Construction, Working and Maintenance of Electro Hydraulic Thruster Drum Brakes

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The information contained in this article represents a significant collection of technical information about construction, working and maintenance of electro hydraulic thruster drum brakes. This information will help to achieve increased reliability at a decreased cost. Assemblage of this information will provide a single point of reference that might otherwise be time consuming to obtain. Most of information given in this article is mainly derived from literature on the subject from sources as per the reference list given at the end of this article. For more information, please refer them. All information contained in this article has been assembled with great care. However, the information is given for guidance purposes only. The ultimate responsibility for its use and any subsequent liability rests with the end user. Please view the disclaimer uploaded on http://www.practicalmaintenance.net.

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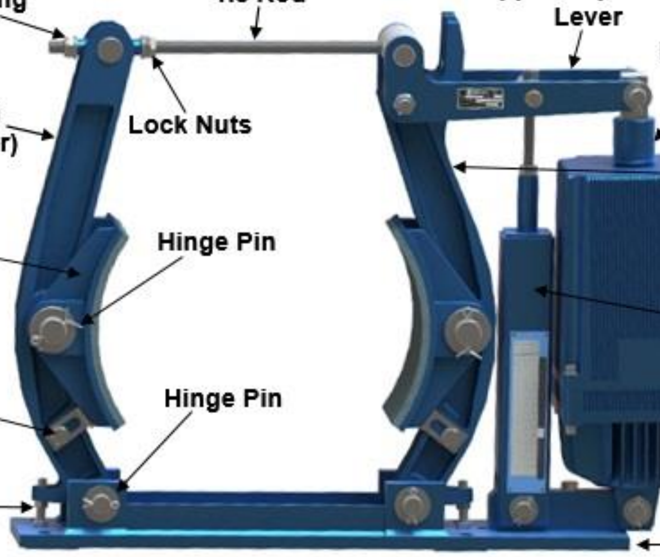
Electro Hydraulic Thruster Drum Brakes

Electro hydraulic thruster (commonly called thruster) drum brake is a device used to retard the speed of moving machinery and to stop it accurately to the desired position. When the braking force is applied to the brake shoes by a pre-stressed compression spring, the shoes press on the rotating brake drum retarding its speed and finally stopping it. The releasing of the brake drum and compressing of the spring is done by the thruster.

Thruster operated drum brakes are mainly used in material lifting and handling equipment (in the field of applications like ports, steel and metallurgy, mining, etc.) mainly because their “soft / smooth” braking and 'fail-to-safety' designs to ensure safety to men and machines. These brakes are called 'fail-to-safety' because the braking is obtained by electrical current loss under the action of pre-stressed compression spring. In case of current loss (power failure), these brakes stop the motor or the driven load.

Information about construction, working, installation and maintenance of electro hydraulic thruster drum brakes and thrusters is given in this article.

Construction of Thruster Operated Drum Brakes

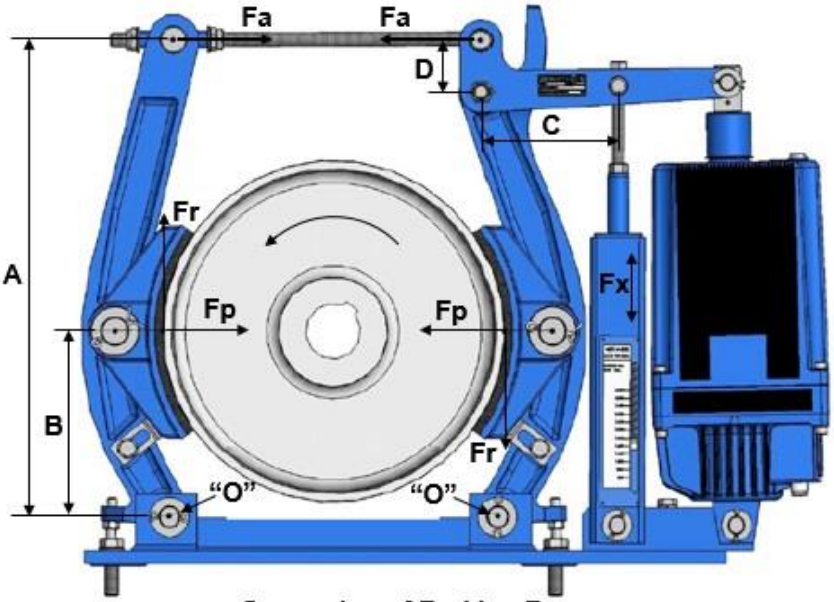


Thruster Operated Drum Brake

As shown in above figure, a thruster operated drum brake has a pair of brake shoes with lining (friction pads). The lining is either glued or riveted to the brake shoe. The shoes are hinged on main (internal) arm and side (external) arm of the brake. Each arm is fitted to the mounting base (called base) with a hinge pin. These arms are connected to each other on top by a tie rod, which is hinged in the main arm and locked to the swivel block in the side arm, by nuts. A crank lever is hinged on the main arm and the other end is fixed to the top clevis of the thruster by a hinge pin. A brake spring is fixed on the crank lever. It is pre-tensioned by a screw and a locknut on the lever. The pre-tension in the spring decides the braking torque. The thruster is fitted on the base by a hinge pin. When the thruster is not energized, the brake shoes are pressed on the brake drum fitted on the drive motor shaft and hold it under the effect of braking force provided by the brake spring. In this condition, the brake is applied and the drum cannot rotate. When the thruster is energized, its piston travels upwards and the crank lever turns which pushes the tie rod and compresses the brake spring. Simultaneously it moves main arm and side arm, releasing the brake drum.

Working of Thruster Operated Drum Brakes

Thruster operated drum brakes are spring applied and electrically released. Following figure shows how the braking force is generated by the brake spring for braking (applying brake).



Generation of Braking Force

A thruster operated drum brake uses the force exerted by the brake spring for braking. As shown in above figure, the compressed brake spring tends to expand itself creating the extension force (Fx). A force (Fa) is created by the extension force (Fx) and is conveyed to the brake arms which is equal but in the opposite direction in each arm. Due to the relationship of the distances (A and B) that are there is in the arms with respect to the rotation axis (O), a clamping force (Fp) is created which is equal in both brake shoes but in the opposite direction that makes the brake to operate (apply/close). The clamping force created in the brake shoe (Fp) generates a friction force (Fr) at a tangent to the drum in one direction or the other depending on the rotation direction of the drum. The result of adding the two friction forces of brake shoes is called/known as braking force.

Brake torque can be calculated as per the following.

Fa (N) = Fx, extension force of the brake spring (N) × C (mm) / D (mm)
= [K, spring constant (N/mm) × {L1, uncompressed spring length (mm) - L2, compressed spring length (mm)}] × C (mm) / D (mm)

Fp (N) = Fa (N) × A (mm) / B (mm)

Fr (N) = μ, coefficient of friction for the brake shoe lining (usually 0.4) × Fp (N)

Braking Force (N) = 2 × Fr (N)

Braking Torque (Nm) = Braking Force (N) × Drum radius (m) = 2 × Fr (N) × Drum radius (m) = Fr (N) × Drum diameter (m)

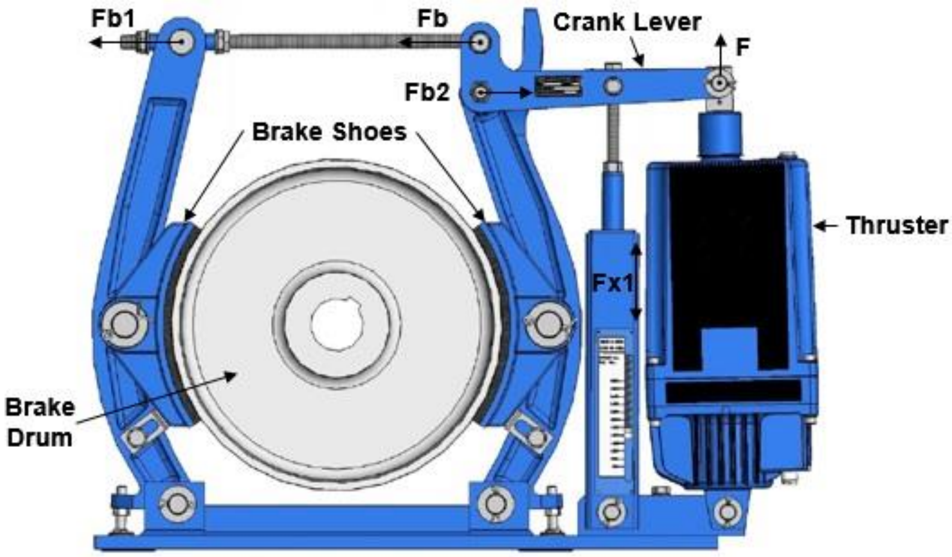
As per one Indian manufacturer, braking torque of 180 to 250% of motor rated torque is sufficient for normal applications like Cranes, Hoist and other material handling equipments. For CT (cross travel) and LT (long travel) drives, braking torque of 180 to 150% of motor rated torque will ensure braking without excessive noise and mechanical jerk.

Rated (Full-load or Braking) torque of a motor can be calculated by the following formula.

$T = 9550\ P_{kW} / n_r$

Where,
T = Rated torque (Nm)
P_{kW} = Rated power (kW)
n_r = Rated rotational speed (rpm)

Following figure shows how the break drum is released by the thruster.



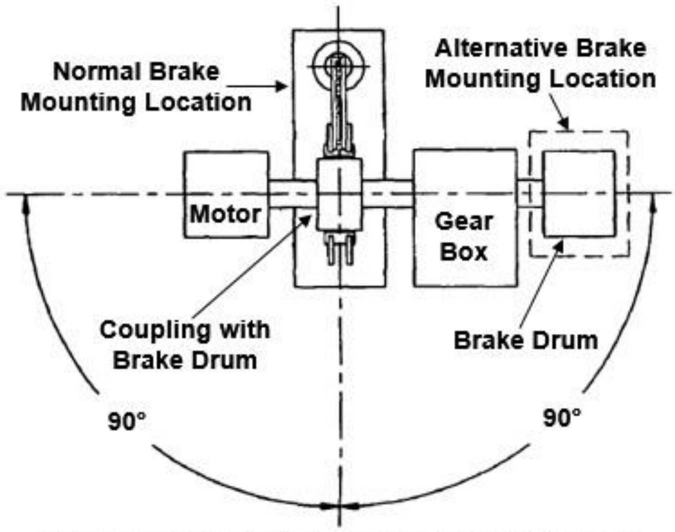
Releasing of Brake Drum

As shown in above figure, the thruster drum brake releases (opens) the brake when the thruster is energized (electric power is supplied). When the thruster is energized, it generates a force (F) capable of overcoming the force Fx1, the force generated by the brake spring when the brake is open. It may be noted that Fx1 > Fx where Fx is the force of the brake spring when the brake is closed. When the force (F) is generated in the thruster, the thruster's piston pushes the crank lever up with which force Fb is generated, which is transmitted to the brake arms, generating forces Fb1 and Fb2 making the brake arms to open, unlocking/releasing the drum's brake shoes.

