SERVICE REPAIR

MANUAL

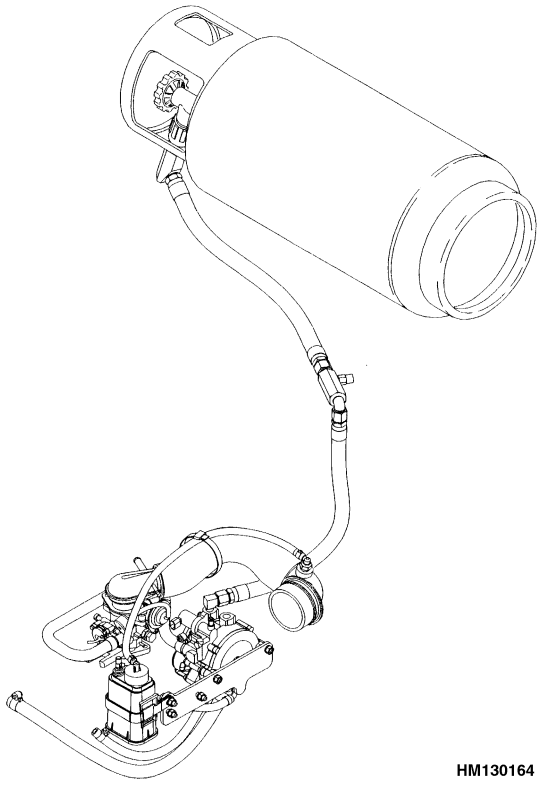
Hyster D010 (S25XM S30XM S35XM S40XMS) Forklift

HYSTER

LPG FUEL SYSTEM

AISAN CLOSED-LOOP

S/H1.50-2.00XMS
(S/H25-40XMS) [D010, E001];
S/H2.00-3.20XM
(S/H40-65XM) [D187, H177]



HM130164

HYSTER

PART NO. 1495954

900 SRM 948

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY CONNECTOR before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:

WARNING

Indicates a condition that can cause immediate death or injury!

CAUTION

Indicates a condition that can cause property damage!

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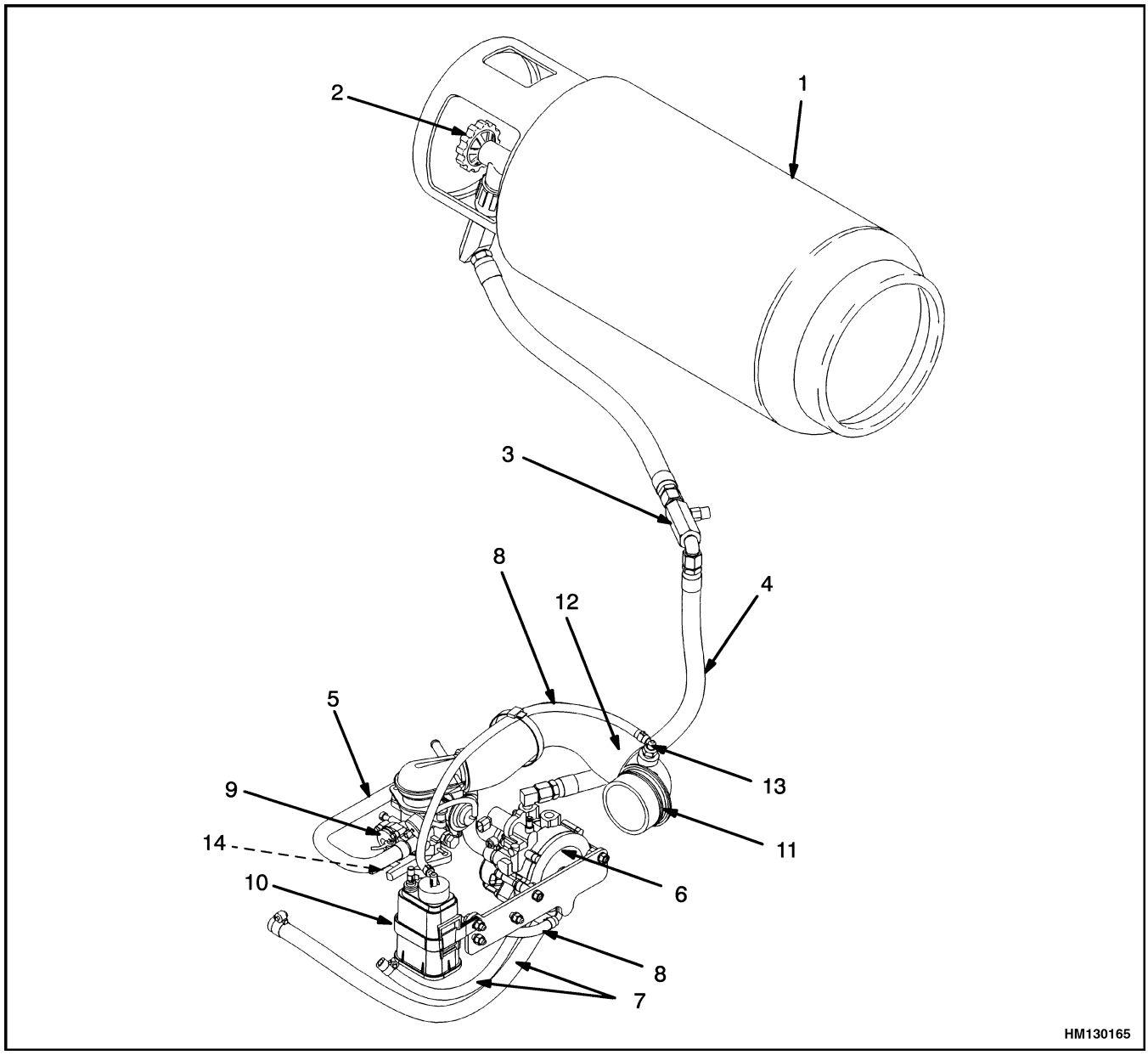
This section is for the following models:

S/H1.50-2.00XMS (S/H25-40XMS) [D010, E001];
S/H2.00-3.20XM (S/H40-65XM) [D187, H177]

General

This section has the description, operation, and repair procedures for the parts of the LPG fuel system used on the Mazda 2.0 liter, Mazda 2.2 liter, and GM 3.0L Engines.

