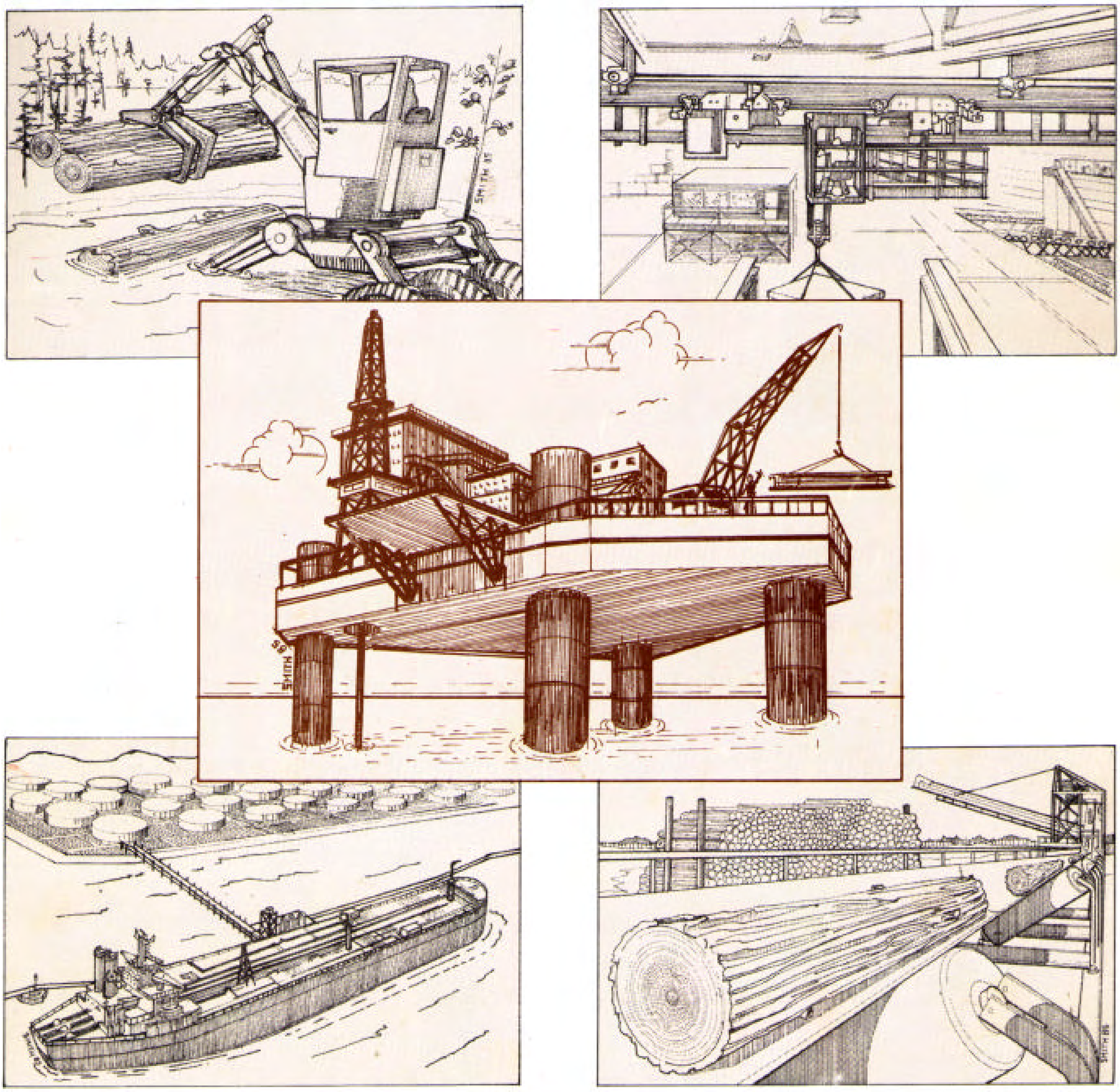
Stearns® *Industrial Clutches and Brakes*

Brake Training Program

- **Solenoid Actuated Brakes**
- **Armature Actuated Brakes**



Stearns® *Brakes*

Training Program

I. Introduction to Braking Systems

The basic function of a brake in a power transmission system is to stop and/or hold the load. There are many reasons to use brakes; most reasons are related to improved productivity or safety.

Brakes are frequently used to control deceleration, provide accurate positioning, or increase cycle rates, thereby improving productivity. Brakes can also be used for tensioning. The so called "fail-safe" type brake* like the cost-effective Stearns spring-set electrically released disc brake has an added feature. Because the brake is set by shutting off electric power, it will automatically set when there is a power failure.

There are many types of braking systems that can be used with a power transmission system. Each of these types can be placed into one of the following categories:

- Internal braking
- External braking

Internal braking systems generate torque by converting the electric motor into a braking device. Internal brakes use electrical switch gear and electronic circuitry to perform the braking.

Obviously, internal braking can be used only where the prime mover is an electric motor. Internal brakes can only be used for stopping, they are incapable of providing a holding function. The three methods of internal braking are:

- Plugging - electrically reversing the motor
- Regenerative braking - using an inverter to convert kinetic energy of the load into electrical energy
- Dynamic braking - injecting direct current into the motor stator after disconnecting it from the AC line

External braking requires the addition of an electrical, mechanical, hydraulic, or pneumatic device to the power transmission system. External braking devices generate a braking and/or holding torque outside of (external to) the motor. External braking devices include:

- Friction brakes
- Eddy current brakes
- Hysteresis brakes
- Magnetic particle brakes
- Sprag or cam brakes (backstop brakes)

* Fail safe means that if *electrical power* fails, the brake will set, provided that the brake is functioning properly.

II. External Braking Systems

External braking offers a number of advantages over internal braking. One of the most significant is that external braking can be used with any type of prime mover–electric motor, internal combustion engine, hydraulic motor, etc. Another advantage of external braking is mounting flexibility. An external brake can be attached directly to the prime mover, or it can be installed at some other location in the power transmission system.

Electric motors are the most common type of prime mover found in today's power transmission systems. Because of this popularity, a special type of external brake...called motor mounted...has been developed for use with electric motors. These brakes mount directly to the C-face of a NEMA type motor. When mounted in this fashion, the brake is located on the auxiliary side of dual-shaft motor.

When using external brakes, the heat generated in the braking process is absorbed by the brake, not the motor. This can be an advantage in some high cycle applications, because the brake can be designed to dissipate heat rapidly. In addition, some external brakes are capable of providing a holding torque (not available with internal brakes).

Friction and backstop brakes use mechanical principles to accomplish the actual braking. Friction brakes can, however, be actuated electrically, mechanically, pneumatically, or hydraulically. Backstop brakes usually actuate automatically.

The other brakes...eddy current, hysteresis, and magnetic particle...accomplish braking through electromagnetic phenomena. They are also actuated electrically; but are not "fail safe."

Following is a brief description of each of these external braking systems.

Eddy current

A typical eddy current brake (Figure 2-1) consists of a segmented stationary field assembly, a field coil, and a smooth-surface brake rotor that surrounds the field assembly. A small air gap exists between the smooth-surface rotor and the stationary field assembly.

In operation, direct current is applied to the field coil and an electromagnetic field is established in the stationary field assembly. If the brake rotor is turning, eddy currents are induced in it. These eddy currents react with the magnetic field in the field assembly and produce a torque that opposes motion of the drum. This torque is proportional to the square of the direct current applied to the field. Figure 2-2 illustrates how torque varies with speed on several different types of eddy current brakes. The different characteristics are attributable to different designs for the stationary field assembly.

Note that at zero slip, the eddy current brake has no torque, and, therefore, cannot be used where holding is require. Eddy current brakes have good torque control and long life. They are useful for providing drag loads. The most common application is tensioning. Eddy current brakes are expensive, and frequently require special cooling provisions.

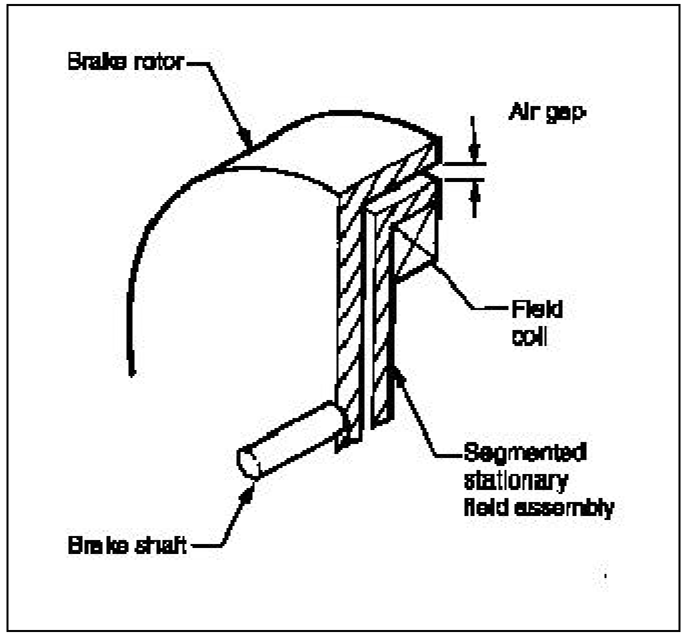


Figure 2-1. Typical eddy current brake

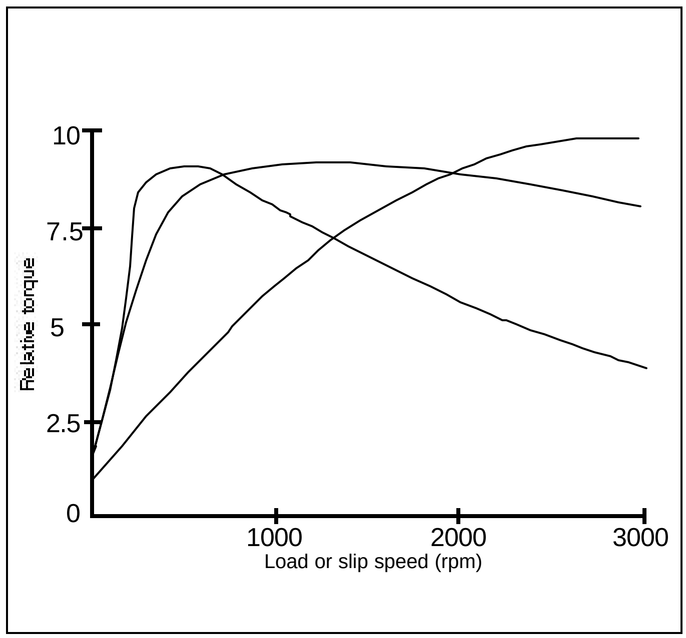


Figure 2-2. Torque characteristics for eddy current brakes

Hysteresis brake

Hysteresis braking is accomplished with two basic components.

- A reticulated pole structure including a coil to energize it
- A permanent magnet rotor

The two components are fitted together, but are not in physical contact (Figure 2-3).

When DC power is applied to the coil, an electromagnetic field develops in the air gap of the pole structure. This field is directed through the concentrically mounted permanent magnet rotor.

The rotor resists motion through the magnetic field. This resistance, or *braking torque* is directly proportional to the coil current, and it is essentially independent of rotor speed throughout the range of the brake (Figure 2-4).

Hysteresis brakes provide smooth operation, long life, and excellent controlability. However, these brakes are very expensive and, for practical purposes, limited to small sizes. Typical applications for these brakes include tensioning, mechanical damping, positioning, and as a load simulator on test stands.

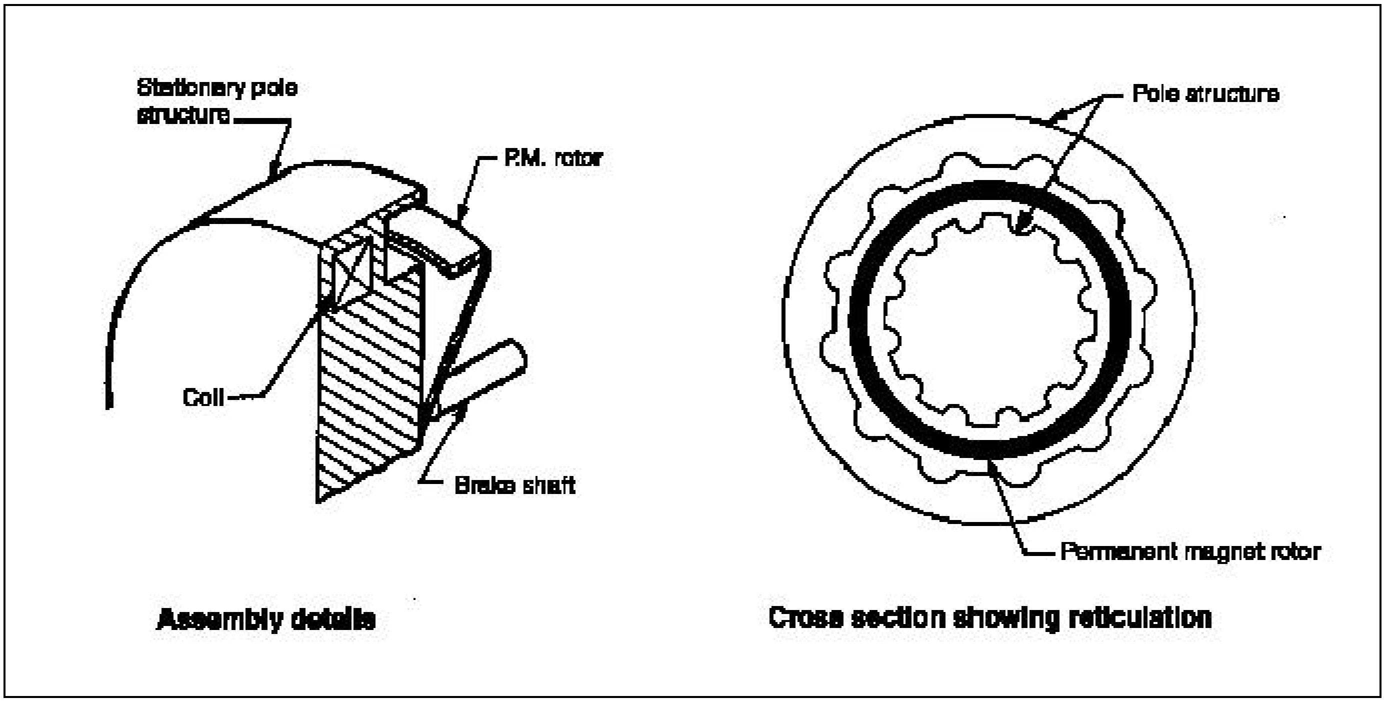


Figure 2-3. Typical hysteresis brake

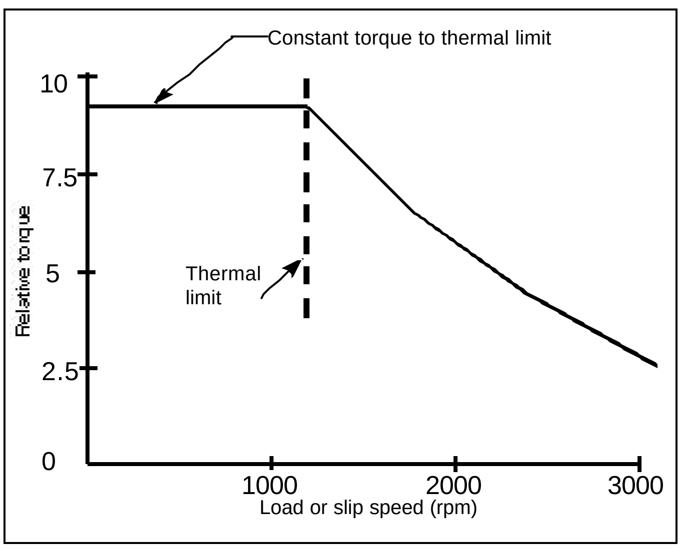


Figure 2-4. Typical torque characteristic for hysteresis brake

Magnetic particle brakes

The magnetic particle brake consists of a smooth rotor and brake shaft assembly that is contained within a stator. The stator also contains a dc coil (Figure 2-5). A magnetic powder composed of fine iron particles is located in the air gap between the stator and rotor.

When the coil is energized, an electromagnetic field is formed in the air gap. This field causes the iron particles to link up and bond the rotor to the stator. Since the stator is held stationary, the net effect is a braking torque on the rotor and brake shaft. The amount of magnetic particle bonding and hence the brake torque, is directly proportional to the current flowing in the stator coil.

The torque of a magnetic particle brake is independent of speed as shown in Figure 2-6. The torque can be easily adjusted by varying the current to the stator coil. Magnetic particle brakes are useful in tensioning and positioning applications, where continuous changes of speed are required.

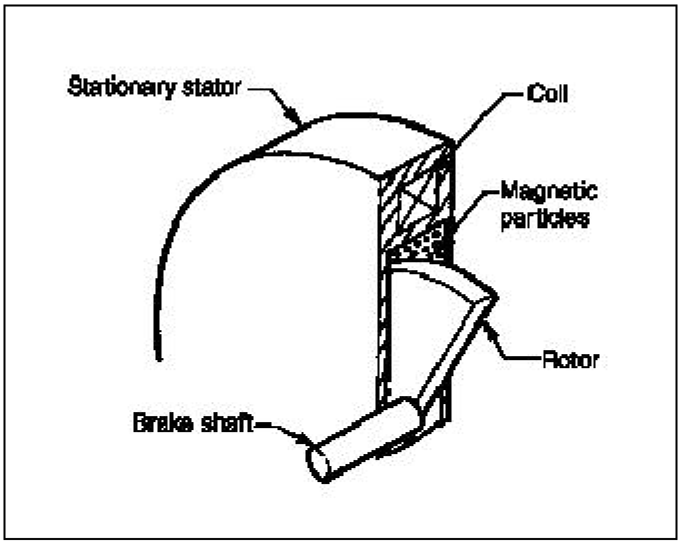


Figure 2-5. Typical magnetic particle brake

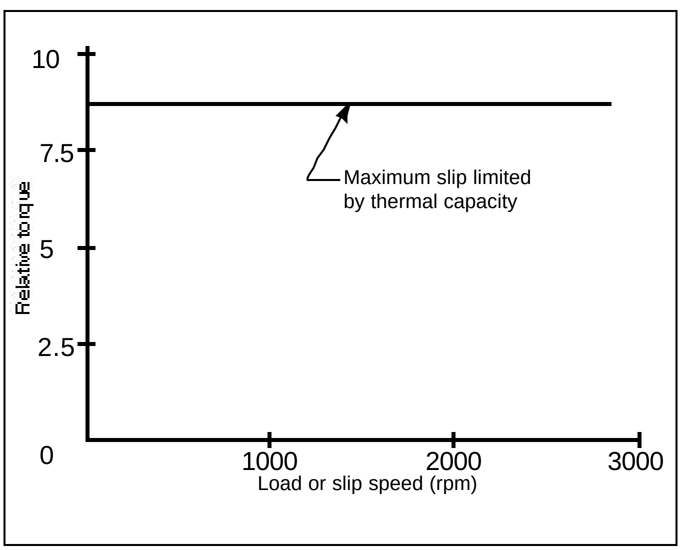


Figure 2-6. Typical magnetic particle brake torque characteristic

Mechanical backstop brakes

This category of brakes includes roller, ratchet, sprag, cam, and wrap spring devices. They all rely on some type of mechanical wedging action to accomplish braking. These devices are called backstop brakes or overrunning clutches, and allow rotation in one direction, while preventing rotation in the other direction.