Installation of Drum Brake

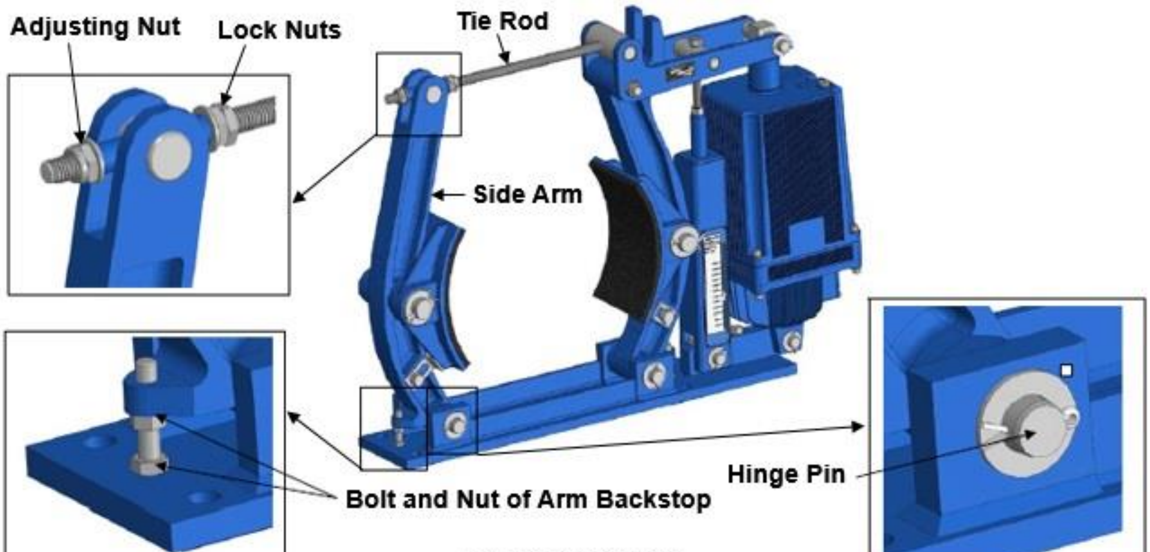
A brake is always located at high speed side of the gearbox (an application) because its higher speed enables to absorb the kinetic energy with smaller torque (higher the speed, lower the torque), and thereby smaller brake. Generally, the coupling between motor and the gearbox is provided with a brake drum.

As shown in the following figure, the brake is normally installed between motor and gearbox, that is to say on high speed shaft, with brake drum always installed on gearbox side, which is the load side, so that it can stop a lifted mass or a travelling or a rotating mass. In case it is not possible to install the brake between motor and gearbox, it should be installed on the gearbox’s high speed shaft extension.



Top View - Brake Installation (Mounting Location)

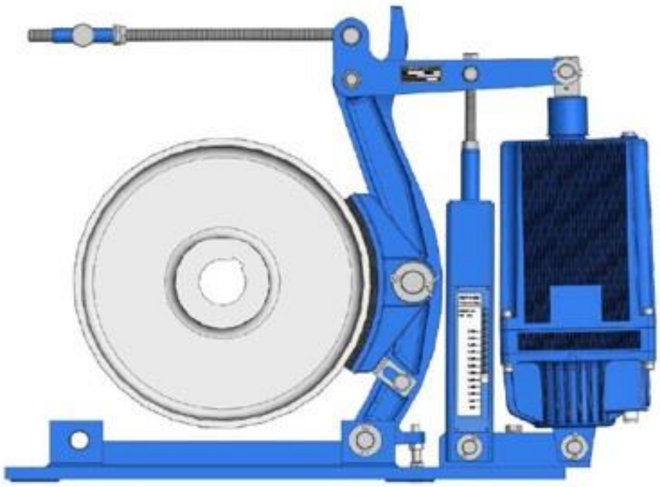
Thus, as shown in above figure, there are two possible cases of drum with which the drum brake can be mounted: normal location (between motor and gearbox) and alternative location (brake drum on an open/free ended shaft).



Brake Installation

For installing a brake on a drum on an open/free ended shaft (at the alternative location), the brake can be insert through the open/free end of the drum after increasing the distance between its arms (if required). For increasing the distance between the arms, after loosening the bolt and nut of arm backstop, loosen the lock nuts on the tie rod (see above figure). Now loosen the adjusting nut and push the side arm out to increase the distance between the arms. Now the brake can be installed at the alternative location.

For installing the brake on a drum coupling between a motor and gearbox (at normal location), side arm need to be removed so that the brake assembly without side arm can be installed at the normal location. For removing the side arm, after loosening the bolt and nut of the arm backstop, loosen the lock nuts on the tie rod and remove the adjusting nut. Now remove the hinge pin of the side arm after removing split pin from it. Now remove the side arm. After removing the side arm, the brake assembly without the side arm can be installed at the normal location as shown in the following figure (with brake shoe of the main arm touching the brake drum).



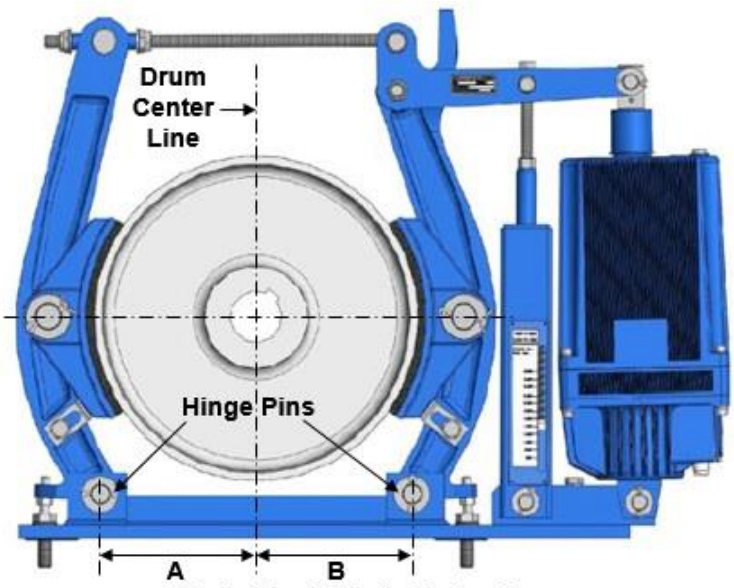
Installation of Brake Assembly Without Side Arm

After installation of brake assembly without side arm at normal location, install the side arm back (in original position) following the disassembly steps in the reverse order.

As the brake arms and the brake shoes are movable, the brake's friction pads (also called brake pads or brake lining) would have full contact on the brake drum even when the brake is not aligned correctly. But in this case the friction pads wouldn't be loaded equally. Thus one pad would heat up more and wear faster.

In view of above, after mounting the brake on the brake drum, heed the following instructions to center (height and centering must be within 0.25 mm) the brake to the brake drum.

- Insert mounting bolts into the mounting base but don't tighten them yet.
- Use shims to adjust differences in height between brake and brake drum if necessary.
- Now center the brake to the brake drum and tighten the mounting bolts to the recommended torque. As shown in the following figure, for the brake to be at center of the brake drum, hinge pins of the arms should be at same/equal distance from the drum center line (i.e. A = B). A plumb and a ruler may be used to measure distances A and B.



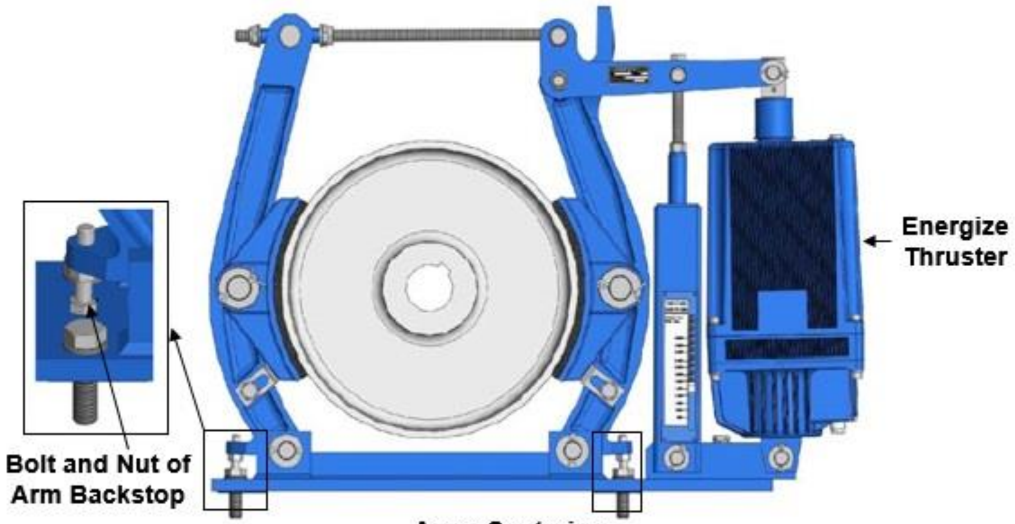
Centering Brake to Brake Drum

Make sure that both brake shoes have full contact on the brake drum. It is recommended that the non-parallelism and inclination of the brake lining surface to the brake drum surface should not exceed 0.1 mm for 100 mm of the brake drum width.

Brake Adjustment and Setting

After installation of the brake, proceed with the electrical connection of the thruster. After providing electric connection to the thruster, carry out following adjustment and setting to the brake.

