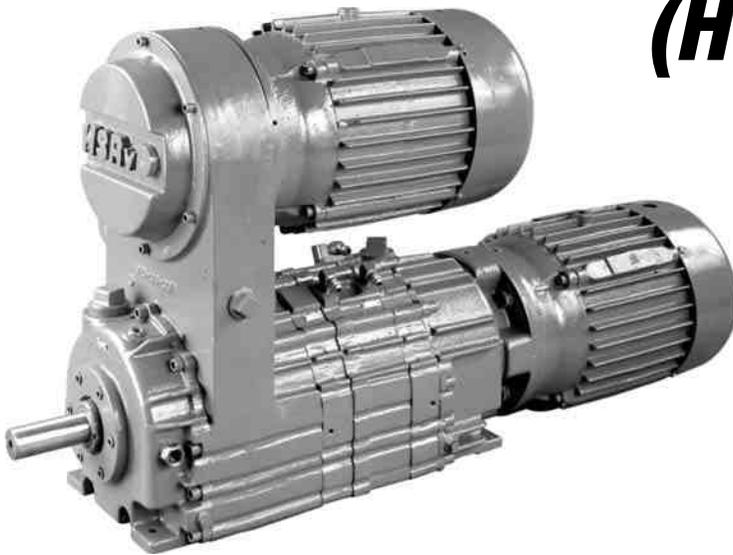


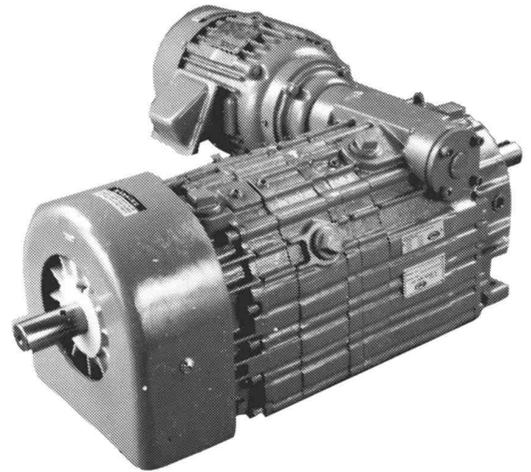


502-HS/MS-03

**SERVICE MANUAL  
AND  
REPAIR PARTS  
FOR  
*MULTI-SPEED  
DRIVES (MSDr)*  
AND  
*HIGH SPEED  
REVERSING DRIVES  
(HSRvD)***



**HIGH SPEED REVERSING DRIVES (*HSRvD*)**



**MULTI-SPEED DRIVES (*MSDr*)**

**WARNING - Read this manual before any installation, maintenance and operation.**



**FORCE CONTROL INDUSTRIES, INC.**

**MANUFACTURERS OF MECHANICAL AND  
ELECTRICAL POWER TRANSMISSION EQUIPMENT**

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## LIMITED WARRANTY

### SPECIAL 24 MONTH WARRANTY

**Upon written approval of the application by Force Control Industries, Inc. the Standard Warranty period will be extended to 24 months.**

Force Control Industries, Inc. ("Force Control") warrants its products to be free from defects in material and workmanship under normal and proper use for a period of one year from the date of shipment. Any products purchased from Force Control that upon inspection at Force Control's factory prove to be defective as a result of normal use during the one year period will be repaired or replaced (at Force Controls' option) without any charge for parts or labor. This limited warranty shall be void in regard to (1) any product or part thereof which has been altered or repaired by a buyer without Force Control's previous written consent or (2) any product or part thereof that has been subjected to unusual electrical, physical or mechanical stress, or upon which the original identification marks have been removed or altered. Transportation charges for shipping any product or part thereof that the buyer claims is covered by this limited warranty shall be paid by the buyer. If Force Control determines that any product or part thereof should be repaired or replaced under the terms of this limited warranty it will pay for shipping the repaired or replaced product or part thereof back to the buyer. EXCEPT FOR THE EXPRESS WARRANTY SET OUT ABOVE, FORCE CONTROL DOES NOT GRANT ANY WARRANTIES EITHER EXPRESSED OR IMPLIED, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR USE. The warranty obligation set forth above is in lieu of all obligations or liabilities of Force Control for any damages. Force Control specifically shall not be liable for any costs incurred by the buyer in disconnecting or re-installing any product or part thereof repaired or replaced under the limited warranty set out above. FORCE CONTROL EXPRESSLY EXCLUDES ALL LIABILITY FOR ANY INDIRECT OR CONSEQUENTIAL DAMAGES THE BUYER MAY SUSTAIN IN CONNECTION WITH THE DELIVERY, USE, OR PERFORMANCE OF FORCE CONTROL PRODUCTS. Under no circumstances shall any liability for which Force Control is held responsible exceed the selling price to the buyer of the Force Control products that are proven to be defective. This limited warranty may be modified only in writing signed by a duly authorized officer of the company. This limited warranty applies exclusively to Force Control products; warranties for motors and gear reducers and other component parts may be provided by their respective manufacturers. Any legal action for breach of any Force Control warranty must be commenced within one year of the date on which the breach is or should have been discovered.

A Return Goods Authorization (RGA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. Force Control will pay the shipping costs of returning the owner parts that are covered by warranty.

Force Control believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, Force Control reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult Force Control if errors are suspected. In no event shall Force Control be liable for any damages arising out of or related to this document or the information contained in it.



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# Section 1 - DESCRIPTION & OPERATION

## 1-1 UNIT DESCRIPTION

### A. Multi-Speed Drive Units (MSDr)

The Multi-Speed Drive Unit, as shown in *Figure 1.01*, consists of a Primary Input Shaft, Secondary Input Worm Shaft and the Output Shaft. Both the Primary Input Shaft and the Secondary Input Shaft can be a Male Shaft or a Quill Shaft. The Male Input Shaft is either belt driven or directly coupled to the Drive Motor. The Quill Input Shaft enables the drive motor to be C-Face Mounted directly to the Clutch/Brake Unit.

### B. High Speed Reversing Drive Units (HSRvD)

The High Speed Reversing Drive Unit, also shown in *Figure 1.01*, consists of a Primary Input Shaft which can be a Male Shaft for belt drive or direct coupled to the Primary Input Drive Motor. A Quill Shaft is also available for C-Face Mounting. The Secondary Drive Motor is directly mounted to the transfer case and incorporates a Silent Chain Drive for a positive transfer of the Secondary Drive Torque at a minimal noise level.

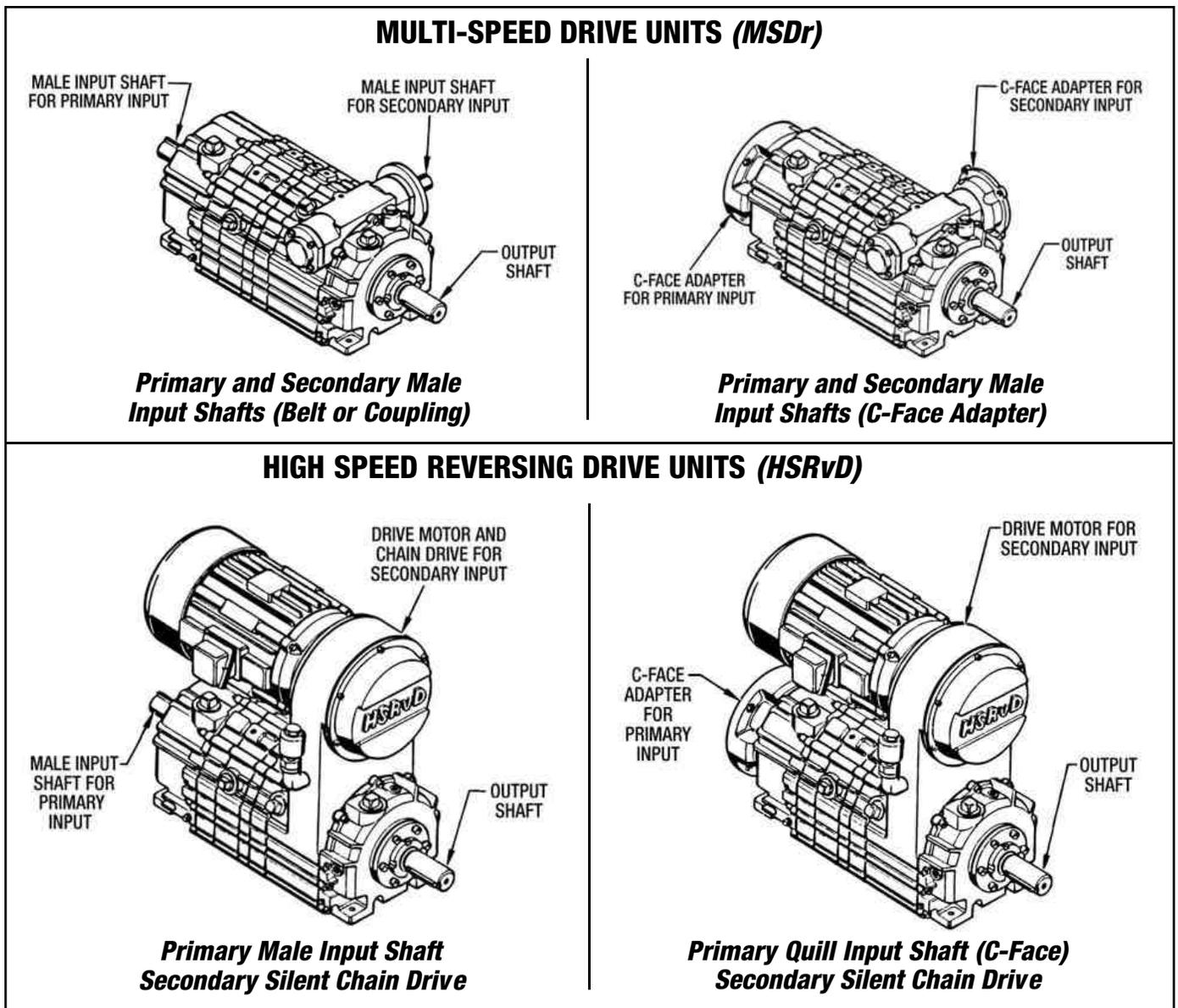


Figure 1.01 - Drive Unit Configurations

## 1-2 AVAILABLE DRIVE OPTIONS

The following chart shows all available drive options as per Drive and Model Size.

TYPE OF DRIVE	MODEL NUMBER	PRIMARY INPUT			SECONDARY INPUT		
		MALE INPUT		QUILL SHAFT C-FACE MNTG.	MALE SHAFT BELT DRIVE	QUILL SHAFT C-FACE MNTG.	SILENT CHAIN DRIVE
		BELT DRIVE	DIRECT COUPLE				
MSDr	M3						-----
	M5						-----
	M0			-----			-----
	M1			-----			-----
HSRvD	R3				-----	-----	
	R5				-----	-----	
	R0				-----	-----	

 - Option Available

 - Option Not Available

### NOTE:

Water Cooled and Fan Cooled Units are also available for the following models:

- a.. WATER COOLING (Available for all models except M1.)
- b. FAN COOLING (Only available with Male Primary Input Shaft.)

## 1-3 THE OIL SHEAR PRINCIPLE

Conventional clutches and brakes depend on friction between solid surfaces operating in air to transmit torque. Friction does the job, but produces a great amount of heat and wear. The HSRvD, and MSDr uses the *Posidyne* Clutch/Brake principle of oil shear, with the friction surfaces operating in a continually replenished recirculating supply of oil. The oil molecules tend to cling to each other and to the friction surfaces. As moving and stationary elements are brought together, a thin but positive film of oil is maintained between them, controlled by the clamping pressure and carefully designed grooves in the elements. Torque is transmitted from one element to the other through the viscous shear of the oil film. So long as there is relative motion between the elements, they are protected by the oil, thus greatly reducing wear. The oil also effectively transmits heat away from the friction elements.

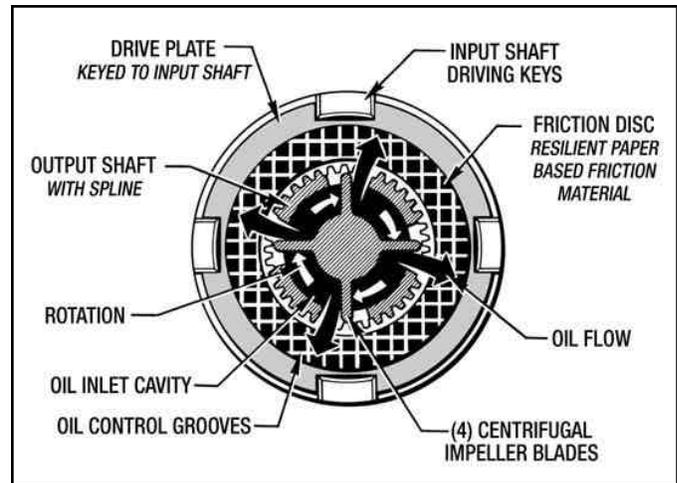


Figure 1.02 - The Oil Shear Principle

## 1-4 DESCRIPTION OF CLUTCH AND BRAKE STACKS

In the HSRvD and MSDr clutch and brake stacks, the friction surfaces consist of alternate carbon steel drive plates and friction discs. The friction discs consist of a resilient paper-based friction material bonded to steel discs with oil control grooves machined into the friction surfaces. (See Figure 1.02) The friction discs have internal teeth which mate with a spline on the output shaft, and the drive plates are keyed to the input shafts in the clutches and to the housing for the brake. The splined sections of the output shaft contain centrifugal impellers to maintain a positive flow of oil between the friction discs and the drive plates maintaining the "Oil Shear Principle" described in Section 1-3.

## 1-5 OPERATION

The MSDr Assembly (Figure 1.03) shows the drive in the neutral or "off" position. A nominal braking force and brake stack centering force is provided by springs located in the piston housings which move the pistons toward each other engaging the brake stack. The two input shafts run continuously. As either piston is actuated by compressed air to engage its respective clutch, the opposing piston's movement is limited as it contacts the piston retainer. This releases the brake and also allows additional clearance in the opposing clutch stack during times of differential speeds.

When clutch pressure is exhausted, the pistons move back engaging the brake stack and centering it up.

Brake actuation pressure is applied to obtain the additional, desired brake torque.

In the MSDr, the two input shafts normally run in the same direction, but at a different constant speed.

Output shaft speed is determined by the selection of the clutch. With the right MSDr setup, it is possible to have the two input shafts running at two different speeds in the opposite direction.

In the HSRvD, the two input shafts are counter-rotating and run continuously. The output shaft rotation is determined by the selection of the Primary Clutch or the Secondary Clutch. The Secondary Input is driven by a silent chain and sprocket configuration.

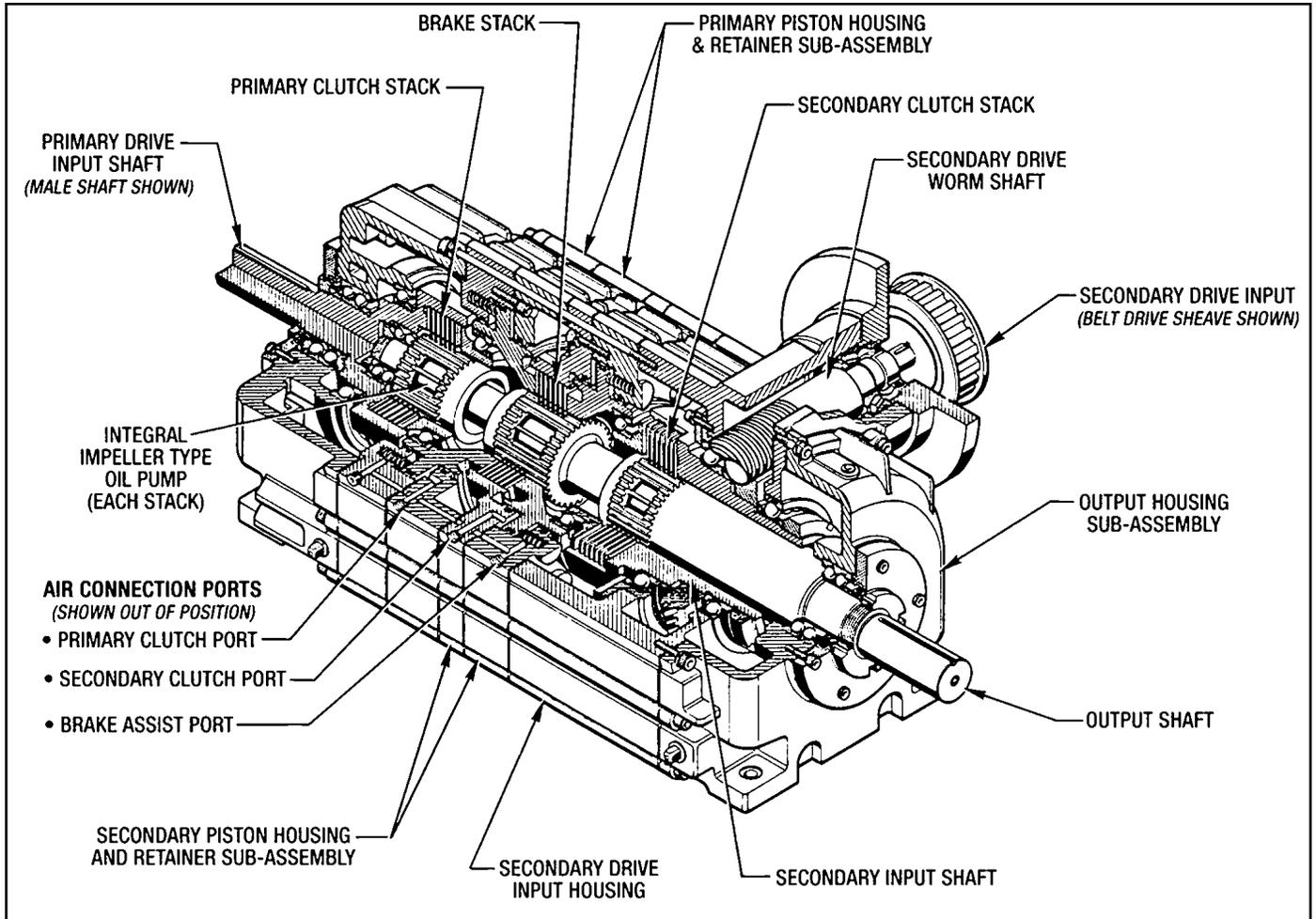


Figure 1.03 - Multi-Speed (MSDr) Assembly

# Section 2 - SPECIFICATIONS

**Table 1 - MULTI-SPEED DRIVE (MSDr)**

Size	Logic	Primary & Secondary Clutch Torque (In. Lbs.)		Brake Torque (In. Lbs.)				Maximum RPM		Thermal Horsepower			Air Volume Per Engmt. (Cu. In.)	Oil Capacity (Qts.)
		Static @ Max PSI	Dynamic @ Max PSI	With Springs Only		With Max Air Assist		Basic & Fan Cool	Water Cool	Cooling*				
				Static	Dynamic	Static	Dynamic			Basic	**Fan	***Water		
M3	SA	2306 @ 80	1991 @ 80	514	444	1848 @ 40	1596 @ 40	1800	3600	Horiz	Horiz	Horiz	8	6
	A	2368 @ 80	2036 @ 80	522	451	-----	-----			0.75	2.80	8.00		
	B	1530 @ 80	1322 @ 80	1041	899	-----	-----			Vert	Vert	Vert		
	SCP	2233 @ 60	1928 @ 60	0	0	1518 @ 60	1311 @ 60			0.38	1.40	4.00		
M5	SA	3792 @ 80	3275 @ 80	936	808	3336 @ 40	2881 @ 40	1800	3600	Horiz	Horiz	Horiz	8	14
	A	3792 @ 80	3275 @ 80	936	808	-----	-----			1.00	4.50	12.00		
	B	2251 @ 80	1944 @ 80	1866	1611	-----	-----			Vert	Vert	Vert		
	SCP	3661 @ 60	3162 @ 60	0	0	2942 @ 60	2541 @ 60			0.50	2.25	6.00		
M0	SA	8253 @ 80	7127 @ 80	2481	2143	7968 @ 40	6881 @ 40	1800	1800	Horiz	Horiz	Horiz	12	18
	A	8791 @ 80	7592 @ 80	2366	2043	-----	-----			1.00	6.00	15.00		
	B	5030 @ 80	4344 @ 80	4733	4088	-----	-----			Vert	Vert	Vert		
	SCP	8501 @ 60	7341 @ 60	0	0	7660 @ 60	6588 @ 60			0.50	3.00	7.50		
M1	SA	10314 @ 80	6188 @ 80	2335	1401	7778 @ 40	4667 @ 40	1200	N/A	N/A	Horiz	N/A	15	20
	A	10896 @ 80	6538 @ 80	2345	1412	-----	-----			4.00**	-----	-----		
	B	6234 @ 80	3740 @ 80	4695	2817	-----	-----			Vert	-----	-----		
	SCP	14424 @ 80	8655 @ 80	0	0	10319 @ 60	6191 @ 60			2.00**	-----	-----		

**Table 2 - HIGH SPEED REVERSING DRIVE (HSRvD)**

Size	Logic	Primary & Secondary Clutch Torque (In. Lbs.)		Brake Torque (In. Lbs.)				Maximum RPM		Thermal Horsepower			Air Volume Per Engmt. (Cu. In.)	Oil Capacity (Qts.)
		Static @ Max PSI	Dynamic @ Max PSI	With Springs Only		With Max Air Assist		Basic & Fan Cool	Water Cool	Cooling*				
				Static	Dynamic	Static	Dynamic			Basic	**Fan	***Water		
R3	SA	2306 @ 80	1991 @ 80	514	444	1848 @ 40	1596 @ 40	1800	3600	Horiz	Horiz	Horiz	8	6
	A	2368 @ 80	2036 @ 80	522	451	-----	-----			0.75	2.80	8.00		
	B	1530 @ 80	1322 @ 80	1041	899	-----	-----			Vert	Vert	Vert		
	SCP	2233 @ 60	1928 @ 60	0	0	1518 @ 60	1311 @ 60			N/A	1.40	4.00		
R5	SA	3792 @ 80	3275 @ 80	936	808	3336 @ 40	2881 @ 40	1800	3600	Horiz	Horiz	Horiz	8	14
	A	3792 @ 80	3275 @ 80	936	808	-----	-----			1.00	4.50	12.00		
	B	2251 @ 80	1944 @ 80	1866	1611	-----	-----			Vert	Vert	Vert		
	SCP	3661 @ 60	3162 @ 60	0	0	2942 @ 60	2541 @ 60			N/A	2.25	6.00		
R0	SA	8253 @ 80	7127 @ 80	2481	2143	7968 @ 40	6881 @ 40	1800	1800	Horiz	Horiz	Horiz	12	18
	A	8791 @ 80	7592 @ 80	2366	2043	-----	-----			1.00	6.00	15.00		
	B	5030 @ 80	4344 @ 80	4733	4088	-----	-----			Vert	Vert	Vert		
	SCP	8501 @ 60	7341 @ 60	0	0	7660 @ 60	6588 @ 60			N/A	3.00	7.50		

**CONTROL LOGICS**

1. **SA** - Spring Set Brake, Air assist.
2. **A** - Spring Set Brake, 75% Clutch / 25% Brake with 80 PSIG.
3. **B** - Spring Set Brake, 50% Clutch / 50% Brake with 80 PSIG.
4. **SCP** - Self Centered Piston.

**NOTES:**

- \* - Ratings based on 1800 RPM operating speed. Higher thermal ratings available with forced lubrication. Consult factory with application details.
- \*\* - Size M1 rated at 1200 RPM.
- \*\*\* - Cooling water flow requirements in: GPM = .10 x calculated thermal horsepower load.

**Table 3 - PRESSURE VS. TORQUE CHART (MSDr) and (HSRvD)**

Size	Logic	CLUTCH			BRAKE					
		$C_M$		$C_E$	$C_E$	$B_0$	$B_M$		$B_S$	$B_T$
		Clutch Static Torque (Lb. In.)	Max. Air Actuation Pressure (PSI)	Clutch Engagement Air Pr. (PSI)	Clutch Net Torque (Lb. In./PSI)	Spring Set Torque w/o Air Assist (Lb. In.)	Brake Static Torque (Lb. In.)	Brake Actuation Pressure (PSI)	Max. Air Brake Spring Bias Pr. (PSI)	Brake Net Torque (Lb. In./PSI)
M3 R3	SA	2306	@ 80	22.30		514	1848	@ 40	15.4	33.4
	A	2368	@ 80	21.00		522	N/A	15.6	N/A	
	B	1530	@ 80	41.70	40.0	1041	N/A	31.2	N/A	
	C	2064	@ 60	8.36		N/A	N/A	N/A	N/A	
	SCP	2233	@ 60	4.12		0	1518	@ 60	-3.0	26.6
M5 R5	SA	3792	@ 80	23.16		936	3336	@ 40	15.6	60.0
	A	3792	@ 80	23.16		936	N/A	15.6	N/A	
	B	2251	@ 80	46.26	66.7	1866	N/A	31.1	N/A	
	C	3386	@ 60	9.25		N/A	N/A	N/A	N/A	
	SCP	3661	@ 60	5.13		0	2942	@ 60	-4.9	53.4
M0 R0	SA	8253	@ 80	27.38		2481	7968	@ 40	18.1	137.2
	A	8791	@ 80	23.95		2366	N/A	17.3	N/A	
	B	5030	@ 80	47.93	156.8	4733	N/A	34.5	N/A	
	C	7905	@ 60	9.60		N/A	N/A	N/A	N/A	
	SCP	8501	@ 60	5.80		0	7660	@ 60	-4.2	137.2
M1	SA	10314	@ 80	27.04		2335	7778	@ 40	17.2	136.1
	A	10896	@ 80	23.95		2354	N/A	17.3	N/A	
	B	6234	@ 80	47.93	194.4	4695	N/A	34.5	N/A	
	C	13686	@ 80	9.60		N/A	N/A	N/A	N/A	
	SCP	14424	@ 80	5.80		0	10319	@ 60	-4.2	136.1

To Find Torque Developed At  
A Given Actuation Pressure.

<p><b>Clutch Torque = (PSI-<math>C_E</math>) x <math>C_T</math></b></p> <p><b>Brake Torque = (PSI-<math>B_S</math>) x <math>B_T</math></b></p>
--

PSI = Air Pressure @ Posidyne Port.

To Find Actuation Pressure  
Needed For Required Torque.

<p><b>Clutch PSI = (<math>T_R / C_T</math>) + <math>C_E</math></b></p> <p><b>Brake PSI = (<math>T_R / B_T</math>) + <math>B_S</math></b></p>
--

$T_R$  = Required Static Torque.