Friction brakes

Friction brakes act by generating frictional forces as two or more surfaces rub against each other. The stopping power or capacity of a friction brake depends on the area in contact and coefficient of friction of the working surfaces as well as on the actuation pressure applied. Wear occurs on the working surfaces, and the durability of a given brake (or service life between maintenance) depends on the type of friction material used for the replaceable surfaces of the brake.

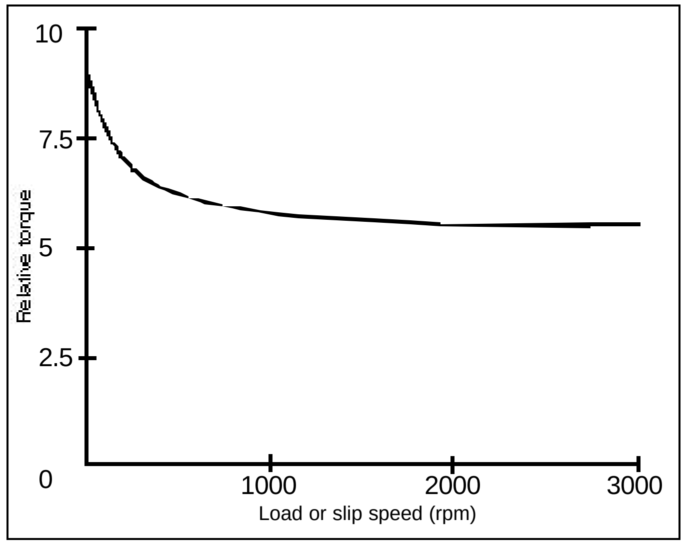


Figure 2-7. Typical torque characteristic for friction brake

Friction brakes are available in three forms - disc (caliper and plate), shoe, or band. They can be actuated electrically, mechanically, hydraulically, or pneumatically.

Friction brakes can be operated in either of two ways. In the first, the actuator is used to engage or set the brake; a spring disengages the brake when the actuation force is removed. In the second, the brake is engaged by spring pressure or a permanent magnet, and the actuator is used to release the brake by overcoming the actuating force. This second type is frequently referred to as “fail safe” because it automatically sets if the actuator power fails or is accidentally shut off.

The torque characteristic for a friction brake is shown in Figure 2-7. The maximum torque occurs at zero slip speed and decreases as slip speed increases; however, the torque then stabilizes at approximately 60-80% of the static torque value.

The major characteristics of external brakes are summarized in Table 2-1.

Figure 2-1. Summary of external brake characteristics

	First Cost	Available with Fail Safe Capability	Torque Adjustability	Holding Torque	Life	Actuation
Friction	Low	Yes	Limited	Yes	Moderate	Electrical Mechanical Fluidic
Eddy current	High	No	Easy	No	Long	Electrical (DC)
Hysteresis	High	No	Easy	Yes	Long	Electrical (DC)
Magnetic particle	Moderate	No	Easy	Yes	Long	Electrical (DC)
Backstop	Low	No	None	Yes	Moderate	Automatic

III. Principles of Friction Braking

Friction brakes are simple, low cost, flexible, and reliable. They are the only type suitable when a load must be brought to a full, rapid stop. They are also the most practical brakes for use in cycling applications. When released, friction brakes offer minimal residual drag.

Friction brakes are available in a variety of styles, and can be operated with several different types of actuators. All styles, however, have two common characteristics:

- Braking torque
- Heat dissipation

The torque or stopping force of a friction brake is created by two working surfaces rubbing against one another. For any given type of working surface material, the braking torque is dependent upon the total area of surface in contact and the pressure compressing the surfaces. This torque is also dependent upon the coefficient of friction (a measure of stickiness) of the brake's working surfaces.

The coefficient of friction takes two forms – static and dynamic. The *static* coefficient of friction is usually higher than dynamic, and exists only when there is *no relative motion* between the brakes working surfaces. The *dynamic* coefficient of friction exists when there is *motion.* Hence the torque of a friction brake is usually highest when there is no relative motion of the friction surfaces. This torque is called the static torque. As relative motion (slip) between the friction surfaces increases from the zero value, brake torque decreases. Normally the torque stabilizes and remains constant at some value of slip. A typical curve showing brake torque versus slip speed is shown in Figure 3-1. Note that when slip is greater than zero, torque varies with the slip speed. This torque (when slip exists) is called dynamic torque.

Most published brake torques are static torques. It is important to recognize and take into account the difference between static torque and dynamic torque when selecting and applying a friction brake.

The other important characteristic of a friction brake is its thermal capacity. Every time a friction brake stops a load, it converts the mechanical energy of the load into heat energy. The brake must be able to throw off or dissipate this heat energy to its surroundings. The measure of a brake's ability to dissipate heat to its surrounding is called thermal capacity. If the thermal capacity of a brake is exceeded during a stop (heat energy input exceeds heat energy dissipated) the brake temperature increases, and could eventually cause the brake to fail. Obviously, thermal capacity is another important consideration in friction brake selection.

Friction brakes are available in three basic forms – band, shoe, or disc. The band brake, shown in Figure 3-2, is the simplest type of friction brake. A flexible steel band usually lined with friction material, is tightened around a rotating drum. The band is normally tightened by a mechanical linkage; however, it can be actuated electrically, pneumatically, hydraulically, or mechanically. The stopping power of a band type friction brake is not great. They are usually used as parking brakes to lock shafts that are already stationary.

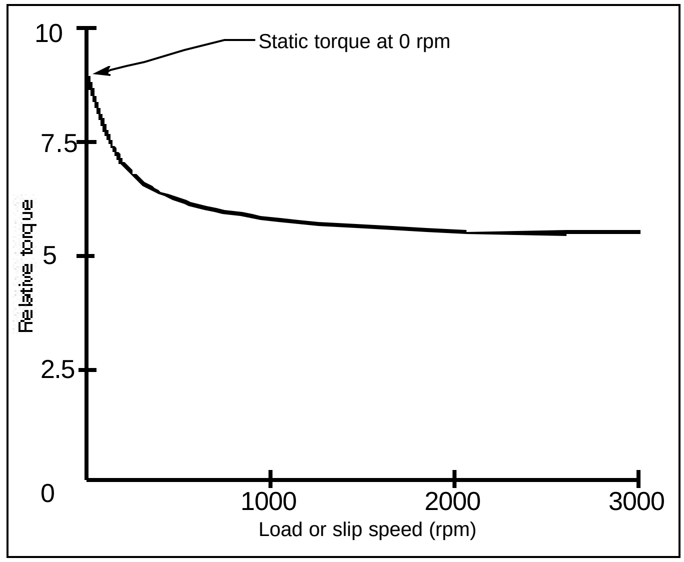


Figure 3-1. Friction brake torque characteristic showing static torque

Until recently the most common type of friction brake was the shoe or drum brake. It owed its popularity to the fact that it was the predominant brake used on automobiles. In recent years, however, disc brakes have become more popular with the auto industry. The shoe brake consists of a rotating drum connected to the load. Shoes that conform to the circumference of the drum, and that are lined with friction material, are forced into contact with the drum to provide a stopping torque. The shoes can be internal and expand outward to contact the inner circumference of the drum; or they can be external and contract to contact the outer circumference (Figure 3-3). Shoe brakes are very rugged, but are not practical for high torques because of their size. Shoe brakes are normally foot-mounted.

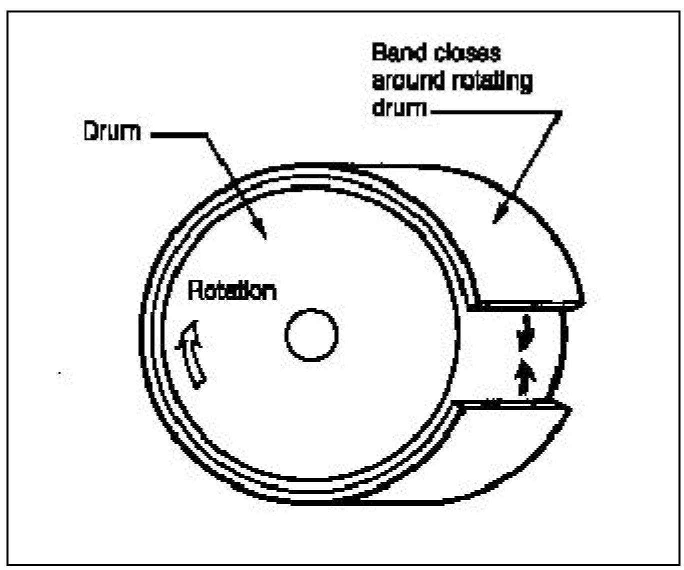


Figure 3-2. Typical band brake

The most popular friction brake, and generally considered the best performing brake is the disc brake. Disc brakes are available in two forms; caliper and plate type (Figure 3-4). The caliper type is widely used on automobiles and aircraft.

The caliper disc brake consists of a disc frequently called the rotor which is connected to the load. A caliper, with friction pads on each side of the rotor, stop the rotor by gripping it with a pinching action. Caliper disc brakes are less susceptible to fade because heat can be dissipated easily from the disc. Caliper disc brakes have a high thermal capacity per unit of torque, and are, therefore, frequently used in tensioning applications. Plate-type disc brakes consist of a stationary disc sometimes called a pressure plate and a rotating disc that is connected to the load. To effect a stop, the face of the pressure plate is pressed against the face of the rotating disc. Plate-type disc brakes have a lower thermal capacity per unit of torque than caliper disc brakes. However, plate type brakes are suitable for multiple disc operation. This provides a high braking torque in a small, convenient, and rugged package. The plate-type disc brake is the most effective form of braking.

Each of the above types of friction brakes can be operated in one of two modes (Figure 3-5).

In the first mode, the actuator is used to apply the brake; a spring is frequently used to disengage the brake when the actuation force is removed.

In the second mode, the brake is engaged by a spring or permanent magnet, and the actuator is used to release the brake. A brake of this type is frequently referred to as a "fail-safe" brake because it automatically sets if the actuator fails.

Friction brakes can be actuated electrically, pneumatically, hydraulically, or mechanically. Mechanical actuation is usually accomplished with a lever or a gear arrangement. Mechanical actuation is not suited for automatic control systems.

Pneumatically and hydraulically actuated brakes are similar (both rely on the movement of a fluid). In fact, many brakes of the same design can be used with either hydraulic or pneumatic actuation. Actuation is usually accomplished via pistons (air or hydraulic) and pressure plates. Actuation can also be accomplished by an inflatable bladder that compresses the friction surfaces. The chief disadvantage of pneumatic or hydraulic actuation is the added cost for installation and maintenance of support equipment (compressor, pumps, valves, and piping).

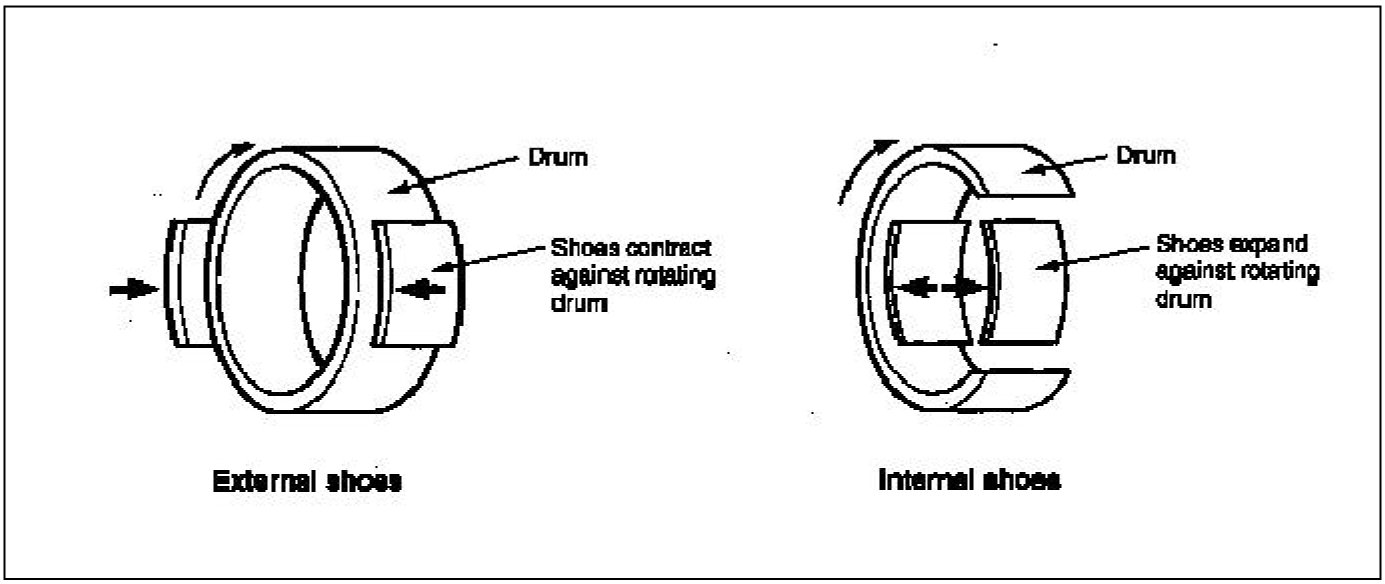


Figure 3-3. Typical shoe brakes

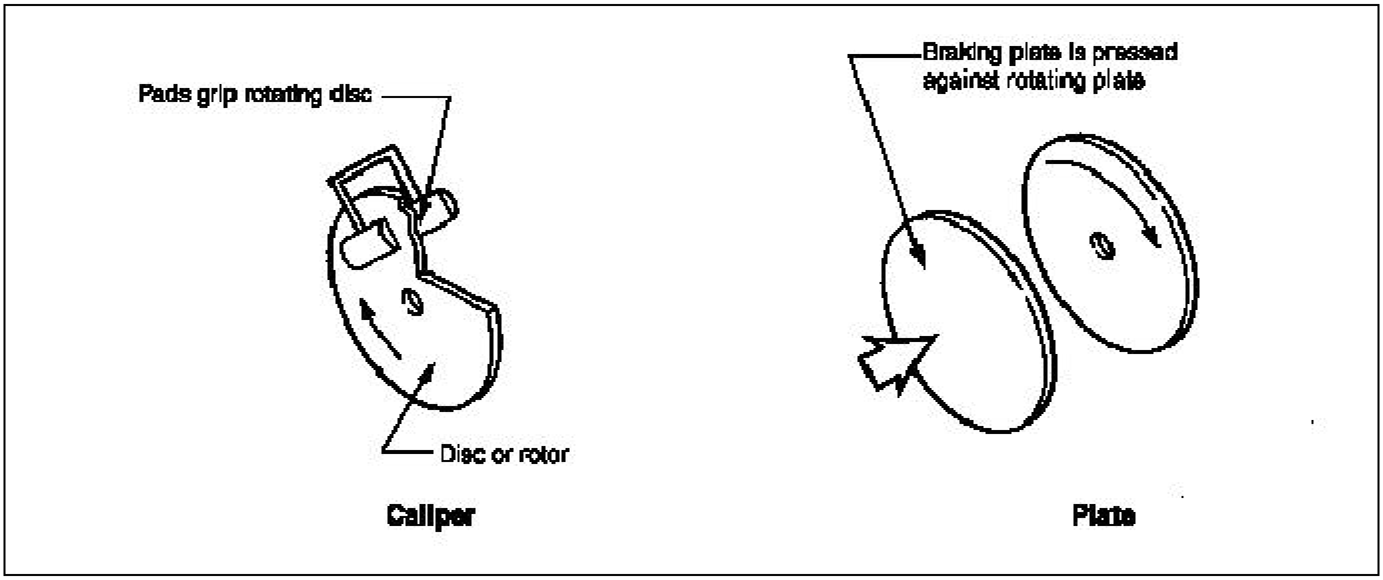


Figure 3-4. Typical disc brake types

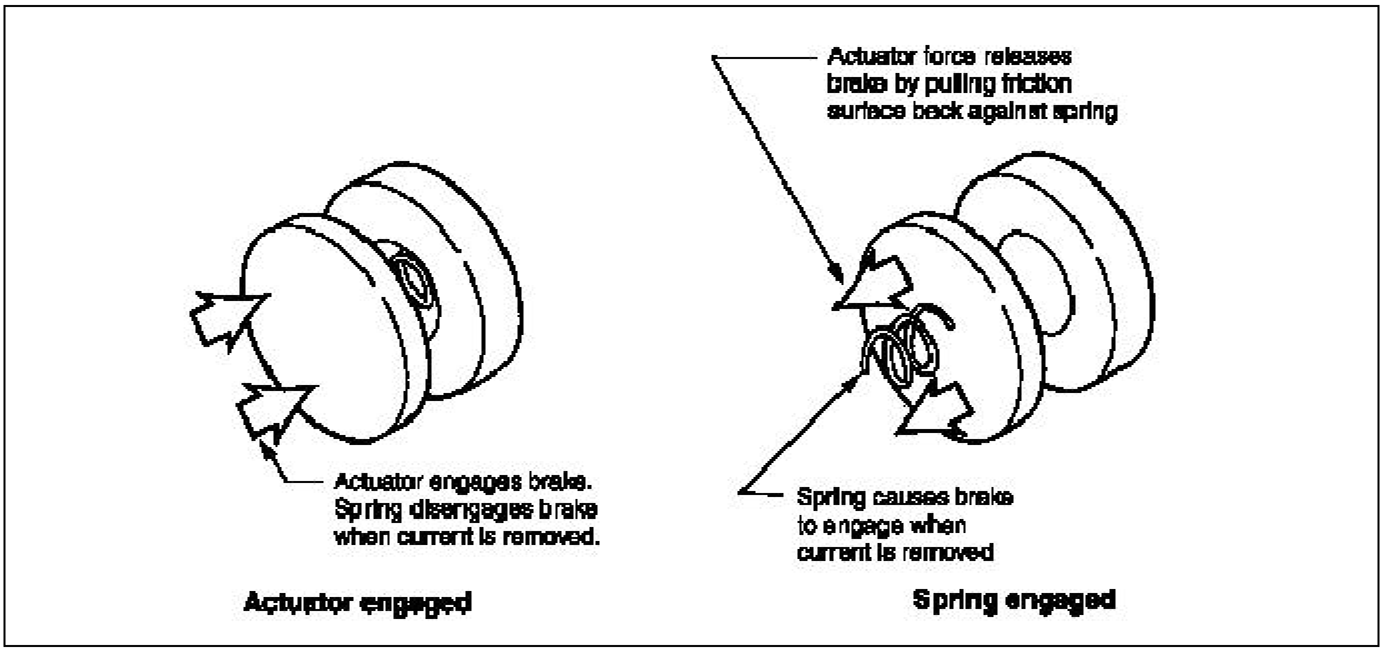


Figure 3-5. Two modes of friction brake operation

Electrical actuation allows extremely fast reaction and cycle rates. It is also well suited for remote and automatic control. Electric actuation allows a great deal of control flexibility, and permits direct interface with computerized controllers.

Electrically actuated brakes are available as either direct acting or solenoid actuated types. Direct acting brakes use a magnet that pulls directly on a pressure plate to activate the brake. The solenoid actuated type uses a small, efficient solenoid and a lever arrangement to actuate the brake.