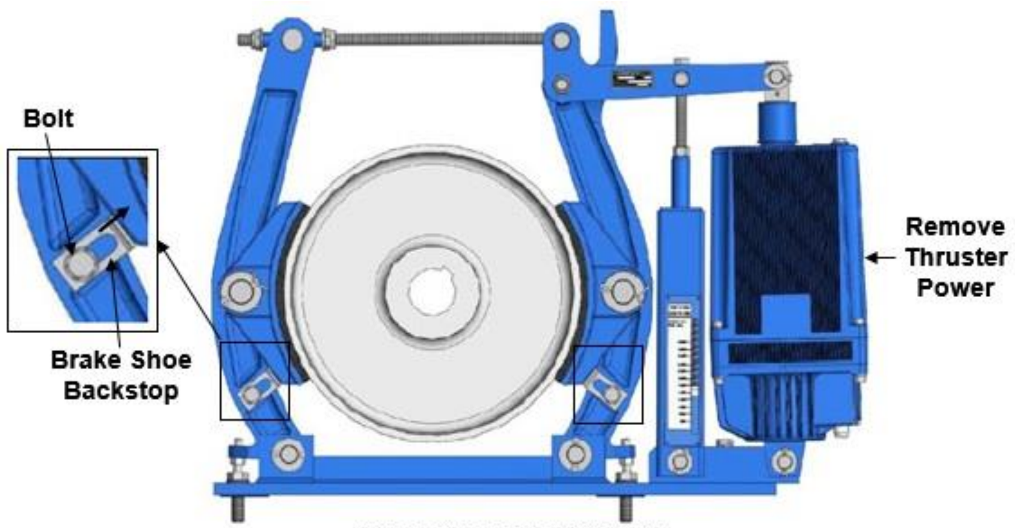
Arms Centering



Arms Centering

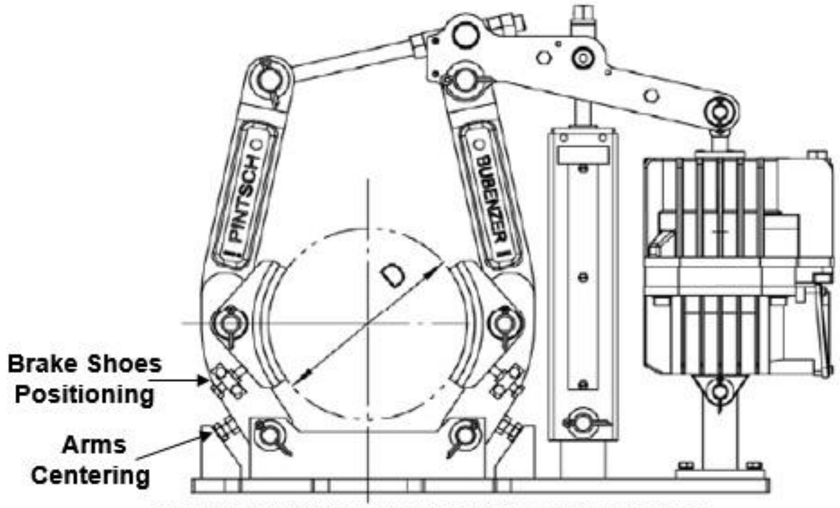
Arms centering (setting of equal air gap width) is done by means of the backstops of the arms with the base. For centering the arms, loosen the nuts and bolts of both arm's backstops. Now energize (power) the thruster to release (open) the brake. Now adjust the bolts of the arm's backstops so that the shoes are equally separated from the drum. In this position one of the bolt slightly touches the base and the other is close to it without touching. Secure the bolts of the arm's backstops with the nuts.

Brake Shoes Positioning



Brake Shoes Positioning

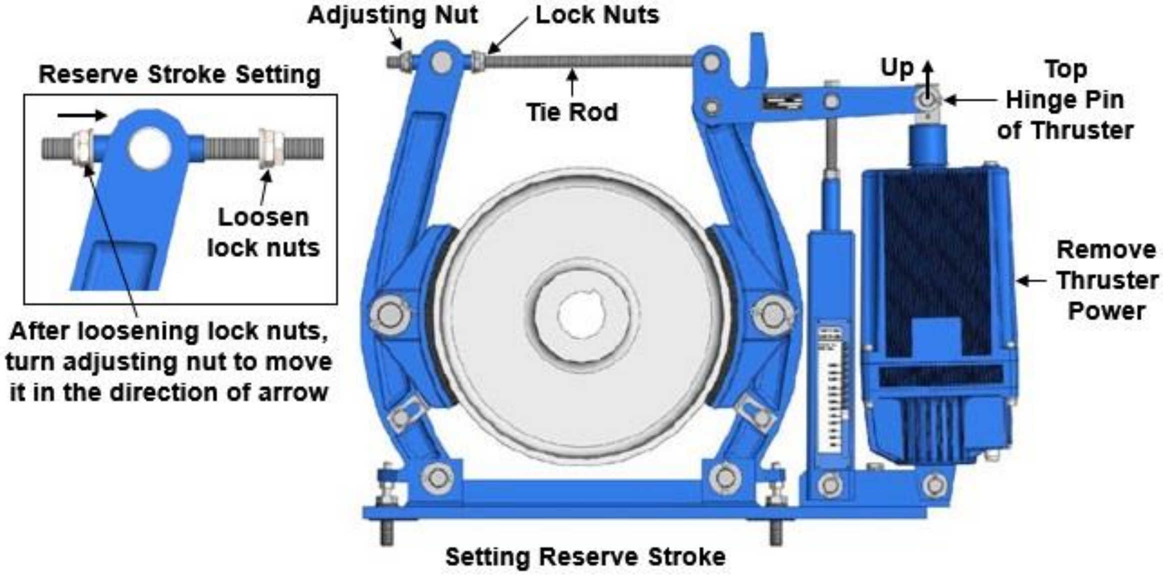
Brake shoes positioning prevent the brake shoes from tilting and grinding at the brake drum while the brake is released. For positioning the brake shoes, remove electric power from the thruster so that the brake shoes press on the brake drum. Next loosen the backstop bolts of the brake shoes and move the backstops forward (as shown by arrow in above figure) until they make contact with the brake shoes, but without pressing excessively. Tighten and lock the brake shoe backstop bolts to complete their positioning.



Arms Centering and Brake Shoes Positioning

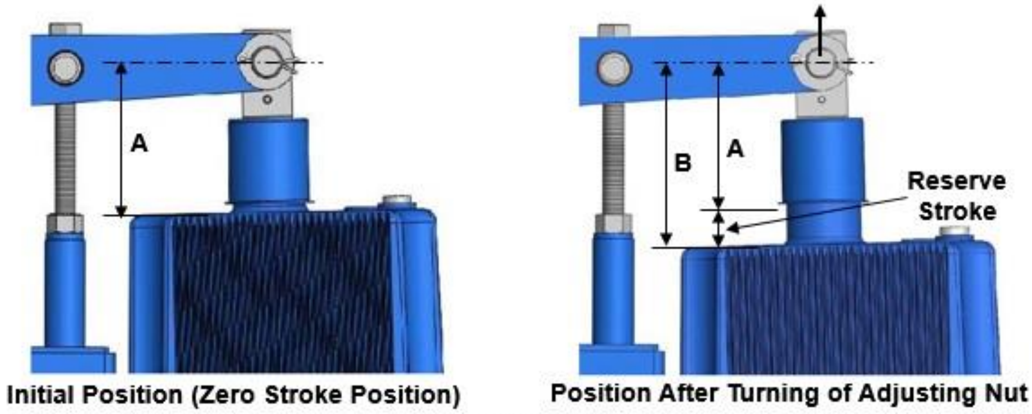
It may be noted that for arms centering and brake shoes positioning, different manufacturers use different methods. For example, as shown in above figure, for brake shoes positioning some manufacturers use an arrangement which is similar to the arrangement for arms centering.

Setting Reserve Stroke/Path



Setting Reserve Stroke

For setting the reserve stroke, remove electric power from the thruster and back the adjusting nut so that thruster's top hinge pin is at position corresponding to zero stroke of the thruster, called initial/starting position of the thruster. Now turn/rotate the adjusting nut of the tie rod to move it in the direction of arrow after loosen its lock nuts so that top pin of the thruster moves up (in direction of arrow) by the reserve stroke recommended by the brake manufacturer. After stroke setting, tighten lock nuts to lock position of the adjusting nut.



Reserve Stroke

As shown in above figure, Reserve Stroke = Distance B − Distance A. Where, B = position of the top hinge pin of the thruster after it has moved up by the recommended reserve stroke from initial (zero stroke) position and A = initial position of the top hinge pin of the thruster.

As a progressive loss of braking torque takes place during the use of the brake due to wear of the brake shoes lining, it is necessary to turn/rotate the adjusting nut of the tie rod periodically for resetting the brake to the correct (recommended) reserve stroke because if piston rod bottoms out, the brake will slip. It may be noted that wear of brake shoes lining between 1 and 2 mm in both shoes indicate loss of virtually entire reserve stroke. However, a brake does not require readjustment of the reserve stroke setting if the self adjusting device (automatic recovery option) is fitted to it because in such case the reserve stroke remains constant during the linings wear and the braking torque also remains constant.

As Thruster Stroke (Full/Total Stroke of Thruster) = Opening Stroke + Reserve Stroke, some manufacturers recommend to set opening stroke of the thruster instead of reserve stroke. For this, top hinge pin of the thruster is first raised fully corresponding to full stroke of the thruster and then lowered by the recommended opening stroke.

It may be noted that in effect, both the methods are same. After reserve stroke (or opening stroke) setting to the recommended amount, when the brake is released (operated) it will result in approximately “Brake Shoe Stroke”, the gap between each brake lining and the brake drum as per the following table if brakes are manufactured as per DIN Standard 15435.

Brake Diameter, mm	160*	200	250	315	400	500	630	710
Brake Shoe Stroke, mm	0.80	1.00	1.25	1.25	1.60	1.60	2.00	2.00

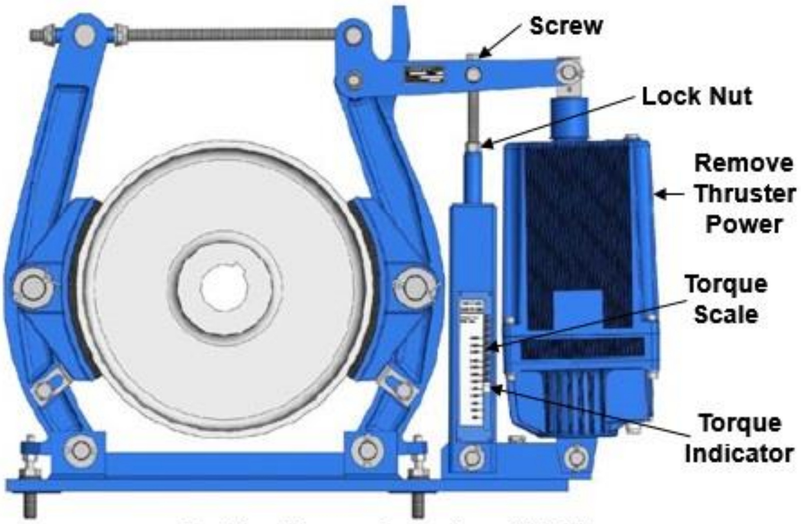
* Not as per DIN Standard

Braking Torque Adjustment/Setting

Remove the thruster power to carry out braking torque adjustment. The braking torque is obtained by compressing the brake’s spring by spring’s screw.

A brake is fitted with a torque scale and torque pointer/indicator. The torque scale shows a maximum and minimum torque value to which the brake can be set. If customer has provided the recommended braking torque value, it is shown in the brake’s name plate.

Position of the torque pointer/indicator on the torque scale shows the braking torque. As shown in the following figure, for braking torque adjustment, loosen the lock nut and rotate (manipulate) the screw to the recommended (or desired) torque value. There are two types of screw in use: rising and non-rising. The figure shows use of a non-rising type screw.



