## **Centric Overload & Centrifugal Clutches** Solutions To Torque/Timing Control





# Boston Gear

Boston Gear offers the industry's largest line up of reliable speed reducers, gearing and other quality drivetrain components.

With more than 125 years of frontline experience, Boston Gear is recognized globally as a premier resource for extremely reliable, high-performance power transmission components. Boston Gear offers the industry's most comprehensive product array featuring more than 30,000 standard products combined with the ability to custom engineer unique solutions when required. Product lines include standard enclosed gear drives, custom speed reducers, AC/DC motors, DC drives and Centric brand overload clutches and torque limiters.

## VISIT US ON THE WEB AT **BOSTONGEAR.COM**



# Altra Motion

Altra is a leading global designer and producer of a wide range of electromechanical power transmission and motion control components and systems. Providing the essential control of equipment speed, torque, positioning, and other functions, Altra products can be used in nearly any machine, process or application involving motion. From engine braking systems for heavy duty trucks to precision motors embedded in medical robots to brakes used on offshore wind turbines, Altra has been serving customers around the world for decades.

Altra's leading brands include Ameridrives, Bauer Gear Motor, Bibby Turboflex, Boston Gear, Delevan, Delroyd Worm Gear, Formsprag Clutch, Guardian Couplings, Huco, Jacobs Vehicle Systems, Kilian, Kollmorgen, Lamiflex Couplings, Marland Clutch, Matrix, Nuttall Gear, Portescap, Stieber, Stromag, Svendborg Brakes, TB Wood's, Thomson, Twiflex, Warner Electric and Wichita Clutch.

### VISIT US ON THE WEB AT ALTRAMOTION.COM



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#### **Centric Clutch History**

Since 1948, Centric Clutch has been manufacturing Centrifugal Clutches for a wide range of industries. Designed as a means to connect power in a drive train with soft start or delay capabilities, Centric's centrifugal clutch was the industry's first overload protection device with repeatable performance.

Capitalizing on the need for a dependable and repeatable torque limiter, Centric produced the Trig-O-Matic Overload Release Clutch, the original single position, mechanical torque limiting device. Customer requests for a simple cost effective overload device led to the development of the Trig-O-Matic Lite and Centrigard<sup>™</sup> which further solidified the company's position as an industry leader.

Centric revolutionized torque limiting technology with the VariTorque, the first single position pneumatic overload clutch. The VariTorque was designed to meet the specific needs of paper converting machinery where large starting inertias, high production speeds, and the possibility of equipment failure is great.

The addition of three Model H clutches have helped to position the Centric family of products as one of the industry's premier offerings of mechanical overload protection devices.

By combining Centric's industry expertise and engineering capabilities with Boston Gear's distributor network and responsiveness oriented culture, customer expectations will continue to be met and exceeded. In a world where down time is unacceptable, Boston Gear will continue the Centric tradition of producing high quality, durable clutches quickly and efficiently. Yesterday, today, and tomorrow, Boston Gear will provide you, our valued customers, with the answers to all of your torque overload needs.

### **Applications**

Because we realize that no two torque overload applications are the same, Boston Gear is available to put over 120 years of mechanical power transmission expertise to work for you.

### **Contact Us**

Feel free to contact our technical support team at www.centricclutch.com or call us at 704-688-7324 or Tech Support at 800-816-5608.



Trig-O-Matic Overload Clutch Packaging Machine Case Palletizer



Varitorque Overload Clutch Paper Converting Machine



H1900 Overload Clutch Water Treatment Plant

| CENTRIGARD™<br>OVERLOAD<br>CLUTCHES        | Pages 7-8                         |                                   |                           |
|--|-----------------------------------|-----------------------------------|---------------------------|
| TRIG-O-MATIC LITE™<br>OVERLOAD<br>CLUTCHES | LOR SERIES<br>Pages 9-13          |                                   |                           |
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### **Quick Selection Guide**

|                                    |                                |                                | Spring                         | Loaded Mechai                 | nical Torque Lim              | iters                         |                               |                                |                                |
|------------------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------------|--------------------------------|
| Model                              | Centrigard                     | LOR                            | ORC-F                          | ORC-SA                        | ORC-SB                        | ORC-SP                        | ORC-SM                        | HOR                            | WOR                            |
| Applications                       | Packaging<br>Duty              | Packaging<br>Duty              | Packaging<br>Duty              | Packaging<br>Duty             | Packaging<br>Duty             | Packaging<br>Duty             | Packaging<br>Duty             | Washdown<br>Duty               | Wastewater<br>Duty             |
| Torque<br>Repeatability            | +-10%                          | +-10%                          | +-10%                          | +-10%                         | +-10%                         | +-10%                         | +-10%                         | +-10%                          | +-10%                          |
| Reset Type                         | Fully<br>Automatic             | Fully<br>Automatic             | Fully<br>Automatic             | Fully<br>Automatic            | Semi-<br>Automatic            | Manual<br>Reset               | Manual<br>Reset               | Fully<br>Automatic             | Automatic or<br>Manual         |
| Shut down<br>mechanism             | Plate style<br>automatic reset | Plate style<br>automatic reset | Plate style<br>automatic reset | Pin style<br>automatic reset  | Plate style<br>manual reset   | Plate style<br>manual reset   | Pin style<br>automatic reset  | Plate style<br>automatic reset | Plate style<br>automatic reset |
| Free wheeling                      | No                             | No                             | No                             | No                            | No                            | Yes                           | Yes                           | No                             | Yes/No                         |
| Reset Position                     | Single                         | Single                         | Single                         | Single                        | Single                        | Single                        | Single                        | Single                         | Four                           |
| Maximum RPM                        | 1000                           | 1000                           | 500                            | 1800                          | 1800                          | 1800                          | 1800                          | 500                            | 50                             |
| Minimum Torque<br>Range (Inch-Ibs) | 50                             | 200                            | 70                             | 35                            | 35                            | 35                            | 35                            | 25                             | 850                            |
| Maximum Torque<br>Range (inch-lbs) | 1,200                          | 5,000                          | 10,000                         | 25,000                        | 25,000                        | 25,000                        | 25,000                        | 50,000                         | 30,000                         |
| Minimum bore<br>size (inch)        | 1/2                            | 1/2                            | 1/2                            | 1/2                           | 1/2                           | 1/2                           | 1/2                           | 7/16                           | 3/4                            |
| Maximum bore<br>size (inch)        | 1-1/4                          | 2-3/4                          | 2-3/4                          | 3-15/16                       | 3-15/16                       | 3-15/16                       | 3-15/16                       | 3-5/8                          | 4-1/4                          |
| Mounting<br>Options                | Sprocket/Pulley                | Sprocket/Pulley                | Sprocket/Pulley/<br>Couplings  | Sprocket/Pulley/<br>Couplings | Sprocket/Pulley/<br>Couplings | Sprocket/Pulley/<br>Couplings | Sprocket/Pulley/<br>Couplings | Sprocket/Pulley/<br>Couplings  | Sprocket/Pulley                |
| Page Number                        | 7                              | 11                             | 27                             | 19                            | 19                            | 19                            | 19                            | 37                             | 47                             |

#### **Boston Gear Overload Clutches**





Trig-O-Matic



H1600



H1900



Centrigard

### **Quick Selection Guide**

#### **Boston Gear Overload Clutches**

| Pneumatic Torque Limiters          |                                |                                |                                |  |  |  |  |  |
|------------------------------------|--------------------------------|--------------------------------|--------------------------------|--|--|--|--|--|
| Model                              | POR                            | PDC                            | VOR                            |  |  |  |  |  |
| Applications                       | High Speed<br>Washdown Duty    | Washdown<br>Duty               | Washdown<br>Duty               |  |  |  |  |  |
| Torque<br>Repeatability            | +-5%                           | +-5%                           | +-5%                           |  |  |  |  |  |
| Reset Type                         | Fully<br>Automatic             | Fully<br>Automatic             | Fully<br>Automatic             |  |  |  |  |  |
| Shut down<br>mechanism             | Plate style<br>automatic reset | Plate style<br>automatic reset | Plate style<br>automatic reset |  |  |  |  |  |
| Free wheeling                      | No                             | Yes                            | No                             |  |  |  |  |  |
| Reset Position                     | Single                         | Single                         | Single                         |  |  |  |  |  |
| Maximum RPM                        | 3600                           | 1800                           | 1000                           |  |  |  |  |  |
| Minimum Torque<br>Range (Inch-Ibs) | 120                            | 300                            | 250                            |  |  |  |  |  |
| Maximum Torque<br>Range (inch-lbs) | 33,000                         | 4,000                          | 10,000                         |  |  |  |  |  |
| Minimum bore<br>size (inch)        | 7/16                           | 5/8                            | 5/8                            |  |  |  |  |  |
| Maximum bore<br>size (inch)        | 3-1/4                          | 1-3/4                          | 2-3/16                         |  |  |  |  |  |
| Mounting<br>Options                | Sprocket/Pulley/<br>Couplings  | Sprocket/Pulley                | Sprocket/Pulley                |  |  |  |  |  |
| Page Number                        | 55                             | 65                             | 71                             |  |  |  |  |  |

#### **Centrifugal Clutches**

|                                       | Centrifugal Clutches |            |            |            |  |  |  |  |  |  |
|---------------------------------------|----------------------|------------|------------|------------|--|--|--|--|--|--|
| Model Type A Type AVL Type H Type NLS |                      |            |            |            |  |  |  |  |  |  |
| Applications                          | Heavy Duty           | Heavy Duty | Heavy Duty | Heavy Duty |  |  |  |  |  |  |
| Max. HP                               | 2300                 | 2300       | 800        | 8360       |  |  |  |  |  |  |
| Max. Bore                             | 7.0                  | 7.0        | 4-3/4      | 8.0        |  |  |  |  |  |  |
| Spring Controlled                     | Yes                  | Yes        | Yes        | Yes        |  |  |  |  |  |  |
| Free Engagement                       | Yes                  | Yes        | No         | Yes        |  |  |  |  |  |  |
| Bored to Size                         | Yes                  | Yes        | Yes        | Yes/No     |  |  |  |  |  |  |
| Bushing Mounted                       | No                   | No         | No         | Yes        |  |  |  |  |  |  |
| Vertical Lift Out                     | No                   | Yes        | No         | No         |  |  |  |  |  |  |
| Pulley/PTO<br>Mounted                 | No                   | No         | Yes        | No         |  |  |  |  |  |  |
| Steel Banded                          | Yes/No               | Yes/No     | Yes/No     | Yes/No     |  |  |  |  |  |  |
| Torque Limiting                       | Yes                  | No         | No         | Yes/No     |  |  |  |  |  |  |
| Page Number                           | 76                   | 76         | 76         | 84         |  |  |  |  |  |  |









Type NLS



Type H





H2000



## **Centrigard™ Overload Clutch**

Centric products have long been known as the most durable overload clutches on the market. Today we have added a maintenance friendly clutch that provides zero backlash. This clutch will be ready to limit the transmitted torque no matter if the overload jam is once a year or many times per day.

#### **Features**

- Compact design with fewer components
- Widest torque range in its class: 50 to 1,200 in. lbs.
- Fully automatic reset
- Roller Detent
- Bi-directional single position clutch
- Hardened components rated for thousands of overloads
- Maximum torque limit stop
- Corrosion resistant hard-anodized housing
- Durable stainless steel limit switch plate/trip plate for remote overload detection
- Bored to size (1.250 inch max. bore size)
- Designed and manufactured in the U.S.A.
- Torq/Gard Interchange





## **Centrigard™ Overload Clutch**

### **Type F Flexible Coupling**



| Clutch | Torque | Clutch Bore | Coupling      | Coupling      | Torque Range (Lb. In.) |      | Maximum | Weight |
|--------|--------|-------------|---------------|---------------|------------------------|------|---------|--------|
| Size   | Code   | Max (in.)   | Max. (2) Bore | Max. (1) Bore | Min                    | Max  | RPM     | (lbs.) |
| 060    | М      | 1.25        | 1.562         | 1.500         | 50                     | 1200 | 1000    | 5.0    |

Refer to page 96 for a complete list of bore codes.

(1) Square Key, (2) Flat Key See ORC1 coupling on page 22 for misalignment limits.

### **Sprocket Mount**



#### **Minimum Acceptable Plate Sprocket Mounts**

| Minim          | Minimum Number of Teeth per Pitch Size |       |       |       |       |  |  |  |  |  |
|----------------|--|-------|-------|-------|-------|--|--|--|--|--|
| Clutch<br>Size | #35                                    | #40   | #60   | #80   |       |  |  |  |  |  |
|                | 3/8 1/2                                |       | 5/8   | 3/4   | 1     |  |  |  |  |  |
|                | Pitch                                  | Pitch | Pitch | Pitch | Pitch |  |  |  |  |  |
| CGC060         | 31                                     | 24    | 20    | 17    | 14    |  |  |  |  |  |



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#### **Features**

- Simple cost-effective design
- Bi-directional operation
- Single position reset
- Reliable limit switch actuating plate
- Easy torque adjustment
- Maximum torque limit stop
- Through shaft or end shaft mounting
- Large bore capacity
- Bored to size
- Torq/Gard interchange



Torque transmission between the roller and the rotor is the key to the disengagement of the clutch. The roller is held in the detent of the rotor by the radial load generated by compressing the spring pack. This load determines the torque capacity of the clutch. Increasing or decreasing the spring compression provides an adjustment to the torque capacity. When a torque overload condition occurs, the roller moves out of the detent and free-wheels much like a needle bearing. This rolling action increases the efficiency in which the clutch operates and reduces any fluctuation of the torque setting caused by frictional changes. Refer to Figure 2.





The movement of the actuating plate during disengagement can be used to trip a limit switch or sensor and signal a torque overload condition. The drive should be shut down immediately and the source of the overload detected and cleared. The automatic reset feature of the clutch allows it to re-engage in its single position without manual assistance. Simply restart the drive and the clutch is again ready to provide accurate and dependable disconnect protection for your equipment.

### Flange with Proximity Plate

As the Trig-O-Matic Lite overload clutch is disengaged, the flange (Actuating Plate) moves 0.18 inches. This movement can be used to trip a mechanical limit switch and signal a torque overload condition. Many applications require that a proximity sensor be used in place of the mechanical limit switch which necessitates the addition of a metallic plate to the nonmetallic flange. This metallic flange can be ordered on the Trig-O-Matic Lite overload clutch by indicating a letter P in the catalog number after the size (e.g., LOR-060P-AP16).

### **Operating Principles**

The LOR Series Trig-O-Matic Lite is an automatic reset, roller detent style clutch. It was designed to be cost-effective without sacrifice to accurate and dependable disconnect protection for mechanical equipment. Refer to Figure 1.



#### Selection

- 1. Determine overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 86 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

- b. Determine the "weak link" in the drive train, (i.e. chain, reducer, belt or shaft). Select an overload release torque that is below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size, keyway, and taper bore or straight bore bushing model.
- 3. Refer to the Basic Selection Chart for the appropriate clutch size.
- 4. Refer to Page 12 for ratings and dimensions.

#### **Basic Selection Chart**

| Clutch | Bore  |        | Bore Torque Range |       | Torque Range | Maximum |
|--------|-------|--------|-------------------|-------|--------------|---------|
| Size   | Min   | Max*   | (Lb. In.)         | RPM   |              |         |
| 060    | .500  | 1.4375 | 200-700           | 1,000 |              |         |
| 200    | 1.000 | 2.1250 | 600-2,000         | 1,000 |              |         |

\*Max bores will require flat keys (supplied with unit).



Each clutch is tested throughout the torque range then set at the minimum torque range value at the factory. The torque dial label is indexed to a match mark on the clutch at the number "1" location. The torque dial label has eight hash marks evenly spaced at 45 degrees. To increase the torque, loosen the locking screw and turn the adjusting screw clockwise. When the desired torque value is achieved, secure the torque adjustment screw by tightening the locking screw.





#### How to Order

When ordering a Trig-O-Matic Lite LOR Series Overload Clutch, please include code letters/numbers for series, size, type, torque range, and unit bore. Not all combinations are possible. Please refer to Page 12 for details.

#### Example:

Required Size 060 Trig-O-Matic Lite Overload Clutch, standard flange, adjustable torque range, with a one inch bore:



### **Straight Bore**





#### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | D<br>+.002/004 | E    | F    | G   | Н   | I   | J    | К      | L    | М     |
|----------------|------|------|----------------|------|------|-----|-----|-----|------|--------|------|-------|
| 060            | 2.25 | 7.50 | 2.375          | 3.38 | 6.00 | .24 | .74 | .40 | 3.77 | 1/4-20 | 0.56 | 2.875 |
| 200            | 2.98 | 9.50 | 3.250          | 5.25 | 8.00 | .22 | .94 | .59 | 4.91 | 3/8-16 | 0.75 | 4.500 |

#### Ratings

| Clutch | A Bores (inch) |          |         | Torque Range | Max.  | WR <sup>2</sup> | Weight |
|--------|----------------|----------|---------|--------------|-------|-----------------|--------|
| Size   | Min            | Max. (1) | Max (2) | (LbIn.)      | RPM*  | (LbIn.²)        | (Lbs.) |
| 060    | .5000          | 1.3750   | 1.4375  | 200-700      | 1,000 | 39              | 7.5    |
| 200    | 1.0000         | 2.0000   | 2.1250  | 600-2,000    | 1,000 | 181             | 19     |

\*Maximum RPM dependent on operation of clutch with limit switch and immediate shut down. (1) Square Key

(2) Flat Key

#### **Bore Tolerances**

| Bores    | Tolerance   |
|----------|-------------|
| 0" to 1" | +.0005/0000 |
| 1" to 3" | +.0010/0000 |

#### Minimum Acceptable Plate Sprocket Mounts\*

| Minimum Number of Teeth per Pitch Size |       |       |       |       |       |       |       |
|--|-------|-------|-------|-------|-------|-------|-------|
| Clutch                                 | #25   | #35   | #40   | #50   | #60   | #80   | #100  |
| Sizo                                   | 1/4   | 3/8   | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 |
| Size                                   | Pitch |
| 060                                    | 47    | 32    | 25    | 21    | 18    | —     | —     |
| 200                                    | _     | 48    | 37    | 30    | 26    | 20    | —     |

\*Please contact Boston Gear for Sprocket Clutch Assemblies.

Clutches are shipped set for the minimum torque value unless specified.

#### Refer to Page 11 for ordering information.

#### **Standard Keyways**

| Bore Range    | Square      |
|---------------|-------------|
| Over – To     | W x D       |
| 5/16 – 7/16   | 3/32 x 3/64 |
| 7/16 – 9/16   | 1/8 x 1/16  |
| 9/16 – 7/8    | 3/16 x 3/32 |
| 7/8 – 1-1/4   | 1/4 x 1/8   |
| 1-1/4 – 1-3/8 | 5/16 x 5/32 |
| 1-3/8 – 1-3/4 | 3/8 x 3/16  |
| 1-3/4 – 2-1/4 | 1/2 x 1/4   |
| 2-1/4 – 2-3/4 | 5/8 x 5/16  |
|               |             |

## **Trig-O-Matic Lite Overload Clutches**

### **Suggested Mounting Arrangements**

Boston Gear can provide assistance for virtually any drive layout. Plate sprockets, timing belt pulleys, gears, and couplings can be provided upon request.





**Plate Sprocket Mount with End Shaft** 

**Timing Belt Pulley Mount with Through Shaft** 



## **Trig-O-Matic Lite Overload Clutches**

|--|

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:  | 7. Shut Down Method:  |
|--|---|
| ☐ New  | Prox Plate  |
| ☐ Existing   | Pin Style (ORC only)  |
| – Replacement Model #  | None Required   |
| 2. Power transmission requirements at  |   |
| clutch location:   | Name:   |
| □ RPM  | Phone #   |
| Limiting Torque Level  |   |
| 3 Type:  | Fax #   |
| Mechanical (Spring Loaded)   | Company   |
| Pneumatic  | E-Mail  |
| <ul> <li>4. Type:</li> <li>Fully Automatic Re-Engagement</li> <li>Manual (Free Wheeling)</li> <li>Semi Automatic (ORC model only)</li> </ul>                           | Use the space below to note any relevant application data or to detail your question. |
| <ul> <li>5. Method of Torque Transmission:</li> <li>Flexible Coupling</li> <li>Rigid Coupling</li> <li>Sprocket Mount</li> <li>Sprocket Size and Tooth Count</li></ul> |   |
| 6. Bore Size:  |   |
| Sprocket Mount (Clutch Bore) Coupling Mount (Clutch Bore)  |   |
| (Coupling Bore)  |   |
|  |   |
|  |   |
|  |   |
|  |   |



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### **Features**

- Bi-directional operation
- Single positioning for re-engagement at the exact cycle point at which it released
- Limit switch actuation for remote detection of overload condition
- · Completely enclosed for dirty applications
- Automatic or manual reset
- · Various configurations for direct and indirect drives
- Six sizes (Model F five sizes) to accommodate various bore and torque ranges



**Standard Model S** 



**Fully Automatic Model F** 



The Trig-O-Matic's unique "Trigger" action design disconnects the load at the instant an overload occurs and at the exact torque limit you set. When the overload condition is corrected, the clutch resets at the exact cycle point and torque at which it released.

The ORC Series Trig-O-Matic Overload Clutch is available in two models: the Standard Model S and the Fully Automatic Model F. Both provide single position engagement and a means to signal an overload condition. Each model is available in various sizes and types to adapt to your drive train. They incorporate reliability, repeatability and adjustability to protect your machinery from costly damage or downtime.

#### **Applications**

The ORC Series Trig-O-Matic Overload Release Clutch can be applied on any drive train where the protection of reducers, indexers, chain, sprockets or product is required. It can replace less precise and less reliable devices such as shear pins and friction clutches.

Typical applications include: packaging machinery, paper converting machinery, baking equipment, bottling and capping machinery, indexing machinery, labeling machinery, conveyors, presses and water treatment equipment.



#### **Selection**

- 1. Determine the overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

Torque (Lb. In.) = 
$$\frac{\text{HP x 63025}}{\text{RPM}} \text{X SF}$$

- b. Determine the "weak link" in the drive train, (i.e. chain, reducer, belt or shaft). Select an overload release torque that is below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size(s) and keyway(s):
  - a. Shaft size at the clutch location determines the clutch bore.
  - b. Shaft size at the coupling location determines the coupling bore (if applicable).
- 3. Choose the appropriate Model (S or F), based upon the drive layout and the application's requirements.
- 4. Refer to the Basic Selection Chart for the appropriate clutch size.
- 5. Refer to Part Numbering System to complete selection.

The Standard Model S is Boston Gear's basic low-cost unit on which various optional features can be added. The clutch mechanism is available in automatic or manual reset. Typically, a manual reset clutch is used where it will run disengaged for extended periods of time. The automatic reset is generally used in conjunction with a limit switch to shut the drive down. The Standard Model is typically used to replace shear pins and where access to the clutch is available. See page 19.

The Fully Automatic Model F includes all the features available in the Standard Model plus an automatic switch actuating mechanism, an automatic clutch mechanism and three mounting styles. The Model F is generally used where the unit is not easily accessible. This model is a complete overload clutch designed especially for production and packaging machinery. See page 27.

| ORC Series Model S            | ORC Series Model F            |
|-------------------------------|-------------------------------|
| Bi-directional                | Bi-directional                |
| Single Position               | Single Position               |
| Manual Clutch Reset           | Automatic Clutch Reset        |
| Automatic Clutch Reset        | Automatic Oldien Nesel        |
| Clutch Types C, N, R, T       | Clutch Types C, N, R, T       |
| One Mounting Style            | Three Mounting Styles         |
| Limit Switch Pin              | Fully Automatic               |
| Limit Switch Plate Actuator   | Limit Switch Plate Actuator   |
| Additional Features:          | Additional Features:          |
| Torque Selector Dial          | Torque Selector Dial          |
| Max. Torque Limit Stop        | Max. Torque Limit Stop        |
| Grease Pack & Relief Fittings | Grease Pack & Relief Fittings |
|                               | Locking Collar Mounting       |
| Optional:                     | Optional:                     |
| Pressure Lube Bearings        | Balancing                     |
| Balancing                     | One-Directional Feature       |
| Locking Collar Mounting       |                               |

#### **Trig-O-Matic Model Feature Comparisons**

| Deele | Coloction | Ohart |
|-------|-----------|-------|
| Basic | Selection | Unart |

| Standard Model S |              |        |                     |              | Fully Automatic Model F |              |        |                  |               |
|------------------|--------------|--------|---------------------|--------------|-------------------------|--------------|--------|------------------|---------------|
| Clutch           | Max.<br>Bore | Torque | Torque F<br>(Lb. II | Range<br>n.) | Clutch                  | Max.<br>Bore | Torque | Torque I<br>(Lb. | Range<br>In.) |
| SIZE             | (Inch)*      | COUE   | Min.                | Max.         | 3126                    | (Inch)*      | Code   | Min.             | Max.          |
|                  |              | L      | 35                  | 100          |                         |              | L      | 70               | 140           |
| 1                | 0.8750       | М      | 75                  | 275          | 1                       | 0.7500       | М      | 110              | 275           |
|                  |              | Н      | 200                 | 400          |                         |              | Н      | 260              | 400           |
|                  |              | L      | 50                  | 200          |                         |              | L      | 100              | 200           |
| 2                | 1.1875       | М      | 200                 | 600          | 2                       | 1.1250       | М      | 200              | 600           |
|                  |              | Н      | 400                 | 1,000        |                         |              | Н      | 400              | 1,000         |
|                  |              | L      | 200                 | 850          |                         |              | L      | 200              | 850           |
| 3                | 1.8120       | М      | 800                 | 2,200        | 3                       | 1.7500       | М      | 800              | 2,200         |
|                  |              | Н      | 1,200               | 3,000        |                         |              | Н      | 1,200            | 3,000         |
|                  |              | L      | 600                 | 1,400        |                         |              | L      | 600              | 1,400         |
| 4                | 2.3120       | М      | 1,200               | 3,000        | 4                       | 2.1250       | М      | 1,200            | 3,000         |
|                  |              | Н      | 2,850               | 5,000        |                         |              | Н      | 2,850            | 5,000         |
|                  |              | L      | 1,600               | 3,000        |                         |              | L      | 1,600            | 3,000         |
| 5                | 3.0000       | М      | 2,500               | 6,000        | 5                       | 2.7500       | М      | 2,500            | 6,000         |
|                  |              | Н      | 4,000               | 10,000       |                         |              | Н      | 4,000            | 10,000        |
|                  |              | L      | 4,000               | 8,000        |                         |              | _      | _                | _             |
| 6                | 3.9375       | М      | 7,500               | 14,000       | —                       | —            | —      | -                | —             |
|                  |              | Н      | 12,500              | 25,000       |                         |              | —      | —                | —             |

\*Larger bores may require flat keys (supplied with unit).

### Standard Model S

#### **Operating Principles**

The Standard Model S ORC Series Trig-O-Matic Overload Release Clutch consists of two basic components: the rotor and the housing assembly. The clutch rotor is keyed and secured to the drive shaft with a setscrew.

The housing assembly includes a drive pawl and a reset pawl which are pivoted within the clutch housing. The drive pawl is held engaged in the rotor notch by the combined pressure of the drive and reset springs as shown in Figure 1. The combined pressure of these two springs determines the maximum torque which is transmitted without overload. With the clutch mechanism in the engaged position shown in Figure 1, the rotor and housing are held together and the entire unit rotates with the drive shaft at the same speed.



Figure 1 – Engaged

The Standard Model Trig-O-Matic is available in two clutch reset types: Manual and Automatic.

#### **Manual Reset**

The instant an overload occurs, the pressure of the drive and reset springs is overcome by the extra force applied to them. The drive pawl is forced out of its engaged position from the rotor and as it pivots up, the reset pawl lifts and locks it out of contact with the rotor as shown in Figure 2. The clutch then rotates freely.

When the overload condition has been corrected, the clutch is reset by inserting a hexagon wrench in the reset screw and turning the screw clockwise until the reset pawl releases the drive pawl. When the drive pawl re-engages with the rotor, the reset screw must be backed out to its original stop position. This is essential to restore the torque to its original setting.



Disengaged - Manual

#### **Fully Automatic or Semi-Automatic**

The instant an overload occurs, the pressure of the drive and reset springs is overcome by the extra force applied to them. The drive pawl is forced out of its engaged position from the rotor. After one revolution the drive pawl will automatically return to its engaged position. If the overload is still present, it will not seat and will continue to rotate until overload has been removed. The drive should be stopped as soon as possible. After the overload condition has been corrected the drive must be "jogged" until the drive pawl engages with the rotor.

Note: Models "SB" and "SC" are semi-automatic because the actuating plate must be manually reset. See models F (page 27) or SA for fully automatic operation.



Disengaged - Automatic

### **Limit Switch Pin**

A Limit Switch Pin is furnished as a standard item for model SA and SM to activate a limit switch that triggers the electrical controls. The travel of the Limit Switch Pin protruding radially from the clutch housing is controlled by the drive pawl motion upon disengagement. The Limit Switch Pin can only be effective if the housing continues to turn when an overload occurs and the rotor stops, (i.e., the housing is the driver and the rotor is the driven). The housing RPM must be considered to determine the time for the Limit Switch Pin to revolve around before contacting the limit switch.

The standard Limit Switch Pin extension is 1-inch, however, it can be made flush with the housing when engaged. If the Limit Switch Pin is not required, it can be omitted from the assembly with a "Z1" suffix.

If instantaneous operation of a limit switch is required or if the housing stops upon overload, see Page 25 for the Limit Switch Plate Actuator or the Model F on page 27. Units which include this device do not have the Limit Switch Pin.

## Trig-O-Matic Overload Clutches

## **Torque Selector Dial**

The torque selector dial shown in Figure 4 is a standard feature on all Standard Model S Trig-O Matic clutches. Each clutch is individually calibrated to specific torque values. The housing has two milled marks indicating minimum and maximum torque. In addition, these values are stamped on the housing adjacent to each mill mark. To adjust the torque, loosen the "lock screw", turn the torque adjusting screw (stamped #9) until it is flush with the milled depth and the red scribed lines match the required output position. Additional marks can be indicated upon request.

### **Maximum Torque Limit Stop**

A maximum torque limit stop is supplied to prevent clutch lockup. In conjunction with a torque selector dial, the maximum value indicated by the deepest milled mark can not be exceeded.

### **Grease Pack Fittings**

Grease pack fittings are supplied countersunk into the clutch housing to pack the clutch cavity, preventing corrosion. This feature is especially suitable for outdoor or washdown service.



Figure 4



#### **ORC Model S Series Part Numbering System**

### How to Order — Standard Model S

When ordering an ORC Series Trig-O-Matic Overload Clutch, please include code letters for series, size, model, type, torque range, unit bore and coupling bore (if applicable). Not all combinations are possible.

#### Example:

Required Size 2 Trig-O-Matic Overload Clutch, Standard Model S, automatic reset with pin actuator, flexible coupling, light torque range, with a one inch unit bore and a one inch coupling bore:



(Only include second bore "P20" if clutch is a coupling style)

### **Model SA and SM**

Type T Sprocket, Sheave, Pulley Mounting

For additional dimentional information on Model SB and SP, see page 25.



#### **All Dimensions in Inches**

| Clutch<br>Size | А     | С    | D    | E    | F     | G<br>+.000/002 | H<br>Bolt Circle | Т   | U    | V    | Weight<br>(Lbs.) |
|----------------|-------|------|------|------|-------|----------------|------------------|-----|------|------|------------------|
| 1              | 4.50  | 2.31 | 2.25 | 0.37 | 2.87  | 1.875          | 2.375            | .13 | 1.28 | 1.03 | 6                |
| 2              | 6.00  | 2.75 | 2.69 | 0.43 | 3.68  | 2.250          | 3.000            | .13 | 1.53 | 1.22 | 12               |
| 3              | 8.00  | 3.50 | 3.44 | 0.50 | 4.87  | 3.250          | 4.125            | .13 | 1.94 | 1.56 | 26               |
| 4              | 10.00 | 4.47 | 4.41 | 0.68 | 6.12  | 3.203          | 5.000            | .13 | 2.66 | 1.81 | 55               |
| 5              | 12.00 | 5.12 | 5.06 | 0.81 | 7.50  | 4.125          | 6.250            | .13 | 3.00 | 2.12 | 100              |
| 6              | 16.00 | 6.25 | 6.19 | 1.06 | 10.00 | 6.000          | 8.750            | .25 | 3.68 | 2.56 | 215              |

Refer to Page 21 for mounting hole patterns.

#### Ratings

| Clu | ıtch | Torqu | e Range | (Lb. In.) | Max.  | WR <sup>2</sup>       |  |
|-----|------|-------|---------|-----------|-------|-----------------------|--|
| Si  | ze   | L     | М       | Н         | RPM*  | (LbIn. <sup>2</sup> ) |  |
| -   | Min. | 35    | 75      | 200       | 1 900 | 14                    |  |
| 1   | Max. | 100   | 275     | 400       | 1,000 | 14                    |  |
| n   | Min. | 50    | 200     | 400       | 1 200 | 54                    |  |
| 2   | Max. | 200   | 600     | 1,000     | 1,200 | 54                    |  |
| 2   | Min. | 200   | 800     | 1,200     | 1 200 | 212                   |  |
| 3   | Max. | 850   | 2,200   | 3,000     | 1,200 |                       |  |
| 1   | Min. | 600   | 1,200   | 2,850     | 000   | 602                   |  |
| 4   | Max. | 1,400 | 3,000   | 5,000     | 900   | 093                   |  |
| Б   | Min. | 1,600 | 2,500   | 4,000     | 600   | 1 0 1 0               |  |
| 5   | Max. | 3,000 | 6,000   | 10,000    | 000   | 1,010                 |  |
| 6   | Min. | 4,000 | 7,500   | 12,500    | 600   | 6 9 1 0               |  |
| 0   | Max. | 8,000 | 14,000  | 25,000    | 000   | 0,940                 |  |

Clutches are shipped set for the minimum torque value of the selected range.

\*For speeds exceeding 75% of the maximum RPM, Ball Bearings and balancing are recommended.

Sprockets, gears, sheaves and pulleys can be mounted upon request.

Refer to Page 21 for sprocket sizes.

Refer to Page 19 for ordering information.

#### **Clutch Bores**

| Clutch | Bores (inch) |          |          |  |  |  |  |
|--------|--------------|----------|----------|--|--|--|--|
| Size   | Min.         | Max. (1) | Max. (2) |  |  |  |  |
| 1      | 0.5000       | 0.7500   | 0.8750   |  |  |  |  |
| 2      | 0.6250       | 1.1250   | 1.1875   |  |  |  |  |
| 3      | 0.7500       | 1.7500   | 1.8125   |  |  |  |  |
| 4      | 1.1250       | 2.2500   | 2.3125   |  |  |  |  |
| 5      | 1.5000       | 2.7500   | 3.0000   |  |  |  |  |
| 6      | 2.0000       | 3.7500   | 3.9375   |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### **Model S and F**

**Type T Mounting Hole Patterns** 



#### **Clutch Sizes 1 and 2**

**Clutch Sizes 3 and 4** 

Clutch sizes 5 and 6

1 Dowel Hole at 14°

|                |      | Mounting Holes |              |                |                               |               |  |  |
|----------------|------|----------------|--------------|----------------|-------------------------------|---------------|--|--|
| Clutch<br>Size | Qty. | Thread<br>Size | Tap<br>Depth | Bolt<br>Circle | Pilot<br>Dia.<br>+.000<br>002 | Dowel<br>Size |  |  |
| 1              | 3    | 1/4-20         | .50          | 2.375          | 1.875                         | .25           |  |  |
| 2              | 3    | 5/16-18        | .50          | 3.000          | 2.250                         | .31           |  |  |
| 3              | 4    | 3/8-16         | .62          | 4.125          | 3.250                         | .37           |  |  |
| 4              | 4    | 1/2-13         | .87          | 5.000          | 3.203                         | .50           |  |  |
| 5              | 6    | 5/8-11         | 1.00         | 6.250          | 4.125                         | .62           |  |  |
| 6              | 6    | 5/8-11         | 1.00         | 8.750          | 6.000                         | .62           |  |  |

#### Minimum Number of Teeth Adaptable to Type T Clutches

|        |                    | Standard Chain Size and Pitch |         |       |       |       |       |       |          |         |       |
|--------|--------------------|-------------------------------|---------|-------|-------|-------|-------|-------|----------|---------|-------|
| Clutch | #25                | #35                           | #40     | #41   | #50   | #60   | #80   | #100  | #120     | #140    | #160  |
| Size   | 1/4                | 3/8                           | 1/2     | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 | 1-1/2    | 1-3/4   | 2     |
|        | Pitch              | Pitch                         | Pitch   | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch    | Pitch   | Pitch |
| 1      | 40                 | 28                            | 22      | 22    | 18    |       |       |       |          |         |       |
| 2      | 54                 | 36                            | 28      | 28    | 22    | 19    |       |       | Not Reco | mmended |       |
| 3      |                    | 45                            | 34      | 36    | 28    | 25    | 19    |       |          |         |       |
| 4      |                    |                               | 42      | 45    | 36    | 30    | 23    | 19    | ]        |         |       |
| 5      | Consult Factory 42 |                               |         |       | 36    | 30    | 22    | 19    | 17       |         |       |
| 6      |                    | e e. louir i                  | c.c.c.y |       |       | 48    | 36    | 30    | 24       | 21      | 19    |

For smaller sprockets, consult Boston Gear Engineering at 800-816-5608.

### **Model SA and SM**

**Type C Flexible Coupling** 





#### **All Dimensions in Inches**

| Clutch<br>Size | A     | В     | С    | D    | E     | U    | т   | V    | Angular<br>Misalignment* | Max.<br>Parallel<br>Offset* | Weight<br>(Lbs.) |
|----------------|-------|-------|------|------|-------|------|-----|------|--------------------------|-----------------------------|------------------|
| 1              | 4.50  | 3.94  | 2.31 | 2.00 | 4.25  | 1.28 | .13 | 1.03 | < 1°                     | .012                        | 10               |
| 2              | 6.00  | 4.62  | 2.75 | 2.56 | 5.25  | 1.53 | .13 | 1.22 | < 1°                     | .015                        | 18               |
| 3              | 8.00  | 5.87  | 3.50 | 3.50 | 5.87  | 1.94 | .13 | 1.56 | < 1°                     | .016                        | 39               |
| 4              | 10.00 | 7.71  | 4.47 | 4.87 | 9.12  | 2.66 | .13 | 1.81 | < 1°                     | .027                        | 94               |
| 5              | 12.00 | 8.87  | 5.12 | 5.68 | 10.50 | 3.00 | .13 | 2.12 | < 1°                     | .031                        | 163              |
| 6              | 16.00 | 11.12 | 6.25 | 7.63 | 13.25 | 3.68 | .25 | 2.56 | < 1°                     | .045                        | 354              |

\*Parallel offset and angular misalignment are proportionally reduced if both are present

| Ratings |            |       |         |           |                       |                 |  |
|---------|------------|-------|---------|-----------|-----------------------|-----------------|--|
| Clu     | utch       | Torqu | e Range | (Lb. In.) | Max.                  | WR <sup>2</sup> |  |
| S       | Size L M H |       | Н       | RPM*      | (LbIn. <sup>2</sup> ) |                 |  |
| -1      | Min.       | 35    | 75      | 200       | 1 900                 | 25              |  |
| 1       | Max.       | 100   | 275     | 400       | 1,000                 | 25              |  |
| 0       | Min.       | 50    | 200     | 400       | 1 200                 | 20              |  |
| 2       | Max.       | 200   | 600     | 1,000     | 1,200                 | 00              |  |
| 3       | Min.       | 200   | 800     | 1,200     | 1 200                 | 300             |  |
| 5       | Max.       | 850   | 2,200   | 3,000     | 1,200                 | 500             |  |
| л       | Min.       | 600   | 1,200   | 2,850     | 900                   | 1 100           |  |
| 4       | Max.       | 1,400 | 3,000   | 5,000     | 300                   | 1,130           |  |
| 5       | Min.       | 1,600 | 2,500   | 4,000     | 600                   | 2 850           |  |
| 5       | Max.       | 3,000 | 6,000   | 10,000    | 000                   | 2,000           |  |
| 6       | Min.       | 4,000 | 7,500   | 12,500    | 600                   | 10 900          |  |
| 0       | Max.       | 8,000 | 14,000  | 25,000    | 000                   | 10,900          |  |

Clutches are shipped set for the minimum torque value of the selected range.