Stearns Division manufactures three basic friction brake lines:

1. Solenoid-Actuated Brakes (SAB) – plate disc types that are spring set and electrically released.
2. Armature-actuated Brakes (AAB) – direct-acting brakes. Also spring-set and electrically released.
3. SCEB heavy duty brakes – plate disc type that are spring set and electrically released. These brakes are direct acting and dc actuated.

The remainder of this manual will be devoted to a discussion of Stearns spring-set disc brakes.

IV. Functional Description of Stearns Solenoid-Actuated Brakes

A Stearns disc brake is an electro-mechanical friction device that is spring engaged and electrically released. It's function is to stop and hold a rotating shaft. This simple device is easily controlled, and is a highly effective means of braking.

Basic components

Stearns disc brakes have a number of major subassemblies (Figure 4-1). These are the:

- Housing
- Support plate assembly
- Pressure plate
- Friction disc(s)
- Stationary disc(s)
- Hub
- Endplate

These components will be found in almost every Stearns disc brake. They vary in configuration from series to series, but they perform the same function in all models.

The housing and endplate form the brake enclosure. The endplate also provides the means for mounting the brake (usually to a NEMA C-face motor) and it serves as one of the working friction surfaces of the brake.

Stationary discs and friction discs, frequently called the disc pack, provide the majority of the working surfaces of the brake (the endplate and pressure plate provide the remainder).

The friction disc(s) and hub are the brake's rotating components. A friction disc, made of a blend of friction materials, is designed with a hole in its center that slips over the brake hub. The hub is attached to the motor shaft. When the shaft rotates, the brake hub and friction discs turn along with it.

Stationary discs, usually made of steel, cast iron, or bronze, are used in multiple disc brakes, those with 2 or more friction discs. As their name implies, they provide a stationary working surface against which the rotating surface of the friction discs can rub when the brake is set. Stationary discs are restrained from rotation by the endplate. Braking torque is generated by compressing the disc pack between the endplate and the pressure plate. The brake pressure spring, located on the support plate, provides the compressing force against one side of the pressure plate.

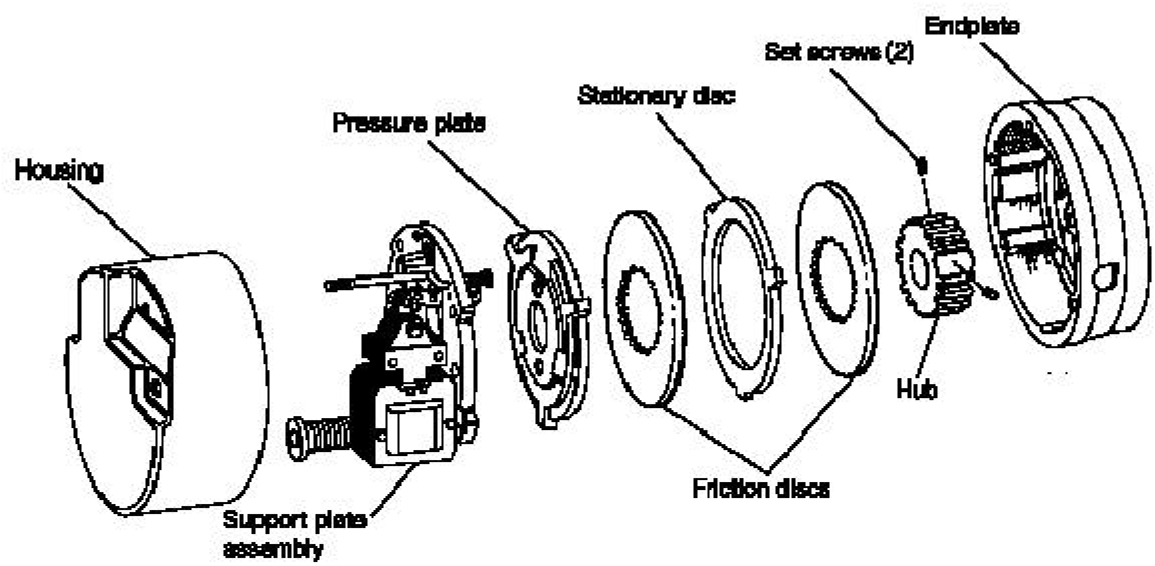


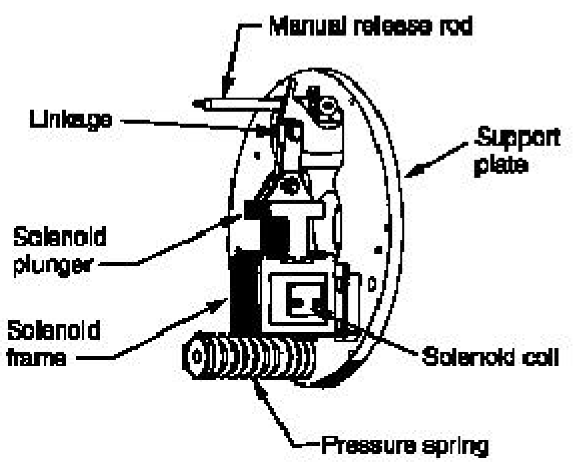
Figure 4-1. Exploded view of typical Stearns SAB brake showing basic operating components

Most Stearns brakes have unitized construction - the actuating mechanism, lever, and linkages - are all assembled on one unit called the support plate assembly. All the critical adjustments for torque and wear are made on this assembly. Unitized construction simplifies installation and servicing of a Stearns brake by saving time (the entire operating mechanism is removed in one piece) and by reducing the need for adjustments (critical adjustments are preserved on the unitized support plate even when it is removed and replaced during installation and servicing).

Every support plate assembly has a number of basic components (Figure 4-2). These are the:

- Support plate
- Solenoid assembly
- Solenoid linkage
- Lever
- Pressure spring

The support plate is the structure upon which all the other components are assembled. The solenoid assembly is the electromechanical device used to release the brake through a linkage and lever arrangement. The pressure spring provides the force necessary to produce braking.



Lever arm and auto adjust assembly located on back side

Figure 4-2. Support plate assembly

Operating principles

Figure 4-3 and 4-4 are cutaway illustrations of a typical Stearns motor-mounted brake in both the set and release conditions. The brake operates in the following manner.

The brake hub is attached to the motor shaft. The friction discs fit around the hub and are free to move axially along the hub. When the motor and the brake solenoid coil are de-energized, the brake is in a set condition, as shown in Figure 4-3. In this condition, the pressure spring pulls the lever arm in a counter-clockwise direction about the pivot point. This action applies force against the pressure plate at the contact points, causing the pressure plate to clamp the friction discs against the brake endplate to retard motion. The clamped friction discs prevent the hub and motor shaft from rotating.

The brake is released electrically when voltage is applied to the brake solenoid coil. This released condition is shown in Figure 4-4. Electric current flowing through the coil produces an electromagnetic force which pulls the solenoid plunger downward into the center of the coil. This action pulls the lever arm away from the pressure plate, releasing the clamping force on the friction discs. This allows the brake hub and motor shaft to turn freely.

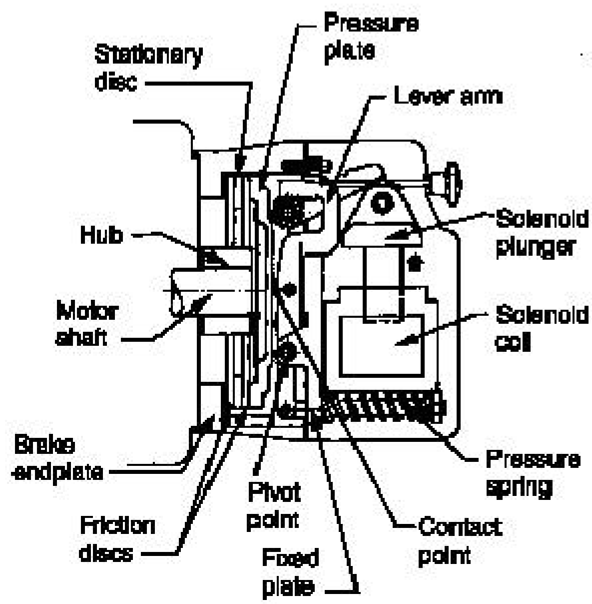


Figure 4-3. Brake in engaged mode

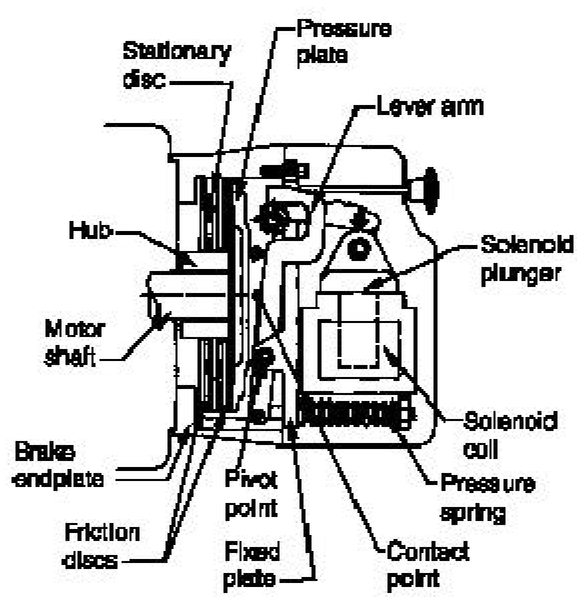


Figure 4-4. Brake in disengaged mode

To stop, electric current to the brake solenoid coil is interrupted, collapsing the electromagnetic field in the solenoid. The solenoid plunger returns to its original de-energized position, as shown in Figure 4-3. This allows the pressure spring to drive the lever arm forward, forcing the discs together and restoring the brake to a spring-set or holding condition.

An important feature of a Stearns spring-set brake is its power failure characteristic. If a loss of electric power to the brake occurs, the brake will automatically engage and hold the load.

Manual release mechanisms

In normal operation a Stearns motor-mounted brake is electrically released by its solenoid when the motor is energized. Most Stearns brakes can also be manually released for emergency, setup, or maintenance situations. Manual release is accomplished by pulling on an external rod on some brakes, or by turning an external lever or knob on others. The rod, lever, or knob then mechanically moves the solenoid plunger down into the solenoid frame, releasing the brake.

There are two types of manual release available on Stearns brakes:

- Automatic reset
- Non-locking (deadman)

Engaging an automatic reset manual release locks the brake in a release condition. However, the brake is automatically restored to normal operation when it is electrically actuated. If an automatic reset manual release is accidentally left on, normal actuation of the brake restores normal operation. This mechanism can also be manually reset by physically disengaging it.

A non-locking or deadman manual release is operative only while it is held manually in the release position.

A manual release warning indicator can be provided by using a limit switch that is actuated when the brake is released manually. The limit switch can be used to operate an indicator, a control circuit, or perform other safety functions.

Most Stearns disc brakes are equipped with an automatic-reset manual release. Non-locking (deadman) manual releases can be provided on many Stearns brakes as a special option.

Manual release results in only a partial release of the brake. Consequently, operation of equipment while the brake is in this manually release mode is not recommended. Excessive dragging of the friction discs could cause the brake to overheat.

Brake wear adjustment

All friction brakes require adjustment to compensate for friction disc wear. Some Stearns brakes feature automatic self-adjustment. The others have a simple, convenient manual adjustment.

Manually adjusted Stearns brakes have a convenient screwdriver adjustment. This adjustment changes the length of the linkage/lever arrangement and, in doing so, compensates for the thinner disc pack.

Brakes designed to automatically adjust for friction disc wear are called *self-adjusting* brakes. The self-adjust mechanism is a simple wrap-spring clutch that automatically adjusts the brake's solenoid air gap to compensate for wear of the friction discs. It also compensates for lining expansion due to heat generated by rapid start-stop applications. Automatic adjustment occurs every time the brake is operated.

A cutaway diagram of a typical self-adjusting brake is shown in Figure 4-5. The lever arm and self-adjust mechanism are also shown. Referring to Figure 4-6, the self-adjusting mechanism works in the following manner.

As the friction discs wear, the lever arm (8) moves forward under the influence of the pressure spring. The top of the lever arm has a set of teeth referred to as the rack (8A). This rack is designed to engage with a part of the self-adjust mechanism called the pinion. The pinion (4) is a small gear that engages with the teeth of the rack. As spring pressure moves the lever arm forward, the rack forces the pinion to rotate in a counterclockwise direction.

In addition to its gear, the pinion has a shaft extension (4A) and hub (4B). The pinion shaft fits inside the solenoid lever hub (2A). The pinion hub and solenoid lever hub are coupled by a coiled wrap spring (3) whose inside diameter is smaller than the outside diameter of the hubs. With the wrap spring forced over the two hubs, counterclockwise rotation of the pinion wraps it down tightly on the hubs connecting them in a positive engagement.

As the lever arm (8) gradually moves forward, due to friction disc wear, the pinion is forced to rotate counterclockwise. Since the pinion is connected to the solenoid lever (by means of the wrap spring) rotation of the pinion forces the solenoid lever to move into a higher position.

As the solenoid lever gradually moves higher, the solenoid air gap increases. This increase must be controlled, since too great an air gap can cause a reduction in brake torque. Control is provided by a fixed tab called a wrap spring stop (6), which is located on the brake's support plate.

As the pinion (4), the solenoid lever (2), and the wrap spring (3) are turned counterclockwise, a small projection tang (3A) at the end of the wrap spring gradually moves up until it is stopped by the wrap spring stop (6).

As further counterclockwise rotation occurs, the pressure of the fixed stop (6) against the wrap spring tang (3A) will cause the wrap spring to unwind and release the bond between the pinion hub (4B) and the solenoid lever hub (2A). This action allows the solenoid lever (2) to operate independently from the lever arm (8). Consequently, the lever arm (8) continues to move forward, adjusting for friction disc wear. Correct air gap is maintained because the solenoid lever is no longer forced into a higher position.

The self-adjusting mechanism also compensates for friction disc expansion.

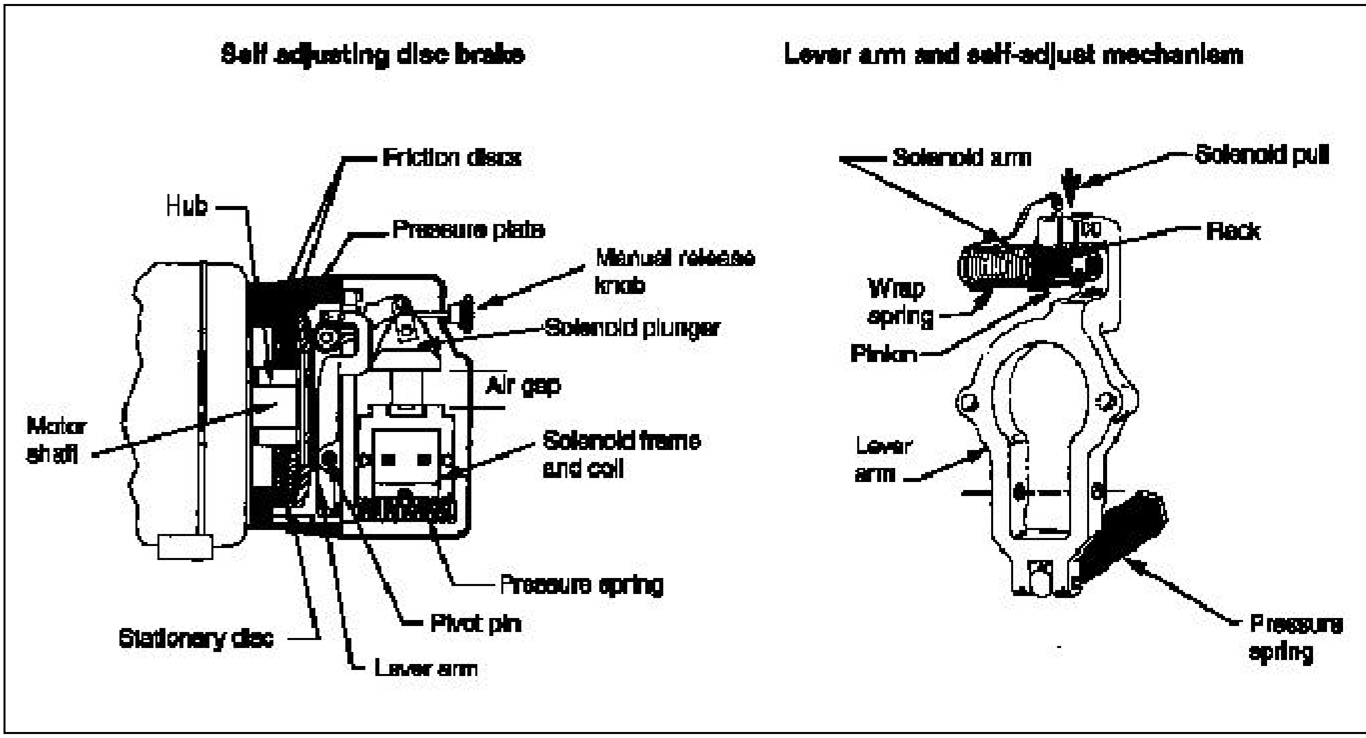


Figure 4-5. Typical Stearns self-adjusting disc brake mechanism

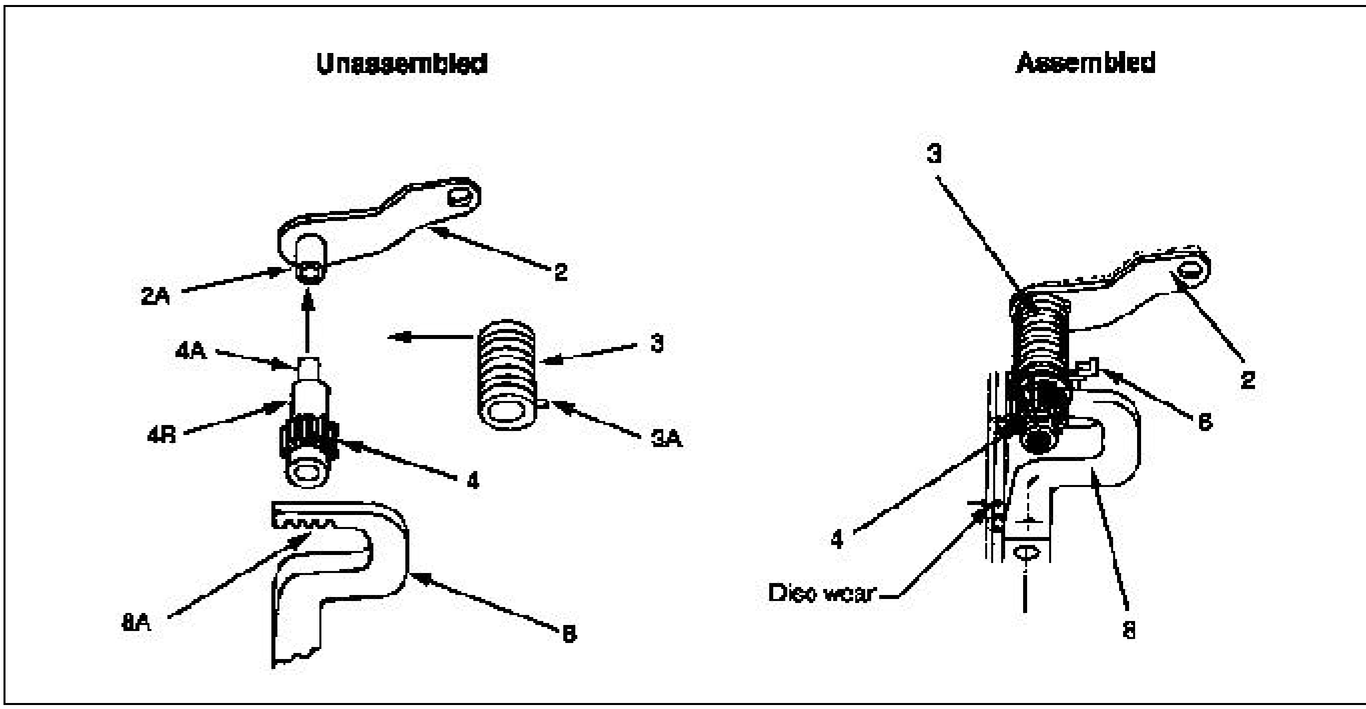


Figure 4-6. Operation of the self-adjusting mechanism

Modification for vertical installations

Disc brakes are normally installed and operated in a horizontal orientation (motor or load shaft in a horizontal plane). Some applications, however, require that the brake be installed in a vertical orientation. Most Stearns brakes must undergo a minor modification before being operated in a vertical orientation.