Braking Torque Adjustment/Setting

After adjusting/setting the torque to the recommended (or desired) torque value, lock the screw by tightening the lock nut.

After adjusting the torque to the recommended value, running-in of the brake shoes lining is essential to insure an even contact pattern on the lining which will avoid uneven loading on part of the lining surface.

For running-in under load, load the drive with approximately half the rated load and carry out approximately 10 to 15 braking (emergency stop) operations. Check the contact pattern. If the contact pattern is satisfactory, load the drive at the rated load and carry out approximately 10 to 15 braking operations. Check the reserve stroke of the thruster. Readjust if necessary. Running-in is completed as soon as the stopping distance at rated load and maximum speed is not reducing any further after repeated braking operations.

Brake Standards

To ensures that the brake parts (e.g. brake shoes with lining) made as per same standard by different manufacturers are interchangeable, it is recommended to procure a brake as per some standard. Many manufacturers are making brakes as per following DIN standard.

DIN 15435-1: Power transmission engineering; drum brakes; connecting dimensions
DIN 15435-2: Power transmission engineering; drum brakes; brake shoes
DIN 15435-3: Power transmission engineering; drum brakes; brake linings
DIN 15431: Power transmission engineering; brake drums; main dimensions

Optional Items

Thruster drum brakes are supplied with various optional items as under.

Stainless Steel Pins

For continued proper operation of a brake, it is essential that the various components are able to move freely. Therefore, use of stainless steel pins is suggested/recommended for the brakes installed outdoors or in salty and humid environments. The stainless steel pins are made in AISI 420, hardened and tempered. Many times SS main pins are also provided with nipples for grease lubrication.

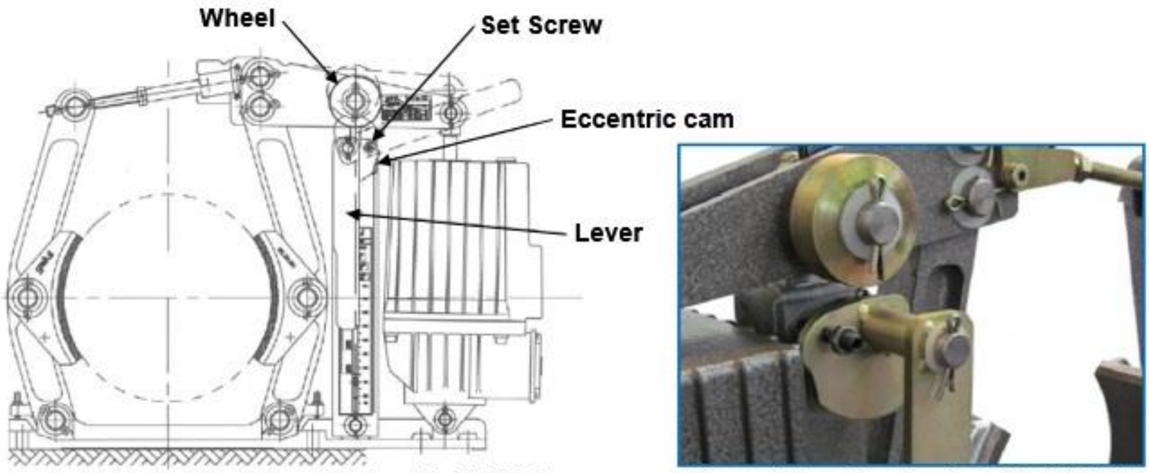
1.5 Times Wider Brake Shoes

Standard Brake Shoes 1.5 Times Wider Brake Shoes

Standard Brake Shoes and 1.5 Times Wider Brake Shoes

The 1.5 times wider brake shoes are 1.5 times wider than standard brake shoes, for example as per DIN 15435. They are used for heavy duty drum brakes. The 1.5 times wider brake shoes allow a better dissipation of thermal energy and a better use of the lining. However, such brake shoes must be used with brake drums or couplings with brake drums 1.5 times wider than the standard brake drums as per DIN 15431.

Manual Opening System (latching or non-latching type)



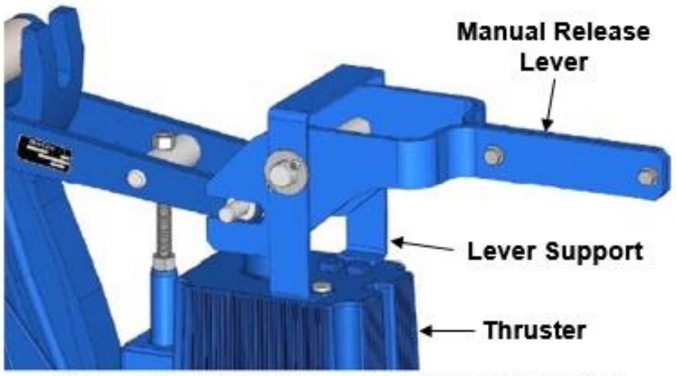
Manual Opening System (Left Side) Manual Opening System (Right Side)

Manual Opening System

The manual opening/release system is an option for facilitating maintenance and/or for some special installations which require the possibility to open the brake manually and eventually to lock/latch it in open position.

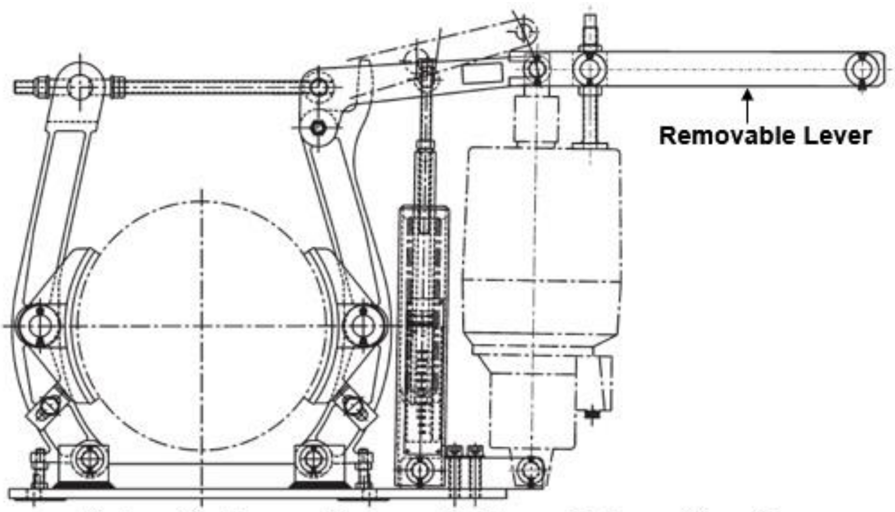
As shown in above figure, typically the system is made with a lever with eccentric cam which, held and lifted, working on a wheel allows to open the brake and to eventually lock it in open position. As shown in above figure, the option can be installed on left side (as in Drawing) or on right side (as in Picture). For closing the brake, it is necessary to put the lever back in vertical position. An optional arrangement is also provided/available which allow to open the brake manually but doesn’t allow to lock/latch the brake in open position.

As shown in the following figure, many times a brake is provided with a lever for manual release operation on the thruster. By means of the lever the brake can be opened/released manually in case of an emergency situation, e.g. to lower a load after an emergency stop.



Brake with Manual Release Lever on Thruster

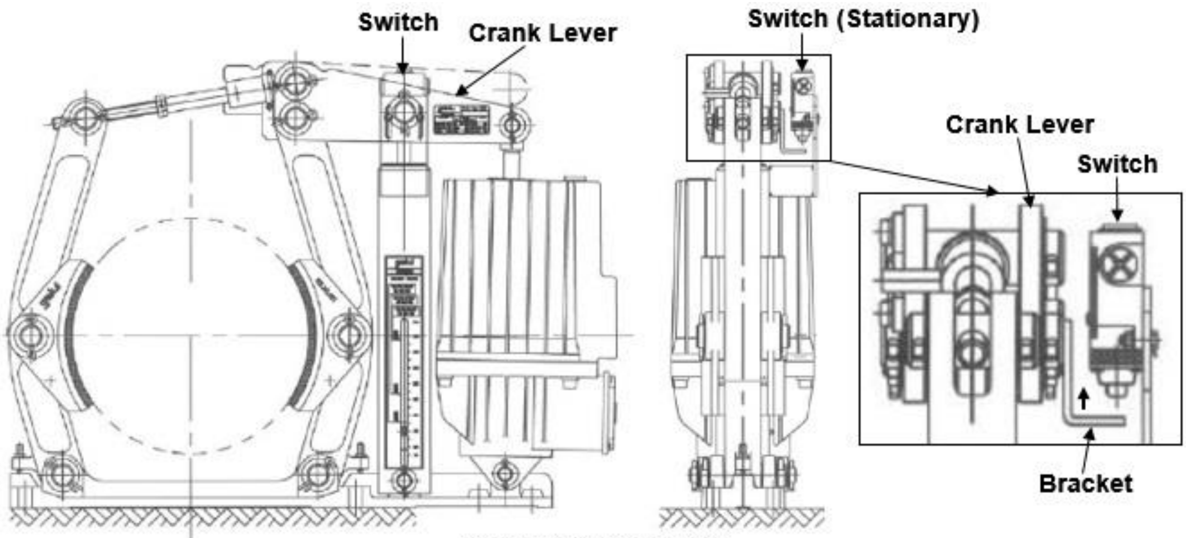
The lever should be pushed downwards SLOWLY to open the brake. If the lever is released, the brake automatically closes.



Brake with Removable Lever for Manual Release Operation

As shown in above figure, many times a brake is provided with a removable lever for manual release operation. The lever should be stored safely in its proper place.

Open Position Switch

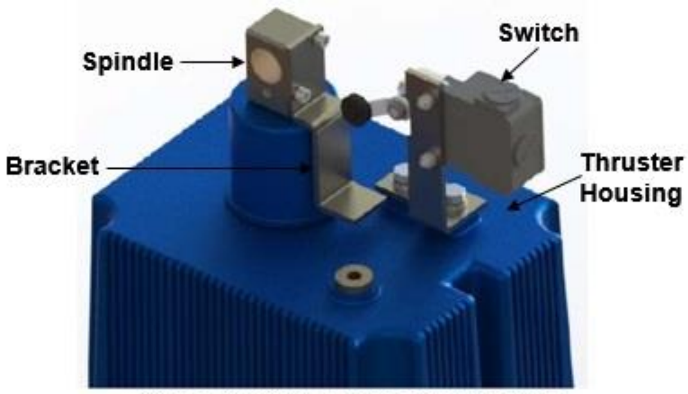


Open Position Switch

Limit switches can be provided to indicate the status of the brake. The open position switch is an option for avoiding the accidental start of the machine's main motor before the brake is completely open.

