Maintaining Conventional Residential Oil-Fired Heating Systems– You Can Do It Series

Michigan State University Extension Service

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You Can Do It, Too

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Maintaining Conventional Residential Oil-Fired Heating Systems

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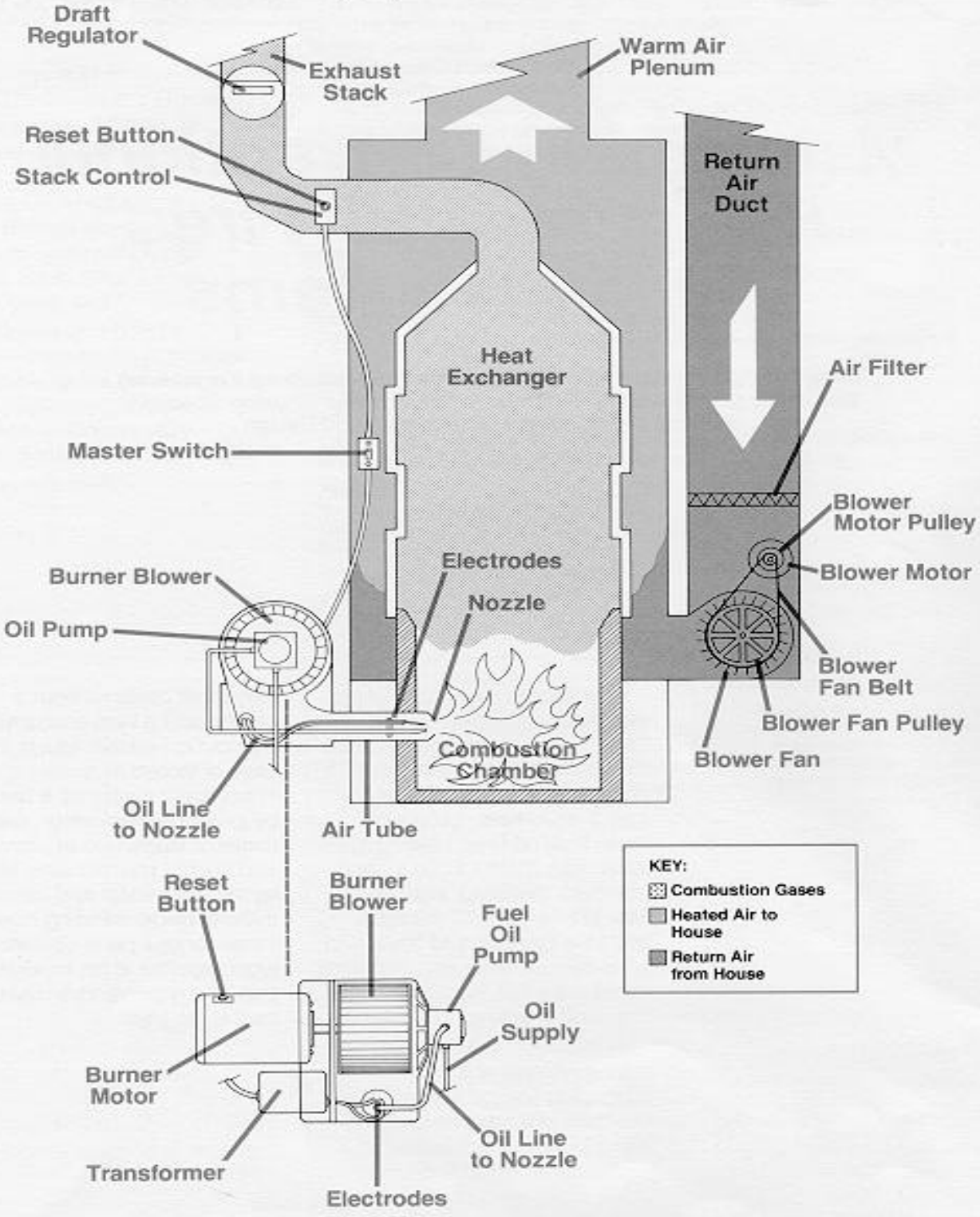
This publication covers maintenance of conventional oil-fired heating systems only Information on maintenance and repair of the newer oil furnaces is not covered.

