

# HSV (Hydrostatic Speed Variator)

## Installation & Maintenance Manual

P-5032-TBW  
Form 1076B



**WARNING:**

**Rotating equipment must be properly guarded.**

**It is the responsibility of the user to properly guard all rotating equipment to comply with OSHA or any applicable regulations. Failure to properly guard may contribute to severe injury should someone come in contact with the rotating parts or should the rotating part fail.**

**WARNING:**

**DO NOT use Wood's products on any primary aircraft drive or any other drive which could endanger human life should a drive component fail.**

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## INTRODUCTION

The Hydrostatic Speed Variator (HSV) is an integrated hydrostatic transmission which is designed to vary the speed of fixed speed industrial base motors. Today many industries require more versatility than fixed base speeds such as 900, 1200, 1800, and 3600 RPMs offer. Though 2 speed motors are available, they are expensive and difficult to find replacements for when necessary. The HSV handles variable speed requirements as well as a number of secondary functions.

The HSV offers infinitely variable speed reduction ratios from 0 to the input speed. Its ratio range is extensive, 42:1 with 1750 RPM input. The speed controls are completely reversible and speed can be controlled with the power on or off.

In addition to these primary functions, the HSV provides high starting torque, even at low speeds. It maintains accurate control of resistive, overhauling, and alternating loads and it offers excellent dynamic braking capacity. Its high reliability and simple, rugged construction makes the HSV good for dirty washdown and explosion-proof applications. The self-contained modular unit requires only minimum maintenance.

## IMPORTANT SAFETY NOTICE

Proper service and repair is important to the safe, reliable operation of all hydrostatic speed variators. The service procedures recommended and described in this manual are effective methods of performing service operations.

It is impossible to know, evaluate and advise you of all conceivable ways in which service might be done or of the possible hazardous consequences of each way.

## OPERATION OF THE HSV

The Hydrostatic Speed Variator (HSV) is an integrated hydrostatic transmission consisting of a variable displacement radial piston pump driving a fixed displacement radial piston motor. The pump-motor system is completely contained within one case, providing light weight and ease of maintenance and serviceability.

The hydrostatic closed loop operates in the following manner. The input shaft (19) rotates the cylinder block of the radial piston pump (8, 10). The pistons (9) stroke in and out of their cylinders pumping hydraulic oil through the distributor shaft (14) to the radial piston hydraulic motor (8, 11). The oil then returns directly to the pump. In both the pump and the motor the stroke of the pistons is limited by the eccentric rings (6, 39). The position of the pump eccentric ring is controlled by the hand-wheel. This varies the flow rate from the pump to the motor. Since the motor eccentric ring is fixed in place, the speed of the hydraulic motor is directly proportional to the flow received from the pump. The pump eccentric ring can be moved to either side of the concentric center position, thereby reversing the flow and reversing the output shaft. When a torque load is applied to the output shaft, a pressure proportional to the torque is produced in the passages which transmit oil from the pump to the hydraulic motor. Some leakage occurs in these high pressure sections causing slip. The low pressure return line is supplied by a small charge pump (15, 16, 17, 18). It makes up for the small leakage and maintains a positive pressure (approximately 120 psi) at the inlet of the main pump. The charge pump also provides positive lubrication and power to the hydraulic controls. The crossover check valves (84) direct the charge flow to the low pressure side of the closed loop. High system pressure is limited by the main relief valves (85). These provide protection from excessive torque overloads for both the variator and the driven machine. The input and output shafts are independently mounted in their end covers and coupled to their respective cylinder blocks. Consequently, no shaft deflections are transmitted to the hydraulic mechanism and no hydraulic forces are carried by the shaft bearings.

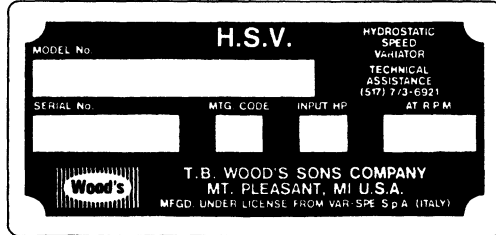
## TOOL LIST

In most cases, a standard set of tools is all that will be needed to rebuild the HSV. However, these items will be helpful, if available:

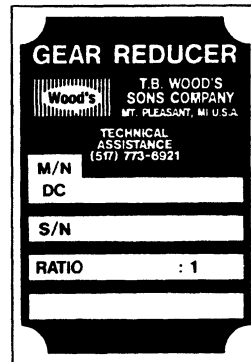
- metric Allen wrench set
- pocket magnet
- rubber mallet or brass hammer
- sheet of plastic (at least 10" x 12") piece of shim stock
- acetylene torch
- heavy gloves
- air gun with metric hex drives (optional)
- needle nose pliers
- snap ring pliers

# NAME PLATE AND SERIAL NUMBER IDENTIFICATION

The name plate is located on the speed control side of the HSV.



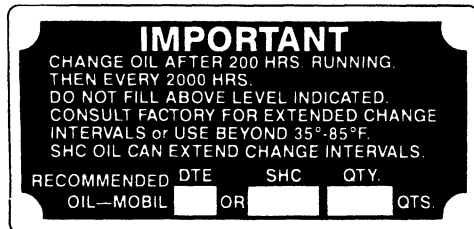
The helical speed reducer plate is located on the gear reducer, itself.



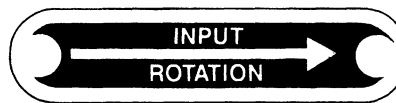
NAME PLATE

GEAR REDUCER PLATE

The lubrication plate is located on the side of the HSV, opposite the name plate.



The direction of rotation plate is located on the input cover and belt guard, if the unit is equipped with one.



OIL SPECIFICATION  
PLATE

INPUT ROTATION PLATE

## HSV – Shaft Load Capacities

HSV SIZE	INPUT SHAFT		OUTPUT SHAFT	
	AXIAL (LBS)	RADIAL (LBS)	AXIAL (LBS)	RADIAL (LBS)
11	79	132	79	132
12	128	155	128	155
13	185	240	185	240
14	220	285	220	285
15	250	245	250	375
16	330	385	330	515
16B	430	685	330	515
17	430	685	430	870
17B	510	825	430	870

Above loads are calculated for forces applied to the midpoint of the shaft.

**CAUTION:** Rotating equipment is potentially dangerous and should be properly shielded. The user should check for all applicable safety codes in his area and provide a suitable guard.

1. Select a support base for the HSV which is adequately sized and solid enough to prevent vibrations.
2. The reducer should be level and bolted tightly.
3. The input and output shafts should be properly aligned with other equipment to minimize shaft loading.

4. As the arrow indicates, INPUT ROTATION SHOULD BE CLOCK-WISE as you face the input shaft. The input shaft is closest to the control mechanism.
5. The driving motor should be connected to the INPUT SIDE of the variator. (Note: To prevent input shaft lock up on an HSV 14 with a 182 TC NEMA-C flange input, do not use a Reliance brand motor.)

SHAFT LOAD  
CAPACITIES

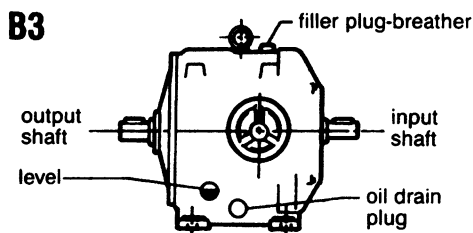
HSV  
INSTALLATION  
PROCEDURES

# MOUNTING POSITIONS OF THE HSV

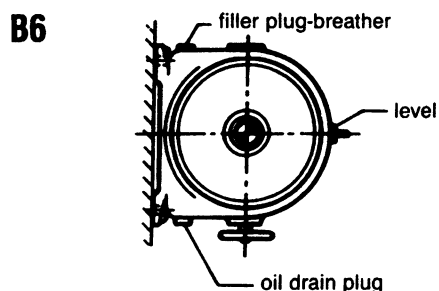
## HORIZONTAL POSITION B

The HSV is capable of being installed with the shafts inclined 30° from the horizontal by increasing the oil level slightly. Vertical and sidewall mounting

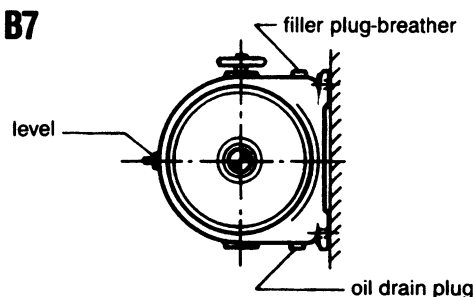
require the installation of Option Code C: Vertical Mount Kit. Sizes 16B and 17B cannot be mounted vertically.



