Marland Backstops

To Prevent Reversal of Inclined Conveyors and Vertical Bucket Elevators

Marland Clutch

The Company

Marland

Since 1931, Marland has been producing backstops, clutches and clutch couplings. Marland products are based on a one-way clutch design, utilizing the principle of cylindrical rollers on inclined cam planes.

In December of 1996, Colfax acquired Marland along with three other divisions comprising the Mechanical Power Transmission Group of Zurn Industries, making Marland a part of the Colfax family of products.

Colfax, headquartered in Erie, Pennsylvania, has specialized in the design and manufacture of mechanical power transmission products since 1928.

Colfax product lines include one-way, overrunning and overload release clutches, friction clutches and brakes, enclosed geardrives, gear and diaphragm couplings, mill spindles, and universal joints.

The cover photo and the photo below show some of the thirteen size 240MA Backstops installed on large conveyors at an Arizona mining operation.

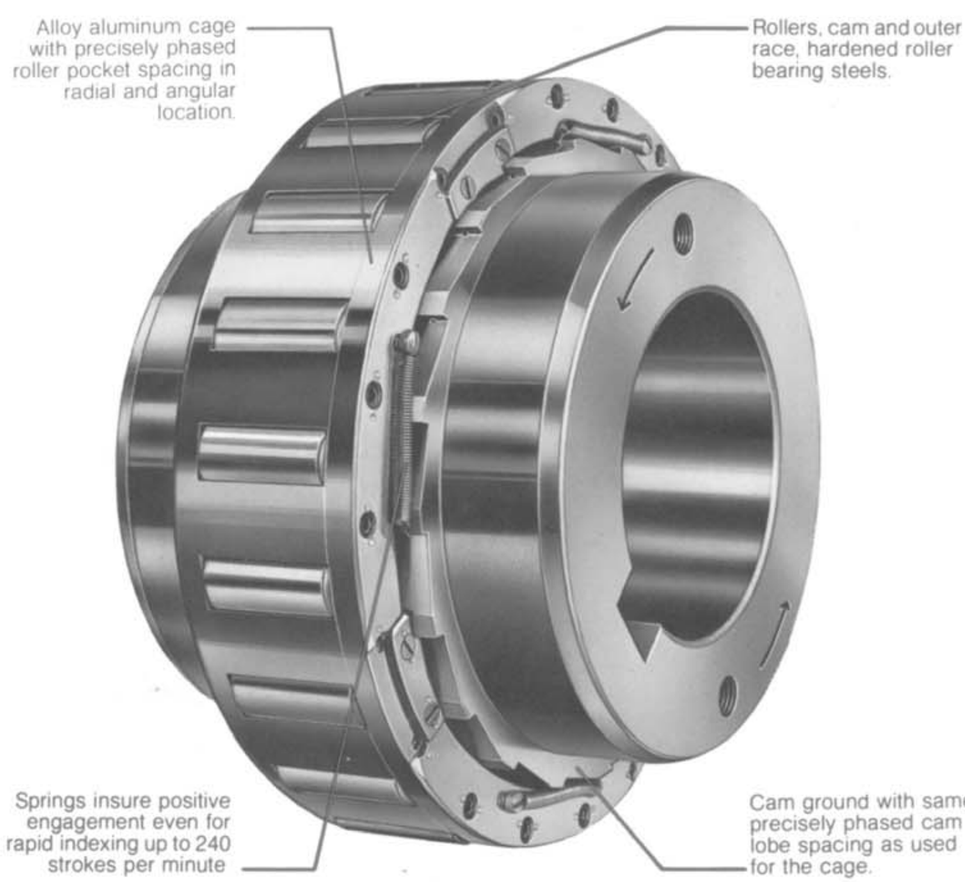
Marland Products

The Marland principle of rollers on inclined cam planes has proven its dependability for over 60 years in worldwide installations ranging from food processing plants to equipment used in steel mills and heavy mining industries. Proving the inherently long-life Marland design, the first two Marland clutch units installed in February, 1931, operated continuously for 31 years without repairs or replacements of any kind until the system became obsolete in 1962. Cam, rollers and outer race inspection showed them ready for additional years of service.

The Need For Adequate Backstops

Positive protection against reverse torque runaways of inclined conveyor or elevator installations, and adequate provision for the safety of operation personnel, can be assured by considering the following:

1. The causes of reverse torque loading conditions.
2. The importance of installing backstops on low speed headshafts —where reverse torque loads originate.
3. Use of sound methods for selecting backstop sizes, based on many years of successful installations, rather than theoretical reverse torque calculations.
4. The basic design, operating principle and uniformly high torque capacity of Marland One-Way backstops.
5. The simple maintenance and lubrication requirements of the Marland design.



Operating Details

During freewheeling, (normal operation), the cam and roller assembly rotate with the headshaft as shown by the arrows in illustration 2. The outer race is secured to stationary coverplates and "I" Beam Torque arm. An oil film wedges and separates the rollers from the outer race. This moves the rollers a few thousandths of an inch imparting relative angular motion between the roller cage and cam. This slight movement of the rollers into the deeper cam zones, with a clean lubricant film wedge between rollers and outer race, permits freewheeling without metal to metal contact.

