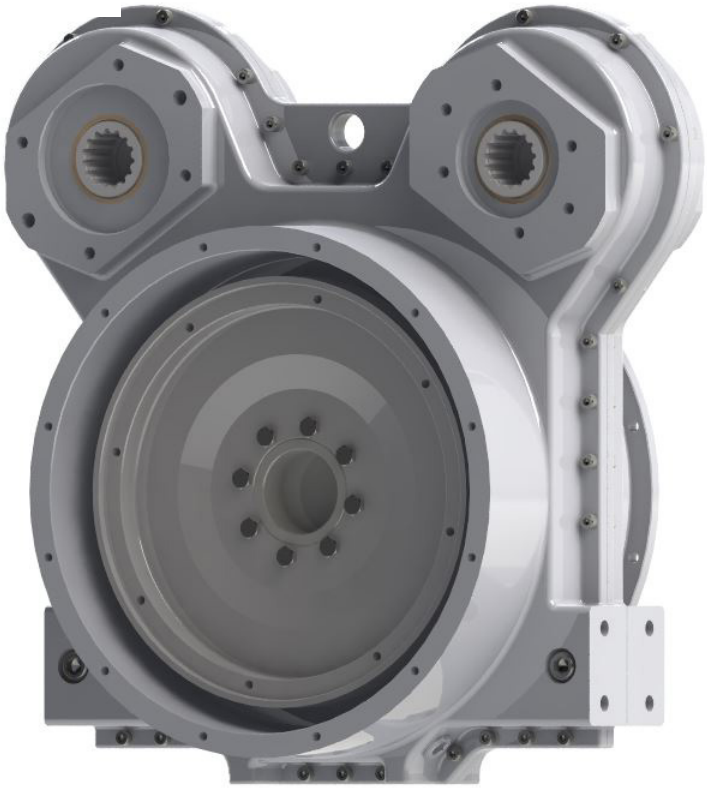
The Logan 2-position pump Drive is outfitted for up to (4) PTI/PTO pads, and can accommodate up to 730 HP / 544 kW Engines, with maximum speeds up to 2600 RPM.

- **SAE J617 No. 1, 2, 3**
- **SAE J744 A, B**
- **Suitable for most flexible couplings or flywheel drive plates**

FlexaDrive 2-position pump drive - Output Side

Total heads capacity of 300 HP / 225 kW. A single head has a maximum 160 HP/120 kW. Various step-up, step-down gear ratios are available for direct drive PTO's.

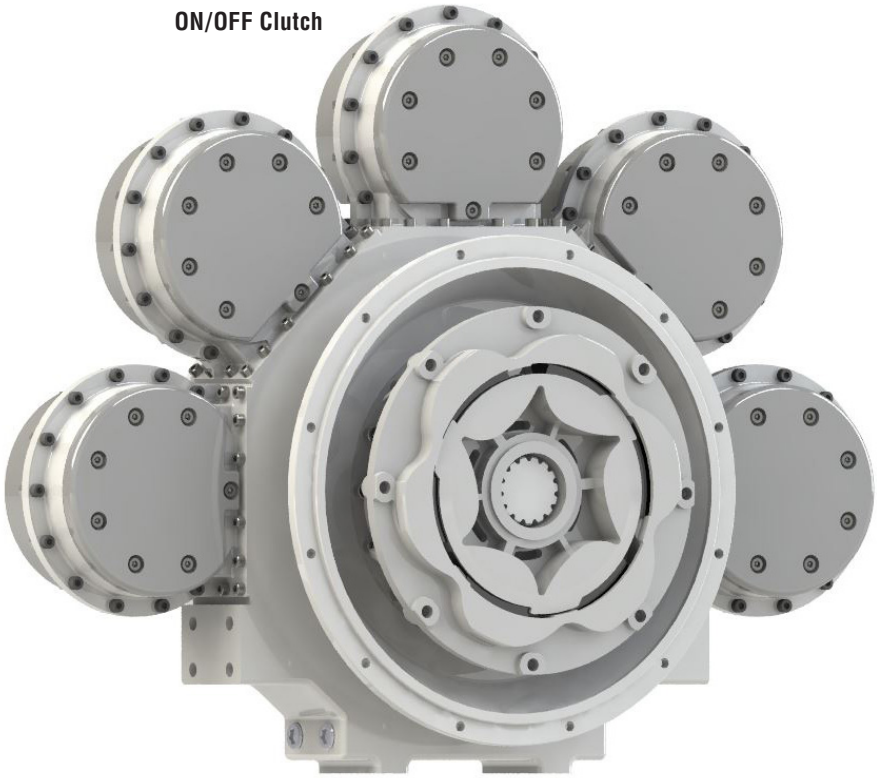
- **SAE J617 No. 3**
- **SAE J744 A, B, C**
- **Output options:**
  - Pulley
  - Clutch
  - Drive shaft flange
  - Electric motor flange



Logan FlexaDrive™ 5-position Pump Drive System 300 HP

For engines up to 730 HP / 554 kW

ON/OFF Clutch



FlexaDrive 5- position pump drive - Input Side

The Logan 5-position pump Drive is outfitted for up to (10) PTI/PTO pads, and can accommodate up to 730 HP / 544 kW Engines, with maximum speeds up to 2400 RPM.