As shown in above figure, to get an indication when the brake is completely open, a switch (micro switch) is installed on spring housing which remains stationary. A bracket is mounted on the crank lever. When command is given to open/release the brake, the bracket fitted on the crank lever starts moving up (as shown by arrow) along with the crank lever. When thruster is about to complete its stroke, the bracket actuates the switch which gives indication that the brake is now completely open.

As shown in the following figure, sometimes a switch (limit switch) is installed on the thruster housing and a bracket is fitted on the thruster spindle. When thruster is about to complete its stroke, the bracket actuates the switch which gives indication that the brake is now completely open.



Open Position Switch on Thruster

It may be noted that if required, some manufacturers are also providing/installing inductive proximity switch instead of a limit / micro switch.

Protection Cover

Protection Cover

If the brake is to be installed open-air or in places subject to dust or splashing or to possible sliding of other materials, it is necessary to protect the brake by protection cover to avoid the insertion of foreign bodies between the linings and the brake drum.

Special Paint

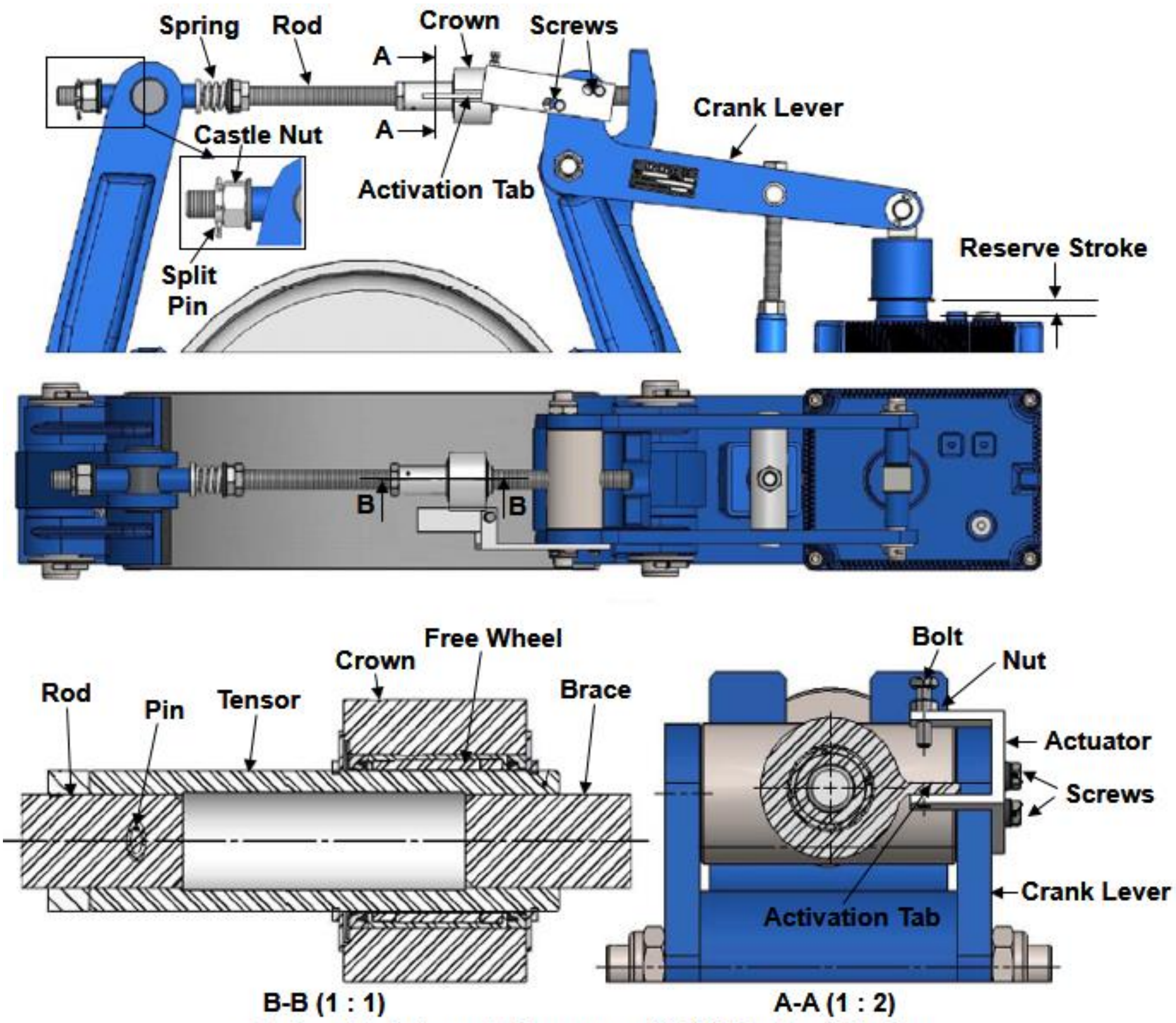
Some supplies offer the brakes painted in accordance with the client's specifications. The special paint option makes it possible for the client to choose or advise on the coating required to meet their specific requirement.

Information on brakes with automatic recovery (self adjusting) device is given in the following section.

Brakes with Automatic Recovery (Self Adjusting) Device

The automatic recovery device automatically adjusts the brake with repeated and minimum rotations of the rod (in a brake with automatic recovery device, Tie Rod = Rod + Tensor + Brace) during the progressive linings wear, so that the braking torque and the "Brake Shoe Stroke", the gap between each brake lining and the brake drum remain constant.

The automatic recovery device is considered indispensable for all the hoist drive brakes and for heavy duty brakes. Maintenance time is also reduced as a direct result of using the self adjust device.



Brake with Automatic Recovery (Self Adjusting) Device

Above figure shows construction of a typical brake with automatic recovery (self adjusting) device.

Construction and Working of Brake with Automatic Recovery (Self Adjusting) Device

As explained earlier, in a thruster brake system without automatic recovery device (brakes with manual recovery for brake lining wear), a short stroke (lifting path) of the thruster is allocated as reserve (reserve stroke) for lining wear and the remaining stroke is being used for opening the brake shoes. In these brakes, for recovery of brake lining wear, the arms are brought closer manually by turning the adjusting nut provided on the tie rod periodically.

See the above figure. In brakes with automatic recovery device, bringing of the arms together due to lining wear is performed by a tensor automatically (that is, the work of periodic manual turning of adjusting nut is carried out by the tensor automatically) as explained below.

As shown in above figure, the tensor is threaded to the brace and the rod is fastened to the tensor by means of a pin.

The tensor has a free wheel (basically unidirectional needle bearing) with a crown that holds the activation tab which is dragged by the actuator between the upper and lower positions. This actuator is joined to the crank lever and placed so that the activation tab remains stationary, when the brake has the proper reserve for the wear of linings.

When wear has occurred the value of the reserve stroke of the thruster decreases, increasing the opening stroke and the activation tab ascends (moves up) dragged by the lower stop of the actuator: the tensor does not move as the wheel is in its free-wheeling direction. The next time the brake opens, the activation tab that is above its correct point, is dragged downwards by the bolt (on the upper stop of the actuator) until it reaches the correct point: now the tensor is able to turn dragged by the free wheel, screwing onto the brace and drawing in the arms in order to recover the wear that has occurred in the linings.

In addition to the tensor and the free wheel, the brake steering device includes other components to ensure proper operation of the system: thus, a spring causes friction on the tensor, which is required so that the said tensor does not slide back, but stays still and it is the free wheel that rotates in its free direction: the spring's tension is set by the position of the castle nut with a split pin.

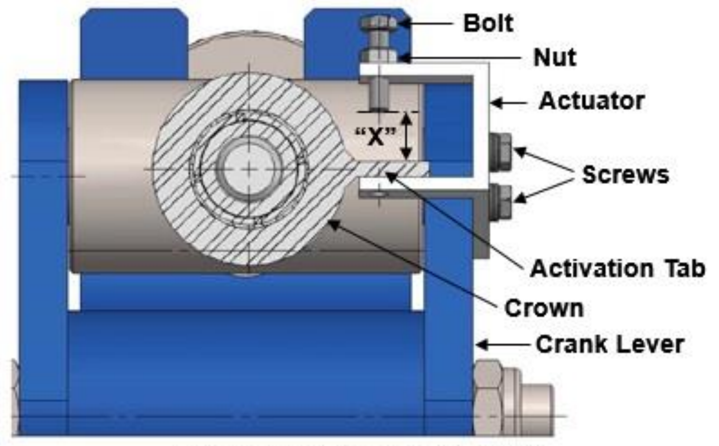
Installation and Setting of Brake with Automatic Recovery Device

For installation of the brake, remove the split pin and castle nut (instead of adjusting nut in case of a brake without automatic recovery device) to remove the side arm. If necessary to facilitate the work, it is recommended to dismantle the actuator from the crank lever by loosening the screws. After installation of the brake install/assemble all the removed parts back. Now center the brake to the brake drum and tighten the mounting bolts. Now center the arms and position the brake shoes. Now carry out adjustment/setting of the actuator (reserve stroke/path). Generally, all the brakes are sent to client (user) after setting of actuator and hence its setting is not required by client. However, following is given to check or set the actuator if required in future.

For adjustment of the actuator (for reserve stroke and open stroke), proceed in the following manner:

Turn the castle nut (without actuator, i.e. actuator and its screws dismantled) with its split pin clockwise, until the shoes rest on the drum, which you will recognize on noticing a significant resistance to rotation and until the recommended reserve stroke amount/value is attained by the thruster’s spindle.

Now install the actuator with its respective screws on the crank lever. While installing the actuator (thruster's spindle at reserve stroke position), the activation tab on crown should be in contact with the lower stop of the actuator as shown in the following figure.



Actuator Adjustment (Setting)

Now (from this reserve stroke position) activate the thruster with electric power to open the brake fully (corresponding to open stroke of the thruster) and in its open position, tighten the bolt (on the actuator) until it makes contact with the activation tab on the crown as shown in above figure.

Activate/operate the thruster several times in order to ascertain that distance "X" shown in above figure is maintained and then lock the bolt with the nut.

Finally adjust/set the braking torque as described earlier for a brake without automatic recovery device.