\*For speeds exceeding 75% of the maximum RPM, ball bearings and balancing are recommended.

#### **Clutch and Coupling Bores**

| Clutch | Turne    | E      | Bores (inch | ı)       |
|--------|----------|--------|-------------|----------|
| Size   | туре     | Min.   | Max. (1)    | Max. (2) |
| 1      | Clutch   | 0.5000 | 0.7500      | 0.8750   |
| 1      | Coupling | 0.5000 | 1.5000      | 1.5625   |
| 2      | Clutch   | 0.6250 | 1.1250      | 1.1875   |
| 2      | Coupling | 0.6250 | 1.8125      | 1.9375   |
| 0      | Clutch   | 0.7500 | 1.7500      | 1.8125   |
| 3      | Coupling | 0.7500 | 2.5000      | 2.6250   |
| Δ      | Clutch   | 1.1250 | 2.2500      | 2.3125   |
| 4      | Coupling | 1.1250 | 3.6875      | 3.8125   |
| 5      | Clutch   | 1.5000 | 2.7500      | 3.0000   |
| Э      | Coupling | 1.5000 | 4.2500      | 4.5000   |
| e      | Clutch   | 2.0000 | 3.7500      | 3.9375   |
| 0      | Coupling | 2.0000 | 5.5000      | 5.7500   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### **Model SA and SM**

Type N Indexing Coupling





#### **All Dimensions in Inches**

| Clutch<br>Size | А     | В     | С    | D    | E     | Т   | U    | V    | Weight<br>(Lbs.) |
|----------------|-------|-------|------|------|-------|-----|------|------|------------------|
| 1              | 4.50  | 3.81  | 2.31 | 2.00 | 4.25  | .13 | 1.28 | 1.03 | 10               |
| 2              | 6.00  | 4.44  | 2.75 | 2.56 | 5.25  | .13 | 1.53 | 1.22 | 18               |
| 3              | 8.00  | 5.75  | 3.50 | 3.00 | 7.00  | .13 | 1.94 | 1.56 | 39               |
| 4              | 10.00 | 7.59  | 4.47 | 4.87 | 9.12  | .13 | 2.66 | 1.81 | 94               |
| 5              | 12.00 | 8.68  | 5.12 | 5.68 | 10.50 | .13 | 3.00 | 2.12 | 163              |
| 6              | 16.00 | 10.94 | 6.25 | 8.18 | 13.25 | .25 | 3.68 | 2.56 | 354              |

#### Ratings Torque Range (Lb. In.) Clutch Max. WR<sup>2</sup> (Lb.-In.2) Size Μ Н **RPM\*** L Min. 35 75 200 1 1,800 25 Max. 275 100 400 400 Min. 50 200 2 80 1,200 Max. 200 600 1,000 Min. 200 800 1,200 300 3 1,200 Max. 850 2,200 3,000 Min. 600 1,200 2,850 4 900 1,190 Max. 1,400 3,000 5,000 Min. 1,600 2,500 4,000 5 600 2,850 Max. 3,000 6,000 10,000 Min. 4.000 7,500 12,500 6 600 10,900 Max. 8,000 14,000 25,000

Clutches are shipped set for the minimum torque value of the selected range.

\*For speeds exceeding 75% of the maximum RPM, ball bearings and balancing are recommended.

#### **Clutch and Coupling Bores**

| Clutch   | Tuno     | E      | ores (inch | )        |
|----------|----------|--------|------------|----------|
| Size     | туре     | Min.   | Max. (1)   | Max. (2) |
| 4        | Clutch   | 0.5000 | 0.7500     | 0.8750   |
| 1        | Coupling | 0.5000 | 1.5000     | 1.5625   |
| 0        | Clutch   | 0.6250 | 1.1250     | 1.1875   |
| 2        | Coupling | 0.6250 | 1.8125     | 1.9375   |
| 0        | Clutch   | 0.7500 | 1.7500     | 1.8125   |
| ა        | Coupling | 0.7500 | 1.7500     | 1.8125   |
| 4        | Clutch   | 1.1250 | 2.2500     | 2.3125   |
| 4        | Coupling | 1.1250 | 3.6875     | 3.8125   |
| 5        | Clutch   | 1.5000 | 2.7500     | 3.0000   |
| Э        | Coupling | 1.5000 | 4.2500     | 4.5000   |
| <u> </u> | Clutch   | 2.0000 | 3.7500     | 3.9375   |
| U        | Coupling | 2.0000 | 5.5000     | 5.7500   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### **Model SA and SM**

**Type R Rigid Coupling** 





#### **All Dimensions in Inches**

| Clutch<br>Size | А     | В     | С    | D    | E     | т   | U    | V    | Weight<br>(Lbs.) |
|----------------|-------|-------|------|------|-------|-----|------|------|------------------|
| 1              | 4.50  | 3.81  | 2.31 | 2.00 | 4.25  | .13 | 1.28 | 1.03 | 10               |
| 2              | 6.00  | 4.44  | 2.75 | 2.56 | 5.25  | .13 | 1.53 | 1.22 | 18               |
| 3              | 8.00  | 5.75  | 3.50 | 3.00 | 7.00  | .13 | 1.94 | 1.56 | 39               |
| 4              | 10.00 | 7.59  | 4.47 | 4.87 | 9.12  | .13 | 2.66 | 1.81 | 94               |
| 5              | 12.00 | 8.68  | 5.12 | 5.68 | 10.50 | .13 | 3.00 | 2.12 | 163              |
| 6              | 16.00 | 10.94 | 6.25 | 8.18 | 13.25 | .25 | 3.68 | 2.56 | 354              |

#### Ratings

| Clu | ıtch | Torqu | e Range | (Lb. In.) | Max.  | WR <sup>2</sup>       |  |
|-----|------|-------|---------|-----------|-------|-----------------------|--|
| S   | ize  | L     | М       | Н         | RPM*  | (LbIn. <sup>2</sup> ) |  |
| -1  | Min. | 35    | 75      | 200       | 1 200 | 25                    |  |
| I   | Max. | 100   | 275     | 400       | 1,000 | 20                    |  |
| n   | Min. | 50    | 200     | 400       | 1 200 | 20                    |  |
| 2   | Max. | 200   | 600     | 1,000     | 1,200 | 60                    |  |
| 2   | Min. | 200   | 800     | 1,200     | 1 200 | 300                   |  |
| 3   | Max. | 850   | 2,200   | 3,000     | 1,200 | 300                   |  |
| Л   | Min. | 600   | 1,200   | 2,850     | 000   | 1 100                 |  |
| 4   | Max. | 1,400 | 3,000   | 5,000     | 900   | 1,190                 |  |
| 5   | Min. | 1,600 | 2,500   | 4,000     | 600   | 2 850                 |  |
| 5   | Max. | 3,000 | 6,000   | 10,000    | 000   | 2,000                 |  |
| 6   | Min. | 4,000 | 7,500   | 12,500    | 600   | 10 000                |  |
| 0   | Max. | 8,000 | 14,000  | 25,000    | 000   | 10,900                |  |

Clutches are shipped set for the minimum torque value of the selected range.

\*For speeds exceeding 75% of the maximum RPM, ball bearings and balancing are recommended.

#### **Clutch and Coupling Bores**

| Clutch | T        | E      | Bores (inch | )        |
|--------|----------|--------|-------------|----------|
| Size   | туре     | Min.   | Max. (1)    | Max. (2) |
| 4      | Clutch   | 0.5000 | 0.7500      | 0.8750   |
| 1      | Coupling | 0.5000 | 1.5000      | 1.5625   |
| 2      | Clutch   | 0.6250 | 1.1250      | 1.1875   |
| 2      | Coupling | 0.6250 | 1.8125      | 1.9375   |
| 0      | Clutch   | 0.7500 | 1.7500      | 1.8125   |
| 3      | Coupling | 0.7500 | 1.7500      | 1.8125   |
| 4      | Clutch   | 1.1250 | 2.2500      | 2.3125   |
| 4      | Coupling | 1.1250 | 3.6875      | 3.8125   |
| 5      | Clutch   | 1.5000 | 2.7500      | 3.0000   |
| 5      | Coupling | 1.5000 | 4.2500      | 4.5000   |
| 6      | Clutch   | 2.0000 | 3.7500      | 3.9375   |
| 0      | Coupling | 2.0000 | 5.5000      | 5.7500   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### **Model S Options**

Semi-Automatic Model SB and SP Proximity Plates

#### Limit Switch Plate Actuator, Models SB/SC and SP/SS

Available for all types, the Standard Model S Trig-O-Matic Limit Switch Plate Actuator provides instant operation of a limit switch to shut down the drive or to actuate an alarm should an overload occur. When an overload occurs, the drive pawl motion releases the actuating plate and it trips a limit switch. The total motion of the plate is .31 of an inch (See Figure 5).

After the overload has been cleared and the clutch is re-engaged, the actuating plate is manually returned to its normal operating position by applying equally spaced pressure to the surface of the plate.

A limit switch should be able to operate within the plate travel of .31 of an inch. Wire the switch in parallel with a jog circuit so that the drive can then be indexed to the start/run circuit.

#### **Balancing**

Static balancing is available for applications that exceed 50% of the catalog maximum RPM. Always consult the factory with complete drive details and layout for these high speed applications. Ball bearings are recommended for speeds exceeding 75% of maximum rating and is available with a "B1" suffix.

#### **Custom Variations**

Sprockets, sheaves, pulleys and gears can be supplied and mounted to the clutch. Contact Boston Gear Engineering at 800-816-5608.

Bores and keyways (i.e. metric, non-standard)

#### **Special Finishes**

All clutches are supplied with a standard lacquer finish. Special coatings, finishes, or paints are also available upon request. Adding suffix - F2 to the model number will provide Steel-It paint and food grade grease.

#### **Pressure Lube Model**

Pressure lube bronze bearings are preferred for use in harsh environments such as wastewater treatment plants or installations requiring wash-down service. Grease fittings are furnished to permit periodic lubrication to the inside diameter of the sleeve bearings.

The Pressure Lube Model Trig-O-Matic is available with either the Limit Switch Pin or the Limit Switch Plate Actuator and is available by adding an L1 suffix to the model number. Available on sizes 3, 4, 5, and 6 only.



Figure 5

#### **All Dimensions in Inches**

| Clutch<br>Size | А     | С    | R*    | Т    | Z    |
|----------------|-------|------|-------|------|------|
| 1              | 4.50  | 2.31 | 5.50  | 2.53 | 2.00 |
| 2              | 6.00  | 2.75 | 7.00  | 2.97 | 3.25 |
| 3              | 8.00  | 3.50 | 9.50  | 3.72 | 4.50 |
| 4              | 10.00 | 4.47 | 11.50 | 4.69 | 5.75 |
| 5              | 12.00 | 5.12 | 13.50 | 5.34 | 5.50 |
| 6              | 16.00 | 6.25 | 17.50 | 6.50 | 7.25 |

\*The R dimension may be reduced to the A dimension if required, specify SC for a semi-automatic clutch with a reduced plate and SS for a manual reset with a reduced diameter plate. Example: ORC2SCTMP16



#### Figure 6

Figure 6 illustrates two methods of utilizing a single limit switch to detect an overload condition.

### **Fully Automatic Model F**

### **Operating Principles**

The Fully Automatic Model F Trig-O-Matic Overload Release Clutch consists of three basic components: the rotor, the housing assembly and the automatic limit switch actuating plate assembly. The clutch rotor is keyed and secured with a locking collar (Models FJ and FG) or, with a setscrew (Model FR).

The housing assembly includes a drive pawl and a reset pawl which are pivoted within the clutch housing. The drive pawl is held in its engaged position by the combined pressure of the drive and reset springs as shown in Figure 7. The combined pressure of these two springs determines the maximum torque which is transmitted without overload. With the clutch mechanism in the engaged position, the rotor and housing are held together and the entire unit rotates with the drive shaft at the same speed.

When an overload occurs, the rotor rotates from its normal position within the housing. At this instant, the combined pressure of the drive and reset springs is overcome by the extra force applied to them and the drive pawl disengages from the rotor. The pressure applied by both springs holds the drive pawl in contact with the rotor, (See Figure 8). After one revolution, the drive pawl will automatically re-engage.

The automatic limit switch actuating plate assembly is incorporated to provide a means by which an external limit switch can be actuated to stop the drive.



Figure 7 – Engaged







Figure 9 – Switch Actuating Plate Assembly

After the overload condition has been corrected, the drive must be "jogged" until the drive pawl engages with the rotor. The clutch has now reindexed itself to its original position.

The fully automatic Model F includes, as standard, a limit switch actuating plate assembly. Upon overload, the rotor is released from its engaged position within the housing. The resulting rotation causes the cam plate, which is keyed to the rotor, to exert pressure on the lift-out buttons forcing them to move the actuating plate axially away from the clutch housing, (See Figure 9).

When the clutch re-engages, the actuating plate is automatically returned to its original position by the return spring's pressure on the return pins.

The actuating plate can only retract completely to its original position upon re-engagement of the drive pawl with the rotor.

### **Locking Collar Mounting**

Three clutch models are available for mounting. Models FJ and FG incorporate a locking collar design which provides a positive clamp on the key and shaft. Model FR uses a standard setscrew mounting arrangement, (See Figure 10).

| Model FJ | Model FJ is used where<br>full shaft length is<br>available.<br>Collar Mounted |
|----------|--|
| Model FG | Model FG is used where<br>shaft length is limited.<br>Collar Mounted           |
| Model FR | Model FR is used where<br>overall space is limited.<br>Set Screw Mounted       |

Figure 10 – Model F Styles

### **Fully Automatic Model F**

#### **Torque Selector Dial**

The torque selector dial shown in Figure 11 is a standard feature on all Fully Automatic Model F Trig-O-Matic clutches. Each clutch is individually calibrated to specific torque values. The housing has two milled marks indicating minimum and maximum torque. In addition, these values are stamped on the housing adjacent to each mill mark. To adjust the torque, loosen the "lock screw", turn the torque adjusting screw (stamped #9) until it is flush with the milled depth and the red scribed lines match the required output position. Additional marks can be indicated upon request.

#### **Maximum Torque Limit Stop**

A maximum torque limit stop is supplied to prevent clutch lock-up. In conjunction with a torque selector dial, the maximum value indicated by the deepest milled mark can not be exceeded.

#### **Grease Pack Fittings**

Grease pack and relief fittings are supplied countersunk into the clutch housing to pack the clutch cavity, preventing corrosion. This feature is especially suitable for outdoor or washdown service.



Figure 11



#### How to Order — Standard Model F

When ordering an ORC Series Trig-O-Matic Overload Clutch, please include code letters for series, size, model, type, torque range, unit bore and coupling bore (if applicable). Not all combinations are possible.

#### Example:

Required Size 2 Trig-O-Matic Overload Clutch, Model F automatic reset, limited available shaft length, flexible coupling, light torque range, with a one inch unit bore and a one inch coupling bore:



(Only include second bore "P20" if clutch is a coupling style)

### Model FJ, FG, and FR

Type T Sprocket, Sheave, Pulley Mounting



#### **All Dimensions in Inches**

| Clutch<br>Size | А     | B1   | B <sub>2</sub> | B₃   | С   | E   | F    | G<br>+.000/002 | H<br>Bolt Circle | К    | М    | Ν    | Р   | R     | Т    | V    | Weight<br>(Lbs.) |
|----------------|-------|------|----------------|------|-----|-----|------|----------------|------------------|------|------|------|-----|-------|------|------|------------------|
| 1              | 4.50  | 3.72 | 4.49           | 3.20 | .50 | .37 | 2.87 | 1.875          | 2.375            | 0.78 | 1.87 | 1.56 | .38 | 5.50  | 2.83 | 1.22 | 7                |
| 2              | 6.00  | 4.22 | 4.96           | 3.66 | .56 | .43 | 3.68 | 2.250          | 3.000            | 0.74 | 2.37 | 2.25 | .38 | 7.50  | 3.28 | 1.47 | 14               |
| 3              | 8.00  | 5.46 | 6.38           | 4.66 | .75 | .50 | 4.87 | 3.250          | 4.125            | 0.97 | 3.25 | 3.00 | .59 | 9.50  | 4.08 | 1.88 | 30               |
| 4              | 10.00 | 6.79 | 7.50           | 5.94 | .87 | .68 | 6.12 | 3.203          | 5.000            | 0.72 | 4.25 | 4.00 | .82 | 11.50 | 5.12 | 2.60 | 66               |
| 5              | 12.00 | 7.76 | 9.32           | 6.70 | .87 | .81 | 7.50 | 4.125          | 6.250            | 1.75 | 5.00 | 5.25 | .86 | 14.00 | 5.85 | 2.93 | 123              |

Sprockets, sheaves, pulleys, and gears can be mounted upon request. Refer to Page 29 for maximum sprocket sizes and mounting hole patterns.

#### **Ratings**

| Clu | itch | Torqu | e Range | (Lb. In.) | Max. | WR <sup>2</sup>       |  |
|-----|------|-------|---------|-----------|------|-----------------------|--|
| Si  | ze   | L     | М       | Н         | RPM  | (LbIn. <sup>2</sup> ) |  |
| -1  | Min. | 70    | 110     | 260       | 1400 | 10                    |  |
| 1   | Max. | 140   | 275     | 400       | 1400 | 10                    |  |
| 2   | Min. | 100   | 200     | 400       | 1000 | 65                    |  |
| 2   | Max. | 200   | 600     | 1,000     | 1000 | 00                    |  |
| 3   | Min. | 200   | 800     | 1,200     | 1000 | 228                   |  |
| 5   | Max. | 850   | 2,200   | 3,000     | 1000 | 200                   |  |
| Л   | Min. | 600   | 1,200   | 2,850     | 700  | 815                   |  |
| 4   | Max. | 1,400 | 3,000   | 5,000     | 700  | 015                   |  |
| 5   | Min. | 1,600 | 2,500   | 4,000     | 500  | 2 170                 |  |
|     | Max. | 3,000 | 6,000   | 10,000    | 500  | 2,170                 |  |

Clutches are shipped set for the minimum torque value of the selected range.

#### **Clutch Bores**

| Clutch | B      | Bores (inch) |          |  |  |  |  |  |  |  |
|--------|--------|--------------|----------|--|--|--|--|--|--|--|
| Size   | Min.   | Max. (1)     | Max. (2) |  |  |  |  |  |  |  |
| 1      | 0.5000 | 0.7500       | -        |  |  |  |  |  |  |  |
| 2      | 0.6250 | 1.0000       | 1.1250   |  |  |  |  |  |  |  |
| 3      | 0.7500 | 1.6250       | 1.7500   |  |  |  |  |  |  |  |
| 4      | 1.1250 | 2.0000       | 2.2500   |  |  |  |  |  |  |  |
| 5      | 1.5000 | 2.6250       | 2.7500   |  |  |  |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

## Model S and F

Type T Mounting Hole Patterns



#### **Clutch Sizes 1 and 2**

**Clutch Sizes 3 and 4** 

Clutch Sizes 5 and 6

|                |      |                | Mountir      | ng Holes       |                               |               |
|----------------|------|----------------|--------------|----------------|-------------------------------|---------------|
| Clutch<br>Size | Qty. | Thread<br>Size | Tap<br>Depth | Bolt<br>Circle | Pilot<br>Dia.<br>+.000<br>002 | Dowel<br>Size |
| 1              | 3    | 1/4-20         | .50          | 2.375          | 1.875                         | .25           |
| 2              | 3    | 5/16-18        | .50          | 3.000          | 2.250                         | .31           |
| 3              | 4    | 3/8-16         | .62          | 4.125          | 3.250                         | .37           |
| 4              | 4    | 1/2-13         | .87          | 5.000          | 3.203                         | .50           |
| 5              | 6    | 5/8-11         | 1.00         | 6.250          | 4.125                         | .62           |
| 6              | 6    | 5/8-11         | 1.00         | 8.750          | 6.000                         | .62           |

#### Minimum Number of Teeth Adaptable to Type T Clutches

|        | Standard Chain Size and Pitch |           |        |       |       |       |       |                     |          |          |       |
|--------|-------------------------------|-----------|--------|-------|-------|-------|-------|---------------------|----------|----------|-------|
| Clutch | #25                           | #35       | #40    | #41   | #50   | #60   | #80   | #100 #120 #140 #160 |          |          |       |
| Size   | 1/4                           | 3/8       | 1/2    | 1/2   | 5/8   | 3/4   | 1     | 1-1/4               | 1-1/2    | 1-3/4    | 2     |
|        | Pitch                         | Pitch     | Pitch  | Pitch | Pitch | Pitch | Pitch | Pitch               | Pitch    | Pitch    | Pitch |
| 1      | 40                            | 28        | 22     | 22    | 18    |       |       |                     |          |          |       |
| 2      | 54                            | 36        | 28     | 28    | 22    | 19    |       |                     | Not Reco | ommended |       |
| 3      |                               | 45        | 34     | 36    | 28    | 25    | 19    |                     |          |          |       |
| 4      |                               |           | 42     | 45    | 36    | 30    | 23    | 19                  | ]        |          |       |
| 5      |                               | Consult F | actory |       | 42    | 36    | 30    | 22                  | 19       | 17       |       |
| 6      |                               |           |        |       |       | 48    | 36    | 30                  | 24       | 21       | 19    |

For smaller sprockets, consult Boston Gear Engineering at 800-816-5608.

### **Model FJ and FR**

**Type C Flexible Coupling** 



Model FJ

**Model FR** 

#### **All Dimensions in Inches**

| Clutch<br>Size | A     | Bı    | B₃    | С   | D    | E     | М    | N    | Р   | R     | S    | Т    | v    | Angular<br>Misalignment* | Max.<br>Parallel<br>Offset* | Weight<br>(Lbs.) |
|----------------|-------|-------|-------|-----|------|-------|------|------|-----|-------|------|------|------|--------------------------|-----------------------------|------------------|
| 1              | 4.50  | 5.41  | 4.89  | .50 | 2.00 | 4.25  | 1.87 | 1.56 | .38 | 5.50  | 1.50 | 2.89 | 1.28 | < 1°                     | .012                        | 10               |
| 2              | 6.00  | 6.15  | 5.59  | .56 | 2.56 | 5.25  | 2.37 | 2.25 | .38 | 7.50  | 1.75 | 3.34 | 1.53 | < 1°                     | .015                        | 20               |
| 3              | 8.00  | 7.89  | 7.09  | .75 | 3.50 | 5.87  | 3.25 | 3.00 | .59 | 9.50  | 2.25 | 4.14 | 1.93 | < 1°                     | .016                        | 42               |
| 4              | 10.00 | 10.09 | 9.23  | .87 | 4.87 | 9.12  | 4.25 | 4.00 | .82 | 11.50 | 3.12 | 5.18 | 2.66 | < 1°                     | .027                        | 103              |
| 5              | 12.00 | 11.57 | 10.51 | .87 | 5.68 | 10.50 | 5.00 | 5.25 | .86 | 14.00 | 3.62 | 5.91 | 3.00 | < 1°                     | .031                        | 180              |

\*Parallel offset and angular misalignment proportionately reduced if both are present.

#### Ratings

| Clu        | ıtch | Torque | e Range | (Lb. In.) | Max. | WR <sup>2</sup>       |  |
|------------|------|--------|---------|-----------|------|-----------------------|--|
| Si         | ze   | L      | М       | Н         | RPM  | (LbIn. <sup>2</sup> ) |  |
| Min.       |      | 70     | 110     | 260       | 1/00 | 26                    |  |
| 1          | Max. | 140    | 275     | 400       | 1400 | 20                    |  |
| 2          | Min. | 100    | 200     | 400       | 1000 | 80                    |  |
| 2          | Max. | 200    | 600     | 1,000     | 1000 | 09                    |  |
| 3          | Min. | 200    | 800     | 1,200     | 1000 | 307                   |  |
| 5          | Max. | 850    | 2,200   | 3,000     | 1000 | 521                   |  |
| Λ          | Min. | 600    | 1,200   | 2,850     | 700  | 1 270                 |  |
| 4          | Max. | 1,400  | 3,000   | 5,000     | 700  | 1,270                 |  |
| 5 Mi<br>Ma | Min. | 1,600  | 2,500   | 4,000     | 500  | 3 160                 |  |
|            | Max. | 3,000  | 6,000   | 10,000    | 500  | 5,100                 |  |

Clutches are shipped set for the minimum torque value of the selected range.

#### **Clutch and Coupling Bores**

| Clutch | Turne    | E      | Bores (inch | )        |
|--------|----------|--------|-------------|----------|
| Size   | туре     | Min.   | Max. (1)    | Max. (2) |
| 4      | Clutch   | 0.5000 | 0.7500      | -        |
| 1      | Coupling | 0.5000 | 1.5000      | 1.5625   |
| 2      | Clutch   | 0.6250 | 1.0000      | 1.1250   |
| 2      | Coupling | 0.6250 | 1.8125      | 1.9375   |
| 0      | Clutch   | 0.7500 | 1.6250      | 1.7500   |
| 3      | Coupling | 0.7500 | 2.5000      | 2.6250   |
| 4      | Clutch   | 1.1250 | 2.0000      | 2.2500   |
| 4      | Coupling | 1.1250 | 3.6875      | 3.8125   |
| 5      | Clutch   | 1.5000 | 2.6250      | 2.7500   |
| 5      | Coupling | 1.5000 | 4.2500      | 4.5000   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

(2) Flat Key

### **Model FJ and FR**

**Type N Indexing Coupling** 



Model FJ

Model FR

#### **All Dimensions in Inches**

| Clutch<br>Size | А     | B1    | B₃    | С   | D    | E     | М    | N    | Р   | R     | S    | Т    | V    | Weight<br>(Lbs.) |
|----------------|-------|-------|-------|-----|------|-------|------|------|-----|-------|------|------|------|------------------|
| 1              | 4.50  | 5.28  | 4.76  | .50 | 2.00 | 4.25  | 1.87 | 1.56 | .38 | 5.50  | 1.50 | 2.89 | 1.28 | 10               |
| 2              | 6.00  | 5.96  | 5.41  | .56 | 2.56 | 5.25  | 2.37 | 2.25 | .38 | 7.50  | 1.69 | 3.34 | 1.53 | 20               |
| 3              | 8.00  | 7.77  | 6.97  | .75 | 3.00 | 7.00  | 3.25 | 3.00 | .59 | 9.50  | 2.25 | 4.14 | 1.93 | 42               |
| 4              | 10.00 | 9.97  | 9.12  | .87 | 4.87 | 9.12  | 4.25 | 4.00 | .82 | 11.50 | 3.12 | 5.18 | 2.66 | 103              |
| 5              | 12.00 | 11.44 | 10.38 | .87 | 5.68 | 10.50 | 5.00 | 5.25 | .86 | 14.00 | 3.62 | 5.91 | 3.00 | 180              |

| - |   |     |   |   |   |  |
|---|---|-----|---|---|---|--|
|   | ~ | -   | n | ~ | ^ |  |
|   | - |     |   |   | • |  |
|   | ш | ••• |   | м | • |  |
|   |   |     |   | _ |   |  |

| Clu | ıtch | Torqu | e Range | (Lb. In.) | Max. | WR <sup>2</sup>       |  |
|-----|------|-------|---------|-----------|------|-----------------------|--|
| Si  | ze   | L     | М       | Н         | RPM  | (LbIn. <sup>2</sup> ) |  |
| -1  | Min. | 70    | 110     | 260       | 1400 | 26                    |  |
| 1   | Max. | 140   | 275     | 400       | 1400 | 20                    |  |
| 2   | Min. | 100   | 200     | 400       | 1000 | 80                    |  |
| 2   | Max. | 200   | 600     | 1,000     | 1000 | 09                    |  |
| 3   | Min. | 200   | 800     | 1,200     | 1000 | 307                   |  |
| 5   | Max. | 850   | 2,200   | 3,000     | 1000 | 521                   |  |
| Λ   | Min. | 600   | 1,200   | 2,850     | 700  | 1 270                 |  |
| 4   | Max. | 1,400 | 3,000   | 5,000     | 700  | 1,270                 |  |
| 5   | Min. | 1,600 | 2,500   | 4,000     | 500  | 3 160                 |  |
| 5   | Max. | 3,000 | 6,000   | 10,000    | 500  | 3,160                 |  |

Clutches are shipped set for the minimum torque value of the selected range.

#### **Clutch and Coupling Bores**

| Clutch | Turne    | E      | Bores (inch | )        |
|--------|----------|--------|-------------|----------|
| Size   | туре     | Min.   | Max. (1)    | Max. (2) |
| 1      | Clutch   | 0.5000 | 0.7500      | -        |
|        | Coupling | 0.5000 | 1.5000      | 1.5625   |
| 2      | Clutch   | 0.6250 | 1.0000      | 1.1250   |
| 2      | Coupling | 0.6250 | 1.8125      | 1.9375   |
| 2      | Clutch   | 0.7500 | 1.6250      | 1.7500   |
| 3      | Coupling | 0.7500 | 1.7500      | 1.8125   |
| 1      | Clutch   | 1.1250 | 2.0000      | 2.2500   |
| 4      | Coupling | 1.1250 | 3.6875      | 3.8125   |
| 5      | Clutch   | 1.5000 | 2.6250      | 2.7500   |
| 5      | Coupling | 1.5000 | 4.2500      | 4.5000   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

(2) Flat Key

### **Model FJ and FR**

**Type R Rigid Coupling** 



Model FJ

Model FR

| Clutch<br>Size | А     | B1    | B₃    | С   | D    | E     | М    | N    | Р   | R     | S    | Т    | V    | Weight<br>(Lbs.) |
|----------------|-------|-------|-------|-----|------|-------|------|------|-----|-------|------|------|------|------------------|
| 1              | 4.50  | 5.28  | 4.76  | .50 | 2.00 | 4.25  | 1.87 | 1.56 | .38 | 5.50  | 1.50 | 2.89 | 1.28 | 10               |
| 2              | 6.00  | 5.96  | 5.41  | .56 | 2.56 | 5.25  | 2.37 | 2.25 | .38 | 7.50  | 1.69 | 3.34 | 1.53 | 20               |
| 3              | 8.00  | 7.77  | 6.97  | .75 | 3.00 | 7.00  | 3.25 | 3.00 | .59 | 9.50  | 2.25 | 4.14 | 1.93 | 42               |
| 4              | 10.00 | 9.97  | 9.12  | .87 | 4.87 | 9.12  | 4.25 | 4.00 | .82 | 11.50 | 3.12 | 5.18 | 2.66 | 103              |
| 5              | 12.00 | 11.44 | 10.38 | .87 | 5.68 | 10.50 | 5.00 | 5.25 | .86 | 14.00 | 3.62 | 5.91 | 3.00 | 180              |

|  | All | Dimer | nsions | in | Inches |
|--|-----|-------|--------|----|--------|
|--|-----|-------|--------|----|--------|

| Ratings |      |       |         |           |      |                       |  |
|---------|------|-------|---------|-----------|------|-----------------------|--|
| Clutch  |      | Torqu | e Range | (Lb. In.) | Max. | WR <sup>2</sup>       |  |
| Size    |      | L     | М       | Н         | RPM  | (LbIn. <sup>2</sup> ) |  |
| 4       | Min. | 70    | 110     | 260       | 1400 | 26                    |  |
| 1       | Max. | 140   | 275     | 400       | 1400 | 20                    |  |
| 2       | Min. | 100   | 200     | 400       | 1000 | 80                    |  |
| 2       | Max. | 200   | 600     | 1,000     | 1000 | 03                    |  |
| З       | Min. | 200   | 800     | 1,200     | 1000 | 307                   |  |
| 3       | Max. | 850   | 2,200   | 3,000     | 1000 | 521                   |  |
| 1       | Min. | 600   | 1,200   | 2,850     | 700  | 1 270                 |  |
| 4       | Max. | 1,400 | 3,000   | 5,000     | 700  | 1,270                 |  |
| 5       | Min. | 1,600 | 2,500   | 4,000     | 500  | 3 160                 |  |
| 5       | Max. | 3,000 | 6,000   | 10,000    | 500  | 5,100                 |  |

Clutches are shipped set for the minimum torque value of the selected range.

#### **Clutch and Coupling Bores**

| Clutch | Turna    | Bores (inch) |          |          |  |  |
|--------|----------|--------------|----------|----------|--|--|
| Size   | туре     | Min.         | Max. (1) | Max. (2) |  |  |
| 4      | Clutch   | 0.5000       | 0.7500   | -        |  |  |
| 1      | Coupling | 0.5000       | 1.5000   | 1.5625   |  |  |
| 2      | Clutch   | 0.6250       | 1.0000   | 1.1250   |  |  |
| 2      | Coupling | 0.6250       | 1.8125   | 1.9375   |  |  |
| 2      | Clutch   | 0.7500       | 1.6250   | 1.7500   |  |  |
| 3      | Coupling | 0.7500       | 1.7500   | 1.8125   |  |  |
| 1      | Clutch   | 1.1250       | 2.0000   | 2.2500   |  |  |
| 4      | Coupling | 1.1250       | 3.6875   | 3.8125   |  |  |
| 5      | Clutch   | 1.5000       | 2.6250   | 2.7500   |  |  |
| 5      | Coupling | 1.5000       | 4.2500   | 4.5000   |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

(2) Flat Key

### **Fully Automatic Model F Options**

#### **One-Direction Option**

For applications with oscillating torque loads, a onedirectional clutch is available to prevent needless disengagement of the clutch due to back-loading conditions.

The unique rotor/drive pawl configuration permits the clutch to disengage in the normal running direction in the event of an overload. It back stops any load in the opposite direction and is virtually a solid connection when driven in the opposite direction (see Figure 12).



Figure 12

To select either the RIGHT-HAND or LEFT-HAND configuration:

- 1. Determine the normal direction of rotation facing either
  - a. the limit switch plate, or
  - b. the housing
- 2. Determine whether the input is driving through either
  - a. the rotor, or
  - b. the housing
- 3. With this information, select the correct configuration from the chart below.

| Clockwise Running Rotation         |                         |  |  |  |
|------------------------------------|-------------------------|--|--|--|
| Facing Limit Switch Plate          |                         |  |  |  |
| Rotor Driving (input)              | Housing Driving (input) |  |  |  |
| Right-Hand Clutch                  | Left-Hand Clutch        |  |  |  |
| Clockwise Rur                      | nning Rotation          |  |  |  |
| Facing Housing                     |                         |  |  |  |
| Rotor Driving (input)              | Housing Driving (input) |  |  |  |
| Left-Hand Clutch                   | Right-Hand Clutch       |  |  |  |
| Counter Clockwise Running Rotation |                         |  |  |  |
| Facing Limit                       | Switch Plate            |  |  |  |
| Rotor Driving (input)              | Housing Driving (input) |  |  |  |
| Left-Hand Clutch                   | Right-Hand Clutch       |  |  |  |
| Counter Clockwise Running Rotation |                         |  |  |  |
| Facing Housing                     |                         |  |  |  |
| Rotor Driving (input)              | Housing Driving (input) |  |  |  |
| Right-Hand Clutch                  | Left-Hand Clutch        |  |  |  |

#### **Custom Variations**

Sprockets, sheaves, pulleys and gears can be supplied and mounted to the clutch.

See page 21 or contact Boston Gear Engineering at 800-816-5608 for additional information.

Bores and keyways (i.e. metric, non-standard).

#### **Special Finishes**

All clutches are supplied with a standard lacquer finish. Special coatings, finishes, or paints are also available upon request. Adding suffix - F2 to the model number will provide steel IT paint and food grade grease.

#### **Typical Limit Switch Layout**

The layout in Figure 13 uses a single limit switch to detect an overload condition. The switch should be able to operate within the travel of the limit switch plate. Upon overload the limit switch plate will move to actuate the limit switch and shut down the drive.

The switch should be wired in parallel with a jog circuit so that the drive can be indexed for re-engagement. After the clutch has been re-engaged, the limit switch will be reset and the drive can be restarted.



Figure 13

The limit switch actuating plate supplied with the Model F Trig-O-Matic Overload Clutch is furnished with a mild steel plate suitable for use with a proximity sensor.

| Li | m | it | SI | wi | tc | h |
|----|---|----|----|----|----|---|
|----|---|----|----|----|----|---|

| Clutch<br>Size | Movement<br>(Inch) | Tracking Radius<br>(Inch) |
|----------------|--------------------|---------------------------|
| 1              | .18                | 2.38                      |
| 2              | .18                | 3.25                      |
| 3              | .18                | 4.18                      |
| 4              | .18                | 5.25                      |
| 5              | .18                | 6.25                      |

## **Trig-O-Matic Overload Clutches**

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:  | 7. Shut Down Method:                         |  |  |  |
|--|--|--|--|--|
| □ New  | Prox Plate                                   |  |  |  |
| <br>┌─ Existing  | Pin Style (ORC only)                         |  |  |  |
| – Replacement Model #  | None Required                                |  |  |  |
| 2. Power transmission requirements at  |  |  |  |  |
| clutch location:   | Name:  |  |  |  |
| RPM     Limiting Torque Level  | Phone #                                      |  |  |  |
| -  | Fax #<br>Company                             |  |  |  |
| 3. Type:<br>Mechanical (Spring Loaded)   |  |  |  |  |
| Pneumatic  | E-Mail                                       |  |  |  |
| 4. Type:   | Lise the space below to note any relevant    |  |  |  |
| <ul> <li>Fully Automatic Re-Engagement</li> <li>Manual (Free Wheeling)</li> <li>Semi Automatic (ORC model only)</li> </ul> | application data or to detail your question. |  |  |  |
| 5. Method of Torque Transmission:  |  |  |  |  |
| <ul> <li>Flexible Coupling</li> <li>Rigid Coupling</li> <li>Sprocket Mount</li> </ul>                                      |  |  |  |  |
| Sprocket Size and Tooth Count  |  |  |  |  |
| 6. Bore Size:  |  |  |  |  |
| Sprocket Mount (Clutch Bore) Coupling Mount (Clutch Bore) (Coupling Bore)  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |


## **Section Contents**

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### **Features**

- Bi-directional operation
- Single position indexing
- Automatic reset
- Convenient torque adjustment
- Maximum torque limit stop
- Limit switch actuating mechanism
- Clamp collar for secure mounting
- Hardened components for long life
- Electroless nickel finish and stainless steel hardware for superior corrosion resistance
- Sealed from environmental contamination
- Interchanges POR Series
- Available in all Stainless upon request

### **Operating Principles**

The HOR Series H1600 is an automatic reset ball detent style overload release clutch. It has been designed to provide accurate and dependable torque disconnect protection for mechanical power transmission equipment. Torque is transmitted through the clutch in one of two paths. Refer to Figure 1.