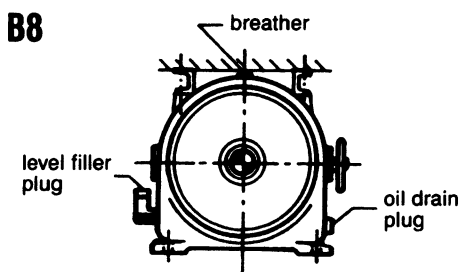
Horizontal shaft  
Floor mounting



Horizontal shaft  
Wall mounting with feet on the left  
looking at the output shaft  
**To be prepared in factory**  
Option Code C Required

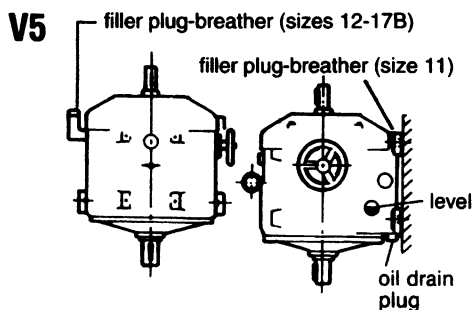


Horizontal shaft  
Wall mounting with feet on the right  
looking at the output shaft  
**To be prepared in factory**  
Option Code C Required

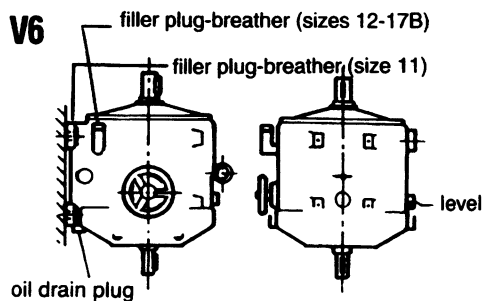


Horizontal shaft  
Ceiling mounting

## VERTICAL POSITION V

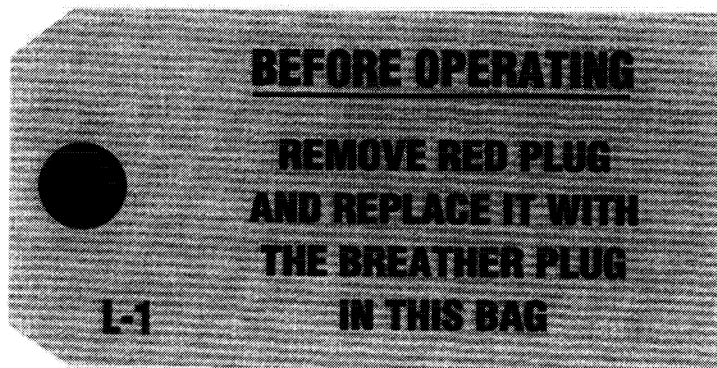


Vertical shaft output downwards  
Wall mounting with feet  
**To be prepared in factory**  
Option Code C Required



Vertical shaft output upwards  
Wall mounting with feet  
**To be prepared in factory**  
Option Code C Required

# HSV START UP PROCEDURES



**CAUTION:** Some units are shipped from the factory with the breather plug hole sealed to avoid lubrication seepage during shipping. **THE RED PLUG MUST BE REMOVED AND DISCARDED AND THE BREATHER PLUG INSTALLED BEFORE HSV START UP.**

1. Before starting the HSV, check the oil level at the sight port to make sure it is correct. Use the oil specification chart as a reference.
2. The control mechanism can be mounted to either side of the HSV case.
3. Use the adjusting control to vary the output RPM. Unless otherwise stated, the adjusting control offers progressive variations for both directions of rotation.
4. Check that input motor direction coincides with arrow on the case. Reversed input direction will cause internal damage.
5. The variator is best applied when its output speed is equal to or just above the maximum speed required for the driven machine. Make sure, however, that this condition does not overload the variator. Electric motor amperage may run above name plate levels at full load when the HSV is new due to initial shaft seal drag and break in. To check actual load on the HSV, use a Code M pressure tap and gauge. Consult with factory for details.
6. A new unit should be run 15 to 20 minutes at low speed upon initial start up with little or no load to provide proper break-in.
7. If installed in a cold ambient temperature, the HSV should be run at LOW speed for a few minutes to warm the oil.
8. At full load, the normal operating temperature of the HSV is 110°F (60°C) above ambient temperature.

- 
1. Consult the Oil Specification chart to find the proper oil type and quantity for the HSV.  
NOTE: The warranty will be voided if these servicing requirements are not followed.
  2. Change oil after first 200 hours of operation.
  3. Change oil every 2000 hours afterward.
  4. Extended intervals may be attained up to 8,000 hours by using synthetic oils rather than the standard mineral base oils.
  5. Wood's helical speed reducers are filled with fluid grease lubricant at the factory. Initial fill will last 10,000 operating hours at temperatures ranging between 10 and 120°F.
  6. Consult the Fluid Grease Lubricant chart to find the proper lubricant and quantity for the gear reducer.
  7. Before refilling the gear reducer, clean the gear casing thoroughly.

## HSV MAINTENANCE PROCEDURES

# WOOD'S GEAR REDUCER LUBRICANT CHART

## AMOUNT OF LUBRICANT QTS.

### SINGLE REDUCTION UNITS

MTG POS	REDUCER SIZE				
	DC11	DC21	DC31	DC41	DC51
B3	0.3	0.7	1.2	1.8	2.4
B6	0.5	1.1	1.8	2.6	3.7
B7	0.5	1.1	1.8	2.6	3.7
V5	0.6	1.3	2.4	3.2	4.7
V6	0.5	1.7	2.1	3.2	4.2

### DOUBLE REDUCTION UNITS

MTG POS	REDUCER SIZE										
	DC02	DC12	DC22	DC32	DC42	DC52	DC62	DC72	DC82	DC92	DC102
B3	0.3	0.3	0.7	1.3	1.9	2.9	9.0	16.0	23.0	44.0	66.0
B6	0.7	0.8	1.8	2.7	3.2	5.9	8.0	10.0	19.0	36.0	53.0
B7	0.7	0.8	1.8	2.7	3.2	5.9	14.0	22.0	35.0	51.0	78.0
V5	0.8	1.1	2.5	3.5	4.4	7.4	21.0	33.0	49.0	94.0	122.0
V6	0.9	1.2	3.0	4.1	5.2	8.0	21.0	34.0	51.0	81.0	114.0

### TRIPLE REDUCTION UNITS

MTG POS	REDUCER SIZE										
	DC03	DC13	DC23	DC33	DC43	DC53	DC63	DC73	DC83	DC93	DC103
B3	0.5	0.8	1.2	2.1	3.0	4.9	8.0	15.0	22.0	43.0	64.0
B6	0.8	1.1	2.2	3.2	4.1	6.9	16.0	24.0	38.0	61.0	80.0
B7	0.8	1.1	2.2	3.2	4.1	6.9	13.0	21.0	34.0	49.0	76.0
V5	1.4	1.7	3.7	5.7	7.6	10.0	20.0	32.0	48.0	92.0	119.0
V6	1.1	1.7	3.6	4.9	7.0	9.9	20.0	33.0	50.0	79.0	112.0

### RECOMMENDED LUBRICANTS

Type of Lubricant	Ambient Temp. Range (°F)	kin Viscosity (cSt) at 40°C (mm 2/S)	Viscosity SUS 175 100°F	AGMA Lubricant No.	ISO Grade	AMOCO	CHEVRON	EXXON	MOBIL	SHELL	TEXACO
Oil	15 to 125	196 to 242	900 to 1100	SEP	220EP	Amogear EP220	NL Gear Compound 220	Spartan EP220	Mobile Gear 630	Omaia Oil 220	Meropa 220
	-10 to +75°	90 to 765	465 to 165	3-4EP	100-150EP	Amogear EP150	NL Gear Compound 150	Spartan EP150	Mobil 629	Omaia Oil 100	Meropa 150
	Below 10°††	15 to 680		135 to 165	—	—	EP Hydraulic —	Univis Oil 22	Mobile D.T.E. J13	—	Texamatic Fluid 9226 or Texamatic Type F
Oil - Synthetic	-40° to 175°††	—	90 to 4000	—	—	—	—	—	Mobile SHC 629 or 634	—	Synstar GL75W-140
Fluid Grease	5° to 120°	—	—	—	—	—	—	—	—	—	Markfak 00

For bearings not lubricated in oil bath use a lithium base bearing grease, NLGI #2 or #3

† Ambient temperatures below -20°F and above 140°F require special oil seals.

†† Consult with the factory for these applications.

Bold ambient temperature indicates factory filled.



# HSV OIL SERVICING REQUIREMENTS

Variator Size	Ambient Temperature	Gulf Oil	Amoco Oil	Shell Oil	Mobil
					Anti-Wear Hydraulic Oils
11	5°-35°F <sup>(1)</sup>	Harmony 22	Spindle "C"	Tellus 22	DTE 16
	35°-86°F	Harmony 32AW	Rykon 32	Tellus 32	DTE 16
	86°-104°F <sup>(2)</sup>	Harmony 68 AW	Rykon 68	Tellus 68	DTE 26
12, 13 14, 15	5°-35°F <sup>(1)</sup>	Harmony 68 AW	Rykon 68	Tellus 68	DTE 16
	35°-86°F	Harmony 100 AW	Rykon 100	Tellus 100	DTE 18 or DTE Oil Heavy
	86°-104°F <sup>(2)</sup>	Harmony 150 AW	Amovis 150	Turbo 150	DTE 18 or DTE Oil Heavy
16, 16B 17, 17B	5°-35°F <sup>(1)</sup>	Harmony 68 AW	Rykon 68	Tellus 68	DTE 16
	35°-104°F <sup>(2)</sup>	Harmony 150 AW	Amovis 150	Turbo 150	DTE 18 or DTE Oil Extra Heavy