When the brake is disengaged or released in a vertical orientation, the weight of the disc pack elements (stationary disc, friction discs and pressure plate) causes the disc pack to compress and produces drag. This drag, in addition to being inefficient, could cause damage to the brake.

The vertical modification for Stearns brakes consists of springs, or a combination of guide pins and springs. It maintains the separation between stationary members of the disc pack (pressure plate, stationary discs, and endplate) while the brake is disengaged.

There are two somewhat different Stearns brake vertical modifications, depending upon whether the brake is above or below the motor. They are called: vertical above modification (when the brake is located above the motor) and vertical below modification (when the brake is below the motor).

A typical vertical above modification is shown in Figure 4-7. The cutaway shows the pin and spring arrangement. (Three of these pin and spring arrangements are located at 120° intervals around the periphery of the brake's disc pack.) The pin is pressed into the brake endplate. The stationary disc and pressure plate have clearance holes drilled into them. The holes are large enough to allow the discs to slide freely up and down on the pin. Springs are located on the pins between each of the stationary members (between endplate and stationary disc and between stationary disc and pressure plate.) When the brake is released, the small springs maintain a separation between the stationary elements, reducing drag to an acceptable level. When the brake is set by the pressure spring and lever mechanism (acting on the pressure plate) the small vertical springs are overcome and the disc pack is compressed. Figure 4-8 illustrates vertical above mod for those brakes that require only springs. These brakes utilize "push-in" springs that are turned or screwed directly into the stationary disc/pressure plate.

The vertical below modification is shown in Figure 4-9. The pin is pressed into the pressure plate. Also, no springs are needed between the last stationary disc and the endplate. Figure 4-10 illustrates vertical below mod, springs only.

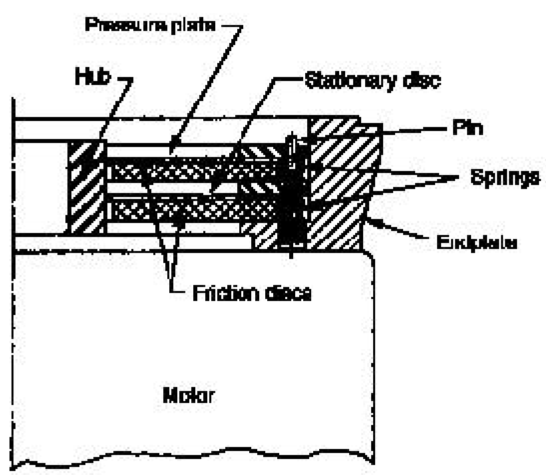


Figure 4-7. Vertical above modification, pins & springs

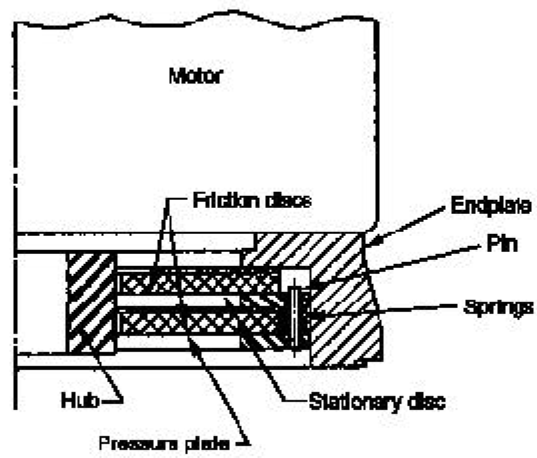


Figure 4-9. Vertical below modification, pins & springs

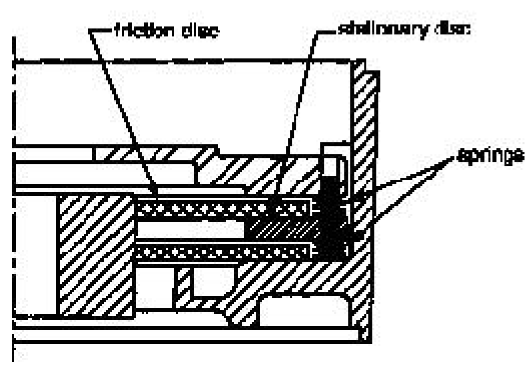


Figure 4-8. Vertical above, springs only

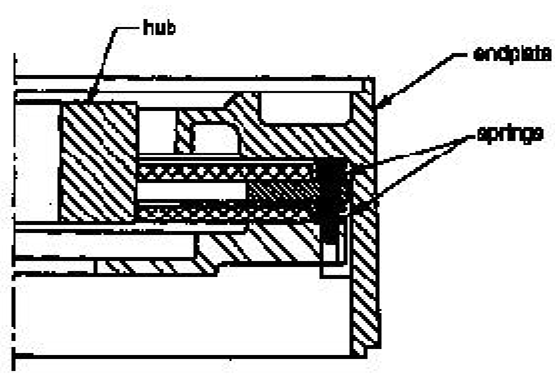


Figure 4-10. Vertical below, springs only

Stearns disc brake types

Stearns offers several types of disc brakes. They all function in the same manner, but differ in enclosure design and materials used. Stearns brakes are available for:

- Industrial duty
- Hazardous location
- Marine duty
- Navy
- Maritime duty

Industrial duty brakes

Industrial brakes are primarily used in nonhazardous locations in factories and outdoors. The following enclosures are available for Stearns brakes:

- Standard enclosures = NEMA 1/IP21 and NEMA 2/IP23
- Dust-tight, waterproof (DTWP) enclosures = NEMA 4/IP54 and NEMA 4X/IP55

Enclosure types are defined by NEMA (National Electrical Manufacturers Association), and by IEC (International Electrotechnical Commission) who uses a two-digit Index of Protection (IP) designation. The first digit of the IP indicates how well the motor is protected against the entry of solid objects; the second digit refers to water entry.

Protection Against Solid Objects		**Protection Against Liquids**	
Number	*Definition*	*Number*	*Definition*
0	No protection	0	No protection
1	Protected against solid objects of over 50 mm (e.g. accidental hand contact)	1	Protected against water vertically dripping (condensation)
2	Protected against solid objects of over 12 mm (e.g. finger)	2	Protected against water dripping up to 15° from the vertical
3	Protected against solid objects of over 2.5 mm (e.g. tools, wire)	3	Protected against rain falling at up to 60° from the vertical
4	Protected against solid objects of over 1 mm (e.g. thin wire)	4	Protected against water splashes from all directions.
5	Protected against dust	5	Protected against jets of water from all directions
6	Totally protected against dust.	6	Protected against jets of water comparable to heavy seas.
		7	Protected against the effects of immersion to depths of between 0.15 and 1m
		8	Protected against the effects of prolonged immersion at depth

Brakes with *standard* enclosures are used in locations where NEMA Type 1 and 2 enclosures are required. When mounted on a NEMA C-face motor, a brake with a standard enclosure is drip-proof. They are commonly used on open, drip-proof or enclosed motors operating indoors or in protected outdoor environments.

Brakes with NEMA 1 (IP21) or NEMA 2 (IP23) enclosures provide protection against:

- Accidental contact with the enclosed electrical connections and moving components of the brake
- Falling dirt
- Falling liquids and light splashing
- Dust, lint, fibers and flyings

Brakes with *dust-tight*, *waterproof* (DTWP) enclosures are used in locations where NEMA type 3 and 4 enclosures are required. When mounted on a NEMA C-face motor that is enclosed, such as totally enclosed, non-ventilated (TENV) motor, the brake is dust-tight, waterproof. NEMA 4 brakes are provided with an oil seal between the hub and endplate, with gaskets at necessary joints, and with a drain plug (Figure 4-11). They are selected for outdoor installations, or where there are moist, abrasive or dusty environments.

Brakes with NEMA 4 (IP54) enclosures provide protection against:

- Accidental contact with the enclosed electrical connections and moving components of the brake
- Falling dirt
- Falling liquids and light splashing
- Lint, fibers and flyings
- Windblown dust
- Rain, snow and sleet
- Low pressure hosedown and splashing water

Space heaters are frequently used on outdoor brake installations.

Brakes with NEMA 4X (IP55) enclosures provide the same protection as the NEMA 4 (IP54) brakes, but also include:

- Corrosion resistance
- BISSC (Baking Industry Sanitation Standards Committee) certification
- Meets National AAA Dairy Standards
- Compliance with Wisconsin Food and Dairy regulations

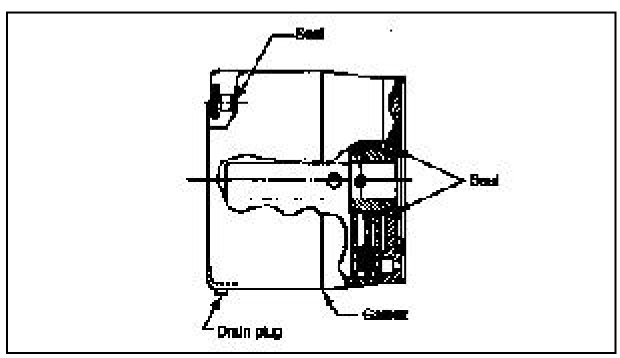


Figure 4-11. NEMA 4

Hazardous location brakes

Enclosures for standard Stearns disc brakes are designed to prevent accidental contact with the internal mechanism while keeping contaminants from the operating parts. Many installations, however, require additional protection due to the presence of explosive gases or ignitable dusts in the atmosphere. Hazardous locations are defined in the National Electrical Code (NEC) and designated by Class, Division and Group.

- *Class I* – Locations where the atmosphere may contain flammable gases or vapors in explosive or ignitable ratios.
- *Class II* – Locations with combustible dust in suspension in the atmosphere.
- *Divisions* – Each hazardous-location Class is also divided into two Divisions, 1 and 2. Division 1 is a *normally* hazardous location. Division 2 is normally *not* hazardous. Hazardous-location electric disc brakes are designed to meet Division 1 requirements and can therefore be used in both types of locations.

  Division 2 also available for Division 2 environments ONLY.
- *Groups* – Class I gases and vapors are listed in four Groups A, B, C and D, based on specific properties such as maximum explosion pressure and ignition temperature. Class II airborne dusts are listed in three Groups: E, F, and G. The dust properties considered include thermal and electrical conductivity and ignition temperature.

The enclosure of a hazardous location brake is designed to prevent flame propagation from inside the brake to the outside atmosphere. This is accomplished through tortuous flame paths having controlled clearances.

Thus if any part or particle inside the brake were ignited, the flame would be snuffed out before it reached the outside atmosphere. Hazardous location brakes are not gasketed, and protection from weather and washdowns must be provided.

The NEC specifies a maximum external surface temperature for the various types of hazardous locations (see Table 4-1). The surface temperature of Stearns hazardous location brakes is limited by thermostats.

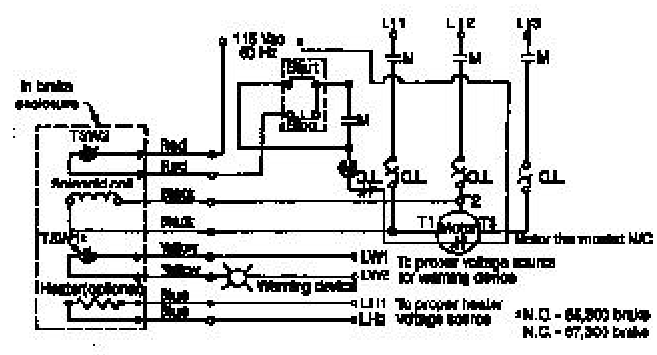


Figure 4-12. Typical wiring diagram for hazardous location brake with thermostat switches

A thermostat switch inside the brake can be wired to the motor control circuit to limit the brake enclosure's surface temperature. Stearns hazardous duty brakes with thermostat surface temperature control employ two thermostat switches. When the temperature limit is reached the main switch interrupts the motor starter circuit causing the motor to shut down and the brake to set. A second thermostat switch activates at a lower temperature. It can be used to actuate an alarm indicating an impending thermal overload. A typical circuit diagram is shown in Figure 4-12.

Brake labels and listing

Stearns brakes for use in hazardous locations are marked to show the Class, Group, and maximum Class II operating temperature (in a 40°C ambient) of the brake enclosure, as well as the minimum Class I ignition temperature of the gases or vapors to which they can be exposed.

Generally, compliance with the NEC is demonstrated by UL Listing of the product in Underwriters Laboratories Hazardous Location Equipment Directory. A label displaying the UL mark and required rating information will be found on each Stearns brake to confirm the listing.

In Canada, the Canadian Standards Association (CSA) is an organization with the responsibility to publish and administer national electrical standards as well as to test and certify electrical products. The CUL or CSA monogram will be found on Stearns hazardous-location brakes sold in Canada to confirm certification.

Stearns *motor-mounted,* hazardous-location electric disc brakes are Listed only when mounted to a Listed hazardous-location motor of the same Class and Group at the motor manufacturer's facility, and where the combination has been accepted by UL. This procedure completes the explosion-proof assembly of the brake. However, *foot-mounted* Listed hazardous-location disc brakes are also available for coupling to a motor, and may be installed by anyone.

To replace an existing *motor-mounted,* hazardous-location disc brake in the field and *retain the Listing,* Underwriters Laboratories must be contacted. A UL inspector may supervise the field installation, assuring the motor manufacturer's procedure is followed. Otherwise, the complete brake motor assembly must be replaced by another Listed brake motor.

Hazardous-location brake enclosures

Division I hazardous-location brakes are *not* waterproof. The enclosure prevents flame propagation to the outside atmosphere through tortuous flame paths having controlled clearances. Protection from weather and washdowns must be provided. If the brake is used in a high humidity or low temperature environment, internal electric heaters should be used. Division 2 Brakes have a waterproof NEMA 4 enclosure.

Thermal considerations

A major design requirement of hazardous-location brakes is to limit exterior surface temperature. The surface temperature of the enclosure must not exceed a specified limit as a result of heat energy created in stopping the motor and load. This NEC restriction on the exterior surface temperature limits the hazardous-location brake's ability to dissipate heat, resulting in less thermal capacity than a comparable brake with a NEMA 2 or NEMA 4 enclosure.

THEREFORE, HAZARDOUS-LOCATION BRAKES ARE INTENDED ESSENTIALLY FOR NON-CYCLIC OR HOLDING PURPOSES, BUT MAY BE USED FOR STOPPING LIGHT INERTIAL LOADS.

Marine duty brakes

Stearns marine duty brakes are available from 10 through 1,000 lb-ft. All feature Stearns exclusive self-adjusting mechanism that ends the need for periodic brake adjustment.

A Stearns marine duty brake has NEMA 4/IP54 enclosure (cast iron) with the following special features:

- Brass pressure plate
- Splined hub
- Brass stationary discs
- Special friction discs

With the exception of these special internal components, marine brakes have the same construction and features of the comparable industrial brake models. The brass internal components prevent corrosion condensation that may occur. As added protection against condensation, a space heater is recommended on all marine duty brakes.

Stearns marine duty brakes are suitable for many applications, including capstan, mooring, topping, and vang winches aboard maritime vessels, dry dock winches, and offshore jackup oil rigs. Marine brakes are designed to conform with the brake specifications in IEEE Standard 45, "IEEE Recommended Practice for Electrical Installations on Shipboard."

Navy Brakes

All Stearns Navy brakes are designed in accordance with Military Specification MIL-B-16392C. Many of these series are also listed on the Navy's Qualified Products List, indicating that they have been tested recently and approved by the Bureau of Ships.

The following features are common to all Navy brakes:

- Spraytight or watertight enclosure (NEMA 4 /IP54)
- Ductile iron exterior (housing and endplate)
- Brass or ductile iron internal parts (pressure plate and stationary disc)
- Brass or ductile iron support plate
- Brass or stainless steel hardware
- Special paint per Navy Specifications
- Dead-man release
- AC voltages only

Navy brakes are available with automatic self-adjust or manual adjust. A special hazardous-location (not UL listed) version is also available.

Stearns Navy brakes are suitable for many applications aboard vessels, including: capstan, mooring, topping, vang and anchor winches.

Maritime duty brakes

Stearns maritime duty brakes are designed for shipboard applications where compliance with a Navy Military Specification is not required. These brakes are suitable for U.S. Coast Guard applications and many shipboard conditions where "no cast iron" construction is specified. They are designed to conform with the brake specifications in IEEE Standard 45, "IEEE Recommended Practice for Electrical Installations on Shipboard." The maritime brakes are similar to a Navy brake in construction, but do not have a dead-man release or special Navy paint, and are not designed or tested to meet the Navy Specification MIL-B-16392C. They have the same self-adjust mechanism and manual release as the comparable industrial brakes.

The brass and ductile iron construction of maritime brakes helps to prevent corrosion due to condensation that may occur in a shipboard environment. For additional protection against condensation, a space heater is recommended as a modification on all maritime brakes.

A hazardous location maritime duty brake is also available for Class I, Group D locations.

Table 4-1

Hazardous-Location Classification		Substance in Atmosphere	Maximum External Surface Temperature – Class I Locations		Maximum External Surface Temperature – Class II Locations		Brake Series (Division I Hazardous)
Class	Group		(°C)	°F	(°C)	°F	
I	C	Ethylene,Cyclopropane, hydrogen sulfide	*(180)* *(180)* *(180)*	356 356 212			65,300 82,300 87,300-00/ 01/02
	D	Gasoline, naphtha, benzine, butane, propane, alcohol, acetone, lacquer solvents, natural gas, ammonia	*(280)* *(180)* *(100)* *(180)*	536 356 212 356			65,000 65,300 87,300-00/01/02 82,300
II	E	Dust of aluminum, magnesium or their commercial alloys			*(165)* *(100)* *(200)*	329 212 392	65,300 87,300-02 only 82,300
	F	Carbon black, coal, coke dusts			*(165)* *(100)* *(200)*	329 212 392	65,300 87,300-00/02 82,300
	G	Flour, starch, grain dusts			*(165)* *(100)*	329 212	65,300 87,300-00/02

Maximum exterior surface temperature is based on operation in an ambient of 104°F *(40°C).*

V. Performance Features of Stearns Solenoid Actuated Brakes

Stearns spring set disc brakes are rugged, reliable, and the most cost effective form of braking. They have many performance and convenience features:

- "Fail-safe" design
- Compact, unitized construction
- Manual release with automatic reset
- Simple to install
- Adaptable to complex control systems
- Low moment of inertia
- Adjustable torque
- Self-adjusting for wear
- Add no heat to the motor
- React fast, without residual drag
- Easy to maintain
- Backed by the Stearns organization

Each of these features results in quantifiable benefits for a Stearns disc brake user.