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## Section 3 - INSTALLATION

### IMPORTANT SAFETY PRECAUTIONS

The Multi-Speed Drive Units and High Speed Reversing Drive Units described in this manual must not be installed or operated at any Speeds, Horsepower Loads or Temperatures not specified in this manual.

Failure to limit operating conditions of the drive to all specified conditions could damage the drive unit and cause damage or malfunction to interconnected equipment and also void the warranty.

#### WARNING

Before any installation and before attempting any repairs to the drive, open the electrical disconnects to both drive motors. Shut off the air supply to the drive and lock them out. Also bleed off any remaining air pressure trapped in the pneumatic lines. These steps must be taken to avoid any possibility of personal injury.

### 3-1 RECEIVING THE DRIVE

Check the drive for shortage or damage immediately after arrival. Prompt reporting of the carrier's agent, with notations made on the freight bill, will expedite satisfactory adjustment by the carrier. When unloading or handling the drive, keep it upright. All Drives are filled with oil, ready to run, when shipped. However, before placing the unit in service or storage, check the oil level to make sure none has spilled out in transit. Add oil if necessary (Refer to **Section 4 LUBRICATION**). If the drive is not to be installed and operated soon after arrival, store it in a clean, dry place having a slow, moderate change in ambient temperature. Actuate pistons and rotate shafts once a month to re-lubricate working surfaces.

### 3-2 MOUNTING THE DRIVE

Installation of the drive should be made in much the same manner, and receive the same care as for a precision gear reducer. Standard Drives are designed for horizontal operation.

**Note the following precautions when mounting the drive:**

1. The Drive should be mounted on a firm, level base or foundation.

Use socket head cap screws or SAE grade 5 bolts to bolt the drive securely in place. Before tightening

down the bolts, check alignment with driven machinery, then recheck after tightening. Failure to limit operating conditions of the drive to all specified conditions could damage the Drive Unit and cause damage or malfunction to inter-connected equipment.

2. If the Primary Drive Motor Shaft is to be directly coupled, use only a flexible coupling (with horsepower service factor 3 to 1) to take care of maximum torque requirements. Make sure that the shafts to be coupled are concentric within the coupling manufacturer's specifications. Check for horizontal, vertical or angular misalignment. Use shims as necessary to correct any misalignment.

#### CAUTION

**Do not drive couplings or bushings onto shaft, as this may damage the bearings.**

3. If the Primary Drive Shaft is to be connected through a belt, chain or gear drive, locate the sheave, sprocket or gear as close as possible to the drive housing and the drive motor bearing to minimize overhung loads. Align to run true and adjust belt or chain tension per manufacturer's specifications.

#### CAUTION

**Excessive belt or chain tension will damage bearings.**

4. Furnish and install appropriate safety guards for all external rotating drive parts.
5. With "Piggy back" mounting of the Secondary Drive Motor, Force Control furnishes all Secondary Drive Motor Mounting Parts and required Belt Guards. Drive belts and sheaves are provided as an option as per customer's requirements.

If the motor mounting parts are not furnished by Force Control, then the customer must supply and install all appropriate Safety Guards for all exposed drive rotating parts, as required.

6. The Air Breather (#45) is removed before shipment and a pipe plug put in its place. In most cases this will be a red plastic plug. This is to prevent oil spillage during shipment. This plug must be removed and the Breather (#45) installed to prevent damage to the drive. The Breather (#45) is taped to the drive for shipment.

#### CAUTION

**Failure to install this Breather (#45) will result in overheating, which will cause the brake and clutch components to malfunction and void the warranty.**

7. After the Drive has been in operation for a few hours, make sure that all mounting bolts are tight and re-check alignment of all driving components.
8. After 40 hours of operation check mounting bolts and tighten if necessary.

### 3-3 WIRING SPECIFICATIONS

(See Motor Plate for Wiring Specifications.)

### 3-4 PNEUMATICS

Note the following when planning and installing the Pneumatic System: (See Figure 3.01)

1. Use direct acting solenoid air valves or pilot operated valves to give the response speed required. Locate the valves as close as possible to the air inlets on the drive. The valves may be installed directly on the drive if they are supported.

### WARNING

Clutch valving must be interlocked so that both clutches cannot be actuated at the same time. A three-position-five way valve is recommended. Actuating both clutches at the same time will cause damage to the drive.

Clutch/brake air interlock is not necessary because internal construction of the drive prevents clutch/brake overlap.

2. Be sure to use valves with a minimum Cv factor of .8. Lubricators are not necessary for the HSRvD or MSDr, but they may be used if needed for air valve operation.
3. The optional accumulator should be used for quick response, particularly if the air line loss and the nature of the air supply is such that recovery is slow. Size the accumulator to be at least ten (10) times the air required per engagement. (See Section 2 SPECIFICATIONS).

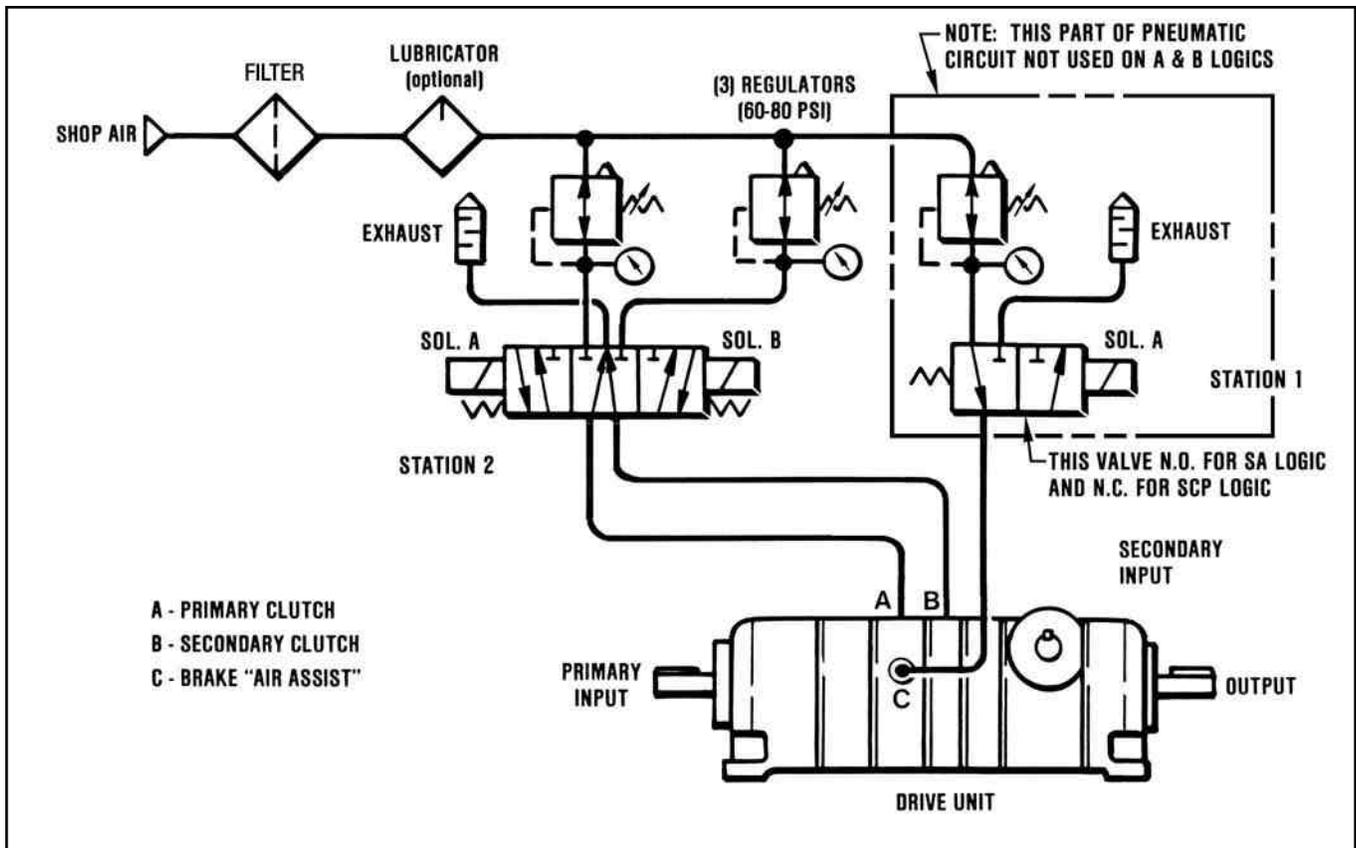


Figure 3.01 - Typical Pneumatic Schematic For "SA" Logic

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- 
4. Pressure is directly proportional to torque. Use only the pressure necessary to drive the machine. This will give additional life to the drive.
  5. A new drive will produce an abundance of torque until it has burnished in. Initial regulator settings should be set at about 80% of charted ratings (**See Section 2 "TORQUE VS. ACTUATION PRESSURE"**). After using the drive for a few weeks, the acceleration time may increase. Increasing the air pressure will restore the acceleration.

### **3-5 START UP**

1. Lock out machine and air pressure. Verify that the Electrical Power is OFF to avoid personal injury.

2. Recheck all Air Connections for tightness to see if they are correct as shown in the Pneumatic Schematic (*Figure 3.01*).
3. Set Air Regulators to 80 % of required air pressure. (As charted in **Section 2 - TORQUE VS. ACTUATION PRESSURE.**)
4. Unlock Main Disconnect.
5. Check out Secondary Drive speed mode for proper rotation and adjust all limit switches as needed.
6. Check operation of Primary Motor Drive.

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## **Section 4 - LUBRICATION**

### **4-1 CHECKING THE OIL LEVEL**

When the drive is installed and weekly thereafter, or until experience dictates otherwise, check the oil level. Always check the oil level with the drive at room temperature and while it is not running.

The drive has an oil sight gauge located at the output end of the drive. The oil level is to show at the center of the gauge.

### **4-2 CHANGING THE OIL**

**NOTE:**

Open the disconnects to the drive motors before attempting to change the oil.

Every three months completely drain the oil from the drive using the drain plugs provided. If the oil sight gauge is dirty, it should be removed and cleaned.

Reinstall the drain plugs and refill the drive to the center of the sight gauge with fresh oil.

**CAUTION**

**Do not overfill the Drive Unit. Excess oil will cause the unit to overheat.**

### **4-3 TYPE OF OIL**

Use only Mobile Automatic Transmission Fluid type ATF210 or type "F".

## Section 5 - OPERATIONAL CHECKS

These Operational Checks are to be made when the Drive Unit is removed from service for repair. Provisions for manually controlled 60 to 80 PSI air pressure must be made for these Operational Checks.

### 5-1 GENERAL SET-UP INSTRUCTIONS

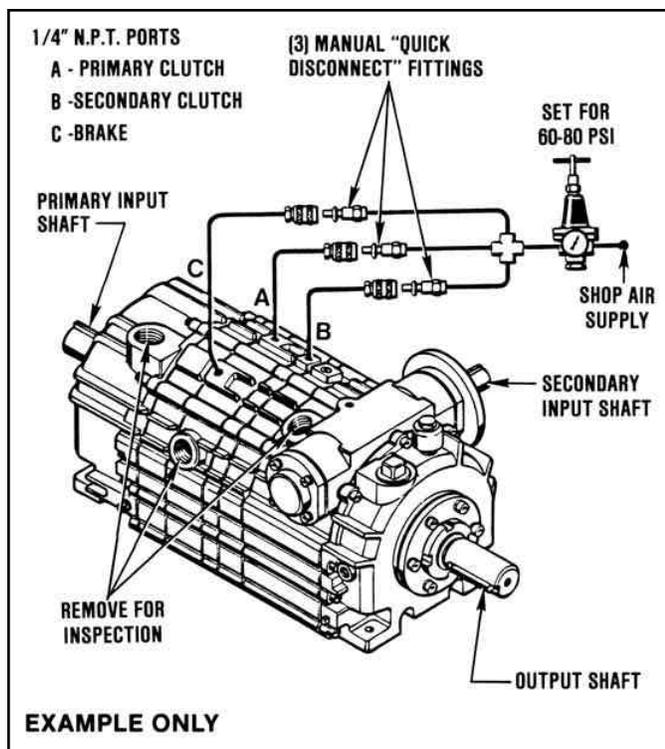
(See Figure 5.01)

The set-up shown in Figure 5.01 is only an example. The basic requirement is that the air supply have a quick acting shut-off action. Lever type shut-off valves suitable for air operation would be another option.

1. Install the 60 to 80 PSI air supply to the drive Unit and remove the (3) Inspection Plugs as shown in Figure 5.01.

#### CAUTION

**Do not remove these Inspection Plugs while the Drive is running.**



### 5-2 CHECKING CLUTCH AND BRAKE PISTON SEALS AND MOVEMENT

1. Manually apply air pressure to the "Primary Clutch" Port. With the aid of a flash light, observe the Clutch Piston to see if it actuates quickly and smoothly.

Internal damage may be indicated if the piston action is irregular or if it sticks or binds.

Also listen for air leaks and look for air bubbles in the oil that would indicate damage to the piston seals.

2. Exhaust the air pressure from the Primary Clutch Port and observe to see that the Clutch Piston moves back smoothly to the normal "Braking Position".
3. Apply air pressure to the "Secondary Clutch" Port and repeat steps 1 and 2 to check the Secondary Piston seals and movement.
4. Apply air to the "Brake" port. On all models, except ones with SCP logic, the Brake is spring loaded so there will not be any observable piston movement when air is applied. On units with SCP logic, the piston will move when air is applied. Check the piston movement, if applicable, and check for leakage and air bubbles in the oil to see if the piston seals are functioning properly.
5. Replace Inspection Plugs.

### 5-3 CHECKING CLUTCH AND BRAKE ENGAGEMENT OR INPUT SHAFT VS. OUTPUT SHAFT ROTATION (WITH MALE INPUT SHAFTS)

1. When applying air pressure to the desired "Clutch" Port, simply rotate the proper Input Shaft by hand and observe the rotation of the Output Shaft. Likewise, when the air pressure is not applied to the clutch port or when air pressure is applied to the "Air Assist" brake port, the Output Shaft should be locked in the braking position and should not rotate.

With SCP logic the Output Shaft is free to rotate when air pressure is not applied to the "Brake" port. Applying air should lock the Output Shaft.

#### (WITH C-FACE MOUNTED DRIVE MOTORS)

If the C-Face mounted Drive Motors are still attached, then the Input Shafts are not accessible to be manually rotated to check Clutch/Brake engagement and Input Shaft vs. Output Shaft rotation.

1. Temporarily hook-up Drive Motors and "Bump" them to check the Clutch or Brake Operating Modes and Output Shaft rotation.

**CAUTION**

Do not attempt to run motors with the Inspection Plugs removed. They first must be replaced.

**5-4 DRIVE MOTORS**

Check wiring connections against the wiring diagram on the Name Plate. "Bump" the motor and check direction of rotation. Check all connections for tightness.

**5-5 PNEUMATIC CONTROL**

The Pneumatic Control Operational Checks are to be made with Pneumatic Control Valves hooked up.

1. Shut off air supply, lock it out, and bleed off any trapped air in the system.

2. Insert Diagnostic Pressure Gauges in the air supply between the control valves and the drive. (See Figure 5-2)

3. Activate Solenoid Control Valves for desired Function. (See Pneumatic Control Logic Diagram on Figure 5.02)

- a. Primary Drive
- b. Secondary Drive
- c. Brake "Air Assist"

4. Check air pressure with installed diagnostic pressure gauges for each function.

Check all connections for tightness and any air leaks.

5. Check all electrical connections and solenoid operation per manufacturer's specifications.

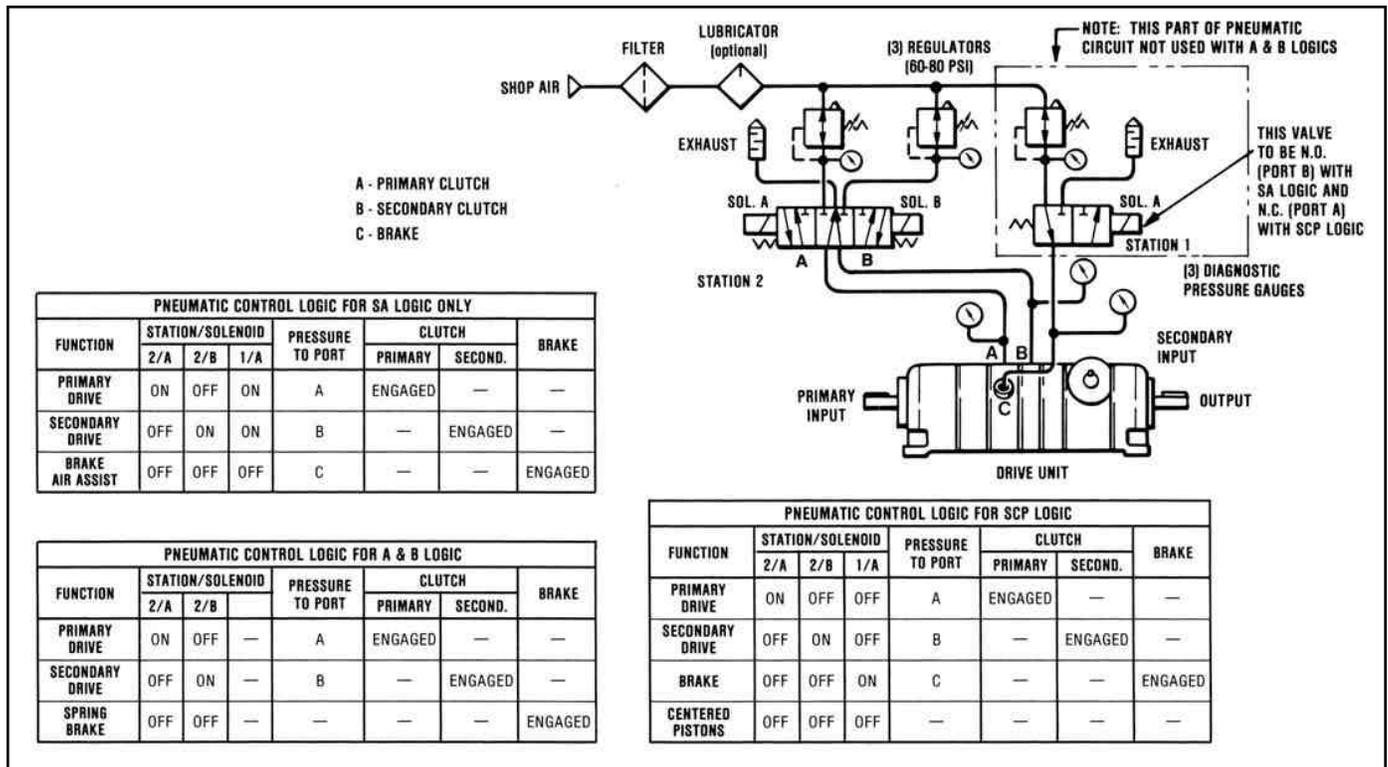


Figure 5.02 - Pneumatic Control Diagram

# Section 6 - TROUBLESHOOTING

**CAUTION**

Open disconnect to Prime Mover and lock it out while making repairs or checking machinery to avoid any personal injury.

## 6-1 TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSE	REMEDY
A. Either clutches or the brake fails to engage properly.	1. Loss of air supply ..... 2. Loss of electrical signal ..... 3. Worn friction surfaces ..... 4. Stuck or damaged piston .....	a b c d
B. Picks up load too quickly.	1. Air pressure too high .....	e
C. Either clutches or the brake fail to disengage properly.	1. Valve malfunction ..... 2. Electrical signal error ..... 3. Stuck or damaged piston .....	a, f b d
D. Clutch fails to engage.	1. Loss of air supply ..... 2. Loss of electrical signal ..... 3. Worn friction surfaces ..... 4. Stuck or damaged piston ..... 5. Electrical signal error .....	a b c d g
E. Noise and vibration.	1. Mounted on poor foundation ..... 2. Misaligned couplings ..... 3. Damaged bearings ..... 4. Silent chain is loose (HSRvD only) .....	h i j k
F. Drive overheats. (Temperature over 225° F)	1. Clutch or brake fails to engage or disengage properly causing excessive slippage ..... 2. Improper oil level ..... 3. Cooling media not functioning properly .....	a, j m n
G. Oil leakage out breather.	1. Damaged piston seals ..... 2. Oil level too high .....	o m
H. Clutch or brake does not repeat.	1. Air pressure changed ..... 2. Oil temperature change ..... 3. Resistance in machine changed .....	a p l

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## 6-2 REMEDIES

### NOTE:

When checking pneumatics, shut off air supply, lock it out, and bleed off any trapped air in the system. Insert “diagnostic pressure gauges” in the air supply between the valves and drive or in the extra ports in the drive.

- a. Set up “diagnostic pressure gauges” as noted above. Manually activate the valves and check the gauges for proper pressure and sequence.
- b. Set up “diagnostic pressure gauges” as noted above. Actuate the valves and check the gauges for proper sequence.
- c. Remove the proper inspection port plug. Actuate the proper clutch or brake. Use a screwdriver to check to see if the plates and discs are clamped up tight. Use a flashlight to check plates for signs of excessive heat.
- d. Remove the proper inspection port plug. Actuate the proper piston. Use a flashlight to visually inspect the piston movement. Check that it actuates quickly and smoothly. If the piston action is irregular or if it tends to stick or bind, internal damage may be indicated.
- e. Adjust air pressure. Check “Torque vs. Actuation Pressure” Chart in Section 2, Table 1 or 2.
- f. Follow the valve manufacturer’s specs and check out the air valves.
- g. Disassemble to the extent necessary and inspect for damaged parts. See **Section 7** and follow instructions through the piston removal procedure.
- h. Check mounting bolts. Check installation.
- i. Check couplings and alignment.
- j. Check bearings. Disconnect couplings and rotate each shaft by hand. If bearings feel “rough or stick in spots” replace them. Always check bearings when any unusual noise or vibration develops in the drive.
- k. Remove either silent chain inspection port plugs to check the chain for slack. Remove silent chain access cover if necessary to adjust slack. (**See Section 9-10.**)
- l. A change in the driven machinery’s resistance will cause the drive to overheat or lose its repeatability. Check out machinery for the problem.
- m. Check oil level. **See Section 4 - Lubrication.**
- n. On water cooled drives, check the water supply and drain for restriction or loss of flow. On fan cooled drives, check for air restrictions around fan or shroud.
- o. Remove the proper inspection port plug. Actuate the proper piston. Use a flashlight to visually inspect for air bubbles in the oil indicating a leak. Listen for air leaks above the oil level.
- p. For installations requiring precise starting and stopping, operating temperatures are important. Operating temperatures between 1160 and 1650 F are recommended. If the oil is allowed to drop to ambient temperatures overnight, the clutch input shafts should be run for approximately 1/2 hour before operating machinery.

# Section 7 - DISASSEMBLY

## WARNING

Before attempting any repairs on the Drive Unit, open disconnects to the prime mover, shut off air supply and lock them out to avoid any possibility of personal injury.

## 7-1 GENERAL DISASSEMBLY PROCEDURE

1. Disconnect the Drive and move it to a suitable work area.

### NOTE:

On Belt Driven or Direct Coupled Units, remove all necessary safety guards, belts, sheaves and couplings.

For Water Cooled Units, disconnect water inlet and outlet piping. Drain water from the unit.

Disconnect all necessary pneumatic piping.

2. Remove drain plugs at the bottom of the Drive Unit and drain all of the oil into a suitable container and either save for reuse or discard as the condition warrants.

### NOTE:

For ease of disassembly, we recommend that you set the Drive Unit on the Output End with the Output Shaft in a vertical down position. Supply suitable bracing and clamping to stabilize the Drive Unit for Disassembly.

An overhead crane and a soft sling is also recommended to remove heavy castings and parts.

## IMPORTANT

**UNLESS THE DRIVE IS TO BE COMPLETELY OVERHAULED, IT SHOULD ONLY BE DISASSEMBLED TO THE EXTENT NECESSARY TO GAIN ACCESS TO THE WORN OR DAMAGED PARTS.**

Both the MSDr Units and the HSRvD units are comprised of (5) basic sub-assemblies, as shown in Figures 7.01 and 7.02, and can be disassembled as complete sub-assemblies and for easy access to the Clutch or Brake Stacks, as shown in Figure 10.01.

1. PRIMARY INPUT HOUSING SUB-ASSEMBLY (See Figure 10.02)
2. OPTIONAL FAN COOLING AND WATER COOLING (See Figure 10.03)

3. PRIMARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY (See Figure 10.04)
4. SECONDARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY (See Figure 10.04)
5. SECONDARY INPUT HOUSING SUB-ASSEMBLY (Male Input Shaft for Belt Drive) (See Figure 10.05)
6. SECONDARY INPUT HOUSING SUB-ASSEMBLY (Quill Input Shaft for C-Face Mounting) (See Figure 10.06)
7. SECONDARY INPUT HOUSING SUB-ASSEMBLY (HSRvD) CHAIN DRIVE (See Figure 10.07)
8. OUTPUT HOUSING SUB-ASSEMBLY (See Figure 10.08)

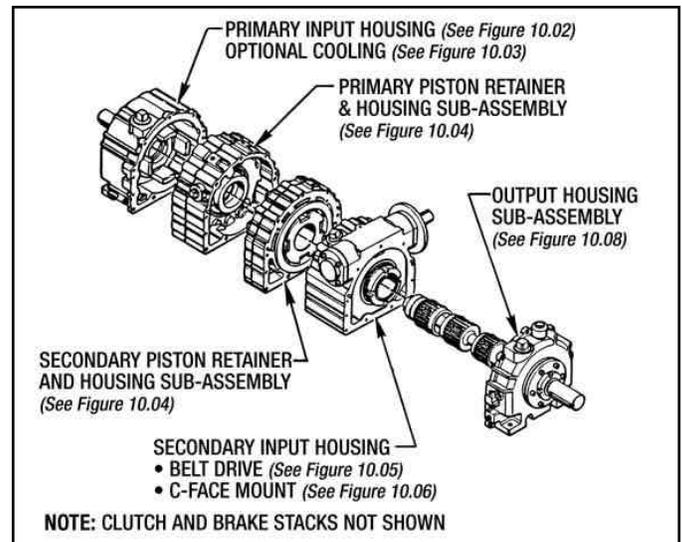


Figure 7.01 - Multi-Speed Drive (MSDr) Sub-Assemblies

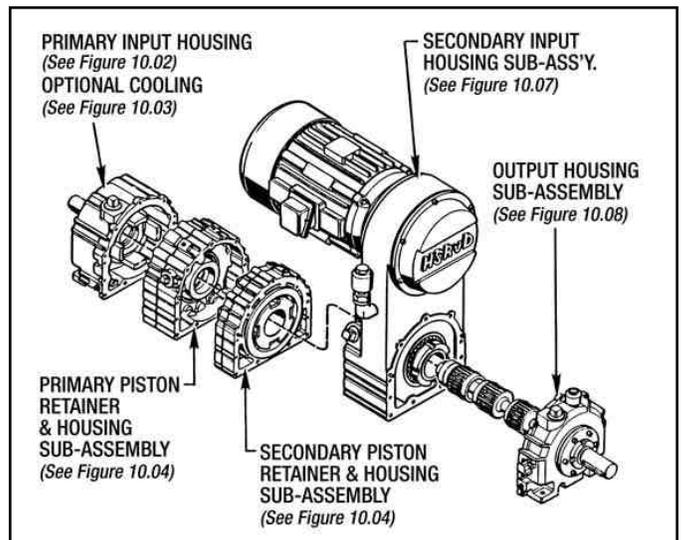


Figure 7.02 - High Speed Reversing Drive (HSRvD) Sub-Assemblies

## 7-2 REMOVING C-FACE MOUNTED PRIMARY DRIVE MOTOR

1. Attach appropriate sling or lifting hook to Drive Motor for support and removal.
2. Remove (4) Hex Hd. Screws (#415) and (4) Lockwashers (#416) from the C-Face Adapter (#200).
3. Slide motor shaft out of the Quill Input Shaft (#2).