## OIL SPECIFICATION CHART

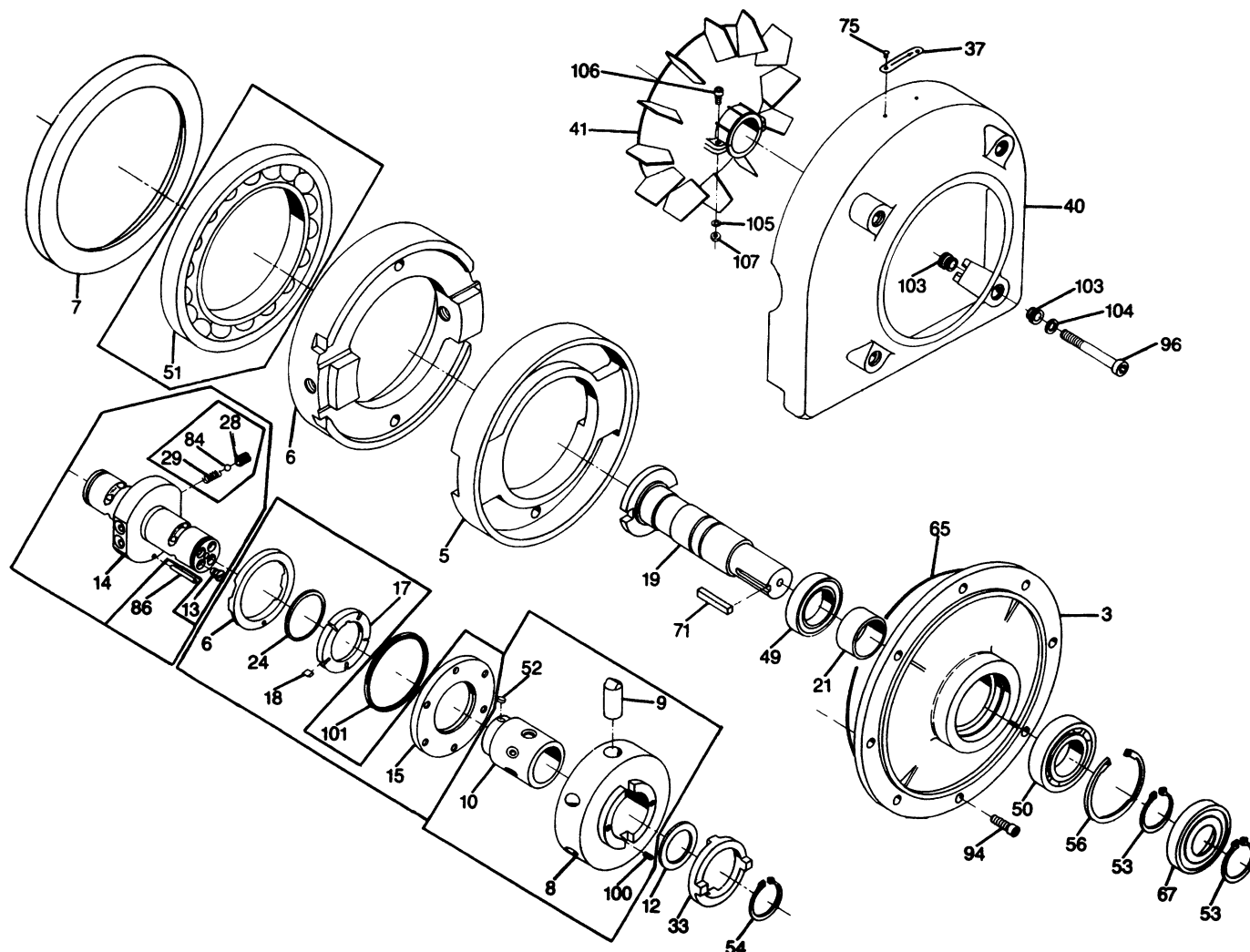
Variator Size	Ambient Temperature	Lubriplate Hydraulic Oils	Extended Drain Synthetic Oils <sup>(3)</sup>		USDA Food Grade Lubricants
			Mobil	Lubriplate	
11	5°-86°F	HO-0 or HO-32	SHC 626	SPO-233	Contact Factory
	86°-104°F	HO-68 or HO-2			
12, 13 14, 15	5°-35°F	HO-68 or HO-2	SHC 626	SPO-233	
	35°-86°F	HO-2A	SHC 629	SPO-244	
	86°-104°F	HO-3	SHC 629	SPO-244	
16, 16B 17, 17B	5°-35°F	HO-68 or HO-2	SHC 626	SPO-233	
	35°-104°F	HO-3	SHC 629	SPO-244	

- (1) Electric oil preheater (Code P) recommended for temperatures below 5°F.  
 (2) Oil cooler (Code R) highly recommended for temperatures above 104°F.  
 (3) Synthetic oils provide extended operating temperature ranges and lubricant life. Drain intervals may be extended up to 8,000 hours. Contact factory for more information.

Mounting Position	HSV Size	11	12	13	14	15	16	16B	17	17B
Horizontal	Quarts	0.5	0.8	1.5	1.85	4.8	6.9	7.5	12.8	13.4
	Liters	0.5	0.75	1.4	1.75	4.5	6.5	7.0	12.0	12.5
Vertical	Quarts	0.75	0.8	1.6	1.85	5.3	8.5	—	15.0	—
	Liters	0.7	0.75	1.5	1.75	5.0	8.0	—	14.0	—
Inclined 30°	Quarts	0.85	1.0	2.0	2.3	5.3	8.5	—	15.0	—
	Liters	0.8	0.9	1.8	2.1	5.0	8.0	—	14.0	—

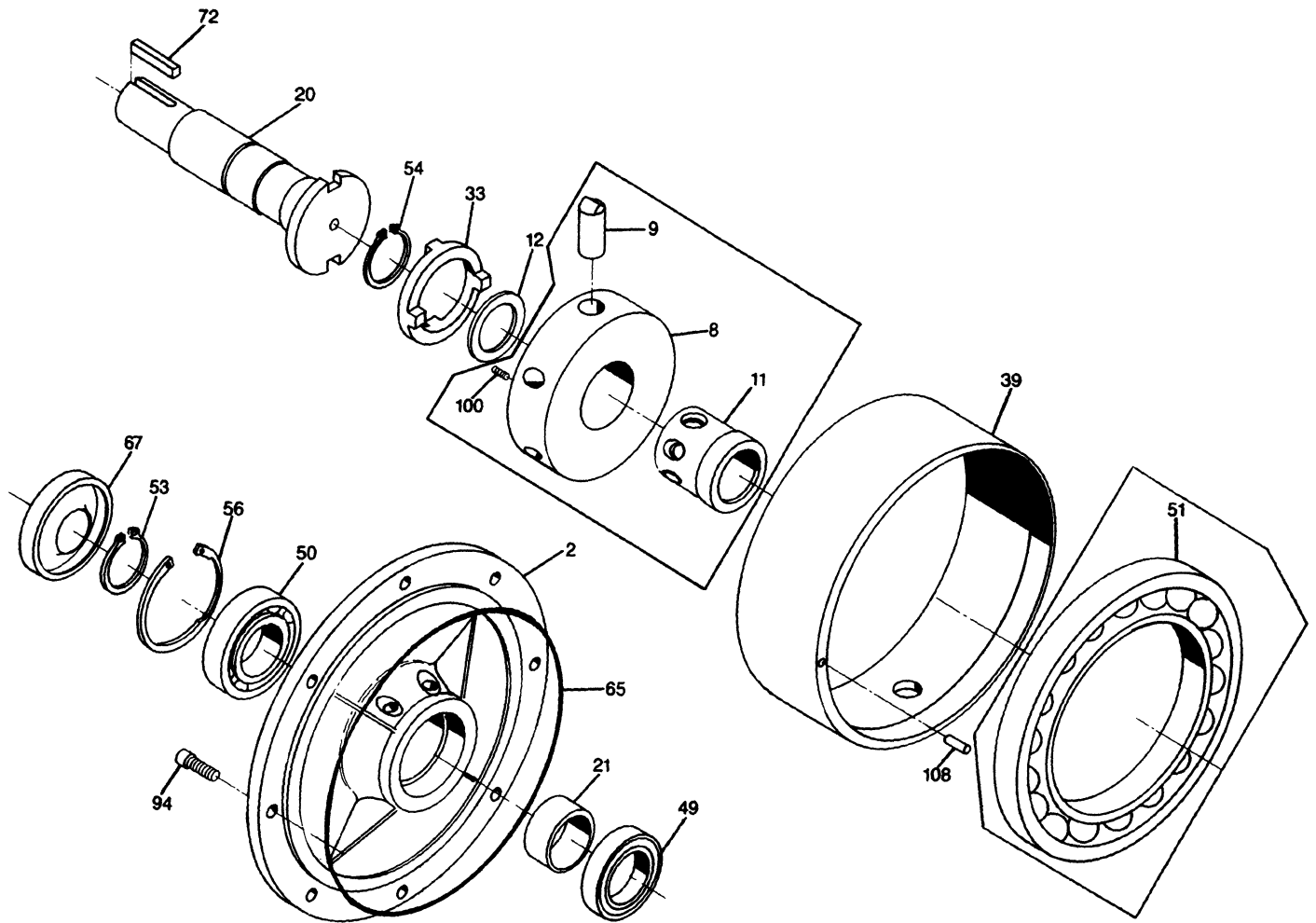
The quantity of oil required by the variator changes according to the mounting position of the variator.