"Fail-safe" design

Stearns brakes are spring engaged. Any time power to the brake is interrupted, on purpose or accidentally, the brake engages. It remains engaged, even after the load has stopped, and provides a holding torque. Thus, a power failure causes the brake to automatically stop and hold the load, preventing injury or machine damage. Additionally, the brake can be left in the engaged mode indefinitely without drawing any current.

Compact, unitized construction

Disc design results in high torque and small size. This allows for a compact brake that can be mounted on the motor. In addition, all Stearns spring engaged, solenoid released disc brakes feature unitized construction. The solenoid, lever, pressure springs, and linkage are all mounted on a single structure called the support plate. It can easily be removed, repaired,and replaced without requiring any adjustment.

As a result, Stearns brakes are:

- Small compact packages
- Capable of foot or motor mounting
- Easy to service
- Require a minimum of tools
  (standard screwdriver and wrench)
- Have no complicated adjustments

Manual release with automatic reset

Most Stearns brakes incorporate a manual release mechanism that is actuated by convenient external lever, rod, or knob. This feature allows the brake to be temporarily released for setup, maintenance, or emergency situation. This release is automatically reset. If it is accidentally left on, normal electrical actuation of the brake resets the manual release.

Simple installation

Stearns brakes can be mounted directly to NEMA C-face motors. This eliminates the need for special alignment procedures and reduces floor space requirements.

Stearns brakes are single-phase. Wiring is simple and low cost because only two wires are required. Most brakes are wired directly to the motor's terminal box. No additional controls are required because Stearns brakes can be controlled by a normal motor starter.

Stearns brakes are factory adjusted and burnished, allowing plant personnel to install them in minutes using standard hand tools.

Adaptable to complex control systems

Stearns brakes are highly flexible. They can be controlled by something as basic and simple as a motor starter or as sophisticated as a computer. They can easily be adapted to use with today's programmable controllers.

Low moment of inertia

The only rotating parts on a Stearns brake are friction discs and the brake hub, and these parts are designed to minimize inertia. This low inertia design imposes a minimum additional burden upon the motor (when starting) and does not appreciably affect machine stopping time.

Adjustable torque

The torque of many Stearns brakes can be adjusted over a moderate range by removing the housing and turning the torque adjustment mechanism on the support plate. This allows you to adjust brake torque for the desired stopping time, increasing performance and decreasing machine wear.

Self-adjusting

Stearns self-adjusting disc brakes feature an exclusive, automatic adjusting device that eliminates the major cause of brake maintenance–adjustment to compensate for friction lining wear. This feature makes Stearns self-adjusting brakes ideal for remote or inaccessible locations and for applications where rapid cycling necessitate frequent wear adjustment.

The self-adjust feature means Stearns disc brakes always operate at peak efficiency, providing more uniform braking, longer friction disc life, less maintenance time, and smooth, quiet operation.

Adds no heat to motor

When a Stearns brake is used, the braking energy is absorbed in the brake, not the motor. There is no need to use a special motor. This feature allows you to add a Stearns brake to almost any application.

Fast reaction, no residual drag

Friction braking with spring actuation gives fast positive reaction. When release there is little or no residual drag. You get precision stopping for high productivity with no increased drag on the motor.

Easy to maintain

A Stearns brake can be completely disassembled, worn parts replaced, and the brake re-assembled in minutes using shop personnel and standard tools. Popular replacement parts are available worldwide in convenient kits. This reduces expensive downtime and eliminates the need for highly trained service technicians and expensive parts inventories.

Backed by the Stearns name

The Stearns name means quality and performance in braking systems. It means the broadest line of braking systems. It also means worldwide availability of application assistance, service, and parts. Stearns brake users seldom need help, but when they do, it is available.

VI. Selecting a Stearns Solenoid-Actuated Brake

Stearns spring set disc brakes can be easily selected from Tables 6-1 and 6-2.

Given motor data:

1. Horsepower (hp)
2. Speed (rpm)
3. NEMA C-face frame size

Determine:

1. Static torque rating of the brake (lb-ft)
2. Brake series

Step 1 – Given the motor horsepower and speed, select the brake torque from Table 6-1.

Example: Given a 5 hp, 1800 rpm motor, the selected brake is 20 or 25 lb-ft.

Do not use Table 6-1 to select brakes for overhauling or high inertial loads, or where a stop in specified time or distance is required. For these applications the total inertia of the load and power transmission system must be determined to make a brake selection. Refer to sections on torque and thermal ratings and determination.

Step 2 – Given the NEMA C-face motor frame size, select the brake series from Table 6-2.

Example: Given the 5 hp, 1800 rpm motor in Step 1 with a NEMA 184TC frame, series 56,500, 87,000, 87,300 or 87,700 brakes can be selected to mount directly to the motor.

Table 6-1. Torque selection

In this table, brake torque ratings are no less than 140% of the motor full load torque. For brakes other than Stearns, refer to manufacturer's specifications for brake selection.

Motor hp	Brakemotor shaft speed (rpm)						
	700	900	1200	1500	1800	3000	3600
	Static torque rating of brake (lb-ft)						
1/6	3	1.5	1.5	1.5	0.75	0.5	0.5
1/4	3	3	3	1.5	1.5	1.75	0.5
1/3	6	3	3	3	1.5	1.5	1.75
1/2	6	6	3	3	3	1.5	1.5
3/4	10	6	6	6	6	3	3
1	15	10	6	6	6	3	3
1-1/2	20	15	10	10	10	6	3
2	25	20	15	10	10	6	6
3	35	25	20	15	15	10	6
5	75	50	35	25	20 or 25	15	10
7-1/2	105	75	50	50	35	25	15
10	105	105	75	50	50	25	25
15	175	125	105	75	75	50	35
20	230	175	125	105	105	50	50
25	330	230	175	125	105	75	50
30	330	330	230	175	125	75	75
40	440	330	330	230	175	105	105
50	550	440	330	330	230	*	*
60	750	550	440	330	330	*	*
75	1000	750	550	440	330	*	*
100	—	1000	750	500	440	*	*
125	—	1000	1000	750	500	*	*
150	—	—	1000	750	750	*	*
200	—	—	—	1000	1000	*	*
250	—	—	—	—	1000	*	*

*Exceeds maximum speed rating for series 81,000, 82,000 and 86,000 brakes.

Table 6-2. Brake Series Selection

Torque Range (lb-ft)	Brake Series	C-Face Motor Frame Size												
		Sub-fhp	48C	56C	143TC 145TC	182TC 184TC	213TC 215TC	254TC 254UC 256TC 256UC	284TC 284UC 286TC 286UC	324TC 324UC 326TC 326UC	364TC 364UC 365TC 365UC	404TC 404UC 405TC 405UC	444TC 444UC 445TC 445UC	504UC 504SC 505C 505SC
Manually-Adjusted Brakes (require periodic adjustment to compensate for friction disc wear)														
1.5-6	48,100		①											
1.5-25	56,X00			①	①	②	②	②						
10-25	56,500					①								
Self-Adjusting Brakes (automatically compensate for friction disc wear)														
6-105	87,X00			③	③	①	①	①	②	②	②	②		
6-105	87,000-B			③	③	①	①	①	②	②	②	②		
50-105	87,100								①					
125-230	81,000					②	②	②	②	①	①	①	②	
125-550	82,000					②	②	②	②	①	①	①	②	
500-1000	86,000									②	②	②	①	
500-1000	86,100													①
Division I Hazardous Location Brakes (for atmospheres containing explosive gases or ignitable dusts)														
1.5-15	65,000			④	④									
1.5-15	65,300			①	①	②	②	②						
10-105	87,300					①④	①④	①④	②	②	②	②		
125-330	82,300					②	②	②	②	①④	①④	①④	②	
Division 2 Hazardous Location Brakes														
1.5-25	56,800			①	①	②	②	②						
6-105	87,800			③	③	①	①	①	②	②	②	②		
Double C-Face Brake Couplers (for direct coupling a C-face motor to a C-face gear reducer)														
1.5-25	56,700			①	①									
10-105	87,700					①	①	①						
10-105	87,700-B					①	①	①						

① Brake mounts directly to motor C-face
② Adapter required to mount brake to motor C-face. Refer to brake specifications for adapter information.
③ Brake endplate modified for direct mounting to motor C-face without an adapter.
④ Brake is foot mounted for coupling to a hazardous-location motor.

Torque ratings and determination

The brake torque selections in Table 6-1 are based upon the motor's full load torque and a minimum service factor of 1.4 to arrive at the required static torque for the brake. Static torque is calculated with the formula:

$$T_s = \frac{5252 \text{ X } P}{N} \text{ X SF}$$

Where, T_s = Static brake torque, lb-ft
P = Motor horsepower, hp
N = Motor full load speed, rpm
SF = Service factor
5252 = Constant

The service factor selected will depend upon the type of application. For simple rotary and linear loads, service factors from 1.2 to 1.4 are typically used so the dynamic brake torque is equal to or greater than the full load torque of the motor. Overhauling loads generally use an SF or 1.4 to 1.8, so the dynamic brake torque is equal to or greater than the maximum or breakdown torque of the motor.

For applications where the load data is known, where high inertial loads exist, or where a stop in a specified time or distance is required, the dynamic torque to retard the total inertia should be determined using the relationship:

$$T_d = \frac{Wk^2 \text{ X } N}{308 \text{ X } t}$$

Where, T_d = Average dynamic braking torque, lb-ft
Wk^2 = Total inertia reflected to brake, lb-ft^2
N = Shaft speed at brake, rpm
t = Desired stopped time, sec
308 = Constant

Overhauling loads

Applications with a descending load, such as power lowered crane palletizers, hoist, or lifts, require a brake with sufficient torque to both *stop* the load, and *hold* it at rest. Overhauling loads having been brought to rest still invite motion of the load due to the effect of gravity. Therefore, brake torque must be larger than the overhauling torque in order to stop and hold the load. If brake torque is equal to or less than the overhauling torque, there is no net torque available for stopping a descending load.

The dynamic torque to overcome the overhauling load is determined by the formula:

$$T_o = \frac{0.158 \times W \times V}{N}$$

Where, T_o = Overhauling dynamic torque of load reflected to brake shaft, lb-ft

W = Weight of load, lb

V = Linear velocity of descending load, ft/min

N = Shaft speed at brake, rpm

0.158 = Constant

The total dynamic torque to decelerate the descending load and to overcome the overhauling effect is the sum of the two calculated dynamic torques:

$$T_T = T_d + T_o$$

Static torque and brake ratings

Stearns brake torque ratings are nominal static torque. That is, the torque required to begin rotation of the brake from a static, engaged condition. This value is to be distinguished from dynamic torque which is the retarding torque required to stop a linear, rotating or overhauling load. For Stearns disc brakes dynamic torque is approximately 80% of the static torque rating of a brake for stopping time up to one second. Longer stopping time will produce additional brake heat and possible fading (reduction) of the dynamic torque. All brakes are factory burnished and adjusted to produce no less than rated nominal static torque.

Thermal ratings and determination

When a brake stops a load, it converts mechanical energy to thermal energy or heat. The heat is absorbed by components of the brake. This heat is then dissipated by the brake. The ability of a given brake to absorb and dissipate heat without exceeding temperature limitations is known as thermal capacity.

There are two categories of thermal capacity for a brake. The first is the maximum kinetic energy the brake can absorb in one stop, generally referred to as a “crash” or “emergency” stop. The second is the heat dissipation capability of the brake when it is frequently cycled. Both ratings are listed in the specification tables for specific brake models.

The energy a brake is required to absorb in one stop by a given power transmission system is determined by the formulas below. The calculated energy of the system should not exceed the maximum kinetic energy rating of the brake, or torque may fall appreciably.

In the case of linear loads, the energy that the brake must absorb is determined by the formula:

$$KE_l = \frac{Wv^2}{2g}$$

Where, KE_l = Kinetic energy of rotating load, ft-lb

W = Weight of load, lb

v = Linear velocity of load, ft/sec

g = Gravitational acceleration constant, 32.2 ft/sec^2

In the case of rotational loads, the energy that the brake must absorb is determined by the formula:

$$KE_r = \frac{Wk_r^2 \times N_B^2}{5875}$$

Where, KE_r = Kinetic energy of rotating load, ft-lb

Wk_T^2 = Inertia of the rotating load reflected to brake shaft, lb-ft^2

N_B = Shaft speed at brake, rpm

5875 = Constant

In the case of overhauling loads, both the kinetic energy of the linear and rotating loads and the potential energy transformed into kinetic energy by the change in height or position must be considered when determining the total energy that the brake must absorb. The potential energy transformed to kinetic energy is determined by the formula:

$$PE = Ws$$

Where, PE = Change in potential energy, ft-lb

W = Weight of overhauling load, lb

s = Distance load travels, ft

Thus, the total energy to be absorbed by a brake stopping an overhauling load is:

$$E_T = KE_1 + KE_r + PE$$

For applications demanding optimum brake performance, such as high inertia loads and frequent stops, the rate of energy dissipation required by the system is determined using the following equations.

For rotating or linear loads, the rate at which a brake is required to absorb and dissipate heat when frequently cycled is determined by the relationship:

$$TC = \frac{Wk_T^2 \times N_B^2 \times n}{3.2 \times 10^6}$$

Where, TC = Thermal capacity required for rotating or linear loads, hp-sec/min

Wk_T^2 = Total system inertia reflected to brake, lb-ft^2

N_B = Shaft speed at brake, rpm

n = Number of stops per minute, not less that 1

3.2×10^6 = Constant

For overhauling loads, the rate at which a brake is required to absorb and dissipate heat when frequently cycled is determined by the relationship:

$$TC = \frac{E_T \times n}{550}$$

Where, TC = Thermal capacity required for overhauling loads, hp-sec/min

E_T = Total energy brake absorbs, ft-lb

n = Number of stops per minute, not less than 1

550 = Constant

Brake location considerations

Whenever practical, a brake should be located on the high speed shaft of a power transmission system. This permits a brake with the lowest possible torque to be selected for the system.

Electrical considerations

Stearns spring-set disc brakes are available with standard motor voltages, frequencies and insulation classes. Most models can be furnished with either single or dual voltage coils. Both AC and DC brake solenoid coils are available on most models. Solenoid coils with special voltages and frequencies are also available. All AC coils are single phase and can be applied to either single or polyphase NEMA type motors without modifications.

Stearns brake solenoid coils are rated for continuous duty and can be energized continuously without overheating. When cycled, the coil heating effects are greatest due to inrush current, and the cycle rate must not exceed the maximum rating given in the specification tables for specific brake models.

Selecting a hazardous location brake

When specifying a Stearns hazardous-location disc brake, the Class and Group designations of the hazardous atmosphere and its ignition temperature must be known. Table 4-1 gives the hazardous atmospheres that Stearns brakes are suitable for, along with the brake's maximum operating temperature.

Step 1 – Determine the Class and Group designation of the hazardous atmosphere.

Step 2 – For Class I hazardous substances, determine the ignition temperature of the explosive gas or vapor. Select a brake listed for the appropriate Group with a maximum external surface temperature that does not exceed the ignition temperature of the explosive gas or vapor.

Step 3 – For Class II hazardous substances, select a brake listed for the appropriate Group.

VII. Installation and Servicing

Installation and servicing of a typical Stearns brake is very simple even though it requires that the brake be disassembled. This simplicity is the result of careful design and unitized construction wherein the solenoid, coil, spring, and lever mechanisms are all conveniently located on one removable assembly - the support plate assembly.

Installation

Prior to installing any brake, it is wise to check that:

- The C-face on the brake or adapter is compatible with motor C-face.
- The bore of the brake hub is the same diameter as the motor shaft.
- The coil voltage is the same as the motor or power source voltage.

The first step to install a typical Stearns brake is to remove the housing and support plate assembly (Figure 7-1). This allows access to the brake disc pack - pressure plate, friction discs, and stationary discs. When the disc pack is removed, the remaining assembly is the brake endplate. Note that the brake hub is usually supplied loose. The endplate is attached to the motor endbell and secured with bolts.

Once the endplate is installed, the brake hub can be positioned on the motor shaft and secured. Positioning of the hub is relative to the friction disc farthest from the brake endplate (Figure 7-2). The distance the hub extends beyond this face varies with brake size and series. The hub is secured to the motor shaft with a key and setscrews.

The disc pack is now reinstalled in the brake. Freedom of movement of the disc pack is required - friction discs must be free to move axially along the brake hub and stationary disc and the pressure plate must be free to move axially within the endplate assembly.

If the brake is modified for vertical operation, there will be springs between the elements of the disc pack. These springs prevent gravity from compressing the disc pack when the brake is in the released state.

Once the disc pack is properly placed, the unitized support plate assembly can be positioned and secured with the support plate screws. At this point, electrical connections are made between the brake coil and the motor. After the electrical connections are complete, the brake housing is replaced and secured. The installation is then complete. Detailed instructions are available for each brake series.

Electrical connections

All Stearns brakes are single phase. When used with a single phase AC motor, the brake is connected in parallel with the motor (Figure 7-3). When used with a 3-phase AC motor the coil may be connected across any 2 of the 3 power leads. These connections can be made at the motor or the starter; however, since the brake is normally motor mounted, connections to the motor terminal box are usually more convenient.