## 7-3 REMOVING C-FACE MOUNTED SECONDARY DRIVE MOTOR

1. Attach appropriate sling or lifting hook to the Drive Motor for support and removal.
2. Remove (4) Cap Screws (#262) and (4) Lockwashers (#265) from the C-Face Adapter (#155).
3. Slide Motor Shaft out of the Quill Input Shaft (# 153).

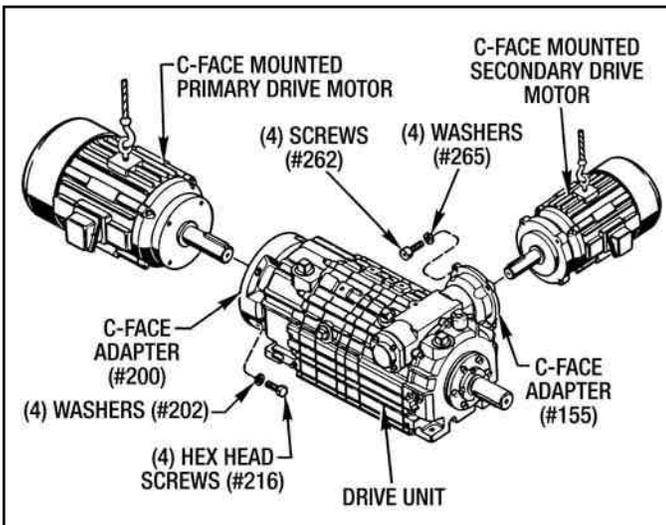


Figure 7.03 - Removing C-Face Mounted Motors

### **(FAN COOLED UNITS)**

## 7-4 REMOVING FAN SHROUD AND FAN

(See Figure 10.03)

### **(Models M3, R3, M0, R0 and M1)**

1. Loosen Set Screw (#88) from top of the Fan Shroud.

### **(Models M5 and R5)**

1. Remove (2) Screws (#67) and (2) Washers (#182) from the sides of the Fan Shroud.

### **(All Models)**

2. Remove (2) Screws (#66) from the bottom rear of the Fan Shroud.

3. Pull the Fan Shroud (#24) away from the Primary Input Housing Sub-Assembly.
4. Loosen Set Screw (#70) and remove Fan (#25) from the Primary Input Shaft (#2).
5. Remove both Keys (#180) and (#37).

### **(MI Models Only)**

6. Remove Spacer (#183) from the Primary Input Shaft (#2).

## 7-5 SEPARATION AND REMOVAL OF MAJOR SUB-ASSEMBLIES FOR ACCESS TO CLUTCH AND BRAKE STACKS

(See Figure 10.01)

### **NOTES:**

Jackscrew holes are provided to aid in separation of the main housings from each other.

Do not attempt to reuse Gaskets (#53) and (#54). They must be replaced with new ones at reassembly.

When removing the CLUTCH or BRAKE STACKS, always keep the Drive Plates (#13) and the Friction Discs (#12) in the same order as they were removed.

### **(Primary Clutch Stack)**

1. Remove Allen Nuts (#152) and Lockwashers (#127) from the input end of the Primary Input Housing Sub-Assembly.
2. Using jackscrews, separate and lift the Primary Input Housing Sub-Assembly away from the Drive Unit.
3. Remove and discard Gasket (#53).
4. The PRIMARY CLUTCH STACK can now be removed from the output shaft spline.

### **(Brake Stack)**

5. Separate and remove the Primary Piston Retainer and Housing Sub-Assembly from the remaining Drive Unit.
6. Remove and discard Gasket (#54).
7. Remove the BRAKE STACK from the output shaft spline.

### **(Secondary Clutch Stack)**

8. Separate and remove the Secondary Piston Retainer and Housing Sub-Assembly from the unit.
9. Remove and discard Gasket (#53).
10. Remove the remaining SECONDARY CLUTCH STACK from the output shaft spline.

### IMPORTANT REMINDER

When removing the CLUTCH/BRAKE STACKS, always keep the Drive Plates (#13) and the Friction Discs (#12) in the same order as they were removed.

If repair or replacement of the CLUTCH or BRAKE STACKS is the only repair to be done, then proceed to Section 8 - CLEANING AND INSPECTION.

## 7-6 REMOVING SECONDARY INPUT HOUSING SUB-ASSEMBLY FROM THE OUTPUT HOUSING SUB-ASSEMBLY

(See Figure 10.01)

1. Place Drive Unit in a horizontal position for access to attaching screws.

### **(M3 and R3 Models)**

2. Remove (9) Screws (#61), (2) Screws (#69) and (11) Lockwashers (#127) from output end of the Output Housing Sub-Assembly.

### **(M5, R5, M0, R0 and M1 Models)**

2. Remove (11) Screws (#61) and (11) Lockwashers (#127) from the output end of the output housing.

### **(All Models)**

3. With the aid of jackscrews, separate the Output Housing Sub-Assembly from the Secondary Input Housing Sub-Assembly.
4. With care, slide the Output Shaft (#1) out of the Secondary Input Housing Sub-Assembly.
5. Remove and discard Gasket (#53).

## 7-7 REMOVAL OF WATER COOLED HEAT EXCHANGER (See Figure 10.03)

### NOTES:

Only remove this Heat Exchanger (#48) if replacement or repair is required.

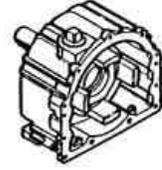
It will be necessary to use a suitable punch to drive the tube ends out of the Primary Input Housing. Care must be taken not to damage external machined surfaces.

1. Remove both Elbows (#71), Tee (#242) and the Zinc Anode (#176) from the Housing.
2. Remove (2) Screws (#56).
3. With a suitable punch, tap out the tube ends from the Housing (#8) and remove the Heat Exchanger (#48).

## DISASSEMBLY OF MAJOR SUB-ASSEMBLIES

### 7-8 PRIMARY INPUT HOUSING SUB-ASSEMBLY (With Male Input Shaft)

(See Figure 10.02)



1. If the Key (#180) is still intact in the Primary Input Shaft (#2), remove it at this time.

### **(M3, R3, M5 and R5 Models)**

2. Remove Locknut (#15) from Primary Input Shaft (#2).
3. Unscrew (6) Screws (#63) and remove along with (6) Lockwashers (#128). Remove Bearing Retainer (#7), taking care not to damage the lip of Oil Seal (#31).
4. Check Oil Seal (#31) and replace if necessary.
5. Remove and discard Gasket (#55).

### **(M0 and R0 Models)**

2. Remove Locknut (#15) from Primary Input Shaft (#2).
3. Unscrew (6) Screws (#63) and remove along with (6) Lockwashers (#128). Remove Bearing Retainer (#7), taking care not to damage the lip of Oil Seal (#31).
4. Check Oil Seal (#31) and replace if necessary.
5. Remove O-Ring (#87) and replace if necessary.
6. The Mating Ring (#4) is not a press-fit for these models so it can be removed by hand. Also remove and check O-Ring (#80).

### **(M1 Model Only)**

2. Unscrew (6) Screws (#63) and remove along with (6) Lockwashers (#128). Remove Bearing Retainer (#7), taking care not to damage the lip of Oil Seal (#31).
3. Check Oil Seal (#31) and remove if it is damaged and needs to be replaced.
4. Remove and check O-Ring (#87).
5. Procedure to remove Wear Sleeve (#4).

### NOTE:

Only remove this Wear Sleeve if damage is indicated and replacement is necessary.

With a chisel, the same width as the Wear Ring, make about 5 or 6 notches in the ring parallel to the Input Shaft. It can now be removed from the Input Shaft by hand. (See Figure 7.04)

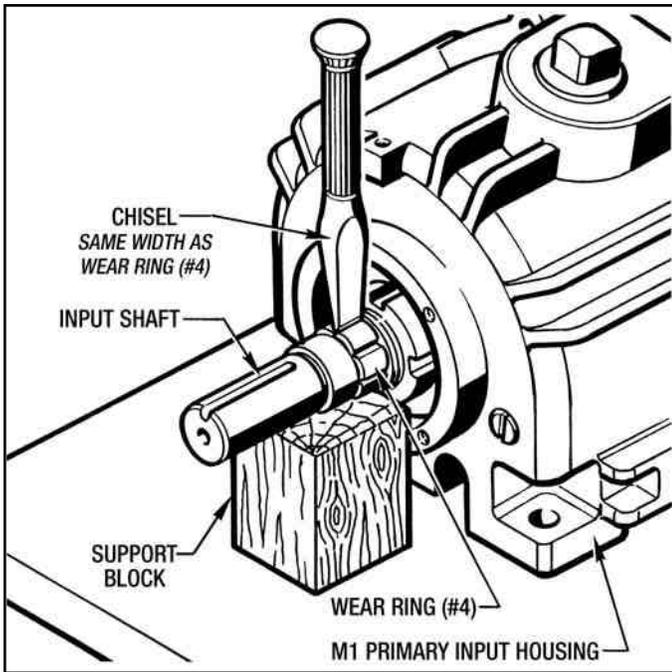


Figure 7.04 - Removing Wear sleeve (#4)  
From M1 Primary Input shaft

- Remove Locknut (#15) and Lockwasher (#185) if Bearings (#26) or (#35) are to be replaced and the Primary Input Shaft is to be pressed out of the Housing.

## 7-9 REMOVING THE MALE PRIMARY INPUT SHAFT FROM THE PRIMARY INPUT HOUSING

### IMPORTANT

DO NOT ATTEMPT TO REMOVE THE PRIMARY INPUT SHAFT UNLESS BEARINGS (#26), (#27) OR (#35) HAVE TO BE REPLACED.

### (All Models)

- Use an Arbor Press to press the Input Shaft out of the Input Housing as shown in Figure 7.05.

### (M3, R3, M5 and R5 Models)

- The Mating Ring (#4) will be pushed off the Input Shaft when pressed out of the Housing. Check the Ring for damage.

### (M0, R0 and M1 Models)

- Remove Bearings (#26) from the Input Housing.

### (All Models)

- Use a puller to remove Bearing (#27) from the Input Shaft. (See Figure 7.06)

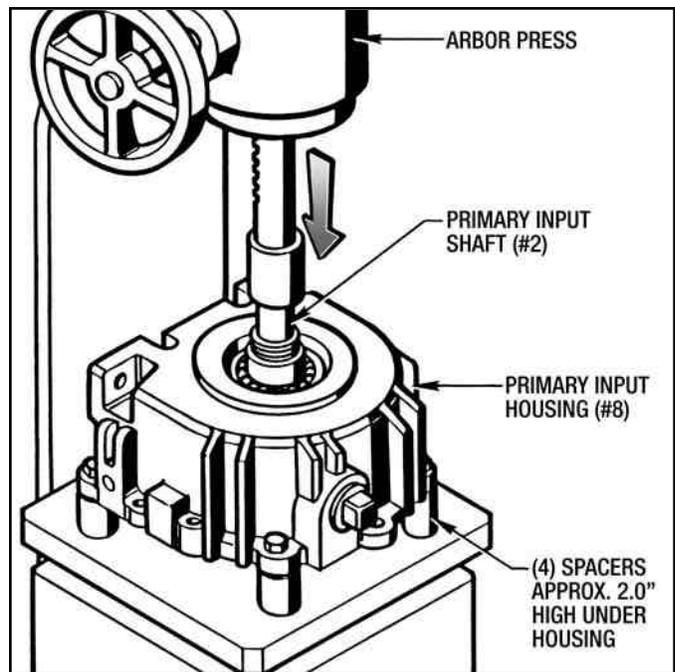


Figure 7.05 - Removing Primary Input Shaft

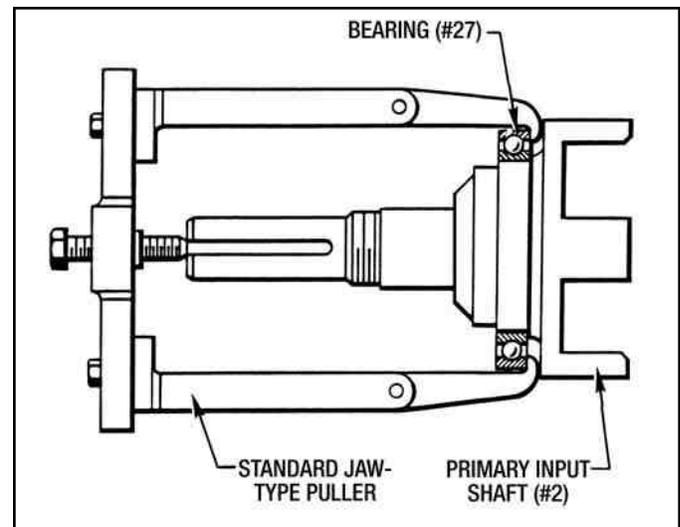
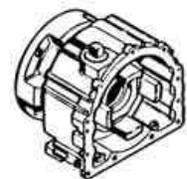


Figure 7.06 - Removing Bearing (#27) From Primary Input Shaft

## 7-10 PRIMARY INPUT HOUSING SUB-ASSEMBLY (With Quill Input Shaft)

(See Figure 10.02)



### (M3 and R3 Models Only)

- Remove (6) Screws (#63) and (6) Lockwashers (#128). Remove Bearing Retainer (#207) and Gasket (#206). Discard the gasket.

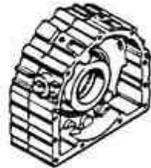
2. Check Oil Seal (#208) for damage and remove if necessary.
3. Remove Locknut (#209) from the Quill Input Shaft (#2).
4. Using the same procedure as described in **Section 7-9**, remove the Quill Input Shaft (#2) from the Housing with an Arbor Press (See Figure 7.05).
5. Remove Bearing (#38) from the Housing.
6. As shown in Figure 7.06, remove Bearing (#27) from the Quill Input Shaft using a Standard Jaw-Type Bearing Puller.

If leakage was indicated within the Quill Input Shaft, then the O-Ring (#104) needs to be replaced.

7. With a suitable dull punch, knock out the Freeze Plug (#99) from the input end of the shaft. Check and replace O-Ring (#104) if necessary.
8. Remove and check Retaining Ring (#52).

## 7-11 PRIMARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY

(See Figure 10.04)



## SECONDARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY

(See Figure 10.04)



1. Evenly back out and remove (4) screws (#62) and (4) Lockwashers (#128).

### CAUTION

Both Sub-Assemblies are under spring pressure and care must be taken to avoid personal injury when removing these screws (#62) and separating the Sub-Assemblies.

### (Primary Sub-Assembly)

2. Separate the Piston Retainer (#191) from the Piston Housing (#10) and remove Gasket (#51).

### (Secondary Sub-Assembly)

2. Separate the Piston Retainer (#191) from the Piston Housing (#11) and remove Gasket (#51).

### (Both Sub-Assemblies)

3. Remove the Piston Sub-Assembly which consists of: (a) Thrust Plate (#5), (b) Piston (#3), (c) Bearing (#27), (d) Teflon Liner (#43) and (e) (2) O-Rings (#40).
4. The Teflon Liner (#43) and the (2) O-Rings (#40) can now be removed for inspection and replacement. (See Figure 7.07)

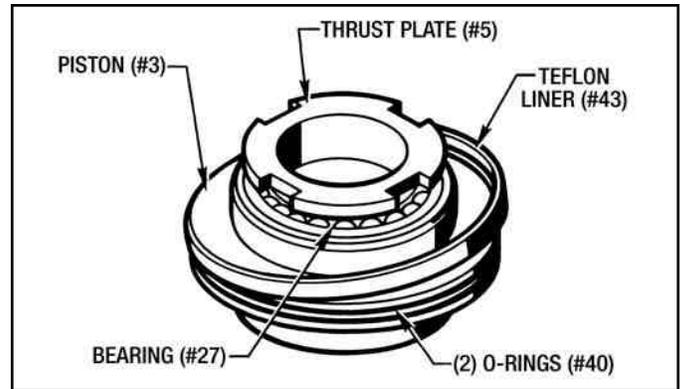


Figure 7.07 - Piston Sub-Assembly

5. Using an arbor press, remove the Thrust Plate (#5) and Bearing (#27) from the Piston (#3).

### IMPORTANT

Only remove the Thrust Plate (#5) and the Bearing (#27) if replacement of either part is necessary.

6. Remove Springs (#36), and on drives with SCP Logic, also remove Springs (#96). (The quantity of springs are predetermined at the factory for your torque requirements. When removing these springs, if all of the holes are not used, it would be helpful for you to make a free-hand sketch locating the position of the springs. This will help at reassembly.)

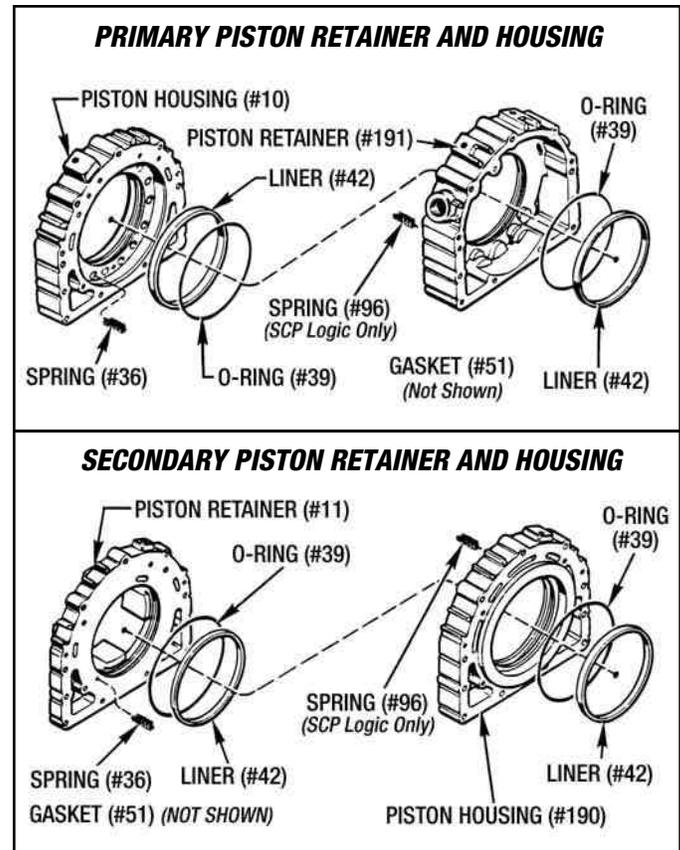
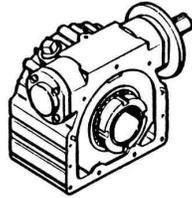


Figure 7.08 - Piston Retainers and Housings

- Remove the Liners (#42) and the O-Rings (#39) from the Piston Housings.

## 7-12 SECONDARY INPUT HOUSING SUB-ASSEMBLY (With Male Input Shaft)

(See Figure 10.05)



Remove any remaining belt guards, belts, sheaves or pulleys connected to the Input Shaft or Housing. (See Figure 7-9 for removal of Input Sheave or Pulley.)

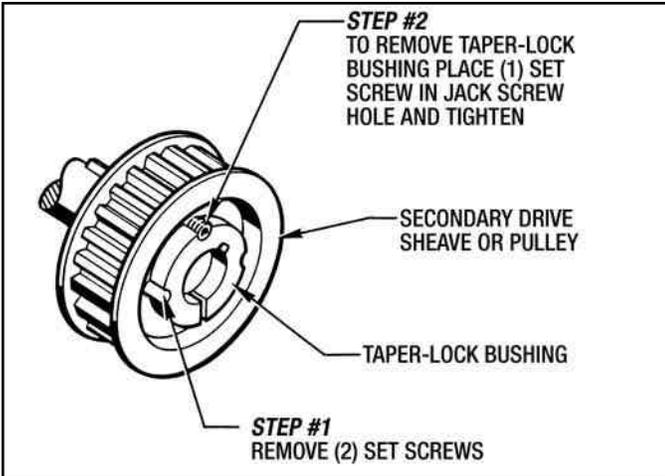


Figure 7.09 - Removing Drive Sheave Or Pulley

### (M3 and M5 Models)

- Remove Key (#166) from the Worm Shaft (#153). Tape keyway on the worm shaft so the lip of the Oil Seal (#158) will not be damaged when removed.
- On the drive side remove (4) Screws (#264) and (4) Lockwashers (#175).

**Slide Bearing Retainer (#155) off of the worm shaft carefully so Oil Seal (#158) will not be damaged.**

- Check Oil Seal (#158) and remove it from the Bearing Retainer (#155) if replacement is necessary.
- Remove Shims (#913) and save for Reassembly.
- On the opposite side, remove (4) Screws (#159) and (4) Lockwashers (#175).

Remove the Bearing Retainer (#156) and Shims (#913). Save the Shims for Reassembly.

- Slide both Bearing Cups (#167) out of the bearing bores.
- Unscrew and remove (4) Screws (#278) along with (4) Lockwashers (#126).

Remove the Bearing Retainer (#163) from the Housing (#164).

- Manually raise the Worm Shaft (#153) to the top of the bearing bores and slide the Secondary Input Shaft Sub-assembly out of the rear of the Housing. (See Figure 7.10)

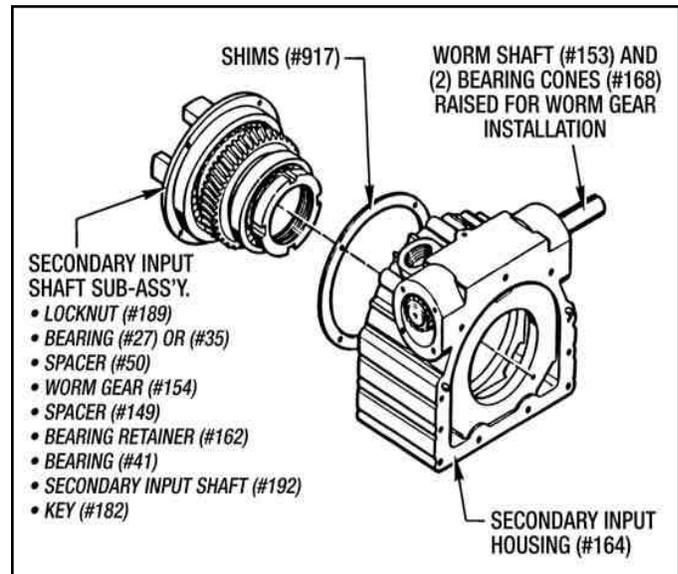


Figure 7.10 - Removing Secondary Input Shaft Sub-Assembly

- Shims (#917) can now be removed from the Secondary Input Shaft Sub-Assembly.
- Once the Secondary Input Shaft Sub-Assembly has been removed, slide the Worm Shaft (#153) out of the Housing (#164). If replacement is needed for the Bearing Cones (#168), use a Jaw-Type Bearing Puller to remove them from the worm shaft.

### (M0 and M1 Models)

- Remove Key (#166) from the Worm Shaft (#153). Tape the keyway on the worm shaft so the lip of the Oil Seal (#158) will not be damaged when removed.
- On the drive side, remove (4) Screws (#264) and (4) Lockwashers (#175).

Slide Bearing Retainer (#155) off of the worm shaft carefully so the Oil Seal (#158) will not be damaged.

- Check Oil Seal (#158) and remove it from the Bearing Retainer (#155) if replacement is necessary.
- Remove Gasket (#161) and discard.

- If oil leakage was indicated around the Oil Seal (#158), and the Wear Sleeve (#184) shows signs of wear or damage, then remove the Wear Sleeve as shown in Figure 7.11. With a mallet and a 5/8" wide chisel, make 5 or 6 notches in the Wear Sleeve parallel to the Worm Shaft. This will buckle the sleeve and release it from the Worm Shaft. It can now be removed by hand.

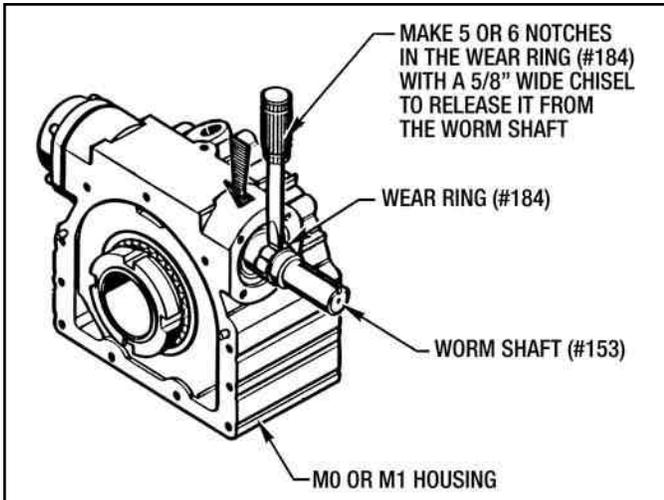


Figure 7.11 - Removing Wear Sleeve (#184) From Secondary Input Worm Shaft (M0 and M1 Models)

6. On the opposite side, remove (4) Screws (#159) and (4) Lockwashers (#175).

Remove the Bearing Retainer (#156) and Shims (#913). Save the Shims for Reassembly.

7. Remove Spacer (#171) and both Bearing Cups (#167) out of the bearing bores.
8. Unscrew and remove (4) Screws (#278) along with (4) Lockwashers (#126) from the Bearing Retainer (#163).
9. Manually raise the Worm Shaft (#153) to the top of the bearing bores and slide the Secondary Input Shaft Sub-Assembly out of the rear of the Housing. (See Figure 7.10)

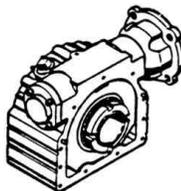
10. Shims (#917) can now be removed from the Secondary Input Shaft Sub-Assembly.

