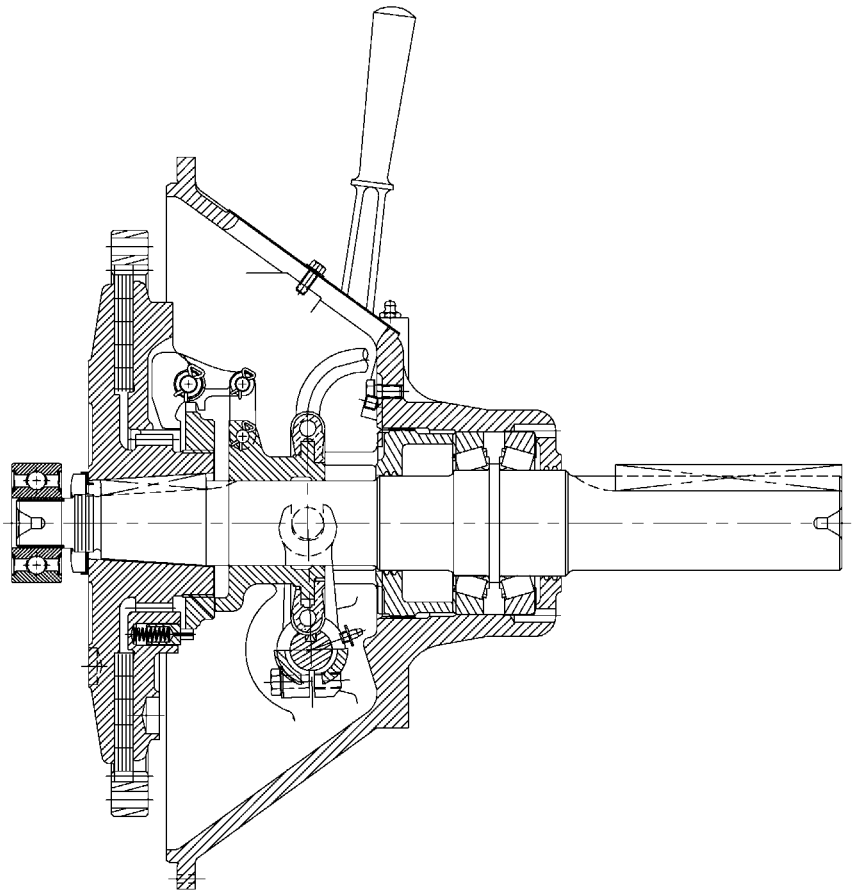
NACD®

North American Clutch & Driveline, Inc.

Manufacturer of Agricultural & Industrial Clutches

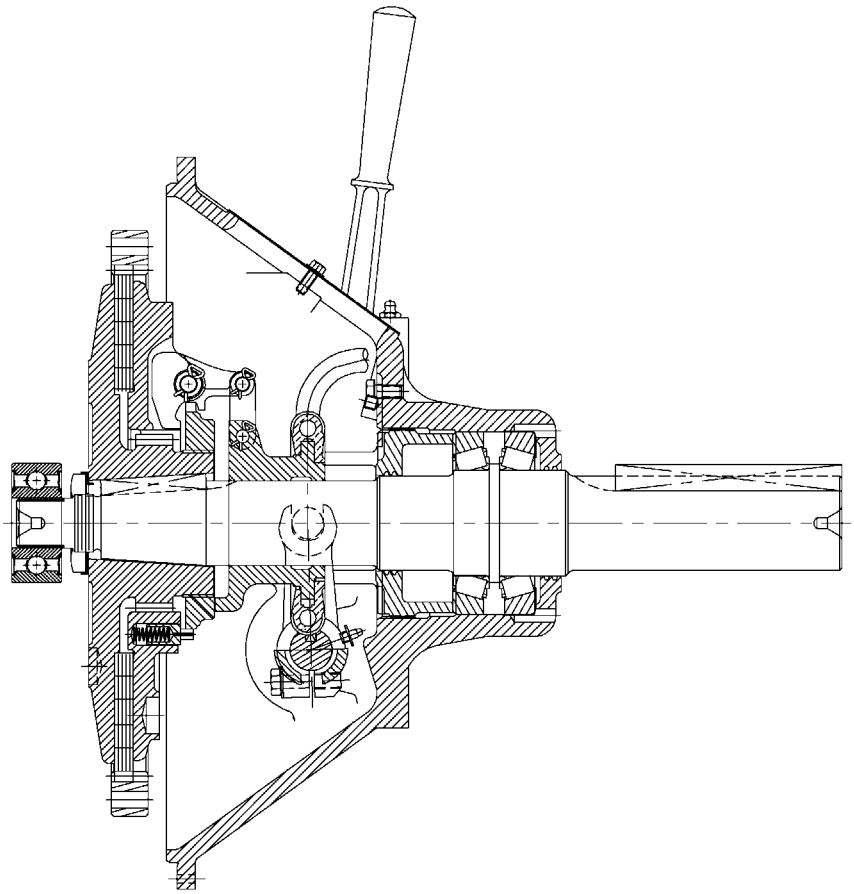


NACD Power Take-Off Service Manual

1022762AM

SP111AM and SP211AM Series

Includes Installation, Operation, Maintenance and Overhaul Instructions



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Phone: (800) 383-9204
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www.naclutch.com

NOTICE
IMPORTANT INFORMATION

It is imperative that proper installation, maintenance, operation and safety procedures be followed explicitly regarding products manufactured by North American Clutch & Driveline.

GENERAL:
Safe working and operating practices must be employed by all personnel working on, with, or near NACD products. NACD will not be responsible for personal injury.

SAFETY NOTICE:
Accidents may result from use of manufactured products, resulting in possible danger to person(s) or property. Therefore, it is important and imperative that correct, safe procedures be followed. Products must be installed, maintained, operated and used in accordance with the engineering information specified. Continual and repeated inspections and observations should be employed as necessary to assure that safe operations and a safe environment exist under prevailing conditions. Use proper guards and other suitable safety equipment, devices and procedures that may be desirable or specified in safety codes, or as necessary to prevent accidental injury to person(s) or property. These devices are neither provided by NACD nor are they the responsibility of NACD.

OWNER / OPERATOR / USER RESPONSIBILITIES:
Knowledge of and performance of the procedures specified in this publication are the responsibility of the owner(s), operator(s), user(s) and all person(s) working on or near the products described herein. Following these procedures and explicit adherence to the information described should ensure safe and reliable use, repair, and operation of products provided by NACD.

WARRANTY:
NACD's limited Warranty is described in detail in this publication. It is the responsibility of the original purchaser or manufacturer, successive buyers, users, third parties or employees to make themselves aware of this warranty and all conditions it contains.

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North American Clutch & Driveline
Rockford, Illinois

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1.0 INTRODUCTION

GENERAL INFORMATION

This publication provides the information necessary for the operation and maintenance of the NACD equipment specified on the cover of this manual. Specific engineering details and performance characteristics can be obtained from the NACD Sales Department.

Operation and maintenance personnel responsible for this equipment should have this manual at their disposal and be familiar with its contents. Applying the information in the manual will result in consistent performance from the unit and help reduce downtime.

REPLACEMENT PARTS

Parts Lists

See the parts identification and exploded views in the illustration section to facilitate ordering spare or replacement parts.

Ordering Parts

All replacement parts or products (including hoses and fittings) must be of NACD origin or equal,and otherwise identical with components of the original equipment. Use of any other parts or products will void the warranty and may result in malfunction or accident, causing injury to personnel and /or serious damage to the equipment.

Renewal parts and service parts kits may be obtained from any authorized NACD distributor or service dealer.

Parts Shipment

Furnish the complete shipping information and postal address. All parts shipments made from the factory will be FOB or EXWorks Machesney Park, Illinois, USA. State specifically whether the parts are to be shipped by freight, express, etc. If shipping instructions are not specified, the equipment will be shipped the best way, considering time and expense. NACD will not be responsible for any charges incurred by this procedure.

NACD, having stipulated the bill of material number on the unit's nameplate, absolves itself of any responsibility resulting from any external, internal or installation changes made in the field without the express written approval of NACD. All returned parts, new or old, emanating from any of the above-stated changes will not be accepted for credit. Furthermore, any equipment which has been subjected to such changes will not be covered by a NACD warranty.

PREVENTIVE MAINTENANCE/TROUBLESHOOTING

Frequent reference to the information provided in this manual regarding daily operation and limitations of this equipment will assist in obtaining trouble free operation. Schedules are provided for the recommended maintenance of the equipment and, if observed, minimum repairs (aside from normal wear) will result.

In the event a malfunction does occur, a troubleshooting table is provided to help identify the problem area and lists information that will help determine the extent of the repairs necessary to get a unit back into operation.

Lifting Bolt Holes

Most NACD products have provisions for attaching lifting bolts. The holes provided are always of adequate size and number to safely lift the NACD product.

⚠ CAUTION

These lifting points must not be used to lift the complete power unit. Lifting excessive loads at these points could cause failure at the lift point (or points) and result in damage or personal injury.

⚠ CAUTION

Select lifting eyebolts to obtain maximum thread engagement with bolt shoulder tight against housing. Bolts should be near but should not contact bottom of bolt hole.

SAFETY

General

Safe practices must be employed by all personnel operating and servicing this unit. NACD, will not be responsible for personal injury resulting from careless use of hand tools, lifting equipment, power tools, or unaccepted maintenance/operating practices.

Important Safety Notice

Because of the possible danger to person(s) or property from accidents which may result from the use of manufactured products, it is important that correct procedures be followed. Products must be used in accordance with the engineering information specified. Proper installation, maintenance, and operation procedures must be observed. Inspection should be made as necessary to assure safe operations under prevailing conditions. Proper guards and other suitable safety codes should be provided. These devices are neither provided by NACD nor are they the responsibility of NACD.

SOURCES OF SERVICE INFORMATION

Each series of maintenance manuals issued by NACD is current at the time of printing. When required, changes are made to reflect advancing technology and improvements in state-of-the-art.

Individual product service bulletins are issued to provide the field with immediate notice of new service information .

For the latest service information on NACD products, contact any NACD distributor, or contact the Sales Department, NACD, Rockford, Illinois, USA.

Contact information for Authorized NACD and Service Dealers can be found on the NACD Web site at: www.naclutch.com.

WARRANTY

Equipment for which this manual was written has a limited warranty. For details of the warranty, refer to the warranty statement at the end of this manual.

DESCRIPTION AND SPECIFICATIONS

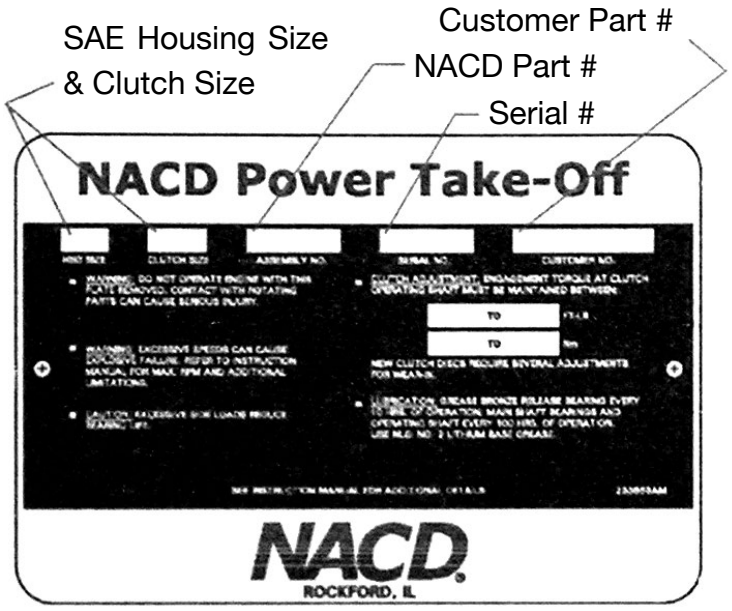
GENERAL INFORMATION

The SP111AM and SP211AM Series NACD Power Take-Offs are engine-mounted power take-offs that use cast iron one-piece housings and contain an integral clutch 11 1/2 inches in diameter. The engine drives the clutch through a drive ring that is bolted to the engine flywheel and connected to the clutch through internal teeth that mesh with external teeth on the clutch friction plate(s). Clutch engagement and disengagement for most units is accomplished by use of the external hand lever assembly. Some units may use other actuation methods.

Main bearings are lubricated and cooled with grease , depending upon the design specifications. Most units use pilot bearings that are pre-lubricated and sealed for life. Those that require periodic relubrication are lubricated through a grease fitting located in the output end or side of the clutch shaft.

FINDING THE NACD POWER TAKE-OFF MODEL AND SERIAL NUMBER

The nameplate identifies the model, bill of material (BOM) and the serial number of the unit. These numbers are necessary to identify the correct parts for your Power Take-Off.



IDENTIFYING THE SAE HOUSING SIZE

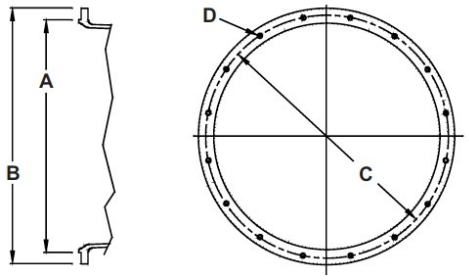


Table 1: SAE Housing Identification

SAE Hsg No.	A Housing Pilot Diameter		B Housing Flange O.D.		C Bolt Circle Diameter		D Bolt Holes		
							Qty.	Dia.	
	mm	inches	mm	inches	mm	inches		mm	inches
1	511.18	20.125	552.4	21.75	530 .22	20.875	12	12.29	.484
2	447 .68	17.625	489 .0	19.25	466.72	18.375	12	10.99	.433
3	409 .58	16.125	450 .8	17.75	428 .62	16.875	12	10.99	.433

SPECIFICATIONS

Maximum Safe Operating Speeds for NACD Take-offs
(Refer to BOM and NACD Power Take-Off Reference Listing)

PTO Model	Grease Lubricated Main Bearing(s)	Steel or Nodular Drive Ring	
		Solid Drive Plate(s)	Split Drive Plate
SP111AM Series	Grease	3600	3200
SP211AM Series	Grease	3500	3160

Table 2: Maximum Safe Operating Speeds

Pilot bearing position (If used)

(Refer to BOM and NACD Power Take-Off Reference Listing.)

Ball-Type

The owner/operator is responsible for checking the flywheel to ensure that the pilot bearing is installed on the shaft with sufficient clearance without bottoming in the flywheel bore. The depth of the pilot bore from the flywheel housing face to shoulder on the flywheel pilot flange is 100.07 mm. (3.94 in.).

Roller-Type

Roller Bearing	Bearing O.D.	Bearing Nominal Width (C)	Bearing Nominal Width +/.tolerance
101578AM	72 mm. (2.835 in.)	30.1 mm. (1.185 in.)	0.5 mm. (0.0025in)

Table 3: Roller-Type Pilot Bearing Dimensions

Tapered Roller Bearing End Play

Table 4: Recommended Bearing End Play for Tapered Roller Bearings Used in Side Loaded and In Line applications.

	Recommended End Play	
PTO Model	mm.	inches
SP111AM Series	.10 - .18	.004 - .008
SP211AM Series	.10 - .18	.004 - .008

Engagement force on the operating shaft

Table 6: Torque at operating shaft to engage clutch

	Recommended Engagement Force	
PTO Model	Nm	Lb.-Ft.
SP111AM Series	144 -191	107 - 141
SP211AM Series	181 - 240	133 - 177

Filling the Main Bearing Cavity during initial assembly.

Grease Lubrication:
Hand-pack the bearings before assembly. Hand-packing requires that the roller elements and bearing races be coated with grease. After assembly, add grease through the grease fitting until grease escapes from the outboard labyrinth seal all around the shaft. Do Not Overfill. Always rotate the shaft while adding grease to the bearing cavity.

Filling the Main Bearing Cavity during periodic maintenance.

Refer to the information contained in the Maintenance section of this manual.

PTO Deflection

PTO deflection due to loads imposed by the application should not exceed
0.254 mm (0.010 in.). Deflection should be measured at the support plate pilot with the dial indicator base mounted on a rigid part of the engine. See the illustration in Installation Tips in the Installation section of this manual.

TORQUE VALUES FOR FASTENERS

Note: The tables below provide information for several different types of fasteners : U.S. Standard Fine and Coarse Thread Capscrews , Bolts, and Nuts; Metric Coarse Thread Capscrews, Bolts, and Nuts; Tapered Pipe Plugs (with thread lubricant); Straight Threaded Tube Fittings, Hose Fittings, and 0-ring Plugs. Be sure to use the appropriate table to obtain the correct torque value.