# INPUT COVER ASSEMBLY AND INTERNAL PARTS



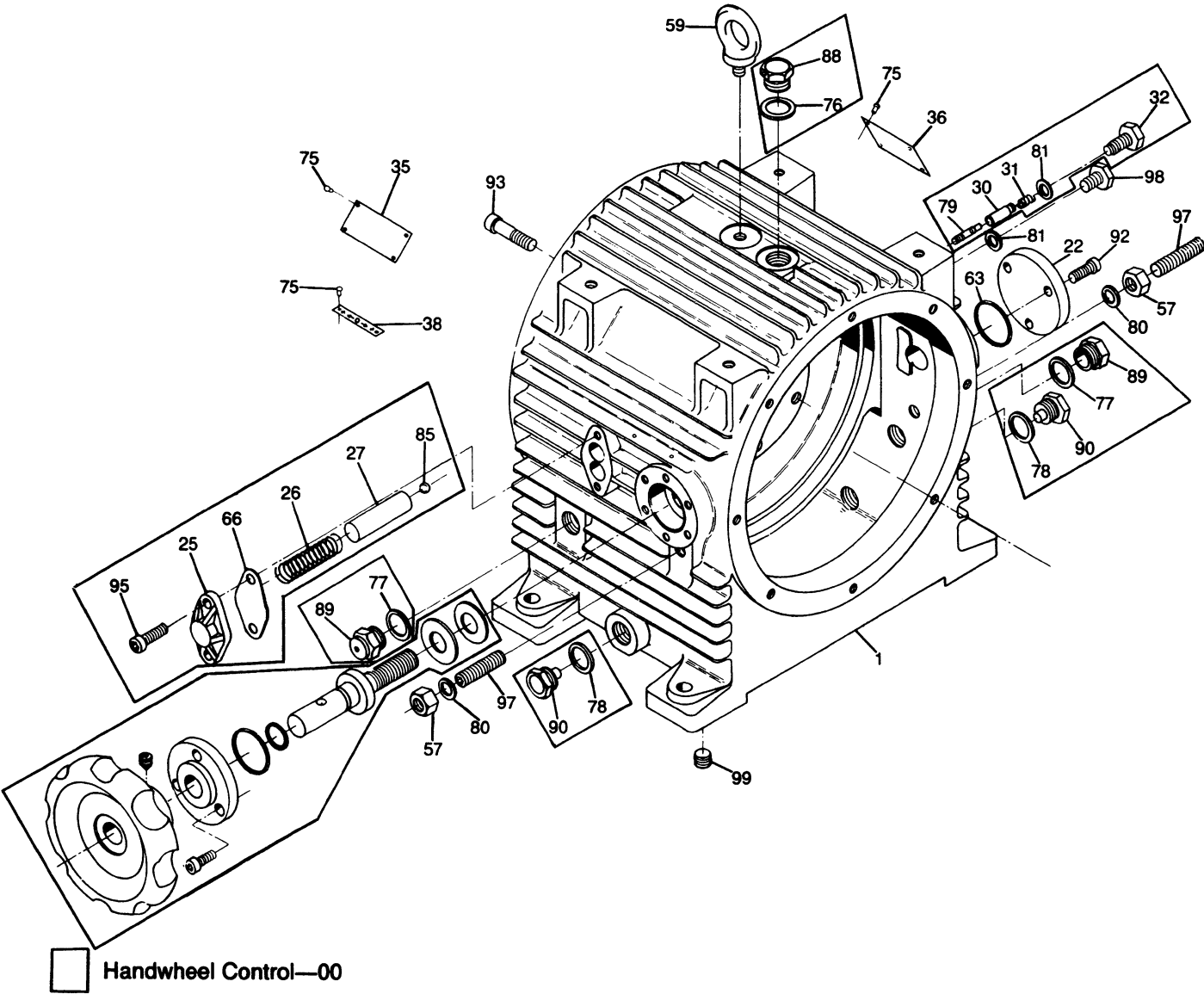
**Circled items are sold in kits only. See pages 10, 11, 12.**

# OUTPUT COVER ASSEMBLY AND INTERNAL PARTS



**Circled items are sold in kits only. See pages 10, 11, 12.**

# BASE UNIT AND EXTERNAL PARTS



**Circled items are sold in kits only. See pages 10, 11, 12.**

# HSV GENERAL PARTS LIST

To request spare parts please give size of HSV, HSV serial number, kit reference number and part name. Parts with separate reference numbers are sold in subassemblies or kits only. See page 12 for kit designation.

## BASE UNIT

Part Ref. No.	Kit Ref. No.	Quantity Each Size							Part Name
		11	12	13	14	15	16	17	
1		1	1	1	1	1	1	1	Case
5		1	1	1	1	1	1	1	External Sliding Ring
6		1	1	1	1	1	1	1	Pump Eccentric Adjusting Ring
7		1	1	1	1	1	1	1	Internal Sliding Ring
8	1,2	2	2	2	2	2	2	2	Cylinder Block
9	1,2	14	14	14	14	14	28	36	Piston
10	1	1	1	1	1	1	1	1	Pump Bushing
11	2	1	1	1	1	1	1	1	Pump Bushing
12	11	2	2	2	2	2	2	2	Sliding Washer
13		2	4	4	4	4	4	4	Plug
14		1	1	1	1	1	1	1	Distributing Shaft
15	3	1	1	1	1	1	1	1	Charge Pump Flange
16	3	1	1	1	1	1	1	1	Charge Pump Stator
17	3	1	1	1	1	1	1	1	Charge Pump Impeller
18	3	5	5	5	5	5	7	7	Roller
22		1	1	1	1	1	1	1	Cover for Control Hole
24	3	—	—	—	—	—	—	—	Charge Pump Ring
25		1	1	1	1	1	1	1	Relief Valve Cover
26	4	2	2	2	2	2	2	2	Relief Valve Spring
27	4	2	2	2	2	2	2	2	Relief Valve Piston
28	5	2	2	2	2	2	2	2	Check Valve Seats
29	5	2	2	2	2	2	2	2	Check Spring
30	6	1	1	1	1	1	1	1	Low Pressure Poppet
31	6	1	1	1	1	1	1	1	Charge Pump Relief Valve Spring
32	6	1	1	1	1	1	1	1	Relief Cap Plug
33		—	2	2	2	2	2	2	Oldham Coupling
35		1	1	1	1	1	1	1	Oil Name Plate
36		1	1	1	1	1	1	1	HSV Name Plate
37		1	1	1	1	1	1	1	Rotation Plate (Motor)
38		1	1	1	1	1	1	1	Control Name Plate
39		—	—	—	1	1	1	1	Motor Eccentric Ring
44		—	—	—	—	—	1	1	Locating Bolt
45		—	—	—	—	—	1	1	Internal Pump Eccentric Adjusting Ring
51**	7	2	2	2	2	2	2	2	Bearing
52	1	1	1	1	1	1	1	1	Feather Key or Pin
54	11	1	2	2	2	2	2	2	External Snap Ring
55	11	1	1	1	—	—	—	—	External Snap Ring
57		2	2	2	2	2	2	2	Nut
59		—	—	—	—	1	1	1	Eyebolt
63*	8	1	1	1	1	1	1	1	O-Ring Gasket for Control Plug
66	8	1	1	1	1	1	1	1	Paper Gasket
68		5	7	7	7	7	7	7	Loctite 270
73		1	1	1	1	1	1	1	Loctite AVX586
74		1	1	1	1	1	1	1	Loctite 641
75		12	12	12	12	12	12	12	Screw Rivet
76	9	1	1	1	1	1	1	1	Filler-Breather Plug Gasket
77	9	2	2	2	2	2	2	2	Level Plug Gasket
78	9	2	2	2	2	2	2	2	Drain Plug Gasket

\*Items not sold separately. Available in Seal Kits only. \*\*Items not sold separately. Available in Bearing Kits only.

# HSV GENERAL PARTS LIST

## BASE UNIT (cont.)

## INPUT COVER ASSEMBLY

Part Ref. No.	Kit Ref. No.	Quantity Each Size							Part Name
		11	12	13	14	15	16	17	
79	6	1	1	1	1	1	1	1	Valve Support Stem
80		2	2	2	2	2	2	2	Aluminum Washer for Stops
81		2	2	2	2	2	2	2	Aluminum Washer for Hexagon-Head Screw
82		—	—	—	—	—	—	1	Aluminum Washer
83	5	—	—	—	—	—	1	1	Aluminum Washer
84		2	2	2	2	2	2	2	Ball
85		2	2	2	2	2	2	2	Ball
86		1	1	1	1	1	1	1	Pin
87	3	—	—	—	1	1	—	—	Pin
88		1	1	1	1	1	1	1	Filler-Breather Plug
89		2	2	2	2	2	2	2	Level Plug
90		2	2	2	2	2	2	2	Drain Plug
92		2	3	3	3	3	3	3	Control Hole Plug Screw
93		4	4	6	6	6	8	8	Charge Pump Flange Screw
95		2	2	2	2	2	2	2	Cover Bolt
97		2	2	2	2	2	2	2	Set Screw
98		1	1	1	1	1	1	1	Charge Pressure Port Bolt
99		1	1	1	1	1	1	1	Screw
100*		—	2	2	2	2	2	2	Bushing Screw
101*		—	1	1	1	1	1	1	O-Ring
102	8	—	—	—	—	—	—	2	Check Valve Stop
108		—	—	—	—	1	2	2	Pin
109		2	2	2	2	2	2	2	Thread Sealant
3		1	1	1	1	1	1	1	Input Cover
4		—	—	—	—	—	1	1	Bearing Cover
19		1	1	1	1	1	1	1	Input Shaft
21		1	1	1	1	1	1	1	Bearing Spacer Ring
40		—	—	—	—	1	1	1	Fan Cover
41		—	—	—	—	1	1	1	Cooling Fan
49**		1	1	1	1	1	1	1	Internal Bearing
50**		1	1	1	1	1	1	1	External Bearing
53	12	1	1	1	1	2	2	2	External Snap Ring
56	12	1	1	1	1	1	—	—	Internal Snap Ring
64*	8	—	—	—	—	—	1	1	Bearing Cover O-Ring
65*	8	1	1	1	1	1	1	1	Cover O-Ring
67*	8	1	1	1	1	1	1	1	Shaft Seal
71		1	1	1	1	1	1	1	Shaft Key
91		—	—	—	—	—	4	4	Bearing Cover Bolt
94		4	4	6	6	4	4	4	Cover Bolts
96		—	—	—	—	4	4	4	Fan Cover Bolts
103		—	—	—	—	8	8	8	Rubber Grommet
104		—	—	—	—	4	4	4	Cover Washer
105		—	—	—	—	2	2	2	Fan Washer
106		—	—	—	—	2	2	2	Fan Bolt
107		—	—	—	—	2	2	2	Fan Nut

## NEMA-C FLANGE INPUT COVER ASSEMBLY

(Note: NEMA-C  
input flange parts  
are designated  
with a "G" after  
the part number.)