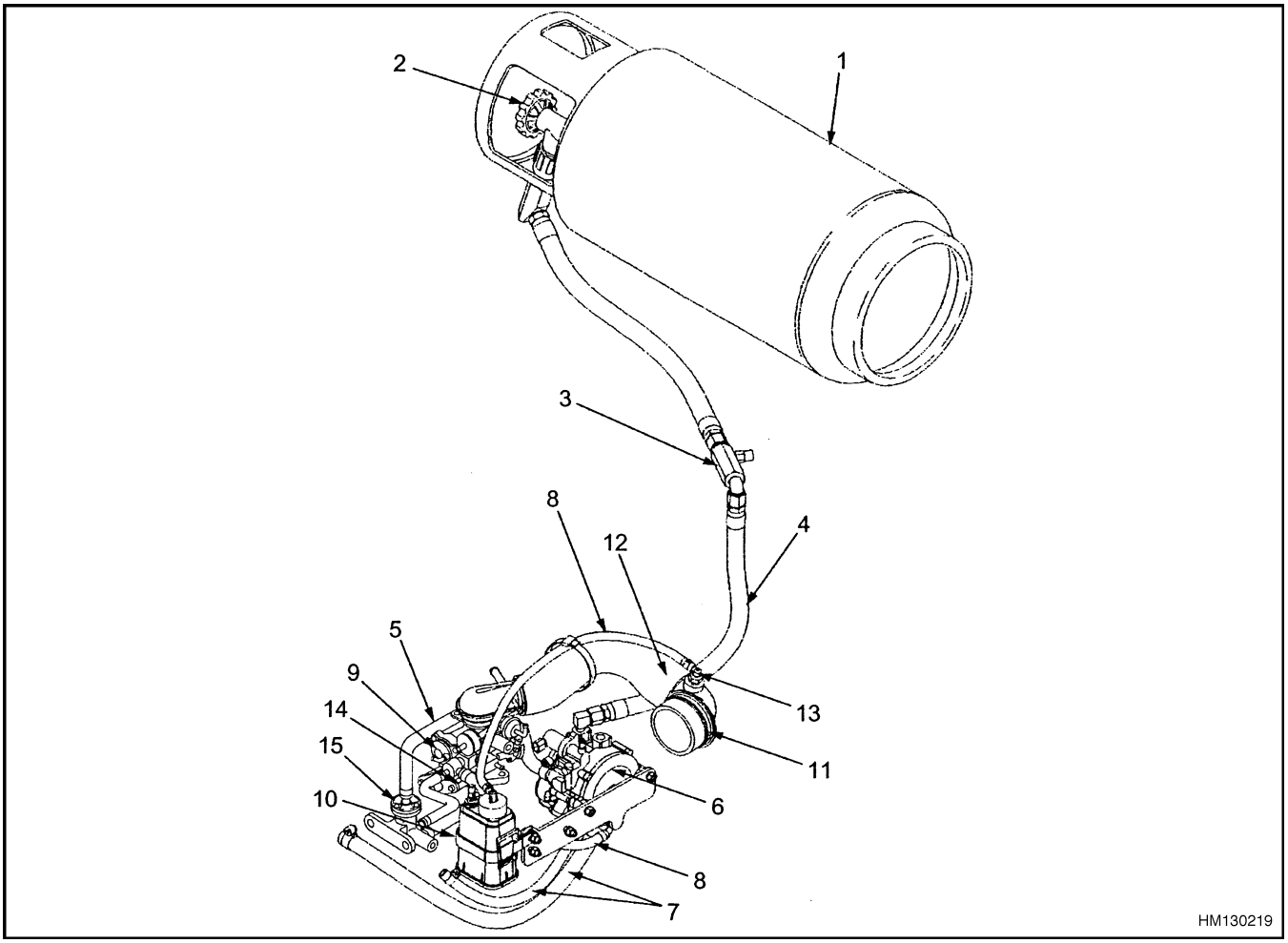


1. LPG TANK
2. SHUTOFF VALVE
3. RELIEF VALVE
4. LIQUID LPG HOSE
5. LPG VAPOR HOSE
6. REGULATOR/FILTER
7. COOLING SYSTEM HOSES
8. VACUUM/BALANCE LINE
9. LPG CARBURETOR
10. RESONATOR
11. AIR FILTER DISCHARGE ELBOW
12. AIR INTAKE HOSE
13. ORIFICE FITTING
14. FUEL INJECTOR

Figure 1. Aisan Closed-Loop LPG System

Description and Operation

The LPG fuel system has a fuel tank and valve, hydrostatic relief valve, regulator, carburetor, solenoid valve, makeup fuel injector, fuel pressure sensor and indicator lamp, and governor. The LPG arrangement is shown in Figure 1 and Figure 2.



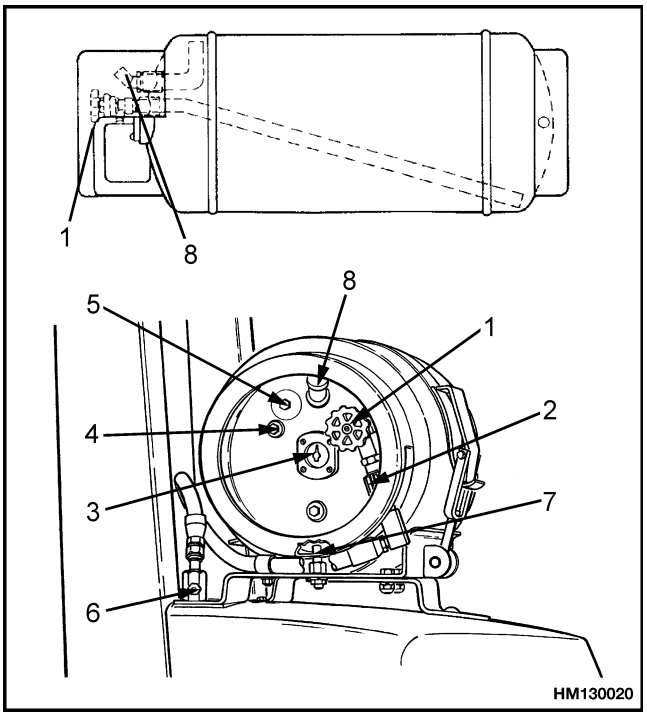
1. LPG TANK
2. SHUTOFF VALVE
3. RELIEF VALVE
4. LIQUID LPG HOSE
5. LPG VAPOR HOSE
6. REGULATOR/FILTER
7. COOLING SYSTEM HOSES
8. VACUUM/BALANCE LINE
9. LPG CARBURETOR
10. RESONATOR
11. AIR FILTER DISCHARGE ELBOW
12. AIR INTAKE HOSE
13. ORIFICE FITTING
14. FUEL INJECTOR
15. FUEL FILTER (SLOW)

Figure 2. Aisan Closed Loop LPG System, EPA Compliant Engine

FUEL TANK

NOTE: Some LPG tanks have an auxiliary fill fitting instead of a plug.

The fuel tank is the reservoir for the LPG system. See Figure 3. The fuel tank keeps the fuel in the liquid condition. The pressure of the fuel is 900 to 1100 kPa (130 to 160 psi) with 100% propane when the tank is full and at an ambient temperature of 27°C (81°F). The tank has a pressure relief valve that is set at 3310 kPa (480 psi). The inlet tube for the pressure relief valve is in the vapor area at the top of the tank.



1. SHUTOFF VALVE
2. QUICK-DISCONNECT FITTING
3. FUEL GAUGE
4. PLUG
5. LIQUID LEVEL INDICATOR
6. RELIEF VALVE
7. ALIGNMENT PIN
8. TANK RELIEF VALVE

Figure 3. LPG Tank

OXYGEN SENSOR

The closed-loop system incorporates an oxygen sensor in the exhaust pipe. The sensor constantly makes comparisons between the oxygen content inside the exhaust manifold and the air outside the engine. If a rich or lean air/fuel mixture is sensed in the exhaust, the sensor provides a signal to the engine control unit (ECU). The ECU will then make an adjustment to the mixture ratio by turning the makeup fuel injector on or off.

