DriveMaster®

Fan Drive Maintenance Training Manual

Engine **Cooling Solutions** Worldwide®

HORTON®

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INTRODUCTION

General Information

Introduction
This student manual for the technical course, DriveMaster Heavy Duty fan drive Maintenance, is designed to train heavy duty diesel technicians how to perform preventive and corrective maintenance on Horton heavy duty DriveMaster fan drives.

The guide, video and CD may be used in the classroom with an instructor or in a self-study mode. After completion of this course, take the Final Test at the end of this student manual. Mail your Final Test to the following address to receive a Certified Horton Technician toolbox sticker and a Horton Certificate of Achievement:

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Website: www.hortonww.com

Horton uses the following special notices to give warning of possible safety related problems which could cause serious injury and provide information to help prevent damage to equipment.

⚠ DANGER

Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING

Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION

Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTE

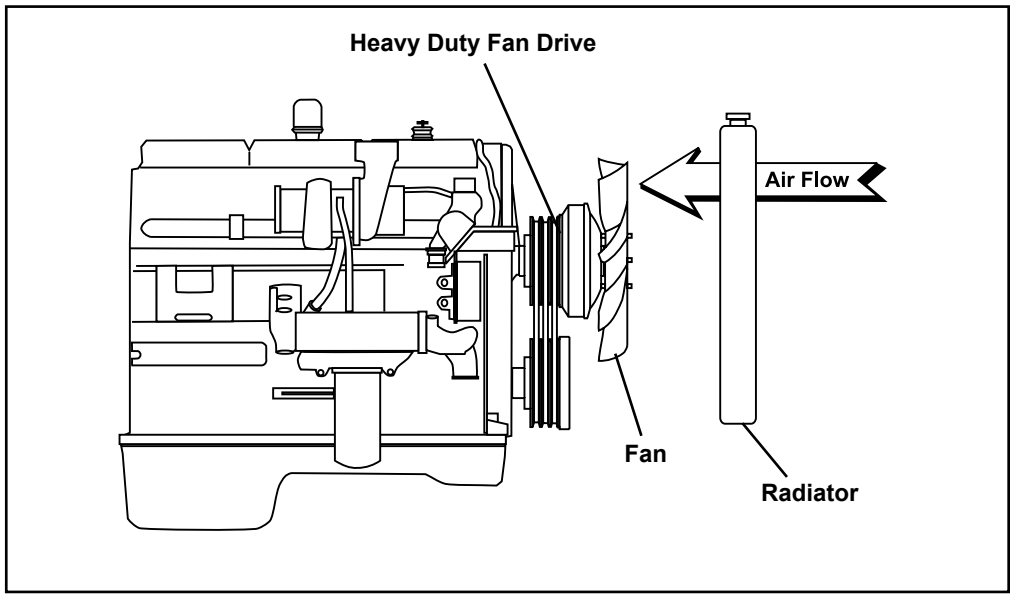
Note is used to notify people of installation, operation, or maintenance information which is important but not hazard related.

LESSON 1: FAN DRIVE SYSTEM

1.1 Operation

Learning Objectives

- Recognize the purpose and advantages of a fan drive.



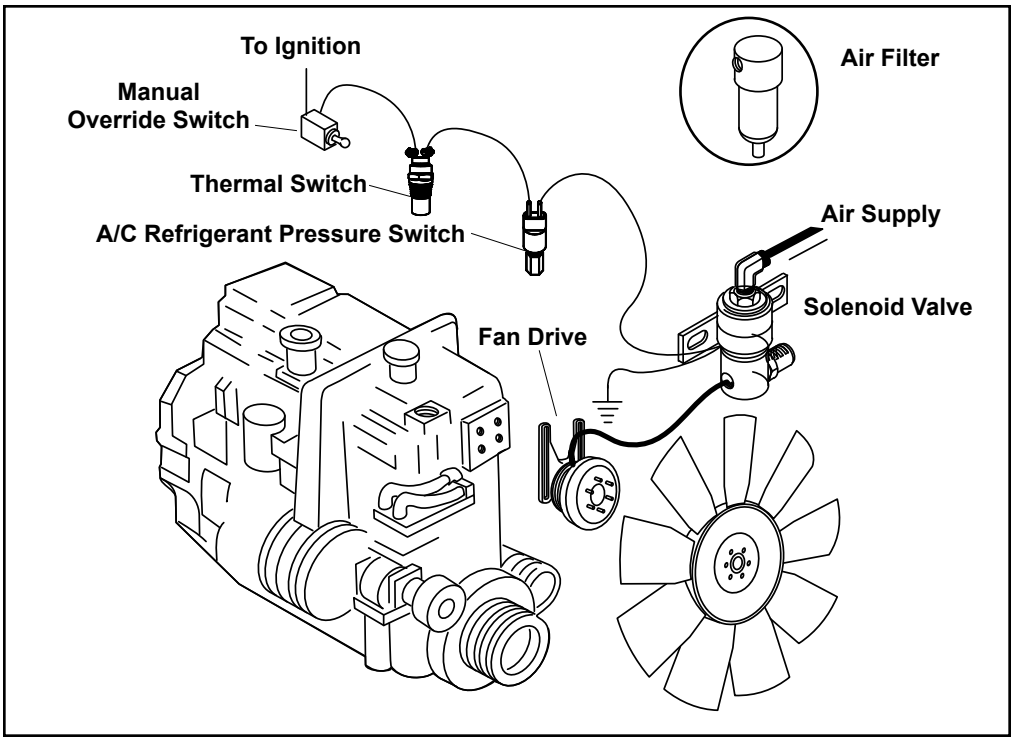
When engaged, the fan drive activates the fan to cool the engine by pulling air through the radiator. Depending on the size and rotational speed of the fan, as much as 70-100 Hp may be needed to run the fan. The fan drive engages only when needed resulting in additional horsepower for drive axles, less noise, and increased fuel economy. Due to these benefits, most new diesel powered vehicles are equipped with a Horton On/Off fan drive.

NOTE:
An engaged fan drive pulls air through the radiator to cool the engine.

Learning Objectives

- Describe the basic operation of the fan drive control system.
- Identify the components of a fan drive electrical control system.
- Describe how air pressure engages/disengages the DriveMaster fan drive.

1.2 Control System



The illustration above depicts an independent fan drive control system. The electrically controlled solenoid valve engages and disengages the fan drive by regulating its air pressure on and off.

The electrical circuit to the solenoid valve contains three switches. Any of these three switches may activate the solenoid and engage the fan drive:

- a **thermal switch** sensing the engine coolant temperature.
- a **Refrigerant Pressure Switch** in the vehicle's air conditioning system.
- an **Optional Manual Override Switch** located on the vehicle's dashboard.

The DriveMaster fan drive is spring-engaged and disengages when air pressure is applied.

EXAMPLE. When the engine coolant temperature rises above the thermal switch's set point, the thermal switch activates the solenoid valve, which shuts off air pressure to the fan drive (supplied by the vehicle's air reservoir) and engages the fan.

Most newer vehicles are equipped with an Electronic Control Module (ECM), which is a small computer that monitors and controls all engine operations, including the fan drive. If a vehicle uses an ECM, there is no direct connection between the sensors and the solenoid valve for the fan drive. Information from sensors and switches is fed into the ECM which controls the solenoid valve.

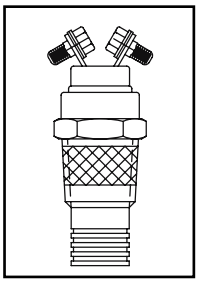
LESSON 2: CONTROL COMPONENTS

Vehicles not using an ECM usually have two sensors to automatically turn the fan on and off. **First is the Engine Coolant thermal switch and, second, the Air Conditioning Refrigerant Pressure Switch**.

Learning Objectives

- Describe the function of a thermal switch in the fan drive control system.
- State the difference between normally-open and normally-closed components.

2.1 Engine Coolant Thermal Switch



The Engine Coolant thermal switch is mounted in the water jacket on the engine.

Thermal switches are either normally-open or normally-closed depending upon the electrical control system.

• In a normally-open thermal switch, the electrical contacts are open when the temperature is below the set point and closed when the temperature is above the set point.

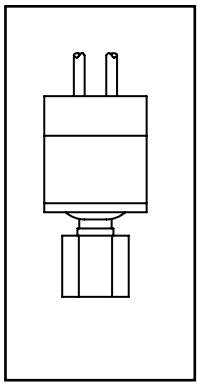
• In a normally-closed thermal switch, the electrical contacts are closed when the temperature is below the set point and open when the temperature is above the set point.

NOTE:
Thermal switch reset point is usually 7°F [3.9°C] below the set point. Truck designers will typically specify a thermal switch with a set point 10-15° F [5.6-8.3° C] higher than the fully open temperature of the engine thermostat.

2.2 Refrigerant Pressure Switch

Learning Objectives

- Describe the function of a Refrigerant Pressure Switch in the fan drive control system.



The Refrigerant Pressure Switch is installed in the high pressure line of the vehicle's air conditioning system.

When the air conditioner is running, heat removed from the air is absorbed by the refrigerant (e.g., freon, R-12 and R-134a). As the refrigerant heats, pressure builds in the air conditioner high pressure line until the refrigerant pressure reaches the switch's set point. The switch then sends a signal to the solenoid valve to engage the fan drive. The fan pulls air through the air conditioner condenser coils, which cools the condenser/refrigerant and reduces refrigerant pressure.

NOTE:
Air Conditioning Refrigerant Pressure Switches are available as either normally-open or normally-closed.

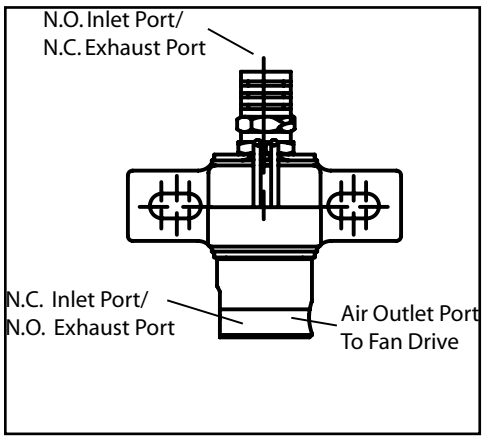
Learning Objectives

- Describe the function of a solenoid valve in the fan drive control system.
- Describe the ideal mounting location for the solenoid valve.

NOTE:
The solenoid valve is controlled by electricity and is available for 12 and 24 volt electrical systems.

2.3 Solenoid Valve

The solenoid valve is the heart of the control system, opening and closing to regulate the air flow to the fan drive.



The solenoid valve is a 3-way valve having two inlet /exhaust ports and one outlet port. Air pressure from the vehicle's air system is fed into one of the inlet ports and the outlet port is connected to the fan drive. Turning the electric current on and off causes a plunger inside the solenoid valve to move up and down. The plunger connects the valve outlet port to one of the two inlet ports:

- the normally-open port when the electric current is off.
- the normally-closed port when the electric current is on.

The valve has a 3/64" [1.19 mm] orifice to regulate the volume of air and ensure smooth engagement and disengagement of the fan drive.

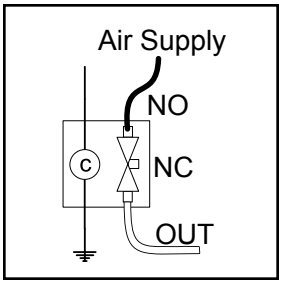
NOTE:
Normal (as in normally-open or normally-closed) refers to the state of the solenoid valve, sensor or switch when it is relaxed or de-energized.

EXAMPLE. Normal can be defined as the state of the solenoid valve if it was completely disconnected and in your hand - the Solenoid would be de-energized, the normally-open port would be open to the outlet port, and the normally-closed port would be closed to the outlet port.

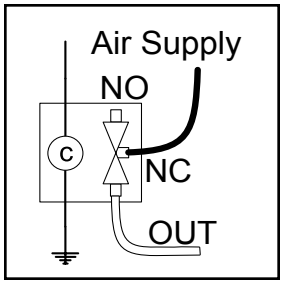
The valve outlet port is always connected to the fan drive. Depending on the vehicle's electrical control circuits, the air supply may be connected to either the normally-open or the normally-closed port. The port not connected to the air supply will exhaust air from the fan drive when it disengages.

Various adapters and fittings are available to permit the solenoid valve to be plumbed either normally-open or normally-closed (i.e., the air supply may be connected to either inlet port). These fittings also permit the solenoid valve to be installed with or without an air filter.

Mount the solenoid valve in a remote location away from the engine to minimize the valve's exposure to excessive heat, vibration, and contaminants. A solenoid valve mounted off of the engine will prolong the life of the solenoid and ensure proper fan drive operation.



Normally-Open



Normally-Closed

3.1 Electronic Control Module

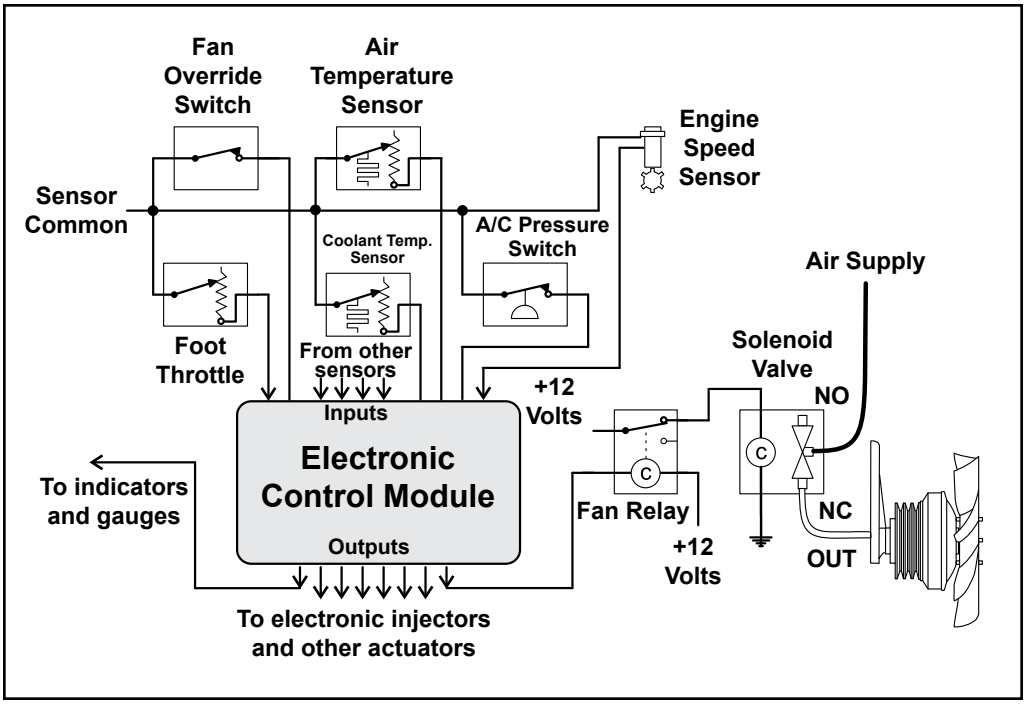
The electrical wiring that controls the fan drive varies from one vehicle to another, but generally will be one of three types of systems:

- ECM controlled
- Normally-Open
- Normally-Closed

Engine manufacturers include Electronic Control Modules (ECMs) in their new designs to control the engine, transmission, and other critical operations to improve engine performance, reliability, and fuel efficiency.

An ECM is essentially a digital computer, containing a microprocessor, random-access-memory (RAM), and read-only-memory (ROM). The ROM contains the computer's program. Design engineers can change a vehicle's control system and engine performance simply by changing the ECM's computer program.

Electronic Control Modules are simpler and more reliable than independent hard-wired systems. The decision logic is in the computer program and not the wiring, and all sensors and actuators are wired to the ECM instead of to each other.



Learning Objectives

- Describe the function of an ECM.
- State the advantages of an ECM system over an independent hard-wired control system.

NOTE:
An ECM is essentially a digital computer, used to control the engine, transmission, and other critical operations to improve performance reliability, and efficiency.

Learning Objectives

- Describe the basic operation of an ECM-Controlled System.
- Describe how ECM sensors operate differently than switches used in independent hard-wired systems.
- Trace the path of a sensor signal to fan drive operation in an ECM-controlled system.

NOTE:
The ECM monitors data from the sensors to send signals to the controls, actuators, and operator's warning lights and gauges.

3.2 Sensors

The diagram on the previous page shows that the sensors are not wired to the solenoid valve or any control actuator as in a conventional system. Instead, each sensor goes to an ECM input pin and each actuator is wired to an ECM output pin. The ECM computer monitors the data from the sensors and sends the appropriate signals to the controls and actuators based on programming logic. The ECM also sends status information to the operator's warning lights and gauges.

In an ECM controlled system, one sensor may affect several actuators and one actuator may be affected by several sensors, depending on how the ECM is programmed.

Sensors used in ECM systems are different than those used in independent systems. Instead of the simple open/close type of sensor, ECM systems use thermistors and sending units to send signals to the ECM (temperature, pressure, speed, or whatever function is being sensed).

EXAMPLE. Instead of a thermal switch opening or closing at a preset temperature, ECM's use a temperature sensor to provide voltage which the logic program converts into an actual temperature measurement. Instead of simply knowing if the coolant temperature is above or below the set point (i.e., hotter that 190° F [88° C]), the program knows the actual temperature (i.e., 196.4° F [91.3° C]).

NOTE:
The ECM program considers several factors before determining fan drive engagement.

The fan drive solenoid is not wired to the sensors as it is in a conventional system but instead wired to a relay controlled by the ECM. The ECM computer program looks at the data from several sensors and decides when to engage and disengage the fan drive. The program considers engine coolant temperature, air-conditioner's refrigerant pressure, intake-manifold air temperature, engine speed, and the engine brake status, and possibly other factors depending on engine configuration.

New troubleshooting techniques may be necessary when working on a truck with an ECM control system. A vehicle's wiring diagram no longer indicates which sensor affects which actuator. The diagram only shows which ECM pin each sensor and actuator is connected. **To determine the relationships between the sensors and actuators, refer to the vehicle or engine service manual for descriptions of exact conditions under which each actuator is engaged (i.e. Fault Codes).**

LESSON 4: ELECTRICAL CONTROL SYSTEMS (NON-ECM)

4.1 Types of Electrical Control Systems

Learning Objectives

- Describe the basic operation of normally-open and normally-closed control systems.
- Describe how solenoid valves should be plumbed in a normally-open or normally-closed system.

