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***Bolens***<sup>®</sup>

**LARGE  
FRAME  
TRACTORS**

SERVICE MANUAL

# LARGE FRAME TRACTORS

## MODEL

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1886s-05  
1886s-06 (HT 18)  
2086 (HT 20)  
2087 (HT 20)  
2288 (HT 22)  
2289 (HT 20)  
2389 (HT 23)  
2388s (HDT 1000)  
2389s (HT 23)

I. GENERAL

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II. ELECTRICAL SYSTEM

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III. DRIVE TRAIN

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IV. FUEL SYSTEM

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5

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## SERIAL NUMBER INFORMATION

1

Model number of Tractor.  
Serial number of Tractor.

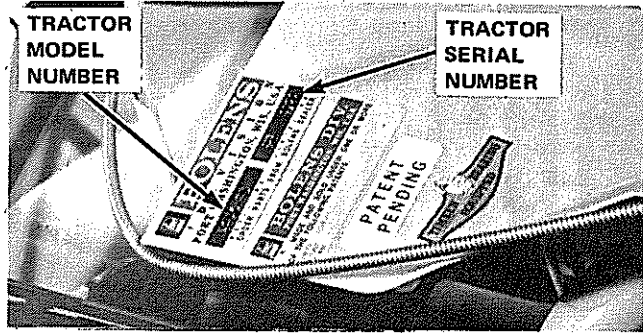


FIGURE 1-1 1886s

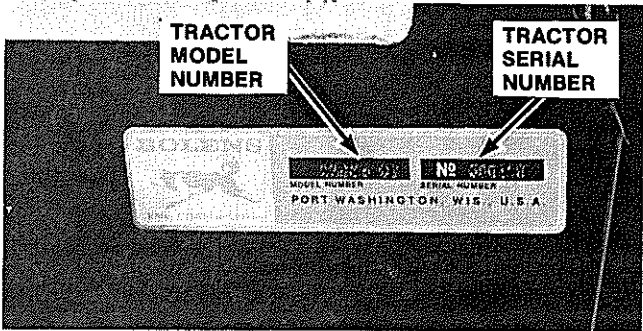


FIGURE 1-2 2086, 2087

Engine Model Number.  
Engine Serial Number.  
Engine Spec. Number.

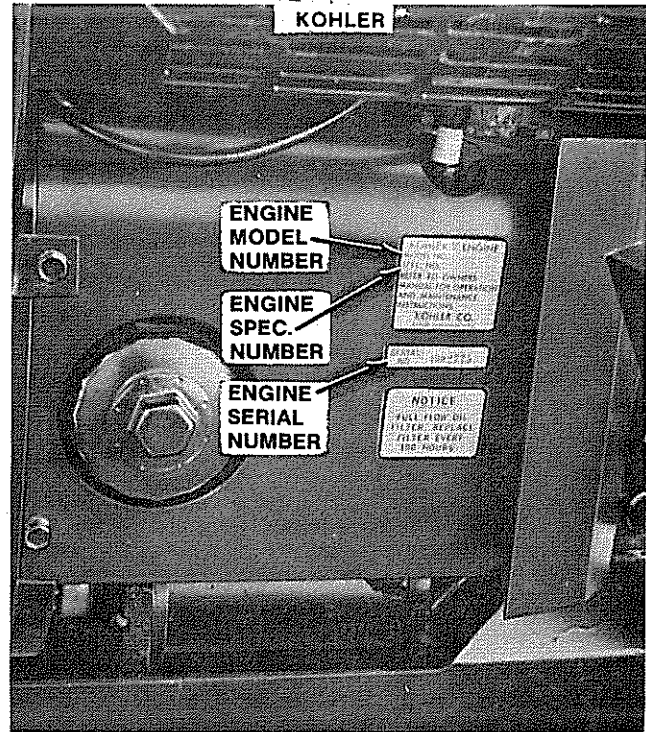
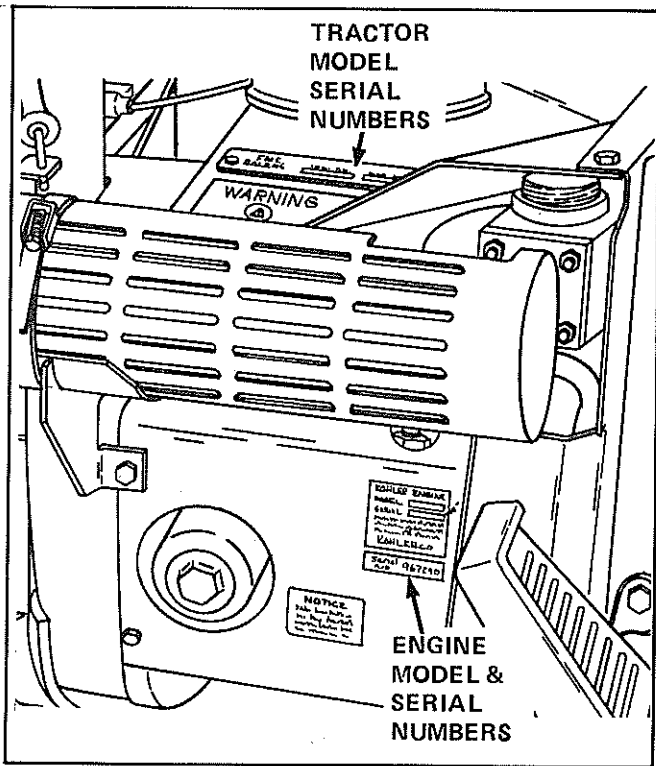
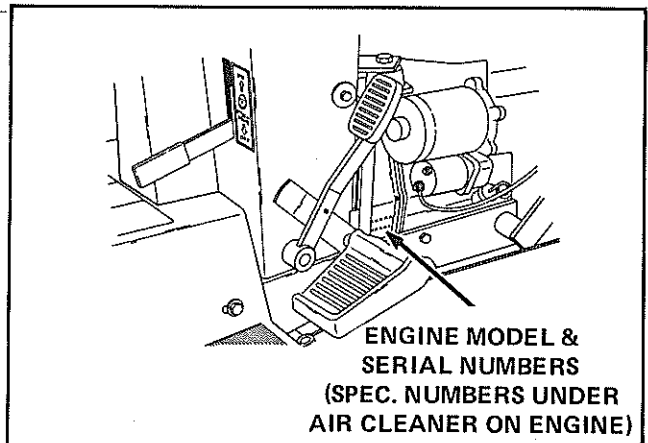
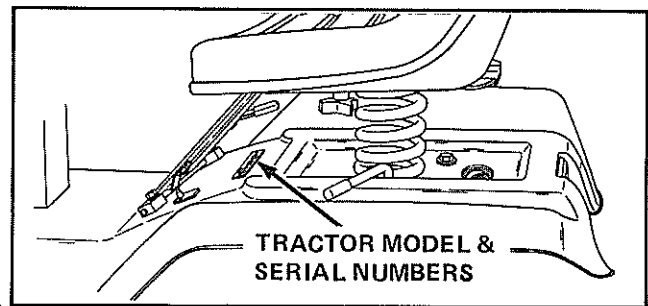


FIGURE 1-3 1886s, 2086, 2087



2389 & 2389s



2288, 2289

SPECIFICATIONS

ENGINE	1886s-05 & 06	2086	2087
Manufacturer	Kohler	Kohler	Kohler
Model/Spec	K482S 35208B & 35113B	K 532S 53100A	K532S 553102A & 53138A
Type	Horz. shaft, air cooled 2 cyl., 4 cycle	Horz. shaft, air cooled, 2 cyl., 4 cycle	Horz. shaft, air cooled, 2 cyl., 4 cycle
Bore and Stroke	3-1/4" X 2-7/8" (82.5 x 73 mm)	3-3/8" X 3" (85.7 X 76.2 mm)	3-3/8" X 3" (85.7 X 76.2 mm)
Piston Displacement	47.7 Cu. In. (781.3 cc)	53.7 Cu. In. (879.6 cc)	53.7 Cu. In. (879.6 cc)
Mfr's H.P. Rating	18 H.P. at 3600 R.P.M.	19.5 H.P. at 3450 R.P.M.	19.5 H.P. at 3450 R.P.M.
Air Cleaner	Paper Element Kohler 277138	Paper Element Kohler 277138	Paper Element Kohler 277138
Oil Capacity	3 Quarts (2.8 liter) and 1 pint (.47 liters) in filter	3 Quarts (2.8 liter) and 1 pint (.47 liter) in filter	3 Quarts (2.8 liter) and 1 pint (.47 liter) in filter
Oil Filter	Kohler 277233	Kohler 277233	Kohler 277233
Governor	Mechanical	Mechanical	Mechanical
Speed Control	Remote, cable operated	Remote, cable operated	Remote, cable operated
Starter	Electric	Electric	Electric
Charging System	30 Amp. Alternator	15 Amp. Alternator	15 Amp. Alternator
Spark Plug Size	14 mm	14 mm	14 mm
Spark Plug	Champion HR 10	Champion HR 10	Champion HR 10
Spark Plug Gap	.025" (0.63 mm)	.025" (0.63 mm)	.025" (0.63 mm)
Breaker Point Gap	.020" (0.5 mm)	.020" (0.5 mm)	.020" (0.5 mm)

ENGINE	2288	2289	2389/2389s
Manufacturer	Ducati	Teledyne Wisconsin	Kohler
Model/Spec	21522	WD2-860	K 582S 36272A/K582S 36328
Type	Horz. shaft, air cooled 4 cycle, 2 cyl. Diesel	Horz. shaft, air cooled 4 cycle, 2 cyl. Diesel	Horz. shaft, air cooled 2 cyl. 4 cycle
Bore and Stroke	3.307" X 3.071 (84 X 78 mm)	3.307" X 3.071" (84 X 78 mm)	3-1/2" x 3" (88.9 mm X 76.2 mm)
Piston Displacement	52.7 Cu. In. (864 cc)	52.7 Cu. In. (864 cc)	57.7 Cu. In. (946.0 cc)
Mfr's H.P. Rating	22 H.P. at 3000 RPM	19.9 H.P. at 3000 RPM	23 H.P. (17.1 KW) at 3600 RPM
Air Cleaner	Bolens 1721457	Bolens 1721457	Paper element Kohler 4708303
Oil Capacity	2.2 Qt. (2 liter) and 1 Pint (.47 liter) in filter.	2.2 Qt. (2 liter) and 1 Pint (.47 liter) in filter.	8 Pts. (2.8 liter) and 1 Pint (.47L) (.47 liter) in filter
Oil Filter	Bolens 1726450	Bolens 1726450	Kohler 277233
Governor	Mechanical	Mechanical	Mechanical
Fuel Filter	Bolens 1738804	Bolens 1738804	
Speed Control	Remote, cable operated.	Remote, cable operated.	Remote, cable operated
Starter	Electric	Electric	Electric
Charging	9 Amp. Alternator (35 Amp. alter, kit available).	9 Amp. Alternator (35 Amp. alter kit available)	15 Amp. Alternator
Spark Plug Size			14 mm
Spark Plug			Champion HR 10
Spark Plug Gap			.035 (0.89 mm)
Breaker Point Gap			.020 (0.51 mm)



<b>MODEL</b>	<b>2388s</b>
Engine Mfg. ....	Mitsubshi
Model/Spec .....	K3D-61FG
Type .....	Vertical shaft, water cooled, overhead valve 3 cyl. diesel
Bore and Stroke .....	2.87 x 3.07 (73 x 78mm)
Piston Displacement .	59.7 cu. in. (0.979 cc)
Mrf's H.P. rating ....	22 H.P. (16.4 Kw) at 3200 RPM
Air Cleaner .....	Dry Type
Oil Capacity .....	3.2 Qt (3.0 L) and 1 pt. (0.47 L) in filter
Oil Filter .....	Bolens No. 1739922
Governor .....	Mechanical
Fuel Filter .....	Bolens No. 1738804
Engine Air Filter .....	Bolens No. 1721457
Speed Control .....	Remote, cable operated
Starter .....	Electric
Hydrostatic Filter ....	Bolens No. 1726450
Radiator Capacity ...	7 Qts (6.6 L)
Battery .....	90 Amp

## CHASSIS

Type .....	Steel channel frame
Length .....	76 in. (192 cm)
Width - With Reg. Tires .....	38 in. (96 cm)
47 in. With Terra Tires .....	47 in. (119 cm)
Height .....	45 in. (114 cm)
Wheel Base .....	52 in. (132 cm)
Turning Radius .....	80 in. (203 cm)
Ground Clearance .....	8-1/2 in. (22.6 cm)
Transmission	
Models 1886, 2086, 2087 .....	Sundstrand in-line
Models 2288, 2388s, 2389, 2389S, 2289 ...	Eaton
Transmission oil qty .....	10 Qts. (9.4L)
Speed Infinitely Variable	
Models 1886, 2086, 2087 .....	Forward - 0-8 MPH (0-12.8 km/h) Rev. - 0-4 MPH (0.64 km/h)
Models 2389, 2288, 2289, 2389s .....	Forward - 0-10 MPH (0-16 km/h) Rev. - 0-5 MPH (0-8 km/h)
Model 2388s .....	Forward - 0-13.8 MPH (0-22 km/h) Rev. - 0-5 MPH (0-8 km/h)
Brakes .....	Disc

## TORQUE SPECIFICATIONS

### TRANSAXLE

Carrier Bolts .....	25 to 30 Ft. Lbs. (24-40 Nm)
Axle Housing Bolts .....	30 Ft. Lbs. (40 Nm)
Wheel Hub Nut .....	150 Ft. Lbs. (203 Nm)

Check Valve Screws .....	10 Ft. Lbs. (13.5 Nm)
Maximum Torque to Rotate Input and Output Shaft After Assembly and Before Running .....	25 In. Lbs. (2.8 Ncm)
Maximum Torque to Rotate Control Shaft After Assembly .....	25 In. Lbs. (2.8 Ncm)

### HYDROSTATIC

Charge Pump Capscrews ...	20 Ft. Lbs. (27 Nm)
Pump, Center and Motor	
Housing Capscrews .....	35 Ft. Lbs. (47 Nm)

# GENERAL (Continued)

## MAINTENANCE CHART KOHLER MODELS

MAINTENANCE REQUIRED	Length of Operation	Type of Maintenance
Engine Oil Filter —	100 Hrs.*	Replace
Engine Cooling Air Screen —	Daily or 10 Hrs.*	Brush Clean
Engine Air Cleaner —	50 Hrs.*	Shake Out Dirt
	100 Hrs.*	Replace
Cooling Fins — (Engine) —	Daily or 10 Hrs.	Clean — Use Air Hose if Available
Spark Plugs —	100 Hrs.	Service or Replace
Breaker Points —	500 Hrs.	Service or Replace
Ignition Timing —	500 Hrs.**	Adjust
Engine Valves —	500 Hrs.**	Adjust
Engine Cylinder Heads —	500 Hrs.**	Remove Carbon
Fuel Filter —	100 Hrs.	Clean
Battery —	Daily or 10 Hrs.	Check Water Level — Add As Necessary
Hydrostatic Transmission	50 Hrs.*	Clean — Use Air Hose if Available
Belts —	50 Hrs.*	Check for Wear and Adjust
Tires —	25 Hrs.	Check for Damage and Air Pressure
Transmission Filter —	<u>After First 5 Hours then After Every 100 Hours</u>	Change and Add Oil to Bring to Operating Level <u>Use Only Bolens Filter</u>

\*More often under extreme conditions.

\*\*Services should be performed by an Authorized Kohler Engine Dealer.

## MAINTENANCE CHART WISCONSIN & DUCATI MODELS

MAINTENANCE REQUIRED	Length of Operation	Type of Maintenance
Engine Oil Filter —	100 Hrs.*	Replace
Engine Cooling Air Screen —	Daily or 10 Hrs.*	Brush Clean
Engine Air Cleaner —	50 Hrs.*	Shake Out Dirt
	500 Hrs.*	Replace
Cooling Fins — (Engine) —	Daily or 10 Hrs.	Clean — Use Air Hose if Available
Valve Tappet —	200 Hrs.	Adjust if Necessary
Engine Valves —	500 Hrs.**	Adjust
Engine Cylinder Heads —	500 Hrs.**	Remove Carbon
Fuel Filter —	100 Hrs.	Clean
Battery —	Daily or 10 Hrs.	Check Water Level — Add As Necessary
Hydrostatic Transmission	50 Hrs.*	Clean — Use Air Hose if Available
Belts —	50 Hrs.*	Check for Wear and Adjust
Tires —	25 Hrs.	Check for Damage and Air Pressure
Transmission Filter —	After First 5 Hours then After Every 100 Hours	Change and Add Oil to Bring to Operating Level <u>Use Only Bolens Filter</u>

\*More often under extreme conditions.

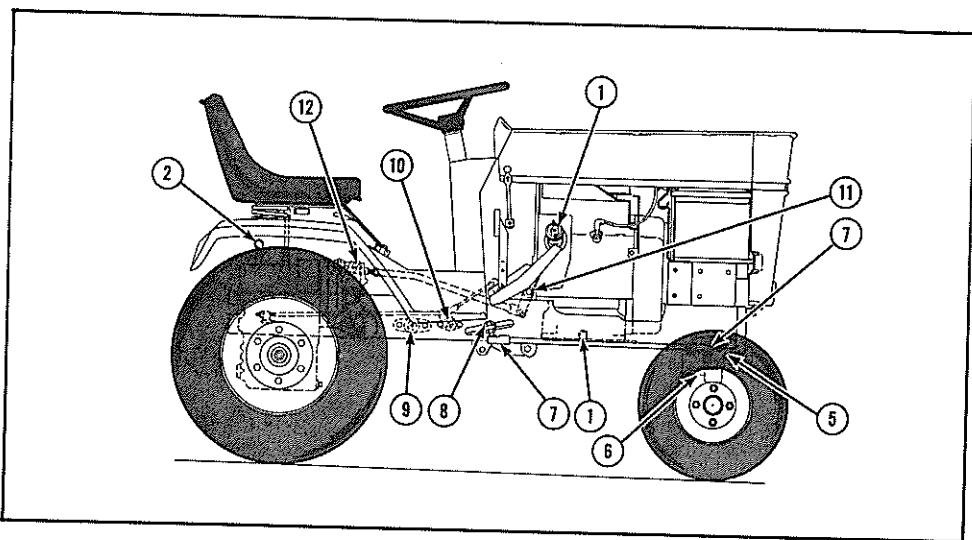
\*\*Services should be performed by an Authorized Wisconsin or Ducati Engine Dealer.

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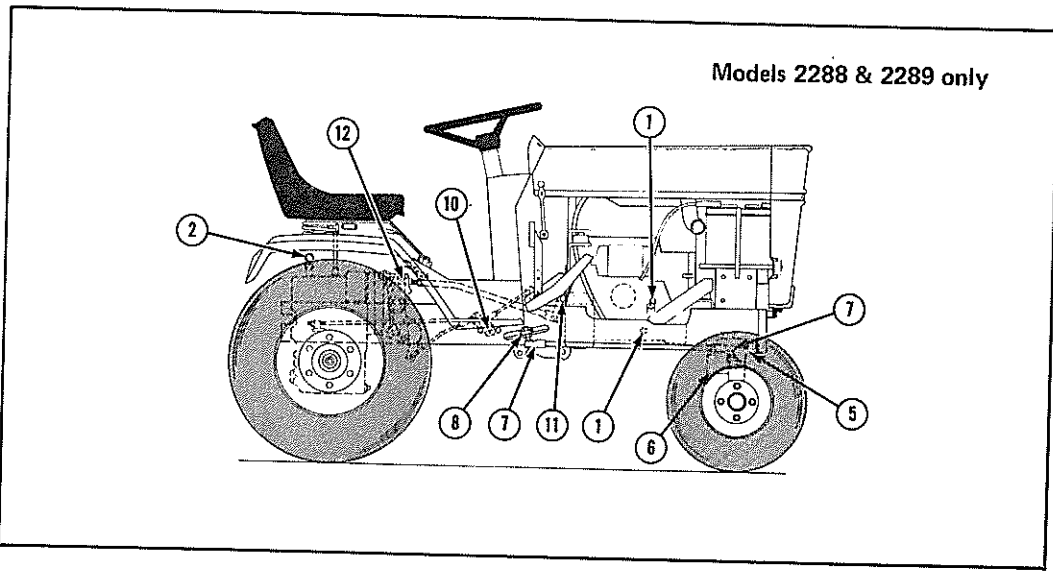


# GENERAL (Continued)

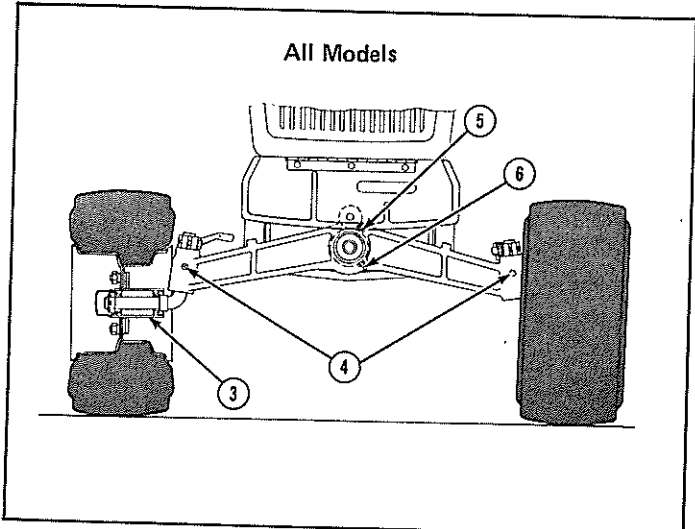
## LUBRICATION POINTS



Models 2288 & 2289 only



All Models



## LUBRICATION

LUBRICATION REQUIRED		Length of Operation	Type of Lubrication	Amount Required
1. Engine Crankcase (Kohler) –		Daily & 10 Hrs.	Engine Oil	Add Oil To Full Mark
Average Temperature	(Spring, Summer, Autumn) (+120° F. to 40° F.) (+44° C to 4° C)	50 Hrs.*	SAE 30 Oil Type SD-DE	Replace 3 QT (2.84L)***
	(Winter) (+40° to 0° F.) (+4° C to -18° C)	50 Hrs.*	SAE 10W-30 Oil Type SD-SE	Replace 3 QT (2.84L)***
	(Winter) (Below Zero)	50 Hrs.*	SAE 5W-20 Oil Type SD-SE	Replace 3QT (2.84L)***
1. Engine Crankcase (Wisconsin & Ducati) –		Daily & 10 Hrs.	Engine Oil (Class CC or better)	Add Oil To Full Mark
		100 Hrs.		Replace 2.2 Qt. (2 liter)
2. Hydrostatic Transmission – (Capacity 10 qts./9.5 liter)		Check Weekly Or 30 Hrs.	Fill with Bolens Oil 1738157 (Benzoil THL 19), or Mobil 423 or Texaco TDH	Level must be maintained in the operating zone (Approximately 10 qts. – 9.5 L)
		When Oil is Discolored	Drain and refill with Bolens Oil 1738157 (Benzoil THL 19), or Mobil 423 or Texaco TDH	
3. Front Wheel Bearings –		Once a year	Wheel Bearing Grease	Pack
4. Front Wheel Spindles –		10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
5. Front Axle Pivot –		10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
6. Attachment Drive		10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
7. Tie Rod Ends and Drag Links –		10 Hrs.	Oil	Small Amount
8. Steering Shaft –		10 Hrs.	Oil	Small Amount
9. Pivot Shaft –		10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
10. Brake Linkage –		10 Hrs.	Oil	Small Amount
11. Travel Pedal Shaft –		10 Hrs.	Oil	Small Amount
12. Hydrostatic Control Arms –		10 Hrs.	Light Machine Oil	Small Amount

\* More often under extreme conditions.

\*\* Plus 1 pint when changing oil filter (.47L).

\*\*\* Or equivalent.

NOTE: A hand type grease gun is recommended when greasing your unit. Hi-pressure type grease guns could cause damage to the fittings and bearing seals. Lubricate all linkages, levers and pins not equipped with grease fittings with lubrication oil once a week, or more often depending on operating conditions.



# GENERAL (Continued)

## MAINTENANCE CHART MITSUBSHI MODELS

MAINTENANCE REQUIRED	Length of Operation	Type of Maintenance
Engine Oil Filter —	10 Hrs.	Check
	50 Hrs.*	Replace
Engine Radiator Coolant —	Daily or 10 Hrs.*	Check
	400 Hrs.	Replace
Engine Air Cleaner —	50 Hrs.*	Shake Out Dirt & Clean
	200 Hrs.*	Replace
Engine Oil —	10 Hrs.	Check
	First 50 Hrs.	Replace
	100 Hrs.	Replace
Valve Clearance —	50 Hrs.~	Check
Injection Nozzles —	200 Hrs.	Set Starting Pressure to 1700 ± 140 PSI (120 ± 10 Kg/cm <sup>2</sup> )
Fuel Filter —	50 Hrs.	Clean
	100 Hrs.	Replace
Battery —	Daily or 10 Hrs.	Check Water Level - Add As Necessary
Hydrostatic Transmission —	50 Hrs.*	Clean - Use Air Hose if Available
Belts —	50 Hrs.*	Check for Wear and Adjust
Tires —	25 Hrs.	Check for Damage and Air Pressure
Transmission Filter —	After First 5 Hours then After Every 100 hours	Change and Add Oil to Bring to Operating Level <b>Use Only Bolens Filter</b>

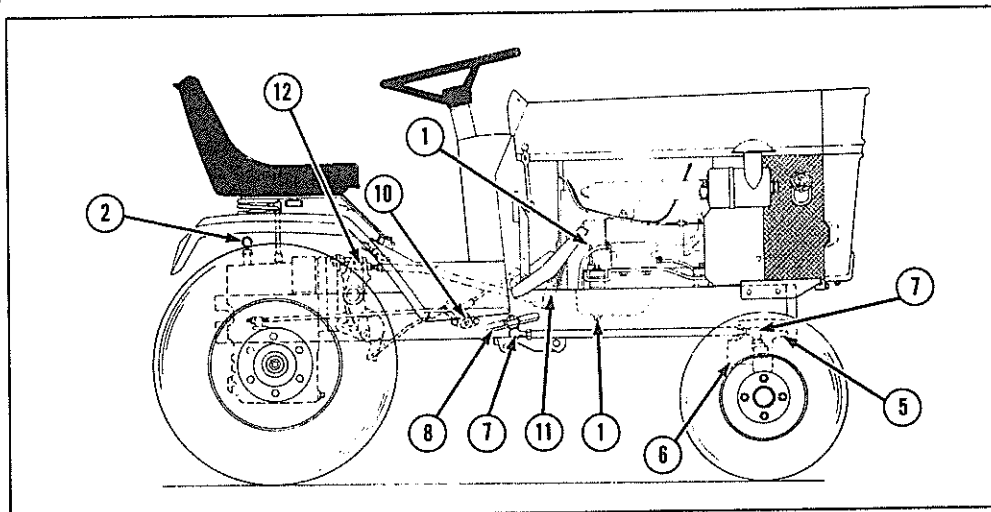
\* More often under extreme conditions.

\*\* Services should be performed by an Authorized Mitsubshi Engine Dealer

## LUBRICATION CHART

LUBRICATION REQUIRED	LENGTH OF OPERATION	TYPE OF LUBRICATION	AMOUNT REQUIRED
1. Engine Crankcase —	Check Daily & 10 Hrs.	20°C (68°F) and up- SAE 30 or 10W30 5°C (41° F) to 20°C (68°F) SAE20 or 10W30 5°C (41°F) and below - SAE 10W30 Class CC or better	Add Oil To Full Mark
	100 Hrs.*		Replace 3.2 Qts. (3.0 liter) 3.7 Qts. (3.5 liter) if filter was replaced
2. Hydrostatic Transmission — (Capacity 10 qts.)	Check Weekly Or 30 Hrs.  When Oil is Discolored	* Bolens Transmission Oil 1738157 or Benzoil THL 19 * Drain and refill with Bolens Transmission Oil 1738157 or Benzoil THL 19	Level must be maintained in the operating zone
3. Front Wheel Bearings —	Once a year	Wheel Bearing Grease	Pack
4. Front Wheel Spindles —	10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
5. Front Axle Pivot —	10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
6. Attachment Drive —	10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
7. Tire Rod Ends and Drag Links —	10 Hrs.	Oil	Small Amount
8. Steering Shaft —	10 Hrs.	Oil	Small Amount
9. Pivot Shaft —	10 Hrs.	Grease with Multi-Purpose Grease ***	1-2 Strokes
10. Brake Linkage —	10 Hrs.	Oil	Small Amount
11. Travel Pedal Shaft —	10 Hrs.	Oil	Small Amount
12. Hydrostatic Control Arms —	10 Hrs.	Light Machine Oil	Small Amount

\* More often under extreme conditions.  
\*\*\* Or equivalent.



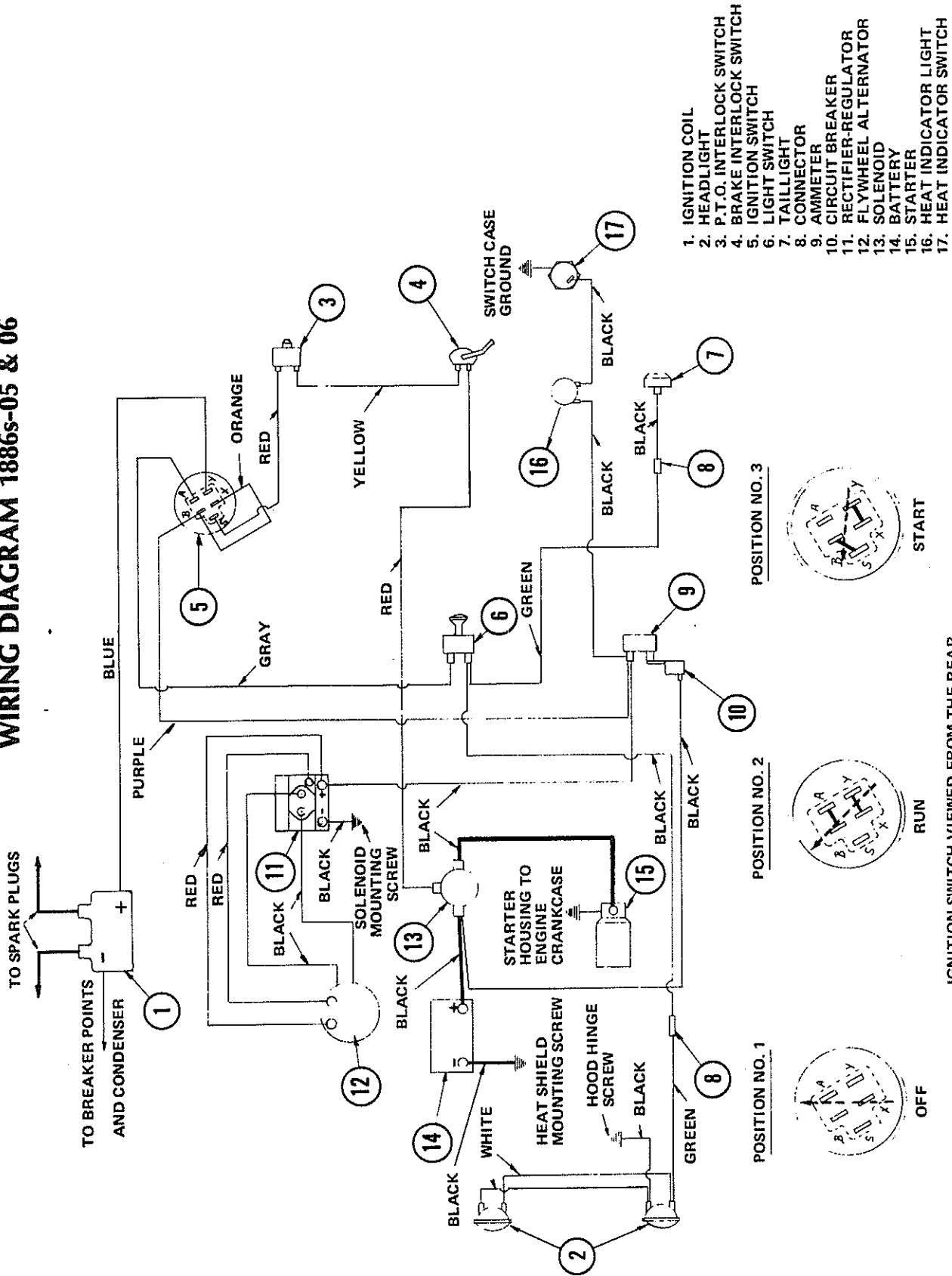
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## TROUBLE SHOOTING GUIDE

2

PROBLEM	PROBABLE CAUSE	REMEDY
Starter Motor does not energize	<ol style="list-style-type: none"> <li>1. P.T.O. engaged</li> <li>2. Brake pedal not depressed</li> <li>3. Corroded or loose electrical connections</li> <li>4. Discharged battery</li> <li>5. Defective switches P.T.O. interlock, brake interlock ignition switch, etc.</li> <li>6. Defective solenoid</li> </ol>	<ol style="list-style-type: none"> <li>1. Disengage P.T.O.</li> <li>2. Depress brake pedal and lock</li> <li>3. Clean and tighten</li> <li>4. Locate problem and recharge</li> <li>5. Check and replace if necessary</li> <li>6. Check and replace if necessary</li> </ol>
Starter Motor turns too slow	<ol style="list-style-type: none"> <li>1. Weak or partially discharged battery</li> <li>2. Corroded or loose electrical connections</li> </ol>	<ol style="list-style-type: none"> <li>1. Check battery charge or replace if necessary</li> <li>2. Clean and tighten</li> </ol>
Battery discharges rapidly	<ol style="list-style-type: none"> <li>1. Low water level</li> <li>2. Low or no output from alternator</li> <li>3. Short in electrical system</li> </ol>	<ol style="list-style-type: none"> <li>1. Check and refill</li> <li>2. Check output and repair if necessary</li> <li>3. Check out and repair</li> </ol>
Battery will not charge	<ol style="list-style-type: none"> <li>1. Dirt and moisture on case</li> <li>2. Corroded or loose battery terminals</li> <li>3. Defective battery</li> <li>4. No alternator output</li> <li>5. Defective rectifier-regulator</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean case</li> <li>2. Clean and tighten</li> <li>3. Replace battery</li> <li>4. Check out alternator and repair or replace</li> <li>5. Check out rectifier-regulator, replace if necessary</li> </ol>
Lights not operating	<ol style="list-style-type: none"> <li>1. Bulbs burned out</li> <li>2. Loose or poorly connected wire</li> <li>3. Circuit breaker defective</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace bulbs</li> <li>2. Install properly and tighten</li> <li>3. Check out circuit breaker, replace if necessary</li> </ol>

## WIRING DIAGRAM 1886s-05 & 06



1. IGNITION COIL
2. HEADLIGHT
3. P.T.O. INTERLOCK SWITCH
4. BRAKE INTERLOCK SWITCH
5. IGNITION SWITCH
6. LIGHT SWITCH
7. TAILLIGHT
8. CONNECTOR
9. AMMETER
10. CIRCUIT BREAKER
11. RECTIFIER-REGULATOR
12. FLYWHEEL ALTERNATOR
13. SOLENOID
14. BATTERY
15. STARTER
16. HEAT INDICATOR LIGHT
17. HEAT INDICATOR SWITCH

FIGURE 2-1

# ELECTRICAL SYSTEM (Continued)

## LIGHT CIRCUIT 1886s-05 & 06

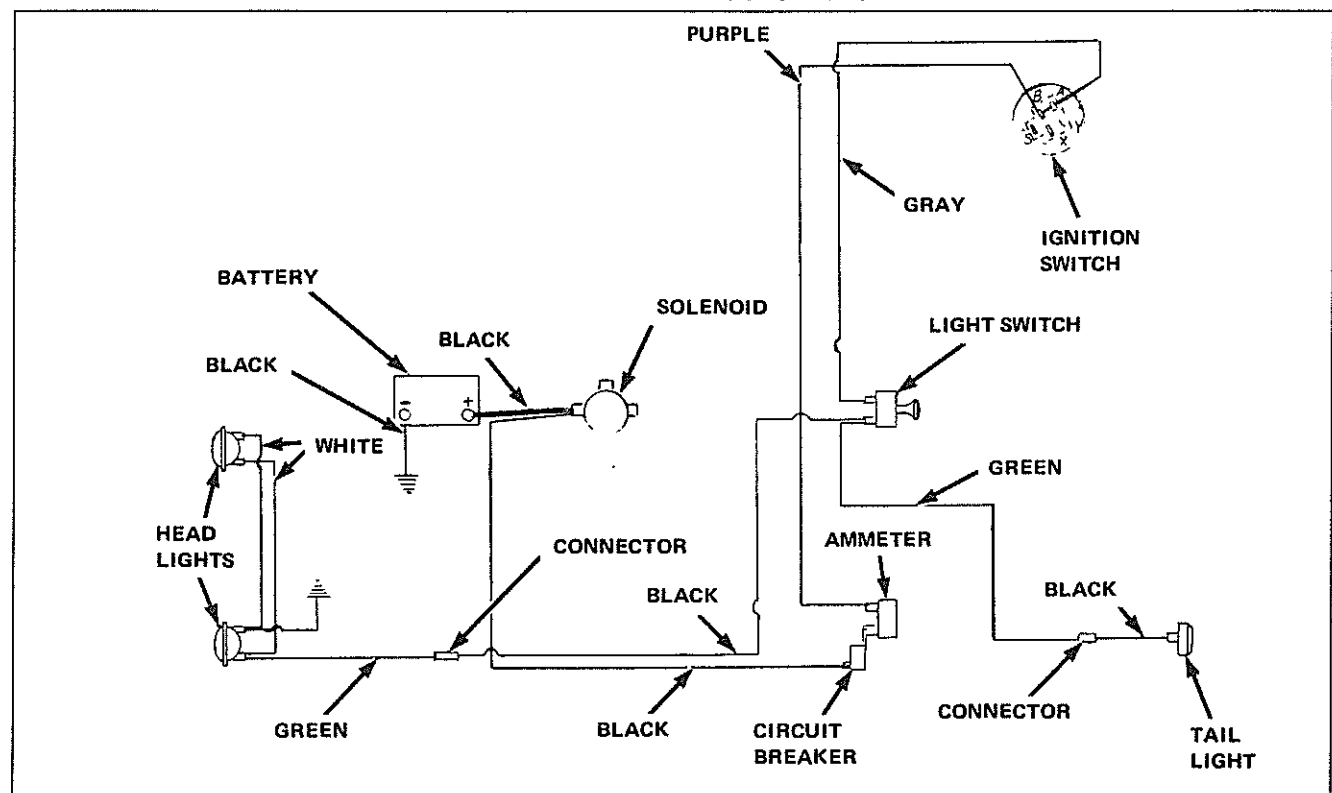


FIGURE2-2

## START-RUN CIRCUIT 1886s-05 & 06

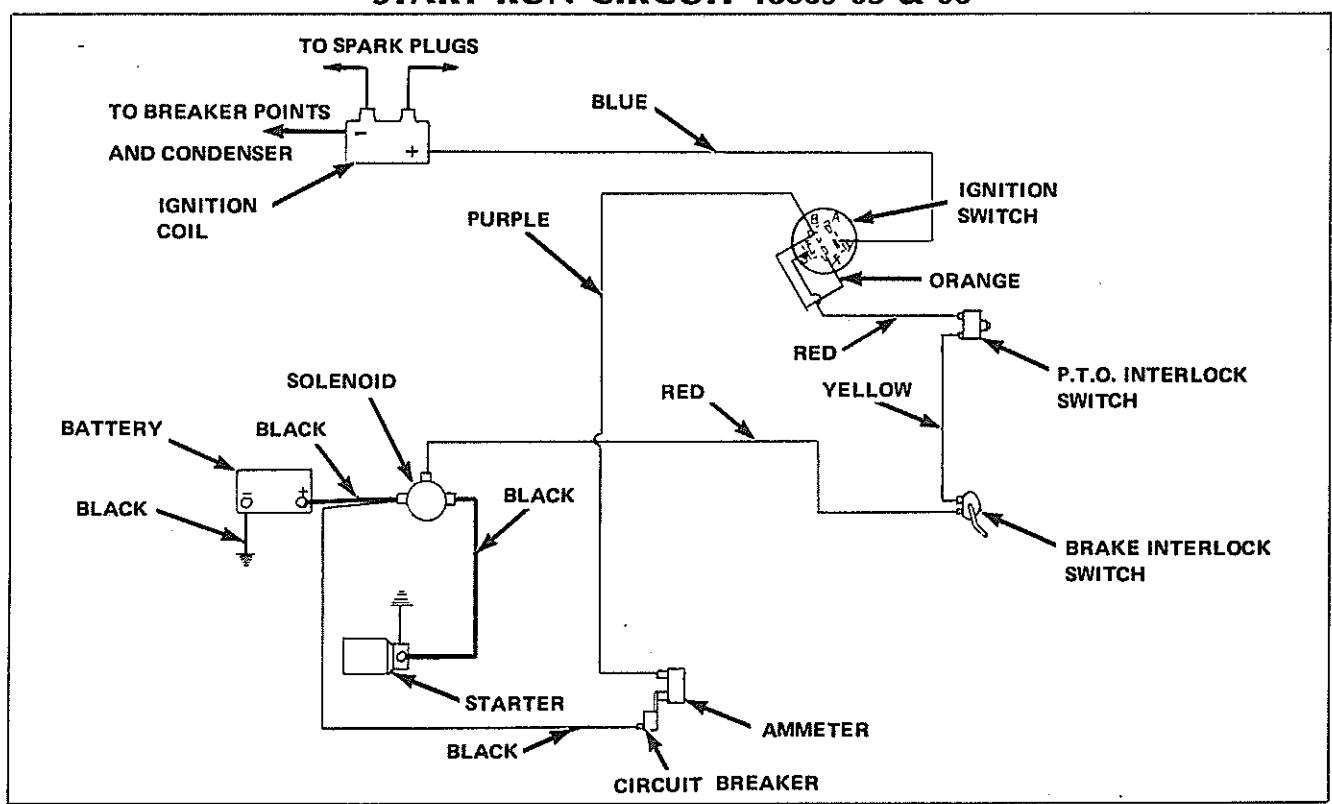


FIGURE2-3

CHARGING CIRCUIT 1886s-05 & 06

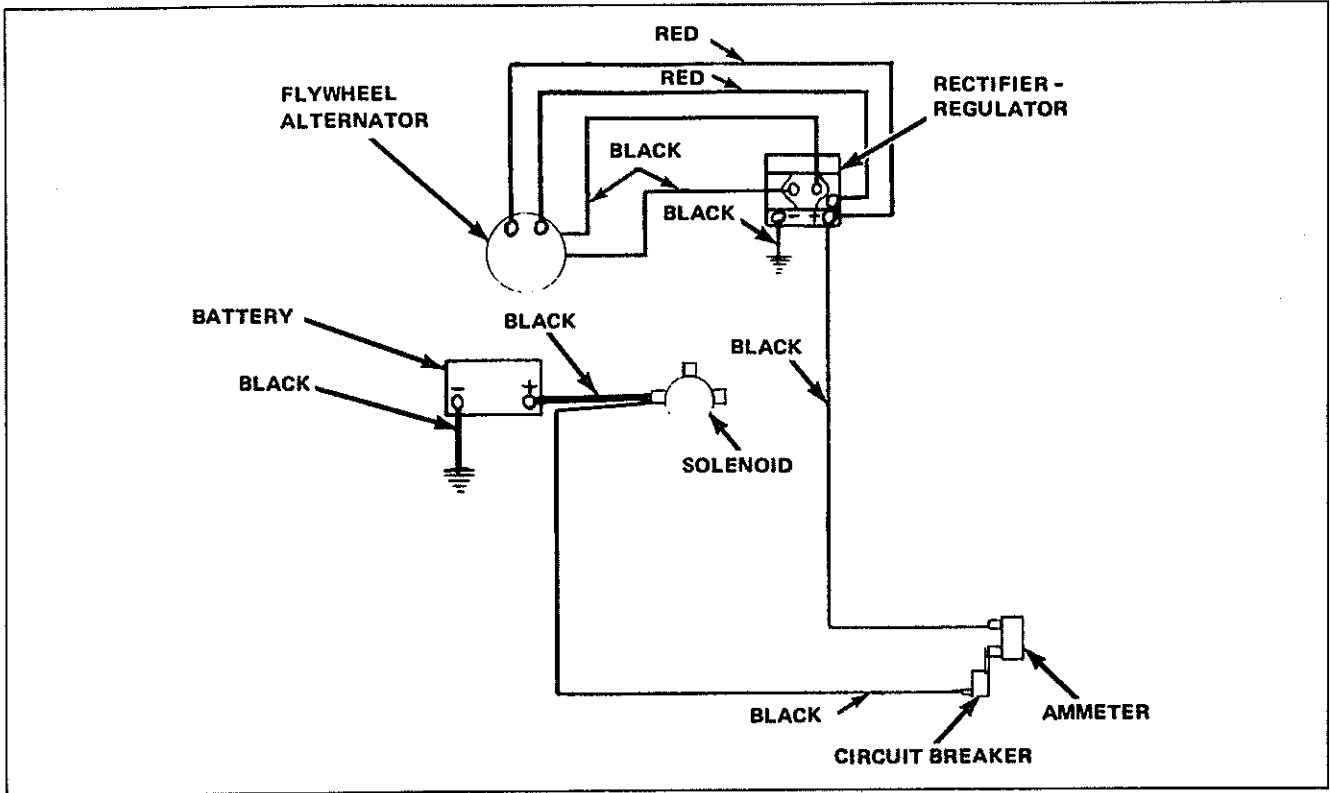


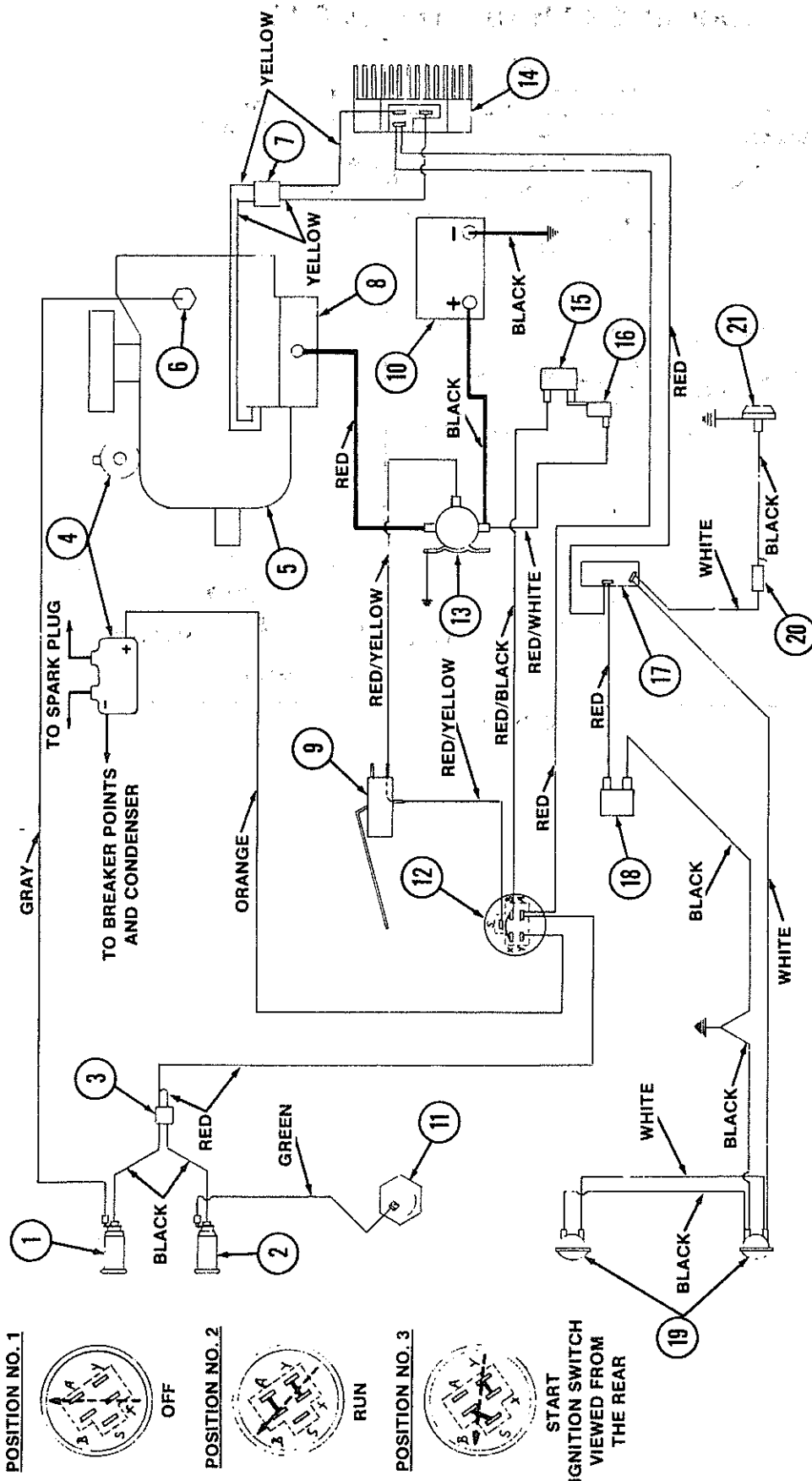
FIGURE 2-4

2



# ELECTRICAL SYSTEM (Continued)

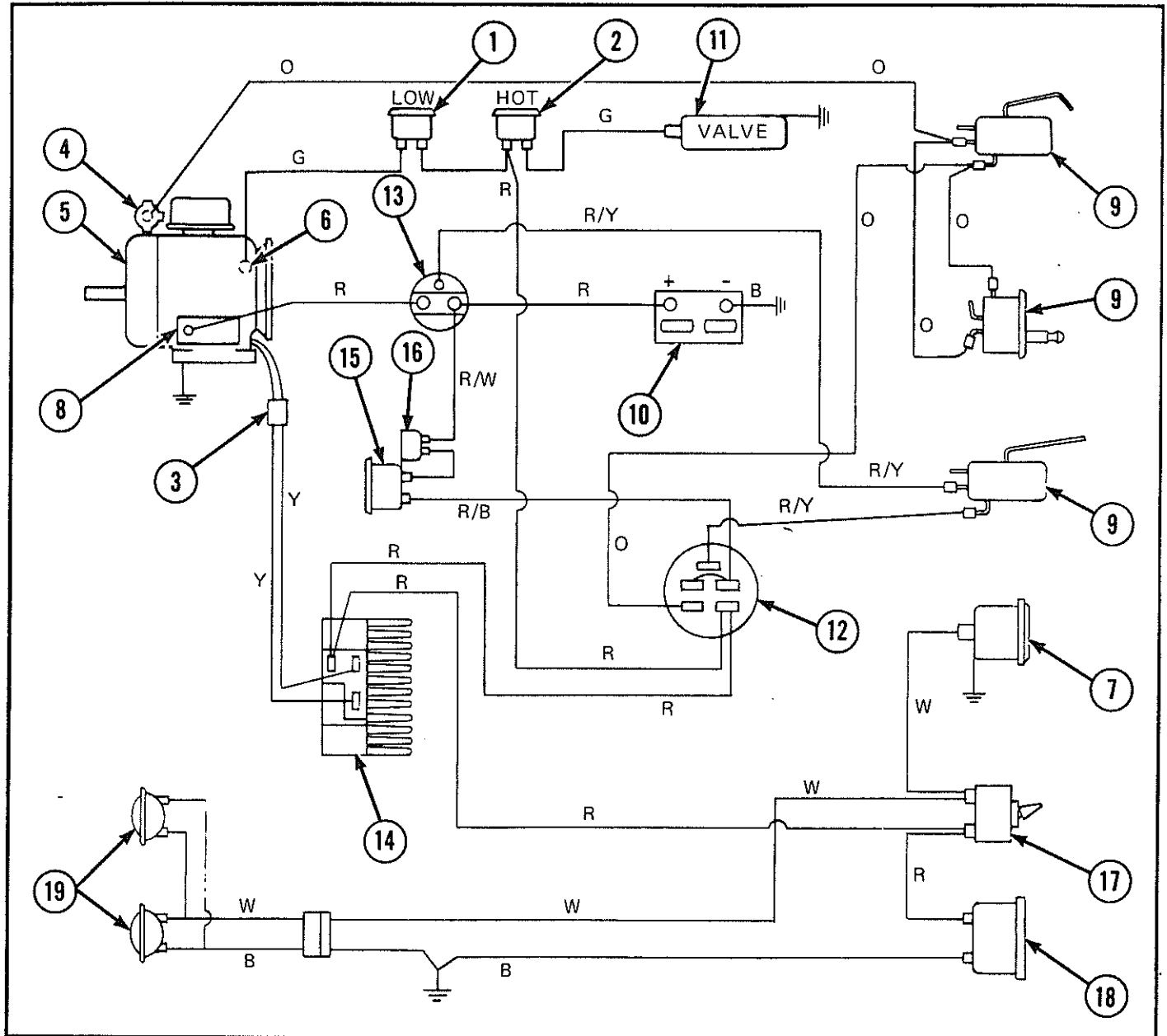
WIRING DIAGRAM 2086 & 2087 S/N 0100101 TO 0399999



- |                         |                           |                         |
|-------------------------|---------------------------|-------------------------|
| 1. OIL PRESSURE LIGHT   | 8. STARTER                | 15. AMMETER             |
| 2. HEAT INDICATOR LIGHT | 9. INTERLOCK SWITCH       | 16. CIRCUIT BREAKER     |
| 3. CONNECTOR            | 10. BATTERY               | 17. LIGHT SWITCH        |
| 4. IGNITION COIL        | 11. HEAT INDICATOR SWITCH | 18. OPTIONAL HOUR METER |
| 5. ENGINE               | 12. IGNITION SWITCH       | 19. HEAD LIGHTS         |
| 6. OIL PRESSURE SWITCH  | 13. SOLENOID              | 20. CONNECTOR           |
| 7. CONNECTOR            | 14. RECTIFIER — REGULATOR | 21. TAIL LIGHT          |