The basic operations of the regulator and the carburetor are similar to the Aisan open-loop LPG system.

REGULATOR

The function of the regulator is to change the liquid fuel to a vapor (gas) and to control the pressure of the vapor. See Figure 4 and Figure 5. The LPG fuel changes from a liquid to a vapor inside the primary pressure-reduction chamber. This conversion process cools the vapor, which in turn cools the surrounding parts of the regulator. Engine coolant is circulated through the regulator and, by convection, transfers the cold out of the chamber. Regardless of the ambient temperature, the engine coolant is always warmer than the vapor after expansion, thereby providing the warming function. This warming function of the engine coolant prevents the regulator from being too cold to operate.

The regulator consists of four chambers:

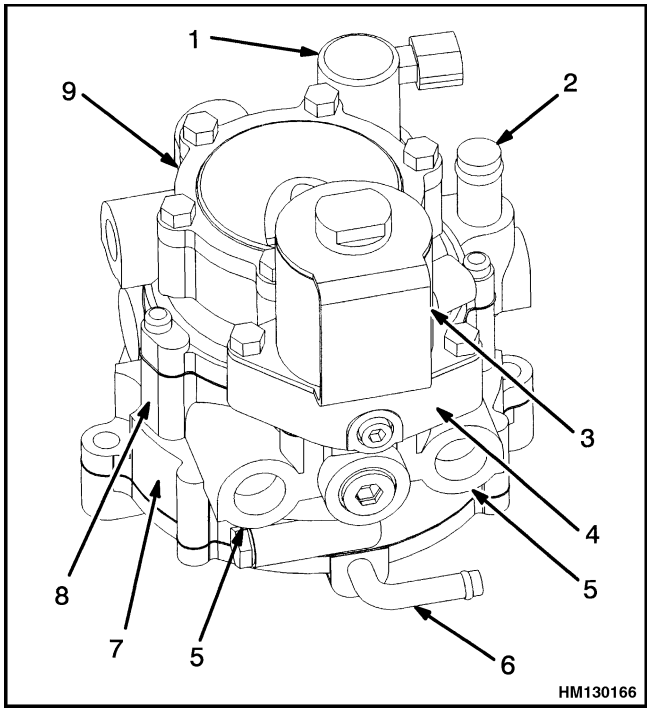
Chamber A - Start of the vaporization process.

Chamber B - Primary pressure-reduction chamber where primary vaporization occurs and the pressure is reduced. Also provides low-pressure vapor for the fuel injector.

Chamber C - Secondary pressure-reduction chamber where the vapor pressure is reduced to zero (atmospheric).

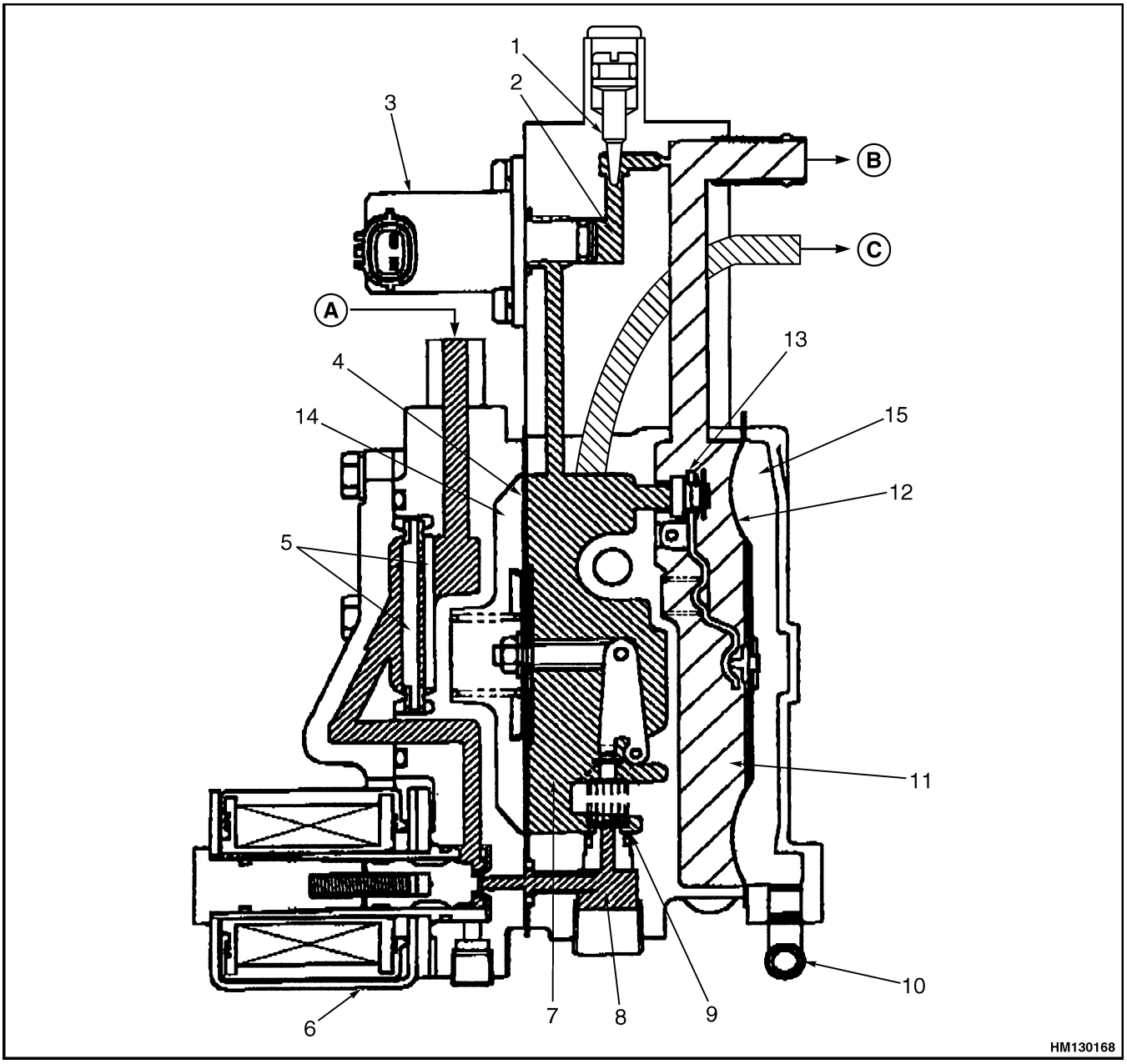
Chamber D - Provides fuel during engine start and idle.

The regulator has three operating modes: start mode, idle mode, and run mode. These modes are described in detail in the following sections.