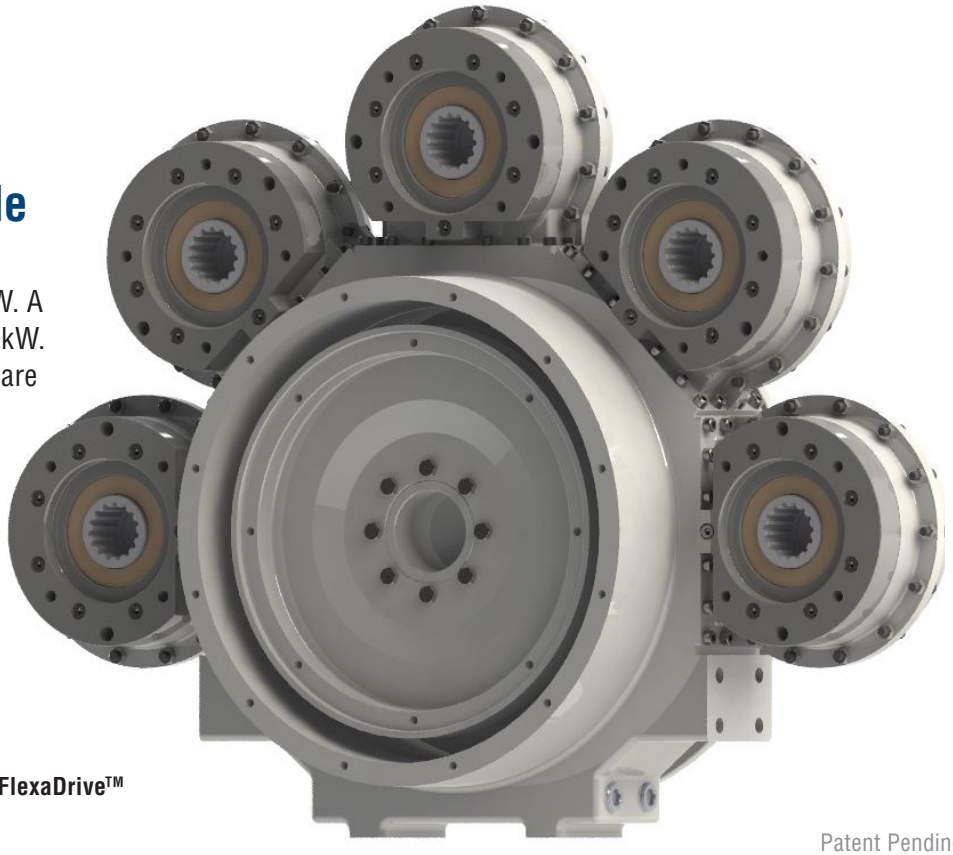
- **SAE J617 No. 1, 2, 3**
- **SAE J744 A, B**
- **Suitable for most flexible couplings or flywheel drive plates**

Flexible Coupling

FlexaDrive 5-position pump drive - Output Side

Total heads capacity of 300 HP / 225 kW. A single head has a maximum 160HP/120kW. Various step-up, step-down gear ratios are available for direct drive PTO's.

- **SAE J617 No. 3**
- **SAE J744 A, B, C**
- **Output options:**
  - Pulley
  - Clutch
  - Drive shaft flange
  - Electric motor flange



FlexaDrive™

Patent Pending

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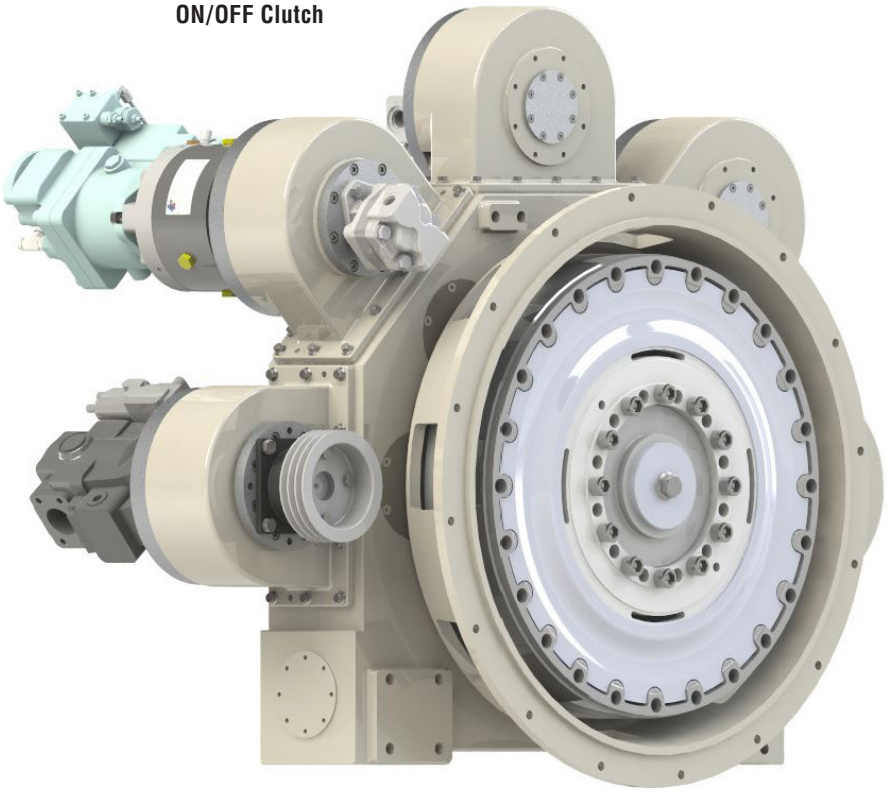
Logan FlexaDrive™ 5-position Pump Drive System 600 HP