Part Ref. No.	Quantity Each Size							Part Name
	11	12	13	14	15	16	17	
3G	1	1	1	1	1	1	—	Nema-C Flange Input Cover
4G	—	—	—	—	1	1	—	Bearing Cover
19G	1	1	1	1	1	1	—	Input Shaft
21G	—	—	—	—	1	1	—	Bearing Spacer Ring
40G	—	—	—	—	1	1	—	Fan Cover
41G	—	—	—	—	1	1	—	Cooling Fan
49** <sup>10</sup>	—	—	—	—	1	1	—	Internal Bearing
50** <sup>10</sup>	—	—	—	—	1	1	—	External Bearing
53G <sup>12</sup>	—	—	—	—	2	2	—	External Snap Ring

\*Items not sold separately. Available in Seal Kits only.

\*\*Items not sold separately. Available in Bearing Kits only.

# HSV GENERAL PARTS LIST

## NEMA-C FLANGE INPUT COVER ASSEMBLY (cont.)

(Note: NEMA-C flanges are not available for the HSV size 16B, 17 and 17B).

## OUTPUT COVER ASSEMBLY

## NEMA-C OUTPUT COVER ASSEMBLY

(Note: NEMA-C output flange parts are designated with an "F" after the part number.)

Part Ref. No.	Quantity Each Size							Part Name
	11	12	13	14	15	16	17	
64°G	—	—	—	—	1	1	—	Bearing Cover O-Ring
65°G	1	1	1	1	1	1	—	Cover O-Ring
67°G	1	1	1	1	1	1	—	Shaft Seal
91G	—	—	—	—	4	4	—	Bearing Cover Bolt
94G	4	4	6	6	4	4	—	Cover Bolts
96G	—	—	—	—	4	4	—	Fan Cover Bolts
103G	—	—	—	—	8	8	—	Rubber Grommet
104G	—	—	—	—	4	4	—	Cover Washer
105G	—	—	—	—	2	2	—	Fan Washer
106G	—	—	—	—	2	2	—	Fan Bolt
107G	—	—	—	—	2	2	—	Fan Nut

Part Ref. No.	Kit Ref. No.	Quantity Each Size							Part Name
		11	12	13	14	15	16	17	
2		1	1	1	1	1	1	1	Output Cover
4		—	—	—	—	—	1	1	Bearing Cover
20		1	1	1	1	1	1	1	Output Shaft
21		1	1	1	1	1	1	1	Bearing Spacer Ring
49**	10	1	1	1	1	1	1	1	Internal Bearing
50**	10	1	1	1	1	1	1	1	External Bearing
53	12	1	1	1	1	1	1	1	External Snap Ring
56	12	1	1	1	1	1	—	—	Internal Snap Ring
64*	8	—	—	—	—	—	1	1	Bearing Cover O-Ring
65*	8	1	1	1	1	1	1	1	Cover O-Ring
67*	8	1	1	1	1	1	1	1	Shaft Seal
72		1	1	1	1	1	1	1	Shaft Key
91		—	—	—	—	—	4	4	Bearing Cover Bolt
94		4	4	6	6	8	8	8	Cover Bolt
2F		1	1	1	1	1	1	1	NEMA-C Flange Output Cover
4F		—	—	—	—	—	1	1	Bearing Cover
20F		1	1	1	1	1	1	1	Output Shaft
21F		1	1	1	1	1	1	1	Bearing Spacer Ring
49F**	10	1	1	1	1	1	1	1	Internal Bearing
50F**	10	1	1	1	1	1	1	1	External Bearing
53F	12	1	1	1	1	1	1	1	External Snap Ring
56F	12	1	1	1	1	1	—	—	Internal Snap Ring
64F	8	—	—	—	—	—	1	1	Bearing Cover O-Ring
65F	8	1	1	1	1	1	1	1	Cover O-Ring
67F	8	1	1	1	1	1	1	1	Shaft Seal
72F		1	1	1	1	1	1	1	Shaft Key
91F		—	—	—	—	—	4	4	Bearing Cover Bolt
94F		4	4	6	6	8	8	8	Cover Bolt or Stud
108F		4	4	6	6	8	8	8	Spring Washer
109F		4	4	6	6	8	8	8	Nut

\*Items not sold separately. Available in Seal Kits only. \*\*Items not sold separately. Available in Bearing Kits only.

### Repair Kits

- |                                  |                         |
|----------------------------------|-------------------------|
| 1 Input Rotating Group           | 7 Main Bearing Kit      |
| 2 Output Rotating Group          | 8 Seal Kit              |
| 3 Charge Pump                    | 9 Plug and Breather Kit |
| 4 High Pressure Relief Valve Kit | 10 Shaft Bearing Kit    |
| 5 Check Valve Kit                | 11 Base Retainer Kit    |
| 6 Low Pressure Relief Valve Kit  | 12 Shaft Retainer Kit   |

Note: Specify HSV part number and serial number when ordering parts.

# TROUBLESHOOTING THE HYDROSTATIC SPEED VARIATOR

POSSIBLE HSV PROBLEM	CAUSE	REMEDY
<b>A) Will not hold speed or maintain torque</b>	1. Operating temperature too high or incorrect oil being used.	Refer to oil servicing requirement chart for correct oil. Replace oil with correct grade.
	2. Variator leaking internally due to wear.	Variator must be rebuilt.
	3. RPM range too low.	If the actual maximum output speed is less than what the HSV is rated for, change the gearbox ratio so the HSVs output speed matches its rating.
	4. Charge pump pressure less than 90 psi.	Clean charge relief valve located under top hex nut. Lengthen spring if necessary.
<b>B) Output shaft speed not constant (RPMs decrease)</b>	1. Periodic shock loads too high causing main valve to open.	Replace HSV with higher HP unit.
	2. Oil viscosity (grade) too low.	Refer to oil servicing chart. Replace oil with correct grade.
	3. Variator size too small for application.	Replace variator with higher HP unit.
<b>C) Operating temperature greater than 120 F above ambient temperature</b>	1. Type of oil unsuitable.	Refer to oil servicing chart. Replace oil with correct grade.
	2. Variator leaking internally due to wear.	Variator must be rebuilt.
	3. Excessive internal friction.	Variator must be rebuilt.
	4. Overloading causes main relief valve to open.	Check load. If possible, check amperage drawn by electric motor.
	5. Ambient temperature higher than 105 F.	Air cool variator or install air or water heat exchanger.
<b>D) Excessive noise</b>	1. Overloading causes relief valve chattering, pistons slapping.	Check load. If possible, check amperage drawn by electric motor.
	2. Charge pump pressure less than 90 psi.	Clean charge relief valve located under top hex nut. Lengthen spring if necessary.
	3. Incorrect installation, base unsuitable.	Replace with more rugged base or fit with vibration dampers.
	4. Ball bearings seized up. Improper bearing clearance.	Replace ball bearings.
	5. Driving motor damaged.	Repair motor.



# TROUBLESHOOTING THE HYDROSTATIC SPEED VARIATOR

POSSIBLE HSV PROBLEM	CAUSE	REMEDY
<b>E) Output shaft moves slowly</b>	1. Insufficient oil in variator.	Check oil level and fill as needed.
	2. Drive motor running wrong direction of rotation.	Change rotation. Correct variator rotation is clockwise as you face the input shaft. Plus, rotation is marked.
	3. Charge pump pressure lower than 90 psi.	Clean charge relief valve located under top hex nut. Lengthen spring if necessary.
	4. Incorrect installation.	Check the mounting specification. Correct as specified.
	5. RPM range too low.	If the actual maximum output speed is less than what the HSV is rated for, change the gearbox ratio so the HSVs output speed matches its rating.
<b>F) Oil foaming excessively</b>	1. Type of oil unsuitable.	Refer to oil servicing chart. Replace with correct grade of oil.
	2. Insufficient oil in variator.	Check oil level and fill as needed.
	3. Air drawn into pump.	Gasket on charge pump flange damaged or missing. Disassemble HSV to check. Replace gasket.
<b>G) Variator seized, input or output shaft</b>	1. Variator pump or motor seized.	Pump or motor rotating groups must be removed and examined. Bronze bushings must be cleaned up or rotating groups replaced.
	2. Too much bearing friction.	Check shaft ball bearings and replace if necessary. Check to be sure oil lube holes on the bearing are upright.
	3. Electrical equipment failure.	Check electrical connection on motor. Repair if necessary.
<b>H) Variator difficult to start</b>	1. Type of oil unsuitable.	Refer to oil servicing chart. Replace with correct grade of oil.
	2. Variator too small for application.	Replace variator with higher HP unit.
	3. Voltage or electric current lower than driving motor requires.	Check connections on electric motor and repair if necessary.
	4. RPM range too low.	If the actual maximum output speed is less than when the HSV is rated for, change the gearbox ratio so the HSVs output speed matches its ratings.