Torque transmission between the balls and housing is the key to the disengagement of the clutch. The balls are forced into the pockets of the housing by an axial load generated by compressing a spring pack. This axial load determines the torque capacity of the clutch. Increasing or decreasing the spring compression or changing spring packs provides a means for multiple torque adjustments. When a torque overload condition occurs, the balls roll out of the pockets and freewheel similar to a ball thrust bearing. This rolling action increases the efficiency in which the clutch operates and reduces any fluctuation of torque setting due to frictional changes. Refer to Figure 2.



The movement of the cover during disengagement can be used to trip a limit switch and signal a torque overload condition. The drive should be shut down immediately and the source

of the overload determined and cleared. The drive can then be restarted. The automatic reset feature of the clutch will allow it to reengage without manual assistance and the clutch will once again be ready to provide accurate and dependable torque disconnect protection for your equipment.



### **Torque Adjustment**

Figure 2

The HOR Series H1600 Series Clutch can be factory set to your requirements. The torque setting of the clutch can easily be adjusted in the field to suit your needs. Two degrees of adjustment are available and described below.

Fine Adjustment: Lift the bearing lock washer tabs which secure the nut in position. Use a spanner wrench to adjust the bearing nut to your desired torque setting. Clockwise rotation will increase the torque and conversely, counterclockwise rotation will decrease the torque. Once the desired torque setting is made, fold the tab of the washer over the slot on the bearing nut to secure it in position at the new torque release level.

Coarse Adjustment: Large variations in torque setting can be accomplished by replacing the disc spring pack with that of a higher or lower spring rate. This change will effectively alter the load which can be applied to the balls.

### **Selection**

- 1. Determine the overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

- b. Determine the "weak link" in the drive train, (i.e., chain, reducer, belt or shaft). Select an overload release torque below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size(s) and keyway(s):
  - a. Shaft size at the clutch location determines clutch bore.
  - b. Shaft size at the coupling location determines coupling bore (if applicable).
- 3. Choose the appropriate Style based upon the drive layout and available space (See Figure 3).
- 4. Refer to the Basic Selection Chart for the appropriate clutch size.
- 5. Refer to Part Numbering System to complete selection.



| Figure | 3 |
|--------|---|

| Clutch<br>Size | Max.<br>Bore*<br>(In.) | Torque<br>Code | Torque<br>Range<br>(Lb. In.) |
|----------------|------------------------|----------------|------------------------------|
|                |                        | L              | 25-60                        |
| 02             | F - 0.5625             | M              | 50-125                       |
|                | L - 0.6875             | H              | 75-175                       |
|                |                        | W              | 100-250                      |
|                |                        | L              | 175-550                      |
| 04             | F - 1.1250             | M              | 250-850                      |
|                | L - 1.2500             | H              | 350-1,300                    |
|                |                        | W              | 600-2,000                    |
|                |                        | L              | 350-1,200                    |
|                | F - 1 6250             | М              | 500-1,800                    |
| 05             | I - 1 8125             | H              | 750-2,600                    |
|                | L 1.0120               | W              | 1,000-4,000                  |
|                |                        | Y              | 1,650-6,000                  |
|                |                        | L              | 600-1,900                    |
|                |                        | M              | 750-2,700                    |
| 06             | 2.1250                 | Н              | 1,000-3,800                  |
|                |                        | W              | 1,500-5,600                  |
|                |                        | Y              | 2,800-10,000                 |
|                |                        | L              | 2,250-7,500                  |
| ng             | 3 1250                 | M              | 3,000-10,500                 |
| 00             | 0.1200                 | Н              | 4,250-15,000                 |
|                |                        | W              | 6,250-22,500                 |
|                |                        | L              | 6,000-22,000                 |
| 11             | 3.6250                 | М              | 9,000-32,000                 |
|                |                        | Н              | 12,000-50,000                |

#### **Basic Selection Chart**

\*Maximum bores may require flat keys (supplied with unit).

### How to Order

When ordering a HOR Series H1600 Overload Clutch, please include code letters/numbers for series, size, style, type, torque range, unit bore and coupling bore (if applicable).

#### Example:

Required size, 05 HOR Series H1600 Overload Clutch, standard style, flexible coupling, medium torque range, and a one inch bore on both the unit and coupling:





**HOR Series Part Numbering System** 

## Style F

### Type B Basic Sprocket Mounting





**All Dimensions in Inches** 

| Clutch | D    | C    | D     | Е    |       | 14   | Р         | D     | c    | т    | U    | Mounting Holes |         |       |  |  |
|--------|------|------|-------|------|-------|------|-----------|-------|------|------|------|----------------|---------|-------|--|--|
| Size   | D    | U    | U     | Ē    | L     | LI   | +.000/002 | n     | 3    | 1    | U    | N              | K       | М     |  |  |
| 02     | 1.75 | 0.29 | 2.81  | 0.45 | 3.52  | 2.00 | 1.781     | 5.81  | 2.63 | .060 | .94  | 0.38           | #8-32   | 2.125 |  |  |
| 04     | 2.38 | 0.35 | 4.25  | 0.56 | 4.79  | 3.00 | 2.688     | 7.25  | 3.63 | .078 | 1.23 | 0.50           | #10-24  | 3.062 |  |  |
| 05     | 3.50 | 0.43 | 5.88  | 0.70 | 6.20  | 3.88 | 3.625     | 8.88  | 5.00 | .110 | 1.60 | 0.75           | 5/16-18 | 4.250 |  |  |
| 06     | 4.25 | 0.50 | 7.12  | 0.80 | 6.73  | 4.38 | 4.000     | 10.12 | 5.56 | .128 | 1.71 | 0.81           | 3/8-16  | 4.750 |  |  |
| 09     | 5.75 | 1.03 | 9.50  | 1.40 | 9.00  | 5.50 | 5.750     | 12.50 | 7.56 | .165 | 2.10 | 0.88           | 7/16-14 | 6.625 |  |  |
| 11     | 6.25 | 1.28 | 11.62 | 1.65 | 10.66 | 6.88 | 6.500     | 14.62 | 9.00 | .183 | 2.69 | 1.00           | 5/8-11  | 7.750 |  |  |

Ratings

| Clutch | Tor  | que Ran | ige (Lb. In | .)     | Max. | WR <sup>2*</sup> | Weight* |  |
|--------|------|---------|-------------|--------|------|------------------|---------|--|
| Size   | Code | Min.    | MRT         | Max.   | RPM  | (LbIn.²)         | (Lbs.)  |  |
|        | L    | 25      | 45          | 60     |      |                  |         |  |
| 00     | М    | 50      | 100         | 125    | 500  | 0.4              |         |  |
| 02     | Н    | 75      | 125         | 175    | 500  | 3.4              | 3.9     |  |
|        | W    | 100     | 200         | 250    |      |                  |         |  |
|        | L    | 175     | 400         | 550    |      |                  |         |  |
| 0.4    | М    | 250     | 600         | 850    | 500  | 00.0             | 11.0    |  |
| 04     | Н    | 350     | 850         | 1,300  | 500  | 22.3             | 11.0    |  |
|        | W    | 600     | 1,400       | 2,000  |      |                  |         |  |
|        | L    | 350     | 900         | 1,200  |      |                  |         |  |
|        | М    | 500     | 1,300       | 1,800  |      | 129              | 30.2    |  |
| 05     | Н    | 750     | 1,800       | 2,600  | 500  |                  |         |  |
|        | W    | 1,000   | 2,750       | 4,000  |      |                  |         |  |
|        | Y    | 1,650   | 4,000       | 6,000  |      |                  |         |  |
|        | L    | 600     | 1,400       | 1,900  |      |                  |         |  |
|        | М    | 750     | 1,900       | 2,700  |      |                  |         |  |
| 06     | Н    | 1,000   | 2,600       | 3,800  | 500  | 266              | 43.3    |  |
|        | W    | 1,500   | 3,900       | 5,600  |      |                  |         |  |
|        | Y    | 2,800   | 7,000       | 10,000 |      |                  |         |  |
|        | L    | 2,250   | 5,500       | 7,500  |      |                  |         |  |
| 00     | М    | 3,000   | 7,500       | 10,500 | 500  | 1 155            | 104     |  |
| 09     | Н    | 4,250   | 10,000      | 15,000 | 500  | 1,155            | 104     |  |
|        | W    | 6,250   | 15,000      | 22,500 |      |                  |         |  |
|        | L    | 6,000   | 15,000      | 22,000 |      |                  |         |  |
| 11     | М    | 9,000   | 20,000      | 32,000 | 500  | 2,995            | 171     |  |
|        | Η    | 12,000  | 30,000      | 50,000 |      |                  |         |  |

### \*Weight and WR<sup>2</sup> estimated with maximum bores.

MRT is the Minimum Recommended Torque setting for those applications

which require a minimal degree of backlash.

Clutches are shipped set for the minimum torque value of the selected range. Refer to Page 37 for ordering information.

### **Clutch Bores**

| Clutch | Bores (inch) |          |  |  |  |  |  |
|--------|--------------|----------|--|--|--|--|--|
| Size   | Max. (1)     | Max. (2) |  |  |  |  |  |
| 02     | 0.5000       | 0.5625   |  |  |  |  |  |
| 04     | 1.0000       | 1.1250   |  |  |  |  |  |
| 05     | 1.5000       | 1.6250   |  |  |  |  |  |
| 06     | 1.9375       | 2.1250   |  |  |  |  |  |
| 09     | 2.8750       | 3.1250   |  |  |  |  |  |
| 11     | 3.1875       | 3.5000   |  |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### Minimum Number of Teeth Adaptable to Type B Clutches

|        |      | Standard Chain Size and Pitch |       |       |       |       |       |       |  |  |  |  |
|--------|------|-------------------------------|-------|-------|-------|-------|-------|-------|--|--|--|--|
| Clutch | Tuno | #25                           | #35   | #40   | #50   | #60   | #80   | #100  |  |  |  |  |
| Size   | Type | 1/4                           | 3/8   | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 |  |  |  |  |
|        |      | Pitch                         | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch |  |  |  |  |
| 02     | В    | 39                            | 27    | 22    | —     | —     | —     | —     |  |  |  |  |
| 04     | В    | 51                            | 35    | 28    | 23    | —     | —     | —     |  |  |  |  |
| 05     | В    | 69                            | 47    | 36    | 30    | 26    | _     | —     |  |  |  |  |
| 06     | В    | 76                            | 52    | 40    | 33    | 28    | —     | —     |  |  |  |  |
| 09     | В    | 101                           | 68    | 52    | 43    | 36    | 28    | 24    |  |  |  |  |
| 11     | В    | 119                           | 80    | 61    | 50    | 43    | 33    | 27    |  |  |  |  |

## **Style L Extended Hub**

**Type B Basic Sprocket Mounting** 





**All Dimensions in Inches** 

| Clutch | р    | <u> </u> | 01   | Р     | D E  | 1     | 14    | Р         | P      | 1      | п     | c    | т    |      | M    | lounting Ho | oles  |
|--------|------|----------|------|-------|------|-------|-------|-----------|--------|--------|-------|------|------|------|------|-------------|-------|
| Size   | D    | U        | UI.  | U     | E    | L     | LI    | +.000/002 | Min.   | Max.   | К     | 3    | I    | U    | Ν    | K           | М     |
| 02     | 1.75 | 0.29     | 1.25 | 2.81  | 2.04 | 4.63  | 3.25  | 1.781     | 0.9843 | 0.9847 | 5.81  | 2.63 | .060 | .45  | 0.38 | #8-32       | 2.125 |
| 04     | 2.38 | 0.35     | 1.44 | 4.25  | 2.35 | 6.06  | 3.88  | 2.688     | 1.5728 | 1.5738 | 7.25  | 3.63 | .078 | .74  | 0.50 | #10-24      | 3.062 |
| 05     | 3.50 | 0.43     | 2.06 | 5.88  | 3.24 | 8.18  | 5.25  | 3.625     | 2.3623 | 2.3628 | 8.88  | 5.00 | .110 | 1.06 | 0.75 | 5/16-18     | 4.250 |
| 06     | 4.25 | 0.50     | 3.62 | 7.12  | 4.87 | 10.25 | 6.88  | 4.000     | 2.7560 | 2.7566 | 10.12 | 5.56 | .128 | 1.15 | 0.81 | 3/8-16      | 4.750 |
| 09     | 5.75 | 1.03     | 4.25 | 9.50  | 6.28 | 13.23 | 9.00  | 5.750     | 3.9350 | 3.9370 | 12.50 | 7.56 | .165 | 1.50 | 0.88 | 7/16-14     | 6.625 |
| 11     | 6.50 | 1.28     | 4.50 | 11.62 | 7.16 | 15.01 | 10.00 | 6.500     | 4.7220 | 4.7240 | 14.62 | 9.00 | .183 | 1.54 | 1.00 | 5/8-11      | 7.750 |

#### **Ratings**

| Clutch | То   | rque Ran | ge (Lb. In. | )      | Max. | WR <sup>2*</sup>      | Weight* |  |
|--------|------|----------|-------------|--------|------|-----------------------|---------|--|
| Size   | Code | Min.     | MRT         | Max.   | RPM  | (LbIn. <sup>2</sup> ) | (Lbs.)  |  |
|        | L    | 25       | 45          | 60     |      |                       |         |  |
| 00     | М    | 50       | 100         | 125    | 500  | 0.5                   | 4.0     |  |
| 02     | Н    | 75       | 125         | 175    | 500  | 3.5                   |         |  |
|        | W    | 100      | 200         | 250    |      |                       |         |  |
|        | L    | 175      | 400         | 550    |      |                       |         |  |
| 04     | М    | 250      | 600         | 850    | 500  | 00.4                  | 11 E    |  |
| 04     | Н    | 350      | 850         | 1,300  | 500  | 22.4                  | 11.5    |  |
|        | W    | 600      | 1,400       | 2,000  |      |                       |         |  |
|        | L    | 350      | 900         | 1,200  |      |                       |         |  |
|        | М    | 500      | 1,300       | 1,800  |      | 130                   | 31.7    |  |
| 05     | Н    | 750      | 1,800       | 2,600  | 500  |                       |         |  |
|        | W    | 1,000    | 2,750       | 4,000  |      |                       |         |  |
|        | Y    | 1,650    | 4,000       | 6,000  |      |                       |         |  |
|        | L    | 600      | 1,400       | 1,900  |      |                       |         |  |
|        | М    | 750      | 1,900       | 2,700  |      |                       |         |  |
| 06     | Н    | 1,000    | 2,600       | 3,800  | 500  | 270                   | 47.0    |  |
|        | W    | 1,500    | 3,900       | 5,600  |      |                       |         |  |
|        | Y    | 2,800    | 7,000       | 10,000 |      |                       |         |  |
|        | L    | 2,250    | 5,500       | 7,500  |      |                       |         |  |
| 00     | М    | 3,000    | 7,500       | 10,500 | E00  | 1 100                 | 110     |  |
| 09     | Н    | 4,250    | 10,000      | 15,000 | 500  | 1,180                 | 112     |  |
|        | W    | 6,250    | 15,000      | 22,500 |      |                       |         |  |
|        | L    | 6,000    | 15,000      | 22,000 |      |                       |         |  |
| 11     | M    | 9,000    | 20,000      | 32,000 | 500  | 3,040                 | 182     |  |
|        | Н    | 12,000   | 30,000      | 50,000 |      |                       |         |  |

### **Clutch Bores**

| Clutch | Bores (inch) |          |  |  |  |  |  |  |
|--------|--------------|----------|--|--|--|--|--|--|
| Size   | Max. (1)     | Max. (2) |  |  |  |  |  |  |
| 02     | 0.6250       | 0.6875   |  |  |  |  |  |  |
| 04     | 1.1250       | 1.2500   |  |  |  |  |  |  |
| 05     | 1.7500       | 1.8125   |  |  |  |  |  |  |
| 06     | 1.9375       | 2.1250   |  |  |  |  |  |  |
| 09     | 2.8750       | 3.1250   |  |  |  |  |  |  |
| 11     | 3.2500       | 3.6250   |  |  |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### Minimum Number of Teeth Adaptable to Type B Clutches

|        |      |       | Sta   | ndard | Chain S | Size a | nd Pito | h     |
|--------|------|-------|-------|-------|---------|--------|---------|-------|
| Clutch | Tuno | #25   | #35   | #40   | #50     | #60    | #80     | #100  |
| Size   | Type | 1/4   | 3/8   | 1/2   | 5/8     | 3/4    | 1       | 1-1/4 |
|        |      | Pitch | Pitch | Pitch | Pitch   | Pitch  | Pitch   | Pitch |
| 02     | В    | 39    | 27    | 22    | —       |        | —       | —     |
| 04     | В    | 51    | 35    | 28    | 23      | —      | —       | —     |
| 05     | В    | 69    | 47    | 36    | 30      | 26     | —       | —     |
| 06     | В    | 76    | 52    | 40    | 33      | 28     | —       | —     |
| 09     | В    | 101   | 68    | 52    | 43      | 36     | 28      | 24    |
| 11     | В    | 119   | 80    | 61    | 50      | 43     | 33      | 27    |

\*Weight and WR<sup>2</sup> estimated with maximum bores.

MRT is the Minimum Recommended Torque setting for those applications which require a minimal degree of backlash.

Clutches are shipped set for the minimum torque value of the selected range. Refer to Page 37 for ordering information.

## Style F

**Type C Flexible Coupling** 



#### All Dimensions in Inches

| Clutch | В    | с    | D     | D1    | L     | L1   | Р    | R     | т    | U    | Max. All<br>Misalig | owable<br>nment* |
|--------|------|------|-------|-------|-------|------|------|-------|------|------|---------------------|------------------|
| Size   | _    | -    |       |       |       |      |      |       |      | _    | Parallel*           | Angular*         |
| 02     | 1.75 | 1.25 | 2.81  | 3.94  | 5.50  | 2.00 | 2.50 | 5.81  | .060 | .94  | .012                | 1°               |
| 04     | 2.38 | 1.25 | 4.25  | 5.13  | 6.64  | 3.00 | 3.25 | 7.25  | .078 | 1.23 | .016                | 1°               |
| 05     | 3.50 | 2.38 | 5.88  | 6.88  | 9.94  | 3.88 | 3.88 | 8.88  | .110 | 1.60 | .027                | 1°               |
| 06     | 4.25 | 2.88 | 7.12  | 8.13  | 11.25 | 4.38 | 4.25 | 10.12 | .128 | 1.71 | .045                | 1°               |
| 09     | 5.75 | 4.00 | 9.50  | 11.13 | 14.52 | 5.50 | 6.12 | 12.50 | .165 | 2.10 | .045                | 1°               |
| 11     | 6.25 | 4.50 | 11.62 | 14.00 | 16.67 | 6.88 | 7.50 | 14.62 | .183 | 2.69 | .045                | 1°               |

\*Parallel and Angular misalignment are proportionally reduced when both are present.

Ratings

| Clutch | Tor               | que Ran | ige (Lb. In | .)     | Max. | WR <sup>2*</sup> | Weight* |
|--------|-------------------|---------|-------------|--------|------|------------------|---------|
| Size   | Code              | Min.    | MRT         | Max.   | RPM  | (LbIn.²)         | (Lbs.)  |
|        | L                 | 25      | 45          | 60     |      |                  |         |
| 00     | М                 | 50      | 100         | 125    | 500  | 10.0             | 0.0     |
| 02     | Н                 | 75      | 125         | 175    | 500  | 10.0             | 0.0     |
|        | W                 | 100     | 200         | 250    |      |                  |         |
|        | L                 | 175     | 400         | 550    |      |                  |         |
| 04     | М                 | 250     | 600         | 850    | 500  | 44.0             | 10.0    |
| 04     | Н                 | 350     | 850         | 1,300  | 500  | 44.0             | 10.0    |
|        | W                 | 600     | 1,400       | 2,000  |      |                  |         |
|        | L                 | 350     | 900         | 1,200  |      |                  |         |
|        | M 500 1,300 1,800 |         |             |        |      |                  |         |
| 05     | Н                 | 750     | 1,800       | 2,600  | 500  | 241              | 49.0    |
|        | W                 | 1,000   | 2,750       | 4,000  |      |                  |         |
|        | Y                 | 1,650   | 4,000       | 6,000  |      |                  |         |
|        | L                 | 600     | 1,400       | 1,900  |      |                  |         |
|        | М                 | 750     | 1,900       | 2,700  |      |                  |         |
| 06     | Н                 | 1,000   | 2,600       | 3,800  | 500  | 550              | 82.0    |
|        | W                 | 1,500   | 3,900       | 5,600  |      |                  |         |
|        | Y                 | 2,800   | 7,000       | 10,000 |      |                  |         |
|        | L                 | 2,250   | 5,500       | 7,500  |      |                  |         |
| 00     | М                 | 3,000   | 7,500       | 10,500 | 500  | 0.005            | 100     |
| 09     | Н                 | 4,250   | 10,000      | 15,000 | 500  | 2,320            | 160     |
|        | W                 | 6,250   | 15,000      | 22,500 |      |                  |         |
|        | Ĺ                 | 6,000   | 15,000      | 22,000 |      |                  |         |
| 11     | М                 | 9,000   | 20,000      | 32,000 | 500  | 6,215            | 305     |
|        | Н                 | 12,000  | 30,000      | 50,000 |      |                  |         |

\*Weight and WR<sup>2</sup> estimated with maximum bores.

MRT is the Minimum Recommended Torque setting for those applications which require a minimal degree of backlash.

Clutches are shipped set for the minimum torque value of the selected range. Refer to Page 37 for ordering information.

#### **Clutch and Coupling Bores**

| Clutch |          | Bc       | ores     |  |
|--------|----------|----------|----------|--|
| Size   | Type     | Max. (1) | Max. (2) |  |
| 02     | Clutch   | 0.5000   | 0.5625   |  |
| 02     | Coupling | 1.1875   | -        |  |
| 04     | Clutch   | 1.0000   | 1.1250   |  |
| 04     | Coupling | 1.8750   | -        |  |
| 05     | Clutch   | 1.5000   | 1.6250   |  |
| 05     | Coupling | 2.3125   | 2.3750   |  |
| 06     | Clutch   | 1.9375   | 2.1250   |  |
| 00     | Coupling | 2.6250   | 2.7500   |  |
| 00     | Clutch   | 2.8750   | 3.1250   |  |
| 09     | Coupling | 4.0000   | 4.1250   |  |
|        | Clutch   | 3.1875   | 3.5000   |  |
| 11     | Coupling | 4.6250   | 5.0000   |  |

Refer to Page 96 for a complete list of bore codes.

(1) Square Key

(2) Flat Key

# **Style F**





#### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | D     | L     | L1   | М     | Р    | R     | т    | U    |
|----------------|------|------|-------|-------|------|-------|------|-------|------|------|
| 02             | 1.75 | 0.75 | 2.81  | 4.36  | 2.00 | 2.125 | 1.38 | 5.81  | .060 | .94  |
| 04             | 2.38 | 1.62 | 4.25  | 6.51  | 3.00 | 3.062 | 2.50 | 7.25  | .078 | 1.23 |
| 05             | 3.50 | 2.13 | 5.88  | 8.43  | 3.88 | 4.250 | 3.31 | 8.88  | .110 | 1.60 |
| 06             | 4.25 | 2.20 | 7.12  | 9.02  | 4.38 | 4.750 | 3.50 | 10.12 | .128 | 1.71 |
| 09             | 5.75 | 3.34 | 9.50  | 12.43 | 5.50 | 6.625 | 5.25 | 12.50 | .165 | 2.10 |
| 11             | 6.25 | 3.96 | 11.62 | 14.77 | 6.88 | 7.750 | 6.00 | 14.62 | .183 | 2.69 |

#### **Ratings**

| Clutch | То   | rque Ran | ige (Lb. In | ı.)    | Max. | WR <sup>2*</sup> | Weight* |  |
|--------|------|----------|-------------|--------|------|------------------|---------|--|
| Size   | Code | Min.     | MRT         | Max.   | RPM  | (LbIn.²)         | (Lbs.)  |  |
|        | L    | 25       | 45          | 60     |      |                  |         |  |
| 00     | М    | 50       | 100         | 125    | 500  |                  | 47      |  |
| 02     | Н    | 75       | 125         | 175    | 500  | 4.1              | 4.7     |  |
|        | W    | 100      | 200         | 250    |      |                  |         |  |
|        | L    | 175      | 400         | 550    |      |                  |         |  |
| 04     | М    | 250      | 600         | 850    | 500  | 26.2             | 10.0    |  |
| 04     | Н    | 350      | 850         | 1,300  | 500  | 20.3             | 13.5    |  |
|        | W    | 600      | 1,400       | 2,000  |      |                  |         |  |
|        | L    | 350      | 900         | 1,200  |      |                  | 35.5    |  |
|        | М    | 500      | 1,300       | 1,800  |      | 146              |         |  |
| 05     | Н    | 750      | 1,800       | 2,600  | 500  |                  |         |  |
|        | W    | 1,000    | 2,750       | 4,000  |      |                  |         |  |
|        | Y    | 1,650    | 4,000       | 6,000  |      |                  |         |  |
|        | L    | 600      | 1,400       | 1,900  |      |                  | 50.9    |  |
|        | М    | 750      | 1,900       | 2,700  |      |                  |         |  |
| 06     | Н    | 1,000    | 2,600       | 3,800  | 500  | 296              |         |  |
|        | W    | 1,500    | 3,900       | 5,600  |      |                  |         |  |
|        | Y    | 2,800    | 7,000       | 10,000 |      |                  |         |  |
|        | L    | 2,250    | 5,500       | 7,500  |      |                  |         |  |
| 00     | М    | 3,000    | 7,500       | 10,500 | 500  | 1 005            | 104     |  |
| 09     | Н    | 4,250    | 10,000      | 15,000 | 500  | 1,295            | 124     |  |
|        | W    | 6,250    | 15,000      | 22,500 |      |                  |         |  |
|        | L    | 6,000    | 15,000      | 22,000 |      |                  |         |  |
| 11     | Μ    | 9,000    | 20,000      | 32,000 | 500  | 3,290            | 200     |  |
|        | Н    | 12,000   | 30,000      | 50,000 |      |                  |         |  |

**Clutch and Coupling Bores** 

| Clutch | Turna    | Bores    |          |  |  |
|--------|----------|----------|----------|--|--|
| Size   | туре     | Max. (1) | Max. (2) |  |  |
| 02     | Clutch   | 0.5000   | 0.5625   |  |  |
| 02     | Coupling | 0.7500   | -        |  |  |
| 04     | Clutch   | 1.0000   | 1.1250   |  |  |
| 04     | Coupling | 1.6250   | 1.6875   |  |  |
| 05     | Clutch   | 1.5000   | 1.6250   |  |  |
| 05     | Coupling | 2.1250   | 2.2500   |  |  |
| 06     | Clutch   | 1.9375   | 2.1250   |  |  |
| 00     | Coupling | 2.2500   | 2.3125   |  |  |
| 00     | Clutch   | 2.8750   | 3.1250   |  |  |
| 09     | Coupling | 3.3750   | 3.5000   |  |  |
| 11     | Clutch   | 3.1875   | 3.5000   |  |  |
| 11     | Coupling | 4.0000   | 4.1250   |  |  |

Refer to Page 96 for a complete list of bore codes.

(1) Square Key (2) Flat Key

\*Weight and WR<sup>2</sup> estimated with maximum bores.

MRT is the Minimum Recommended Torque setting for those applications which require a minimal degree of backlash.

Clutches are shipped set for the minimum torque value of the selected range. Refer to Page 37 for ordering information.

## **Type T Adapter Mounts to Existing Housing Bolt Pattern**

Type T Sprocket, Pulley, Sheave or Gear Mount





### **All Dimensions in Inches**

| Clutch<br>Size | С    | D    | Е    | К      | L    | М     | N   | P<br>+.000/002 | R    | S    | WR <sup>2</sup><br>(LbIn. <sup>2</sup> ) | Weight<br>(Lbs.) |
|----------------|------|------|------|--------|------|-------|-----|----------------|------|------|--|------------------|
| 02             | 0.28 | 2.63 | 0.40 | #8-32  | 0.71 | 1.422 | .38 | 1.094          | —    | 1.75 | 0.5                                      | 0.5              |
| 04             | 0.34 | 3.63 | 0.63 | #8-32  | 1.02 | 2.250 | .38 | 1.922          | 3/16 | 2.58 | 2.0                                      | 1.0              |
| 05             | 0.47 | 5.00 | 0.59 | 1/4-20 | 1.26 | 3.219 | .50 | 2.750          | 1/4  | 3.66 | 12                                       | 3.0              |
| 06             | 0.69 | 5.56 | 0.81 | 1/4-20 | 1.55 | 3.406 | .50 | 2.938          | 1/4  | 3.90 | 25                                       | 5.4              |
| 09             | 0.88 | 7.56 | 1.00 | 3/8-16 | 2.00 | 5.094 | .75 | 4.344          | 3/8  | 5.84 | 93                                       | 11               |
| 11             | 1.02 | 9.00 | 1.14 | 3/8-16 | 2.32 | 5.938 | .75 | 5.188          | 1/2  | 6.69 | 241                                      | 19               |

Mounting bolts must be minimum 160,000 PSI tensile, Rc 36-43 Dowel pins must be minimum 150,000 PSI shear, Rc 50-58 core hardness

| Minimum Number of Teeth Adaptable to Type T Clutches   |
|--|
| Type T Clutches Allow for the Use of Smaller Sprockets |

|        |      | Standard Chain Size and Pitch |       |       |       |       |       |       |  |  |
|--------|------|-------------------------------|-------|-------|-------|-------|-------|-------|--|--|
| Clutch | Type | #25                           | #35   | #40   | #50   | #60   | #80   | #100  |  |  |
| Size   | Type | 1/4                           | 3/8   | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 |  |  |
|        |      | Pitch                         | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch |  |  |
| 02     | Т    | 27                            | 19    | 15    | _     | —     | -     | —     |  |  |
| 04     | Т    | 37                            | 26    | 20    | 17    | —     | —     | —     |  |  |
| 05     | Т    | 50                            | 35    | 27    | 23    | 19    | Ι     | —     |  |  |
| 06     | Т    | 54                            | 37    | 29    | 24    | 20    | 16    | 14    |  |  |
| 09     | Т    | 79                            | 54    | 41    | 34    | 29    | 23    | 19    |  |  |
| 11     | Т    | 90                            | 61    | 47    | 38    | 32    | 25    | 21    |  |  |

The Type T adapter may be ordered separately or factory mounted to the HOR Series Clutches shown on Pages 38 and 39, by specifying Type T.

## **General Information**

### **Torque Adjustment Wrench**

Standard bearing nuts are used to adjust the spring load which controls the release torque of the clutch. These nuts are slotted and can easily be turned using a common, commercially available hook style spanner wrench. Refer to the table below for wrenches which are compatible with Boston Gear's torque overload release clutches.

### **Torque Adjustment Wrench**



|                |                       | Wrench Pa                       | rt Number            |                     | Specifications (Inches) |                |               |        |
|----------------|-----------------------|---------------------------------|----------------------|---------------------|-------------------------|----------------|---------------|--------|
| Clutch<br>Size | Armstrong<br>Tool Co. | McMaster-<br>Carr<br>Supply Co. | Williams<br>Tool Co. | Snap-On<br>Tool Co. | Diameter<br>Range       | Hook<br>Thick. | Hook<br>Depth | Length |
| 02             | 34-301                | 5471A11                         | 471                  | AHS300              | .75 to 2.00             | .34            | .13           | 6.38   |
| 02, 04         | 34-304                | 5471A12                         | 472                  | AHS301              | 1.25 to 3.00            | .41            | .16           | 8.13   |
| 04, 05, 06     | 34-307                | 5471A13                         | 474                  | AHS304              | 2.00 to 4.75            | .47            | .19           | 11.38  |
| 09, 11         | 34-310                | 5471A14                         | 474A                 | AHS307              | 4.50 to 6.25            | .47            | .25           | 12.13  |
| 11             | 34-313                | 5471A23                         | 474B                 | —                   | 6.12 to 8.75            | .47            | .31           | 13.75  |

Figure 5 Suggested Mounting Arrangements



Type B, Style F with Sprocket Mounted

### **Torque Overload Detection**

The HOR Series H1600 Clutch is an automatic reset device designed for use when a fully disconnecting type is not desirable either because it is inaccessible and cannot be manually reset or because frequent resetting is not feasible. Because of this feature, it is important that the drive be shut down immediately upon a torque overload condition to prevent possible damage to the clutch caused by long-term reengaging and disengaging. Figure 4 utilizes a single limit switch to detect an overload condition. The switch should be able to operate within the disengagement travel of the clutch. Upon an overload, the cover of the clutch will move to actuate the limit switch and shut down the drive. The switch should be wired in parallel with a jog button so the drive can be indexed and permit the clutch to reengage at a safe speed. Once the clutch has been reengaged the limit switch will be reset and the drive can be restarted.



Type B, Style L with Sheave Mounted

Figure 4 Limit Switch Layout



# H1600 Overload Clutches

## **Torque Limiter Application Data**

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:                       | 7. Shut Down Method:                         |
|---------------------------------------|--|
| □ New                                 | Prox Plate                                   |
| □ Existing                            | Pin Style (ORC only)                         |
| – Replacement Model #                 | None Required                                |
| 2. Power transmission requirements at |  |
| clutch location:                      | Name:  |
| □ RPM                                 | Phono #                                      |
| Limiting Torque Level                 |  |
|                                       | Fax #  |
| 3. Type:                              | Company                                      |
| Pneumatic                             | E-Mail                                       |
| 4. Type:                              |  |
| Fully Automatic Re-Engagement         | Use the space below to note any relevant     |
| Manual (Free Wheeling)                | application data of to detail your question. |
| Semi Automatic (ORC model only)       |  |
| 5. Method of Torque Transmission:     |  |
| Flexible Coupling                     |  |
| Rigid Coupling                        |  |
| Sprocket Mount                        |  |
| Sprocket Size and Tooth Count         |  |
| 6. Bore Size:                         |  |
| Sprocket Mount (Clutch Bore)          |  |
| Coupling Mount (Clutch Bore)          |  |
| (Coupling Bore)                       |  |
|                                       |  |
|                                       |  |
|                                       |  |
|                                       |  |



## Designed for the water and wastewater industry

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# H1900 Overload Clutches Waste Water Industry WOR Series

### **Features**

- Automatic or manual reset
- Large bore capacity
- Through shaft or end shaft mounting
- Accurate torque release
- Stainless steel enclosure
- Electroless nickel plated
- Adaptable for all drives
- Operating parts are hardened for long life



### **Operating Principles**

The WOR Series H1900 is a mechanical ball detent overload release clutch. It has been designed to provide accurate and dependable torque overload protection for mechanical water and wastewater treatment equipment.

Torque is transmitted between the balls and the detents of the rotor in the following manner:

The chrome alloy balls are forced into the detents of the 50 Rc hardened rotor by an axial load generated by compressing a spring pack. This axial load is what determines the torque capacity of the clutch. Increasing or decreasing the spring compression or changing spring packs provides a means for multiple torque adjustments. When a torque overload condition occurs, the balls roll out of the rotor detents. This rolling action reduces any fluctuation in torque due to frictional changes (See Figure 1).

The movement of the cover during disengagement of the balls can be used to trip a limit switch and signal an overload condition. The drive should be shut down immediately and the source of the overload determined and cleared. After the clutch has been reset the drive can then be restarted.





The **Manual Reset** (Style M or N) clutch can be reset in multiple positions. Rotate the drive until a lube fitting or a barring hole on the housing lines up with a tapped hole on the rotor. The rotor keyway should also be lined up with a lube fitting on the housing. After the proper position has been established, push evenly on both sides of the limit switch actuating plate. When the clutch is properly reset, the steel balls will move back into their detents and the actuating plate will return to its original position. An audible sound will be detected when the clutch re-engages, (See Figure 2).



Figure 2

The **Automatic Reset** (Style A or B) version will re-engage without manual assistance. The steel balls will move back into their pockets every 1/4 of a revolution (1/8 of a revolution on the Size 11). After the overload condition has been cleared, jog the drive until the balls return to their detents and the actuating plate returns to its original position. An audible sound will be detected when the clutch re-engages.

### Selection

- 1. Determine the overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

Torque (Lb. In.) = 
$$\frac{\text{HP x 63025}}{\text{RPM}}$$
 X SF

- b. Maximum drive torque of chain: If using non-metallic chain, contact the manufacturer of the chain and ask for its maximum drive torque.
- c. For shear pin replacement: Contact your local Boston Gear Area Sales Manager or the factory. They will gladly calculate the shear torque of your existing shear pins for you.
- 2. Determine the bore size and keyway.
- 3. Choose the proper style from Figures 3, 4, or 5 based upon the drive layout.
- 4. Refer to the Basic Selection Chart for the appropriate clutch size.

#### Figure 3

Type B, Style A and M Through-Bore for line shaft sprocket drive applications typically found on rectangular tanks and longitudinal collector drives.



## Figure 4

Type B, Style B and N For end-shaft mounted sprocket drive applications including cross collectors and bar screens. End-shaft design accommodates larger shafts.



#### **Basic Selection Chart**

|      | Torque | Torque Rar | nge (LbIn.) | Maximum I | Bore (In.)* |
|------|--------|------------|-------------|-----------|-------------|
| Size | Code   | Minimum    | Maximum     | Style A/M | Style B/N   |
|      | L      | 850        | 1,700       |           |             |
| 05   | М      | 1,100      | 2,200       | 1.7500    | 2.0000      |
|      | Н      | 1,400      | 2,800       |           |             |
|      | W      | 2,500      | 5,000       |           |             |
|      | L      | 1,250      | 2,500       |           |             |
| 06   | М      | 1,800      | 3,750       | 2.2500    | 2.7500      |
|      | Н      | 2,500      | 5,500       |           |             |
|      | W      | 4,000      | 8,000       |           |             |
|      | L      | 2,250      | 5,750       |           |             |
| 09   | М      | 3,750      | 8,500       | 3.0000    | 4.2500      |
|      | Н      | 5,500      | 12,000      |           |             |
|      | W      | 8,500      | 20,000      |           |             |
|      | L      | 5,000      | 12,000      |           |             |
| 11   | М      | 9,000      | 16,500      | 4.0000    | 4.2500      |
|      | Н      | 12,000     | 25,000      |           |             |
|      | W      | 16,000     | 30,000      |           |             |

\*Larger bores may require flat keys (supplied with unit).