1. IDLE BYPASS SOLENOID VALVE
2. FUEL OUTLET
3. MAIN SOLENOID VALVE
4. CHAMBER A
5. COOLANT PORTS
6. RESONATOR PORT
7. CHAMBER C
8. CHAMBER B
9. FUEL FILTER CHAMBER

Figure 4. Regulator



A. LPG INPUT FROM FUEL TANK

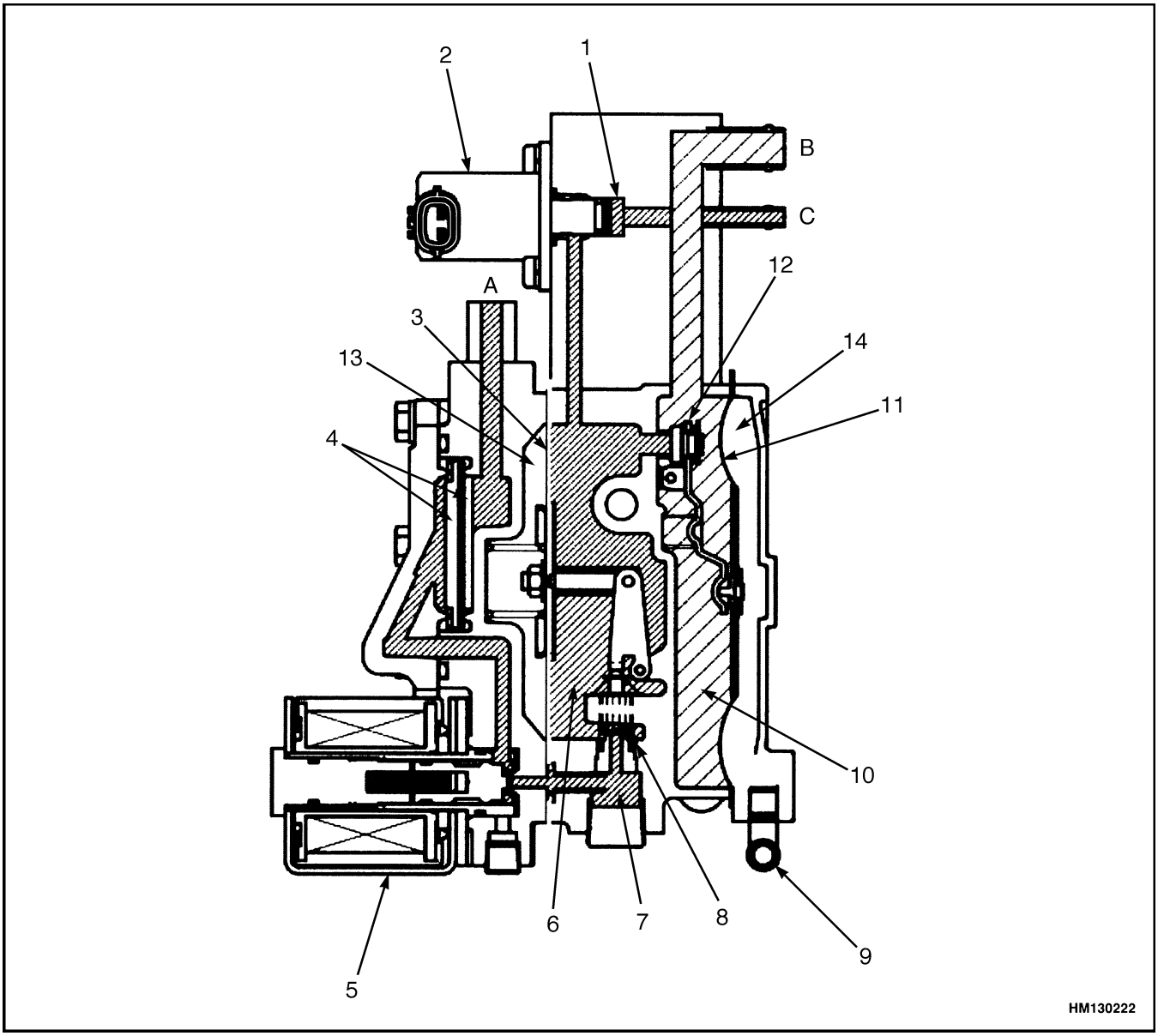
B. LPG OUTPUT TO CARBURETOR

C. LPG OUTPUT TO FUEL INJECTOR

1. IDLE MIXTURE ADJUSTING SCREW*
2. CHAMBER D
3. IDLE BYPASS SOLENOID
4. DIAPHRAGM*
5. FUEL FILTER
6. MAIN SOLENOID
7. CHAMBER B
8. CHAMBER A
9. INLET VALVE*
10. RESONATOR PORT
11. CHAMBER C
12. DIAPHRAGM*
13. INLET VALVE*
14. VACUUM CHAMBER 1
15. VACUUM CHAMBER 2

*THE IDLE MIXTURE ADJUSTING SCREW ON THIS REGULATOR CANNOT BE ADJUSTED. ITEMS 4, 9, 12, AND 13 ARE NOT SERVICEABLE PARTS.

Figure 5. Inside the Regulator



A. LPG INPUT FROM FUEL TANK
B. LPG OUTPUT TO CARBURETOR
C. LPG OUTPUT TO FUEL FILTER

1. CHAMBER D
2. IDLE BY-PASS SOLENOID
3. DIAPHRAGM
4. FUEL FILTER
5. MAIN SOLENOID
6. CHAMBER B
7. CHAMBER A
8. 1ST VALVE
9. RESONATOR CONNECTION
10. CHAMBER C
11. DIAPHRAGM
12. 2ND VALVE
13. CHAMBER 1
14. CHAMBER2

Figure 6. Inside the Regulator (EPA Compliant Engine)

Start Mode

When the ignition switch is turned to the **START** position and the engine begins to crank, both the main solenoid valve and the idle bypass solenoid valve are activated, allowing the LPG to flow from the fuel tank through the fuel filter to chamber A. See Figure 5. The fuel pressure opens the inlet valve between chambers A and B, and the fuel enters the primary pressure reduction chamber (chamber B).

When the pressure in chamber B reaches 24.5 to 34.5 kPa (7.2 to 10.2 inHg), the diaphragm expands outward and closes the inlet valve, maintaining a constant pressure in chamber B. A very small portion of the fuel is bled off into chamber D, where the idle mixture adjusting screw controls the amount of fuel that is allowed to flow out to the carburetor to start ignition.

When the throttle valve is opened slightly, the demand for fuel at the carburetor causes a slight vacuum at the output port of the regulator. This vacuum causes the diaphragm in chamber C to depress. This opens the inlet valve between chambers B and C, allowing fuel to flow from chamber B to chamber C. This allows large amounts of fuel to flow to the carburetor for complete combustion.

Idle Mode

In the idle mode, the demand for fuel at the carburetor is low and the vacuum is absent at the fuel outlet port. This causes the diaphragm in chamber C to relax and close the inlet valve between chambers B and C. See Figure 5. Pressure in chamber B builds up to 24.5 to 34.5 kPa (7.2 to 10.2 inHg), causing the diaphragm in chamber B to expand and close off the fuel supply. A balance is reached between the amount of vaporizing (liquid) through chamber A and the amount of vapor escaping past the idle mixture adjusting screw in chamber D.