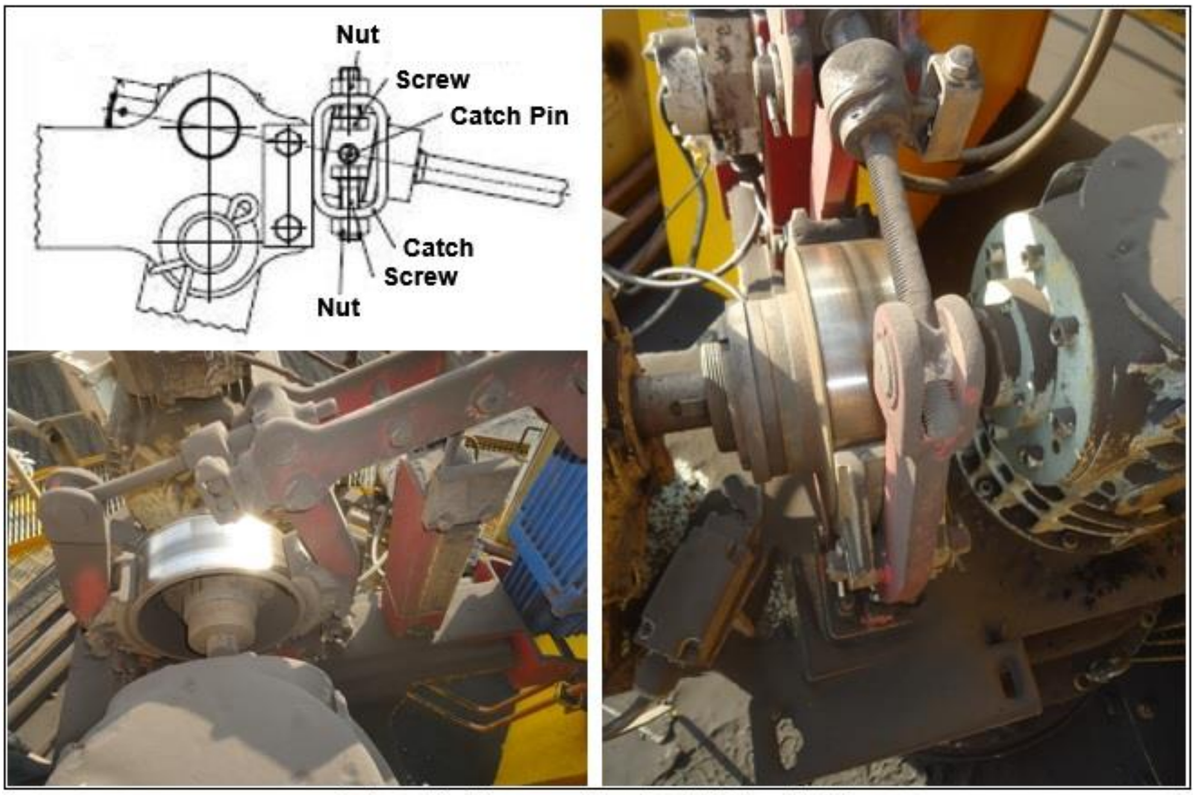
Lining Wear Micro Switch

Lining Wear Micro Switch

Sometimes lining wear micro switch is provided on a brake with automatic recovery device. It detects and signals when wear of lining reaches its limit. Above figure shows typical lining wear micro switch provided on a brake with automatic recovery device. As shown in above figure, the disc moves towards the micro switch due to lining wear and on wear reaching the critical value, it actuates the micro switch generating alarm signal.

Automatic Recovery Device Construction Variations

Though design of automatic recovery devices is based on use of a free wheel (unidirectional needle bearing), also called clutch mechanism by some manufacturer, their construction varies from manufacturer to manufacturer.



Automatic Recovery Device Utilizing Catch

Above figure shows construction of an automatic recovery device utilizing component called a catch which is almost similar to construction utilizing actuator (shown in previous section). See the accumulation of dust on the brake assembly due to open air installation (to prevent malfunction and maximize life of components, a protection cover may be fitted).

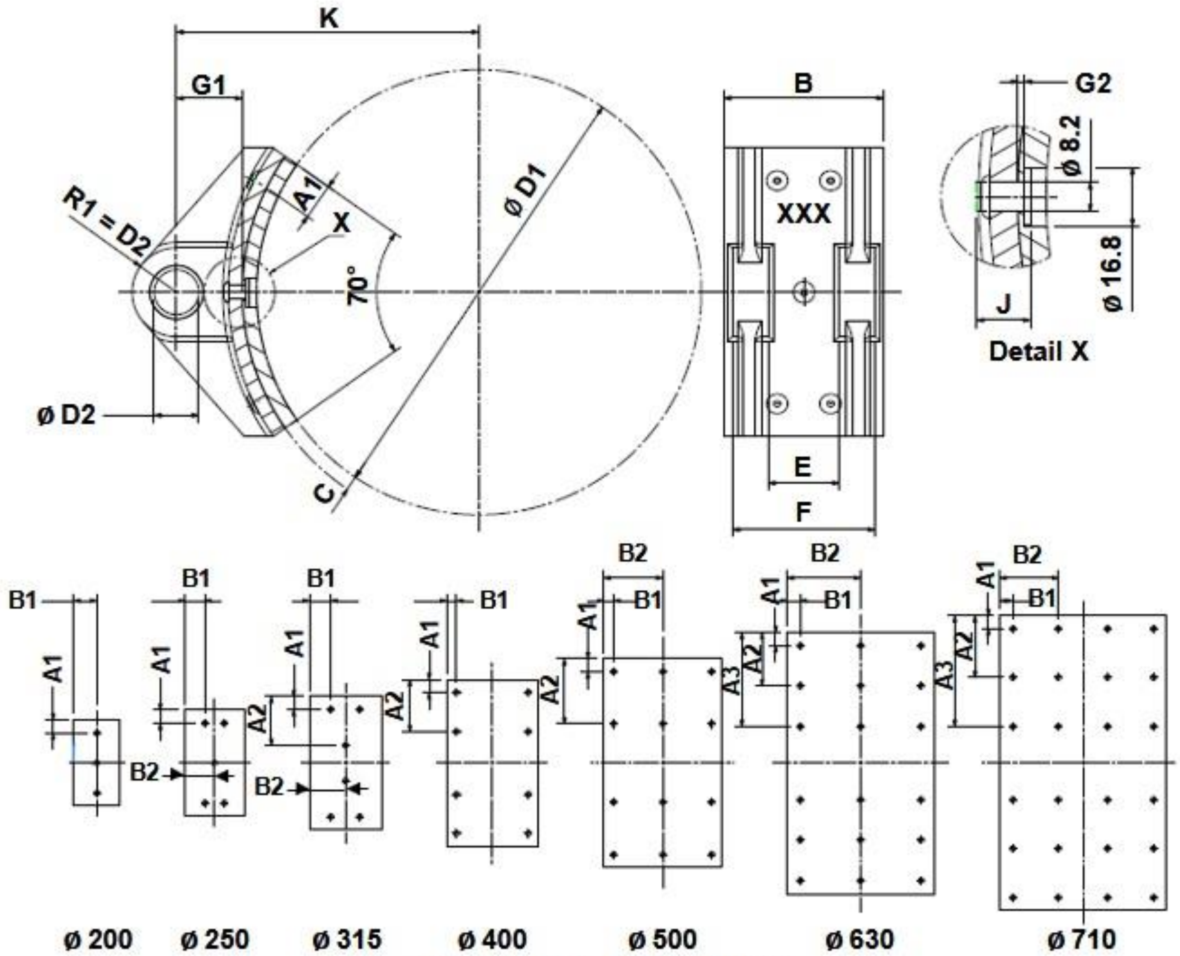
Automatic Recovery Device Utilizing Pawl and Ratchet Wheel

Above figure shows construction of an automatic recovery device utilizing a spring loaded pawl (pivoted bar) and a ratchet wheel.

Dimensions of Brake Shoes and Lining Segments as per DIN 15435

Brake shoes are made from aluminium, cast iron or fabricated steel and are supplied with or without drillings for riveting.

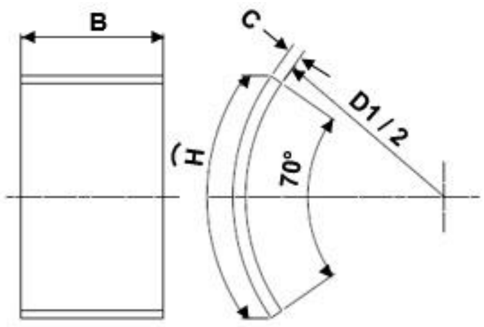
Lining segments are generally made from asbestos free woven fiber material or asbestos free bonded/molded fiber material and are either glued/bonded (vulcanized) or riveted to the brake shoes. Generally, the lining material is having coefficient of friction, $\mu = 0.4$. It is recommended to use fiber linings with copper wires to avoid sticking of the shoes to the drum in damp and cold environments.



Dimensions of Brake Shoes

Reference to above figure, dimensions (in mm) of brake shoes as per DIN 15435, part 2 are as per the following table.

Dimensions of Brake Shoes as per DIN 15435, Part 2															
∅D1	B	C	∅D2	E	F	G1	G2	J	K	A1	A2	A3	B1	B2	No. of Rivets
200	70	8	20	35	65	32	2	15	140	20	-	-	35	-	3
250	90	8	25	40	80	37	2	15	170	20	-	-	30	45	5
315	110	10	30	50	100	44.5	3	18	212	20	75	-	33	55	6
400	140	10	35	62	125	50	3	18	260	20	80	-	15	-	8
500	180	12	40	80	160	58	3	20	320	20	100	-	15	90	12
630	225	12	45	100	200	63	3	20	390	20	82	144	20	112.5	18
710	255	15	50	112	224	70	3	22	440	20	95	170	20	90	24

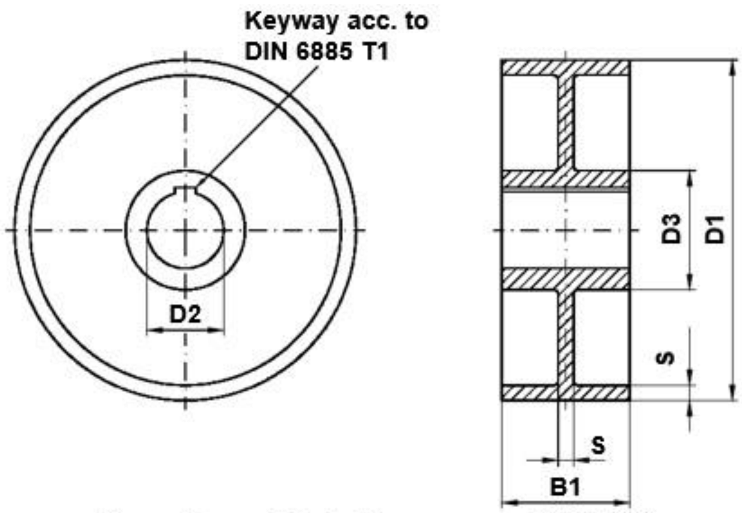


Dimensions of Lining Segments

Reference to above figure, dimensions (in mm) of lining segments as per DIN 15435, part 3 are as per the following table.

D1, Brake Drum Diameter	H (Circum. Length)	B (Width)	C (Thickness)
200	132	70	8
250	162	90	8
315	204	110	10
400	256	140	10
500	320	180	12
630	400	225	12
710	452	255	15

Dimensions of Brake Drums as per DIN 15431



Dimensions of Brake Drums as per DIN 15431

Reference to above figure, dimensions (in mm) of a brake drums as per DIN 15431 are as per the following table.