Note: All threads and bearing face to be lubricated with light oil film prior to assembly.

Table 10: U.S. Standard Fine and Coarse Thread Capscrews, Bolts, and Nuts

	SAE Grade 5		SAE Grade 8	
Thread Diameter	N-m	lb.-ft.	N-m	lb.-ft.
1/4	8 - 11	6 - 8	14 - 16	10 - 12
5/16	18 - 23	13 - 17	27 - 33	20 - 24
3/8	34 - 39	25 - 29	47 - 56	35 - 41
7/16	50 - 58	37 - 43	75 - 88	55 - 65
1/2	81 - 95	60 - 70	113 - 132	83 - 97
9/16	111 - 133	82 - 98	163 - 190	120 - 140
5/8	163 - 190	120 - 140	224 - 264	165 - 195
3/4	278 - 332	205 - 245	400 - 468	295 - 345
718	447 - 529	330 - 390	637 - 746	470 - 550
1	671 - 793	495 - 585	969 - 1132	715 - 835
1 1/8	834 - 997	615 - 735	1376 - 1607	1015 - 1185
1 1/4	1152 - 1356	850 - 1000	1864 - 2203	1375 - 1625

Table 11: Metric Coarse Thread Capscrews, Bolts, and Nuts

Thread Size	Property Class 8.8		Property Class 10.9		Property Class 12.9	
	N-m	lb.-ft.	N-m	lb.-ft.	N-m	lb.-ft.
M6	9 -10	6.5 - 7.5	12 - 14	9 - 10	14 - 16	10 - 12
M8	21 -25	16 - 18	31 - 35	23 - 26	34 - 40	25 - 29
M10	43 - 49	32 - 36	60 - 68	44 - 51	70 - 80	51 - 59
M12	74 - 86	55 - 63	104 - 120	77 - 88	121 - 139	89 - 103
M16	179 - 205	132 - 151	256 - 294	189 - 217	298 - 342	219 - 253
M18	247 - 281	182 - 208	350 - 398	258 - 294	412 - 469	304 - 346
M20	348 - 400	257 - 295	493 - 567	364 - 418	581 - 669	429 - 493
M22	475 - 541	351 - 399	669 - 762	494 - 562	792 - 902	584 - 666
M24	603 - 693	445 - 511	848 - 976	626 - 720	1000 - 1150	737 - 848
M30	967 - 1113	714 - 820	1674 - 1926	1235 - 1421	2000 - 2301	1475 - 1697

Table 12. Tapered Pipe Plugs (with thread lubricant)

NPTF Size (in.)	In Cast Iron or Steel		In Aluminum	
	N-m (+ or - 5%)	lb.-ft. (+ or - 5%)	N-m (+ or - 5%)	lb.-ft. (+ or - 5%)
1/6-27	1/6-27	8.5	7.5	5.5
1/8-27	1/8-27	10.5	9	6 .5
1/4-18	1/4-18	25	21 .5	16
3/8- 18	3/8- 18	27	23	17
1/2-14	1/2-14	50	40.5	30
3/4-14	3/4-14	54	46	34
1-11 1/2	1-11 1/2	80	68	50
1 1/4-11 1/2	1 1/4-11 1/2	85	75	55
1 1/2-11 1/2	1 1/2-11 1/2	85	75	55

Table 13: Straight Threaded Tube Fittings, Hose Fittings, and 0-ring Plugs

Nominal Thread Diameter	N-m (+ or - 5%)	lb.-ft. (+ or - 5%	Nominal Thread Diameter	N-m (+ or - 5%)	lb.-ft. (+ or - 5%)
5/16	5	3.5	M10X1.0	12	9
3/8	11.5	8.5	M12X1 .5	16	12
7/16	16	12	M14X1 .5	20	15
1/2	20	15	M16X1.5	24	18
9/16	24.5	18	M18X1.5	34	25
5/8	24 .5	18	M22X1 .5	54	40
11/16	34	25	M27X2.0	75	55
3/4	40.5	30	(in iron)		
7/8	54	40	M27X2.0	75	55
1 1/16	75	55	(in aluminum)		
1 3/16	88	65	M33X2.0	88	65
1 1/4	88	65	M42X2.0	108	80
1 5/16	108	80	M48X2.0	108	80
1 3/8	108	80			
1 5/8	108	80			
1 7/8	108	80			
2 1/2	108	80			

INSTALLATION

INSTALLATION TIPS

Main Bearing Adjustment

1. NACD Power Take-Offs with SP111AM and SP211AM clutches are approved for either in-line drive or side loaded applications within allowable limits.

Alignment

2. The flywheel and flywheel housing alignment must be within specifications. Perform the measurements shown in Prior To Installation in this Installation section.

3. Avoid excessive misalignment between the engine and PTO. Check the following if abnormal wear of parts exists:

a. Excessive loads tend to deflect parts to which PTOs are mounted. A dial indicator can be mounted on a rigid part of the engine or independently on the foundation to determine deflection under actual operating conditions . See Support Plate, Belt or chain tension/Allowable Side Load Pulls and Deflection Caused by Side Load Pulls in this Installation section and information contained in the Description and Specifications section regarding these issues

b. Readings taken before the drive is installed with the engine standing still and when under operating conditions (with the engine off and all belts, chains, driveshafts and/or support plates attached and secured with bolts torqued to specifications) will indicate the extent of deflection. In no case should the deflection exceed 0.254 mm. (0.010 in.) (T.I.R.) at the bearing carrier.

Note: The dial indicator should never be applied with the engine running. This is unsafe and could result in damage to the dial indicator.

4. In a u-joint-type installation, to realize the longest possible life of the power take-off bearings, the best possible alignment must be maintained between the center line of the power take-off shaft and the center line of the driven unit shaft. See information contained in Alignment-U-Joint Type Installation in this Installation section.

5. In side-load installations, alignment between the drive and drive pulleys must be carefully established and maintained. See Position and Measure Alignment of the Sheave in this Installation section.

DRIVE RING

6. The drive ring must be properly installed. See information in Drive Ring Installation in this Installation section .

Pilot Bearings

7. Ball-type pilot bearings and Roller-type pilot bearings must be installed properly. See Ball-Type Pilot Bearing Installation or Roller-Type Pilot Bearing Installation in this Installation section.

Support Plate

8. When mounting the engine and Power Take Off in the machine, a customer-supplied support plate may be required to support the output end of the pto housing. See the information about customer-supplied support plates and NACD PTO Support Plate Specifications contained in the Description and Specifications section of this manual.

⚠ WARNING

Failure to follow this requirement may result in damage to the power take off or the engine flywheel housing.

Belt or chain tension/Allowable Side Load Pulls

9. Avoid excessive tightening of belts or chains. See the Allowable Side Load tables in this Installation section.

10. Avoid excessively loose belts or chains. Belt tension or chain adjustment that is below specifications can cause belt or chain "whip" during operation, resulting in bearing failure and shortened power take-off service life .

Deflection Caused by Side Load Pulls

11. Power Take-Off deflection due to loads imposed by the application should not exceed specified limits shown in PTO Deflection in the Description and Specifications section. Deflection should be measured at the support plate location on the power take-off (or main bearing area of the housing if no support plate is used).

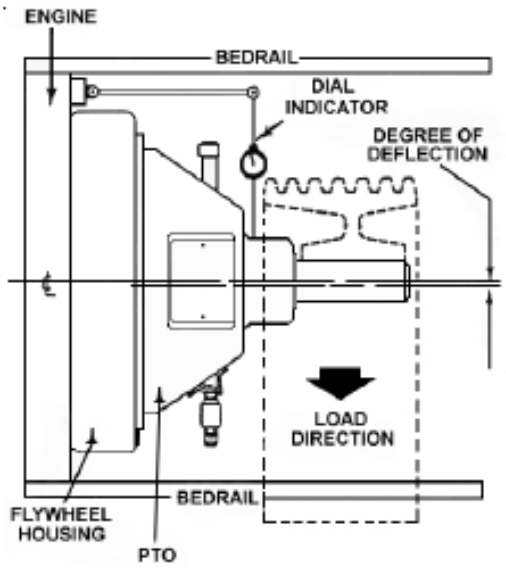


Figure 6. Determining Deflection While Applying Side Loads

⚠ CAUTION

The dial indicator should not be applied while the unit is operating. This could result in damage to the dial indicator.

Lubrication

12. Verify that the PTO is properly lubricated prior to starting the engine .

a. The throwout collar is lubricated by grease through a grease fitting on the outside of the main housing.

b. All SP111AM and SP211AM Series main bearings are lubricated by grease through a grease fitting in the housing.

c. The sealed-for-life pilot bearing should not be lubricated during service.

Refer to the NACD Power Take-Off Reference Listing and Filling the Main Bearing Cavity in the Description and Specifications section , Lubrication in the Maintenance section and Engineering Drawings near the back of this manual.

Clutch Adjustment

13. Verify that the clutch is adjusted according to the procedure outlined in Clutch Adjustment in the Maintenance section. Failure to do so will result in premature clutch wear and failure.

Note: NACD will not be responsible for any damage or injury resulting from improper adjustment and/or lubrication. This includes any accessory drives and loads.

Hand Lever Position

14. Proper hand lever position is required to obtain long service life of the throwout bearing. See Hand Lever Position for NACD Power Take-Offs. See hand lever position and adjustment procedure for NACD Power Take-Offs in the installation section.

Air Engagement Mechanisms

15. Air engagement mechanisms must be installed and adjusted properly for proper clutch actuation and long service life of the PTO. No preload on the throwout bearing can exist either in the fully-engaged or fully released positions, and the air mechanism must be engineered and installed to provide proper engagement force and stroke to properly engage and disengage the clutch . See Setting Up Air Engagement on NACD Power Take-Offs in this Installation section.

Prior to Installation (Ref: SAE J1033 and J617)

Refer to Identifying the SAE Housing Size in the Description and Specifications section of this manual.

⚠ CAUTION

Most NACD products mount directly onto the flywheel of the engine. Flywheel-to-driven component interference is possible due to mismatch of components or other reasons. Therefore, engine crankshaft endplay as well as flywheel alignment check must be made before the driven component, the Power Take-Off, is installed.

After installation of the Power Take-Off, crankshaft end play should be measured again. End play at the second measurement should be the same as the first. A difference in these two end play measurements could be an indication of interference. Consequently, the Power Take-Off should be removed and the source of interference found and corrected.

NACD will not be responsible for system damage caused by engine to NACD match-up regardless of the cause of interference. This engine crankshaft end play check is considered mandatory.

Note: All measurements must be taken with the engine or motor mounted on its supports after the flywheel and housing have been thoroughly cleaned.

1. Measure and record the engine crankshaft or motor shaft endplay using a dial indicator. Record this value, as it will be used later. _____

2. Bolt the indicator to the flywheel so the indicator is perpendicular to the flywheel housing face and the indicator stem rides on the flywheel housing face.

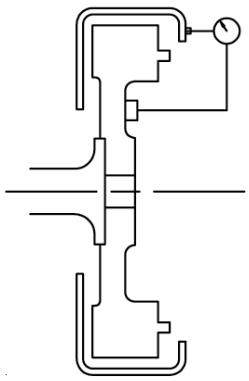


Figure 7. Checking Flywheel Housing Face

3. Rotate the shaft through on entire revolution and note the runout. The total indicator reading (T.I.R.) must not exceed:

SAE #1, #2, #3 Housing .008" (.203mm)

Note: The flywheel and crankshaft of the engine must be held against either the front or rear of the crankshaft thrust bearing while the total indicator sweep (T.I.R.) is being made.

4. Readjust the indicator so the stem rides on the pilot bore of the flywheel housing face.

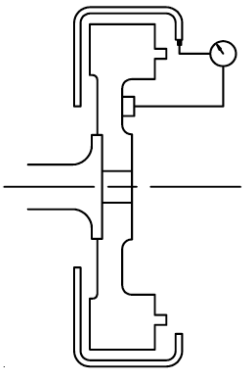


Figure 8. Checking Flywheel Housing Bore

5. Rotate the shaft through one entire revolution and note the runout. The total indicator reading (T.I.R.) should not exceed:

SAE #1, #2, #3 Housing .008" (.203mm)

6. Remove the indicator base from the flywheel and bolt it to the flywheel housing face. Position the indicator stem so that it rides where the drive ring will sit on the flywheel face.

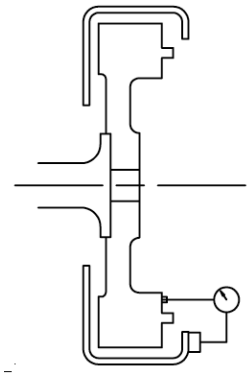


Figure 9. Checking Driving Ring Surface of Flywheel

7. Rotate the shaft through one entire revolution and note the face runout of the flywheel. The total indicator reading (T.I.R.) must not exceed 0.01mm. (0.0005 in.) per 25.4 mm. (per inch) of flywheel diameter.

Note: The flywheel and crankshaft of the engine must be held against either the front or rear of the crankshaft thrust bearing while the total indicator sweep (T.1.R.) is being made.

8. Readjust the indicator stem so it rides on the driving ring pilot bore of the flywheel.

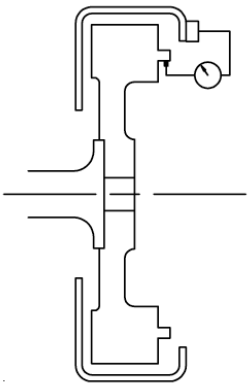
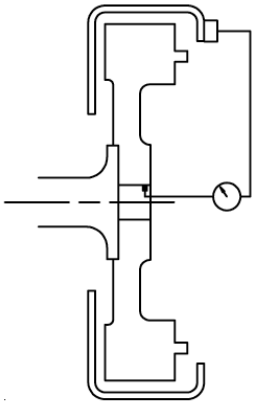


Figure 10. Checking Driving Ring Pilot Bore of Flywheel

9. Rotate the shaft through one entire revolution and note the driving ring bore eccentricity. The total indicator reading (T.I.R.) must not exceed 0.13 mm. (0.005 in.) .

10. Readjust the indicator stem so that it rides on the pilot bearing bore cavity.

Figure 11. Checking Pilot Bearing Bore of Flywheel



11. Rotate the shaft through one entire revolution and note the pilot bearing bore eccentricity. The total indicator reading (T.I.R.) must not exceed 0.13 mm. (0.005 in.) .

Note: Eccentricity between the driving ring pilot bore and the pilot bearing bore must not exceed 0.20 mm. (0.008 in.).

DRIVE RING INSTALLATION

Refer to information regarding cleaning and inspection of the drive ring in the Cleaning and Inspection section of this manual before proceeding.

1. Clean the drive ring and flywheel of any dirt or debris as necessary.

2. Use crocus cloth or emery cloth to remove any surface imperfections such as nicks, burrs, and sharp edges on the O.D. or the surface that will be mounted against the flywheel face.

3. Use crocus cloth or emery cloth to remove any surface imperfections such as nicks, burrs, and sharp edges in the I.D. of the flywheel pilot bore or on the face that will be in contact with the drive ring.

4. Position the drive ring against the flywheel , piloted in the mounting bore, and secure with eight hex-head capscrews. Torque the capscrew to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section of this manual.

⚠ CAUTION

Drive ring attachment screws must be grade 8 per SAE J429. Do not use substitutes.

BALL-TYPE PILOT BEARING INSTALLATION

Refer to the NACD Power Take-Off Reference Listing in the Description and Specifications section and Engineering Drawings near the back of this manual.

Refer to information regarding cleaning and inspection in the Cleaning and Inspection section of this manual before proceeding.

For non-greasable pilot bearing ONLY: (bearing has 2 grease seals.)

1. Non-greasable, double-sealed pilot bearings require no re-lubrication and may be installed in the flywheel or adapter with either side toward the PTO and clutch. The shaft should have no grease fittings. If it does, remove the grease fitting(s) and replace with pipe plugs as a precaution to insure grease is not forced into the pilot bearing cavity of the flywheel. A build-up of pressure caused by forcing grease into the cavity can cause the pilot bearing to be forced out of the flywheel, resulting in a bearing or shaft failure.

ROLLER-TYPE PILOT BEARING INSTALLATION

Some NACD Power Take-Offs are designed with roller-type pilot bearings. All of the roller-type bearings available from NACD are the separate race type, i.e. the inner race is removable from the outer race and seal assembly. Due to its design configuration, axial alignment of the inner and outer races is extremely important. The information and instructions below will assure proper bearing mounting.