## Figure 5 Type J, Style A and M For through-bore sprocket drive appli-

cations which require a Jaw Clutch for manual disengagement of the drive. Jaw-Clutch/Sprocket assemblies are available from Boston Gear.





### **How to Order**

When ordering a WOR Series H1900 Overload Clutch for Wastewater Treatment applications, please include code letters/ numbers for series, size, style, type, torque range, and bore size.

#### Example:

Required size, 05 WOR Series H1900 Overload Clutch, automatic reset, through-bore mounting, basic type, medium torque range, with a one inch bore:



P-1500-BG 5/21

## **Style A and M Through-Bore**

Type B Basic Sprocket Mounting



### **All Dimensions in Inches**

| Clutch | Clutch |     | P C D | D         |      | F     | <u> </u> | Mounting Holes |         |       | Min. H78 |
|--------|--------|-----|-------|-----------|------|-------|----------|----------------|---------|-------|----------|
| Size   | A      | D   |       | +.000/002 | E    | Г     | G        | No.            | Thread  | Depth | Sprocket |
| 05     | 5.76   | .13 | 4.000 | 3.123     | 6.19 | 8.19  | 4.50     | 6              | 5/16-18 | 0.75  | 9 Tooth  |
| 06     | 7.45   | .17 | 4.875 | 4.000     | 7.62 | 9.62  | 5.25     | 8              | 1/2-13  | 1.12  | 9 Tooth  |
| 09     | 9.14   | .19 | 4.875 | 4.000     | 9.65 | 11.62 | 6.12     | 8              | 1/2-13  | 1.25  | 9 Tooth  |
| 11     | 10.00  | .19 | 6.500 | 5.500     | 9.65 | 11.62 | 7.00     | 8              | 1/2-13  | 1.25  | 11 Tooth |

### Ratings

| Clutch | Torque | Torque Rar | nge (Lb. In.) | Max. | Weight<br>(Lbs.) |  |
|--------|--------|------------|---------------|------|------------------|--|
| Size   | Code   | Min.       | Max.          | RPM  |                  |  |
|        | L      | 850        | 1,700         |      |                  |  |
| 05     | М      | 1,100      | 2,200         | 50   | 24               |  |
| 05     | Н      | 1,400      | 2,800         | 50   | 24               |  |
|        | W      | 2,500      | 5,000         |      |                  |  |
|        | L      | 1,250      | 2,500         |      |                  |  |
| 06     | М      | 1,800      | 3,750         | 50   | 40               |  |
| 00     | Н      | 2,500      | 5,500         | 50   |                  |  |
|        | W      | 4,000      | 8,000         |      |                  |  |
|        | L      | 2,250      | 5,750         |      |                  |  |
| 00     | М      | 3,750      | 8,500         | 50   | 80               |  |
| 03     | Н      | 5,500      | 12,000        | 50   | 00               |  |
|        | W      | 8,500      | 20,000        |      |                  |  |
|        | L      | 5,000      | 12,000        |      |                  |  |
| 11     | М      | 9,000      | 16,500        | 50   | 87               |  |
| 11     | Н      | 12,000     | 25,000        | 50   | 07               |  |
|        | W      | 16,000     | 30,000        |      |                  |  |

Clutches are shipped set for the minimum torque value of the specified range.

Refer to Page 47 for ordering information.

### **Clutch Bores**

| Clutch | Bores (inch) |          |          |  |  |  |  |
|--------|--------------|----------|----------|--|--|--|--|
| Size   | Min.         | Max. (1) | Max. (2) |  |  |  |  |
| 05     | 0.6250       | 1.6250   | 1.7500   |  |  |  |  |
| 06     | 0.6250       | 2.1250   | 2.2500   |  |  |  |  |
| 09     | 1.0000       | 2.7500   | 3.0000   |  |  |  |  |
| 11     | 1.0000       | 3.7500   | 4.0000   |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

## **Style B and N End-Shaft**

Type B Basic Sprocket Mounting



#### **All Dimensions in Inches**

| Clutch | •     | <b>_</b> | 0     |           |      |       |      | Min. H78 |     |         |       |          |
|--------|-------|----------|-------|-----------|------|-------|------|----------|-----|---------|-------|----------|
| Size   | A     | В        |       | +.000/002 | E    | F     | G    | н        | No. | Thread  | Depth | Sprocket |
| 05     | 7.00  | 0.13     | 4.000 | 3.123     | 6.19 | 8.19  | 3.30 | 2.09     | 6   | 5/16-18 | 0.75  | 9 Tooth  |
| 06     | 9.04  | 0.17     | 4.875 | 4.000     | 7.62 | 9.62  | 4.69 | 2.56     | 8   | 1/2-13  | 1.12  | 9 Tooth  |
| 09     | 10.75 | 0.19     | 6.500 | 5.500     | 9.65 | 11.62 | 5.88 | 3.00     | 8   | 1/2-13  | 1.25  | 11 Tooth |
| 11     | 11.44 | 0.19     | 6.500 | 5.500     | 9.65 | 11.62 | 5.88 | 3.00     | 8   | 1/2-13  | 1.25  | 11 Tooth |

| Ratings |
|---------|
|---------|

| Clutch | Torque | Torque Rar | nge (Lb. In.) | Max. | Weight |  |
|--------|--------|------------|---------------|------|--------|--|
| Size   | Code   | Min.       | Max.          | RPM  | (Lbs.) |  |
|        | L      | 850        | 1,700         |      |        |  |
| 05     | М      | 1,100      | 2,200         | 50   | 25     |  |
| 05     | Н      | 1,400      | 2,800         | 50   | 25     |  |
|        | W      | 2,500      | 5,000         |      |        |  |
|        | L      | 1,250      | 2,500         |      | 42     |  |
| 06     | М      | 1,800      | 3,750         | 50   |        |  |
| 00     | н      | 2,500      | 5,500         | 50   |        |  |
|        | W      | 4,000      | 8,000         |      |        |  |
|        | L      | 2,250      | 5,750         |      |        |  |
| 00     | М      | 3,750      | 8,500         | 50   | 92     |  |
| 09     | н      | 5,500      | 12,000        | 50   | 00     |  |
|        | W      | 8,500      | 20,000        |      |        |  |
|        | L      | 5,000      | 12,000        |      |        |  |
| 11     | М      | 9,000      | 16,500        | 50   | 87     |  |
|        | Н      | 12,000     | 25,000        |      | 07     |  |
|        | W      | 16,000     | 30,000        |      |        |  |

Clutches are shipped set for the minimum torque value of the specified range.

Refer to Page 47 for ordering information.

### **Clutch Bores**

| Clutch | Bores (inch) |          |  |  |  |
|--------|--------------|----------|--|--|--|
| Size   | Min.         | Max. (1) |  |  |  |
| 05     | 0.6250       | 2.0000   |  |  |  |
| 06     | 0.6250       | 2.7500   |  |  |  |
| 09     | 1.0000       | 4.2500   |  |  |  |
| 11     | 1.0000       | 4.2500   |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

## **Style A and M Through-Bore**

Type J Jaw Clutch Adapter



### **All Dimensions in Inches**

| Clutch<br>Size | А     | В   | С     | D<br>+.000/002 | E    | F     | G   | н    | I    |
|----------------|-------|-----|-------|----------------|------|-------|-----|------|------|
| 05             | 10.20 | .13 | 2.875 | 3.250          | 6.19 | 8.19  | .38 | 4.00 | 4.50 |
| 06             | 12.25 | .17 | 3.500 | 3.875          | 7.62 | 9.62  | .38 | 4.50 | 5.25 |
| 09             | 14.62 | .19 | 4.000 | 4.500          | 9.65 | 11.62 | .50 | 5.00 | 6.12 |
| 11             | 15.87 | .19 | 5.000 | 5.500          | 9.65 | 11.62 | .50 | 5.50 | 7.00 |

### Ratings

| Clutch | Toraue | Torque Rar | nge (Lb. In.) | Max. | Weight |  |
|--------|--------|------------|---------------|------|--------|--|
| Size   | Code   | Min.       | Max.          | RPM  | (Lbs.) |  |
|        | L      | 850        | 1,700         |      |        |  |
| 05     | М      | 1,100      | 2,200         | 50   | 31     |  |
| 05     | н      | 1,400      | 2,800         | 50   | 51     |  |
|        | W      | 2,500      | 5,000         |      |        |  |
|        | L      | 1,250      | 2,500         |      |        |  |
| 06     | М      | 1,800      | 3,750         | 50   | 50     |  |
| 00     | н      | 2,500      | 5,500         | 50   |        |  |
|        | W      | 4,000      | 8,000         |      |        |  |
|        | L      | 2,250      | 5,750         |      | 06     |  |
| na     | М      | 3,750      | 8,500         | 50   |        |  |
| 03     | н      | 5,500      | 12,000        | 50   | 30     |  |
|        | W      | 8,500      | 20,000        |      |        |  |
|        | L      | 5,000      | 12,000        |      |        |  |
| 11     | М      | 9,000      | 16,500        | 50   | 110    |  |
|        | Н      | 12,000     | 25,000        | 50   | 119    |  |
|        | W      | 16,000     | 30,000        |      |        |  |

Clutches are shipped set for the minimum torque value of the specified range.

Refer to Page 47 for ordering information.

### **Clutch Bores**

| Clutch | Bores (inch) |          |          |  |  |  |  |
|--------|--------------|----------|----------|--|--|--|--|
| Size   | Min.         | Max. (1) | Max. (2) |  |  |  |  |
| 05     | 0.6250       | 1.6250   | 1.7500   |  |  |  |  |
| 06     | 0.6250       | 2.1250   | 2.2500   |  |  |  |  |
| 09     | 1.0000       | 2.7500   | 3.0000   |  |  |  |  |
| 11     | 1.0000       | 3.7500   | 4.0000   |  |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

## **General Information**

## Limit Switch Layout



Figure 6

### **Torque Overload Detection**

The WOR Series H1900 is offered with an automatic reset (Style A/B). Because of this feature, it is important that the drive be shut down immediately upon a torque overload condition. Figure 6 utilizes a single limit switch to detect an overload. The switch should be able to operate within the disengagement travel of the clutch. Upon an overload, an oversized stainless steel plate attached to the cover will move to actuate the limit switch and shut down the drive.

### **Torque Adjustment Wrench**

Standard bearing nuts are used to adjust the spring load which controls the release torque of the clutch. These nuts are slotted and can easily be turned using a common, commercially available hook style spanner wrench. Refer to the table at bottom of this page for wrenches which are compatible with Boston Gear's torque overload release clutches.

### Suggested Specifications for Water and Wastewater Treatment Applications

Overload release clutches shall be installed to provide positive protection against damaging jams to the drives. They are to be located on the output sides of speed reducers, or as near as possible to the potential source of the overload so that the drive components are adequately protected.

The clutches shall be a ball detent type which when an overload occurs, the detent balls will roll free from their seat against pre-set spring pressure, completely disengaging the drive. Springs are to be a precision Belleville design conforming to spec. DIN-2092 and DIN-2093.

Resetting shall be a simple manual push back re-engagement (or automatic reset) and torque values will remain constant within plus or minus 10% after each disengagement or re-engagement.

All clutches shall be fully adjustable through a wide torque range to meet varying conditions and include a maximum torque limit stop to prevent adjustment beyond designed torque values. A circular plate is to be incorporated in the cover as a means to operate a limit switch to annunciate and/ or stop the drive.

The clutches shall be completely sealed suitable for outdoor installations, including a stainless steel cover, electroless nickel plated external parts, and an external grease fitting for packing the units.

Chrome alloy steel detent balls shall be hardened to 60 Rc and all major internal components hardened to 50 Rc minimum for long life.

The WOR Series H1900 Overload Release Clutches shall be manufactured by Boston Gear, Charlotte, North Carolina 28216.





# H1900 Overload Clutches

## **Torque Limiter Application Data**

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:  | 7. Shut Down Method:                         |
|--|--|
| □ New  | Prox Plate                                   |
| Existing   | Pin Style (ORC only)                         |
| – Replacement Model #  | None Required                                |
| 2. Power transmission requirements at  |  |
| clutch location:   | Name:  |
| RPM  | Phone #                                      |
|  | Fax #  |
| 3. Type:   | Company                                      |
|  | E-Mail                                       |
| 4. Туре:   |  |
| <ul> <li>Fully Automatic Re-Engagement</li> <li>Manual (Free Wheeling)</li> <li>Semi Automatic (ORC model only)</li> </ul> | application data or to detail your question. |
| 5. Method of Torque Transmission:  |  |
| Flexible Coupling  |  |
| Rigid Coupling   |  |
| Sprocket Mount   |  |
| Sprocket Size and Tooth Count  |  |
| 6. Bore Size:  |  |
| Sprocket Mount (Clutch Bore)   |  |
| Coupling Mount (Clutch Bore)   |  |
| (Coupling Bore)  |  |
|  |  |
|  |  |
|  |  |
|  |  |



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# H2000 Pneumatic Overload Clutches POR Series

### **Features**

- "In-Flight" torque control offers precise pneumatic torque control
- Remotely adjustable for starting and overrunning loads
- Bi-directional operation
- Single position indexing
- Automatic reset
- Through-shaft design
- · Limit switch actuating mechanism
- Clamp collar for secure mounting
- Hardened parts for long clutch life
- Internal needle roller thrust bearings
- Lubrication fittings
- Sealed from environmental contamination
- Electroless nickel finish and stainless steel hardware for superior corrosion resistance
- Interchanges HOR Series

### **Operating Principles**

The POR Series H2000 is a pneumatic, ball detent style overload release clutch. It has been designed to provide accurate and dependable torque disconnect protection for mechanical power transmission equipment. Torque is transmitted through the clutch in one of two paths, (Refer to Figure 1).

Torque transmission between the balls and housing is the key to the disengagement of the clutch. The balls are forced into the pockets of the housing by an axial load generated by an



air cylinder. This axial load determines the torque capacity of the clutch. Increasing or decreasing the air pressure provides a means for remotely controlled precise "in-flight" torque adjustment. When a torque overload condition occurs, the balls roll out of the pockets and free wheel much as a ball thrust bearing. This rolling action increases the efficiency in which the clutch operates and reduces any fluctuation of torque setting due to frictional changes, (Refer to Figure 2).

The clutch has been designed with an internal valving mechanism. During an overload condition, the air is purged instantaneously from the cylinder.

The movement of the air cylinder during disengagement can be used to trip a limit switch and signal a torque overload condition. The drive should be shut down immediately and the source of the overload determined and cleared. The drive can then be restarted.

To engage the clutch, reapply air pressure and jog the drive until the clutch engages. Adjust the release torque by increasing the air pressure supplied to the clutch to reach the desired torque value. The clutch is now ready for normal operation.



Figure 1



Figure 2

### Selection

- 1. Determine the overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

Torque (Lb. In.) =  $\frac{HP \times 63025}{RPM} X SF$ 

- b. Determine the "weak link" in the drive train, (i.e., chain, reducer, belt or shaft). Select an overload release torque below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size(s) and keyway(s):
  - a. Shaft size at the clutch location determines the clutch bore.
  - b. Shaft size at the coupling location determines the coupling bore, (if applicable).
- 3. Choose the appropriate Style (See Figure 3) based upon the drive layout and available space.
- 4. Refer to the Basic Selection Chart for the appropriate clutch size. Determine the approximate start-up and running air pressures for the application.
- 5. Refer to Part Numbering System to complete selection.

| Clutch<br>Size | Max.*<br>Bore (In.) | Torque<br>Code | Torque Range<br>(LbIn.) | Max.<br>RPM |  |  |  |  |  |  |  |  |  |
|----------------|---------------------|----------------|-------------------------|-------------|--|--|--|--|--|--|--|--|--|
| 02             | 0.750               | Н              | 120-470                 | 3,600       |  |  |  |  |  |  |  |  |  |
| 04             | 1.187               | Н              | 400-1,400               | 1,800       |  |  |  |  |  |  |  |  |  |
| 05             | 1 750               | L              | 850-2900                | 1 800       |  |  |  |  |  |  |  |  |  |
| 05             | 1.750               | Н              | 1,350-4,700             | 1,000       |  |  |  |  |  |  |  |  |  |
| 00             | 0 105               | L              | 1,000-4,050             | 1 000       |  |  |  |  |  |  |  |  |  |
| 00             | 2.125               | Н              | 2,800-7,800             | 1,200       |  |  |  |  |  |  |  |  |  |
| 09             | 3.125               | Н              | 5,800-17,800            | 1,200       |  |  |  |  |  |  |  |  |  |
| 11             | 3.250               | Н              | 8,200-33,000            | 1,200       |  |  |  |  |  |  |  |  |  |

Pagia Coloction Chart

\*Larger bores may require flat keys (supplied with unit).

Figure 3





### How to Order

When ordering a POR Series H2000 Overload Clutch, please include code letters for series, size, style, type, torque range, unit bore and coupling bore (if applicable). Not all combinations are possible. Please refer to Pages 54-57 for details. **Example:** 

Required size, 05 POR Series H2000 Overload Clutch, full available shaft length, flexible coupling, large torque range, with a one inch unit bore and a one inch coupling bore:



(Only include second bore "P20" if clutch is a coupling style)

# H2000 Pneumatic Overload Clutches POR Series

## Style F

### Type B Basic Sprocket Mounting





#### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | D     | Е    | F     | G     | Н    | I    | K    | L     | L1   | P<br>+.000/002 | R     | S    | т    | Weight<br>(Lbs.) |
|----------------|------|------|-------|------|-------|-------|------|------|------|-------|------|----------------|-------|------|------|------------------|
| 02             | 1.75 | 0.29 | 2.81  | 0.45 | 3.50  | 3.88  | 1.84 | 2.19 | 0.56 | 4.47  | 2.95 | 1.781          | 5.81  | 2.63 | .060 | 5.0              |
| 04             | 2.38 | 0.35 | 4.25  | 0.56 | 4.00  | 4.75  | 1.76 | 2.79 | 0.54 | 5.57  | 3.77 | 2.688          | 7.25  | 3.63 | .078 | 11.6             |
| 05             | 3.50 | 0.43 | 5.87  | 0.70 | 6.25  | 6.63  | 2.87 | 3.33 | 0.77 | 6.88  | 4.57 | 3.625          | 8.88  | 5.00 | .110 | 28.3             |
| 06             | 4.25 | 0.50 | 7.13  | 0.80 | 7.25  | 7.75  | 3.00 | 3.54 | 0.72 | 7.42  | 5.00 | 4.000          | 10.12 | 5.56 | .128 | 41.0             |
| 09             | 5.75 | 1.03 | 9.50  | 1.40 | 9.25  | 10.00 | 3.87 | 4.63 | 1.03 | 9.75  | 6.30 | 5.750          | 12.50 | 7.56 | .165 | 98.5             |
| 11             | 6.00 | 1.28 | 11.62 | 1.65 | 11.50 | 12.25 | 4.50 | 5.20 | 1.25 | 11.25 | 7.44 | 6.500          | 14.62 | 9.00 | .183 | 155              |

### **Mounting Detail**

| Clutch<br>Size | Thread<br>Depth<br>N | Thread<br>Size<br>K | Bolt<br>Centers<br>M |
|----------------|----------------------|---------------------|----------------------|
| 02             | 0.38                 | 8-32                | 2.125                |
| 04             | 0.50                 | 10-24               | 3.062                |
| 05             | 0.75                 | 5/16-18             | 4.250                |
| 06             | 0.81                 | 3/8-16              | 4.750                |
| 09             | 0.88                 | 7/16-14             | 6.625                |
| 11             | 1.00                 | 5/8-11              | 7.750                |

### Ratings

| Clutch | Torque | Torque Range | Max.  | WR2*  |
|--------|--------|--------------|-------|-------|
| 0120   | 0000   |              |       |       |
| 02     | H      | 120 - 470    | 3,600 | 3.3   |
| 04     | Н      | 400-1,400    | 1,800 | 18.6  |
| 05     | L      | 850-2,900    | 1 200 | 80.0  |
| 05     | Н      | 1,350-4,700  | 1,000 | 80.0  |
| 06     | L      | 1,000-4,050  | 1 200 | 175   |
| 00     | Н      | 2,800-7,800  | 1,200 | 175   |
| 09     | Н      | 5,800-17,800 | 1,200 | 805   |
| 11     | Н      | 8,200-33,000 | 1,200 | 1,863 |

\*Estimated with maximum bores.

Clutches are shipped set for the minimum torque value for the selected range.

Refer to Page 55 for ordering information.

#### **Clutch Bores**

| Clutch | Bores    | s (inch) |
|--------|----------|----------|
| Size   | Max. (1) | Max. (2) |
| 02     | 0.6250   | 0.7500   |
| 04     | 1.1250   | 1.1875   |
| 05     | 1.5625   | 1.6250   |
| 06     | 2.0000   | 2.1250   |
| 09     | 2.8750   | 3.1250   |
| 11     | 3.1250   | 3.2500   |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

(2) Flat Key

### Minimum Number of Teeth Adaptable to Type B Clutches

|        |      |       | Stan  | dard Ch | nain Siz | e and I | Pitch |       |
|--------|------|-------|-------|---------|----------|---------|-------|-------|
| Clutch | Tuno | #25   | #35   | #40     | #50      | #60     | #80   | #100  |
| Size   | туре | 1/4   | 3/8   | 1/2     | 5/8      | 3/4     | 1     | 1-1/4 |
|        |      | Pitch | Pitch | Pitch   | Pitch    | Pitch   | Pitch | Pitch |
| 02     | В    | 39    | 27    | 22      | —        | —       | —     | —     |
| 04     | В    | 51    | 35    | 28      | 23       | —       | —     | —     |
| 05     | В    | 69    | 47    | 36      | 30       | 26      | —     | —     |
| 06     | В    | 76    | 52    | 40      | 33       | 28      | —     | —     |
| 09     | В    | 101   | 68    | 52      | 43       | 36      | 28    | 24    |
| 11     | В    | 119   | 80    | 61      | 50       | 43      | 33    | 27    |

# Style L

Type B Basic Sprocket Mounting



### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | C1   | D     | E    | F     | G     | Н    | I    | L     | L1   | P<br>+.000/002 | F<br>Min. | P1<br>Max. | R     | S    | Т    | Weight<br>(Lbs.) |
|----------------|------|------|------|-------|------|-------|-------|------|------|-------|------|----------------|-----------|------------|-------|------|------|------------------|
| 02             | 1.75 | 0.29 | 1.00 | 2.81  | 1.79 | 3.50  | 3.88  | 1.28 | 1.63 | 5.24  | 3.00 | 1.781          | 0.9843    | 0.9847     | 5.81  | 2.63 | .060 | 5.2              |
| 04             | 2.38 | 0.35 | 1.44 | 4.25  | 2.35 | 4.00  | 4.75  | 1.22 | 2.25 | 6.83  | 3.81 | 2.688          | 1.5728    | 1.5738     | 7.25  | 3.63 | .078 | 11.9             |
| 05             | 3.50 | 0.43 | 1.54 | 5.87  | 2.72 | 6.25  | 6.63  | 2.10 | 2.60 | 8.12  | 4.66 | 3.625          | 2.3623    | 2.3628     | 8.88  | 5.00 | .110 | 28.9             |
| 06             | 4.25 | 0.50 | 2.25 | 7.13  | 3.50 | 7.25  | 7.75  | 2.28 | 2.82 | 9.40  | 5.46 | 4.000          | 2.7560    | 2.7566     | 10.12 | 5.56 | .128 | 42.3             |
| 09             | 5.75 | 1.03 | 2.50 | 9.50  | 4.53 | 9.25  | 10.00 | 2.84 | 3.60 | 11.85 | 7.22 | 5.750          | 3.9350    | 3.9370     | 12.50 | 7.56 | .165 | 103              |
| 11             | 6.50 | 1.28 | 2.63 | 11.62 | 5.28 | 11.50 | 12.25 | 3.25 | 3.95 | 13.63 | 8.16 | 6.500          | 4.7220    | 4.7240     | 14.62 | 9.00 | .183 | 160              |

#### **Mounting Detail**

| Clutch<br>Size | Thread<br>Depth<br>N | Thread<br>Size<br>K | Bolt<br>Centers<br>M |
|----------------|----------------------|---------------------|----------------------|
| 02             | 0.38                 | 8-32                | 2.125                |
| 04             | 0.50                 | 10-24               | 3.062                |
| 05             | 0.75                 | 5/16-18             | 4.250                |
| 06             | 0.81                 | 3/8-16              | 4.750                |
| 09             | 0.88                 | 7/16-14             | 6.625                |
| 11             | 1.00                 | 5/8-11              | 7.750                |

### Ratings

| Clutch<br>Size | Torque<br>Code | Torque Range<br>(Lb. In.) | Max.<br>RPM | WR <sup>2*</sup><br>(Lb-In <sup>2</sup> ) |
|----------------|----------------|---------------------------|-------------|---|
| 02             | Н              | 120 - 470                 | 3,600       | 3.4                                       |
| 04             | Н              | 400-1,400                 | 1,800       | 18.9                                      |
| 05             | L              | 850-2,900                 | 1 800       | 81.7                                      |
| 05             | Н              | 1,350-4,700               | 1,000       | 01.7                                      |
| 06             | L              | 1,000-4,050               | 1 200       | 178                                       |
| 00             | Н              | 2,800-7,800               | 1,200       | 170                                       |
| 09             | Н              | 5,800-17,800              | 1,200       | 820                                       |
| 11             | Н              | 8,200-33,000              | 1,200       | 1,889                                     |

\*Estimated with maximum bores.

Clutches are shipped set for the minimum torque value for the selected range.

Refer to Page 55 for ordering information.

#### **Clutch Bores**

| Clutch | Bores    | s (inch) |
|--------|----------|----------|
| Size   | Max. (1) | Max. (2) |
| 02     | 0.6250   | 0.7500   |
| 04     | 1.1250   | 1.1875   |
| 05     | 1.7500   | -        |
| 06     | 2.0000   | 2.1250   |
| 09     | 2.8750   | 3.1250   |
| 11     | 3.1250   | 3.2500   |
|        | _        |          |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

### Minimum Number of Teeth Adaptable to Type B Clutches

|        |      |       | Stan  | dard Ch | nain Siz | e and l | Pitch |       |
|--------|------|-------|-------|---------|----------|---------|-------|-------|
| Clutch | Tuno | #25   | #35   | #40     | #50      | #60     | #80   | #100  |
| Size   | туре | 1/4   | 3/8   | 1/2     | 5/8      | 3/4     | 1     | 1-1/4 |
|        |      | Pitch | Pitch | Pitch   | Pitch    | Pitch   | Pitch | Pitch |
| 02     | В    | 39    | 27    | 22      | —        | —       | —     | —     |
| 04     | В    | 51    | 35    | 28      | 23       | —       | —     | —     |
| 05     | В    | 69    | 47    | 36      | 30       | 26      | —     | —     |
| 06     | В    | 76    | 52    | 40      | 33       | 28      | —     | —     |
| 09     | В    | 101   | 68    | 52      | 43       | 36      | 28    | 24    |
| 11     | В    | 119   | 80    | 61      | 50       | 43      | 33    | 27    |

# H2000 Pneumatic Overload Clutches POR Series

## Style F

Type C Flexible Coupling



#### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | D     | D1    | F     | G     | н    | I    | К    | L     | L1   | Ρ    | R     | Т    | Parallel<br>Offset | Angular Mis-<br>alignment | Weight<br>(Lbs.) |
|----------------|------|------|-------|-------|-------|-------|------|------|------|-------|------|------|-------|------|--------------------|---------------------------|------------------|
| 02             | 1.75 | 1.25 | 2.81  | 3.94  | 3.50  | 3.88  | 1.84 | 2.19 | 0.56 | 6.44  | 2.95 | 2.50 | 5.81  | .060 | .012               | 1°                        | 8.6              |
| 04             | 2.38 | 1.25 | 4.25  | 5.13  | 4.00  | 4.75  | 1.76 | 2.79 | 0.54 | 7.42  | 3.77 | 3.25 | 7.25  | .078 | .016               | 1°                        | 18.5             |
| 05             | 3.50 | 2.38 | 5.87  | 6.88  | 6.25  | 6.63  | 2.87 | 3.33 | 0.77 | 10.62 | 4.57 | 3.88 | 8.88  | .110 | .027               | 1°                        | 47.2             |
| 06             | 4.25 | 2.88 | 7.13  | 8.13  | 7.25  | 7.75  | 3.00 | 3.54 | 0.72 | 11.94 | 5.00 | 4.25 | 10.12 | .128 | .045               | 1°                        | 79.7             |
| 09             | 5.75 | 4.00 | 9.50  | 11.13 | 9.25  | 10.00 | 3.87 | 4.63 | 1.03 | 15.25 | 6.30 | 6.13 | 12.50 | .165 | .045               | 1°                        | 174              |
| 11             | 6.00 | 4.50 | 11.62 | 14.00 | 11.50 | 12.25 | 4.50 | 5.20 | 1.25 | 17.26 | 7.44 | 7.50 | 14.62 | .183 | .045               | 1°                        | 289              |

Parallel and angular misalignment are proportionally reduced when both are present.

### **Torque Range Ratings**

| Clutch<br>Size | Torque<br>Code | Torque Range<br>(Lb. In.) | Max.<br>RPM | WR <sup>2*</sup><br>(Lb-In <sup>2</sup> ) |  |
|----------------|----------------|---------------------------|-------------|---|--|
| 02             | Н              | 120 - 470                 | 3,600       | 9.6                                       |  |
| 04             | Н              | 400-1,400                 | 1,800       | 39.5                                      |  |
| 05             | L              | 850-2,900                 | 1 800       | 192                                       |  |
| 05             | Н              | 1,350-4,700               | 1,000       |   |  |
| 06             | L              | 1,000-4,050               | 1 200       | 159                                       |  |
| 00             | Н              | 2,800-7,800               | 1,200       | 400                                       |  |
| 09             | Н              | 5,800-17,800              | 1,200       | 1,975                                     |  |
| 11             | Н              | 8,200-33,000              | 1,200       | 5,083                                     |  |

\*Estimated with maximum bores.

Clutches are shipped set for the minimum torque value for the selected range.

#### **Clutch and Coupling Bores**

| Clutch | Turne    | Bore     | es (inch) |  |
|--------|----------|----------|-----------|--|
| Size   | туре     | Max. (1) | Max. (2)  |  |
| 02     | Clutch   | 0.6250   | 0.7500    |  |
| 02     | Coupling | 1.1875   | -         |  |
| 04     | Clutch   | 1.1250   | 1.1875    |  |
| 04     | Coupling | 1.8750   | -         |  |
| 05     | Clutch   | 1.5625   | 1.6250    |  |
| 05     | Coupling | 2.3125   | 2.3750    |  |
| 06     | Clutch   | 2.0000   | 2.1250    |  |
| 00     | Coupling | 2.6250   | 2.7500    |  |
| 00     | Clutch   | 2.8750   | 3.1250    |  |
| 09     | Coupling | 4.0000   | 4.1250    |  |
| 11     | Clutch   | 3.1250   | 3.2500    |  |
| 11     | Coupling | 4.6250   | 5.0000    |  |

Refer to Page 96 for a complete list of bore codes.

(1) Square Key

(2) Flat Key

### Refer to Page 55 for ordering information.

### **Style F Type R Rigid Coupling**



#### **All Dimensions in Inches**

| Clutch<br>Size | В    | С    | D     | D1   | F     | G     | Н    | I    | К    | L     | L1   | М     | Р    | R     | Т    | Weight<br>(Lbs.) |
|----------------|------|------|-------|------|-------|-------|------|------|------|-------|------|-------|------|-------|------|------------------|
| 02             | 1.75 | 0.75 | 2.81  | 2.63 | 3.50  | 3.88  | 1.84 | 2.19 | 0.56 | 5.31  | 2.95 | 2.125 | 1.38 | 5.81  | .060 | 5.8              |
| 04             | 2.38 | 1.62 | 4.25  | 3.63 | 4.00  | 4.75  | 1.76 | 2.79 | 0.54 | 7.29  | 3.77 | 3.062 | 2.50 | 7.25  | .078 | 13.9             |
| 05             | 3.50 | 2.13 | 5.87  | 5.00 | 6.25  | 6.63  | 2.87 | 3.33 | 0.77 | 9.11  | 4.57 | 4.250 | 3.31 | 8.88  | .110 | 33.6             |
| 06             | 4.25 | 2.20 | 7.13  | 5.56 | 7.25  | 7.75  | 3.00 | 3.54 | 0.72 | 9.71  | 5.00 | 4.750 | 3.50 | 10.12 | .128 | 48.6             |
| 09             | 5.75 | 3.34 | 9.50  | 7.56 | 9.25  | 10.00 | 3.87 | 4.63 | 1.03 | 13.18 | 6.30 | 6.625 | 5.25 | 12.50 | .165 | 118              |
| 11             | 6.00 | 3.96 | 11.62 | 9.00 | 11.50 | 12.25 | 4.50 | 5.20 | 1.25 | 15.30 | 7.44 | 7.750 | 7.50 | 14.62 | .183 | 184              |

### **Ratings**

| Clutch<br>Size | Torque<br>Code | Torque Range<br>(Lb. In.) | Max.<br>RPM | WR <sup>2*</sup><br>(Lb-In <sup>2</sup> ) |  |
|----------------|----------------|---------------------------|-------------|---|--|
| 02             | Н              | 120 - 470                 | 3,600       | 4.0                                       |  |
| 04             | Н              | 400-1,400                 | 1,800       | 22.6                                      |  |
| 05             | L              | 850-2,900                 | 1 800       | 97.0                                      |  |
| 05             | Н              | 1,350-4,700               | 1,000       |   |  |
| 06             | L              | 1,000-4,050               | 1 200       | 205                                       |  |
| 00             | Н              | 2,800-7,800               | 1,200       | 203                                       |  |
| 09             | Н              | 5,800-17,800              | 1,200       | 945                                       |  |
| 11             | Н              | 8,200-33,000              | 1,200       | 2,158                                     |  |

\*Estimated with maximum bores.

Clutches are shipped set for the minimum torque value for the selected range.

### **Clutch and Coupling Bores**

| Clutch | Turne    | Bc       | ores     |  |
|--------|----------|----------|----------|--|
| Size   | туре     | Max. (1) | Max. (2) |  |
| 02     | Clutch   | 0.6250   | 0.7500   |  |
| 02     | Coupling | 0.7500   | -        |  |
| 04     | Clutch   | 1.1250   | 1.1875   |  |
| 04     | Coupling | 1.6250   | 1.6875   |  |
| 05     | Clutch   | 1.5625   | 1.6250   |  |
| 05     | Coupling | 2.1250   | 2.2500   |  |
| 06     | Clutch   | 2.0000   | 2.1250   |  |
| 00     | Coupling | 2.2500   | 2.3125   |  |
| 00     | Clutch   | 2.8750   | 3.1250   |  |
| 09     | Coupling | 3.3750   | 3.5000   |  |
| 11     | Clutch   | 3.1250   | 3.2500   |  |
| 11     | Coupling | 4.0000   | 4.1250   |  |

Refer to Page 96 for a complete list of bore codes.

(1) Square Key

(2) Flat Key

#### Refer to Page 55 for ordering information.

# H2000 Pneumatic Overload Clutches POR Series

## **Style T Adapter Mounts to Existing Housing Bolt Pattern**

Type T Sprocket, Pulley, Sheave, or Gear Mount





#### **All Dimensions in Inches**

| Clutch<br>Size | С    | D    | E    | К      | L    | М     | N   | P<br>+.000/002 | R    | S    | WR <sup>2</sup><br>(LbIn. <sup>2</sup> ) | Weight<br>(Lbs.) |
|----------------|------|------|------|--------|------|-------|-----|----------------|------|------|--|------------------|
| 02             | 0.28 | 2.63 | 0.40 | #8-32  | 0.71 | 1.422 | .38 | 1.094          | —    | 1.75 | 0.5                                      | 0.5              |
| 04             | 0.34 | 3.63 | 0.63 | #8-32  | 1.02 | 2.250 | .38 | 1.922          | 3/16 | 2.58 | 2.0                                      | 1.0              |
| 05             | 0.47 | 5.00 | 0.59 | 1/4-20 | 1.26 | 3.219 | .50 | 2.750          | 1/4  | 3.66 | 12                                       | 3.0              |
| 06             | 0.69 | 5.56 | 0.81 | 1/4-20 | 1.55 | 3.406 | .50 | 2.938          | 1/4  | 3.90 | 25                                       | 5.4              |
| 09             | 0.88 | 7.56 | 1.00 | 3/8-16 | 2.00 | 5.094 | .75 | 4.344          | 3/8  | 5.84 | 93                                       | 11               |
| 11             | 1.02 | 9.00 | 1.14 | 3/8-16 | 2.32 | 5.938 | .75 | 5.188          | 1/2  | 6.69 | 241                                      | 19               |

Mounting bolts must be minimum 160,000 PSI tensile, Rc 36-43.

Dowel pins must be minimum 150,000 PSI shear, Rc 50-58 core hardness.

### Minimum Number of Teeth Adaptable to Type T Clutches Type T Clutches Allow for the Use of Smaller Sprockets

|        |                    |       | Standard Chain Size and Pitch |       |       |       |       |       |  |  |  |  |
|--------|--------------------|-------|-------------------------------|-------|-------|-------|-------|-------|--|--|--|--|
| Clutch | Tuno               | #25   | #35                           | #40   | #50   | #60   | #80   | #100  |  |  |  |  |
| Size   | ze <sup>rype</sup> | 1/4   | 3/8                           | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 |  |  |  |  |
|        |                    | Pitch | Pitch                         | Pitch | Pitch | Pitch | Pitch | Pitch |  |  |  |  |
| 02     | Т                  | 27    | 19                            | 15    | —     | —     | Ι     | —     |  |  |  |  |
| 04     | Т                  | 37    | 26                            | 20    | 17    | —     | -     | —     |  |  |  |  |
| 05     | Т                  | 50    | 35                            | 27    | 23    | 19    | —     | —     |  |  |  |  |
| 06     | Т                  | 54    | 37                            | 29    | 24    | 20    | 16    | 14    |  |  |  |  |
| 09     | Т                  | 79    | 54                            | 41    | 34    | 29    | 23    | 19    |  |  |  |  |
| 11     | Т                  | 90    | 61                            | 47    | 38    | 32    | 25    | 21    |  |  |  |  |

The Type T adapter may be ordered separately or factory mounted to the POR Series Clutches shown on Pages 56 and 57, by specifying Type T.

# **H2000 Overload Clutches**

## **General Information**

### **Limit Swltches**

The POR Series H2000 clutch is an automatic reset device. It is important that the drive be shut down immediately upon a torque overload condition. The switch should be able to operate within the disengagement travel of the clutch. Upon an overload, the cylinder of the clutch will move to actuate the limit switch and shut down the drive. An oversized metallic plate provides a means for sensing movement from both ends and for utilizing a precision proximity switch.