D1	B1	D2 (Pilot Hole)*	D2 Max. H7 (Finish Bored)*	D3*	S*
200	75	22	50	80	10
250	95	27	60	95	12
315	118	37	80	125	15
400	150	51	90	140	18
500	190	66	100	160	20
630	236	66	110	170	25
710	265	85	120	190	30

* These dimensions vary for different manufacturers.

Brake drum are supplied standalone (without coupling) or with a coupling. In general, cast iron drums (EN-GJL-250 as per European standard EN 1561) are used for 1500 rpm up to size ø400 mm. For drums ø500 mm or greater, it is recommended to use spheroid/nodular graphite cast iron (EN-GJS as per European standard EN 15613). They are also made from carbon steel, C45 and St 52 (welded).

Brake Maintenance

A periodical and correct maintenance will ensure correct functioning of the brake, ensuring safety and increasing its lifetime.

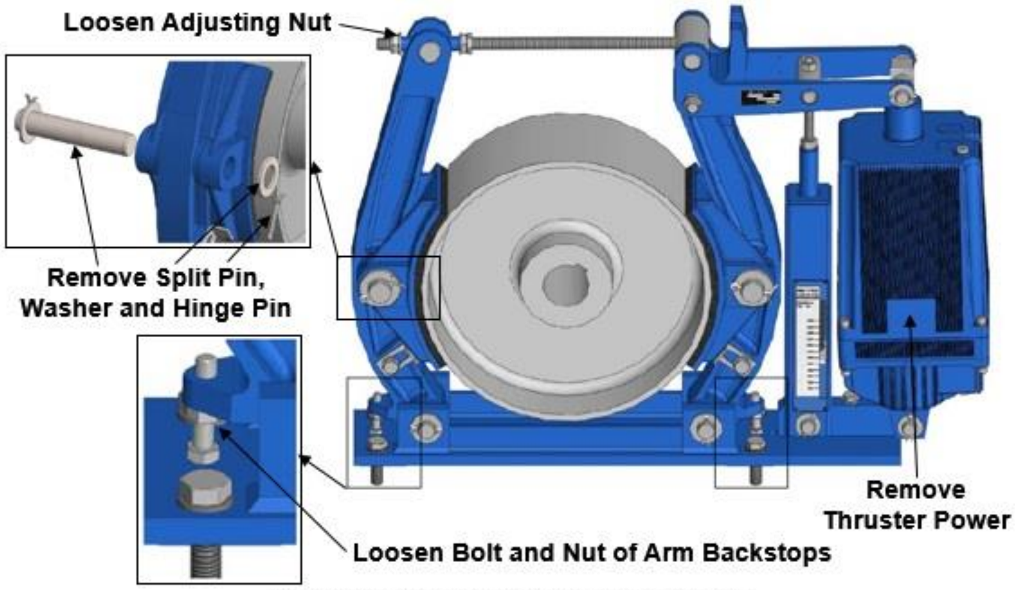
After about 150 operating hours or monthly, it is recommended to check a brake for easy movement of brake linkage, cleanliness of contact surfaces, reserve stroke of thruster, lining wear (lining thickness), condition of the brake drum, brake spring tension (torque) and proper functioning of limit / micro switches and automatic recovery device (if installed).

If maintenance-free (self-lubricating) bushings are installed, lubrication will not be required. In case nipples are provided for greasing, lubricate the pins.

The braking force can only be transferred to the brake drum when both contact surfaces (brake drum and brake pads) are clean. Make sure they are free from oil, rust and other contaminations. The brake itself, especially the moving parts have to be kept clean for easy movement of brake linkage.

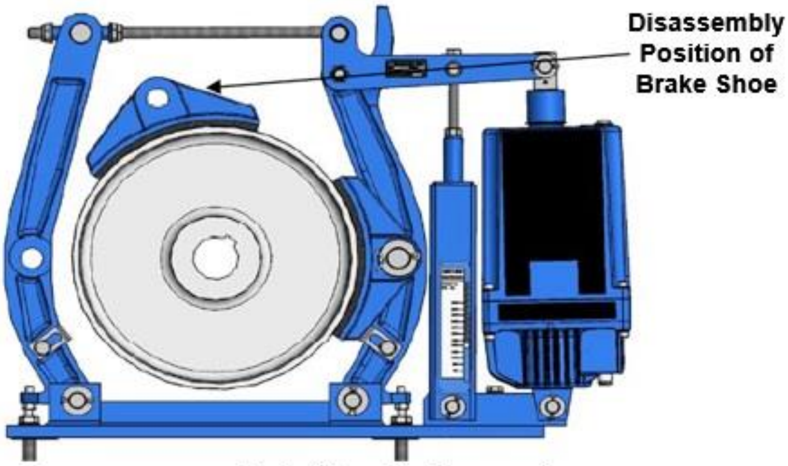
Check the reserve stroke of the thruster when the brake drum is cool. When it is at half way of the value recommended by the manufacturer, proceed to recover it. Also ensure that the arms are centered and brake shoes are properly positioned (the brake shoes should not be tilting and grinding at the brake drum while the brake is released).

Check the thickness of the brake linings. When the thickness of the brake linings is less than 3 mm at the lowest point in case of glued/bonded linings, or is less than 5 mm in case of riveted linings, replace/change the brake shoes. In case a micro/limit switch is installed on a brake with automatic recovery (self adjusting) device, it will give a signal when lining gets worn out to the preset limit. Some manufacturers are also offering a lining wear detection option where two cables are inserted into the lining to give signal when lining gets worn out.



Preparation for Removing Brake Shoes

For removing brake shoes, remove electric power from the thruster. Now as shown in above figure, loosen bolt and nut of arm backstops. Next loosen the adjusting nut to open the brake (to make gap between brake drum and brake shoes). Now remove split pin, washer and hinge pin from one brake shoe for its replacement.



Brake Shoe Replacement

Now rotate the brake shoe around the drum, up until the position shown in the above diagram, so that it can be removed. Mount the new brake shoe and install hinge pin, washer and split pin to complete its replacement. Replace the other brake shoe in the similar way.

Now check the brake shoes centering and set the reserve stroke of thruster to complete the brake shoes replacement work.

Check condition of the brake drum. Replace the brake drum if cracks appear on it or when the wear exceeds 2 mm of brake drum diameter.

Verify the torque to which the brake was set. Any change in the value of the torque could affect the proper functioning of the brake and cause problems.

Verify proper functioning of limit / micro switches and correct the settings if required.

It may be noted that in case of a brake with automatic recovery (self adjusting) device, the freewheel may be subject to wear and jamming. It can be detected/recognized by a constant reduction of the reserve stroke in case of lining wear. In view of this, check the reserve stroke of the thruster. If found reduced, proceed to recover it manually and plan for its maintenance or replacement.

Painting

In case of additional painting, do NOT paint/contaminate:

- Hinges or joints
- Brake drum surface
- Brake pads
- Spindle and automatic recovery (self adjusting) device if installed
- Rod of the thruster
- Electrical components
- Name plates, torque scale, etc.

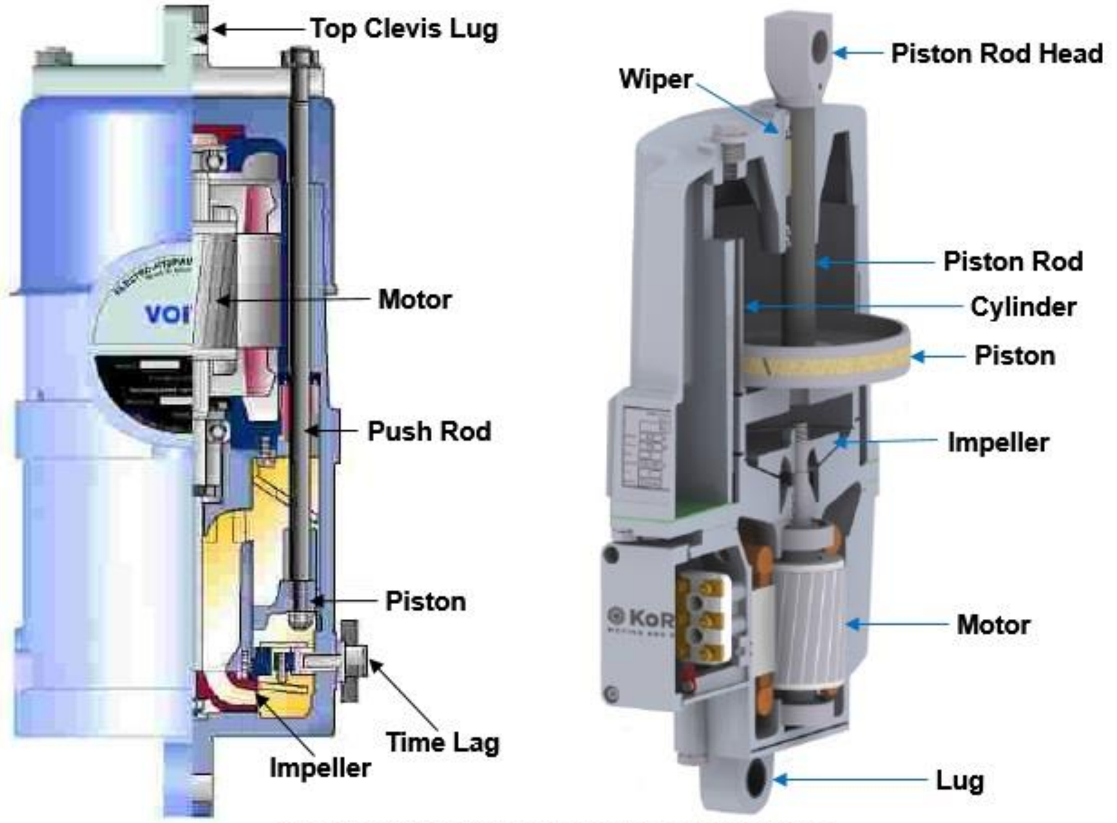
Note

The brake shoes with worn lining can be replaced with identical new brake shoes or they can be regenerated, that is to say that their lining can be renewed. In case of riveted lining, new lining segments may be riveted in-house (by user). In case of glued/bonded lining segments, they can be sent to the manufacturer who will remove the worn lining and will glue/bond new lining on them.

It is recommended not to use brake shoes with lining riveted on them because there is a risk of possible disjunction of the lining during the braking phase.

Construction and Working of Electro Hydraulic Thruster

Electro hydraulic thruster is a device which develops linear thrust (or force) required to operate the required mechanism. This linear and jerk free thrust is widely used to actuate thruster operated shoe brakes, commonly used in material handling equipments.