FIGURE 2-5

## WIRING DIAGRAM 2087 S/N 0400101 AND UP & 2389



<ol style="list-style-type: none"> <li>1. OIL PRESSURE LIGHT</li> <li>2. HEAT INDICATOR LIGHT</li> <li>3. CONNECTOR</li> <li>4. IGNITION COIL</li> <li>5. ENGINE</li> <li>6. OIL PRESSURE SWITCH</li> <li>7. TAIL LIGHT</li> <li>8. STARTER</li> <li>9. INTERLOCK SWITCH</li> <li>10. BATTERY</li> <li>11. HEAT INDICATOR SWITCH</li> <li>12. IGNITION SWITCH</li> <li>13. SOLENOID</li> <li>14. RECTIFIER - REGULATOR</li> <li>15. AMMETER</li> <li>16. CIRCUIT BREAKER</li> <li>17. LIGHT SWITCH</li> <li>18. HOUR METER</li> <li>19. HEAD LIGHTS</li> </ol>	<p style="text-align: center;"><b>COLOR CODE</b></p> <p>GY -- GRAY                  G -- GREEN                  W -- WHITE                  R -- RED                  B -- BLACK                  O -- ORANGE                  Y -- YELLOW                  R/W -- RED/WHITE                  R/B -- RED/BLACK                  R/Y -- RED/YELLOW</p>
--	---

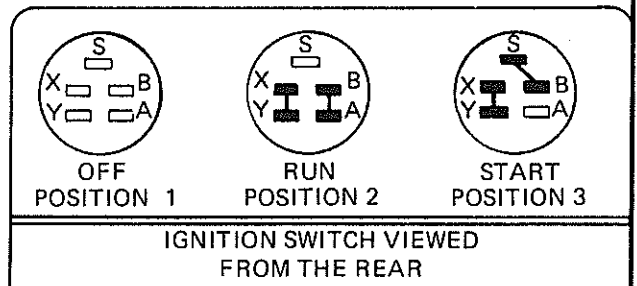
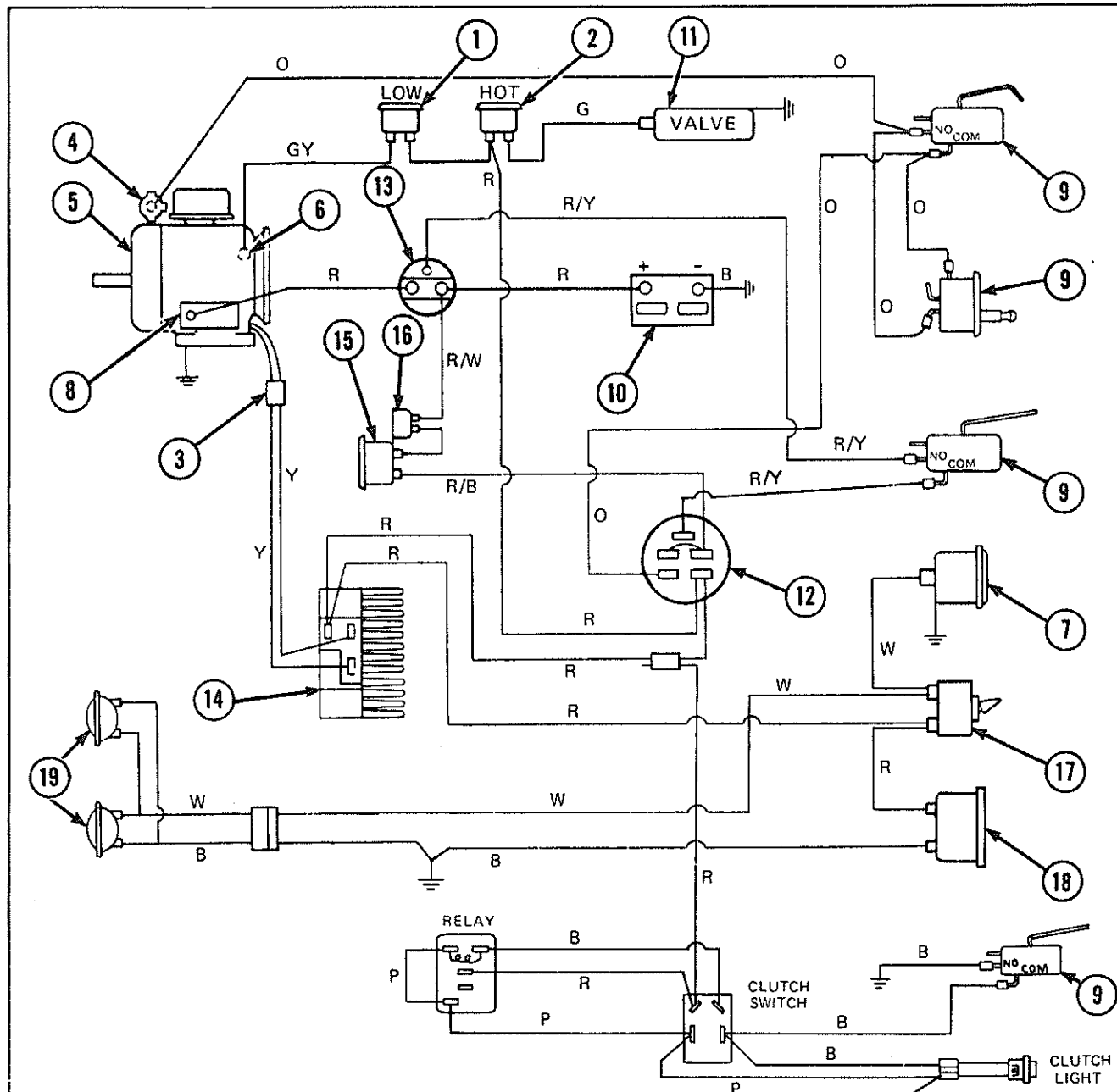


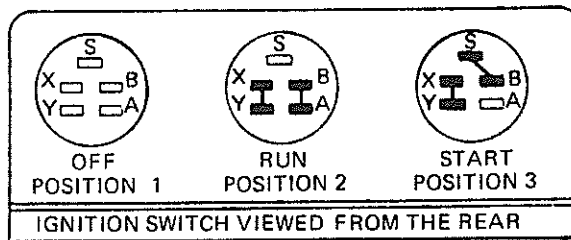
FIGURE 2-5A

# ELECTRICAL SYSTEM (Continued)

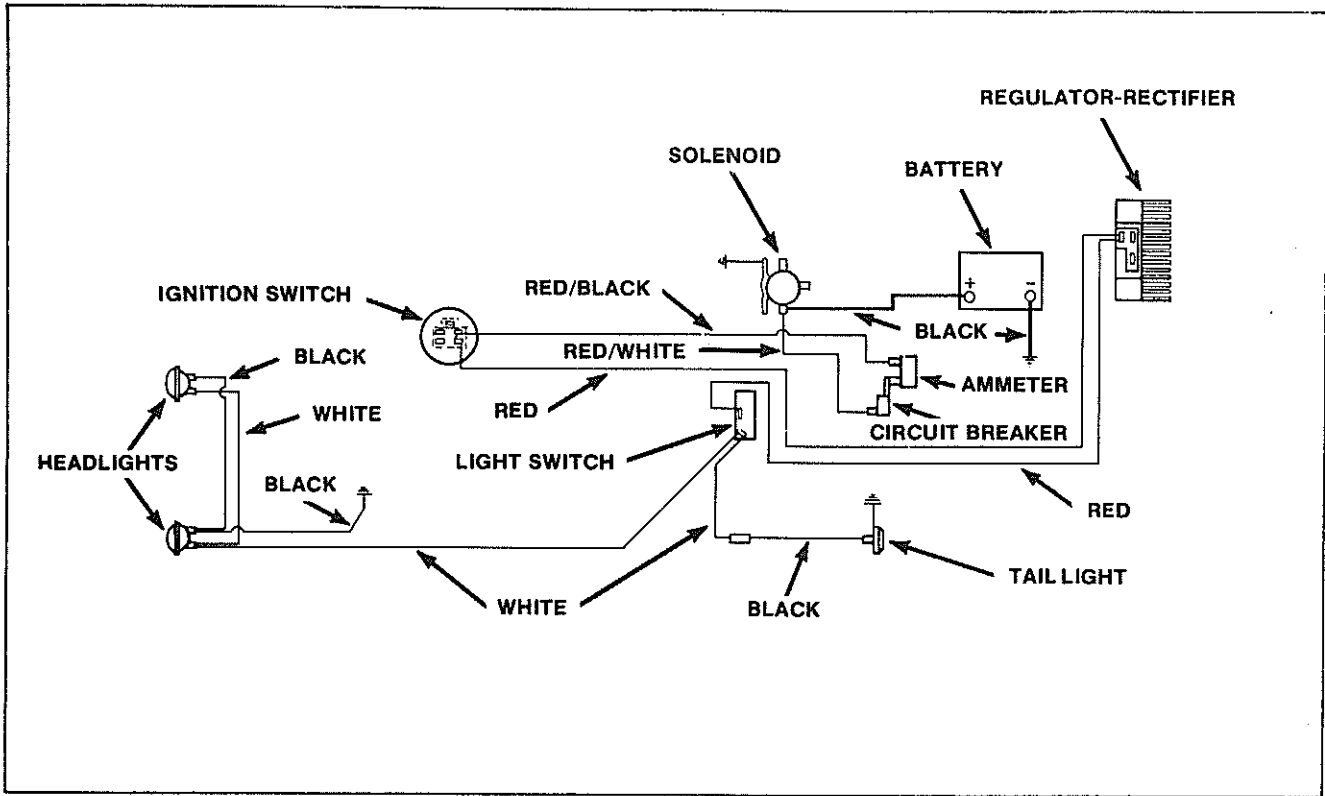
WIRING DIAGRAM 2389s S/N 0100101 and later



1. OIL PRESSURE LIGHT	COLOR CODE
2. HEAT INDICATOR LIGHT	
3. CONNECTOR	GY - GRAY
4. IGNITION COIL	G - GREEN
5. ENGINE	W - WHITE
6. OIL PRESSURE SWITCH	R - RED
7. TAIL LIGHT	O - ORANGE
8. STARTER	Y - YELLOW
9. INTERLOCK SWITCH	R/W - RED/WHITE
10. BATTERY	R/B - RED/BLACK
11. HEAT INDICATOR SWITCH	R/Y - RED/YELLOW
12. IGNITION SWITCH	P - PURPLE
13. SOLENOID	
14. RECTIFIER - REGULATOR	
15. AMMETER	
16. CIRCUIT BREAKER	
17. LIGHT SWITCH	
18. HOUR METER	
19. HEAD LIGHTS	

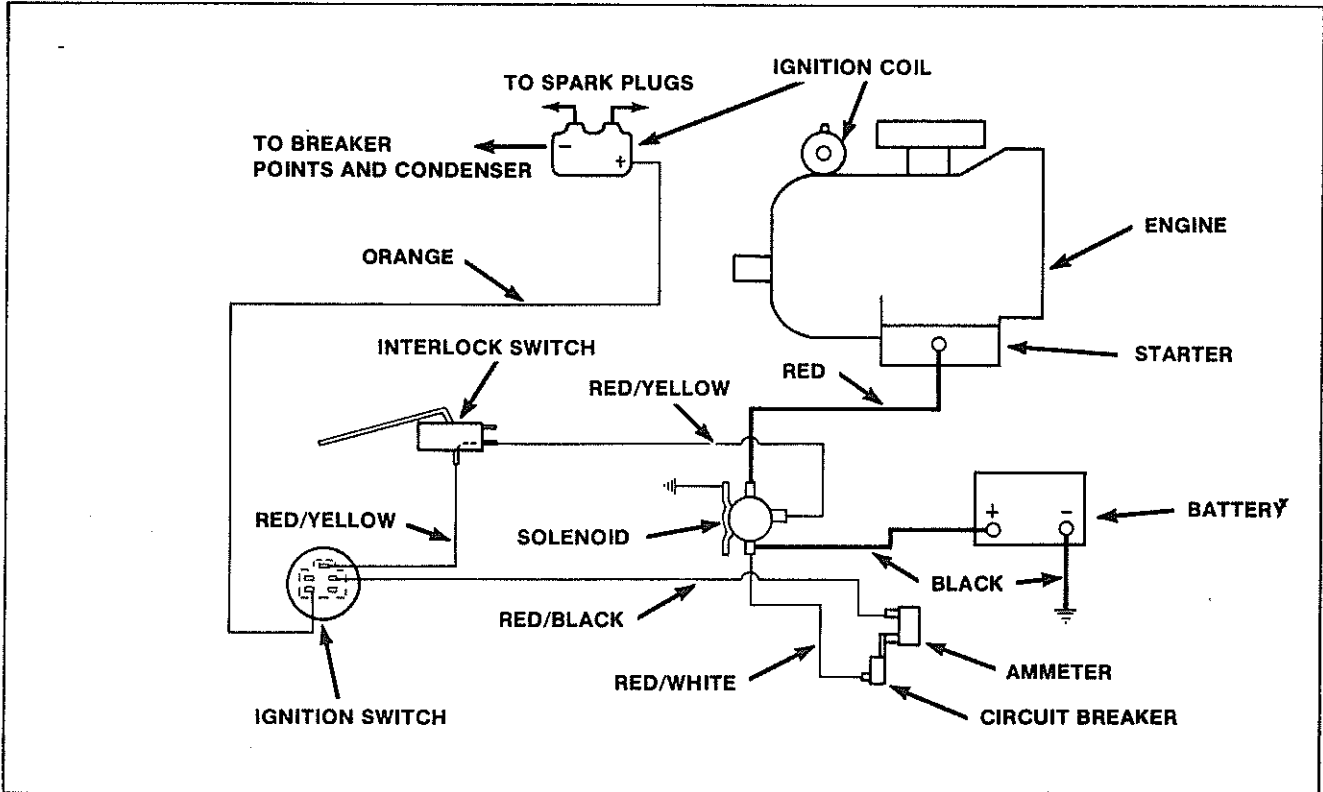


**LIGHT CIRCUIT 2086, 2087, 2389 & 2389s**



**FIGURE 2-6**

**START-RUN CIRCUIT 2086 & 2087 S/N 0100101 THRU 0399999**

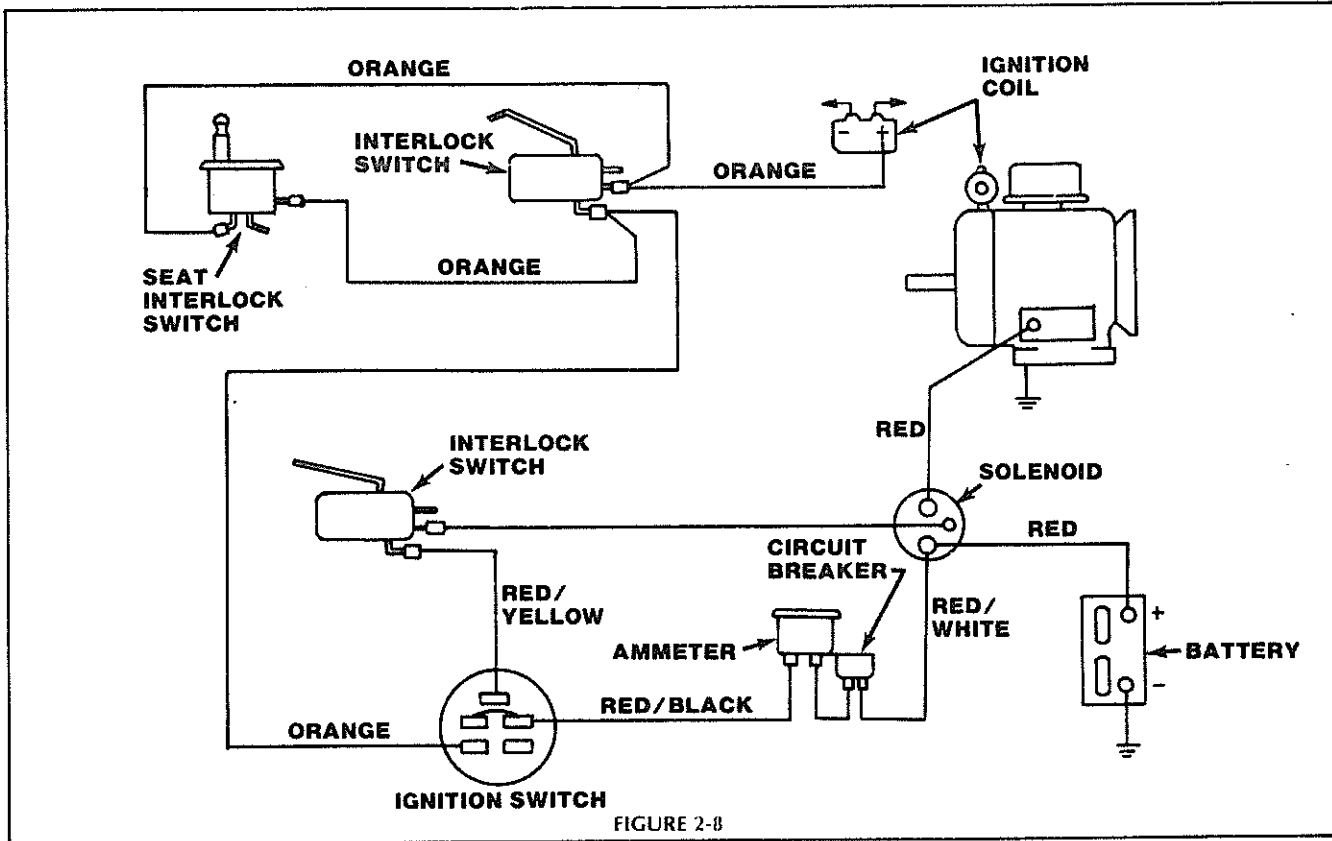


**FIGURE 2-7**

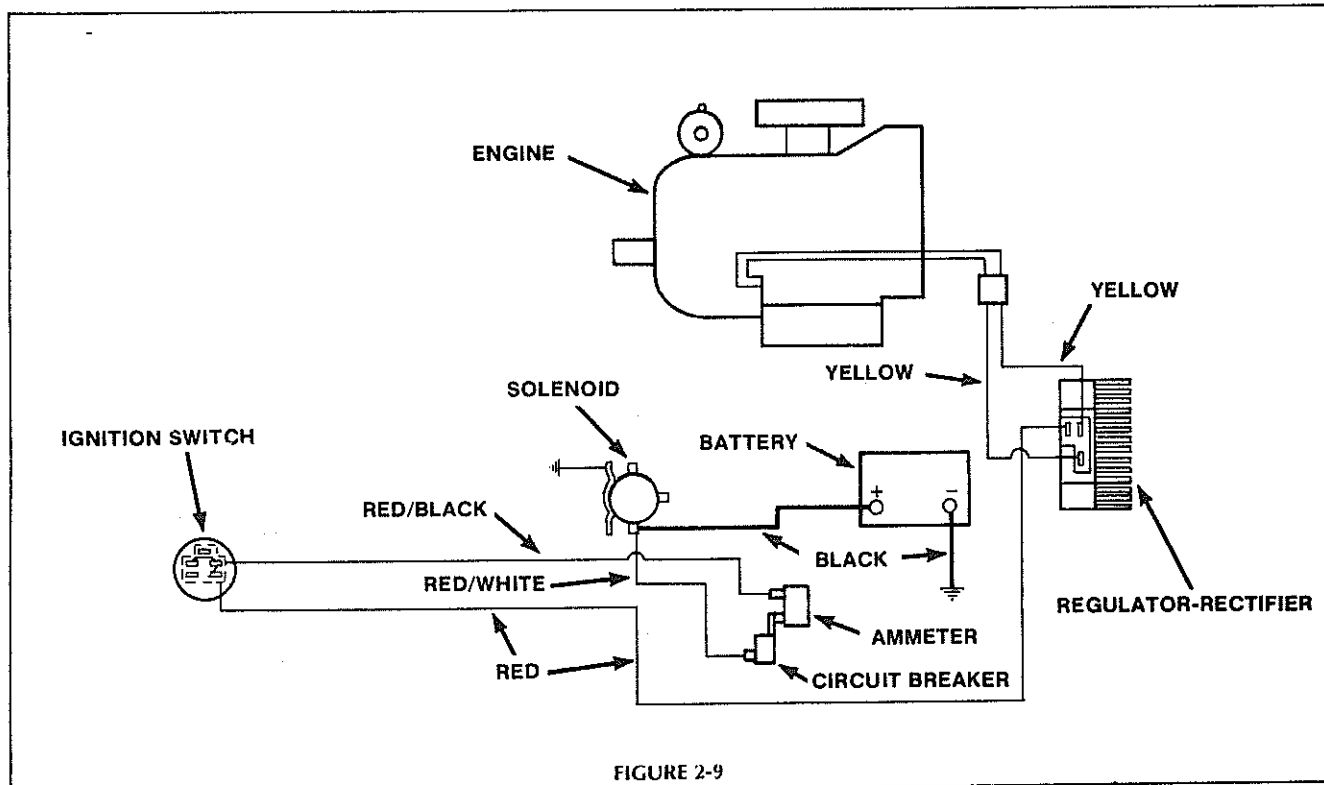
**2**

# ELECTRICAL SYSTEM (Continued)

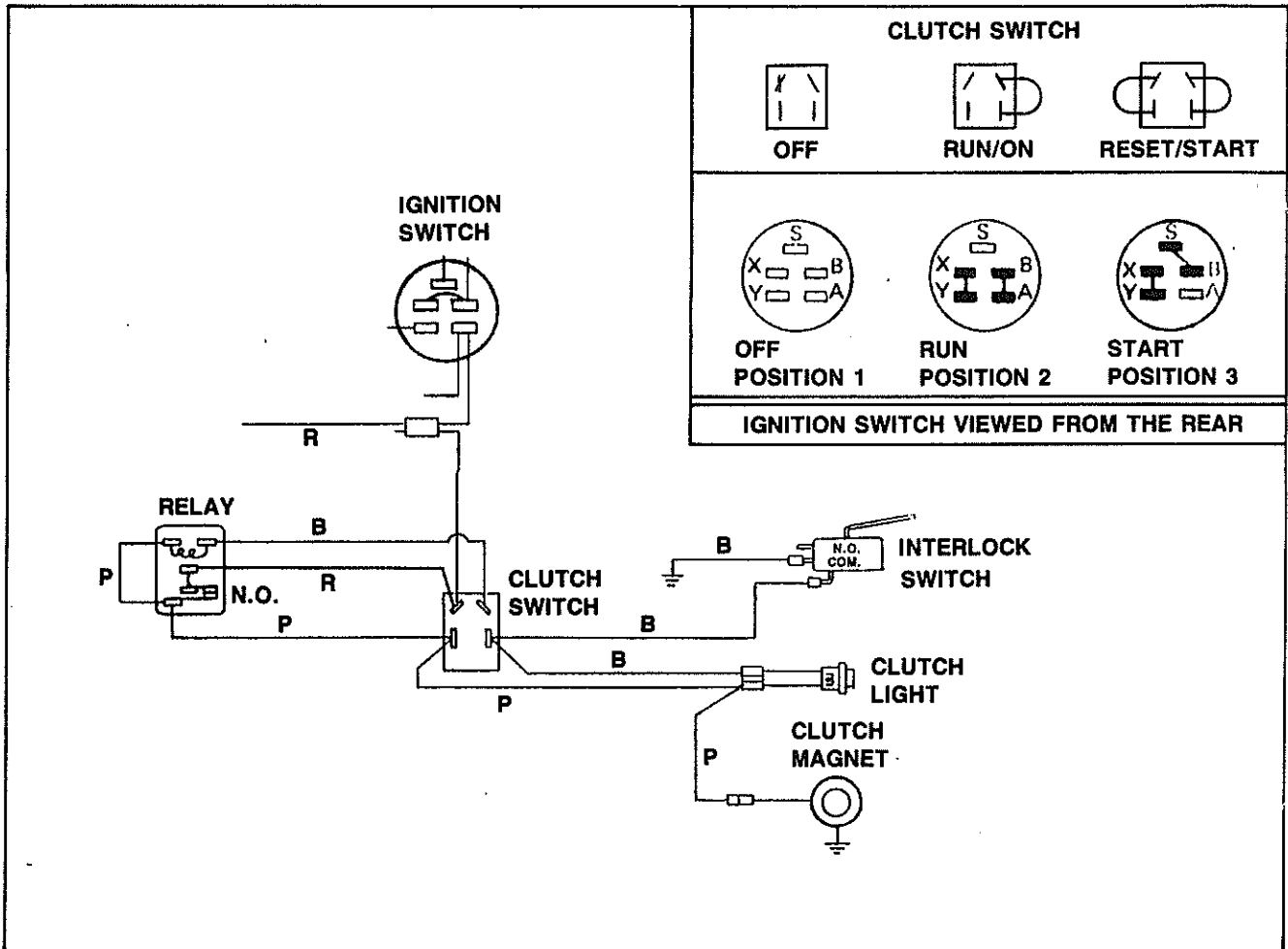
## START-RUN CIRCUIT 2087 S/N 0400101 AND UP, 2389 & 2389s



## CHARGING CIRCUIT 2086, 2087, 2389 & 2389s

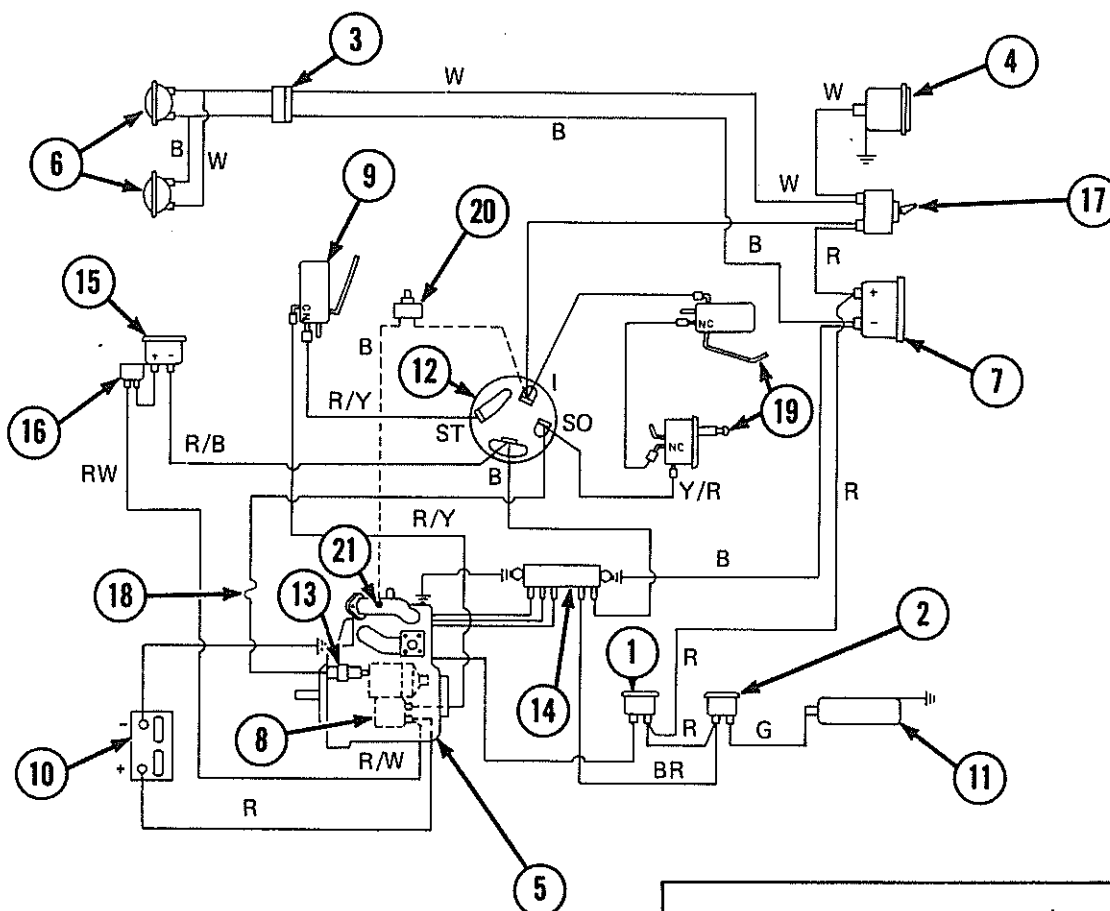


## CRUISE CONTROL CLUTCH CIRCUIT



# ELECTRICAL SYSTEM (Continued)

WIRING DIAGRAM 2288 & 2289 S/N 0100101 - 0199999

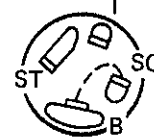


1. OIL PRESSURE LIGHT
2. HEAT INDICATOR LIGHT
3. CONNECTOR
4. TAIL LIGHT
5. ENGINE
6. HEAD LIGHTS
7. HOUR METER
8. STARTER
9. INTERLOCK SWITCH (PTO BRAKE)
10. BATTERY
11. HEAT INDICATOR SWITCH
12. IGNITION SWITCH
13. SOLENOID (2288 ONLY)
14. RECTIFIER - REGULATOR
15. AMMETER
16. CIRCUIT BREAKER
17. LIGHT SWITCH
18. FUSE 6A (2288 ONLY)
19. INTERLOCK SWITCH NOT FUNCTIONAL ON 2288
20. COLD START SWITCH (PART OF COLD START KIT)
21. THERMOSTART PLUG (PART OF COLD START KIT)

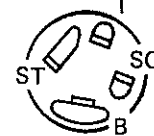
**COLOR CODE**

- GY - GRAY
- G - GREEN
- W - WHITE
- R - RED
- BR - BROWN
- O - ORANGE
- Y/R - YELLOW/RED
- R/W - RED/WHITE
- R/B - RED/BLACK
- R/Y - RED/YELLOW

STOP  
POSITION  
(MODEL 2289  
ONLY)



OFF  
POSITION



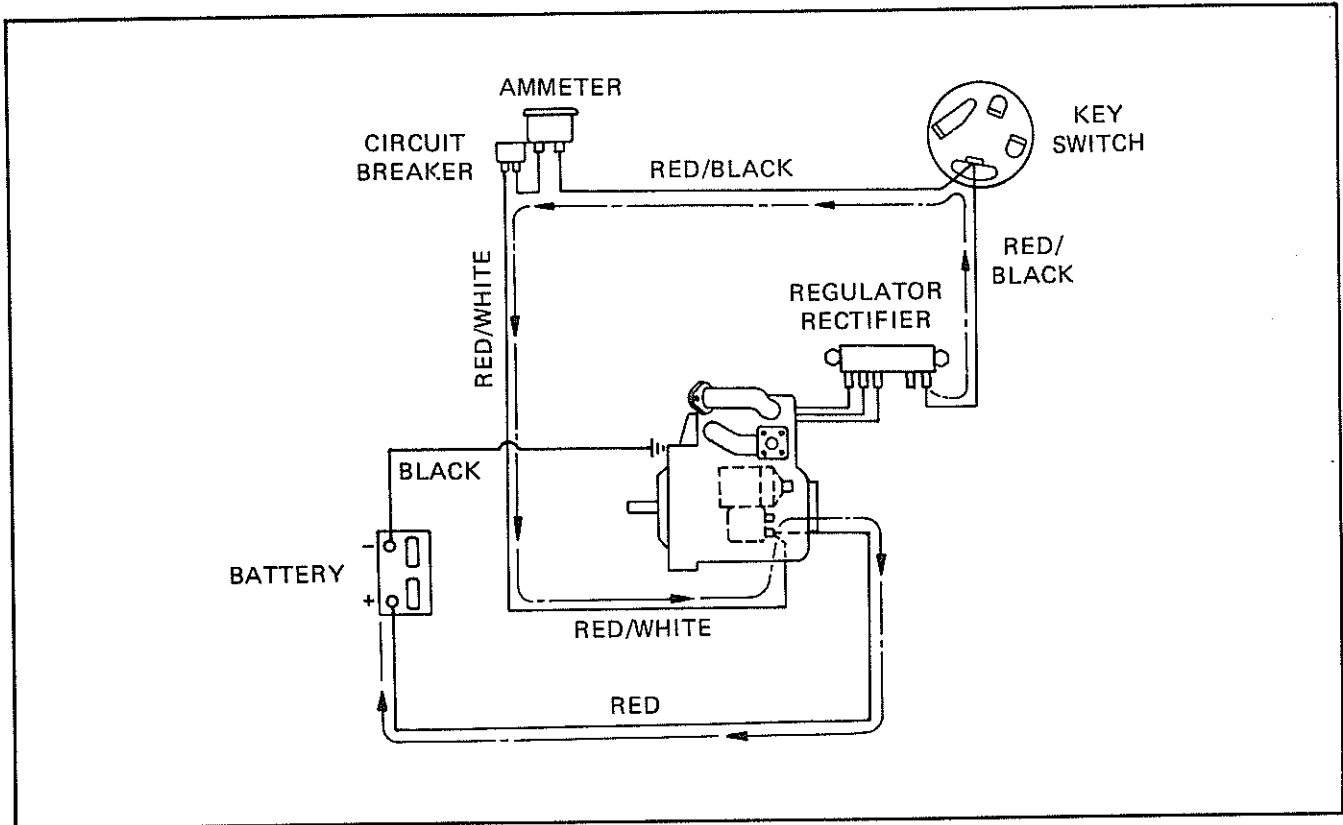
RUN  
POSITION



START  
POSITION

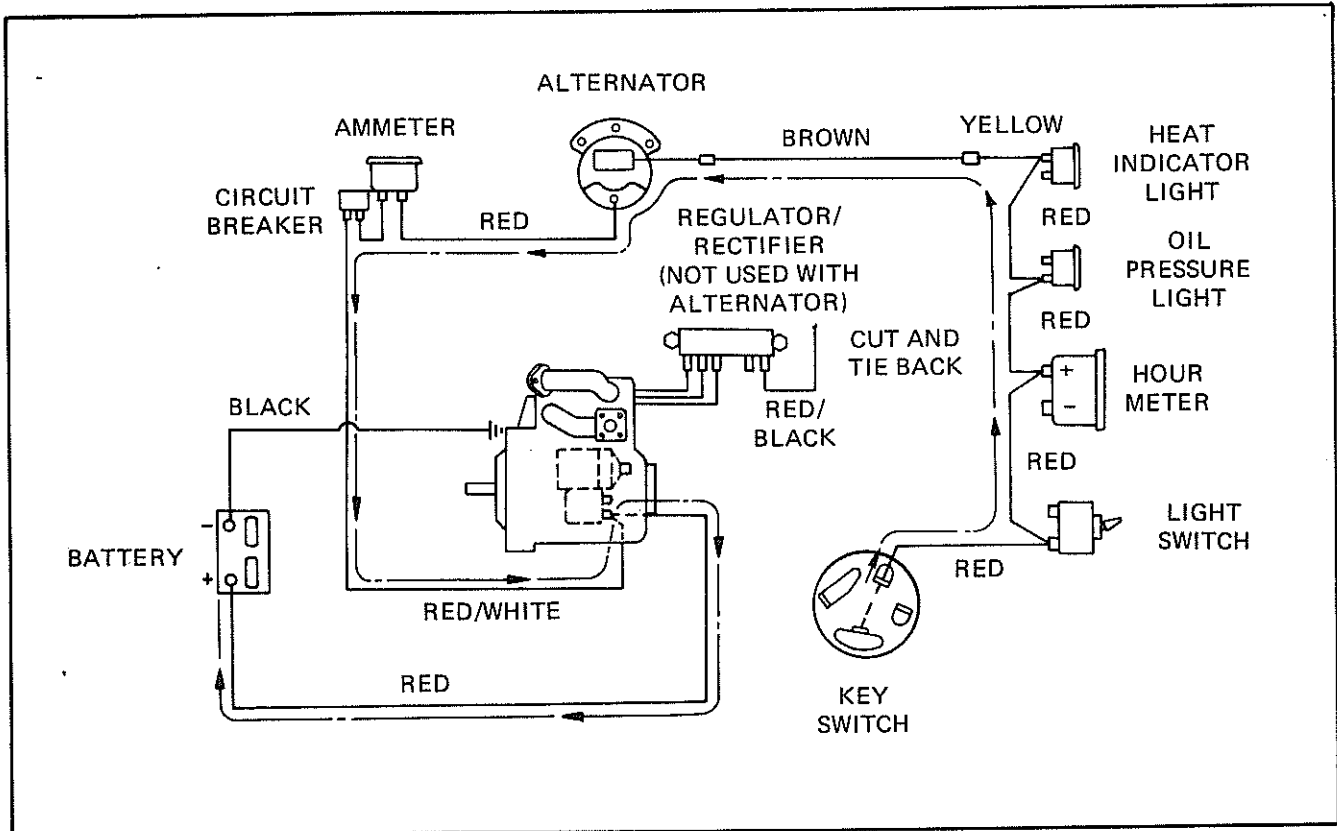


## CHARGING CIRCUIT 2288 & 2289 S/N 0100101 THRU 0199999



2

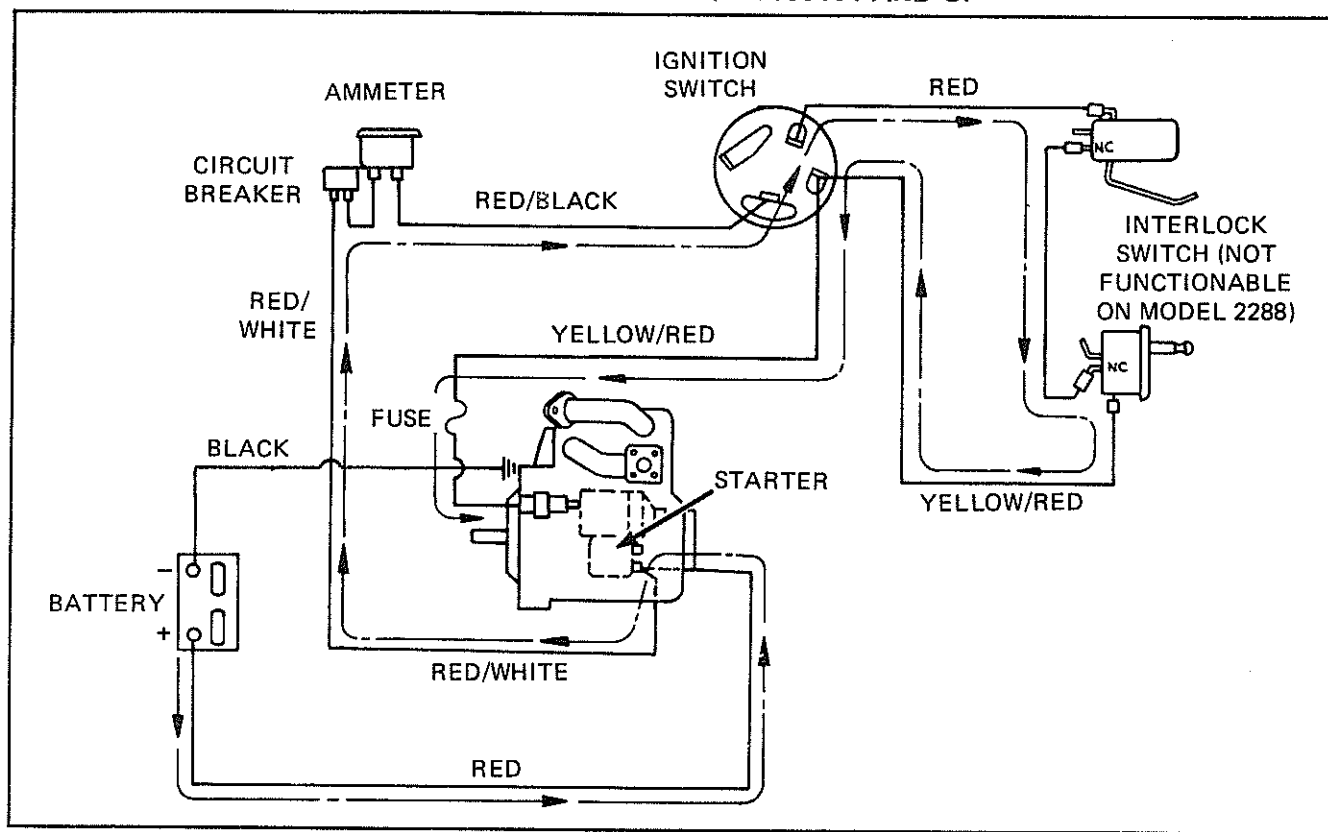
## CHARGING CIRCUIT 2288 & 2289 S/N 0100101 thru 0199999 (with Alternator Kit Model 18317)



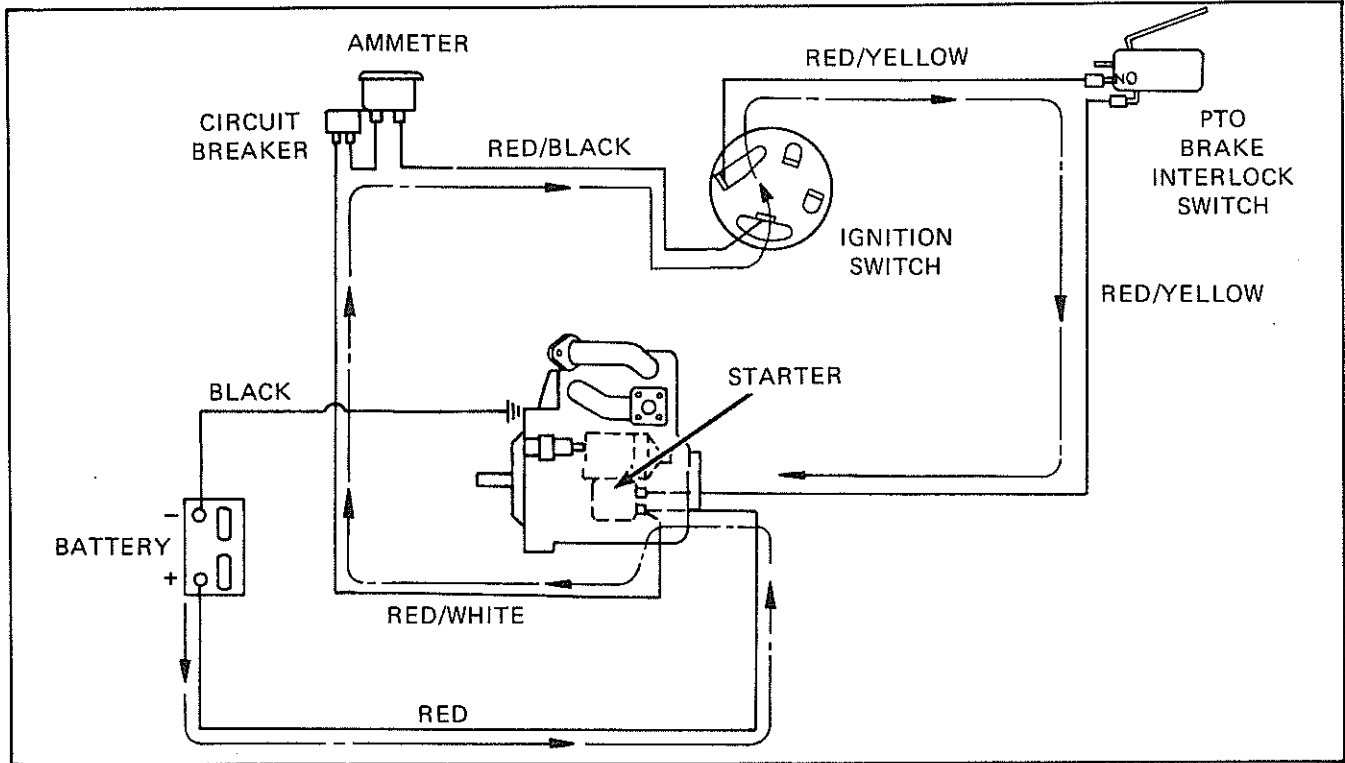


# ELECTRICAL SYSTEM (Continued)

SEAT CIRCUIT 2288 & 2289 S/N 0100101 AND UP

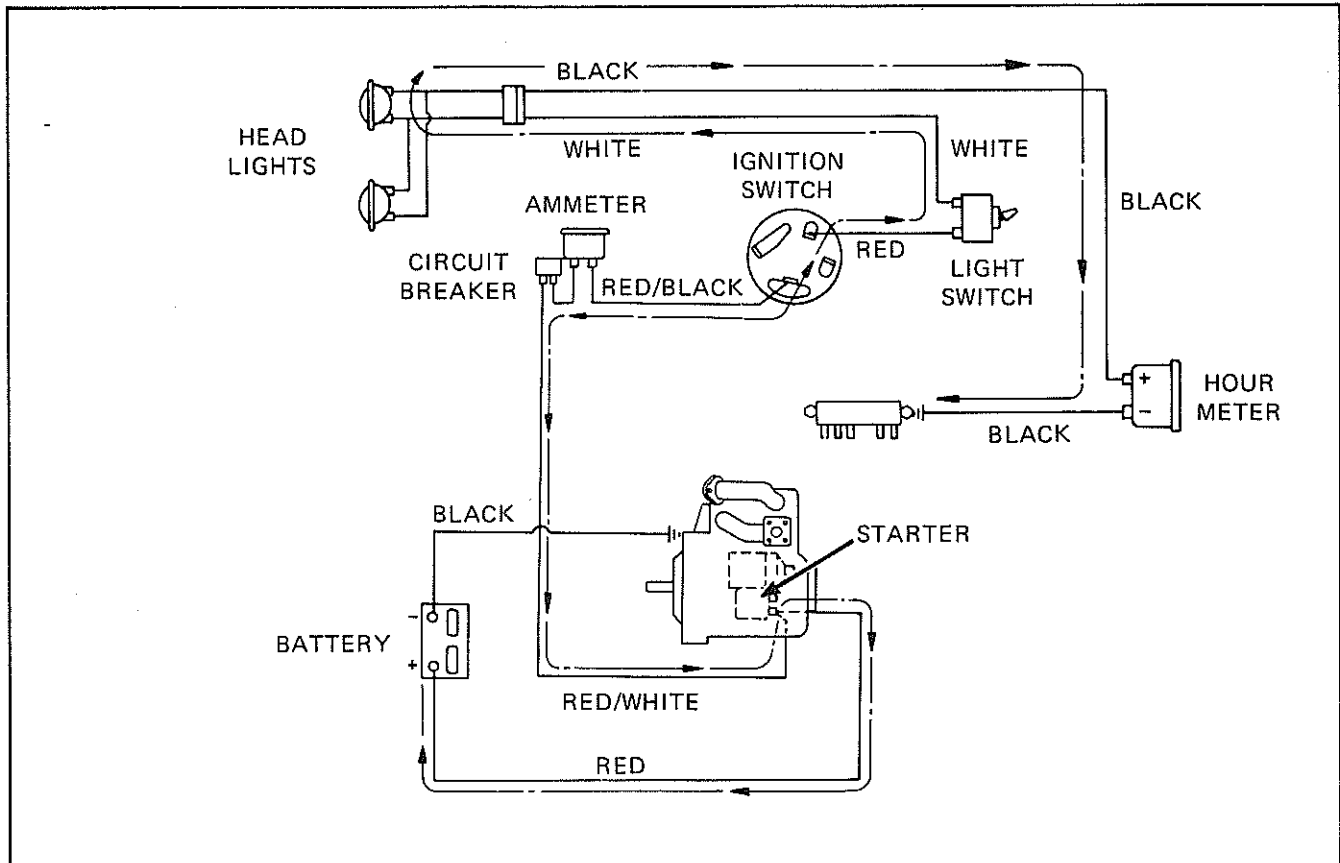


## START CIRCUIT MODELS 2288 & 2289 S/N 0100101 AND UP



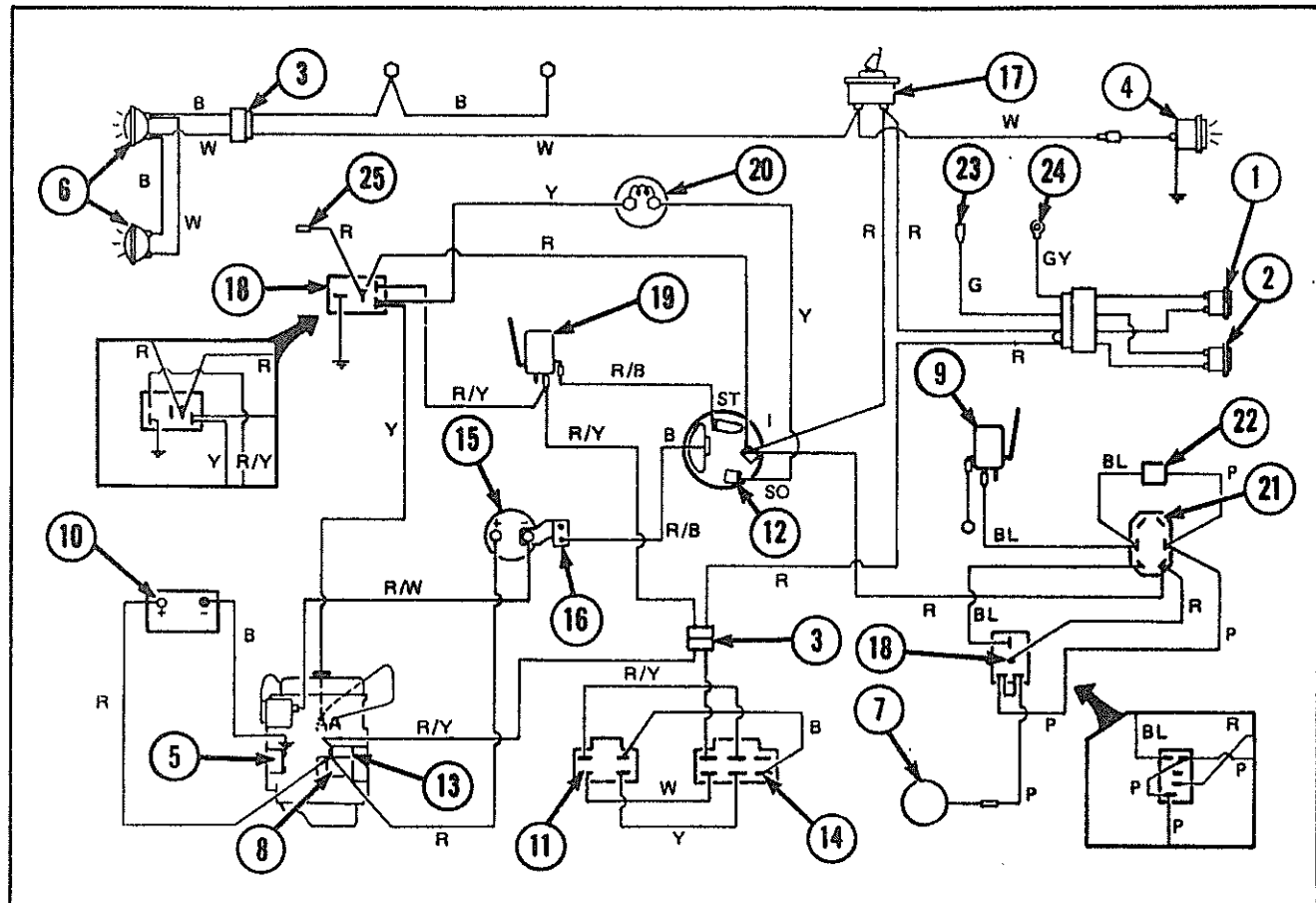
2

## LIGHT CIRCUIT MODELS 2288 & 2289 S/N 0100101 AND UP



# GROUP II. ELECTRICAL SYSTEM

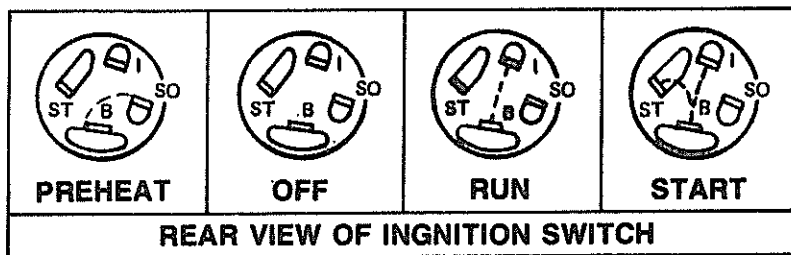
## WIRING DIAGRAM MODEL 2388s



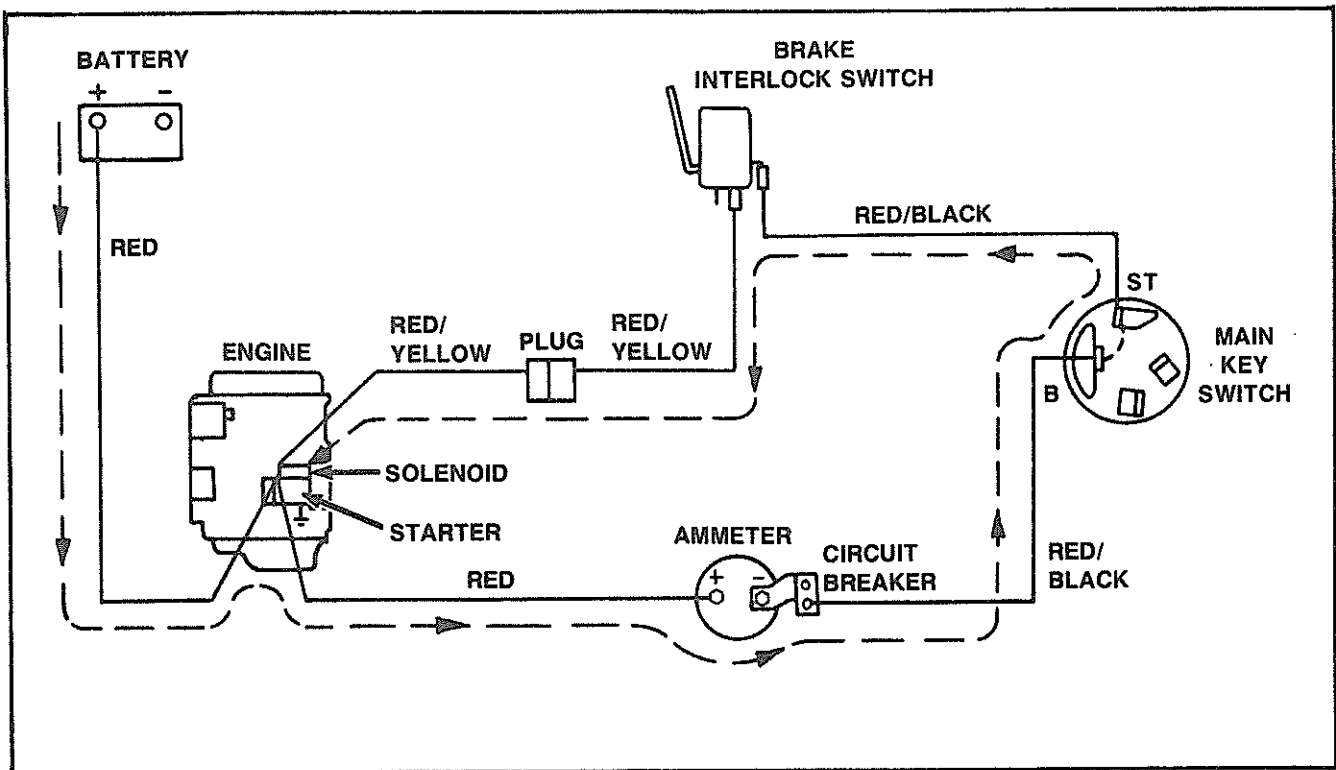
1. OIL PRESSURE LIGHT
2. HEAT INDICATOR LIGHT
3. CONNECTOR
4. TAIL LIGHT
5. ENGINE
6. HEADLIGHTS
7. SPEED CLUTCH
8. STARTER
9. INTERLOCK SWITCH
10. BATTERY
11. ALTERNATOR PLUG
12. MAIN SWITCH
13. SOLENOID
14. REGULATOR PLUG
15. AMMETER
16. CIRCUIT BREAKER
17. LIGHT SWITCH
18. RELAY
19. INTERLOCK SWITCH (BRAKE)
20. GLOW PLUG
21. SPEED SWITCH
22. SWITCH LIGHT
23. HYDROSTATIC TEMP.
24. OIL PRESSURE
25. FUEL PUMP PLUG