Instructions for Assembly

NOTE: Pilot Bearing race to be assembled flush with end of input shaft

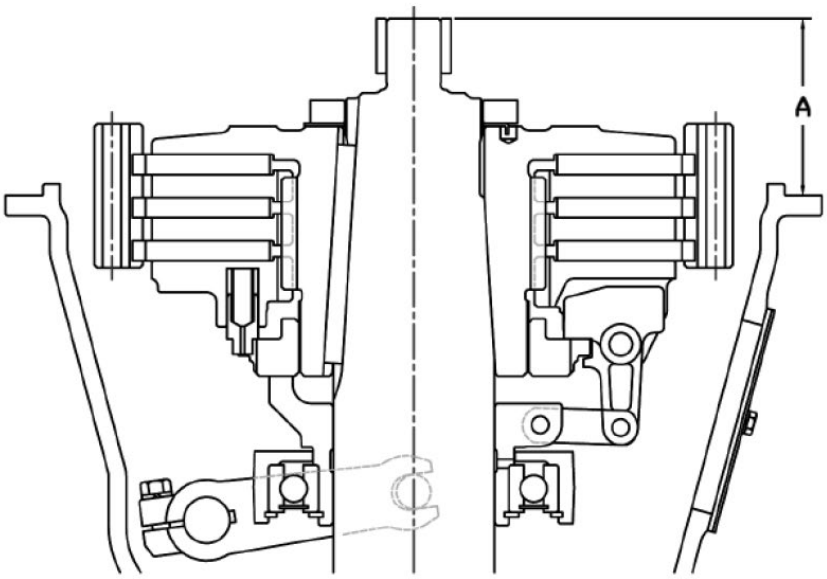


Figure 1

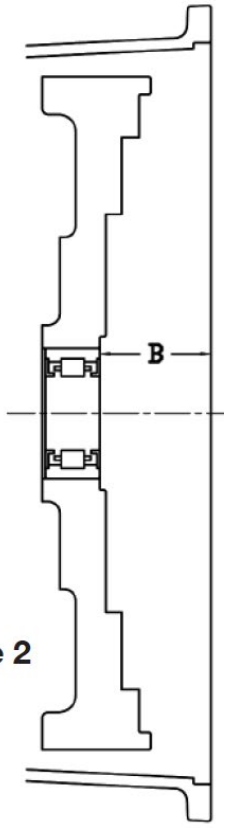


Figure 2

Figure 3. Roller Bearing Data

Roller Brg Part No.	Brg O.D.	Reccomended Flywheel Bore	Brg I.D.	Replaces Ball Bearing Size	Roller Brg. Width Nominal
101578AM	2.8356	2.8350	1.1806	306	1.1850
	2.8351	2.8344	1.1802		
101653AM	3.1506	3.1500	1.3775	307	1.3725
	3.1501	3.1494	1.3770		
101848AM	3.9384	3.9377	1.7707	309	1.5600
	3.9378	3.9367	1.7712		

Pilot Roller Bearing Assembly Dimensions

PTO	Bearing	"A" Dimension "Inner Race"	"B" Dimension "Outer Race"	Bearing Width	B = A - Width
434680AM	101578AM	3.847	2.660	1.185	2.662
436050AM		3.847	2.660		2.662
437560AM		3.875	2.690		2.690
437687AM		3.847	2.660		2.662
437417AM	101653AM	3.873	2.500	1.373	2.500
437437AM		3.873	2.500		2.500
437457AM		3.861	2.488		2.488
437466AM		3.861	2.488		2.488
437667AM		3.861	2.488		2.488
411095AM	101848AM	3.861	2.301	1.560	2.301
437557AM		3.861	2.301		2.301

INSTRUCTIONS FOR ASSEMBLY

1. Press inner race of roller bearing on clutch shaft flush with end of shaft
2. Place unit on bench with clutch shaft vertical as shown
3. Measure dimension A as shown in figure 1
4. Installation dimension B for bearing outer race is determined by subtracting the bearing width shown in figure 3 from dimension A (B = A - Brg. Width)
5. Install bearing outer race and roller assembly into flywheel cavity to dimension B

PTO INSTALLATION TO ENGINE OR DRIVING MEMBER

Refer to the NACD Power Take-Off Reference Listing in the Description and Specifications section, the exploded views in the Illustration section and Engineering Drawings near the back of this manual.

Refer to information regarding cleaning and inspection in the Cleaning and Inspection section of this manual before proceeding.

1. Clean the PTO housing flange, flywheel housing flange, and pilot bearing bore of any debris.

2. Make sure the housing flange and flywheel housing flange are free of surface imperfections such as nicks, burrs, and sharp edges. Remove them using fine emery cloth or crocus cloth.

3. Install a minimum of three guide studs in the flywheel housing, located approximately 120°apart . Using a suitable hoist, position the PTO on the guide studs and slide it against the flywheel housing, carefully aligning the pilot bearing with the pilot bearing bore in the flywheel and the teeth of the friction plates (6) with the drive ring (1) .

⚠ CAUTION

Do not force the PTO unit onto the engine. If any resistance is noted, repeat the clutch plate centering procedure shown either in the clutch assembly or final assembly information of the Assembly section of this manual to align and center the friction plates so they mesh properly with the teeth of the drive ring.

4. Secure the PTO housing to the flywheel housing with 16 hex-head capscrews. Torque the capscrew to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section of this manual.

Note: PTO housing to flywheel housing attachment screws must be grade 5 or better.

5. Rap the output end of the main shaft with a soft hammer to remove any preload on the main bearings and/or pilot bearing.

⚠ CAUTION

This step must not be omitted. Bearing failure may result.

6. Measure the crankshaft endplay again. The measurement must be the same value as recorded from step 1 under Prior To Installation. Locate and correct the source of preload if the end play is not the same value.

⚠ CAUTION

Engine and/or PTO failure will result from any excessive preload on components .

7. Install the key (34) on the output end of the clutch shaft (33) and install the drive sheave , chain sprocket , or u-joint flange as the application requires .

⚠ WARNING

Refer to the NACD Power Take-Off Reference Listing in the Description and Specifications section towards the back of this manual. If a customer-supplied PTO support plate mounted at the output end of the PTO is to be used, refer to information regarding the support plate in NACD PTO Support Plate Specifications in the Description and Specifications section of this manual.

8. Install the hand lever assembly (53) as shown in the Hand Lever Position for NACD Power Take-Offs.

HAND LEVER POSITION FOR POWER TAKE-OFFS

Normal Position: Operating Shaft Horizontal

To insure there is no preload on the shifting mechanism, the hand lever position with the clutch engaged should be slightly past vertical position, slightly towards engine.

⚠ WARNING

The handle should NEVER be installed in a horizontal position when the operating shaft is positioned horizontally. Improper handle position can cause throwout collar failure resulting in catastrophic failure of the clutch.

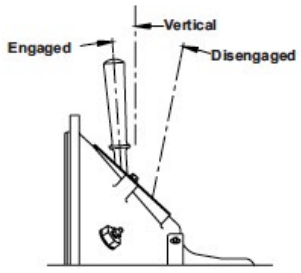


Figure 15. Hand Lever Position

Special Position: Operating Shaft Vertical

If the installation requires that the operating shaft be in a vertical position, a stop collar must be installed to prevent the weight of the hand lever, operating shaft and throwout yoke from creating a preload on the throwout collar. Position the hand lever as described above and also position and lock a stop collar on the operating shaft so that the throwout yoke is centered on the throwout collar. Contact NACD's Service Department for information on use of a stop collar.

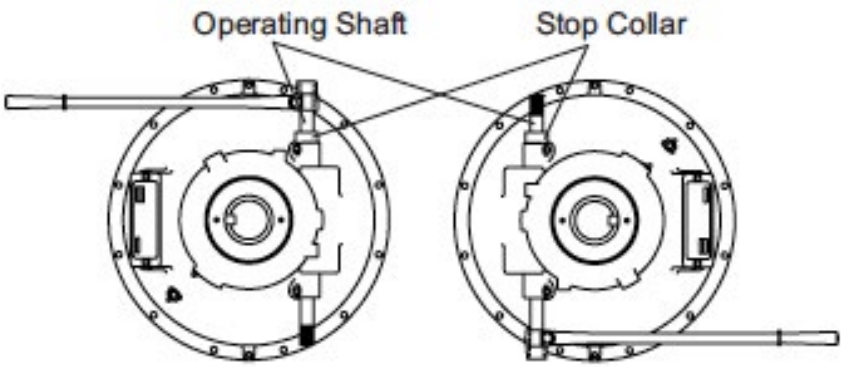


Figure 16. Use of a stop collar with a vertical operating shaft

POSITION AND MEASURE ALIGNMENT OF THE SHEAVE

1. Align the driveR and driveN shafts so that the faces of the sheaves are aligned and parallel to each other. Misalignment must be LESS THAN 1/2 of 1 degree between the faces .

2. Position the sheave (driveR sheave on the PTO shaft) so it is aligned with the driveN sheave (on equipment being driven by the PTO) .

3. Calculate MAXIMUM allowable misalignment distance of the faces: Max. = 0.222 mm. (0.00875 in.) x distance between sheave centerlines.

4. Place a tight cord or straight edge against both edges of the flat face of one sheave. Measure the distance between the cord or straight edge and the face of the other sheave. The gap is the misalignment distance. Align the sheaves to meet specifications.

⚠ CAUTION

Misalignment between the sheaves will result in shortened service life of the belts and may result in premature equipment failure.

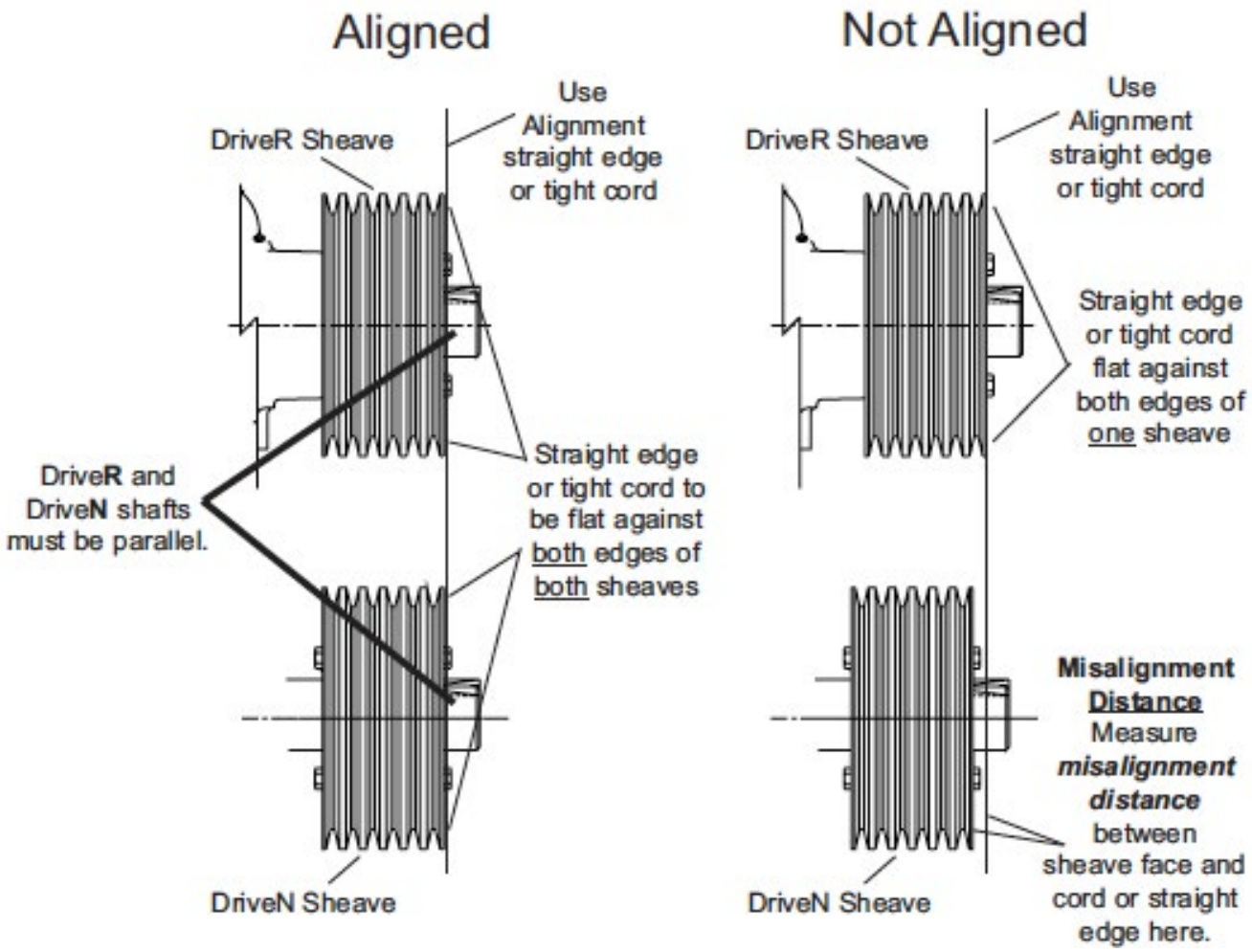
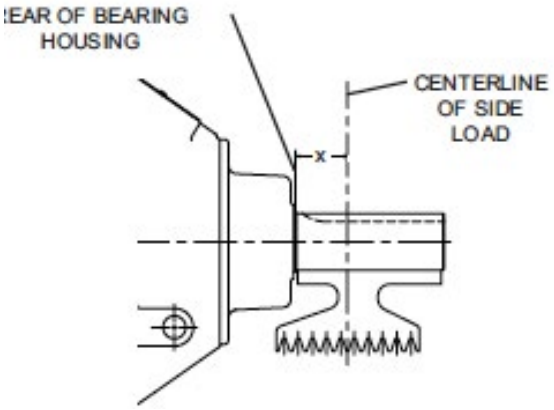


Figure 18. Align Sheaves to Specifications

ALLOWABLE SIDE LOADS

Side loads must NEVER exceed the values shown in this section.



$$L = \frac{126{,}000 \times H.P.}{N \times D} \times F \times A$$

Figure 19. Allowable Side Pull and Formula to Determine Applied Load Formula values:

L = actual applied load (Lbs.)
N = shaft speed (RPM)
D = pitch diameter (in.) at sheave, etc.
F = load factor

1.0 for chain or gear drive	2.5 for all V belts
1.5 for timing belts	3.5 for flat belts

A= 1.0 for Low & Moderate Duty Drives 1.4 for Severe Shock Loads or Large Inertia Loads (Reciprocating Compressors, Crushers, Chippers, Planers, etc)

If side load pulls are found to exceed the Allowable Side Loads shown in the charts and graphs that follow, take appropriate action, BEFORE OPERATING THE PTO, to bring the side loads within acceptable limits.

ALIGNMENT - U-JOINT-TYPE INSTALLATION

Refer to illustration on next page.

To realize the longest possible life of the power take-off bearings, the best possible alignment must be maintained between the center line of the power take-off shaft and the center line of the driven unit shaft.

1. It is extremely important that the forks of the drive shaft between the PTO and the driven unit lie in the same plane. This will prevent severe vibrations from occurring in the drive shaft.

2. The center lines of the PTO shaft and the driven unit input shaft must be offset within the limits recommended by the u-joint manufacturer to prolong the life of the universal joint needle bearings.

3. It is extremely important that the center lines of the PTO shaft and driven unit input shaft be parallel. This will further prevent vibrations which cause premature PTO bearing failure.

4. Proper lubrication of the PTO is important for satisfactory service. Refer to lubrication specifications in the Maintenance section of this manual.

Align the centerlines of the PTO shaft and the input shaft of the driven unit. (One possible method is described below.)

5. To align the engine and gear head by this method, two accurate straight edges at least 91 cm. (36 in.) long and a tape measure are required.

6. Place the straight edges horizontally along the face of the PTO and gear head hubs. Measure distances A and B. These two distances should be equal within 3.17 mm. (.125 in.) at a point 45 .7 cm. (18 in.) from the centerline of the shaft. Move the engine and/or driven unit to obtain this specification .

7. Rotate the shafts so the straight edges are in a vertical position . Measure the distances C and D as was done for A and B in step 2. These two distances should be equal within 3.17 mm. (.125 in.) at a point 45 .7 cm. (18 in.) from the centerline of the shaft. Move the engine and/or driven unit to obtain this specification .

8. Secure the engine and driven unit. Recheck A and B, C and D as described in steps 5 through 7 above. All measurements must be within the specifications . If not, repeat steps 5 through 7 until specifications are met.