11. Once the Secondary Input Shaft Sub-Assembly has been removed, slide the Worm Shaft (#153) out of the Housing (#164). If replacement is needed for the Bearing Cones (#168), use a Jaw-Type Bearing Puller to remove them from the worm shaft.

See Section 7-14 if the Secondary Input Shaft Sub-Assembly needs to be disassembled.

### 7-13 SECONDARY INPUT HOUSING SUB-ASSEMBLY (With Quill Input Shaft)

(See Figure 10.06)



1. On the drive side, remove (4) Screws (#264) and (4) Washers (#175). Slide the C-Face Adapter (#155) off of the Quill Input Shaft (#153) being careful not to damage the lip of the Oil Seal (#158).
2. Check the lip of the Oil Seal (#158) for damage, and remove it from the C-Face Adapter if necessary.

### (M3 and M5 Models)

3. Remove and discard Gasket (#161).

### (M0 and M1 Models)

3. Remove and check O-Ring (#104) from the C-Face Adapter (#155).

### (M3, M5, M0 and M1 Models)

4. On the opposite side of the drive side remove (4) Screws (#159) and (4) Lockwashers (#175). Remove the Bearing Retainer (#156) and the Gasket (#161). Discard the gasket when removed.
5. Unscrew the Hex Hd. Screw (#263) and remove along with the Lockwasher (#226) and the Bearing Retainer Washer (#165).
6. Partially push the Worm Shaft (#153) out of the Housing (#164) until the bearing (#157) is freed from the bearing bore. The Worm Shaft (#153) can now be completely removed by just unthreading it from the Worm Gear (#154).
7. The Bearing Spacer (#171) can now be removed off of the worm Shaft.
8. Unscrew and remove (4) Screws (#278) and (4) Lockwashers (#126). The Bearing Retainer (#163) can now be removed from the Housing (#164).
9. Slide the Secondary Input Shaft Sub-Assembly out of the Housing (#164) as shown in Figure 7.12.

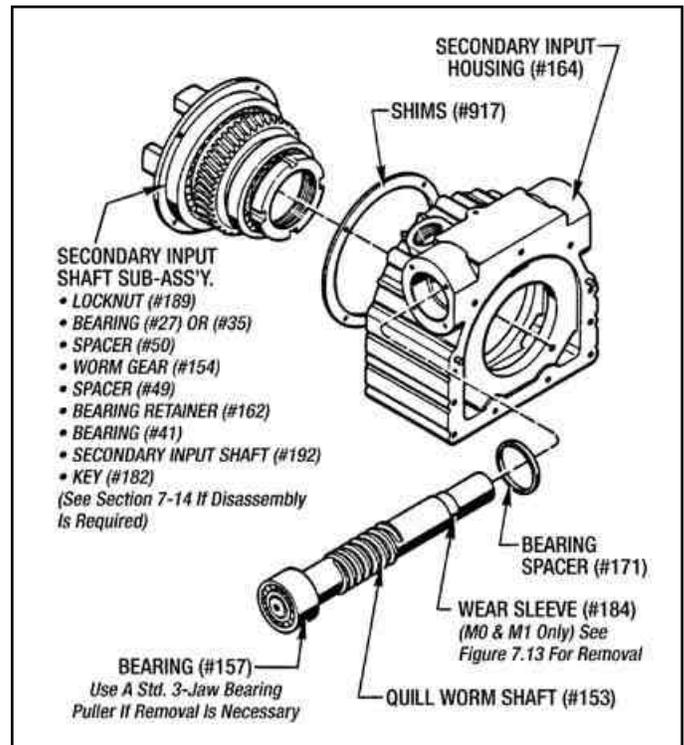


Figure 7.12 - Removing Worm Shaft (#153) And The Secondary Input Shaft Sub-Assembly

10. Shims (#917) can be removed from the Secondary Input Shaft Sub-assembly.
11. See **Chapter 7-14 - DISASSEMBLY OF SECONDARY INPUT SHAFT SUB-ASSEMBLY** if Bearings (#27) or (#35) or (#41) need to be replaced.
12. Use a standard Jaw-Type Bearing Puller if Bearing (#157) needs to be removed from the Worm Shaft (#153).

**(M0 and M1 Only)**

13. If the Wear Sleeve (#184) is damaged and needs to be removed from the Worm Shaft (#153) use the following procedure as shown in *Figure 7.13*.

Place the Worm Shaft in a suitable holding fixture and with a mallet and a 5/8" wide chisel make 5 or 6 notches in the sleeve parallel to the worm shaft. This will buckle the sleeve and release it from the worm shaft. It can now be removed by hand.

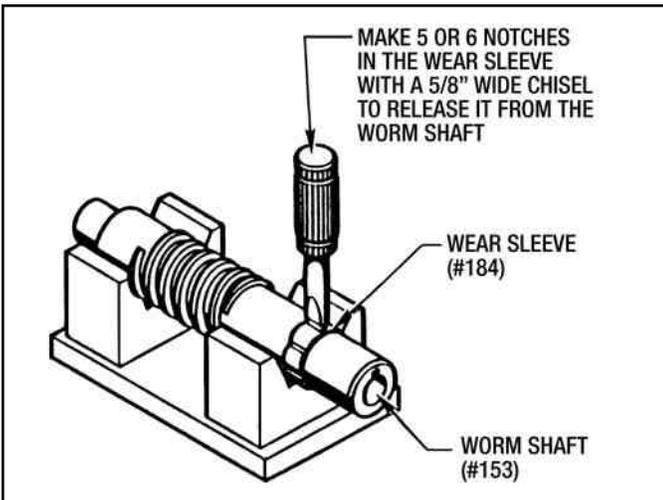


Figure 7.13 - Removing Wear Sleeve From Quill Worm Shaft

**7-14 DISASSEMBLY OF SECONDARY INPUT SHAFT SUB-ASSEMBLY (MSDr Units)**



**With Male Worm Shaft** - (See Figure 10.5)

**With Quill Worm Shaft** - (See Figure 10.6)

**NOTE:**

Do not attempt to disassemble this Secondary Input Shaft Sub-assembly unless Bearings (#27), (#35), (#41) or Gear (#154) needs to be replaced.

1. Remove Locknut (#189) from the Input Shaft.

2. With a Jaw-Type Bearing Puller, remove Bearing (#27) or (#35).
3. Remove Spacer (#50) from the Input Shaft.
4. Next, remove the Worm Gear (#154) with a Jaw-Type Puller and the Key (#182) from the Input Shaft.
5. Slide the Spacer (#49) off of the Input Shaft.
6. Next, remove the Bearing Retainer (#162) from the outer race of Bearing (#41).
7. If Bearing (#41) needs to be replaced, use a suitable Jaw-Type Bearing Puller to remove it from the Input Shaft.

**(M0 and M1 Only)**

8. Remove Bearing Retainer (#163) from the Input Shaft (#192).

**7-15 SECONDARY INPUT HOUSING SUB-ASSEMBLY (HSRvD) UNITS WITH CHAIN DRIVE** (See Figure 10.7)



1. First, remove the Chain Access Cover (#271) by removing (6) screws (#63) from the Transfer Case Housing (#270). Remove Gasket (#77).
2. Loosen (4) Screws(#409). **DO NOT REMOVE THEM AT THIS TIME.** Use a crows foot wrench to gain access to the (2) bottom screws.
3. Insert a rod into the side of the Eccentric Ring (#272) and rotate it to loosen the tension on the Silent Chain (#275), as shown in *Figure 7.14*.

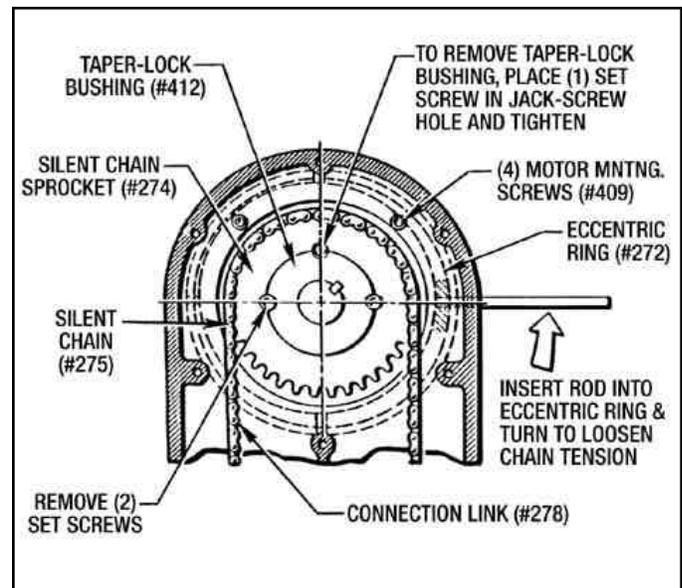
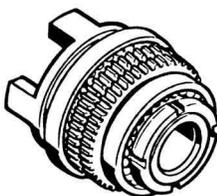


Figure 7.14 - Secondary Drive Chain & Sprocket Removal

4. If the chain needs to be replaced, find the connecting Link (#276) in the Chain (#275) and disconnect it. Pull the chain off of the sprockets and up and out of the transfer case housing.
5. Remove (2) Set Screws in the Taper-Lock Bushing (#412) and insert one of them into the Jack-Screw Hole. Tighten screw to release the bushing from the drive shaft and the Sprocket (#274). Pull the sprocket and bushing off of the drive shaft.
6. Attach a lifting hook or soft sling around the Drive Motor (#408).
7. Remove the (4) Motor Mounting Screws (#409) along with (4) Flat Washers (#404) and (4) Lockwashers (#410).
8. Pull the Drive Motor (#408) away from the Transfer Case Housing using the sling and overhead crane.
9. Remove the Eccentric Ring (#272) and the Gasket (#290).
10. Unscrew (4) Screws (#278) and remove with (4) Lockwashers (#126). Remove the Bearing Retainer Ring (#163) from the Transfer Case Housing (#270).
11. Slide the Secondary Input Shaft Sub-Assembly out the rear of the housing.

### 7-16 DISASSEMBLY OF SECONDARY INPUT SHAFT SUB-ASSEMBLY (HSRvD) UNITS WITH CHAIN DRIVE



(See Figure 10.7)

1. First remove the Locknut (#189).
2. Remove the Bearing (#27) with a standard Jaw-Type Bearing Puller.
3. Slide the Spacer (#50) off of the Input Shaft.
4. Next, remove the Chain Sprocket (#273) with a Jaw-Type Puller and the Key (#182) from the Input Shaft.
5. Slide the Spacer (#49) off the Shaft.
6. With a suitable Jaw-Type Puller, remove the Bearing (#41) only if it needs to be replaced.

### 7-17 OUTPUT HOUSING SUB-ASSEMBLY

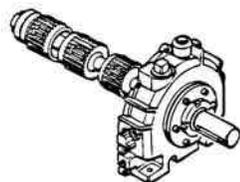
(See Figure 10.8)

**(All Models)**

1. First, remove the Key (#181) from the Output Shaft (#1) and place tape over the Keyway.

**(M3, R3, M5 and R5 Models)**

2. Unscrew and remove Locknut (#15).
3. Remove (6) Screws (#63) and (6) Lockwashers (#128) from the Bearing Retainer (#7).



4. Remove Bearing Retainer (#7) and the Gasket (#55) from the housing. Discard the gasket after removal.
5. Inspect and remove Oil Seal (#31), if necessary, from the Bearing Retainer (#7).

**(M0 and R0 Models)**

2. Unscrew and remove Locknut (#15).
3. Remove (6) Screws (#63) and (6) Lockwashers (#128) from the Bearing Retainer (#7).
4. Remove the Bearing Retainer (#7) and the O-Ring (#87) from the housing. Remove and inspect the O-Ring (#87).
5. Check the lip of the Oil Seal (#31) for damage or wear and, if necessary, remove it from the Bearing Retainer (#7).
6. Slide the Mating Ring (#4) and the O-Ring (#80) off of the Output Shaft (#1).

**(M1 Model Only)**

2. Remove (6) Screws (#63) and (6) Lockwashers (#128) from the Bearing Retainer (#7).
3. Remove the Bearing Retainer (#7) and the O-Ring (#87) from the Output Housing. Remove and inspect the O-Ring (#87).
4. Check the lip of the Oil Seal (#31) for damage and, if necessary, remove it from the Bearing Retainer (#7).
5. Procedure to remove Wear Sleeve (#4).

With a chisel the same width as the Wear Sleeve, make about 5 or 6 notches in the sleeve parallel to the Output Shaft. It can now be removed from the Input Shaft by hand. (See Figure 7.15)

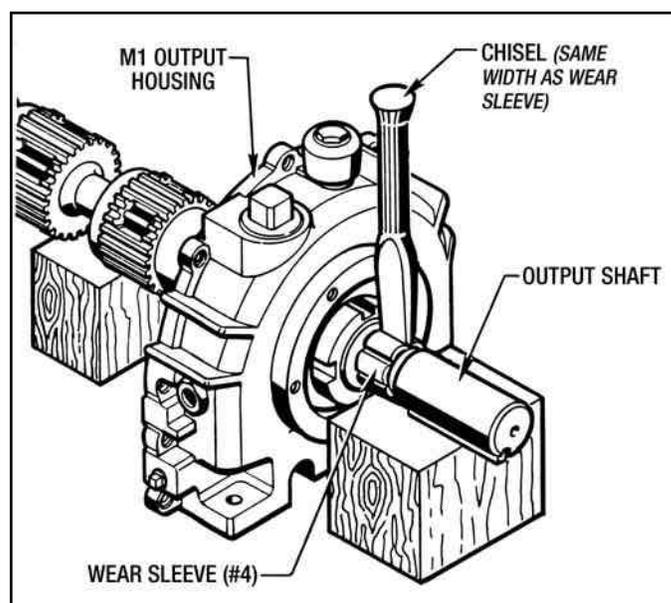


Figure 7.15 - Removing Wear Sleeve From Output Shaft (M1)

**NOTE:**

Only remove this Wear Sleeve if damage is indicated and replacement is necessary.

## 7-18 REMOVING THE OUTPUT SHAFT FROM THE OUTPUT HOUSING

(See Figure 7.16)

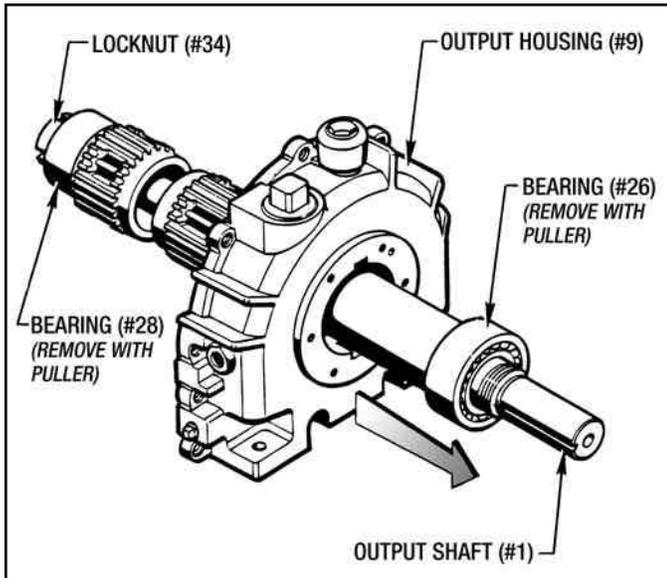


Figure 7.16 - Removing Output Shaft From Output Housing

1. For all models except M1, remove Locknut (#34) from the rear of the Output Shaft (#1).
2. If Bearing (#28) needs to be replaced, the Output Shaft does not need to be removed from the Output Housing. Use a Standard Jaw-Type Bearing Puller to remove it.
3. Slide the Output Shaft (#1) out of the housing as shown in Figure 7.16.
4. Using a bearing puller, remove Bearing (#26) from the Output Shaft (#1). (On M3, R3, M5 and R5 Models the Mating Ring (#4) will also come off when the Bearing (#26) is removed.)

**NOTE:**

Only remove this Bearing (#26) if replacement is necessary.

**THIS COMPLETES THE DISASSEMBLY PROCEDURE FOR THE MULTI-SPEED DRIVE (MSDr) AND THE HIGH SPEED REVERSING DRIVE (HSRvD).**

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## Section 8 - CLEANING & INSPECTION

### WARNING

**Petroleum-based cleaning solvents are flammable, and open flames or smoking by personnel in the vicinity of these solvents is extremely hazardous and must not be permitted.**

### 8-1 CLEANING AND INSPECTION

Clean metal parts in a suitable solvent and dry in a stream of low pressure compressed air. The Clutch and Brake Drive Plates (#13) can be cleaned in a solvent, but DO NOT clean the Clutch and Brake Friction Discs (#12) in solvent. Use only a clean, dry and lint-free rag to clean these Friction Discs. (Solvent will damage the resilient paper-based friction material used on the Friction Discs.) Keep the Drive Plates and Friction Discs in the same order as they were removed. After cleaning, inspect parts for cracks, distortion, scoring, nicks, burrs or other damage which would affect serviceability. Pay particular attention to the following:

1. Check the disc wear surfaces for scoring, galling or evidence of uneven wear.
2. Check the clutch and brake plates for scoring or galling. Make sure they are flat. If a perceptible ridge is worn in any of the drive plates, replace all of the drive plates and friction discs as a complete set.

3. Carefully check the piston and bore surfaces for nicks, scratches, scoring or other would affect operation or cause leakage.
4. Pay particular attention to Wear Sleeves and Mating Rings (#4) and (#184) and shafts in the area of rotary seals. Check for nicks, scratches or other damage which would cause leakage. Replace any damaged parts.
5. It is not necessary to remove the ball bearings to check their operation. Slowly rotate the free race of each bearing by hand checking to see if it turns freely without rough or flat spots.

### 8-2 REPAIR AND REPLACEMENT

A fine stone or crocus cloth may be used to remove minor surface defects from parts so long as the operating or sealing action of the part is not affected. The use of coarser abrasives or other machining methods should not be attempted. Otherwise, damaged parts should be replaced. Replacement is recommended also for the following, as applicable:

1. Replace all O-rings, liners, gaskets and oil seals removed during the course of disassembly.
2. Replace clutch or brake discs and drive plates in complete sets only.

# Section 9 - REASSEMBLY

## 9-1 GENERAL REASSEMBLY INSTRUCTIONS

1. Lubricate O-Rings and the lips of all Oil Seals with the same oil as used in the drive unit immediately before reassembly and installation of any mating parts.
2. O-Ring Liners (#43) will be easier to install if heated in an oven to 200° F max.

The installation of press fitted parts can be eased by heating the outside parts in an oven. Heat Bearings to 250° F max.

### CAUTION

**Wear suitable gloves when handling heated parts.**

3. Apply Gasket Sealant **Permatex #3D**, or equivalent, to all Flat Gaskets except for the following gaskets:
  - a. Gasket (#77) under the Access Cover (#271) shown on *Figure 10.07*. Do not use any sealant on this gasket.
  - b. Gasket (#290) at the top rear of the Transfer Case Housing (#270). Use **Copper Coat** (K & W Products, Inc. Stock #1612) on this gasket.

### IMPORTANT

**Apply sealant to gaskets and mating surfaces immediately before assembly.**

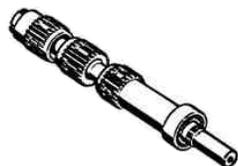
4. Use Cap Screw Adhesive (**Loctite #271**), or equivalent, on studs (#283) and (#284) shown on *Figure 10.01*. Apply adhesive only on the ends that screw into the Secondary Input Housing. Use sparingly and clean any excess off with (**Loctite Cleaner #755**). Also apply (**Loctite #271**) to all Locknuts.
5. Place a light coating of Gasket Sealant (**Permatex #3D**) in the bore for all Oil Seals immediately before pressing oil seals into the bore.
6. See **Section 9-23** for all **Screw Torque Requirements**.

## REASSEMBLY OF MAJOR SUB-ASSEMBLIES

Basically, the Reassembly Procedure is just a reverse order of the Disassembly Procedure.

## 9-2 INSTALLING BEARINGS ON OUTPUT SHAFT

(See *Figure 10.08*)

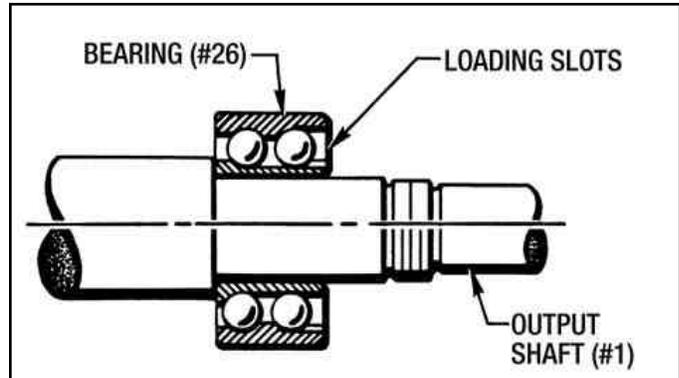


## (M3, R3, M5 and R5 Models)

1. Press Bearing (#26) onto Output Shaft (#1) using an arbor press.

### IMPORTANT

**Outboard Bearing (#26) must be installed with the Loading Slots towards the output end of the shaft. (See *Figure 9.01*)**



*Figure 9.01 - Installing Outboard Bearing (#26) (M3, R3, M5 and R5 Only)*

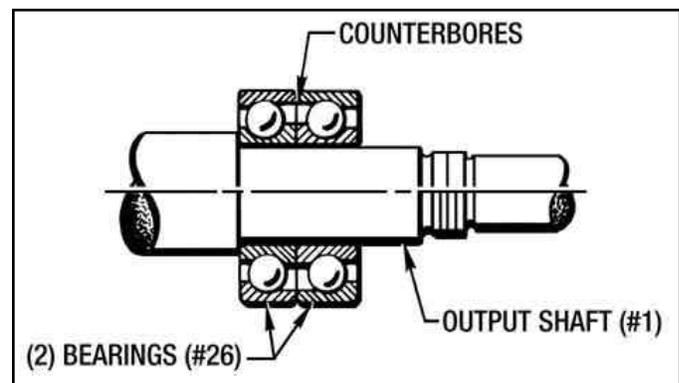
2. Press Bearing (#28) onto the other end of the Output Shaft (#1).
3. Screw Locknut (#34) onto shaft. Use (**Loctite #271**) on threads.

## (M0, R0 and M1 Models)

1. Press (2) Outboard Bearings (#26) onto the Output Shaft (#1) using an arbor press.

### IMPORTANT

**The Outboard Bearings (#26) must be installed with the Counter-bores facing each other, as shown in *Figure 9.02*.**



*Figure 9.02 - Installing Outboard Bearing (#26) (M0, R0, M1 Models)*

### **(M0 and R0 Models)**

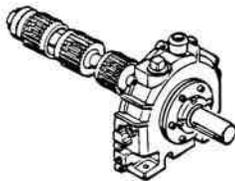
2. Press Bearing (#28) onto the other end of the Output Shaft (#1) using an arbor press.
3. Screw Locknut (#34) onto the shaft. Use **(Loctite #271)** on threads.

### **(M1 Model Only)**

2. Press Bearing (#28) onto the other end of the Output Shaft (#1) using an arbor press.
3. Press Wear Sleeve (#4) onto the shaft using an arbor press and appropriate support tooling.

## **9-3 OUTPUT HOUSING SUB-ASSEMBLY**

(See Figure 10.08)



1. Guide the Output Shaft Sub-Assembly into the Output Housing (#9), as shown in Figure 9.03.
2. Press the Mating Ring (#4) onto the shaft.
3. Press the Oil Seal (#31) into the Bearing Retainer (#7). Use **(Permatex #3D)** or equivalent.
4. Install Gasket (#55) with **(Permatex #3D)** onto the Output Housing (#9).

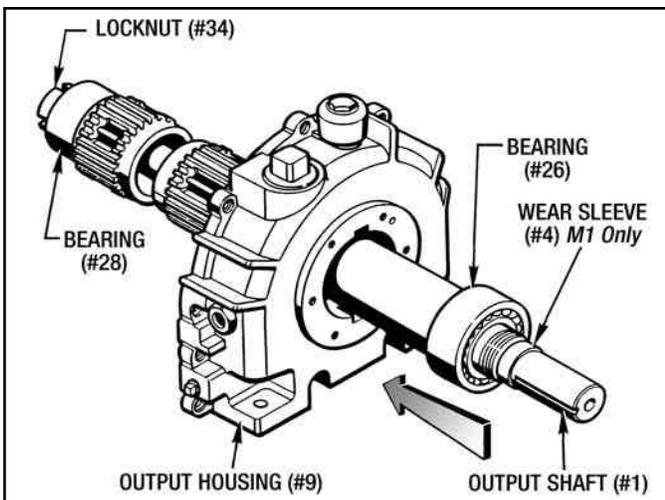


Figure 9.03 - Installing Output Shaft Into Output Housing

### **(M3, R3, M5 and R5 Models)**

5. Lubricate the lip of the Oil Seal (#31) and the Mating Ring (#41) with ATF-210. Slide the Bearing Retainer (#7) over the output shaft, being careful not to damage the oil seal lip. Attach with (6) Screws (#63) and (6) Lockwashers (#128).
6. Screw the Locknut (#15) onto the output shaft. Use **(Loctite #271 adhesive)** sparingly on the threads. Clean off any excess.

### **(M0 and R0 Models)**

2. Lubricate the O-Ring (#80) and Mating Ring (#4) with ATF-210 oil and install onto the output shaft.
3. Press the Oil Seal (#31) into the Bearing Retainer (#7), using **(Permatex #3D)** in the bore.
4. Lubricate and install the O-Ring (#87) onto the shoulder of the bearing retainer. Also lubricate the oil seal lip.
5. Slide the Bearing Retainer (#7) over the output shaft and attach with (6) Screws (#63) and (6) Lockwashers (#128) to the output housing.
6. Screw the Locknut (#15) onto the shaft using **(Loctite #271)** adhesive sparingly on the threads. Wipe away any excess adhesive.

### **(M1 Model Only)**

2. Install Lockwasher (#185) and Locknut (#15) onto the output shaft.
3. Press Oil Seal (#31) into bore of Bearing Retainer (#7) using a thin coat of **(Permatex #3D)** in the bore.
4. Lubricate O-Ring (#87) and install it onto the bearing retainer shoulder. Lubricate the Oil Seal Lip (#31) and the Wear Sleeve (#4).
5. Slide the Bearing Retainer (#7) over the output shaft, being careful not to damage the oil seal lip.
6. Attach with (6) Screws (#63) and (6) Lockwashers (#128).

### **(All Models)**

7. Replace Air Breather (#45), Sight Glass (#46) and any other plugs or fittings removed at disassembly.
8. Install Key (#181) into the output shaft keyway.