# DISASSEMBLING THE HSV SIZES 11-17

## SECTION I

### TEARING DOWN INPUT ROTATING GROUP (PRIMARY ROTATING GROUP OR RADIAL PISTON PUMP)

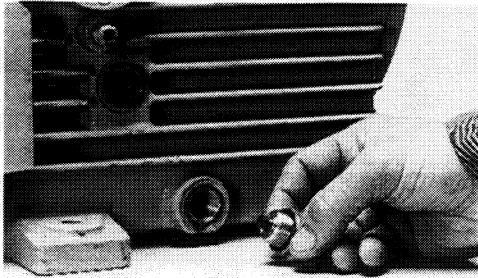


Fig. 1

Remove the electric motor, if one is attached. Then drain the oil from the case by removing the drain plug (90) located on the side of the case (Fig. 1).

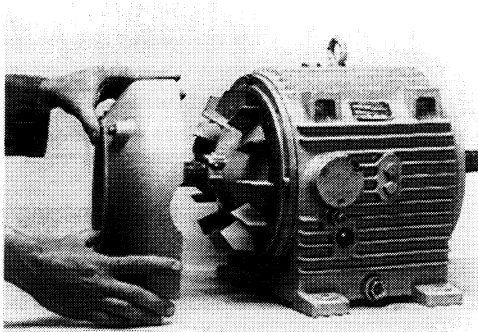


Fig. 2

Remove cap screws with an Allen wrench, and then remove fan cover, where applicable (Fig. 2).

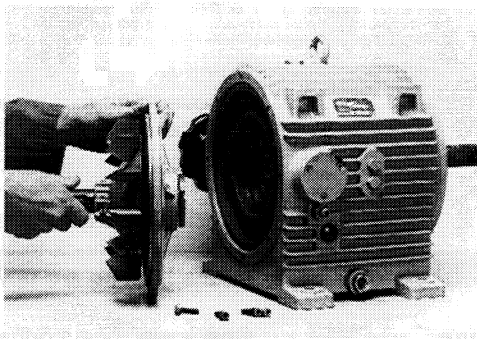


Fig. 3

Remove input cover, input shaft, and fan as one unit (Fig. 3).

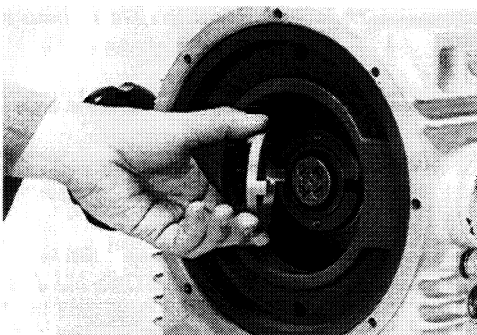


Fig. 4

Remove the Oldham coupling (33) and the O-ring (65). Normally the O-ring can be reused, so save it (Fig. 4).

# DISASSEMBLING THE HSV SIZES 11-17

Remove the snap ring (54) and washer (12) (Fig. 5).

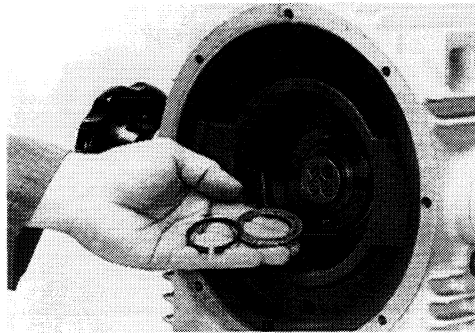


Fig. 5

Align the speed control and eccentric ring at the zero speed position. When they are aligned at zero, they will be concentric with the case. Slide a piece of plastic or thin shim stock around the rotating group to keep the pistons in place. It is important to keep the pistons in their original bores, because they are wear mated (Fig. 6).

**NOTE:** If the plastic will not slide in, remove the main relief valve cover (25) to relieve the trapped hydraulic pressure. For more information about the relief valve, see Section IV.

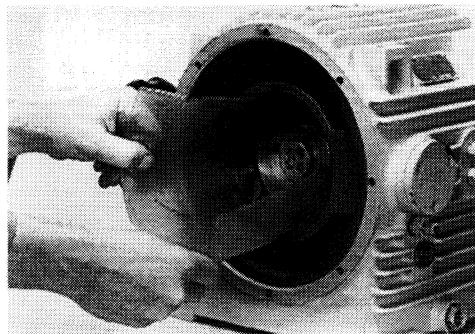


Fig. 6

**Pull out the input rotating group. The input rotating group should come out easily, using a bolt inserted as a handle (Fig. 7).**

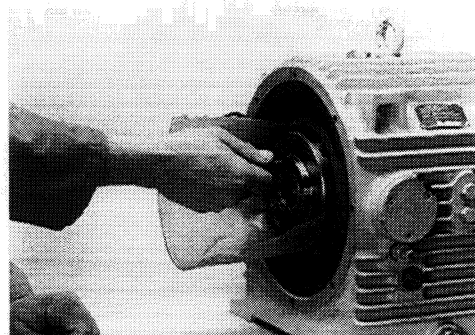


Fig. 7

If the input rotating group has seized up, remove it with a slide puller or gear puller (Fig. 8).

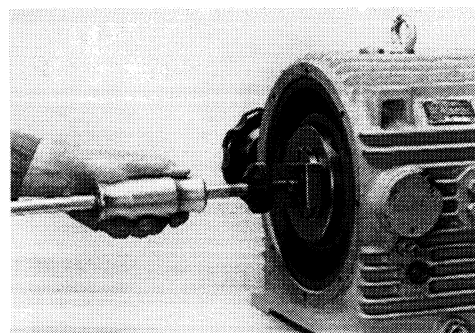


Fig. 8

# DISASSEMBLING THE HSV SIZES 11-17

## SECTION II

### TEARING DOWN OUTPUT ROTATING GROUP (RADIAL PISTON MOTOR)

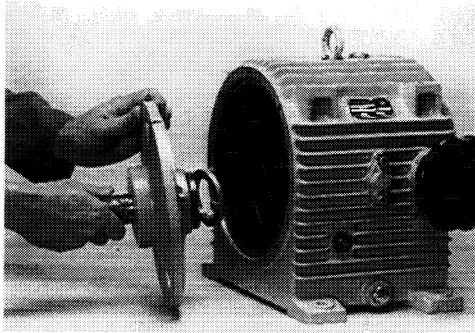


Fig. 9

Remove the gear reducer, if one is installed. Remove drain plug (90) from the side of the case and drain oil.

Remove cap screws and then tap off the output cover assembly with a soft hammer. Then the shaft, Oldham coupling, O-ring and output cover can be removed as a complete assembly (Fig. 9).

**NOTE:** DO NOT use a lead hammer, since it could contaminate the unit with lead particles. **AVOID** using a steel hammer since it could break off altogether.

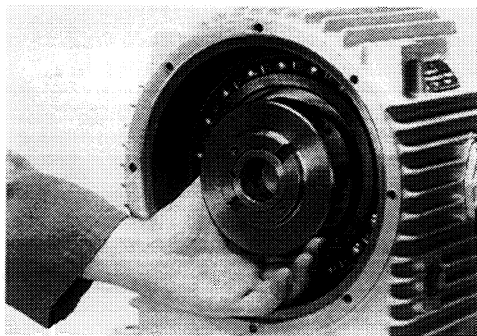


Fig. 10

Remove snap ring (54) and washer (12). Next, remove the output rotating group. Be careful the pistons do not drop out of the bores when you remove the output rotating group (Fig. 10).

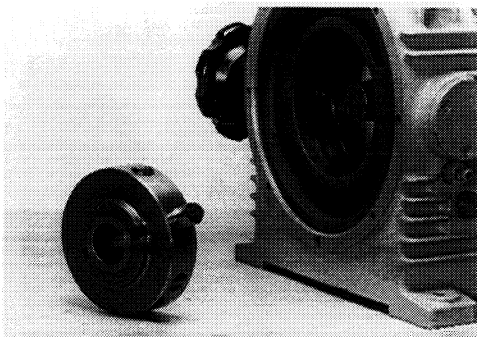


Fig. 11

Keep the pistons with their original bores because they are wear mated (Fig. 11).

## SECTION III

### REMOVING CHARGE PUMP (FEED PUMP)

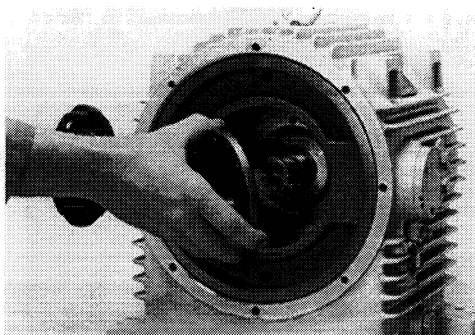


Fig. 12

Once the input and output rotating groups have been removed, the charge pump can be removed. Usually, the eccentric ring and bearing can remain in place during this procedure. However, Section VI gives directions for eccentric ring and bearing removal.

Unbolt the charge pump cover (15) and then remove the O-ring (101) and bolts (93) (Fig. 12). Bolts are removed from output side on sizes 11, 12, 14 & 15.

## DISASSEMBLING THE HSV SIZES 11-17

Use a magnet to remove the vanes or rollers (Fig. 13).

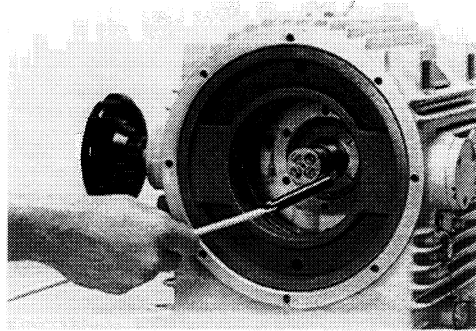


Fig. 13

Then use a screwdriver to pull out the rotor (17) (Fig. 14).