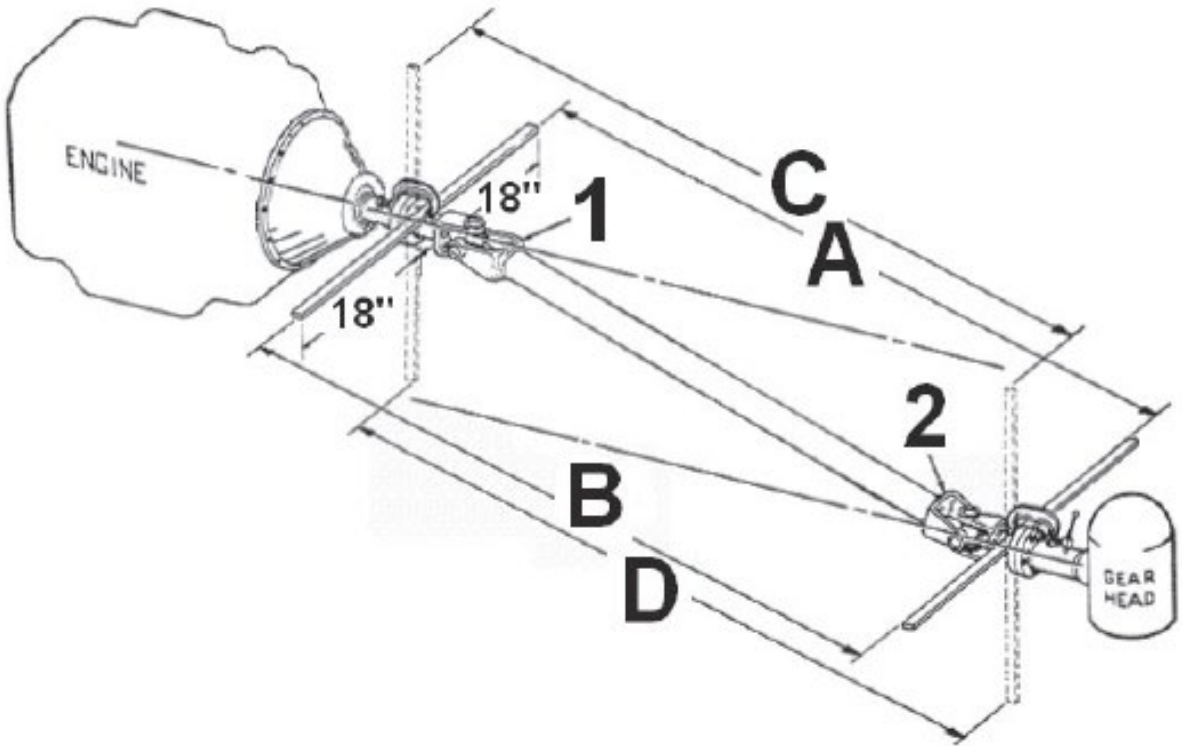


Figure 20. Alignment - U-Joint-Type Installation

SETTING UP AIR ENGAGEMENT ON POWER TAKE OFFS

1. The cylinder should be located so that the piston moves forward and backward in exactly the same direction as the engagement lever and is aligned so it travels in exactly the same plane.

2. The air cylinder must be of sufficient size to operate the required torque to engage the clutch. It must have some means to make adjustment on the piston stroke.

3. Air pressure must be constant. Low pressures could give only partial engagement which will cause failures of the clutch and throwout collar.

4. The piston travel must be within limits established to both fully engage and fully disengage the clutch. Failure to provide these parameters will cause failure and possible breakage of the clutch.

5. The engaging cylinder must not place a pressure either in the engaged or disengaged direction after completion of its cycle. The throwout collar must float free after engagement or disengagement. Operating the PTO with constant pressure on the throwout collar will result in failure .

Suggestion: A slotted connector, similar to the one illustrated below may be used.

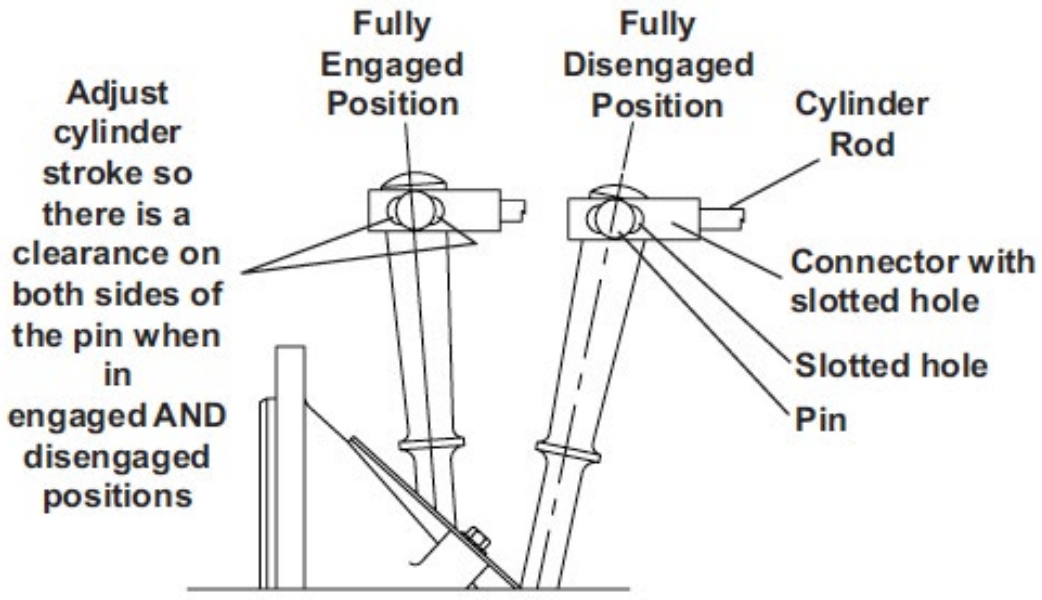


Figure 21. Slotted Connector Used on Air Cylinder Rod

6. The air cylinder must be readjusted when the clutch is readjusted and any time the travel or position moves from the specifications described above.

Determine the length of travel for the engaging cylinder.

7. Multiply the length of the hand lever by the value shown in the following chart. This provides the approximate required length of the piston stroke.

Note: The hand lever length is the distance from the center of the operating shaft to the point where the cylinder will be connected to the lever.

Model	Engaging Stroke Travel at 25.4 mm (1 in.)	
	MM	inches
SP111AM Series	8.255	.325
SP211AM Series	6.782	.267

Table 15. Engaging Stroke Travel at 25.4 mm. (1 in.)

Determine the engaging force in pounds required at the cylinder.

8. Divide the force value in the chart below by the length of the hand lever (in inches). This provides the required force (in pounds) that must be provided by the piston.

Note: Periodically disconnect the power cylinder to measure the clutch engagement force. Refer to Clutch Adjustment in the Maintenance section.

Model	Engaging Force Required in Cylinder	
	force (newtons)	force (pounds)
SP111AM Series	6850	1540
SP211AM Series	8585	1930

Table 16. Engaging Force Required at Cylinder at 25.4 mm. (1 in.)

OPERATION

GENERAL INFORMATION

Model SP111AM and SP211AM Series Power Take-Offs consist of a manually engaged and disengaged disconnect clutch mounted on an output shaft in a cast iron housing that is bolted to the engine. Clutch engagement and disengagement is accomplished by means of an operating lever on the outside of the PTO housing, which actuates an internal linkage mechanism.

A drive ring is bolted to the engine flywheel. Internal teeth of the drive ring mesh with external teeth of the clutch driving plate(s). These are the input components of the Power Take-Off. Input components always rotate at engine rpm.

Output components of the Power Take-Off consist of a clutch hub that is mounted on the output shaft, a linkage mechanism for clutch engagement and disengagement and clutch adjustment components. Clutches designed with multiple clutch driving plates have a clutch center plate located between the friction plates. The clutch center plate and pressure plate are driven through internal teeth that mesh with external teeth on the clutch hub. Until clutch engagement is initiated while the engine is running, the output components do not rotate.

During clutch engagement, the clutch pressure plate is moved to clamp the clutch driving plate(s) against the friction face of the clutch hub (or the center plate(s). The internal engagement mechanism of the clutch locks the clutch pressure plate in the engaged position to complete the drive. Thus, at full clutch engagement, the output shaft is driven at engine speed.

Grease lubricated main bearings are located in the PTO housing and/or bearing carrier. Most designs include a pilot bearing mounted in the engine flywheel to support the front end of the clutch shaft.

CLUTCH ENGAGEMENT PROCEDURE

Normal clutch engagement

⚠ WARNING

Do not start the engine with the nameplate removed.

The PTO clutch should normally be engaged with the engine at the lowest rpm possible. The clutch should be engaged quickly to avoid an extended period of slippage during engagement. The clutch should be engaged with the engine operating below 1,000 rpm.

After the clutch is fully engaged and the load has been brought up to engine engagement speed, the engine rpm may be increased to operating speed.

Clutch engagement where high inertia loads exist.

NACD recommends that the PTO installation be designed to allow clutch engagement at 1,000 rpm or below. Under extreme circumstances, where high inertia loads must be picked up, the engine may have to be operated at higher speeds while the engagement occurs, as engaging the clutch at 1,000 rpm or below may result in stalling the engine.

⚠ CAUTION

Clutch engagement should occur at the lowest possible engine rpm.

Heavy inertia loads may be brought up to engine speed by a series of short clutch engagements and disengagements (sometimes referred to as "bumping") at intervals long enough to gradually increase the speed of the load, yet prevent excessive heat build-up in the friction facings .

After the clutch is fully engaged and the load has been brought up to engine engagement speed, the engine rpm may be increased to operating speed.

⚠ CAUTION

Under no circumstances should the clutch be slipped for more than a second or two without either fully engaging or disengaging the clutch to permit it to cool.

Clutch Engagement To Clear A Jammed Driven Device

⚠ WARNING

Never engage the PTO to unjam a stuck load. Doing so could result in injury to the operator, and damage to the equipment.

Always shut the engine off and disengage the clutch before clearing a jammed load. The jam should be cleared, and the output shaft must be rotated to be certain that the jam is completely removed before starting the engine and engaging the PTO.

Operator should be aware of the required clutch engagement force

The clutch engagement force must be at the proper level to realize long life of the PTO clutch. If this engagement force seems low, refer to the Clutch Adjustment Procedure in the Maintenance section of this manual.

⚠ WARNING

Insufficient clutch engagement force can cause clutch slippage resulting in catastrophic clutch failure.

The engagement lever must be located in the proper position to prevent premature failures of the internal throwout collar components. The engagement lever should be in the vertical position with the clutch engaged. See Hand Lever Position for NACD Power Take-Offs in the Installation section of this manual.

⚠ WARNING

Improper handle position can cause throwout collar failure resulting in catastrophic failure of the clutch.

MAINTENANCE

Tapered Roller Bearing Adjustment

1. Tapered roller bearing end play adjustment should have been adjusted prior to installation of the power take-off. Periodically check for excessive shaft movement during clutch engagement and disengagement and during operation to insure failure is not occurring. See information in the Installation section of this manual.

Pilot Bearings

2. Ball-type pilot bearings and Roller-type pilot bearings must be installed properly.

LUBRICATION

3. Verify that the PTO is properly lubricated prior to starting the engine and at all times during operation. Refer to the NACD Power Take-Off Reference Listing in the Description and Specifications section.

Throwout bearing failures may be, among other causes , the result of improper lubrication.

CLUTCH ADJUSTMENT

4. Check frequently to insure that the clutch is adjusted according to the procedure outlined in Clutch Adjustment in this Maintenance section . Failure to do so will result in premature clutch wear and failure .

Note: NACD will not be responsible for any damage or injury resulting from improper adjustment and/or lubrication. This includes any accessory drives and loads.

Hand Lever Position

5. Throwout bearing failures may be, among other causes, the result of improper hand lever position. See Hand Lever Position for NACD Power Take-Offs in the Installation section of this manual.

Alignment

6. The flywheel and flywheel housing alignment should have been set within specifications prior to installation of the Power Take-Off and must be maintained for long service life of the components.

Misalignment of driven components can result in Power Take-Off failure . Periodically check for bolts that may have loosened or driven components that have not been properly aligned during servicing or maintenance procedures . See information regarding Alignment in the Installation section of this manual.

Support Plate

7. When mounting the engine and Power Take-Off in the machine, a customer-supplied support plate may be required to support the output end of the PTO housing. Proper installation and alignment of the support plate must be maintained.

Periodically check to insure that the bolts securing the support plate are tightened to specifications and that the support plate is properly reinstalled and realigned whenever work is performed on the Power Take-Off or power package module. See the information about customer-supplied support plates and NACD Support Plate Specifications contained in the Description and Specifications section of this manual.

⚠ WARNING

Failure to follow maintain this requirement may result in damage to the Power Take-Off or the engine flywheel housing.

Belt Or Chain Tension/Allowable Side Load Pulls

8. Maintain proper belt or chain tension adjustments. Avoid excessively tight or excessively loose belts or chains. Failure to maintain proper belt or chain adjustment can cause bearing failure and shortened power take-off service life.

Deflection Caused By Side Load Pulls

9. Maintain proper side load that does not exceed specified limits shown in Allowable Side Load Pulls in the Installation section and PTO Deflection in the Description and Specifications section.

Air Engagement Mechanisms

10. Air engagement mechanisms must remain properly adjusted at all times. See Setting Up Air Engagement on NACD Power Take-Offs in the Installation section.

Lubrication

Refer to the NACD Power Take-Off Reference Listing, and the illustrations below for location of fittings.

Grease Specifications

USE ONLY NGLI (National Grease and Lubrication Institute) APPROVED High grade, lithium base #2, short fibre grease with an EP (extreme pressure) additive recommended for use in high speed roller bearings operating at 200 degrees F. (93.3 degrees C.)

Grease specifications for special conditions
For ambient temperatures above 100 degrees F (37.8 degrees C), contact NACD for specifications.

GREASE CAUTION: Do not mix sodium or calcium based greases with lithium grease. Do not mix different types of greases under any circumstances in NACD Power Take-Offs. Do not use molybdenum disulfide grease.

Lubrication Locations

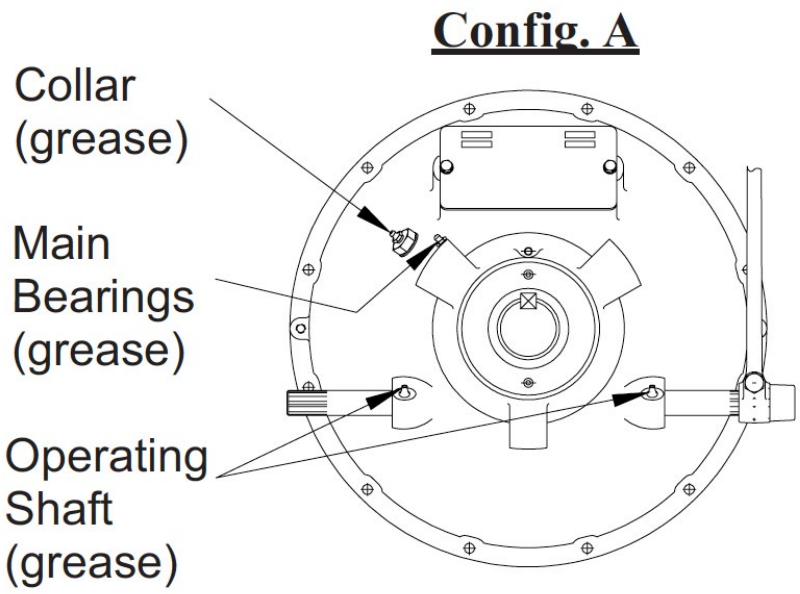


Figure 22: Lubrication Locations

Refer to the inspection plate and NACD Power Take-Off Reference Listing in the Description and Specifications section of this manual.

Lubrication Intervals

The following lubrication intervals are suggested as the guidelines. The owner/operator is responsible for establishing lubrication intervals appropriate to the duty cycle and environmental operating conditions to which the PTO is subjected.

Release bearing-bronze:
Using a hand operated grease gun, add 1 or 2 pumps of grease every 8-10 hours of operation (or add grease until grease begins to weep from the ID of the bearing and from between the release sleeve and the shaft). Rotate the shaft (by hand) while adding grease. Do not over-grease!

Release sleeve used with non-greasable bearing:
Using a hand operated grease gun, add 1 or 2 pumps of grease per 500 hours of operation (or add grease until grease begins to weep from between the release sleeve and the shaft). Rotate the shaft (by hand) while adding grease. Do not over-grease!!

Main bearings:
Grease every 100 hours of operation. Add grease until grease is forced out of the labyrinth seal(s) around the shaft. Manually (not by starting the engine) rotate the shaft while adding grease.

PTO cross shaft:
Grease every 500 hours of operation. Add one or two pumps of grease from a hand operated grease gun.

Clutch linkage and levers:
Lubricate sparingly with engine oil every 500 hours of operation

Pilot bearing: (non-greasable type)
Cartridge-type pilot bearings are sealed units and require no additional lubrication.