For engines up to 5000 HP / 3700 kW

ON/OFF Clutch



Flexible Coupling

FlexaDrive 5- position pump drive - Input Side

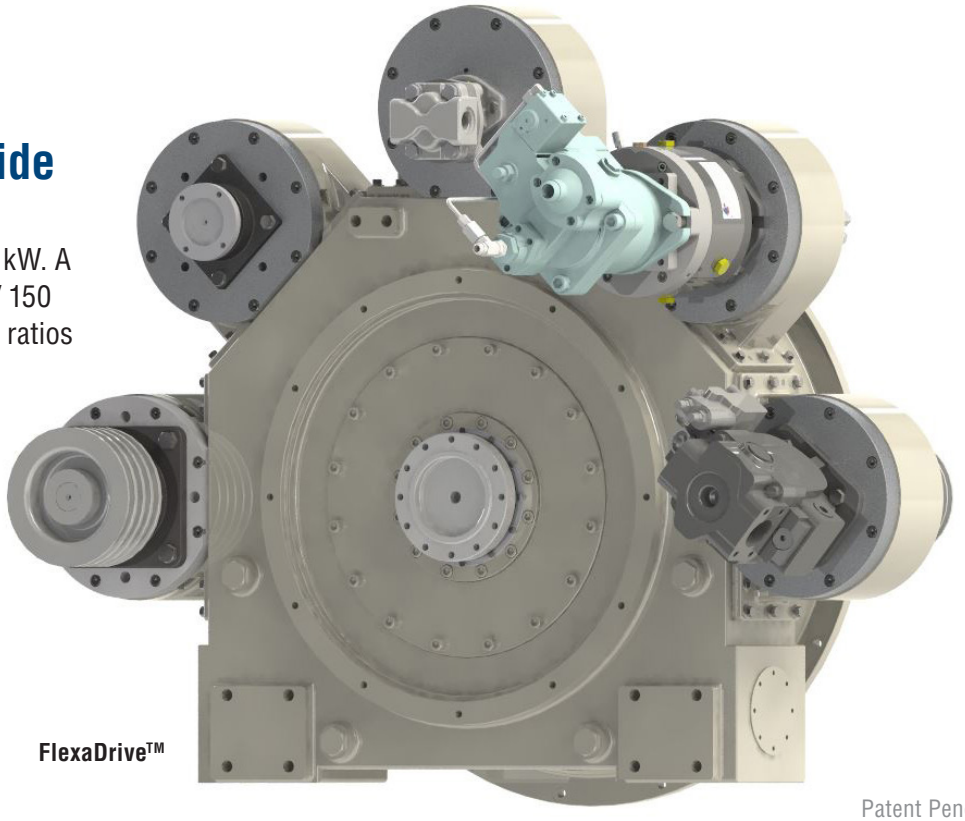
The Logan 5-position pump Drive is outfitted for up to (10) PTI/PTO pads, and can accommodate up to 5000 HP / 3700 kW Engines, with maximum speeds up to 2400 RPM.

- **SAE J617 No. 00, 0, 1**
- **SAE J744 A, B**
- **Suitable for most flexible couplings or flywheel drive plates**

FlexaDrive 5-position pump drive - Output Side

Total heads capacity of 600 HP / 450 kW. A single head has a maximum 200 HP / 150 kW. Various step-up, step-down gear ratios are available for direct drive PTO's.

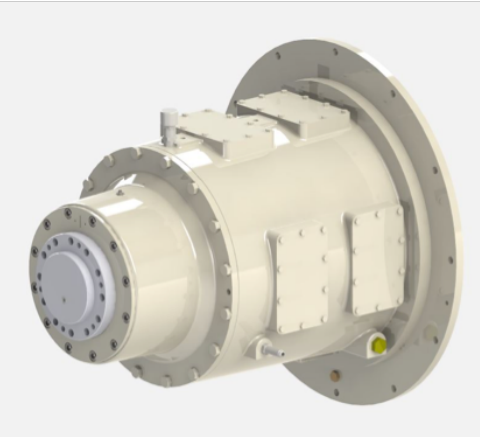
- **SAE J617 No. 00, 0, 1**
- **SAE J744 A, B, C, D**
- **Output options:**
  - Pulley
  - Clutch
  - Drive shaft flange
  - Electric motor flange



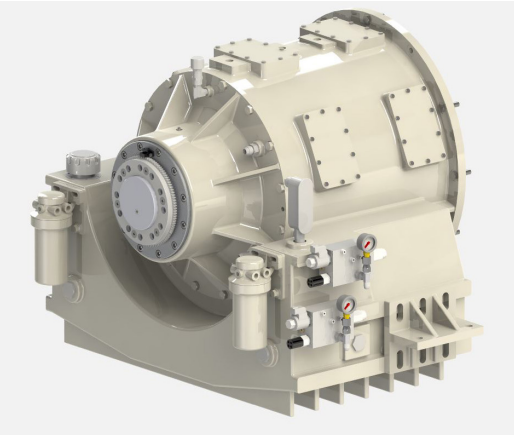
FlexaDrive™

Patent Pending

Logan Bell Housing PTO clutches are hydraulic or pneumatically activated and can operate wet (oil bath) or dry. The Logan FlexaDrive Mounts to a wide range of Logan Bell Housing PTO's, Logan LSC series Clutches, as well as any marine transmission for direct torque transmission. Clutch Housings can be mounted rigidly or through soft mounts to the engine base frame or engine foundation.