Stearns supplies both single voltage and dual voltage coils. Single voltage coils have two connections which are wired to the motor or starter. Dual voltage coils have 4 connections. (Depending on the type of coil, these connections may be 2 lead wires and 2 terminals or they may be 4 lead

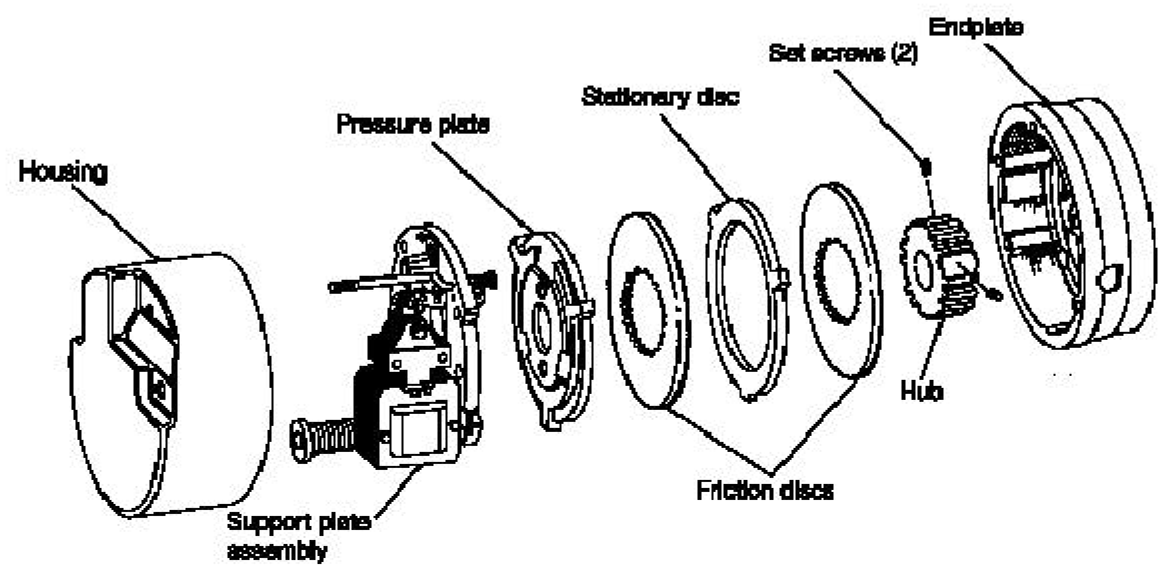


Figure 7-1. Typical arrangement of Stearns brake showing basic components

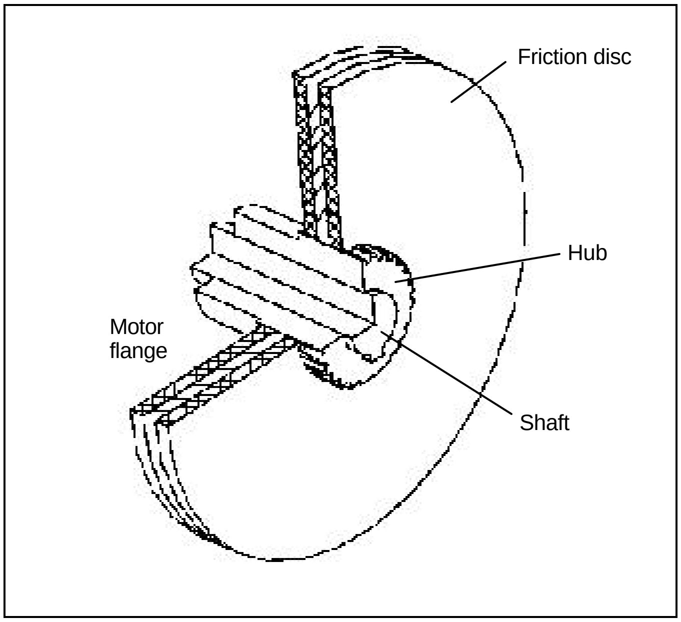


Figure 7-2. Position of hub relative to friction discs

wires. Regardless of type, they are connected in the same way.) To connect a dual voltage coil for the lower voltage, leads 1 and 3, and leads 2 and 4 are wired together and these are connected to the power source as shown in Figure 7-4. For use on the high voltage, leads 3 and 4 are connected together and leads 1 and 2 are connected to the power source as shown in Figure 7-4. Some brakes use two single voltage coils. These are connected in parallel inside the brake, and 2 leads are used to connect the brake to the power source.

Dual frequency coils are also available. These are *single-voltage,* but can be connected for use with either 50 Hz or 60 Hz frequency. Dual frequency coils have 3 leadwires, and are connected as shown in Figure 7-4.

Connection of the coil to a single-voltage motor (Wye and Delta wiring) is shown in Figure 7-5. Connection to a dual voltage motor is shown in Figure 7-6.

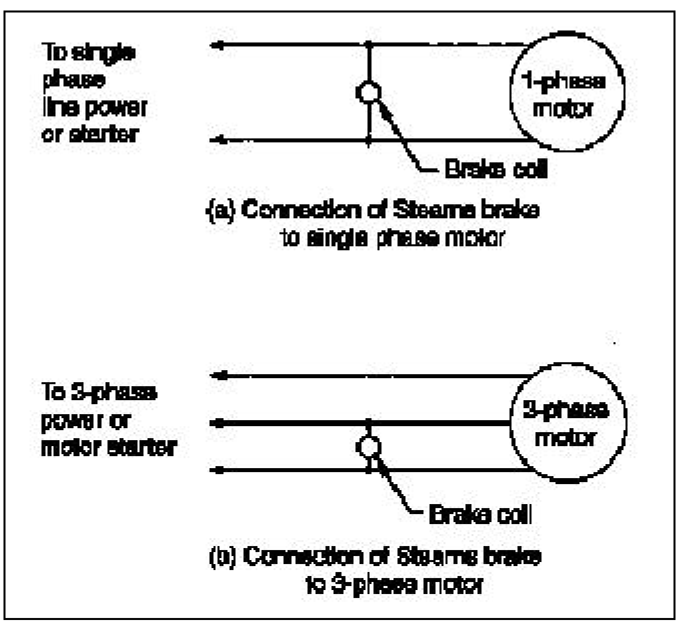


Figure 7-3. Electrical connection of Stearns brake

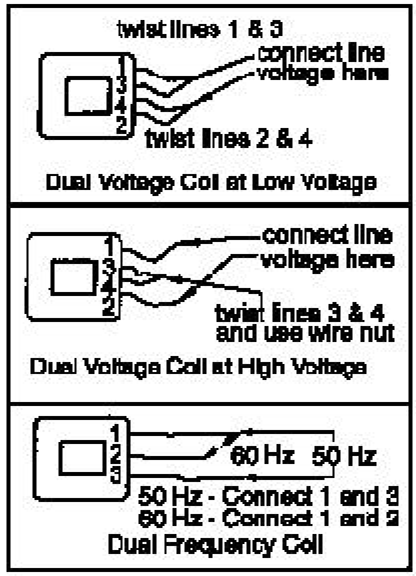


Figure 7-4. Dual voltage and Dual frequency coils

Inverter motor and special control systems

Brakes contain either a single phase AC coil or DC coil that requires instantaneous power within ± 10% of rating at the coil. A separate power source is required when this brake is used in conjunction with a motor or control system that limits voltage or current input (i.e. inverter motors) or causes a ramping of the power supply.

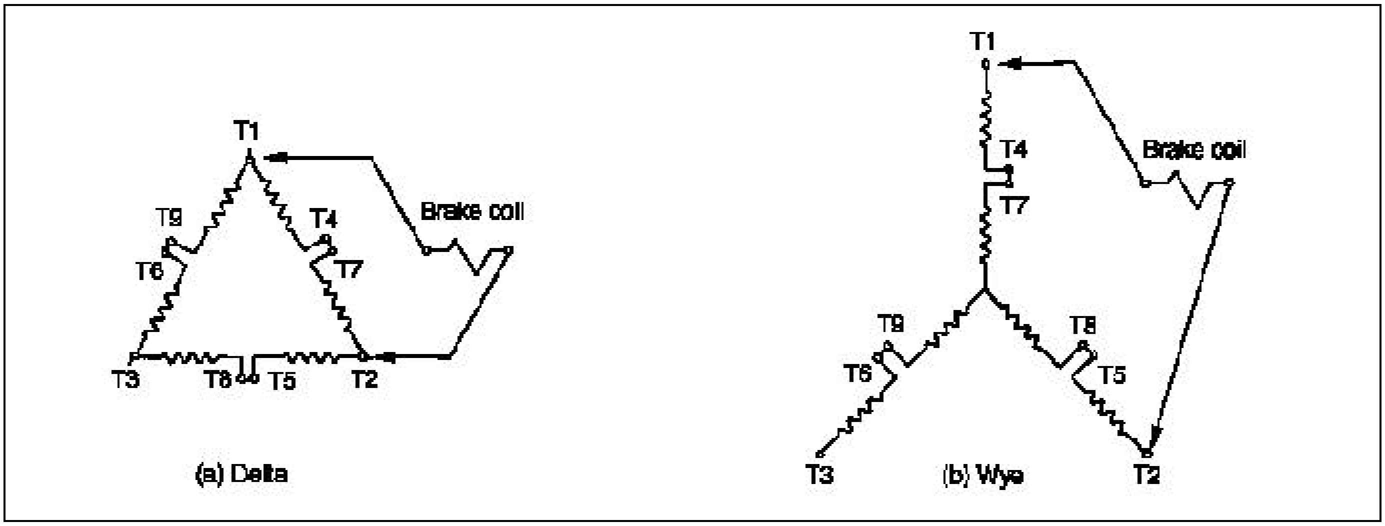


Figure 7-5. Connection to single-voltage motor

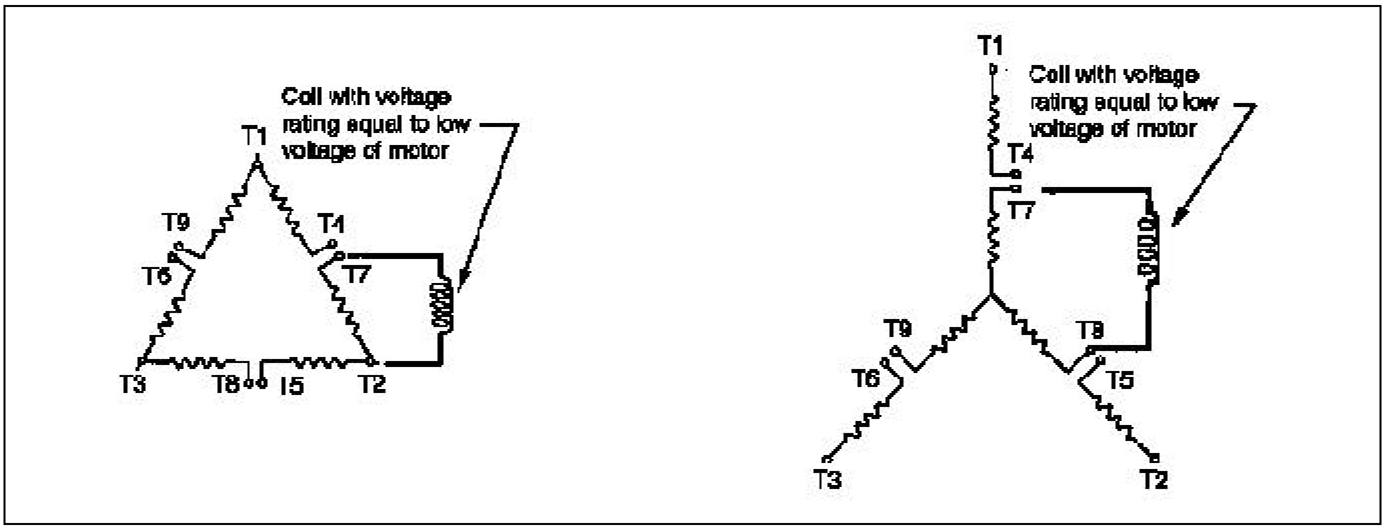


Figure 7-6. Connection to dual voltage motor

Brake adjustments

Friction discs wear during normal operation. This wear causes the solenoid air gap to increase and the brake to gradually lose torque. To maintain maximum braking performance, this wear must be compensated for.

Stearns self-adjusting brakes automatically compensate for wear, eliminating the need for periodic adjustment. On most manually adjusted brakes, a wear indicator shows when adjustment is needed. Brakes without wear indicators need adjustment whenever a definite increase in stopping time is noted.

Adjustment can be accomplished simply and quickly. The housing is removed. The wear adjustment screws are located on the unitized support plate. Adjustments are made with a screwdriver while measuring the solenoid air gap.

Replacement of worn parts

Eventually, the friction discs will wear to a point where adjustment can no longer have an effect. At this time the friction discs must be replaced. To replace friction discs, the housing and support plate assembly are removed, exposing the disc pack. When replacing friction discs it is good practice to check the stationary parts of the disc pack for wear. Manually adjusted brakes must be readjusted when new discs are installed.

The other major components that might require replacement are the coil and solenoid assembly. All coils and most solenoids can be replaced without removing the unitized support plate assembly. These replacements can also be accomplished simply and with a minimum of downtime.

Most replacement parts for the popular Stearns brake series are available in replacement parts kits. The kits include the renewal parts, mounting hardware, and detailed instructions, all packaged in a convenient container. Both kits and individual parts are available worldwide through the Stearns distribution network.

VIII. Standard Solenoid-Actuated Brake Models and Available Options

A complete description, including dimensions and specifications, for all standard Stearns brakes is included in Catalog 200. The following is a summary of the standard units and commonly specified options.

Standard Stearns brakes are available in four basic categories.

- Close-coupled
- Double C-face coupler
- Hazardous location, Division 1 and Division 2
- Foot-mounted with bearing-supported through-shaft

Close-coupled brakes

Close-coupled brakes mount to the auxiliary end of a C-face motor. A C-face is a machined surface with threaded holes to which a user can mount driven equipment. These brakes are available in .5 lb-ft through 1000 lb-ft static torque.

Series 48,100

- Static torque 1.5 - 6 lb-ft
- Mounts to NEMA 48C motor
  3.0” register
  3.75” bolt circle
- Manual wear adjustment
- NEMA 2, IP23 enclosure
- Adjustable torque
- Mounts in any position without modification
- Side manual release lever with automatic reset

Series 56,X00

- Static torque 1.5 - 25 lb-ft
- Mounts to NEMA 56C - 145 TC motor
  4.5” register
  5.88” bolt circle
  56,500 series mounts to NEMA 182 TC - 256 TC/UC frame motor
  8.5” register
  7.25” bolt circle
- Manual wear adjustment
- Nema 2/IP23, Nema 4/IP54, and Nema 4X/IP55 enclosures available
- Adjustable torque

One- & two-disc brakes mount in any position without modification, three-disc brakes come with springs to modify for vertical above or below. There are 9 different series brakes within the 56,X00, to include various enclosure materials and release types, and including a Division 2 hazardous location brake series.

Series 87,000

- Static torque 6-105 lb-ft
- Mounts to NEMA 182 TC - 256 TC/UC frame
  8.5” register
  7.25” bolt circle
- Self-adjusting for wear
- NEMA 2/IP23, NEMA 4/IP54, and NEMA 4X/IP55 enclosures available
- All brakes require modification for vertical above mounting
- 50 lb-ft and above require modification for vertical below mounting
- Vertical mods require springs only for this series
- Pull-type manual release

Series 87,100

- Static torque 50-105 lb-ft
- Mounts to NEMA 284 TC/UC - 286 TC/UC frame motor
  10.5” register
  9.0” bolt circle
- Self-adjusting for wear
- NEMA 2/IP23 or NEMA 4/IP54 enclosure
- All brakes require modification for vertical mounting using vertical springs only
- Pull-type manual release

Series 81,000

- Static torque 125-230 lb-ft
- Mounts to NEMA 324 TC/UC/TSC/USC - 405 TC/UC/TSC/USC frame motor
  12.5” register
  11.0” bolt circle
- Self-adjusting for wear
- NEMA 2/IP23 or NEMA 4/IP54 enclosure
- All brakes require modification for vertical mounting, using guide pins and springs
- Pull type manual release

Series 82,000

- Static torque 125-550 lb-ft
- Mounts to NEMA 324 TC/UC/TSC/USC - 405 TC/UC/TSC/USC frame motor
  12.5” register
  11.0” bolt circle
- Self-adjusting for wear
- NEMA 2/IP23 or NEMA 4/IP54 enclosure
- All brakes require modification for vertical mounting, using guide pins and springs
- Pull-type manual release

Series 86,000

- Static torque 500-1000 lb-ft
- Mounts to NEMA 444 and 445 TC/UC/TSC/USC frame motor
  16.0” register
  14.0” bolt circle
  86,100 series mounts to 505C frame
  16.5” register
  14.5” bolt circle
- Self-adjusting for wear
- NEMA 2/IP23 or NEMA 4/IP54 enclosure
- All brakes require modification for vertical mounting, using guide pins and springs
- Pull-type manual release unit has 2 release knobs, since these brakes have 2 solenoid/coil assemblies

Division I hazardous location brakes

Series 65,300; 87,300; and 82,300 brakes are designed for use in hazardous locations. They have a special enclosure that prevents flame propagation to the outside atmosphere.

Division 1 is any normally hazardous location.

Series 65,300

- UL listed for Class I, Group C and D, Class II, Groups E, F, and G.
- Static torque 1.5-15 lb-ft
- Mounts to NEMA 56C - 145 TC frame motor
  4.5" register
  5.88" bolt circle
- Manual wear adjust
- Hazardous location NEMA 7 enclosure
- Vertical modification required on 6-15 lb-ft, guide pins and springs
- Knob-type manual release

Series 87,300

- UL listed for Class I, Group C and D, Class II, Group F and G
  87,300-01 series available for Class I, Group C and D only; brake includes bearing
  87,300-02 series available for Class I, Group C and D, Class II, Group E, F, and G; brake includes bearing & slinger. (Slinger covers bearing to prevent dust).
- Static torque 10-105 lb-ft
- Mounts to NEMA 182TC - 256 TC/UC frame motor
  8.5" register
  7.25" bolt circle
- Self-adjusting for wear
- Hazardous location NEMA 7 and NEMA 9
- Vertical above modification required on all units; vertical below modification required for 50 lb-ft and above. Uses guide pins and springs
- Pull-type manual release
- Also available in a foot-mounted brake with output shaft

Series 82,300

- UL listed for Class I, Group C and D, Class II, Group E and F
- Static torque 125 - 330 lb-ft
- Mounts to NEMA 324 TC/TSC/UC/USC - 405 TC/TSC/UC/USC frame motor
  12.5" register
  11.0" bolt circle
- Self-adjusting for wear
- Hazardous location NEMA 7 and NEMA 9
- All brakes require modification for vertical mounting, uses guide pins and springs
- Pull-type manual release
- Also available in a foot-mounted brake with output shaft

Division 2 hazardous location brakes

Series 56,800 and 87,800 are designed for use in division 2 hazardous locations. Division 2 is normally NOT hazardous, but can become hazardous.

Series 56,800

- UL listed for Division 2, Class I, Groups A, B, C, D, and Class II, Groups F and G.
- Static torque 1.5 - 25 lb-ft
- Mounts to NEMA 56C - 145 TC frame motor
  4.5" register
  5.88" bolt circle
- Manual wear adjust
- NEMA 4/IP54 enclosure
- One & two-disc brakes mount in any position without modification,three-disc brakes come with springs to modify for vertical above or below
- Side manual release lever

Series 87,800

May be ordered as 87,800-00, for Division 2, Class II, Groups F and G or 87,800-01, for Division 2, Class I, Groups A, B, C, D, and Class II, Groups F and G

- Static torque 6 - 105 lb-ft
- Mounts to NEMA 182 TC - 256 TC/UC frame motor
  8.5" register
  7.25" bolt circle
- Self-adjusting for wear
- NEMA 4/IP54 enclosure
- Vertical above modification required on all units; vertical below modification required for 50 lb-ft and above. Uses springs only.
- Pull- type release

Double C-face coupler brakes

Series 56,700 and 87,700 are coupler brakes. They can be mounted between a C-face motor and C-face gear reducer.

Series 56,700

- Static torque 1.5 - 25 lb-ft
- Mounts to NEMA 56 C - 145 TC frame motor
  4.5" register
  5.88" bolt circle
- Manual wear adjustment
- NEMA 2/IP23, NEMA 4/IP54, and NEMA 4X/IP55
- One & two-disc brakes mount in any position without modification, three-disc brakes come with springs to modify for vertical above or below
- Knob-type manual release

Series 87,700

- Static torque 10 - 105 lb-ft
- Mounts to NEMA 182 TC - 256 TC/UC frame motor
  8.5" register
  7.25" bolt circle

- Self-adjusting for wear• NEMA 2/IP23, NEMA 4/IP54, and NEMA 4X/IP55
- Vertical above modification required on all units; vertical below modification required for 50 lb-ft and above. Uses guide pins and springs.
- Side manual release lever

Foot-mounted with bearing-supported through shaft

Series 55,200 and 87,200 are foot mounted and contain a through shaft with a bearing on each end for overhung, or side load capability.

Series 55,200

- Static torque 1.5 - 15 lb-ft
- Manual wear adjustment
- NEMA 2/IP23
- Horizontal mounting only
- Side manual release lever

Series 87,200

- Static torque 10 - 105 lb-ft
- Self-adjusting for wear
- NEMA 2/IP23 or NEMA 4/IP54
- Horizontal mounting only
- Side manual release lever

Common modifications and options

Stearns brakes are available with some or all of the following modifications. Check Bulletin 200 for specific series modifications.