The lubrication intervals and the amount of grease used should be adjusted to minimize the amount of grease forced out of the housing and the clutch release bearing. A small amount of grease driven from the housing and clutch release bearing is an indication that enough grease is being provided.

CLUTCH ADJUSTMENT

⚠ WARNING

Be sure engine is off before adjusting the clutch. Adjusting the clutch with the engine running may result in personal injury and/or damage to equipment.

Note: Clutches in new power take-offs require checking of adjustment after installation and prior to operation.

New clutch plates have a wear-in period during which the clutch may require several adjustments. The model SP111AM and SP211AM clutches described in this manual do not automatically adjust to compensate for wear of the clutch facing(s), and therefore must be manually adjusted. Maintaining the correct engagement pressure is the responsibility of the owner/operator.

Clutch adjustment should be checked on a newly placed in service power take-off after the first eight hours of operation. Adjustments should be made at the ten to fifteen hour intervals until the new plates are worn in. The owner/operator must periodically adjust the clutch to ensure correct clutch operation. The clutch should be adjusted if the force required to engage the clutch drops by 10-15% of the specified engagement force. Destructive damage may have already occurred if engagement force is allowed to diminish to the point where the clutch fails to carry the load (slippage), or if facing(s) have overheated.

After wear-in, clutch adjustment should be checked regularly. Heavy duty applications (rock crushers,etc.) which have frequent engagements with long periods of clutch slippage will require more frequent adjustments than light duty applications. Need for clutch adjustment is also indicated if the clutch does not pull, heats up, or if the operating lever jumps out of engagement.

In order to determine if clutch adjustment is necessary, operating shaft torque must be measured. A torque wrench should be used at the cross shaft to measure engagement force. The clutch should ENGAGE within the torque readings shown. An adapter, NACD part number 236484AM, may be obtained to provide a 1.5" hex nut at the end of the cross shaft. The adapter may be used in place of the standard handle for the purpose of checking clutch adjustment with a torque wrench, or it may be installed on the end of the cross shaft opposite the standard handle. (Most PTOs have serrations on both ends of the cross shaft.) All NACD handles are cast with this hex.

If operating shaft torque or hand lever effort is at or below minimum, adjust clutch until the maximum force (for your model PTO) is required to engage the clutch.

Note: Do not adjust the clutch too tight. Forces above maximum may cause clutch component failure

To adjust the clutch:

Refer to the exploded views in the illustrations section of this manual.

2. Remove the instruction cover plate (45) from the housing (44) and turn the clutch shaft until the adjusting ring lock pin (25) can be reached.

3. Disengage the adjusting lock pin and insert a cotter pin or small nail into the hole provided to hold it in the disengaged position. Turn the adjusting yoke (26) to the right (or clockwise when looking at the flywheel) until the required engagement torque is obtained at the operating shaft (55) to engage the clutch . Refer to the Description and Specifications section of this manual for correct engagement torque.

4. Remove the cotter pin or small nail. Re-engage the adjusting ring lock pin.

5. Repeat steps 3 and 4 above as necessary until the proper torque reading is obtained. Replace the instruction cover plate and secure with two hex-head capscrews (46). Securely tighten.

FRICTION PLATE REPLACEMENT

Refer to the exploded views in the illustrations section of this manual. A common symptom indicating that the friction plates (6) are worn out are:

1. The adjusting yoke (26) cannot be turned clockwise any further.

It is necessary to remove and disassemble the clutch assembly to replace the friction plates. Refer to instructions in the Disassembly and Assembly sections of this manual.

⚠ CAUTION

FIELD ADJUSTMENT - TAPERED ROLLER BEARING END PLAY

Refer to exploded views in the illustrations section of this manual.

All SP111AM and SP211AM Series: The only approved method for field adjustment of tapered roller bearings (39, 40, 41 , 42) in NACD Power Take-Off units is by the use of a dial indicator to read actual bearing end play.

Adjustment:
Refer to the procedure in (Final Setting) Measure and Set Bearing End Play as described for your bearing housing configuration in the Assembly section of this manual.

Refer to the illustration below and Standard End Play setting for Tapered Roller Bearings in the Description and Specifications section.

DISASSEMBLY

The following procedure is for complete disassembly of the unit. Prior to this procedure, the Power Take-Off should be removed from the engine. Qualified personnel should do the work in a fully equipped facility.

POWER TAKE-OFF REMOVAL FROM THE ENGINE

Refer to the NACD Power Take-Off Reference Listing in the Description and Specifications section , the exploded views in the Illustrations section and Engineering Drawings near the back of this manual.

1. Remove all attached parts from the output end of the power take-off.

2. Remove the hex nut and hex-head capscrew securing the hand lever to the operating shaft.

3. Remove the shaft key.

4. Attach lifting equipment to the Power Take-Off and take out the slack just enough to begin to support the weight of the PTO. Do not apply too much force.

⚠ CAUTION

Lifting devices and their capacity must be capable of supporting the weight of the power take-off and all attached devices and equipment. Suspend the PTO with the lifting devices securely attached at 3 positions (minimum) so it remains with the main drive shaft in a horizontal position until it is safely lowered and resting on a secure bed.

5. Remove the twelve hex-head capscrews securing the power take-off to the engine flywheel housing. Use two bolts (3/8"- 16 UNC x 1 1/2" or 7/ 16"- 16 UNG x 1 1/2") as pusher screws in the two tapped holes provided in the housing flange. Use the pusher screws to separate the PTO from the engine flywheel housing. Remove the power take-off from the engine.

6. Remove the eight hex-head capscrews securing the drive ring to the engine flywheel.

CLUTCH REMOVAL

1. Support the power take-off on a bench with the clutch end facing up. Use wooden blocks under the power take-off.

2. If the pilot bearing (or pilot bearing inner race) remained on the shaft, remove it using a standard bearing puller.

3. If the pilot bearing is a two-piece bearing, remove the bearing's outer race from the flywheel using a standard bearing puller.

Note: The pilot bearing will be destroyed upon removal. If the bearing seal is broken the bearing is considered destroyed.

4. Remove the two hex-head capscrews and remove the instruction plate if they were not previously removed.

5. Use a 15/16" wrench to remove the jam nut and lock washer from the hose fitting located on the side of the power take-off housing. Push the fitting and hose into the power take-off housing.

6. Straighten the bent portion of the hub nut lock washer . Use a 4" wrench or socket to remove the hub nut from the clutch shaft. Remove the hub nut lock washer.

7. Use a gear puller with threaded legs for tapped holes to pull the clutch assembly from the clutch shaft. Install the puller so the threaded legs screw into the holes provided in the hub-and-back plate, usually 1/2"- 13 UNC, and the jackscrew exerts force on the end of the clutch shaft.

⚠ CAUTION

The thread puller holes are not to be used as jackscrews.

Remove the clutch and puller from the clutch shaft. Remove the hub key if it was not removed with the clutch.

CLUTCH DISASSEMBLY

All 11 1/2 -inch model clutches

1. Set the clutch assembly on a bench with the throwout collar facing up. Disengage the clutch.

2. Remove the grease fitting (23) from the hose fitting (20) . Remove the hose (19) and hose fitting (18) from the trunnion of the collar assembly.

3. Remove the three cotter pins (17) from the three clevis pins (16) securing the sliding sleeve to the links (15).

4. Remove the sleeve and collar assembly from the links.

BRONZE COLLAR DISASSEMBLY

5. Remove two hex huts and two hex head bolts to remove the throwout collar halves from the sliding sleeve.

BALL BEARING COLLAR DISASSEMBLY

6. Remove the internal snap ring (31) from the sleeve side of the collar and let it hang on the sleeve.

7. Tap the collar from the release bearing (30).

8. Remove the external snap ring (29) from the sliding sleeve (27).

9. Press the sleeve from the bearing in a press or pull the bearing from the sleeve.

10. Remove the snap ring from the sleeve .

All 11 1/2 - inch model clutches

11. Pull the adjusting lock pin (25) , compressing the lock pin spring (24), and unscrew the adjusting ring (26) from the hub-and-back plate assembly. Remove the adjusting lock pin and spring from the adjusting ring.

12. Straighten and remove the three cotter pins (12) , three washers (10) and three clevis pins (11) that secure the levers to the pressure plate (8) . Remove three levers from the pressure plate.

13.Straighten and remove the three cotter pins (13) and the three clevis pins (14) to disconnect the six links from the three levers (9).

14. Remove the pressure plate and drive plate (6) from the hub-and-back plate (4) .

Two plate 11 1/2-inch model clutches only

16. Remove the remaining driving plate(s) (6) and center plate(s) (7) from the hub-and-back plate.

REMOVE THE OPERATING SHAFT AND THROWOUT YOKE

All SP111AM and SP211AM

5. Remove the hex-head capscrew from the throwout yoke (54). Tap one end of the operating shaft (55) gently to expose one of the woodruff keys (56). Remove the key. Do the same for the other side of the shaft to remove the other key. Remove the operating shaft from the clutch housing (44) and throwout yoke.

6. Remove the two grease fittings (57) from the outside of the housing near the operating shaft holes only if replacement of the parts is necessary.

CLUTCH SHAFT AND HOUSING DISASSEMBLY - CONFIGURATION A

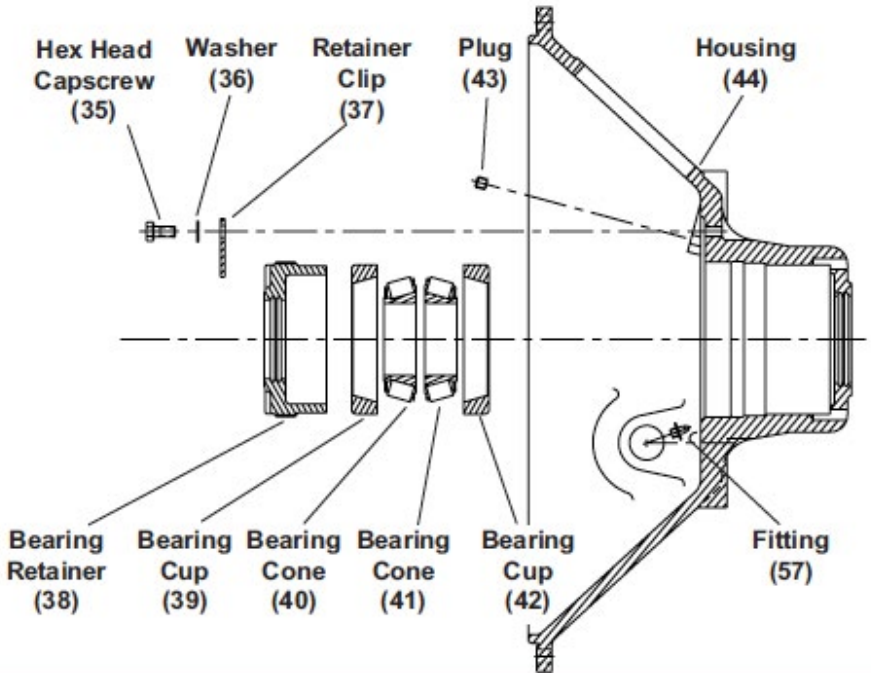


Figure 25. Illustration - Main Bearing Housing Configuration A

1. Position the PTO on the bench with the input end up.

2. Remove the hex head capscrew (35), lock washer (36) and the retainer clip (37) so the bearing retainer (38) may be rotated.

3. Rotate the bearing retainer counter-clockwise to remove it.

4. Lift the clutch shaft (33) with the two bearing cones (40 & 41) from the housing. The forward bearing cup (39) will come out with the shaft and bearing cones.

5. Use an arbor press to remove the bearing cones from the clutch shaft. The bearing cones remove in opposite directions from the shaft shoulder.

6. Remove the rear bearing cup (42) from the housing by removing the three plugs (52) (if used) from the access holes inthe housing and tapping the race from the bore through the holes using a blunt punch.

7. Remove the grease fitting (51) from the housing.

CLEANING AND INSPECTION

Bearings

1. Thoroughly wash bearings in clean solvent if they have been in service. Soak bearings in solvent if they are particularly dirty.

⚠ CAUTION

Never dry bearing with compressed air. Do not spin bearings while they are not lubricated. Oil bearings with SAE 10 engine oil immediately after cleaning. Be sure bearings are oiled before inspection. Protect clean bearings, whether they are new or have been in service, from dirt, dust, grit or any other contaminant.

2. Inspect bearings for roughness of rotation. Replace the bearing if roughness is found .

3. Inspect bearings for corrosion, scored, scratched, cracked, pitted or chipped races, and for indication of excessive wear of balls or rollers. If one of the these defects is found, replace the bearing.

Preventing Entrance of Dirt Into Bearings

4. Dirt and grit in bearings are often responsible for bearing failure. Consequently , it is important to keep bearings clean. Do not remove grease from new bearings. Keep the wrapper on new bearings until immediately before they are to be installed. Do not expose new clean bearings until they are ready to be used in the assembly. Keep them wrapped in a clean lint-free cloth or paper to keep out dust and debris. Protect bearings from contamination even after they are installed on the shaft or in the bore.

Housings, Cast Parts and Machined Surfaces

5. Replace cast parts or housings that are cracked.

6. Inspect bearing bores for grooved, burred or galled conditions that would indicate that the bearing has been turning in its housing. If the damage cannot be repaired to like-new condition with a crocus cloth, replace the part. Bore diameters must not exceed the maximum dimension shown in Wear Limits in the Description and Specifications section of this manual.

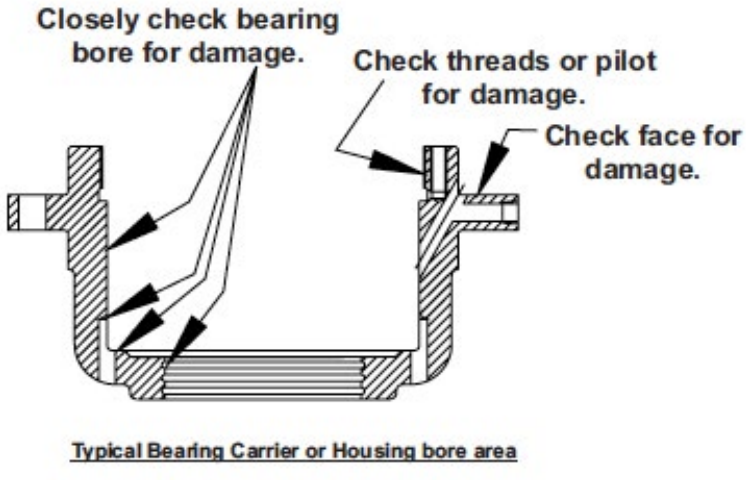
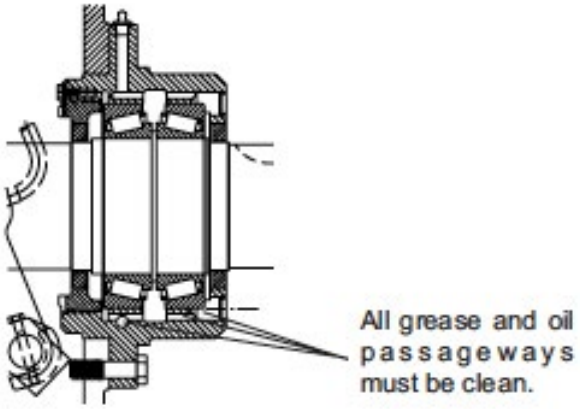


Figure 31. Inspect the bores, threads and faces

7. Inspect bores for wear, grooves, scratches and dirt. Remove burrs and scratches with crocus cloth or a soft stone. Replace parts that are deeply grooved or scratched.

8. Inspect oil and grease passages for obstructions. If an obstruction is found, remove it with compressed air or by working a wire or wire brush back and forth through the passage and flushing it with solvent.

Figure 32. Be sure passageways are clean.



Shafts, seal lip contact surfaces and bearing journals

9. Inspect machined surfaces for burrs, scratches, nicks and foreign matter. If such defects cannot be removed with crocus cloth or a soft stone, replace the part.

10. Inspect bearing journals on the shaft for grooved, burred or galled conditions that would indicate that the bearing has been turning on the shaft. If the damage cannot be repaired to like-new condition with a crocus cloth, replace the part. Bearing journal diameters must not be less than the dimensions shown in Wear Limits in the Description and Specifications section of this manual.

11. Inspect the pilot bearing journal on the clutch shaft. If it is worn in any way, or if it shows signs that the pilot bearing has been turning on the journal, replace the clutch shaft. Pilot bearing journal diameters must not be less than the dimensions shown in Wear Limits in the Description and Specifications section of this manual.