Periodically, oil-fired heating systems need adjustment to keep them running in the safest, most efficient and least costly manner. This publication is designed to help you understand how oil-fired heating systems work (both forced air and hot water systems), what periodic preventive maintenance tasks the units should have, and what special tasks and problems might arise that would need the attention of a heating contractor.

All oil-fired heating systems are composed of a heat producing source (a furnace in the case of forced air systems and a boiler for hot water systems) heat exchanger; a distribution system (ducts in the case of forced air systems, pipes in hot water systems); a burner by-products elimination system (exhaust stack, flue or chimney); and control mechanisms (such as the thermostat and master switch). Understanding how these various parts operate and work together is an important part of any preventive maintenance program.

Figure 1 - Typical Older Fuel Oil Forced Air Furnace.

*(**WARNING NOTE:** This diagram illustrates general principles of heating and heat circulation. It is not intended to be used as a detailed guide.)*



HOW AN OIL-FIRED HEATING SYSTEM WORKS

How the Typical Oil Burner Works

When a room thermostat is turned up or the room temperature drops below the thermostat setting, the unit signals the furnace or boiler that additional heat is needed. As a result of the signal, the burner motor activates the fuel oil pump, sending fuel oil to a nozzle at the end of an air tube (see Figs. 1 and 2). Under high pressure, the fuel oil is pushed through the nozzle to form a fine mist. At the same time, the burner blower, also operated by the burner motor, blows room air into the same air tube. The two-the air and the fuel oil mist-combine to form a highly flammable vapor that is then ignited by a spark supplied by the ignition electrodes. Once started, the flames continue to burn in the combustion chamber with additional fuel oil and room air supplied through the air tube/ nozzle. In turn, the combustion gases from the flame flow through the flue passageways of the heat exchanger, heating it, and then continue to flow up and out the exhaust stack (see Fig. 1 for a forced air distribution system and Fig. 2 for a hot water distribution system). In the meantime, heat is transferred from the flue gases through the heat exchanger walls to the heat distribution medium (either air or water) that flows through the supply system, distributing heat to various parts of the home.

How a Typical Forced Air Distribution System Works

When the air temperature in the heat exchanger reaches a predetermined temperature, which is controlled by a fan-and-limit control, the furnace blower begins pulling cool room air through the return air registers and ducts (see Figs. 1 and 3). The air is passed through a filter to clean it of dust. It then passes through the heat exchanger, as described above, where it is warmed by the hot combustion gases passing through the heat exchanger on their way out of the house. The furnace blower then forces the warm supply air into a plenum and through the supply ducts, finally distributing it through supply registers in each room in the home. The two air supplies, the combustion air and the air distributed through the house system, should never come in direct contact with each other.

How a Hot Water Distribution System Works

When a house thermostat calls for heat from a hot water distribution system, the circulator pump is activated (see Fig. 2) and supplies hot water held in reserve in the boiler throughout the distribution system-through the supply main, the supply branches and finally the baseboard units (i.e., radiators or convectors in some systems) in the various rooms (see Fig. 4). As cool room air passes over the warmed baseboard unit surfaces, the air absorbs heat and distributes it throughout the room. Individuals, furnishings and objects near the baseboard units are also warmed by heat given off by the units. The now cool water completes the cycle, flowing from the baseboard units through the return branches and the return main back to the boiler.

When the water in the boiler drops below a predetermined temperature, the aquastat activates the burner (see Fig. 2). The heat given off by the burner warms the heat exchanger and rewarms the water in the boiler, which holds it in reserve until the circulator pump moves the water through the distribution system once again. This two-phase process enables the system to maintain an on-demand supply of hot water at all times. The homeowner does not have to wait for the water to be reheated and circulated through the system.