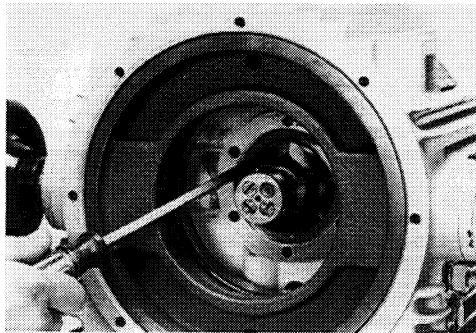


Fig. 14

If there is a vane ring behind the rotor, remove it also (Fig. 15).

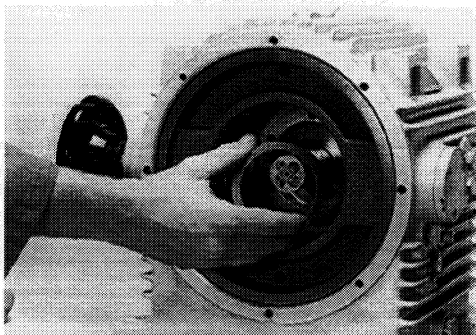


Fig. 15

Drive out the dowel pin (86) to clear the stator (Fig. 16).

Rotate the stator (16) to loosen the loctite and then remove it. A small pry bar or bent screwdriver may be required here.

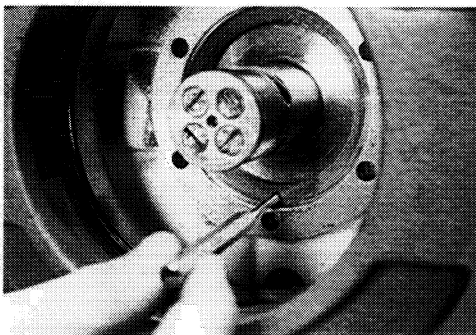


Fig. 16

# DISASSEMBLING THE HSV SIZES 11-17

## SECTION IV

### REMOVING MAIN RELIEF VALVES

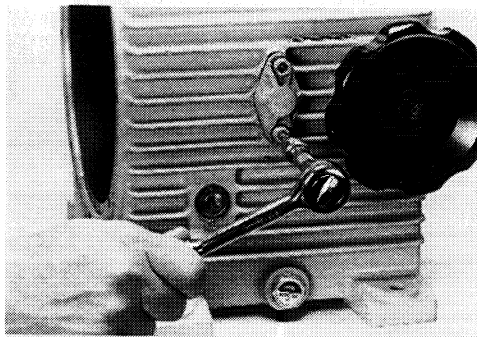


Fig. 17

Remove the bolts and the main relief valve cover (15) (Fig. 17).

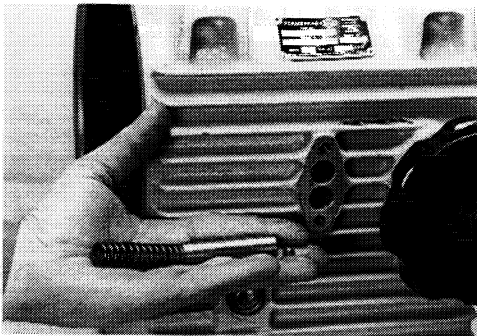


Fig. 18

Remove the spring (26), piston (27) and ball (85) from each bore (Fig. 18).

## SECTION V

### REMOVING DISTRIBUTOR SHAFT

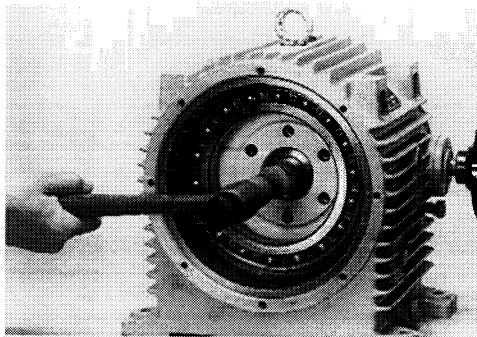


Fig. 19

Once the input rotating group, output rotating group, charge pump, and main relief valve have been removed, the distributor shaft can be removed from the input side. Use a soft mallet (brass or rubber) to drive the shaft out (Fig. 19).

Distributor shaft should be left in place unless the check valves need to be replaced. When installing, the distributor shaft must be resealed and aligned. See Section X.

## SECTION VI

### REMOVING INPUT ECCENTRIC RINGS AND MAIN BEARING

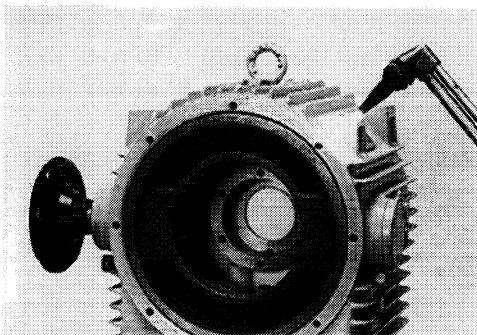


Fig. 20

The input side of the case needs to be heated to aid eccentric ring and bearing removal. Follow the usual safety precautions for working with an acetylene torch.

Use an acetylene torch to heat an area approximately 3" wide along the circumference of the outside of the case. Move the torch continuously so that you do not burn a hole in the case or set the paint on fire. Because the case is aluminum, it will expand faster than the steel bearing block. Heat the case for a few minutes (Fig. 20).

# DISASSEMBLING THE HSV SIZES 11-17

Wear heavy gloves to remove the external sliding ring (5). If necessary, use a pry bar to loosen it (Fig. 21).

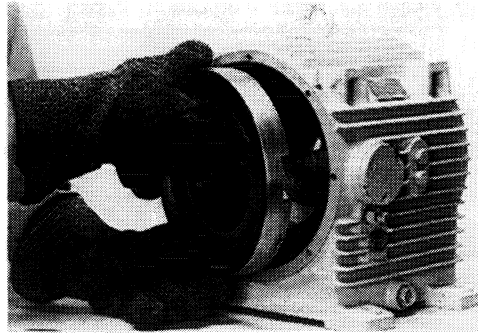


Fig. 21

Use METRIC Allen wrench to remove the set screw from the speed control. Unscrew hand control wheel, unbolt the cover, and unscrew the shaft (Fig. 22).

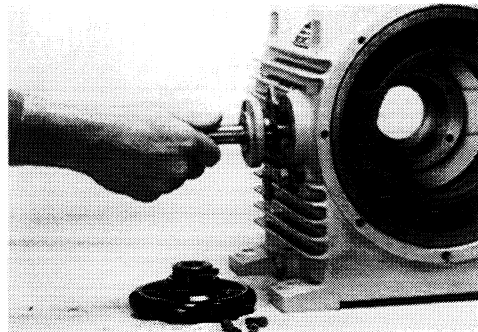


Fig. 22

Slide out the eccentric ring (6) and bearing carrier (Fig. 23).

Remove internal sliding ring (7).

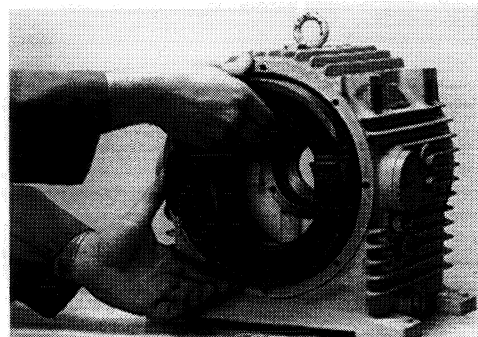


Fig. 23

Press out the bearing (Fig. 24).

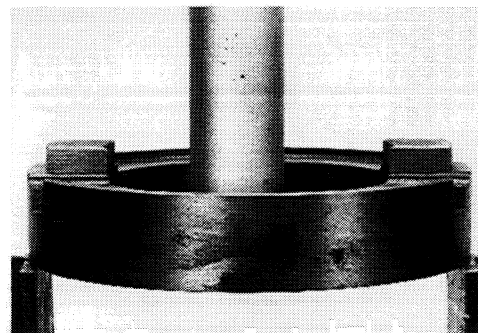


Fig. 24



# DISASSEMBLING THE HSV SIZES 11-17

## SECTION VII

### REMOVING OUTPUT ECCENTRIC RINGS AND MAIN BEARING

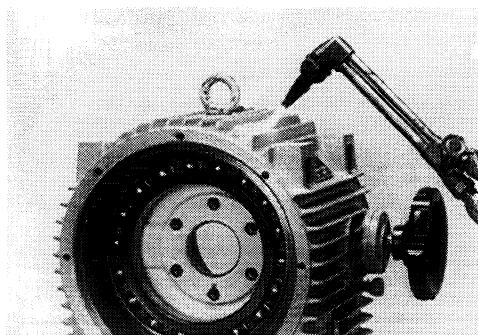


Fig. 25

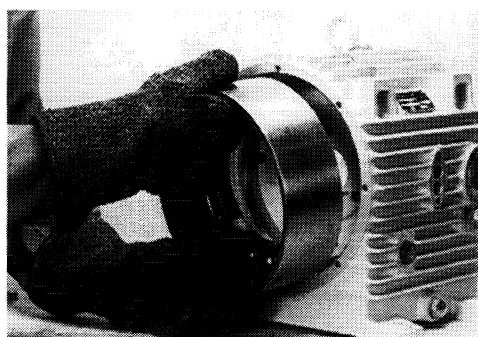


Fig. 26

If the oil has not been drained and output cover removed at this point, this should be done. For sizes 16 and larger, remove the large locating bolt (30mm on size 16, 16B and 32mm on sizes 17, 17B) from the right side of the unit. See Section XI for more detail.