## **9-4 SECONDARY INPUT SHAFT SUB-ASSEMBLY (MSDr Units Only)**



### **(With Male Input Worm Shaft)**

See Figure 10.05

### **(With Quill Input Worm Shaft)**

See Figure 10.06)

### **(M3 and M5 Models)**

1. Press the Bearing (#41) onto the Input Shaft (#192) making sure that it seats on the shoulder of the Input Shaft.  
  
Place the Bearing Retainer (#162) on the outer race of the installed Bearing (#41).

## (M0 and M1 Models)

- Drop the Bearing Retainer (#163) over the Input Shaft (#192).

Press the Bearing (#41) onto the Input Shaft (#192) making sure that it seats on the shoulder of the Input Shaft.

Place the Bearing Retainer (#162) on the outer race of the installed Bearing (#41).

## (M3, M5, M0 and M1 Models)

- Install Spacer (#49), Key (#182), Worm Gear (#154) and the other Spacer (#50) onto the input shaft. (**NOTE:** The Worm Gear (#154) will have to be pressed onto the input shaft.)
- Press Bearing (#27) or (#35) onto the input shaft.
- Using (**Loctite #271**) adhesive sparingly on the threads, install the Locknut (#189).
- Determine Thickness Requirements for Shim (#917).

The following procedure is only necessary if any of these parts had to be replaced: (1.) Worm Gear (#154), (2.) Spacer (#49), (3.) Bearing (#41) or (4.) Bearing Retainer (#162).

### The procedure is as follows:

(See Figure 9.04)

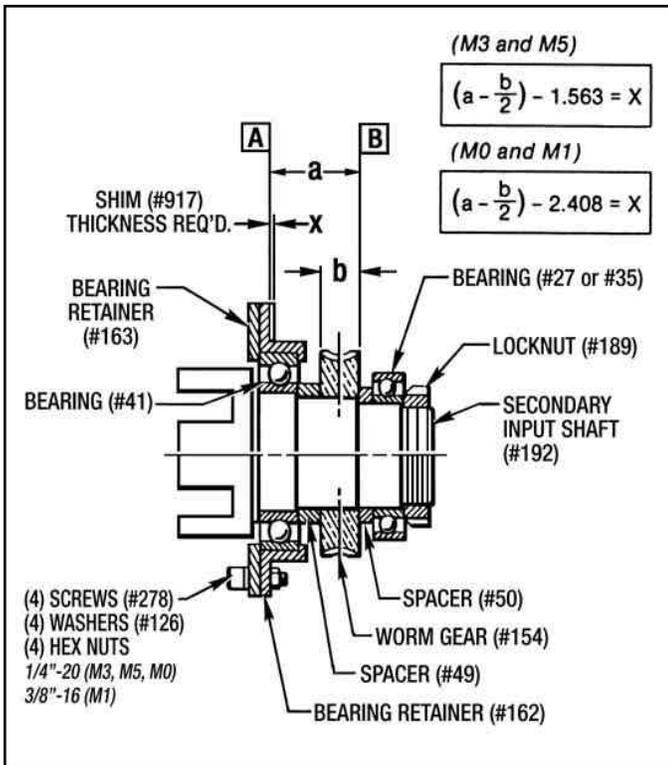


Figure 9.04 - Determining Shim (#917) Thickness Requirements

- Using (4) Screws (#278), (4) Lockwashers (#126) and (4) appropriate sized Hex Nuts, bolt the two Bearing Retainers (#162) and (#163) together.

- Set the Input Shaft (#192) upright on the lug end.

- Take a reading from **Surface "A"** to **Surface "B"**. This is **Dimension "A"**.

- Measure the thickness of the Worm Gear (#154). This is **Dimension "B"**. Divide it by two. Then subtract this figure from reading found in Step 3.

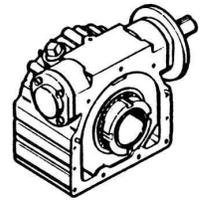
- Subtract 1.563 (*M3 and M5 Models*) or 2.408 (*M0 and M1 Models*) from the end figure found in **Step 4**. This will give you the Shim Thickness (**Dimension "X"**) required for Shim' (#917).

- Remove screws and nuts from the bearing retainers.

## 9-5 SECONDARY INPUT HOUSING SUB-ASSEMBLY

(With Male Input Worm Shaft)

(See Figure 10.05)



### (M3 and M5 Models)

- Press both Bearing Cones (#168) onto the Worm Shaft (#153).

### (M0 and M1 Models)

- Press both Bearing Cones (#168) onto the Worm Shaft (#153). Using appropriate support tooling, press the Wear Sleeve (#184) onto the drive end of the worm shaft.

### (All Models)

- Insert the Worm Shaft (#153) with the bearing cones into the bearing bores of the Housing (#164).
- Place the Shims (#917) onto the Secondary Input Shaft Sub-Assembly. (Shim thickness as determined in Figure 9-4.)
- Manually raise the Worm Shaft (#153) to the top of the bearing bores to give the necessary clearance for the worm gear clearance.
- Insert the assembled Secondary Input Shaft into the rear of the housing, as shown in Figure 9.05.
- Attach Bearing Retainer (#163) into the housing with screws (#278) and Lockwashers (#126).
- Apply a thin coat of (**Permatex #3D**) in the oil seal bore of the Bearing Retainer (#155) and press the Oil Seal (#158) into the bore, being careful not to damage the lip of the oil seal.
- Slide the Bearing Cups (#167) into the bearing bores of the housing.

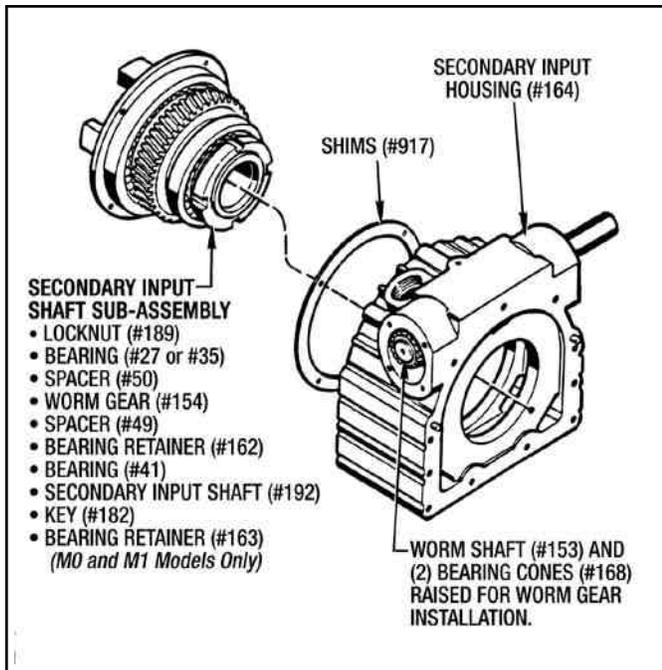


Figure 9.05 - Installing Secondary Input Shaft Sub-Assembly

### (M3 and M5 Models)

9. Replace Shims (#913) onto the pilot of Bearing Retainer (#155).

Lubricate the lip of the Oil Seal (#158) and slide the Bearing Retainer (#155) over the end of the Worm Shaft (#153), being careful not to damage the oil seal lip on the keyway.

Bolt the Bearing Retainer (#155) to the housing with (4) Screws (#264) and (4) Lockwashers (#175).

10. On the opposite side, replace Shims (#913) and bolt the Bearing Retainer (#156) to the housing with (4) Screws (#159) and (4) Lockwashers (#175).

(See Section 9-6 to check the Worm Shaft End Play.)

11. Replace Key (#166) and all pipe plugs removed.

### (M0 and M1 Models)

9. Using **(Permatex #3D)** gasket sealant, install Gasket (#161) to the drive side of the housing.

Lubricate the oil seal lip and slide the Bearing Retainer (#155) over the Worm Shaft (#153) being careful not to damage the oil seal lip on the keyway.

Bolt the Bearing Retainer (#155) to the housing using (4) Screws (#264) and (4) Lockwashers (#175).

10. Install the Bearing Spacer (#171) into the bearing bore on the opposite side of the housing.

Place the Shims (#913) onto the Bearing Retainer (#156) and attach the Retainer to the housing using (4) Screws (#159) and (4) Lockwashers (#175).

(See Section 9-6 to check the Worm Shaft End Play.)

11. Install the Key (#166) back into the worm shaft. Replace all pipe plugs removed at disassembly.

## 9-6 CHECKING WORM SHAFT END PLAY (Male Secondary Input Worm Shaft Only)

**WORM SHAFT END PLAY - .003" TO .005" MAX.**

1. Install a Dial Indicator with a magnetic mount to the drive side of the Secondary Input Housing Sub-Assembly, as shown in Figure 9.06. Manually push the worm shaft in and out while rotating it. Add or subtract Shims (#913) on the opposite side to get the correct end play of **.003"** to **.005"**.

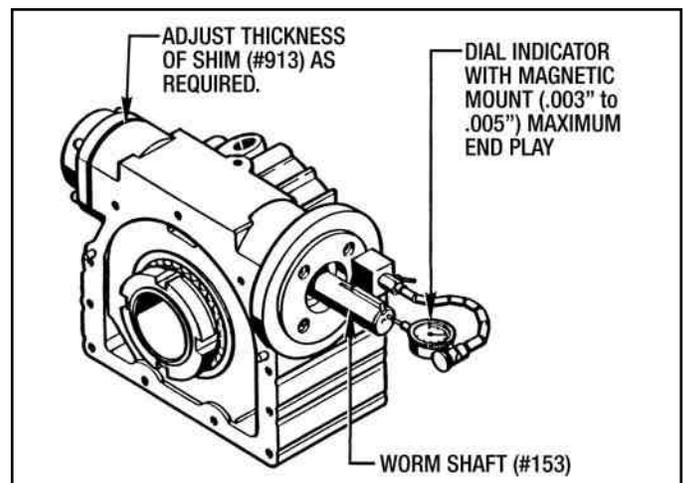
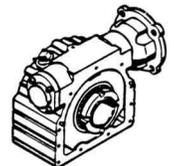


Figure 9.06 - Checking Worm Shaft End Play

## 9-7 SECONDARY INPUT HOUSING SUB-ASSEMBLY (With Quill Input Worm Shaft)



(See Figure 10.06)

1. Place Shims (#917) on assembled Secondary Input Shaft. (Shim thickness as determined in Section 9-4.)
2. Insert the Secondary Input Shaft Sub-Assembly into the Housing (#164). Attach Bearing Retainer (#163) with Screws (#278) and Lockwashers (#126).
3. Press the Ball Bearing (#157) onto the Worm Shaft (#153). Attach Bearing Washer (#165) with Lockwasher (#226) and Hex Hd. Screw (#263) to the end of the worm shaft.

### (M3 and M5 Models)

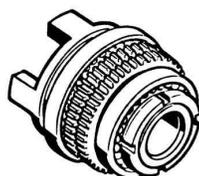
4. Using **(Permatex #3D)**, install Gasket (#161) to the drive side of the housing.
5. Place Bearing Spacer (#171) into the housing bearing bore.

6. Slide the Worm Shaft (#153) into the housing. When contact is made with the Worm Gear (#154) rotate the worm shaft to thread it into the mating teeth of the worm gear. Slide the Bearing (#157) all the way into the bearing bore.
7. Install the Gasket (#161) to the housing using **(Permatex #3D)** gasket sealant.  
Bolt the Bearing Retainer (#156) to the housing using (4) Screws (#159) and (4) Lockwashers (#175).
8. Press the Oil Seal (#158) into the C-Face Adapter (#155) after applying a thin coat of **(Permatex #3D)** in the oil seal bore.
9. Lubricate the lip of the oil seal first, then slide the C-Face Adapter (#155) over the end of the worm shaft, being careful not to damage the oil seal lip.
10. Bolt the C-Face Adapter (#155) to the housing using (4) Screws (#264) and (4) Lockwashers (#175).

### **(M0 and M1 Models)**

4. Using appropriate backup tooling, press the Wear Sleeve (#184) onto the Worm Shaft (#153).
5. Place Bearing Spacer (#171) into the housing bearing bore.
6. Slide the Worm Shaft (#153) into the housing. When contact is made with the Worm Gear (#154), rotate the worm shaft to thread it into the mating teeth of the worm gear. Slide the Bearing (#157) all the way into the bearing bore.
7. Install the Gasket (#161) to the housing using **(Permatex #3D)** gasket sealant.  
Bolt the Bearing Retainer (#156) to the housing using (4) Screws (#159) and (4) Lockwashers (#175).
8. Press the Oil Seal (#158) into the C-Face Adapter (#155) after applying a thin coat of **(Permatex #3D)** in the oil seal bore.  
Lubricate the O-Ring (#104) and place it on the C-Face Adapter (#155).
9. Lubricate the lip of the oil seal first, then slide the C-Face Adapter (#155) over the end of the worm shaft, being careful not to damage the oil seal lip.
10. Bolt the C-Face Adapter (#155) to the housing using (4) Screws (#264) and (4) Lockwashers (#175).

### **9-8 SECONDARY INPUT SHAFT SUB-ASSEMBLY (HSRvD) Units With Chain Drive** (See Figure 10.07)



1. Press bearing (#41) onto the Input Shaft (#192).
2. Install Spacer (#49), Key (#182), Sprocket (#273) and Bearing Spacer (#50) back on the input shaft in the order shown on *Figure 10.07*. (**NOTE:** The Sprocket (#273) will have to be pressed on.)
3. Press Bearing (#27) onto the shaft.
4. Apply **(Loctite #271)** to the Locknut (#189) threads and install on the input shaft.

### **9-9 SECONDARY INPUT HOUSING SUB-ASSEMBLY (HSRvD Units With Chain Drive)**

(See Figure 10.07)



1. Slide the assembled Input Shaft into the rear of the Transfer Case Housing (#270).  
Attach the Bearing Retainer (#163) to the housing with (4) Screws (#278) and (4) Lockwashers (#126).
2. From the top, drop the chain (#275) into the housing down and around the Sprocket (#273). Attach the Connector Link (#276) to the chain.
3. Apply a coat of "**Copper Coat**" to both sides of Gasket (#290). Allow the "**Copper Coat**" to dry before proceeding any further.
4. Install the Gasket (#290) and the Eccentric Ring (#272) onto the pilot diameter of the housing.
5. Manually raise the Chain (#275). With the aid of an overhead crane, slide the Drive Motor (#408) into the rear of the housing, mating the male pilot diameter on the motor face with the female diameter in the Eccentric Ring (#272). Attach with (4) Hex Hd. Screws (#409), (4) Lockwashers (#410) and (4) Flat Washers (#404). **DO NOT TIGHTEN SCREWS AT THIS TIME.** (See Figure 9.07.)
6. Raise the chain again and position the Sprocket (#274) on the drive motor shaft aligning the chain teeth with the sprocket teeth.
7. Insert the rod into the Eccentric Ring and turn it CCW to loosen the chain.
8. Center the Sprocket (#274) on the motor shaft and insert the Bushing (#412) into the sprocket. Position the sprocket from the front face of the transfer case housings, as shown in *Figure 9.08*. Tighten (2) set screws in the Bushing (#412).
9. To check and adjust the Chain Tension, see **Section 9-10**.
10. Install Gasket (#77) and Access Cover (#271) with (6) Screws (#63). **Do not use any gasket sealant when installing this gasket.**

11. Replace Pipe Plug (#193) only at this time.

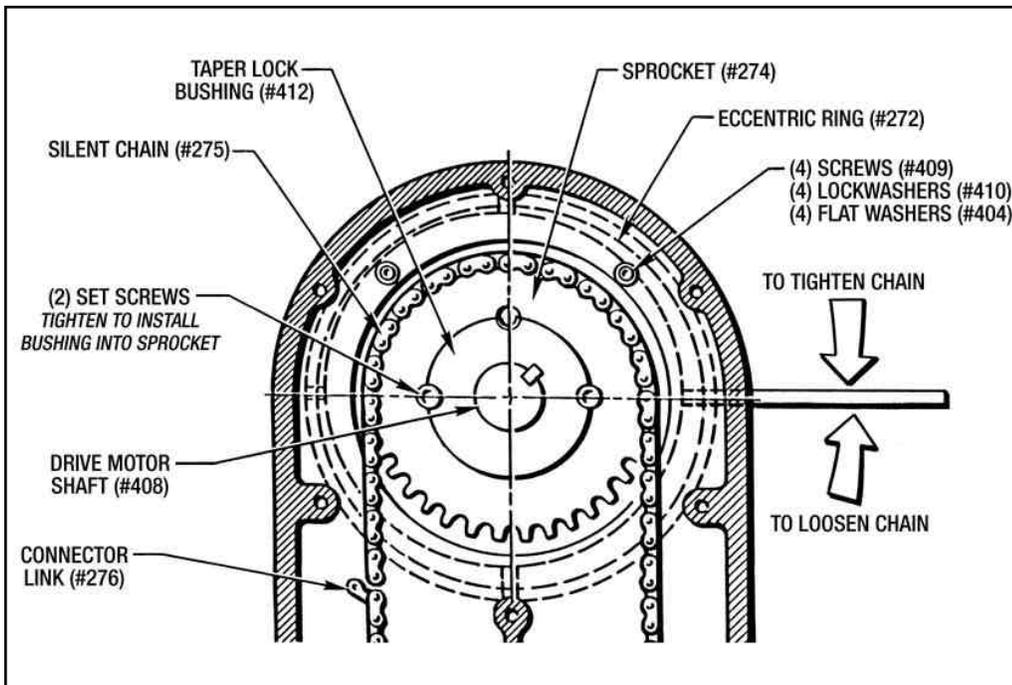


Figure 9.07 - Chain Drive Assembly

## 9-10 CHECKING AND ADJUSTING THE SECONDARY DRIVE CHAIN TENSION (See Figure 10-7)

### NOTE:

This procedure for Checking and Adjusting the Secondary Drive Chain Tension is necessary at Reassembly Time and after the Drive Unit has been put back into service and run for approximately 2,000 cycles.

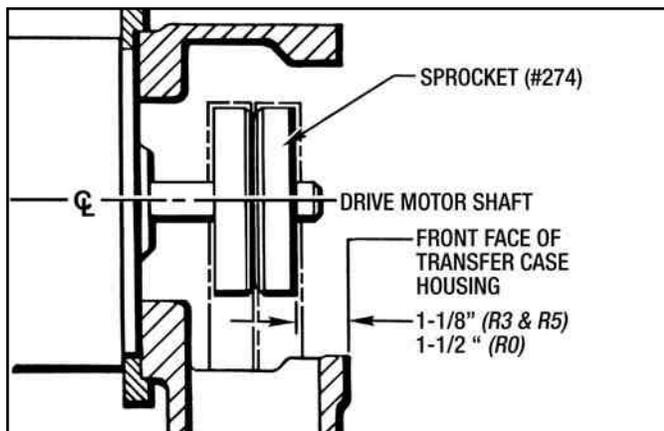


Figure 9.08 - Secondary Drive Sprocket Alignment

### A. CHECKING CHAIN TENSION

(See Figure 9.09)

### WARNING

Open electrical disconnect to prime mover and lock it out to avoid personal injury.

1. Remove Pipe Plug (#194) from one side of the housing and the Air Breather (#45), Reducer Bushing (#406) and Elbow (#405) from the other side.

2. Insert a rigid rod into the R.H. inspection port and push the chain as far as possible by hand. This will tighten the chain on the opposite side.

3. Insert a rigid scale and take a measurement from the chain's tight side to the outside of the housing, as shown in Figure 9.09 (Dimension "A").

4. Remove the rod from the R.H. inspection port. Take another measurement by pushing the slack chain in as far as possible with the rigid scale (Dimension "B").
5. Subtract Dimension "A" from Dimension "B". The max. allowable difference is 1/2". If the difference is greater than 1/2", then the chain needs to be re-tensioned.

### IMPORTANT

Failure to check the chain tension periodically will result in a chain failure if it is allowed to stretch too far.

### B. ADJUSTING CHAIN TENSION

(Figure 9.09)

1. Remove Access Cover (#271) and Gasket (#77), if necessary, from the front of the housing.
2. Loosen (4) Hex Hd. Screws (#409) using a Crows Foot Wrench, but do not remove them.
3. Insert a rod into the side of the Eccentric Ring (#272) and turn it Clockwise to tighten the tension on the chain.

### CAUTION

DO NOT OVER TIGHTEN THE CHAIN TENSION. THIS COULD OVERLOAD THE MOTOR BEARINGS.

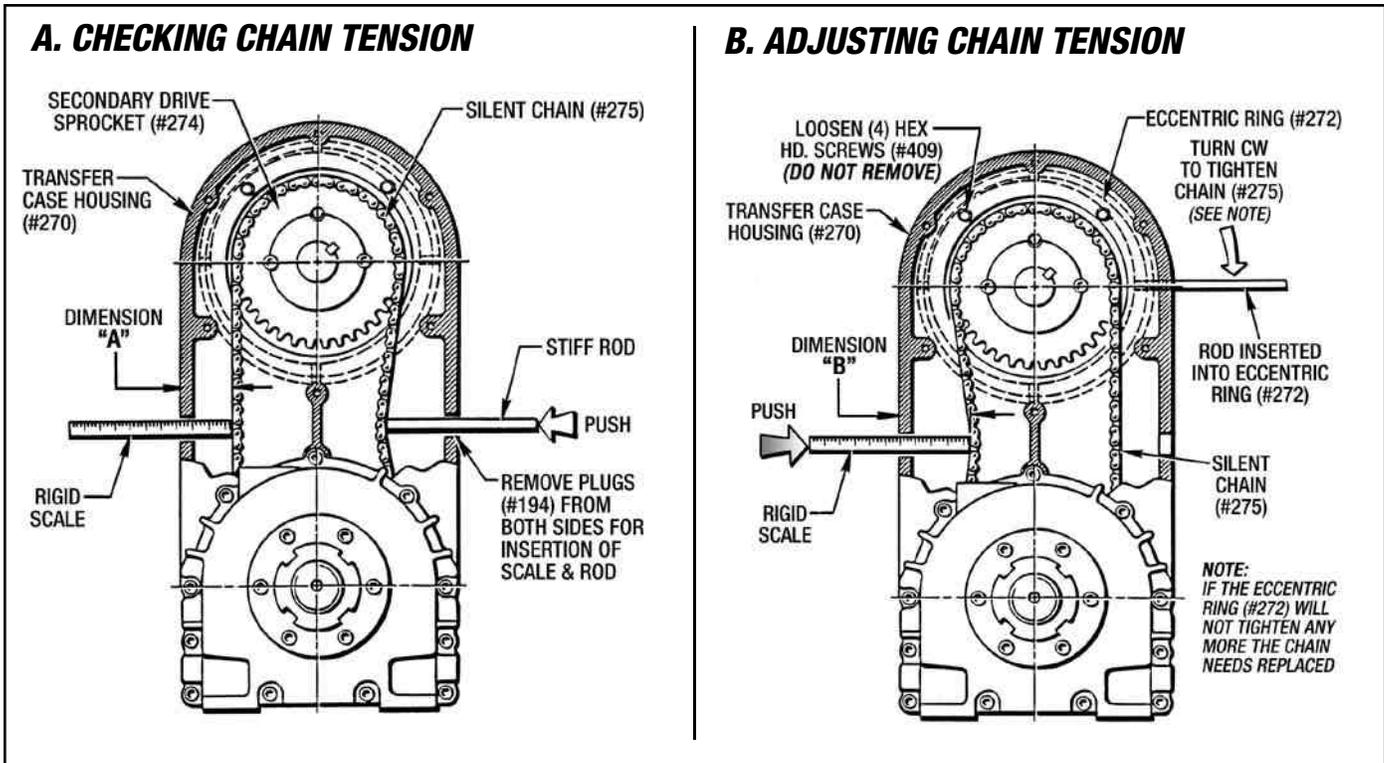


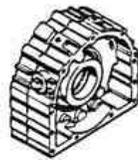
Figure 9.09 - Checking & Adjusting Chain Tension

4. Recheck the chain tension, as previously described, and adjust as needed.
5. Retighten (4) Screws (#409).
6. Replace Access Cover (#271) and Gasket (#77) with (6) Screws (#63). **Do not use any gasket sealant on this gasket.**

Replace Pipe Plugs, Fittings and Air Breather.

### 9-11 PRIMARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY

(See Figure 10.04)



### SECONDARY PISTON RETAINER & HOUSING SUB-ASSEMBLY

(See Figure 10-4)



1. Install O-Rings (#39) and Liners (#42) into Piston Retainers and Piston Housings. Lubricate O-Rings before installation. (See Figure 9.10)

**NOTES:**

1. Drive units with "A" and "B" Logic will not have an O-Ring and Liner in the Piston Housing.
2. Spring (#96) is only used for "SCP" Logic.

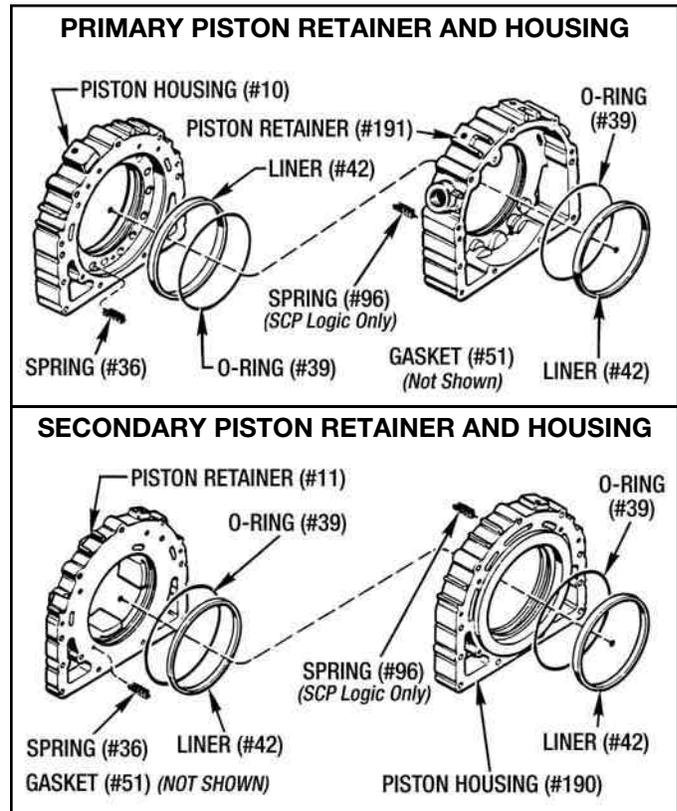


Figure 9.10 - Piston Retainers and Housings

### IMPORTANT

Before applying (Loctite #620) to the Bearing (#27) I.D. and O.D. clean it well with (Loctite #755) cleaning solvent or equivalent.