The electrical wiring that controls the fan drive varies from one vehicle to another, but generally will be one of three types of systems:

- Normally-Open
- Normally-Closed
- ECM controlled

Most newer engine designs are ECM controlled. Manufacturers that tend to have **normally-closed** electrical controls include:

Blue Bird
GMC
Mack
Ford
International
White GMC

Manufacturers that tend to have **normally-open** electrical controls include:

Freightliner
Mack
Western Star
Kenworth
Volvo
Peterbilt

The fan drive electrical control system may be normally-open or normally-closed, and the solenoid valve may be plumbed to work in either system.

Horton DriveMaster fan drives are plumbed as follows:

- For a normally-open electrical system, connect the air supply to the normally-open port of the solenoid valve.
- For a normally-closed electrical system, connect the air supply to the normally-closed port of the solenoid valve.

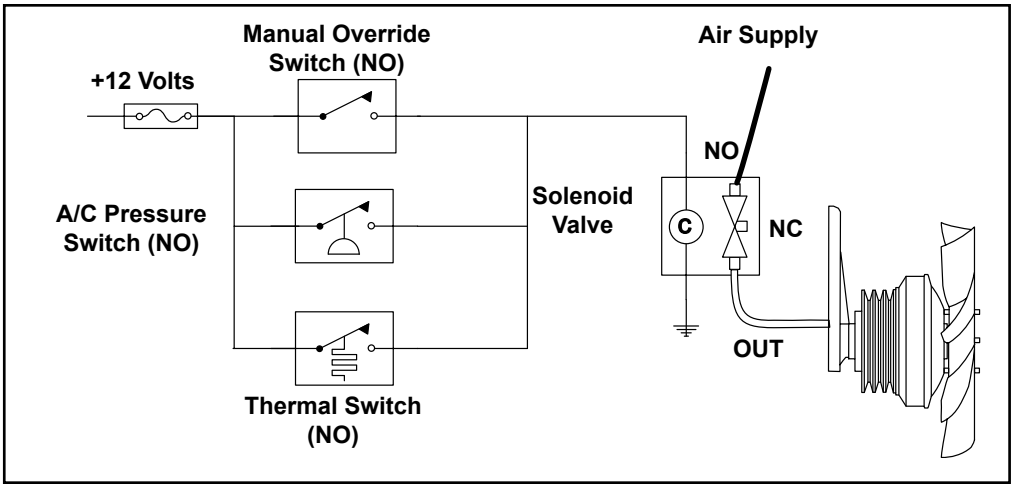
The commonly-used term “normally-open system” refers to an electrical system. The commonly-used term “normally-open valve” refers to the pneumatics of the valve.

Learning Objectives

- State how switches are wired in a normally-open control system.
- Describe the operation of the solenoid valve if all switches are open.
- Describe the operation of the solenoid valve if a single switch closes.

4.2 Normally-Open Electrical Controls

In a normally-open control system, all switches are below their set points and the electrical circuit to the solenoid valve is **open**.



NOTE:
A quick, easy way to check if a solenoid is normally-open or normally-closed is to blow in the top. If the air escapes from the outlet port going to the fan drive, the solenoid is normally-open. If the air is blocked from the outlet port going to the fan drive and escapes through the exhaust port, the solenoid is normally-closed.

In such a system, all electrical switches are wired in parallel. Electricity from the 12 volt power supply can take any of the three parallel paths to reach the solenoid valve.

All three switches are shown in their normal state (open). When all switches are open, no electricity flows to the solenoid valve and the solenoid remains open. The solenoid valve connects the outlet port to the normally-open port and provides air pressure to the fan drive. The fan drive disengages.

When one of the electrical switches closes, electricity flows to energize the solenoid valve. The solenoid valve connects the outlet port to the normally-closed inlet port and blocks air pressure going to the fan drive, engaging the fan drive.

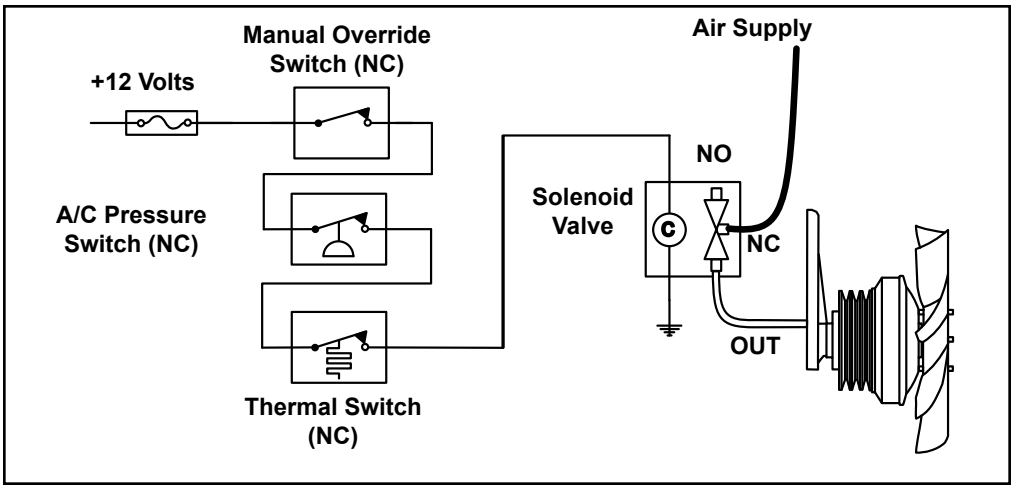
EXAMPLE. The engine coolant temperature rises above the thermal switch's set point. The normally-open thermal switch closes causing electricity to flow through the thermal switch energizing the solenoid valve. The solenoid valve plunger moves to connect the outlet port to the normally-closed inlet port. Air pressure exhausts through the valve to allow engagement of the fan drive, turning the fan.

4.3 Normally-Closed Electrical Controls

Learning Objectives

- State how switches are wired in a normally-closed control system.
- State how to determine if a solenoid valve is normally-open or normally-closed.
- Describe the operation of the solenoid valve if a switch opens.

The following schematic diagram is of a normally-closed electrical control system. When all switches are below their set points, the electrical circuit to the solenoid valve is **closed**.



In such a system, all electrical switches are wired in series. Electricity from the 12 volt power supply must flow through all three switches before it reaches the solenoid valve.

All three switches are shown in their normal state (closed). Electricity flows to the solenoid valve and the solenoid is energized. The solenoid valve connects the outlet port to the normally-closed inlet port and provides air pressure to the fan drive. The fan drive disengages.

When one of the electrical switches opens, the electrical current is broken and the solenoid valve de-energizes. The solenoid valve connects the outlet port to the normally-open inlet port and blocks air pressure to the fan drive, engaging the fan drive.

EXAMPLE. The engine coolant temperature rises above the thermal switch's set point. The normally-closed thermal switch opens, causing a break in the electrical current and de-energizing the solenoid valve. The solenoid valve plunger moves to connect the outlet port to the normally-open inlet port. Air pressure exhausts through the valve and allows engagement of the fan drive, turning the fan.

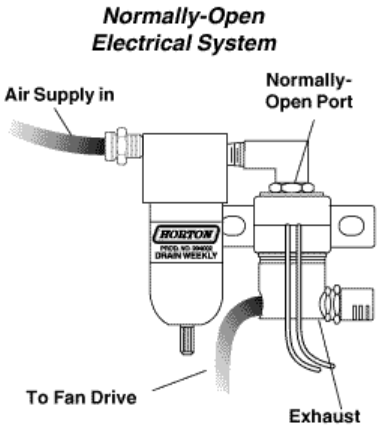
NOTE:
A quick, easy way to check if a solenoid is normally-open or normally-closed is to blow in the top. If the air escapes from the outlet port going to the fan drive, the solenoid is normally-open. If the air is blocked from the outlet port going to the fan drive and escapes through the exhaust port, the solenoid is normally-closed.

Learning Objectives

- For each type of control system determine: 1) if switches are wired in parallel or series, 2) if sensors are used, 3) the proper port to plumb the solenoid valve, and 4) the proper method to test the fan drive.

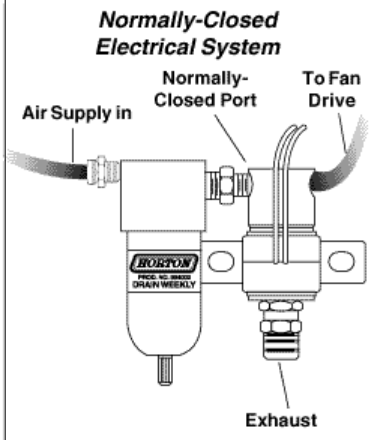
4.4 Comparison - Open/Closed Electrical Controls

Normally-Open Electrical System



- Electrical switches are wired in parallel.
- Air supply plumbed to solenoid's normally-open port (the end port).
- Test fan drive by installing a jumper wire across a sensor.
- Manual Override Switch (if equipped).

Normally-Closed Electrical System



- Electrical switches are wired in series.
- Air supply plumbed to solenoid's normally-closed port (the side port).
- Test fan drive by disconnecting a wire from a sensor.
- Manual Override Switch (if equipped).

Learning Objectives

- (Review Only)

4.5 Summary - Open/Closed Electrical Controls

Normally-open Electrical System with normally-open solenoid valve	
<u>All switches open</u> Solenoid de-energized Drive disengaged	<u>Any switch closed</u> Solenoid energized Drive engaged

Normally-closed Electrical System with normally-closed solenoid valve	
<u>All switches closed</u> Solenoid energized Drive disengaged	<u>Any switch open</u> Solenoid de-energized Drive engaged

LAB ACTIVITY - FAN DRIVE CONTROL COMPONENTS

Locate a truck with a Horton DriveMaster fan drive, preferably a make and model you would work on.

Locate the components listed below and answer the questions by filling in the corresponding blanks and checking the box next to the number when you complete a step. Upon completion, please check this activity with an instructor or supervisor.

Learning Objective

- Locate and identify components of the fan drive system.
- Interpret the vehicle's electrical diagram for various fan drive system components.

⚠ WARNING

For your safety, be sure the engine is off.

☐ 1. Locate the DriveMaster fan drive and list the model.

_____

☐ 2. Locate the solenoid valve.

☐ 3. Locate the fan drive air filter (if equipped).

☐ 4. Locate the coolant temperature switch or sensor.

☐ 5. Locate the air-conditioning refrigerant pressure switch (if equipped).

☐ 6. Locate the fan drive manual override switch (if equipped).

☐ 7. How many belts are on the fan drive sheave? _____

☐ 8. What engine components do the belts go around?

_____

☐ 9. How many bolts mount the fan drive to the engine?

☐ 10. Locate the air hose that supplies air to the solenoid. Where does the hose attach to the air supply?

_____

☐ 11. Does the truck have an ECM?

_____

☐ 12. In the truck's service manual, locate the electrical diagram for the fan drive control solenoid and the ECM.

☐ 13. Draw the schematic symbol used in your truck's electrical diagram for each of the following components:

Solenoid Valve

Engine-Coolant Thermal Switch/Sensor

Air-Conditioning Refrigerant Pressure Switch/Sensor

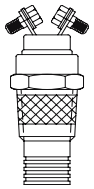
Manual Override Switch

REVIEW QUESTIONS - FAN DRIVE CONTROL SYSTEM

1. Advantages of using a Horton fan drive include increased horsepower, consistent coolant temperature, and increased fuel economy. **True / False**

2. In the operation of most ECM-controlled fan drive systems without a relay, the ECM sends a direct signal to the Solenoid valve to engage or disengage the friction disc. **True / False**

3. Identify this component by circling its name.

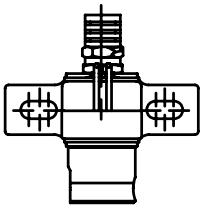


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

4. Identify this component by circling its name.

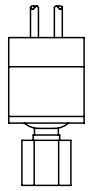


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

5. Identify this component by circling its name.



COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

6. The fan drive is engaged when air pressure is applied through the solenoid valve. **True / False**

7. The engine coolant thermal switch sends a signal to engage the fan drive when the engine coolant reaches the switch's high set point. **True / False**

8. In a normally-closed electrical control system, electrical contacts are closed when engine temperature and air conditioning pressure are below high set points. **True / False**

9. When air conditioning pressure reaches the low set point, a signal is sent to the solenoid valve or ECM by the **a) thermal switch, b) Solenoid Switch, c) Refrigerant Pressure Switch.**

10. The solenoid valve functions to regulate air to each of the electrical control components. **True / False**

11. It is best to locate the solenoid valve close to the fan drive, and on the engine block if possible. **True / False**

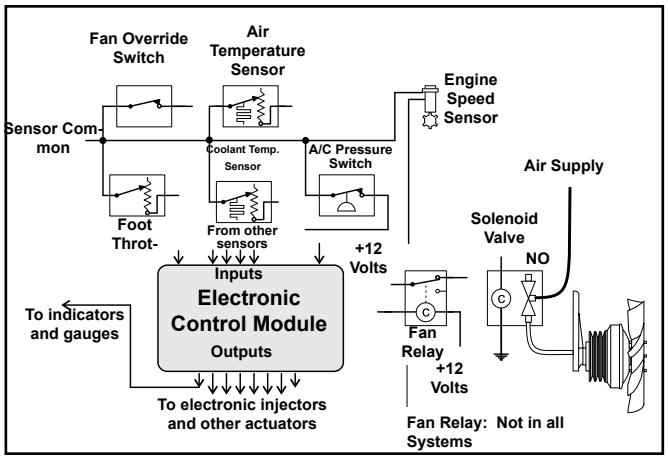
12. An Electronic Control Module is: **a) a computer, b) a sensor, c) a sending unit**

13. ECM control systems improve engine performance, reliability and fuel efficiency more than non-ECM control systems. **True / False**

14. ECMs monitor data from sensors and send the appropriate signals to controls and actuators based on: **a) operator options, b) programming logic, c) vehicle service periods.**

15. In most ECM-controlled systems, sensors and actuators are wired directly to the ECM, not the solenoid valve. **True / False**

16. Draw the path of a sensor signal to fan drive operation in an ECM-controlled system.



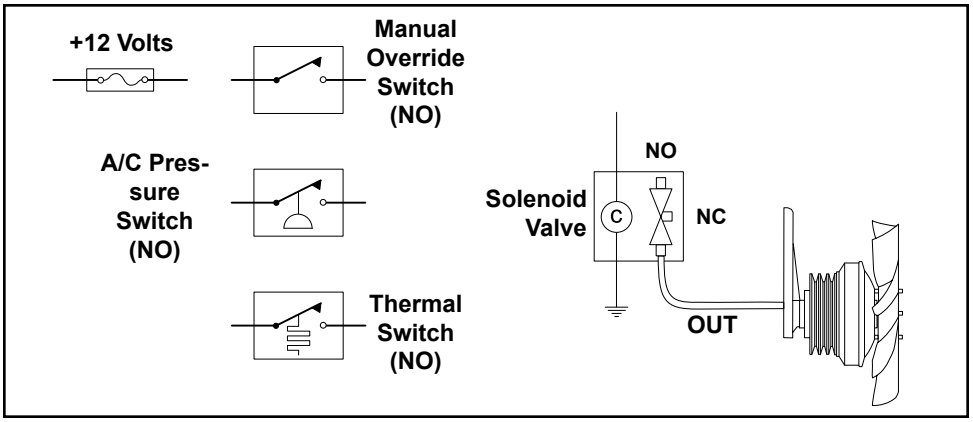
17. To find fault code explanations when troubleshooting ECM-controlled systems, look: **a) under the hood, b) inside the door panel, c) in the service manual.**

18. The three types of fan drive control systems are ECM-controlled, normally-open and normally-closed. **True / False**

19. If a vehicle has a normally-open control system, the air supply for the DriveMaster should be connected to the: **a) normally-open, or B) normally-closed,** port of the 3-way solenoid valve.

20. In a normally-open control system, switches are wired in: **a) series, b) parallel.**

21. On the diagram, connect the electrical components for a normally-open control system and indicated if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.

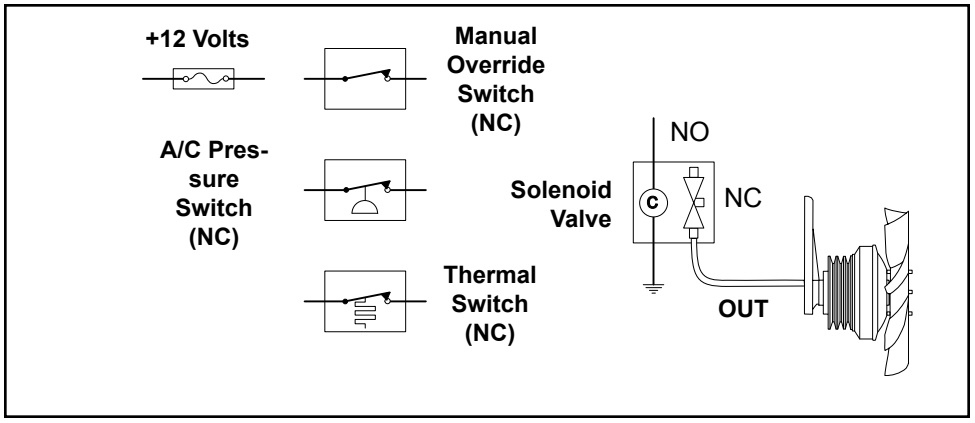


22. When all switches are open in normally-open control system, the solenoid is: **a) energized, b) de-energized,** and the fan drive is: **a) engaged, b) disengaged.**

23. If a switches closes in a normally-open control system, the solenoid is: **a) energized, b) de-energized,** and the fan drive is: **a) engaged, b) disengaged.**

24. In a normally-closed control system, switches are wired in parallel. **True / False**

25. On the diagram below, connect the electrical components for a normally-closed control system and indicate if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.