12. Inspect threaded openings for damaged threads. Chase damaged threads with a tap of the correct size.

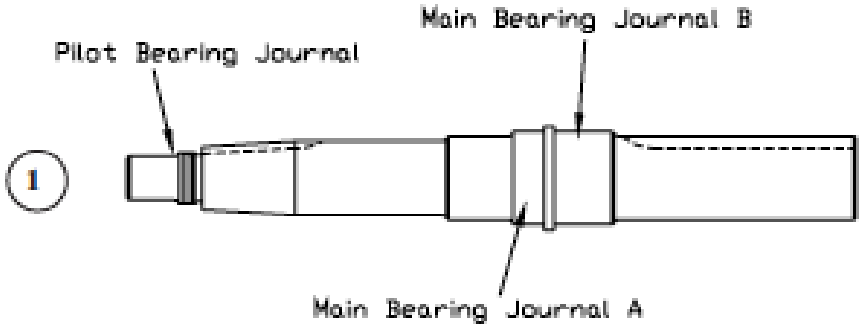


Figure 33. Inspect bearing journal s and seal journals

ASSEMBLY

The following procedure is for complete assembly of the unit. Prior to this procedure, the power take-off should be removed from the engine. Qualified personnel should do the work in a fully equipped facility.

Note: Illustrations used here are to aid in understanding and completing the procedure , and may not appear to be consistent with the previous assembly steps.

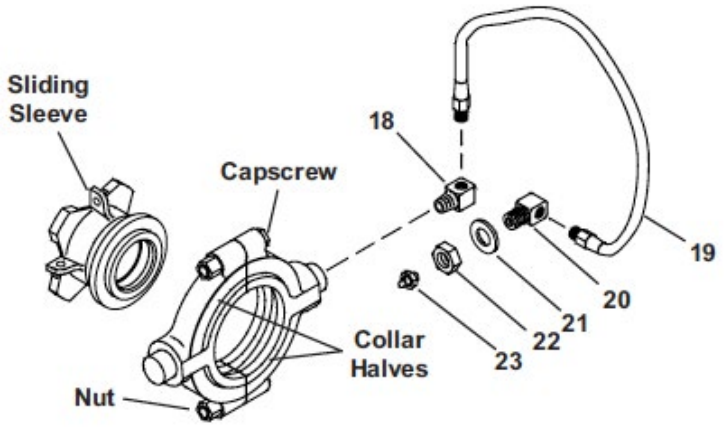
CLUTCH ASSEMBLY

All SP111AM and SP211AM

Bronze Throwout Collar only : (Ball Bearing Type Throwout Collar skip to step 3.)

1. Lubricate the shoulder of the sliding sleeve (27) with No. 30 engine oil prior to installation of the split collar. Place the throwout collar halves over the sliding sleeve shoulder. Install 2 hex head capscrews 1/2" - 20 x 3 1/4" through the halves. Install 2 hex nuts on the capscrews. Torque the capscrews to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section.

Figure 36. Assembly of Bronze Throwout Collar

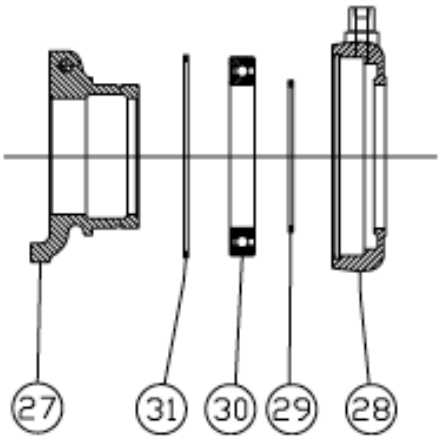


2. Check collar rotation to be sure it turns freely on the sliding sleeve. (Proceed at step 14.)

Ball Bearing Type Throwout Collar

3. Place the sliding sleeve (27) on the bed of a press with the bearing end up. Place the external snap ring (31) on the sleeve before the bearing (30) is installed.

Figure 37. Assembly of Ball Bearing Type Throwout Collar



4. Press the ball bearing (30) on the sleeve. Press tight to stop against the shoulder.

Note: Pack the bearing with grease before installing it on the collar.

Note: Apply force only against the inner race of the bearing. Pressing against the outer race or contact with the balls will damage the bearing, leading to premature failure.

5. Install the external snap ring (29) to secure the bearing.

6. Install the throwout collar (28) over the bearing. Seat the collar tight against the bearing.

⚠ WARNING

Excessive pressure or sharp impact against the outer race of the bearing during installation of the collar will damage the bearing, leading to premature failure.

7. Turn the sliding sleeve assembly over on the bed of the press. Install the internal snap ring (31) in the collar.

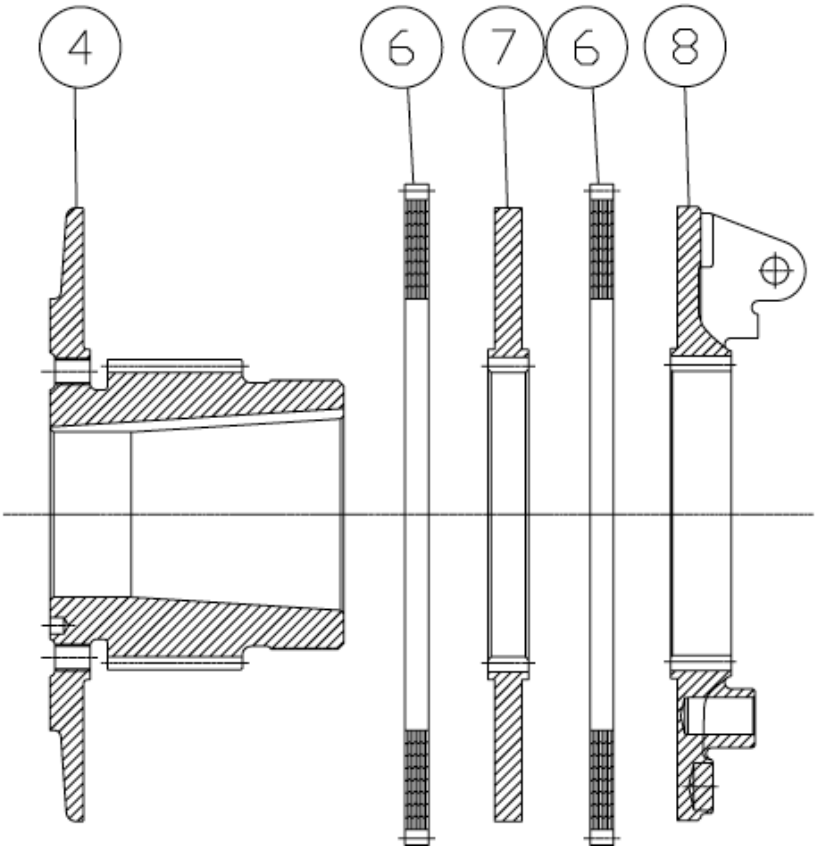
Assemble The Plate Stack

8. Set the hub and back plate (4) on a bench with the threaded and splined section facing up.

9. Install a friction plate (6) on the hub-and-backplate.

Figure 39. Typical SP111AM and SP211AM Plate Stack (SP211AM is shown)

SP211AM Series Clutches only: (SP111AM Series Clutches, skip to step 12.)



10. Install a center plate (7) so it rests flat on the friction plate, meshing the splines of the center plate and hub-and-backplate .

11. Install a second friction plate (6) on the center plate.

All SP111AM and SP211AM Series

12. Install the pressure plate (8) on the top friction plate, meshing the splines of the center plate and hub-and-backplate.

13. Install the adjusting lock pin spring (24) into the pocket in the pressure plate and install the adjusting lock pin (25) on the spring .

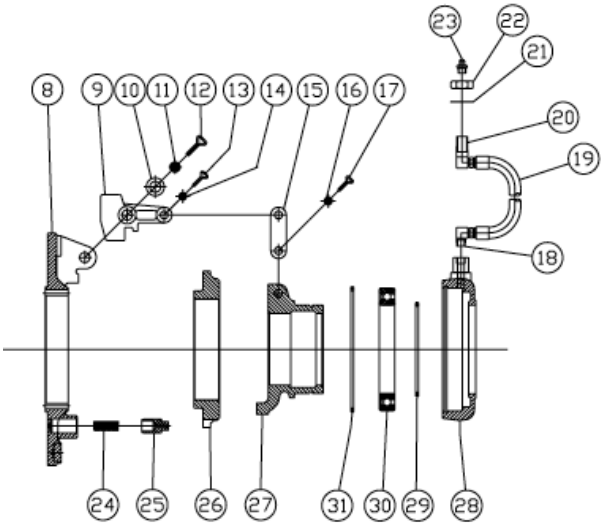


Figure 40. Illustration - Levers, Links, Sleeve, Throwout Collar

14. Push down on the pin, compressing the spring while screwing the adjusting yoke (26) partially onto the threaded part of the hub-and-back plate.

15. Place the levers (9) between the lugs of the pressure plate and secure to the pressure plate with three clevis pins (11).

Note: Hook each lever under the edge of the adjusting yoke while aligning the clevis pin hole with the holes in the pressure plate lugs.

16. Place a washer (10) on each clevis pin and install three cotter pins (12). Spread the legs of the cotter pins as shown below.

Note: The head of the clevis pin must be in the clockwise side of the lug when viewing it from the top (sliding sleeve) side.

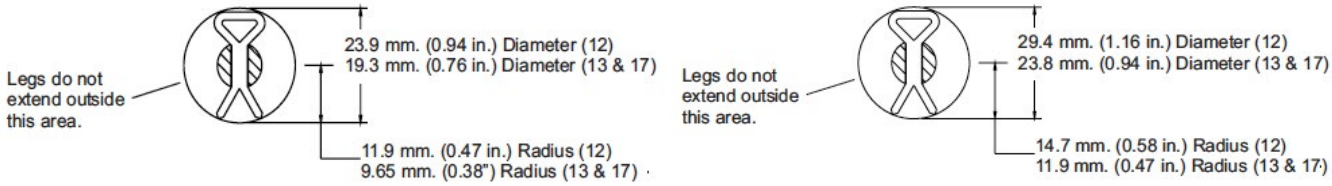


Figure 41. Spread the cotter pin legs - SP111AM and SP211AM

17. Attach six lever links (15) one on each side of each of the three clutch levers (9). Secure with three clevis pins (14) and three cotter pins (13).

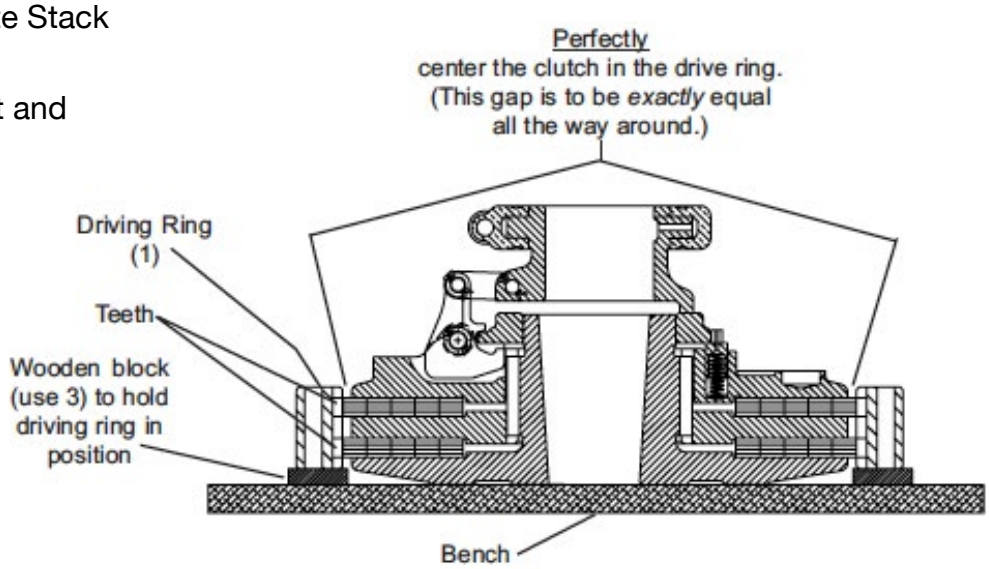
18. Place the pre-assembled sliding sleeve (27) on the adjusting yoke, aligning the three lugs between the three pairs of lever links.

19. Attach the links to the sliding sleeve with three clevis pins (16) and three cotter pins (17).

20. Install the hose fitting (18) in the collar trunnion, and attach the flexible hose (19) , hose fitting (20) and lubrication fitting (23).

(Proceed to step 48)

Figure 46. Align the Plate Stack



Proceed to Clutch Shaft and Housing Assembly.

CLUTCH SHAFT AND HOUSING ASSEMBLY - BEARING HOUSING CONFIGURATION A

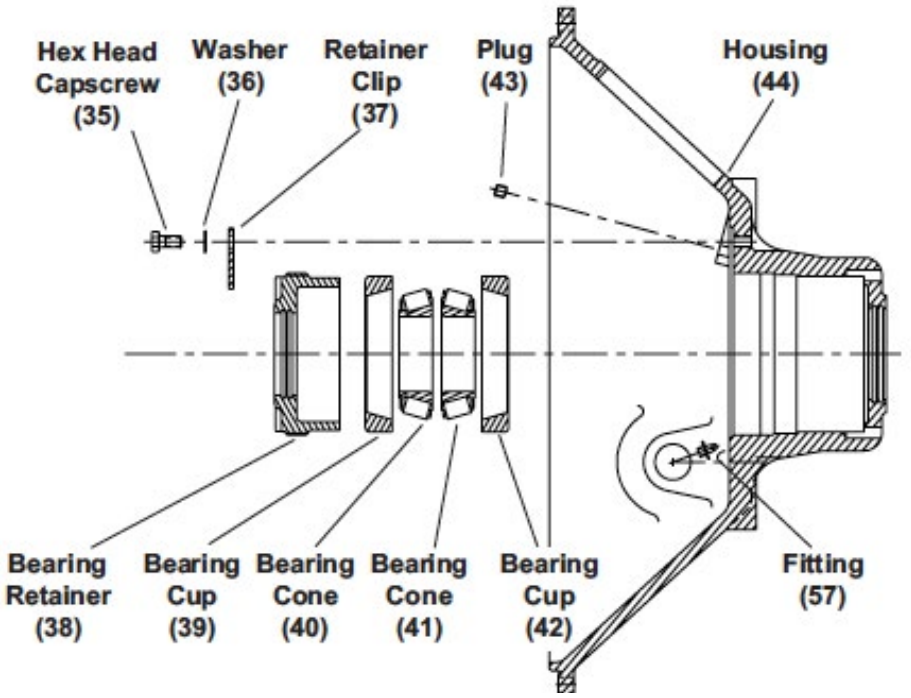


Figure 47. Illustration - Main Bearing Configuration A

Install Main Bearings On The Clutchshaft

1. Clean the tapered bearing cones (40 & 41) and clutch shaft (33) with isopropyl solvent to remove any oil or grease residue.

Note: Do not use any oil or paraffin based solvents.

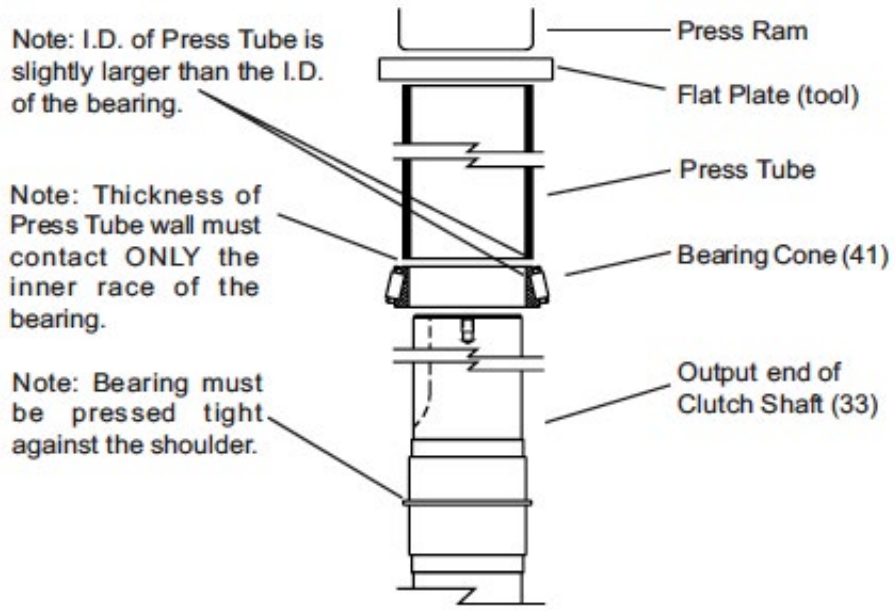
2. Use an arbor press to install the two bearing cones on the clutch shaft. Install the cones, one from each end, with the back faces (wide section) butting against the shoulder on the clutch shaft. (See note below regarding alternative installation method.)