As an option, Boston Gear offers a limit switch kit which mounts directly to the clutch. There are two sets of tapped holes on the face of the piston for mounting two limit switches. One switch may be used for your pneumatic control unit and the other switch may be used for the motor control. The motor control switch is used to open the circuit to the motor during a torque overload condition. The switch should be wired in its normally closed condition and in parallel with the JOG button of the motor control. This will permit the drive to be started in the event the clutch has stopped with the limit switch circuit in an open state.

The kit comes complete with a mechanical limit switch, mounting bracket and mounting hardware. Figure 4 shows the limit switch kits available for the POR Series H2000. Before using this switch in your circuit, verify that the electrical ratings meet your requirements. B-32UNC-28 TYP.

| Clutch Size | А     | В     | С    | D    | Е    |
|-------------|-------|-------|------|------|------|
| 02          | 3.88  | 5.81  | .060 | 1.63 | 1.50 |
| 04          | 4.75  | 7.25  | .078 | 2.25 | 1.73 |
| 05          | 6.63  | 8.88  | .110 | 2.60 | 2.63 |
| 06          | 7.75  | 10.12 | .128 | 2.82 | 3.06 |
| 09          | 10.00 | 12.50 | .165 | 3.60 | 4.00 |
| 11          | 12.25 | 14.62 | .183 | 3.95 | 5.00 |

Consult factory for ordering information.

Figure 4 Limit Switch Kit

| Clutch Size | Item Code |
|-------------|-----------|
| 02 & 04     | 76493     |
| 05 & 06     | 76494     |
| 09 & 11     | 17571     |
|             |           |

Figure 5 Suggested Mounting Arrangements



with Sprocket Mounted

Type B, Style L with Sheave Mounted

# **H2000 Pneumatic Overload Clutches**

## **Torque Curves**





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# Pneumatic Overload Disconnect Clutches PDC Series

### **Features**

- "In-Flight" torque control offers precise pneumatic torque control
- Nickel plated and stainless steel exterior for superior corrosion resistance
- Completely sealed design
- Remotely adjustable for starting and overrunning loads
- Accurate and dependable disconnection, +/- 5% of torque setting
- Single position ball detent
- Provides maximum radial capacity, eliminating sprocket mounted bearings
- Dual radial ball bearings
- Internal valve
- Through shaft design
- Bi-directional operation
- Single position indexing
- Automatic reset
- Limit switch actuation mechanism
- Clamp collar for secure mounting
- Hardened parts for long clutch life
- Sealed from environmental contamination

The Boston Gear PDC Series Pneumatic Torque Limiting Disconnect Clutch is unique from other pneumatic clutches on the market today. Along with providing the expected protection from overloads in your equipment, it also allows the rotation of the two halves when the air is off and exhausted from the clutch.

The PDC clutches are completely sealed from the atmosphere and other harmful contaminants and all exterior surfaces are nickel plated for corrosion resistance and wash down service. Angular contact ball bearings are used in the units to provide added thrust capacity. Since many of these clutches are used with timing belt pulleys or sprockets, we have designed the unit with two radial ball bearings to provide support to the pulley or sprocket.

### **Operating principles**

The Boston Gear PDC Series Pneumatic Disconnect Clutch is a ball detent air actuated device. It has been designed to provide accurate and dependable torque overload protection for mechanical power transmission equipment. It has also been designed to provide a remote disconnection of the drive when the air supply is removed. The following diagram demonstrates the engaged and disengaged functions.



The top half of the view shows the unit in an engaged condition. 20 to 80 psi of shop air is forced into the air chamber. That air pressure exerts a force on a hardened thrust plate that pushes against six chrome alloy steel balls. The balls are forced into detent pockets, which allow the assembly to transmit torque. Increasing or decreasing the air pressure remotely controls precision "in flight" torque adjustment. The machinery can still be in operation when the torque rating is being adjusted. When a torque overload occurs, the housing and rotor rotate independently of each other. The balls roll out of their detents and a limit switch actuating plate moves forward to trip a limit switch and signal a torque overload condition. The drive should be shut down immediately and the source of the overload determined and cleared. To re-engage the clutch, re-apply the air pressure and jog the drive until the clutch engages. The PDC Series is a single position device. The unit will re-engage every 360° in the same location every time.

The bottom half of the view shows the unit in a disengaged condition. When air is disconnected, internal springs push the ball cage away from detent face of the housing. The balls are held captive by the ball cage so they also move away from the detent face. At this point, the unit is free to rotate in a disengaged condition. The main components that transmit torque are not in contact with each other.

### Selection

- 1. Determine overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

Forque (Lb. In.) = 
$$\frac{\text{HP x } 63025}{\text{RPM}}$$
 X SF

- b. Determine the "weak link" in the drive train, (i.e. chain, reducer, belt or shaft). Select an overload release torque that is below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size:
  - a. Shaft size at the clutch location determines the clutch bore.
- 3. Refer to the Basic Selection Chart for the appropriate clutch size. Determine the approximate start-up and running air pressures for the application.
- 4. Refer to Pages 66 and 67 for ratings, dimensions and types.
- 5. Refer to Part Numbering System to complete selection.

#### **Basic Selection Chart**

| Clutch<br>Size | Max.*<br>Bore (In.) | Torque<br>Code | Torque Range<br>(LbIn.) | Max.<br>RPM |
|----------------|---------------------|----------------|-------------------------|-------------|
| 04             | 1.1875              | Н              | 300-1,700               | 1,800       |
| 05             | 1.7500              | Н              | 820-4,000               | 1,800       |

\*Larger bores may require flat keys (supplied with unit)







### **PDC Series Part Numbering System**



### How to Order

When ordering a PDC Series Overload Clutch, please include code letters/numbers for series, size, type, torque range, and unit bore.

### Example:

Required Size 04 PDC series Overload Clutch, full available shaft length, basic mount, large torque range with a one inch bore.



# **Pneumatic Overload Disconnect Clutches PDC Series**

## Style F

Type B Basic Hub Design



### **All Dimensions in Inches**

| Clutch<br>Size | A    | В    | С    | D   | E    | F    | G    | Н   | I    | J | К   |
|----------------|------|------|------|-----|------|------|------|-----|------|---|-----|
| 04             | 7.00 | 2.38 | 1.36 | .63 | 2.00 | 4.67 | 5.50 | .34 | 2.20 | 3 | .56 |
| 05             | 8.00 | 3.38 | 1.14 | .94 | 1.98 | 5.92 | 6.58 | .50 | 2.20 | 4 | .75 |

| Clutch<br>Size | L    | L1   | М     | N       | P<br>+.000/002 | Q      | R    | S    | Т   |
|----------------|------|------|-------|---------|----------------|--------|------|------|-----|
| 04             | 6.20 | 2.70 | 4.062 | 5/16-18 | 3.500          | 1/4-20 | .95  | 4.53 | .13 |
| 05             | 7.18 | 3.22 | 4.750 | 3/8-16  | 4.125          | 10-24  | 1.16 | 5.25 | .15 |

### **Clutch Bores**

| Clutch | Bores (inch) |          |  |  |  |
|--------|--------------|----------|--|--|--|
| Size   | Max. (1)     | Max. (2) |  |  |  |
| 04     | 1.1250       | 1.1875   |  |  |  |
| 05     | 1.6250       | 1.7500   |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

Refer to Page 65 for ordering information

# **Pneumatic Overload Disconnect Clutches PDC Series**

### **Style F** Type R Reduced Hub Design



### **All Dimensions in Inches**

| Clutch<br>Size | A    | В    | С    | D   | E    | F    | G    | Н   | I    | J | К   |
|----------------|------|------|------|-----|------|------|------|-----|------|---|-----|
| 04             | 7.00 | 2.38 | 1.36 | .56 | 2.00 | 4.67 | 5.50 | .34 | 2.20 | 3 | .56 |

| Clutch<br>Size | L    | L1   | М     | N    | P<br>+.000/002 | Q      | R   | S    | Т   |
|----------------|------|------|-------|------|----------------|--------|-----|------|-----|
| 04             | 6.20 | 2.70 | 3.312 | 8-32 | 3.000          | 1/4-20 | .95 | 4.53 | .13 |

### **Clutch Bores**

| Clutch | Bores    | (inch)   |  |  |  |
|--------|----------|----------|--|--|--|
| Size   | Max. (1) | Max. (2) |  |  |  |
| 04     | 1.1250   | 1.1875   |  |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key (2) Flat Key

Refer to Page 65 for ordering information

# **Pneumatic Overload Disconnect Clutches**

## **Torque Limiter Application Data**

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:                       | 7. Shut Down Method:                         |
|---------------------------------------|--|
| □ New                                 | Prox Plate                                   |
| <br>┌── Existing                      | Pin Style (ORC only)                         |
| – Replacement Model #                 | None Required                                |
| 2. Power transmission requirements at |  |
| clutch location:                      | Name:  |
| □ RPM                                 | Phone #                                      |
| Limiting Torque Level                 |  |
| o <b>T</b>                            | Fax #  |
| 3. Type:                              | Company                                      |
| Pneumatic                             | E-Mail                                       |
| 4. Туре:                              |  |
| Fully Automatic Re-Engagement         | Use the space below to note any relevant     |
| Manual (Free Wheeling)                | application data or to detail your question. |
| Semi Automatic (ORC model only)       |  |
| 5. Method of Torque Transmission:     |  |
| Flexible Coupling                     |  |
| Rigid Coupling                        |  |
| Sprocket Mount                        |  |
| Sprocket Size and Tooth Count         |  |
| 6. Bore Size:                         |  |
| Sprocket Mount (Clutch Bore)          |  |
| Coupling Mount (Clutch Bore)          |  |
| (Coupling Bore)                       |  |
|                                       |  |
|                                       |  |
|                                       |  |



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# Varitorque Pneumatic Overload Clutches VOR Series

### **Features**

- "In Flight" torque control. Precise torque control adjustable for starting and overrunning loads
- Single positioning for re-engagement at the exact cycle point at which it released
- Torque accuracy within ±5%
- Bi-directional operation
- Electroless nickel finish
- · Six point drive engagement
- Automatic disconnect
- · Deublin flange mounted air union
- Automatic switch actuating plate for instantaneous remote detection of overload condition
- · Completely enclosed for "dirty" applications
- Pressure lubrication
- · Positive split locking collar for secure shaft mounting
- Operates on static air pressure (20-80 psi), no elaborate air systems required

### **Operating Principles**

#### Air Union

The air pressure supplied to the clutch enters through the hex steel rotor of the Deublin air union. When the VOR Series VariTorque is engaged and operating, the union rotor is the only stationary part. The union housing rotates on a double row ball bearing protected by dirt-tight seals. A spring-loaded carbon micro-lapped seal prevents air leakage between the rotor and housing of the union. The air passes through the union housing into the cylinder assembly of the VariTorque.

#### **Cylinder Assembly**

Air pressure acts against the surface area of the piston exerting a force to move the piston against the pressure pins. Resulting torque ranges are developed by different size piston surface areas of the two cylinder sizes, (L-small, H-large).

The switch actuating plate moves with the piston. It is directly connected to the piston through the cylinder housing via trip pins and trip plate bolts. The plate's lateral motion can be used to actuate a limit switch signaling an overload condition.



The valve assembly located through the piston serves two purposes. The first is to provide the single position engagement of the clutch. The piston will not be energized until the valve is seated in its cam seat located on the end of the rotor. This ensures that the rotor and cylinder-housing assembly always engage in the same relative position. The second purpose of the valve assembly is to relieve cylinder air pressure by allowing it to escape through the air exhaust muffler upon overload.

#### **Piston Springs**

Once the valve is seated in its single home position, the clutch can be engaged. Air pressure forces the piston against the three piston springs. These springs serve to move the piston and switch actuating plate out when the clutch overloads or the air pressure is shut off to the clutch.

#### **Housing Assembly**

The force from the piston is transmitted to six pressure pins. Six pawls equally spaced around the rotor are forced by the pressure pins to engage into six notches in the rotor barrel. The pressure pins, pawls and rotor are made of alloy steel and are electroless nickel plated for long life.

When the set torque limit in the VariTorque is exceeded, the pawls are forced out of the notches in the rotor barrel. They in turn push the pressure pins and piston. When the rotor turns in relation to the housing-cylinder assembly, the valve rides up the ramp of the cam seat and relieves the cylinder air pressure. The rotor now can rotate freely, independent of the housing assembly on two sealed ball bearings.
### **Selection**

- 1. Determine the overload release torque by one of these methods:
  - a. Use the torque formula with horsepower and RPM specific to the selected clutch location. A service factor may be required for high inertia starts, reversing or peak load conditions, (refer to Page 98 for service factor information. For average applications, a service factor "SF" of 1.25 is recommended):

Torque (Lb. In.) = 
$$\frac{\text{HP x 63025}}{\text{RPM}}$$
 x SF

- b. Determine the "weak link" in the drive, (i.e. chain, reducer, belt or shaft). Select an overload release torque below the "weak link's" maximum torque rating.
- c. Physically measure the drive torque with a torque wrench and size accordingly.
- 2. Determine the bore size and keyway.
- 3. Determine the approximate start-up and running air pressures for the application.
- 4. Refer to the Basic Selection Chart for the appropriate clutch size.
- 5. Refer to Page 72 for ratings and dimensions.
- 6. Refer to Page 97 for recommended mounting locations.

Air pressure and torque capacity 80 70 60 P.S.L) 50 **NR PRESSURE** 40 30 20 10 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 TORQUE (Lb. In.)

Figure 1

#### **Basic Selection Chart**

| Clutch<br>Size | Maximum<br>Bore (In.)* | Torque<br>Code | Torque Range<br>(Lb. In.) | Maximum<br>RPM |  |  |
|----------------|------------------------|----------------|---------------------------|----------------|--|--|
| 44             | 1.3125                 | L              | 250-1,000                 | 1 000          |  |  |
| 11             | 1.2500                 | Н              | 800-2,800                 | 1,000          |  |  |
| 13             | 2.1875                 | L              | 900-3,600                 | 1 000          |  |  |
|                | 2.0000                 | Н              | 2,800-10,000              | 1,000          |  |  |

\*Larger bores may require flat keys (supplied with unit).

#### VOR Series Part Numbering System



### How to Order

When ordering a VOR Series VariTorque Overload Clutch, please include code letters/numbers for series, size, style, type, torque range, and unit bore.

#### Example:

Required Size, 11 VOR Series Overload Clutch, end shaft mount, basic type, small torque range, with a one inch bore:



P-1500-BG 5/21

## Varitorque Pneumatic Overload Clutches VOR Series

## Style **B**

**Type B Basic Sprocket Mounting** 



**All Dimensions in Inches** 

| Clutch<br>Size | A    | в     | С   | E    | F   | G<br>±.001 | H<br>Bolt<br>Center | J   | к    | L    | М    | N    | Ρ   | R    | S   | Т    | v    | W    | X<br>+.0000 | Mo<br>F<br>Qty. | ounting<br>Ioles<br>Thread<br>Size |
|----------------|------|-------|-----|------|-----|------------|---------------------|-----|------|------|------|------|-----|------|-----|------|------|------|-------------|-----------------|------------------------------------|
| 11             | 4.75 | 9.03  | .68 | 1.50 | .21 | 2.748      | 3.500               | .06 | 0.96 | 1.69 | 2.75 | 2.19 | .13 | 4.75 | .44 | 4.42 | 3.03 | 1.62 | 1.7722      | 6               | 5/16-18                            |
| 13             | 6.50 | 10.19 | .87 | 2.00 | .21 | 4.498      | 5.500               | .06 | 1.38 | 2.62 | 4.00 | 1.81 | .16 | 6.50 | .44 | 5.44 | 4.47 | 1.62 | 2.7565      | 6               | 5/8-11                             |

| Clutch<br>Size | Torque<br>Code | Torque<br>Range<br>(LbIn.) | Max.<br>RPM | Air<br>Inlet<br>(NPT) | WR2<br>(LbIn.2) | Weight<br>(Lbs.) |
|----------------|----------------|----------------------------|-------------|-----------------------|-----------------|------------------|
| 11             | L              | 250-1,000                  | 1,000       | 1/4                   | 45.7            | 17               |
|                | Н              | 800-2,800                  |             |                       | 46.5            | 18               |
| 13             | L              | 900-3,600                  | 1,000       | 1/4                   | 197             | 39               |
|                | Н              | 2,800 - 10,000             |             |                       | 212             | 41               |

#### **Clutch Bores**

| Clute | ch | Torque | Bores (inch) |          |  |  |
|-------|----|--------|--------------|----------|--|--|
| Siz   | е  | Range  | Max. (1)     | Max. (2) |  |  |
| 44    |    | L      | 1.1875       | 1.3125   |  |  |
| 11    |    | Н      | 1.1875       | 1.2500   |  |  |
| 10    | 10 | L      | 1.7500       | 2.1875   |  |  |
| 13    | '  | Н      | 1.7500       | 2.0000   |  |  |

Refer to Page 96 for a complete list of bore codes. (1) Square Key

(2) Flat Key

#### Refer to Page 71 for ordering information.

## Varitorque Pneumatic Overload Clutches

## **General Information**

#### **Limit Switch**

In the layout in Figure 2 the limit switch should be wired in its normally closed condition. The switch is used to open the circuit to the motor during a torque overload condition. The switch should be wired in parallel with the JOG button so the drive may be started in the event the VariTorque clutch has stopped with the limit switch circuit in an open state.

#### **Air Controls**

The HIGH pressure regulator should be set at a pressure just HIGH enough to permit the VariTorque clutch to overcome any momentary overload torques caused during the machine's start-up and stopping period.

The LOW pressure regulator should be set at a pressure just LOW enough to permit the VariTorque clutch to overcome the normal operating torques caused during the machines running period and to permit a crisp and positive re-engagement of the VariTorque clutch should an overload occur.

### **Indirect Drives**

The VariTorque overload release air clutch is utilized in conjunction with chain sprockets or belt driven sheaves. For chain and sprocket applications smaller than those shown in the table below or belt driven sheave applications, consult with the factory. In most cases, a minor modification of the VariTorque design or the sprocket/sheave will permit usage.

### **Special Finishes**

All VariTorque clutches are supplied with an electroless nickel finish. Special coatings, finishes or paints are also available.

#### **Custom Variations**

- Sprockets or sheaves supplied and mounted
- Dimensional changes (i.e. overall length, actuating plate diameters)
- · Bores and keyways (i.e. metric, non-standard)
- Special adaptations



| Operating Mode   | Air Pressure | Limit Switch |
|--|--------------|--------------|
| Jog (Re-engagement)  | Low          | Open         |
| Start  | High         | Closed       |
| Run  | Low          | Closed       |
| Stop   | High         | Closed       |
| Overload (Disengagement)   | Low          | Open         |
| The second secon |              |              |

The limit switch should be wired in its normally closed position

Refer to Boston Gear's Fluid Power Products Catalog for air preparation and control products.

#### **Minimum Acceptable Plate Sprocket Mounts**

|        |       | Chain Size and Pitch |       |       |       |       |       |       |       |       |  |  |  |
|--------|-------|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| Clutch | #35   | #40                  | #41   | #50   | #60   | #80   | #100  | #120  | #140  | #160  |  |  |  |
| Size   | 3/8   | 1/2                  | 1/2   | 5/8   | 3/4   | 1     | 1-1/4 | 1-1/2 | 1-3/4 | 2     |  |  |  |
|        | Pitch | Pitch                | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch | Pitch |  |  |  |
| 11     | 45    | 34                   | 35    | 28    | 24    | 19    | 16    | 14    | 12    | —     |  |  |  |
| 13     | 60    | 45                   | 45    | 36    | 31    | 24    | 20    | 17    | 16    | 14    |  |  |  |

Boston Gear will also supply and mount sprockets or sheaves, as specified, for a complete package.

Figure 2

## Varitorque Pneumatic Overload Clutches VOR Series

## **Torque Limiter Application Data**

Fax To 800-816-5608

Please select your product intent below and provide as much application information as possible.

| 1. Application:  | 7. Shut Down Method:  |
|--|---|
| ☐ New  | Prox Plate  |
| <br>┌── Existing   | Pin Style (ORC only)  |
| – Replacement Model #  | None Required   |
| 2. Power transmission requirements at  |   |
| clutch location:   | Name:   |
| RPM     Limiting Torque Level  | Phone #   |
|  | Fax #   |
| 3. Type:   | Company   |
| Pneumatic  | E-Mail  |
| 4. Туре:   |   |
| <ul> <li>Fully Automatic Re-Engagement</li> <li>Manual (Free Wheeling)</li> <li>Semi Automatic (ORC model only)</li> </ul> | Use the space below to note any relevant application data or to detail your question. |
| 5. Method of Torque Transmission:  |   |
|  |   |
| Rigid Coupling   |   |
| Sprocket Mount   |   |
| Sprocket Size and Tooth Count  |   |
| 6. Bore Size:  |   |
| Sprocket Mount (Clutch Bore)   |   |
| Coupling Mount (Clutch Bore)   |   |
| (Coupling Bore)  |   |
|  |   |
|  |   |
|  |   |



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## **Centric Centrifugal Clutches CCC Series**

### **Features**

- Automatic engagement and disengagement
- · Delayed engagement produces a "no load start"
- No slippage at full running speed
- Controlled soft-start acceleration
- 100% efficient at rated speed
- Standard, spring control, and deep pocket models
- · Protection against shock loads during start-up
- Custom clutches can be designed to be RPM limiters or a "brake" on a runaway system

### Why are they used?

The Boston Gear Centric Centrifugal Clutch offers many advantages in motor and engine drive applications. Utilizing the centrifugal clutch enables the selection of normal torque motors for running loads rather than the selection of high torque motors for starting loads. The centrifugal clutch also sharply reduces the motor starting current requirements and heat losses inherent in the direct starting of a drive. This adds up to reduced power factors, greater efficiency and therefore, greater economy in motor drives.

When used with engine drives, the spring controlled centrifugal clutch allows the engine to warm up before starting the load or to stand by at an idling speed. Thus the spring controlled centrifugal clutch is used to great advantage in such applications as dual drives and engine driven pumping systems. This style clutch can also be used with turbines where a warm up period is necessary.

#### Free Engagement Standard Style





On any drive, the Boston Gear Centric Centrifugal Clutch provides protection against the shock loads which occur in the starting of a rigidly coupled drive. In many cases these loadings are capable of seriously damaging components of the drive and often expensive safety factors have to be designed into the machinery to protect against these loadings. The use of a centrifugal clutch eliminates these possibilities.

The use of a Boston Gear Centric Centrifugal Clutch allows the designer of a particular drive complete flexibility in clutch selection as each clutch is fabricated to order. Friction shoes of specific weights are custom designed therefore, any capacity within a particular clutch size can be obtained. The same holds true in the case of the spring controlled clutch. This style of clutch is designed to provide the specific engagement or disengagement speeds required by a specific application.

Spring Controlled Style



#### **CCC Series Part Numbering System**



### **Operating Principles**

The Boston Gear Centric Centrifugal Clutch utilizes two basic force principles in its operation, centrifugal force and friction force. Centrifugal force is that force which tends to pull a rotating body away from its center of rotation. Friction force exists between any two bodies in contact where one of the bodies is trying to move relative to the other body.

Figure 1, a face view of a centrifugal clutch, shows the basic components of the device. The driver half or spider is mounted to the motor or engine shaft and the driven half is connected to the load either directly or by means of some indirect drive arrangement. The friction shoes are the connective element between the driver and driven.

When the drive is set in motion, the spider and the shoes start to rotate. The spider imposes a driving force ( $F_3$ ) on the friction shoe as shown in Figure 2. The centrifugal force ( $F_1$ ) developed by the rotary motion of the friction shoe impresses it against the drum creating a frictional force ( $F_2$ ) between the shoe and the drum.

As the drive increases in speed, the centrifugal force increases and thereby frictional force increases. When the frictional force reaches sufficient magnitude, it overcomes the resistance of the load, and the clutch drives. At full load speed, the shoe is "locked" firmly against the drum and no slippage occurs.

In engine and turbine applications, where it is necessary to "warm up" before attempting to drive a load, a spring controlled clutch is utilized. Figure 3 shows a typical spring control shoe. Here, a flat spring is placed over pins which run through the base of the shoe. This spring is retained in slots which are milled in the legs of the spider creating additional forces (Fs) which are applied to the friction shoes. The thickness of the spring utilized determines at what speed the particular drive may idle while warming up. At this idling speed the centrifugal force (F<sub>1</sub>) developed by the rotation is not of sufficient magnitude to overcome the total spring force (2Fs) acting in the opposite direction on the friction shoe. As the speed of the drive increases above the point at which the spring forces (Fs) and the centrifugal force (F1) are balanced, the shoe is pressed against the drum creating a friction force. The operation from this point on is as described above.

#### **Selection**

There are an infinite number of combinations of Boston Gear Centric Centrifugal Clutches. While operating on the same basic principles, every clutch is designed to suit a specific customer application. To assure that the appropriate clutch is selected, please complete the Selection Guide on Page 94 and fax it to Boston Gear.

Upon receipt, our application engineering department will review your requirements and return the optimal Boston Gear Centric Centrifugal Clutch design along with its dimensional drawings.











## **Available Styles**

Boston Gear Centric Centrifugal Clutches are available for two basic applications: Styles F and J for electric motors and Style L for engines and turbines.

Standard Style F incorporates a shoe arrangement designed for electric motors, (Figure 4). As the motor comes up to speed, the outer friction shoes engage the driven half (the drum) and accelerate it. As it and the load come up to speed, the inner friction shoes engage the driver (the spider) locking up the drive.



Where overload protection is required or greater capacity is needed in the drive, Style J containing deep pockets should be ordered, (Figure 5).

Style L incorporates a spring controlled shoe arrangement designed for engines, turbines, dual drives, or whenever a delayed engagement is desired, (Figure 6).

Figure 6 Spring Controlled Style L /M (Delayed Engagement)



For applications where either high speeds or large horsepower conditions exist, Styles G, K and M may be provided. These styles are identical to the models shown in Figures 4, 5 and 6, however they also incorporate steel bands wrapped around the housing helping to reduce stress, (Figure 7).





Figure 7 Style F with Steel Band

## Type A Free Engagement Style and Spring-Controlled Centrifugal Clutches Bored to Size





Max Angular Misalignment- 1/4°

Max Parallel Misalignement- .010"

\* The actual horsepower rating is largely dependent on RPM and may be higher or lower than the indicated HP. Contact engineering before finalizing clutch selection.

## **Type V Free Engagement and Spring-Controlled Vertical Liftout Centrifugal Clutches**



PROVIDES VERTICAL LIFT OUT CLEARANCE OF DUAL DRIVE SYSTEMS CLUTCH SIZES 7 AND 8 SLIDE BACK ON THE DRUM SIDE.

| Clutch    | Maximum | Wt. in Lbs.<br>with Max.<br>Bore | DIMENSIONS IN INCHES |                |       |       |       |       |      |      |      |  |  |  |
|-----------|---------|----------------------------------|----------------------|----------------|-------|-------|-------|-------|------|------|------|--|--|--|
| Sizes     | Inches  |                                  | А                    | A <sup>1</sup> | В     | С     | C1    | D     | J    | K    | HP** |  |  |  |
| 7 x 2-1/2 | 2.375   | 40                               | 7.62                 | 8.62           | 8.25  | 4.12  | 4.00  | 3.93  | 4.00 | 3.25 | 125  |  |  |  |
| 8 x 3     | 2.875   | 55                               | 8.83                 | 9.75           | 9.50  | 4.62  | 4.75  | 4.68  | 4.75 | 3.75 | 160  |  |  |  |
| 10 x 3    | 2.625   | 100                              | 10.81                | 11.75          | 9.75  | 4.50  | 4.56  | 5.12  | 4.19 | 1.00 | 215  |  |  |  |
| 12 x 4    | 3.00    | 200                              | 13.12                | 14.00          | 12.31 | 5.75  | 5.68  | 6.25  | 5.50 | 1.00 | 356  |  |  |  |
| 14 x 4    | 3.50    | 325                              | 15.16                | 16.00          | 12.31 | 5.75  | 5.68  | 7.38  | 5.50 | 1.00 | 450  |  |  |  |
| 16 x 5    | 4.75    | 400                              | 17.38                | 18.25          | 14.68 | 7.00  | 6.80  | 8.50  | 6.62 | 1.00 | 562  |  |  |  |
| 19 x 5    | 5.00    | 900                              | 20.50                | 21.50          | 15.00 | 7.00  | 7.00  | 10.00 | 8.87 | 1.06 | 1400 |  |  |  |
| 24 x 8    | 7.00    | 1350                             | 26.50                | 26.50          | 21.81 | 10.68 | 10.00 | 12.00 | 9.94 | 1.06 | 2280 |  |  |  |

Max Angular Misalignment 1/4°

Max Parallel Misalignment .010"

\*\* The actual horsepower rating is largely dependent on RPM and may be higher or lower than the indicated HP. Contact engineering before finalizing clutch selection.

## Type H Spring Controlled Pulley Mounted PTO Centrifugal Clutches Available as Shaft or Engine Mounted



| Clutch | Maximum | T. un   |       | DIMENSIONS IN INCHES |       |      |      |      |     |      |  |  |
|--------|---------|---------|-------|----------------------|-------|------|------|------|-----|------|--|--|
| Sizes  | Inches  | Grooves | А     | A <sup>1</sup>       | В     | D    | J    | к    | Y   | HP** |  |  |
| 6 x 2  | 1.4375  | 2       | 6.56  | 7.50                 | 5.43  | 2.62 | 3.68 | 0.0  | .63 | 90   |  |  |
| 8 x 3  | 2.000   | 4       | 8.95  | 8.95                 | 6.30  | 5.12 | 4.30 | 0.0  | 0.0 | 160  |  |  |
| 12 x 4 | 3.500   | 6       | 13.12 | 14.00                | 11.69 | 7.00 | 5.50 | .75  | 1.0 | 350  |  |  |
| 16 x 5 | 4.500   | 8       | 17.38 | 18.25                | 15.32 | 8.50 | 6.62 | 1.70 | 1.0 | 560  |  |  |

\*\* The actual horsepower rating is largely dependent on RPM and may be higher or lower than the indicated HP. Contact engineering before finalizing clutch selection.

## **Available Types**

Type A Centric Centrifugal Clutches are similar to standard coupling/clutch designs in that the installation and removal of the clutch requires horizontal clearance. This type of design may necessitate the relocation of other drive train components to achieve this clearance.

The Type V clutch is a modification of the basic Type A unit. This construction is utilized to a great advantage in direct drive applications where the equipment used is too heavy to be conveniently telescoped at assembly or disassembly. Figure 8 shows how either piece of equipment can be vertically lifted out of its assembled position. The Type V clutch construction allows the clutch spider to be slipped back over its own hub, completely clearing the clutch drum (see page 80). If a Type A construction had been used here, it would have been necessary to first move the pump horizontally in order to clear the drum and spider before a vertical lift could have been accomplished. This horizontal movement is often not convenient and sometimes impossible such as in certain dual drives and of course where space limitations exist.

Figure 8 Vertical Liftout Type V



### **Overload Detection**

In Figure 9 a safety device is incorporated to indicate an overload condition. In such applications a centrifugal switch is utilized. The switch is set to trip below a certain critical RPM determined by the application, and in so doing, actuate a signal or shut down the drive, The illustration shows the most common method of using a centrifugal switch in conjunction with a Boston Gear centrifugal clutch. "A" groove sheaves are mounted on the driven member of the clutch and the centrifugal switch. These sheaves are of such a ratio as to allow the centrifugal switch to operate within its limits.

For example, a drive arrangement is set to turn at 1750 RPM. It is determined that the desired cut out speed for the application is at 1500 RPM. The centrifugal switch is set to trip at speeds below 750 RPM and normally will run at 875 RPM which, through a 2:1 ratio corresponds to the drive RPM of 1750.

In actual operation the drive is turning at 1750 RPM. An overload occurs in the driven machinery and the capacity of the clutch is exceeded. While the driver half is still turning at the 1750 RPM, the driven half is dragging due to the increased capacity and drops below the 1500 RPM speed. The switch is actuated by this decrease in speed and an alarm is sounded or the drive is shut down.



## **Operating Principles**

The NLS centrifugal clutch is a rugged time-proven unit which provides equipment protection and system overload protection. This is done by allowing the motor or other driving source to accelerate to operating speed without load and to slip automatically when overloaded. This clutch is available in a free (type A) and delayed engagement (type AD) model, also in various sizes to handle different horsepower capacities.

#### TYPE A Free Engagement

The shoes are a free floating part of the driving unit to which the power is applied. As the driver picks up speed, the shoes are forced outward by centrifugal force to make contact with the inside surface of the driven half. The shoes will make smooth contact and slip until the load reaches full speed. Both members then rotate as a unit with no slippage or power loss. Larger units have both inner and outer shoes.

#### TYPE AD

#### **Delayed Engagement (Spring Controlled)**

Operating under the same principle as the type A unit, the type AD uses springs to hold the shoes out of engagement until the driver reaches a predetermined rpm. At this point centrifugal force, acting on the shoes, overcomes the spring force, allowing smooth engagement of the power source with the load. Because the shoes are out of engagement until the driver is above the predetermined speed, this unit is ideal for dual or stand-by drives as well as idling or warming-up engines.





TYPE A WITH ONE ROW OF SHOES



TYPE AD FOR DELAYED ENGAGEMENT

## **Easy Step by Step Selection Method**

### Step #1

Determine HP and minimum driving RPM (also idle RPM if delayed engagement type is required).

### Step #2

Using the service factor chart, determine the proper service factor based on the prime mover and driven equipment.

|  |   | DRIVEN EQUIPMENT L   | DAD CLASSIFICATIONS   |   |
|--|---|--|---|---|
|  | LIGHT STEADY LOADS<br>Starting torque is equal<br>to or slightly greater<br>than running torque.  | MODERATE LOADS<br>High starting torque or<br>above average running<br>torque.  | MEDIUM LOADS<br>Starting torque is<br>approximately double<br>running torque.   | HEAVY-DUTY LOADS<br>High starting torque,<br>shock loading, light<br>torque reversals<br>during drive.  |
|  |   | $\sim$   | $\sim$  | MMM   |
| PRIME MOVER  | Centrifugal pumps,<br>uniformly loaded<br>conveyors, light-duty<br>fans and blowers, liquid<br>mixers and agitators,<br>centrifugal compressors,<br>lobe and vane type<br>blowers, gear pumps,<br>textile machinery, wood-<br>working machinery | Machine tools,<br>hot oil pumps, heavy-<br>duty centrifugal pumps,<br>cooling towers, slurry<br>agitators, boiler feed<br>pumps, hoists,<br>conveyors. | Dredge pumps,<br>dynamometer drives,<br>light-duty hammermills,<br>lineshafts, paper-<br>converting machinery,<br>rotary kilns, rotary or<br>screw-type pumps for<br>high viscosity fluids,<br>paper mill cranes. | Mine ventilating fans,<br>reciprocating pumps<br>or compressors, paper<br>making machinery,<br>heavy-duty hammer-<br>mills, ore crushers,<br>pulverizing mills. |
| Steam, gas or air turbine  | 1.00  | 1.25   | 1.50  | 1.75  |
| AC electric motor  | 1.25  | 1.50   | 1.50  | 1.75  |
| DC electric motor or DOL<br>start AC electric motor,<br>hydraulic motors | 1.25  | 1.50   | 1.75  | 2.00  |
| Gasoline, natural gas, propane<br>or other spark ignition engine         | 1.75  | 1.75   | 2.00  | CONSULT<br>ENGINEERING  |
| Diesel*  | 2.00  | 2.50   | 2.75  | CONSULT<br>ENGINEERING  |

\* Consult application engineering on all engine drives.

Dual drive applications are to be treated as two single drives for service factor purposes.

For conveyor applications consult applications engineering.

For any application with extremes in inertia, starting torque, or questionable equipment, consult application engineering.

## **Easy Step by Step Selection Method**

### Step #3

Specify the clutch selected.



Sure-Grip bushings are sold separately.

| Ordering examples |  |
|-------------------|--|
| N016-2            | 16A-2 clutch (no modifications)  |
| N016-2-B          | 16A-2 clutch with dynamic balancing                                    |
| N016-2-S          | 16A-2 clutch with steel ring   |
| N016-2-B-S        | 16A-2 clutch with dynamic balancing and steel ring                     |
| N016-B-L-S        | 16A-2 clutch with dynamic balancing, limited end float, and steel ring |
| J3316             | J Sure-Grip bushing with a 3-3/16 bore                                 |
|                   |  |

Note: All NLS clutches use non-asbestos shoe linings.

## **Easy Step by Step Selection Method**

#### Step #4

Calculate the Design HP (HP x service factor). Using the Design HP and the driving RPM, select the type and size clutch from the following charts.