### COLOR CODE

R/B	RED/BLUE
GY	GRAY
G	GREEN
W	WHITE
R	RED
R/W	RED/WHITE
R/B	RED/BLACK
R/Y	RED/YELLOW
P	PURPLE

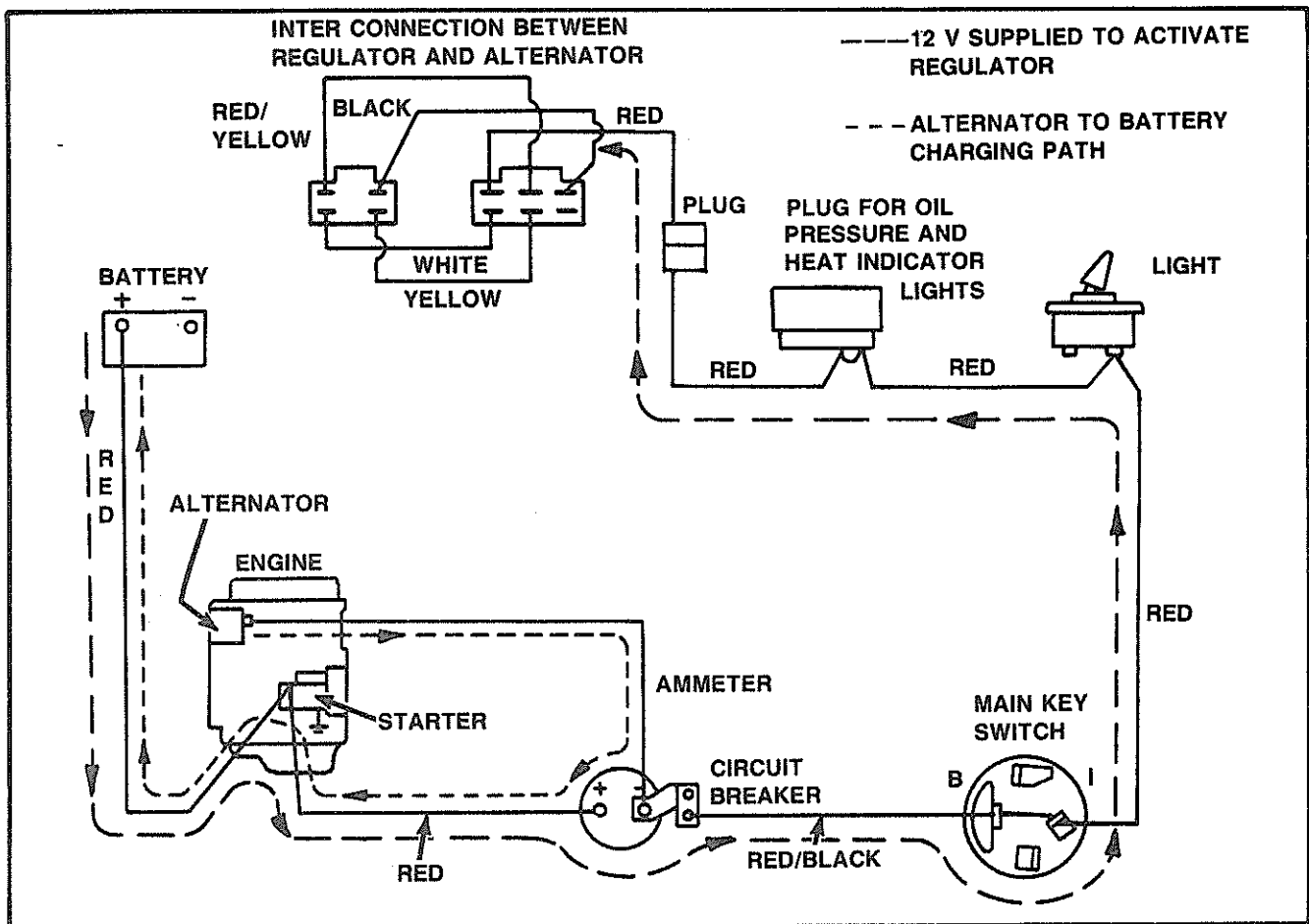


## STARTING CIRCUIT 2388s



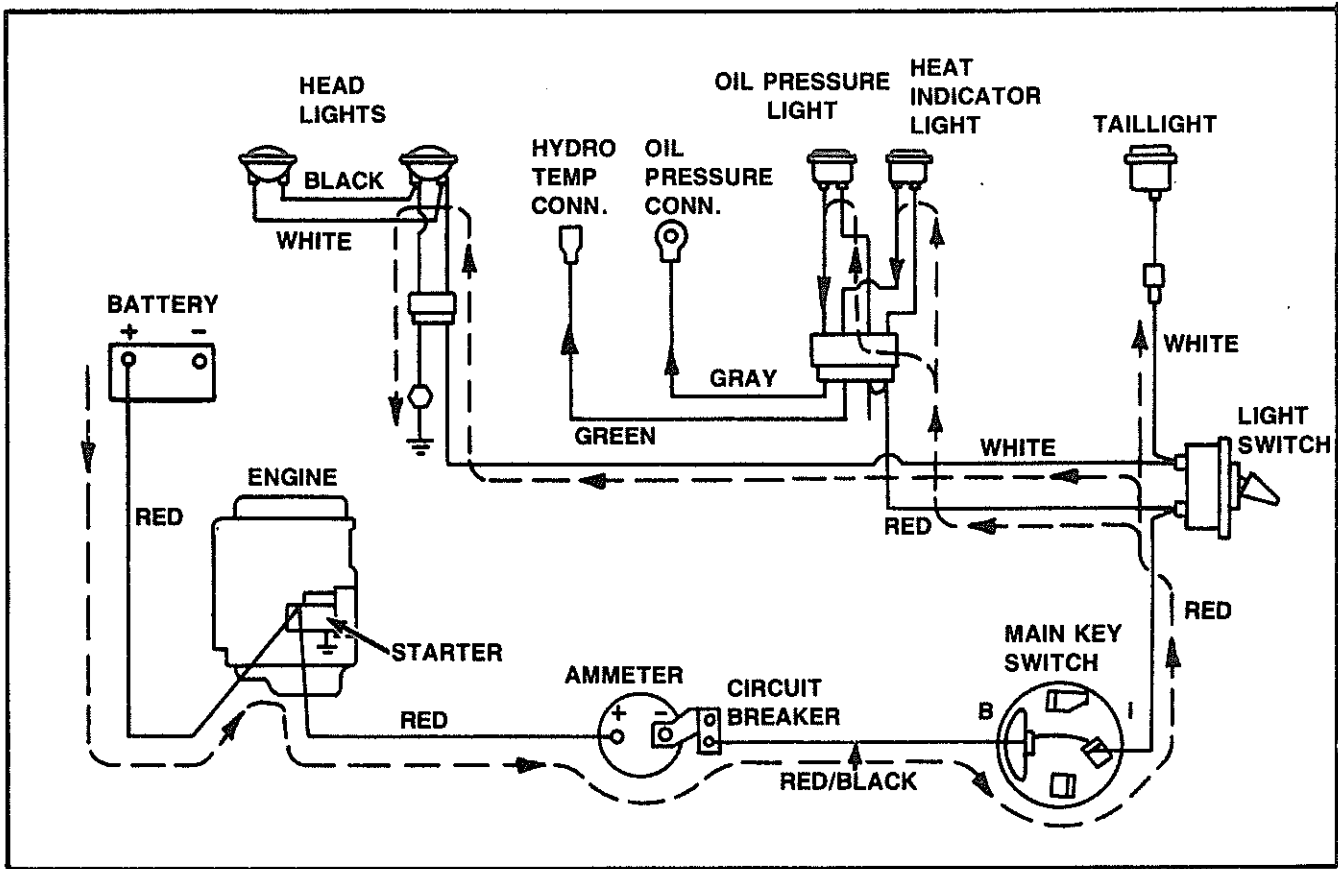
2

## RUN CIRCUIT 2388s

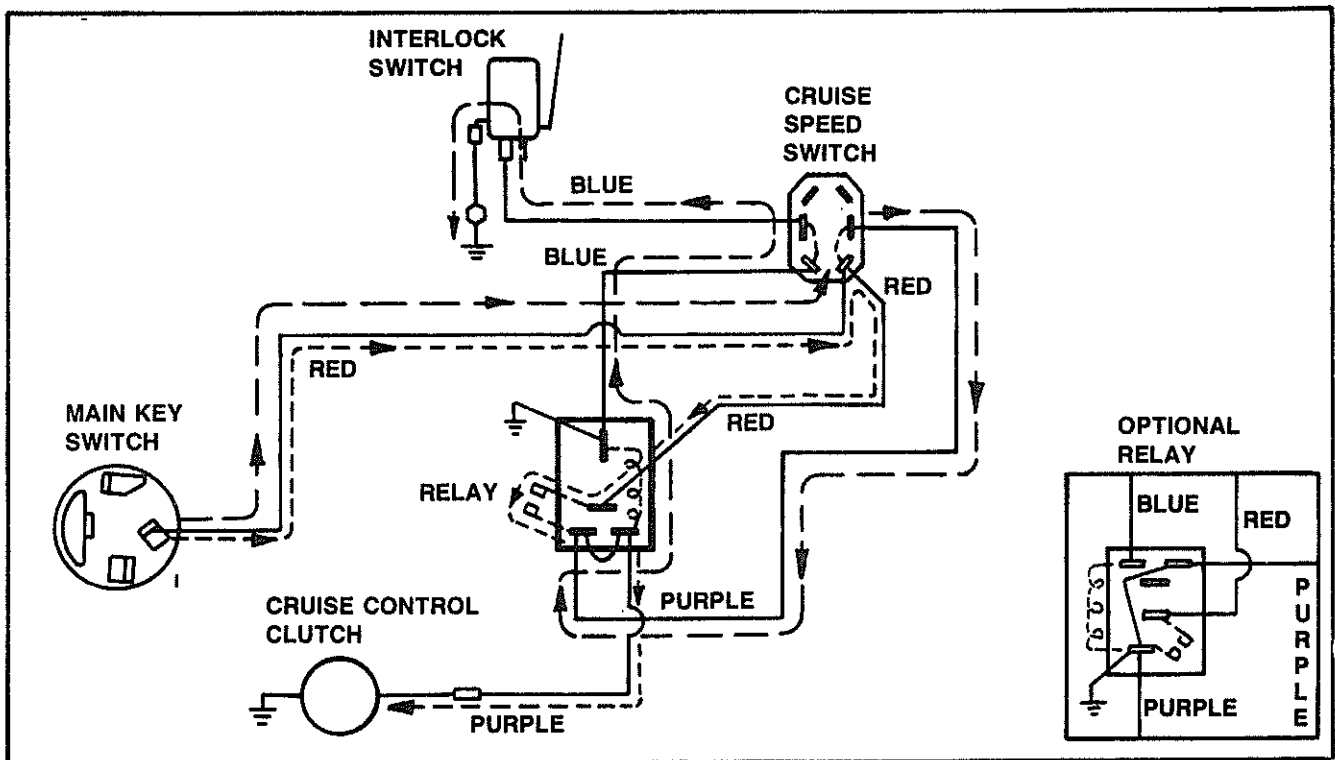


# ELECTRICAL SYSTEM (Continued)

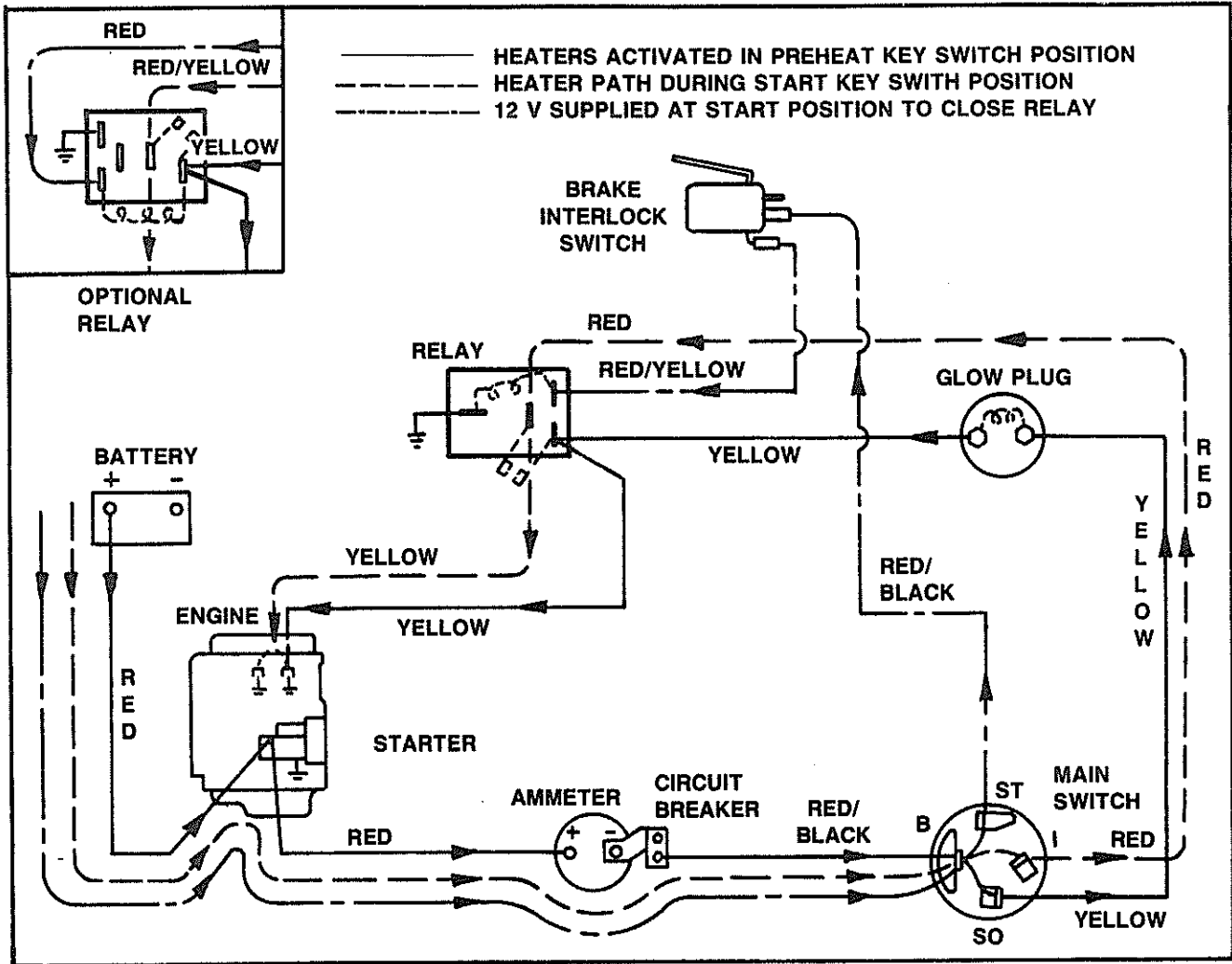
## LIGHT CIRCUIT 2388s



## CRUISE CONTROL CIRCUIT 2388s



## PREHEAT CIRCUIT



## TESTING ELECTRICAL SYSTEM

### TESTING BATTERY

#### CHECKING SPECIFIC GRAVITY

To determine whether the battery is capable of meeting the requirements of the starting motor, it is necessary to subject the battery to a load test. The battery must be at least 75% charged for this test. To determine the percentage of charge a hydrometer reading should be taken.

The following table illustrates ranges of specific gravity for each cell in various states of charge at 80°F.

#### SPECIFIC GRAVITY

	PERCENTAGE CHARGED
1.250 TO 1.280 .....	100%
1.230 TO-1.250 .....	75%
1.200 TO 1.220 .....	50%
1.170 TO 1.190 .....	25%
1.140 TO 1.160 .....	10%
1.110 TO 1.130 ....	DISCHARGED

#### CHECKING BATTERY VOLTAGE

Battery voltage can be checked with a volt-ohmmeter and should be between 11.5 and 12.5 volts.

#### BATTERY CRANKING TEST

For this test the battery should be approximately 80°F. (26°C).

1. Check battery electrolyte level, add water if necessary. Battery must be fully charged.

2. Check battery voltage. It should be between 11.5 and 12.5 volts.

3. Crank the engine using the starter motor for 15 seconds. Battery voltage should not drop below 9.0 volts at the end of this 15 second test.

4. If voltage is less than 9.0 volts, repeat steps 1 through 4. If same results are obtained, replace battery.

#### SOLENOID TEST

The solenoid is a sealed unit and must be replaced if found inoperative.

To test the solenoid connect 12 volts between the solenoid case and the small solenoid terminal. **CAUTION:** If battery is the 12 volt power source a spark may ignite battery gases.

When contact is made the plunger should be activated. If test does not activate the plunger, replacement is necessary.

#### SWITCH TEST

Before electrical tests of the switches are made, make sure mechanical adjustments of the actuating mechanisms are correct.

#### SEAT SWITCH

The seat switch is wired normally open (NO).

To test connect ohmmeter as shown in Figure 2-10 and depress plunger. Meter should indicate zero resistance. At normally closed position the meter should indicate an infinite resistance.

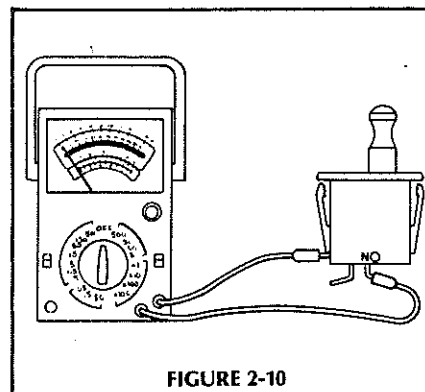


FIGURE 2-10

2086, 2087, 2288, 2289, 2389, 2389s, and 2388s

## TESTING BATTERY CHARGING SYSTEM

Battery does not charge.

Check to make sure all wiring harness plugs have good electrical connections. Check wires for damage caused by vibration, heat, etc. Refer to charging circuit wiring diagram.

With the battery connected, check DC voltage from the B terminal of the Rectifier-Regulator to ground. The reading should be 13.8 volts or higher. Place a load on the battery, such as the headlights, to reduce the battery voltage below the 13.8 volts. If the battery charges, it was fully charged at time of first test. If battery does not charge, the stator or Rectifier-Regulator is defective.

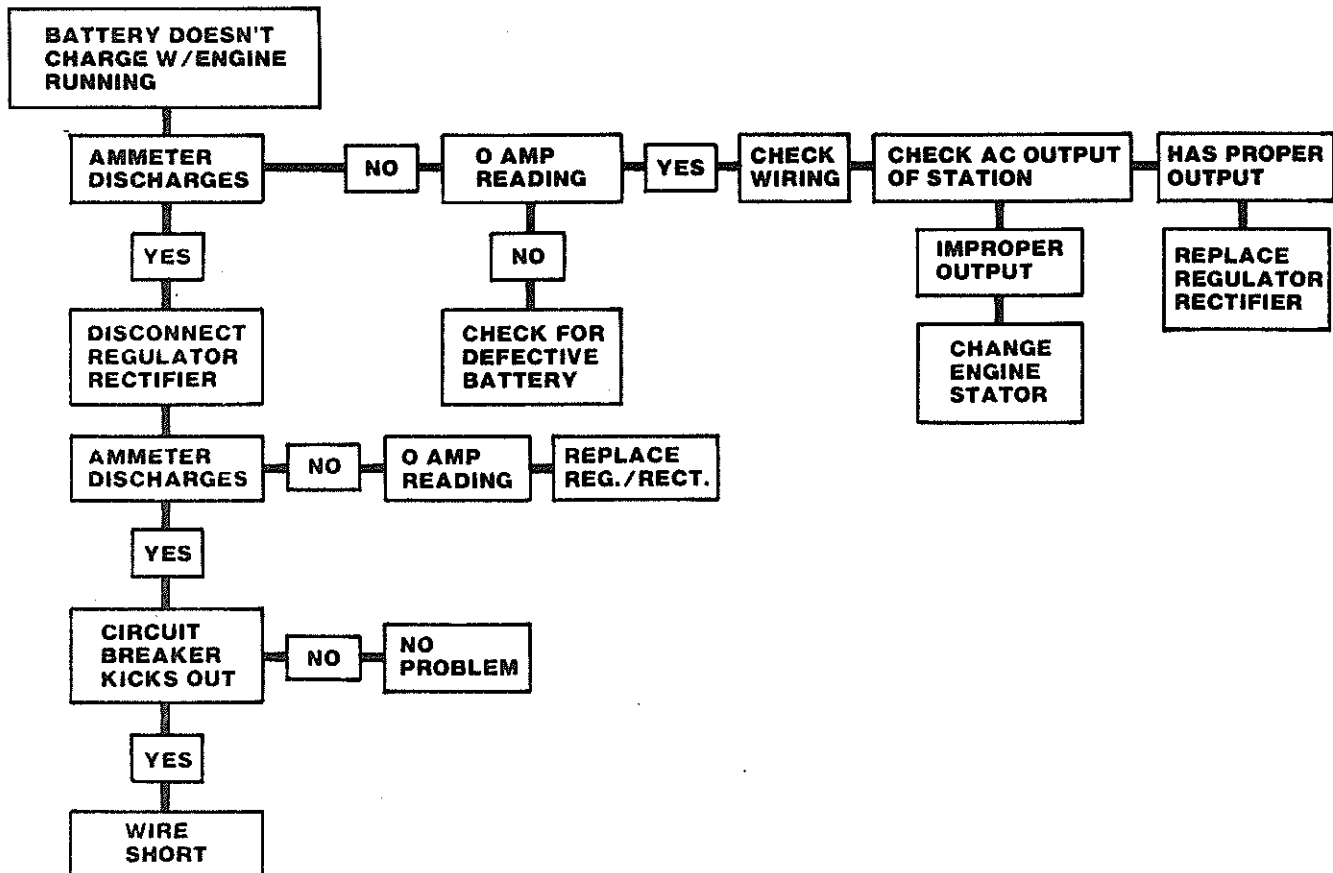
Testing to determine which is defective.

Remove wiring harness plug which comes from stator in engine from the Rectifier-Regulator. Run engine at full R.P.M. and check AC voltage at plug. If reading is below 28 AC volts, the stator may be defective. If the reading is more than 28 AC volts, the Rectifier-Regulator may be defective.

Battery charges at high rate.

Check the DC voltage from the B terminal of the Rectifier-Regulator to ground. If the reading is over 14.7 DC volts, the Regulator system of the Regulator-Rectifier may be defective.

2





## TROUBLE SHOOTING GUIDE

PROBLEM	PROBABLE CAUSE	REMEDY
Unit will not operate in either forward or reverse	<ol style="list-style-type: none"> <li>1. Free wheeling valve open (Sundstrand Hydro models)</li> <li>2. System low on oil</li> <li>3. Plugged oil filter</li> <li>4. Faulty control linkage</li> <li>5. Hydro input shaft not turning</li> <li>6. Hydro unit not functioning</li> </ol>	<ol style="list-style-type: none"> <li>1. Close valve</li> <li>2. Refill to proper level</li> <li>3. Replace filter</li> <li>4. Check linkage, correct problem</li> <li>5. Check input shaft key, replace if necessary</li> <li>6. Repair or replace hydro</li> </ol>
Unit will operate in one direction only	<ol style="list-style-type: none"> <li>1. Faulty control linkage</li> <li>2. One check valve stuck open</li> </ol>	<ol style="list-style-type: none"> <li>1. Check linkage, correct problem</li> <li>2. Remove and inspect, clean or replace if needed</li> </ol>
Loss of power	<ol style="list-style-type: none"> <li>1. Low on oil</li> <li>2. Free wheeling valve partially open (Sundstrand Hydro models)</li> <li>3. Filter or suction line clogged</li> <li>4. Worn linkage</li> <li>5. Air in system</li> <li>6. Engine lugs down</li> </ol>	<ol style="list-style-type: none"> <li>1. Check and add as necessary</li> <li>2. Close valve</li> <li>3. Replace filter, clean and refill system</li> <li>4. Replace or adjust</li> <li>5. Refill and check for leaks</li> <li>6. Check engine for proper power level</li> </ol>
Unit operating hot	<ol style="list-style-type: none"> <li>1. Oil level low</li> <li>2. Dirt on transmission</li> <li>3. Excessive load or high drawbar loading</li> <li>4. Fan not turning</li> <li>5. Partially plugged filter</li> <li>6. Internal damage to hydro</li> </ol>	<ol style="list-style-type: none"> <li>1. Check for leaks and refill to proper level</li> <li>2. Clean external surface</li> <li>3. Reduce load or drawbar loading</li> <li>4. Check fan for proper operation</li> <li>5. Replace filter and oil</li> <li>6. Repair or replace hydro</li> </ol>

## PRINCIPLE OF HYDROSTATIC OPERATION

### EATON

The Eaton Model 11 hydrostatic transmission is composed of four (4) major components; a charge pump; a variable displacement, radial ball-piston pump; a fixed displacement, radial ball-piston motor; and a system of valves located between the pump and motor.

The transmission converts mechanical energy at its input shaft into fluid flow under pressure from its

pump, transfers this fluid energy to its motor which in turn converts it back to mechanical energy at its output shaft. The purpose of this transformation is to provide variable output speed, with easy reversing, all with a constant input speed. In operation, the pressure of the fluid in the hydrostatic transmission closed loop varies as the "load" increases or decreases.

If the load increases, so does the pressure of the fluid in the transmission. This change in load and pressure automatically changes the torque output of the transmission. The greater the load (pressure), the more torque the transmission produces the match the load requirements. If the load is lessened, pressure decreases and torque output drops.

### SUNDSTRAND

Engine power is transmitted to the pump input shaft of the transmission by the tractor drive shaft. Rotation of the input shaft causes the main pump block and the charge pump to turn, thus initiating the power transmitting function. Oil from the reservoir is drawn by the charge pump, through the inlet filter, and forced into the low pressure line by way of the low pressure check valves. Oil introduced into the low pressure line by the charge pump fills the area in back of the pistons in the pump section. When the variable swashplate is in the vertical or neutral position the pistons do not move in or out resulting in no oil flow to the pistons in the motor section. Thus the tractor will not move. By tilting the variable swashplate the pistons are forced in and out of the cylinder block, as they rotate across the angled swashplate forcing the oil from the cylinder block under high pressure. The further the swashplate is tilted the longer the stroke of the pistons, causing a greater volume of oil being pumped to the motor section, thus increasing the speed of the tractor. At the bottom of their stroke, the pistons pass again to the

low pressure side of the valving plate and are refilled by the charge pump and oil returning from the motor through the low pressure line. The high pressure oil travels through internal passages to the inlet side of the piston motor. In the motor section, high pressure oil acting on the back of the piston forces the piston "down the stationary tilted swashplate causing the cylinder block to rotate and turn the output shaft." When the variable swashplate is tilted in the opposite position, the pressures are reversed and the motor cylinder block will rotate in the opposite direction, thus reversing the direction of the tractor.

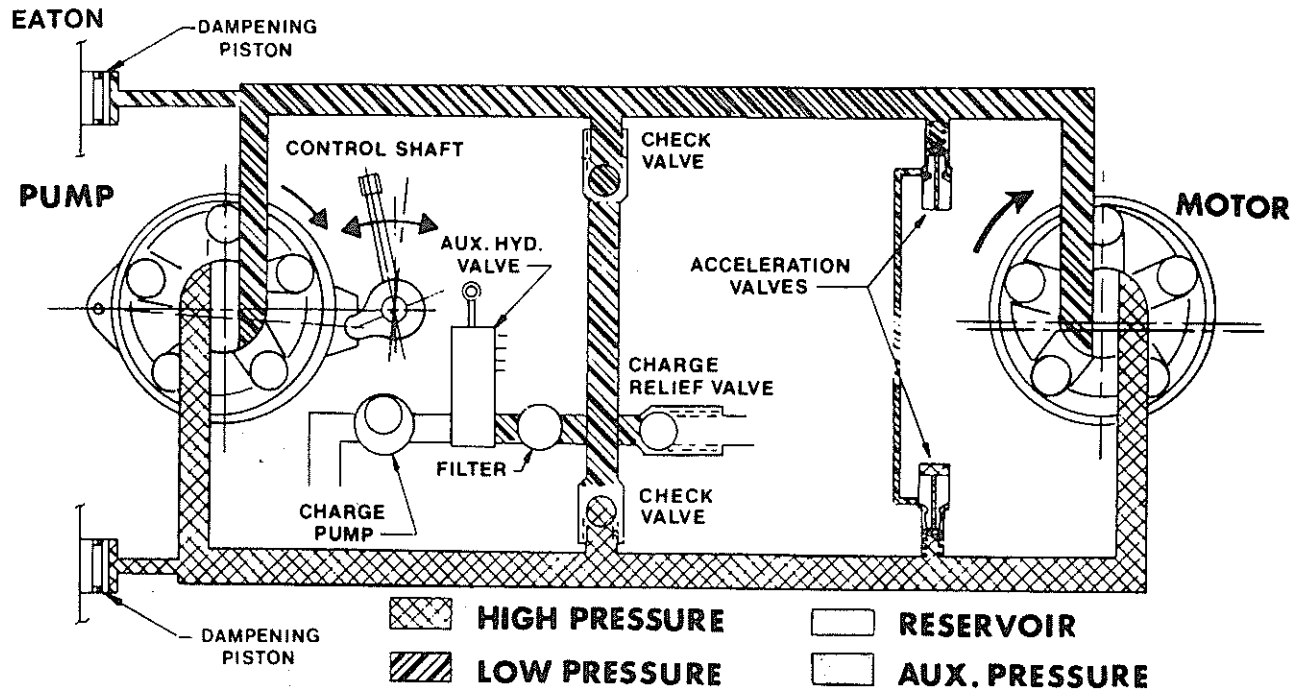
The acceleration valves are placed in the circuit to limit vehicle acceleration to a safe rate. With the control lever in neutral, oil is under low pressure throughout the circuit. When the control lever is advanced rapidly from the neutral to the forward position, the circuit pressure increases and the forward acceleration valve bleeds some of the high pressure oil to the low pressure side of the circuit thus limiting vehicle acceleration. As the vehicle con-

tinues to accelerate at the safe rate, high pressure oil leaking past the acceleration valve body forces the valve down against its seat, stopping the bleeding of oil to the low pressure side. The acceleration valve will remain in this position as long as the control lever position is unchanged. When the control lever is moved into reverse position, the reverse acceleration valve performs in the same way.

The charge pump relief valve is a simple spring loaded valve. The function of this valve is to regulate the supply of low pressure oil to the pistons in the pump section. The excess charge oil is bypassed by this valve to the implement circuit.

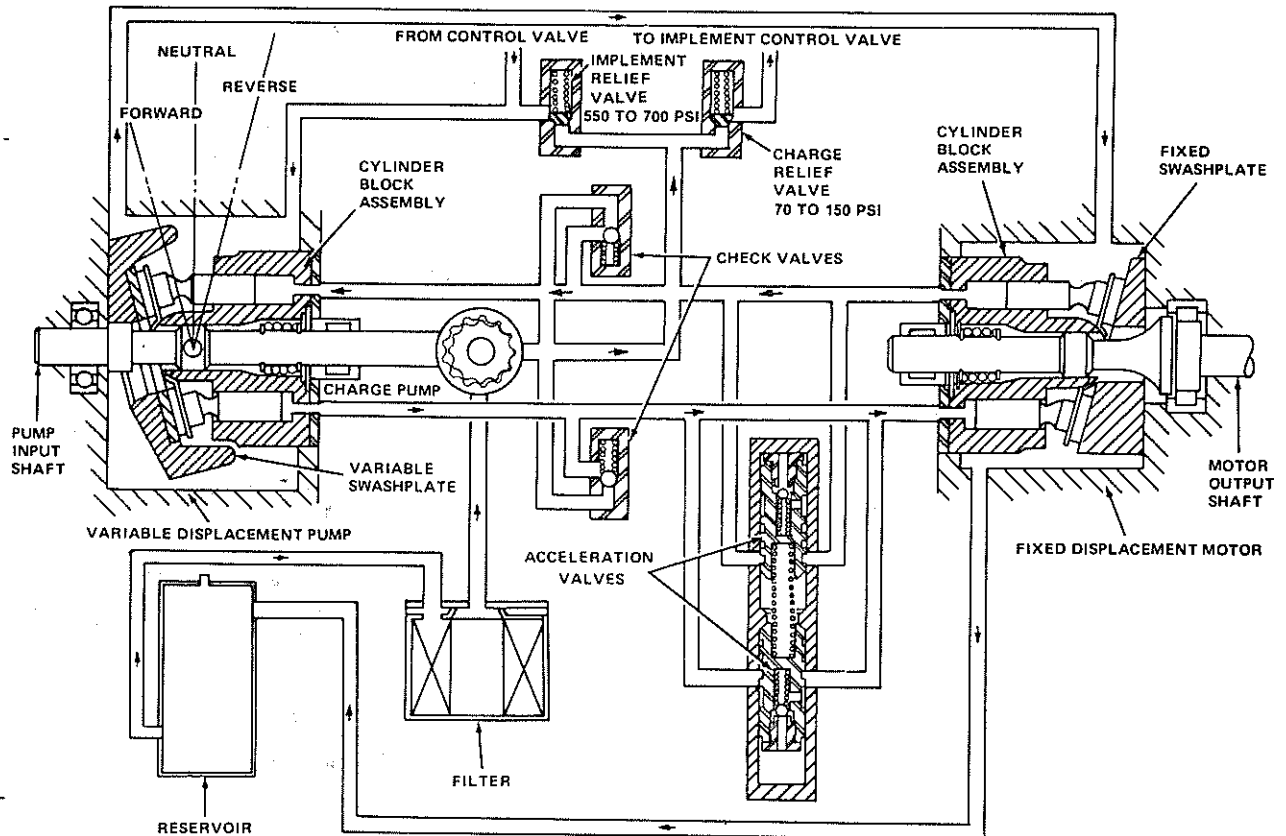
When implement hydraulic cylinders are actuated, the pressure supplied by the charge pump is limited by the implement relief valve. The reason for this is to permit the charge pump to supply high pressures for intermittent periods to permit sufficient pressures for implement cylinder actuation. When the implement relief valve opens, the oil is by-passed to the case and pumped into the transaxle.

## HYDROSTATIC TRANSMISSION FLOW CHART



3

## SUNDSTRAND



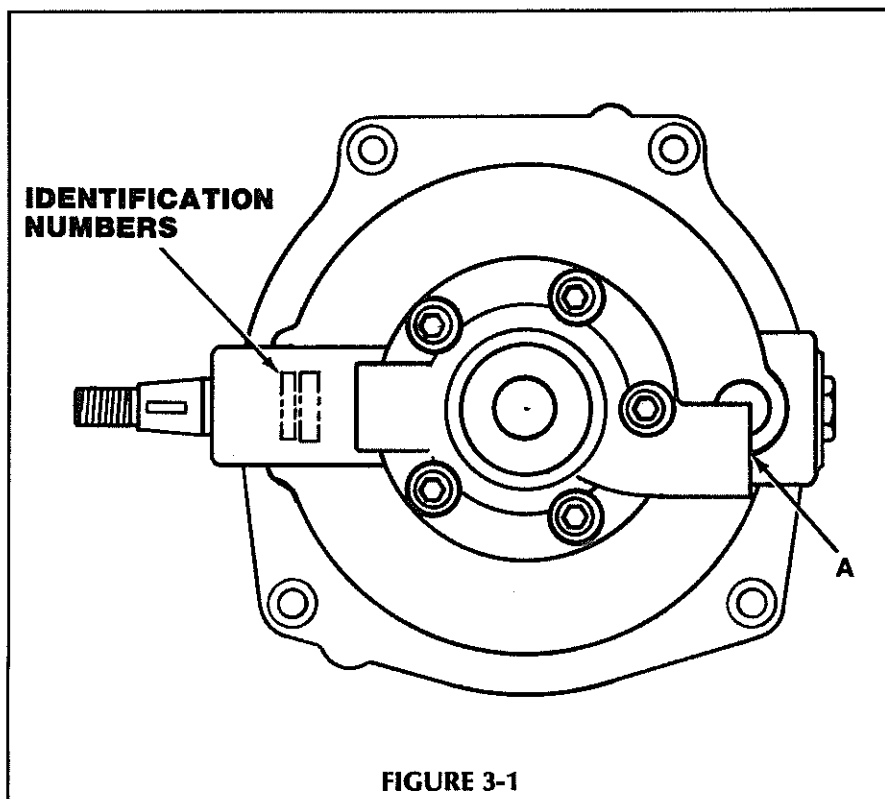
## DRIVE TRAIN (Continued)

### IDENTIFICATION (EATON)

A Eaton Right Hand drive hydrostatic is used in the HT series tractor.

### EATON

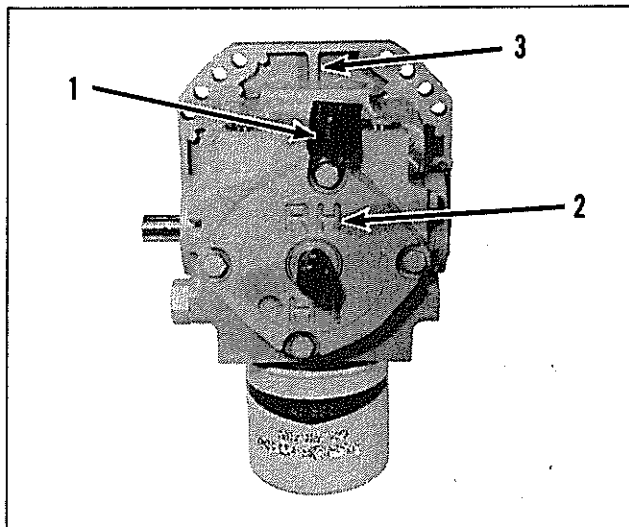
To identify, locate the Serial Number stamped in area specified.



### IDENTIFICATION (SUNDSTRAND)

A Sundstrand Right Hand drive hydrostatic is used in the large frame tractor. There are three ways of identifying the Right Hand hydrostatic.

1. Model Number located on hydrostatic identification tag.
2. Charge pump housing should have the R.H. (Right Hand) casting marking up and above the input shaft.
3. Motor housing must have the straight casting mark up.



Hydrostatic valves which can be checked, repaired, or replaced with unit remaining in the tractor are identified in Fig. 3-3.

1. Reverse Acceleration Valve Assy.
2. Charge Pump Relief Valve Assy.
3. Acceleration Valve Spring.
4. Forward Acceleration Valve Assy.
5. Free Wheeling By-Pass Valve.
6. Implement Relief Valve Assy.

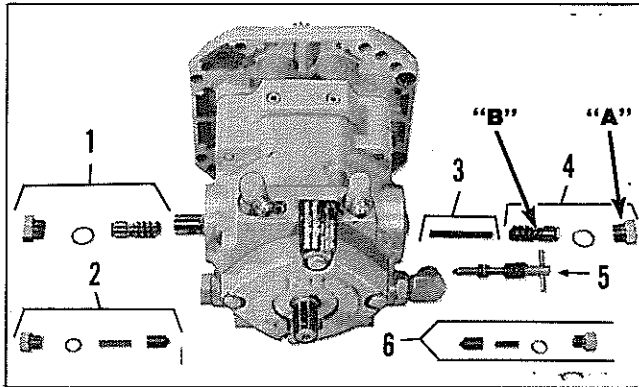


FIGURE 3-3

Right side of hydrostatic shows location of the charge pump relief valve assembly and the reverse acceleration valve. See Fig. 3-3.

Left side of hydrostatic shows location of the implement relief valve assembly, the free wheeling valve and the forward acceleration valve.

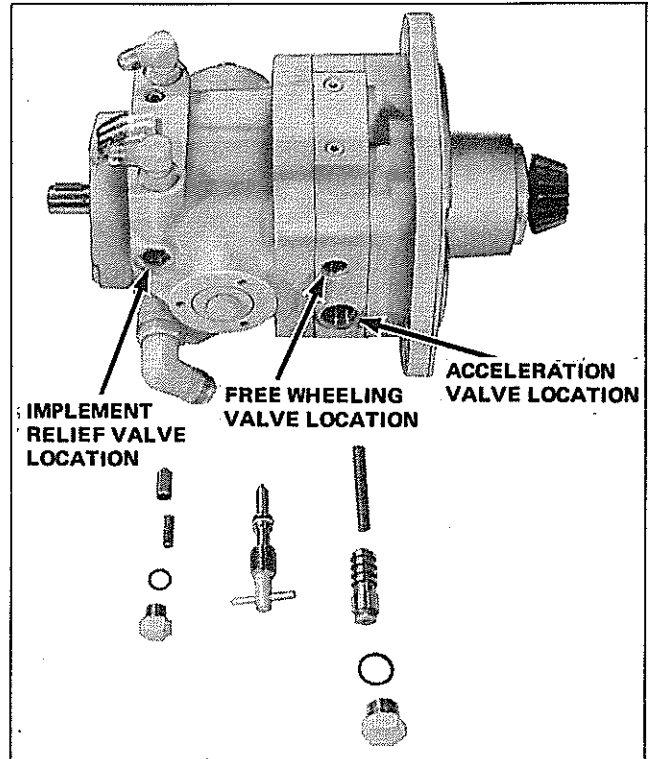


FIGURE 3-4

To check the acceleration valve the cap "A", Fig. 3-3 can be turned out of the body "B." The spring and ball can then be removed and inspected for dirt which could cause erratic shifting of the hydrostatic.

## TESTING HYDRO (SUNDSTRAND)

The hydrostatic charge pump and implement pressure should be checked before the hydro unit is blamed for some other malfunctioning part in the drive train. A pressure gage which reads at least 1000 P.S.I. should be used for this test.

### PROCEDURE FOR CHECKING BOTH CHARGE PUMP AND IMPLEMENT PRESSURE

1. To check the charge pump pressure, install the pressure gage into either of the two pipe fittings on the top of the hydro (fig. 3-7).
2. Start the engine and run at full R.P.M.
3. The gage (fig. 3-8) should register a pressure reading of 70 to 150 P.S.I. If the pressure reading is below 70 P.S.I. check the following.
  - A. The oil filter may be plugged. Replace if necessary.
  - B. The pickup tube may be plugged. Clean if necessary.
  - C. The charge pump relief valve (fig. 3-3) may be inoperative. Check the spring tension and valve seating. Replace the spring and valve if necessary.
4. If after completing these checks and making the necessary corrections the charge pressure is still below 70 P.S.I., the charge pump may be at fault.
5. To check the implement pressure, the gage should be installed in the same pipe fitting as for checking the charge pump pressure.
6. With the engine running at full R.P.M., hold the hydraulic lift valve lever in the lift position until the hydraulic lift cylinder reaches the end of its travel. The pressure reading should then be 550 to 800 P.S.I.
7. If the implement pressure is below 500 P.S.I., and the charge pump pressure is over 70 P.S.I., check the following:
  - A. A leak in the hydraulic system. Repair if necessary.
  - B. The implement relief valve (fig. 3-3) may be inoperative. Check the spring tension and valve seating. Replace the spring and valve if necessary.

**NOTE:** Shims are available to increase implement relief valve pressure. 1 Shim .012" in thickness will increase pressure approximately 50 psi.

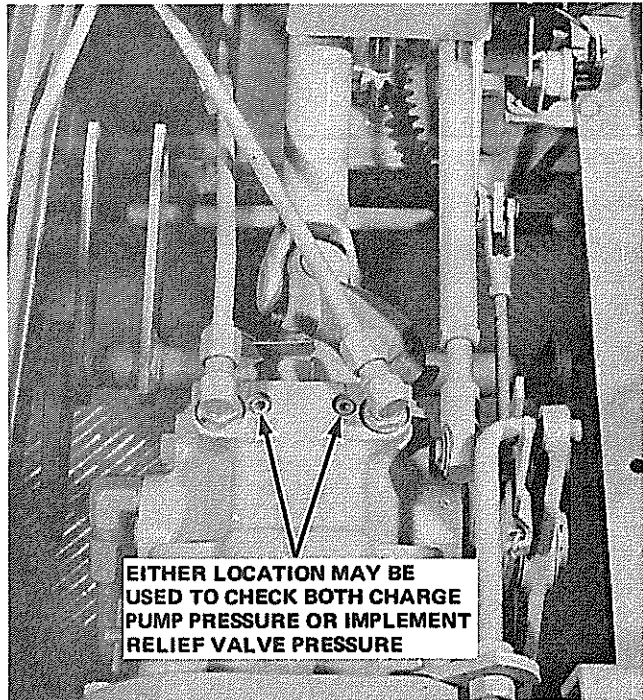


FIGURE 3-7

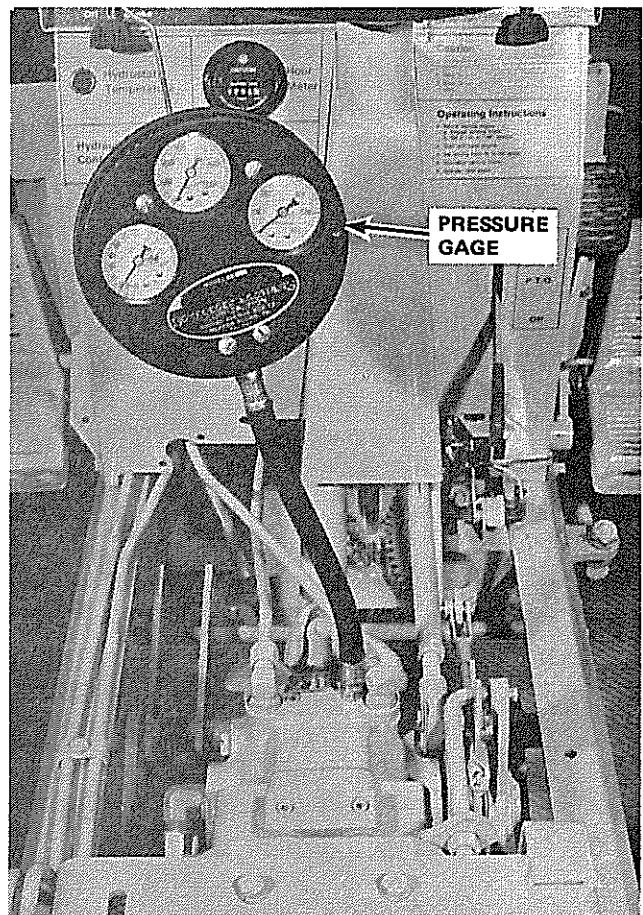


FIGURE 3-8

## HYDRO REMOVAL

1. Drain fluid from Transaxle.

**NOTE: DO NOT REUSE OLD FLUID.**

2. Loosen set screw and remove bolt holding drive shaft on engine crankshaft. Slide shaft forward until it clears hydro input shaft.
3. Disconnect hydraulic lines (Reference "A" fig. 3-9).
4. Disconnect pick-up tube line (Reference "B" at hydro end).
5. Remove hydro oil filter.
6. Remove bolt holding neutral adjusting rod (Reference "C").
7. Drive out roll pin (Reference "A" fig. 3-12) holding linkage to control shaft. Remove linkage as an assembly.
8. Remove the remaining three bolts holding hydro.

**NOTE: Hold hydro while removing last bolt to prevent it from dropping. Remove hydro from tractor.**

9. Remove the two oil line fittings and the pick-up tube fitting from old hydro.
10. Remove roll pin from free wheeling valve.

## HYDRO INSTALLATION

1. Remove protection cap from oil filter stud and stake stud to prevent it from turning further into hydro during filter installation.

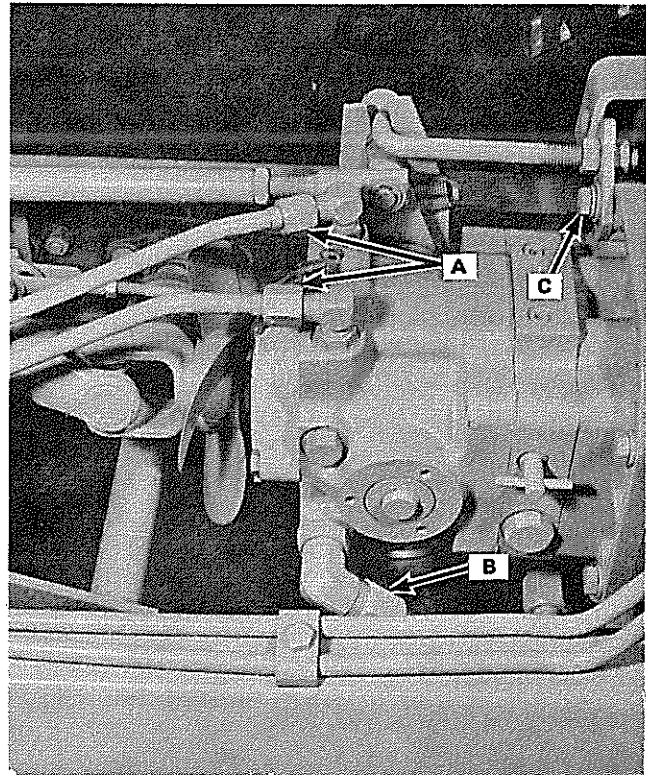


FIGURE 3-9

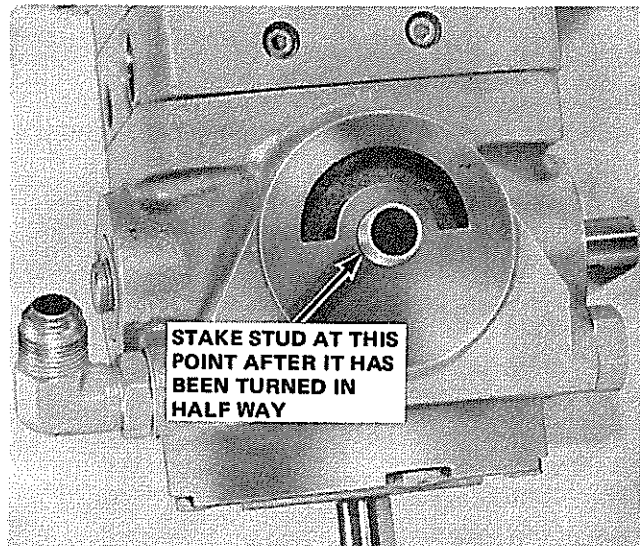


FIGURE 3-10



## DRIVE TRAIN (Continued)

2. When replacing the hydro package the bevel output gear must be removed from the old hydro and installed on the new one. The bevel gear is held on with either an external snap ring (fig. 3-11) or a nut (fig. 3-11A). Make sure snap ring is properly installed in the groove. The snap ring should be replaced when it shows signs of weakness or distortion.

3. Install roll pin into free wheeling valve.

**NOTE: BE CAREFUL NOT TO DAMAGE VALVE.**

4. Install the two oil line fittings and pickup tube fitting (fig. 3-9). Do not tighten packing nuts so fittings can be adjusted to lines.

5. Install gasket onto hydro using grease to hold it in place.

**NOTE: Refer to old hydro for bolt pattern to locate gasket.**

6. Install hydro and the three shorter bolts. (Save longer bolt to attach neutral adjusting rod.)

7. Install linkage on control shaft and drive in roll pin to hold in place.

8. Install neutral adjusting rod and torque all four bolts to 31 ft. lbs.

9. Install pick-up tube and tighten packing nut.

10. Install the two hydraulic oil lines and tighten packing nuts.

11. Slide driveshaft onto hydro input shaft until hole lines up on engine crankshaft. Install bolt and nut and tighten. Tighten set screw. Check for 1/8" clearance between drive shaft and hydrostatic. Adjust engine mounts if necessary.

12. Fill a new oil filter with new hydrostatic fluid (type "F"). Grease filter "O" ring and install hand tight only.

13. Fill transaxle assembly with approximately 8 quarts of new hydrostatic fluid.

14. Loosen pick-up tube line at hydro end, (Reference "B" figure 3-9) until fluid leaks out. Retighten.

15. Install negative battery cable.

16. Remove spark plugs from engine and crank for approximately 15 seconds to fill hydro with fluid. Reinstall spark plugs.