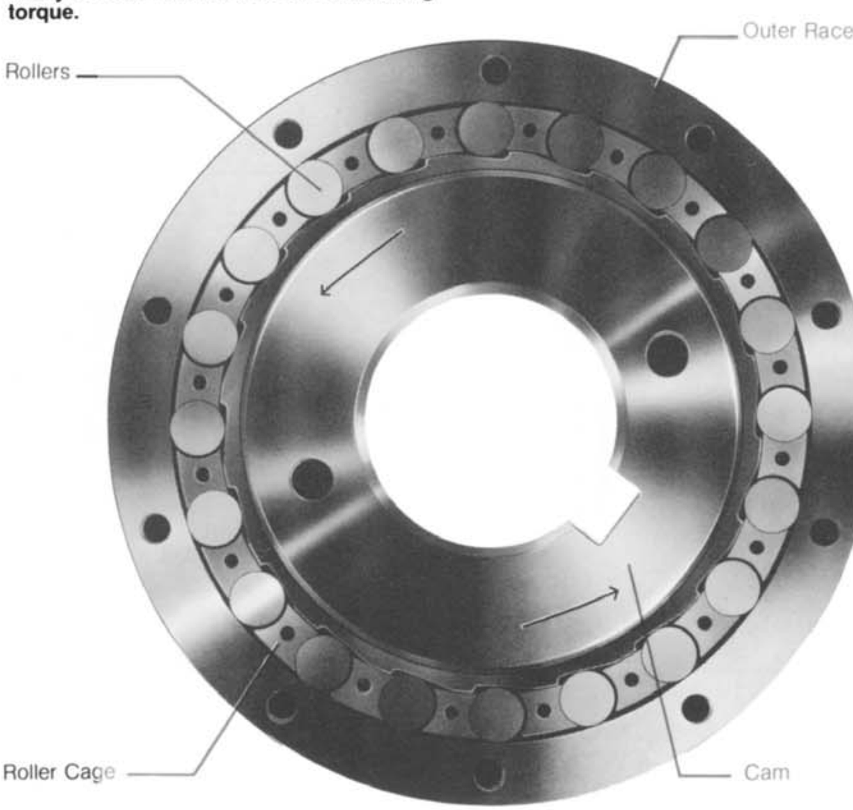
When the conveyor decelerates and the cam subsequently comes to rest, the spring actuated roller cage, illustration 1, has already positioned the rollers into the contact zone. All rollers have been positively guided to engage uniformly and maintain their relative positions accurately to assure uniform load distribution. The rollers then engage in compression between the precision ground, hardened cam plane surfaces and the inside diameter of the outer race. Relative motion between the cam and outer race is not required to engage rollers. When the backstop is in the "engaged" or "backstopping" condition, the cam, rollers, and outer race are relatively stationary and therefore, not subject to wear if used within normal tabulated rating.

Mounting Details

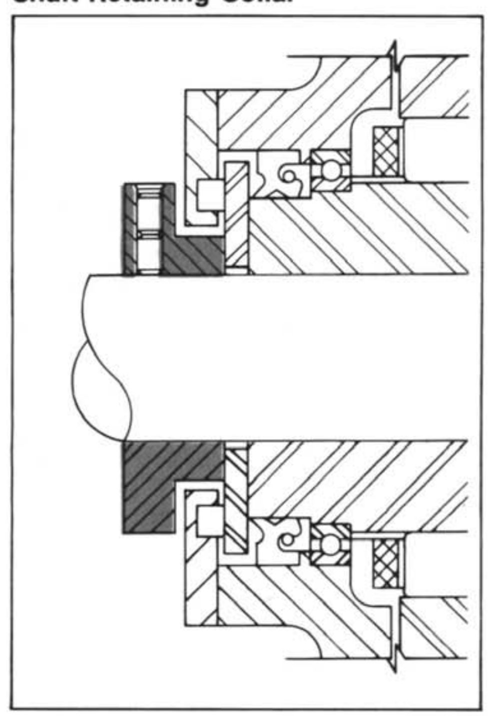
Marland backstops are furnished with a clearance fit in the bore for easy field installation. The key should be a "drive tight" fit on the sides only. This key fit may be sufficient to prevent creeping of the backstop on the shaft, however, if desired, Marland can furnish shaft retaining collars as an option to insure axial retention. (See Below)

Illustration 2

Coverplate and roller cage end ring have been removed, exposing the rollers. Note that while at rest, all rollers are strictly in-phase ready to share the load when transmitting torque.



Shaft Retaining Collar



Design Features

Design Features

Marland backstops are completely mechanical, automatic operating units, incorporating a time proven basic operating principle, to provide greater safety and longer life with minimum maintenance requirements. Thirteen standard sizes are available up to 720,000 pound-feet of torque. Superior performance is assured by the following design features:

SIMPLE INITIAL INSTALLATION Backstop is symmetrical and can be mounted for desired free shaft rotation. Arrows on cam faces or inner labyrinth show the direction of free rotation.

The torque arm is a single "I" beam section which is attached to the backstop with two precision ground torque arm pins. This greatly simplifies field installation. The arm may be placed up, down, or at any angle, and provides uniform loading on both coverplates. The preferred position is horizontal to reduce bearing loading for longer bearing life.

SEALED OIL CHAMBER. The Clutch elements and ball bearings are continuously self-oiled in a sealed oil chamber. The recommended lubricant is automatic transmission fluid such as "Dexron", which is readily available and suitable for a wide range of ambient temperatures. A double-lip oil seal is provided adjacent to the ball bearings to keep oil in and contaminants out. See illustration 3.

POSITIVE TRIPLE SEALING. See illustration 4.

1. All metal labyrinth, grease packed.
2. Full circle square packing against ground inner labyrinth which maintains grease seal and serves as an additional barrier to entry of dirt.
3. Double-lip oil seal to prevent grease from entering oil chamber and oil dilution of sealing grease.

MINIMUM MAINTENANCE. Grease fittings in each outer labyrinth are provided for occasional renewal of grease seal which forces out dirt and old grease through relief fittings. A periodic check of oil level and purity can readily be made through oil level indicator while in operation or at rest. If inspection reveals impurities in the oil, draining, flushing and refilling can be easily accomplished through the piping, tees, and drain plugs furnished.

Special Requirements

In over 60 years as the recognized leader in the design and manufacture of freewheeling clutches, the Marland engineering staff has been given many unusual and difficult requirements for clutches and backstops. This has resulted in special designs to meet those exacting requirements. If your needs cannot be filled by a standard item, give us the engineering details. It may be that we already have a solution to your problem, and if not, we'll go to work and find one.