### TYPE A

#### Free Engagement Horsepower Tables

In the NLS free engagement clutch the shoes are a free-moving part of the driving half to which the power is applied. As the driving half picks up speed the shoes are forced outward by centrifugal force into contact with the inside surface of the driven half (drum) which is attached to the load or driven machine. As the shoes make smooth contact, they slip momentarily, or until friction causes the driven half to rotate. When the driven equipment reaches full speed, complete engagement of the shoes with the driven half has taken place, and both members rotate as a unit with **no slippage, or power loss.** 

|             |         |         |         |        |        | Minim   | num Dyn | amic HP   |         |         | S           | Shoe R | Replacement  |      |
|-------------|---------|---------|---------|--------|--------|---------|---------|-----------|---------|---------|-------------|--------|--------------|------|
| Description | Bushing | Max.    | Product |        | _      | Min     | imum Dr | iving RPI | M       |         | Outer       |        | Inner        |      |
|             |         | Bore    | Number  | 400    | 500    | 600     | 720     | 870       | 1160    | 1750    | Product No. | Qty.   | Product No.  | Qty. |
| 4A-1        | SH      |         | N004-1  | 0.02   | 0.04   | 0.07    | 0.11    | 0.20      | 0.50    | 1.60    | N004-408    | 2      | NONE         |      |
| 4A-2        | SH      | 1-5/8   | N004-2  | 0.04   | 0.07   | 0.13    | 0.23    | 0.40      | 0.90    | 3.30    | N004-408    | 4      | NONE         |      |
| 4A-3        | SH      |         | N004-3  | 0.05   | 0.09   | 0.15    | 0.27    | 0.50      | 1.10    | 3.90    | N004-412    | 4      | NONE         |      |
| 6A-1        | SDS     |         | N006-1  | 0.09   | 0.20   | 0.30    | 0.50    | 1.00      | 2.40    | 8.00    | N006-613    | 2      | NONE         |      |
| 6A-2        | SDS     | 1-15/16 | N006-2  | 0.15   | 0.30   | 0.50    | 0.90    | 1.60      | 3.80    | 13.00   | N006-613    | 3      | NONE         |      |
| 6A-3        | SDS     |         | N006-3  | 0.20   | 0.40   | 0.70    | 1.20    | 2.10      | 5.00    | 17.00   | N006-613    | 4      | NONE         |      |
| 6A-4        | SDS     |         | N006-4  | 0.29   | 0.60   | 1.00    | 1.80    | 3.20      | 7.50    | 26.00   | N006-613    | 6      | NONE         |      |
| 7A-1        | SK      |         | N007-1  | 0.38   | 0.75   | 1.30    | 2.20    | 3.90      | 9.40    | 32.00   | N007-726    | 3      | NONE         |      |
| 7A-2        | SK      | 2-9/16  | N007-2  | 0.51   | 1.00   | 1.70    | 3.00    | 5.20      | 12.00   | 43.00   | N007-726    | 4      | NONE         |      |
| 7A-3        | SK      |         | N007-3  | 0.77   | 1.50   | 2.60    | 4.50    | 7.90      | 19.00   | 64.00   | N007-726    | 6      | NONE         |      |
| 8A-1        | SF      |         | N008-1  | 0.90   | 1.80   | 3.20    | 5.60    | 9.80      | 23.00   | 80.00   | N008-834    | 4      | NONE         |      |
| 8A-2        | SF      | 2-15/16 | N008-2  | 1.00   | 2.00   | 3.60    | 6.00    | 11.00     | 26.00   | 88.00   | N008-842    | 4      | NONE         |      |
| 8A-3        | SF      |         | N008-3  | 1.30   | 2.70   | 4.90    | 8.20    | 14.00     | 35.00   | 120.00  | N008-834    | 6      | NONE         |      |
| 8A-4        | SF      |         | N008-4  | 1.50   | 3.00   | 5.40    | 9.10    | 16.00     | 38.00   | 132.00  | N008-842    | 6      | NONE         |      |
| 10A-1       | E       |         | N010-1  | 1.50   | 3.00   | 5.50    | 9.00    | 16.00     | 38.00   | 132.00  | N010-1033   | 4      | N010-1026-I  | 4    |
| 10A-2       | E       | 3-1/2   | N010-2  | 1.50   | 3.50   | 6.00    | 10.00   | 18.00     | 43.00   | 149.00  | N010-1042   | 4      | N010-1026-I  | 4    |
| 10A-3       | E       |         | N010-3  | 2.00   | 4.50   | 7.50    | 13.00   | 24.00     | 56.00   | 192.00  | N010-1033   | 6      | N010-1026-I  | 6    |
| 10A-4       | E       |         | N010-4  | 2.50   | 5.00   | 9.00    | 15.00   | 28.00     | 65.00   | 224.00  | N010-1042   | 6      | N010-1026-I  | 6    |
| 12A-1       | F       |         | N012-1  | 3.00   | 6.50   | 12.00   | 19.00   | 35.00     | 82.00   | 285.00  | N012-1275   | 3      | N012-1256-I  | 3    |
| 12A-2       | F       | 3-15/16 | N012-2  | 4.00   | 8.50   | 16.00   | 26.00   | 47.00     | 110.00  | 380.00  | N012-1275   | 4      | N012-1256-I  | 3    |
| 12A-3       | F       |         | N012-3  | 6.00   | 12.00  | 21.00   | 36.00   | 65.00     | 154.00  | 533.00  | N012-1260   | 6      | N012-1256-I  | 6    |
| 12A-4       | F       |         | N012-4  | 6.50   | 13.00  | 23.00   | 39.00   | 70.00     | 165.00  | 570.00  | N012-1275   | 6      | N012-1256-I  | 6    |
| 14A-1       | F       |         | N014-1  | 8.50   | 17.00  | 31.00   | 51.00   | 92.00     | 217.00  | 749.00  | N014-1453   | 6      | N014-1468-I  | 3    |
| 14A-2       | F       | 3-15/16 | N014-2  | 10.00  | 20.00  | 36.00   | 60.00   | 108.00    | 255.00  | 879.00  | N014-1470   | 6      | N014-1468-I  | 4    |
| 14A-3       | F       |         | N014-3  | 13.00  | 27.00  | 48.00   | 81.00   | 144.00    | 340.00  | 1170.00 | N014-1470   | 8      | N014-1468-I  | 6    |
| 16A-1       | J       |         | N016-1  | 13.00  | 26.00  | 47.00   | 79.00   | 141.00    | 333.00  | 1150.00 | N016-16110  | 4      | N016-16100-I | 3    |
| 16A-2       | J       | 4-1/2   | N016-2  | 14.00  | 28.00  | 50.00   | 84.00   | 150.00    | 354.00  | 1220.00 | N016-1685   | 6      | N016-16100-I | 4    |
| 16A-3       | J       |         | N016-3  | 20.00  | 39.00  | 70.00   | 118.00  | 212.00    | 499.00  | 1720.00 | N016-16110  | 6      | N016-16100-I | 4    |
| 16A-4       | J       |         | N016-4  | 26.00  | 53.00  | 93.00   | 158.00  | 282.00    | 666.00  | 2290.00 | N016-16110  | 8      | N016-16100-I | 6    |
| 19A-1       | BTS     |         | N019-1  | 43.00  | 87.00  | 154.00  | 260.00  | 461.00    | 1090.00 |         | N019-19150  | 6      | N019-19100-I | 6    |
| 19A-2       | BTS     |         | N019-2  | 57.00  | 115.00 | 204.00  | 346.00  | 614.00    | 1450.00 |         | N019-19150  | 8      | N019-19100-I | 8    |
| 24A-1       | BTS     |         | N024-1  | 77.00  | 156.00 | 276.00  | 468.00  | 828.00    | 1967.00 |         | N024-24140  | 8      | N024-24180-I | 4    |
| 24A-2       | BTS     |         | N024-2  | 114.00 | 221.00 | 391.00  | 663.00  | 1170.00   | 2785.00 |         | N024-24200  | 8      | N024-24180-I | 6    |
| 24A-3       | BTS     |         | N024-3  | 164.00 | 332.00 | 587.00  | 995.00  | 1760.00   | 4180.00 |         | N024-24200  | 12     | N024-24180-I | 8    |
| 24A-4       | BTS     |         | N024-4  | 219.00 | 443.00 | 783.00  | 1327.00 | 2345.00   | 5570.00 |         | N024-24200  | 16     | N024-24220-I | 8    |
| 25A-1       | BTS     |         | N025-1  | 246.00 | 498.00 | 881.00  | 1490.00 | 2640.00   | 6270.00 |         | N024-24200  | 18     | N024-24180-I | 8    |
| 25A-2       | BTS     |         | N025-2  | 287.00 | 581.00 | 1030.00 | 1740.00 | 3080.00   | 7310.00 |         | N024-24200  | 21     | N024-24220-I | 8    |
| 25A-3       | BTS     |         | N025-3  | 342.00 | 669.00 | 1160.00 | 2000.00 | 3530.00   | 8360.00 |         | N024-24200  | 24     | N024-24180-I | 8    |

Horsepower tables are based on ideal test conditions. As with all friction clutches, the actual horsepower will vary with application conditions. When using a model with inner shoes:

A) horsepower ratings prior to shoe lock-up (dynamic horsepower ratings) do not include inner shoe.

B) horsepower rating after complete shoe lock-up with inner shoe (static horsepower ratings) are approximately double the dynamic rating. For high speed applications and models above 10", consult application engineering.

## Easy Step by Step Selection Method

## **TYPE AD**

### **Delayed Engagement Horsepower Tables**

In the NLS delayed engagement clutch, shoe engagement is controlled by springs. The springs are fastened to the clutch shoes and inserted in slots in the driving half. Spring action holds the shoes out of engagement with the driven half until the driving half reaches a pre-determined RPM. Above this RPM, centrifugal force acting on the shoes overcomes the spring force allowing smooth engagement of the power source with the driven equipment. Since the shoes do not contact the driven half unless the driving half is started and accelerated, the delayed engagement type AD is ideal for dual or standby drives. The cushioned contact also means no sudden load imposed on motor, electrical, clutch or driven equipment.

|             |         |         |         |          | Minimun       | n Dynamic HF | )          | Max.     | Shoe Replace | ment |
|-------------|---------|---------|---------|----------|---------------|--------------|------------|----------|--------------|------|
| Description | Bushing | Max.    | Product | Minimu   | m Driving RPI | M / Maximum  | Idle RPM   | Idle     | Outer        |      |
|             |         | Bore    | Number  | 870/300* | 1160/700*     | 1750/1000*   | 2500/1500* | RPM      | Product No.  | Qty. |
| 4AD-1       | SH      | 1-5/8   | N104-1  | 0.18     | 0.31          | 1.10         | 3.20       | 300-1500 | N104-9001    | 2    |
| 4AD-2       | SH      | 1-5/8   | N104-2  | 0.37     | 0.63          | 2.30         | 6.40       | 300-1500 | N104-9001    | 4    |
| 6AD-1       | SDS     | 1-15/16 | N106-1  | 0.80     | 1.40          | 5.00         | 14.60      | 300-1500 | N106-9001    | 2    |
| 6AD-2       | SDS     | 1-15/16 | N106-2  | 1.20     | 2.10          | 8.00         | 21.90      | 300-1500 | N106-9001    | 3    |
| 6AD-3       | SDS     | 1-15/16 | N106-3  | 1.70     | 2.80          | 10.50        | 29.20      | 300-1500 | N106-9001    | 4    |
| 6AD-4       | SDS     | 1-15/16 | N106-4  | 2.50     | 4.30          | 15.50        | 43.80      | 300-1500 | N106-9001    | 6    |
| 7AD-1       | SK      | 2-1/2   | N107-1  | 3.00     | 5.00          | 18.50        | 50.00      | 300-1500 | N107-9001    | 3    |
| 7AD-2       | SK      | 2-1/2   | N107-2  | 4.00     | 6.80          | 24.50        | 67.00      | 300-1500 | N107-9001    | 4    |
| 7AD-3       | SK      | 2-1/2   | N107-3  | 6.00     | 10.90         | 37.00        | 100.00     | 300-1500 | N107-9001    | 6    |
| 8AD-1       | SF      | 2-15/16 | N108-1  | 7.50     | 13.00         | 47.00        | 136.00     | 300-1500 | N108-9001    | 4    |
| 8AD-2       | SF      | 2-15/16 | N108-2  | 11.50    | 19.50         | 71.00        | 204.00     | 300-1500 | N108-9001    | 6    |
| 10AD-1      | SF      | 2-15/16 | N110-1  | 17.00    | 30.00         | 109.00       | —          | 300-1000 | N110-9001    | 4    |
| 10AD-2      | SF      | 2-15/16 | N110-2  | 26.00    | 45.00         | 164.00       | —          | 300-1000 | N110-9001    | 6    |
| 12AD-1      | F       | 3-15/16 | N112-1  | 27.00    | 47.00         | 173.00       | —          | 300-1000 | N112-9001    | 2    |
| 12AD-2      | F       | 3-15/16 | N112-2  | 41.00    | 71.00         | 259.00       | —          | 300-1000 | N112-9001    | 3    |
| 12AD-3      | F       | 3-15/16 | N112-3  | 55.00    | 95.00         | 346.00       | —          | 300-1000 | N112-9001    | 4    |
| 12AD-4      | F       | 3-15/16 | N112-4  | 83.00    | 142.00        | 519.00       | —          | 300-1000 | N112-9001    | 6    |
| 14AD-1      | F       | 3-15/16 | N114-1  | 73.00    | 125.00        | —            | —          | 200-700  | N114-9001    | 4    |
| 14AD-2      | F       | 3-15/16 | N114-2  | 110.00   | 188.00        |              | —          | 200-700  | N114-9001    | 6    |
| 14AD-3      | F       | 3-15/16 | N114-3  | 147.00   | 251.00        | —            |            | 200-700  | N114-9001    | 8    |
| 16AD-1      | J       | 4-1/2   | N116-1  | 100.00   | 172.00        | —            | —          | 200-700  | N116-9001    | 2    |
| 16AD-2      | J       | 4-1/2   | N116-2  | 201.00   | 344.00        |              | —          | 200-700  | N116-9001    | 4    |
| 16AD-3      | J       | 4-1/2   | N116-3  | 302.00   | 516.00        |              | —          | 200-700  | N116-9001    | 6    |
| 16AD-4      | J       | 4-1/2   | N116-4  | 402.00   | 689.00        | —            | —          | 200-700  | N116-9001    | 8    |
| 19AD-1      | BTS     |         | N119-1  | 521.00   | —             | —            | —          | 200-500  | N119-9001    | 6    |
| 19AD-2      | BTS     |         | N119-2  | 695.00   | —             | —            | —          | 200-500  | N119-9001    | 8    |
| 24AD-1      | BTS     |         | N124-1  | 701.00   |               |              | _          | 50-300   | N124-9001    | 4    |
| 24AD-2      | BTS     |         | N124-2  | 1402.00  | <u> </u>      | —            | —          | 50-300   | N124-9001    | 8    |
| 24AD-3      | BTS     |         | N124-3  | 2103.00  | <u> </u>      | —            | —          | 50-300   | N124-9001    | 12   |
| 24AD-4      | BTS     |         | N124-4  | 2805.00  | —             | —            | —          | 50-300   | N124-9001    | 16   |

\* Horsepower ratings listed are based on idle speed as indicated.

For high speed applications, models above 10", or special idle speeds, consult application engineering. Horsepower ratings listed are based on ideal test conditions. As with all friction clutches, the actual horsepower will vary with application conditions.

### Step #5

Check high speed applications for dynamic balancing and steel band requirements.

|        |                 | RPM                    |                     |
|--------|-----------------|------------------------|---------------------|
| Clutch | Dynamic Balance | Steel Band On Required | Max RPM with        |
| Size   | Between         | Output Member Above    | Max Shoe Compliment |
| 4      | 4700-11500      | 5700                   | 11500               |
| 6      | 3200-7600       | 3900                   | 7600                |
| 7      | 2700-6600       | 3300                   | 6600                |
| 8      | 2400-5700       | 2900                   | 5700                |
| 10     | 1900-4600       | 2300                   | 4600                |
| 12     | 1225-3800       | 1900                   | 3800                |
| 14     | 1400-3300       | 1600                   | 3300                |
| 16     | 1200-2900       | 1400                   | 2900                |
| 19     | 1000-1750       | 1200                   | 1750                |
| 24     | 900-1600        | 1000                   | 1600                |
| 25     | 500-1600        | 1000                   | 1600                |

## Easy Step by Step Selection Method

### Step #6

Check bore size and available space envelope.

### TYPE A

### **Free Engagement**

**Dimensions in Inches** 





### MODELS 4A THRU 16A

| Clutch | Sure-Grip | Max.    | ۸      | A with | P       | 0       | <b>D</b> | -      | F      | ~     |         | V       | V       | Shaft I | End Gap | м      | D.M     | Approx |
|--------|-----------|---------|--------|--------|---------|---------|----------|--------|--------|-------|---------|---------|---------|---------|---------|--------|---------|--------|
| Size   | Busning   | Bore    | A      | Band   | В       | U       | U        | E      | F      | G     | н       | X       | Ŷ       | IVIIN   | wax     | IVI    | B+IVI   | Lbs.   |
| 4A     | SH        | 1-5/8   | 4.4375 | _      | 4.8125  | 2.2500  | 1.1250   | 1.0000 | 2.7500 | .2500 | 4.3750  | 1.0625  | 1.0625  | .0625   | 2.0000  | _      | 4.8125  | 8      |
| 6A     | SDS       | 1-15/16 | 6.5000 | 7.4375 | 5.5313  | 3.0625  | .9375    | 1.0313 | 3.1250 | .2500 | 5.0313  | 1.3125  | 1.3125  | .1250   | 2.4063  | .8125  | 6.3438  | 25     |
| 7A     | SK        | 2-1/2   | 7.6250 | 8.4375 | 7.3125  | 3.6250  | 1.5000   | 1.5625 | 3.8750 | .3125 | 6.6875  | 1.9375  | 1.9375  | .1250   | 2.8125  | .6875  | 8.0000  | 40     |
| 8A     | SF        | 2-15/16 | 8.7500 | 9.4375 | 8.0000  | 4.2500  | 1.2813   | 1.7813 | 4.6250 | .3438 | 7.3125  | 2.2500  | 2.2500  | .1250   | 2.8125  | 1.8750 | 9.8750  | 55     |
| 10A    | E         | 3-1/2   | 10.750 | 11.750 | 10.5000 | 4.1250  | 3.1250   | 2.2500 | 6.0000 | .5000 | 9.5000  | 3.0000  | 3.0000  | .1250   | 3.5000  | —      | 10.5000 | 105    |
| 12A    | F         | 3-15/16 | 13.000 | 14.000 | 11.3750 | 5.5000  | 3.4375   | 1.3125 | 6.6250 | .5625 | 10.2500 | 3.9375  | 3.9375  | .1250   | 2.3750  | —      | 11.3750 | 225    |
| 14A    | F         | 3-15/16 | 15.000 | 16.000 | 11.3750 | 5.5000  | 3.4375   | 1.3125 | 6.6250 | .5625 | 10.2500 | 3.9375  | 3.9375  | .1250   | 2.3750  | —      | 11.3750 | 250    |
| 16A    | J         | 4-1/2   | 17.250 | 18.250 | 13.6250 | 6.6250  | 4.1875   | 1.5625 | 7.2500 | .6250 | 12.3750 | 4.8750  | 4.8750  | .1250   | 2.6250  | —      | 13.6250 | 400    |
| 19A    | BTS       |         | 20.500 | 21.500 | 14.8125 | 6.8750  | 6.2500   | 1.0625 | 10.00  | —     | —       | 7.0000  | 7.0000  | .1250   | .1875   | —      | 14.1875 | 600    |
| 24A    | BTS       |         | 25.500 | 26.500 | 19.0625 | 9.8750  | 8.0000   | 1.0625 | 12.50  | —     | —       | 8.7500  | 10.0000 | .1250   | .1875   | —      | 19.0625 | 1225   |
| 25A    | BTS       |         | —      | 26.500 | 24.1875 | 13.8750 | 9.2500   | 1.0625 | 12.50  | —     | —       | 10.0000 | 10.0000 | .1250   | 4.0781  | —      | 24.1875 | 1400   |
|        |           |         |        |        |         |         |          |        |        |       |         |         |         |         |         |        |         |        |

## TYPE AD

### **Delayed Engagement**

**Dimensions in Inches** 



### **MODELS 4AD THRU 16AD**



### MODELS 19AD & 24AD

| Clutch<br>Size | Sure-Grip<br>Bushing | Max.<br>Keyed<br>Bore | A       | A with<br>Steel<br>Band | В       | С      | D      | E      | F       | G     | Н       | х      | Y      | <u>Shaft</u><br>Min | End Gap<br>Max | М      | B+M     | Approx.<br>Wt.<br>Lbs. |
|----------------|----------------------|-----------------------|---------|-------------------------|---------|--------|--------|--------|---------|-------|---------|--------|--------|---------------------|----------------|--------|---------|------------------------|
| 4AD            | SH                   | 1-5/8                 | 4.4375  | —                       | 4.8125  | 2.2500 | 1.1250 | 1.0000 | 2.7500  | .2500 | 4.3750  | 1.0625 | 1.0625 | .0625               | 2.0000         | -      | 4.8125  | 8                      |
| 6AD            | SDS                  | 1-15/16               | 6.5000  | 7.4375                  | 5.5313  | 3.0625 | .9375  | 1.0313 | 3.1250  | .2500 | 5.0313  | 1.3125 | 1.3125 | .1250               | 2.0313         | .8125  | 6.3438  | 25                     |
| 7AD            | SK                   | 2-1/2                 | 7.6250  | 8.4375                  | 7.3125  | 3.6250 | 1.5000 | 1.5625 | 3.8750  | .3125 | 6.6875  | 1.9375 | 1.9375 | .1250               | 2.8125         | .6875  | 8.0000  | 40                     |
| 8AD            | SF                   | 2-15/16               | 8.7500  | 9.4375                  | 8.0000  | 4.2500 | 1.2813 | 1.7813 | 4.6250  | .3438 | 7.3125  | 2.2500 | 2.2500 | .1250               | 2.8125         | 1.3750 | 9.3750  | 55                     |
| 10AD           | SF                   | 2-15/16               | 10.7500 | 11.7500                 | 8.5625  | 4.1250 | 2.0000 | 1.7500 | 5.1250  | .3438 | 7.8750  | 2.2500 | 2.2500 | .1250               | 3.5000         | .6875  | 9.2500  | 105                    |
| 12AD           | F                    | 3-15/16               | 13.0000 | 14.0000                 | 11.3750 | 5.5000 | 3.4375 | 1.3125 | 6.6250  | .5625 | 10.2500 | 3.9375 | 3.9375 | .1250               | 2.3750         | .6250  | 12.0000 | 215                    |
| 14AD           | F                    | 3-15/16               | 15.0000 | 16.0000                 | 11.3750 | 5.5000 | 2.1250 | 1.3125 | 6.6250  | .5625 | 10.2500 | 3.9375 | 3.9375 | .1250               | 2.3750         | .6250  | 12.0000 | 240                    |
| 16AD           | J                    | 4-1/2                 | 17.2500 | 18.2500                 | 13.6250 | 6.6250 | 4.1875 | 1.5625 | 7.2500  | .6250 | 12.3750 | 4.8750 | 4.8750 | .1250               | 2.6250         | .6250  | 14.2500 | 385                    |
| 19AD           | BTS                  |                       | 20.5000 | 21.5000                 | 14.1875 | 6.8750 | 6.2500 | 1.0625 | 10.0000 | -     | _       | 7.0000 | 7.0000 | .1250               | .1875          | -      | 14.1875 | 575                    |
| 24AD           | BTS                  |                       | 25.5000 | 26.5000                 | 18.9375 | 9.8750 | 8.0000 | 1.0625 | 12.5000 | _     | _       | 8.7500 | 8.7500 | .1250               | 1.4375         | -      | 18.9375 | 1175                   |

## Easy Step by Step Selection Method

| Sure Grip |   |  | Sure Grip                 |   |  | Standard Keys  | eat Dimen          | isions              |
|-----------|---|--|---------------------------|---|--|--|--------------------|---------------------|
| Bushing   | Bores   | Keyseat  | Bushing                   | Bores   | Keyseat                                      | Shaft Dia.   | Width              | Depth               |
| SH        | 1/2 - 1-3/8<br>1-7/16 - 1-5/8<br>1-11/16              | Standard<br>3/8 x 1/16<br>No K.S.                | E                         | 7/8 - 2-7/8<br>2-15/16 - 3-1/4<br>3-5/16 - 3-1/2      | Standard<br>3/4 X 1/8<br>7/8 X 1/16          | 1/2-9/16<br>5/8-7/8  | 1/8<br>3/16        | 1/16<br>3/32        |
| SDS       | 1/2 - 1-11/16<br>1-3/4<br>1-13/16<br>1-7/8 - 1-15/16  | Standard<br>3/8 x 1/8<br>1/2 x 1/8<br>1/2 x 1/16 | F                         | 1 - 3-1/4<br>3-5/16 - 3-3/4<br>3-13/16 - 3-15/16<br>4 | Standard<br>7/8 X 3/16<br>1 X 1/8<br>NO K.S. | 15/16 - 1-1/4<br>1-5/16 - 1-3/8<br>1-7/16 - 1-3/4<br>1-13/16 - 2-1/4     | 5/16<br>3/8<br>1/2 | 5/32<br>3/16<br>1/4 |
| sк        | 2<br>1/2 - 2-1/8<br>2-3/16 - 2-1/4                    | No K.S.<br>Standard<br>1/2 x 1/8                 | J                         | 1-7/16 - 3-13/16<br>3-7/8 - 3-15/16<br>4 - 4-1/2      | Standard<br>1 X 3/8<br>1 X 1/8               | 2-13/16 - 2-3/4<br>2-13/16 - 3-1/4<br>3-15/16 - 3-3/4<br>3-13/16 - 4-1/2 | 3/4<br>7/8<br>1    | 3/8<br>7/16<br>1/2  |
|           | 2-5/16 - 2-1/2<br>2-9/16 - 2-5/8                      | 5/8 x 1/16                                       |                           | BTS NLS Models  |  | 4-9/16 - 5-1/2   | 1-1/4              | 5/8                 |
|           | 1/2 - 2-1/4   | Standard   | Model                     | Bores   | Keyseat                                      | 5-9/16 - 6-1/2   | 1-1/2              | 3/4                 |
| SF        | 2-5/16 - 2-1/2<br>2-9/16 - 2-3/4<br>2-13/16 - 2-15/16 | 5/8 X 3/16<br>5/8 X 1/16<br>NO K.S.              | 19A &<br>19AD<br>24A, 25A | 3 - 5-5/8<br>5-11/16 - 6-5/8<br>3-1/4 - 7             | Standard<br>Shallow<br>Standard              | 6-9/16 - 7-1/2<br>7-9/16 - 9   | 1-3/4<br>2         | 3/4<br>3/4          |
|           |   |  | & 24AD                    | 7-1/16 - 8-3/8  | Shallow                                      |  |                    |                     |

### Bore and keyseat information

NOTE: When installing Sure-Grip bushings follow wrench torque supplied in NLS instructions.

### Step #7

Check clutch capacity for high inertia starts.

If inertia is not known or clutch speed is not listed, see step # 8.

|        | Maximu  | ım WR² (lbs. ft | .2) that may be | e started at st | andard motor s | speeds.  |          |
|--------|---------|-----------------|-----------------|-----------------|----------------|----------|----------|
| Clutch | 870 RPM | 1170 RPM        | 1750 RPM        | Clutch          | 870 RPM        | 1170 RPM | 1750 RPM |
| 4      | 500     | 290             | 130             | 14              | 8000           | 4700     | 2100     |
| 6      | 1400    | 800             | 350             | 16              | 15000          | 8000     | 3700     |
| 7      | 2000    | 1100            | 510             | 19              | 22000          | 13000    | 5600     |
| 8      | 3000    | 1700            | 790             | 24              | 38000          | 20000    | _        |
| 10     | 3800    | 2100            | 880             | 25              | 47600          | 26400    | _        |
| 12     | 7000    | 4000            | 1800            |                 |                |          |          |
|        |         |                 |                 |                 |                |          |          |

### Step #8

If inertia is not known or clutch speed is not listed on WR<sup>2</sup> chart.

#### **ACCELERATION TABLE**

| Clutch<br>Model No. | Energy Capacity<br>Horsepower-Seconds |
|---------------------|---------------------------------------|
| 4A, 4AD             | 245                                   |
| 6A, 6AD             | 680                                   |
| 7A, 7AD             | 980                                   |
| 8A, 8AD             | 1,400                                 |
| 10A, 10AD           | 1,650                                 |
| 12A, 12AD           | 3,400                                 |
| 14A, 14AD           | 4,000                                 |
| 16A, 16AD           | 7,200                                 |
| 19A, 19AD           | 11,000                                |
| 24A, 24AD           | 17,000                                |
| 25A                 | 25,000                                |
| 30A                 | 38,000                                |

Maximum allowable acceleration time in seconds can be calculated by dividing the energy capacity in horsepower-seconds by the clutch design horsepower.

If actual acceleration time exceeds the maximum allowable time, a larger clutch should be selected or if the start-up frequency is more than 1 every half-hour.

## Example: A 12A-3 is rated at 533 hp @ 1750 with an energy capacity of 3400 Horsepower-seconds

 $\frac{3400 \text{ Horsepower-seconds}}{533 \text{ Horsepower}} = 6.4 \text{ seconds maximum allowable acceleration time}$ without a Steel Band

By adding a Steel Band the acceleration time is increased by 35% 6.4 x 1.35 = 8.6 seconds with a Steel Band

## **Sure-Grip Bushings**

## **Dimensions**

Sure-Grip bushings are designed to transmit the rated torque capacity listed in the table below when the cap screws are tightened as indicated. The bushings are stocked in all popular bore sizes, including metric bores, within the bore range for a particular bushing.



QT



Bushings JA to J inclusive w/Setscrew Except JA





### SURE-GRIP BUSHING TORQUE RATINGS AND DIMENSIONS

|       | Torque   | (Note 1)     | (Note 2)     |        | DI     | MENSIO | NS IN IN | CHES   |        |                | Сар            | Recommended     |
|-------|----------|--------------|--------------|--------|--------|--------|----------|--------|--------|----------------|----------------|-----------------|
| Busn. | (InLbs.) | Max.<br>Bore | Max.<br>Bore | А      | В      | D      | Е        | F*     | L      | Bolt<br>Circle | Required       | Torque (FtLbs.) |
| SH    | 3,500    | 1.6250       | 36           | .3750  | 1.8710 | 2.6875 | .8750    | .8125  | 1.2500 | 2.2500         | 3-1/4 x 1-3/8  | 6               |
| SDS   | 5,000    | 1.9375       | 42           | .4375  | 2.1875 | 3.1875 | .8750    | .7500  | 1.3125 | 2.6875         | 3-1/4 x 1-3/8  | 6               |
| SD    | 5,000    | 1.9375       | 42           | . 4375 | 2.1875 | 3.1875 | 1.3750   | 1.2500 | 1.8125 | 2.6875         | 3-1/4 x 1-7/8  | 6               |
| SK    | 7,000    | 2.5000       | 56           | .5000  | 2.8125 | 3.8750 | 1.3750   | 1.2500 | 1.8750 | 3.3125         | 3-5/16 x 2     | 10              |
| SF    | 11,000   | 2.9375       | 63           | .5000  | 3.1250 | 4.6250 | 1.5000   | 1.2500 | 2.0000 | 3.8750         | 3-3/8 x 2      | 2               |
| Е     | 20,000   | 3.5000       | 78           | .7500  | 3.8340 | 6.0000 | 1.8750   | 1.6250 | 2.6250 | 5.0000         | 3-1/2 x 2-3/4  | 40              |
| F     | 40,000   | 3.9375       | 90           | .8125  | 4.4375 | 6.6250 | 2.8125   | 2.5000 | 3.6250 | 5.6250         | 3-9/16 x 3-5/8 | 50              |
| J     | 55,000   | 4.5000       | 105          | 1.000  | 5.1484 | 7.2500 | 3.5000   | 3.1875 | 4.5000 | 6.2500         | 3-5/8 x 4-1/2  | 75              |
| М     | 125,000  | 5.5000       | 130          | 1.250  | 6.500  | 9.1250 | 5.5000   | 5.1875 | 6.7500 | 7.8750         | 4-3/4 x 6-3/4  | 100             |
| N     | 150,000  | 6.0000       | 140          | 1.500  | 7.000  | 10.000 | 6.6250   | 6.2500 | 8.1250 | 8.5000         | 4-7/8 x 8      | 150             |

\* Mating hub length.

1. MAX INCH BORE WITH KEYSEAT.

2. MAX MM BORE WITH STANDARD KEYSEAT.

### SEE PAGES 91-93 FOR BORE AND KEYSEAT INFORMATION AND WEIGHTS.

## **Sure-Grip Bushings**

## **BORE AND KEYSEAT DIMENSIONS**

### (INCHES)

Sure-Grip Bushings are available from stock with all the bores and keyseats listed below. In some cases, as the bore increases in diameter, a shallow keyseat is provided—due to insufficient metal thickness. When this happens, the correct rectangular key is furnished at no charge. This does not affect the bushing's ability to transmit the load. The rectangular key, or flat key as some call it, fits into the standard keyway in the shaft.

| Product<br>No.                | Bore                 | Key Seat                                  | Wt.<br>(*)        | Product<br>No.             | Bore                      | Key Seat                            | Wt.<br>(*)        | Product<br>No.             | Bore                      | Key Seat                                | Wt.<br>(*)           |
|-------------------------------|----------------------|---|-------------------|----------------------------|---------------------------|-------------------------------------|-------------------|----------------------------|---------------------------|---|----------------------|
|                               | SH BUSI              | HINGS                                     |                   | SD                         | BUSHIN                    | <b>GS</b> (continued)               |                   | SK                         | BUSHIN                    | GS (continued)                          |                      |
| SHMPB<br>SH12                 | 7/16<br>1/2          | No KS<br>1/8 x 1/16                       | 1.1               | SD11/16<br>SD34            | 11/16<br>3/4              | 3/16 x 3/32<br>3/16 x 3/32          | 2.0<br>2.0        | SK2316<br>SK214            | 2-3/16<br>2-1/4           | 1/2 X 1/8<br>1/2 X 1/8                  | 2.0<br>1.9           |
| SH58<br>SH11/16               | 9/16<br>5/8<br>11/16 | 3/16 x 3/32                               | 1.1               | SD13/16<br>SD78<br>SD15/16 | 13/10<br>7/8<br>15/16     | 3/16 x 3/32<br>3/16 x 3/32          | 2.0<br>1.9        | SK21458KS<br>SK2516        | 2-1/4<br>2-5/16           | 5/8 X 1/8<br>5/8 X 1/16                 | 1.9                  |
| SH34<br>SH13/16               | 3/4<br>13/16         | 3/16 x 3/32<br>3/16 x 3/32<br>3/16 x 3/32 | 1.0               | SD1<br>SD1<br>SD1116       | 1 1-1/16                  | 1/4 x 1/8<br>1/4 x 1/8              | 1.8<br>1.8        | SK2716<br>SK212            | 2-7/16                    | 5/8 X 1/16<br>5/8 X 1/16                | 1.6                  |
| SH78<br>SH15/16               | 7/8<br>15/16         | 3/16 x 3/32<br>1/4 x 1/8                  | 1.0<br>1.0        | SD118<br>SD1316            | 1-1/8<br>1-3/16           | 1/4 x 1/8<br>1/4 x 1/8              | 1.7<br>1.7        | SK2916<br>SK258            | 2-9/16<br>2-5/8           | No KS<br>No KS                          | 1.3                  |
| SH1<br>SH1116                 | 1<br>1-1/16          | 1/4 x 1/8<br>1/4 x 1/8                    | .9<br>.9          | SD114<br>SD1516            | 1-1/4<br>1-5/16           | 1/4 x 1/8<br>5/16 x 5/32            | 1.6<br>1.6        |                            | SF BUS                    | HINGS                                   |                      |
| SH118<br>SH1316               | 1-1/8<br>1-3/16      | 1/4 x 1/8<br>1/4 x 1/8                    | .9<br>.8          | SD138<br>SD13838KS         | 1-3/8<br>1-3/8            | 5/16 x 5/32<br>3/8 x 3/16           | 1.5<br>1.5        | SFMPB                      | 1/2                       | No KS                                   | 5.1                  |
| SH114<br>SH1516               | 1-1/4<br>1-5/16      | 1/4 x 1/8<br>5/16 x 5/32                  | .8<br>.7          | SD1716<br>SD112            | 1-7/16<br>1-1/2           | 3/8 x 3/16<br>3/8 x 3/16            | 1.4<br>1.4        | SF58<br>SF34               | 5/8<br>3/4                | 3/16 X 3/32                             | 5.0                  |
| SH138<br>SH1716               | 1-3/8<br>1-7/16      | 5/16 x 5/32<br>3/8 x 1/16                 | .7<br>.7          | SD1916<br>SD158            | 1-9/16<br>1-5/8           | 3/8 x 3/16<br>3/8 x 3/16            | 1.3<br>1.2        | SF78<br>SF15/16            | 7/8                       | 3/16 X 3/32<br>3/16 X 3/32<br>1/4 X 1/8 | 4.9                  |
| SH112<br>SH1916               | 1-1/2<br>1-9/16      | 3/8 x 1/16<br>3/8 x 1/16                  | .6<br>.6          | SD11116<br>SD134           | 1-11/16<br>1-3/4          | 3/8 x 3/16<br>3/8 x 1/8             | 1.2<br>1.1        | SF1<br>SF1116              | 1 1-1/16                  | 1/4 X 1/8<br>1/4 X 1/8                  | 4.8                  |
| SH158<br>SH11116              | 1-5/8<br>1-11/16     | 3/8 x 1/16<br>No KS                       | .5<br>.5          | <u>SD11316</u><br>SD178    | <u>1-13/16</u><br>1-7/8   | 1/2 x 1/8<br>1/2 x 1/16             | 1.1               | SF118<br>SF1316            | 1-1/8<br>1-3/16           | 1/4 X 1/8<br>1/4 X 1/8                  | 4.7<br>4.6           |
| 5                             | SDS BUS              | HINGS                                     | 1                 | SD11516<br>SD2             | 1-15/16<br>2              | 1/2 x 1/16<br>No KS                 | .9<br>.8          | SF114<br>SF1516            | 1-1/4<br>1-5/16           | 1/4 X 1/8<br>5/16 X 5/32                | 4.5<br>4.5           |
| SDSMPB<br>SDS12               | 7/16<br>1/2          | No KS<br>1/8 x 1/16                       | 1.7<br>1.7        | 9                          | SK BUSI                   | HINGS                               |                   | SF138<br>SF13838KS         | 1-3/8<br>1-3/8            | 5/16 X 5/32<br>3/8 X 3/16               | 4.4<br>4.4           |
| SDS9/16<br>SDS58              | 9/16<br>5/8          | 1/8 x 1/16<br>3/16 x 3/32                 | 1.7<br>1.6        | SKMPB<br>SK12              | 7/16<br>1/2               | No KS<br>1/8 x 1/16                 | 3.6<br>3.6        | SF1716<br>SF112            | 1-7/16                    | 3/8 X 3/16<br>3/8 X 3/16                | 4.3                  |
| SDS11/16<br>SDS34             | 3/4                  | 3/16 x 3/32<br>3/16 x 3/32                | 1.6               | SK9/16<br>SK58             | 9/16<br>5/8               | 1/8 x 1/16<br>3/16 x 3/32           | 3.6<br>3.6        | SF1916<br>SF158            | 1-9/16                    | 3/8 X 3/16<br>3/8 X 3/16                | 4.2                  |
| SDS13/16<br>SDS78             | 7/8<br>15/16         | 3/16 x 3/32<br>3/16 x 3/32                | 1.0               | SK11/16<br>SK34            | 11/16<br>3/4              | 3/16 x 3/32<br>3/16 x 3/32          | 3.5               | SF1110<br>SF134<br>SF11316 | 1-1/10                    | 3/8 X 3/16                              | 4.0<br>3.9<br>3.8    |
| SDS13/10<br>SDS1<br>SDS1116   | 1-1/16               | 1/4 x 1/8<br>1/4 x 1/8                    | 1.5               | SK13/16<br>SK78            | 13/10<br>7/8<br>15/16     | 3/16 x 3/32<br>3/16 x 3/32          | 3.5<br>3.4<br>2.4 | SF178<br>SF11516           | 1-7/8                     | 1/2 X 1/4<br>1/2 X 1/4<br>1/2 X 1/4     | 3.7                  |
| SDS118<br>SDS1316             | 1-1/8<br>1-3/16      | 1/4 x 1/8<br>1/4 x 1/8                    | 1.4<br>1.4        | SK13/10<br>SK1<br>SK1116   | 1                         | 1/4 x 1/8<br>1/4 x 1/8              | 3.3               | SF2<br>SF2116              | 2<br>2-1/16               | 1/2 X 1/4<br>1/2 X 1/4                  | 3.5<br>3.4           |
| SDS114<br>SDS1516             | 1-1/4<br>1-5/16      | 1/4 x 1/8<br>5/16 x 5/32                  | 1.3<br>1.3        | SK118<br>SK1316            | 1-1/8<br>1-3/16           | 1/4 x 1/8<br>1/4 x 1/8              | 3.2<br>3.2        | SF218<br>SF2316            | 2-1/8<br>2-3/16           | 1/2 X 1/4<br>1/2 X 1/4                  | 3.3<br>3.2           |
| SDS138<br>SDS13838KS          | 1-3/8<br>1-3/8       | 5/16 x 5/32<br>3/8 x 3/16                 | 1.2<br>1.2        | SK114<br>SK1516            | 1-1/4<br>1-5/16           | 1/4 x 1/8<br>5/16 x 5/32            | 3.1<br>3.1        | SF214<br>SF21458KS         | 2-1/4<br>2-1/4            | 1/2 X 1/4<br>5/8 X 5/16                 | 3.1<br>3.1           |
| SDS1716<br>SDS112             | 1-7/16<br>1-1/2      | 3/8 x 3/16<br>3/8 x 3/16                  | 1.2<br>1.1        | SK151638KS<br>SK138        | 1-5/16<br>1-3/8           | 3/8 x 3/16<br>5/16 x 5/32           | 3.1<br>3.0        | SF2516<br>SF238            | 2-5/16<br>2-3/8           | 5/8 X 3/16<br>5/8 X 3/16                | 3.1                  |
| SDS1916<br>SDS158             | 1-9/16               | 3/8 x 3/16<br>3/8 x 3/16                  | 1.1               | SK13838KS<br>SK1716        | 1-3/8<br>1-7/16           | 3/8 x 3/16<br>3/8 x 3/16            | 3.0<br>2.9        | SF2716<br>SF212<br>SF2016  | 2-7/16<br>2-1/2<br>2-0/16 | 5/8 X 3/16<br>5/8 X 3/16                | 2.9                  |
| SDS1110<br>SDS134<br>SDS11316 | 1-3/4                | 3/8 x 1/8<br>1/2 x 1/8                    | 1.0<br>1.0<br>q   | SK112<br>SK1916            | 1-1/2<br>1-9/16           | 3/8 x 3/16<br>3/8 x 3/16            | 2.9               | SF258<br>SF21116           | 2-5/8                     | 5/8 X 1/16<br>5/8 X 1/16                | 2.0                  |
| SDS178<br>SDS11516            | 1-7/8                | 1/2 x 1/16<br>1/2 x 1/16                  | .9<br>.8          | SK130<br>SK11116<br>SK134  | 1-5/6<br>1-11/16<br>1-3/4 | 3.8 x 3/16<br>3.8 x 3/16            | 2.7<br>2.6<br>2.5 | SF234<br>SF278             | 2-3/4<br>2-7/8            | 5/8 X 1/16<br>3/4 X 1/16                | 2.2                  |
| SDS2                          | 2                    | No KS                                     | .7                | SK13412KS<br>SK11316       | 1-3/4<br>1-13/16          | 1/2 x 1/4<br>1/2 X 1/4              | 2.5               | SF21516                    | 2-15/16                   | 3/4 X 1/32                              | 1.7                  |
|                               | SD BOS               | HINGS                                     | <b>.</b>          | SK11516                    | 1-7/8                     | 1/2 X 1/4                           | 2.4               | EN/DD                      | E BUSI                    | HINGS                                   | 40.5                 |
| SDMPB<br>SD12<br>SD9/16       | 7/16<br>1/2<br>9/16  | NO KS<br>1/8 x 1/16<br>1/8 x 1/16         | 2.1<br>2.1<br>2.1 | SK2<br>SK2116              | 2<br>2-1/16               | 1/2 X 1/4<br>1/2 X 1/4<br>1/2 X 1/4 | 2.3<br>2.2<br>2.1 | ЕМРВ<br>E78<br>E15/16      | 7/8<br>7/8<br>15/16       | NO KS<br>3/16 X 3/32<br>1/4 X 1/8       | 10.8<br>10.8<br>10.8 |
| SD58                          | 5/8                  | 3/16 x 3/32                               | 21                | SK218                      | 2-1/8                     | 1/2 X 1/4                           | 2.0               |                            |                           |   |                      |

\* Approximate weight in lbs.