MAINTENANCE AND INSPECTION YOU CAN DO

During the heating season, furnaces and boilers can accumulate a build-up of dirt. In addition, the various moving parts wear. Dirt and wear can lead to a loss of system efficiency, system failures, and health and safety problems. Annual inspections and maintenance are required to keep an oil-fired heating system operating efficiently and safely. You can do a number of the maintenance and inspection tasks yourself. You may want to ask your heating contractor to show you some of the procedures during his or her next visit or consult your heating system owner's manual. It should provide an excellent guide to the

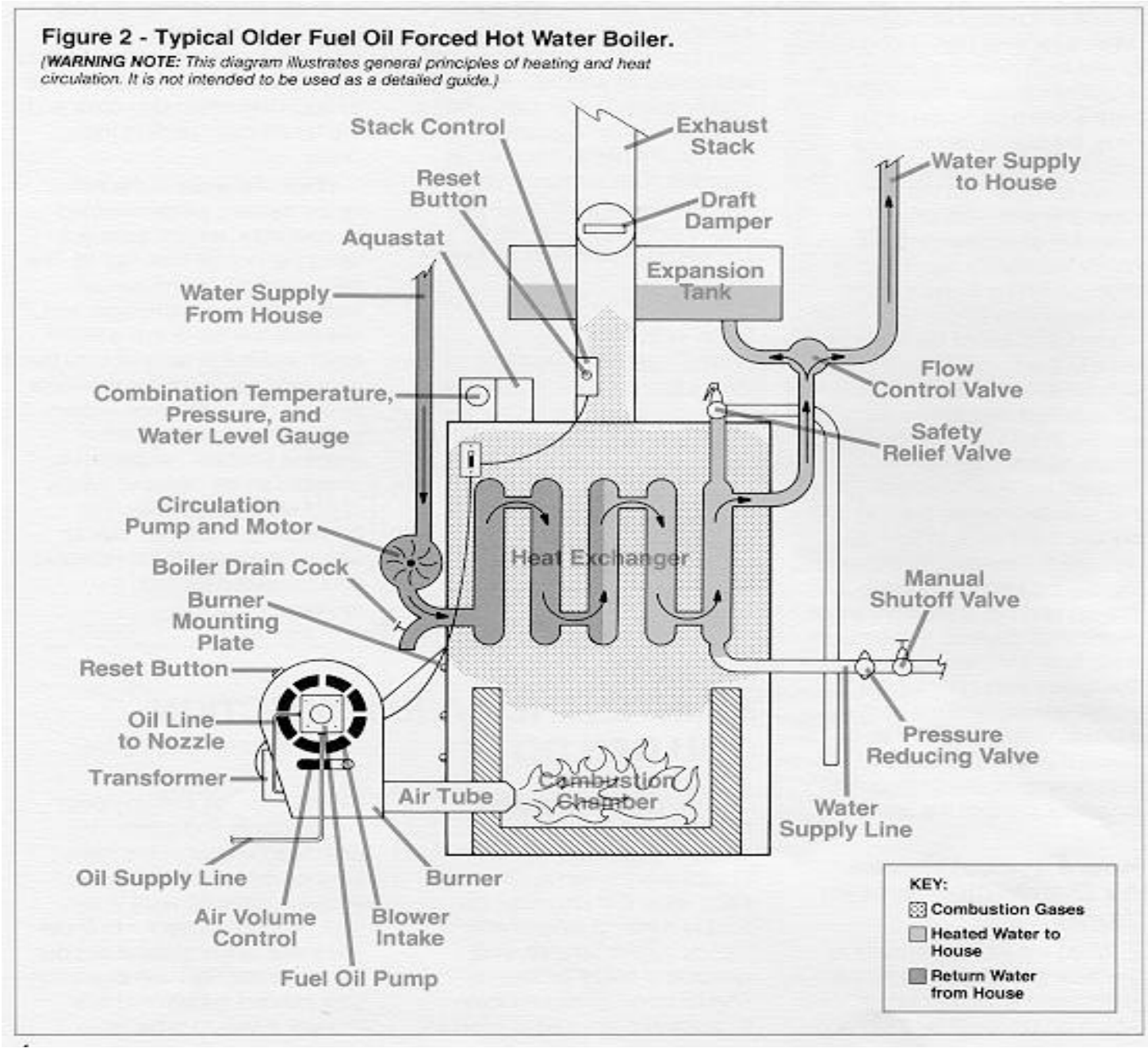
types of activities do-it-yourselfers can do. This publication describes some of those activities in a general way, but the owner's manual will give you specifics for your system.