2. Apply (Loctite #620) to the I.D. of Bearing (#27) and press it onto the Thrust Plate (#5). Make sure that the bearing is firmly seated on the thrust plate shoulder.
3. Apply (Loctite #620) to the O.D. of Bearing (#27) and press the bearing and thrust plate into the Piston (#3). Again, make sure that the bearing is firmly seated against the piston shoulder.
4. Lubricate the O-Rings (#40) and install them onto the Piston (#3).
5. Heat up the Teflon Liner in an oven to 200° F max and install it on the outside diameter of the piston.

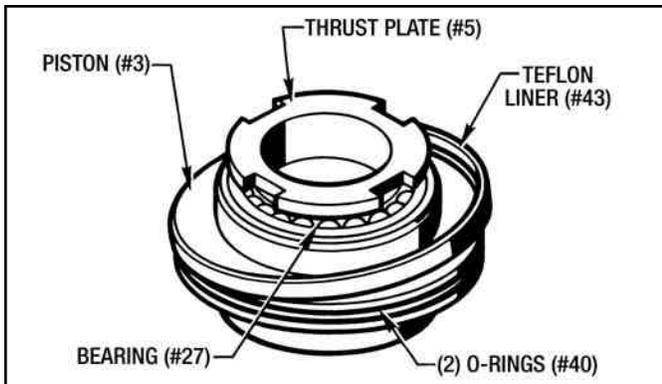


Figure 9.11 - Piston Sub-Assembly

6. Apply (Permatex #3D) to the housing surface and install Gasket (#51) to the piston housing. Wipe away all excess sealant.
7. Replace Springs (#36) and (#96), if required, back into the appropriate holes in the housing or retainer. Grease may be used to hold the springs in their pockets during reassembly.
8. Insert the Piston Sub-Assembly into the Piston Housing. Be very careful not to damage the Teflon Liners (#39) in the housing and on the piston.
9. Apply (Permatex #3D) to the mating surface of the Piston Retainer. Clean off any excess sealant.
10. Assemble the Piston Retainer to the Piston Housing with (4) Screws (#62) and (4) Washers (#128).

### IMPORTANT

When placing the Piston Retainer over the piston, be careful not to damage the Teflon Liner (#42) in the retainer. Tighten down the Screws (#62) in an even manner to compress the Springs correctly.

## 9-12 PRIMARY INPUT HOUSING SUB-ASSEMBLY (With Male Input Shaft)

(See Figure 10.02)

### (All Models)

1. Press Bearing (#27) or (#35) onto the Primary Input Shaft (#2).

Insert the Primary Input Shaft (#2) and the Bearing into the Primary Input Housing (#8) as shown in Figure 9.12.

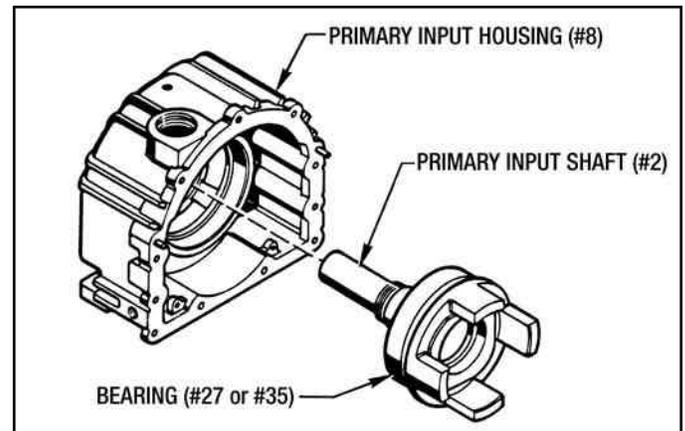
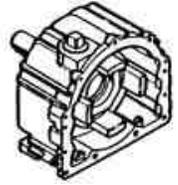


Figure 9.12 - Primary Male Input Shaft Installation

2. Set the Primary Input Shaft and Housing Sub-Assembly into an Arbor Press, as shown in Figure 9.13. Using an appropriate sized tube, press on the inner race of Bearing (#26) until it bottoms out. (Do not press on the bearing cage or outer race.)

### IMPORTANT

(M3, R7, M5 and R5 Models)

The Bearing Loading Slots must be in the "Up" position, as shown in Figure 9.13.

(M0, R0 and M1 Models)

The Bearing Counterbores must be positioned as shown in Figure 9.13.

### (M3, R3, M5 and R5 Models)

Using the same arbor press set-up as above, press the Mating Ring (#4) onto the shaft.

4. Apply a thin coat of (Permatex #3D) to the oil seal bore in the Bearing Retainer (#7) and press the Oil Seal (#31) into the Bearing Retainer.
5. Install the Gasket (#55) to the housing face using (Permatex #3D) gasket sealant. Clean off any excess.

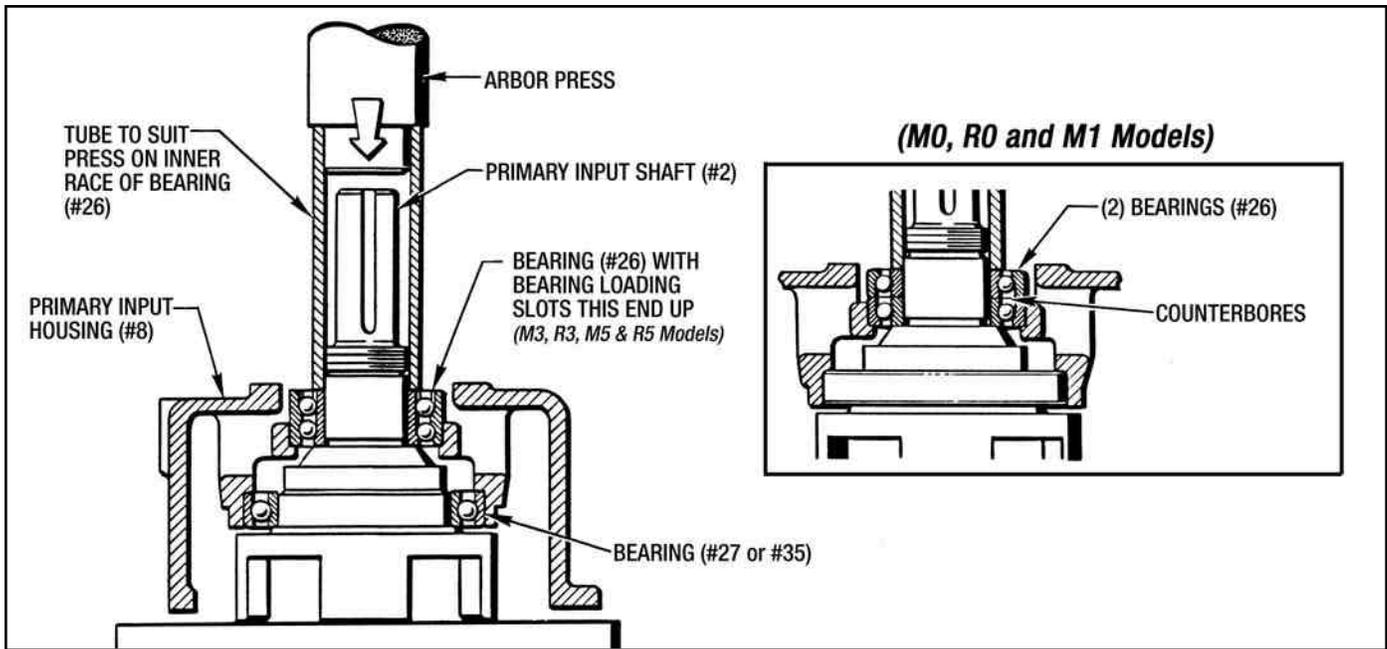


Figure 9.13 - Pressing Bearing (#26) Into Primary Input Housing

- Place some tape over the keyway and then slide the Bearing Retainer (#7) over the shaft, being careful not to damage the lip of the oil seal.

Attach the bearing retainer with (4) Screws (#63) and (4) Lockwashers (#128).

- Apply **(Loctite #271)** sparingly to the threads on the input shaft and install Locknut (#15). Clean off any excess adhesive with **(Loctite #755)** cleaner.

### **(M0 and R0 Models)**

- Lubricate the O-Ring (#80) and install it and the Mating Ring (#4) onto the input shaft.
- Apply a thin coat of **(Permatex #3D)** to the oil seal bore in the Bearing Retainer (#7) and press the Oil Seal (#31) into the bore.
- Lubricate the O-Ring (#87) and place it on the bearing retainer shoulder.
- Place some tape over the keyway and then slide the Bearing Retainer (#7) over the shaft, being careful not to damage the lip of the oil seal.

Attach the Bearing Retainer with (4) Screws (#63) and (4) Lockwashers (#128).

- Apply **(Loctite #271)** sparingly to the threads on the input shaft and install Locknut (#15). Clean off any excess adhesive with **(Loctite #755)** cleaner.

### **(M1 Model Only)**

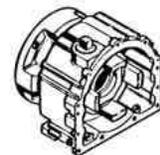
- Place the Lockwasher (#185) and the Locknut (#15) onto the Primary Input Shaft (#2) and tighten the locknut.

- Press the Wear Sleeve (#4) onto the Input Shaft. Use a similar arbor press set-up and appropriate support tooling, as shown in Figure 9.13.
- Put a thin coat of **(Permatex #3D)** into the oil seal bore of Bearing Retainer (#7) and press the Oil Seal (#31) into the Bearing Retainer. Clean off any excess.
- Lubricate the O-Ring (#87) and place it on the shoulder of the Bearing Retainer (#7).
- Place some tape over the keyway on the shaft to protect the oil seal lip.

Slide the Bearing Retainer (#7) over the Input Shaft and attach with (4) Screws (#63) and (4) Lockwashers (#128).

## **9-13 PRIMARY INPUT HOUSING SUB-ASSEMBLY (With Quill Input Shaft)**

(See Figure 10.02)



### **(M3, R3, M5 and R5 Models)**

- Press the Bearing (#27) onto the Primary Input Shaft (#2), using an arbor press.
- Assemble the Retaining Ring (#52), O-Ring (#104) and press the Freeze Plug (#99) into the input shaft bore, from the lugged end of the input shaft.
- Insert the Input Shaft (#2) into the Input Housing (#8), as shown in Figure 9.14.

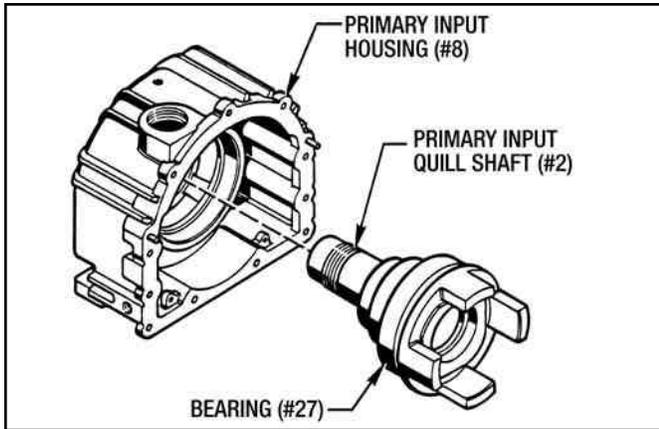


Figure 9.14 - Primary Input Quill Shaft Installation

4. Set the Primary Input Shaft and Housing Sub-Assembly into an arbor press as shown in Figure 9.15. Using an appropriate sized tube, press on the inner race of Bearing (#38) until it bottoms out.

**NOTE:**

Do not press on bearing cage or the outer race of the bearing.

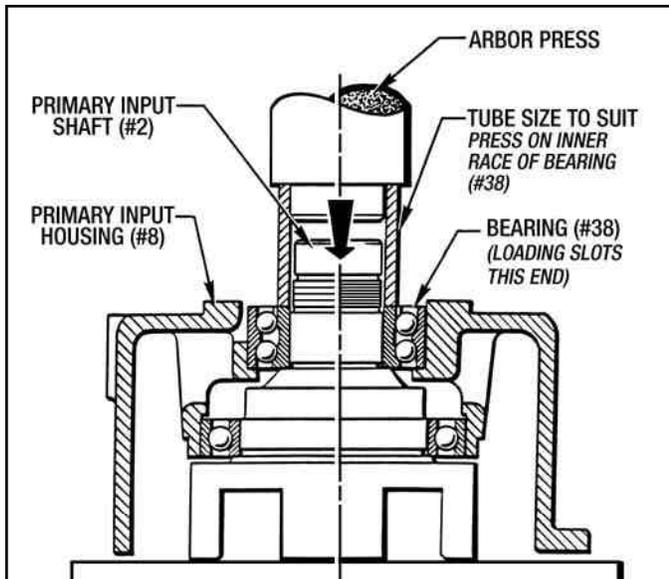


Figure 9.15 - Installing Bearing (#38) Into Primary Input Housing (Quill Input Shaft)

5. Install Locknut (#209). Use **(Loctite #271)** on threads and clean with **(Loctite #755)** cleaner.
6. Place a thin coat of **(Permatex #3D)** into the bore of Bearing Retainer (#207) and press the Oil Seal (#208) into the bore. Clean off any excess.
7. Apply **(Permatex #3D)** gasket sealant to the housing face and install Gasket (#206). Clean off any excessive sealant.

8. Attach the Bearing Retainer (#207) to the housing with (4) Screws (#63) and (4) Lockwashers (#128).
9. If the C-Face Adapter was removed, remount the C-Face Adapter (#200) back on the housing and attach with (4) screws (#201) and (4) Lockwashers (#202).

## 9-14 INSTALLING WATER COOLED HEAT EXCHANGER

(See Figure 10.03)

1. Guide the Heat Exchanger (#48) into the Primary Input Housing Sub-Assembly, making sure that the tube ends project out the (2) holes in the rear face of the Housing.

Attach with (2) Screws (#56).

2. Mark the tubing approximately 1/16" beyond the face of the housing. (See Figure 9.16)

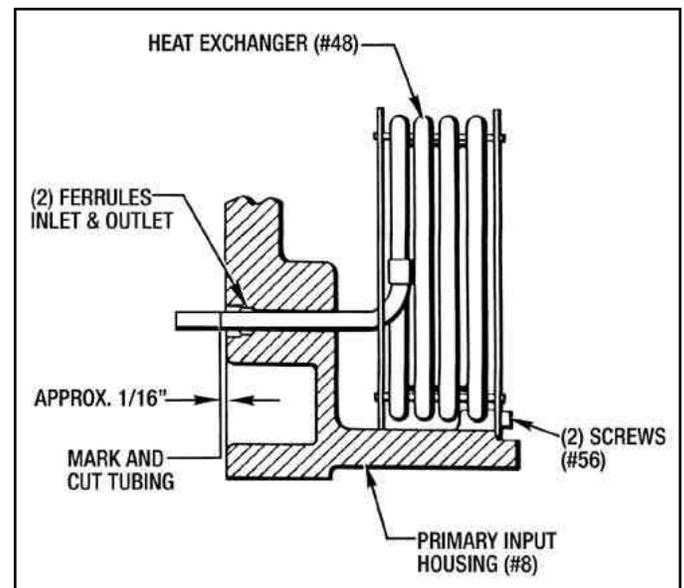


Figure 9.16 - Installing Water Cooled Heat Exchanger

3. Remove the Heat Exchanger from the Housing and cut off tubes on the 1/16" marks. The ends of the tubes must be square and free of all burrs before reassembly.
4. Reinstall the Heat Exchanger back into the Housing and place the (2) Ferrules on the tubing, as shown in Figure 10.3.

**NOTE:**

When tightening Fitting (#71), do not OVER TIGHTEN and then back off. This will cause the compression seal to leak.

## **ATTACHING MAJOR SUB-ASSEMBLIES & INSTALLING CLUTCH/BRAKE STACKS**

### **9-15 ATTACHING OUTPUT HOUSING TO SECONDARY INPUT HOUSING**

(See Figure 10.01)

1. Install Gasket (#53) to rear of the Output Housing. Apply (**Permatex #3D**) sealant to both sides of the Gasket. Clean off any excess sealant.
2. Slide the Output Shaft into the Secondary Input Housing Sub-Assembly.

#### **(M3 and R3 Models)**

3. Attach the Output Housing to the Secondary Input Housing with (9) Screws (#61), (2) Screws (#69) and (11) Lockwashers (#127).

#### **(M5, R5, M0, R0 and M1 Models)**

3. Attach the Output Housing to the Secondary Input Housing with Screws (#61) and Lockwashers (#127).

#### **(All Models)**

4. Install the Gasket (#53) to the rear face of the Secondary Input Housing, using gasket sealant (**Permatex #3D**). Clean off any excess.
5. Install (2) Studs (#283) into the rear of the Secondary Input Housing to act as a guide in the Reassembly of the other Major Sub-Assemblies.

#### **NOTE:**

Install these (2) Studs opposite each other and with the slotted end exposed. Do not apply any screw adhesive to the studs at this time. They have to be removed at a later time.

### **9-16 INSTALLING SECONDARY CLUTCH STACK AND SECONDARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY**

(See Figure 10.01)

Place the assembled unit in a vertical position with the output shaft pointing downwards to ease the Reassembly Procedure.

1. Install the Secondary Clutch Stack onto the Output Shaft Spline starting with a Drive Plate (#13) and then a Friction Disc (#12), ending with a Drive Plate. Align the notches in the Drive Plate with the lugs on the Secondary Input Shaft and the internal teeth in the Friction Disc with the Output Shaft Spline.

For Vertical Installation, also install (4) Spring Separators (#229) on each Drive plate (#13) except the 1st. Drive Plate installed as shown in the inset on (Figure 10.01).

2. Coat the mating surface of the Secondary Piston Housing with gasket sealant and lower the Secondary Piston Retainer and Housing Subassembly over the extended studs onto the assembled unit.

### **9-17 INSTALLING THE BRAKE STACK, PRIMARY PISTON RETAINER AND HOUSING SUB-ASSEMBLY**

(See Figure 10.01)

1. Install the Brake Stack onto the Output Shaft Spline starting with a Drive Plate (#13) and then a Friction Disc (#12), ending with a Drive Plate. Align the notches in the Drive Plate with the lugs on the Secondary Piston Retainer and the internal teeth in the Friction Disc with the Output Shaft Spline.

For Vertical Installation, also install (4) Spring Separators (#229) on each Drive Plate (#13) except the 1st. Drive Plate installed as shown in the inset on (Figure 10-1).

2. Install Gasket (#54) using gasket sealant on mating surfaces. Clean off any excess sealant.
3. Lower the Primary Piston Retainer and Housing Sub-Assembly over the extended studs onto the assembled unit.

### **9-18 INSTALLING THE PRIMARY CLUTCH STACK AND THE PRIMARY INPUT HOUSING SUB-ASSEMBLY**

(See Figure 10.01)

1. Install the Primary Clutch Stack onto the Output Shaft Spline starting with a Drive Plate (#13) and then a Friction Disc (#12), ending with a Drive Plate. Align the notches in the Drive Plate with the similar notches in the Clutch Thrust Plate (#5) and the internal teeth in the Friction Disc with the Output Shaft spline.

For Vertical Installation, also install (4) Spring Separators (#229) on each Drive Plate (#13) except the 1st. Drive Plate installed as shown in the inset on (Figure 10.01).

2. Install Gasket (#53). Apply gasket sealant to both mating surfaces. Clean off excess sealant.
3. Lower the Primary Input Housing Sub-Assembly over the (2) extended studs. Turn the Primary Input Shaft by hand to align the lugs with the mating notches in the Drive Plates and the Primary Thrust Plate (#5).

### CAUTION

Do not force the Primary Input Sub-Assembly down into the Clutch Stack This could bend and damage the Drive Plates.

4. Remove the (2) studs previously installed. Install all of the studs, one at a time, with the following procedure:
  - a. Apply **(Loctite #271)**, sparingly, only to the end of the stud being inserted.
  - b. Insert the stud into the housing. Using the slots in the exposed end of the stud, adjust it so 1/2" of thread is exposed beyond the Input Housing flange.

### NOTE:

It is **IMPORTANT** that this procedure be completed for each stud, one at a time, so the Loctite Adhesive does not have time to set, making the 1/2" adjustment impossible.

5. After all of the studs have been properly adjusted to the right height, replace the Allen Nuts (#152) and the Lockwashers (#128).
6. If your Drive Unit has a Male Primary Input Shaft and is not equipped with Fan Cooling, then replace the Key (#180) into the shaft.

This completes the Reassembly Procedure for the Major Sub-Assemblies. Before proceeding any further, an **OPERATIONAL CHECK** of the Clutch and Brake Piston Movement should be made. Apply 60 to 80 PSI to the clutch and brake ports, as indicated in **Section 5 - OPERATION CHECKS**, and observe the piston movements through the inspection ports.

## 9-19 FAN AND FAN SHROUD INSTALLATION

(See Figure 10.03)

### (M1 Model Only)

1. Place Spacer (#183) on the Primary Input Shaft (#2).
- ### (All Models)
2. Install Key (#37).
  3. Place Fan (#25) on the Input Shaft and tighten Set Screw (#70).
  4. Place the Fan Shroud (#24) into place and attach with (2) Screws (#66) in the bottom rear of the Shroud.
  5. Install Key (#180).

### (M3, R3, M0, R0 AND R1 Models)

6. Clamp the Fan Shroud with Nuts (#86).

### (M5 and R5 Models Only)

6. Attach Shroud with (2) Screws (#67) and (2) Washers (#182) on both sides of the Shroud.

## 9-20 ATTACHING C-FACE MOUNTED PRIMARY AND SECONDARY DRIVE MOTORS

1. Attach an appropriate soft sling or lifting hook to the drive motors and, with care, slide the motor shafts into the Quill Input Shafts, making sure the keys on the motor shafts aligns with the keways in the input shafts. (See Figure 9.18)

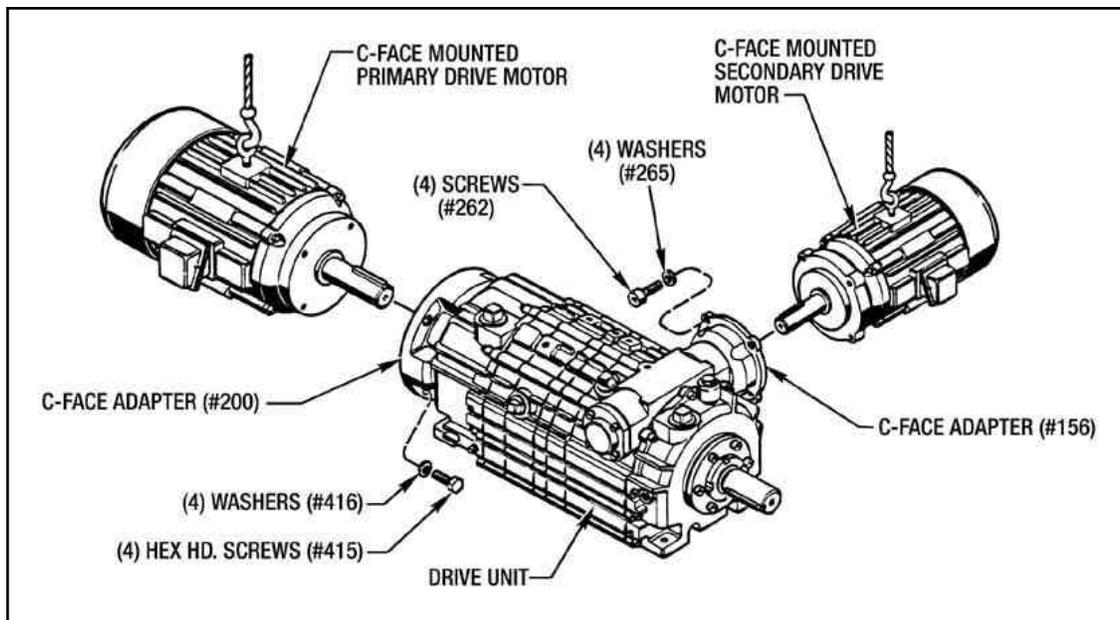


Figure 9.18 - Attaching C-Face Motors

### CAUTION

**Be very careful not to bump the Input Shafts. This could damage the bearings and the lip of the oil seals.**

2. Attach the Primary Drive Motor with (4) Screws (#216) and (4) Lockwashers (#202). Use (4) Screws (#262) and (4) Lockwashers (#265) for the Secondary Drive Motor. (See Figure 9.18).

## 9-21 INSTALLING BELT DRIVEN SHEAVE OR PULLEY

**(With Male Input Shaft Only)**

1. Install guard back plate if necessary.
2. Assemble the Taper-Lock Bushing and the Drive Sheave or Pulley with the (2) Set Screws placed in the (2) Locking Holes.
3. Place Assembled Drive Sheave or Pulley onto the Male Input Shaft as close as possible to the drive unit to minimize overhang shaft deflection. Tighten (2) Set Screws to lock it on the Input Shaft (See Figure 9.19).

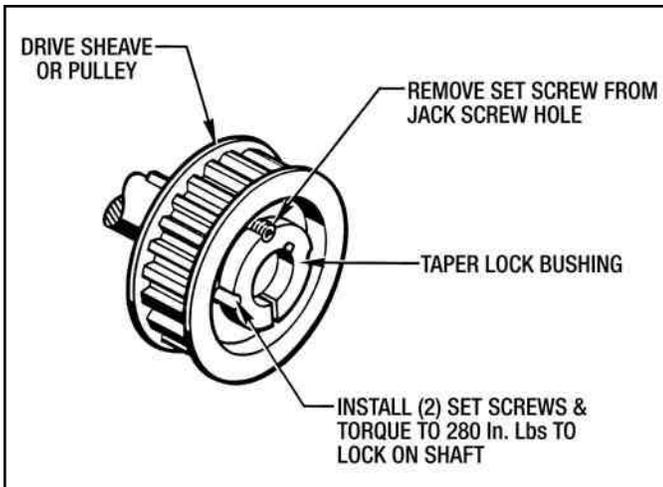


Figure 9.19 - Installing Drive Sheave or Pulley With Taper-Lock Bushing

## 9-22 FINAL REASSEMBLY

1. Replace all pipe plugs and fittings removed for inspection or disassembly.
2. Fill the Drive Unit with Mobile Automatic Transmission Fluid type ATF-210 or type "F", as indicated in Section 4 - LUBRICATION.

3. Replace all external motor drive parts, safety guards, sheaves, pulleys, belts and couplings on belt drive units.
4. Before placing the Drive Unit back into service, completely check out the Operation as described in Section 5 - OPERATIONAL CHECKS.

**REASSEMBLY IS NOW COMPLETE AND THE DRIVE UNIT IS READY FOR SERVICE.**

## 9-23 SCREW TORQUE REQUIREMENTS

The following Torque Requirements are given for Grade SAE 5 Cap Screws and Bolts.