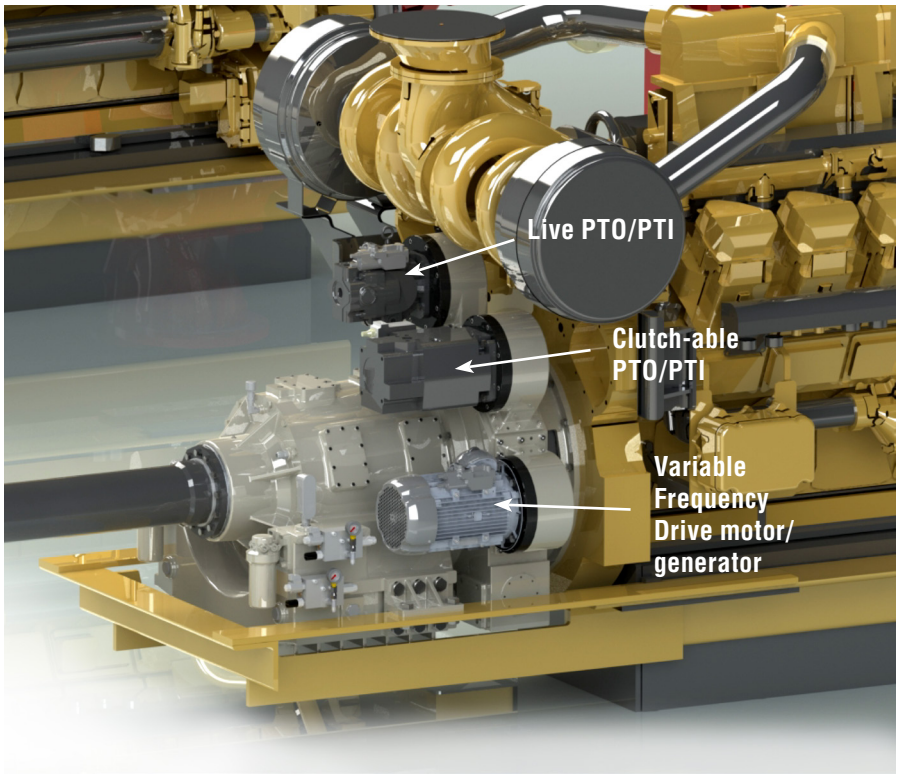
Logan connect-disconnect Bell Housing PTO Clutch. Operates wet (oil bath) or dry



Logan Bell Housing Clutches are also designed for intermittent or continuous slip, for dynamic positioning. With optional J-1939 communication for standard engine protocol.

Logan FlexaDrive™ for Conventional Applications

The Logan FlexaDrive adds the possibility of up to ten live or clutch-able PTO's or PTI's with a wide variety of RPM ratios on a drive line. With a small foot print, it can fit in the tightest locations and be used with nearly any engine. Mounted on to the SAE J617 Bell Housing mount on the engine or free standing and driven by a flywheel or flywheel mounted flexible coupling, it can be THE solution for designers, equipment builders and owners with what to do about installations of the multiple PTO mounted systems from multiple suppliers. The FlexaDrive can also be used as a PTI and a drive line power booster during emergencies or for system increases thus avoiding expensive re-powers or decrease original design engine displacement. Nearly any style of main drive output can be accommodated, transmission, clutch, or drive shaft.



Conventional installation showing multiple output options.

- **Simplifies failure mode analysis**
- **Standardizes and simplifies addition of multiple system suppliers hydraulic power supplies**
- **Mounts to any engine**
- **Uses most manufacturers flexible couplings for input**
- **Every PTO pad can be live or clutch-able**
- **Most common hydraulic pump pad sizes**
- **Simply mount electric motors and generators**
- **Add power into drive lines**

Logan FlexaDrive™ for Hybrid Applications

Single Source for Power:

Imagine a vessel that only requires main engines, not generators and other auxiliary power sources, to produce electricity, drive bow thrusters, power mission specific hydraulic equipment (cranes or fishing equipment), run fire and cooling pumps provide back-up, and redundancy for critical vessel systems. The Logan FlexaDrive™ makes all of this possible.

Hybrid Technology:

In recent years, there has been considerable emphasis placed on reducing emissions in the marine industry. Regulatory bodies around the globe have imposed stringent limits on the amount and types of emissions that can be released. Marine operators and technology developers are aggressively working to reduce the fuel consumed and the emissions produced by the world's fleets.

Hybrid technology has been at the forefront of these initiatives and has been identified by ship owners as a means of making their vessels more environmentally friendly, while at the same time reducing operating and maintenance costs. Logan Clutch has been a proud contributor to several hybrid projects and continues to look for opportunities to assist clients with leading edge propulsion concepts.