26. Air will escape through the outlet port going to the fan drive of a normally-open solenoid valve when air is applied to the normally-open port. **True / False**

27. If a switch opens in a normally-closed control system, the solenoid is: **a) energized, b) de-energized,** and the fan drive is **a) engaged, b) disengaged.**

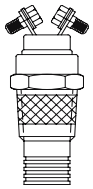
28. The fan drive can be tested in a normally-open control system by disconnecting a wire from a sensor. **True / False**

Review Answers - Fan Drive Control System

1. Advantages of using a Horton fan drive include increased horsepower, consistent coolant temperature, and increased fuel economy. **True** / False

2. In the operation of most ECM-controlled fan drive systems without a relay, the ECM sends a direct signal to the Solenoid valve to engage or disengage the friction disc. **True** / False

3. Identify this component by circling its name.

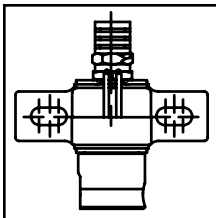


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

4. Identify this component by circling its name.

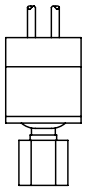


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

5. Identify this component by circling its name.



COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

6. The fan drive is engaged when air pressure is applied through the solenoid valve. True / **False**

7. The engine coolant thermal switch sends a signal to engage the fan drive when the engine coolant reaches the switch's high set point. **True** / False

8. In a normally-closed electrical control system, electrical contacts are closed when engine temperature and air conditioning pressure are below high set points. **True** / False

9. When air conditioning pressure reaches the low set point, a signal is sent to the solenoid valve or ECM by the a) thermal switch, b) Solenoid Switch, **c) Refrigerant Pressure Switch.**

10. The solenoid valve functions to regulate air to each of the electrical control components. True / **False**

11. It is best to locate the solenoid valve close to the fan drive, and on the engine block if possible. True / **False**

12. An Electronic Control Module is: **a) a computer,** b) a sensor, c) a sending unit

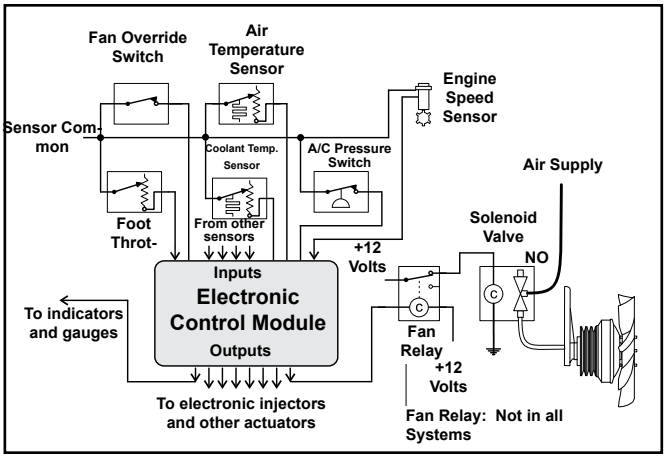
13. ECM control systems improve engine performance, reliability and fuel efficiency more than non-ECM control systems. **True** / False

14. ECMs monitor data from sensors and send the appropriate signals to controls and actuators based on:

    a) operator options, **b) programming logic,** c) vehicle service periods.

15. In most ECM-controlled systems, sensors and actuators are wired directly to the ECM, not the solenoid valve. **True** / False

16. Draw the path of a sensor signal to fan drive operation in an ECM-controlled system.



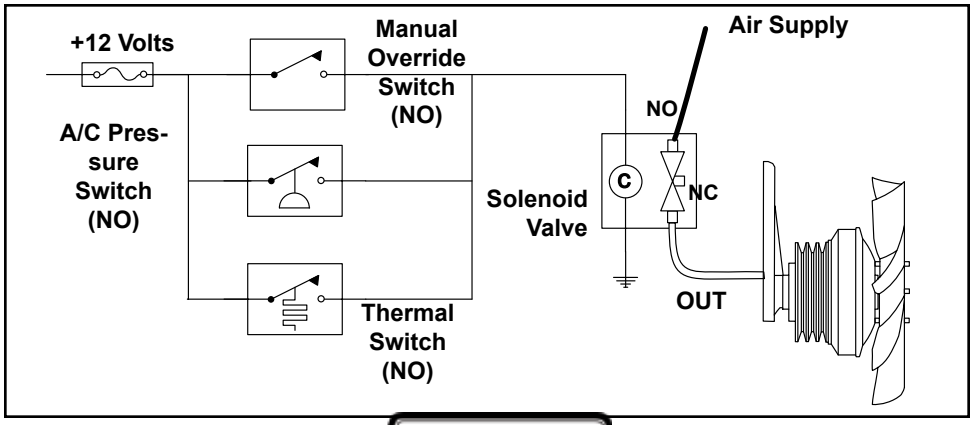
17. To find fault code explanations when troubleshooting ECM-controlled systems, look: a) under the hood, b) inside the door panel, c) **in the service manual.**

18. The three types of fan drive control systems are ECM-controlled, normally-open and normally-closed. **True** / False

19. If a vehicle has a normally-open control system, the air supply for the DriveMaster should be connected to the: **a) normally-open,** or B) normally-closed, port of the 3-way solenoid valve.

20. In a normally-open control system, switches are wired in: a) series, **b) parallel.**

21. On the diagram, connect the electrical components for a normally-open control system and indicated if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.

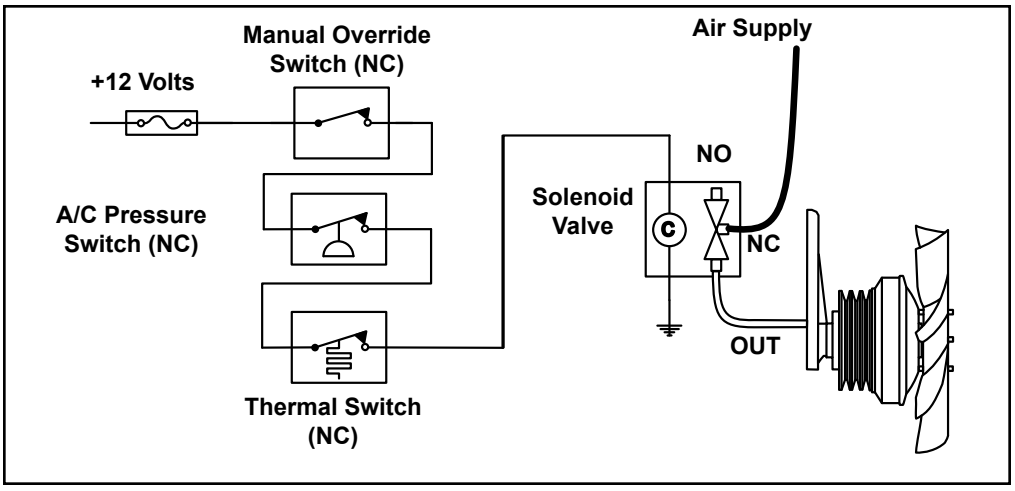


22. When all switches are open in normally-open control system, the solenoid is: a) energized, **b) de-energized,** and the fan drive is: a) engaged, **b) disengaged.**

23. If a switches closes in a normally-open control system, the solenoid is: **a) energized,** b) de-energized, and the fan drive is: **a) engaged,** b) disengaged.

24. In a normally-closed control system, switches are wired in parallel. True / **False**

25. On the diagram below, connect the electrical components for a normally-closed control system and indicate if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.



26. Air will escape through the outlet port going to the fan drive of a normally-open solenoid valve when air is applied to the normally-open port. **True** / False

27. If a switch opens in a normally-closed control system, the solenoid is: a) energized, **b) de-energized,** and the fan drive is **a) engaged,** b) disengaged.

28. The fan drive can be tested in a normally-open control system by disconnecting a wire from a sensor. True / **False**

PRIOR TO SERVICING

You must follow your company safety practices, which should adhere to or be better than Federal or State approved shop safety practices and procedures. Be sure that you read and understand all the procedures and instructions before beginning work on this unit.

NOTE

Parts replacement and/or repair of your Horton DRIVE MASTER fan drive should be performed only by the Horton Factory or an authorized Horton Distributor or Dealer to keep your warranty coverage intact during the warranty period.

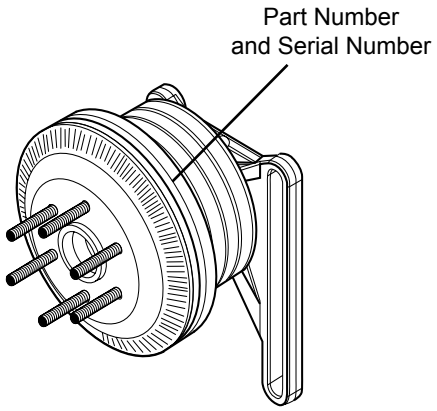
Before rebuilding your DRIVEMASTER fan drive, note the fan drive Serial No., Service Part No., Date of Installation, and Vehicle Mileage.

Serial No._____

Service Part No._____

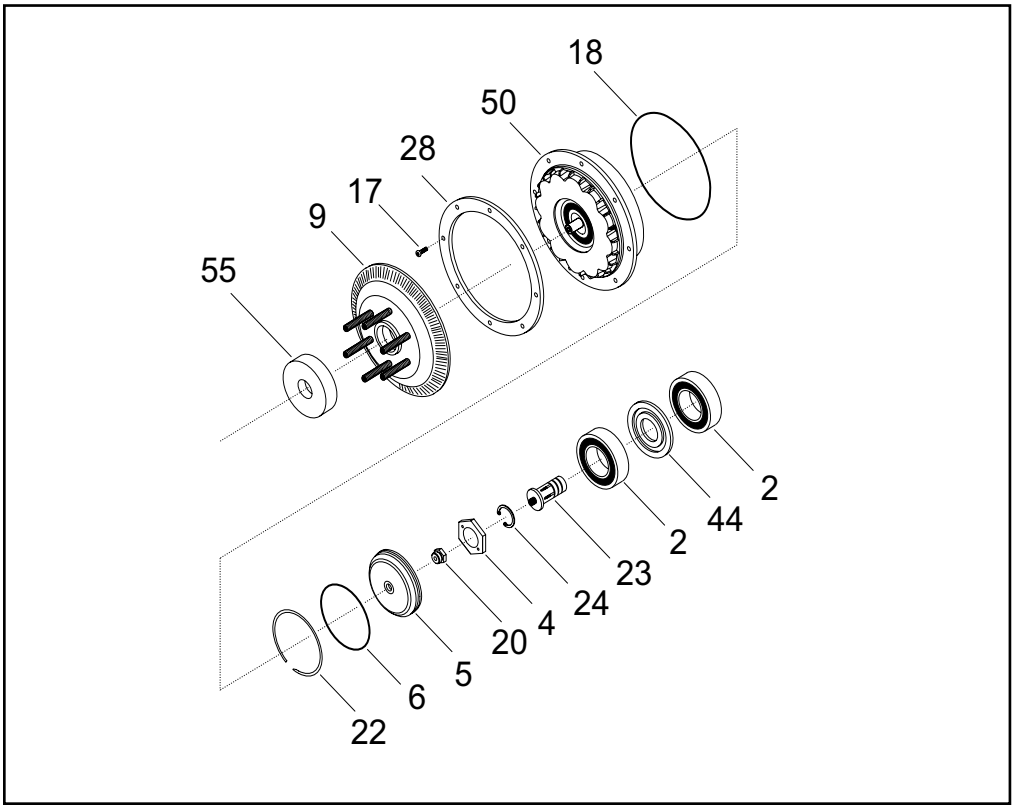
Installation Date_____

Vehicle Mileage_____



LESSON 5: DRIVEMASTER PARTS AND REPAIR KITS

5.1 Parts Identification



ITEM	DESCRIPTION	QTY
1	Fan Mounting Disc/Studs	1
2	Button Head Screws	8
3	Friction Liner	1
4	Cage Nut (Used for repairs only)	-
5	Spring Housing / Piston	1
6	Air Chamber Seal	1
7	Air Chamber Cap Retaining Ring	1
8	O-Ring Seal	1
9	Air Chamber Cap	1
10	Face Seal	1
11	Bearing Nut	1
12	Air Cartridge Retaining Ring	1
13	Air Cartridge Assembly	1
14	Ball Bearings	2
15[1]	Bearing Spacers	1
16[2]	Sheave	1
17[2]	Journal Bracket	1

[1] Not used on all fan drives

[2] Denotes item is not include in Repair Kit

Learning Objectives

- Recognize externally visible parts.
- Identify commonly replaced parts.

Learning Objectives

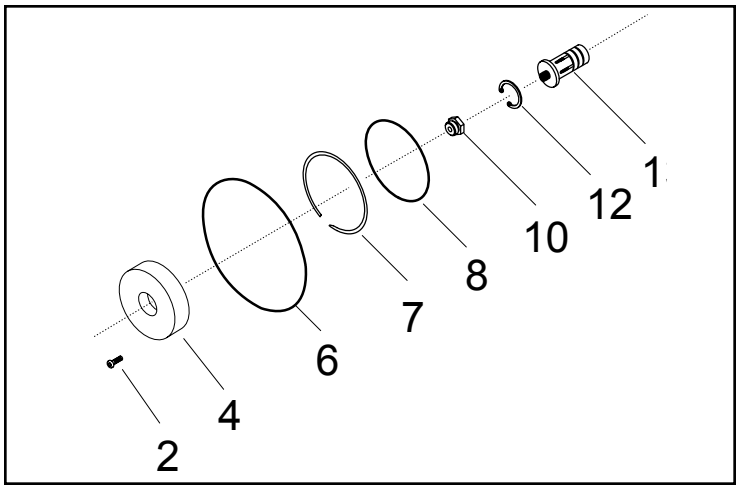
- Describe when a Seal Kit would be used.

5.2 Repair Kits

Horton offers several different ways to repair or rebuild your DriveMaster fan drive. For specific part numbers, visit the online catalog at www.hortonww.com or call Horton Customer Service at 1-800-621-1320.

1. DriveMaster Seal Kit

Install a Seal Kit if an air leak has developed inside of the DriveMaster fan drive. The Seal Kit consists of the parts listed and described below:



Button Head Screws (#2): Used to attach the friction liner and the spring housing / piston assembly to the sheave.

Cage Nut (#4): Used to keep the spring housing / piston assembly together when removing from the sheave. It maintains pressure on internal springs after the Button Head Screws are removed.

Air Chamber Seal (#6): Forms an air seal between the air chamber and the spring housing / piston assembly. It is positioned around the bottom half of the spring housing / piston assembly.

Retaining Rings (#7, #12): There are two retaining rings in the seal kit. The smaller retaining ring is used to hold the air cartridge inside the journal bracket shaft. When installing this retaining ring, the beveled side must be facing the air cartridge. The larger retaining ring is used to hold the air chamber cap in place.

O-Ring (#8): Forms an air seal between the air chamber and the air chamber cap.

Face Seal (#10): Screws into the center of the air chamber cap, forming an air seal with the carbon tip of the air cartridge.

Air Cartridge (#13): Fits inside the journal bracket shaft. Air pressure comes up through the center of the shaft, into and through the air cartridge, and into the air chamber. The air cartridge has a spring loaded carbon tip that presses against the face seal, forming an air tight seal while the fan drive is spinning.

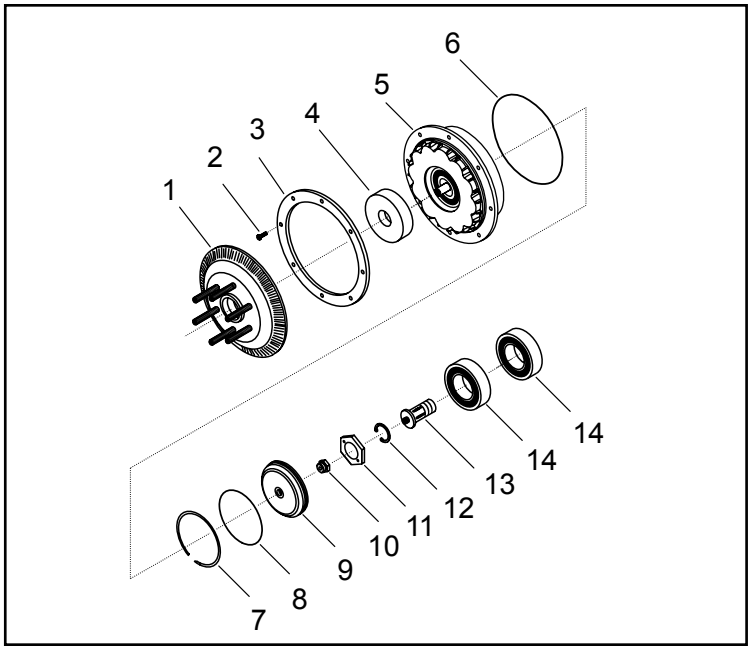
T55 Torx Plus Bit (not pictured): Used to help remove the fan mounting disc from the jack bolt.

O-Ring Lubricant (not pictured): Apply lubricant to the new air chamber cap O-ring and the air chamber seal before installation.

2. DriveMaster Super Kit

Learning Objectives
- Describe when a Super Kit would be used.

Install a Super Kit if the bearings are running rough or if the DriveMaster fan drive needs to be completely rebuilt due to excessive wear. The Super Kit consists of the parts listed and described below:



Fan Mounting Disc (#1): The fan mounting disc is the part that the fan is bolted on to. It is also the part that contacts the friction liner when the fan drive is engaged. The fan mounting disc is screwed onto the jack bolt. Different DriveMasters have different stud lengths. Check this when making repairs.

Button Head Screws (#2)

Friction Liner (#3): Attached to the sheave on top of the spring housing / piston assembly.

Cage Nut (#4)

Spring Housing / Piston Assembly (#5): The internal mechanism that engages and disengages the DriveMaster fan drive when air pressure is either removed or applied.

Air Chamber Seal (#6)

Retaining Rings (#7, #12)

O-Ring (#8)

Face Seal (#10)

Bearing Nut (#11): Used to hold the sheave onto the journal bracket shaft.

Air Cartridge (#13)

Sheave Bearings (#14): Use a bearing press to remove old bearings and install new bearings into the center of the sheave. The bearings are prelubricated and sealed. They are also contain markings that need to be aligned for proper installation. (If there are spacers in between the old bearings that were removed, reuse those spacers by positioning them between the new bearings before installation. DO NOT remove the seals and attempt to lubricate the old or new bearings.) Some DriveMasters use one double row bearing instead of the two single row bearings. Check to make sure you have the right kit.