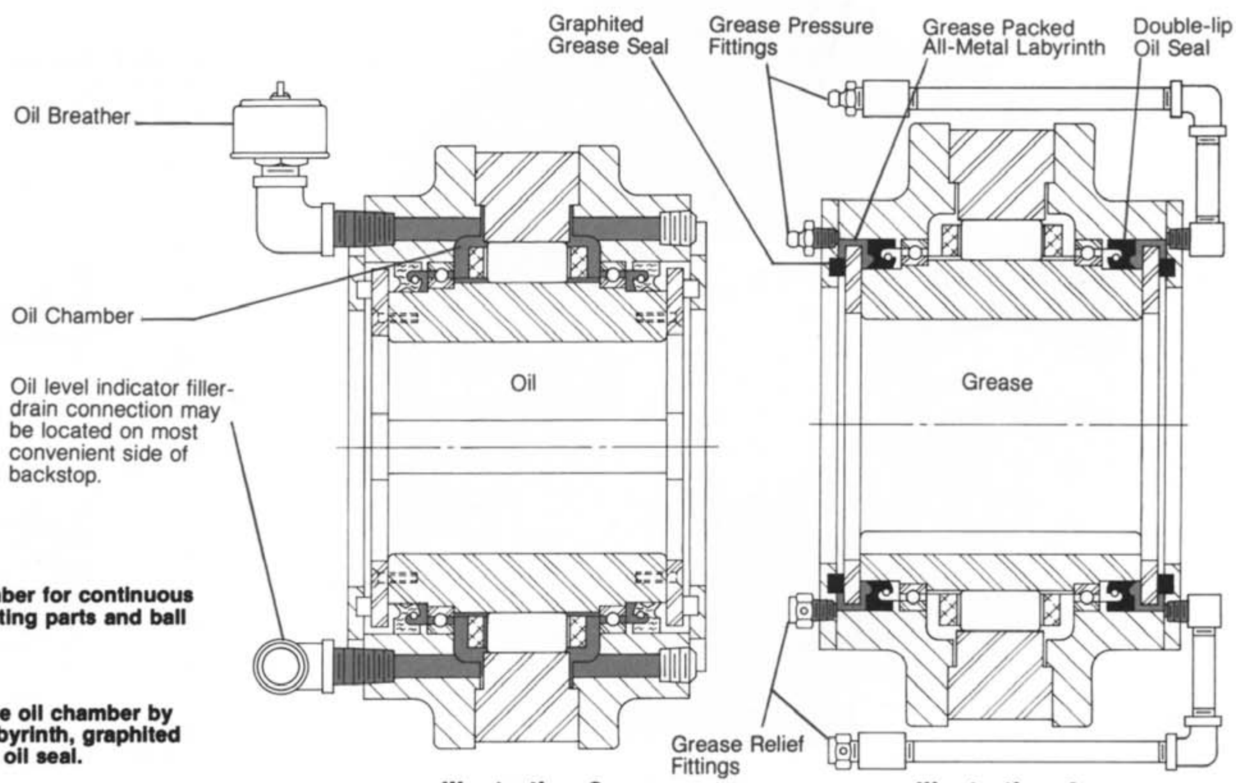


Illustration 3 **Illustration 4**

Illustration 3
Shows the sealed oil chamber for continuous lubrication of clutch operating parts and ball bearings.

Illustration 4
Positive triple sealing of the oil chamber by grease-packed all-metal labyrinth, graphited grease seal and double-lip oil seal.

Advantages of Marland Cylindrical Rollers on Flat Inclined Cam Surfaces

Free Rotation

The cylindrical rollers used in all Marland clutch products are free to rotate in their individual pockets during freewheeling permitting the load to be engaged and re-engaged on any part of the roller circumference and cylinder surface as indicated by the arrows in illustration 5.

Longer Service Life

Engagement of the roller under load does not always fall on the same line, zone, or spot to result in spalling or cratering, as may occur with non-cylindrical, irregularly shaped wedges or sprags which are not free to rotate. This results in longer service life for the contacting surfaces.

Accurate Dimensions

Cylindrical rollers are easy to produce and reproduce to precision dimension limits which are readily checked with micrometers, go-no-go gauges, or if necessary, with the extreme closeness of light band inspection.

Full Contact

Precision-ground, flat cam areas furnish ideal contacting surfaces for the cylindrical rollers and assure full contact with the entire cylinder length of each roller.

Lower Stress

When roller and cam are engaged under compressive loading, (illustration 5), the load is uniformly distributed over a large zone of contact with consequently lower stresses to result in more durable, efficient operation.

The Limitation of Non-Cylindrical Clutch Wedges or Sprags

Non-cylindrical, irregularly shaped wedges or sprags have been resorted to by some designers whose primary aim was to lower clutch production costs. This design uses a cheaper cylindrical inner race, in place of the precision ground cam used in the Marland design.

Odd-shaped sprag elements with compound curves are difficult to produce, and reproduce, to the same high degree of accuracy consistently maintained in the production of cylindrical rollers. Many non-cylindrical sprags, produced by cold die drawing, may be subject to dimensional variations which can occur between sprags produced when the die is new and those drawn after the die becomes worn and enlarged with use.

When an assembly of such odd-shaped sprag elements is engaged in compressive loading between the inner and outer races, dimensional variations such as a slightly oversize curve radius, will subject such individual elements to higher stresses and may cause failure due to spalling or cratering of the relatively higher stressed surfaces.

Sprags with compound curves are not free-to-rotate when confined within the annular space between cylindrical inner and outer races, but must be retained in position to engage. This causes a rubbing of the sprags on the races during freewheeling and consequent wear, since a backstop is in the freewheeling condition most of its operating time. In addition, sprag contact surface for engaging is limited to the small zone indicated by the arrows in illustration 6. This reduced available zone of contact can result in shorter life of wedges or sprags.

Note in illustrations 5 and 6, the available load-bearing surface of a Marland roller includes the entire roller circumference and full cylinder length, compared to the relatively limited load-bearing zone of the retained sprag.