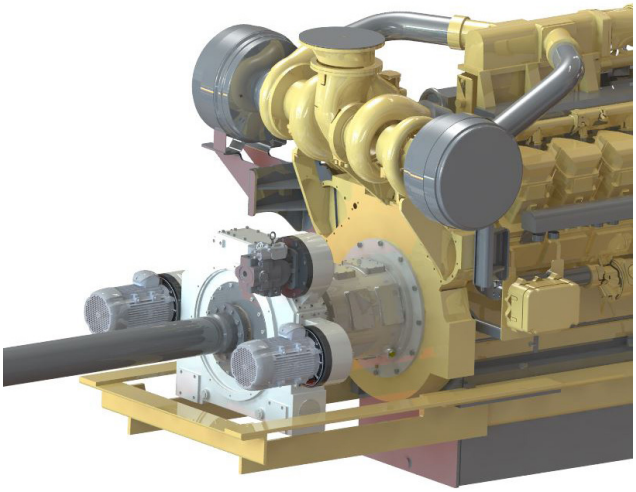
Logan FlexaDrive Scalability

A case-in-point is the new Logan FlexaDrive™ for Main Propulsion. This unique product is comprised of a multi-disc friction clutch and the revolutionary FlexaDrive™ gearbox. The modular design means that the units can either be used together or independently to satisfy a vessel's operational requirements. The clutches are hydraulically actuated and can be purchased in "on/off" or "slipping" models. The FlexaDrive™ gearbox provides your propulsion line with built in "scalability". This compact design allows up to five PTO/PTI drive towers to be added, as required, to satisfy current or future requirements for shipboard auxiliary power.

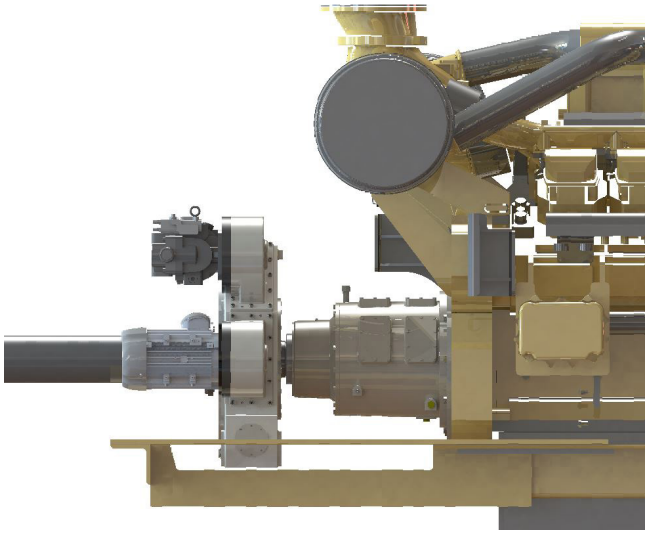
Incorporating the new Logan FlexaDrive™ into your existing or new-build vessel can open the door to implementing hybrid and other efficiency enhancing functionality, either now or in the future. Attaching an induction motor to one of the drive towers provides not only a source of additional electrical power when the main engine is running, it is able to provide propulsive power to the shaft line when the engine is not. This can be done to provide a "come home" mode in case of engine failure, or can be part of a hybrid arrangement that is designed to reduce fuel consumption and emissions.

Return on Investment: Reduced Fuel Consumption and a Cleaner Footprint

Choosing a Logan FlexaDrive™ to be part of your new build or retrofit project will not only provide return on investment for years to come based on efficiency, it can also reduce your overall capital expenditure as well. The Logan FlexaDrive™ opens the door to reducing the number of generators fitted, or stand-alone hydraulic systems; all of these can be supplied by the Logan FlexaDrive™ fitted with the appropriate attachments.



Logan Flexadrive for hybrid applications. Up to (10) PTO/PTI. 500 HP/400kw total. (200HP/150kw per pad)



Side view of Flexadrive showing Logan direct drive bell housing PTO coupled between engine and Flexadrive.

Clutch design contributes to hybrid success

Hybrid tug technology is beginning to gain acceptance in the world's leading shipyards. Logan Clutch can claim to have been in on the ground floor, given its relationship with Foss Maritime and Aspin-Kemp (AKA) – early pioneers of the hybrid model.

U.S. Hybrid Tug, The Campbell Foss
Campbell Foss was the world's second hybrid tug.

Founded in 1889, Seattle-based Foss Maritime offers a complete range of maritime services and project management to customers across the Pacific Rim, Europe, South America and around the globe. With one of the largest fleets of tugs and barges on the US West Coast, Foss operates two shipyards – in Seattle, Washington, and Rainier, Oregon – and offers worldwide marine transportation, emphasizing safety, environmental responsibility and high-quality service.

Logan Clutch was one of the suppliers involved with the conversion of the Dolphin Class tug Campbell Foss into the world's second hybrid tug.

Campbell Foss was built in 2005 in the Foss yard in Rainier, and was originally a conventional tug powered with two 2,540hp Caterpillar 3512C engines coupled to Rolls-Royce US205 fixed-pitch azimuth thrusters.

The conversion involved adding a new Logan LCH-1250 bell housing clutch on to the 21in flywheel output of the 3512s with an integrated Centa torsional coupling.

Logan looked to Centa Corporation to provide a torsional vibration analysis (TVA) of the redesigned system to assure the complete propulsion system would operate free from any potentially damaging resonant speed conditions.

Bob Lennon, Centa's vice president, Sales, said: "Centa's TVA report confirmed the Centamax Size 18000 coupling between engine flywheel and Logan clutch input was the ideal solution. The balance of the Centa components from the existing system were then modified and reused.

"Centalink elements at the input and output of the Aspin Kemp Associates (AKA)-supplied motor/generator allow for compensation of expected high misalignment events (protecting the bearings from high load conditions), and further Centax rubber elements were kept in place to provide added misalignment and torsional damping to the complete system." The flange output of the clutch was connected by a shaft to the motor generators provided by AKA.

AKA and Foss were the key architects of the hybrid conversion – calling upon Logan to be their clutch solution provider.