The idle mixture adjusting screw is set for a lean mixture at the factory. The fuel injector supplies additional fuel to the carburetor at idle. The ECU controls the fuel injector by using inputs from the oxygen sensor and vacuum switch 1.

Run Mode

In the run mode, the throttle valve on the carburetor is opened, creating a vacuum at the fuel outlet port. This causes the diaphragm in chamber C to expand and open the inlet valve between chambers B and C. See Figure 5. This causes the pressure to drop in chamber B and relaxes the diaphragm in chamber B. This opens the inlet valve between chambers A and B. Fuel is supplied to the carburetor through chamber C, the idle bypass valve, and chamber D.

RESONATOR

The resonator is connected by vacuum hoses to a special orifice fitting on the air filter discharge elbow (see Figure 1 and Figure 7) and to the resonator port of the regulator (see Figure 4). The resonator port connects to vacuum chamber 2 (see Figure 5).

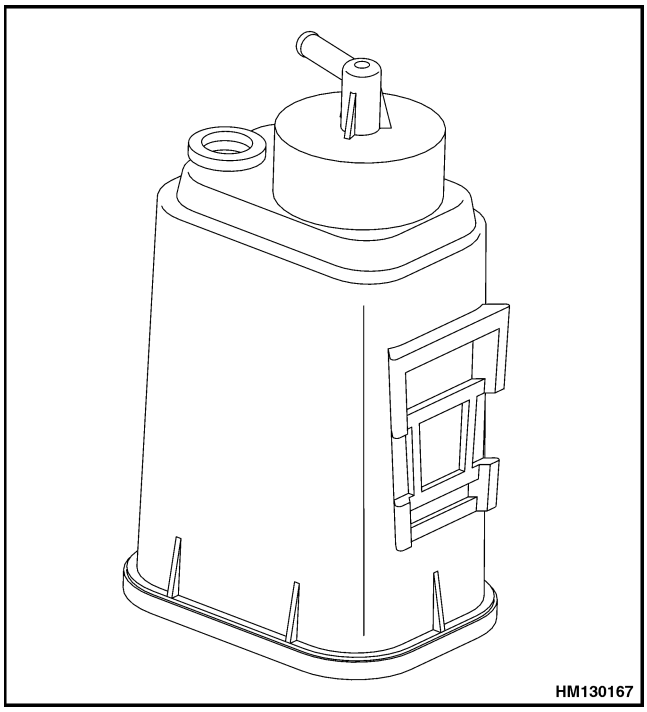


Figure 7. Resonator

As the air filter clogs, the intake vacuum increases for any relative throttle position. This increased vacuum has a similar increase in the vacuum of chambers C and 2. By increasing the vacuum of chambers C and 2 by the same level as the intake restriction, a balance is maintained and the relative position of the diaphragms remains unchanged. This maintains a constant fuel mixture regardless of the air filter restriction. See Figure 5.

The special orifice fitting and the resonator act as vacuum dampeners. The air being drawn through the intake system does not flow in a constant stream, but rather in small pulses generated during the intake stroke of the pistons. Without the resonator and orifice, these pulses could be generated at a frequency that is a natural harmonic of the diaphragm.

This would cause the diaphragm to vibrate uncontrollably and force the engine mixture to be either very rich or lean under certain operating conditions.

CARBURETOR

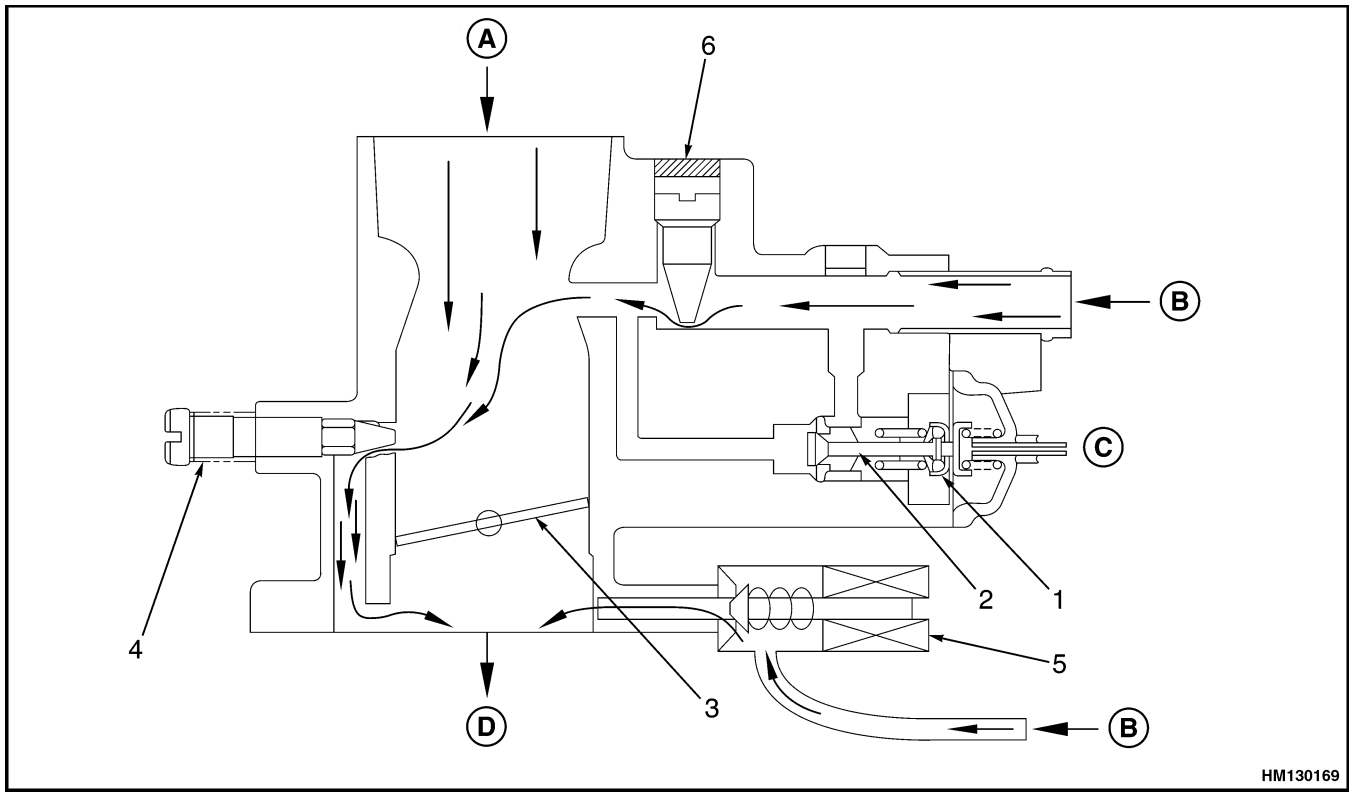
Like the regulator, the carburetor has three operating modes: start mode, idle mode, and run mode. These modes are described in detail in the following sections.