Construction of Electro Hydraulic Thrusters

Above figure shows construction of typical electro hydraulic thrusters. As shown in the figure, an electro hydraulic thruster combines all the basic parts of a hydraulic system - electric motor, pump, piston, etc., assembled into a single, sealed enclosure complete with the hydraulic oil (sometimes filled after installation).

When the thruster is energized, the pump exerts a hydraulic pressure under the piston, which is then forced upwards at full thrust capacity from start to finish and stays at the top of its stroke until switched off, when it will return under gravity and/or the reaction of the application, to its closed position. It may be noted that the force from the piston to the top clevis lug (piston rod head) is either transferred through push rod/s or piston rod as shown in above figure.

Overload and underload in the thruster cannot cause damage to the motor since if the load is greater than what the thruster can lift, the piston remains at the bottom of the cylinder and the impeller spins harmlessly in oil. If all load is removed, the piston stops at the top of its stroke and the impeller again spins harmlessly in oil.

The totally enclosed electro hydraulic thruster motor (the larger sizes are fan cooled) is fitted with special extended motor shaft to drive the centrifugal impeller which pumps oil from the upper to the lower chamber, forcing the piston up. The piston is attached to the top clevis lug by two push rods (piston rod) that pass through the bushed glands (seals and a wiper) and the electro hydraulic thruster remains extended with the piston at the top of its stroke, as long as the motor is energized. When it is switched off the oil flows back through the stationary impeller up through the centre tube into the top chamber allowing the piston to return to its original position under gravity and possible assistance from the application. The rate at which the thruster opens and closes can be controlled by fitting time lags (generally an optional item). Time lags control the flow of oil during start up and shutdown and are externally adjustable. The DIN standard number for force, stroke, fastenings and general dimensions of a thruster is 15430.

In a thruster, hydraulic force is generated by the piston because the impeller of the centrifugal pump generates a hydraulic pressure in the space under the piston. The amount of force is dependent on piston area and the pressure.

Generally, the impeller is having radial blades which enables operation in both directions of rotation of the impeller.

Type of Duty

The stress limit of a thruster is determined by the heating up of components and hydraulic fluid which is caused by losses occurring in the motor and in the pump system. Assuming an ambient temperature of +40°C, the admissible service temperatures will be below +100°C. Under conditions of high ambient temperatures (in tropical countries, installation near furnaces etc.), the type of duty shall be selected so that the admissible service temperature will not be exceeded. Otherwise the service life of the thruster would be reduced.

Thrusters are used in intermittent duty as well as types of application, requiring the devices to be permanently connected over extended periods of time, such as brake of a belt conveyor which must be kept in the released position. The intermittent duty is determined by the percentage duty/power cycle (% of cycle period in which thruster is active) and frequency of operating cycles. The uninterrupted continuous operation of a thruster leads to the highest permissible heating. This should be considered during the design stage of a device.

Options

Thrusters can be equipped with any of the following options:

<u>Time Lags</u>

The average opening (startup) and closing (shutdown) time of a shoe brake with standard thruster (without a time lag) is about 0.3 seconds. Time lags control the flow of oil during opening and closing. Using time lags, the time can be increased up to about 15 times the standard average time. Depending on the requirement of an application, time lags are provided for opening, closing or both, opening as well as closing.

Normally closing time lag is provided on brakes for horizontal movements (cranes' bridge travelling called long travel, cranes' trolley traversing called cross travel, etc.), while it shouldn't be installed on brakes for vertical movements (hoist drives). It is used for halting a machine gradually, without jerk.

Inner Spring

For applications where a return force of the piston has to be ensured, thrusters are equipped with an inner spring.

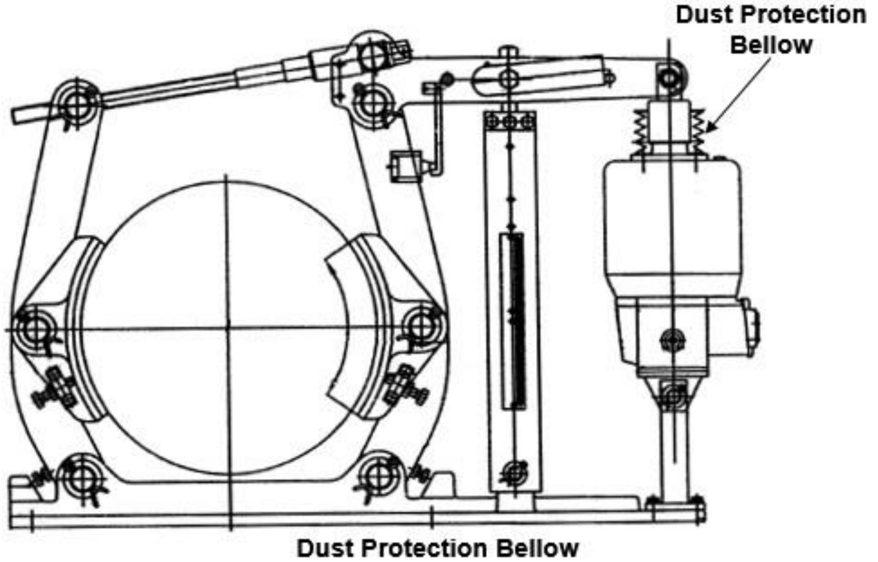
Viton Seals

Thrusters are generally designed for working at ambient temperature between −20°C and +55°C (in USA, −25°C and +40°C). If they are to be installed at an ambient temperature higher than +70 °C, they are offered with VITON seals. It could be also necessary to use a special oil for them in such case.

Heater

The heaters are an indispensable option for all the thrusters installed at ambient temperature lower than −20 °C and in any case suggested for all the thrusters installed at ambient temperature lower than 0°C. It could be also necessary to use a special oil for them in such case.

Dust Protection Bellow



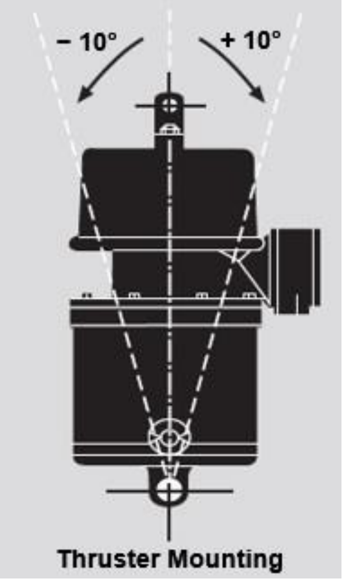
Dust Protection Bellow

Many times thrusters are designed with a piston rod instead of push rods. If so, they are offered with a dust protection bellow for their use in very dirty or humid environments (severe impact of dirt, water and the like) to protect the piston rod and the wiper (piston rod packing).

Oil Filling

Fill the thruster with good quality hydraulic or transformer grade oil as per manufacturer's recommendation. Fill the oil through upper oil filling plug until it over flows. For removing trapped air (if any), run the upward and downward strokes manually for several times and if oil level decreases, fill the oil until oil overflows. When it is required, oil can be drained through bottom drain plug. While filling oil, thruster must be held vertically. A too low oil level can cause a loss of lifting force of the thruster with consequent difficult or missed opening of the Brakes. Ensure proper tightening of filling and draining plug after filling oil.

Installation (Mounting)



As shown in above figure, it is recommended that the thruster be mounted within ±10° of the vertical (so that there is no transverse force on the piston rod) and connected to the mechanism by fitted pins of the correct size. The final electrical connection to the terminal box must be flexible.

Maintenance

As practically all working surfaces are immersed in oil, little maintenance is required. However, for smooth and quick thrust, push/guide rods must be properly cleaned time to time. For free movement, pin joints also should be cleaned periodically. Lubricate the pin joints if provided with grease nipples.

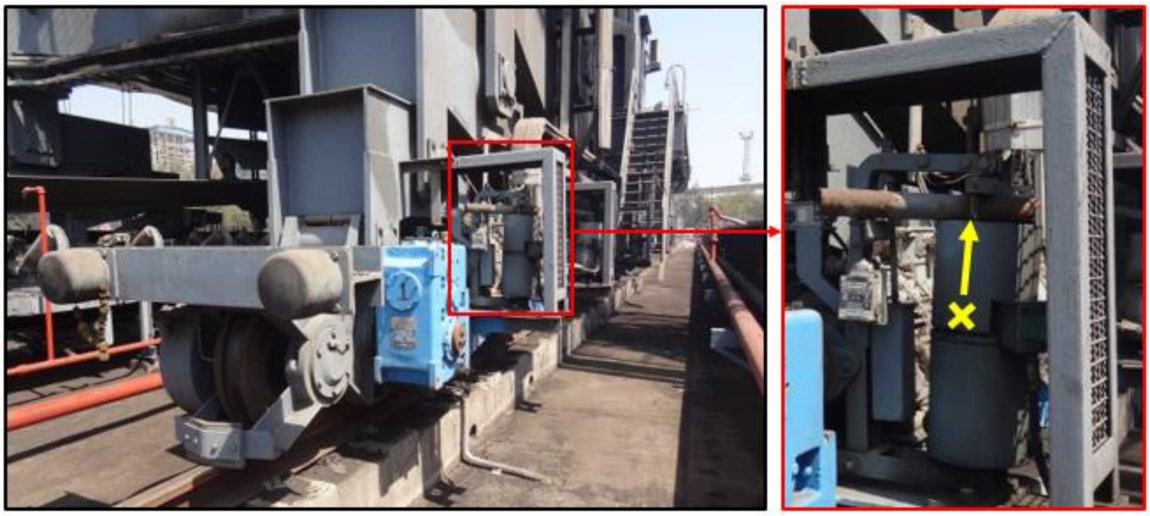
It is recommended to change the oil on an annual basis, or otherwise when it can be seen that the oil has lost its original color or performance features.

Troubleshooting

Symptom	Possible Reason	Action
Brake doesn't close	Brake is mechanically blocked	Check
	Brake is manually released	Manually close
	Spring tension too low	Adjust spring tension
	Spring damaged	Exchange spring unit
	Reserve stroke too small	Adjust reserve stroke
	Brake pads worn	Exchange brake pads
Brake doesn't open	Spring tension too high	Adjust spring tension
	Reserve stroke too big	Adjust reserve stroke
	No power supply	Check electrical supply / connection
	Thruster damaged	Exchange thruster
Braking distance too long	Spring tension too low	Adjust spring tension
	Brake pads have uneven contact	Align brake
	Reserve stroke too small	Set reserve stroke
	Brake pads and/or drum soiled	Clean pads and/or drum
	Brake pads worn	Exchange brake pads
	Brake drum worn	Exchange brake drum

Caution

Following figure shows bogies of a stacker cum reclaimer. It can be seen that one of the thruster is blocked by a piece of pipe.



Brake Mechanically Blocked

For Safety - Don’t use any mechanical device to block the brake!

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