If the owner's manual is not available, write to the manufacturer and request that one be sent to you. You will find the manufacturer's name and probably the address on the nameplate affixed to your unit somewhere. If the manufacturer's address is not available, consult your heating contractor or search the Yellow Pages to find the name of a heating contractor that sells the brand you own. In your letter, give the model and serial number of your unit so the correct owner's manual can be sent to you. Both numbers can be found on the unit's nameplate.

If you are a novice do-it yourselfer, follow the manufacturer's recommendations carefully, and do only those tasks explained in the manual. All others should be done by a heating contractor. Oil is an efficient

Figure 2 - Typical Older Fuel Oil Forced Hot Water Boiler.

*(**WARNING NOTE:** This diagram illustrates general principles of heating and heat circulation. It is not intended to be used as a detailed guide.)*



and safe fuel if the equipment burning it is well maintained by knowledgeable people. Novices and inexperienced tinkerers should be aware of the potential for creating problems.

The Furnace/Boiler

1. Change the fuel oil filter periodically (see Figs. 1 and 5). The fuel filter cleans the fuel of any impurities (e.g., dirt and water) that may affect the efficient supply, ignition and burning of the fuel. Consult the owner's manual for the correct procedure.

2. Clean and lubricate the burner motor (see Fig. 1). Dust and oil buildup will shorten the life of the burner motor. Vacuum away any loose dust and wipe away any oil buildup or greasy dirt. Lubricate the burner motor according to your owner's manual.

3. Inspect the burner mounting plate for evidence of leaks (see Fig. 1). They can alter the fuel/air mixture and allow smoke to escape into the room. If smudges are present around the plate, call your heating contractor to correct the situation.