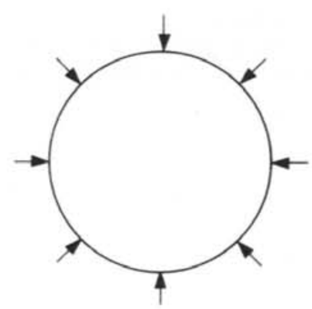
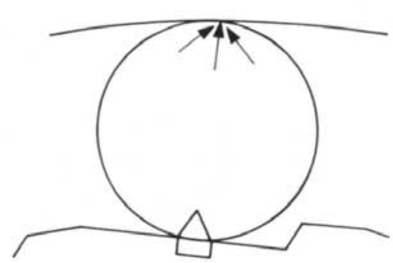


Illustration 5



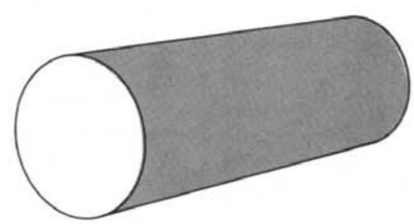
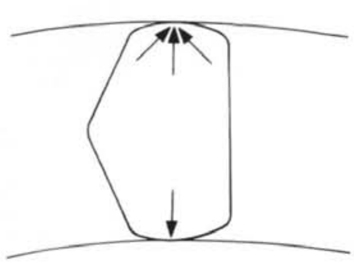


Illustration 6



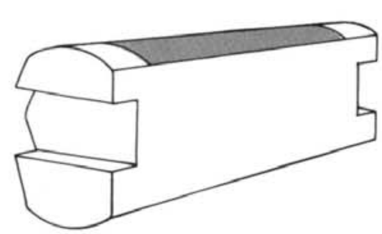


Illustration 5
Marland cylindrical rollers are free to rotate during freewheeling and provide broad contact over the entire length of the rollers under compressive loading.

Illustration 6
Non-cylindrical clutch wedges are not free to rotate. Any dimensional variations are accentuated by repeated contact in the same reduced areas during compressive loading.

Locate Backstops Where Reverse Torque Loads Originate

Where Reverse Torque Loads Originate

The ideal time to prevent reversal of a loaded inclined conveyor or elevator is at the very instant when forward rotation of the headshaft ceases. Even a small time lag before arresting the backward travel results in a greater effort needed to bring the inclined conveyor to rest and to hold the load.

When high speed shaft backstops are used the amount of time and the distance of reverse motion of the inclined conveyor or elevator before the backstop can become effective, is determined by the accumulated backlash of any gears, couplings, keys, chains, sprockets and shafts in the drive system.

It is obvious that a reversed torque load, further reinforced by any accumulated backlash in the drive system, could result in the failure of any one of these connecting drive components when the reverse torque load is permitted to travel beyond the headshaft where it originated, to reach a backstop installed at some higher speed location in the drive system.

Locating Backstops on Low-Speed Drive Pulley(s)

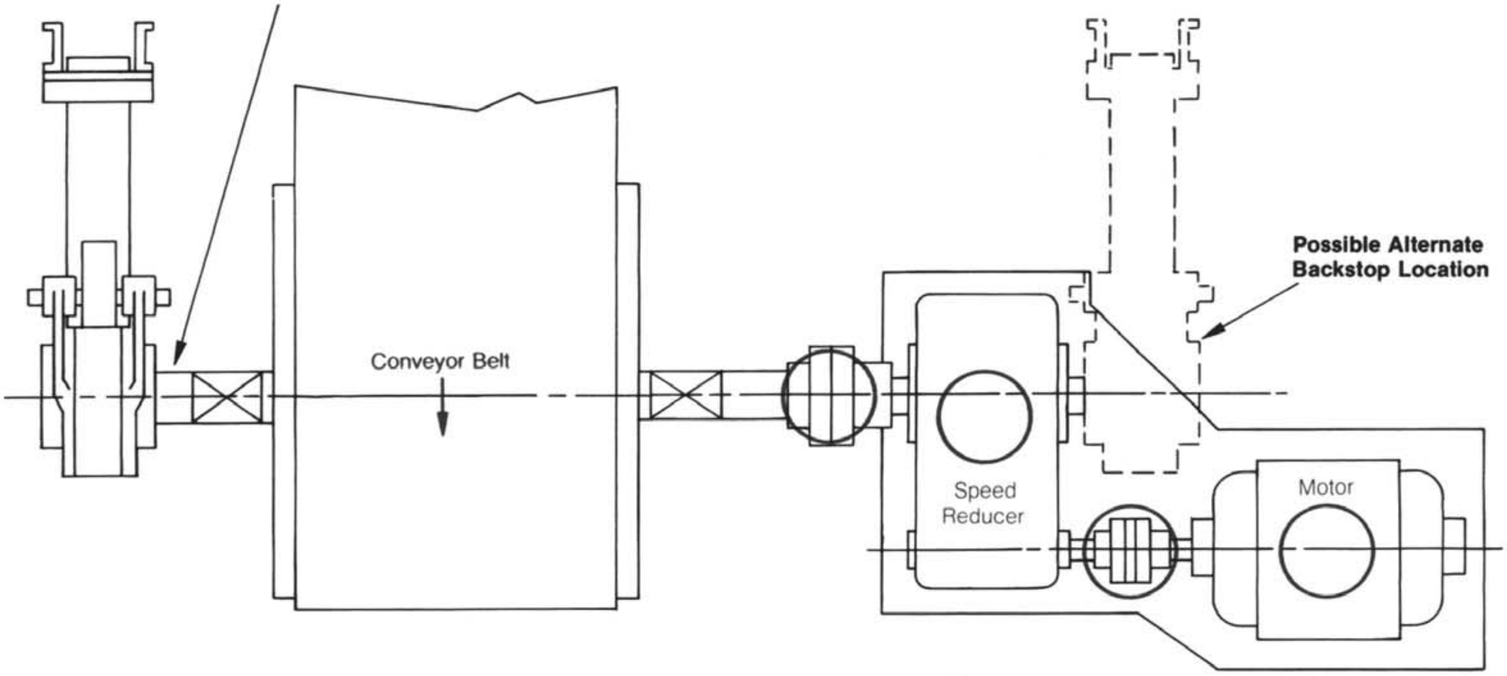
Failure of any part of the drive between the head (or drive pulley) shaft, and a high speed shaft backstop can cause a reversed runaway condition. Maximum protection against such reversed runaways can be obtained only when backstops are installed on low speed drive pulley shafts where the reverse torque originates and where such backstops can function instantly, before backlash and reverse motion can occur.