Start Mode

Before any fuel is provided to the carburetor, the ignition switch must be turned to the **ON** position and the engine must be cranked without pressing the accelerator. See Figure 8. The ECU level control unit on the engine wiring harness senses that the engine is in start mode and provides an electrical signal to energize the main solenoid, the idle bypass solenoid, and the fuel injector. Fuel then flows from the regulator to the carburetor.

The fuel flows past the orifice and into the main chamber of the carburetor, where it mixes with the air coming from the air cleaner. Because the throttle valve is closed, the air/fuel mixture flows past the idle air bypass adjusting screw, through the bypass port, to the intake manifold, and into the cylinder.

The fuel injector supplies fuel to the base of the carburetor. The fuel injector is controlled by the ECU. The engine is in closed-loop mode once the oxygen sensor is hot.



A. AIR
B. LPG
C. VACUUM FROM MANIFOLD
D. TO INTAKE MANIFOLD

1. POWER DIAPHRAGM
2. POWER VALVE
3. THROTTLE VALVE
4. IDLE AIR BYPASS ADJUSTING SCREW
5. FUEL INJECTOR
6. TAMPER-PROOF PLUG

Figure 8. Carburetor, Start Mode

Idle Mode

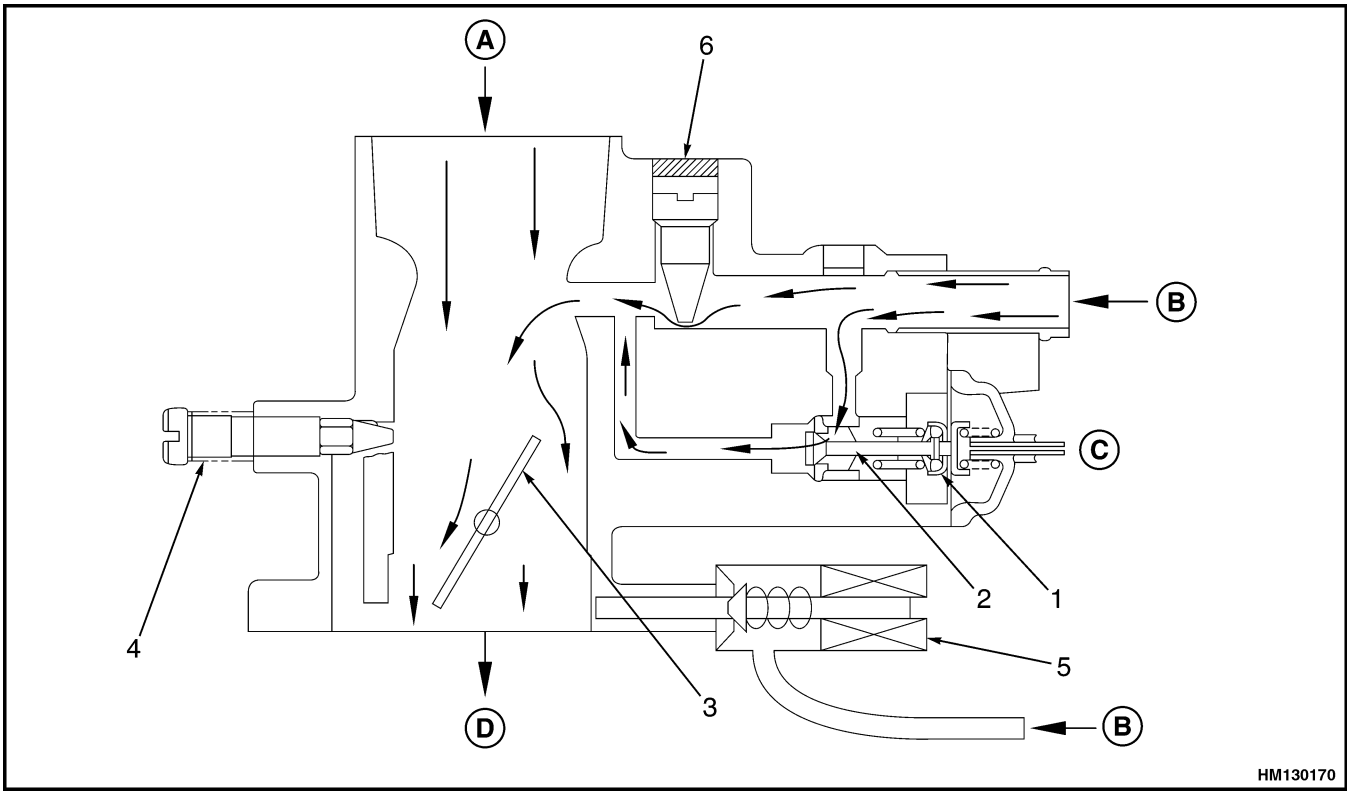
Engine idle is set by adjusting the airflow at the carburetor with the idle air bypass adjusting screw. See Figure 8. The idle mixture is set at the factory and cannot be adjusted. The engine idle is operating in open-loop mode until the oxygen sensor is heated.

Run Mode

When the accelerator is pressed, the throttle valve opens, creating a slight vacuum at the output of the regulator and causing fuel to flow at a greater rate. See Figure 9. Under heavy load, the vacuum in the intake manifold decreases. Decreasing the vacuum on the manifold side of the power diaphragm opens the power valve. The open power valve richens the fuel mixture. The oxygen sensor senses the richer fuel mixture and the ECU turns off the fuel injector. The engine is running in open-loop mode when the power valve is open. The opening and closing of the power valve according to the vacuum in the intake manifold provides optimum fuel supply to the carburetor (depending on engine load).

Governor

The governor is installed between the carburetor and the intake manifold. The governor helps control the maximum speed of the engine.



A. AIR
B. LPG
C. VACUUM FROM MANIFOLD
D. TO INTAKE MANIFOLD

1. POWER DIAPHRAGM
2. POWER VALVE
3. THROTTLE VALVE
4. IDLE AIR BYPASS ADJUSTING SCREW
5. FUEL INJECTOR
6. TAMPER-PROOF PLUG

Figure 9. Carburetor, Run Mode

Hoses Replacement

The hoses installed on LPG systems are specially made. Hoses that are made for use with hydraulic oil will be damaged by LPG. When replacing the LPG hoses, be sure to use only HYSTER APPROVED LPG hoses.

When replacing the hose to the quick-disconnect fitting, make sure that it is the same length as the hose it replaces. A hose that is the wrong length allows the tank to be installed in an incorrect position.

LPG Tank Repair

REMOVE

WARNING

Before disconnecting any part of the LPG fuel system, close shutoff valve on fuel tank. Run engine until fuel lines are empty and engine stops. If engine will not run, close shutoff valve on fuel tank and release fuel slowly in a non-hazardous area.

LPG can cause an explosion even when tanks are empty. When replacing tanks, do not weld, cause sparks, or permit flammable material on or near tanks. Do not change tanks when engine is running. Tanks must be filled by authorized personnel. Follow all safety rules. Do not remove any parts from tank.

Frost on surface of tank, valves, or fittings and the odor of LPG fuel indicates a leak. Inspect LPG system and repair a leak immediately. An LPG fuel leak creates an explosion hazard and a fire hazard. Do not attempt to start engine if there is a leak in LPG fuel system.