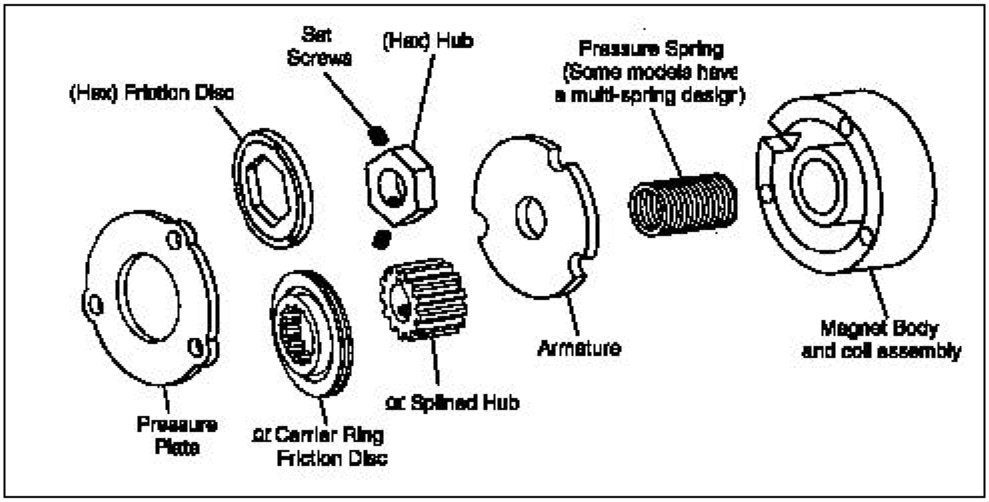
- Modifications for vertical (above or below motor) mounting
- Class H coil insulation - high ambient temperature or high cycle rate applications
- Special duty friction materials
- Space heaters for high humidity/low temperature installations
- Brass parts for corrosion resistance
- Navy or Marine duty brakes - meets military specifications
- Thru-shaft modifications - hole in brake cover for motor shaft to extend beyond cover
- Foot mounting kits
- Motor frame adapters
- Solenoid actuated warning switch - indicates when the brake is released
- Side manual release
- Non-locking (deadman) release
- Carrier ring friction discs - friction material is bonded to a metal ring
- Non-standard voltages

Other modifications are available. This list contains only the most common modifications.

IX. Armature - Actuated Brakes (AAB)

In addition to Solenoid-Actuated Brakes, Stearns Division manufactures Armature-Actuated Brakes (AAB).

AAB brakes are direct-acting, DC actuated, spring set and electrically released. This type of brake develops braking and holding torque in the absence of electrical power. They can decelerate and hold a rotational load or can be ordered to provide for a holding function only, where the motor is used as the dynamic brake.

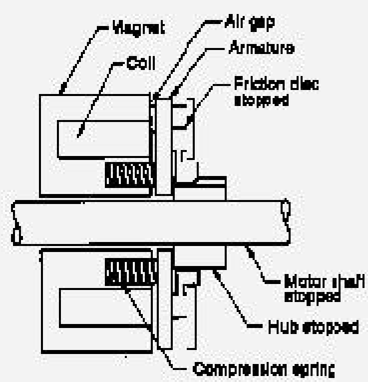


Basic Components

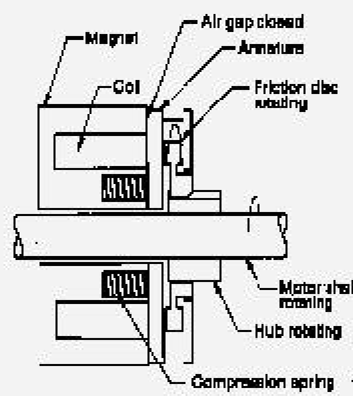
Operating Principle

When electrical power is applied, the armature is pulled by the electromagnetic force in the magnet body assembly, which overcomes spring action. This allows the friction disc to rotate freely. When electrical power is interrupted, the electromagnetic force is removed and the pressure spring mechanically forces the armature plate to clamp the friction disc between itself and the pressure plate. This develops torque to stop or hold the load.

Engaged Condition
(power off)



Disengaged Condition
(power on)



Response times

When the electrical current is removed from the brake coil, and the pressure springs push the armature into contact with the pressure plate, torque begins to build up. This buildup of torque is called the engagement curve (See Figure 9-1). At time 0, coil voltage is removed and the magnetic force begins to decay.

Time T11 is the time from when the power is switched off until the beginning of the rise in torque. Time T12 is the time from the beginning of the rise in torque until the rated moment is reached. T1 is the sum of the response time T11 and the rise time T12, or the total time for the brake to set.

When electrical current is again applied to the coil, magnetic force builds, and the armature is pulled into contact with the magnet body, releasing the brake. Total brake release time is shown as T2, or total time from when the power is switched on until the brake is disengaged.

The importance of this relationship is that when an electrical signal is removed from a brake, the load does NOT instantaneously stop. Therefore, the engagement and disengagement times must be factored into the application. This may seem like an inconsequential period of time (milliseconds), but if a customer has an application requiring extremely high cycle rates, or requires very accurate stopping distances, it becomes necessary to consider time even as small as milliseconds.

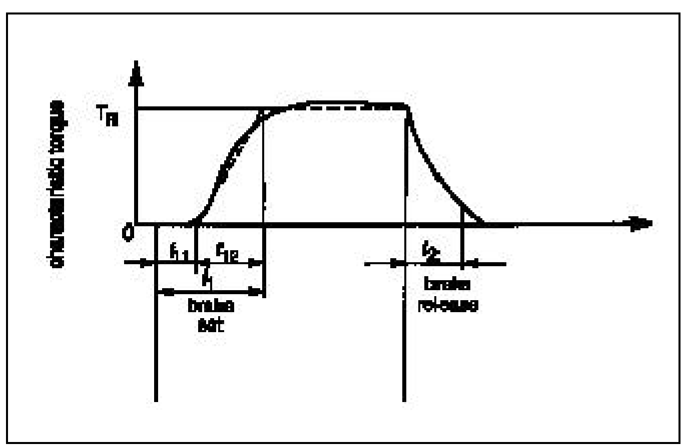


Figure 9-1.

Rectifiers

All AAB brakes operate on direct current (DC) voltage. However, if a source of DC voltage is not available, a rectifier may be used. The primary function of a rectifier is to convert alternating current (AC) voltage to direct current (DC) voltage.

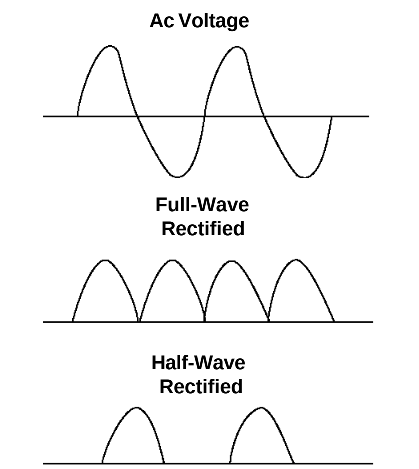
Basic configurations

-Full wave rectifier

Both half cycles of the line sine waveform cycle are made with the same polarity. DC output voltage is VDC=.90VAC

-Half wave rectifier

One half of the line sine waveform cycle is NOT utilized at all, leaving one polarity of voltage as an output.
DC output voltage is VDC=.45VAC



All rectifiers are for 50 or 60 Hz line frequency

Versions that reduce response time of the brake to coil turn on or turn off:

-TOR-AC

Provides coil turn off nearly as fast as DC side switching. Must be switched on/off by a switch in an AC lead of the TOR-AC input.

-Ouickset

Provides quicker coil turn off where the rectifier AC input leads are permanently wired directly to the AC motor line input terminals. Serves to reduce the brake set time in the presence of motor generated voltage after it is turned off.

-Ouickset/OuickRelease

Provides the quickset function as well as provides an overexcitation function to energize the coil to reduce the armature attraction time. Can also be used as a rated coil voltage turn on rectifier with reduced voltage (wattage) during the remainder of the coil on-time.

Manual release options

Similar to the Solenoid-Actuated brakes, the AAB's have a manual release mechanism for use in emergency situations or during regular maintenance. The release of the brake is accomplished by pulling or pushing the brake armature into the magnet body, allowing the friction disc to rotate. Both a locking, or maintained release and a non-locking, or non-maintained (also known as a deadman) release is available.

A locking/maintained release lever locks the brake into a released position. On the AAB brakes, the release lever must be manually reset, or pushed manually back into place for the brake to set. An example of a locking/maintained release is shown in Fig 9-2.

A non-maintained/deadman release must be held manually in the release position. See Fig 9-3.

Another type of locking/maintained release uses 2 manual release bolts. As the bolts are tightened, the armature is pulled into the magnet body, releasing the brake. To reset the brake, the bolts must be loosened. See Fig 9-4.

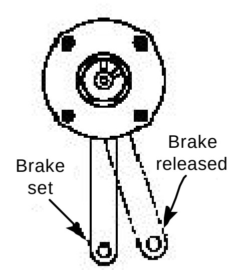


Figure 9-2.

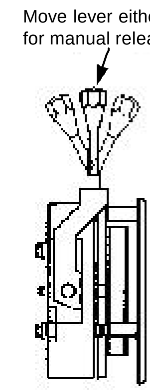


Figure 9-3.

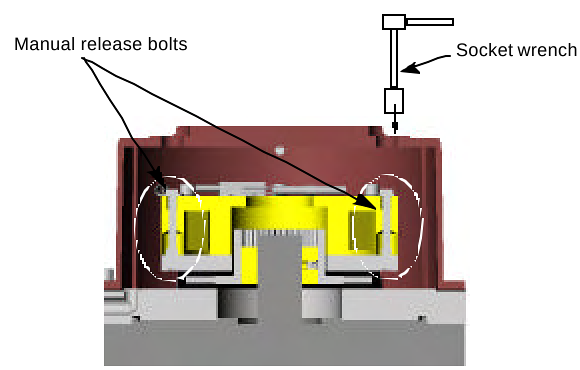


Figure 9-4.

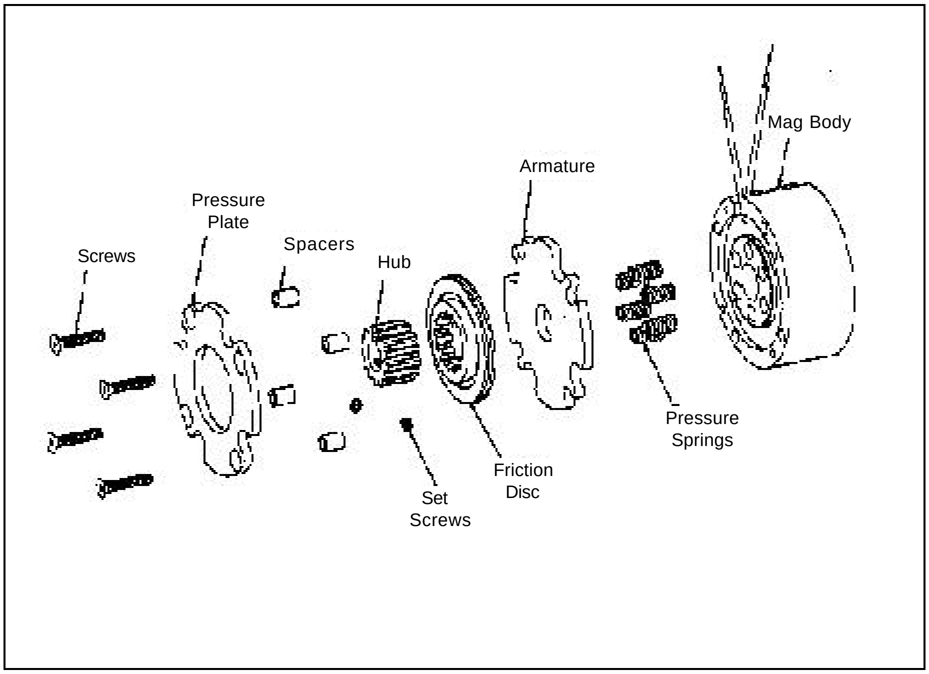
Vertical mounting

All AAB's use only one friction disc, and therefore can be mounted in any position, including vertical above and below the motor, without any modification.

Series 310

This series is also referred to as the AAB-S, the “S” representing servo, since these brakes are ideal for the servomotor market.

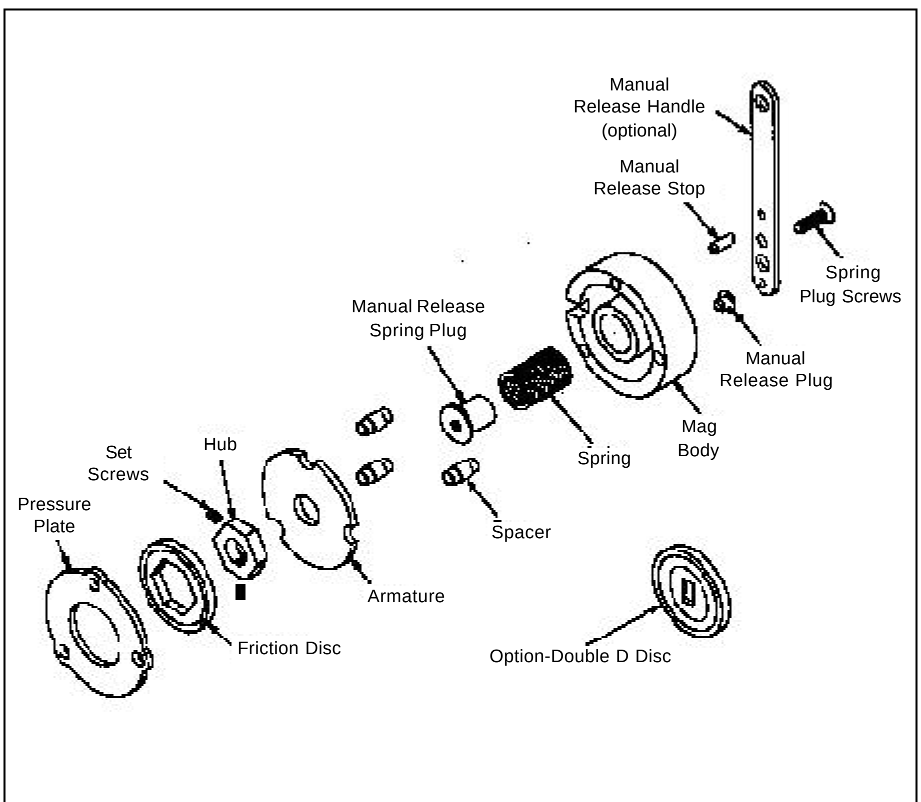
- *Designed for static holding applications only*
- *Static torque 8 lb-in. through 350 lb-in.*
- *Six sizes available, mounting/bolt circles of:*
  1.640 in. 2.500 in. 3.750 in.
  1.770 in. 2.913 in. 4.500 in.
- *Can be mounted magnet body side or pressure plate side*
- *Splined hub and friction disc*
- *Minimum backlash, or movement of hub, after brake is set*



Series 320

This series is also referred to as the AAB-R, or “round”. They can be used to replace an older version of a Stearns square AAB.

- *Designed for stopping and holding applications*
- *Static torque 3 lb-in. through 60 lb-in.*
- *Four sizes available,with mounting/bolt circles of:*
  1.545 in. 2.220 in.
  2.125 in. 2.844 in.
- *Magnet body mounting or pressure plate mounting*
- *Available with standard “hex” hub, or double -D disc for slotted shaft- which eliminates the need for a hub*
- *Optional maintained manual release lever*



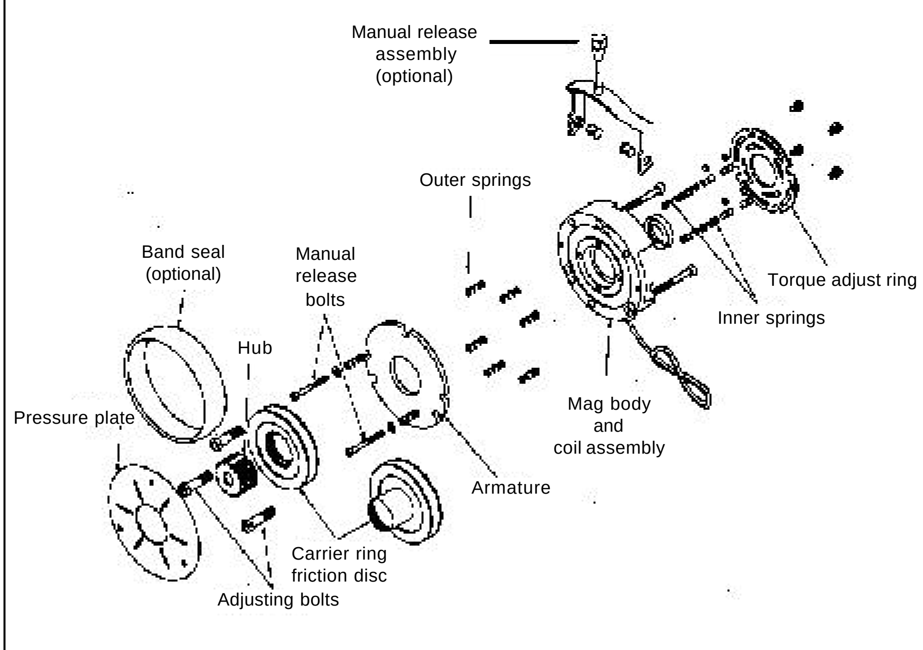
Series 333

Series 333 is also referred to as the AAB-E, since it directly replaces many European brakes.

- *Designed for dynamic braking applications*
- *For metric/IEC mounting*
- *Static torque 3 lb-ft. through 300 lb-ft.*
- *Nine sizes, with mounting/bolt circles of:*

72 mm	*132 mm*	*196 mm*
90 mm	*145 mm*	*230 mm*
112 mm	*170 mm*	*278 mm*

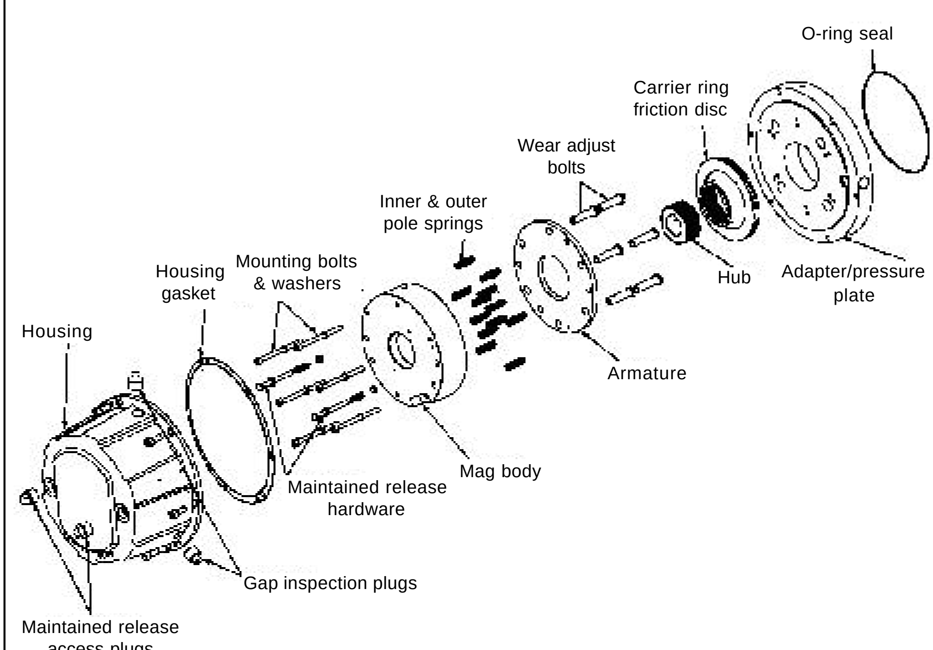
- *Directly interchangeable with many European brakes such as Lenze, Kebco, and Binder*
- *Adjustable torque*
- *Splined hub and friction disc*
- *Optional deadman (non-locking) manual release*



Series 350

Series 350 is also referred to as the AAB-C, or crane brake.