In some installations it may be physically impossible to locate the backstop on the pulley shaft. In these cases, the alternate location could be on the double extended low speed reducer shaft. See illustration 7.

Where the design and speed of the equipment will not permit the use of a low speed backstop, refer to Cecon backstop units.

Illustration 7

A Marland automatic backstop located at this end of the headshaft will provide a maximum of safety against reversal.



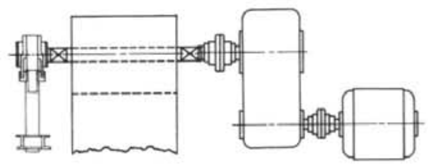
◯ Failure may occur at any of these driving parts circled, their keys, the speed reducer, couplings, motor or of electric current, while the inclined conveyor or elevator is heavily loaded. Any motor brake or backstop, located between the motor and the heavily loaded headshaft would be of no value in preventing a reversed runaway.

Recommended Backstop Locations for Typical Conveyor Arrangements

Single Drive Pulley

For head pulley driven inclined conveyors or elevators, the backstop should be located on the head pulley drive shaft. With the drive at one end of the head pulley shaft, the backstop should be located at the opposite end, away from the speed reducer and coupling. See illustration 8.

Illustration 8



For a single drive pulley other than the head pulley, the backstop should be located on the drive pulley shaft, rather than on the head pulley shaft. The head pulley may not have sufficient belt wrap to keep the loaded belt from slipping backward when the backstop prevents reversal of the pulley and its shaft. With the drive at one end of the drive pulley shaft, the backstop should be located at the opposite end, away from the speed reducer and coupling. See illustration 9.

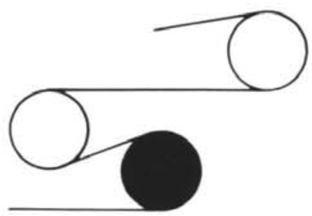
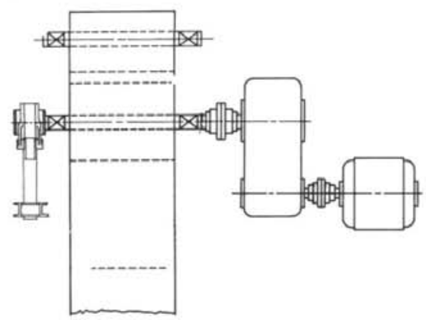
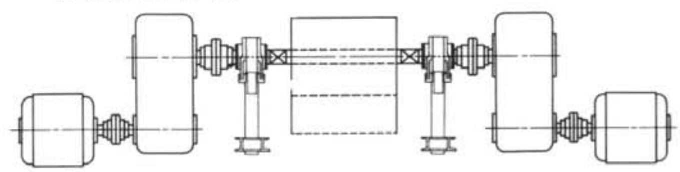


Illustration 9



When dual drives to a single pulley shaft are used as in illustration 10, the backstops should be located on the shaft between the low speed couplings and adjacent pulley shaft bearings.

Illustration 10



Tandem Drive Pulleys

Backstops should be located on both primary and secondary drive pulley shafts. Thus the secondary pulley backstop(s) will insure tractive friction on both pulleys. See illustration 11.

Primary drive pulley shaft backstops should have capacity equal to the total primary and secondary motor (or motors) normal rating. Secondary drive pulley shaft backstops should have capacity equal to the secondary motors normal rating.

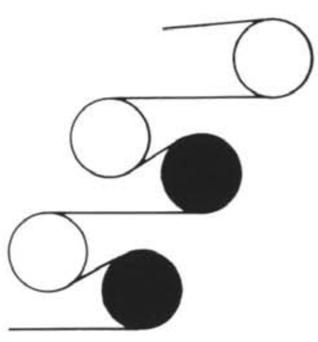
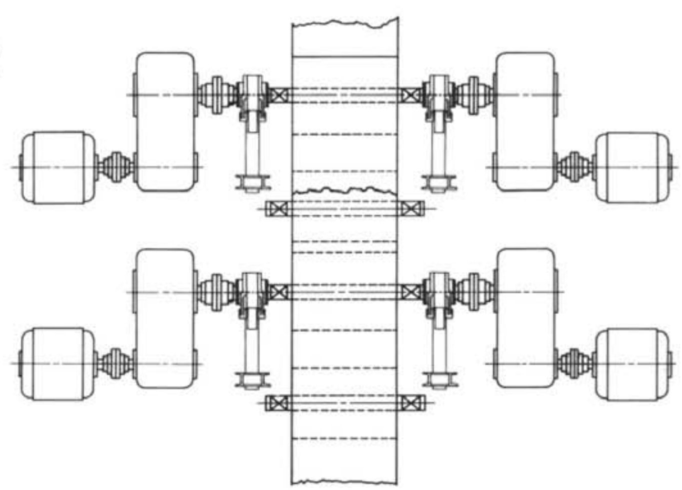


Illustration 11



Principles for Selecting Backstop Sizes for Low Speed Shafts

In the past, the usual basis for determining the size of a backstop included only consideration of calculated lift and frictional loads. In some cases selection was made based on subtraction of all of the frictional load from the lift load to arrive at the net backstop capacity required. Backstops so selected could prove to be of inadequate capacity and could result in very serious and costly damage. More conservative selection was based on subtracting only one-half the frictional load from the lift load. Lift loads were also calculated at the maximum depth "spill load", rather than at normal or recommended conveyor or elevator values, in an attempt to guard against either an expected or intentional overloading of conveyors and their respective backstops. This method dictated the use of larger backstops which reduced the danger from overloads and resulted in fewer runaways. The more conservative selection procedure could be dangerously misleading where a heavily overloaded or completely stalled motor could develop.

Improper Feed Adjustment

Where a conveyor or elevator feed is improperly adjusted during initial installation or later regular operation of the equipment, a stalled condition may develop resulting from flooding of the belt or choking of the elevator. During such overloads, electric motors may develop 200 to 250 percent of normal torque rating before they "cut out" by automatic or manual control in order to prevent damage to the motor windings. Such high torque is transmitted from the motor to the drive pulley shaft where it induces a high tension or "rubber band stretch" in the belt. When the motor "cut out" occurs, the "stretched rubber band" effect of the overloaded or stalled belt reacts on the drive pulley to rotate it in reverse. This condition overloads the backstop to the fully stalled motor torque rating, less only the frictional loss of the driving unit between the stalled motor and the headshaft.