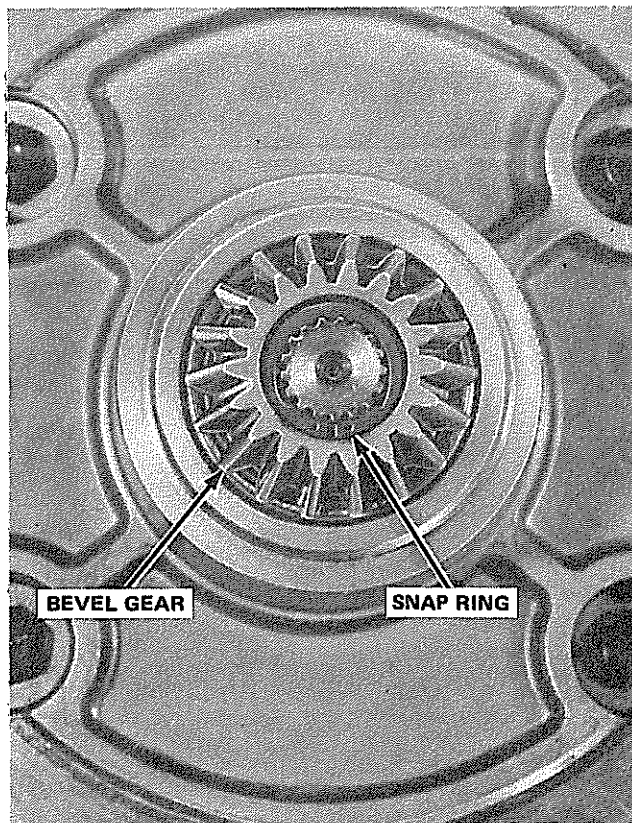


FIGURE 3-11

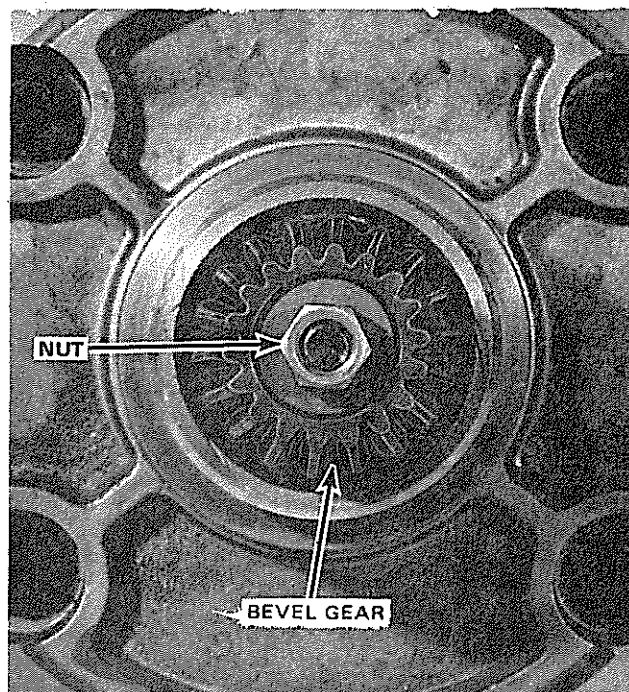


FIGURE 3-11A



17. Start unit and operate at low engine R.P.M. Actuate hydraulic lift lever to fill rest of system with fluid.
18. Securely block up rear of tractor. Make sure free wheeling valve is closed. Place travel pedal into the neutral position. Start the engine and release the brakes. If rear wheels creep forward, loosen nuts (Reference "B" Fig. 3-12) and shorten rod (Reference "C") until wheels stop creeping. If rear wheels creep backward lengthen rod (Reference "C") until wheels stop creeping. Retighten nuts (Reference "B").
19. Stop unit and check fluid level. Add fluid if necessary.

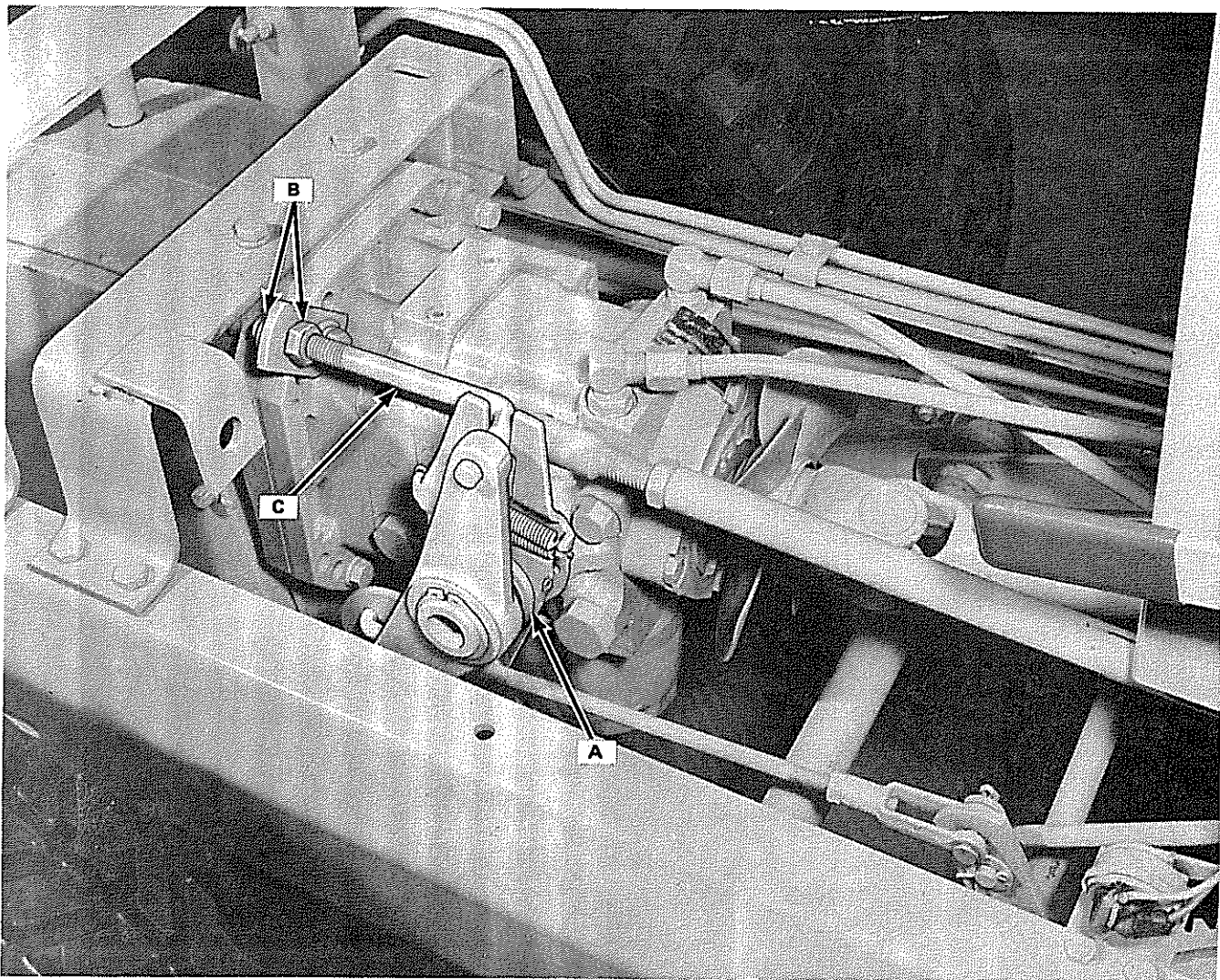


FIGURE 3-12

# DRIVE TRAIN (Continued)

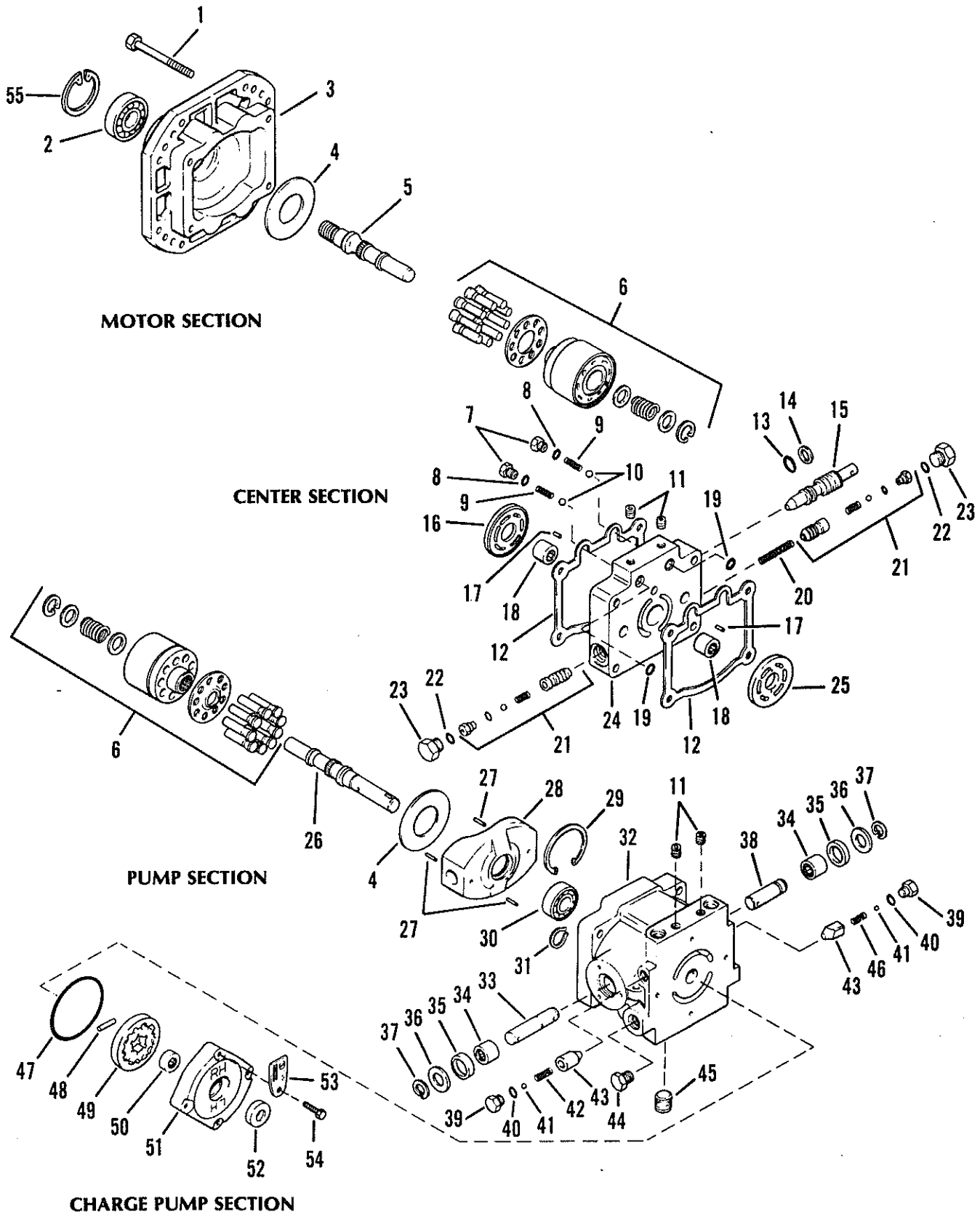


FIGURE 3-13 HYDROSTATIC EXPLODED VIEW

## LEGEND FOR FIGURE 3-14

1		Socket Hd. Cap Screw 5/16-18 x 1-3/4 (Included with Ref. 4) .....	1
2	1744151	Ball Bearing (Input) .....	1
3	1724381	Oil Seal (Included with Ref. 4) .....	1
4	1744190	Charge Pump Kit (Includes Ref. 1, 3, 5, 6, 8, 10 & 12 .....	1
5	1724375	Snap Ring (Included with Ref. 4) .....	1
6	1744155	Sq. Seal Ring (Incl. with Ref. 4) .....	1
8	1744157	Sq. Seal Ring (Incl. with Ref. 4) .....	1
9	1744154	Cover Sub Assy. (Includes Ref. 13) .....	1
10	Buy Local	Socket Hd. Cap Screw 5/16-18 x 1-1/4 (Included with Ref. 4) .....	6
11	1744171	Retaining Ring .....	1
12	1744159	Drive Pin (Included with Ref. 4) .....	1
13	1724376	Oil Seal (Included with Ref. 9) .....	1
14	1744185	Square Seal Ring .....	1
15	1744162	Input Shaft Sub Assy. (Keyed) .....	1
16	1744164	Pump Rotor & Ball Assy. ....	1
17	1744184	Cam Ring Assy. ....	1
18	1744176	Cam Ring Insert .....	1
19	1744167	Pintle Assy. (Includes internal parts) .....	1
20	1744177	Motor Rotor & Ball Sub Assy. ....	1
21	1744010	Output Shaft Sub Assy. ....	1
22	1744180	Body Assy. Includes Ref. 21, 24, 25 .....	1
23	1744179	O-Ring Plug Sub Assy. ....	1
24	1104440	Ball Bearing (Output) .....	1
25	1724380	Retaining Ring .....	1

## TESTING HYDROSTATIC

### EATON HYDRO

The hydrostatic pressure can be checked using a pressure gauge which reads at least 1000 P.S.I. To check the hydrostatic pressure install the gauge into a tee hydraulic fitting between hydrostatic port (A) Figure 3-13A and existing hydraulic tube. Start engine and run for 5-10 minutes. At full RPM the pressure reading should be 140 P.S.I.  $\pm$  50 (964 kPa).

**NOTE:** If the rear wheels will spin on a concrete surface when the tractor is against a barrier, the hydro is probably operating correctly. Caution must be used when performing this test to prevent damage or injury.

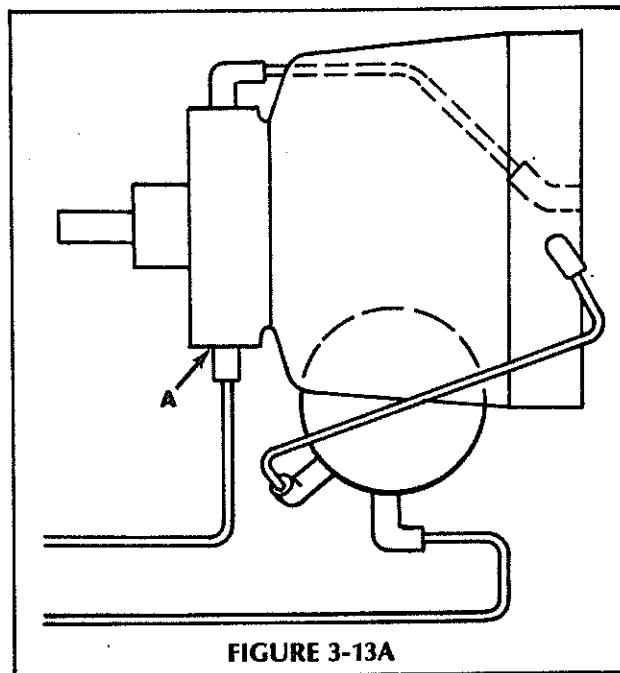


FIGURE 3-13A

### EATON HYDRO REPAIR

AN EATON HYDROSTATIC REPAIR MANUAL IS AVAILABLE AT THE FACTORY. CONTACT YOUR BOLENS DEALER FOR ASSISTANCE.

**NOTE:** Before any repair work clean the area thoroughly.

1. "O" Ring (1) is replaceable.
2. To replace control shaft seal, item (2).

**NOTE:** We recommend removal of transmission from vehicle.

Remove control arm with approved tool (standard puller). **WARNING:** DO NOT attempt to pry or drive the control arm off the shaft, as internal damage can occur. Remove control shaft seal item (2). **NOTE:** A hook puller or screw driver may be used.

Wipe seal counterbore clean and examine for damaged surfaces. Install new double lip seal, item (2), with the steel retainer to the outside. Press or tap lightly until seal is bottomed. **CAUTION:** Over-travel of the seal will cut the rubber nose. Use a square-faced tube with the O.D. slightly smaller than the O.D. of the seal and the I.D. a slip fit over the shaft. Grease the seal lips before installation. Install control arm. **NOTE:** Lubricate the tapered portion of the shaft. Remove capscrew, item (3), and add hydrostatic fluid until unit is full. Replace and tighten capscrew, item (3).

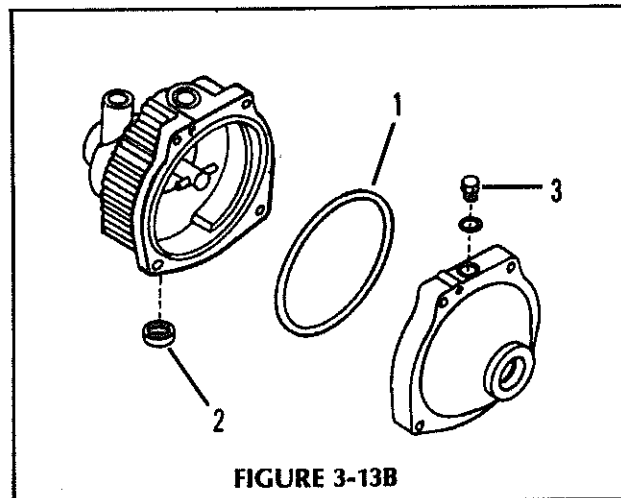


FIGURE 3-13B

## EATON HYDROSTATIC REMOVAL

1. Remove the transaxle from the frame. See transaxle removal.
2. Tip the transaxle back and rest on a 6" block.
3. Remove any dirt or grease from hydraulic suction line (A) fittings.
4. Disconnect hydraulic suction line (A) and save.
5. Remove nut and washer on control shaft and slide control arm assembly (B) off and save.

**NOTE: A puller may have to be used when removing the control arm.**

6. Remove remaining 2 oil filter hydraulic lines at hydro.
7. Remove the four (4) mounting screws (C) securing the hydro and oil filter.
8. If replacing complete hydro, remove the three hydraulic tube fittings and install them into the new hydrostatic. Do not tighten.
9. If replacing complete hydro remove bevel gear (D) on output shaft. To disassemble, hold spacer (E) in place when loosening nut. Position bevel gear onto new hydrostatic and fasten. Torque nut to 24 ft. lbs. (32.5 N.m).

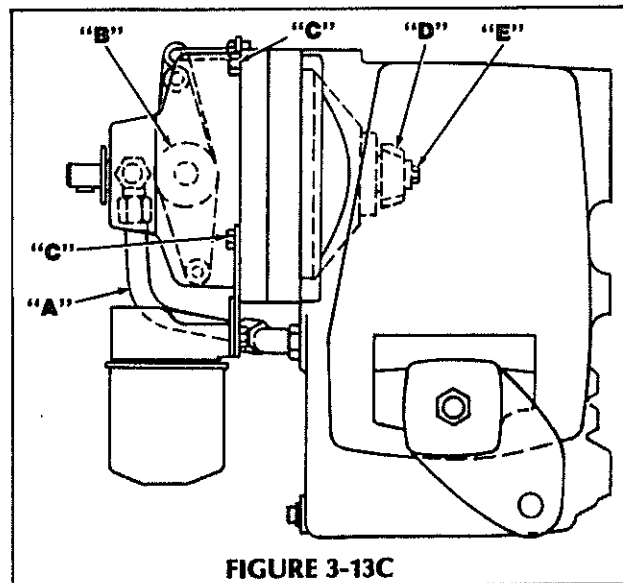


FIGURE 3-13C

3

## EATON HYDRO INSTALLATION

1. Tip the transaxle back and rest on a 6" (15 cm) block.
2. Install spacer, nut (E), and bevel gear (D) on output shaft. Torque nut to 24 ft. lbs. (32.5 N.m).
3. Install control arm assembly (B) to control shaft. Secure with nut and washer.
4. Install hydro to transaxle housing.
5. Install the four mounting screws (C) to secure the hydro and oil filter.
6. Install the three hydraulic tube fittings.
7. Connect hydraulic suction tube (A).

## HYDROSTATIC REPAIR (SUNDSTRAND)

If trouble shooting and pressure checks indicate a need for disassembly of the hydrostatic for repair, the unit must be removed from the tractor. After removal, the open ports should be sealed off and the external surface thoroughly cleaned in a mild cleaning solvent. **IMPORTANT:** Do not use a cleaning solvent that is harmful to paint or rubber.

To simplify the repair of the hydrostatic it will be discussed in four basic sections:

1. Charge pump section
2. Pump section
3. Center section
4. Motor section

**NOTE:** Before disassembly of the various sections, a line should be scribed across the top of the transmission so the proper positions of the sections will be maintained during reassembly.

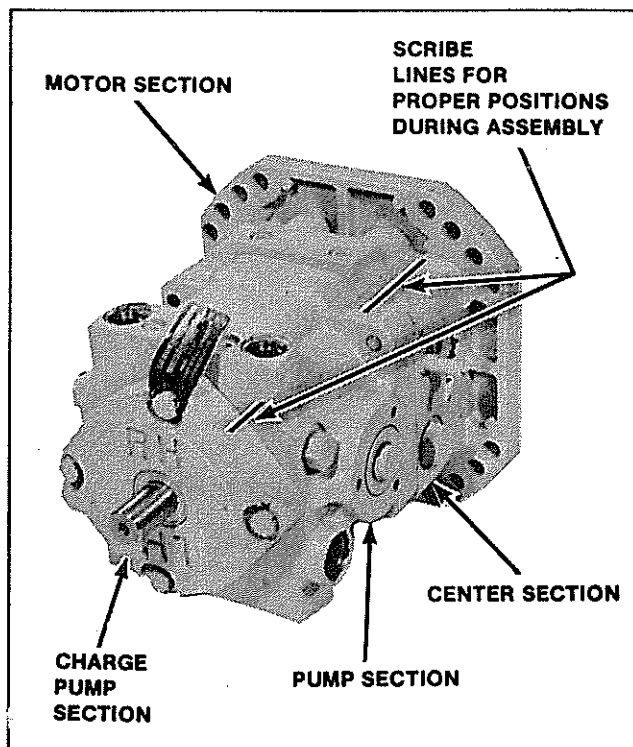


FIGURE 3-14

## REMOVAL OF CHARGE PUMP

1. Before removing housing, inspect the input shaft especially the keyway, for burrs or sharp edges that could damage the lip seal.
2. Remove the four capscrews and pull housing off the input shaft.
3. The charge pump "O" ring, drive pin, gerotor assembly, bearing and seal can now be inspected and replaced if necessary.

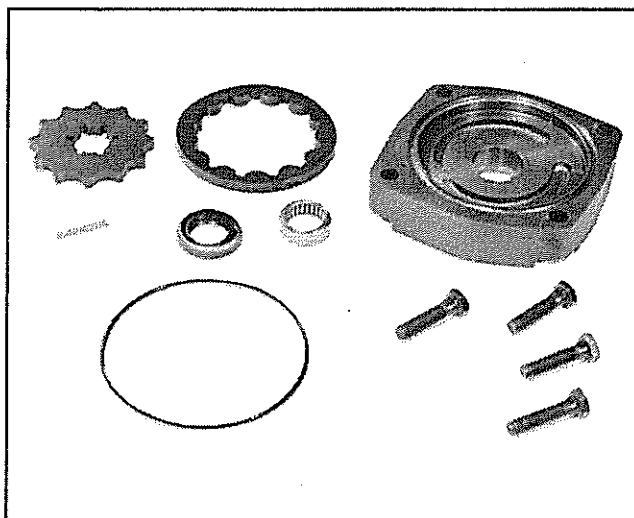


FIGURE 3-15

## LEGEND FOR FIGURE 3-13

- |    |                             |    |                               |
|----|-----------------------------|----|-------------------------------|
| 1  | Cap Screw                   | 28 | Pump Swash Plate              |
| 2  | Bearing                     | 29 | Snap Ring                     |
| 3  | Motor Housing               | 30 | Bearing                       |
| 4  | Thrust Plate                | 31 | Snap Ring                     |
| 5  | Motor Shaft                 | 32 | Pump Housing                  |
| 6  | Cylinder Block Assembly     | 33 | Control Shaft                 |
| 7  | Check Valve Cap             | 34 | Bearing                       |
| 8  | "O" Ring                    | 35 | Seal                          |
| 9  | Spring                      | 36 | Washer                        |
| 10 | Ball                        | 37 | Retaining Ring                |
| 11 | Pipe Plugs                  | 38 | Trunnion Shaft                |
| 12 | Gaskets                     | 39 | Hex Plug                      |
| 13 | "O" Ring                    | 40 | "O" Ring                      |
| 14 | Back Up Ring                | 41 | Shim Pack                     |
| 15 | Free Wheeling Valve         | 42 | Charge Relief Valve Spring    |
| 16 | Motor Valve Plate           | 43 | Poppet Valve                  |
| 17 | Pin                         | 44 | Hex Plug                      |
| 18 | Bearing                     | 45 | Filter Union                  |
| 19 | "O" Ring                    | 46 | Implement Relief Valve Spring |
| 20 | Acceleration Valve Spring   | 47 | "O" Ring                      |
| 21 | Acceleration Valve Assembly | 48 | Drive Pin                     |
| 22 | "O" Ring                    | 49 | Charge Pump (Gerotor)         |
| 23 | Hex Plug                    | 50 | Bearing                       |
| 24 | Center Section              | 51 | Charge Pump Housing           |
| 25 | Pump Valve Plate            | 52 | Seal                          |
| 26 | Pump Shaft                  | 53 | Identification Tag            |
| 27 | Roll Pins                   | 54 | Cap Screw                     |
|    |                             | 55 | Snap Ring (Later Models)      |

# DRIVE TRAIN (Continued)

## EATON MODEL 11 BREAKDOWN

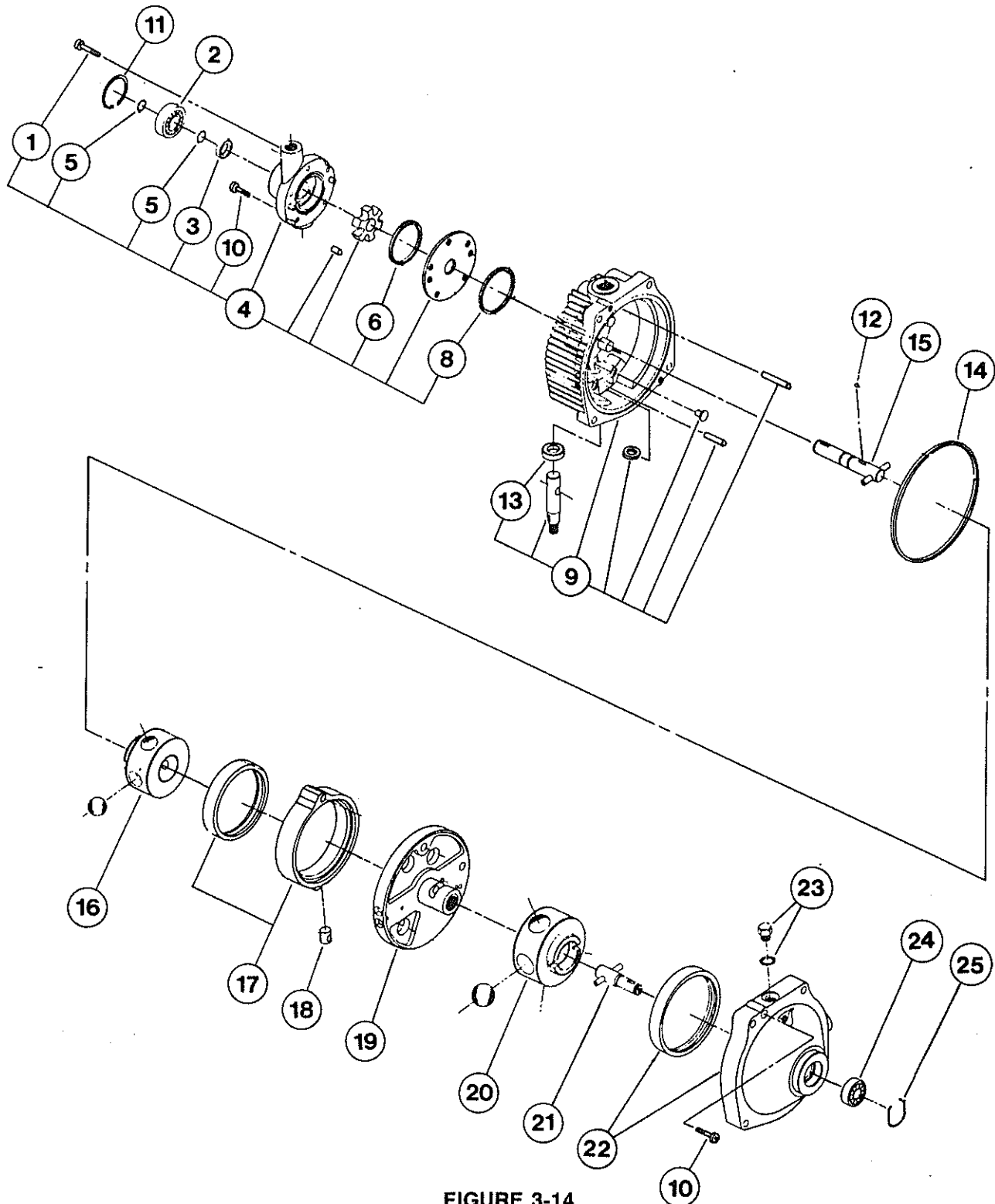


FIGURE 3-14



**NOTE:** Two different charge pumps were used on the hydrostatics. The 90-1118-02 and 03 charge pump used a ball bearing, larger diameter input shaft seal, and a non-hardened input shaft.

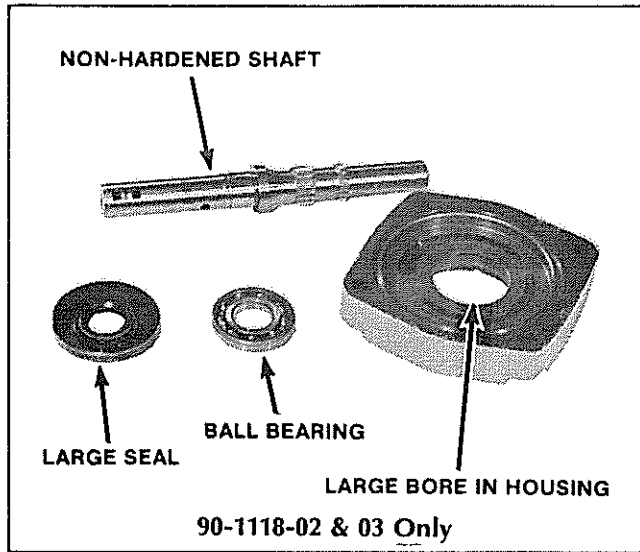


FIGURE 3-16

The 90-1118-04 & later models charge pump use a needle bearing, smaller diameter seal, and a hardened input shaft. The hardened input shaft is needed to provide the inner race for the needle bearing.

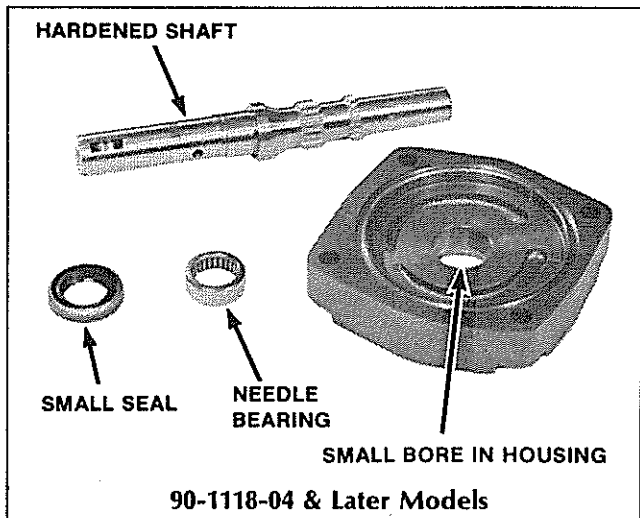


FIGURE 3-17

## CHARGE PUMP INSPECTION

1. The gerotor surface should be inspected on both sides for grooves or pickup of foreign material.
2. The drive pin should be inspected for cracks or fatigue points.
3. The charge pump oil cavity lead-ins and inner housing surface should be inspected for damage or excessive wear.

Damaged or worn parts should be replaced.

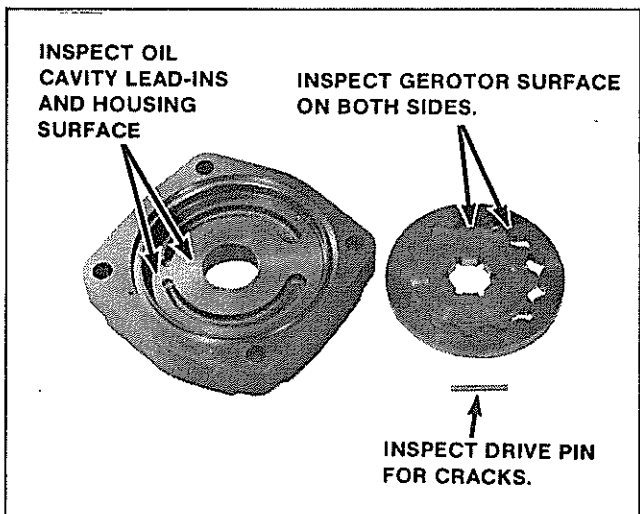


FIGURE 3-18

## ASSEMBLY PROCEDURE OF CHARGE PUMP

Clean all parts and lubricate with new hydrostatic transmission fluid before assembly.

1. Install the input shaft bearing into the charge pump housing. Bearing must be installed from the inside and be flush to .005" below its bore, with the lettered side out.
2. Install the seal into the housing until seated. Press only on the outer edge.
3. Install new "O" ring into housing groove.
4. Install drive pin into hole in input shaft.
5. Install gerotor assembly over drive pin.
6. Install charge pump housing. Be careful not to damage lip seal. Torque capscrews to 20 ft. lbs.

## SEPARATING PUMP, MOTOR AND CENTER SECTIONS

1. Set the hydrostatic pump end down on a soft wooden block with a center hole for the input shaft to extend into.
2. Remove the four capscrews located in the motor section which hold the 3 sections together. Remove all screws equally to prevent damage to threads or surfaces. The three sections are somewhat spring loaded so care must be taken to prevent the transmission from falling apart.
3. When the four capscrews have been removed, the transmission should separate into the three basic sections.

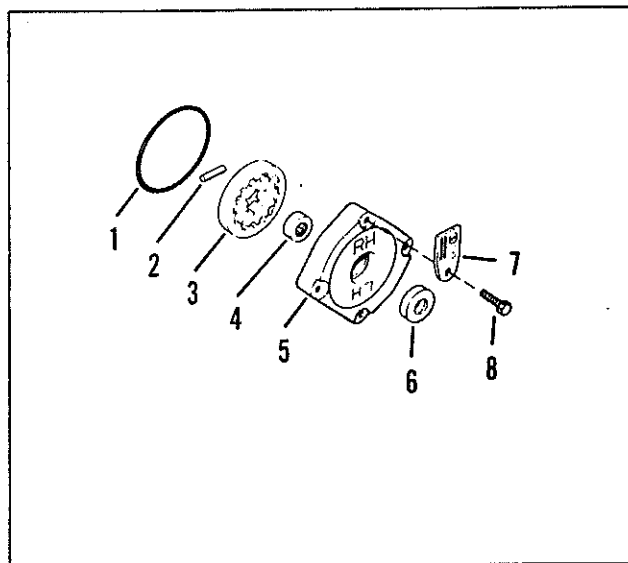


FIGURE 3-19

## CHARGE PUMP SECTION

- 1 "O" Ring
- 2 Drive Pin
- 3 Charge Pump (Gerotor).
- 4 Bearing
- 5 Charge Pump Housing
- 6 Seal
- 7 Identification Tag
- 8 Cap Screw

## DISASSEMBLY OF PUMP SECTION

1. Remove cylinder block assembly from pump housing.
2. Remove thrust plate from swashplate.
3. Remove pump variable swashplate.
  - A. Set pump housing, charge pump end down on a soft wooden block with a center hole for input shaft to extend into.
  - B. With a punch and light hammer tap spring roll pins through variable swashplate.

**NOTE: Excessive heavy pounding may damage bearings.**

- C. Push shafts from swashplate and housing and remove the swashplate.
  - D. Press the needle bearings from housing.
4. Remove pump driveshaft.
    - A. Remove snap rings.
    - B. Tap lightly on input end of pump shaft with a soft hammer to remove the bearing and shaft.
    - C. Press bearing from driveshaft.

## INSPECTION OF PUMP SECTION

1. Inspect control and trunnion shaft bearings and seals.
2. Inspect thrust plate for scratches or wear. Replace all worn or damaged parts.

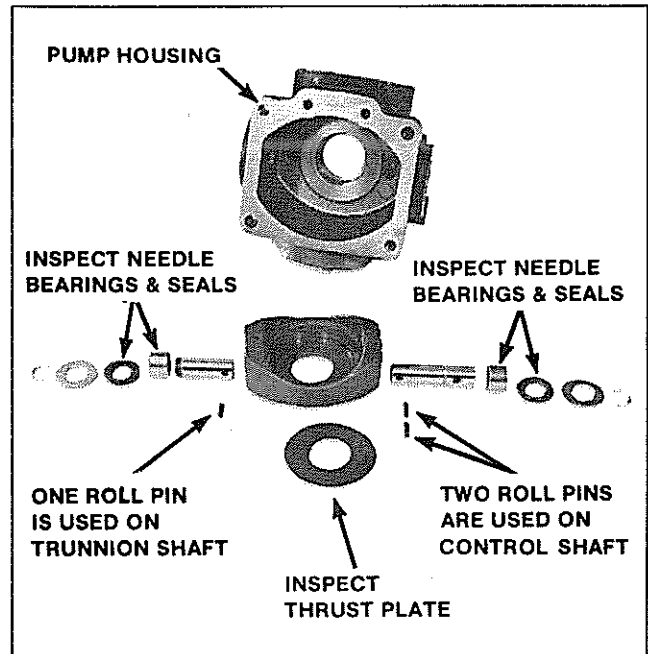


FIGURE 3-20

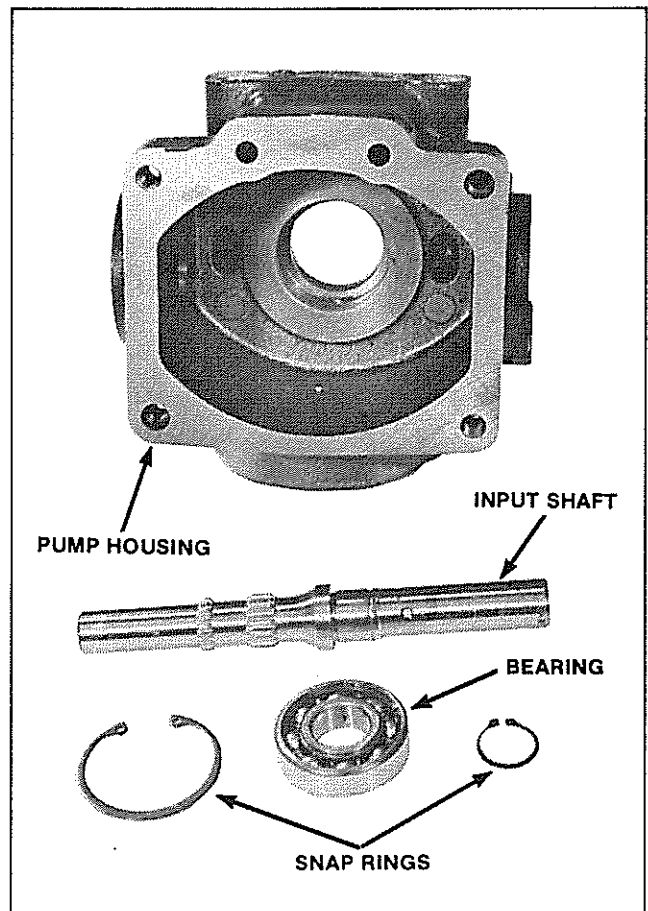


FIGURE 3-21

## DRIVE TRAIN (Continued)

### INSPECTING CYLINDER BLOCK ASSEMBLIES

The pump cylinder block and the motor cylinder block are identical.

1. Inspect the cylinder blocks for wear or pickup of foreign material.
2. Inspect the piston retainer for straightness. The retainer must be straight so the piston slipper surfaces will not wear uneven.
3. Inspect the piston assembly. The lubricant hole must be free of obstruction and the slipper surface even. If the slipper surface has more than  $1/32$ " taper, the cylinder block assembly must be replaced.

Individual parts are not available for the cylinder blocks because of the close tolerances. If any problem is evident the complete cylinder block must be replaced.

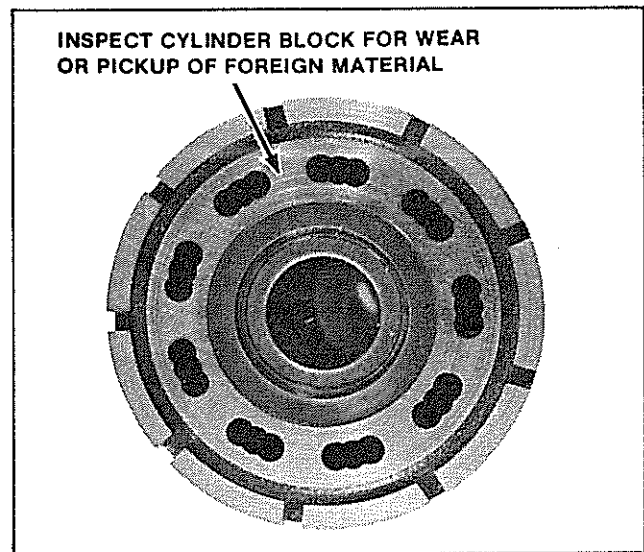


FIGURE 3-22

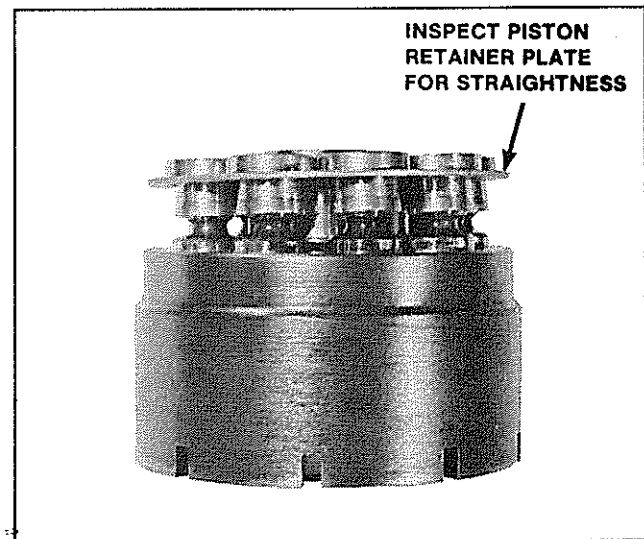


FIGURE 3-23

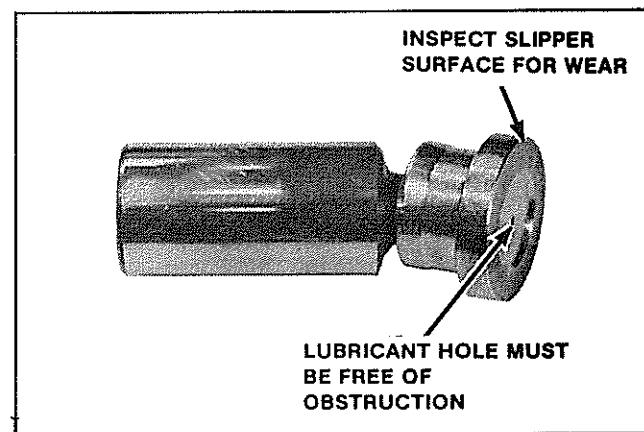


FIGURE 3-24

## ASSEMBLY OF PUMP SECTION

1. Press bearings into housing, lettered edge out, until flush to .005 below lip seal recess of housing.
2. Press bearing on pump shaft to shoulder.
3. Install input shaft and bearing into housing.
4. Position pump housing with check valve passageways up.
5. Place swashplate over driveshaft into housing.
6. Insert shorter trunnion shaft into housing and swashplate from left side and longer control shaft (small hole end) into housing and swashplate from right side.
7. Install the spring roll pins. Two on control shaft side, one on trunnion shaft side. Proper installation is when pins are 1/4" into swashplate.
8. Install thrust plate to swashplate.
9. Align splines of cylinder block kit with input shaft splines and install into housing.

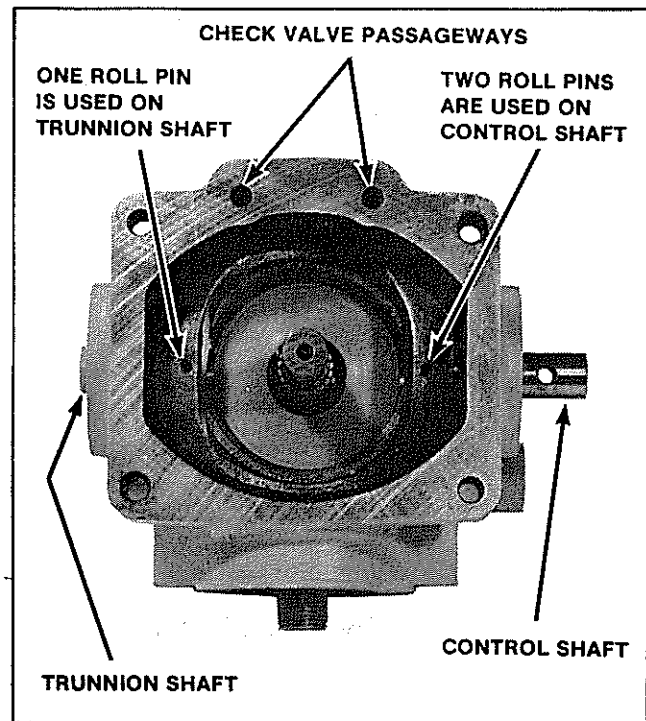


FIGURE 3-25

3

## PUMP SECTION

- 1 Cylinder Block Assembly
- 2 Pump Shaft
- 3 Key
- 4 Thrust Plate
- 5 Pin
- 6 Pump Swashplate
- 7 Snap Ring
- 8 Bearing
- 9 Snap Ring
- 10 Pump Housing
- 11 Pipe Plugs
- 12 Control Shaft
- 13 Bearing
- 14 Seal
- 15 Washer
- 16 Retaining Ring
- 17 Trunnion Shaft
- 18 Hex Plug
- 19 "O" Ring
- 20 Shim Pack
- 21 Charge Relief Valve Spring
- 22 Poppet Valve
- 23 Implement Relief Valve Spring
- 24 Hex Plug
- 25 Filter Union
- 26 Poppet Valve

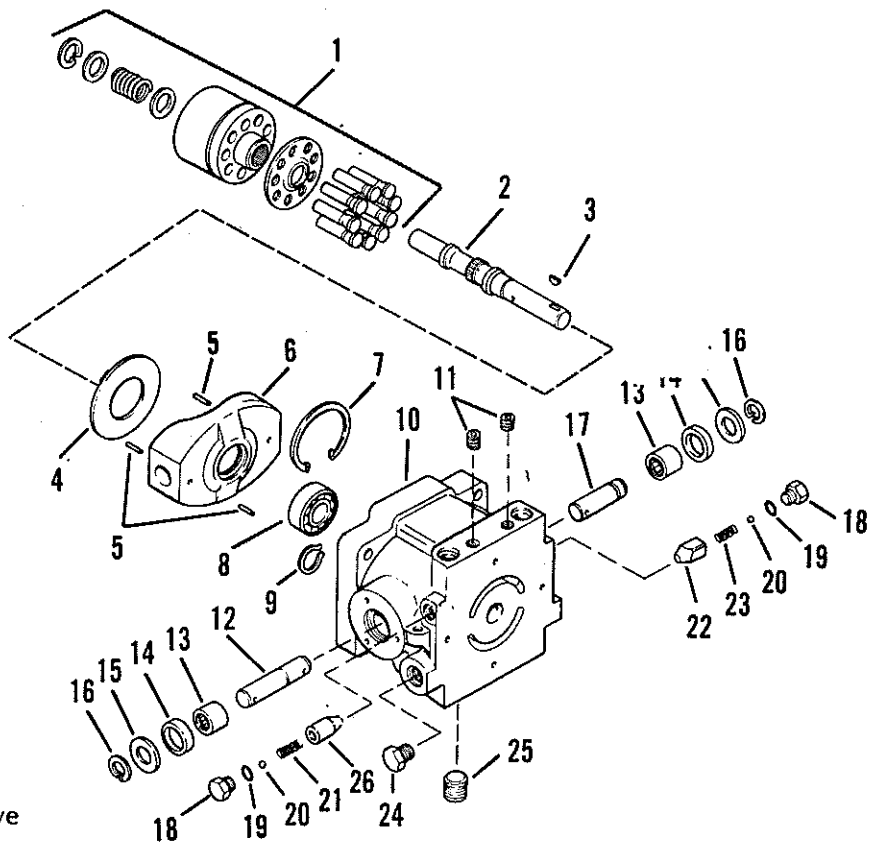


FIGURE 3-26

## DRIVE TRAIN (Continued)

### DISASSEMBLY OF CENTER SECTION

1. Remove valve plates and valve plate locating pins.
2. Remove gaskets.
3. Remove bearings.
4. Remove check valve "O" rings, pump side and check valves, motor side.

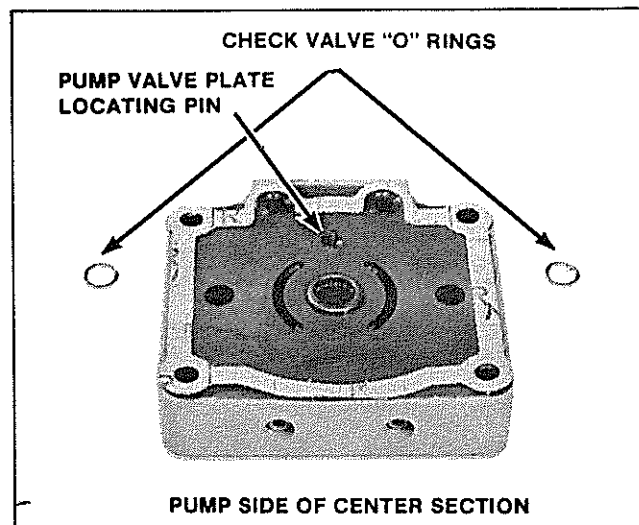


FIGURE 3-27

### INSPECTION OF CENTER SECTION

1. Inspect bearings.
2. Inspect check valves and check valve seats. Make sure check valves operate freely.
3. Inspect back side of motor and pump valve plates for dirt or wear in the locating pin slots.

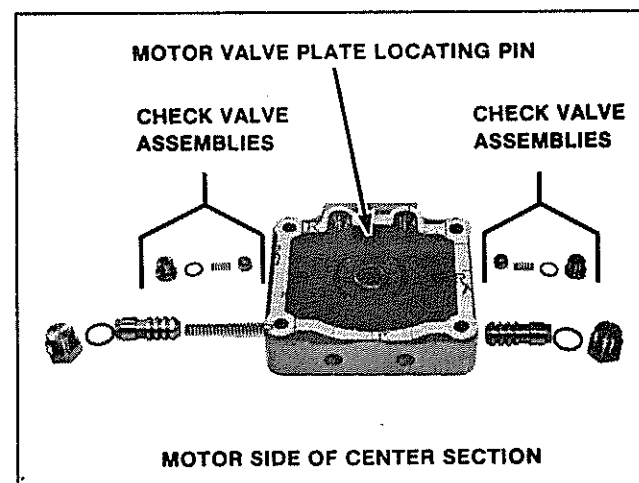


FIGURE 3-28

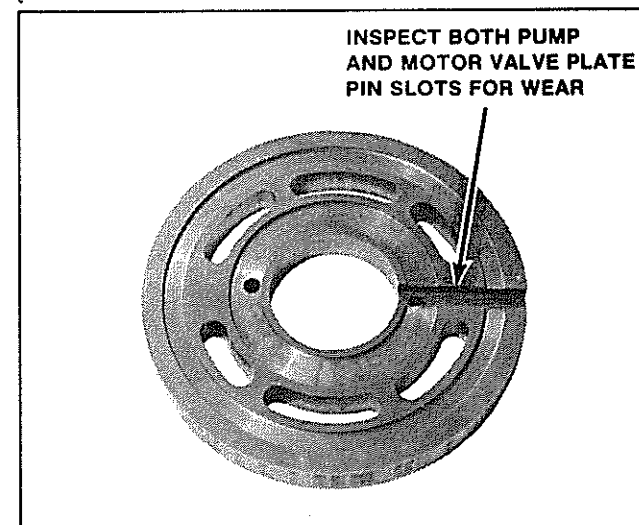


FIGURE 3-29

## PUMP AND MOTOR VALVE PLATE IDENTIFICATION

Since the pump cylinder block assembly only turns in the right hand or clockwise rotation, the lead-ins on the pump valve plate are located for right hand rotation only. The motor cylinder block assembly turns in both directions thus the motor valve plate has lead-ins for both right and left hand rotation.

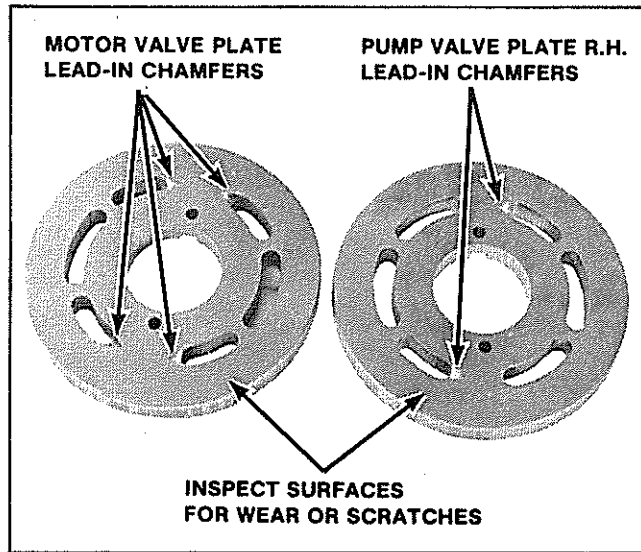


FIGURE 3-30

## ASSEMBLY OF CENTER SECTION

1. Install bearings into center section. Bearings must protrude .100 inch from polished surface, printed end out.
2. Install check valves on motor side of center section. Torque check valves to 10 ft. lbs.
3. Install "O" rings to pump side of center section.
4. Install valve plate pins and valve plates. The pump valve plate has two lead-ins and goes on the pump side of center section and the motor valve plate has four lead-ins and goes to the motor side of center section.
5. Use new gaskets on both sides of center section.