Note: Special tools are not available from NACD, but can be fabricated in any capable machine shop.

Note: Use a piece of steel tubing approximately 5 cm. (2 inches) longer than the distance from the end of the shaft to the shoulder and just slightly larger in inside diameter than the bearing cone's inside diameter. The tubing must not be thick enough to contact the cage of the bearing during installation.

Figure 48. Install bearing cones on the shaft

Note: An alternative method to install the bearing cones is to heat them in an oven at 135° C. (275° F.) for one hour and install them immediately on the clutch shaft. Let the bearing cone cool to room temperature after installation while continuing to apply force as the bearing cools. This is necessary to ensure that it remains properly seated.



⚠ WARNING

Handle the heated parts with care. The heated parts are extremely HOT.

3. After the bearings return to room temperature, coat the bearing rollers and both bearing cups with a light film of clean No. 30 engine oil.

Clutch Housing

4. Set the clutch housing (44) on the bed of a press with the input end of the housing facing up.

Note: There should be sufficient clearance below the housing to allow for installation of the clutch shaft.

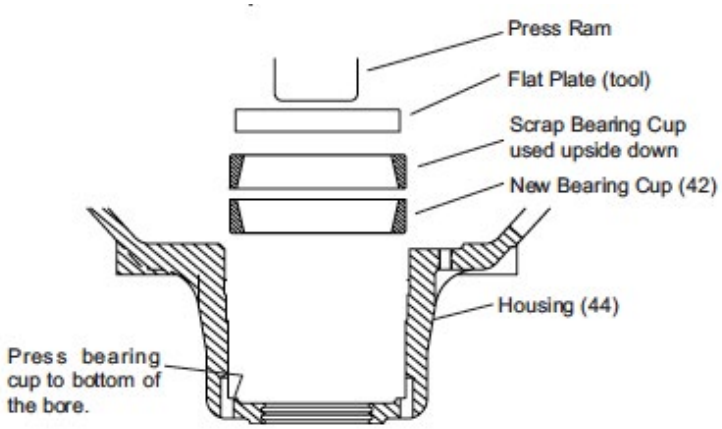
5. Install 2 lubrication fittings (57) if they were removed.

6. Use a round steel plate slightly smaller in diameter than the outer diameter of the rear main bearing cup (42) . Place the bearing cup on the housing, back (wide section) face down. Be sure the plate does not press against the bearing cup's roller contact surface in the cup. Press the cup to the bottom of the bore.

Note: Special tools are not available from NACD, but can be fabricated in any capable machine shop.

Note: A scrap bearing cup the same size as the one being installed (42) may be used as an installation tool in addition to a flat plate.

Figure 49. Install the rear bearing cup (42)



Install the clutch shaft and bearings into the housing.

7. Carefully install shaft and bearings in the housing. The output end of the shaft must enter the housing first.

Note: DO NOT pre-grease the bearings prior to installation into the housing.

8. Install the front bearing cup (39) in the bore on top of the upper bearing cone. Press it tight against the cone.

9. Install the bearing retainer (38) in the housing. Thread the bearing retainer tight against the bearing.

Note: The notches must be up.

(Preliminary setting) Measure and set bearing end play.

⚠ WARNING

The only approved method for adjustment of tapered roller bearings in NACD Power Take-Offs is by use of a dial indicator to read actual bearing end play. This preliminary setting is for assembly purposes only. Final bearing end play must be adjusted as described below in "(Final setting) Measure and set bearing end play."

10. Tighten the bearing retainer until 6.8 Nm. (60 in.-lbs.) of torque is required to rotate the shaft.

Note: Do not overtighten! Damage may occur to the bearings or bearing retainer.

Rotate the shaft several revolutions. This aligns and seats the bearing cones in the bearing cups and creates a "zero" clearance.

11. Note the position of any one of the notches in the bearing retainer relative to the threaded hole for the retainer lock capscrew.

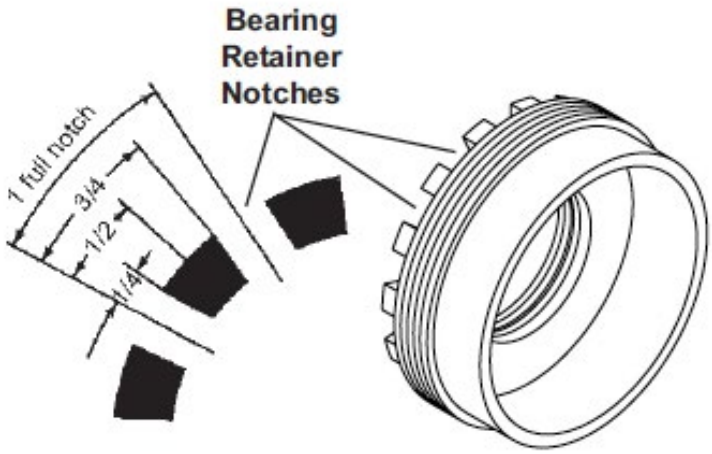


Figure 50. Bearing Retainer Notches

Back off the bearing retainer (38) to create a clearance between the bearing retainer and bearing cup. The notch closest to the threaded hole (aligned with or clockwise from the hole) is the first notch.

SP111AM and SP211AM Series: Back off 3 1/2 - 4 1/2 notches

Note: Bump the output end of the shaft with a soft mallet hard enough to move and seat the front bearing cup up against the bearing retainer and create the specified bearing clearance after each adjustment of the bearing retainer.

⚠ WARNING

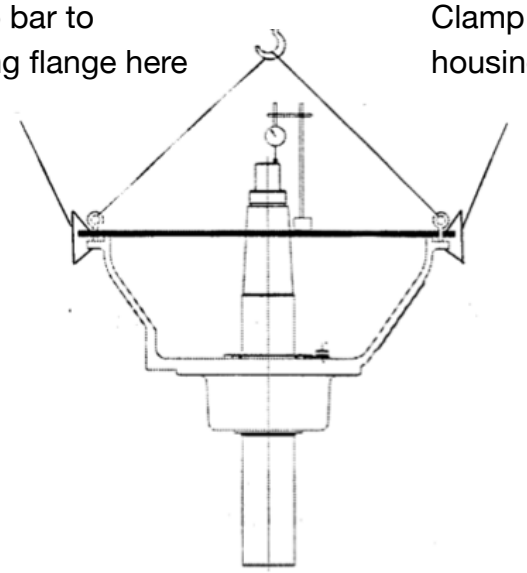
Only a preliminary adjustment procedure has been completed by backing off the bearing retainer. The only approved method for adjustment of tapered roller bearings in NACD Power Take-Offs is by use of a dial indicator to read actual bearing end play. Continue to (Final Setting) Measure and set bearing end play to complete the adjustment procedure.

(Final setting) Measure and set bearing end play

12. Support the PTO with a sling and chain hoist as illustrated.

Clamp bar to housing flange here

Clamp bar to housing flange here



13. Raise the PTO high enough for access to the output end of the drive shaft. Using a soft, but heavy mallet against a hard wood block, strike the end of the shaft to seat the front bearing cup.

14. Lower the PTO and repeat the procedure in 13 on the front end of the drive shaft to seat the rear bearing cup.

CAUTION: Sufficient force must be used to securely seat the cups, but abusive force can damage the roller surface of the cups, resulting in bearing failure.

15. Insert 4 pieces of shim stock between the shaft and the bearing retainer to fill the gap and minimize sideways movement of the shaft.

16. Attach a dial indicator to a solid bar clamped across the housing as shown. Position the tip of the dial indicator on the nose of the shaft with the direction of indicator tip travel parallel to the shaft. Set the dial indicator to "0".

17. Lower the PTO so the shaft rests on a wood block. Allow a small amount of slack in the lifting strap. Tap lightly on the bell housing to move it downward. Read the dial indicator. The amount of bearing end play will be indicated.

18. Raise the PTO off the wood block. Lightly tap on the pilot bearing end of the drive shaft to move it downward against the rear bearing cup.

19. Again read the dial indicator. It should have returned to "0". If it didn't, repeat 13 through 18 to obtain an accurate reading.

Main bearing end play should be:
(Grease lubricated bearings:)
Configuration A: .004” - .008” (loose)
(check with bearings lightly oiled, not greased)

20. If adjustment is necessary, proceed as follows: Rotate the bearing retainer clockwise to decrease or counter-clockwise to increase the setting, then repeat 13 through 18 to verify the proper setting has been attained.

21. Install the adjustment lock.

INSTALL THE OPERATING SHAFT AND THROWOUT YOKE

SP111AM and SP211AM Series
1. Position the clutch housing on a bench with the input end facing up. Install the operating shaft (55) halfway into the clutch housing. Slip the throwout fork (54) onto the operating shaft and push the shaft through to the hole on the other side of the clutch housing far enough to expose one of the woodruff key slots at the center of the throwout fork.

2. Install one woodruff key (56) in the operating shaft.

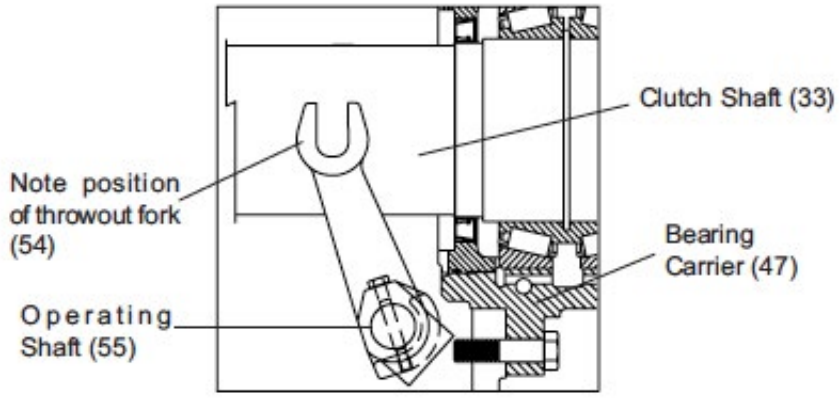


Figure 74. Install the throwout fork

4. Push the operating shaft the other way to expose the other key slot in the center of the fork.

5. Install the other woodruff key (56).

6. Center the operating fork so the hex head capscrews will enter the bottom of the throwout fork and thread into the top section. Install the two hex-head capscrews and tighten. Torque the capscrews to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section.

(Proceed to PTO Final Assembly)

PTO FINAL ASSEMBLY

Install The Clutch In The Clutch Housing

1. Set up and support the main housing assembly (44) with attached parts on the bench with the input side facing up.

Note: The output end of the shaft must rest securely on a solid surface.

2. Carefully place the clutch assembly over the clutch shaft while:

A. Aligning the trunnions on the collar with the throwout fork .

B. Aligning the keyways in the hub-and-back plate with the keyway in the clutch shaft.

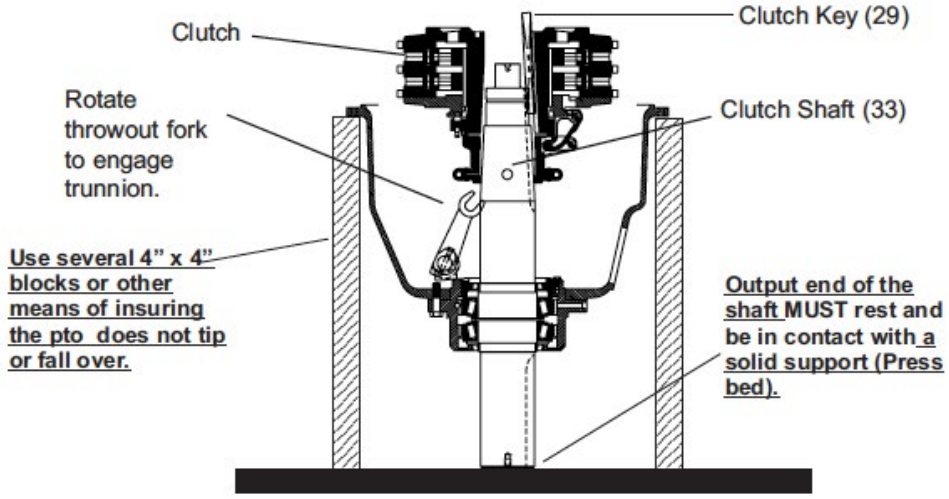


Figure 75. Assemble clutch into Power Take-Off

3. Partially install the hub key (29) in the keyway. Tap the hub-and-back plate with a large, but soft mallet, to seat it on the tapered surface of the clutch shaft.

⚠ CAUTION

Be sure the output end of the shaft is resting on a solid surface to absorb the force through the shaft rather than through the bearing surfaces.

4. Drive the hub key (29) into position slightly below the surface of the hub and-back plate (4) .

Note: Do not use excessive hammer force when installing the key.

5. Install the hub nut lock washer (3) over the clutch shaft (33), locating its tab in the drilled hole on the hub-and-back plate (4). Install the hub nut (2) and torque to 180 ft-lbs for SP and 225 ft-lbs for DP.

6. Bend a side of the hub nut lock washer up against a flat on the hub nut.

7. Route the flexible hose assembly (19) clear of all moving parts and push the end hose fitting (20) through the hole in the clutch housing.

8. Install the lock washer (21) and jam nut (22) to retain the end fitting (23) in the housing. Torque the capscrews to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section.

⚠ CAUTION

Confirm that the hose assembly is not twisted or applying preload to the collar assembly.

9. Install all remaining plugs and external components on the power take off.

Center The Clutchplates

11. If not previously done, visually center the friction plates (6) on the clutch and align the teeth. Press down on the collar assembly to lock the plates in place. If necessary, pull the adjustment lock pin to compress the lock pin spring , and rotate the adjusting yoke assembly until the plates are locked in position when the collar is pressed down.

Note: This is an initial setting to hold the plates in place until after the pto is mounted on the engine, so it is imperative that the teeth be exactly aligned and the plates are exactly centered on the clutch. The driving ring may be used as an alignment fixture to align the teeth and center the plates relative to the hub-and-backplate so they are perfectly aligned when the PTO is installed on the engine.

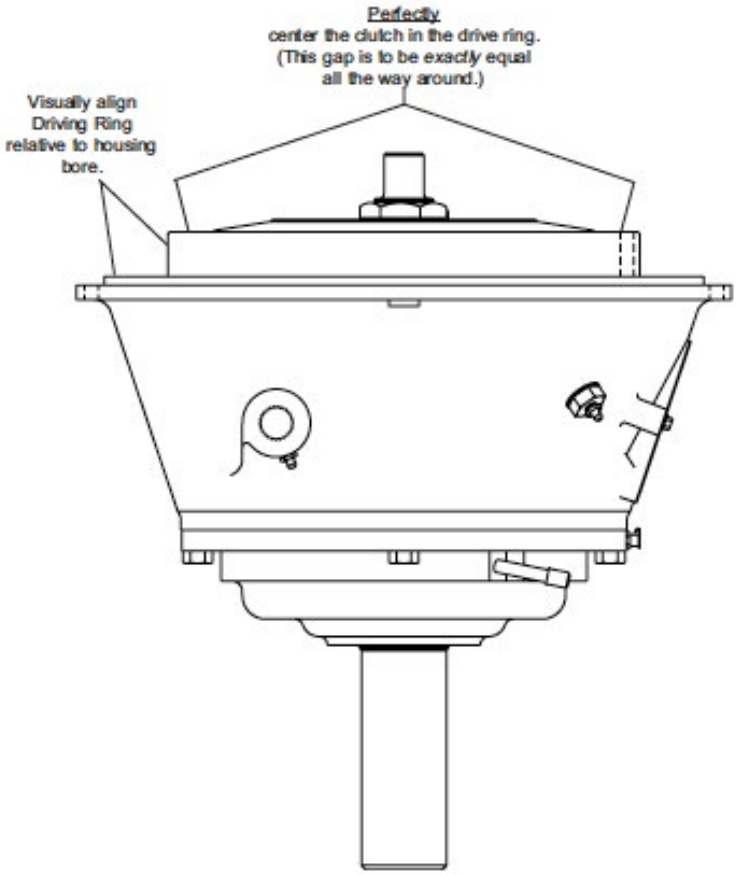


Figure 76. Using the driving ring as an alignment tool

Final Assembly And Lubrication

12. Install the power take-off according to instructions in the Installation section of this manual.

13. Adjust the clutch according to Clutch Adjustment in the Maintenance section of this manual.

14. Fill the main bearing cavity with grease.

15. Lubricate the remainder of the PTO according to lubrication specifications in the Description and Specifications section of this manual.