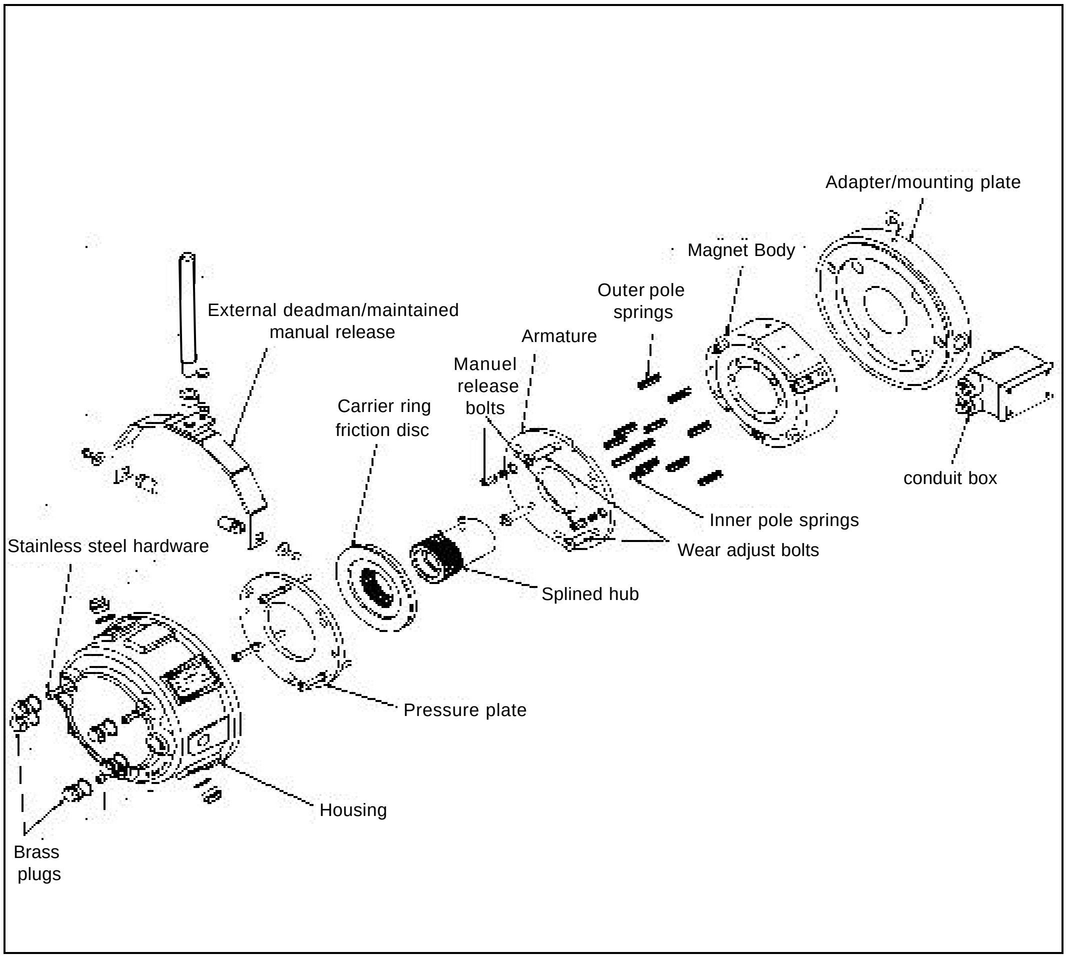
- *Designed for dynamic braking applications*
- *Ideal for crane applications*
- *Static torque 60 lb-ft. through 300 lb-ft.*
- *NEMA C-face mounting:*
  - *182-256 TC/TSC*
  - *284-286 TC/TSC*
  - *324-405 TC/TSC*
- *Pressure plate mounted*
- *Splined hub and carrier ring friction disc*
- *Conduit box is standard*
- *Internal Maintained manual release*
- *IP56 enclosure*



Series 360

Also referred to as AAB-C for crane duty, but this series is magnet body mounted instead of pressure plate mounted. Magnet body mount creates an advantage in maintenance/change out of parts. *The heavy magnet body does not have to be removed to obtain access to the brake, making it easier to perform maintenance.*

- *Designed for dynamic braking applications*
- *Ideal for crane applications*
- *Static torque 60 lb-ft. through 300 lb-ft.*
- *NEMA C-face mounting:*
  - *182-256 TC/TSC*
  - *284-286 TC/TSC*
  - *324-405 TC/TSC*
- *IEC C-face and D-flange mounting:*
  - *132C-160C*
  - *132D-225D*
- *Magnet body mounted*
- *Splined hub and carrier ring friction disc*
- *Conduit box is standard*
- *External Maintained/ Deadman manual release (optional)*
- *IP56 enclosure*



Wear Adjustment

Series 310 and 320 do not require adjustment for friction disc wear. Once the discs are worn, these units can be replaced.

Series 333, 350, and 360 have a manual wear adjustment, using adjustment bolts as shown in figure 9-5.

- Set air gap is measured at the adjusting bolts, between the armature and magbody.
- Normal friction disc wear will cause air gap to increase from original setting.
- Rotate each wear adjust screw evenly to achieve original gap

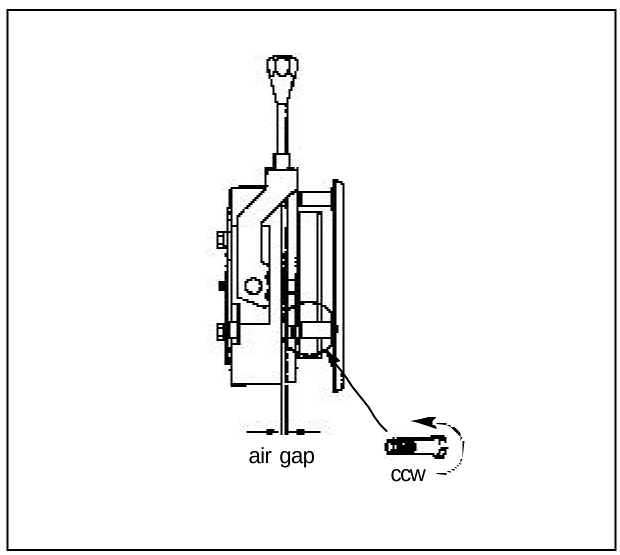


Figure 9-5. Wear adjustment– Adjustment bolts

AAB Options/Modifications

<table>
<tr><th>Options/Modifications</th><th colspan="2">Description</th><th>Series</th></tr>
<tr><td>AC Input Voltage</td><td colspan="2">Rectifiers available to convert AC input voltage to DC output</td><td>ALL</td></tr>
<tr><td>Airgap Shim</td><td colspan="2">Insulating paper between the magnet body and armature
Improves the brake set time</td><td>320/333/350/360</td></tr>
<tr><td rowspan="3">Brake Housings</td><td colspan="2">Aluminum housing</td><td>333</td></tr>
<tr><td colspan="2">Aluminum housing (cast iron is standard)- Significant reduction in brake weight</td><td>350/360</td></tr>
<tr><td colspan="2">Stamped steel</td><td>320</td></tr>
<tr><td rowspan="5">Corrosion Resistance</td><td colspan="2">Band seal</td><td>320/333</td></tr>
<tr><td colspan="2">Breather drain- Allows excess moisture to be removed from the brake</td><td>350/360</td></tr>
<tr><td colspan="2">Motor gasket</td><td rowspan="3">333/350/360</td></tr>
<tr><td colspan="2">Space heater- 115, 230, 460 volt AC</td></tr>
<tr><td colspan="2">Viton motor gasket</td></tr>
<tr><td rowspan="2">Manual Release Options</td><td>Maintained manual release</td><td>Lever-type release- Standard long handle, short handle, or bent handle</td><td>320</td></tr>
<tr><td>Non-Maintained
(Deadman) manual release</td><td>External lever release</td><td>333/360</td></tr>
<tr><td rowspan="8">Mounting Plates</td><td colspan="2">Size 72 adapt to 48 C-face or 56 C-face</td><td rowspan="7">333</td></tr>
<tr><td colspan="2">Size 90 adapt to 48 C-face or 56 C-face</td></tr>
<tr><td colspan="2">Size 112 adapt to 56 C-face</td></tr>
<tr><td colspan="2">Size 132, 145, 170 adapt to 180/210/250 C-face</td></tr>
<tr><td colspan="2">Size 170, 196 adapt to 280 C-face</td></tr>
<tr><td colspan="2">Size 230, 278, 292 adapt to 320 - 400 C-face</td></tr>
<tr><td colspan="2">Special Metric/IEC frame adapters also available</td></tr>
<tr><td colspan="2">Non-standard mounting plates</td><td>320/350/360</td></tr>
<tr><td rowspan="4">Special hub/disc options</td><td colspan="2">Carrier ring friction disc- Reduced noise</td><td rowspan="2">320</td></tr>
<tr><td colspan="2">Double “D” disc- For slotted shaft, eliminates the need for a brake hub</td></tr>
<tr><td colspan="2">Non-standard bore size</td><td>ALL</td></tr>
<tr><td colspan="2">Steel hub- “Press fit” hub</td><td>333</td></tr>
<tr><td rowspan="5">Switches</td><td colspan="2">Mechanical brake release indicator- Manual release actuated- Indicates when the brake is released manually</td><td>320</td></tr>
<tr><td colspan="2">Mechanical brake release indicator- Indicates when the brake is released electrically</td><td>333/350/360</td></tr>
<tr><td colspan="2">Proximity switch- Indicates when the brake is released, using a sensing device without the use of a mechanical switch</td><td rowspan="3">333/350/360</td></tr>
<tr><td colspan="2">Thermal switch- Indicates if brake has exceeded maximum temperature</td></tr>
<tr><td colspan="2">Wear indicator switch- Indicates friction disc wear</td></tr>
<tr><td>Through-Shaft</td><td colspan="2">Hole in brake housing to allow motor shaft to extend beyond brake</td><td>333/350/360</td></tr>
<tr><td rowspan="3">Wiring Options</td><td colspan="2">Conduit Box</td><td>350/360</td></tr>
<tr><td colspan="2">Longer cable length</td><td>ALL</td></tr>
<tr><td colspan="2">Terminal Strip</td><td>333/350/360</td></tr>
</table>

Armature Actuated Brakes (AAB) Torque Selection

Select the proper torque rating based on horsepower and rpm (speed at the clutch or brake) using the *Torque Selection Chart* below. Based on 1.4 service factor.

For other service factors and speeds, use the formulas shown below.

Formula for TABLE 1

$$T = \frac{63{,}025 \times P}{N} \times SF$$

T = Static torque, lb-in.

P = Horsepower, hp

N = Shaft speed at brake, rpm

SF = Service Factor

63,025 = Constant

Formula for TABLE 2

$$T = \frac{5{,}252 \times P}{N} \times SF$$

T = Static torque, lb-ft.

P = Horsepower, hp

N = Shaft speed at brake, rpm

SF = Service Factor

5,252 = Constant

Caution: Do not use Table 1 to select brakes for overhauling or high inertial loads, or where a stop in specified time or distance is required. For these applications the total inertia of the load and power transmission system must be determined to make a brake selection. Refer to sections on torque and thermal ratings and determination, listed in section VI.

NOTE: Series 310 for holding applications only.

TABLE 1

Series 320 Static Torque in lb-in. *(Nm)*

Motor hp	rpm									
	600	800	1000	1200	1500	1800	2000	2400	3000	3600
	Static Torque lb-in *(Nm)*									
1/20	18 *(2.03)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	3 *(.34)*	3 *(.34)*	3 *(.34)*	3 *(.34)*	3 *(.34)*	3 *(.34)*
1/12	18 *(2.03)*	18 *(2.03)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	3 *(.34)*	3 *(.34)*	3 *(.34)*
1/8	35 *(3.95)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	7 *(.79)*	3 *(.34)*
1/6	35 *(3.95)*	35 *(3.95)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	7 *(.79)*	7 *(.79)*	7 *(.79)*
1/4	—	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	7 *(.79)*
1/3	—	—	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*	18 *(2.03)*
1/2	—	—	—	—	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*	18 *(2.03)*	18 *(2.03)*
3/4	—	—	—	—	—	—	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*	35 *(3.95)*
1	—	—	—	—	—	—	—	—	—	35 *(3.95)*

TABLE 2

Series 333/350 Static Torque in lb-ft. *(Nm)*

Motor hp *(kw)*	rpm									
	600	800	1000	1200	1500	1800	2000	2400	3000	3600
	Static Torque lb-ft *(Nm)*									
1/3 *(.25)*	6 *(8)*	6 *(8)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*
1/2 *(.37)*	12 *(16)*	6 *(8)*	6 *(8)*	6 *(8)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*
3/4 *(.55)*	12 *(16)*	12 *(16)*	6 *(8)*	6 *(8)*	6 *(8)*	6 *(8)*	3 *(4)*	3 *(4)*	3 *(4)*	3 *(4)*
1 *(.75)*	25 *(34)*	12 *(16)*	12 *(16)*	12 *(16)*	6 *(8)*	6 *(8)*	6 *(8)*	6 *(8)*	6 *(8)*	3 *(4)*
1-1/2 *(1.1)*	25 *(34)*	25 *(34)*	12 *(16)*	12 *(16)*	12 *(16)*	12 *(16)*	6 *(8)*	6 *(8)*	6 *(8)*	6 *(8)*
2 *(1.5)*	25 *(34)*	25 *(34)*	25 *(34)*	25 *(34)*	12 *(16)*	12 *(16)*	12 *(16)*	6 *(8)*	6 *(8)*	6 *(8)*
3 *(2.2)*	45 *(60)*	45 *(60)*	25 *(34)*	25 *(34)*	25 *(34)*	25 *(34)*	12 *(16)*	12 *(16)*	12 *(16)*	12 *(16)*
5 *(3.7)*	60 *(80)*	60 *(80)*	45 *(60)*	45 *(60)*	25 *(34)*	25 *(34)*	25 *(34)*	25 *(34)*	25 *(34)*	12 *(16)*
7-1/2 *(5.6)*	110 *(150)*	110 *(150)*	60 *(80)*	60 *(60)*	45 *(60)*	45 *(60)*	45 *(60)*	25 *(34)*	25 *(34)*	25 *(34)*
10 *(7.5)*	180 *(240)*	110 *(150)*	110 *(150)*	110 *(150)*	60 *(80)*	45 *(60)*	45 *(60)*	45 *(60)*	25 *(34)*	25 *(34)*
15 *(11.2)*	300 *(400)*	180 *(240)*	110 *(150)*	110 *(150)*	110 *(150)*	60 *(80)*	60 *(80)*	60 *(80)*	45 *(60)*	45 *(60)*
20 *(14.9)*	300 *(400)*	180 *(240)*	180 *(240)*	180 *(240)*	110 *(150)*	110 *(150)*	110 *(150)*	60 *(80)*	60 *(80)*	60 *(80)*
25 *(18.6)*	—	300 *(400)*	180 *(240)*	180 *(240)*	180 *(240)*	110 *(150)*	*	*	*	*
30 *(22.4)*	—	300 *(400)*	300 *(400)*	300 *(400)*	180 *(240)*	180 *(240)*	*	*	*	*
40 *(29.8)*	—	—	300 *(400)*	300 *(400)*	300 *(400)*	180 *(240)*	*	*	*	*
50 *(37.3)*	—	—	—	—	300 *(400)*	300 *(400)*	*	*	*	*
60 *(44.7)*	—	—	—	—	300 *(400)*	300 *(400)*	*	*	*	*

* Exceeds maximum speed rating for Series 333 and Series 350.

X. Typical Stearns Brake Applications

There are hundreds of applications for Stearns disc brakes. In fact, it is difficult to find a modern manufacturing facility without one or more Stearns brakes at work.

A representative list of applications, categorized by industry type, is presented below.

Agricultural equipment
- Automated feeders
- Cotton seed unloaders
- Grain elevators
- Feed grinders and crushers

Aviation equipment
- Aircraft boarding ramps
- Onboard hoists
- Baggage/freight loaders
- Baggage sorting/inspection equipment
- Baggage delivery conveyor systems
- Aircraft painting platforms

Commercial laundry equipment
- Washing machines
- Dry cleaning extractors
- Laundry extractors
- Ironers
- Pressing machines

Construction equipment
- Construction elevators
- Cranes
- Skip hoists
- Aggregate screeners
- Aggregate conveyors
- Bucket elevators
- Construction winches

Food processing equipment
- Bottle washers and fillers
- Can closing machines
- Can testing machines
- Flour mills
- Bakery ovens
- Choppers and mixers
- Carton fillers
- Candy making machines
- Food conveyors

General industrial equipment
- Riveting machines
- Rotary shears
- Wire spoolers
- Automated assembly equipment
- Nailing machines
- Rubber cutting machines
- Tire molders and presses
- Coil winding machines
- Pumps
- Door operators
- Automated welders
- Positioners
- Extrusion presses
- Spring winding and forming machines
- Balancers
- Rotary tables

Machine tools
- Drilling and tapping machines
- Boring mills
- Milling machines
- Grinders
- Lathes
- Screw machines
- Radial drills
- Transfer lines
- Saws
- Automatic chuckers
- Presses
- Press Brakes
- Punch presses

Material handling equipment
- Automated storage/retrieval systems
- Overhead cranes
- Gantry cranes
- Hoists
- Man lifts
- Monorail systems
- Conveyors
- Palletizers
- Portable lifters
- Freight elevators

Marine equipment
- Winches (reel and capstan)
- Mooring
- Vang
- Topping
- Warping
- Anchor
- Shipboard cranes
- Dry docks
- Steering gear
- Jack-up oil rigs

Mill and foundry equipment
- Rolling mill stands
- Pipe and tube drawbenches
- Mold stackers
- Ingot pushers
- Transfer cars
- Shot blast machines
- Lance hoists
- Molding machines
- Automatic furnaces

Mining equipment
- Ore loaders
- Mining conveyors
- Mine elevators
- Shuttle cars
- Face drills
- Hammer mills
- Ball mills

Printing equipment
- Rotary presses
- Letter presses
- Stencil machines
- Stickers
- Folding machines
- Paper slitting machines

Packing equipment
- Strapping equipment
- Carton sealers
- Wrapping machines
- Laminators
- Baling equipment

Railroad equipment
- Car pullers
- Car turntables

Textile equipment
- Looms
- Cards
- Cloth spreaders and cutters
- Warpers
- Sewing machines
- Winders
- Drying machines

Miscellaneous
- Wind generators
- Communication antennas
- Window washing scaffolds
- Cooling tower fans