3

## CENTER SECTION

- 1 Check Valve Cap
- 2 "O" Ring
- 3 Spring
- 4 Ball
- 5 Pipe Plugs
- 6 Gaskets
- 7 "O" Ring
- 8 Back Up Ring
- 9 Free Wheeling Valve
- 10 Motor Valve Plate
- 11 Pin
- 12 Bearing
- 13 "O" Ring
- 14 Acceleration Valve Spring
- 15 Acceleration Valve Assembly
- 16 "O" Ring
- 17 Hex Plug
- 18 Center Section
- 19 Pump Valve Plate

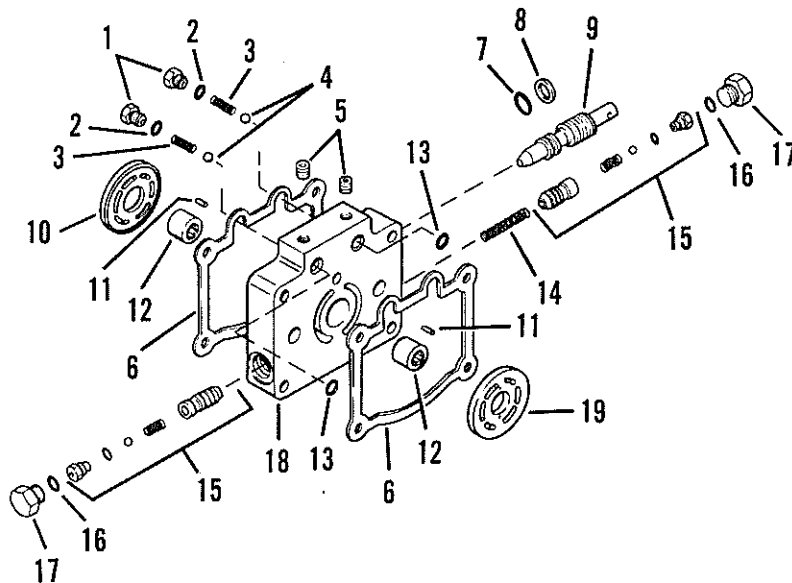


FIGURE 3-31

## DRIVE TRAIN (Continued)

### DISASSEMBLY OF MOTOR SECTION

1. Remove cylinder block assembly.
2. Remove thrust plate.
3. Remove Snap Ring (Later Models)
4. Tap on internal end of motor shaft to remove shaft and bearing from housing.
5. Press bearing from motor shaft.

### INSPECTION OF MOTOR SECTION

1. Inspect thrust plate for scratches or wear. Replace all worn or damaged parts.

### ASSEMBLY OF MOTOR SECTION

1. Press bearing to shoulder on motor shaft.
2. Install motor shaft and bearing into housing.
3. Install Snap Ring (Later Models)
4. Install thrust plate onto motor housing swash-plate.

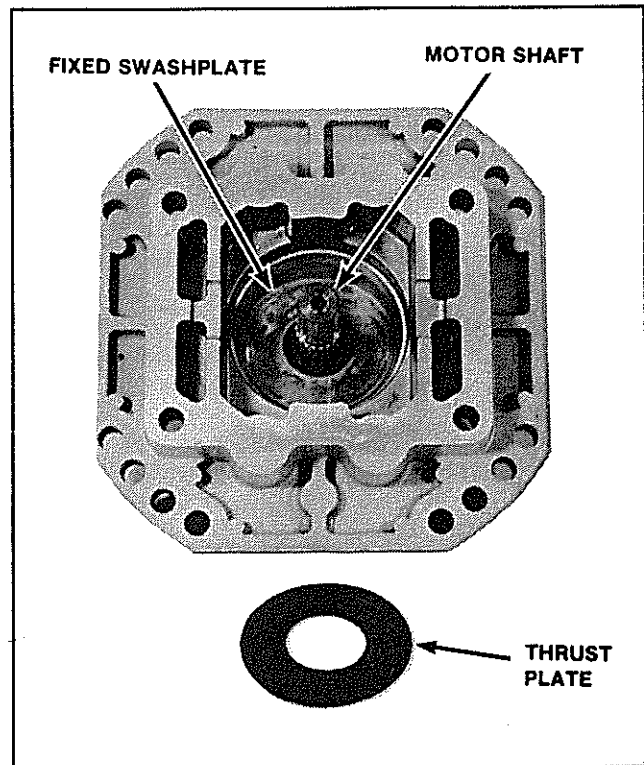


FIGURE 3-32

5. Align spines of cylinder block assembly with splines of motor shaft and install into housing.

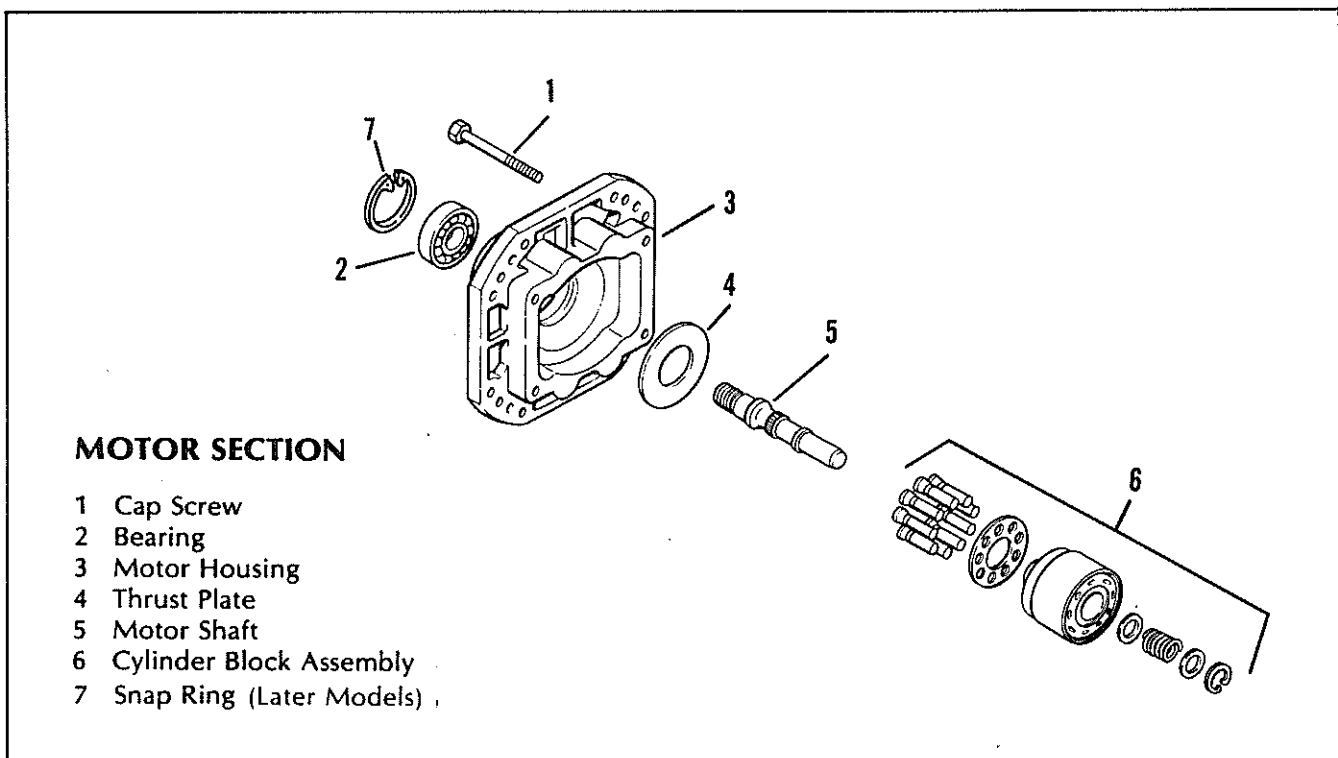


FIGURE 3-33



## ASSEMBLY OF HYDROSTATIC

1. Align Pump, Center, and Motor sections properly.
2. Install the 4 capscrews and torque to 35 ft. lbs.
3. Check the torque needed to turn the input shaft, output shaft, and control shaft. Torque reading should not exceed 25 in. lbs.

**NOTE: If torque exceeds this amount, hydro will have to be disassembled to locate binding.**

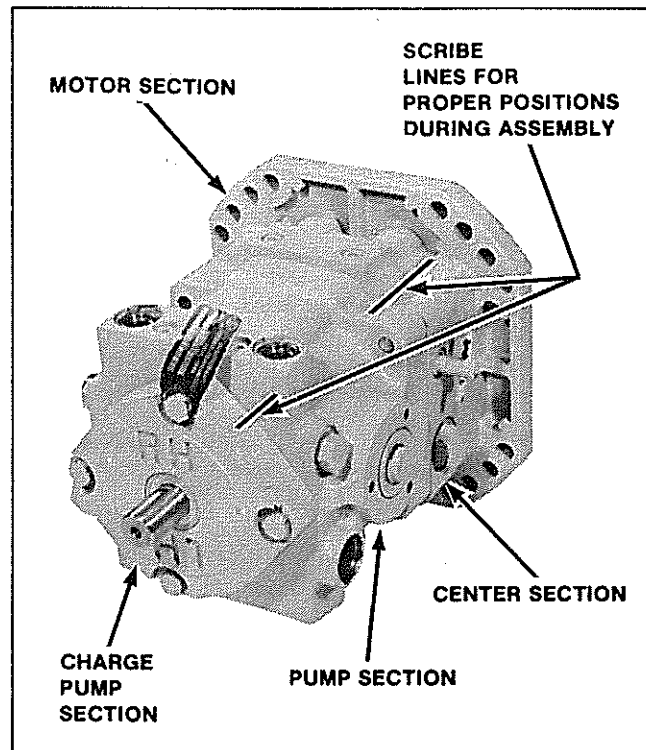


FIGURE3-34

## DRIVE TRAIN (Continued)

### TRANSAXLE REMOVAL

Remove Seat and Fender assembly. Be careful to disconnect seat switch (A) wires under fender.

If transaxle is to be worked on, drain fluid and dispose.

Block up tractor at mid frame.

Remove right and left hand brake arms from cross shaft (B).

Remove right and left hand brake arm extensions (C) 2 bolts each.

Disconnect all hydraulic lines from hydro.

Disconnect hydro control rod (D) at foot pedal.

Remove cotter pin and disconnect quadrant control link (E) at brake cross shaft.

Remove the four screws securing the transaxle to the frame.

Remove the two top mounting screws (F).

Place one foot on the rear hitch or use a bar in rear hitch hole to balance the transaxle while removing.

Slowly roll complete transaxle and hydro assembly back and out of frame. **NOTE:** Driveline will slip off the hydro input shaft. Hold driveline temporarily to avoid damaging fan blades.

After transaxle assembly has cleared frame, tip transaxle back to rest on a 6" (15.2 cm) block.

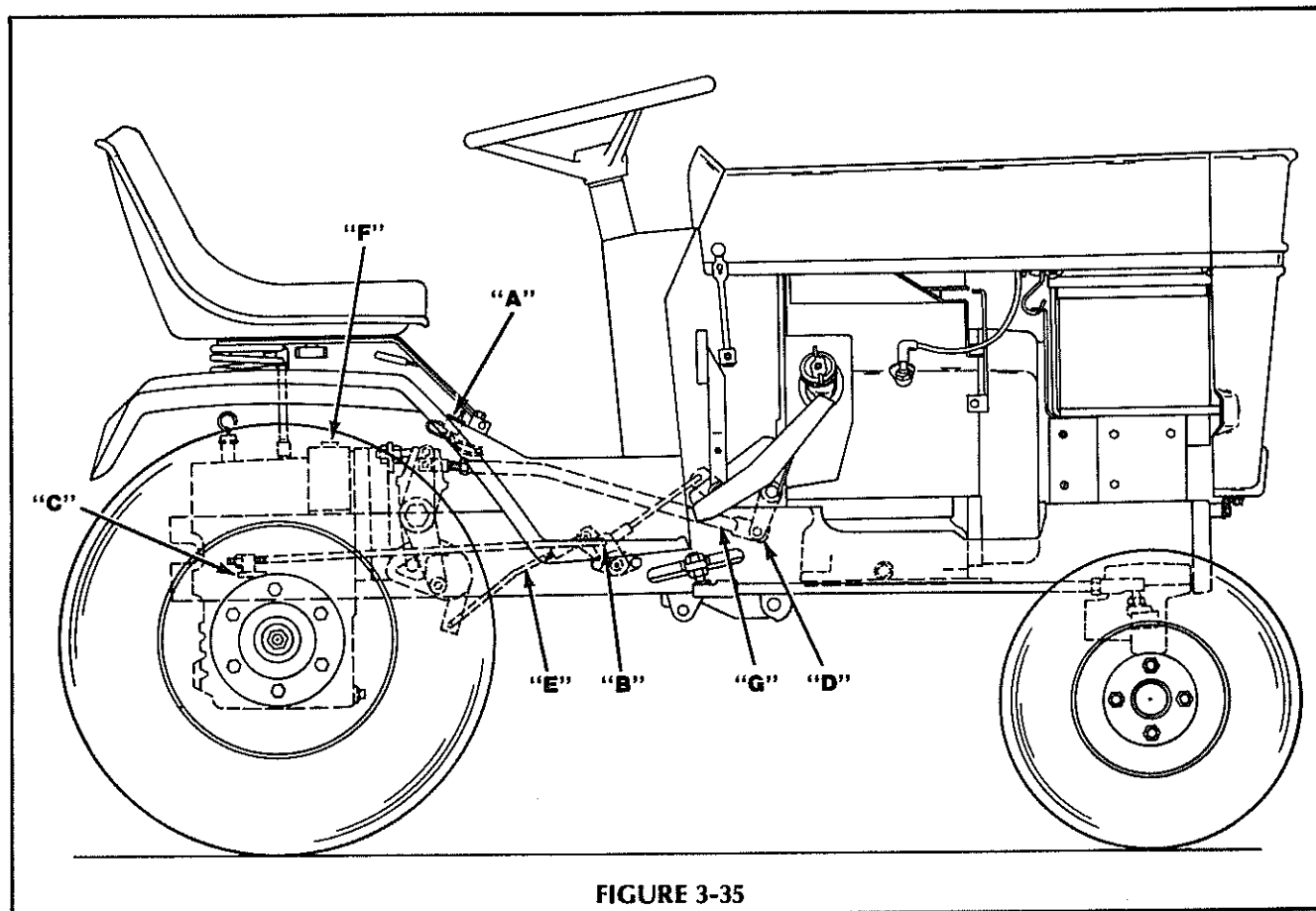


FIGURE 3-35

## TRANSAXLE INSTALLATION

Position right and left hand brake rods on inside of frame rails.

Slowly roll transaxle between the two side frames. At the same time position the following:

1. Lay hydro control rod (G) over brake cross shaft and direct rod toward foot pedal arm (D).
2. Lay control link (E) over cross shaft.
3. Slide drive shaft onto hydro input shaft.

Install the two transaxle mounting bolts (F) finger tight.

Connect hydro control rod (G) to foot pedal arm with clevis pin and cotter pin.

Connect hydraulic lines to hydro.

Connect Quadrant control link (E) to brake cross shaft.

Line up transaxle to frame and install the four axle mounting screws. Torque to 60 ft. lbs. (81 Nm).

Torque two top transaxle bolts (F) to 23 ft. lbs. (30 Nm).

Install new hydraulic fluid, approx. 10 Qts. (9.5 liter).

**NOTE: A new oil filter is recommended.**

Tighten all hydraulic fittings.

Check for interference around driveshaft.

Remove spark plug from engine and motor engine for 15 to 20 seconds.

Reinstall spark plug. Start engine and run at low R.P.M. Actuate lift system.

Block up rear wheels. Restart engine; press pedal forward reverse, then back to Neutral. If wheels continue to creep forward when in neutral, shorten adjusting rod (H) Fig. 3-35A until wheels stop. Lengthen adjusting rod if wheels creep backward.

Recheck transaxle fluid level.

Position fender in place and connect the two wires to the seat switch and secure fender. See figure 3-35B for seat switch connection.

Reinstall seat.

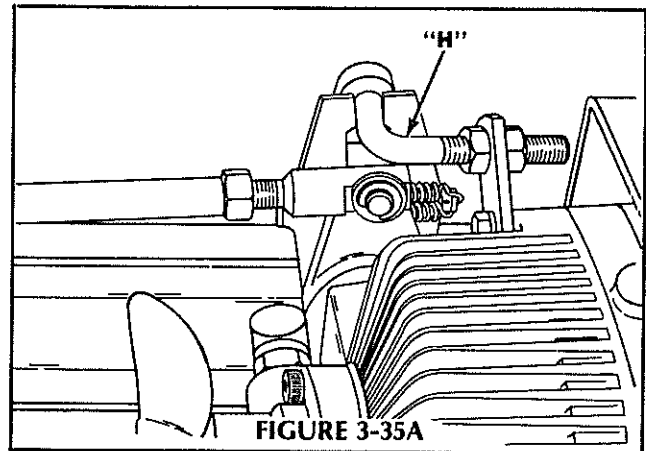


FIGURE 3-35A

3

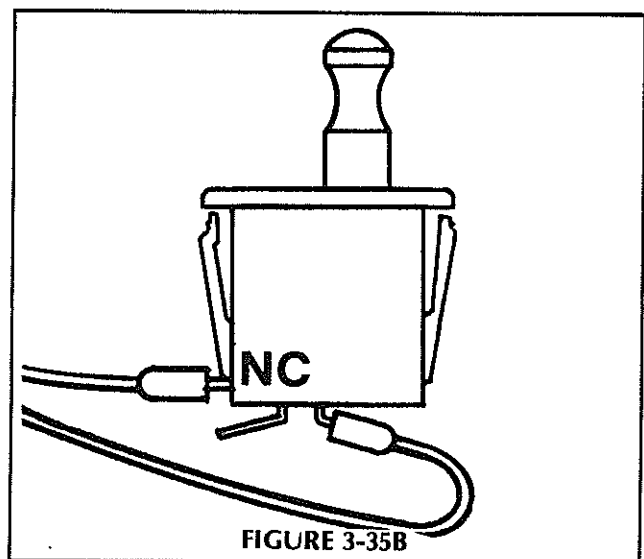
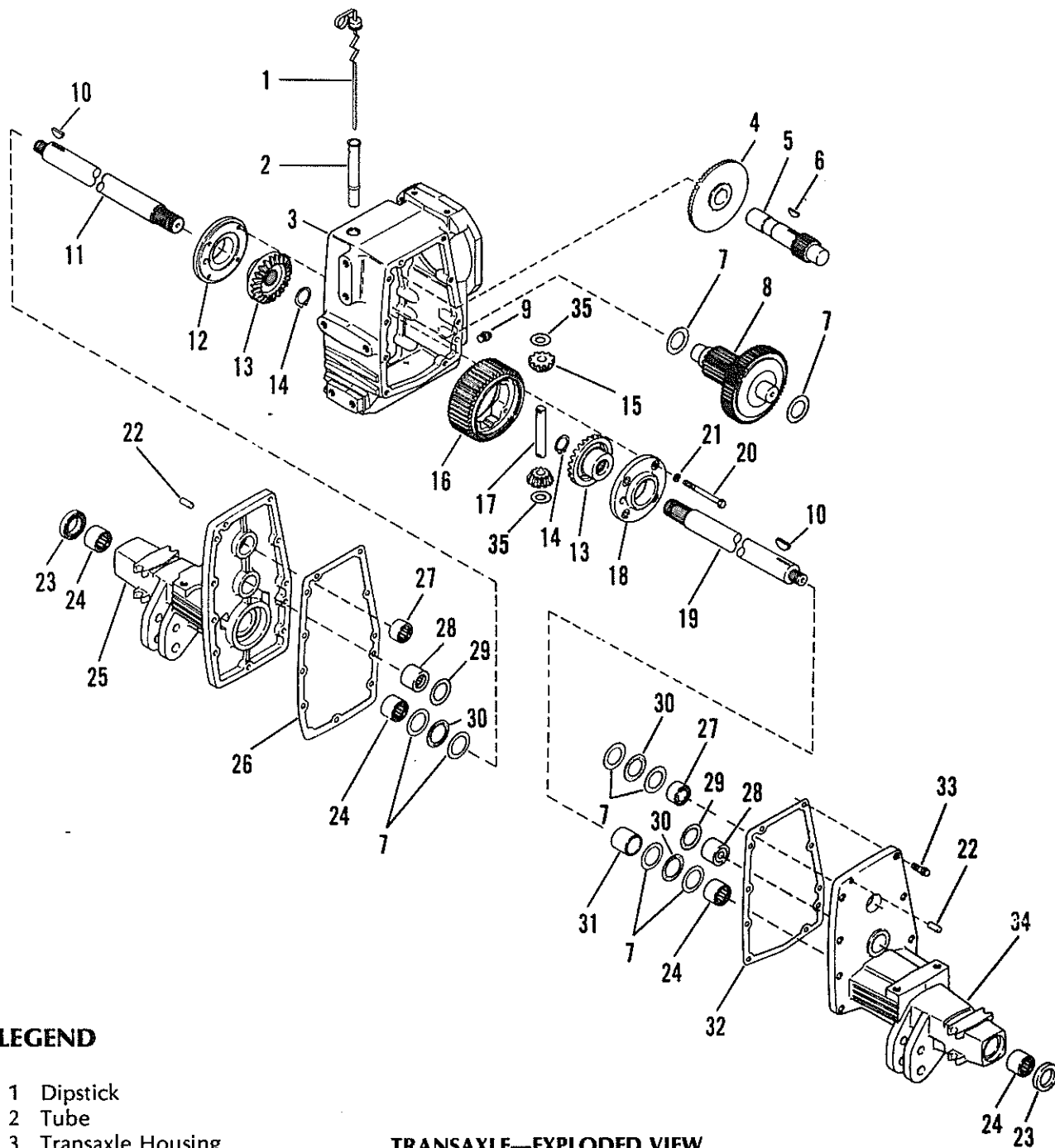


FIGURE 3-35B

# DRIVE TRAIN (Continued)

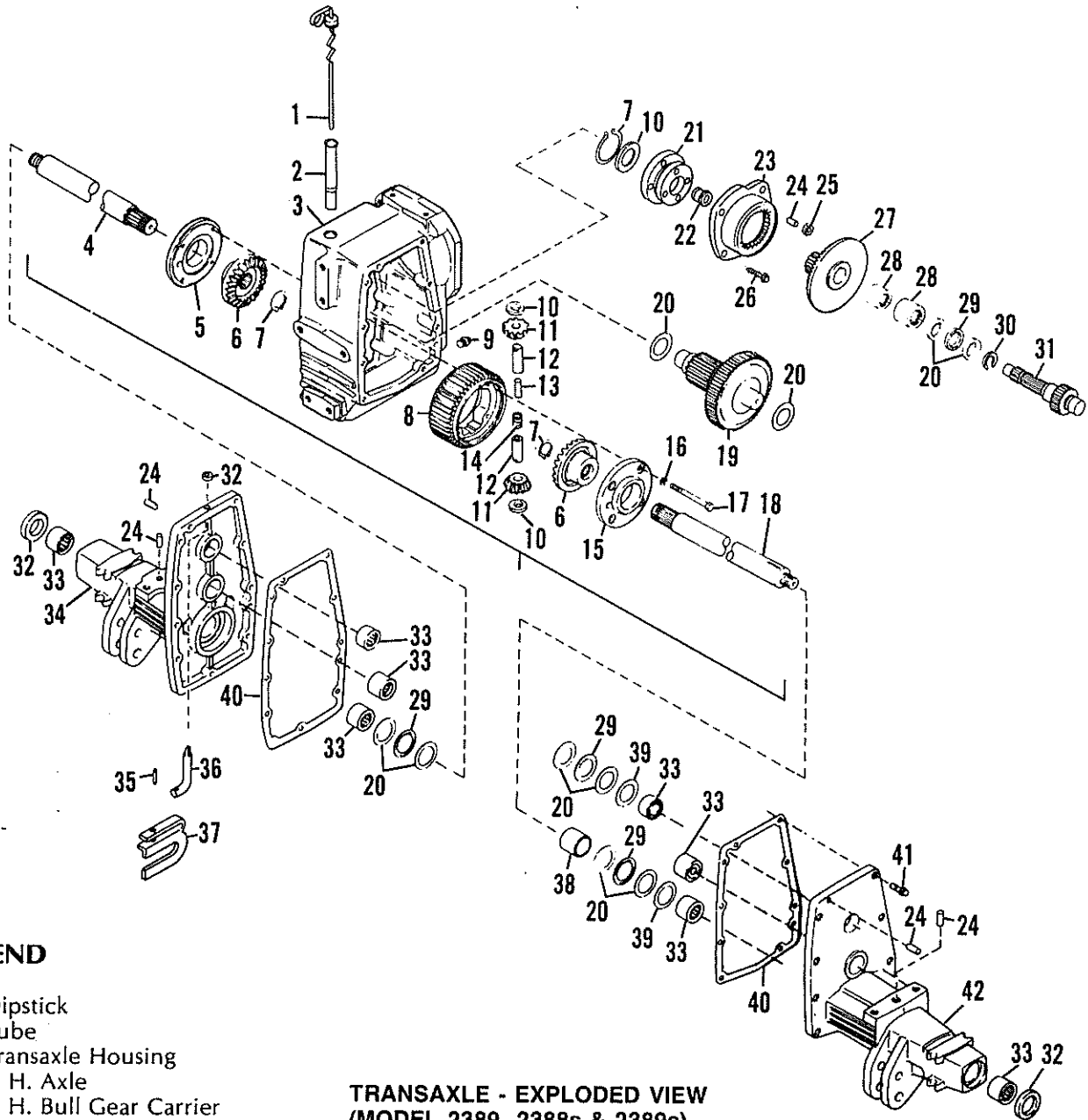


## LEGEND

- 1 Dipstick
- 2 Tube
- 3 Transaxle Housing
- 4 Bevel Gear
- 5 Pinion Shaft
- 6 Woodruff Key
- 7 Thrust Race
- 8 Cluster Gear
- 9 Pipe Plug
- 10 Woodruff Key
- 11 Left Hand Axle
- 12 L.H. Bull Gear Carrier
- 13 Bevel Gear
- 14 External Retaining Ring
- 15 Bevel Pinion
- 16 Bull Gear
- 17 Pinion Shaft

## TRANSAXLE—EXPLODED VIEW (MODELS 1886, 2086 & 2087)

- 18 R.H. Bull Gear Carrier
- 19 Right Hand Axle
- 20 Capscrew
- 21 Lockwasher
- 22 Dowel Pin
- 23 Oil Seal
- 24 Needle Bearing
- 25 L.H. Transaxle Housing Cover
- 26 L.H. Cover Gasket
- 27 Needle Bearing (Closed End)
- 28 Needle Bearing (Closed End)
- 29 Shim
- 30 Thrust Roller Bearing
- 31 Spacer
- 32 R.H. Cover Gasket
- 33 Capscrew
- 34 R.H. Transaxle Housing Cover
- 35 Thrust Washers



## LEGEND

- |                               |                                    |                                     |
|-------------------------------|------------------------------------|-------------------------------------|
| 1. Dipstick                   | 23. Internal Ring Gear             | 34. L. H. Transaxle Housing Cover   |
| 2. Tube                       | 24. Pin                            | 35. Drive Pin                       |
| 3. Transaxle Housing          | 25. Planet Gear                    | 36. Shifter Shaft                   |
| 4. L. H. Axle                 | 26. Counter Bore Screw 5/16-18 x 1 | 37. Shifter Plate                   |
| 5. L. H. Bull Gear Carrier    | 27. Bevel Gear, 56T, 24T & 23T     | 38. Spacer                          |
| 6. Bevel Gear, 22T            | 28. Bearing                        | 39. Shim                            |
| 7. Retaining Ring             | 29. Roller Bearing                 | 40. Cover Gasket                    |
| 8. Bull Gear 44T              | 30. Positioning Ring               | 41. Counterbore Capscrew 3/8-16 x 1 |
| 9. Pipe Plug                  | 31. Pinion Shaft 25T               | 42. R. H. Transaxle Housing Cover   |
| 10. Thrust Washer             | 32. Oil Seal                       |                                     |
| 11. Bevel Pinion, 10T         | 33. Needle Bearing                 |                                     |
| 12. Pinion Shaft              |                                    |                                     |
| 13. Dowel Pin                 |                                    |                                     |
| 14. Compression Spring        |                                    |                                     |
| 15. RH Bull Gear Carrier      |                                    |                                     |
| 16. Lock Washer 5/16          |                                    |                                     |
| 17. Capscrews 5/16-18 x 3-1/2 |                                    |                                     |
| 18. R. H. Axle                |                                    |                                     |
| 19. Cluster Gear, 16T & 45T   |                                    |                                     |
| 20. Thrust Race               |                                    |                                     |
| 21. Planet Gear               |                                    |                                     |
| 22. Sliding Gear              |                                    |                                     |

# DRIVE TRAIN (Continued)

## TWO SPEED TRANSAXLE DISASSEMBLY

1. Drain oil from transaxle.
2. Remove transaxle from tractor (refer to Page 3-21A).
3. Shift transaxle into low range.
4. Remove right axle nut, hub and key. Note: A wheel puller is necessary.
5. Carefully remove right axle housing. Note: location of shims and bearings inside cover.
6. Remove center section of transaxle.
7. Remove cluster gear (Ref. 8 page 3-23) noting location of shims and bearings.

## HIGH AND LOW RANGE DISASSEMBLY (Refer to page 3-23)

1. Remove four (4) counter box screws securing internal ring gear to left axle housing. The complete pinion shaft assembly can now be removed.
2. Remove sliding gear from pinion shaft. Discard positioning ring.

## ASSEMBLY PROCEDURE OF THE CARRIER AND AXLE

A snap ring is used to hold the side gears on the splined axle shafts.

**MAKE SURE THE SNAP RING IS SEATED PROPERLY IN THE CAUTION GROOVE.**

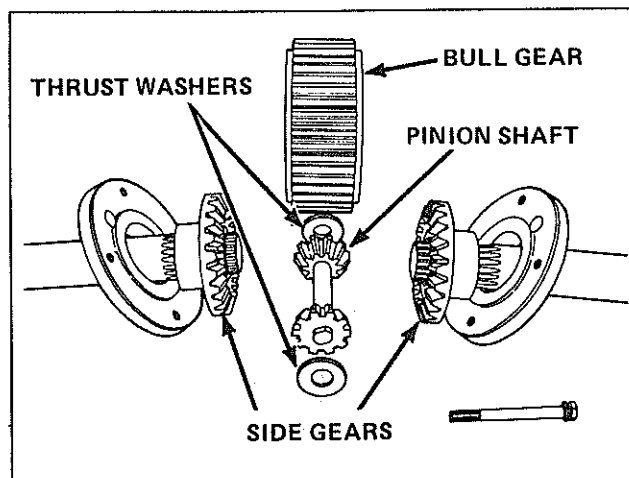


FIGURE 3-36

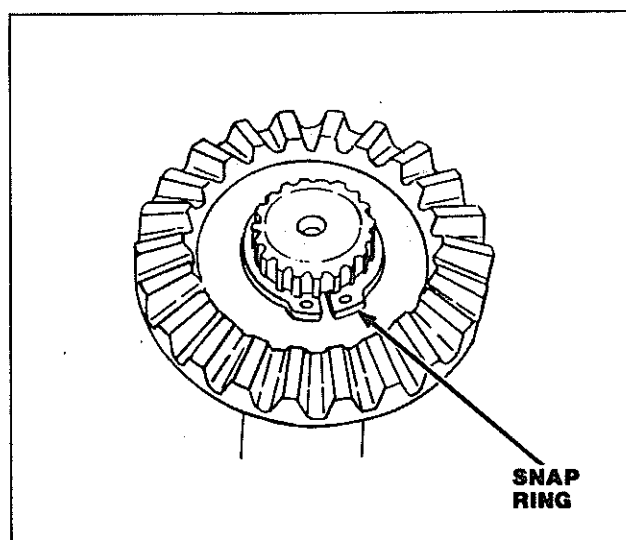


FIGURE 3-37

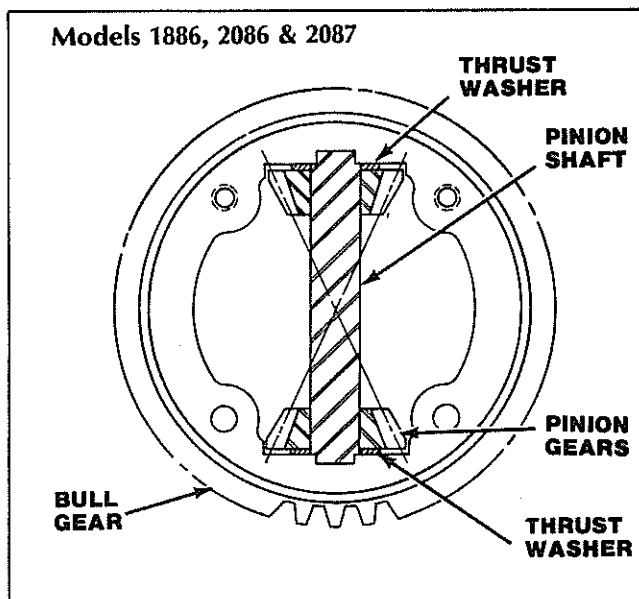


FIGURE 3-38

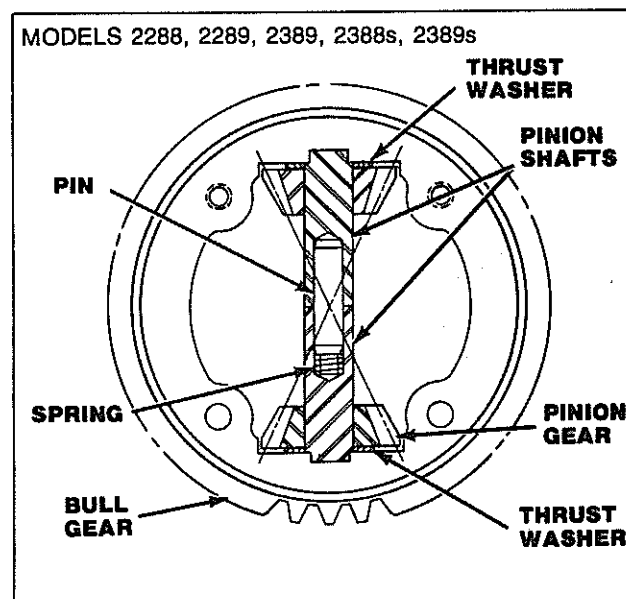


FIGURE 3-38A

The two pinion gears and thrust washers slide on the pinion shaft or pinion shaft assembly and are held in position by the side gears when the carrier is assembled. (See Figures 3-38 and 3-38A.)

The pinion shaft is a slip fit into the machined grooves in the bull gear.

The carrier side plates hold the assembly together and are bolted with four 5/16-18 x 3-1/2" cap-screws. These four bolts should be torqued to 30 ft. lbs. (40 Nm).

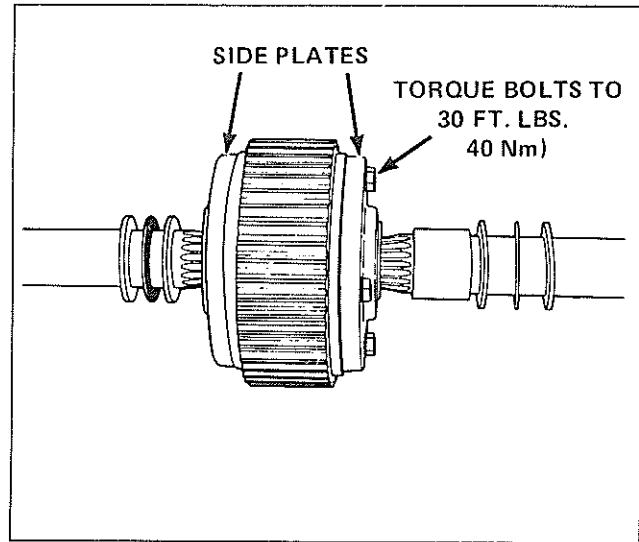


FIGURE 3-39

3

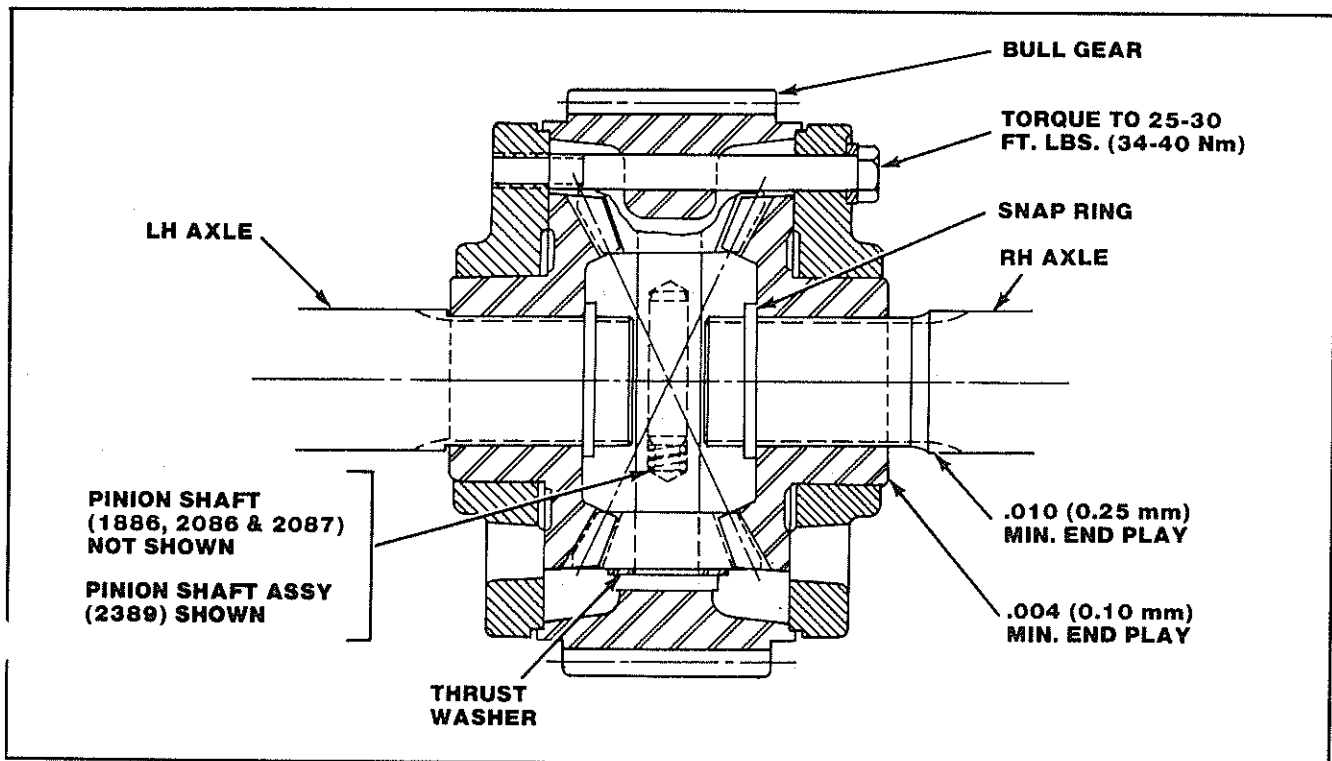
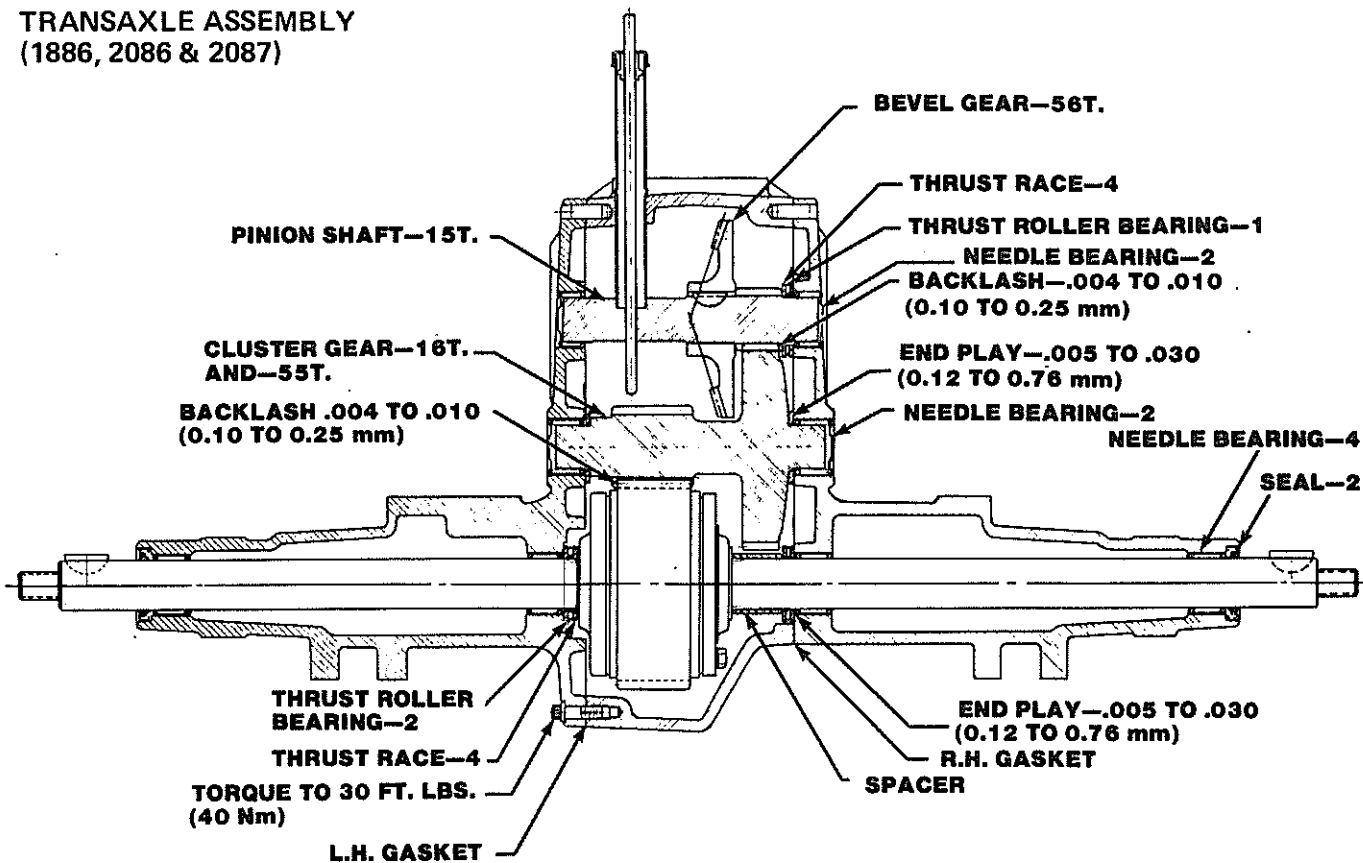


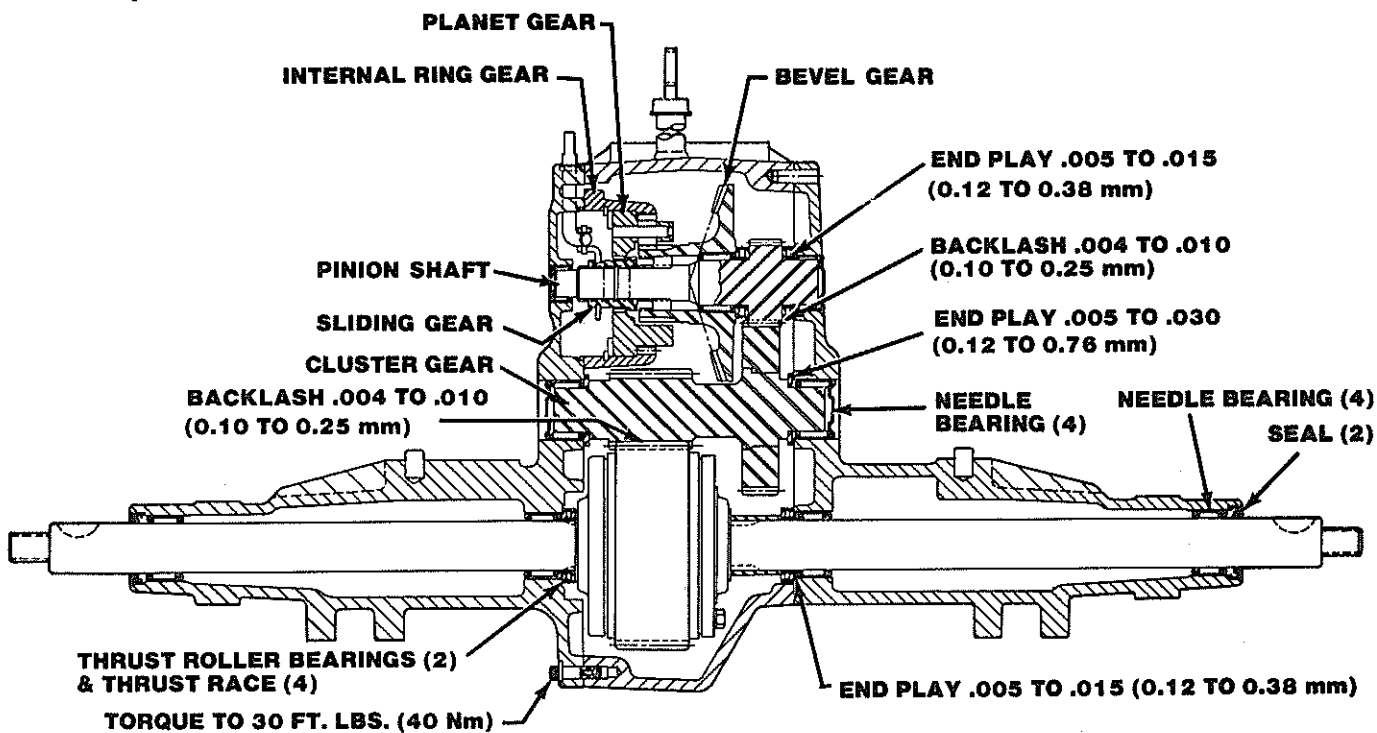
FIGURE 3-40

# DRIVE TRAIN (Continued)

TRANSAXLE ASSEMBLY  
(1886, 2086 & 2087)



TRANSAXLE ASSEMBLY  
(2288, 2289, 2389, 2388s, 2389s)





## CHECKING TRANSAXLE CLEARANCES

Check cluster gear and axle shaft end play. The end play should be .005 to .030 (0.12 to 0.76 mm) on cluster gear and .005 to .015" (0.12 to 0.38 mm) on axle shaft. If the clearance is greater, shims must be installed. The right housing must be removed and the correct number of shims installed until correct end play is reached.

Cluster gear and axle shaft end play can be checked between thrust washer and side of housing using a feeler gage. A dial indicator may also be used.

## DRIVE TRAIN (Continued)

### ASSEMBLY PROCEDURE OF TRANSAXLE

Check needle bearings in side housings. If needles show signs of pitting or any other damage replace them. Use a needle bearing driver and seat bearings to a depth of  $1/32''$  to  $1/16''$  below the machined surface.

**NOTE:** Always install the needle bearings with the stamped end (the end with identification markings) against the seal driving tool.

Needle bearings in end of axle housing should be seated  $1/32''$  to  $1/16''$  below counter bore for the axle seal.

Axle seals should be replaced whenever unit is repaired. Use a seal driver and drive seals until they bottom in axle housing counter bore.

Install carrier and axle assembly into the left side housing. Be careful not to damage axle seal in end of housing.

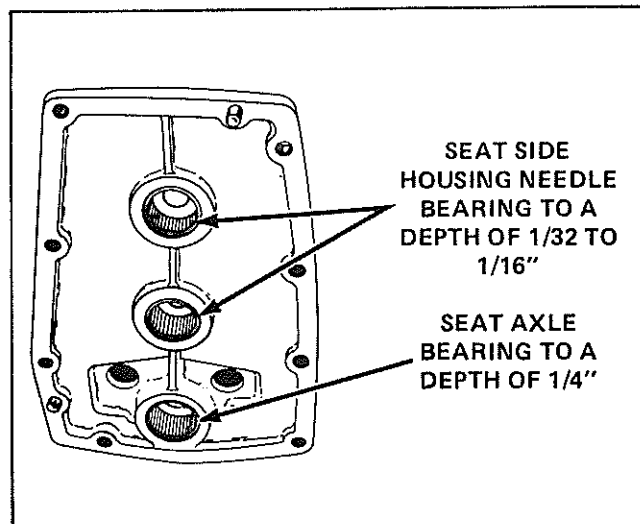


FIGURE 3-45

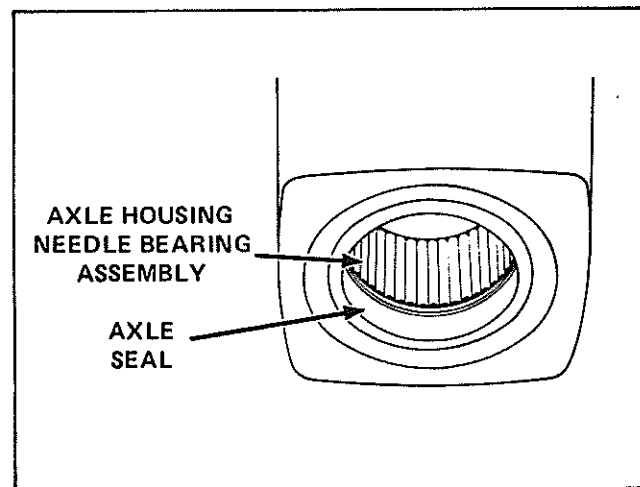


FIGURE 3-46

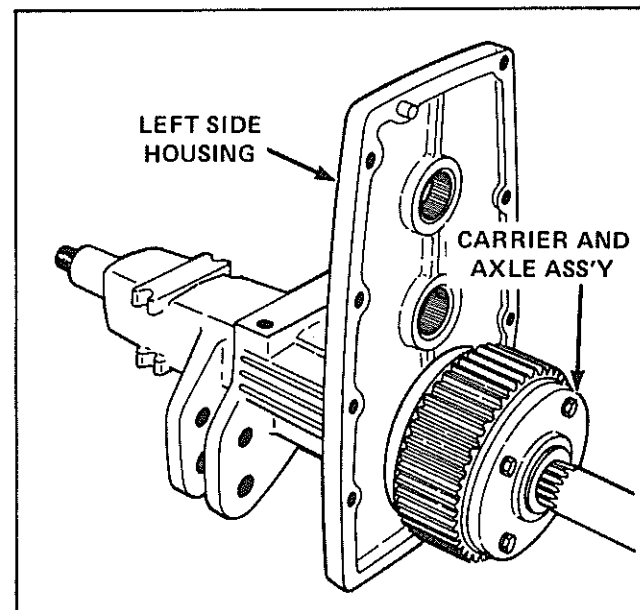


FIGURE 3-47

## TRANSAXLE ASSEMBLY

1. Bolt left side housing with axle assembly to the center housing. Make sure new gasket has been installed and torque housing capscrews to 30 ft. lbs. (40 Nm).

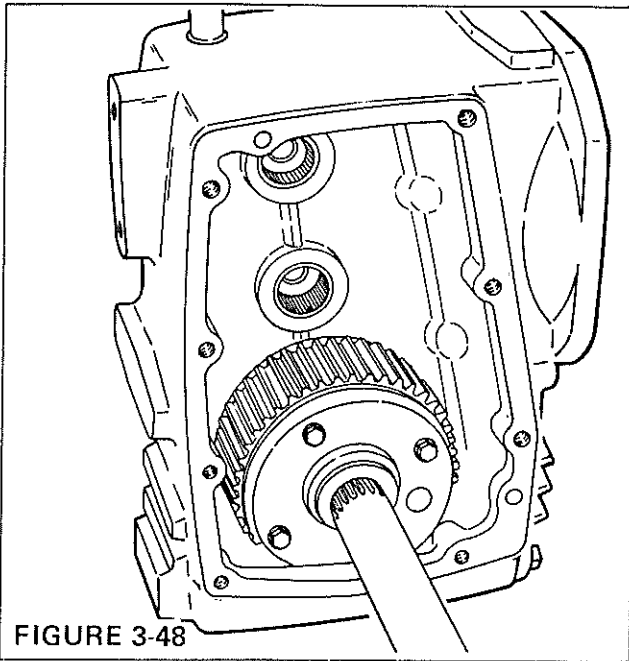


FIGURE 3-48

MODELS 1886, 2086, AND 2087 (STEPS 2 – 5 ONLY)

2. The gear can be removed from the shaft if replacement is necessary. A woodruff key is used to prevent the ring gear from turning on the shaft. An arbor press should be used to press the ring gear on and off the shaft.