16. Place the instruction cover plate (45) in position on the housing and secure with 2 hex-head cap screws 5/16" - 18 x 1/2" (46) . Torque the capscrews to the proper specifications given in Torque Values for Fasteners in the Description and Specifications section .

17. Install the shaft key (34) and all parts previously removed from the output end of the clutch shaft.

ILLUSTRATIONS

LIST OF ILLUSTRATIONS

The following pages include illustrations that are specific to thse models. The illustrations included are listed below.

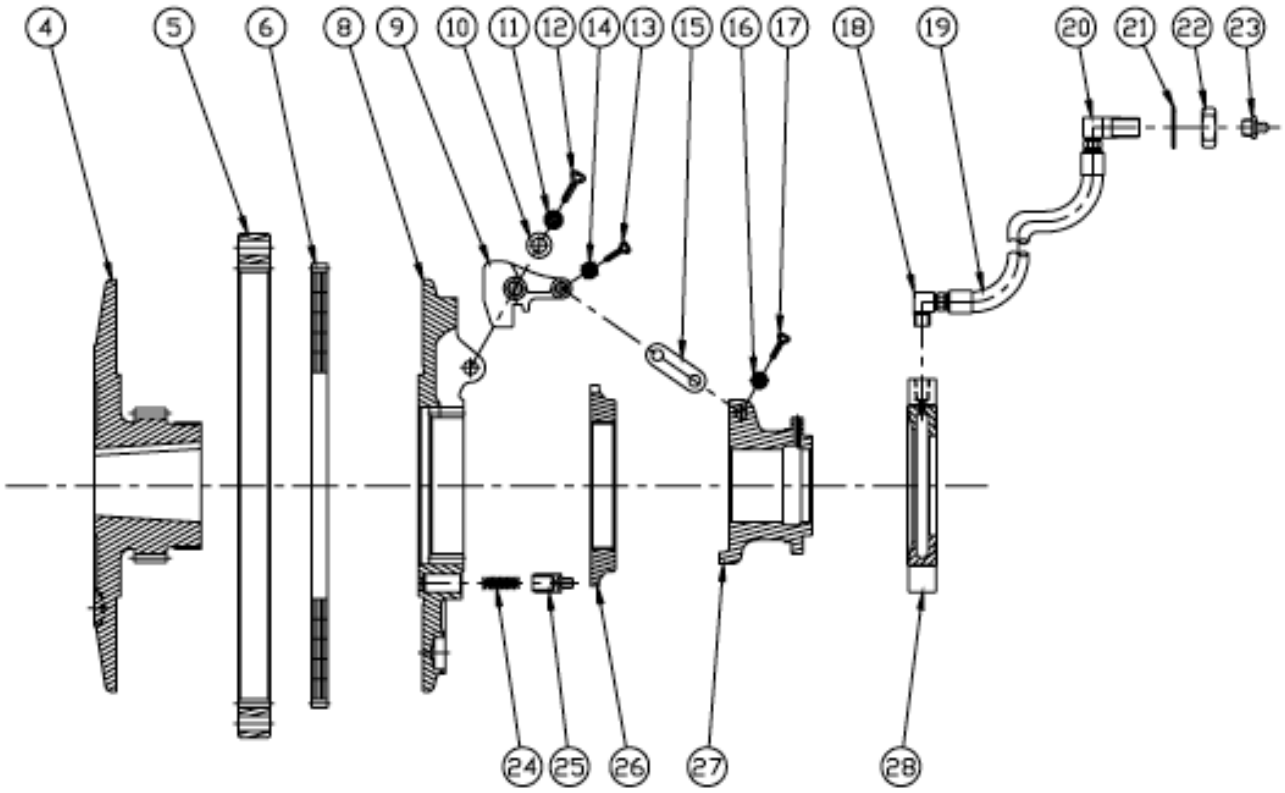
Note: Any part numbers listed in the following illustrations are for reference only. Please refer to your bill of material for part numbers specific to your model.

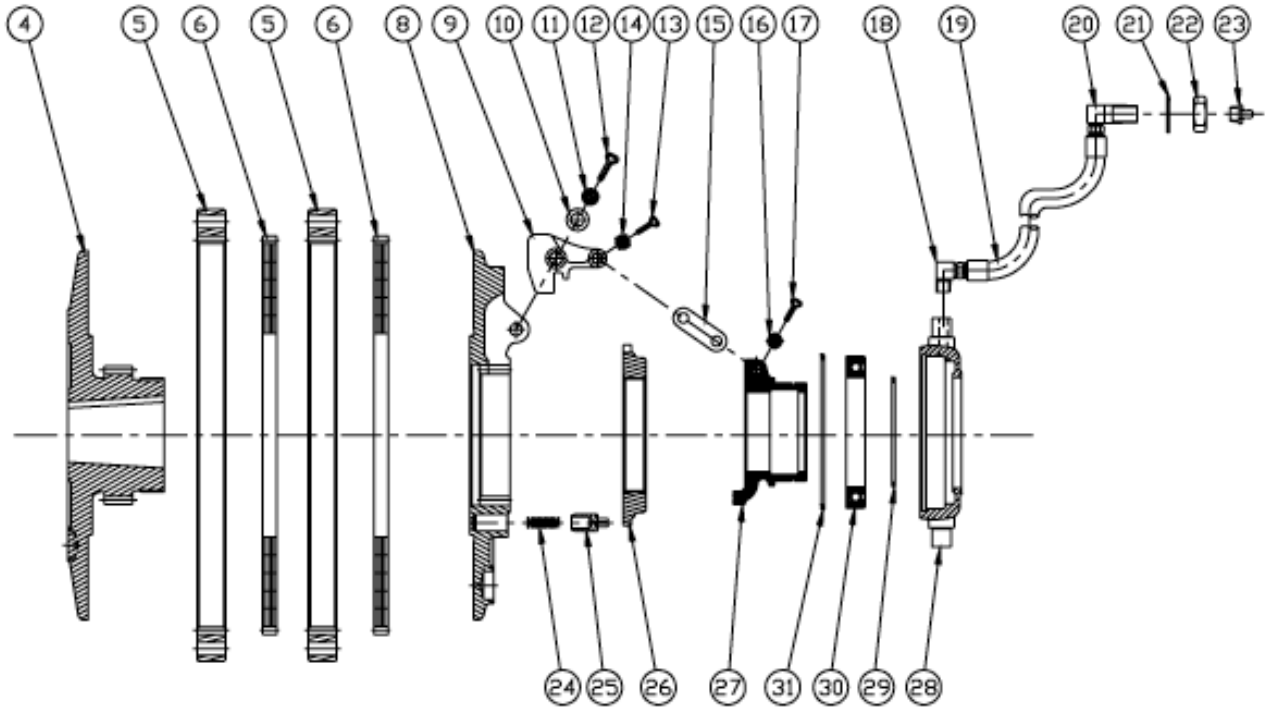
- ☐ Parts Identification List - SP111AM and SP211AM
- ☐ Exploded View (Bearing Housing Configuration A)

Item	Description	Qty.
1	Pilot Bearing	1
2	Nut	1
3	Washer	1
4	Hub-and-back plate	1
5	Ring, drive	1
6	Plate, friction	1 or 2
7	Plate, center	0 or 1
8	Plate, pressure	1
9	Lever	3
10	Washer (lever to pressure plate)	3
11	Pin, clevis (lever to pressure plate)	3
12	Pin, cotter (lever to pressure plate)	3
13	Cotter pin (or washer) (lever to link)	3
14	Pin, clevis (lever to link)	3
15	Link	3
16	Pin, clevis (link to sleeve)	3
17	Clevis pin (link to sleeve)	3
18	Fitting	1
19	Hose	1
20	Fitting	1
21	Washer	1
22	Nut	1
23	Fitting, grease	1
24	Spring, compression	1
25	Pin	1
26	Yoke, adjusting	1
27	Sleeve, sliding	1
28	Collar assembly (collar)	1

Item	Description	Qty.
29	Ring, snap-external	1
30	Bearing, ball	1
31	Ring, snap-internal	1
32	Key-clutch	1
33	Shaft, clutch	1
34	Key-output	1
35	Capscrew, hex-head	1
36	Washer	1
37	Retainer, clip	1
38	Retainer, bearing	1
39	Bearing, cup-front	1
40	Bearing, cone-front	1
41	Bearing, cone-rear	1
42	Bearing, cup-rear	1
43	pipe plug or ball	1
44	Housing	1
45	Plate, instruction	1
46	Screw, machine	2
51	Fitting	1
52	Plug	2 or 3
53	Hand lever assembly	1
54	Throwout yoke	1
55	Shaft, operating	1
56	Key, woodruff	2
57	Fitting (or plug)	2

Exploded View (SP111AM and SP211AM Series Clutches)





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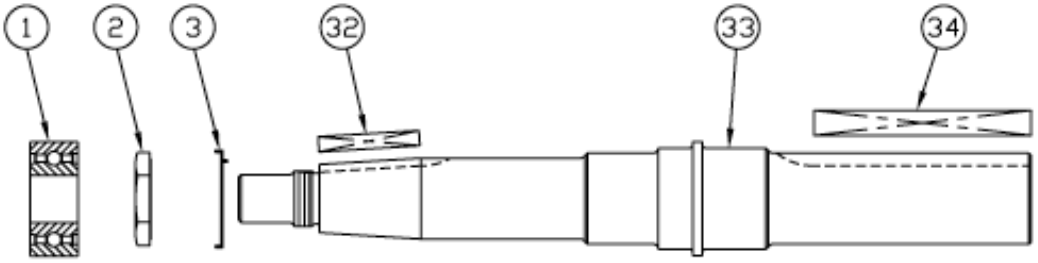
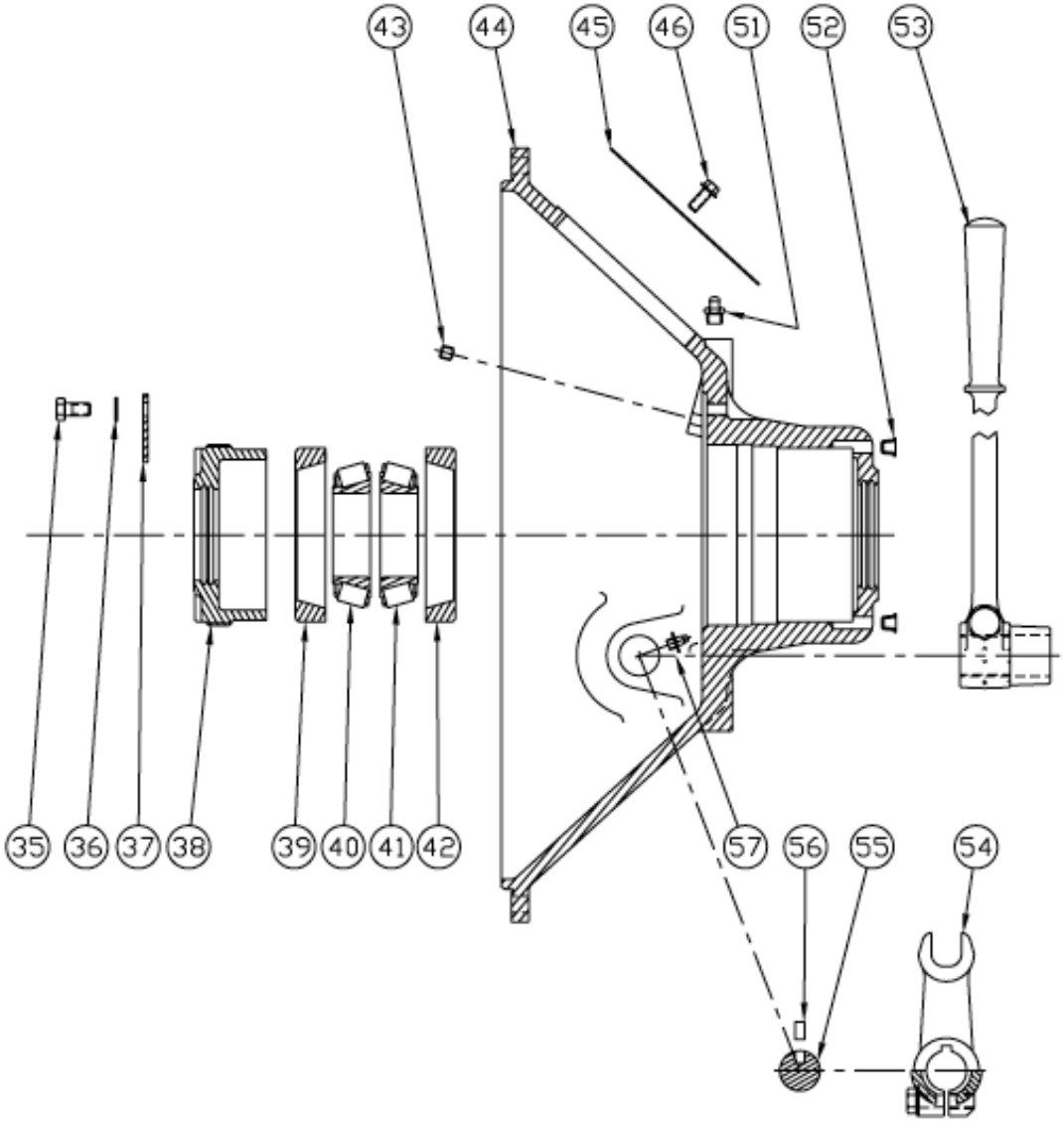
Exploded View (Bearing Housing Configuration A)





North American Clutch & Driveline, Inc.

LIMITED NACD GENERAL WARRANTY, LIMITATIONS OF REMEDIES AND LIMITATIONS OF OTHER WARRANTIES

A. North American Clutch & Driveline warrants all assembled products and parts to the original customer. For Power Take-Off products and parts, such warranty shall extend for a period of twenty-four (24) months from the date of original shipment by NACD to the original customer, but not to exceed twelve (12 months of service or one thousand five hundred (1,500) hours of service, whichever occurs first. **The warranty set forth above is exclusive and North American Clutch & Driveline, Inc. makes no other warranty, express or implied. NACD hereby expressly disclaims any and all other warranties including warranties of merchatability or fitness for a particular purpose.**

. **Limitation of Remedies and Liability: The remedies provided herein are buyer's sole and exclusive remedies. In no event shall NACD be liable for any direct, indirect, special, punitive, incidental or consequential damages including, but not limited to, loss of revenue or profit, loss of use of the product, cost of capital, cost of substitute equipment or facilities, cost of cover, downtime costs, claims of any third parties, including buyers' customers, or any other costs whatsoever, whether based on contract, warranty, tort (including negligence) or any other legal theory.**

The above warranty and remedy are subject to the following terms and conditions:

1. Complete parts or products upon request must be returned transportation prepaid and also the claims submitted to NACD within sixty (60) days after completion of the in-warranty repair.
2. The warranty is void if, in the opinion of NACD, the failure of the part or product resulted from abuse, neglect, improper maintenance or accident.
3. The warranty is void if any modifications are made to any product or part without the prior written consent of NACD.
4. The warranty is void unless the product or part is properly transported, stored and cared for from the date of shipment to the date placed in service.
5. The warranty is void unless the product or part is properly installed and maintained within the rated capacity of the product or part with installations properly engineered and in accordance with the practices, methods and instructions approved or provided by NACD.
6. The warranty is void unless all required replacement parts or products are of NACD origin or are NACD authorized replacement parts, and otherwise identical with components of the original equipment. Replacement parts or products not of NACD origin are not warranted by NACD.

C. As considered for this warranty, the original customer and subsequent purchaser agree to indemnify and hold NACD harmless from and against all and any loss, liability, damages or expenses for injury to persons or property, including without limitation, the original customer's and subsequent purchaser's employees and property, due to their acts or omissions or the acts or omissions of their agents, and employees in the installation, transportation, maintenance, use and operation of said equipment.

Only an NACD authorized factory representative shall have authority to assume any cost or expense in the service, repair or replacement of any part or product within the warranty period, except when such cost or expense is authorized in advance in writing by NACD.

NACD reserves the right to improve the product through changes in design or materials without being obligated to incorporate such changes in products of prior manufacture. The original customer and subsequent purchasers will not use any such changes as evidence of insufficiency or inadequacy of prior designs or materials.

If failure occurs within the warranty period, and constitutes a breach of warranty, repair or replacement parts will be furnished on a no-charge basis and these parts will be covered by the remainder of the unexpired warranty which remains in effect on the complete unit.

**Note: The above constitutes the basic NACD General Limited Warranty and may be supplemented by additional published warranty terms dependent upon the product involved. Supplementary warranty terms are available upon request.*

NOTICE

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