MPB Bushings are unsplit.

(Continued-next page)

## **Sure-Grip Bushings**

## **BORE AND KEYSEAT DIMENSIONS**

| E BUSHINCS (continued)         F BUSHINCS (continued)           E1         1         1/4 X 1/8         10.7           E118         1-1/8         1/4 X 1/8         10.6           E136         1-3/16         1/4 X 1/8         10.5           E136         1-3/16         5/16 X 5/32         10.2           E138         1-3/8         5/16 X 5/32         10.2           E1376         1-7/8         1/2 X 1/4         15.6           E138         1-3/8         3/8 X 3/16         10.2         F218         2-1/16         1/2 X 1/4         15.6           E138         1-3/8         S/3/6         10.0         F218         2-1/16         1/2 X 1/4         15.6           E134         1-3/4         3/8 X 3/16         10.0         F216         2-5/16         5/8 X 5/16         14.3           E134         1-3/4         3/8 X 3/16         9.9         F2236         2-3/8         5/8 X 5/16         14.3           E134         1-15/16         1/2 X 1/4         9.0         F223         2-3/8         5/8 X 5/16         13.9           E134         2-1/16         1/2 X 1/4         8.9         F223         2-3/8         5/8 X 5/16         13.9  | Product<br>No. | Bore            | Key Seat                 | Wt.<br>(*) | Product<br>No. | Bore    | Key Seat                 | Wt.<br>(*) |
|--|----------------|-----------------|--------------------------|------------|----------------|---------|--------------------------|------------|
| EI         1         14 X 1/8         10.7         F138         1-5/8         3/8 X 3/16         16.7           E118         1-1/8         1/4 X 1/8         10.6         F134         1-3/4         3/8 X 3/16         16.3           E1316         1-3/16         1/4 X 1/8         10.5         F178         1-7/8         1/2 X 1/4         16.3           E1516         1-5/16         5/16 X 5/32         10.2         F218         2.1/16         1/2 X 1/4         15.8           E138         1-3/8         3/8 X 3/16         10.1         F2316         2-1/16         1/2 X 1/4         15.4           E1916         1-9/16         3/8 X 3/16         10.0         F2145 8/S         2-1/4         1/2 X 1/4         15.4           E134         1-3/4         3/8 X 3/16         9.8         F2145 8/S         2-1/4         1/2 X 1/4         14.3           E134         1-3/4         3/8 X 3/16         9.6         F216         2-9/16         5/8 X 5/16         13.7           E1376         1-18/16         1/2 X 1/4         9.2         F258         2-5/8         5/8 X 5/16         13.7           E1376         1-18/16         1/2 X 1/4         9.2         F258         2-5/8  | EB             | BUSHING         | S (continued)            |            | F              | BUSHING | <b>S</b> (continued)     |            |
| E1136       1-1/3       1/4 X 1/8       10.5       F134       1-3/4       3/8 X 3/16       16.3         E1144       1-1/4       1/4 X 1/8       10.5       F178       1-7/8       1/2 X 1/4       15.6         E1516       1-5/16       5/16 X 5/32       10.3       F2       2       1/2 X 1/4       15.6         E138       1-3/8       3/8 X 3/16       10.2       F2116       2-1/16       1/2 X 1/4       15.6         E1716       1-7/16       3/8 X 3/16       10.1       F2146       2-1/16       1/2 X 1/4       15.6         E1916       1-9/16       3/8 X 3/16       9.9       F21458KS       2-1/4       5/8 X 5/16       14.3         E134       1-3/4       3/8 X 3/16       9.6       F2716       2-7/16       5/8 X 5/16       14.3         E134       1-3/4       3/8 X 3/16       9.6       F2156       2-5/16       5/8 X 5/16       13.7         E136       1-17/78       1/2 X 1/4       9.4       F216       2-1/16       5/8 X 5/16       13.7         E1376       1-17/78       1/2 X 1/4       9.2       F258       2-5/8       5/8 X 5/16       13.2         E2116       2-11/6       1/2 X 1/4       8.9   | E1             | 1               | 1/4 X 1/8                | 10.7       | F158           | 1-5/8   | 3/8 X 3/16               | 16.7       |
| E114       1-14/4       1/4 X 1/8       10.3       F178       1-7/8       1/2 X 1/4       15.0         E136       1-5/16       5/16 X 5/32       10.3       F1516       1-15/16       1/2 X 1/4       15.4         E138       1-3/8       5/16 X 5/32       10.2       F2116       2-1/16       1/2 X 1/4       15.4         E138       1-3/8       5/16 X 5/32       10.2       F216       2-1/16       1/2 X 1/4       15.4         E137       1-7/8       X/8 X 3/16       9.9       F214       2-1/4       1/2 X 1/4       15.4         E112       1-1/2       3/8 X 3/16       9.9       F214       2-1/4       5/8 X 5/16       14.3         E136       1-5/76       3/8 X 3/16       9.6       F2716       2-7/16       5/8 X 5/16       14.3         E1316       1-13/16       1/2 X 1/4       9.4       F212       2-1/2       5/8 X 5/16       14.3         E138       2-1/8       1/2 X 1/4       9.4       F212       2-1/2       5/8 X 5/16       14.3         E137       1-13/16       1/2 X 1/4       9.0       F2118       2-11/16       5/8 X 5/16       13.4         E214       2-1/8       1/2 X 1/4       8.9  | EI I8          | 1-1/8           | 1/4 X 1/8                | 10.6       | F134           | 1-3/4   | 3/8 X 3/16               | 16.3       |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | E1310          | 1-3/10          | 1/4 X 1/8                | 10.5       | F178           | 1-7/8   | 1/2 X 1/4                | 16.0       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E114<br>E1516  | 1-1/4           | 1/4 A 1/0<br>5/16 ¥ 5/32 | 10.4       | F11516         | 1-15/16 | 1/2 X 1/4                | 15.8       |
| E13838KS       1-3/6       3/8 X 3/16       10.2       F218       2-1/8       1/2 X 1/4       15.2         E176       1-7/16       3/8 X 3/16       10.2       F218       2-1/8       1/2 X 1/4       15.2         E171       1-7/16       3/8 X 3/16       0.0       F214       2-1/8       1/2 X 1/4       15.2         E172       1-7/8       1/2 X 1/4       15.2       F218       2-1/8       1/2 X 1/4       15.2         E178       1-5/8       3/8 X 3/16       9.9       F21458KS       2-1/4       5/8 X 5/16       14.8         E138       1-5/8       3/8 X 3/16       9.9       F21458KS       2-1/4       5/8 X 5/16       14.3         E138       1-7/8       1/2 X 1/4       9.4       F2212       2-1/12       5/8 X 5/16       13.7         E178       1-7/8       1/2 X 1/4       9.0       F2316       2-5/16       5/8 X 5/16       13.7         E2116       2-1/16       1/2 X 1/4       8.9       F2316       2-1/16       3/4 X 3/8       12.1         E2116       2-1/16       1/2 X 1/4       8.9       F2136       2-3/16       3/4 X 3/8       12.3         E2116       2-1/16       1/2 X 1/4       8.5   | F138           | 1-3/8           | 5/16 X 5/32              | 10.3       | <u>F2</u>      | 2-1/16  | 1/2 X 1/4                | 15.0       |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | E13838KS       | 1-3/8           | 3/8 X 3/16               | 10.2       | F218           | 2-1/10  | 1/2 X 1/4<br>1/2 X 1/4   | 15.4       |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | E1716          | 1-7/16          | 3/8 X 3/16               | 10.1       | F2316          | 2-3/16  | 1/2 X 1/4                | 15.0       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E112           | 1-1/2           | 3/8 X 3/16               | 10.0       | F214           | 2-1/4   | 1/2 X 1/4                | 14.8       |
| E1581-5/83/8 X 3/169.8E111161-11/163/8 X 3/169.7E1341-3/43/8 X 3/169.7E1361-3/161/2 X 1/49.4E1371-7/81/2 X 1/49.4E115161-15/161/2 X 1/49.4E2121/2 X 1/49.0E21162-1/1/61/2 X 1/49.0E21162-1/1/61/2 X 1/49.0E21162-1/1/61/2 X 1/49.0E21162-1/1/61/2 X 1/49.9E2182-3/161/2 X 1/48.9E2142-1/41/2 X 1/48.6E2142-1/41/2 X 1/48.6E2142-1/45/8 X 5/168.5E3162-5/165/8 X 5/168.5E3162-5/165/8 X 5/168.5E3333/4 X 3/811.2E2382-3/85/8 X 5/168.1E3382-3/85/8 X 5/167.6E27162-7/165/8 X 5/167.5E37162-7/165/8 X 5/167.5E37162-1/165/8 X 5/167.5E37162-1/163/4 X 3/87.1E33163-3/163/4 X 3/87.1E33163-3/163/4 X 3/87.1E33163-5/167/8 X 3/167.7E33163-5/167/8 X 1/165.7E33163-5/167/8 X 1/165.7E33163-5/167/8 X 1/165.7 <td< td=""><td>E1916</td><td>1-9/16</td><td>3/8 X 3/16</td><td>9.9</td><td>F21458KS</td><td>2-1/4</td><td>5/8 X 5/16</td><td>14.8</td></td<>  | E1916          | 1-9/16          | 3/8 X 3/16               | 9.9        | F21458KS       | 2-1/4   | 5/8 X 5/16               | 14.8       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E158           | 1-5/8           | 3/8 X 3/16               | 9.8        | F2516          | 2-5/16  | 5/8 X 5/16               | 14.5       |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | E11116         | 1-11/16         | 3/8 X 3/16               | 9.7        | F238           | 2-3/8   | 5/8 X 5/16               | 14.3       |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | E134           | 1-3/4           | 3/8 X 3/16               | 9.6        | F2716          | 2-7/16  | 5/8 X 5/16               | 14.1       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E11316         | 1-13/16         | 1/2 X 1/4                | 9.4        | F212           | 2-1/2   | 5/8 X 5/16               | 13.9       |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | E178           | 1-7/8           | 1/2 X 1/4                | 9.3        | F2916          | 2-9/16  | 5/8 X 5/16               | 13.7       |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | E11516         | 1-15/16         | 1/2 X 1/4                | 9.2        | F258           | 2-5/8   | 5/8 X 5/16               | 13.4       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | EZ             | 2               | 1/2 X 1/4                | 9.0        | F21116         | 2-11/16 | 5/8 X 5/16               | 13.2       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E2110<br>E219  | 2-1/10          | 1/2 X 1/4<br>1/2 X 1/4   | 0.9        | F234           | 2-3/4   | 5/8 X 5/16               | 12.9       |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  | E210<br>E2316  | 2-1/0           | 1/2 A 1/4<br>1/2 X 1/4   | 0.0        | F21316         | 2-13/10 | 3/4 X 3/8                | 12.0       |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | F214           | 2-3/10          | 1/2 X 1/4<br>1/2 X 1/4   | 85         | <u>F2/8</u>    | 2-1/8   | 3/4 X 3/8                | 12.3       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E21458KS       | 2-1/4           | 5/8 X 5/16               | 8.5        | F21310<br>F3   | 2-13/10 | 3/4 A 3/0<br>3/4 X 3/8   | 12.1       |
| E38         2-3/8         5/8 X 5/16         8.1         F3316         3-3/16         3/4 X 3/8         10.9           E2716         2-7/16         5/8 X 5/16         7.6         7.8         3/4         3/4 X 3/8         10.9           E212         2-1/2         5/8 X 5/16         7.6         7.8         3/4 X 3/8         10.9           E216         2-9/16         5/8 X 5/16         7.6         F3316         3-5/16         7/8 X 3/16         11.0           E216         2-11/16         5/8 X 5/16         7.5         F3716         3-7/16         7/8 X 3/16         10.3           E2136         2-13/16         3/4 X 3/8         7.1         F328         3-5/8         7/8 X 3/16         10.3           E21316         2-13/16         3/4 X 1/8         6.9         F378         3-7/8         1 X 1/8         8.1           E3         3         3/4 X 1/8         6.7         F3116         3-15/16         1 X 1/8         8.1           E314         3-1/2         7/8 X 1/16         5.7         F378         3-7/8         1 X 1/8         8.1           E314         3-1/2         7/8 X 1/16         5.7         F378         3-15/16         1 X 1/8         7.7 </td <td>E2516</td> <td>2-5/16</td> <td>5/8 X 5/16</td> <td>8.3</td> <td>F318</td> <td>3-1/8</td> <td>3/4 X 3/8</td> <td>11.0</td> | E2516          | 2-5/16          | 5/8 X 5/16               | 8.3        | F318           | 3-1/8   | 3/4 X 3/8                | 11.0       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E238           | 2-3/8           | 5/8 X 5/16               | 8.1        | F3316          | 3-3/16  | 3/4 X 3/8                | 10.9       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E2716          | 2-7/16          | 5/8 X 5/16               | 8.0        | F314           | 3-1/4   | 3/4 X 3/8                | 10.6       |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  | E212           | 2-1/2           | 5/8 X 5/16               | 7.8        | F3516          | 3-5/16  | 7/8 X 3/16               | 11.0       |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  | E2916          | 2-9/16          | 5/8 X 5/16               | 7.6        | F338           | 3-3/8   | 7/8 X 3/16               | 10.6       |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  | E258           | 2-5/8           | 5/8 X 5/16               | 7.5        | F3716          | 3-7/16  | 7/8 X 3/16               | 10.3       |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E2116          | 2-11/16         | 5/8 X 5/16               | 7.3        | F312           | 3-1/2   | 7/8 X 3/16               | 10.0       |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  | E234           | 2-3/4           | <u>5/8 X 5/16</u>        | 7.1        | F358           | 3-5/8   | 7/8 X 3/16               | 9.4        |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E21316         | 2-13/16         | 3/4 X 3/8                | 7.2        | F31116         | 3-11/16 | 7/8 X 3/16               | 9.0        |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   | E2/0<br>E21516 | 2-1/0           | 3/4 X 3/0<br>2/4 V 1/0   | 1.1        | F334           | 3-3/4   | 7/8 X 3/16               | 8.7        |
| E318       3-1/8       3/4 X 1/8       6.7       5-13/16       3-13/16       1/4/178       7.7         E316       3-3/16       3/4 X 1/8       6.0       6.0       6.1       6.1       6.1       6.1       6.1       6.1       6.1       7.7       6.3       6.9       6.9         E316       3-3/16       3/4 X 1/8       6.0       6.0       6.1 <t< td=""><td>E21510<br/>E3</td><td>2-13/10</td><td>3/4 X 1/0<br/>3/4 Y 1/8</td><td>67</td><td>F3/8<br/>F31516</td><td>3-7/8</td><td>I X I/8</td><td>8.1</td></t<>  | E21510<br>E3   | 2-13/10         | 3/4 X 1/0<br>3/4 Y 1/8   | 67         | F3/8<br>F31516 | 3-7/8   | I X I/8                  | 8.1        |
| E3316         3-3/16         3/4 X 1/8         6.0           E3316         3-3/16         3/4 X 1/8         6.0           E314         3-1/4         3/4 X 1/8         5.8           E3516         3-5/16         7/8 X 1/16         5.7           E338         3-3/8         7/8 X 1/16         5.5           E3716         3-7/16         7/8 X 1/16         5.2           E312         3-1/2         7/8 X 1/16         5.2           FMPB         1         No KS         17.9           F11         1         1/4 X 1/8         17.9           F118         1-1/8         1/4 X 1/8         17.7           F1316         1-3/16         1/4 X 1/8         17.5           F138         1-3/8         5/16 X 5/32         17.2           F112         1-1/2         3/8 X 3/16         17.1           J218         2-1/8         1/2 X 1/4         25.6           J218         2-1/8         1/2 X 1/4         25.6           J214         2-1/4         1/2 X 1/4         25.6           J218         2-1/8         1/2 X 1/4         25.6           J214         2-1/4         1/2 X 1/4         25.6   | E318           | 3-1/8           | 3/4 X 1/8                | 63         | F31310<br>E4   | 3-15/10 | I A I/O                  | 6.0        |
| E314         3-1/4         3/4 X 1/8         5.8           E316         3-5/16         7/8 X 1/16         5.7           E338         3-3/8         7/8 X 1/16         5.7           E3716         3-7/16         7/8 X 1/16         5.2           E312         3-1/2         7/8 X 1/16         5.2           FMPB         1         No KS         17.9           F1         1         1/4 X 1/8         17.9           F1         1         1/4 X 1/8         17.9           F118         1-1/8         1/4 X 1/8         17.7           F1316         1-3/16         1/4 X 1/8         17.5           F114         1-1/4         1/4 X 1/8         17.5           F138         1-3/8         5/16 X 5/32         17.2           F112         1-7/16         3/8 X 3/16         17.1           J2218         2-1/8         1/2 X 1/4         25.6           J218         2-1/8         1/2 X 1/4         25.6           J216         2-3/16         1/2 X 1/4         25.6           F1316         1-7/16         3/8 X 3/16         17.1           J218         2-1/8         1/2 X 1/4         25.6   | E3316          | 3-3/16          | 3/4 X 1/8                | 6.0        | . 14           | 7       | NO KO                    | 0.5        |
| E3516         3-5/16         7/8 X 1/16         5.7           E338         3-3/8         7/8 X 1/16         5.5           E3716         3-7/16         7/8 X 1/16         5.2           E312         3-1/2         7/8 X 1/16         5.2           J1716         1-7/16         3/8 X 3/16         28.1           E312         3-1/2         7/8 X 1/16         4.7           JMPBR         1-7/16         3/8 X 3/16         28.1           J1112         1-1/2         3/8 X 3/16         28.0           J112         3-1/2         7/8 X 1/16         4.7           FBUSHINGS           FMPB         1         No KS         17.9           F1         1         1/4 X 1/8         17.7         J178         1-7/8         1/2 X 1/4         26.7           F118         1-1/8         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.5           F1316         1-3/16         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         26.3           F1316         1-7/16         3/8 X 3/16         17.1         J218         2-1/8         1/2 X 1/4         25.  | E314           | 3-1/4           | 3/4 X 1/8                | 5.8        |                | J BUSH  | INGS                     |            |
| E338         3-3/8         7/8 X 1/16         5.5         JMPBR         1-7/16         No KS         28.1           E3716         3-7/16         7/8 X 1/16         5.2         J1716         1-7/16         3/8 X 3/16         28.1           E312         3-1/2         7/8 X 1/16         5.2         J1716         1-7/16         3/8 X 3/16         28.1           FI12         3-1/2         7/8 X 1/16         4.7         J112         1-1/2         3/8 X 3/16         27.8           FMPB         1         No KS         17.9         J1116         1-3/4         3/8 X 3/16         27.2           F11         1         1/4 X 1/8         17.9         J178         1-7/8         1/2 X 1/4         26.7           F118         1-1/8         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.5           F114         1-1/4         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         26.3           F1316         1-3/16         3/16 X 5/32         17.2         J218         2-1/8         1/2 X 1/4         25.6           F1316         1-7/16         3/8 X 3/16         17.1         J2516         2-3/16         1/2 X 1/4  | E3516          | 3-5/16          | 7/8 X 1/16               | 5.7        |                | 4 7/40  | N                        | 00.4       |
| E3716<br>E312         3-7/16<br>3-1/2         7/8 X 1/16<br>7/8 X 1/16         5.2<br>4.7         J1/16<br>J112         1-7/16<br>1-1/2         3/8 X 3/16<br>3/8 X 3/16         28.1<br>28.0           F BUSHINGS         J112         1-1/2         3/8 X 3/16         27.8           FMPB         1         No KS         17.9         J1116         1-3/4         3/8 X 3/16         27.4           F11         1         1/4 X 1/8         17.9         J178         1-7/8         1/2 X 1/4         26.7           F118         1-1/8         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.3           F1316         1-3/16         1/4 X 1/8         17.5         J2         2         1/2 X 1/4         26.3           F114         1-1/4         1/4 X 1/8         17.5         J2         2         1/2 X 1/4         26.3           F1316         1-3/16         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.8           F114         1-1/4         3/8 X 3/16         17.1         J2516         2-3/16         1/2 X 1/4         25.6           F1316         1-7/16         3/8 X 3/16         16.9         J238         2-3/16         1/2 X 1/4         25.6  | E338           | 3-3/8           | 7/8 X 1/16               | 5.5        | JMPBR          | 1-//16  | NO KS                    | 28.1       |
| E312         3-1/2         7/8 X 1/16         4.7         1/12         1/12         3/8 X 3/16         20.8           FMPB         1         No KS         17.9         1916         1-9/16         3/8 X 3/16         27.8           FMPB         1         No KS         17.9         11116         1-11/16         3/8 X 3/16         27.4           J1116         1-11/16         3/8 X 3/16         27.4         1134         1-3/4         3/8 X 3/16         27.4           J1116         1-11/16         3/8 X 3/16         27.4         1134         1-3/4         3/8 X 3/16         27.4           J1116         1-11/16         1/4 X 1/8         17.9         1178         1-7/8         1/2 X 1/4         26.7           F118         1-1/4         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.5           F114         1-1/4         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.6           F1316         1-3/16         1/4 X 1/8         17.5         J216         2-3/16         1/2 X 1/4         25.6           F1316         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16   | E3716          | 3-7/16          | 7/8 X 1/16               | 5.2        | JI/10          | 1-7/10  | 3/8 X 3/10               | 20.1       |
| FBUSHINGS         J11116         J-13/4         J/8 X 3/16         27.4           FMPB         1         No KS         17.9         J11116         1-11/16         3/8 X 3/16         27.4           F1         1         1/4 X 1/8         17.9         J134         1-3/4         3/8 X 3/16         27.2           F118         1-1/8         1/4 X 1/8         17.7         J12         2         1/2 X 1/4         26.7           F118         1-3/16         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.5           F114         1-1/4         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.8           F114         1-1/4         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.6           F13716         1-7/16         3/8 X 3/16         17.1         J214         2-1/4         1/2 X 1/4         25.6           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/16         5/8 X 5/16         25.0           F112         1-9/16         3/8 X 3/16         16.8         J238         2-3/8         5/8 X 5/16         24.7  | E312           | 3-1/2           | 7/8 X 1/16               | 4.7        | JIIZ<br>11016  | 1-1/2   | 3/0 X 3/10<br>2/9 V 2/16 | 20.0       |
| FMPB         1         No KS         17.9         J134         1-3/4         3/8 X 3/16         27.2           F1         1         1/4 X 1/8         17.9         J178         1-7/8         1/2 X 1/4         26.7           F1         1         1/4 X 1/8         17.9         J178         1-7/8         1/2 X 1/4         26.7           F118         1-1/8         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.5           F1316         1-3/16         1/4 X 1/8         17.6         J218         2-1/8         1/2 X 1/4         26.3           F114         1-1/4         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.8           F118         1-3/8         5/16 X 5/32         17.2         J214         2-1/4         1/2 X 1/4         25.6           F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.8         2-3/8         5/8 X 5/16         24.7 <td></td> <td>F RIISH</td> <td>INGS</td> <td></td> <td>J11116</td> <td>1-11/16</td> <td>3/8 X 3/16</td> <td>27.4</td>                      |                | F RIISH         | INGS                     |            | J11116         | 1-11/16 | 3/8 X 3/16               | 27.4       |
| FMPB         1         N0 KS         17.9         J178         1-7/8         1/2 X 1/4         26.7           F1         1         1/4 X 1/8         17.9         J11516         1-15/16         1/2 X 1/4         26.7           F1         1         1/4 X 1/8         17.9         J11516         1-15/16         1/2 X 1/4         26.5           F118         1-1/8         1/4 X 1/8         17.7         J2         2         1/2 X 1/4         26.3           F1316         1-3/16         1/4 X 1/8         17.6         J218         2-1/8         1/2 X 1/4         25.8           F114         1-1/4         1/4 X 1/8         17.5         J2316         2-3/16         1/2 X 1/4         25.6           F138         1-3/8         5/16 X 5/32         17.2         J214         2-1/4         1/2 X 1/4         25.6           F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.8         2-3/8         5/8 X 5/16         24.7 </td <td>EMDD</td> <td></td> <td></td> <td>47.0</td> <td>J134</td> <td>1-3/4</td> <td>3/8 X 3/16</td> <td>27.2</td>               | EMDD           |                 |                          | 47.0       | J134           | 1-3/4   | 3/8 X 3/16               | 27.2       |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$   | FMPB           | 1               |                          | 17.9       | J178           | 1-7/8   | 1/2 X 1/4                | 26.7       |
| F110         1-1/0         1/4 X 1/6         17.7         J2         2         1/2 X 1/4         26.3           F1316         1-3/16         1/4 X 1/8         17.6         J218         2-1/8         1/2 X 1/4         25.8           F114         1-1/4         1/4 X 1/8         17.5         J216         2-3/16         1/2 X 1/4         25.8           F138         1-3/8         5/16 X 5/32         17.2         J214         2-1/4         1/2 X 1/4         25.3           F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.8         2-3/8         5/8 X 5/16         24.7  | F1<br>E110     | <br>  1 1/0     | 1/4 X 1/8                | 17.9       | J11516         | 1-15/16 | 1/2 X 1/4                | 26.5       |
| F1310         1-3/10         1/4 X 1/8         17.5         J218         2-1/8         1/2 X 1/4         25.8           F114         1-1/4         1/4 X 1/8         17.5         J2316         2-3/16         1/2 X 1/4         25.8           F138         1-3/8         5/16 X 5/32         17.2         J2316         2-3/16         1/2 X 1/4         25.6           F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.8         2-3/8         5/8 X 5/16         24.7   | F110<br>E1216  | 1-1/ð<br>1-2/16 | 1/4 A 1/ð<br>1/4 V 1/9   | 17.6       | J2             | 2       | 1/2 X 1/4                | 26.3       |
| F113         1-1/2         1/2 X 1/3         1/2 X 1/4         25.6           F138         1-3/8         5/16 X 5/32         17.2         J214         2-1/4         1/2 X 1/4         25.3           F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.8         16.9         16.8  | F114           | 1-3/10          | 1/4 X 1/0                | 17.0       | J218           | 2-1/8   | 1/2 X 1/4                | 25.8       |
| F1716         1-7/16         3/8 X 3/16         17.1         J2516         2-5/16         5/8 X 5/16         25.0           F112         1-1/2         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7           F1916         1-9/16         3/8 X 3/16         16.9         J238         2-3/8         5/8 X 5/16         24.7  | F138           | 1-3/8           | 5/16 X 5/32              | 17.2       | J2310          | 2-3/10  | 1/2 X 1/4                | 20.0       |
| F112 1-1/2 3/8 X 3/16 16.9 J238 2-3/8 5/8 X 5/16 24.7<br>F1916 1-9/16 3/8 X 3/16 16.8  | F1716          | 1-7/16          | 3/8 X 3/16               | 17.1       | JZ 14<br>12516 | 2-1/4   | 1/2 A 1/4                | 25.3       |
| F1916 1-9/16 3/8 X 3/16 16.8   | F112           | 1-1/2           | 3/8 X 3/16               | 16.9       | 12310          | 2-3/10  | 5/8 ¥ 5/16               | 23.0       |
|  | F1916          | 1-9/16          | 3/8 X 3/16               | 16.8       | 0200           | 2-3/0   | J/U X J/ 10              | 24.1       |

### (INCHES)

\* Approximate weight in lbs.

MPB Bushings are unsplit.

92

Wt.

(\*)

24.5

24.2

23.6

23.3

23.0

22.2

21.9

21.6

20.9

20.5

20.1

19.6

19.3

18.9

18.5

17.7

17.2

16.8

17.4

17.0

16.5

16.1

15.2

14.7

14.2

13.2

12.7

12.2

Key Seat

5/8 X 5/16

3/4 X 3/8

7/8 X 7/16

1 X 1/2

1 X 3/8

1 X 3/8

1 X 1/8

Product No.

J2716

J212

J258

J234

J278

J3

J318

J3316

J314

J338

J3716

J312

J358

J334

J378

J4

J418

J414

J438

J412

J4716

J4316

J31116

J31316

J31516

J3516

J21116

J21516

Bore

2-7/16

2-1/2

2-5/8

2-3/4

2-7/8

3-1/8

3-3/16

3-1/4

3-5/16

3-3/8

3-7/16

3-1/2

3-5/8

3-3/4

3-11/16

3-13/16

3-7/8

4-1/8

4-3/16

4-1/4

4-3/8

4-7/16

4-1/2

4

3-15/16

3

2-11/16

2-15/16

J BUSHINGS (continued)

## (INCHES) WITH METRIC BORE AND KEYSEAT

| Product<br>No. | Bore<br>(mm) | Key 🛛   | Wt.<br>(*) | Product<br>No. | Bore<br>(mm) | Key 🛛    | Wt.<br>(*) | Product<br>No. | Bore<br>(mm) | Key 🛛   | Wt.<br>(*) |
|----------------|--------------|---------|------------|----------------|--------------|----------|------------|----------------|--------------|---------|------------|
|                | SH BUS       | HINGS   |            |                | SF BUSI      | HINGS    |            |                | J BUSH       | INGS    |            |
| SH24MM         | 24           | 8 X 7   | .9         | SF28MM         | 28           | 8 X 7    | 4.7        | J50MM          | 50           | 14 X 9  | 26.5       |
| SH25MM         | 25           | 8 X 7   | .9         | SF30MM         | 30           | 8 X 7    | 4.6        | J55MM          | 55           | 16 X 10 | 25.6       |
| SH28MM         | 28           | 8 X 7   | .9         | SF32MM         | 32           | 10 X 8   | 4.5        | J60MM          | 60           | 18 X 11 | 24.7       |
| SH30MM         | 30           | 8 X 7   | .8         | SF35MM         | 35           | 10 X 8   | 4.4        | J65MM          | 65           | 18 X 11 | 23.9       |
| SH32MM         | 32           | 10 X 8  | .8         | SF38MM         | 38           | 10 X 8   | 4.2        | J70MM          | 70           | 20 X 12 | 23.0       |
| SH35MM         | 35           | 10 X 8  | .7         | SF40MM         | 40           | 12 X 8   | 4.2        | J75MM          | 75           | 20 X 12 | 21.9       |
|                |              |         |            | SF42MM         | 42           | 12 X 8   | 4.1        | J80MM          | 80           | 22 X 14 | 20.9       |
|                | PD2 RD2      | HINGS   |            | SF45MM         | 45           | 14 X 9   | 3.9        | J85MM          | 85           | 22 X 14 | 19.3       |
| SDS24MM        | 24           | 8 X 7   | 15         | SF48MM         | 48           | 14 X 9   | 3.7        | J90MM          | 90           | 25 X 14 | 18.1       |
| SDS25MM        | 25           | 8 X 7   | 1.5        | SF50MM         | 50           | 14 X 9   | 3.6        | J95MM          | 95           | 25 X 14 | 16.8       |
| SDS28MM        | 28           | 8 X 7   | 1.4        | SF55MM         | 55           | 16 X 10  | 3.2        | J100MM         | 100          | 28 X 16 | 16.5       |
| SDS30MM        | 30           | 8 X 7   | 1.4        | SF60MM         | 60           | 18 X 11  | 3.0        |                |              |         |            |
| SDS32MM        | 32           | 10 X 8  | 1.3        | SF65MM         | 65           | 18 X 8†  | 2.6        |                |              |         |            |
| SDS35MM        | 35           | 10 X 8  | 1.2        |                |              | INCO     |            |                |              |         |            |
| SDS38MM        | 38           | 10 X 8  | 1.1        |                | E DUJN       | inus     |            |                |              |         |            |
| SDS40MM        | 40           | 12 X 8  | 1.1        | E35MM          | 35           | 10 X 8   | 10.2       |                |              |         |            |
| SDS42MM        | 42           | 12 X 8  | 1.0        | E38MM          | 38           | 10 X 8   | 10.0       |                |              |         |            |
|                |              |         |            | E40MM          | 40           | 12 X 8   | 9.9        |                |              |         |            |
|                | SD BUS       | HINGS   |            | E42MM          | 42           | 12 X 8   | 9.8        |                |              |         |            |
| SD24MM         | 24           | 8X7     | 18         | E45MM          | 45           | 14 X 9   | 9.6        |                |              |         |            |
| SD25MM         | 25           | 8 X 7   | 1.0        | E48MM          | 48           | 14 X 9   | 9.3        |                |              |         |            |
| SD28MM         | 28           | 8 X 7   | 1.0        | E50MM          | 50           | 14 X 9   | 9.2        |                |              |         |            |
| SD30MM         | 30           | 8 X 7   | 17         | E55MM          | 55           | 16 X 10  | 8.6        |                |              |         |            |
| SD32MM         | 32           | 10 X 8  | 1.6        | E60MM          | 60           | 18 X 11  | 8.1        |                |              |         |            |
| SD35MM         | 35           | 10 X 8  | 1.5        | E65MM          | 65           | 18 X 11  | 7.6        |                |              |         |            |
| SD38MM         | 38           | 10 X 8  | 1.4        | E70MM          | 70           | 20 X 12  | 7.1        |                |              |         |            |
| SD40MM         | 40           | 12 X 8  | 1.3        | E75MM          | 75           | 20 X 12  | 6.9        |                |              |         |            |
| SD42MM         | 42           | 12 X 8  | 1.2        | E80MM          | 80           | 22 X 11† | 6.3        |                |              |         |            |
|                | SK BUS       | HINGS   |            |                | F BUSH       | INGS     |            |                |              |         |            |
| CKOANNA        | 24           | 0 7 7   | 2.2        | F45MM          | 45           | 14 X 9   | 16.2       |                |              |         |            |
| SK24IVIIVI     | 24           |         | 3.3        | F48MM          | 48           | 14 X 9   | 16.0       |                |              |         |            |
| SKZOWIN        | 20           |         | 3.3        | F50MM          | 50           | 14 X 9   | 15.8       |                |              |         |            |
| SKZOWIW        | 20           |         | 3.2        | F55MM          | 55           | 16 X 10  | 15.0       |                |              |         |            |
| SKOOMM         | 20           |         | 0.2        | F60MM          | 60           | 18 X 11  | 14.3       |                |              |         |            |
|                | 25           | 10 X 0  | 2.1        | F65MM          | 65           | 18 X 11  | 13.7       |                |              |         |            |
| SK38MM         | 38           | 10 X 8  | 20         | F70MM          | 70           | 20 X 12  | 12.9       |                |              |         |            |
| SK40MM         | <u>4</u> 0   | 12 8 8  | 3.6        | F75MM          | 75           | 20 X 12  | 12.1       |                |              |         |            |
| SK42MM         | 40           | 12 8    | 27         | F80MM          | 80           | 22 X 14  | 11.2       |                |              |         |            |
| SK45MM         | 45           | 14 X 9  | 2.6        | F85MM          | 85           | 22 X 14  | 10.6       |                |              |         |            |
| SK48MM         | 48           | 14 X 9  | 2.0        | F90MM          | 90           | 25 X 14  | 9.7        |                |              |         |            |
| SK50MM         | 50           | 14 X 9  | 2.3        |                |              |          |            |                |              |         |            |
| SK55MM         | 55           | 16 X 10 | 2.0        |                |              |          |            |                |              |         |            |

### **BORE AND KEY INFORMATION**

\* Approximate weight in lbs.