T55 Torx Plus Bit (not pictured)

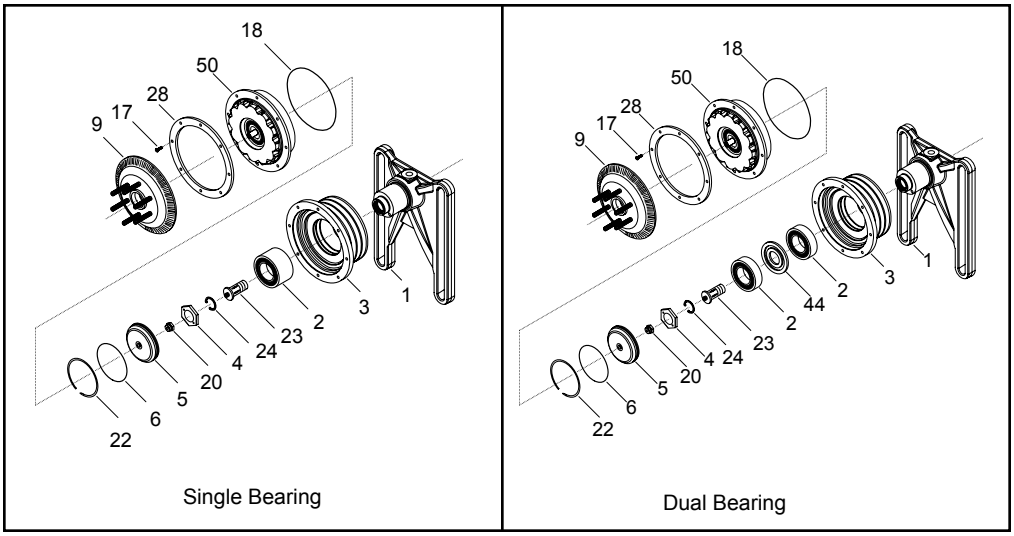
O-Ring Lubricant (not pictured)

Learning Objectives

- Describe when a DriveMaster PolarExtreme Super Kit would be used.

2. DriveMaster PolarExtreme Super Kit

Install a DriveMaster PolarExtreme Super Kit if the bearings are running rough or if the DriveMaster fan drive needs to be completely rebuilt due to excessive wear. If you need more power, the PolarExtreme kit also contains an ultra high-torque clutch package that delivers 2400 inch-pounds of torque.The Kit consists of the parts listed and described below:



Sheave Bearings (#2): Use a bearing press to remove old bearings and install new bearings into the center of the sheave. The bearings are prelubricated and sealed. They are also contain markings that need to be aligned for proper installation. (If there are spacers in between the old bearings that were removed, reuse those spacers by positioning them between the new bearings before installation. DO NOT remove the seals and attempt to lubricate the old or new bearings.)

Bearing Nut (#4): Used to hold the sheave onto the journal bracket shaft.

O-Ring Seal (#6)

Fan Mounting Disc/Studs (#9): The fan mounting disc is the part that the fan is bolted on to. It is also the part that contacts the friction liner when the fan drive is engaged. The fan mounting disc is screwed onto the jack bolt.

Button Head Screws (#17)

Air Chamber Seal (#18)

Face Seal (#20)

Retaining Ring (#22)

Air Cartridge Assembly (#23)

Retaining Ring (#24)

Friction Liner (#28): Attached to the sheave on top of the spring housing / piston assembly.

Spring Housing / Piston Assembly (#50): The internal mechanism that engages and disengages the DriveMaster fan drive when air pressure is either removed or applied.

Cage Nut (#55)

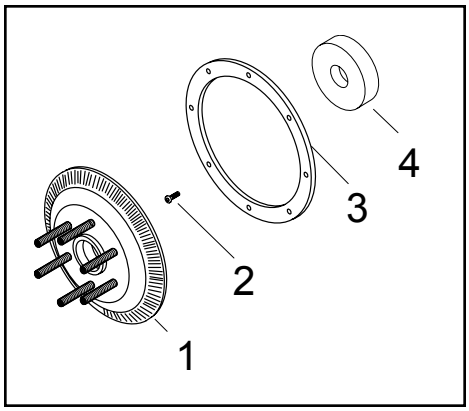
T55 Torx Plus Bit (not pictured)

O-Ring Lubricant (not pictured)

3. DriveMaster Friction Disc Kit

Learning Objectives
- Describe when a Friction Disc Kit would be used.

Install a friction disc kit if the fan mounting disc is damaged from blistering, excessive wear, or failure. The friction disc kit consists of the parts listed and described below:

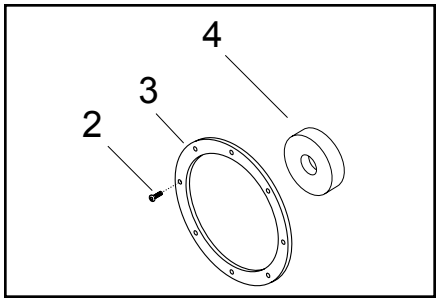


Fan Mounting Disc (#1)
Button Head Screws (#2)
Friction Liner (#3)
Cage Nut (#4)
T55 Torx Plus Bit (not pictured)

4. DriveMaster Friction Liner Kit

Learning Objectives
- Describe when a Friction Liner Kit would be used.

Install a Friction Liner kit if the friction liner is worn. Check the fan mounting disc to make sure there is no excessive wear. If damage is evident use the DriveMaster friction disc kit. The Liner kit consists of the parts listed and described below:



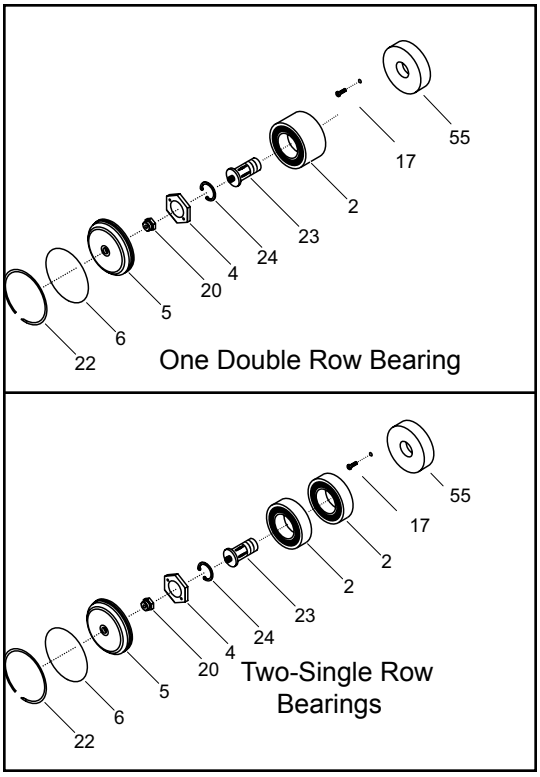
Button Head Screws (#2)
Friction Liner (#3)
Cage Nut (#4)
T55 Torx Plus Bit (not pictured)

Learning Objectives

- Describe when a Bearing/ Cartridge Kit would be used.

5. DriveMaster Bearing/Cartridge Kit

Install a Bearing/Cartridge Kit if the sheave bearings are running rough inside of the DriveMaster Fan Drive. The Bearing/Cartridge Kit consists of the parts listed below (descriptions on previous pages):



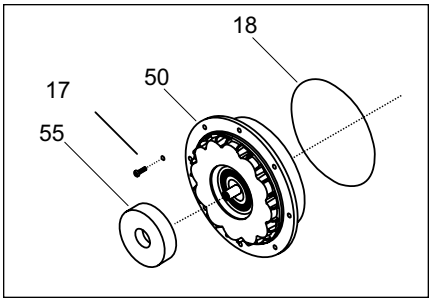
Sheave Bearings (#2)
Bearing Nut (#4)
O-Ring (#6)
Button Head Screws (#17)
Face Seal (#20)
Retaining Ring (#22)
Air Cartridge (#23)
Retaining Ring (#24)
Cage Nut (#55)
T55 Torx Plus Driver (not pictured)
O-Ring Lubricant (not pictured)

Learning Objectives

- Describe when a Clutch Pack Kit would be used.

6. DriveMaster Clutch Pack Kit

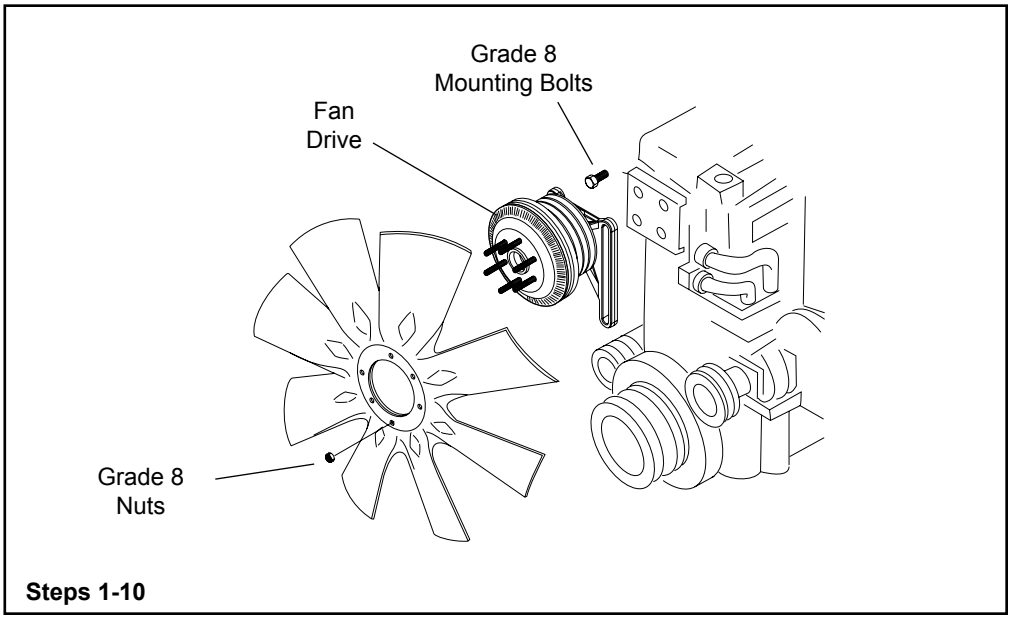
Install a Clutch Pack Kit if the DriveMaster Fan Drive needs to be completely rebuilt due to excessive wear. The Clutch Pack Kit consists of the parts listed below (descriptions on previous pages):



Button head Screws (#17)
Air Chamber Seal (#18)
Spring Housing/Piston (#50)
Cage Nut (Used for Repair Only) (#55)
T55 Torx Plus Driver (not pictured)
O-Ring Lubricant (not pictured)

LESSON 6: REMOVING THE FAN DRIVE

1. Turn the vehicle ignition off.
2. Apply the vehicle's parking brake.
3. Block the vehicle's wheels.
4. Bleed the air from the vehicle's reservoir.
5. Disconnect the air supply line from the fan drive.
6. Loosen the bolts that hold the fan in place.
7. Remove the fan from the fan drive.
8. Remove any drive belts from the fan drive.
9. Remove the fan drive mounting bolts.
10. Carefully maneuver the fan drive out of the engine compartment.



Steps 1-10

Learning Objectives

- Describe the safety precautions and order of steps in removing the fan drive from the vehicle.

NOTE:
The procedure for removing the fan drive varies from one vehicle to another. Refer to the vehicle's service manual for a detailed description of this process.

NOTE:
Protect the radiator from possible damage from the fan during fan removal and fan drive installation.

NOTE:
Because of the weight of the fan drive (ranging from 35-55 Lbs. [15.88-24.95 Kg]), you may want to use a hoist for support during removal.

LESSON 7: DISASSEMBLING THE FAN DRIVE

Learning Objectives

- Describe the steps of safely removing and inspecting the fan mounting disc.
- Recognize signs of wear or damage to the fan mounting disc.

NOTE:
Applying 80-120 PSI [5.44 - 8.16 bar] air pressure to the fan drive air inlet will aid in removal of the FMFD.

NOTE:
Use caution when handling the prybar on the fan mounting disc. Permanent damage may occur if not properly supported. Use a flat blade tool or a prybar that has a handle.

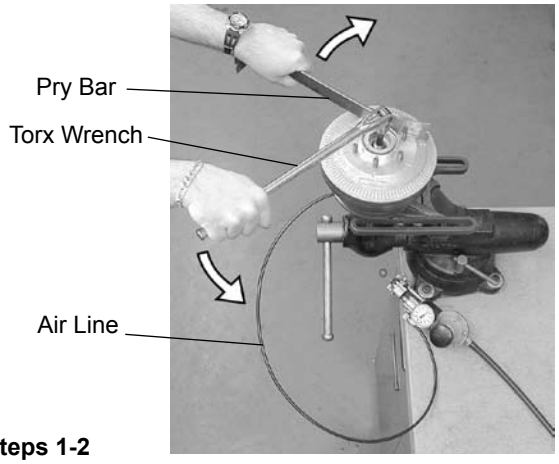
7.1 Tools Required

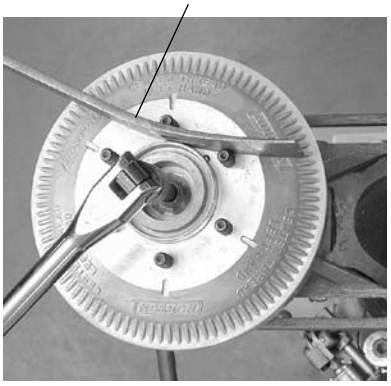
- 2” Socket Wrench
- T55 Torx Plus Bit
- T27 Torx Bit
- Torque Wrench
- Pry Bar
- Ring Pliers
- Screwdrivers

7.2 Disassembly

Fan Mounting Disc Removal and Inspection

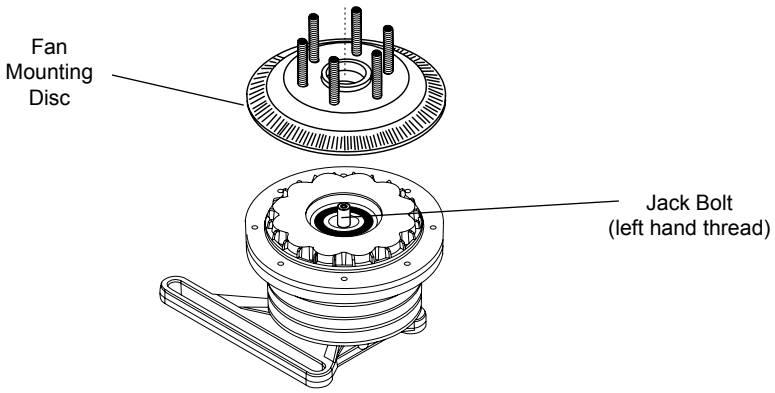
1. Place the fan drive in a vise and clamp the journal bracket tight.
2. Loosen the jack bolt **(left hand thread)** by turning it counter-clockwise using a T55 Torx Plus Bit.





Steps 1-2

3. Unscrew the fan mounting disc from the jack bolt.

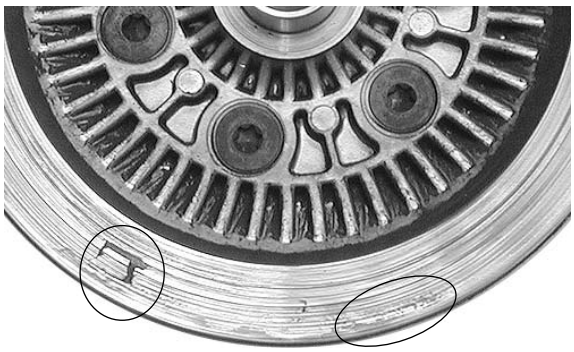


Step 3

4. Inspect the fan mounting disc for wear or damage.

Step 4

Fan Mounting Disc
Good Condition



Look for signs of damage or blistering

Fan Mounting Disc
Bad Condition

Learning Objectives

- Describe the steps of safely removing and inspecting the spring housing / piston assembly.

⚠ WARNING

Remove air pressure from the unit before proceeding to Step 6.

⚠ DANGER

Failure to release air pressure may result in serious personal injury.

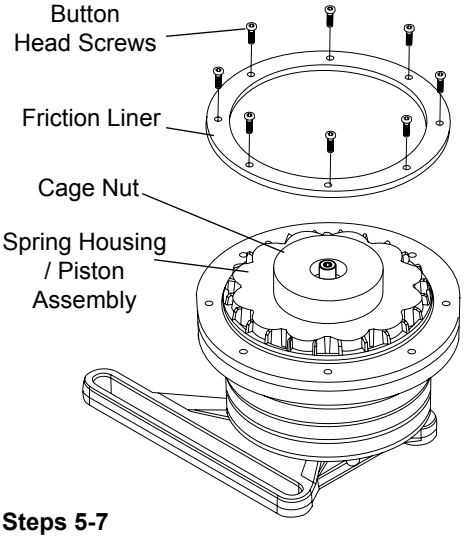
⚠ WARNING

Do not disassemble the Spring Housing. Personal injury could occur.

NOTE:
If you are installing either a friction liner or Fan Disc Kit, proceed to page 35, step 20.

Spring Housing / Piston Assembly Removal

5. Using the Torx wrench to hold the jack bolt, hand-tighten the cage nut (from the Repair Kit) onto the jack bolt **(left hand thread)** over the Spring Housing. The cage nut will keep the Spring Housing and Piston together as an assembly. It will also maintain pressure on the internal Springs after the Button Head Screws are removed.
6. Remove the 8 Button Head Screws using a T27 Torx Bit.
7. Remove the Friction Liner.



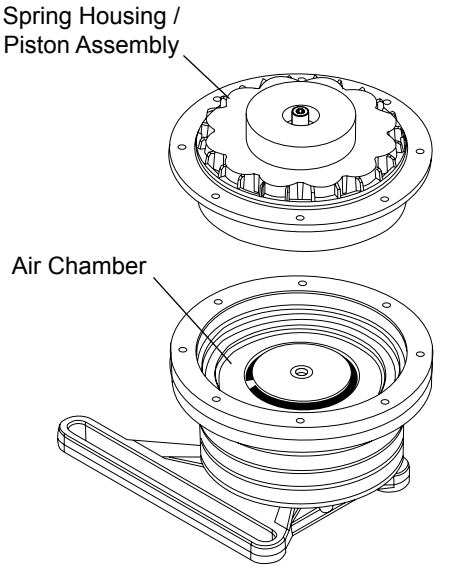
Steps 5-7

⚠ WARNING

The Air Chamber should be clean and moisture-free (with the exception of the seal lubricant) . If not, a problem may exist in the vehicle air system and must be corrected before the fan drive is reinstalled.