Through the AKA control system, the boat's skipper can seamlessly shift from hybrid mode, running at up to 7 knots on full electric, over to diesel mode using the Logan LCH-1250 bell housing power take-off (PTO) as the connect-disconnect – and this occurs with more than 65 tonnes bollard pull.

The conversion takes place in less than 20 seconds in most circumstances, allowing the boat operator the maximum amount of flexibility possible for safety and convenience: all with just the push of the throttle. Logan clutches were a key piece of the hybrid puzzle. Logan Engineering was integral in every step of the process to ensure that the clutch system fitted into the existing engine driveline – without a significant amount of re-engineering.

The boat's operator, Foss Maritime in Long Beach, California, expects to save approximately 30 per cent of the fuel previously used and reduce harmful emissions by more than 25 per cent.

Paul Jamer, vice president, Business Development, at AKA, said: "Historically, marine operators working to improve their environmental footprint and reduce harmful emissions incurred significant up-front costs that were not compensated with operational savings that would offset their investment. "In the case of hybrid technology, however, vessels with a suitable duty cycle, such as tug boats and OSVs, can realize significant savings in fuel and maintenance.

"These savings, which will be realized for the life of the vessel, can result in a significant return on investment. In the case of tugboats, the break-even point is frequently reached in less than five years."

The environmental benefits of the hybrid technology are equally impressive. The AKA/Foss hybrid system was granted verification as an emission-reducing technology, following extensive investigation by the US

Environmental Protection Agency (EPA). The EPA focused on the 'real-life' operating results of Foss Maritime, as well as third party emissions testing on the hybrid tugs and their conventional sister vessels. This was a significant recognition of the benefits of taking a 'system' approach to optimizing propulsion and power generation plants.

The EPA also recently approved the verification of the Foss Maritime/AKA XeroPoint hybrid tugboat retrofit system. XeroPoint is an alternative drive system for use on certain marine vessels. XeroPoint includes a new generator and engine set, modification to the vessel's propulsion system and an energy management system, as well as other components designed to reduce emissions and fuel consumption for harbor tugboats.

Foss Maritime/AKA's testing showed emission reductions of about 25 per cent for particulate matter (PM), 30 per cent for NOx and 30 per cent for CO^2. In addition, these results indicate fuel savings of approximately 30 per cent with the XeroPoint hybrid system.

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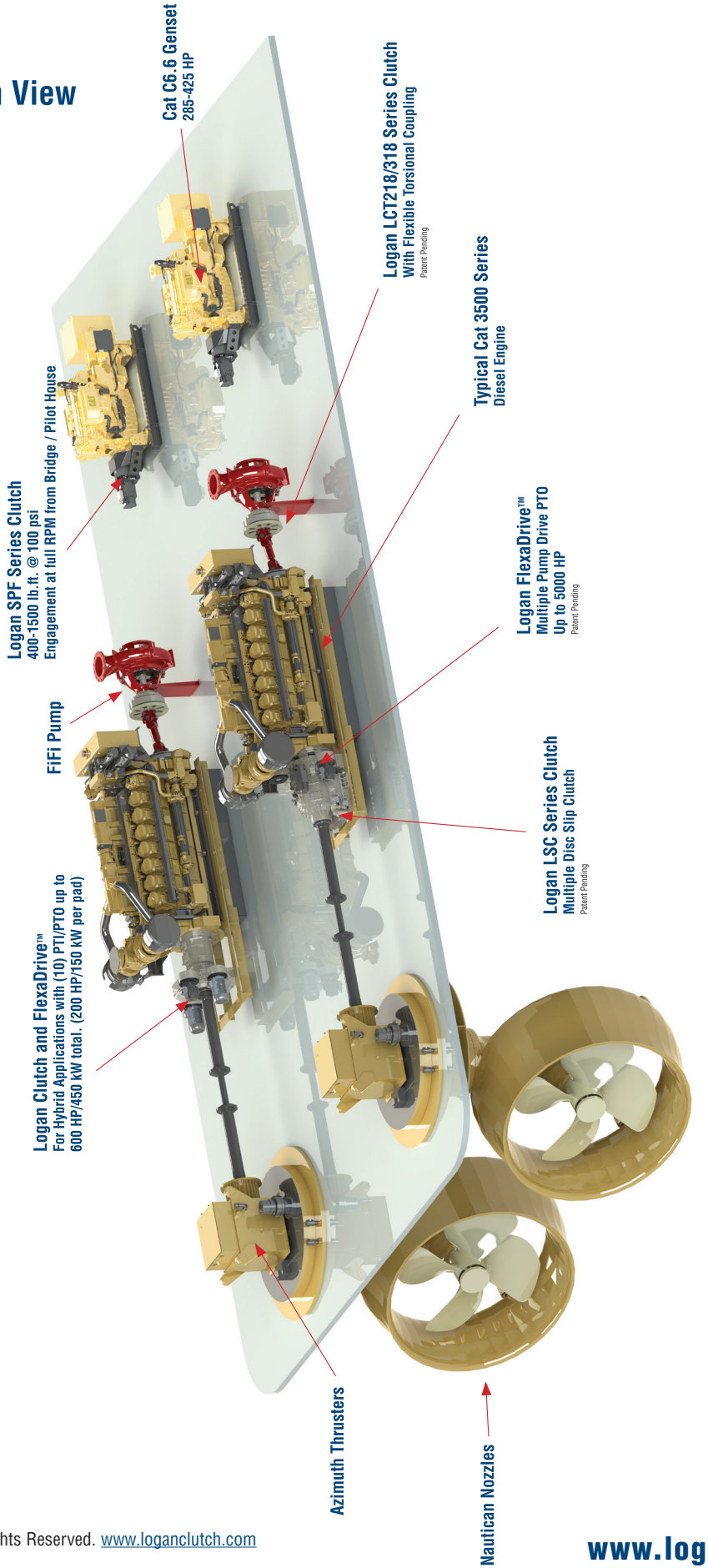
Logan Clutches For Main Propulsion, Auxiliary Power Take-Off Drives / PTO, and FiFi Applications