Momentary Starting Under Load

Momentary starting of the drive motor at a time when the stationary belt was already fully loaded to its normal capacity, developed into an overloaded backstop condition. We found that when the motor was so started, stretching the belt so that conveyor motion was just beginning, and at that instant the motor was intentionally cut out, the stored energy in the "rubber band stretch" reacted on the backstop with much greater force than occurs after a fully loaded conveyor comes to a normal stop.

Where an electronic tramp iron detector resulted in such momentary but very frequent stopping and starting condition, the backstop was severely overloaded far beyond the normal motor rating.

Stalled Conveyors

Even though the conveyor equipment has been in satisfactory operation for some time without overloading, the entry of oversize pieces, timbers or structural scrap, jammed between the bin gate and the belt, could cause the conveyor to stall and overload the motor as noted under improper feed adjustment. Under these conditions the backstops could be overloaded much beyond what would ordinarily be the calculated lift or reverse torque loads.

Other Motor Overloading

Studies further showed that conveyor belts also can be stalled due to improper setting of skirt boards, misaligned pulley and idlers. To properly handle such conditions, selection of the backstop should be based on the maximum possible motor overload rather than on the normal belt loading theoretical calculations.

How to Select a Marland Backstop

General

Backstop selection is based on stalled torque rating of the driving motor to provide for the conditions when overloaded motor "cut-out" may occur and the "stretched rubber band" effect of the stalled belt would react on the pulley to rotate it in reverse against the non-reversing backstop.

The preferred mounting of backstops is directly into the drive pulley shaft whether headshaft or intermediate shaft. For some typical arrangements and recommended backstop locations, see Page 7.

Backstop Size Selection Based on Breakdown or Stalled Torque Rating of Driving Motor

Step 1—*Calculate torque*

Multiply the nameplate motor horsepower(kw) rating by 5250 (9550 metric), then divide the result by the RPM of the low speed drive pulley shaft on which the backstop should be mounted. This determines the pound-feet (N-m) torque which is the basis of backstop ratings.

Step 2—*Service factors to be used*

Multiply the value obtained in Step 1 by the proper factor for the driving motor shown in Table B (factors are based on the *maximum* stalled torque percent of the normal motor rating). The result will be the minimum required torque capacity which is to be used when referring to the rating table.

Step 3—*Select the Marland Backstop*

Refer to Page 11 and select the size of Backstop with a rated torque equal to or greater than the calculated torque.

Check backstop RPM to see whether it is within the listed catalog maximum RPM. If greater, consult Home Office.

Check shaft diameter to see whether it is within the backstop bore limits. If the shafts are too large, a larger size backstop may be selected, or if preferred, shafts may be turned down to accommodate maximum bore for selected backstop.

In all cases, calculate the resulting stress and check conformance of shafting with the applicable design codes.

Ordering Information

When ordering or requesting size selection from Home Office, the following information should be included:

1. Horsepower (kw) of driving motor(s) and maximum stalled torque percent of normal motor rating.
2. RPM of shaft on which backstop is to be mounted.
3. Shaft diameter and keyway size at backstop location.
4. Profile drawing of system and/or general arrangement drawing (if available).

TABLE "B"

Maximum Breakdown or Stalled Torque % of Normal Motor Rating	Service Factor
175%	1.00
200%	1.15
225%	1.30
250%	1.50

ENGLISH
Example of Selection Procedure

Required backstop for mounting on drive pulley shaft rotating at 55 RPM, driven by a 150 HP motor having a maximum stalled torque rating at 200% of normal:

Step 1

$$\frac{150 \times 5250}{55} = 14{,}318 \text{ LB-FT}$$

Step 2

14,318 x 1.15 (service factor) equals 16,466 LB-FT

Step 3

From tabulated rating on Page 11, proper backstop selection is the BC-18MA, rated 18,000 LB-FT, with maximum bore 5-7/16". If drive pulley shaft exceeds this maximum, it will be necessary that shaft be turned to suit, or that the next larger backstop be used.

METRIC
Example of Selection Procedure

Required backstop for mounting on drive pulley shaft rotating at 55 RPM, driven by a 150 KW motor having a maximum stalled torque rating at 200% of normal:

Step 1

$$\frac{150 \times 9550}{55} = 26{,}045 \text{ N-m}$$

Step 2

26,045 x 1.15 (service factor) equals 29,952 N-m

Step 3

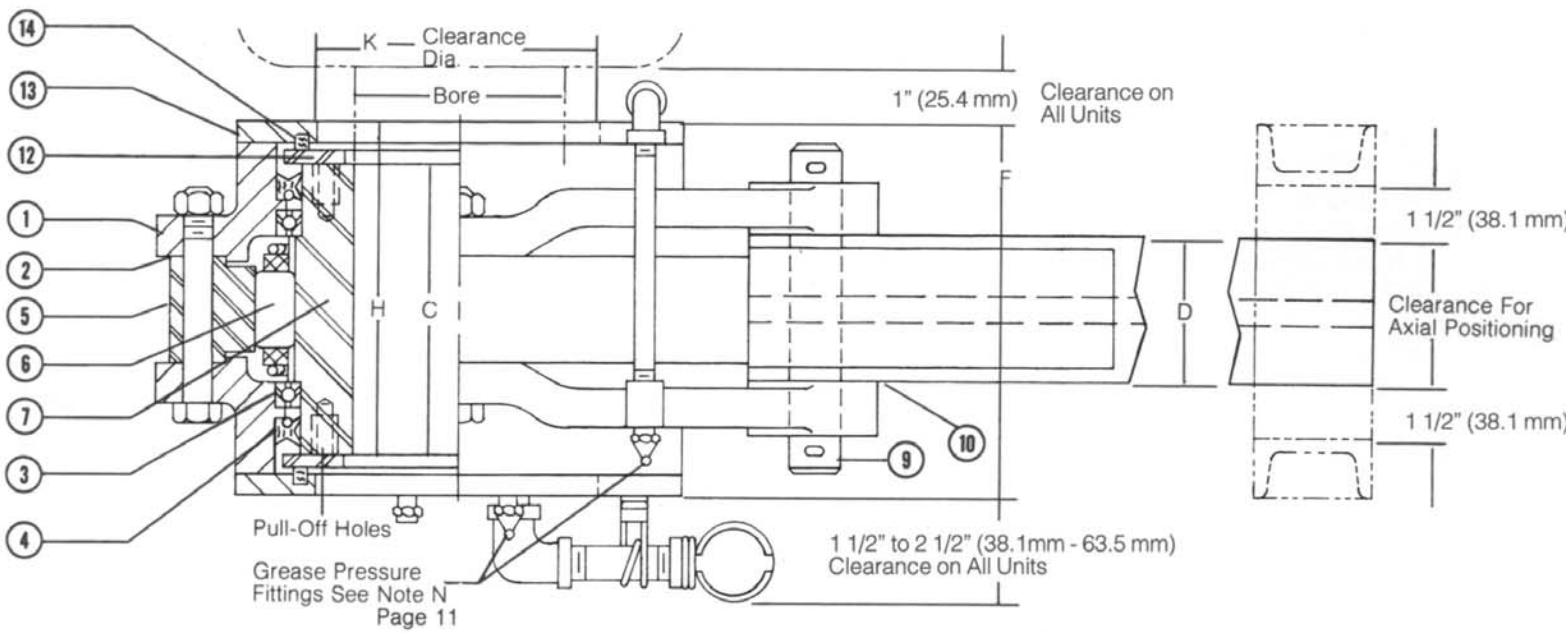
From tabulated rating on Page 11, proper backstop selection is the BC-27MA, rated 36,607 N-m, with maximum bore 165mm. If drive pulley shaft exceeds this maximum, it will be necessary that shaft be turned to suit, or that the next larger backstop be used.

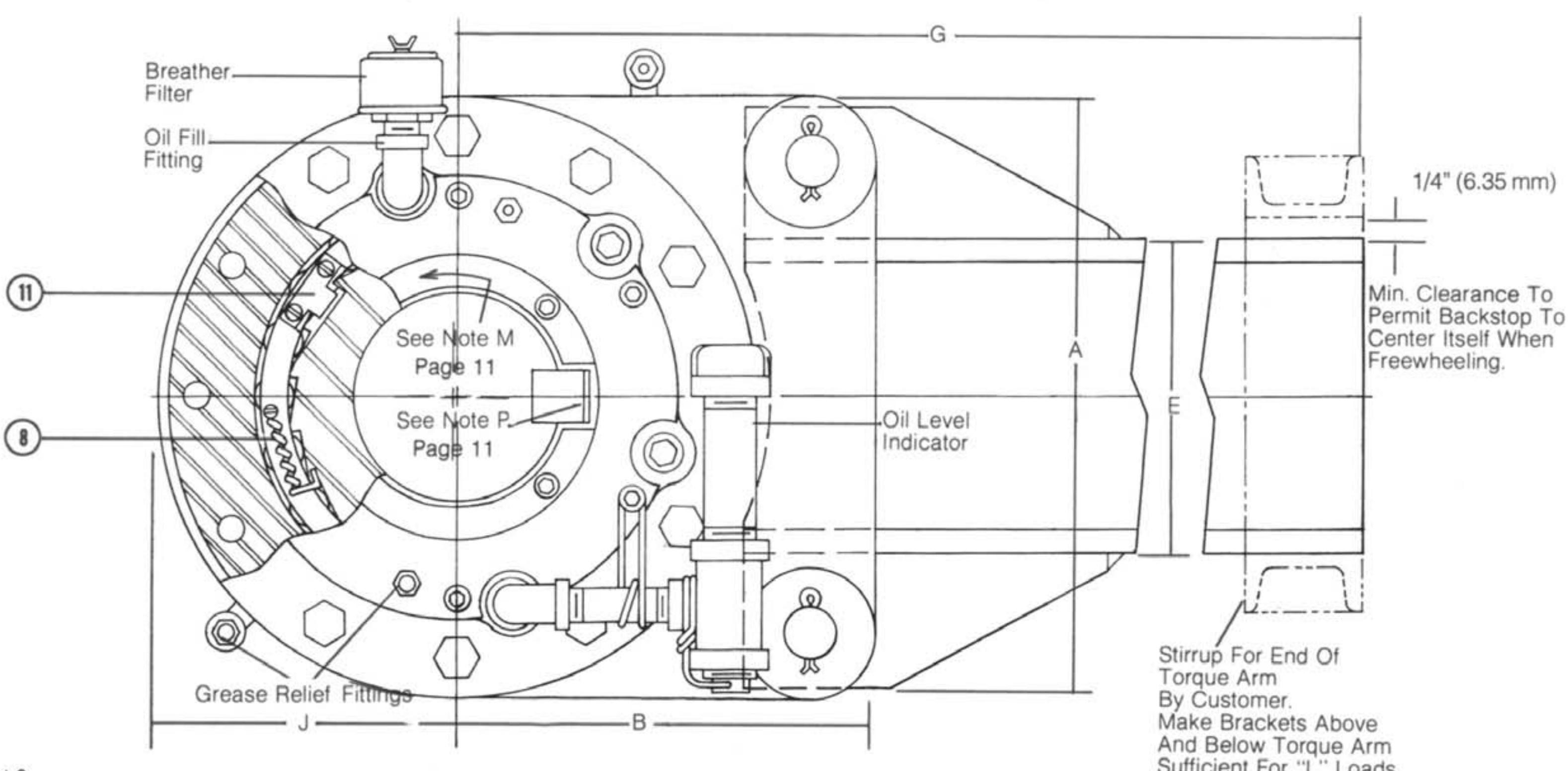
Note: Consult Factory For Size Selection For Dual Drive Or Tandem Pulley Drives.

Marland Backstops
Type BC Series MA

Marland Automatic Backstop covered by one or more of the following U.S. Patents:
3,017,002
3,236,337
3,247,935
Other patents pending.