NOTE
When installing new bearings, you must press on the outer diameter ring of the bearing set to avoid damaging the bearing during installation.

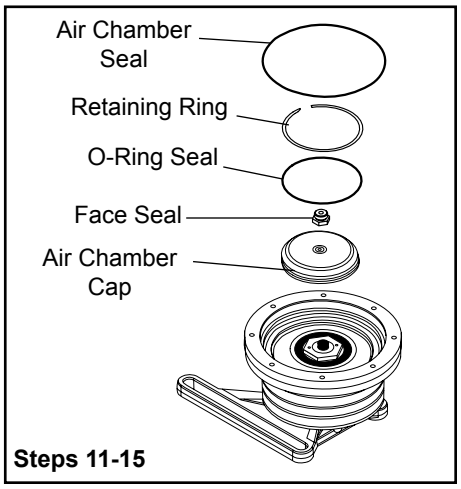
8. Remove the spring housing / piston assembly.
9. Remove the air chamber seal.
10. Examine the inside of the Air Chamber for signs of moisture and/or contaminants.



Steps 8-10

Air Chamber Seals

11. Remove the air chamber cap retaining ring.
12. Gently and evenly pry the air chamber cap out of the sheave using two small screwdrivers placed 180° apart.
13. Remove the O-ring Seal from the air chamber cap.
14. Remove the face seal.
15. Inspect the face seal for signs of wear. Wear indicates that dirt may exist in the air system.



Steps 11-15

Learning Objectives
- Describe the steps of removing and inspecting the air chamber seals.

⚠ WARNING

Wear eye safety protection when removing retaining ring to avoid serious injury.

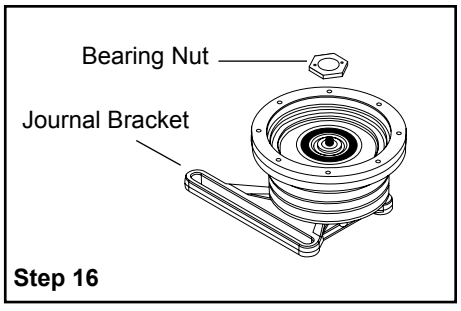
⚠ CAUTION

If dirt or oil exists in the air system, the air system must be cleaned and dried before the fan drive is reinstalled.

NOTE:
If you are only installing a Seal Kit, proceed to page 33, step 5.

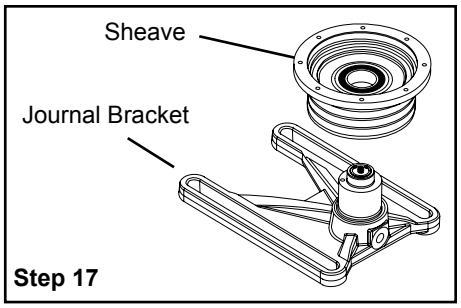
Sheave and Sheave Bearings

16. Remove the Bearing Nut from the journal bracket using a 2” Socket Wrench.



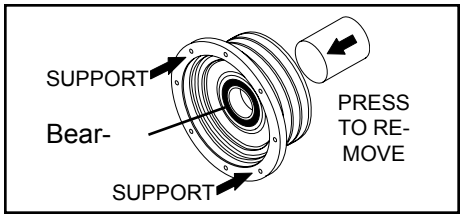
Step 16

17. Remove the sheave from the journal bracket.



Step 17

18. Fully support the sheave and press out the bearings.
19. Fully clean and remove any dirt, debris or corrosion that may be present.



Learning Objectives
- Describe the steps of removing the sheave from the journal bracket.

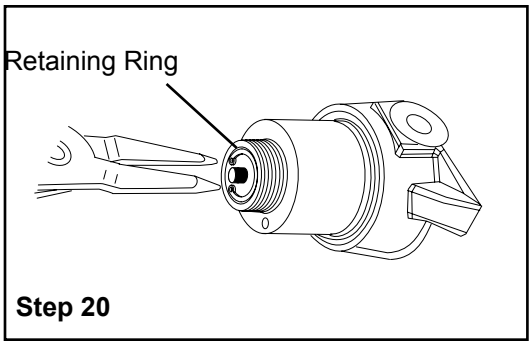
Learning Objectives
- Describe the steps of removing the air cartridge.

⚠ WARNING

Wear eye safety protection when removing retaining ring to avoid serious injury.

Air Cartridge Removal

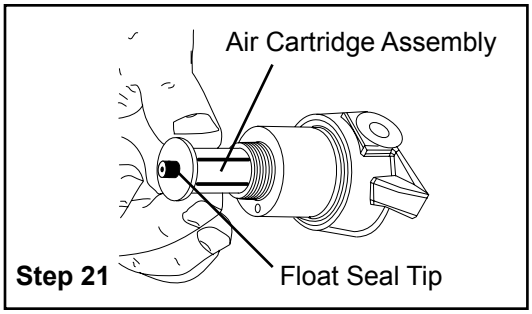
20. Remove the retaining ring.



Step 20

21. Remove the Air Cartridge Assembly.

22. Clean the journal bracket bore if necessary.



Step 21

NOTE
If you are installing a Seal Kit, proceed to page 31, Step 5.

LESSON 8: REBUILDING THE FAN DRIVE

8.1 Torque Specifications

ITEM	DESCRIPTION	TIGHTENING TORQUE
11	Bearing Nut	130 Ft. Lbs. [176 N•m]
--	Jack Bolt (left hand thread)	100 Ft. Lbs. [136 N•m]
3	Button Head Screws	80 In. Lbs. [9 N•m]
10	Face Seal	75-100 In. Lbs. [8.5-11.5 N•m]

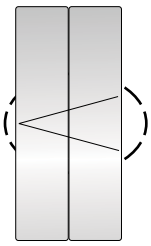
Learning Objectives
- Describe the steps of removing and replacing the sheave bearings.

8.2 Rebuilding

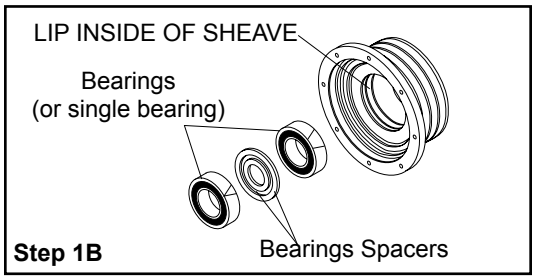
Sheave Bearing Replacement

2. Fully supporting the sheave, press the new sheave bearings (or single bearing) into place, noting the position of the lip inside the sheave. Press outer bearing race to avoid damaging bearings. See Figures 1A, 1B, 1C.

Align the chevron markings on the bearings to form an arrow. The arrow may point in either direction.

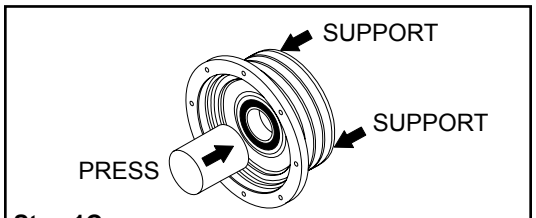


Step 1A



Step 1B

NOTE:
Some models of the DRIVEMASTER fan drive contain bearing spacers. Both bearing spacers must be positioned BETWEEN the sheave bearings when the sheave bearings are replaced.

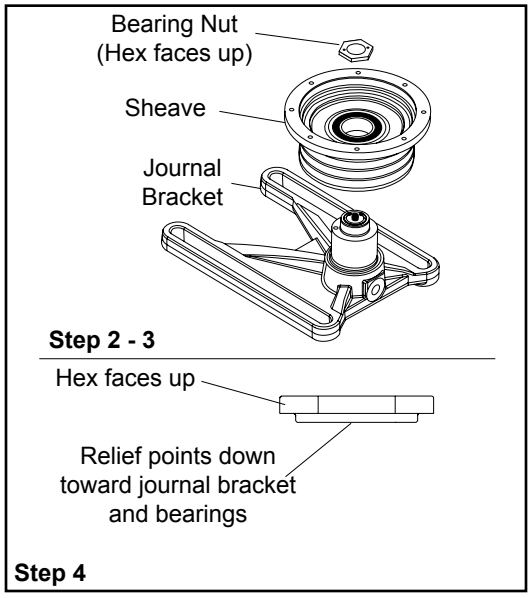


Step 1C

NOTE:
All bearings are prelubricated and sealed. DO NOT remove the seals to lubricate the bearings.

NOTE:
Some DRIVEMASTER models utilize a single (one piece) sheave Bearing.

2. Slide the sheave onto the journal bracket.
3. Replace and tighten the Bearing Nut to 130 Ft. Lbs. [170 N•m] torque.
4. Be sure that the Bearing Nut hex is facing up (see detail below).



Step 2 - 3

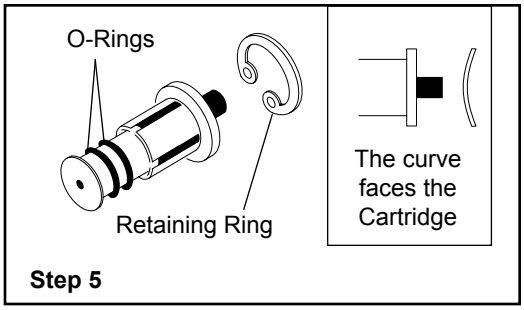
Step 4

Air Cartridge

Learning Objectives

- Describe the steps of removing and replacing the air cartridge.

5. Apply O-ring lubricant to the outside O-rings of the new air cartridge assembly.
6. Install the new air cartridge assembly into the journal bracket.
7. Reinstall the retaining ring.



Step 5

⚠ CAUTION

The retaining ring must be fully seated in the retaining ring groove to keep the air cartridge assembly from moving. Also, the retaining ring is beveled. The curved side must be installed facing the Cartridge.

Learning Objectives

- Describe the steps of safely reassembling the spring housing / piston assembly.
- State lubrication requirements and cautions when reassembling the spring housing / piston assembly.

⚠ CAUTION

Use extreme care when reassembling the Air Chamber components to avoid damage to the O-ring and air chamber seal.

NOTE:
The new face seal is assembled with an O-ring. If the old face seal does not have an O-ring, remove it from the new face seal and apply thread sealant (Loctite® 511 or similar) to the face seal threads.

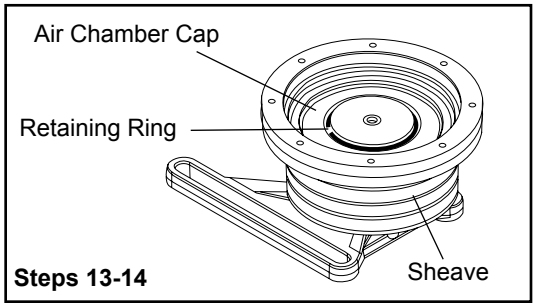
⚠ CAUTION

Do not apply grease beyond Seal contact surface as it will cause improper fan drive function.

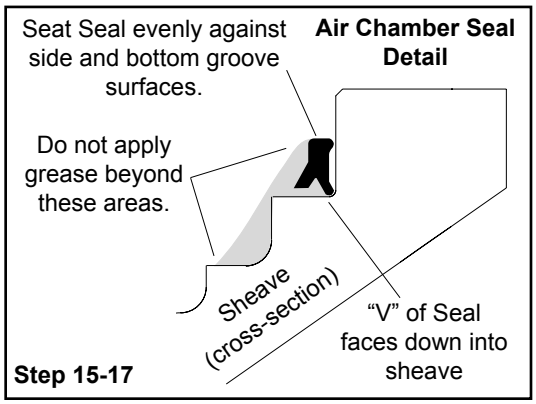
NOTE:
The entire tube of O-ring lubricant should be used when lubricating the new seals and contact surfaces of the sheave and spring housing / piston assembly.

Spring Housing / Piston Assembly Reassembly

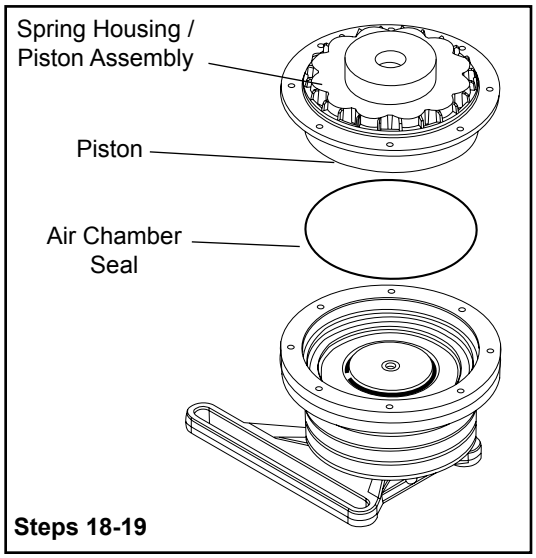
8. Using a clean/dry cloth, clean the float seal tip (see air cartridge illustration, Step 4) of the air cartridge assembly.
9. Also clean the face seal of the air chamber cap.
10. Assemble the air chamber cap and face seal.
11. Lubricate the O-ring Seal with the fresh lubricant supplied in the kit.
12. Install the O-ring Seal on the air chamber cap.
13. Carefully set the air chamber cap into the sheave.
14. Install the retaining ring.
15. Install the air chamber seal into the sheave.
16. Be sure the Seal is evenly seated against the side and bottom of the groove surfaces.
17. Lubricate contact surfaces with the fresh lubricant supplied in the kit.
18. Carefully set the new spring housing / piston assembly from the Repair Kit into position.
19. Gently rotate to align the mounting holes in the assembly with the sheave.



Steps 13-14



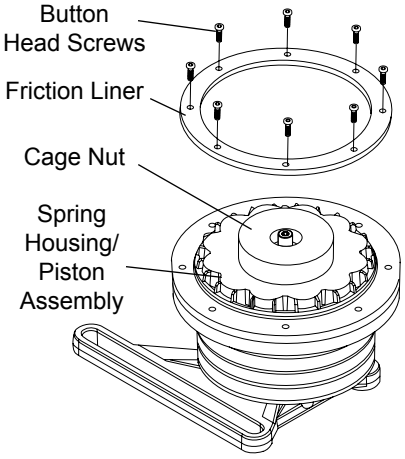
Step 15-17



Steps 18-19

20. Set the new friction liner (from kit) into place. Handle the friction liner by the edges to avoid contamination.

21. Alternately and evenly tighten the 8 Button Head Screws to 80 In. Lbs. [9 N•m] torque.



Steps 20-21

⚠ WARNING

To avoid personal injury, make sure the Button Head Screws are properly tightened to the specified torque before applying air pressure - 80 In. Lbs. [9 N•m].

Learning Objectives

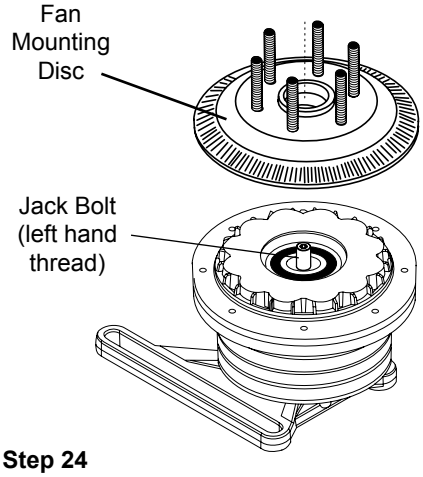
- Describe the steps of safely installing the fan mounting disc.

Fan Mounting Disc Reassembly

22. Apply a minimum of 80 lbs. PSI of clean air to the air inlet.

23. Remove the cage nut from the spring housing / piston assembly.

24. Install the new fan mounting disc (from kit) if applicable.



Step 24

NOTE:
Air must be applied to the air chamber to allow for easy removal of the cage nut and to ensure proper torque is applied to the jack bolt.

⚠ WARNING

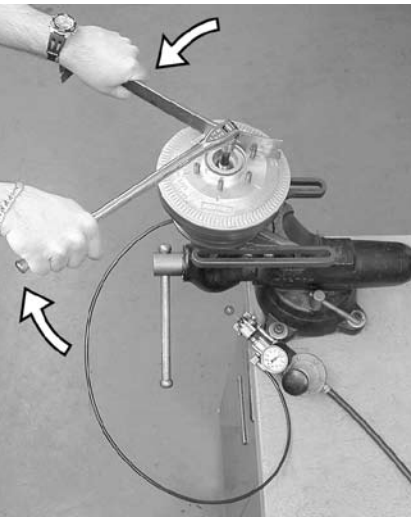
Do not disassemble the Spring Housing. Personal injury could occur.

25. Tighten the jack bolt **(left hand thread)** to 100 Ft. Lbs. [136 N•m] torque.

26. Actuate the DRIVEMASTER and check for proper engagement and disengagement of the fan mounting disc.

27. Check for air leaks at the bleed hole.

28. Check for air leaks around the spring housing / piston assembly.


Step 25

⚠ CAUTION

If a problem exists, it must be corrected prior to mounting the fan drive onto the vehicle. If the problem is not corrected, the fan drive will fail prematurely.

LESSON 9: REINSTALLING THE FAN DRIVE

Learning Objectives

- Describe the steps of safely reinstalling the fan drive.
- Describe requirements for proper belt tensioning.
- Describe methods to check for proper fan drive operation.

⚠ WARNING

On the workbench, apply 90 psi [6.21 bar] clean air pressure and check the fan drive for air leaks.

NOTE:
Protect the radiator from possible damage from the fan during fan removal and fan drive installation.

NOTE:
Most engines have multiple mounting locations. Be sure to use the correct holes for the application.

NOTE:
Use flat washers on each manufacturer's approved bolt or studs - DO NOT use lock washers.

⚠ CAUTION

Correct belt adjustment and alignment is necessary for all belt driven components to assure longevity of component life. Over tightening of belts will shorten bearing life. Loose belts will cause excessive belt wear and shorten bearing life. Consult the equipment manufacturer and/or engine manufacturer specifications for proper belt adjustment.

⚠ WARNING

The maximum fan diameter is 32".
If a larger fan diameter is required, contact Horton at 1-800-621-1320.

NOTE:
Remove all tools from the work area and visually inspect the area in which you have been working prior to starting the engine.