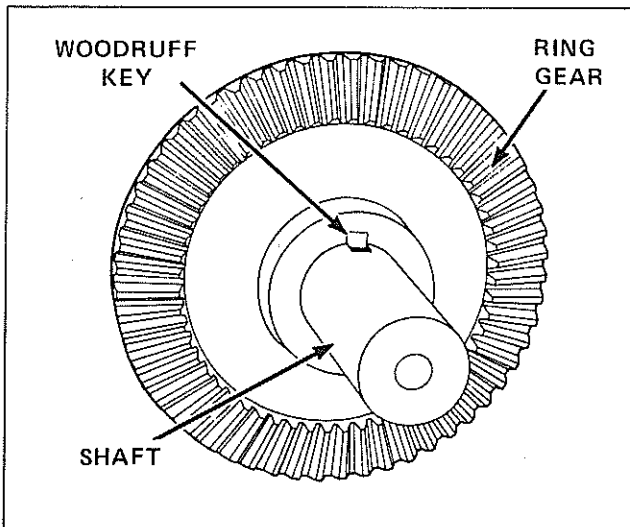


FIGURE 3-49

3. If the cluster gear or pinion gear is replaced, make sure part numbers are checked to assure proper gear ratio. A 55 tooth cluster gear and a 15 tooth pinion gear is used in the large frame transaxle.

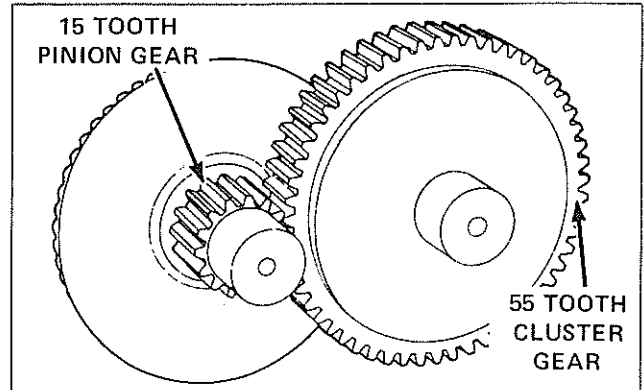


FIGURE 3-51

4. To install ring gear assembly and cluster gear they must be installed together in their normal position as they are meshed in the transaxle. Make sure thrust washer is installed on cluster gear, and slide shafts into the needle bearings.
5. See page 3-31 for final assembly.

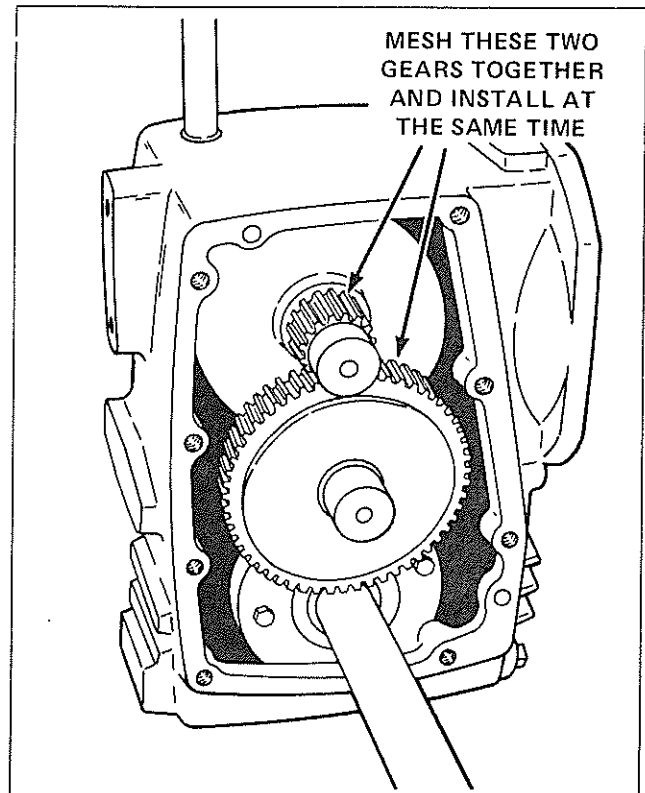
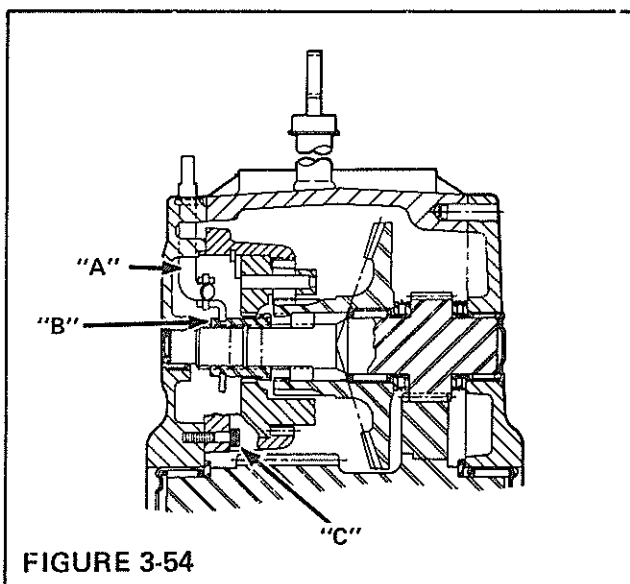
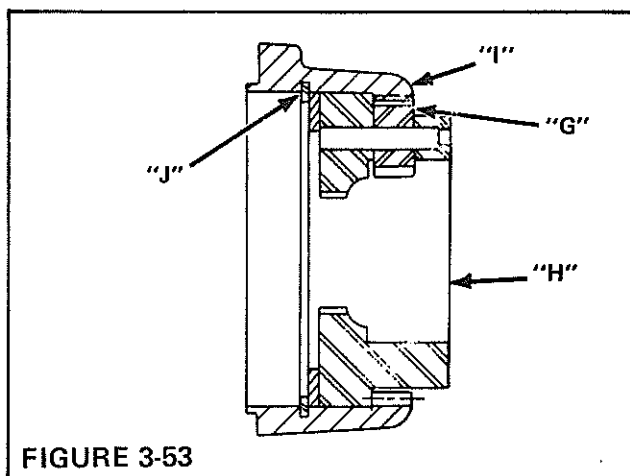
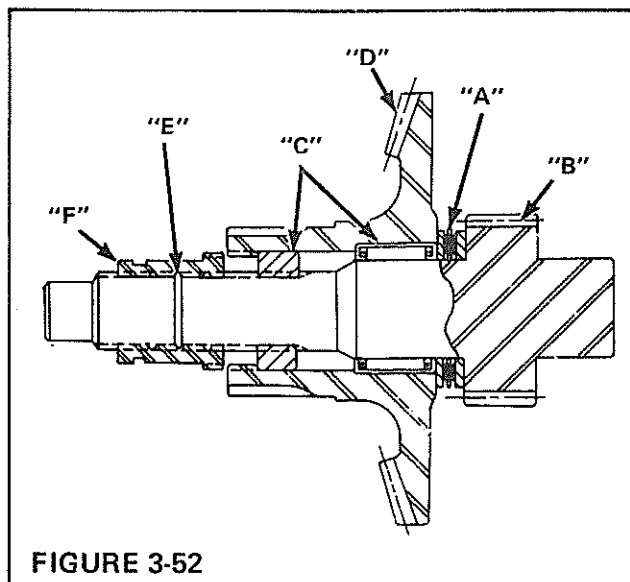


FIGURE 3-51

## DRIVE TRAIN (Continued)

### TWO SPEED TRANSAXLE ASSEMBLY - Model 2389, 2288, 2289, 2388s, 2389s

1. Slide speed thrust race, thrust bearing and another thrust race (A) Fig. 3-52 onto pinion shaft (B).
2. Place pinion shaft through roller and needle bearings (C) in bevel gear (D).
3. Carefully place positioning ring (E) in groove of pinion shaft. Be careful of over-stretching the ring.
4. Slide sliding gear (F) over the positioning ring into first detent. The groove for the shifter arm fork must be towards the end of the pinion shaft.
5. Place planetary gears (G) Fig. 3-53 into planetary carrier (H) and secure in place with roll pins. Place the planet carrier assembly into internal ring gear (I). Install the large thrust washer behind the planet carrier and secure the assembly with large retaining ring (J).
6. Install the pinion shaft assembly, Figure 3-52, into the planet gear assembly, Figure 3-53.
7. Before assembling, install roll pin into shifting arm (A), Figure 3-54 and fork.
8. Slide fork into groove of sliding gear (B). (Gently tap with a hammer until fork is completely in the groove.)
9. Install planetary carrier assembly & pinion shaft assembly into left axle housing by sliding shifting fork into hole in cover and rotating into position. Install four screws (C). Do not tighten until cluster gear is properly installed. Once cluster gear is properly installed with proper washers, torque four screws on planetary carrier to 18 ft. lbs. (24 Nm).



## (ALL MODELS)

The right side of the bevel gear must have a torrington bearing assembly. The cluster gear must have a thrust washer and the axle shaft a spacer and torrington bearing assembly. After the bearings and spacers are installed, the right side housing can be bolted in place. Be careful not to damage axle seal. Use a new gasket and torque capscrews to 30 ft. lbs. (40 Nm).

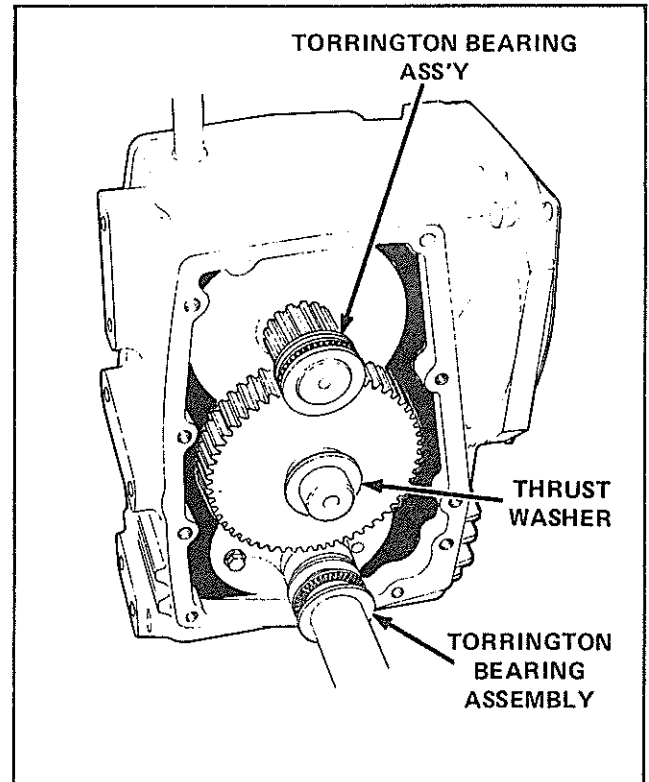


Figure 3-55

## TROUBLE SHOOTING GUIDE

PROBLEM	PROBABLE CAUSE	REMEDY
Hard starting	<ol style="list-style-type: none"> <li>1. Fuel shut off valve closed</li> <li>2. Choke linkage not working properly</li> <li>3. Dirt in fuel system</li> <li>4. Engine flooded</li> <li>5. Carburetor out of adjustment</li> <li>6. Water in fuel system</li> <li>7. Dirty air filter</li> </ol>	<ol style="list-style-type: none"> <li>1. Open valve</li> <li>2. Check linkage and repair</li> <li>3. Clean fuel lines, carburetor, and install new fuel filter</li> <li>4. Check linkage, carburetor float setting etc.</li> <li>5. Adjust carburetor</li> <li>6. Clean system and refill with clean fuel</li> <li>7. Install new air filter</li> </ol>
No fuel reaches carburetor	<ol style="list-style-type: none"> <li>1. Empty fuel tank</li> <li>2. Fuel filter plugged</li> <li>3. Gas tank vent plugged</li> </ol>	<ol style="list-style-type: none"> <li>1. Refill tank</li> <li>2. Clean or replace fuel filter</li> <li>3. Clean out vent</li> </ol>
Carburetor leaks	<ol style="list-style-type: none"> <li>1. Loose fuel line fitting</li> <li>2. Carb float setting set too high</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten fuel line</li> <li>2. Adjust float</li> </ol>
Engine starts but runs rough with low power output	<ol style="list-style-type: none"> <li>1. High or low speed mixture adjustments off</li> <li>2. Incorrect float setting</li> <li>3. Dirty air filter</li> <li>4. Carburetor loose on engine block</li> </ol>	<ol style="list-style-type: none"> <li>1. Readjust carburetor</li> <li>2. Adjust float</li> <li>3. Install new air filter</li> <li>4. Tighten carburetor mounting screws</li> </ol>

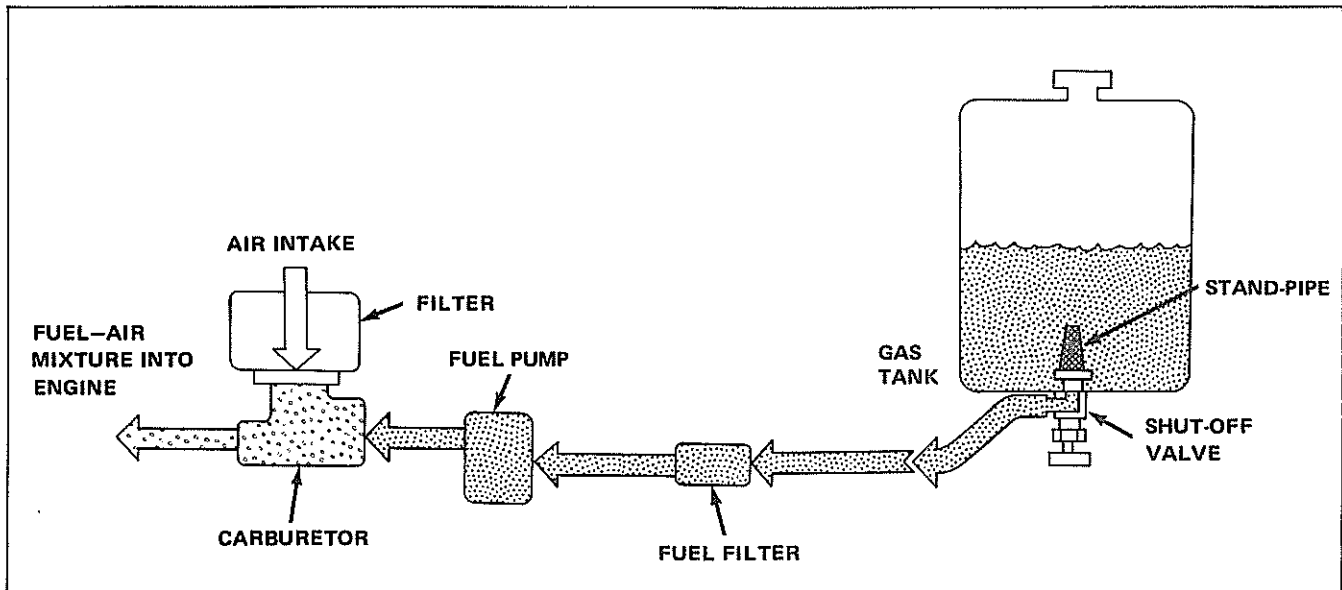


FIGURE 4-1

## FUEL TANK

Fill with clean fresh gasoline of regular grade. (For cold weather operation use winter blend gasoline.) **DO NOT MIX OIL WITH GASOLINE. REFUEL OUTDOORS WITH ENGINE STOPPED AND COOL.**

Check to see that vent hole in fuel tank cap is not plugged.

## FUEL VALVE

The fuel valve is located under the fuel tank. This valve must be fully open for proper operation of the tractor.

## FUEL FILTER

1886s, 2086 & 2087 (Fig. 4-2)

The fuel filter is a cartridge type in-line filter. For cleaning, shut off fuel valve and separate filter with a counterclockwise twist. When reassembling filter, twist the two valves counterclockwise each about one-half turn. This preloads the filter to lock it together. Fig. 4-3.

**NOTE: TO RECLOSE, TWIST THE TWO HALVES COUNTERCLOCKWISE EACH ABOUT ONE HALF TURN BEFORE ASSEMBLING. THEN PLACE TWO HALVES TOGETHER AND CLOSE BY TURNING CLOCKWISE UNTIL THEY ARE SECURELY TIGHTENED.**

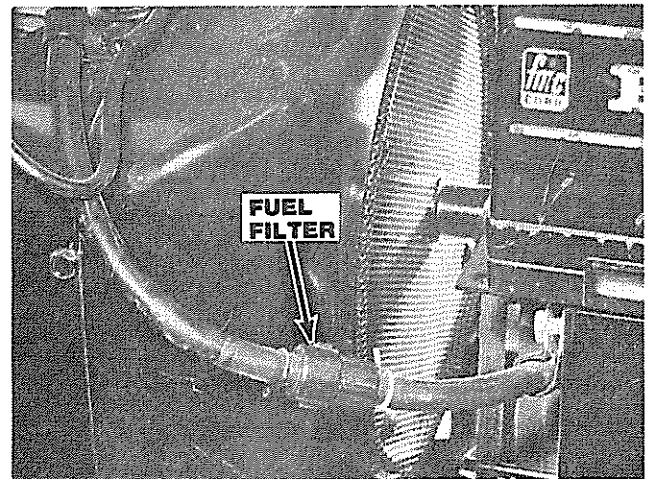


FIGURE 4-2

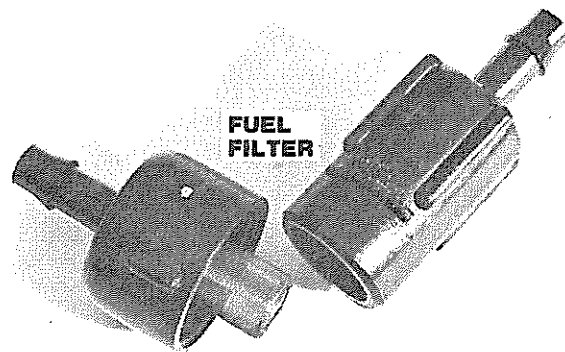


FIGURE 4-3

## FUEL SYSTEM (Continued)

### FUEL FILTER (CONT'D.)

2087 (Later Models) & 2389, 2389s

This filter is a throw away type. Replace when it shows excessive dirt inside.

Turn off fuel tank valve before moving filter. Open valve after replacing filter.

#### Models 2288 & 2289

### FUEL FILTER

There is a fuel filter (A) Figure 4-4 in the line from the fuel tank. This filter is a throw away type. When replacing the filter turn off the fuel valve. This valve is located on the left hand side of the tractor under the foot pedal. Screw off filter and replace. Service after first 50 hrs. and every 200 hrs. thereafter. Open valve again after filter has been replaced.

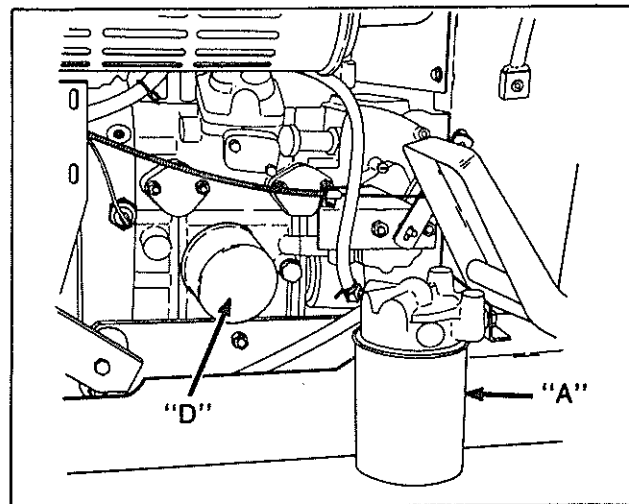


FIGURE 4-4

#### MODELS 2388s

### FUEL FILTER

There is a fuel filter (C) Figure 4-5 in the line from the fuel tank. This filter is a throw away type. When replacing the filter turn off the fuel valve. This valve is located under the fuel tank. Before the filter can be replaced the pressure inside the filter must be relieved. Follow the instructions below.

1. Start the engine.
2. Turn the main switch to the OFF position.
3. Leave the engine run for approximately 1 minute before moving the throttle control to the stop position.

Remove the filter and replace.

Service after the first 50 hours and every 200 hours thereafter. Open valve after the filter is replaced.

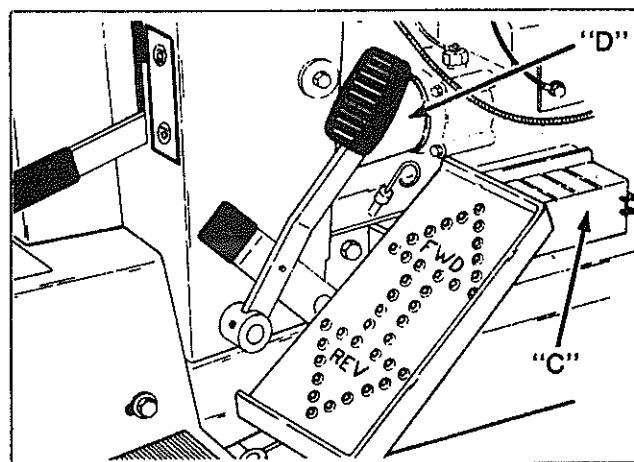


FIGURE 4-5



## AIR CLEANER (Models 1886s, 2086, 2087, 2389, 2389s)

Under normal operating conditions, disassemble and service air cleaner components every 50 hours of operation. Do this more frequently (even daily) if extremely dusty or dirty conditions prevail. The dry type element is cleaned by gently tapping on a flat surface — when doing this, be careful not to damage gasket surfaces on element. **DO NOT** attempt to clean dry type elements in any liquid or with compressed air as this will damage paper filter material. Wipe dirt or dust accumulation from cover including base plate where used.

### IMPORTANT:

Dry type elements should be replaced after each 100 to 200 hours — replace at 100 hours if engine is operated under dirty conditions — replace every 200 hours under good clean air conditions.

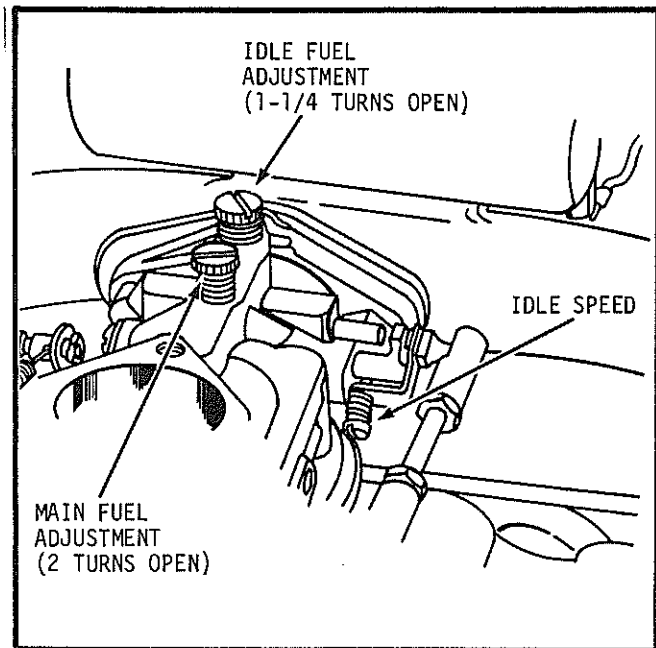


FIGURE 4-6

4

## CARBURETOR ADJUSTMENT

Carburetor is adjusted at the factory and should not have to be reset. If black exhaust smoke is noted, check the air cleaner first. An "overrich" mixture is usually caused by a poorly serviced, clogged air cleaner element, not an improperly adjusted carburetor.

If readjustment becomes necessary, stop the engine. Turn the MAIN and IDLE fuel adjusting screws all the way in until they bottom *LIGHTLY* — do not force them closed as this will damage the needle valves. For preliminary setting, turn MAIN fuel screw out (counterclockwise) two full turns, and the IDLE 1-1/4 turns. For final adjustments, start engine and allow it to warm up then operate at full throttle and under load, if possible. Turn MAIN fuel screw in until engine slows down (lean side) then out until it slows down again from overrich setting — note positions of screw at both settings, then set it about half-way between the two. The IDLE fuel setting can then be adjusted in the same manner for smoothest idle. Rough idle is often due to the idle speed being set too low — check this also.

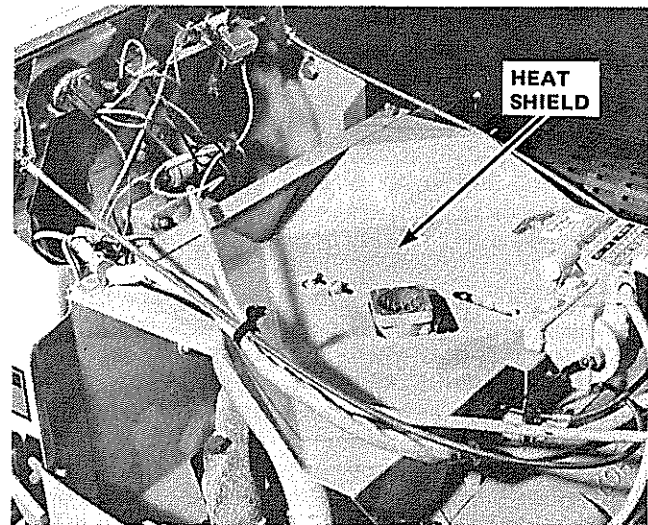


FIGURE 4-7

## IDLE SPEED ADJUSTMENT

To adjust idle speed, remove heat shield to gain access to adjusting screw. The idle speed should be no less than 1,200 R.P.M. The proper idle speed will help prevent carburetor "load up" and engine "kill."

## **FUEL SYSTEM (Continued)**

### **AIR CLEANER (Model 2388S)**

Disassemble and service air cleaner components every 50 hrs. of operation. Do this more frequently (even daily) if extremely dusty or dirty conditions prevail.

The element is cleaned by gently tapping of a flat surface or blowing with compressed air; 100 psi maximum. Check against bright light for holes before reinstalling. Be careful not to damage gasket surfaces on element. Element can also be cleaned with clear water. Make sure element is dry before using. Wipe dirt or dust accumulation from cover, including base plate where used.

Element should be cleaned after the first 50 hours and replaced after each 4 cleanings.

Make sure rubber flapper valve is free of all dirt.

The importance of maintaining an air cleaner in proper condition cannot be over emphasized! Improper air cleaner maintenance can create engine damage which the engine manufacturer will not warrant.



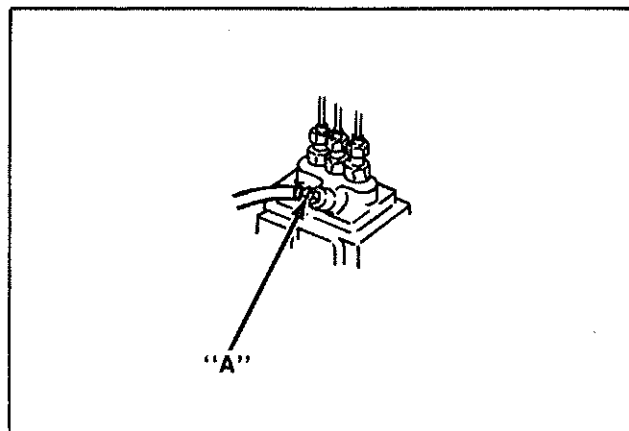
**CAUTION**

**NEVER RUN THE ENGINE WITH AIR CLEANER REMOVED. DIRT WILL ENTER THE ENGINE AND SCORE THE CYLINDERS.**

### **AIR PURGING OF THE FUEL SYSTEM**

Hard starting may result if air is present in the fuel line. Purge the fuel line as follows:

1. Loosen air vent screw (A) Figure 4-8.
2. Place ignition key to the ON position. The fuel pump will now pump fuel through the system. When fuel runs out of air vent (A) reinstall screw.
3. Start up engine and leave running, at full throttle, for a few seconds.



**Figure 4-8**



**CAUTION**

**NEVER RUN THE ENGINE WITH AIR CLEANER REMOVED, DIRT WILL ENTER THE ENGINE AND SCORE THE CYLINDERS.**

### **AIR CLEANER (Models 2288 & 2289s)**

Disassemble and service air cleaner components every 50 hrs. of operation. Do this more frequently (even daily) if extremely dusty or dirty conditions prevail.

The element is cleaned by gently tapping on a flat surface — when doing this, be careful not to damage gasket surfaces on element. Element can also be cleaned with clear water. Make sure element is dry before using. Wipe dirt or dust accumulation from cover, including base plate where used.

Element should be cleaned after the first 50 hours and replaced after each 10 cleanings.

The importance of maintaining an air cleaner in proper condition cannot be over emphasized! Improper air cleaner maintenance can create engine damage which the engine manufacturer will not warrant.

## FRONT AXLE ASSEMBLY

- 1 – Front axle
- 2 – Ball bearing
- 3 – Sleeve bearing
- 4 – P.T.O. shaft
- 5 – Retaining ring
- 6 – Flange bearing (or needle bearing)
- 7 – Thrust race
- 8 – Thrust bearing
- 9 – O-ring
- 10 – Key 1/4 x 1
- 11 – Spindle assembly

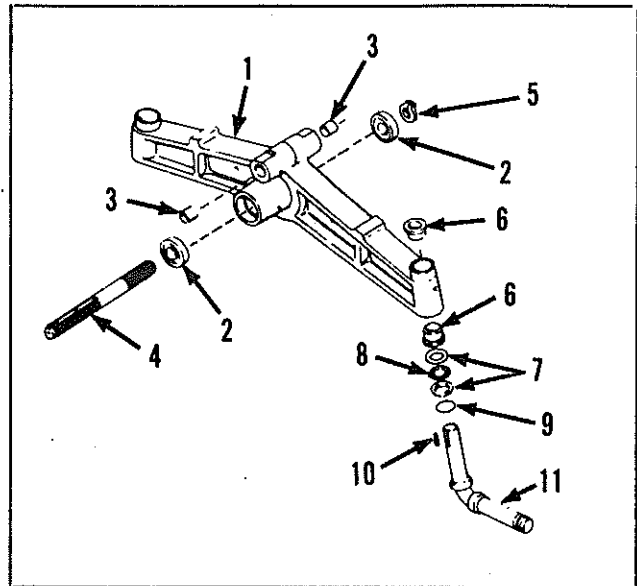


FIGURE 5-1

## FRONT AXLE STOP

If the clearance between the Front axle assembly "A" (Fig. 5-2) and the Stop assemblies "B," is 1/16" or more, the stops must be adjusted.

1. Loosen capscrew "C" (Fig. 5-2).
2. Move Stop assemblies "B" up against Front axle assembly "A".
3. Secure capscrews "C".

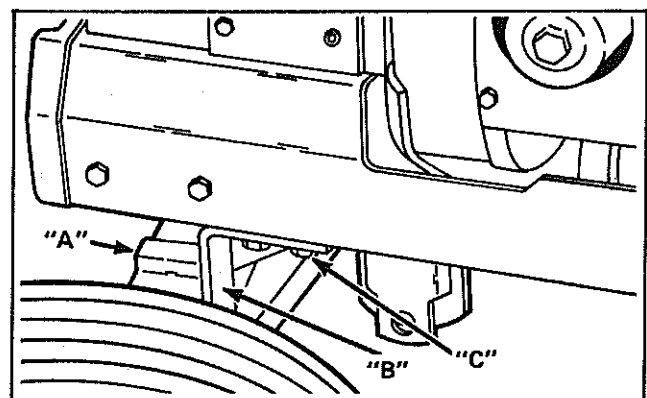


FIGURE 5-2

## FRONT WHEEL ALIGNMENT

1. Turn steering wheel so that front wheels are straight ahead.
2. Disconnect R.H. side of tie rod from steering arm. Measure distance across front of tire, center line to center line. Measure distance across rear of front tire, center line to center line and adjust toe-in from 0 to 3/8" maximum, by turning tie rod in or out as required. (Front reading should be less than rear reading when measured across tire center lines.)
3. Tighten hex nut securely, and reinstall tie rod into steering arm making sure lockwasher is between ball joint and arm.
4. Check length of steering drag link. Overall length should be approximately 27-1/16". Adjust if necessary.

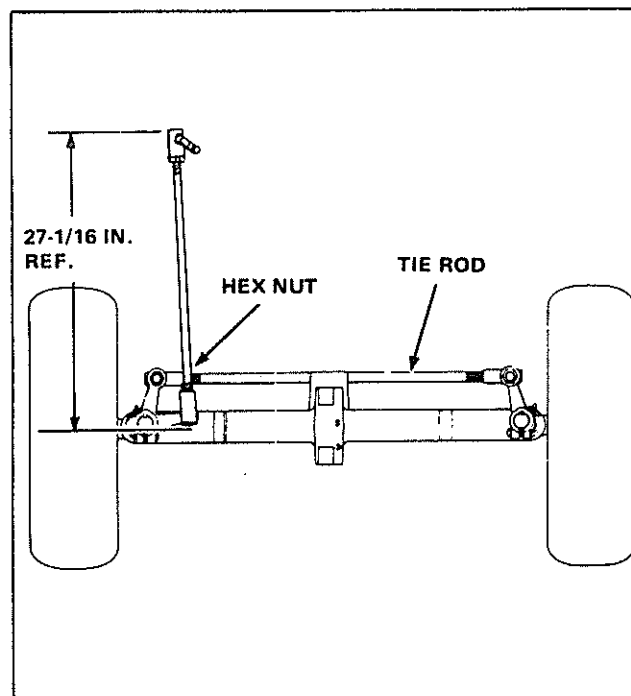


FIGURE 5-4

## TURNING RADIUS

Adjust turning radius if, in making short turns, a front tire interferes with front mounted attachment brackets or center mounted attachments. Adjusting screws are provided as follows:

1. You will find a slot in the right hand frame at the rear of the steering drag link where it connects to the steering gear. Near each end of this slot is a square head setscrew, with lock nut, inserted in the frame.
2. The screw at the front of the slot area controls the LEFT turning radius. The screw at the rear controls the RIGHT turning radius.
3. Turning these screws IN will increase the tractor turning radius. Turning screws OUT will decrease the radius.

**NOTE: ADJUST SCREWS SO THAT TRACTOR TURNING RADIUS IS APPROXIMATELY THE SAME, LEFT AND RIGHT.**

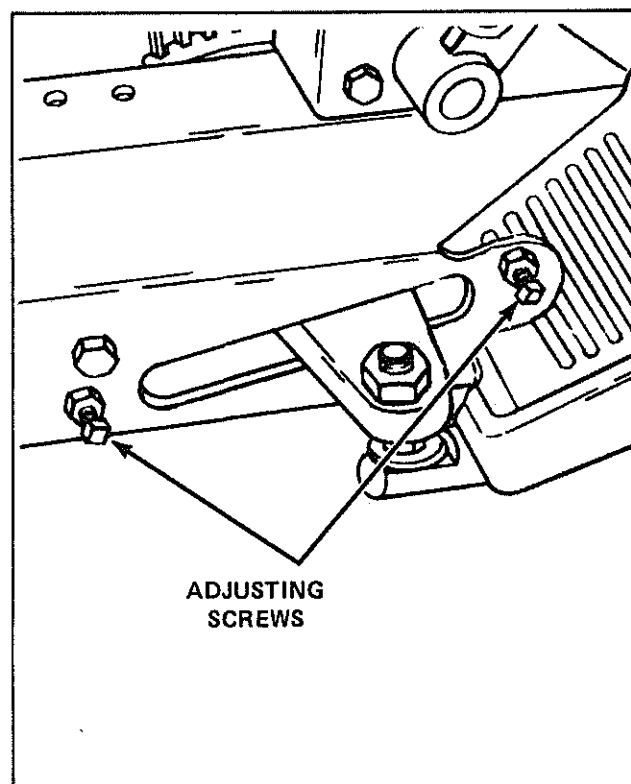


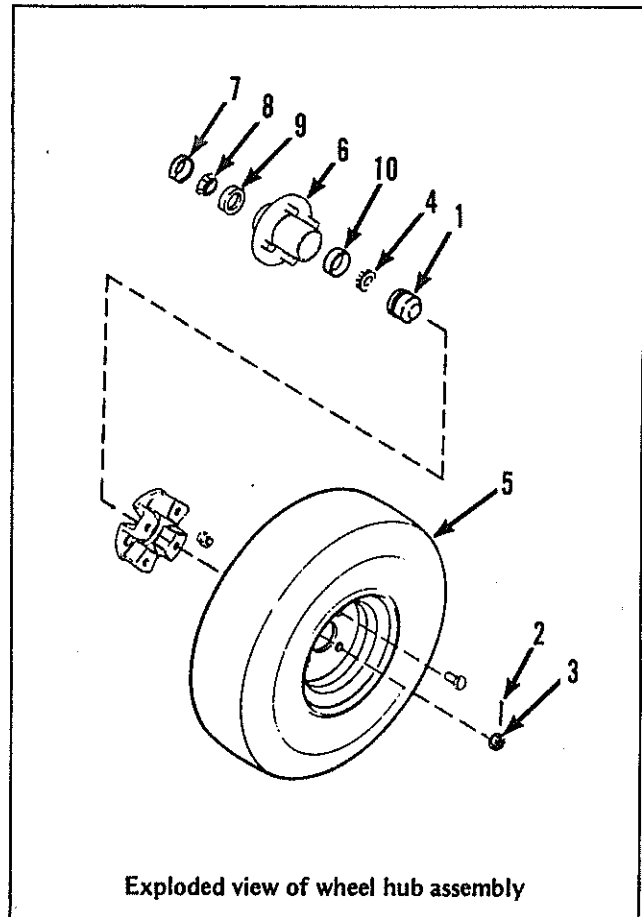
FIGURE 5-5

4. Check to make sure the stops are being used.

## FRONT WHEEL BEARINGS

Front wheel bearings should be repacked at least once a year.

1. Remove the dust cap (1).
2. Remove cotter pin (2) and unscrew slotted nut (3).
3. Remove outer bearing (4).
4. Remove wheel (5) and hub assembly (6) from spindle.
5. Remove seal (7) from hub. If this seal is damaged in any way replace it.
6. Remove inner bearing (8) from hub.
7. Clean both inner race (9) and outer race (10). Check both for wear or pitting. Replace if necessary.
8. Clean bearings in a commercial solvent. Dry with compressed air or a clean cloth.
9. Pack bearings with a good grade of wheel bearing grease.
10. Install inner bearing and seal into hub.
11. Install wheel and hub assembly to spindle.
12. Install outer bearing.
13. Tighten nut until it snugs up against the outer bearing. Spin wheel to align bearings, then back nut off to nearest slot in line with hole in spindle and install new cotter pin.
14. Install dust cap.



Exploded view of wheel hub assembly

FIGURE 5-6

## PNEUMATIC TIRES

Keep both front and rear tires inflated evenly. Under no circumstances should tire inflation be less than 8 pounds, nor more than 12 pounds. Check air pressure with a low pressure gauge. Operating with incorrect pressures may damage tires.

## CHASSIS (Continued)

### DISC BRAKES

After every 50 operating hours check clearance of brake pads. If there is more than .010 inch clearance between the brake pads and brake disc (see Ref. "A"), the brakes need adjustment. To adjust place brake pedal in the OFF position, then turn nut (Ref. "B") clockwise to bring the brake pads closer to the brake disc. The correct clearance is 0 to .010 inch.

**NOTE: Be sure to adjust the brakes on both wheels equally to avoid uneven braking. Check for proper operation.**

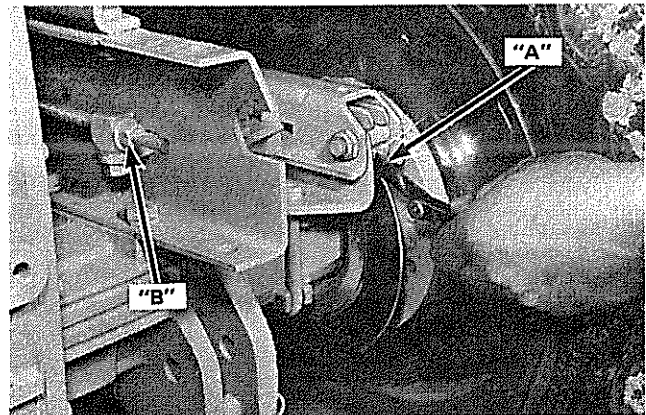
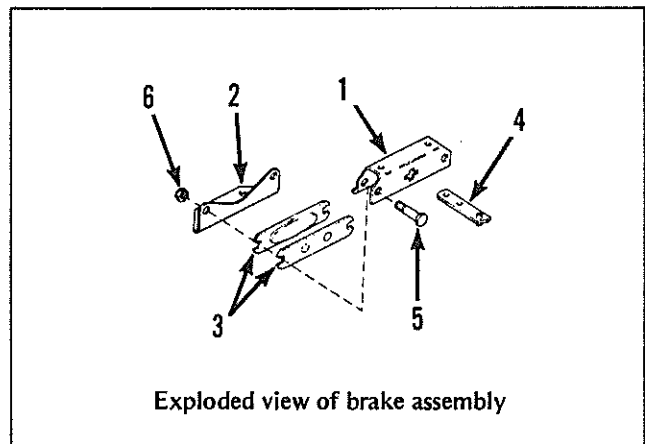


FIGURE 5-7

### BRAKE ASSEMBLY

- 1 — Bracket
- 2 — Support
- 3 — Brake Pads
- 4 — Lever
- 5 — Bolt
- 6 — Lock nut



Exploded view of brake assembly

FIGURE 5-8

Replacing the brake pads.

1. Remove brake assembly from tractor.
2. Remove one of the bolts which hold the brake pads in the bracket.
3. The brake pads can now be removed.
4. Reverse the above procedure to reassemble.

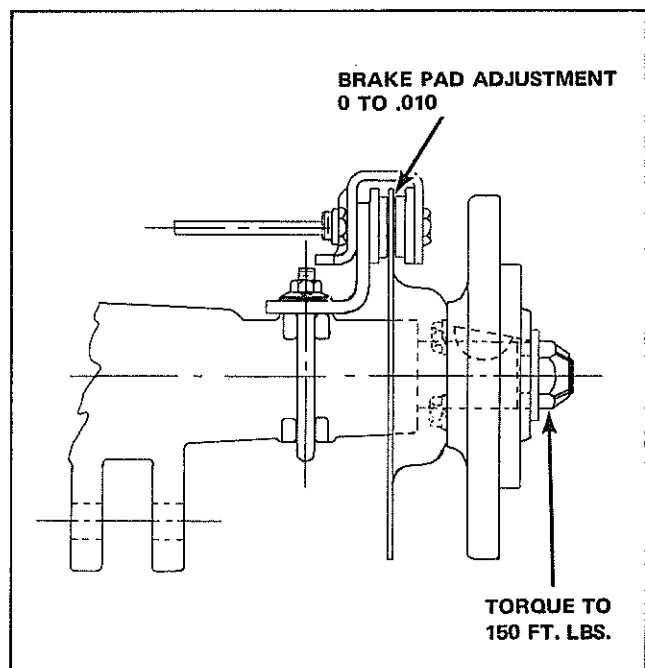
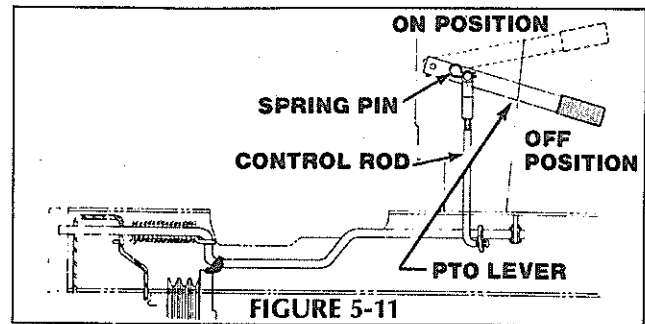


FIGURE 5-9

## POWER TAKE-OFF (P.T.O.) LEVER

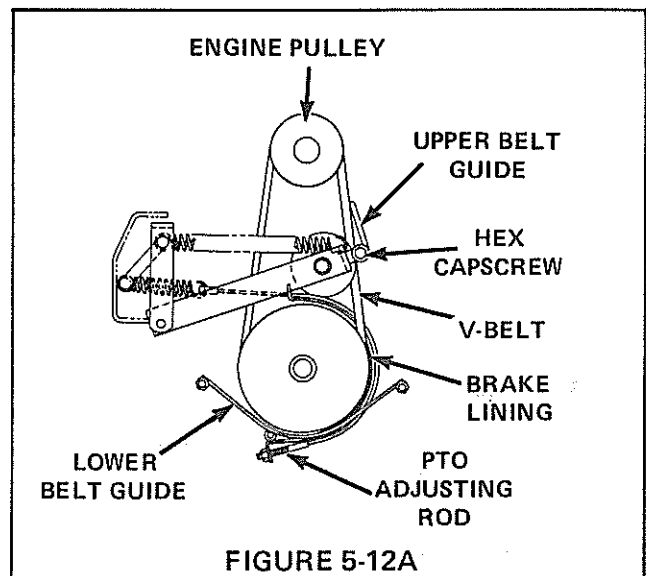
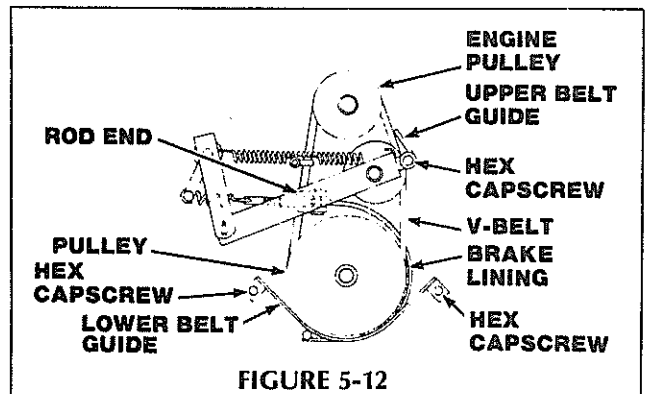
1. Place P.T.O. lever in the OFF position.
2. Remove spring cotter pin and turn the P.T.O. control rod in until the desired tension is obtained. Reinstall spring cotter pin.
3. With the P.T.O. lever in the ON position, loosen the hex capscrew which secures the upper belt guide shown in Figure 5-12. Adjust upper belt guide for 1/8 to 1/4 inch (0.31 to 0.62 cm) clearance between belt and belt guide. Tighten hex capscrew securely.



## P.T.O. BELTS

Should it become necessary to replace P.T.O. belts, install new belts as follows:

1. Place P.T.O. lever in the OFF position.
2. DO NOT disturb upper belt guide, if 1/8 to 1/4 inch (0.31 to 0.62 cm) gap is evident with P.T.O. lever in the "ON" position.
3. Remove lower belt guide and old belts.
4. With hood open place the three NEW BELTS over both ENGINE and IDLER pulley with your right hand while feeding belts up from below with left hand, then feed into grooves of P.T.O. pulley.
5. Reinstall lower belt guide and adjust for a 3/32 to 1/8 inch (0.23 to 0.31 cm) clearance between belt guide and belts with P.T.O. lever in the ON position. Tighten the two hex capscrews securely. Check upper belt guide and adjust if necessary. Place P.T.O. lever in OFF position.



## PTO BRAKE ADJUSTMENT (Models 2087 S/N 0400101 and up and 2389 S/N 0100101 - 0199999)

To adjust brake follow these instructions. With PTO handle in the engaged position or ON, adjust rod end, Figure 5-12, to obtain a gap, not more than 1/16" (0.15 cm) between the PTO pulley and the brake lining. PTO pulley must stop within 5 seconds. If not, adjust rod end till stopping time is reached.

## PTO BRAKE ADJUSTMENT (Models 2288, 2289 S/N 0100101 and up) (Models 2389 S/N 0200101 and up) (Models 2389s and 2388s)

To adjust brake follow these instructions. With PTO handle in the engaged position or ON, adjust rod, Figure 5-12A, to obtain a gap, not more than 1/16" (0.15 cm) between the PTO pulley and the brake lining. PTO pulley must stop within 5 seconds. If not, adjust rod end till stopping time is reached.

## CHASSIS (Continued)

### REAR WHEELS

The rear wheels can be reversed on this tractor. With "Regular Lawn and Garden" or "Regular Agriculture" tires the overall width would be 47 inches with the wheels turned out. With the wheels turned in the overall width would be 38 inches.

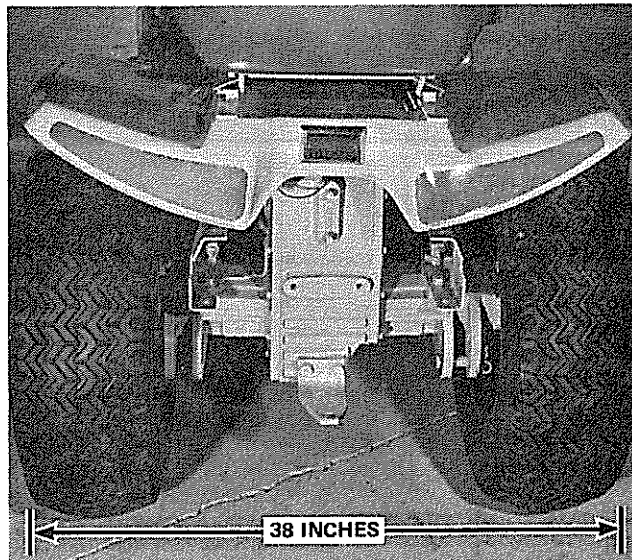


FIGURE 5-13

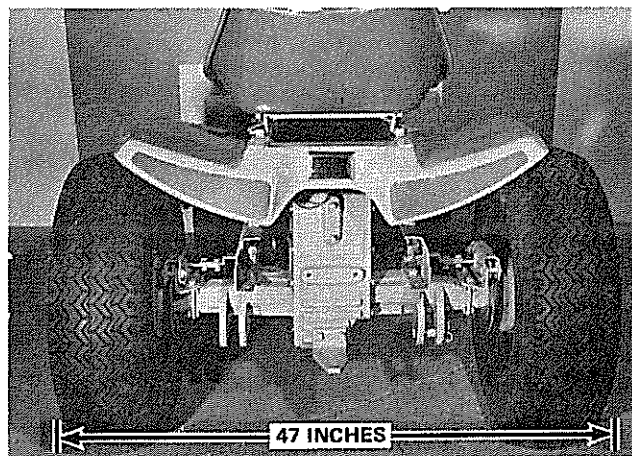


FIGURE 5-14

### TRAVEL PEDAL

The travel pedal angle can be adjusted for the operator's comfort.

1. To bring toe of pedal closer to operator, shorten rod (Ref. "B").
2. To move toe of pedal farther away from operator, lengthen rod (Ref. "B").

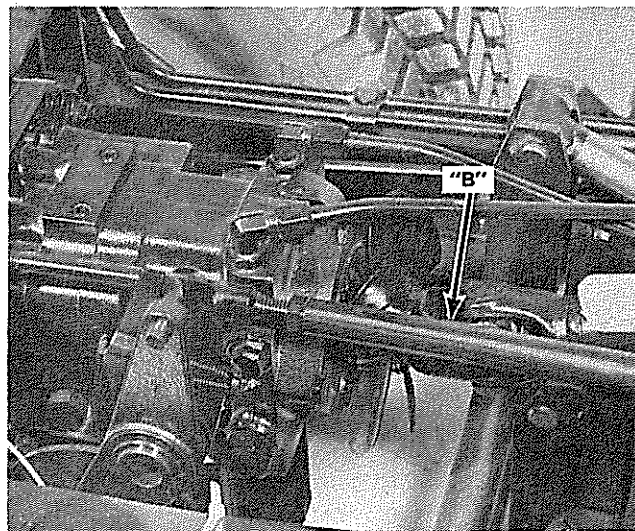


FIGURE 5-15

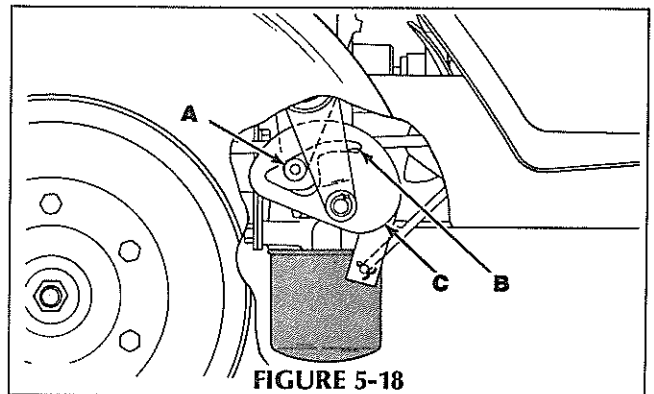
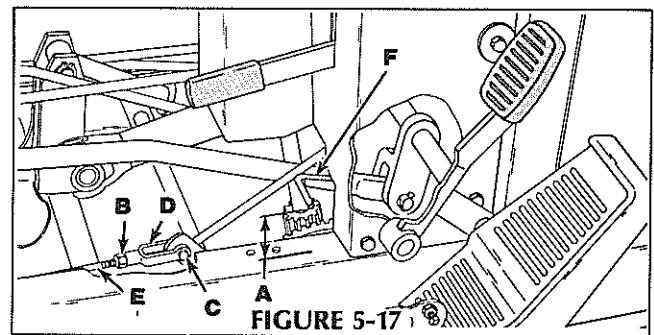
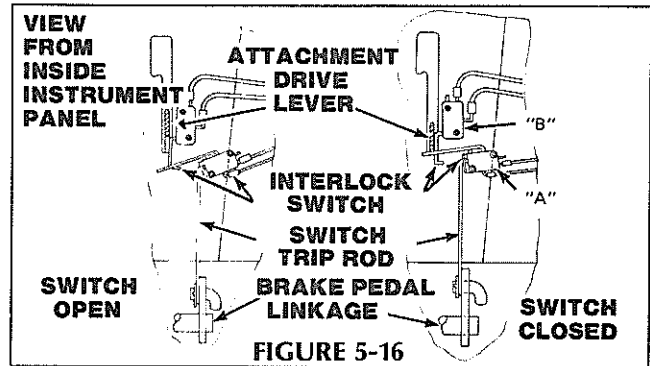


## FOOT BRAKE INTERLOCK SWITCH

Switch (A, Figure 5-16) is wired to be normally open or off when the switch lever is not depressed. When the attachment drive lever is in "Off" position and the "Parking Brake" is set, the switch lever is depressed closing or turning on the switches.