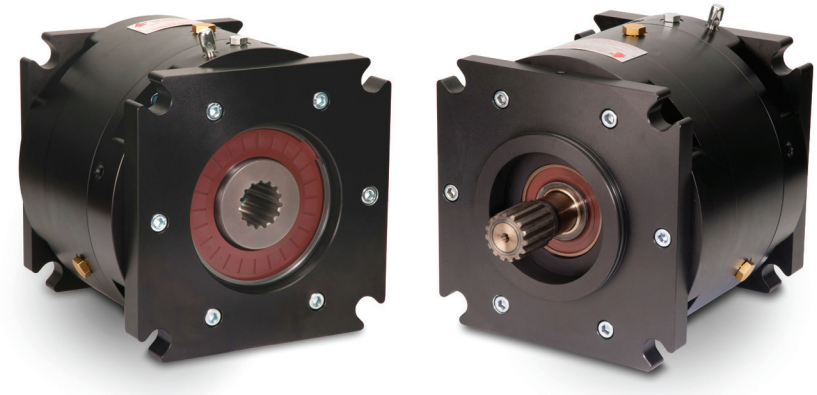
Typical Engine Room View



Logan Power Take-Off (PTO) Clutches for PTO Towers

Simple, Efficient, High-Torque Design

Available to convert the live PTO pad to a clutch-able PTO pad, the SAE PTO is available in popular pump configurations in a wide range of sizes and with every mounting configuration. May be ordered as an option for one or more FlexaDrive PTO outputs.



Standard units available in B, B-B, C, C-C, D and bore with key

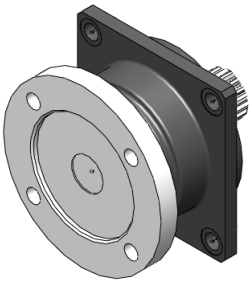
Air of fluid actuated

- Air or Fluid Actuated
- Self-Adjusting Disc Pack
- Smooth Engagement-Disangagement
- Ideal for In-Line Shaft or Pump Pad Applications
- SAE or ISO Mounting Flanges
- Available in B, C, D, D/E Splines, Plus Bore and Key Configuration
- 12 & 24 Volt DC Control Valve System

402 Series Shaft Adapters and Pulley Adapters

For Side Loading and Radial Loads

Available to handle the load of a drive shaft or a pulley driven accessory, there are a wide range of configuratio to suit many different needs. Also available is an attachment to change the PTO pad rotation direction. Always consult Logan Engineering/Documentation to determine that the side load applied is acceptable.



Shaft Adapter

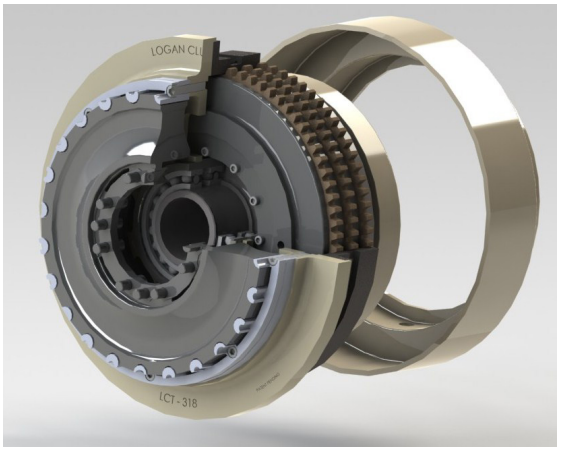
Pulley Adapter

- In stock in popular Dana Spicer and DIN flange sizes
- Adaptable to suit most popular pulley configurations
- Rotation direction change inset may also be used as a clearance spacer

LCT Series Air and Hydraulic Input Mounted Clutches For Main Drive Line

Used With Hybrid Main Drive and Front of Engine PTO Applications

The LCT typically incorporates an integral torsional coupling and may be mounted between the torsional coupling and the FlexaDrive. Available in a range of torques for almost any application, the LCT can be used to disconnect hybrid drive electric motors used on the FlexaDrive PTO. Or when placing a FlexaDrive on the front of a marine engine it can be used for large fire pumps drives.



Show with integral Centamax Coupling for 10,675 LB.FT. / 14,475 Nm

- Air of Fluid Actuated
- Simple, low cost dry clutch with high torque
- For low cycle, high torque applications
- Smooth Engagement-Disengagement
- 12-24 Volt DC control valves

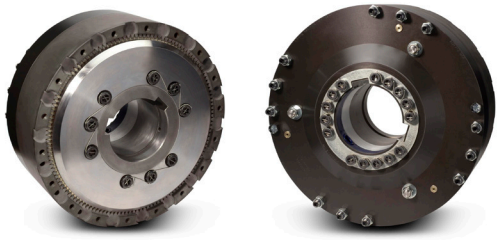
Logan CH Series Air / Fluid Clutches and Brakes

Features:

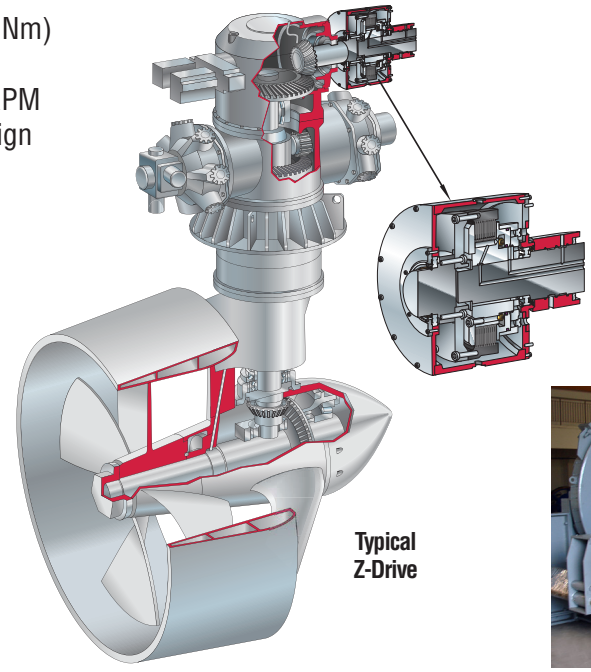
- Torque Ratings from 49,000 lb-in. (5532 Nm) to 1,280,000 lb-in (144,000 Nm)
- Standard operating speeds up to 2,200 RPM
- Modified Standards to Meet Specific Design Requirements

Advantages:

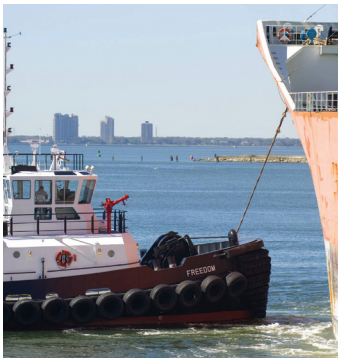
- High Torque, Small Envelope
- Fluid or Air Actuated
- Wet or Dry Operation
- Smooth Engagement – Quick Release



Logan CH Clutches



Typical Z-Drive



Render-Recover, Ship Assist Winches

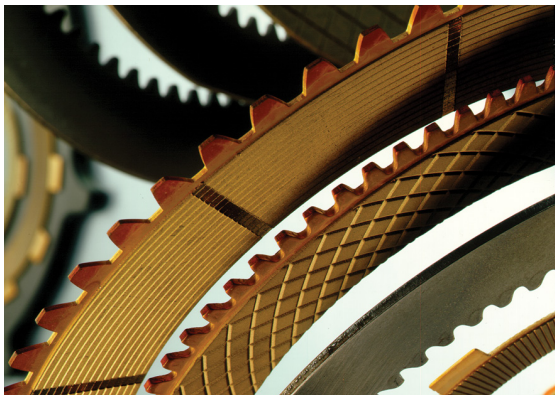
Deck and Hawser Winches

Logan Multiple Disc Clutch and Brake Applications

Logan also manufactures and stocks a wide variety of both friction-faced and high-carbon steel discs for wet or dry clutch and brake applications. Logan incorporates the latest technology in sintered bronze facing material.

- Reduce tooling costs with existing Logan tooling.
- Improve the quality of your existing friction or steel separator discs with improved friction material coefficients, heat treat specifications and mating disc surface finishes.
- Improved delivery - order small lots from existing Logan disc inventory.

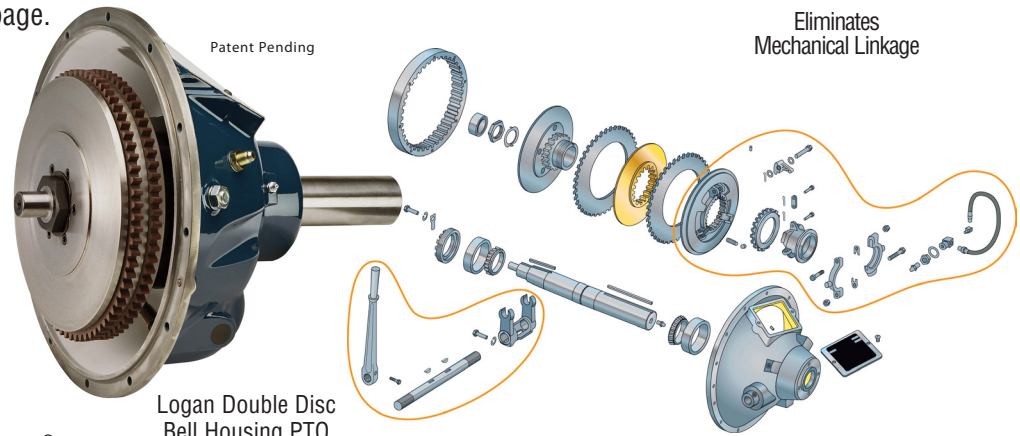
Consider Logan when designing or improving upon your single or multiple-disc clutch or brake application.



Friction-faced and high-carbon steel separator discs

Logan Bell Housing PTO Clutches

- Self Adjusting Disc Pack – minimizes Slippage.
- Available with or without pilot boearing.
- Eliminates Mechanical Linkages, Hand Levers, and Yokes.
- Air or Fluid Actuated - (air is ideal for cold start applications).
- Fast Engagement - Quick Release.
- Remote Activation.
- Modified Standards Available.



Logan Double Disc
Bell Housing PTO

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