NOTE:
For a normally-open electrical system, use a jumper across a sensor. For a normally-closed electrical system, open the circuit by disconnecting a sensor wire.

1. Turn the vehicle ignition off.
2. Apply the vehicle's parking brake.
3. Block the vehicle's wheels.
4. Prepare the area by cleaning all the mounting surfaces of dirt and debris.
5. Position the Drivemaster into place, aligning the mounting bracket holes with mounting holes on engine.
6. Reinstall the mounting bolts and tighten to the vehicle manufacturer's specifications.
7. Replace and adjust the belts.
8. Check the condition of the fan. Look for cracks or missing weights.
9. Remount the fan on the fan drive and tighten the nuts to the vehicle manufacturer's specifications.
10. Reconnect the air supply line to the Drivemaster.
11. Start the engine and let the air pressure build to at least 90 psi [6.21 bar].
12. If the vehicle is fitted with a manual override switch, engage and disengage the fan drive to observe for proper operation as well as air leaks.
13. Turn off the engine.

LESSON 10: PREVENTIVE MAINTENANCE (PM)

10.1 Introduction

Learning Objectives
- Identify general conditions to look for when observing fan drive operation.
- Describe locations and methods for checking for air leaks.

Before performing work on the fan drive, be sure to follow good shop safety practices. Turn the vehicle ignition off, apply the vehicle's parking brake and block the vehicle's wheels.

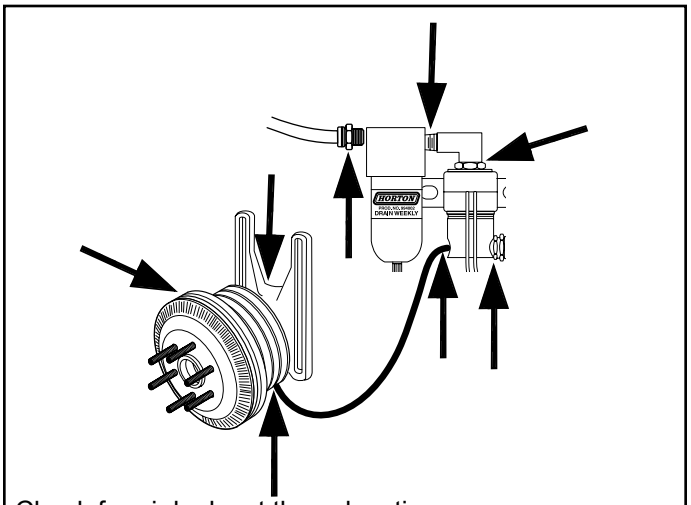
Start the vehicle's engine and build air pressure in excess of 90 PSI [6.21 bar].

Manually engage and disengage the fan drive. Observe the fan and fan drive from a distance. Look for vibration, fan blade contact, fan drive slippage, and fan drive operation.

⚠ WARNING

Be sure the engine is turned off and the fan has stopped turning before approaching fan area to prevent serious personal injury.

Most fan drive failures are caused by air leaks. With regular preventive maintenance (PM), the Horton DriveMaster fan drive will provide years of reliable service. PM is recommended at the weekly air-filter draining, and 25,000 mile [40,000 Km] PM.



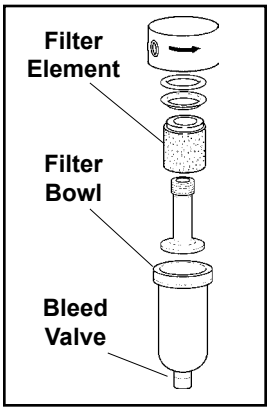
Check for air leaks at these locations

10.2 Weekly PM

Learning Objectives
- State weekly preventive maintenance requirements.

Each week, drain the air filter at its bleed valve and check for moisture.

1. If contaminants are present, disassemble the air filter as shown.
2. Clean all parts with parts solvent and dry them thoroughly.
3. Check the truck's air system for the source of the contamination and make the necessary repairs.



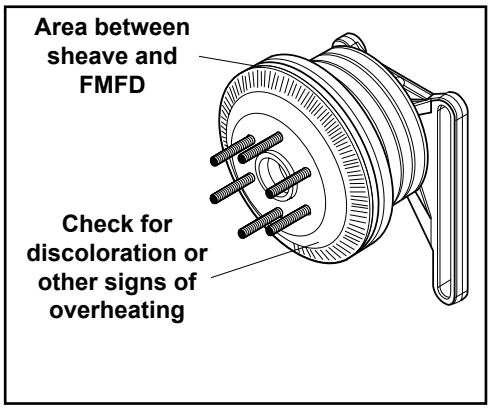
NOTE:
Do not pressure wash the fan drive. The fan drive needs no washing or cleaning. Direct spray from a pressure washer will only result in reduced life or damage to the product.

Learning Objectives

- State 25,000 Mile (40,000Km) preventive maintenance requirements.
- Describe how to manually test fan drive engagement and disengagement.

10.3 25,000 Mile [40,000 Km] PM

Every 25,000 miles [40,000 Km] or when performing an oil drain, conduct a quick check of the fan drive.

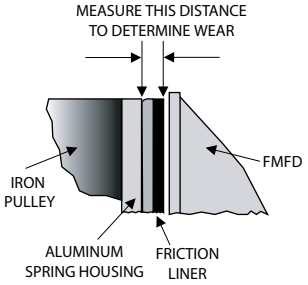


Check for air leaks around the fan drive while air applied to the fan drive.

1. Listen for leaks at the solenoid valve and filter assembly, and in the air hoses and fittings.
2. Feel for a leak with a wet finger or by applying soapy water and looking for bubbles.

NOTE:
If an air leak is not repaired, the fan drive may slip and overheat.

Check the fan drive for discoloration or any other signs of slipping or overheating. The fan drive may slip if incoming air pressure is below 90 psi [6.21 bar] or if an air leak exists inside the fan drive. Never let a leak remain unattended.



Check the fan drive bearings.

1. Turn the fan blade in both directions and feel for worn hub bearings.
2. If the fan belts can be easily removed, remove the belts and check for worn sheave bearings.
3. Turn the sheave in both directions-if either the hub or sheave bearings are worn, repair or replace the fan drive with a Horton DriveMaster Super repair kit, a Horton remanufactured DriveMaster fan drive , a new DriveMaster fan drive or a PolarExtreme DriveMaster fan drive.

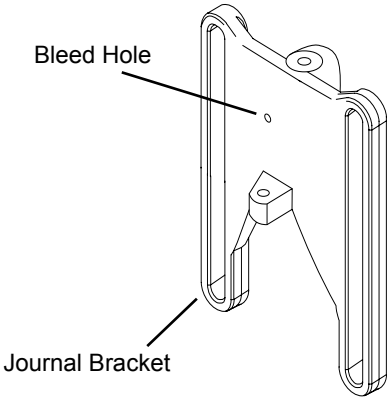
Check the fan drive friction facing for wear by measuring the thickness of the friction material. A new facing is 8.51 mm [~11/32”] thick. Replace the friction material if it has worn to less than 5.76 mm [~1/4”].

Check the electrical wiring at the thermal switch, air conditioning pressure switch, and solenoid valve. Be certain there are not any loose wires or connections.

Check the fan drive for proper engagement and disengagement.
Turn on the ignition switch but do not start the engine.

1. Be certain at least 90 psi [6.21 bar] of air pressure is available in the truck’s reservoir.
2. To manually engage and disengage the fan drive, open and close the electrical circuit going to the solenoid valve as follows:
   a. For a normally-open electrical system, use a jumper wire to short out the thermal switch or the air-conditioning refrigerant pressure switch.
   b. For a normally-closed electrical system, open the circuit by disconnecting a wire from one of the sensors or from the solenoid valve.

LESSON 11: TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	SOLUTION
I. Air leaking from Fan Drive bleed hole	1. Bad seals or air cartridge.  	1. Install Repair Kit.
II. Premature Friction Lining failure		
1. Obstructed fan.	1. Loose shroud, bent fan, torn engine mounts, etc.	1. Find and remove obstruction, repair or replace damaged parts. Install Repair Kit.
2. Low air pressure to fan drive.	2 a. Restricted air line. b. Restricted solenoid valve. c. Low system air pressure. d. System air leak.	2. a. Replace air line. Install Repair Kit. b. Replace solenoid valve. Install Repair Kit. c. Repair system. Install Repair Kit. d. Repair leak. Install Repair Kit.
3. Excessive cycling.	3. a. A/C freon overcharge. b. A/C pressure switch setting too low. c. Poor ground or wire connection. d. Improper temperature control setting. e. Faulty ECM.	3. a. Check and adjust to specifications. b. Check A/C pressure switch. c. Check electrical connections. d. Check temperature setting of all controls. thermal switch setting should engage the fan Drive 10°F higher than the full open temperature of the thermostat. e. Check ECM.

PROBLEM	PROBABLE CAUSE	SOLUTION
II. Premature Friction Lining failure Excessive cycling (continued)	f. Faulty thermal switch. g. Restriction in front of radiator blocking air flow. h. Faulty Air-Temp Switch. **Air Problem** 1. Solenoid valve not exhausting or engaging properly.	f. Replace the Thermal Switch. g. Check for proper shutter operation, winter front or other restriction in or in front of the radiator. h. Replace the Air-Temp Switch. 1. Check for plugged exhaust/ intake port on the solenoid valve. Clean or replace the solenoid valve.
III. Fan Drive fails to engage/disengage	**Electrical Problem** 1. Open/shorted circuit. 2. Improperly wired. 3. Thermal switch incorrect for application. 4. Failed solenoid valve. **Air Problem** 1. Air line restricted. 2. Solenoid valve defective. **Piston will not actuate** 1. Piston seized due to contamination or dry seals.	1. Check electrical connections. 2. Check wiring according to diagram. 3. Check thermal switch application. Replace if wrong or defective. 4. Replace the solenoid valve. 1. Check air line from solenoid to fan drive for kinks or obstructions. 2. Replace the solenoid valve. Check to see if air exhaust is restricted. 1. Clean the air supply and install a Rebuild Kit.

PROBLEM	PROBABLE CAUSE	SOLUTION
IV. Fan Drive cycles frequently	**Electrical Problem** 1. Poor ground wire connection. 2. Improper temperature control settings. 3. A/C Pressure Switch setting too low. 4. Restriction in front of radiator, blocking air flow. 5. Faulty thermal switch. 6. Faulty Air-Temp Switch. 7. Vehicle Coolant level too low.	1. Check electrical connections. 2. Check temperature setting of all controls. thermal switch should engage the fan drive 10° F higher than the full open temperature of the thermostat. 3. Check A/C Pressure Switch. Use higher switch. 4. Check shutter operation, winter fronts, or obstruction in front of radiator. 5. Replace the thermal switch. 6. Replace the Air-Temp Switch. 7. Fill to manufacturer's recommended level.
V. Fan Drive engaged, engine running hot.	1. Restriction in front of radiator. 2. Fan capacity not large enough. 3. Problem in cooling system.	1. Make sure nothing is obstructing the air flow through the radiator. 2. Refer to specifications. 3. Refer to engine manual.

REVIEW QUESTIONS - FAN DRIVE SERVICE

1. DriveMaster fan drive parts that are visible externally are the fan mounting disc, friction liner, air chamber seal, and the journal bracket. **True / False**

2. The two most commonly replaced parts are the fan mounting disc and friction liner. **True / False**

3. A DriveMaster Seal Kit would be the most appropriate choice if: **a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, d) the friction liner is worn.**

4. A DriveMaster Super Kit would be the most appropriate choice if: **a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, d) the friction liner is worn.**

5. A DriveMaster Friction Disc Kit would be the most appropriate choice if: **a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, d) the friction liner is worn.**

6. A DriveMaster Friction Liner Kit would be the most appropriate choice if: **a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, d) the friction liner is worn.**

7. Before removing the fan drive from the vehicle, it is important to: **a) turn the ignition off, b) apply the parking brake, c) block the wheels, d) bleed the air from the reservoir, e) all the above.**

8. Applying 80-120 PSI [5.44 - 8.16 bar] air pressure to the fan drive air inlet will aid in removing the fan drive Mounting disc. **True / False**

9. The jack bolt is loosened by turning it counter-clockwise using a C55 Torx bit. **True / False**

10. Pitting or blistering on the inside contact surface of the fan mounting disc is cause for replacement. **True / False**

11. The cage nut from the repair kit keeps the spring housing / piston assembly together during disassembly. **True / False**

12. Before removing the friction liner, air pressure should be: **Off / On**

13. The air chamber is located directly underneath the spring housing / piston assembly. **True / False**

14. Moisture inside the air chamber is normally just routine condensation. **True / False**

15. When checking the air chamber seals, wear on the face seal may indicate dirt exists in the air system. **True / False**

16. The Air chamber Cap retaining ring must be removed before removing the air chamber cap. **True / False**

17. First, the Bearing Nut is removed, then the Sheave can be removed from the journal bracket. **True / False**

18. The chevron markings on the bearings must be aligned to form an arrow. **True / False**

19. The chevron markings on the bearings need to be aligned when using spacers. **True / False**

20. New bearings must be disassembled and lubricated. **True / False**

21. When installing the bearings, only the outer races should be pressed on. **True / False**

22. When replacing the air cartridge, the curved side of the beveled retaining ring faces the cartridge. **True / False**

23. Eye safety protection should be used when removing the retaining ring of the air cartridge. **True / False**

24. The O-rings of the new air cartridge assembly are lubricated; **a) before, or b) after**, installation.

25. When replacing the Bearing Nut, the hex faces down and the relief of the nut points away from the journal bracket and bearings. **True / False**

26. The friction liner should be properly lubricated before installation. **True / False**

27. When reinstalling the spring housing / piston assembly, the "V" of the main air chamber seal faces down in the sheave. **True / False**

28. The Button Head Screws should be alternately and evenly tightened when replacing the friction liner. **True / False**

29. When reinstalling the spring housing / piston assembly, grease should be applied: **a) deep into the air chamber, b) along the edge of the friction liner, c) only in the immediate area of the air chamber seal.**

30. When lubricating the air chamber seal, use only the amount that fully covers the seal. **True / False**

31. When installing the fan mounting disc, air must be blocked from the air chamber to remove the cage nut and to ensure proper jack bolt torque. **True / False**

32. When removing or installing the DriveMaster, you should protect the radiator. **True / False**

33. Belts should be tensioned according to: **a) fan drive specification, b) industry standards, c) manufacturer or vehicles specifications.**

34. A belt tensioner should be used to determine proper belt tightness as listed in the manufacture or vehicle specifications. **True / False**

35. Air leaks are the #1 cause of fan drive problems. **True / False**

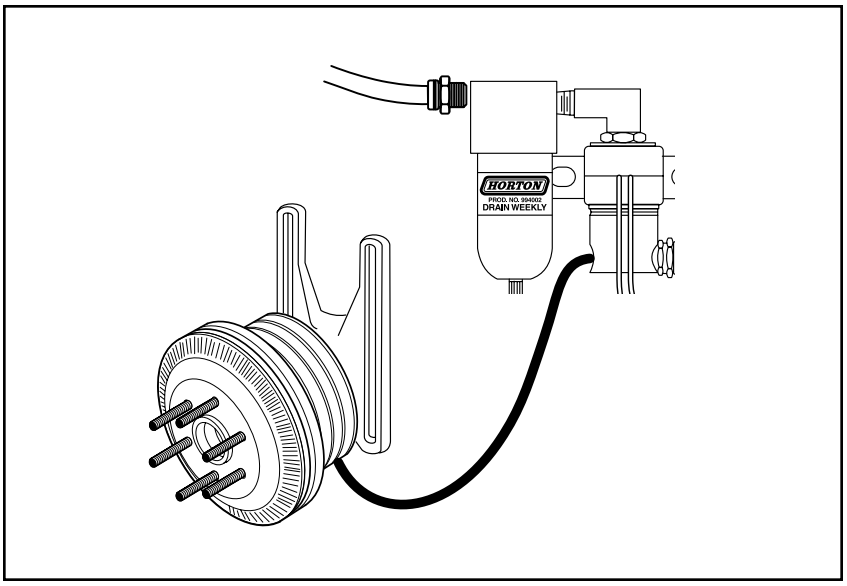
36. When observing fan drive operations, it is a good idea to look for vibration, fan blade contact, or fan drive slippage. **True / False**

37. The fan drive air filter should be drained and inspected for contaminants: **a) weekly, B) monthly, c) annually.**

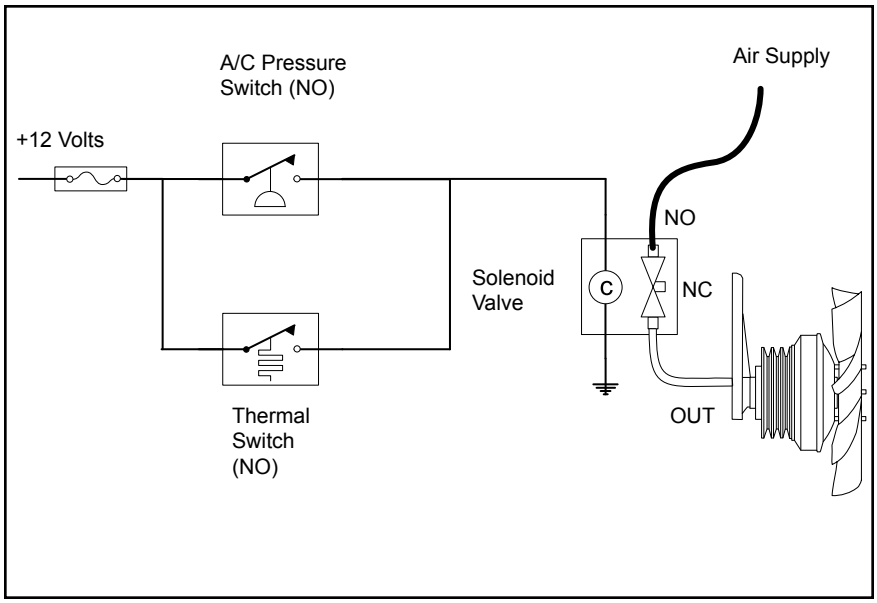
38. 25,000 mile (40,000 Km) PM requirements include checking the fan drive bearings, friction disc facing, wiring, overheating, and proper engagement and disengagement. **True / False**

39. If an air leak is not fixed, the fan drive may start to slip and overheat. **True / False**

40. On the illustration below, indicate at least six places you should check for air leaks.



41. For the fan drive system below, indicate where a jumper wire would be placed to manually test fan drive engagement.



REVIEW ANSWERS - FAN DRIVE SERVICE

1. DriveMaster fan drive parts that are visible externally are the fan mounting disc, friction liner, air chamber seal, and the journal bracket. True / **False**

2. The two most commonly replaced parts are the fan mounting disc and friction liner. **True** / False

3. A DriveMaster Seal Kit would be the most appropriate choice if: **a) an air leak has developed inside the fan drive,** b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, d) the friction liner is worn.