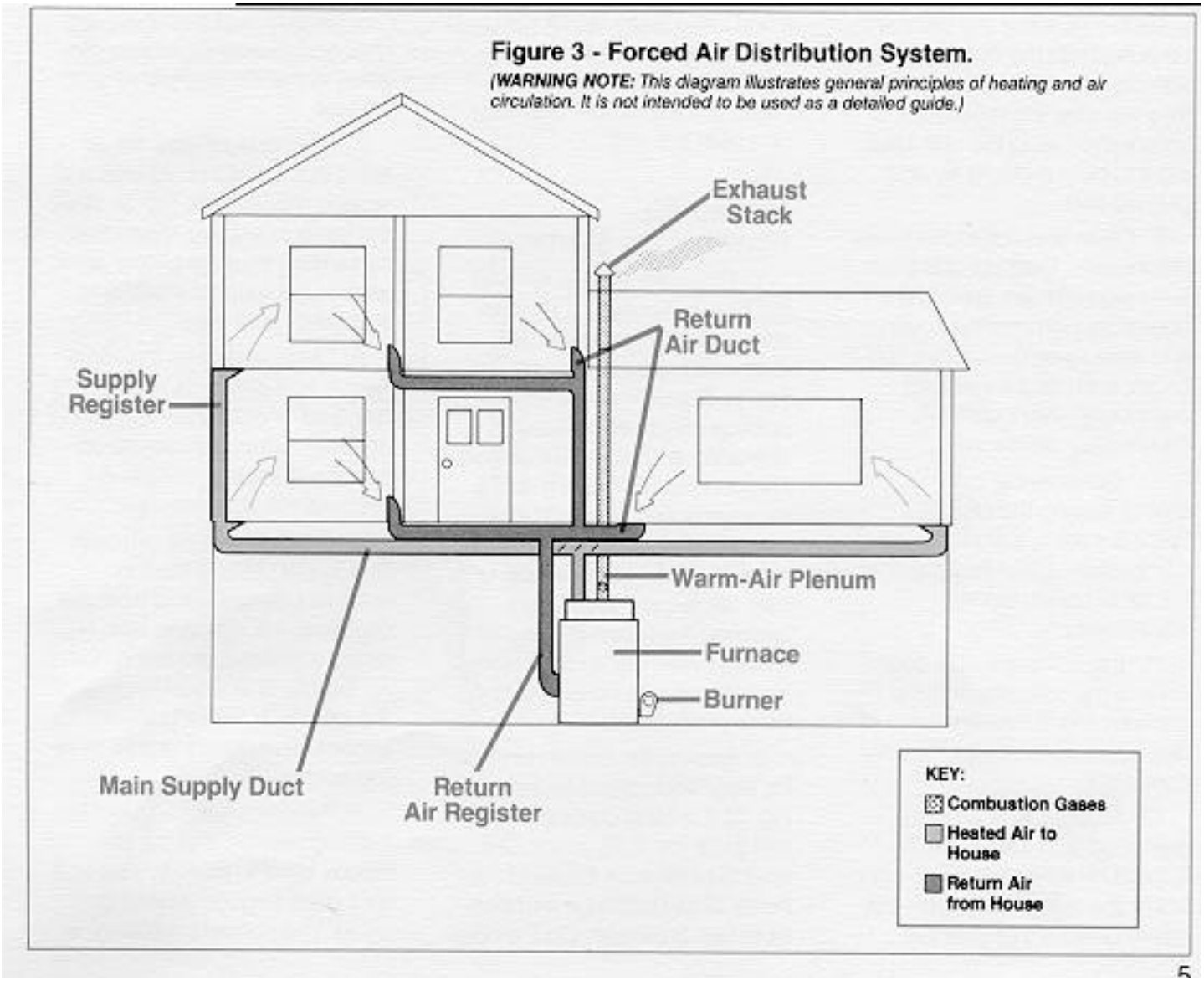
4. Inspect the furnace's/ boiler's electrical system (i.e., master switch and electrical cable, see Fig. 1). Electrical problems affect the performance of a unit and also present a safety hazard. Bad connections, bare wires, blown fuses, tripped circuit breakers and tripped reset buttons (the reset button automatically disconnects the electricity to an overloaded electrical motor) indicate that an electrical problem is present. Contact your heating C-6ntractor to correct it. (Warning: electricity is potentially dangerous for people not familiar with its operation. Repairs should be made by a qualified service person.)

5. Inspect the exhaust stack for bad connections and damaged or corroded pipes (see Figs. 1 and 2). Replace if damage is evident.

6. Clean the draft regulator,

Figure 3 - Forced Air Distribution System.

*(**WARNING NOTE:** This diagram illustrates general principles of heating and air circulation. It is not intended to be used as a detailed guide.)*



the mechanism controlling the rate at which combustion gases are pulled up and out the exhaust stack (see Figs. 1 and 2). Soot and dust buildup can interfere with the draft regulator's efficient operation. Vacuum any loose dust and wipe off any greasy soot. Also clean the back side of the hinged plate. Any modifications or changes in the draft regulator setting should be done by a qualified service person.

7. Inspect the fuel storage tank for leaks. Clues include oil stains or puddles and/or a strong odor in the vicinity of the tank. Call a heating contractor to replace the unit.

8. Clean the furnace room periodically. Dirt and lint from areas surrounding the unit can be pulled into the burner along with combustion air. Eventually they will slow the movement of combustion air to the unit, causing it to burn inefficiently and give off soot.

9. Clean and adjust the room thermostats. Dust buildup interferes with efficient thermostat operation. Remove the cover and wipe away dust with a soft brush, such as a watercolor paint brush. Work carefully- thermostats are fragile.

10. Observe the color of smoke leaving the chimney. Black smoke is a sign of poor combustion. Call a heating contractor to make needed adjustments.