Match mark the bearing block before removing it, to aid realignment at reassembly. Next the output side of the case needs to be heated to aid eccentric ring and bearing removal. Follow the usual safety precautions for working with an acetylene torch.

Use an acetylene torch to heat an area approximately 3" wide along the circumference of the outside of the case. Move the torch continuously so that you do not burn a hole in the case or set the paint on fire. Because the case is aluminum, it will expand faster than the steel bearing block. Heat the case for a few minutes (Fig. 25).

Slide out the eccentric ring (39) and bearing carrier. If necessary, use a pry bar to loosen it (Fig. 26).

Follow the procedure described in Section VI to press out the bearing.

## SECTION VIII

### REMOVING INPUT SHAFT AND BEARING

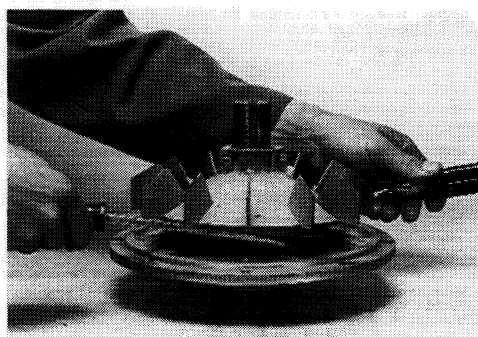


Fig. 27

If the oil has not been drained, remove the drain plug located on the side of the unit and drain.

Remove the input cover. See Section I for more detail. Loosen the Allen head screws on the fan and remove it. If necessary, pry it off (Fig. 27).

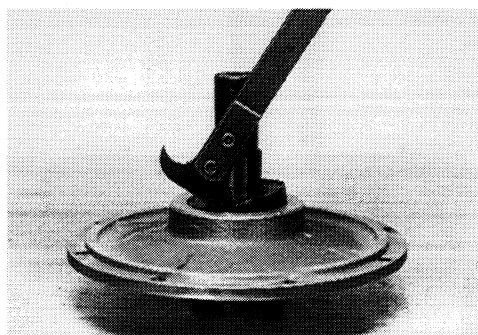


Fig. 28

Remove seal (67). If the unit is equipped with a seal bearing cover and O-ring, it should be removed also (Fig. 28).



## DISASSEMBLING THE HSV SIZES 11-17

Remove external snap ring (53) from shaft (Fig. 29).

NOTE: On size 11 units, remove the internal snap ring from inside of cover.

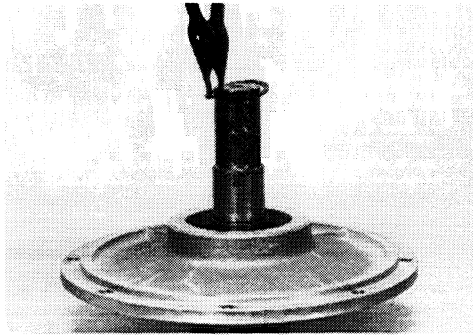


Fig. 29

Press input shaft out of cover (Fig. 30).

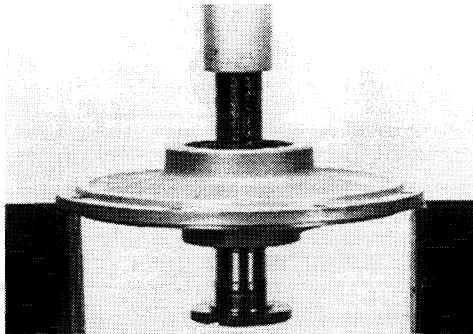


Fig. 30

Remove the output cover. See Section II for more detail. Remove the seal (67), seal bearing cover and O-ring, if the unit is equipped with one (Fig. 28). Remove the external snap ring from the shaft.

NOTE: On size 11 units, remove the internal snap ring from the inside cover.

Press output shaft out of cover as shown in Fig. 30.

### SECTION IX REMOVING OUTPUT SHAFT AND BEARING

# REBUILDING THE HSV SIZES 11-17

## SECTION X

### ASSEMBLING DISTRIBUTOR SHAFT, INPUT ROTATING GROUP, OUTPUT ROTATING GROUP, CHARGE PUMP, MAIN RELIEF VALVE

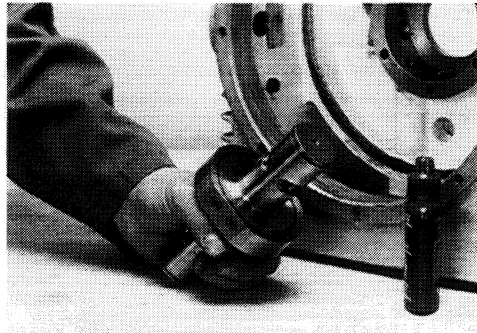


Fig. 31

To reassemble each component, reverse the steps described in the disassembly sections, noting these additions:

When reinstalling the distributor shaft, use a small amount of loctite on the back face (Fig. 31). The housing may have to be heated up with an acetylene torch to ease assembly, being careful not to destroy the internal paint.

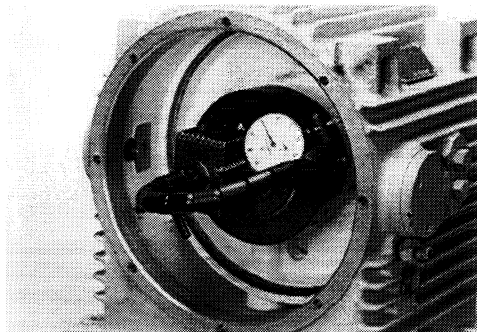


Fig. 32

Check the distributor shaft placement for concentricity using a dial indicator. The distributor shaft should be concentric to the machined surface of the case within 0.001 inches. To do this, insert a rotating group on one end of the shaft with a dial indicator. Check radial alignment. With the charge pump stator and cover in place, the charge pump cover bolts can be tightened and loosened to change the alignment (Fig. 32).

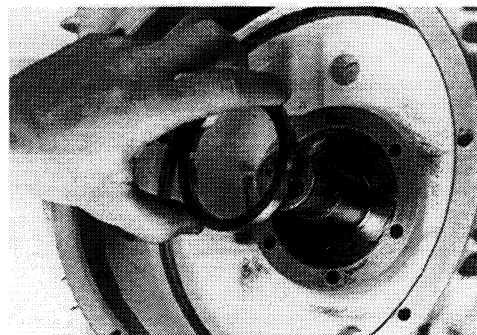


Fig. 33

When the charge pump stator is reinstalled, use a small amount of loctite on the outside diameter (Fig. 33). Clean any excess sealant from the rotating area of the stator.

When replacing the input and output covers, make sure the oil lube holes on the inside near the shaft bearings are directed up to catch the oil spray so proper bearing lubrication is assured.

# DISASSEMBLING THE HSV SIZES 16B AND 17B

## SECTION XI

To disassemble the 16B and 17B (Fig. 34), follow the procedure outlined for the 11-17 with these exceptions:

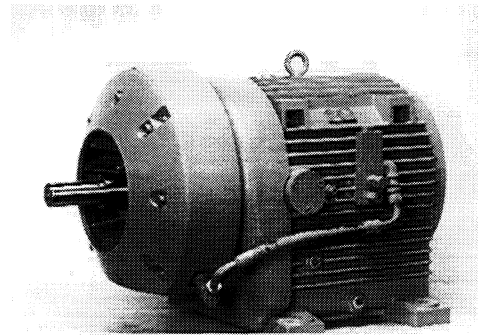


Fig. 34

Disconnect the radiator lines, remove radiator bolts, and then remove the radiator.

For the 17B, the bolts hold the input cover and the radiator in place, so the input cover, radiator, input shaft, and bolts can be removed as one unit (Fig. 35).

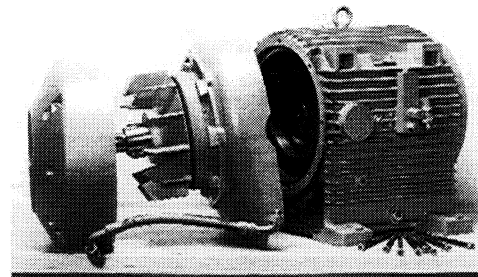


Fig. 35

Use a large jaw puller to remove the fan (Fig. 36).

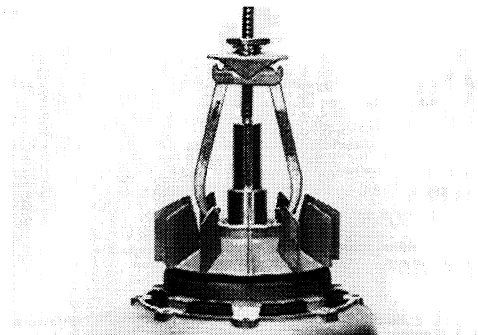


Fig. 36

To reassemble the 16B and 17B HSVs, reverse the disassembly procedure, noting these additions:

Check the distributor shaft for concentricity using a dial indicator. The distributor shaft should be concentric to the machined surface of the case within 0.001 inches.

This can be accomplished by inserting a rotating group on one end of the shaft with a dial indicator to check the radial misalignment. With charge pump stator and cover in place, the charge cover bolts can be loosened and

tightened to change the alignment (see Section X).

When the charge pump stator is reinstalled, use a small amount of loctite on the outside diameter. Clean any excess sealant from the rotating end of the stator.

When replacing the input and output covers, make sure the oil lube holes on the inside are directed up to catch the oil spray.

Once the input cover, shaft, and fan are in place, reinstall the radiator.

## REBUILDING THE HSV – SIZES 16B AND 17B

## SECTION XII

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