4. A DriveMaster Super Kit would be the most appropriate choice if: a) an air leak has developed inside the fan drive, **b) the bearings are running rough or if the fan drive needs to be completely rebuilt,** c) the fan mounting disc is damaged, d) the friction liner is worn.

5. A DriveMaster Friction Disc Kit would be the most appropriate choice if: a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, **c) the fan mounting disc is damaged,** d) the friction liner is worn.

6. A DriveMaster Friction Liner Kit would be the most appropriate choice if: a) an air leak has developed inside the fan drive, b) the bearings are running rough or if the fan drive needs to be completely rebuilt, c) the fan mounting disc is damaged, **d) the friction liner is worn.**

7. Before removing the fan drive from the vehicle, it is important to: a) turn the ignition off, b) apply the parking brake, c) block the wheels, d) bleed the air from the reservoir, **e) all the above.**

8. Applying 80-120 PSI [5.44 - 8.16 bar] air pressure to the fan drive air inlet will aid in removing the fan drive Mounting disc. **True** / False

9. The jack bolt is loosened by turning it counter-clockwise using a C55 Torx bit. **True** / False

10. Pitting or blistering on the inside contact surface of the fan mounting disc is cause for replacement. **True** / False

11. The cage nut from the repair kit keeps the spring housing / piston assembly together during disassembly. **True** / False

12. Before removing the friction liner, air pressure should be: **Off** / On

13. The air chamber is located directly underneath the spring housing / piston assembly. **True** / False

14. Moisture inside the air chamber is normally just routine condensation. True / **False**

15. When checking the air chamber seals, wear on the face seal may indicate dirt exists in the air system. **True** / False

16. The Air chamber Cap retaining ring must be removed before removing the air chamber cap. **True** / False

17. First, the Bearing Nut is removed, then the sheave can be removed from the journal bracket. **True** / False

18. The chevron markings on the bearings must be aligned to form an arrow. **True** / False

19. The chevron markings on the bearings need to be aligned when using spacers. **True** / False

20. New bearings must be disassembled and lubricated. True / **False**

21. When installing the bearings, only the outer races should be pressed on. **True** / False

22. When replacing the air cartridge, the curved side of the beveled retaining ring faces the cartridge. **True** / False

23. Eye safety protection should be used when removing the retaining ring of the air cartridge. **True** / False

24. The O-rings of the new air cartridge assembly are lubricated; **a) before,** or b) after, installation.

25. When replacing the Bearing Nut, the hex faces down and the relief of the nut points away from the journal bracket and bearings. True / **False**

26. The friction liner should be properly lubricated before installation. True / **False**

27. When reinstalling the spring housing / piston assembly, the "V" of the main air chamber seal faces down in the sheave. **True** / False

28. The Button Head Screws should be alternately and evenly tightened when replacing the friction liner. **True** / False

29. When reinstalling the spring housing / piston assembly, grease should be applied: a) deep into the air chamber, b) along the edge of the friction liner, **c) only in the immediate area of the air chamber seal.**

30. When lubricating the air chamber seal, use only the amount that fully covers the seal. True / **False**

31. When installing the fan mounting disc, air must be blocked from the air chamber to remove the cage nut and to ensure proper jack bolt torque. True / **False**

32. When removing or installing the DriveMaster, you should protect the radiator. **True** / False

33. Belts should be tensioned according to: a) fan drive specification, b) industry standards, **c) manufacture or vehicles specifications.**

34. A belt tensioner should be used to determine proper belt tightness as listed in the manufacture or vehicle specifications. **True** / False

35. Air leaks are the #1 cause of fan drive problems. **True** / False

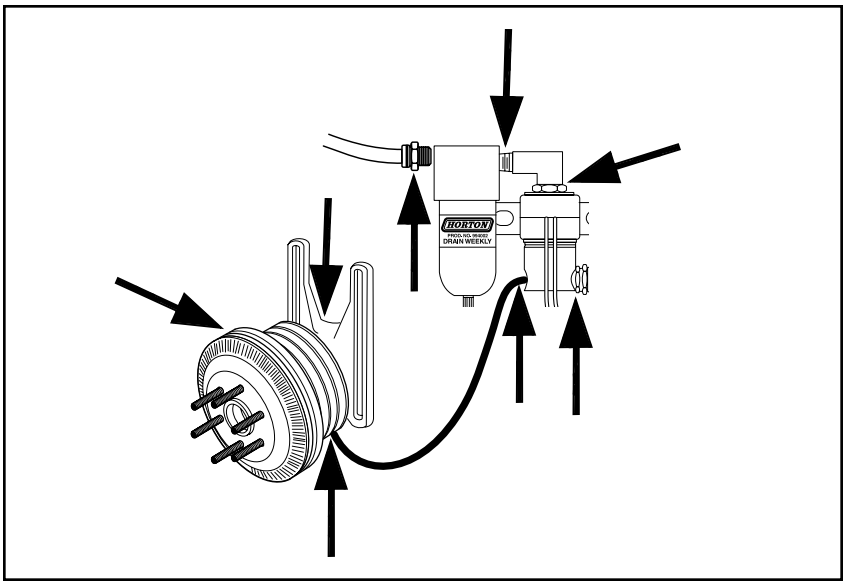
36. When observing fan drive operations, it is a good idea to look for vibration, fan blade contact, or fan drive slippage. **True** / False

37. The fan drive air filter should be drained and inspected for contaminants: **a) weekly,** B) monthly, c) annually.

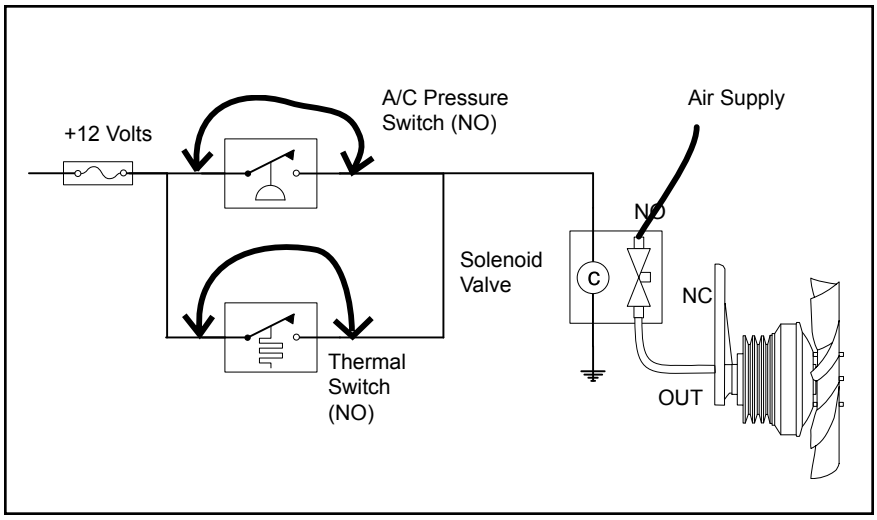
38. 25,000 mile (40,000 Km) PM requirements include checking the fan drive bearings, friction disc facing, wiring, overheating, and proper engagement and disengagement. **True** / False

39. If an air leak is not fixed, the fan drive may start to slip and overheat. **True** / False

40. On the illustration below, indicate at least six places you should check for air leaks.



41. For the fan drive system below, indicate where a jumper wire would be placed to manually test fan drive engagement.



FINAL TEST

Complete the following test then submit your answers to:

Horton, Inc.
2565 Walnut St.
Roseville, MN 55113
Attn: DriveMaster Test

Or fax it to: 651-361-6801

Please fill in the following information so that we can send your test results and training certificate back to you.

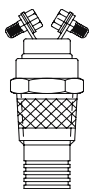
Your Name:_____
Company / School Name:_____
Address 1:_____
Address 2:_____
City, State, Zip_____

FINAL TEST

1. Advantages of using a Horton fan drive include : **a) increased horsepower, less fan noise, increased fuel economy, b) reduced engine RPM and service, c) reduced water pump repairs.**

2. In the fan drive control system, the solenoid valve: **a) acts as a sensor, b) makes sure the air filter is operating properly, c) applies or exhausts air to the fan drive.**

3. Identify this component by circling its name.

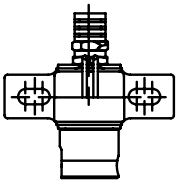


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

4. Identify this component by circling its name.

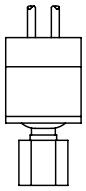


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

5. Identify this component by circling its name.



COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

6. The fan drive is engaged when air pressure is blocked by the solenoid valve. **True / False**

7. The engine coolant thermal switch sends a signal to disengage the fan drive when the engine coolant reaches the switch's high set point. **True / False**

8. In a normally-open electrical control system, electrical contacts are open when engine temperature and air conditioning pressure are below high set points. **True / False**

9. When air conditioning pressure reaches the low set point the refrigerant pressure switch sends a signal to the: **a) air filter, b) thermal switch, c) solenoid valve** to disengage the fan drive.

10. The plunger inside the solenoid valve moves to connect the valve outlet port to one of the two inlet ports. **True / False**

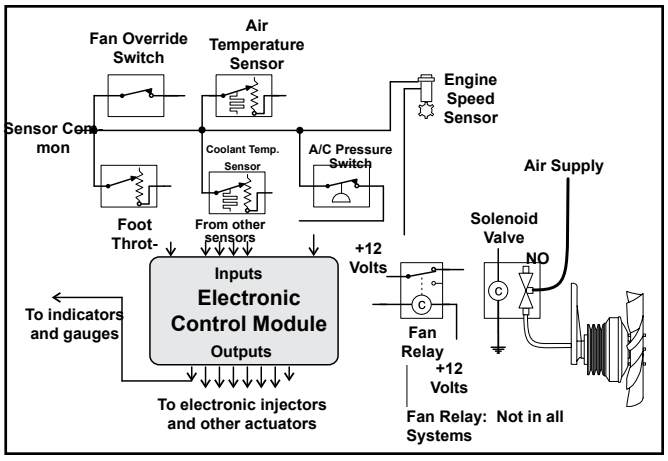
11. Solenoid valves should be mounted: **a) near the engine, b) away from vibration and the elements, c) in an easy service location.**

12. The ECM sends and receives signals from the engine, transmission and other sensors to control how the vehicle operates. **True / False**

13. In an ECM - controlled system, one sensor may affect several actuators and one actuator may be affected by several sensors. **True / False**

14. If a vehicle has an ECM - based control system it will have: **a) A/C pressure switch, b) thermal switch**.

15. Trace the path of a sensor signal to fan drive operation in an ECM - controlled system.



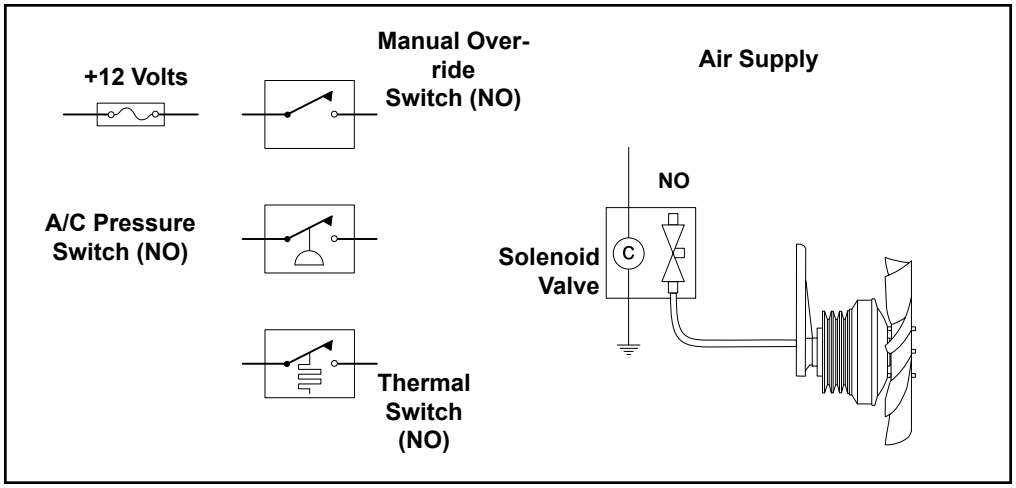
16. ECM fault code explanations are listed in the vehicle service manual. **True / False**

17. The three types of fan drive control systems are: **a) normally-engaged, normally-disengaged, and electrically controlled, b) ECM-controlled, normally-open and normally-closed, c) electronic, pneumatic and hydraulic.**

18. If a vehicle has a normally-closed control system, the air supply for the DriveMaster should be connected to the: **a) normally-open, or B) normally-closed**, port of the 3-way solenoid valve.

19. In a normally-open control system switches are wired in parallel. **True / False**

20. On the diagram, connect the electrical components for a normally-open control system and indicate if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.

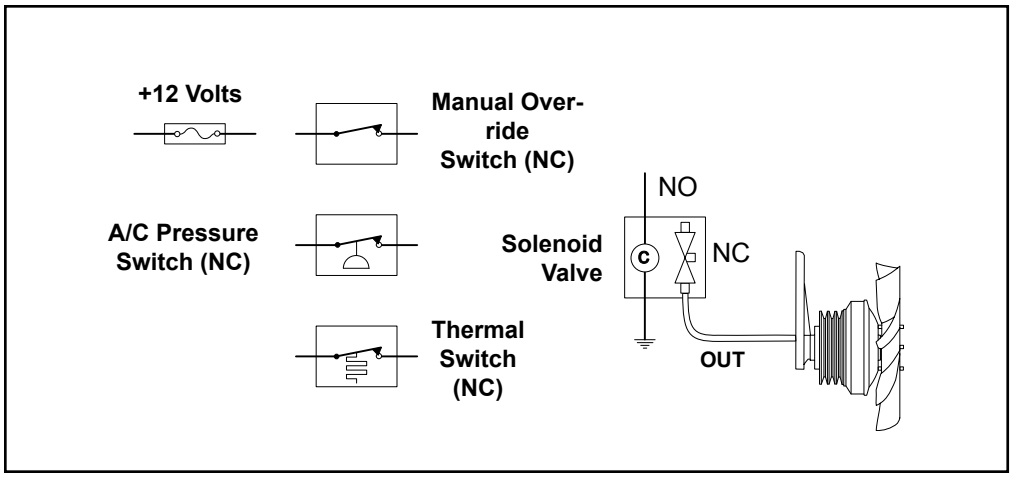


21. When all switches are open in a normally-open control system, the solenoid is: **a) energized, b) de-energized**, and the fan drive is: **a) engaged, b) disengaged.**

22. If a switches closes in a normally-open control system, the solenoid is: **a) energized, b) de-energized**, and the fan drive is: **a) engaged, b) disengaged.**

23. In a normally-closed control system, switches are wired in **a) series, b) parallel**.

24. On the diagram, connect the electrical components for a normally-closed control system and indicate if the air supply is connected to the solenoid valve's normally-open or Normally-Close inlet port.



25. Air will escape through the outlet port going to the fan drive of a normally-open solenoid valve when air is applied to the top. **True / False**

26. If a switch opens in a normally-closed control system, the solenoid is : **a) energized, b) de-energized**, and the fan drive is: **a) engaged, b) disengaged.**

27. The fan drive can be tested in a normally-open control system by disconnecting a wire from a sensor. **True / False**

28. DriveMaster fan drive parts that are visible externally are the fan mounting disc, friction liner, air chamber seal, and the journal bracket. **True / False**

29. The two most commonly replaced parts are the fan mounting disc and friction liner. **True / False**

30. Match the Repair Kit with the most likely application:

___ DriveMaster Seal Kit	**A. The fan mounting disc is damaged**
___ DriveMaster Super Kit	**B. The bearings are running rough or the fan drive needs to be completely rebuilt**
___ DriveMaster Friction Disc Kit	**C. The friction liner is worn**
___ DriveMaster Friction Liner Kit	**D. An air leak has developed inside the fan drive**

31. Are the following steps for removing the fan drive in the correct order? 1. Perform safety precautions. 2. Disconnect the air supply line. 3. Remove the fan. 4. Remove drive belts from the fan drive. 5. Remove the fan drive. **Yes / No**

32. Applying 80-120 PSI [5.44 - 8.16 bar] air pressure to the fan drive air inlet will aid in removing the fan mounting disc. **True / False**

33. The best choice for securing the fan mounting disc when loosening the jack bolt is: **a) a screwdriver, b) rebar, c): flat blade tool or small pry bar.**

34. Pitting or blistering on the inside contact surface of the fan mounting disc is cause for replacement. **True / False**

35. The purpose of the cage nut is to keep the Spring House / Piston assembly together during disassembly of the fan drive. **True / False**

36. Failure to release air pressure before removing the spring housing / piston assembly could cause the assembly to fly up, causing injury. **True / False**

37. The Spring Housing is disassembled and routinely serviced. **True / False**

38. Dirt or moisture problems in the air system must be corrected before the fan drive is reinstalled. **True / False**

39. Air chamber seals should be inspected for: **a) part number and issue date, b) wear, rips and tears, c) hardness, flexibility and grease resistance.**

40. The air chamber cap retaining ring must be removed before removing the air chamber cap. **True / False**

41. The sheave can be pulled off the journal bracket once the Bearing Nut is removed. **True / False**

42. After the chevron markings on the bearings are aligned for form an arrow, the bearings must point toward the front of the fan drive. **True/ False**

43. The chevron markings on the bearings need to be aligned when using spacers. **True / False**

44. When using bearing spacers, the spacers must be positioned OUTSIDE the sheave bearings. **True / False**

45. When installing the bearings, pressing on the : **a) inner**, or **b) outer**, races will damage the bearings causing premature wear.

46. When replacing the air cartridge, the curved side of the beveled retaining ring faces **a) toward, b) away** from the cartridge.