The metric system does not refer to keyseat or keyway dimensions as does the English system; instead, dimensions are given for the key itself, which is rectangular in shape and not square as in the English system. This meets ISO standards.

**† SHALLOW KEY FURNISHED** 

## **Selection Guide**

To select or order a Boston Gear Centric Centrifugal Clutch, please complete the following information and fax this form to Product Support at 800-816-5608.

### **General Information**

| Company        |         |      |         |       |
|----------------|---------|------|---------|-------|
| Address        |         | City |         | State |
| Contact Person | Tel. No | ).   | Fax No. |       |

### **Application Data**

| 1. Drive method:   Electric Motor  Engine/Turbine  Other                                 |
|--|
| 2. Method of drive: 🛛 Direct (Coupling Style) 🖓 Indirect Pulley Mounted (provide sketch) |
| 3. Power transmission requirements at clutch location:                                   |
| Horsepower   |
| Typical running RPM (If range required, specify range.)                                  |
| 4. Type: 🛛 Standard (A) 🛛 Vertical Lift-Out (V)  |
| 5. Speeds (required for engines, turbines, dual drives):                                 |
| Idling RPM Engagement RPM  |
| 6. Bores: Driver (input) inches Driver (output) inches                                   |
| 7. Service Factor Required:  |

Use the space below to sketch any relevant application data:





## **Section Contents**

| BORE CODES            |     |
|-----------------------|-----|
| CLUTCH LOCATION       |     |
| SERVICE FACTORS       |     |
| APPLICATION FORMULAS  | 100 |
| HORSEPOWER AND TORQUE | 101 |
| METRIC CONVERSION     | 103 |

## **Bore Codes**

Use the appropriate bore code shown below to designate the bore diameter (in inches) for the clutch's unit and coupling.

| Bore Size  | Bore Size | Bore                                     |
|------------|-----------|--|
| (Fraction) | (Decimal) | Code                                     |
| 1/8        | 0.1250    | P02                                      |
| 3/16       | 0.1875    | P03                                      |
| 1/4        | 0.2500    | P04                                      |
| 5/16       | 0.3125    | P05                                      |
| 3/8        | 0.3750    | P06                                      |
| 7/16       | 0.4375    | P07                                      |
| 1/2        | 0.5000    | P08                                      |
| 9/16       | 0.5625    | P09                                      |
| 5/8        | 0.6250    | P10                                      |
| 11/16      | 0.6875    | P11                                      |
| 3/4        | 0.7500    | P12                                      |
| 13/16      | 0.8125    | P13                                      |
| 7/8        | 0.8750    | P14                                      |
| 15/16      | 0.9375    | P15                                      |
| 1          | 1.0000    | P16                                      |
| 1-1/16     | 1.0625    | P17                                      |
| 1-1/8      | 1,1250    | P18                                      |
| 1-3/16     | 1 1875    | P19                                      |
| 1-1/4      | 1 2500    | P20                                      |
| 1_5/16     | 1 3125    | P21                                      |
| 1_3/8      | 1.3750    | P22                                      |
| 1_7/16     | 1.3730    | P23                                      |
| 1_1/2      | 1.5000    | P24                                      |
| 1 0/16     | 1.5000    | D24                                      |
| 1 5/9      | 1.5025    | P20                                      |
| 1 11/16    | 1.0230    | F20                                      |
| 1-11/10    | 1.0075    |  |
| 1-0/4      | 1.7000    | P20                                      |
| 1-13/10    | 1.0120    | F29<br>D20                               |
| 1-7/0      | 1.0750    | P30                                      |
| 1-15/16    | 1.9375    | P31                                      |
| 2          | 2.0000    | P32                                      |
| 2-1/16     | 2.0625    | P33                                      |
| 2-1/8      | 2.1250    | P34                                      |
| 2-3/16     | 2.1875    | P35                                      |
| 2-1/4      | 2.2500    | P36                                      |
| 2-5/16     | 2.3125    | P37                                      |
| 2-3/8      | 2.3750    | P38                                      |
| 2-7/16     | 2.4375    | P39                                      |
| 2-1/2      | 2.5000    | P40                                      |
| 2-9/16     | 2.5625    | P41                                      |
| 2-5/8      | 2.6250    | P42                                      |
| 2-11/16    | 2.6875    | P43                                      |
| 2-3/4      | 2.7500    | P44                                      |
| 2-13/16    | 2.8125    | P45                                      |
| 2-7/8      | 2.8750    | P46                                      |
| 2-15/16    | 2.9375    | P47                                      |
| 3          | 3.0000    | P48                                      |
| 3-1/16     | 3.0625    | P49                                      |
| 3-1/8      | 3.1250    | P50                                      |
| 3-3/16     | 3.1875    | P51                                      |
| 3-1/4      | 3.2500    | P52                                      |
| 3-5/16     | 3.3125    | P53                                      |
| 3-3/8      | 3.3750    | P54                                      |
| 3-7/16     | 3.4375    | P55                                      |
| 3-1/2      | 3.5000    | P56                                      |
|            |           | 1. |

| Bore Size  | Bore Size | Bore |
|------------|-----------|------|
| (Fraction) | (Decimal) | Code |
| 3-9/16     | 3.5625    | P57  |
| 3-5/8      | 3.6250    | P58  |
| 3-11/16    | 3.6875    | P59  |
| 3-3/4      | 3.7500    | P60  |
| 3-13/16    | 3 8125    | P61  |
| 3-7/8      | 3 8750    | P62  |
| 3-15/16    | 3 9375    | P63  |
| 4          | 4 0000    | P64  |
| 4-1/16     | 4 0625    | P65  |
| 4-1/8      | 4 1250    | P66  |
| 1-3/16     | 4.1200    | P67  |
| 4-1/4      | 4 2500    | P68  |
| 1-5/16     | 4.2000    | P60  |
| 4-3/8      | 4.3123    | D70  |
| 4-3/6      | 4.3730    | P70  |
| 4-7/10     | 4.4373    |      |
| 4-1/2      | 4.5000    | F12  |
| 4-9/10     | 4.0020    | P/3  |
| 4-0/8      | 4.0200    | P74  |
| 4-11/10    | 4.08/5    | P75  |
| 4-3/4      | 4.7500    | P/6  |
| 4-13/16    | 4.8125    | P//  |
| 4-7/8      | 4.8750    | P/8  |
| 4-15/16    | 4.9375    | P79  |
| 5          | 5.0000    | P80  |
| 5-1/16     | 5.0625    | P81  |
| 5-1/8      | 5.1250    | P82  |
| 5-3/16     | 5.1875    | P83  |
| 5-1/4      | 5.2500    | P84  |
| 5-5/16     | 5.3125    | P85  |
| 5-3/8      | 5.3750    | P86  |
| 5-7/16     | 5.4375    | P87  |
| 5-1/2      | 5.5000    | P88  |
| 5-9/16     | 5.5625    | P89  |
| 5-5/8      | 5.6250    | P90  |
| 5-11/16    | 5.6875    | P91  |
| 5-3/4      | 5.7500    | P92  |
| 5-13/16    | 5.8125    | P93  |
| 5-7/8      | 5.8750    | P94  |
| 5-15/16    | 5.9375    | P95  |
| 6          | 6.0000    | P96  |
| 6-1/16     | 6.0625    | P97  |
| 6-1/8      | 6.1250    | P98  |
| 6-3/16     | 6.1875    | P99  |
| 6-1/4      | 6.2500    | P100 |
| 6-5/16     | 6.3125    | P101 |
| 6-3/8      | 6.3750    | P102 |
| 6-7/16     | 6 4375    | P103 |
| 6-1/2      | 6 5000    | P104 |
| 6-9/16     | 6 5625    | P105 |
| 6-5/9      | 6.0020    | D106 |
| 6_11/16    | 6 6975    | D107 |
|            | 0.00/0    |      |
| 0-3/4      | 0.7500    |      |
| 0-13/10    | 0.0125    | P109 |
| 6-1/8      | 0.8/50    | PI10 |
| 6-15/16    | 6.9375    | P111 |
| 7          | 7.0000    | P112 |

#### **Standard Keyways**

| Bore Range (Inch) | Square      |
|-------------------|-------------|
| Over - To         | WxD         |
| 5/16 - 7/16       | 3/32 x 3/64 |
| 7/16 - 9/16       | 1/8 x 1/16  |
| 9/16 - 7/8        | 3/16 x 3/32 |
| 7/8 - 1-1/4       | 1/4 x 1/8   |
| 1-1/4 - 1-3/8     | 5/16 x 5/32 |
| 1-3/8 - 1-3/4     | 3/8 x 3/16  |
| 1-3/4 - 2-1/4     | 1/2 x 1/4   |
| 2-1/4 - 2-3/4     | 5/8 x 5/16  |
| 2-3/4 - 3-1/4     | 3/4 x 3/8   |
| 3-1/4 - 3-3/4     | 7/8 x 7/16  |
| 3-3/4 - 4-1/2     | 1 x 1/2     |
| 4-1/2 - 5-1/2     | 1-1/4 x 5/8 |
| 5-1/2 - 6-1/2     | 1-1/2 x 3/4 |
| 6-1/2 - 7-1/2     | 1-3/4 - 7/8 |

Square keyways will be furnished unless otherwise specified or noted in catalog.

Keys will be furnished with bores which require reduced keys.

#### **Bore Tolerances (Inch)**

| Diameter | Tolerance   |
|----------|-------------|
| 0 to 1   | +.0005/0000 |
| 1 to 3   | +.0010/0000 |
| 3 and up | +.0020/0000 |

## **Overload/Torque Limiting Clutch Location**

#### Location

The torque limiting clutch should always be located as close as possible to the potential source of an overload condition. Figures 1 through 4 indicate both preferred and non-preferred locations for mounting an Overload Release clutch.

#### Note:

Clutch mounted sprockets, etc. and couplings should be positioned as close to a supporting bearing as possible to minimize overhung loads. A minimum shaft engagement of 1-1/2 times the shaft diameter is recommended for clutch and coupling flange installation.

### **Direct Drives**

Figure 1 shows the preferred location for mounting in a direct drive application. The clutch is mounted on the low speed side of the reducer, and transmits power from its housing, through its rotor to the driven shaft.

Locating the clutch as shown in Figure 2 is **not preferred**. Here the clutch is mounted on the high-speed side of the reducer. Generally, mounting in this manner requires the clutch to be hypersensitive to perform satisfactorily.

#### **Indirect Drives**

Either location of the clutch shown in Figure 3 is **preferred** in indirect drive applications, with the overload protection on the slow speed side of the reducer.

The mounting location in Figure 4 is **not preferred** for the same reasons as those for Figure 2. Always consult the factory when a mounting of this type is necessary.









#### **Figure 3 Indirect Drive Preferred**



#### **Figure 4 Indirect Drive Not Preferred**



## **Application Classification for Various Loads**

|                                 | С        | hart I For Al | l Drives |
|---------------------------------|----------|---------------|----------|
|                                 | Ser      | vice Factor   | Loading  |
| Type of Machine                 | Not More | Not More      | More     |
| To Be Driven                    | Than 15  | Than 10       | Than     |
|                                 | Mins. in | Hrs. per      | 10 Hrs.  |
|                                 | 2 Hrs.   | Day           | Per Day  |
| AGITATORS                       |          |               |          |
| Pure Liquid                     | 0.80     | 1.00          | 1.25     |
| Semi-Liquids, Variable Density  | 1.00     | 1.25          | 1.50     |
| BLOWERS                         |          |               |          |
| Centrifugal and Vane            | 0.80     | 1.00          | 1.25     |
| Lobe                            | 1.00     | 1.25          | 1.50     |
| BREWING AND DISTILLING          |          |               |          |
| Bottling Machinery              | 0.80     | 1.00          | 1.25     |
| Brew Kettles–Continuous Duty    | -        | —             | 1.25     |
| Cookers – Continuous Duty       | -        | —             | 1.25     |
| Mash Tubs – Continuous Duty     | -        | -             | 1.25     |
| Scale Hopper – Frequent Starts  | -        | 1.25          | 1.50     |
|                                 | -        | 1.00          | -        |
|                                 | -        | 1.50          | -        |
|                                 | -        | 1.75          | -        |
|                                 | -        | 1.25          | _        |
| CLARIFIERS                      | -        | 1.00          | 1.25     |
| CLASSIFIERS                     | -        | 1.25          | 1.50     |
| CLAY WORKING MACHINERY          |          |               |          |
| Brick Press & Briquette Machine | _        | 1.75          | 2.00     |
| Extruders and Mixers            | 1.00     | 1.25          | 1.50     |
| COMPRESSORS                     |          | 4.00          | 4.05     |
| Centrifugal                     | _        | 1.00          | 1.25     |
| Reciprocating – Single Cycle    |          | 1.20          | 2.00     |
|                                 |          | 1.75          | 2.00     |
|                                 |          |               |          |
| Apron                           | _        | 1 00          | 1 25     |
| Assembly-Belt – Bucket or Pan   | _        | 1.00          | 1.25     |
| Chain – Flight                  | _        | 1.00          | 1.25     |
| Oven – Live Roll – Screw        | _        | 1.00          | 1.25     |
| CONVEYORS-HEAVY DUTY            |          |               |          |
| NOT UNIFORMLY FED               |          |               |          |
| Apron                           | -        | 1.25          | 1.50     |
| Assembly-Belt – Bucket or Pan   | -        | 1.25          | 1.50     |
| Chain – Flight                  | -        | 1.25          | 1.50     |
| Live Roll                       | -        | -             | -        |
| Oven – Screw                    | _        | 1.25          | 1.50     |
| CRANES AND HOISTS               | _        | 1.75          | 2.00     |
| CRANES AND HOISTS               |          |               |          |
|                                 | *        | 1 00          | 1 25     |
| CRUSHERS                        |          | 1.00          | 1.20     |
| Ore Stope                       |          | 1 75          | 2 00     |
| Sugar                           | _        | 1.50          | 1.50     |
|                                 |          |               |          |
|                                 |          |               |          |
|                                 |          |               |          |

|                                   | Chart I For All Drives |             |          |  |
|-----------------------------------|------------------------|-------------|----------|--|
|                                   | Ser                    | vice Factor | Loading  |  |
| Type of Machine                   | Not More               | Not More    | More     |  |
| To Be Driven                      | Than 15                | Than 10     | Than     |  |
| TO BE BINEI                       | Mins in                | Hrs per     | 10 Hrs   |  |
|                                   | 2 Hrs                  | Dav         | Per Dav  |  |
|                                   | 21113.                 | Day         | T El Day |  |
| ELEVATORS                         |                        |             |          |  |
| Bucket – Uniform Load             | —                      | 1.00        | 1.25     |  |
| Bucket – Heavy Load               | —                      | 1.25        | 1.50     |  |
| Centrifugal Discharge             | -                      | 1.25        | 1.50     |  |
| Freight                           | -                      | 1.25        | 1.50     |  |
| Gravity Discharge                 | -                      | 1.00        | 1.25     |  |
| FANS                              |                        |             |          |  |
| Centrifugal – Light (Small Diam.) | -                      | 1.00        | 1.25     |  |
| Large Industrial                  | -                      | 1.25        | 1.50     |  |
| FEEDERS                           |                        |             |          |  |
| Apron – Belt – Screw              | -                      | 1.25        | 1.50     |  |
| Disc                              | —                      | 1.00        | 1.25     |  |
| Reciprocating                     | -                      | 1.75        | 2.00     |  |
| FOOD INDUSTRY                     |                        |             |          |  |
| Beet Slicer                       | _                      | 1.25        | 1.50     |  |
| Cereal Cooker                     | —                      | 1.00        | 1.25     |  |
| Dough Mixer – Meat Grinder        | -                      | 1.25        | 1.50     |  |
| GENERATORS (NOT WELDING)          | -                      | 1.00        | 1.25     |  |
| HAMMER MILLS                      | _                      | 1.75        | 2.00     |  |
| HOISTS                            |                        |             |          |  |
| Heavy Duty                        | _                      | 1.75        | 2.00     |  |
| Medium Duty and Skip Type         | _                      | 1.25        | 1.50     |  |
| LAUNDRY TUMBLERS                  | _                      | 1.25        | 1.50     |  |
| LINE SHAFTS                       |                        |             |          |  |
| Uniform Load                      | _                      | 1.00        | 1.25     |  |
| Heavy Load                        | _                      | 1.25        | 1.50     |  |
| MACHINE TOOLS                     |                        |             |          |  |
| Auxiliary Drive                   | _                      | 1.00        | 1.25     |  |
| Main Drive – Uniform Load         | _                      | 1.25        | 1.50     |  |
| Main Drive – Heavy Duty           | _                      | 1.75        | 2.00     |  |
| METAL MILLS                       |                        |             |          |  |
| Draw Bench Carriers & Main Drive  | _                      | 1.25        | 1.50     |  |
| SLITTERS                          | _                      | 1.25        | 1.50     |  |
| TABLE CONVEYORS -                 |                        |             |          |  |
| NON REVERSING                     |                        |             |          |  |
| Group Drives                      | _                      | 1.25        | 1,50     |  |
| Individual Drives                 | _                      | 1.75        | 2.00     |  |
| Wiring Drawing.                   |                        |             |          |  |
| Flattening or Winding             | _                      | 1.25        | 1.50     |  |
| MILLS ROTARY TYPE                 |                        | -           | -        |  |
| BALL AND ROD                      |                        |             |          |  |
| Spur Ring Gear and                |                        |             |          |  |
| Direct Connected                  | _                      | _           | 2.00     |  |
| Cement Kilns, Pebble              | _                      | _           | 1.50     |  |
| Dryers and Coolers                | _                      | _           | 1.50     |  |
| Plain and Wedge Bar               | -                      | —           | 1.50     |  |
| Tumbling Barrels                  | -                      | -           | 2.00     |  |
|                                   |                        |             |          |  |

More

Than

10 Hrs.

Per Day

## **Application Classification for Various Loads (continued)**

|                                 | C                   | hart I For A        | I Drives        |                            | C                                       | hart I For A        | J |
|---------------------------------|---------------------|---------------------|-----------------|----------------------------|---|---------------------|---|
|                                 | Se                  | rvice Factor        | Loading         |                            | Sei                                     | rvice Factor        |   |
| Type of Machine                 | Not More            | Not More            | More            | Type of Machine            | Not More                                | Not More            | T |
| To Be Driven                    | Than 15<br>Mins. in | Than 10<br>Hrs. per | Than<br>10 Hrs. | To Be Driven               | Than 15<br>Mins. in                     | Than 10<br>Hrs. per |   |
|                                 | 2 Hrs.              | Day                 | Per Day         |                            | 2 Hrs.                                  | Day                 | 4 |
| MIXERS                          |                     |                     |                 | PUMPS                      |   |                     |   |
| Concrete – Continuous           | -                   | 1.25                | 1.50            | Centrifugal                | -                                       | -                   |   |
| Concrete – Intermittent         | -                   | 1.25                | 1.50            | Proportioning              | -                                       | -                   |   |
| Constant Density                | -                   | 1.00                | 1.25            | Reciprocating              |   |                     |   |
| Semi-Liquid                     | -                   | 1.25                | 1.50            | Single Acting,             |   |                     |   |
| OIL INDUSTRY                    |                     |                     |                 | 3 or more Cycles           | -                                       | 1.25                |   |
| Oil Well Pumping                | -                   | -                   | *               | Double Acting,             |   |                     |   |
| Chillers, Paraffin Filter Press | _                   | 1.25                | 1.50            | 2 or more Cycles           | -                                       | 1.25                |   |
| Rotary Kilns                    | _                   | 1.25                | 1.50            | Rotary – Gear or Lube      | -                                       | 1.00                |   |
| PAPER MILLS                     |                     |                     |                 | RUBBER INDUSTRY            |   |                     |   |
| Agitator (Mixer)                | _                   | 1.25                | 1.50            | Batch Mixers               | _                                       | -                   |   |
| Agitator – Pure Liquids         | _                   | 1.00                | 1.25            | Continuous Mixers          | _                                       | _                   |   |
| Barking Drums – Mechanical      |                     |                     | 0               | Calenders                  | _                                       | -                   |   |
| Barkers                         | _                   | 1 75                | 2 00            | Extruders – Continuous     | _                                       | _                   |   |
| Bleacher                        | _                   | 1.00                | 1.00            | Extruders – Intermittent   | _                                       | _                   |   |
| Beater                          | _                   | 1.00                | 1.20            | Tire Building Machines     | _                                       | _                   |   |
| Calender Heavy Duty             |                     | 1.20                | 2.00            | Tire & Tube Press Openers  | _                                       | _                   |   |
| Calender Anti-Eriction Bras     |                     | 1.00                | 1.00            | SEWAGE DISPOSAL            |   |                     |   |
| Cylinders                       |                     | 1.00                | 1.20            | EQUIPMENT                  |   |                     |   |
| Chippor                         | _                   | 1.25                | 2.00            | Bar Screens                | _                                       | 1 00                |   |
| Chipper<br>Chip Ecodor          | _                   | 1.05                | 2.00            | Chemical Feeders           | _                                       | 1.00                |   |
| Chip Feeder                     | _                   | 1.20                | 1.00            | Collectors                 |   | 1.00                |   |
| Convoyora China Bark            | _                   | 1.00                | 1.20            | Dewatering Screws          | _                                       | 1.00                |   |
| Conveyors - Chips - Bark -      |                     | 1.00                | 1.05            | Scum Breakers              | _                                       | 1.25                |   |
|                                 | _                   | 1.00                | 1.20            | Slow or Bapid Mixers       |   | 1.25                |   |
| Conveyors - Log and Slab        | _                   | -                   | 2.00            | Thickeners                 |   | 1.25                |   |
| Cutter                          | -                   | -                   | 2.00            |                            | _                                       | 1.25                |   |
| Cylinder Molds, Dryers          |                     |                     | 4.05            |                            | _                                       | 1.20                |   |
| (Anti-Friction Brg.)            | -                   | 1.05                | 1.25            | SCREENS                    |   |                     |   |
| Feit Stretcher                  | _                   | 1.25                | 1.50            | Air Washing                | -                                       | 1.00                |   |
| Thiskener (AC)                  | _                   | 1.20                | 1.50            | Rotary – Stone or Gravel   | -                                       | 1.25                |   |
| mickener (AC)                   | _                   | 1.25                | 1.50            | I raveling Water Intake    | -                                       | 1.00                |   |
| Washer (AC)                     | -                   | 1.25                | 1.50            | SKIP HOISTS                | -                                       |                     |   |
|                                 | _                   | _                   | 1.25            | SLAB PUSHERS               | -                                       | 1.25                |   |
| PLASTICS INDUSTRY               |                     |                     |                 | STOKERS                    | -                                       | -                   |   |
| Intensive Internal Mixers       |                     |                     |                 | TEXTILE INDUSTRY           |   |                     |   |
| Batch Type                      |                     | -                   | 1.75            | Batchers or Calenders      | -                                       | 1.25                |   |
| Continuous Type                 | -                   | -                   | 1.50            | Cards                      | -                                       | 1.25                |   |
| Batch Drop Mill – 2 Rolls       |                     | -                   | 1.25            | Card Machines              |   | 1.75                |   |
| Compounding Mills               | -                   | -                   | 1.25            | Dry Cans and Dryers        | -                                       | 1.25                |   |
| Calenders                       | -                   | -                   | 1.50            | Dyeing Machines            |   | 1.25                |   |
| Extruder – Variable Speed       | -                   | -                   | 1.50            | Looms                      | -                                       | 1.25                |   |
| Extruder – Fixed Speed          |                     | -                   | 1.75            | Mangles, Nappers and Pads  | -                                       | 1.25                |   |
| PULLERS                         |                     |                     |                 | Soapers, Tenner Frames     | -                                       | 1.25                |   |
|                                 | 1 _                 | _                   | 2.00            | Spinners, Washers, Winders | _                                       | 1.25                |   |
| Barge Haul                      |                     |                     |                 |                            | 1 C C C C C C C C C C C C C C C C C C C | 1                   |   |
| Barge Haul                      |                     |                     | 2.00            | TUMBLING BARRELS           | 1.50                                    | 1.75                |   |

This list is not all-inclusive and each application should be checked to determine if any unusual operating conditions will be encountered.

## **Application Formulas**

| TO OBTAIN                                 | HAVING  | FORMULA                           |
|---|---|-----------------------------------|
| Velocity (V)<br>Feet Per Minute           | Pitch Diameter (D) of Gear or Sprocket - Inches and Revolutions Per Minute (RPM)    | V = .2618 x D x RPM               |
| Revolutions Per<br>Minute (RPM)           | Velocity (V) Feet Per Minute and<br>Pitch Diameter (D) of Gear or Sprocket - Inches | $RPM = \frac{V}{.2618 \times D}$  |
| Pitch Diameter (D) of<br>Gear or Sprocket | Velocity (V) Feet Per Minute and<br>Revolutions Per Minute (RPM)                    | $D = \frac{V}{.2618 \times RPM}$  |
| Torque (T) In. Lbs.                       | Force (W) Lbs. and Radius (R) Inches  | $T = W \times R$                  |
| Horsepower (HP)                           | Force (W) Lbs. and Velocity (V) Feet Per Minute                                     | $HP = \frac{W \times V}{33000}$   |
| Horsepower (HP)                           | Torque (T) In. Lbs. and Revolutions Per Minute (RPM)                                | $HP = \frac{T \times RPM}{63025}$ |
| Torque (T)                                | Horsepower (HP) and Revolutions Per Minute (RPM)                                    | $T = \frac{63025 \times HP}{RPM}$ |
| Force (W) Lbs.                            | Horsepower (HP) and Velocity (V) Feet Per Minute                                    | $W = \frac{33000 \times HP}{V}$   |
| Revolutions Per Minute<br>(RPM)           | Horsepower (HP) and Torque (T) In. Lbs.   | RPM = <u>63025 x HP</u><br>T      |

## **Horsepower and Torque**

**POWER** is the rate of doing work.

**WORK** is the exerting of a FORCE through a DISTANCE. ONE FOOT POUND is a unit of WORK. It is the WORK done in exerting a FORCE OF ONE POUND through a DISTANCE of ONE FOOT.

**THE AMOUNT OF WORK** done (Foot Pounds) is the FORCE (Pounds) exerted multiplied by the DISTANCE (Feet) through which the FORCE acts.

**THE AMOUNT OF POWER** used (Foot Pounds per Minute) is the WORK (Foot Pounds) done divided by the TIME (Minutes) required.

POWER (Foot Pounds per Minute) =  $\frac{\text{WORK (Ft. Lbs.)}}{\text{TIME (Minutes)}}$ 

**POWER** is usually expressed in terms of HORSEPOWER.

**HORSEPOWER** is POWER (Foot Pounds per Minute) divided by 33,000.

HORSEPOWER (HP)

- = <u>POWER (Ft. Lbs. per Minute)</u> 33,000
- = WORK (Ft. Pounds) 33,000 x TIME (Min.)
- = FORCE (Lbs.) x DISTANCE (Feet) 33,000 x TIME (Min.)

#### ILLUSTRATION OF HORSEPOWER



TORQUE (T) is the product of a FORCE (W) in pounds, times a RADIUS (R) in inches from the center of shaft (Lever Arm) and is expressed in Inch Pounds.



T = WR = 300 x 1 = 300 ln. Lbs.

T = WR = 150 x 2 = 300 ln. Lbs. If the shaft is revolved, the FORCE (W) is moved through a distance, and WORK is done.

WORK (Ft. Lbs.) = W x  $\frac{2\pi R}{12}$  x No. of Rev. of shaft

When WORK is done in a specified TIME, POWER is used.

POWER (Ft. Pounds per Minute) = W x  $\frac{2\pi R}{12}$  x RPM

Since (1) HORSEPOWER = 33,000 Ft. Pounds per Minute

Horsepower (HP) = W x  $\frac{2\pi R}{12}$  x  $\frac{RPM}{33,000}$  =  $\frac{W \times R \times RPM}{63,025}$ 

but TORQUE (Inch Pounds) = FORCE (W) x RADIUS (R)

Therefore HORSEPOWER (HP) =  $\frac{\text{TORQUE (T) x RPM}}{63,025}$ 

Where total reductions are small, 50 to 1 or less, HP figures are commonly used. Higher reductions require that TORQUE figures be used to select drive components, because with large reductions, a small motor can produce extremely high TORQUE at the final low speed. For example, 1/12 HP reduced to 1 RPM using the formula below and neglecting friction:

$$HP = \frac{\overline{\text{TORQUE x RPM}}}{63,025} \text{ or } \overline{\text{TORQUE}} = \frac{\overline{63,025 \times HP}}{RPM}$$

TORQUE = 
$$\frac{63,025 \times 1/12}{1}$$
 = 5,252 ln. Lbs.

Therefore, motors for use with large reductions should be carefully selected. Even a small motor, if stalled, can produce enough Torque to ruin the drive, unless it is protected by an overload clutch.

Neglecting frictional losses, this sketch illustrates the manner in which Torque increases as speed decreases.



## Horsepower and Torque (continued)

### **INERTIA (WK<sup>2</sup>)**

The factor  $WK^2$  is the weight (lbs) of an object multiplied by the square of the radius of gyration (K). The unit measurement of the radius of gyration is expressed in feet.

For solid or hollow cylinders, inertia may be calculated by the equations shown below.

The inertia of solid steel shafting per inch of shaft length is given in the table. To calculate for hollow shafts, take the difference between the inertia values for the O.D. and I.D. as the value per inch. For shafts of materials other than steel, multiply the value for steel by the appropriate material factor.



WK<sup>2</sup> of Rotating Elements – In practical mechanical systems, all the rotating parts do not operate at the same speed. The WK<sup>2</sup> of all moving parts operating at each speed must be reduced to an equivalent WK<sup>2</sup> at the motor shaft, so that they can all be added together and treated as a unit, as follows:

Equivalent WK<sup>2</sup> = WK<sup>2</sup>  $\left[\frac{N}{N_{M}}\right]^{2}$ 

 $\begin{array}{ll} \mbox{Where,} & \mbox{WK}^2 = \mbox{Inertia of the moving part} \\ \mbox{N} = \mbox{Speed of the moving part (RPM)} \\ \mbox{N}_{\rm M} = \mbox{Speed of the driving motor (RPM)} \end{array}$ 

When using speed reducers, and the machine inertia is reflected back to the motor shaft, the equivalent inertia is equal to the machine inertia divided by the square of the drive reduction ratio.

Equivalent  $WK^2 = \frac{WK^2}{(DR)^2}$ 

Where, DR = drive reduction ratio =  $\frac{N_{M}}{N}$ 

| (i ci mon oi congui) |   |                |   |  |
|----------------------|---|----------------|---|--|
| Diam. (In.)          | WK <sup>2</sup> (Lb. Ft. <sup>2</sup> ) | Diam. (In.)    | WK <sup>2</sup> (Lb. Ft. <sup>2</sup> ) |  |
| 3/4<br>10.0002       | 0.00006<br>10-3/4                       | 10-1/2<br>2.58 | 2.35                                    |  |
| 1-1/4                | 0.0005                                  | 11             | 2.83                                    |  |
| 1-1/2                | 0.001                                   | 11-1/4         | 3.09                                    |  |
| 1-3/4                | 0.002                                   | 11-1/2         | 3.38                                    |  |
| 20.003               | 11-3/4                                  | 3.68           |   |  |
| 2-1/4                | 0.005                                   | 12             | 4.00                                    |  |
| 2-1/2                | 0.008                                   | 12-1/4         | 4.35                                    |  |
| 2-3/4                | 0.011                                   | 12-1/2         | 4.72                                    |  |
| 30.016               | 12-3/4                                  | 5.11           |   |  |
| 3-1/2                | 0.029                                   | 13             | 5.58                                    |  |
| 3-3/4                | 0.038                                   | 13-1/4         | 5.96                                    |  |
| 40.049               | 13-1/2                                  | 6.42           |   |  |
| 4-1/4                | 0.063                                   | 13-3/4         | 6.91                                    |  |
| 4-1/2                | 0.079                                   | 14             | 7.42                                    |  |
| 50.120               | 14-1/4                                  | 7.97           |   |  |
| 5-1/2                | 0.177                                   | 14-1/2         | 8.54                                    |  |
| 60.250               | 14-3/4                                  | 9.15           |   |  |
| 6-1/4                | 0.296                                   | 15             | 9.75                                    |  |
| 6-1/2                | 0.345                                   | 16             | 12.59                                   |  |
| 6-3/4                | 0.402                                   | 17             | 16.04                                   |  |
| 70.464               | 18                                      | 20.16          |   |  |
| 7-1/4                | 0.535                                   | 19             | 25.03                                   |  |
| 7-1/2                | 0.611                                   | 20             | 30.72                                   |  |
| 7-3/4                | 0.699                                   | 21             | 37.35                                   |  |
| 80.791               | 22                                      | 44.99          |   |  |
| 8-1/4                | 0.895                                   | 23             | 53.74                                   |  |
| 8-1/2                | 1.000                                   | 24             | 63.71                                   |  |
| 8-3/4                | 1.130                                   | 25             | 75.02                                   |  |
| 91.270               | 26                                      | 87.76          |   |  |
| 9-1/4                | 1.410                                   | 27             | 102.06                                  |  |
| 9-1/2                | 1.550                                   | 28             | 118.04                                  |  |
| 9-3/4                | 1.750                                   | 29             | 135.83                                  |  |
| 10                   | 1 020                                   | 20             | 155 55                                  |  |

#### Inertia of Steel Shafting (Per Inch of Length)

#### **Material Factors**

2.130

10-1/4

| Shaft Material | Factor |
|----------------|--------|
| Rubber         | .121   |
| Nylon          | .181   |
| Aluminum       | .348   |
| Bronze         | 1.135  |
| Cast Iron      | .922   |

| Formulas to Approximate WK <sup>2</sup> |  |  |
|---|--|--|
|   | For a solid cylinder or disc = W x $\frac{r^2}{2}$                     |  |
|   | where r = radius in feet and W is weight in pounds.                    |  |
|   | For a hollow cylinder: WK <sup>2</sup> x $\frac{W^{r}}{2} + r^{2}_{2}$ |  |
|   | where $r_1$ , is $\frac{ID}{2}$ and $r_2$ is $\frac{OD}{2}$ .          |  |
|   |  |  |

## **Metric Conversion Chart**

| MULTIPLY                | BY      | TO OBTAIN               | MULTIPLY                   | BY                       | TO OBTAIN                |
|-------------------------|---------|-------------------------|----------------------------|--------------------------|--------------------------|
| LENGTH                  |         |                         | TORQUE                     |                          |                          |
| Millimeter              | .03937  | Inch                    | Newton-meter               | 8.84                     | Lb. In.                  |
| Centimeter              | .3937   | Inch                    | Lb. In.                    | .113                     | Newton-Meter             |
| Meter                   | 39.37   | Inch                    | Lb. Ft.                    | 1.3558                   | Newton-Meter             |
| Inch                    | 2.54    | Centimeter              | Lb Ft                      | 12                       | l b ln                   |
| Feet                    | 30.48   | Centimeter              |                            | 12                       | LD. III.                 |
| Feet                    | .3048   | Meter                   |                            | MOMENT OF I              | NERTIA                   |
| WEIGHT                  |         |                         | Newton-Meters <sup>2</sup> | 2.42                     | Lb. Ft. <sup>2</sup>     |
| Gram                    | .03527  | Ounce                   | OzIn. <sup>2</sup>         | .000434                  | Lb. Ft. <sup>2</sup>     |
| Kilogram                | 35.27   | Ounce                   | LbIn. <sup>2</sup>         | .00694                   | Lb. Ft. <sup>2</sup>     |
| Kilogram                | 2.205   | Pounds                  | Slug-Ft. <sup>2</sup>      | 32.17                    | Lb. Ft. <sup>2</sup>     |
| Ounce                   | 28.35   | Grams                   | OzInSec. <sup>2</sup>      | .1675                    | Lb. Ft. <sup>2</sup>     |
| Pound                   | 453.6   | Grams                   | LbInSec. <sup>2</sup>      | 2.68                     | Lb. Ft. <sup>2</sup>     |
| ROTATION                |         | POWFR                   |                            |                          |                          |
| RPM                     | .1047   | Rad./Sec.               | /                          |                          |                          |
| RPM                     | 6.00    | Degrees/Sec.            | Joule/sec                  | .001341                  | Horsepower               |
| Degrees/Sec.            | .1667   | RPM                     | Kilocalorie/hour           | 3.967                    | BTW/Hour                 |
| Rad./Sec                | 9.549   | RPM                     | Horsepower                 | .33000                   | Lb. Ft./Min.             |
|                         | VELOCIT | Y                       | Horsepower                 | 746                      | Watts                    |
| Centimeter/second       | .3937   | Inches/Second           | BTU/hour                   | .2521                    | Kilocalorie/Hour         |
| Centimeter/second       | 1.969   | Feet/Minute             | Watts                      | .00134                   | Horsepower               |
| Meter/second            | 3.281   | Feet/Second             | AREA                       |                          |                          |
| Meter/second            | 196.9   | Feet/Minute             | Millimeters <sup>2</sup>   | .00155                   | Inches <sup>2</sup>      |
| Meter/second            | 2.237   | Miles per hour          | Centimeters <sup>2</sup>   | 155                      | Inches <sup>2</sup>      |
| Inch/second             | 25.4    | Millimeters/Second      | Meters <sup>2</sup>        | 10.76                    | Feet <sup>2</sup>        |
| Inch/second             | 2.54    | Centimeters/Second      |                            | 645 1G                   | Millimatora <sup>2</sup> |
| Foot/second             | .3048   | Meters/Second           |                            | 045.10                   |                          |
| Foot/minute             | .00508  | Meters/Second           |                            | 6.452                    | Centimeters <sup>2</sup> |
| VOLUME                  |         | Feet <sup>2</sup>       | 929.03                     | Centimeters <sup>2</sup> |                          |
| Centimeter <sup>3</sup> | .0610   | Inches <sup>3</sup>     | Feet <sup>2</sup>          | .0929                    | Meters <sup>2</sup>      |
| Centimeter <sup>3</sup> | .034    | Fluid Ounce             | DENSITY                    |                          |                          |
| Liter                   | 61.02   | Inches <sup>3</sup>     | la/cm <sup>3</sup>         | .03613                   | Lb/In <sup>3</sup>       |
| Liter                   | .0353   | Feet <sup>3</sup>       |                            | 62.43                    | Lb/Ft <sup>3</sup>       |
| Liter                   | .264    | U.S. Gallon             | lh/in <sup>3</sup>         | 07 69                    | Gr/Cm <sup>3</sup>       |
| Inch <sup>3</sup>       | 16.39   | Centimeter <sup>3</sup> |                            | 21.00                    |                          |
| Feet <sup>3</sup>       | 28.32   | Liter                   |                            | .016                     | G/UM <sup>3</sup>        |
| Gallon                  | 3.785   | Liter                   | lb/ft <sup>3</sup>         | 16.02                    | Kg/M <sup>3</sup>        |

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