Do not use any LPG tank that is damaged. Damaged tanks must be removed from service.

Do not store LPG tanks near heat or an open flame. For complete instructions on the storage of LPG fuels, refer to ANSI/NFPA 58 & 505.

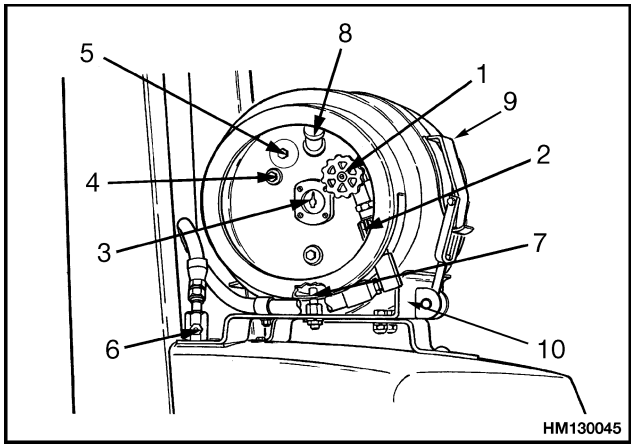
WARNING

LPG is very cold. Always wear gloves to protect your hands from LPG and the cold metal of the tank. Do not permit LPG to contact skin.

WARNING

LPG tanks are heavy. The weight of an LPG tank can exceed the maximum recommended weight for safe lifting by an individual. Get assistance when lifting or lowering an LPG tank. Use correct lifting procedures.

1. Move lift truck to area where tanks are changed.
2. Turn shutoff valve clockwise until valve is completely closed. See Figure 10.



NOTE: SOME LPG TANKS HAVE AN AUXILIARY FILL FITTING INSTEAD OF A PLUG FOR ITEM 4.

1. SHUTOFF VALVE
2. QUICK-DISCONNECT FITTING
3. FUEL GAUGE
4. PLUG
5. LIQUID LEVEL INDICATOR
6. RELIEF VALVE
7. ALIGNMENT PIN
8. TANK RELIEF VALVE
9. TANK LATCH
10. MOUNTING BRACKET

Figure 10. LPG Tank

3. Run engine until it stops. Then turn key to **OFF** position.
4. Disconnect quick-disconnect fitting.
5. Release tank latch and remove tank from bracket.

INSTALL

1. Before the tank is installed on the lift truck, check operation of fuel gauge. See Figure 10. Look at fuel gauge and move tank. The needle of the gauge must move when the fuel moves. If the needle does not move, a new tank must be installed.

WARNING

Make sure that alignment pin extends through correct hole in rim of LPG tank. The hose or fittings can be damaged if the LPG tank is not installed in the correct position. A damaged hose or fitting can release LPG fuel and cause an explosion hazard and fire hazard.

2. Install LPG tank in its bracket so that alignment pin is in correct hole in bracket. Close latches.
3. Connect quick-disconnect fitting to shutoff valve on tank. Use your hand to tighten fitting.
4. Turn shutoff valve counterclockwise to open valve.
5. Inspect fuel system for leaks when shutoff valve is open. Frost on surface of tank, valves, or fittings, or a strong odor of LPG indicates a leak.
6. The shutoff valve on the tank must be closed when the truck is not being used.

Relief Valve Repair

REMOVE AND INSTALL

WARNING

LPG can cause an explosion. Do not cause sparks or permit flammable material near LPG system. Close fuel valve on tank. Disconnect negative battery cable to prevent sparks.

1. Close shutoff valve on tank. See Figure 1.
2. Slowly loosen hose fitting for relief valve. Let fuel drain from fitting before removing relief valve.
3. The valve cannot be repaired. If the valve is damaged, install new valve. After installation, open shutoff valve slowly and inspect system for leaks.

Carburetor Repair

REMOVE

WARNING

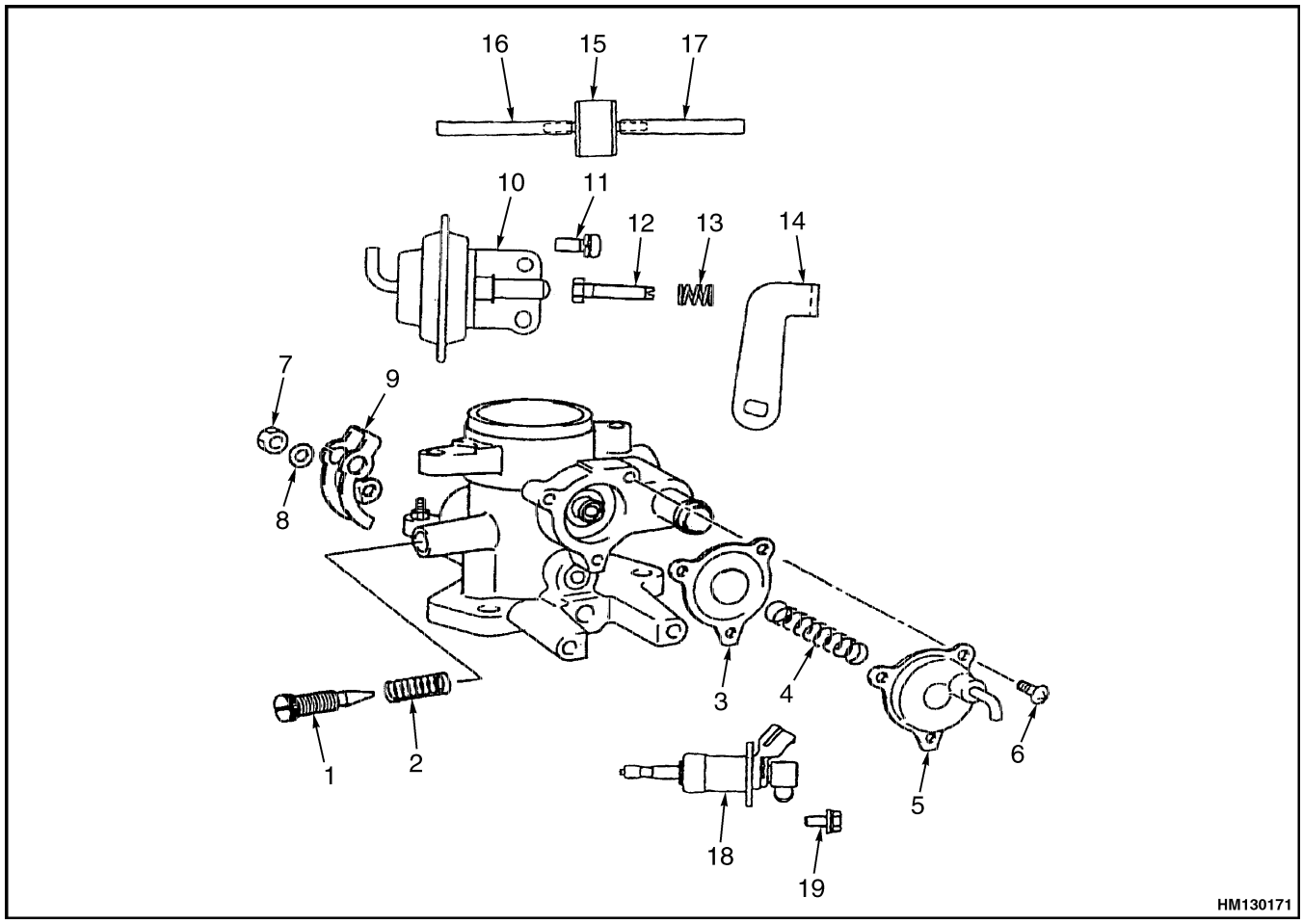
Before disconnecting any part of the LPG fuel system, close shutoff valve on fuel tank. Run engine until fuel lines are empty and engine stops. If engine will not run, close shutoff valve on fuel tank and release fuel slowly in a non-hazardous area.