11. Inspect any visible sections of the chimney and the chimney top. If they are worn or damaged, consult your heating contractor.

12. Most oil furnaces are equipped with a reset button located on either the stack control or the primary control-the safety devices that shut the burner off if a flameless condition exists. Stack controls are found on older units, while primary controls are found on newer ones. If the reset button trips the burner off, a fuel supply or ignition problem has occurred. Push the reset button once to restart the burner. If the reset button trips the burner off again, contact your heating contractor.

13. Safety note: oil-fired furnaces and boilers require an adequate supply of air to ensure proper and safe burning of the fuel. In addition, adequate clearances are necessary between combustibles such as walls, doors and framing members and the furnace/boiler, the vent stack and the chimney Never enclose a unit unless you check with a heating contractor about the unit's combustion air needs. Never store combustible materials near the unit.

Forced Air Distribution System

1. Clean the blower fan and the blower housing and clean and lubricate the blower fan shaft and the blower motor (see Fig. 1). Dust, dirt and debris buildup affects the efficient operation and useful life of these components. Remove it with a vacuum or soft cloth and lubricate according to your owner's manual. (Note: some newer units may not require lubrication because the bearings are sealed.) Warning: shut off electricity to the unit before starting these procedures.

2. Inspect the blower fan belt for wear and correct tension (see Fig. 1). It is fairly common for the belt to be too tight, which can lead to premature failure of the motor or fan bearings and possible belt breakage. On the other hand, a loose belt can slip, causing faster belt wear and premature belt failure. Replace the belt when slippage can no longer be corrected or belt failure seems likely. Adjust the belt tension according to your furnace's owner's manual. (Note: many newer oil furnaces do not have a fan belt-a motor drives the fan directly.) Warning: shut off electricity to the unit before starting belt adjustment.

3. Replace the air filter periodically to ensure that air is circulating freely and cleanly (see Fig. 1). Dirty air filters slow air movement, make other furnace components work harder (which shortens their useful life), and waste energy. Inspect them monthly initially to determine how often they should be changed. Follow directions provided in the furnace owner's manual.

4. Inspect duct work for air leaks that result in heat loss and wasted money (see Fig. 3). While the fan is operating, locate them by running your hand over areas where you suspect leaks. Seal leaks with duct tape.

5. Clean and clear the room supply and return air registers of any dust or obstructions (see Fig. 3). They reduce air circulation and waste energy dollars. A vacuum will do a good job.

6. Any warning signs noted during the heating season such as unusual odors from the registers, discoloration over registers, excessive dirt in the house air supply, or unusual cycling of the burner or fan or both should be reported to your heating contractor.

7. Periodically throughout the heating season, make a conscious effort to listen to your unit as it goes through a heating cycle. The normal procedure is:

the room thermostat calls for heat, the burner goes on, the fan then starts. Both should remain on until the thermostat temperature is satisfied. Once it is satisfied, the burner stops first, followed by the fan. If the burner or the fan or both cycle on and off frequently before the thermostat is satisfied, a problem exists. Consult your heating contractor. Likewise, if the burner ever goes on but the fan does not follow, call a heating contractor.