SCREW SIZE	TORQUE REQUIREMENTS	
	(Inch Lbs.)	(Foot Lbs.)
1/4"	84	7
5/16"	168	14
3/8"	300	25
7/16"	480	40
1/2"	720	60
9/16	1056	88
5/8"	1440	120
3/4"	2400	200
7/8"	3624	302
1"	5592	466

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# Section 10 - ORDERING REPAIR PARTS

## 10-1 GENERAL INFORMATION

This section illustrates, lists and describes, all available Repair Parts for the Force Control Multi-Speed Drive (MSDr) and the High Speed Reversing Drive (HSRvD). Exploded views with numbers are used to identify the various parts in the Drive Units. These numbers are listed in the parts list along with the part name and quantity used.

## 10-2 FACTORY REBUILD SERVICE

Reconditioning service is offered by Force Control Industries at the factory. Before returning a unit for this service, be sure to first contact the Force Control Industries Service Sales Dept. for authorization and shipping instructions. Force Control Industries cannot be responsible for units returned to the factory without prior notice or authorization.

Care must be given to the packaging of returned drives. Always protect mounting feet by attaching to a skid. Shipment-damaged drives always delay repairs. Whenever possible, describe the problem experienced on your shipping papers.

### ***Shipping Address:***

**Force Control Industries, Inc.  
3660 Dixie Highway  
Fairfield, Ohio 45014**

**Telephone: 1(513)868-0900  
Fax: 1(513)868-2105  
E-Mail: [info@forcecontrol.com](mailto:info@forcecontrol.com)**

## 10-3 DRIVE MOTORS

The motors used with these Drive Units are standard and may be repaired or replaced by any qualified motor rebuild facility or supplier.

## 10-4 ORDERING REPAIR PARTS

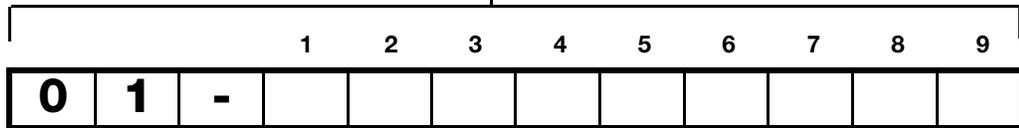
When ordering replacement parts, please specify all of the following information:

1. Drive model number (on the nameplate)
2. Drive serial number (on the nameplate)
3. Part reference number (from the parts list or assembly)
4. Part-name (from the parts list)
5. Quantity (from the parts list)
6. Complete shipping information

Failure to include information for items 1 through 5 will only delay your parts order. Unless another method is specified for item 6, parts less than 50 pounds will be shipped United Parcel Service, parts over 50 pounds will be shipped motor freight. Air freight and other transportation services are available, but only if specified on your order.

# 10-5 MULTI-SPEED DRIVE (MSDr) NAME PLATE & MODEL NUMBER INFORMATION

This Name Plate is located on the side of the Secondary Input Housing.



### SIZE (1, 2)

M	3	= 03
M	5	= 05
M	0	= 10
M	1	= 11

### PRIMARY INPUT (3)

1	= Std.
2	= 4-1/2 AK, 5/8 U
3	= 4-1/2 AK, 7/8 U
4	= 8-1/2 AK, 1-1/8 U
5	= 8-1/2 AK, 1-3/8 U
7	= Piggyback
8	= 4-1/2 AK, 5/8 U
9	= 4-1/2 AK, 7/8 U
A	= 8-1/2 AK, 1-1/8 U
B	= 8-1/2 AK, 1-3/8 U
C	= 4-1/2 AK, 1-1/8 U
D	= 8-1/2 AK, 1-3/8 U
E	= 8-1/2 AK, 1-3/8 U

\*\* - Contact Force Control for this Option.

### LOGIC (4)

A	= A - Spring Set Brake, 75/25
B	= B - Spring Set Brake, 50/50
C	= Clutch Only
D	= SA - Spring Set Brake Air Assist (Std.)
E	= SCP - Self Centering Piston

### OUTPUT (5)

1	= Std.
3	= 4-1/2 AK, 7/8 U
4	= 8-1/2 AK, 1-1/8 U
5	= 8-1/2 AK, 1-3/8 U
6	= P/B, 8-1/2 AK, 1-1/8 U
7	= P/B, 8-1/2 AK, 1-3/8 U
8	= 8-1/2 AK, 1-3/8 U

### RATIO (6)

	M3/M5	M10/M11
A	= 9:1	5:1
B	= 12:1	12:1
C	= 15:1	15:1
D	= 18:1	
E	= 20:1	20:1
F	= 24:1	24:1
G	= 30:1	30:1
H	= 40:1	
I	= 48:1	48:1
J	= 60:1	60:1
K	= 96:1	

### REVISION (9) By Force Control

### SECONDARY INPUT (8)

A	= Std.
B	= 4-1/2 AK, 5/8 U
C	= 4-1/2 AK, 7/8 U
D	= 8-1/2 AK, 1-1/8 U*
E	= 8-1/2 AK, 1-3/8 U*
F	= 4-1/2 AK, 5/8 U, Long Coupled **
G	= 4-1/2 AK, 7/8 U, Long Coupled **
H	= Piggy Back
J	= 8-1/2 AK, 1-1/8 U, Long Coupled **

\* - Not available for M3 or M5

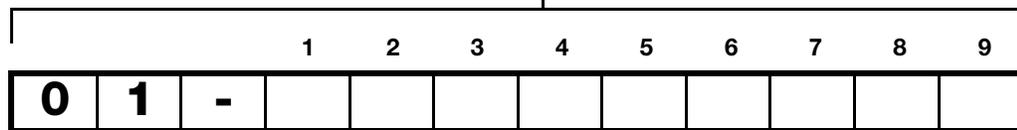
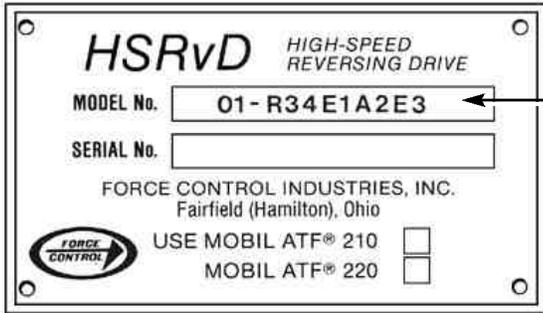
\*\* - Contact Force Control for this Option.

### COOLING (7)

1	= Standard
2	= Water Cooled
3	= Fan Cooled
4	= Fan, Split Shroud

# 10-6 HIGH SPEED REVERSING DRIVE (HSRvD) NAME PLATE AND MODEL NUMBER INFORMATION

This Name Plate is located on the side of the Secondary Input Housing.



### SIZE (1, 2)

R	3	= 03
R	5	= 05
R	0	= 10

### PRIMARY INPUT (3)

1	= Std.
3	= 4-1/2 AK, 7/8 U
4	= 8-1/2 AK, 1-1/8 U C-Face
5	= 8-1/2 AK, 1-3/8 U

### LOGIC (4)

A	= A - Spring Set Brake, 75/25
B	= B - Spring Set Brake, 50/50
C	= Clutch Only
D	= SA - Spring Set Brake Air Assist (Std.)
E	= SCP - Self Centering Piston

### OUTPUT (5)

1	= Std.
3	= 4-1/2 AK, 7/8 U
4	= 8-1/2 AK, 1-1/8 U C-Face
5	= 8-1/2 AK, 1-3/8 U

### RATIO (6)

	03/05	10
U	= ----	2.2:1
V	= 1.8:1	1.8:1
W	= 1.5:1	1.6:1
X	= 1.4:1	1.4:1
Y	= 1.2:1	1.2:1
Z	= 1.0:1	1.0:1

### REVISION (9) By Force Control

### SECONDARY INPUT (8)

D	= 8-1/2 AK, 1-1/8 U
E	= 8-1/2 AK, 1-3/8 U
F	= 10-1/2 AK, 1-5/8 U C-Face
G	= 12-1/2 AK, 1-7/8 U
H	= 12-1/2 AK, 2-1/8 U

### COOLING (7)

1	= Standard
2	= Water Cooled
5	= Fan Cooled
7	= Fan, Split Shroud

**Repair Parts List**  
**MAJOR SUB-ASSEMBLIES & CLUTCH/BRAKE STACKS**  
*(Figure 10.01)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
*12	Friction Disc .....	AR	152	Allen Nut .....	AR
*13	Drive Plate .....	AR	*229	Separator Spring <i>(Vertical Installation)</i> .....	AR
*53	Gasket .....	3	283	Threaded Stud	
*54	Gasket .....	1		<i>M3 and R3</i> .....	9
61	Soc. Hd. Cap Screw .....	AR		<i>M5, R5, M0, R0 and R3</i> .....	AR
69	Soc. Hd. Cap Screw <i>(M3 and R3 Only)</i> .....	2	284	Threaded Stud <i>(M3 and R3 Only)</i> .....	2
127	Lockwasher .....	AR			

AR - As Required

\* - Indicated parts in the Minor Overhaul Kit.

**DRIVE PLATE (#13) & FRICTION DISC (#12) QUANTITIES**

MODEL	LOGIC	FRICTION DISC <i>(Qty.)</i>		DRIVE PLATE <i>(Qty.)</i>	
		CLUTCH	BRAKE	CLUTCH	BRAKE
M3, R3	A, B, SA, SCP	6	6	7	7
	C	6	-----	7	-----
M5, R5	A, B, SA, SCP	10	10	11	11
	C	10	-----	11	-----
M0, R0	A, B, SA, SCP	8	8	9	9
	C	8	-----	9	-----
M1	A, B, SA, SCP	10	10	11	11
	C	10	-----	11	-----

# MAJOR SUB-ASSEMBLIES & CLUTCH/BRAKE STACKS

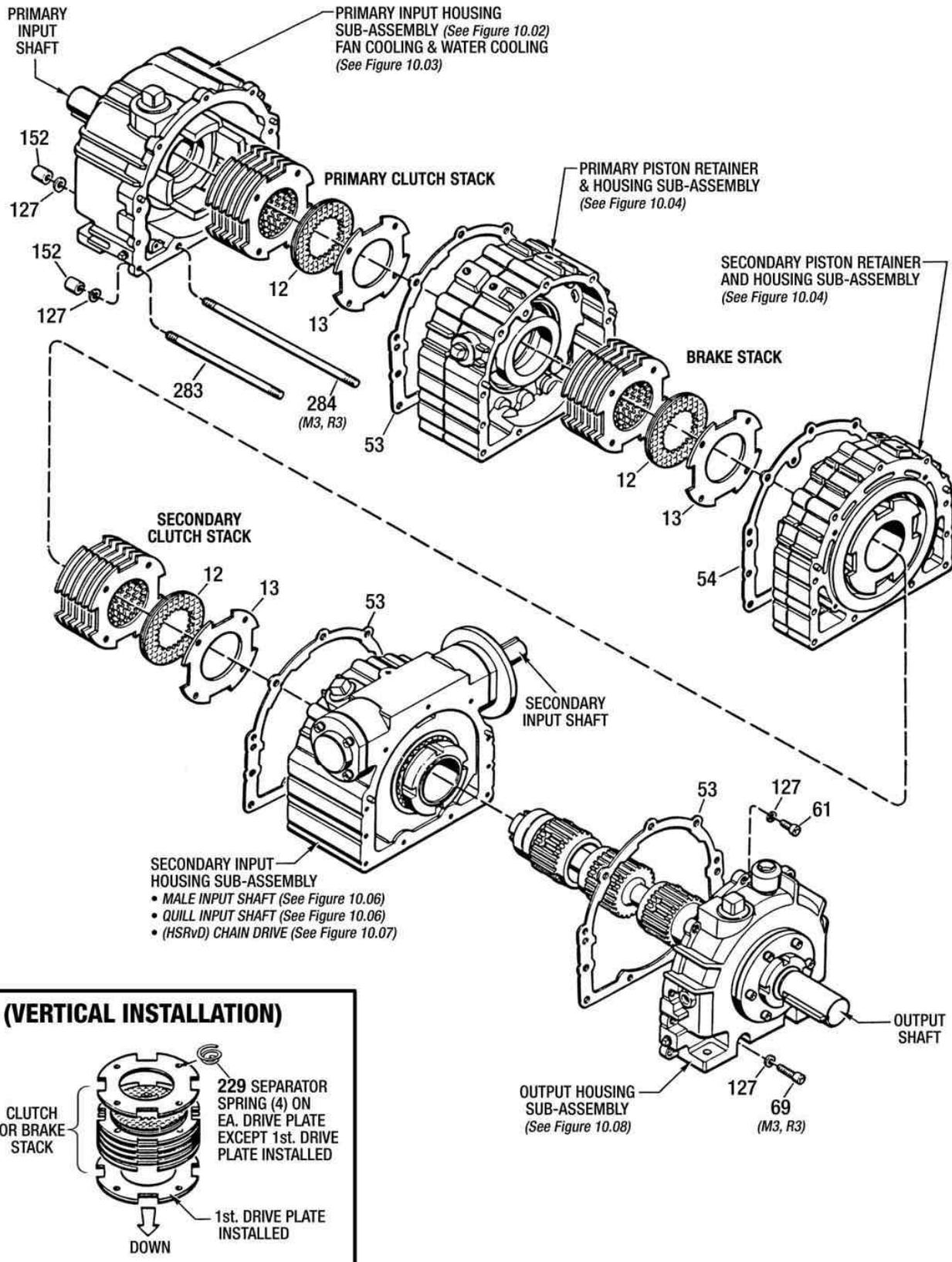


Figure 10.01 - Major Sub-Assemblies and Clutch/Brake Stacks

**Repair Parts List**  
**PRIMARY INPUT HOUSING SUB-ASSEMBLY**  
*(Figure 10.02)*

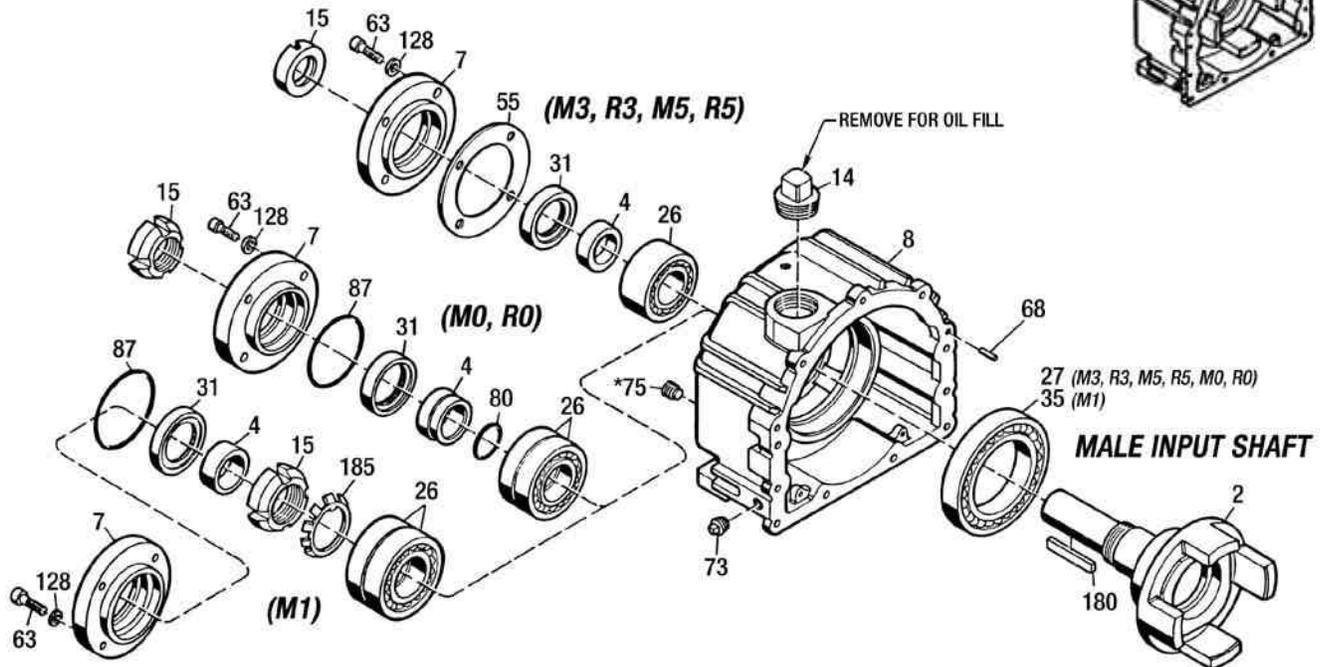
REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
2	Primary Input Shaft .....	1	73	Magnetic Sq. Hd. Pipe Plug .....	2
*4	Mating Ring <i>(All Models except M1)</i> .....	1	75	Water Port Plug .....	2
*4	Wear Sleeve <i>(M1 Model Only)</i> .....	1	*80	O-Ring .....	1
7	Bearing Retainer .....	1	*87	O-Ring .....	1
8	Primary Input Housing .....	1	99	Freeze Plug .....	1
14	Sq. Hd. Pipe Plug .....	1	*104	O-Ring .....	1
**15	Locknut .....	1	128	Lockwasher .....	6
*26	Ball Bearing		180	Key .....	1
	<i>M3, R3, M5 and R5</i> .....	1	185	Lockwasher .....	1
	<i>M0, R0 and M1</i> .....	2	200	C-Face Adapter .....	1
*27	Ball Bearing .....	1	201	Soc. Hd. Cap Screw .....	6
*31	Oil Seal .....	1	202	Lockwasher .....	10
*35	Ball Bearing .....	1	*206	Gasket .....	1
*38	Ball Bearing .....	1	207	Bearing Retainer .....	1
52	Internal Retaining Ring .....	1	*208	Oil Seal .....	1
*55	Gasket .....	1	**209	Locknut .....	1
63	Soc. Hd. Cap Screw .....	6	415	Hex Hd. Cap Screw .....	4
68	Dowel Pin .....	2	416	Lockwasher .....	4

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

# PRIMARY INPUT HOUSING SUB-ASSEMBLY

(With Male Input Shaft For Belt or Coupled Drive)



# (With Quill Input Shaft and C-Face Adapter)

(M3, R3, M5 and R5 Only)

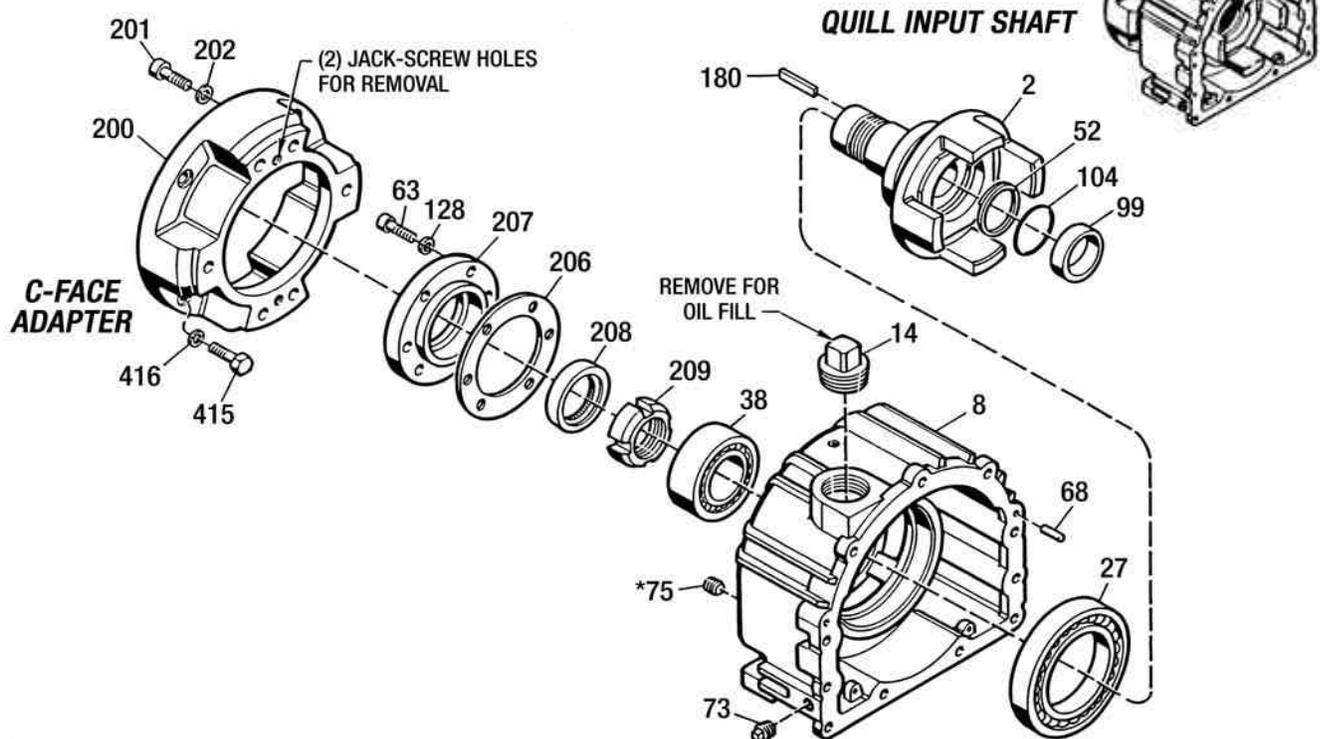


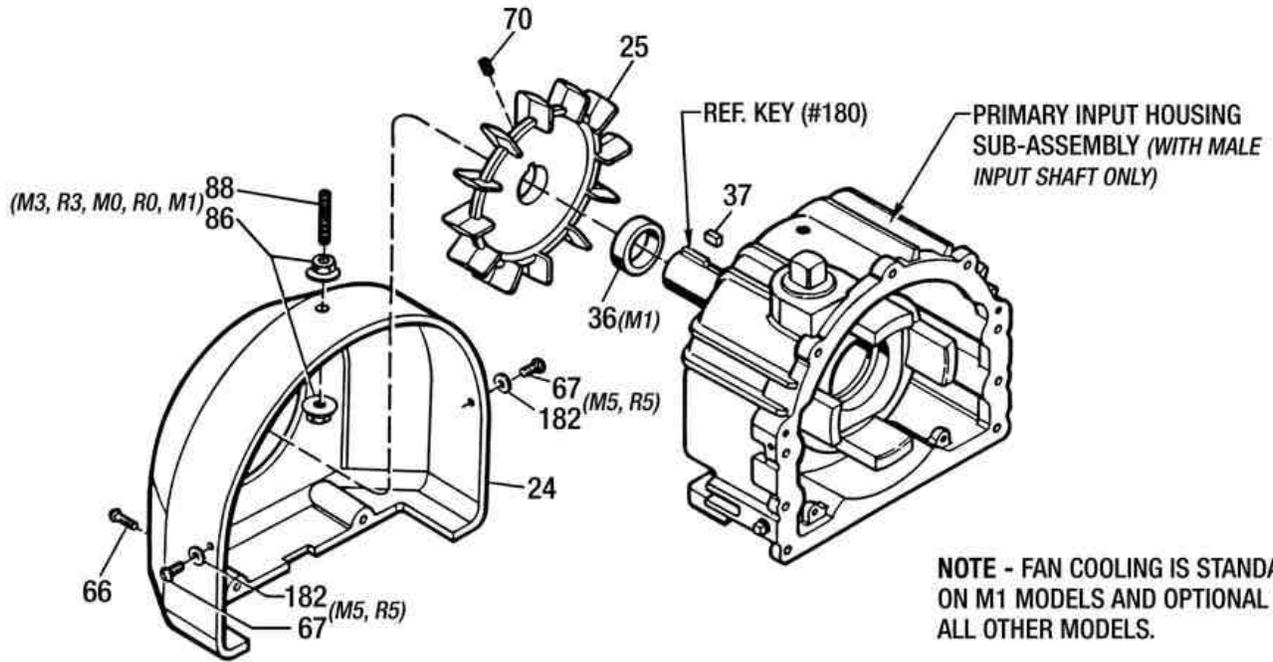
Figure 10.02 - Primary Input Housing Sub-Assembly

**Repair Parts List**  
**FAN COOLING & WATER COOLING OPTIONS**  
*(Figure 10.03)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
24	Fan Shroud .....	1	71	Compression Elbow (Nut Removed) .....	2
25	Fan .....	1	86	Flanged Locknut .....	2
37	Key .....	1	88	Soc. Set Screw .....	1
48	Water Cooled Heat Exchanger .....	1	*176	Zinc Anode .....	1
56	Soc. Hd. Cap Screw .....	2	182	Flat Washer .....	2
66	But. Hd. Cap Screw .....	2	183	Fan Spacer .....	1
67	Rd. Hd. Machine Screw .....	2	242	Pipe Tee, Galvanized .....	1
70	Soc. Set Screw .....	1			

\* - Indicated parts in the Minor Overhaul Kit.