To check adjustment of the interlock switch on the foot brake proceed as follows:

1. Depress the foot brake. When rod (F, Figure 5-17) is 1 to 1-1/4 inches (2.5 to 3.2 cm) from the top of frame rail at (A, Figure 5-17), pin (A, Figure 5-18, should just be in slot (B, of lever C).
2. To adjust loosen hex nut (B, Figure 5-17). Remove pin (C) and turn clevis (D) either clockwise or counterclockwise on rod (E) to obtain proper adjustment.
3. When adjustment is achieved replace pin (C) and lock with cotter pin. Lock clevis (D) with hex nut, (B) Figure 5-17.



## SEAT INTERLOCK SWITCH

### NOTE

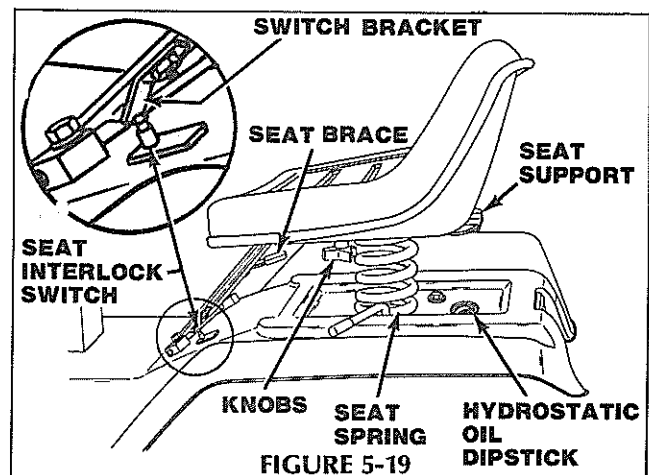
The seat interlock switch and attachment drive switch "B" are not functional on Model 2288.

A second switch is on the attachment drive lever. Switch (B, Figure 5-16) is wired to be normally open or off. This switch works in conjunction with the seat switch, see Figure 5-19.

The seat switch is activated when the back edge of seat support is depressed 5/8 in. (1.6 cm). If not, adjust switch bracket to correct location.

In order for this unit to start the attachment drive lever (B, Figure 5-16) must be down or off and the seat switch must be depressed by sitting on the seat.

If there is a need to start the unit from off the seat, just tip the seat up and lift interlock button up.



**TROUBLE SHOOTING GUIDE**

<b>PROBLEM</b>	<b>PROBABLE CAUSE</b>	<b>REMEDY</b>
Hydraulic lift inoperative	<ol style="list-style-type: none"><li>1. No charge pressure</li><li>2. System low on oil</li><li>3. Implement relief valve stuck open (Sundstrand)</li><li>4. Weak implement relief spring (Sundstrand)</li><li>5. Oil line leaking</li><li>6. Defective lift valve</li><li>7. Defective lift cylinder</li></ol>	<ol style="list-style-type: none"><li>1. Install gage and check pressure</li><li>2. Check level and refill</li><li>3. Check valve, clean or replace if necessary</li><li>4. Replace spring</li><li>5. Replace line</li><li>6. Repair or replace valve</li><li>7. Repair or replace cylinder</li></ol>
Load drops when control valve is in neutral position	<ol style="list-style-type: none"><li>1. Leaking hose from valve to cylinder</li><li>2. Oil leaking past lift cylinder "O" rings</li><li>3. Lift valve "O" rings leaking</li></ol>	<ol style="list-style-type: none"><li>1. Replace hose</li><li>2. Repair lift cylinder</li><li>3. Repair lift valve</li></ol>
Lift valve or lift cylinder leaking	<ol style="list-style-type: none"><li>1. Leaking "O" rings</li></ol>	<ol style="list-style-type: none"><li>1. Replace "O" rings</li></ol>

# HYDRAULIC SYSTEM (Continued)

## PRINCIPLE OF OPERATION

The hydraulic system uses the hydrostatic charge pump as its power source. Its oil supply is also that of the transaxle and hydrostatic transmission. The oil is pumped by the hydrostatic to the hydraulic control valve. When the controls are actuated the oil flow can be directed to the hydraulic cylinder or auxiliary hydraulic connections in either direction.

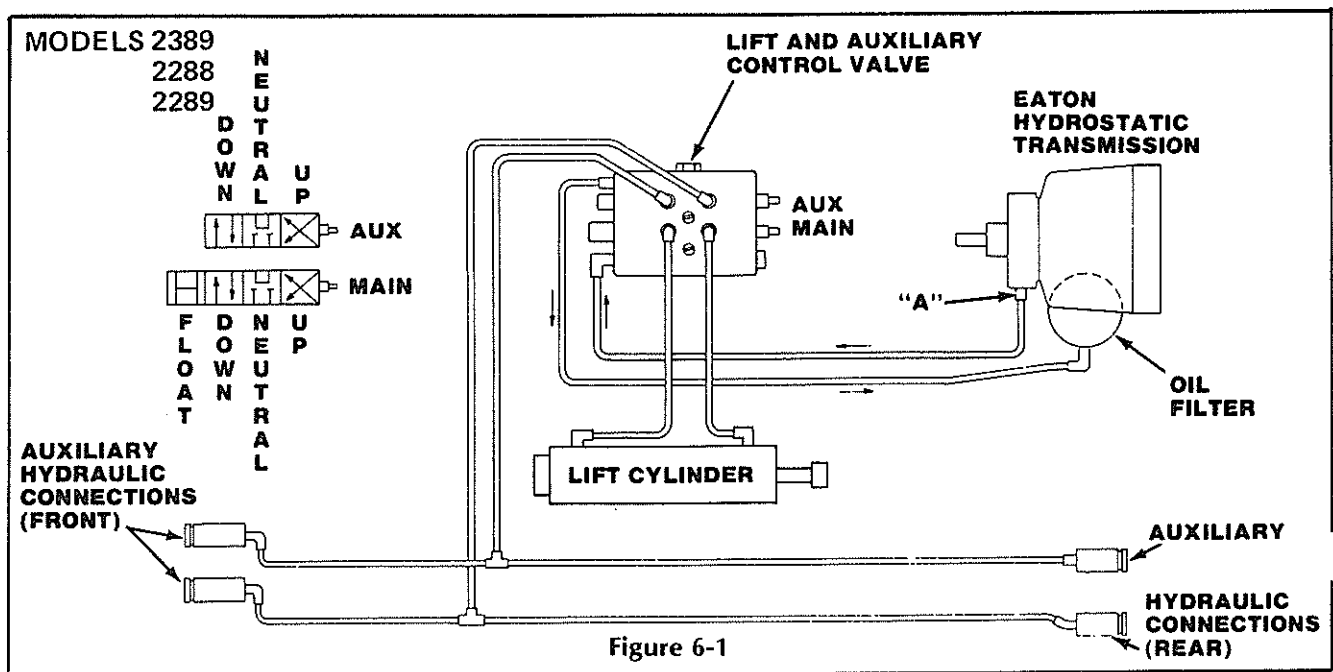
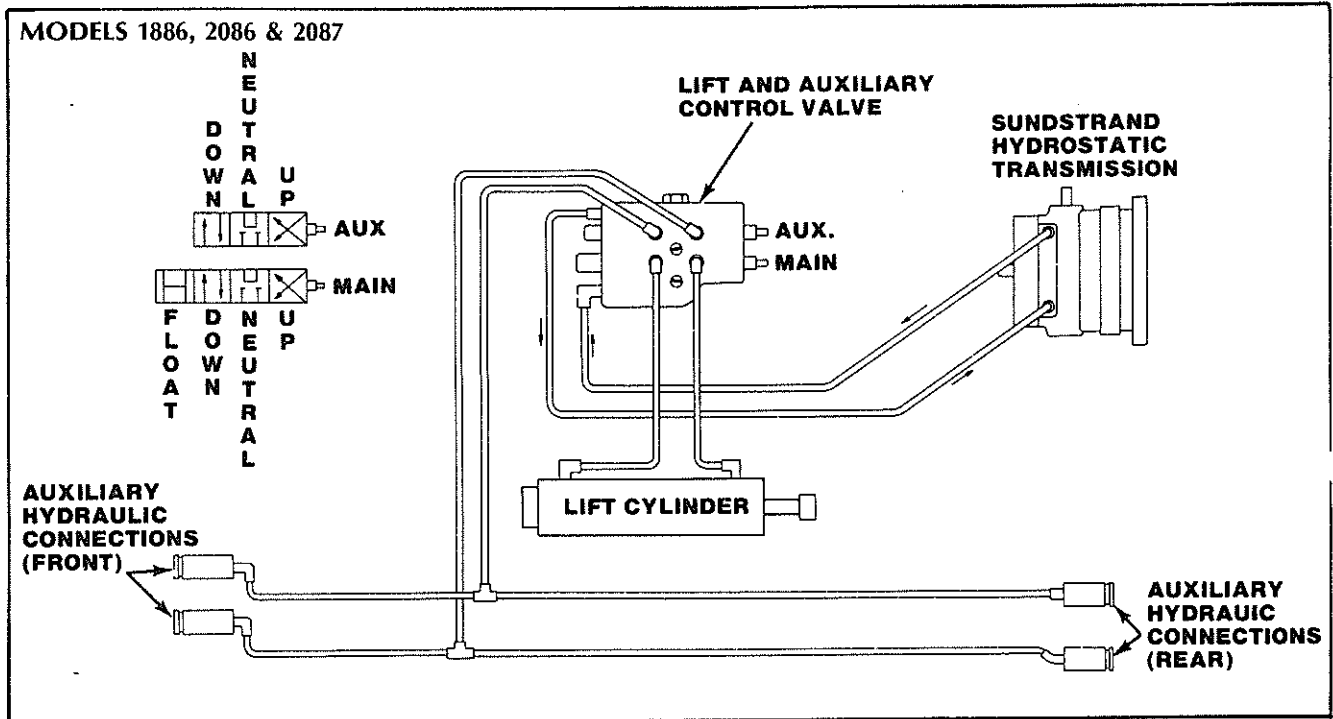
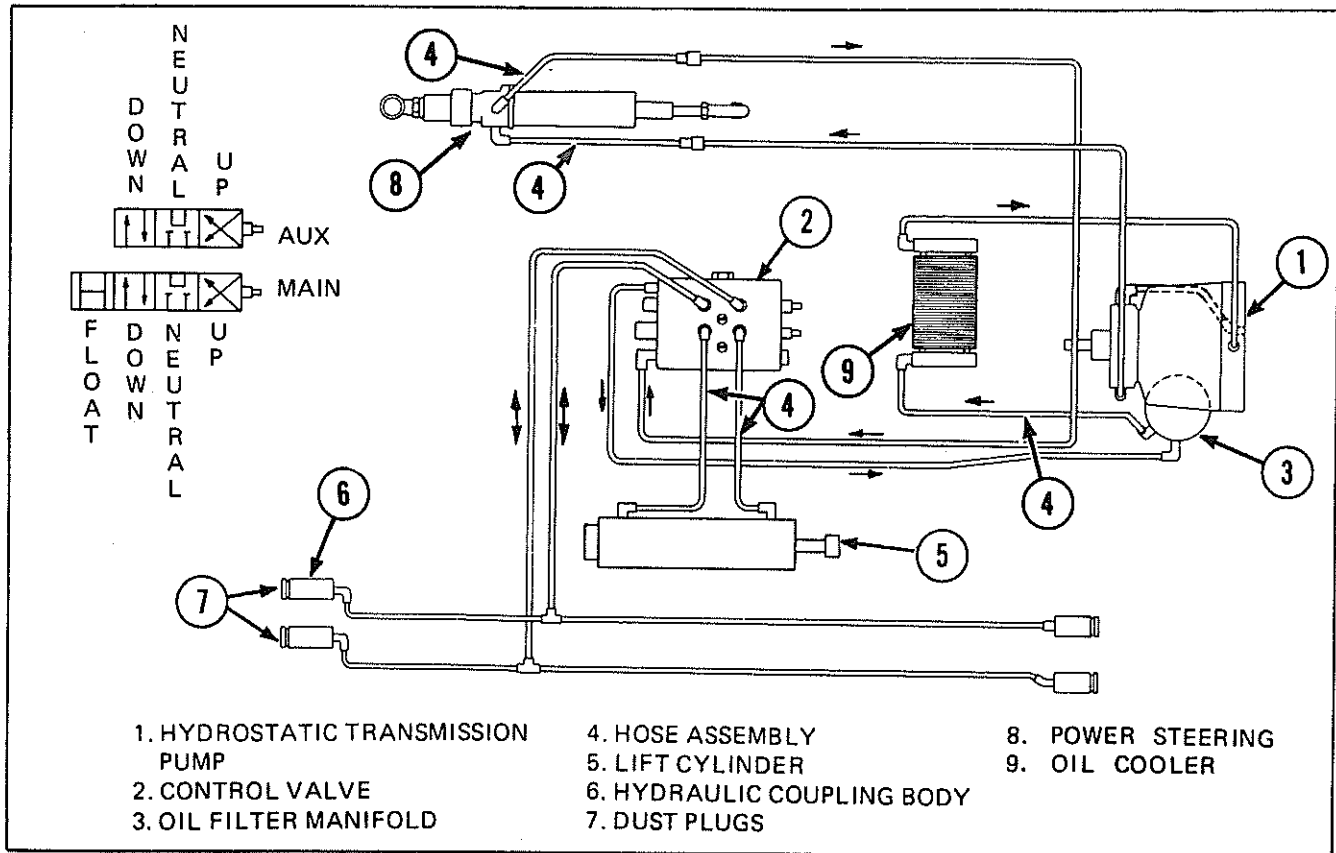


Figure 6-1

MODELS 2388s and 2389s S/N 0100101 and later



## TESTING HYDRAULIC SYSTEM (SUNDSTRAND)

The implement pressure can be checked using a pressure gauge which reads at least 1000 P.S.I. To check the implement pressure install the gauge into the hydrostatic Figure 6-2. Start the engine and run at full R.P.M. Move the hydraulic control valve lever to the lift position until the hydraulic cylinder reaches the end of its travel. The pressure reading should be no less than 500 P.S.I.

If the pressure reading is 500 to 800 P.S.I. and the hydraulic cylinder does not operate properly, check the following:

1. Load too heavy.
2. Restriction in line from hydro to hydraulic cylinder.
3. Malfunctioning cylinder or valve.

If the pressure reading is below 500 P.S.I. and the hydraulic cylinder does not operate, check the following:

1. System low on oil.
2. Plugged oil filter or pickup tube line.
3. Hydraulic oil line leaking.
4. Malfunctioning implement relief valve.
5. Hydraulic valve or cylinder leaking.

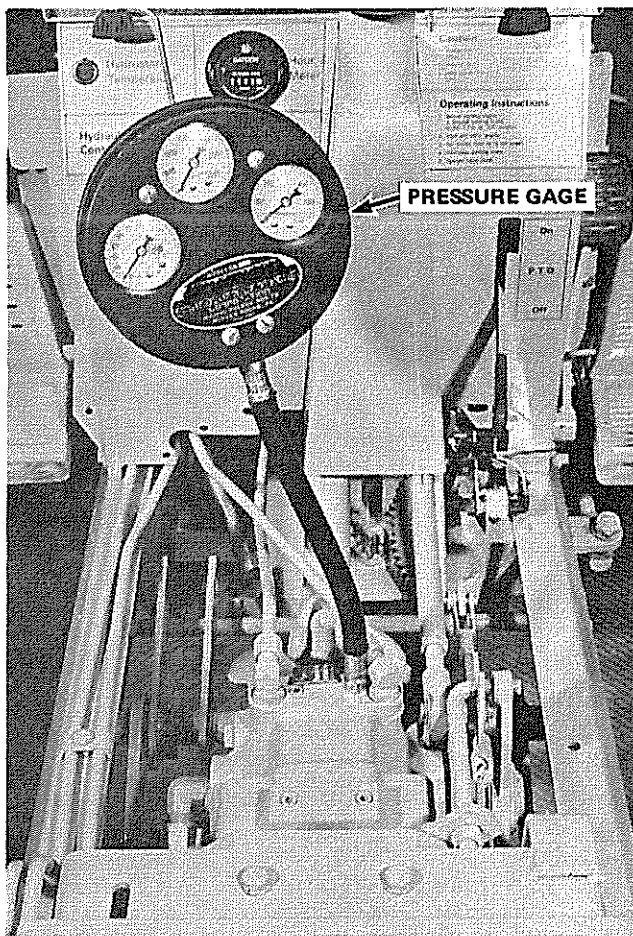


FIGURE 6-2

## CHECKING THE IMPLEMENT RELIEF VALVE

Remove the implement relief valve from the hydro Figure 6-3 and inspect for a damaged valve or distorted spring. The relief valve spring could be too weak or the valve not seating properly. If the valve or spring is pitted, wore uneven, or distorted, replace.

**NOTE: Shims are available to increase implement relief valve pressure. 1 Shim .012" in thickness will increase pressure approximately 50 psi.**

If no pressure reading is picked up on the gauge the charge pump relief valve could be stuck open or the charge pump inoperative. For further information on trouble shooting the hydrostatic, refer to the drive train, Group III.

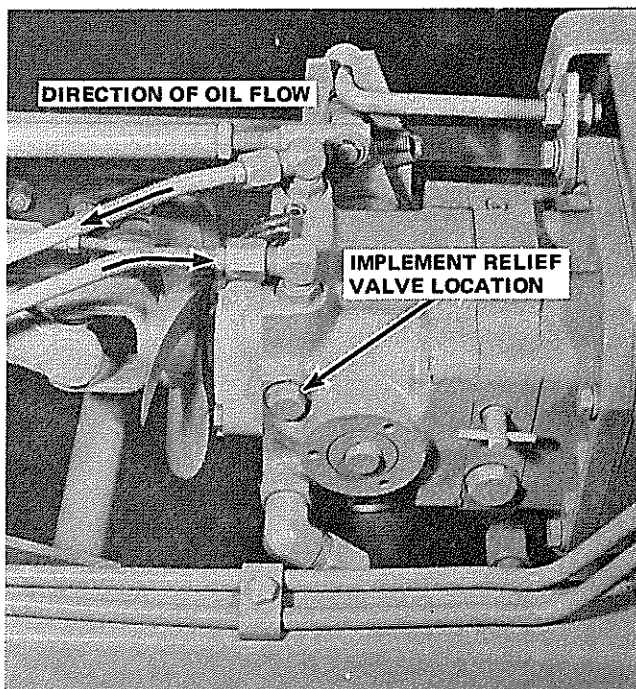


FIGURE 6-3

## TESTING HYDRAULIC SYSTEM

### EATON MODELS

The hydrostatic pressure can be checked using a pressure gauge which reads at least 1000 P.S.I. (6890 kPa),

To check the hydrostatic pressure install the gauge into a tee hydraulic fitting between hydrostatic port (A) Figure 6-4 and existing hydraulic tube. Start engine and run for 5-10 minutes. At full R.P.M. the pressure reading should be 140 PSI  $\pm$  50 (964 kPa).

The lift pressure can be checked using a pressure gauge which reads at least 1000 PSI (6890 kPa). To check

the lift pressure, install the gauge between the control valve and the lift cylinder.

Start the engine and run at full R.P.M. Move the hydraulic control valve lever to the lift position until the hydraulic cylinder reaches the end of its travel. The pressure reading should be no less than 450 PSI (3100 kPa).

If the pressure reading is 450 to 550 PSI (3100 - 3790 kPa) and the hydraulic cylinder does not operate properly, check the following:

1. Load too heavy.
2. Restriction in line from hydro to hydraulic cylinder.
3. Malfunctioning cylinder or valve.

If the pressure reading is below 450 to 500 PSI (3100 - 3790 kPa) and the hydraulic cylinder does not operate, check the following:

1. System low on oil.
2. Plugged oil filter or pickup tube line.
3. Hydraulic oil line leaking.
4. Hydraulic valve or cylinder leaking.

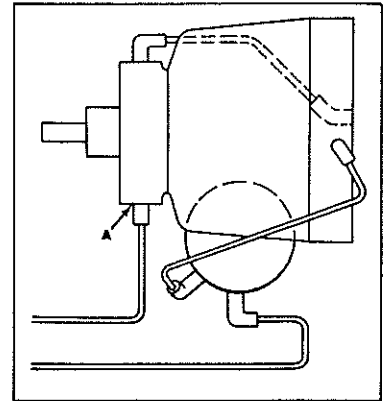


FIGURE 6-4

## HYDRAULIC POWER LIFT

### ALL MODELS REPAIRING THE HYDRAULIC CYLINDER FIGURE 6-3

To remove the piston rod assembly (A) from the cylinder, the internal snap ring (B) and the hose fitting, which goes through hole (C) in the cylinder tube, must be removed.

### PISTON ROD REMOVAL

1. Remove 90° elbow from cylinder tube.
2. Pull the piston rod out until it is fully extended.
3. Pinch snap ring together and pull on piston rod until the assembly slides out of the cylinder housing.

When the piston rod assembly is removed from the cylinder tube hex nut (D) can be loosened and the piston, cylinder head, and related "O" ring washers removed. All parts should be inspected and new "O" rings installed. **IMPORTANT:** Grease "O" rings to prevent damage during assembly.

### REPAIRING THE HYDRAULIC CONTROL VALVE (MODELS 1886, 2086 AND 2087)

The hydraulic control valve regulates and changes the direction of oil flow to the hydraulic cylinder when the control lever is actuated. "O" rings are used on the spools to provide a seal in the bore.

### DISASSEMBLY

When removing spools make sure the location is noted as they are matched to the bore in the valve body. If the spool or valve body, is damaged the complete valve assembly must be replaced.

Remove the filter caps. (When removing the float detent cap which is the longest one, be careful not to lose the spring loaded steel balls.) Remove the spools by pushing them out the filter cap end of the valve body.

Disassembly spools, removing springs and washers. The spool without detent uses the spacer.

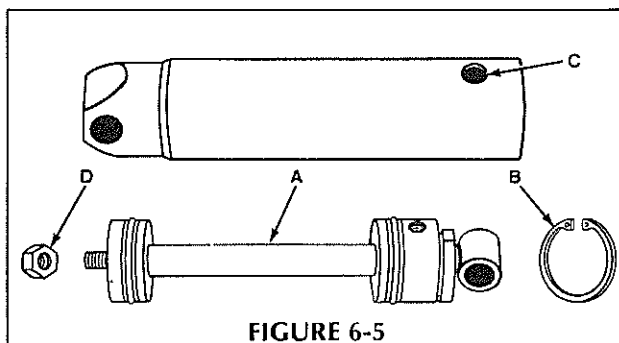


FIGURE 6-5

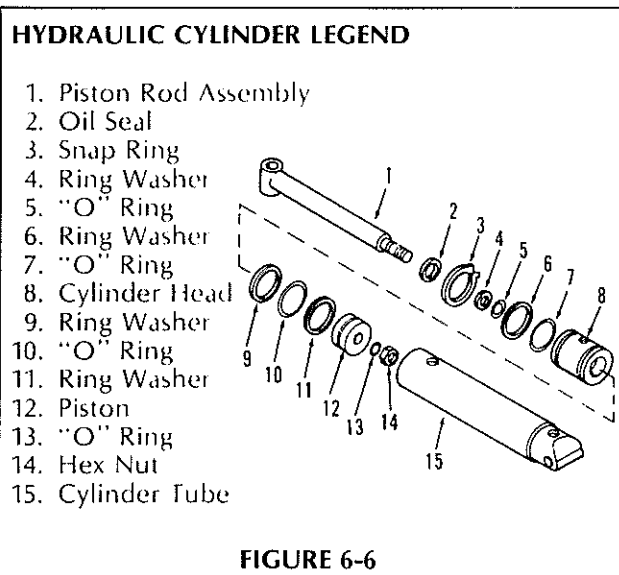


FIGURE 6-6

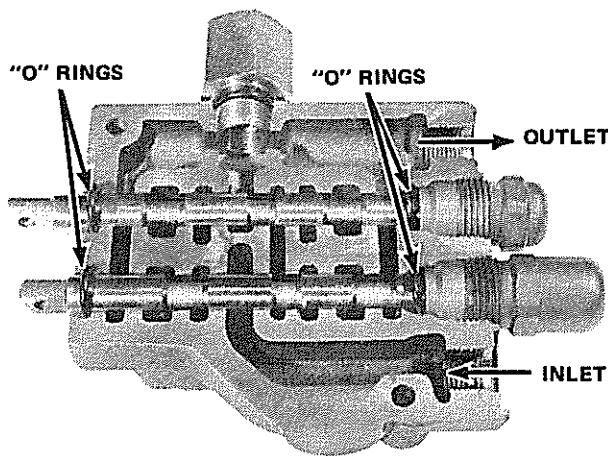


FIGURE 6-7

## MODELS 1886, 2086 & 2087 VALVE

Remove lift check plugs and the temperatures switch adapter fitting.

## MODELS 2288, 2289, 2388s, 2389s & 2389 VALVE

Remove relief valve plug, shims, spring poppet and seat.

## ALL MODELS

Remove "O" rings from spools, lower ends of spool bores, adaptor fitting and lift check plugs.

An "O" ring kit is available for repair of the lift valve. On 1886, 2086 & 2087 Models use Bolens No. 1723215. On models 2288, 2289, 2388s, 2389s & 2389 use Repair Kit 1738514 for Cessna Valves and Kit 1742238 for AICO valves. Before reassembling inspect all parts thoroughly.

Small burrs and scratches can be removed from the spools with fine emery cloth. Clean all parts before assembly.

## ASSEMBLY

1. Install new "O" rings in valve body, apply a coat of grease over the "O" rings.
2. Install new "O" rings on lift check plugs.
3. Install lift check plunger, spring and plug in valve body.
4. Install new "O" rings, springs, and washers on spools. Apply Loctite to screw threads and tighten securely into spool.
5. Install spools into valve body. Be careful not to damage "O" rings.
6. Install detent spring and balls. Hold in place and install filter cap.
7. Install other filter cap and check spools to make sure they are free in the bore.

## (MODELS 2288, 2289, 2388s, 2389s, & 2389 VALVE ONLY)

8. Install relief valve seat, poppet spring, shims and plug, Fig. 6-8A.

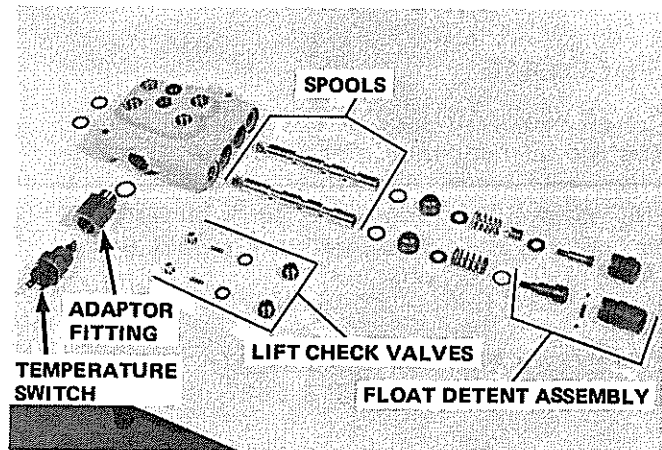


FIGURE 6-8

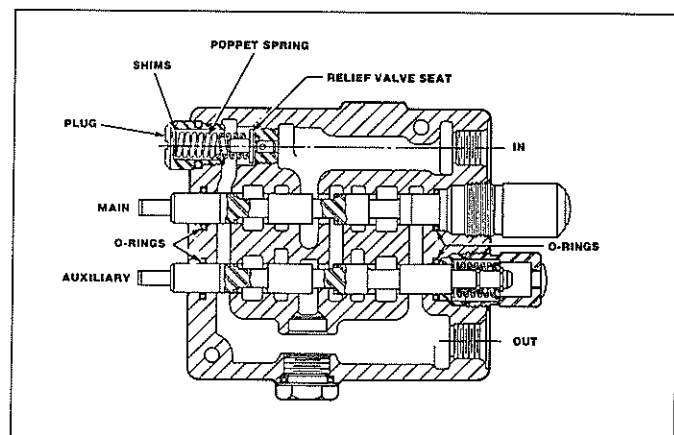


FIGURE 6-8A



## HYDRAULIC SYSTEM (Continued)

### OIL COOLER

The oil cooler kit should be installed if the hydrostatic oil temperature exceeds 250°, the temperature at which the hydrostatic oil temperature warning light comes on. In most cases the oil cooler is only needed when the unit is subjected to heavy drawbar loads.

**OIL COOLER (Model 18087-NLA)**  
Fits Models 1886s, 2086, & 2087.

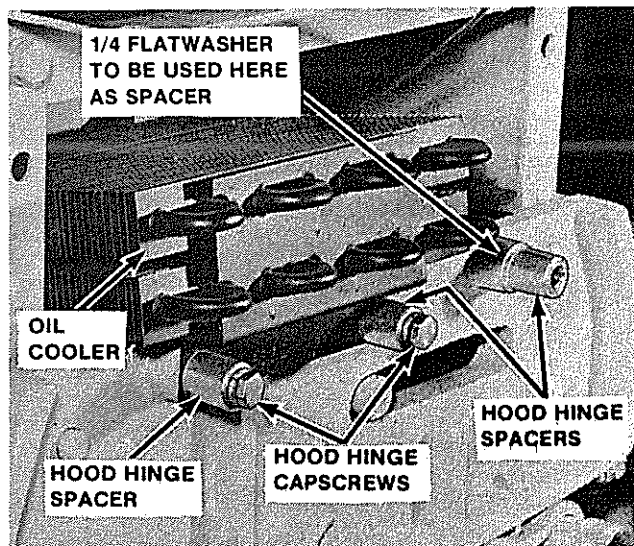


FIGURE 6-9

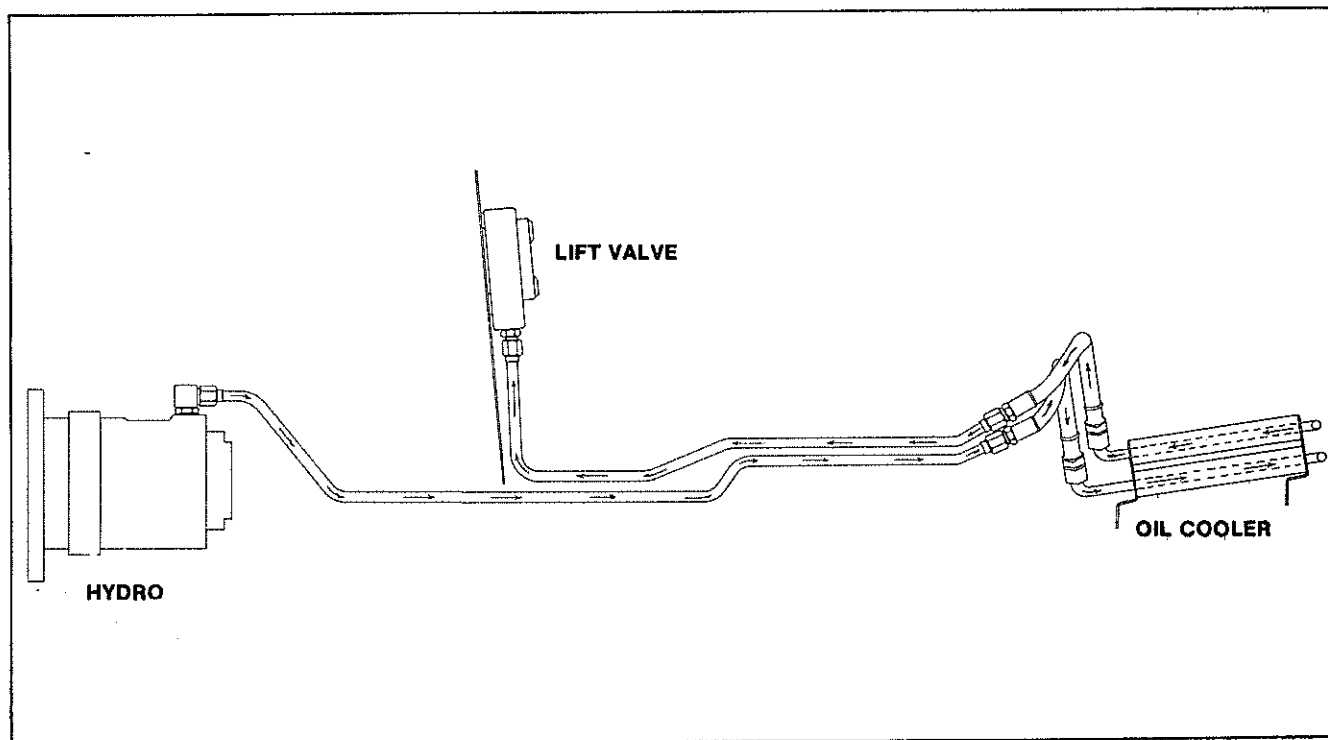


FIGURE 6-10

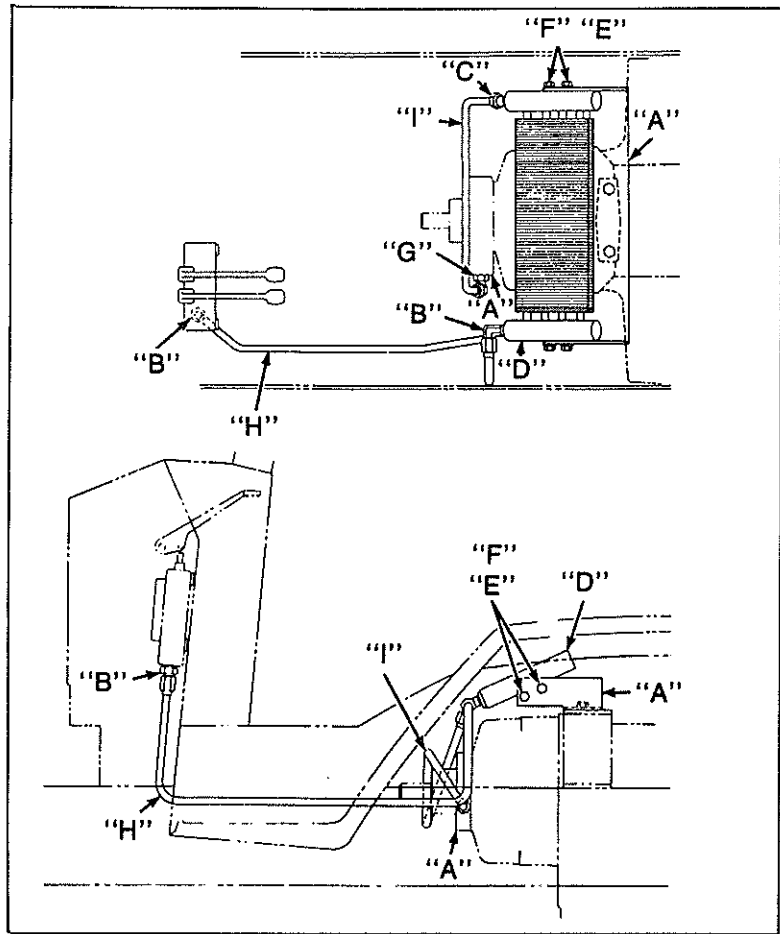
The oil cooler is located in the hydraulic system as shown in the flow diagram. All the hydrostatic oil flows through the oil cooler before going to the control valve.

**OIL COOLER (Model 18111  
S/N 0100101 - 0199999)**

**Fits Models 2289, 2389 & 2389s**

This kit consists of the following parts:

- (A) 1737716 Support Assy ..... 1
- (B) 1185739 Elbow 90° ..... 1
- (C) 1185903 Elbow 45° ..... 1
- (D) 1735815 Oil Cooler ..... 1
- (E) 1186308 Flange Screw,  
1/4-20 x 1/2 ..... 4
- (F) 1186389 Flange Nut, 1/4-20 .4
- (G) 1185737 Elbow 90° ..... 1
- (H) 1738862 Tube Assy ..... 1
- (I) 1738861 Tube Assy ..... 1



**FIGURE 6-11**

**OIL COOLER (Model 18111  
S/N 0200101 and later)**

**Fits Models 2289 & 2389  
Standard on 2389s**

This kit consists of the following parts:

- (D) 1737716 Support Assy ..... 1
- (E) 1185739 90° Elbow ..... 1
- (F) 1721989 Connector ..... 1
- (G) 1735815 Oil Cooler ..... 1
- (H) 1186308 Flange Screw, 1/4-20  
x 1/2 ..... 4
- (I) 1186389 Flange Nut, 1/4-20 .4
- (J) 1738876 Tube Assy ..... 1
- (K) 1738877 Tube Assy ..... 1

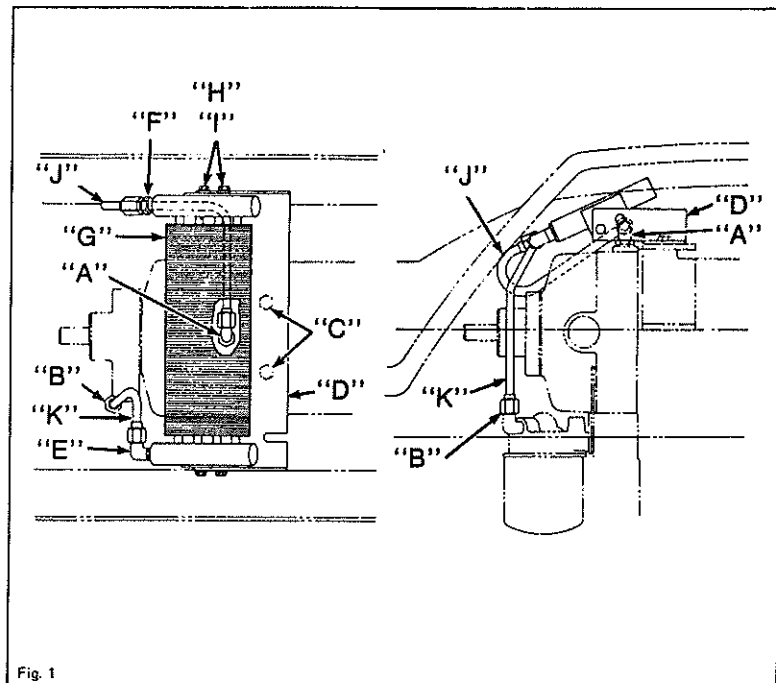


Fig. 1

**FIGURE 6-12**

# HYDRAULIC SYSTEM (Continued)

## POWER STEERING (Standard on some models)

The power steering kit is an option available to customers who prefer the reduced steering effort. In most cases the power steering kit is used with heavy front mounted attachments such as a front end loader, or snow throwers.

### Model 18088 Installation

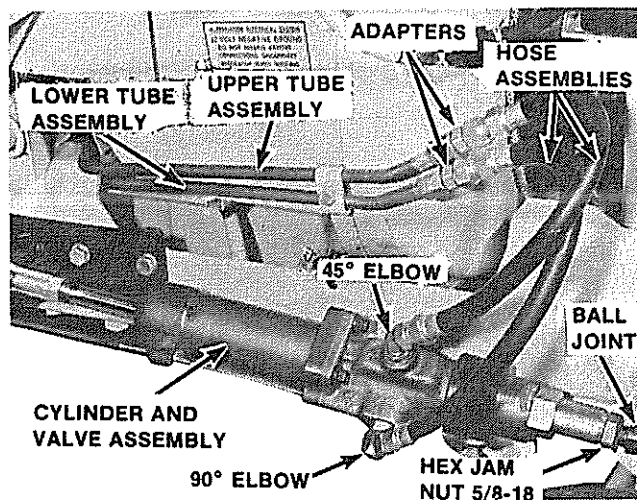


FIGURE 6-13

The oil pressure needed to operate the power steering cylinder is obtained from the Hydrostatic charge pump. The oil flows to the power steering control section as shown in the flow diagram. All the hydrostatic oil flows through the power steering unit before going to the control valve.

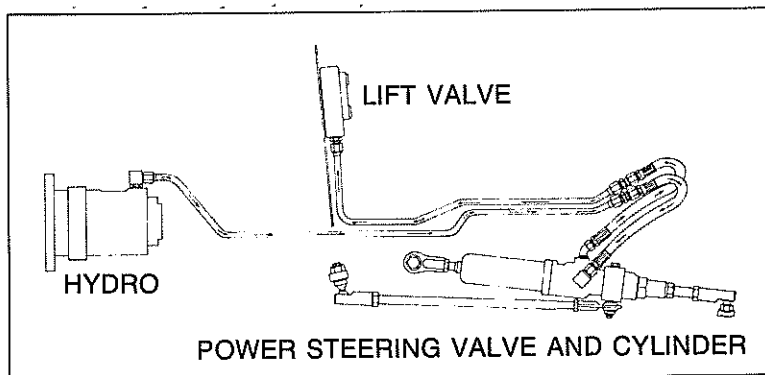


FIGURE 6-14

When the power steering and oil cooler is installed on the same unit all the hydrostatic oil flows to the power steering, then to the oil cooler before going to the control valve. It is important that the complete system is free of leaks to assure proper operation of the hydraulic system.

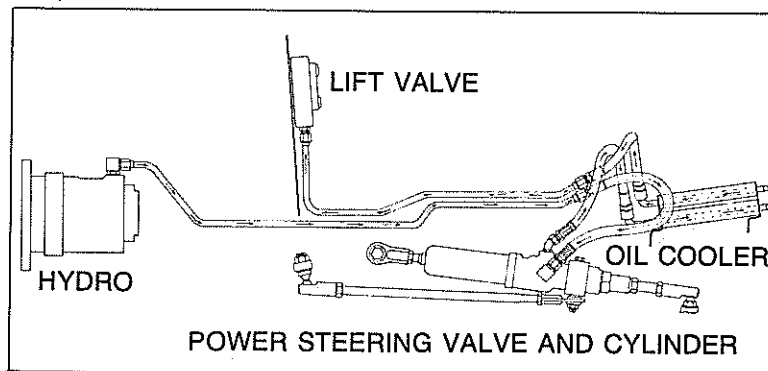


FIGURE 6-15

Models 18112 & 18114

## INSTALLATION

The oil pressure need to operate the power steering cylinder is obtained from the Hydrostatic charge pump. The oil flows to the power steering control section as shown in the flow diagram. All the hydrostatic oil flows through the power steering unit before going to the control valve.

## ADJUSTMENT OF STEERING UNIT

The cylinder should be adjusted so the piston rod extends  $2\text{-}1/4''$  (5.7 cm) when the front wheels are parallel to the tractor. Below dimensions apply to all power steering kits.

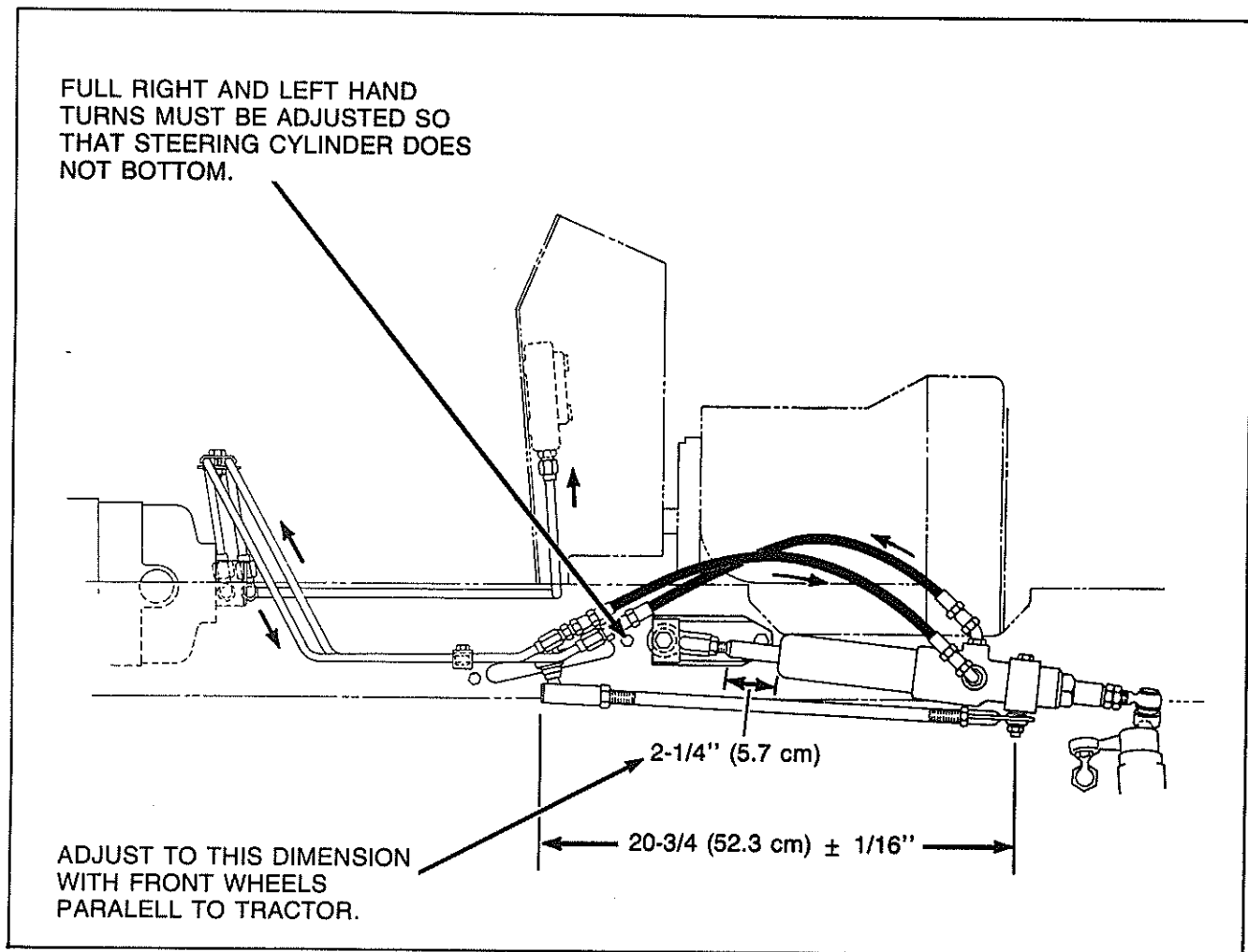


FIGURE 6-16

## HYDRAULIC SYSTEM (Continued)

### PRINCIPLE OF OPERATION

The power steering unit can be broken down into two principal assemblies: The control section and the cylinder section. The control section directs the oil to either the front or back side of the cylinder when the steering linkage is moved. The cylinder then pushes or pulls on the drag link to help reduce the steering effort.

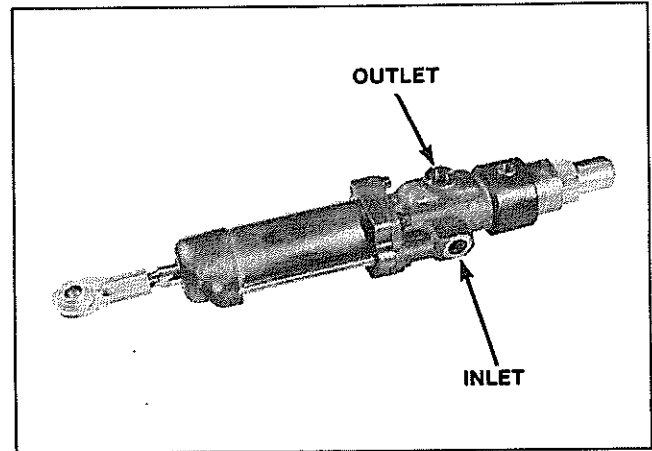


FIGURE 6-17

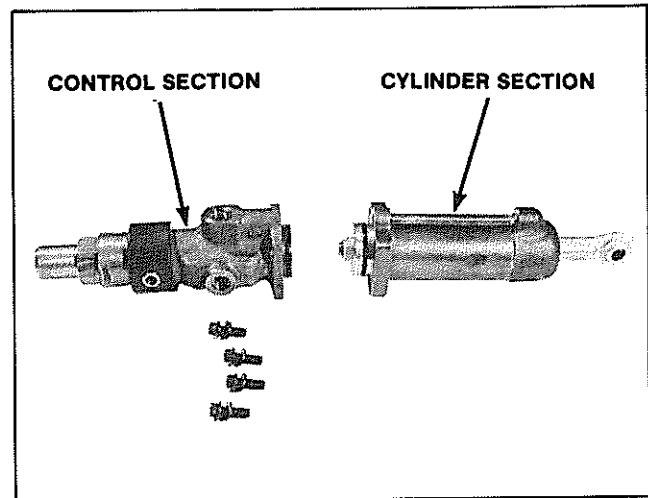
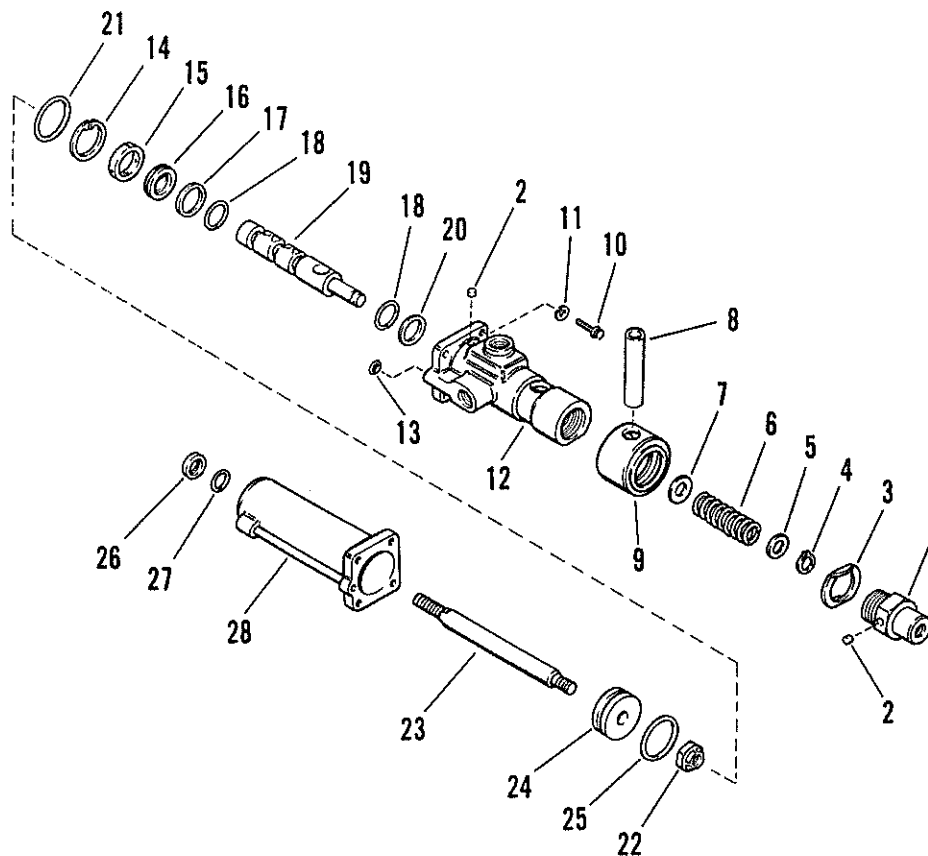


FIGURE 6-18

## REPAIRING CYLINDER

The cylinder can be disassembled and repaired if necessary. An improperly operating power steering unit is usually caused by leaking "O" rings. If the unit is repaired all "O" rings should be replaced. Care must also be taken during re-assembly to prevent damage to the "O" rings. A light coat of grease on the "O" rings will help prevent damage.



Exploded view of power steering valve and cylinder.

### POWER STEERING ASSEMBLY

- |                             |                                      |                    |
|-----------------------------|--------------------------------------|--------------------|
| 1 Cap and Breather Assembly | 10 Capscrew, 12 pt.<br>5/16—18 x 7/8 | 19 Spool           |
| 2 Filter                    | 11 Lockwasher, 5/16                  | 20 Back-up Washer  |
| 3 Washer                    | 12 Valve Body                        | 21 "O" Ring        |
| 4 Retaining Ring            | 13 "O" Ring                          | 22 Locknut, 1/2—20 |
| 5 Washer                    | 14 Retaining Ring                    | 23 Piston Rod      |
| 6 Spring                    | 15 Spacer                            | 24 Piston          |
| 7 Washer                    | 16 Plug                              | 25 "O" Ring        |
| 8 Sleeve                    | 17 "O" Ring                          | 26 Seal            |
| 9 Rubber Seal               | 18 "O" Ring                          | 27 "O" Ring        |
|                             |                                      | 28 Barrel Assembly |

FIGURE 6-19

## TROUBLE SHOOTING GUIDE

PROBLEM	PROBABLE CAUSE	REMEDY
Hard starting or loss of power	<ol style="list-style-type: none"> <li>1. Loose or grounded high tension or breaker point leads</li> <li>2. Improper breaker point gap and timing</li> <li>3. Defective breaker points</li> <li>4. Faulty spark plug or improper gap</li> <li>5. Faulty condenser or coil</li> <li>6. Dirt or gum in fuel line</li> <li>7. Fuel pump faulty</li> <li>8. Dirt in carburetor</li> <li>9. Carburetor improperly adjusted</li> </ol>	<ol style="list-style-type: none"> <li>1. Check and repair leads</li> <li>2. Reset breaker points and timing</li> <li>3. Replace breaker points</li> <li>4. Adjust gap or replace spark plug</li> <li>5. Replace condenser or coil</li> <li>6. Check fuel lines and filters</li> <li>7. Replace fuel pump</li> <li>8. Clean carburetor</li> <li>9. Readjust carburetor</li> </ol>
Overheating	<ol style="list-style-type: none"> <li>1. Insufficient available cool air</li> <li>2. Dirty air intake screen, shroud or cooling fins</li> <li>3. Improper fuel</li> <li>4. Fuel mixture too lean</li> <li>5. Improper ignition timing</li> <li>6. Engine overloaded</li> <li>7. Tight tappet clearance</li> </ol>	<ol style="list-style-type: none"> <li>1. Make sure area in front of flywheel is open</li> <li>2. Clean intake screen, shroud and cooling fins</li> <li>3. Clean and refill tank with proper fuel</li> <li>4. Adjust carburetor</li> <li>5. Reset timing</li> <li>6. Lessen work load</li> <li>7. Adjust tappets</li> </ol>
Backfiring	<ol style="list-style-type: none"> <li>1. Fuel mixture too lean</li> <li>2. Improper timing</li> <li>3. Valve "sticking"</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust carburetor</li> <li>2. Reset timing</li> <li>3. Free up valve</li> </ol>
Skip at high speed	<ol style="list-style-type: none"> <li>1. Spark plug gap too wide</li> <li>2. Improper carburetor setting or lack of fuel</li> <li>3. Wrong type spark plug. Use recommended spark plug</li> <li>4. Improper timing</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust spark plug gap</li> <li>2. Refill tank and adjust carburetor</li> <li>3. Install correct spark plug</li> <li>4. Reset timing</li> </ol>

# ENGINE (Continued)

## TROUBLE SHOOTING GUIDE (Continued)

PROBLEM	PROBABLE CAUSE	REMEDY
Operating erratically	<ol style="list-style-type: none"><li>1. Clogged fuel line</li><li>2. Water in fuel</li><li>3. Faulty choke control</li><li>4. Improper fuel mixture</li><li>5. Loose ignition connections</li><li>6. Air leaks in manifold or carburetor connections</li><li>7. Vent in gas cap plugged</li><li>8. Fuel pump faulty</li></ol>	<ol style="list-style-type: none"><li>1. Clean fuel line</li><li>2. Clean fuel system</li><li>3. Replace choke control</li><li>4. Adjust carburetor</li><li>5. Clean and tighten ignition connections</li><li>6. Tighten manifold and carburetor</li><li>7. Clean gas cap vent</li><li>8. Replace fuel pump</li></ol>
Engine will not idle	<ol style="list-style-type: none"><li>1. Improper carburetor idling adjustment</li><li>2. Carburetor clogged</li><li>3. Spark plug gap set too close</li><li>4. Leaking carburetor or manifold gaskets</li></ol>	<ol style="list-style-type: none"><li>1. Adjust idle speed</li><li>2. Clean carburetor</li><li>3. Adjust spark plug gap</li><li>4. Replace gaskets</li></ol>



## ENGINE – KOHLER

The engine oil level must be maintained in the "safe" operating range at all times. Oil level must be between the "L" (low) and "F" (full) marks on the dipstick. Clean area around dipstick so dirt does not fall into crankcase when dipstick is removed. Check daily and add oil as necessary to maintain proper level – DO NOT OVERFILL. Oil level must not exceed the "F" mark. After completely draining oil, reinstall drain plug then remove oil filler cap and refill with 3 quarts (2.8 liter) of oil – check the oil level on the dipstick before adding more – then bring the level up in the safe range. If the oil filter has been changed, add one additional pint (half quart) (0.47 liters) of oil. Select oil weight and type according to the outside temperature. Refer to 1-7.