47. The float tip seal on the air cartridge should be protected from scratches or damage. **True / False**

48. The O-rings of a new air cartridge assembly are lubricated: **a) before, or b) after**, installation.

49. When replacing the bearing nut, the hex faces down and the relief of the nut points away from the journal bracket and bearings. **True / False**

50. The friction liner should be handled on the edges to avoid contamination, and care must be taken to not get grease, liquids or other contaminants on it. **True / False**

51. When reinstalling the spring housing / piston assembly, the “V” of the air chamber seal can face either up or down. **True / False**

52. The Button Head Screws should be alternately and evenly tightened when replacing the friction liner. **True / False**

53. When reinstalling the spring housing / piston assembly, grease should be applied at, or just below the air chamber seal. **True / False**

54. The entire tube of O-ring lubricant is used when lubricating the new seals and contact surfaces. **True / False**

55. When installing the fan mounting disc, air must be blocked from the air chamber to remove the cage nut and to ensure proper jack bolt torque. **True / False**

56. When removing or installing the DriveMaster, the best way to protect the radiator is by: **a) using cardboard, b) removing the radiator, c) rebuilding the fan drive while on the engine.**

57. Over- or under-adjusting belt tension could result in: **a) premature Bearing failure, b) shortened friction liner life, c) both a and b.**

58. A belt tensioner should be used to determine proper belt tightness as listed in the manufacturer or vehicle specifications. **True / False**

59. Fan drive Operation can be checked by disconnecting/ connecting the lead from the ECM to the solenoid valve (assuming an "on' signal from the ECM is present). **True / False**

60. The most frequent thing to check when performing fan drive preventive Maintenance is: **a) air leaks, b) Bearing wear, c) PSI to engage.**

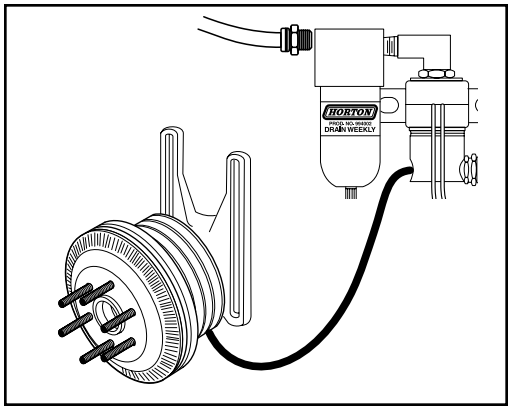
61. When observing fan drive operation, look for: **a) vibration, b) fan blade contact, c) fan drive slippage, d) all of the above.**

62. The fan drive filter element should be cleaned using: **a) hand cleaner, b) soap and water, c) parts solvent.**

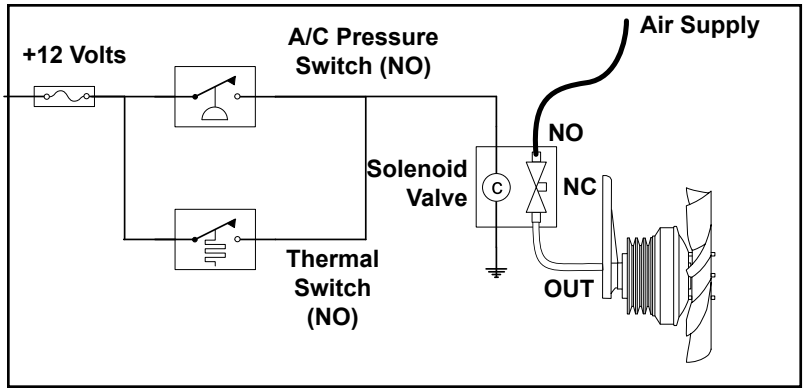
63. 25,000 mile (40,000 Km) PM requirements include checking: **a) for air leaks, b) for discoloring or signs of overheating, c) fan drive bearings, d) friction disc facing, e) Electrical wiring, f) proper engagement and disengagement, g) all the above.**

64. The recommended methods to check for air leaks in the fan drive and control system are: **a) listen, b) wet finger, c) soapy water d) all the above.**

65. On the illustration below, indicate at least six places you should check for air leaks.



66. For the fan drive system below, indicate where a jumper wire would be placed to manually test fan drive engagement.

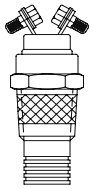


FINAL TEST ANSWERS

1. Advantages of using a Horton fan drive include : **a) increased horsepower, less fan noise, increased fuel economy,** b) reduced engine RPM and service, c) reduced water pump repairs.

2. In the fan drive control system, the solenoid valve: a) acts as a sensor, b) makes sure the air filter is operating properly, **c) applies or exhausts air to the fan drive.**

3. Identify this component by circling its name.

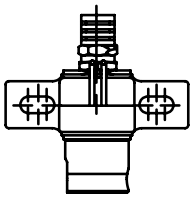


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

4. Identify this component by circling its name.

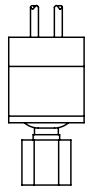


COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

5. Identify this component by circling its name.



COMPONENTS
A. Solenoid Valve

B. Engine Coolant Thermal Switch

C. Refrigerant Pressure Switch

6. The fan drive is engaged when air pressure is blocked by the solenoid valve. **True** / False

7. The engine coolant thermal switch sends a signal to disengage the fan drive when the engine coolant reaches the switch's high set point. True / **False**

8. In a normally-open electrical control system, electrical contacts are open when engine temperature and air conditioning pressure are below high set points. **True** / False

9. When air conditioning pressure reaches the low set point the refrigerant pressure switch sends a signal to the: a) air filter, b) thermal switch, **c) solenoid valve** to disengage the fan drive.

10. The plunger inside the solenoid valve moves to connect the valve outlet port to one of the two inlet ports. **True** / False

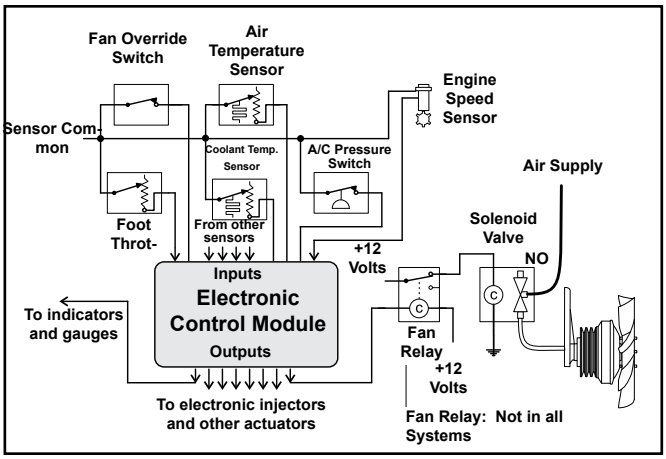
11. Solenoid valves should be mounted: a) near the engine, **b) away from vibration and the elements,** c) in an easy service location.

12. The ECM sends and receives signals from the engine, transmission and other sensors to control how the vehicle operates. **True** / False

13. In an ECM - controlled system, one sensor may affect several actuators and one actuator may be affected by several sensors. **True** / False

14. If a vehicle has an ECM - based control system it will have: **a) A/C pressure switch,** b) thermal switch.

15. Trace the path of a sensor signal to fan drive operation in an ECM - controlled system.



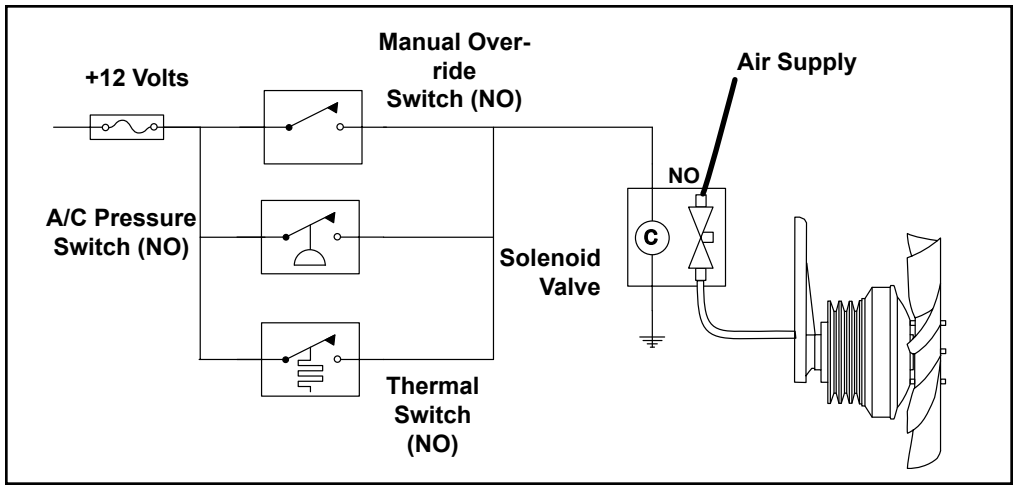
16. ECM fault code explanations are listed in the vehicle service manual. **True** / False

17. The three types of fan drive control systems are: a) normally-engaged, normally-disengaged, and electrically controlled, **b) ECM-controlled, Normally-open and normally-closed,** c) electronic, pneumatic and hydraulic.

18. If a vehicle has a normally-closed control system, the air supply for the DriveMaster should be connected to the: a) normally-open, or **B) normally-closed**, port of the 3-way solenoid valve.

19. In a normally-open control system switches are wired in parallel. **True** / False

20. On the diagram, connect the electrical components for a normally-open control system and indicate if the air supply is connected to the solenoid valve's normally-open or normally-closed inlet port.

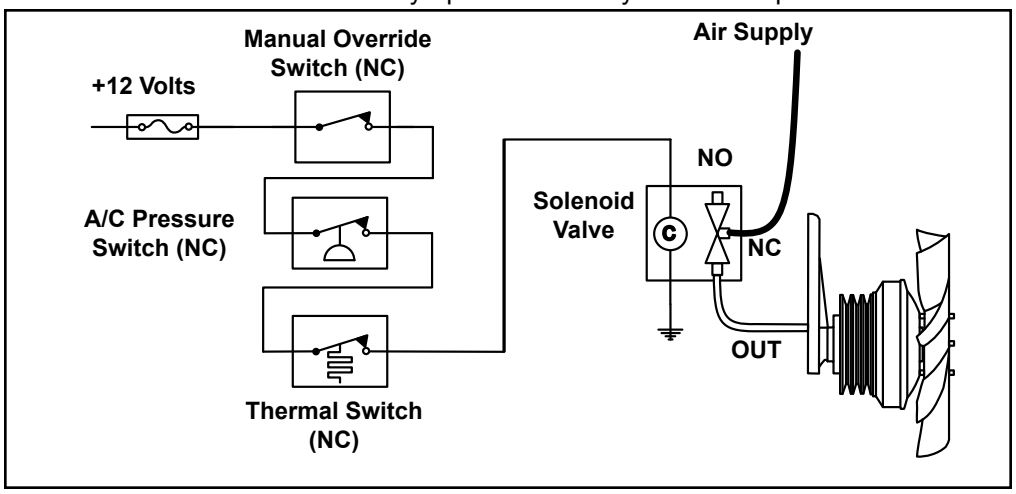


21. When all switches are open in a normally-open control system, the solenoid is: a) energized, **b) de-energized**, and the fan drive is: a) engaged, **b) disengaged.**

22. If a switches closes in a normally-open control system, the solenoid is: **a) energized,** b) de-energized, and the fan drive is: **a) engaged,** b) disengaged.

23. In a normally-closed control system, switches are wired in **a) series,** b) parallel.

24. On the diagram, connect the electrical components for a normally-closed control system and indicate if the air supply is connected to the solenoid valve's normally-open or Normally-Close inlet port.



25. Air will escape through the outlet port going to the fan drive of a normally-open solenoid valve when air is applied to the top. True / **False**

26. If a switch opens in a normally-closed control system, the solenoid is : a) energized, **b) de-energized**, and the fan drive is: **a) engaged,** b) disengaged.

27. The fan drive can be tested in a normally-open control system by disconnecting a wire from a sensor. True / **False**

28. DriveMaster fan drive parts that are visible externally are the fan mounting disc, friction liner, air chamber seal, and the journal bracket. True / **False**

29. The two most commonly replaced parts are the fan mounting disc and friction liner. **True** / False

30. Match the Repair Kit with the most likely application:

_D_ DriveMaster Seal Kit	**A. The fan mounting disc is damaged**
_B_ DriveMaster Super Kit	**B. The bearings are running rough or the fan drive needs to be completely rebuilt**
_A_ DriveMaster Friction Disc Kit	**C. The friction liner is worn**
_C_ DriveMaster Friction Liner Kit	**D. An air leak has developed inside the fan drive**

31. Are the following steps for removing the fan drive in the correct order? 1. Perform safety precautions. 2. Disconnect the air supply line. 3. Remove the fan. 4. Remove drive belts from the fan drive. 5. Remove the fan drive. **Yes** / No

32. Applying 80-120 PSI [5.44 - 8.16 bar] air pressure to the fan drive air inlet will aid in removing the fan mounting disc. **True** / False

33. The best choice for securing the fan mounting disc when loosening the jack bolt is: a) a screwdriver, b) rebar, **c): flat blade tool or small pry bar.**

34. Pitting or blistering on the inside contact surface of the fan mounting disc is cause for replacement. **True** / False

35. The purpose of the cage nut is to keep the Spring House / Piston assembly together during disassembly of the fan drive. **True** / False

36. Failure to release air pressure before removing the spring housing / piston assembly could cause the assembly to fly up, causing injury. **True** / False

37. The Spring Housing is disassembled and routinely serviced. True / **False**

38. Dirt or moisture problems in the air system must be corrected before the fan drive is reinstalled. **True /** False

39. Air chamber seals should be inspected for: a) part number and issue date, **b) wear, rips and tears,** c) hardness, flexibility and grease resistance.

40. The air chamber cap retaining ring must be removed before removing the air chamber cap. **True** / False

41. The sheave can be pulled off the journal bracket once the Bearing Nut is removed. **True** / False

42. After the chevron markings on the bearings are aligned for form an arrow, the bearings must point toward the front of the fan drive. True/ **False**

43. The chevron markings on the bearings need to be aligned when using spacers. **True** / False

44. When using bearing spacers, the spacers must be positioned OUTSIDE the sheave bearings. True / **False**

45. When installing the bearings, pressing on the : **a) inner**, or b) outer, races will damage the bearings causing premature wear.

46. When replacing the air cartridge, the curved side of the beveled retaining ring faces **a) toward,** b) away from the cartridge.

47. The float tip seal on the air cartridge should be protected from scratches or damage. **True** / False

48. The O-rings of a new air cartridge assembly are lubricated: **a) before,** or b) after, installation.

49. When replacing the Bearing nut, the hex faces down and the relief of the nut points away from the journal bracket and bearings. **True** / False

50. The friction liner should be handled on the edges to avoid contamination, and care must be taken to not get grease, liquids or other contaminants on it. **True** / False

51. When reinstalling the spring housing / piston assembly, the “V” of the air chamber seal can face either up or down. True / **False**

52. The Button Head Screws should be alternately and evenly tightened when replacing the friction liner. **True** / False

53. When reinstalling the spring housing / piston assembly, grease should be applied at, or just below the air chamber seal. **True** / False

54. The entire tube of O-ring lubricant is used when lubricating the new seals and contact surfaces. **True** / False

55. When installing the fan mounting disc, air must be blocked from the air chamber to remove the cage nut and to ensure proper jack bolt torque. True / **False**

56. When removing or installing the DriveMaster, the best way to protect the radiator is by: **a) using cardboard,** b) removing the radiator, c) rebuilding the fan drive while on the engine.

57. Over- or under-adjusting belt tension could result in: **a) premature Bearing failure**, b) shortened friction liner life, c) both a and b.

58. A belt tensioner should be used to determine proper belt tightness as listed in the manufacturer or vehicle specifications. **True** / False

59. Fan drive Operation can be checked by disconnecting/ connecting the lead from the ECM to the solenoid valve (assuming an "on' signal from the ECM is present). **True** / False

60. The most frequent thing to check when performing fan drive preventive Maintenance is: **a) air leaks**, b) Bearing wear, c) PSi to engage.

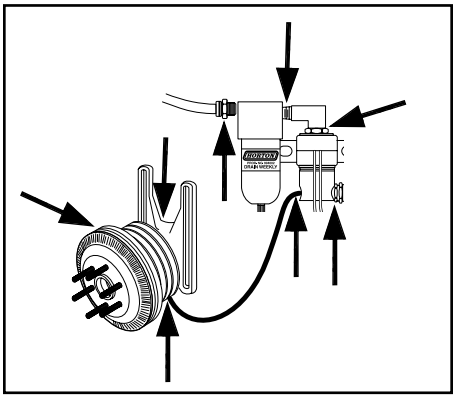
61. When observing fan drive operation, look for: a) vibration, b) fan blade contact, c) fan drive slippage, **d) all of the above**.

62. The fan drive filter element should be cleaned using: a) hand cleaner, b) soap and water, **c) parts solvent.**

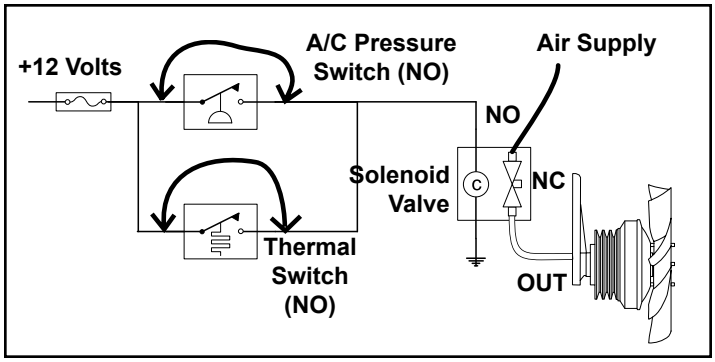
63. 25,000 mile (40,000 Km) PM requirements include checking: a) for air leaks, b) for discoloring or signs of overheating, c) fan drive bearings, d) friction disc facing, e) Electrical wiring, f) proper engagement and disengagement, **g) all the above**.

64. The recommended methods to check for air leaks in the fan drive and control system are: a) listen, b) wet finger, c) soapy water **d) all the above.**

65. On the illustration below, indicate at least six places you should check for air leaks.



66. For the fan drive system below, indicate where a jumper wire would be placed to manually test fan drive engagement.



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