## FAN COOLING (With Male Input Shaft Only)



## WATER COOLING (Optional On All Models Except M1)

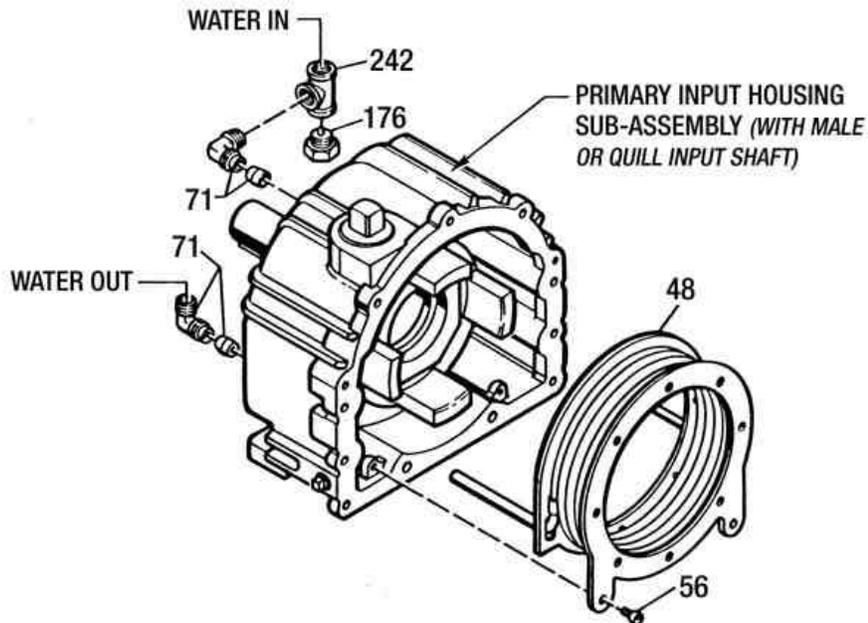


Figure 10.03- Fan Cooling and Water Cooling Options

**Repair Parts List**  
**PRIMARY & SECONDARY PISTON RETAINER & HOUSING SUB-ASSEMBLIES**  
*(Figure 10.04)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
3	Piston .....	2	*43	O.D. Sealing Ring .....	2
**5	Clutch Thrust Plate .....	2	*51	Housing Gasket .....	2
10	Primary Piston Housing .....	1	62	Soc. Hd. Cap Screw .....	8
11	Secondary Piston Retainer .....	1	68	Dowel Pin .....	8
*27	Ball Bearing .....	2	*96	Compression Spring .....	AR
*36	Compression Spring <i>(See Chart Below)</i> .....	AR	128	Lockwasher, 5/16" .....	8
*39	O-Ring .....	4	190	Secondary Piston Housing .....	1
*40	O-Ring .....	4	191	Primary Piston Retainer .....	1
*42	I.D. Sealing Liner .....	4	193	Sq. Hd. Pipe Plug, 1-1/4" NPT .....	1

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

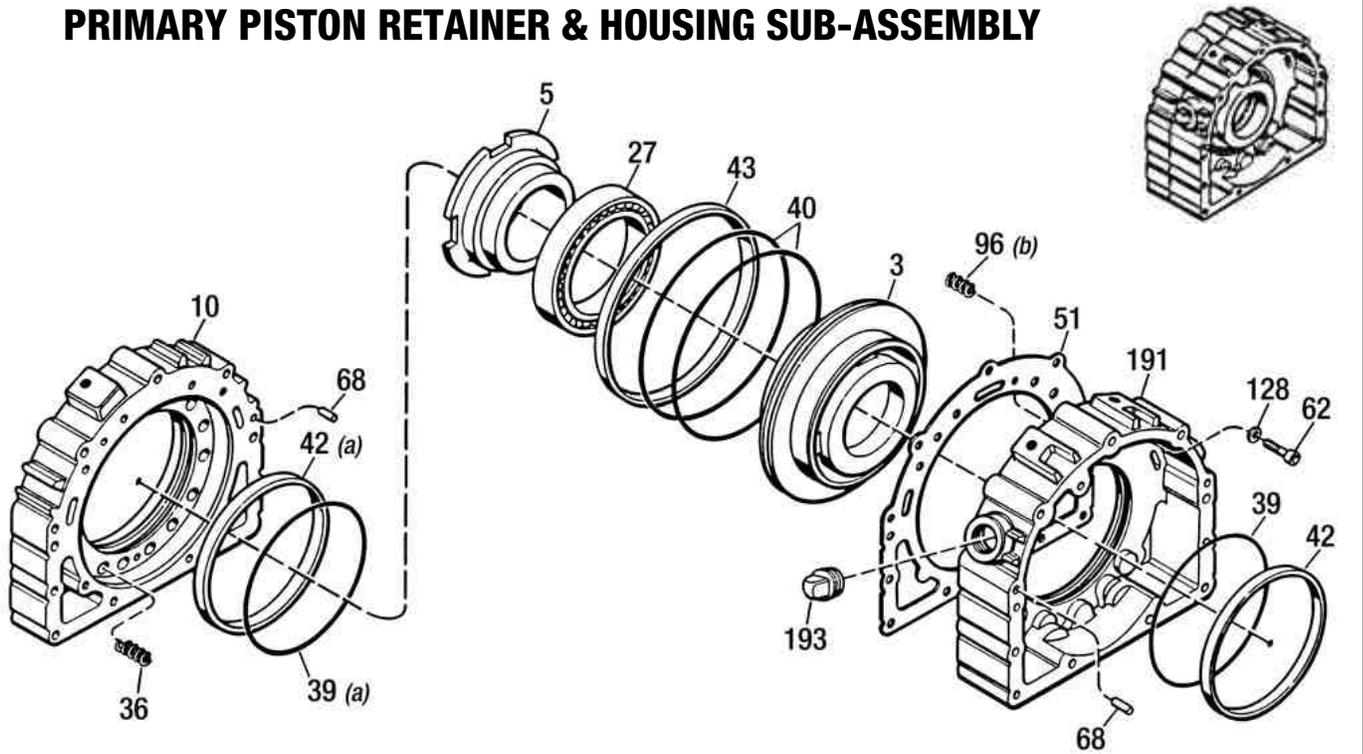
AR - As Required.

**QUANTITY REQUIRED FOR SPRING (#36)**

MODEL NUMBER	CONTROL LOGIC			
	SA	A	B	SCP
M3, R3	30	20	40	20
M5, R5	40	20	40	20
M0, R0, M1	36	20	40	20

Quantities given are total number used. Half of them are used for each Piston Sub-Assembly.

## PRIMARY PISTON RETAINER & HOUSING SUB-ASSEMBLY



## SECONDARY PISTON RETAINER & HOUSING SUB-ASSEMBLY

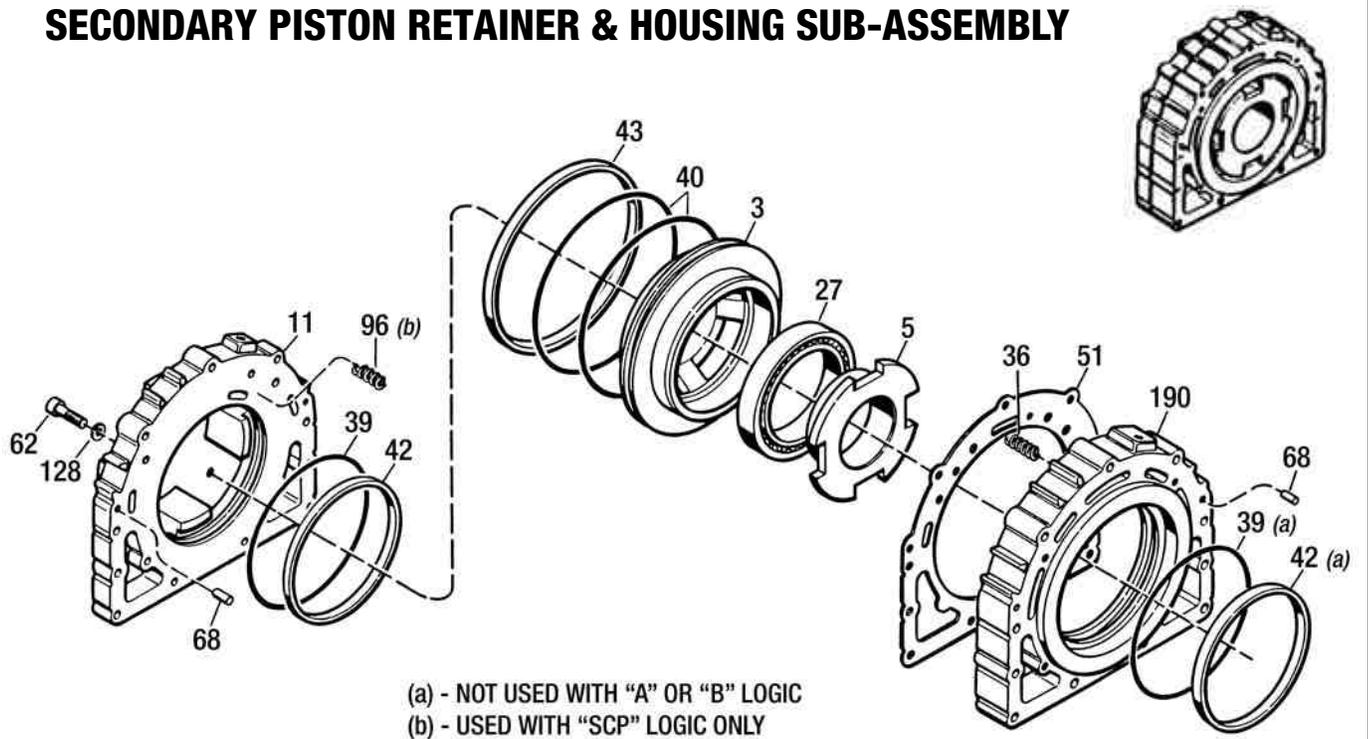


Figure 10.04 - Primary and Secondary Piston Retainer and Housing Sub-Assemblies

**Repair Parts List**  
**SECONDARY INPUT HOUSING SUB-ASSEMBLY**  
*(With Male Input Shaft For Belt or Coupled Drive)*  
*(Figure 10.05)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
*27	Ball Bearing .....	1	164	Secondary Input Housing .....	1
*35	Ball Bearing .....	1	166	Key .....	1
*41	Ball Bearing .....	1	*167	Bearing Cup .....	2
49	Spacer .....	1	*168	Bearing Cone .....	2
50	Spacer .....	1	169	Freeze Plug .....	1
68	Dowel pin .....	2	171	Bearing Spacer .....	1
126	Lockwasher .....	4	175	Lockwasher .....	8
153	Secondary Input Worm Shaft .....	1	182	Key .....	1
154	Worm Gear .....	1	*184	Wear Sleeve .....	1
155	Bearing Retainer .....	1	**189	Locknut .....	1
156	Bearing Retainer .....	1	192	Input Shaft .....	1
*158	Oil Seal .....	1	193	Sq. Hd. Pipe Plug .....	1
159	Soc. Hd. Cap Screw .....	4	264	Soc. Hd. Cap Screw .....	4
*161	Gasket .....	1	278	Soc. Hd. Cap Screw .....	4
162	Bearing Retainer .....	1	*913	Shim Gasket .....	AR
163	Bearing Retainer .....	1	*917	Shim .....	AR

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

AR - As Required.



**Repair Parts List**  
**SECONDARY INPUT HOUSING SUB-ASSEMBLY**  
*(With Quill Input Shaft For C-Face Mounting)*  
*(Figure 10.06)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
*27	Ball Bearing .....	1	163	Bearing Retainer .....	1
*35	Ball Bearing .....	1	164	Secondary Input Housing .....	1
*41	Ball Bearing .....	1	165	Bearing Washer .....	1
49	Spacer .....	1	166	Key .....	1
50	Spacer .....	1	169	Freeze Plug .....	1
68	Dowel pin .....	2	171	Bearing Spacer .....	1
*104	O-Ring .....	1	175	Lockwasher .....	8
126	Lockwasher .....	4	182	Key .....	1
153	Secondary Input Worm Shaft .....	1	*184	Wear Sleeve .....	1
154	Worm Gear .....	1	**189	Locknut .....	1
155	C-Face Adapter .....	1	192	Secondary Input Shaft .....	1
156	Bearing Retainer .....	1	193	Sq. Hd. Pipe Plug .....	1
*157	Ball Bearing .....	4	226	Lockwasher .....	1
*158	Oil Seal .....	1	262	Soc. Hd. Cap Screw .....	4
159	Soc. Hd. Cap Screw .....	4	263	Hex Hd. Cap Screw .....	1
*161	Gasket		264	Soc. Hd. Cap Screw .....	4
	M3 and M5 Models .....	2	265	Lockwasher .....	4
	M0 and M1 Models .....	1	278	Soc. Hd. Cap Screw .....	4
162	Bearing Retainer .....	1	*917	Shim .....	AR

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

AR - As Required.

# SECONDARY INPUT HOUSING SUB-ASSEMBLY

(With Quill Input Shaft For C-Face Mounting)

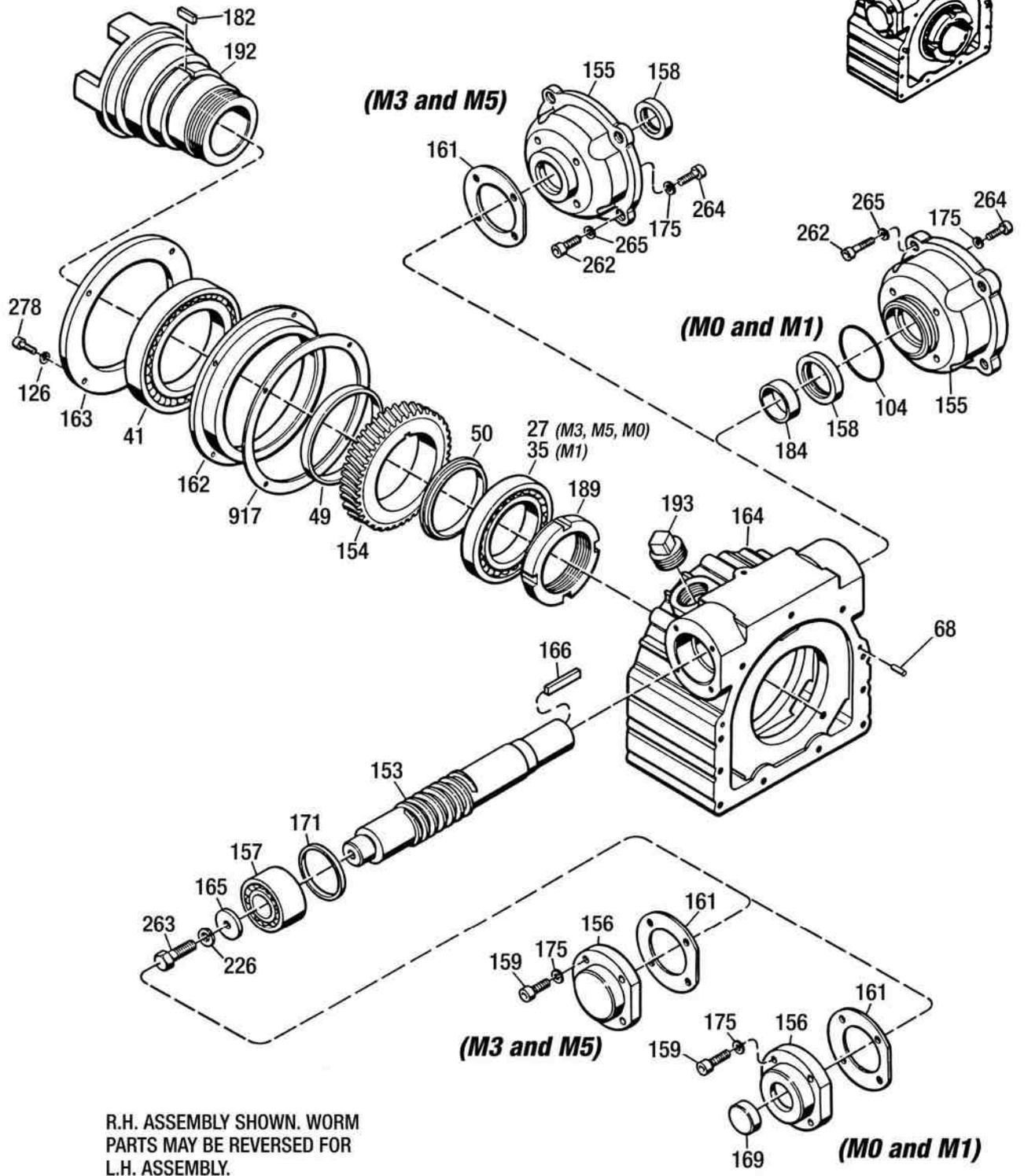


Figure 10.06 - Secondary Input Housing Sub-Assembly (With Quill Input Shaft)

**Repair Parts List**  
**SECONDARY INPUT HOUSING SUB-ASSEMBLY**  
**High Speed Reversing Drive (HSRvD)**  
*(Figure 10.07)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
*27	Ball Bearing .....	1	271	Chain Access Cover .....	1
*41	Ball Bearing .....	1	272	Eccentric Ring .....	1
**45	Air Breather .....	1	273	Chain Sprocket, Input Shaft .....	1
49	Spacer .....	1	274	Chain Sprocket, Motor Shaft .....	1
50	Spacer .....	1	*275	Silent Chain .....	1
63	Soc. Hd. Cap Screw .....	6	*276	Silent Chain Connector Link .....	1
*77	Gasket .....	1	278	Soc. Hd. Cap Screw .....	4
126	Lockwasher .....	4	*290	Seal Gasket .....	1
163	Bearing Retainer .....	1	404	Flat Washer .....	4
182	Key .....	1	405	90° Street Elbow .....	1
**189	Locknut .....	1	406	Reducer Bushing .....	1
192	Secondary Input Shaft .....	1	408	Drive Motor .....	1
193	Sq. Hd. Pipe Plug .....	1	409	Hex Hd. Cap Screw .....	4
194	Sq. Hd. Pipe Plug .....	1	410	Lockwasher .....	4
270	Transfer Case Housing .....	1	412	Taper Lock Bushing .....	1

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

# SECONDARY INPUT HOUSING SUB-ASSEMBLY High Speed Reversing Drive (HSRvD)

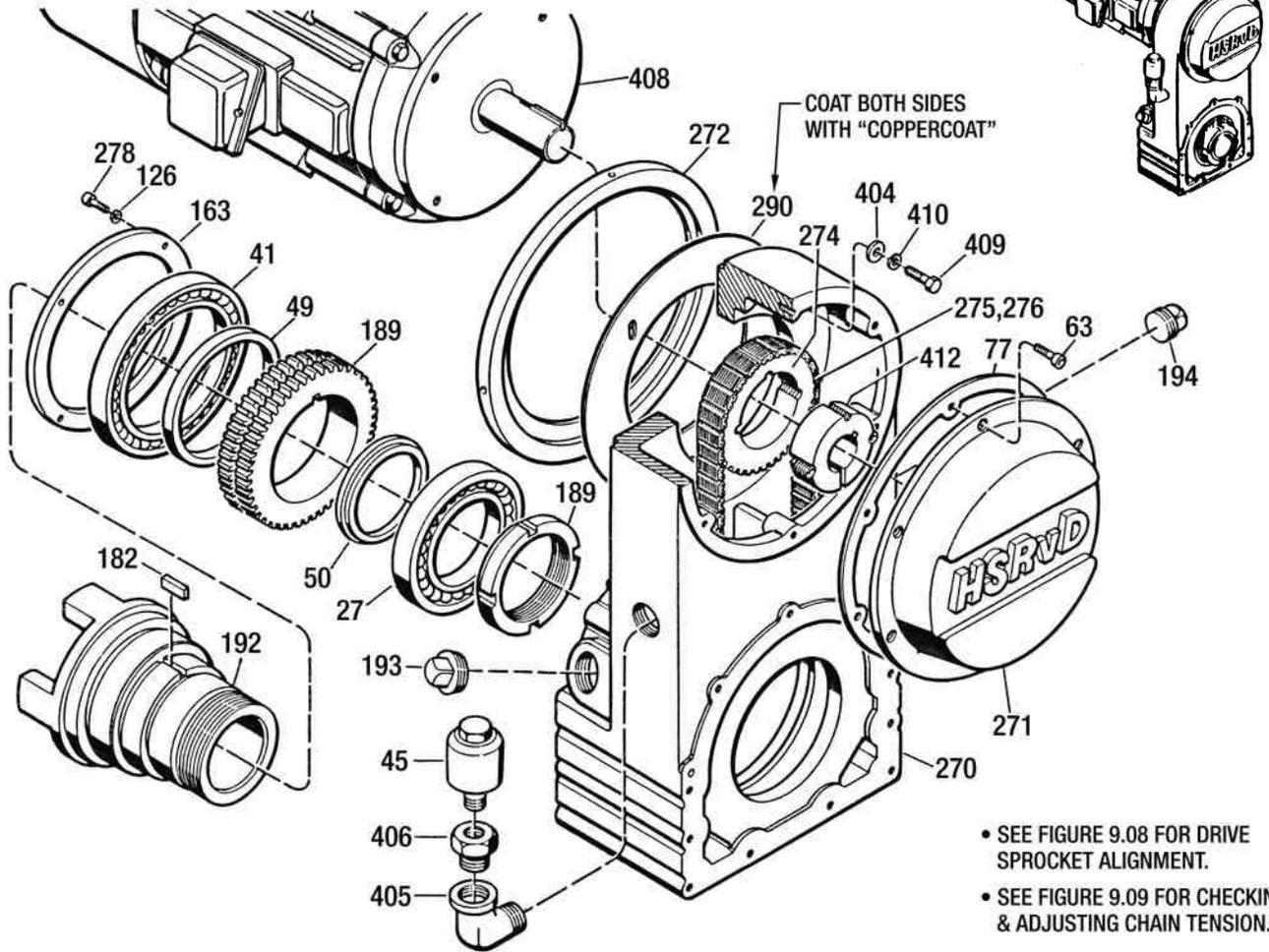


Figure 10.07 - Secondary Input Housing Sub-Assembly - High Speed Reversing Drive (HSRvD)

**Repair Parts List**  
**OUTPUT HOUSING SUB-ASSEMBLY**  
*(Figure 10.08)*

REF No.	PART NAME	QTY.	REF No.	PART NAME	QTY.
1	Output Shaft .....	1	63	Soc. Hd. Cap Screw .....	6
*4	Mating Ring <i>(All Models except M1)</i> .....	1	71	Pipe Plug, C'Sunk .....	1
*4	Wear Sleeve <i>(M1 Only)</i> .....	1	72	Pipe Plug, C'Sunk .....	1
7	Bearing Retainer .....	1	73	Pipe Plug, Mag. Sq. Hd. ....	2
9	Output Housing .....	1	*80	O-Ring .....	1
14	Sq. Hd. Pipe Plug .....	1	*87	O-Ring .....	1
**15	Locknut .....	1	90	Reducer Bushing .....	1
*26	Ball Bearing		117	Street Elbow .....	1
	Double Row <i>(M3, R3, M5 and R5)</i> .....	1	128	Lockwasher .....	6
	Single Row <i>(M0, R0 and M1)</i> .....	2	135	Pipe Plug, C'Sunk .....	1
*28	Ball Bearing .....	1	136	Pipe Plug, Mag. Sq. Hd. ....	1
*31	Oil Shear .....	1	137	Reducer Bushing .....	1
**34	Locknut .....	1	177	Street Elbow .....	1
**45	Breather .....	1	181	Key .....	1
**46	Sight Gauge .....	1	**185	Lockwasher .....	1
*55	Gasket .....	1	216	Special Reducer Bushing .....	1

\* - Indicated parts in the Minor Overhaul Kit.

\*\* - Indicates parts in Major Overhaul Kit. (This Kit also includes all parts in the Minor Overhaul Kit.)

# OUTPUT HOUSING SUB-ASSEMBLY

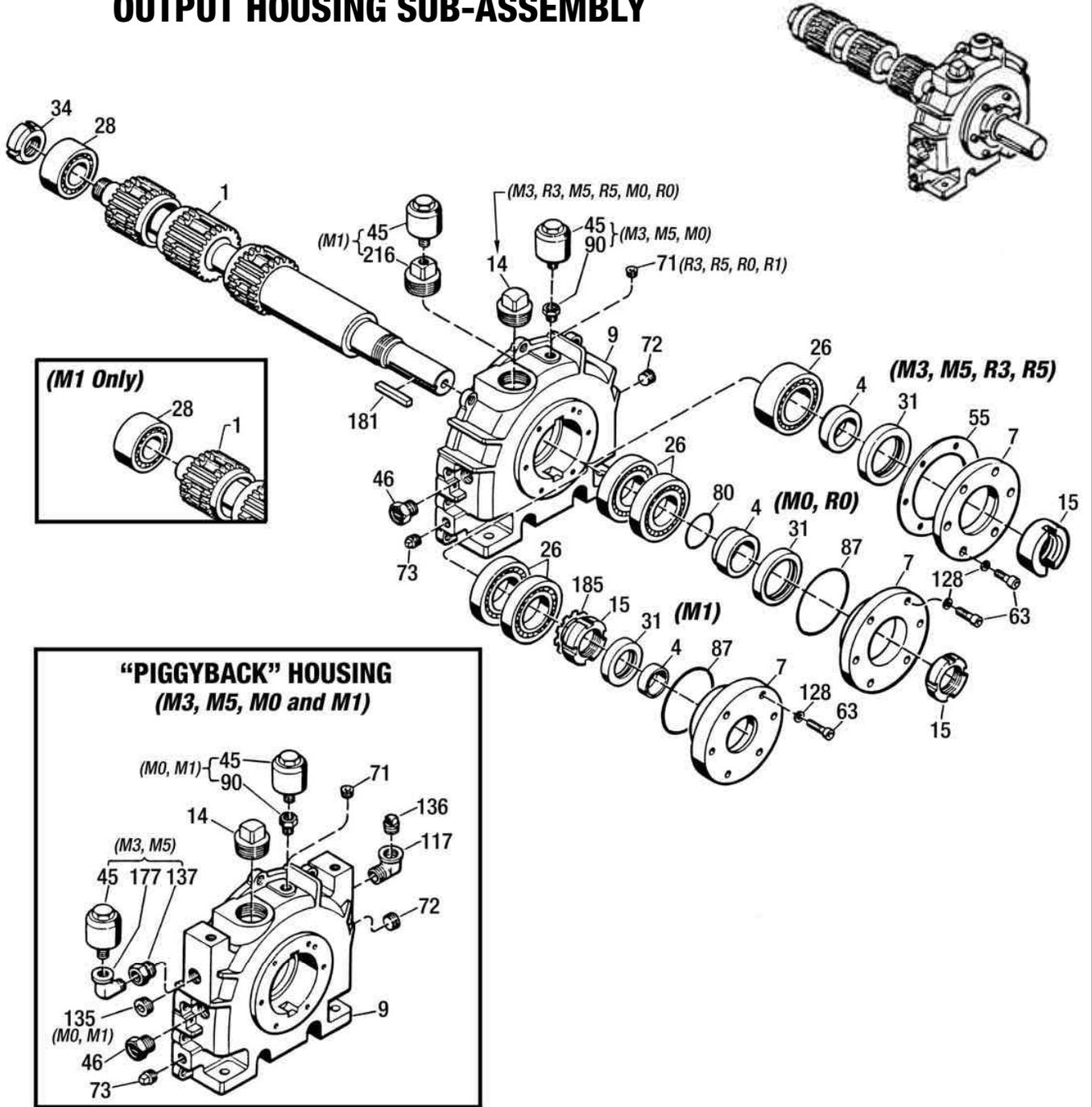


Figure 10.08 - Output Housing Sub-Assembly



# Manual Revision & Printing History

## *Multi-Speed (MSDr) & High Speed Reversing (HSRvD) Drives*

REVISION NUMBER	REVISION DATE <i>(Mo./Yr.)</i>	PRINTING DATE <i>(Mo./Yr.)</i>	REVISION/ACTION DESCRIPTION	REVISION INITIATED BY: <i>(Name)</i>	REVISION MADE BY: <i>(Name)</i>
502-HS/MS-03	-----	10/92	Printed	-----	-----
502-HS/MS-03	8/03	-----	Created complete digital file to create a PDF file for the web. Updated manual format. New cover and back. Added Warranty information. Removed Detroit info. Added Revision History.	Jerry Brooks	Jerry Brooks
	-----		Printed	-----	-----

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***Worldwide Leader in Oil Shear Technology.***

*Providing today's industries  
with Oil Shear Clutch and  
Brake Drives that delivers:  
Flexibility • Efficiency  
Endurance • Performance  
Dependability*

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**“Built to Last - Guaranteed to Perform”**

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