1. Turn shutoff valve clockwise until valve is completely closed. See Figure 1.
2. Run engine until it stops. Then turn key to OFF position.
3. Disconnect hose from air cleaner at bonnet.
4. Disconnect both fuel inlet hoses (large hose to carburetor and smaller hose to fuel injector).
5. Disconnect hose to idle control actuator.
6. Disconnect regulator hose.
7. Disconnect power valve hose.
8. Disconnect throttle cable at carburetor. Remove carburetor from governor.

DISASSEMBLE

NOTE: Note the position of the diaphragm prior to removal to aid in the installation.

1. Disassemble power valve actuator by removing three screws, cover, spring, and diaphragm from carburetor. See Figure 11.
2. Remove idle air bypass adjusting screw and spring from carburetor.
3. Remove two screws and idle control actuator from carburetor.



1. IDLE AIR BYPASS ADJUSTING SCREW
2. SPRING
3. DIAPHRAGM
4. SPRING
5. COVER
6. SCREW
7. NUT
8. LOCKWASHER
9. THROTTLE CABLE LINK
10. IDLE CONTROL ACTUATOR
11. SCREW
12. IDLE-UP ADJUSTING SCREW
13. SPRING
14. LEVER
15. VALVE
16. VACUUM HOSE
17. VACUUM HOSE
18. FUEL INJECTOR
19. BOLT

Figure 11. Carburetor Parts

4. Remove nut, lockwasher, throttle cable link, and lever from carburetor.

5. If damaged, remove adjusting screw and spring from lever.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow recommendations of manufacturer.

Make sure that all of carburetor parts are clean before assembly. Wash all parts (except diaphragm) in solvent. Make sure that air passages in metering valve are clean.

ASSEMBLE

1. If removed, install spring and adjusting screw in lever. See Figure 11.

2. Install lever, throttle cable link, lockwasher, and nut on carburetor. Tighten nut to 9 to 12 N•m (80 to 106 lbf in).

3. Install idle control actuator and two screws on carburetor. Tighten screws to 3.4 to 4.4 N•m (30 to 39 lbf in).

4. Install seal, fuel injector, and two screws on carburetor.

5. Install idle air bypass adjusting screw into carburetor until screw is seated. Unscrew idle air bypass adjusting screw the number of turns specified for the engine in the lift truck. See Table 1.

Table 1. Adjusting Screw

Engine	2.0	2.2	GM
Number of Loosening Turns	1	1	1

6. Using two screws, install idle-up diaphragm on carburetor.

7. Install diaphragm (as noted during removal), spring, cover, and three screws. Tighten screws to 1.5 to 2.0 N•m (13 to 18 lbf in).

INSTALL

1. Install new gasket on governor. See Figure 1. Install carburetor on governor.

2. Connect power valve hose.

3. Connect hose from carburetor (spark advance port) to distributor.

4. Connect hose to idle control actuator.

5. Connect both fuel inlet hoses (large hose to carburetor and smaller hose to fuel injector).

6. Connect hose from air cleaner to bonnet.

7. Connect throttle cable at carburetor. Check and adjust throttle linkage as described in Throttle Linkage Adjustment.

Fuel Injector Repair

REMOVE

1. Turn shutoff valve clockwise until valve is completely closed. See Figure 11.

2. Run engine until it stops, then turn key to **OFF** position.

3. Disconnect hose from fuel injector.

4. Remove two mounting screws. Remove fuel injector and seal from carburetor.

CLEAN AND INSPECT

1. Use a clean cloth to remove any carbon deposits around nozzle.

⚠ WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

⚠ CAUTION

Do not insert wire more than 2.0 mm (0.08 in.) into fuel injector nozzle. Otherwise, internal parts of fuel injector may be damaged.

2. Use a 1.2 mm (0.05 in.) diameter piece of steel wire to clean out inside of nozzle. Insert and pull out wire approximately 10 times while adding 343 to 490 kPa (50 to 71 psi) of pressure through fuel supply port.

3. Use an ohmmeter to check fuel injector coil for continuity. The coil resistance should be 3.5 to 4.5Ω.

4. Apply 12 VDC to both connector terminals of fuel injector. A clicking sound should be heard.

INSTALL

1. Insert seal and fuel injector into carburetor.

2. Install two mounting screws. Tighten screws to 6.4 to 7.9 N•m (57 to 70 lbf in).

3. Connect hose to fuel injector.

Governor Repair

REMOVE

1. Disconnect vacuum hose from governor.
2. Remove governor from intake manifold.
3. Remove and discard gasket.

INSPECT

Inspect governor assembly and all hoses for any damage. Replace any damaged components.

INSTALL

CAUTION

Make sure that all gasket material has been cleaned from mating surfaces of intake manifold and governor. Gasket material left on either surface will affect performance of lift truck.

NOTE: The vacuum hoses installed on the carburetor and governor are made of special high-temperature material. If any of the hoses are replaced, make sure that HYSTER APPROVED hoses are installed.

1. Install new gasket on intake manifold.
2. Install governor on intake manifold.
3. Connect vacuum hose to governor.

Regulator Repair

REMOVE

WARNING

LPG can cause an explosion. Do not permit any sparks or flames in work area.

1. Close shutoff valve on tank. Run engine until it stops. See Figure 1 and Figure 4.
2. Disconnect electrical connectors from main solenoid valve and idle bypass solenoid valve respectively.
3. Put drain pan under drain valve for radiator. Open drain valve so that coolant drains into pan.
4. Disconnect cooling system hoses from regulator.
5. Disconnect liquid LPG hose from regulator.
6. Disconnect both LPG vapor hoses from regulator.
7. Disconnect balance line from regulator. Remove capscrews and regulator from mount.

INSTALL

1. Connect balance line to regulator. Install regulator and capscrews on mount.
2. Connect both LPG vapor hoses to regulator.
3. Connect liquid LPG hose to regulator.
4. Connect cooling system hoses to regulator.
5. Close drain valve and fill cooling system with proper amount and mixture of coolant. See the **Periodic Maintenance** manual for your lift truck.
6. Connect fitting from LPG tank to regulator assembly. Connect electrical connectors from main solenoid valve and idle bypass solenoid valve respectively.
7. Connect hose to carburetor. Open shutoff valve on tank. Start engine.