1. Coverplate
2. Gasket
3. Ball Bearing
4. Oil Seal
5. Outer Race
6. Roller Assembly
7. Cam
8. Spring
9. Pin and Cotter Keys
10. Torque Arm
11. Stop Lug
12. Inner Labyrinth
13. Outer Labyrinth
14. Grease Seal





Dimensions and Data

The torque arm must not be rigidly attached to steel framework. The bracket or stirrup for the end of the torque arm must provide clearance to permit the backstop to center itself in axial and angular positions to prevent pinching of bearings and damage or failure of unit, and must be sufficient for "L" loads above and below torque arm for backstop size selected. The preferred position is horizontal to reduce bearing loading for longer bearing life. Refer to certified drawings and instruction bulletins furnished with each order.

NOTE—M Backstop is symmetrical and can be mounted for desired rotation. Arrow on cam face or inner labyrinth indicates direction of free shaft rotation. Before mounting on shaft, be sure to check direction of free rotation.

NOTE— N Labyrinth seals only are factory packed with grease. Before placing in operation, backstop must be filled internally with recommended oil.

NOTE—P When installed, backstop must be restrained from the possibility of axial movement on the shaft by one of the following:

1. Retention collar
2. Retention key
3. Keeper plate
4. Drive tight cam key

*Keys are furnished for all units supplied with maximum bores. Other bore and key sizes are available meeting metric, AGMA and USA standards as well as custom design requirements. Marland has, on the shelf, many of the popular USA standard sizes for customer convenience.

Engineering Data

Backstop Size	Torque N-m	Rated Torque Lb. Ft.	Max RPM	Load "L" Kgs	Load "L" Lbs.	Max.* Bore mm	Max.* Bore in.	Max.* Bore Keyway mm	Max.* Bore Keyway in.	Ship Weight Kgs.	Ship Weight Lbs.
3MA	4067	3,000	300	510	1,120	75	2 15/16	20 x 4.9	3/4 x 1/4	46	100
6MA	8135	6,000	250	920	2,000	95	3 11/16	25 x 5.4	7/8 x 5/16	69	150
12MA	16270	12,000	210	1325	2,880	115	4 1/2	32 x 7.4	1 x 3/8	100	220
18MA	24405	18,000	180	1776	3,860	140	5 7/16	36 x 8.4	1 1/4 x 7/16	152	330
27MA	36607	27,000	150	2259	4,910	165	6 1/2	40 x 9.4	1 1/2 x 1/2	207	450
45MA	61012	45,000	135	3450	7,500	180	7	45 x 10.4	1 3/4 x 9/16	276	600
63MA	85417	63,000	120	4462	9,700	205	8	50 x 11.4	2 x 11/16	381	830
90MA	122024	90,000	105	6072	13,200	235	9	56 x 12.4	2 1/2 x 3/4	520	1,130
135MA	183035	135,000	90	8464	18,400	265	10	63 x 12.4	2 1/2 x 7/8	690	1,500
180MA	244047	180,000	80	10580	23,000	300	11 3/4	70 x 14.4	3 x 1	966	2,100
240MA	325396	240,000	70	13248	28,800	360	14	80 x 15.4	3 1/2 x 1	1242	2,700
375MA	508432	375,000	60	17250	37,500	460	18	100 x 19.4	4 x 1 1/2	2760	6,000
540MA	732142	540,000	60	20460	45,000	540	21	100 x 21.4	5 x 1 3/4	4140	9,000
720MA	976271	720,000	60	27280	60,000	540	21	100 x 21.4	5 x 1 3/4	4545	10,000

Dimensions (mm/inch)

Backstop Size	A		B		C		D		E		F		G		H		J		K	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
3MA	210	8 1/4	143	5 5/8	105	4 1/8	64	2 1/2	76	3	133	5 1/4	813	32	119	4 11/16	105	4 1/8	86	3 3/8
6MA	248	9 3/4	165	6 1/2	127	5	70	2 3/4	102	4	159	6 1/4	914	36	143	5 5/8	124	4 7/8	108	4 1/4
12MA	292	11 1/2	203	8	133	5 1/4	83	3 1/4	127	6	165	6 1/2	1270	50	149	5 7/8	146	5 3/4	133	5 1/4
18MA	343	13 1/2	235	9 1/4	148	5 13/16	92	3 5/8	152	6	179	7 1/16	1422	56	164	6 7/16	168	6 5/8	162	6 3/8
27MA	384	15 1/8	254	10	178	7	98	3 7/8	178	7	213	8 3/8	1676	66	195	7 11/16	191	7 1/2	181	7 1/8
45MA	445	17 1/2	289	11 3/8	191	7 1/2	105	4 1/8	203	8	225	8 7/8	1829	72	208	8 3/16	216	8 1/2	206	8 1/8
63MA	498	19 5/8	311	12 1/4	203	8	127	5	254	10	238	9 3/8	1981	78	221	8 11/16	244	9 5/8	241	9 1/2
90MA	584	23	362	14 1/4	229	9	140	5 1/2	305	12	267	10 1/2	2083	82	248	9 3/4	270	10 5/8	270	10 5/8
135MA	654	25 3/4	406	16	254	10	143	5 5/8	381	15	298	11 3/4	2235	88	276	10 7/8	308	12 1/8	324	12 3/4
180MA	772	30 3/8	419	16 1/2	273	10 3/4	159	6 1/4	457	18	321	12 5/8	2388	94	297	11 11/16	349	13 3/4	362	14 1/4
240MA	876	34 1/2	457	18	387	15 1/4	162	6 3/8	508	20	406	16	2540	100	–	–	413	16 1/4	–	–
375MA	1041	41	584	23	445	17 1/2	203	8	622	24 1/4	476	18 3/4	3048	120	–	–	495	19 1/2	–	–
540MA	1194	47	673	26 1/2	527	20 3/4	257	10 1/8	692	27 1/4	572	22 1/2	3658	144	–	–	578	22 3/4	–	–
720MA	1194	47	673	26 1/2	552	21 3/4	257	10 1/8	692	27 1/4	597	23 1/2	3658	144	–	–	578	22 3/4	–	–