### OIL FILTER

The filter is mounted on the crankcase of the engine. These are "throw away" cartridge type filter elements. If the cartridge has been overtightened during installation, a strap wrench may have to be used to remove it but usually it can be removed by hand. Use the following procedure to replace:

1. Drain crankcase oil.
2. Place rags or a pan below the cartridge to catch spilled oil. Unscrew the cartridge counter-clockwise and discard.
3. Wipe up any spilled oil, then wipe the adapter clean.
4. Apply grease on oil filter gasket then turn new cartridge (with gasket in place) onto the adapter in clockwise direction – hand tighten only.
5. After replenishing oil and restarting engine, check area around cartridge for signs of oil leakage. Correct leakage if need be by turning cartridge tighter.

Failure to change oil filter elements at the recommended intervals can lead to serious damage to the

engine. An oil filter does a very effective job; however, it must be replaced each 100 hours of operation (every other oil change) under normal conditions or more often if the engine is subject to extremely dirty conditions.

### NOTE

Use only the genuine Kohler oil filter cartridge for replacement.

### AIR SCREEN

Clean flywheel air screen frequently. A dirty air screen and/or engine will cause the engine to overheat and damage the engine.

To clean the flywheel air screen, remove the rubber and steel panels around screen. Replace the panels after the screen has been changed. These panels must remain in place for proper cooling of engine.

### SPARK PLUGS

Every 100 hours remove plugs, check condition and reset at .025 inch (63 mm) or replace plugs if needed. Good operating conditions are indicated if plugs have light coating of gray or tan deposit. A dead white, blistered coating could indicate overheating. A black (carbon) coating may indicate an "over-rich" fuel mixture caused by clogged air cleaner or improper carburetor adjustment. Do not service plugs in poor condition – best results are obtained with new plugs.

### NOTE

Cleaning of spark plugs in cleaning machines that use abrasive grit is not recommended. Spark plugs should be cleaned by scraping or wire brushing and washing with a commercial solvent.

### BREAKER POINTS

Operation is greatly affected by breaker point conditions and adjustment of point gap. If points are burned or badly oxidized, little or no current will pass and as a result the engine may not operate at all, or if

it does run, it is likely to miss particularly at full throttle. This service should be performed by a Authorized Kohler Dealer.

### TIMING

Timing should be performed only by an Authorized Kohler Dealer.

### CYLINDER HEAD SERVICE

After 500 hours of operation have your authorized Kohler Dealer remove the carbon deposits from in the two cylinders.

### NOTE

Under certain operating conditions carbon may build up more rapidly. These build-ups are indicated by heavy deposits of carbon on the spark plug electrodes. When this condition exists 250 hours intervals are recommended.

### VALVE SERVICE

After each 500 operating hours (or sooner if a noisy valve is detached) have your authorized Kohler Dealer service adjust the valves.

### ENGINE REMOVAL

1. Disconnect battery – negative side first.
2. Remove bolt and set screw from drive shaft.
3. Disconnect head light wires, remove hood strap, and front mounting bolts. Remove the hood.
4. Shut off gas at the fuel tank. Disconnect the fuel line.
5. Remove the four bolts holding the platform and remove the gas tank and battery as an assembly.
6. Remove electrical wires, throttle and choke cable from engine.
7. Remove the four engine mounting bolts.
8. Remove PTO belts from engine pulley. (Tip engine forward if necessary).
9. Pull engine forward and up until driveshaft is free of crankshaft.
10. Lift engine out.

Warranty Repair of the Engine must be performed by an authorized Kohler Dealer.

# GROUP VII. ENGINE

## ENGINE REMOVAL AND REINSTALLATION MODEL 2289 & 2288

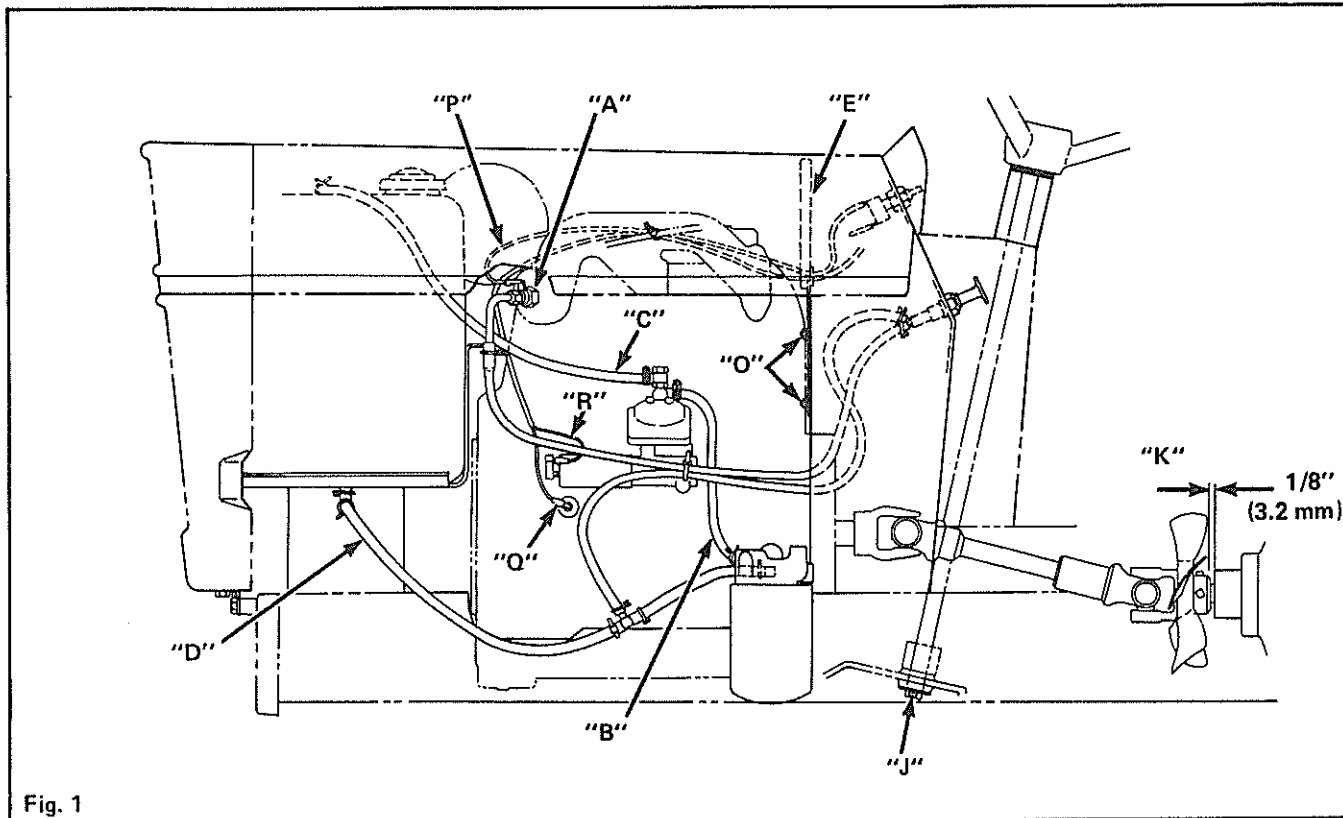


Fig. 1

### REMOVAL

The following parts must be disassembled before the engine can be removed.

1. Battery cables from battery. Negative cable first.
2. Head light harness at grille.
3. Tail light lead.
4. Seat interlock lead.
5. Hood and fender.
6. Battery and fuel tank.
7. Support for battery and fuel tank.
8. Wiring harness and all wires leading to engine.  
Wires from engine to alternator.
9. Primer hose (A) Fig. 1 at engine.
10. Fuel line (B) from engine to filter.  
Vent line (C) from tank to engine.  
Fuel line (D) from tank to filter.
11. Throttle control cable at engine.
12. Rear engine heat shield (E) Fig. 1 from instrument panel.
13. PTO belts from engine.
14. R.H. belt guide (F) Fig. 2 from axle casting.
15. Loosen L.H. wire form belt guide (G) Fig. 2 and pivot down.

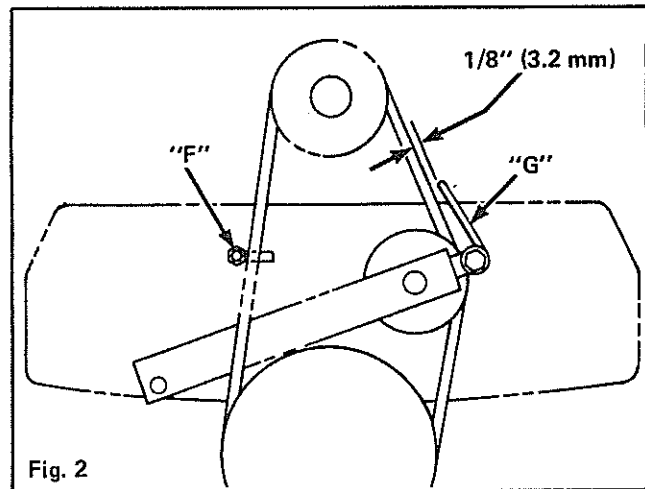


Fig. 2

16. The (4) engine cradle mounting screws.
17. Hydro control rod at hydro.
18. Brake rod (H) Fig. 3 from center shaft.
19. PTO rod (I) Fig. 3 inside instrument panel.

## ENGINE REMOVAL AND REINSTALLATION (CONTINUED)

20. Pin (J) Fig. 1 on bottom of steering shaft.  
Lift shaft out of casting.
21. Instrument panel from frame. (R.H. side is fastened through top of frame and L.H. side is secured with foot pedal mounting screws).
22. Drive shaft (K) Fig. 1 at hydro end.
23. Disconnect control valve from instrument panel by removing the (2) mounting screws through panel.

Instrument panel can not be slid to the rear and engine can be lifted from the frame.

## REINSTALLATION

1. Position engine with drive shaft into frame. Make sure drive shaft is over center cross shaft (L) Fig. 3 of frame.
2. Slide instrument panel back into original position. Make sure steering shaft is inserted in casting.
3. Secure control valve to panel using screws, nuts and lockwashers.
4. Slide rear drive shaft (K) Fig. 1 over front drive shaft and secure to hydro input shaft. End of drive shaft must be approximately 1/8" (3.2 mm) from end of hydro.
5. Secure instrument panel to frame.
6. Reinstall pin (J) Fig. 1 into steering shaft.
7. Reconnect hydro control rod to hydro arm, brake rod (H) Fig. 3 to center cross shaft and PTO rod (I) to PTO hand control.
8. Place round shock tube (M) Fig. 4 over R.H. front engine mount. Insert one flat washer (N) between cradle and rubber mount. Place flat washer on screw and insert (4) screws through cradle and mount. Secure using large flat washer and lock nut.
9. Reinstall PTO belts.
10. Position belt guide (F) Fig. 2 in place and secure using lockwasher and nut. Leg of guide must be behind belts.
11. With PTO lever in the ON position secure wire belt guide (G) to provide approximately 1/8" (3.2 mm) gap between guide and belts.

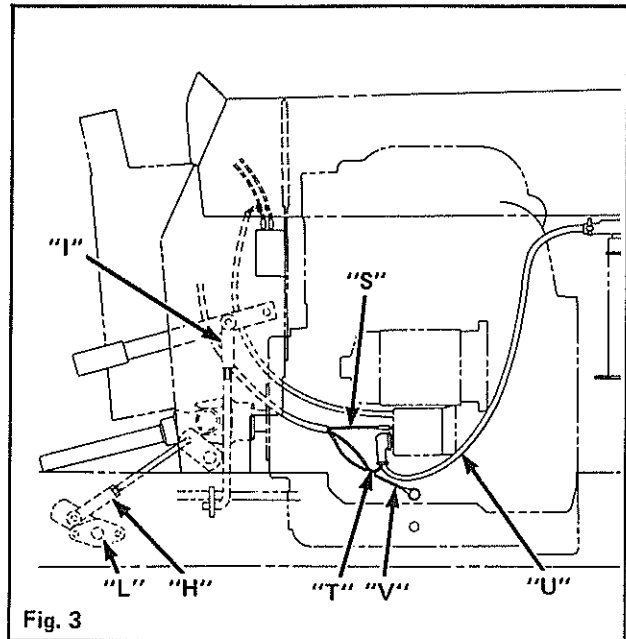


Fig. 3

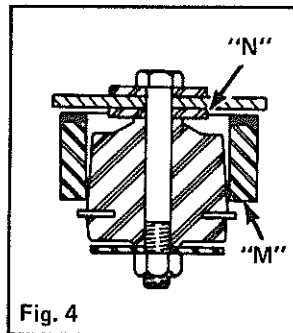


Fig. 4

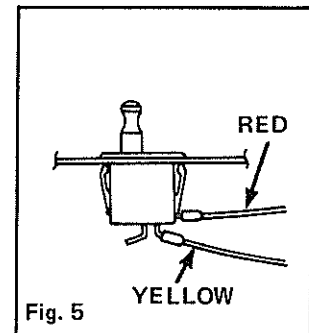


Fig. 5

12. Place star washers over studs (O) Fig. 1 on rear of instrument panel. Insert wiring harness and throttle control through rear engine heat shield. Secure shield on R.H. side using flange nuts. Secure muffler shield and engine shield on L.H. side using flange nuts.
13. Attach throttle cable to engine linkage and secure cable to engine bracket.
14. Install short engine fuel line (B) Fig. 1 to filter manifold.
15. Connect primer hose at engine at point (A).

## ENGINE REMOVAL AND REINSTALLATION (CONTINUED)

16. Connect wiring to engine and regulator as follows:
  - A. Single black wire (P) Fig. 1 from engine temp. switch, if equipped, to engine at manifold.
  - B. Gray wire from wiring harness to engine oil pressure switch (Q) L.H. side.
  - C. Yellow with red stripe from harness to fuel solenoid (R) L.H. side.
  - D. Red with yellow stripe to back of starter solenoid (S) Fig. 3 R.H. side.
  - E. Red wire (T) of harness and positive red wire of battery (U) to screw terminal on starter.
  - F. Secure black lead (V) of harness to R.H. engine cradle with (2) star washers and screw.
  - G. Two yellow and one read lead of harness to regulator as shown in Fig. 6.
  - H. Red and brown lead of harness to regulator as shown in Fig. 6.
17. Reinstall battery and fuel tank support.
18. Connect fuel tank to support. Connect fuel line (C) Fig. 1 from tank to L.H. side of engine. Route line under muffler support rod.
19. Route fuel line (D) Fig. 1 filter manifold over L.H. front engine mount and secure under fuel tank.
20. Reinstall rear fender.
21. Reconnect rear light and seat interlock switch. See Fig. 5 for seat switch connection.
22. Secure all wires and fuel lines away from muffler and moving parts with tie cables.
23. Reinstall hood and lanyard.
24. Connect front head light harness.
25. Reinstall battery to support.
26. Connect RED lead (V) Fig. 3 from starter to POSITIVE post.
27. Connect BLACK lead from engine to NEGATIVE post.

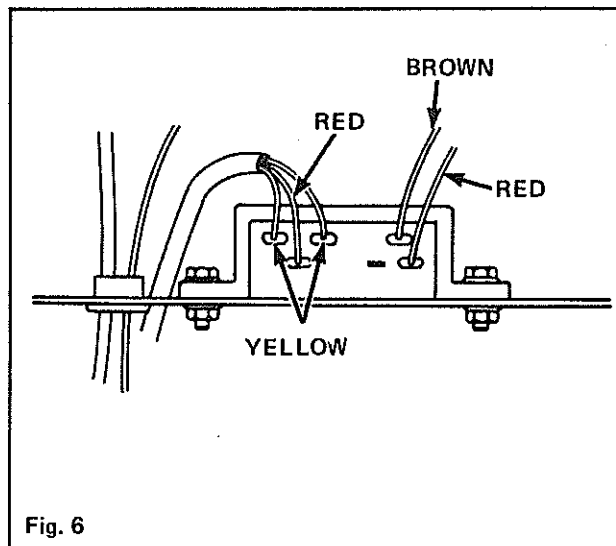


Fig. 6

## MOWERS

### MOWER LEVELING

Set parking brake, start tractor engine and raise mower with lift. Check level of mower, if it needs releveling, proceed as follows:

- Lower mower to the ground.
- Remove clevis pins of leveler rods (A), Figure 8-2.
- If mower was low in front, shorten the leveler rods. If mower was high in front, lengthen the leveler rods.
- Reinstall clevis pins and secure with spring cotters. Securely tighten lock nuts on leveler rod clevises.

Position stop nuts (B) Figure 8-1 on lift links flush with bottom of pivot stud (C). Turn up on the studs until desired height is obtained.

If mower needs leveling from side to side, adjust by turning nut (B) Figure 8-1 either up or down on lift studs (C).

### LUBRICATION

The unit has five grease fittings; one on each blade spindle located on the top side of the mower; one on each universal joint. Lubricate grease fittings every 50 hours of operation or once each year, whichever occurs first, with Bolens multi-purpose grease and Bolens grease gun. Oil all linkages, gauge wheels and anti-scalp roller at periodic intervals.

### NOTE

The gear case is filled at the factory with 11 oz. (.324 liter) of Bolens gear lube. Remove plug at rear of gear case. Check oil level - oil should be to the level of the plug opening - thereafter check at intervals of every 25 hours of operation to maintain plug level.

### GEAR CASE DISASSEMBLY

- Remove universal joint, R.H. belt cover and remove belt from the gear case.
- Disassemble the gear box from the mower support.

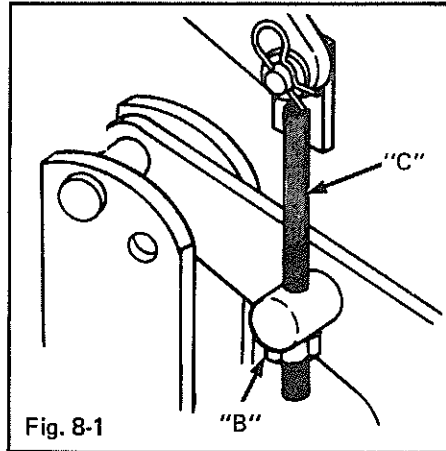


Fig. 8-1

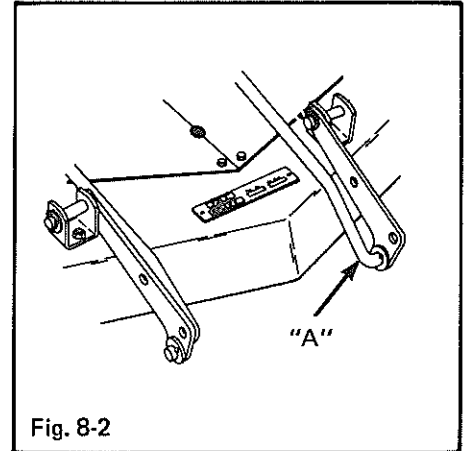


Fig. 8-2

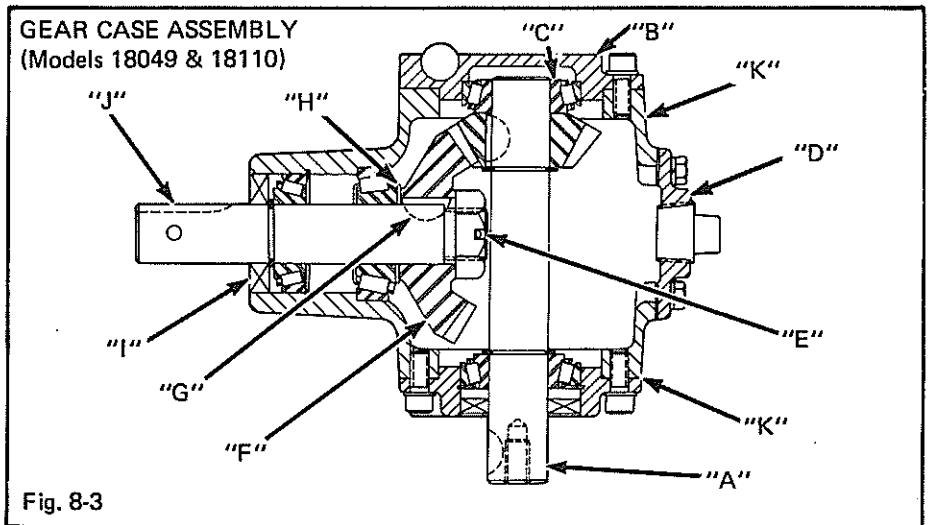


Fig. 8-3

- Remove the rear plug and drain the oil.
- Remove drive pulley and woodruff key from output shaft (A). Remove any burrs on end of shaft.
- Remove cover (B) and roller bearing (C).
- Slide output shaft assembly out of case.
- Remove cover (D).
- Through gear case opening remove cotter pin and nut (E).
- Slide gear (F) off of input shaft and remove woodruff key (G) and shims (H).
- Remove oil seal (I) and slide input

shaft (J) out.

- Replace all worn parts.

### GEAR CASE ASSEMBLY

- If required, remove and replace any bearings and oil seals.
- Insert input shaft (J) through bearings.
- Slide shims (H) on shaft and install woodruff key (G).
- Install gear (F) and secure using nut (E) and cotter pin.
- Install output shaft (A) assembly and bearing into case.
- Install cover (B).

MOWERS

7. Check backlash between gears.  
Shim, if required, to achieve a maximum of .006" (0.15 mm) backlash. Check backlash by holding shaft (A) and turning shaft (J). If gear moves hard, remove some shims (H). If loose, shim at points (H) and (J).

9. Secure cover (D).

10. Fill gear case with 11 oz. (0.32 liter) of EP90 gear lube.

11. Install drive pulley to output shaft.

12. Reinstall gear case to mower.

13. Install belt and belt cover.

SPINDLE REMOVAL AND DISASSEMBLY (Figure 8-4 and 8-5)

1. Remove belt covers.

2. Remove belt from spindle.

3. Remove top pulley (A).

4. Remove two bolts securing cutting blade.

5. Remove 4 bolts (B) holding spindle assembly and remove spindle assembly from mower deck.

6. Remove shaft assembly from spindle housing.

SPINDLE ASSEMBLY (Figure 8-4)

1. Place bearing (C) on shaft assembly.

2. Place spacer (D) on shaft assembly.

3. Place shaft assembly in spindle housing.

4. Place other bearing (E) on shaft assembly.

5. Place spindle housing assembly on mower deck and secure. Torque four (4) bolts (B) to 250 in. lbs. (28 Nm).

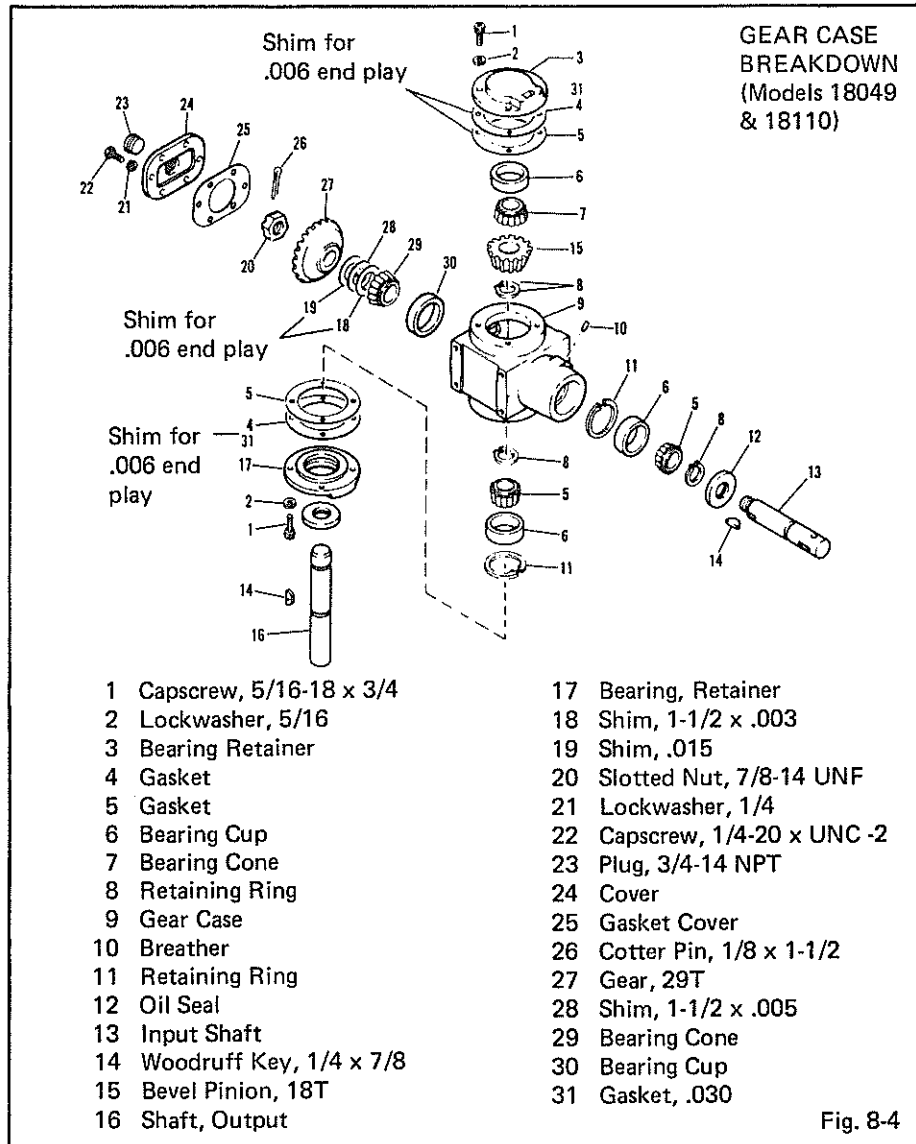
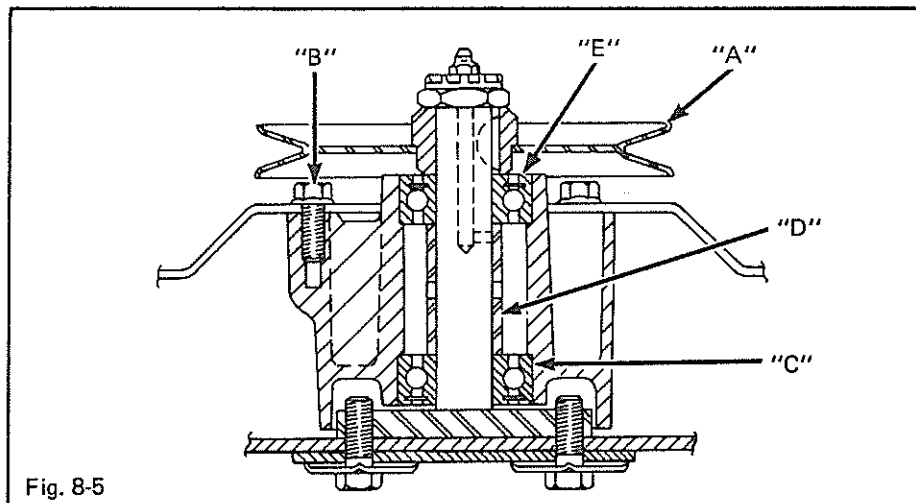


Fig. 8-4



## MOWERS

6. Assemble spindle sheave (A). Secure nut and torque to 90 ft. lbs. (122 Nm).

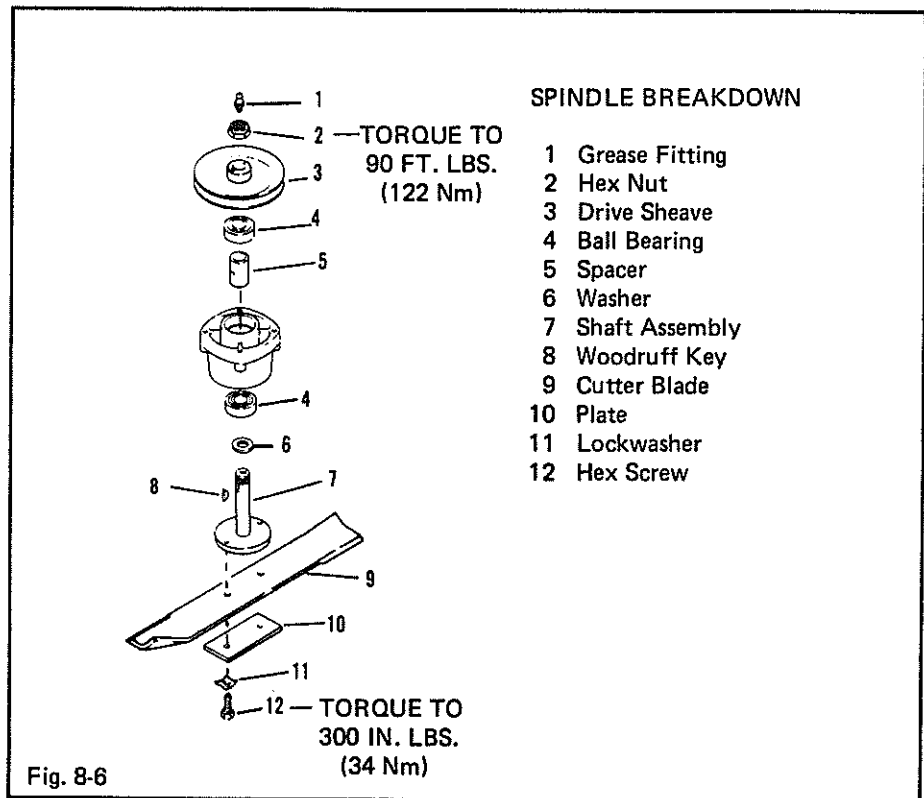
7. Assemble blade, spacer and bolts with lockwashers.

8. Torque bolts to 300 in. lbs. (34 Nm).

### LUBRICATION

There are three grease fittings on the mower; one on top of each blade spindle. Lubricate these grease fittings after every 100 hours of operation with FMC Bolens multi-purpose grease and grease gun.

Frequently lubricate the linkage, gauge rollers and other pivot points with a few drops of lubricating oil, especially on mower after washing out.



## SNOW THROWER

### LUBRICATION

The gear case is filled at the factory to filler hole level with SAE 90 gear lubricant. Check oil level before using the snow caster and every 6 hours of operation thereafter. Add lubricant as needed to maintain filler hole level.

### CHAIN TENSION

The chain is properly adjusted when it has approximately 1/8" (3 mm) of slack. A chain too loose is inclined to jump and too tight a chain will cause excessive wear of chain and sprockets.

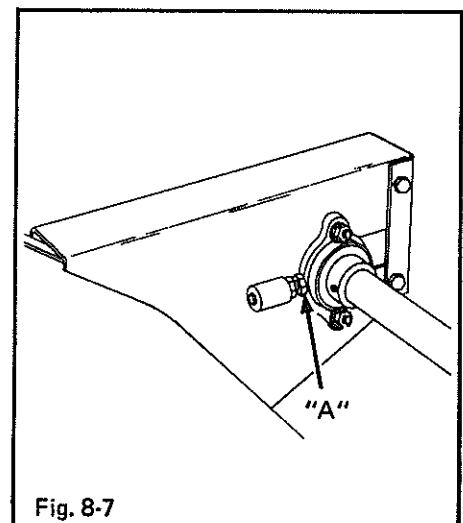
To adjust chain tension, first loosen the four hex head capscrews located beneath

the gear box assembly. Next, loosen the two carriage bolts which mount the self-aligning bearing to the rotor housing, as shown in Figure 8-7. Then loosen the hex nut and adjust the hex head adjusting screw (A) to position sprocket to the desired chain tension.

### IMPORTANT

Be sure to move the gear case and the sprocket an equal distance to maintain proper alignment of the chain on the sprocket.

Tighten the two carriage bolts which mount the bearing and the four cap screws under the gear box.



## SNOW THROWER

### CHAIN REMOVAL

1. Remove rear guard (A).
2. Relieve tension on chain by loosening screw (B).
3. Locate connector link in chain and disconnect.

### CHAIN INSTALLATION

1. Secure chain to sprockets with connector link.
2. Adjust screw (B) to supply tension to the chain.

### AUGER REMOVAL

1. Remove chain as described above.
2. Remove end bearings (C) from each end. A wheel puller may be required to remove bearings.

### AUGER REINSTALLATION

1. Coat shaft ends of auger with loctite Grade D.
2. Install new or old bearings to shaft and secure to housing.
3. Install chain.

### GEAR CASE REMOVAL

1. Remove cover (D), Figure 8-8.
2. Loosen hub (E) from gear case shaft by unscrewing set screws.
3. Remove universal joint.
4. Remove the (4) screws (F) under the housing and remove the gear case.

### GEAR CASE INSTALLATION

1. Position gear case in hub (E) and secure case to the housing using screws (F) removed earlier.
2. Secure hub (E) to shaft.
3. Assemble cover (D) to housing.

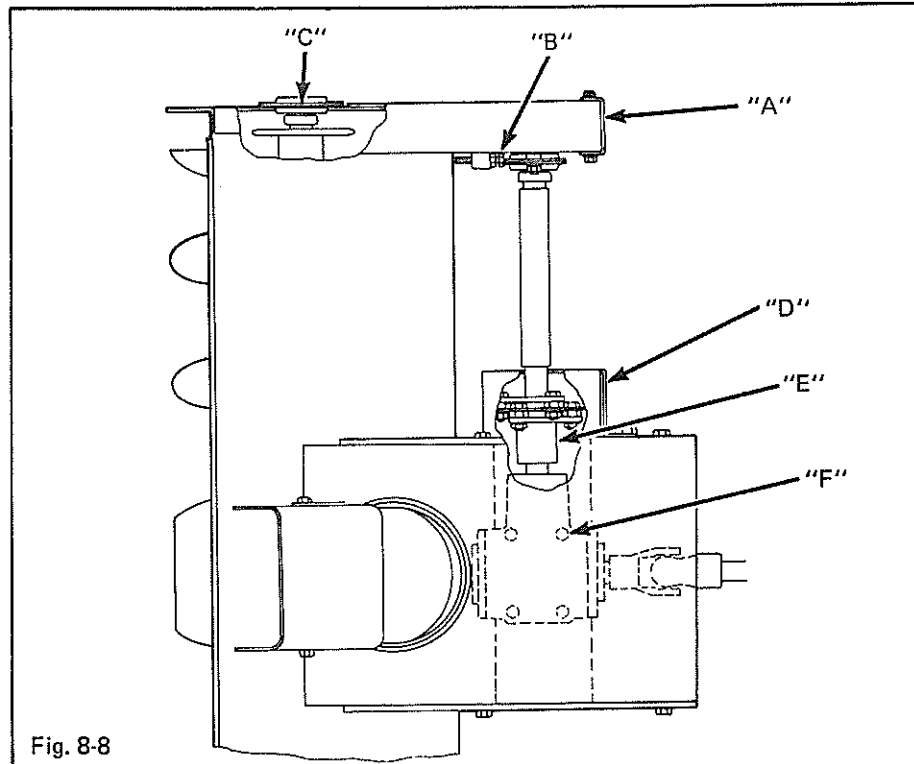


Fig. 8-8

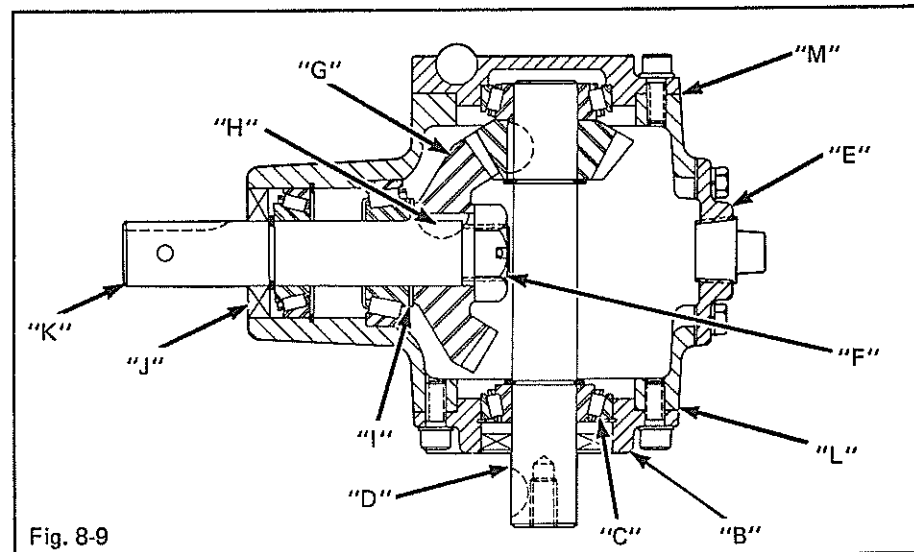


Fig. 8-9

4. Secure universal shaft to gear case shaft.

3. Slide output shaft (D) assembly out of case.

### GEAR CASE DISASSEMBLY

1. Remove the rear plug and drain the oil.
2. Remove cover (B) and roller bearing (C).

4. Remove cover (E).

5. Through gear case opening, remove cotter pin and nut (F).

6. Slide gear (G) off of input shaft and remove woodruff key (H) and shims (I).



## SNOW THROWER

7. Remove oil seal (J) and slide input shaft (K) out.

8. Replace all worn parts.

### GEAR CASE ASSEMBLY

1. If required, remove and replace any bearings and oil seals.

2. Insert input shaft (K) through bearings.

3. Slide shims (I) on shaft and install woodruff key (H).

4. Install gear (G) and secure using nut (F) and cotter pin.

5. Install output shaft (D) assembly and bearing into case.

6. Install cover (B).

7. Check end play of shafts. If required, add or remove shims at points (L) or (M). Check backlash between gears. If gears move hard, remove required shims from point (M) and add at point (L). If gears are loose, remove shims at point (L) and add at points (M). See parts list for shim numbers.

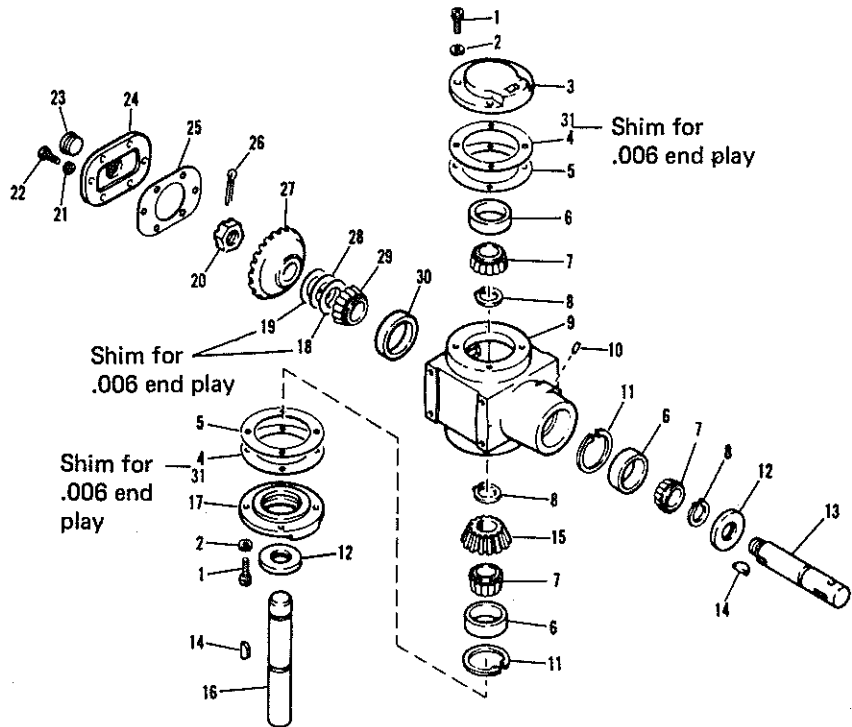
8. Install oil seal (J).

9. Secure cover (E).

10. Fill gear case with 11 oz. (0.32 liter) of EP90 gear lube.

11. Install gear case to housing.

### GEAR CASE BREAKDOWN (Model 18103)



- |                            |                             |
|----------------------------|-----------------------------|
| 1 Capscrew, 5/16-18 x 3/4  | 17 Bearing, Retainer        |
| 2 Lockwasher, 5/16         | 18 Shim, 1-1/2 x .003       |
| 3 Bearing Retainer         | 19 Shim, .015               |
| 4 Gasket                   | 20 Slotted Nut, 7/8-14 UNF  |
| 5 Gasket                   | 21 Lockwasher, 1/4          |
| 6 Bearing Cup              | 22 Capscrew, 1/4-20 x UNC 3 |
| 7 Bearing Cone             | 23 Plug, 3/4-14 NPT         |
| 8 Retaining Ring           | 24 Cover                    |
| 9 Gear Case                | 25 Gasket Cover             |
| 10 Breather                | 26 Cotter Pin, 1/8 x 1-1/2  |
| 11 Retaining Ring          | 27 Gear, 29T                |
| 12 Oil Seal                | 28 Shim, 1-1/2 x .005       |
| 13 Input Shaft             | 29 Bearing Cone             |
| 14 Woodruff Key, 1/4 x 7/8 | 30 Bearing Cup              |
| 15 Bevel Pinion, 18T       | 31 Gasket, .030             |
| 16 Shaft, Output           |                             |

Figure 8-10

# TILLERS

## GEAR CASE REMOVAL

1. Remove tiller from tractor.
2. Remove cover.
3. Remove R.H. and L.H. supports (A).
4. Remove depth shoe (B).
5. Remove tiller tines from gear case shafts by either loosening nuts (C) through hole (D) or by removing tine hubs (E) to loosen nuts.

## GEAR CASE REINSTALLATION

1. Reverse the above procedure.
2. Torque nuts (C) to 90 ft. lbs. (122 Nm).

## GEAR CASE DISASSEMBLY (Figure 8-12)

1. Remove cover side of case and wood-ruff key in tine shaft.
2. Remove screws and lock washers securing the case and cover together. Lift cover (A) off.
3. Remove chain connector link from chain.

4. Disassemble and remove any damaged parts.

End play should not exceed .003" (0.07 mm). If required, shim at point (E).

## GEAR CASE ASSEMBLY

1. See Figures 8-12 and 8-13 for assembly.
2. Before assembling oil seal (B) check end play of input shaft (C) and gear (D).

3. Check backlash of gears. If gears move hard, remove required shims at point (F) and add shims at point (E). If gears are loose, remove shims at point (E) and add shims at point (F). See parts list for shim numbers.

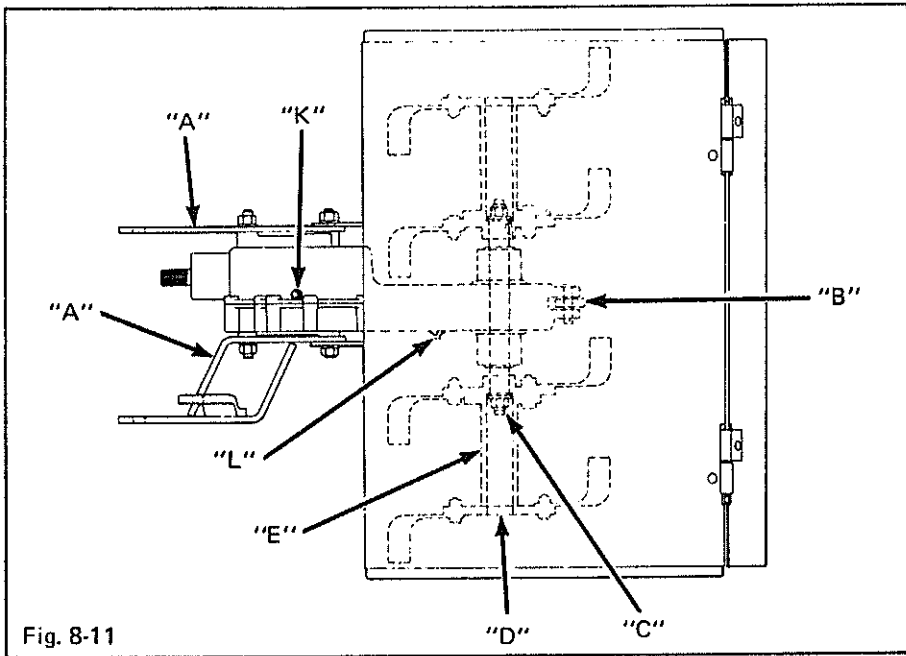


Fig. 8-11

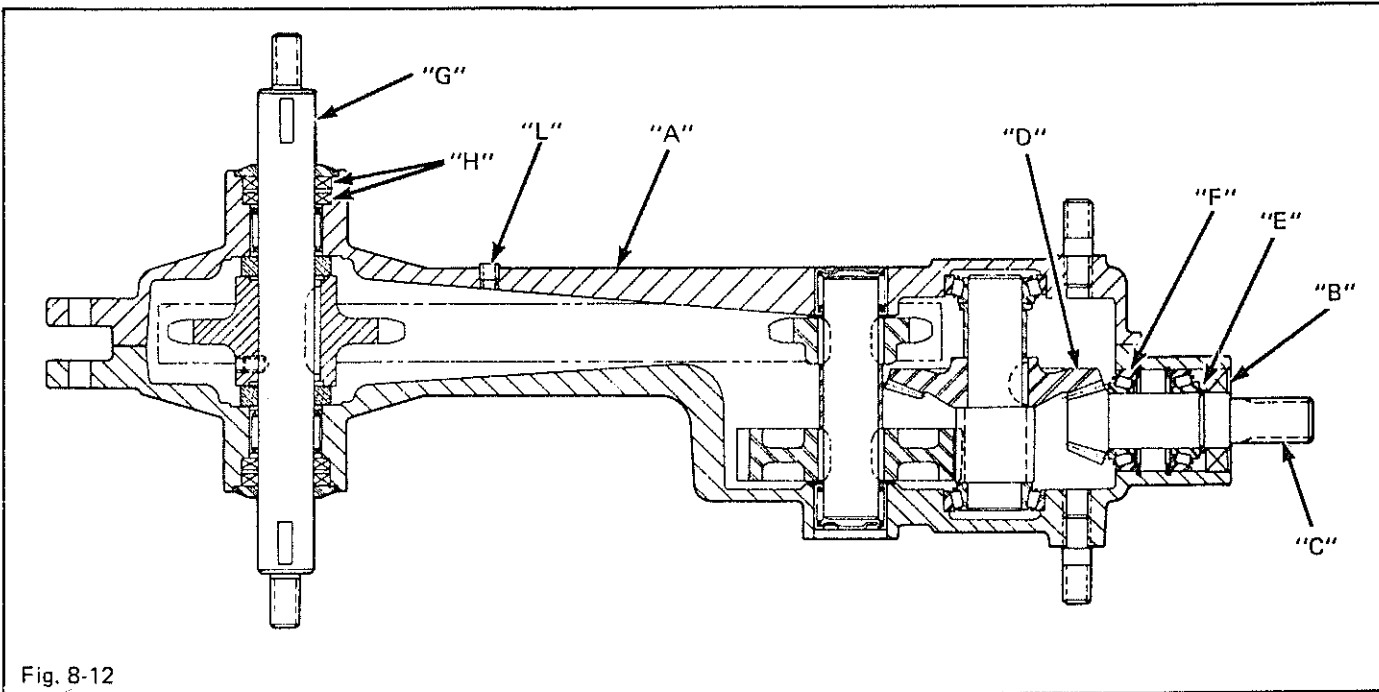


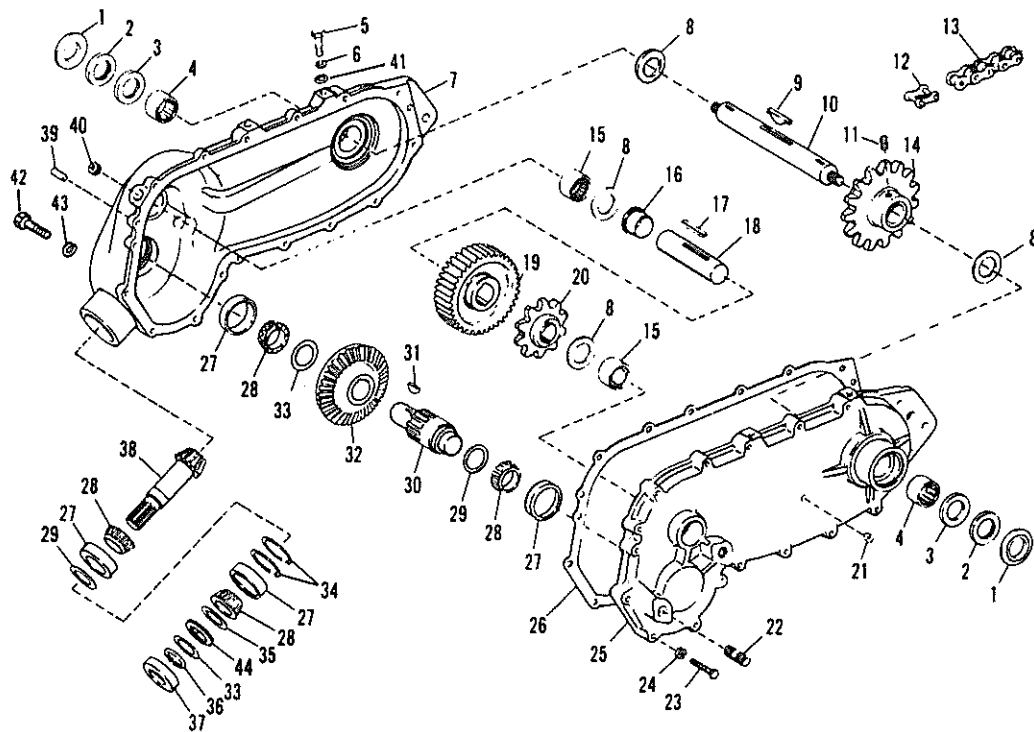
Fig. 8-12

## TILLERS

4. Assemble oil seal (B).

5. If tine shaft (G) is to be reassembled, pack grease between seals (H). Also, apply grease to exposed shaft (G).

6. With the gear case on a flat surface, fill case through either the top plug hole (K) Figure 8-11 or side hole (L) to hole (L) level with EP90 gear lube.



- |                               |                                       |                                   |
|-------------------------------|---------------------------------------|-----------------------------------|
| 1 Seal Washer                 | 17 Special Key, 5/16 x 1/4            | 32 Bevel Gear, 40 Tooth           |
| 2 Oil Seal                    | 18 Shaft                              | 33 Shim                           |
| 3 Oil Seal                    | 19 Gear, 39 Tooth                     | 34 Retaining Ring                 |
| 4 Needle Bearing              | 20 Sprocket, 10 Tooth                 | 35 Shim                           |
| 5 Capscrew                    | 21 Pipe Plug, 1/8                     | 36 Retaining Ring                 |
| 6 Lockwasher                  | 22 Stud, 5/8                          | 37 Oil Seal                       |
| 7 Tiller Case                 | 23 Hex Head Capscrew, 5/16-18 x 1-3/4 | 38 Pinion, 13 Tooth               |
| 8 Thrust Washer               | 24 Lockwasher, 5/16                   | 39 Drive Pin                      |
| 9 Hi-Pro Key, 5/16 x 5/16 x 2 | 25 Gear Case Cover                    | 40 Pipe Plug                      |
| 10 Tine Shaft                 | 26 Gasket                             | 41 Flat Washer, 1/2               |
| 11 Set Screw, 3/8-16 x 1/2    | 27 Bearing Cup                        | 42 Hex Head Cap Screw, 5/8-11 x 2 |
| 12 Roller Chain Connector     | 28 Bearing Cone                       | 43 Lockwasher, 5/8                |
| 13 Roller Chain 1 Inch Pitch  | 29 Shim                               | 44 Thrust Washer (5)              |
| 14 Sprocket - 15 Tooth        | 30 Pinion & Shaft                     | NI Gear Lube, EP90                |
| 15 Needle Bearing             | 31 Woodruff Key                       |                                   |
| 16 Spacer                     |                                       |                                   |