Hot Water Distribution System

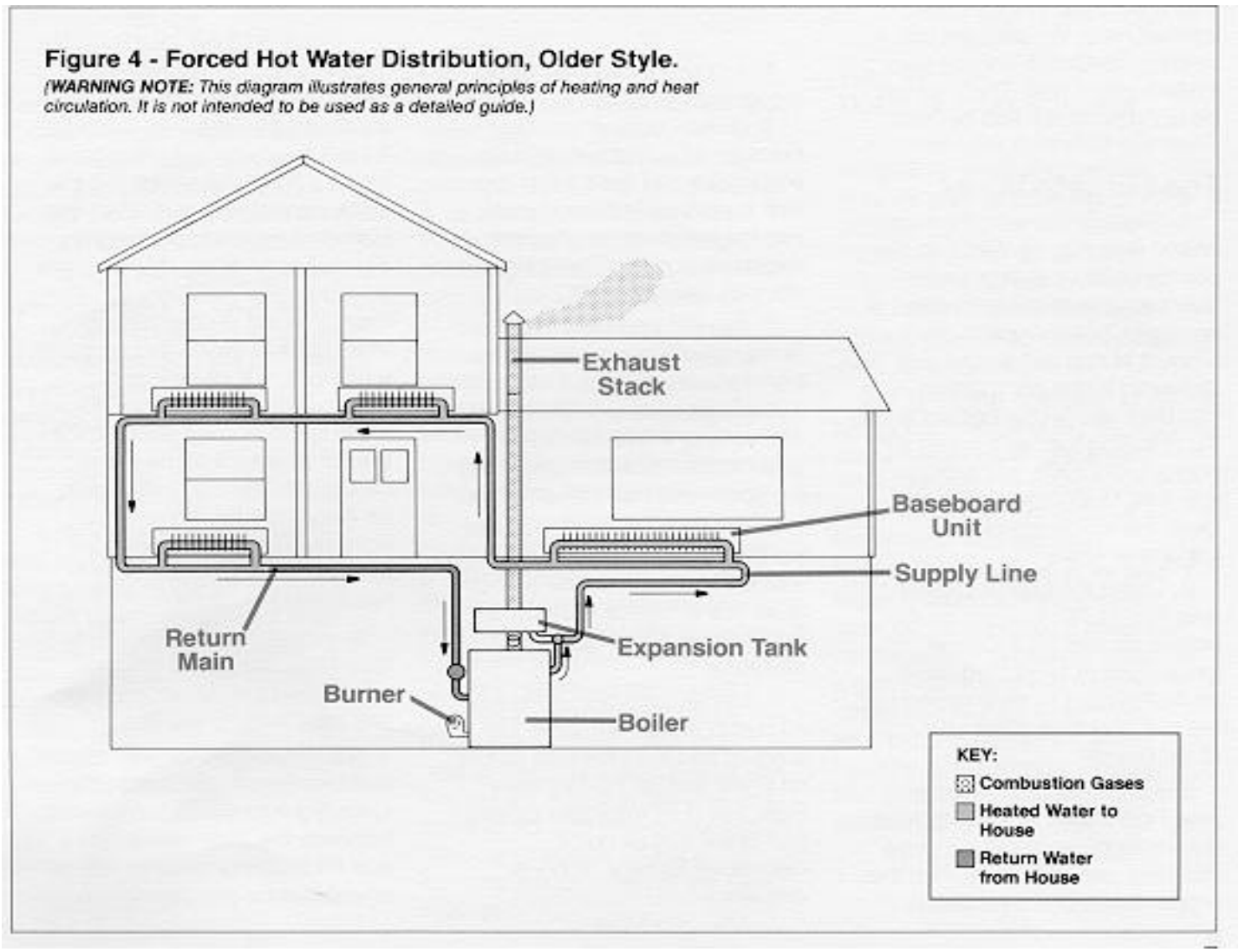
1. Clean the circulator motor and lubricate the motor and circulator pump (see Fig. 2). Dust and dirt buildup inhibit efficient operation. Consult your owner's manual for instructions and lubrication needs.

2. Clean and bleed baseboard units (convectors or radiators in some systems; see Fig. 4). Both dust and dirt buildup on the baseboard unit's fins and air in the pipes decrease the heat transfer efficiency of the baseboard unit. A vacuum and a softbristle brush work well together for cleaning the fins. If air is present in the pipes, you'll hear a sound similar to water trickling. Bleed the unit by opening the air valve until water runs freely from the unit. Then close the valve. (Note: many modern hot water systems contain automatic bleeders and do not require this step. Consult and follow your owner's manual for the correct procedures.)

3. Inspect baseboard units to ensure that adequate clearance exists between them and the floor, particularly carpeted floors. Clearance is necessary to allow air to flow freely around the unit. If your hand cannot slip easily into this area, consult a heating contractor about raising the unit.

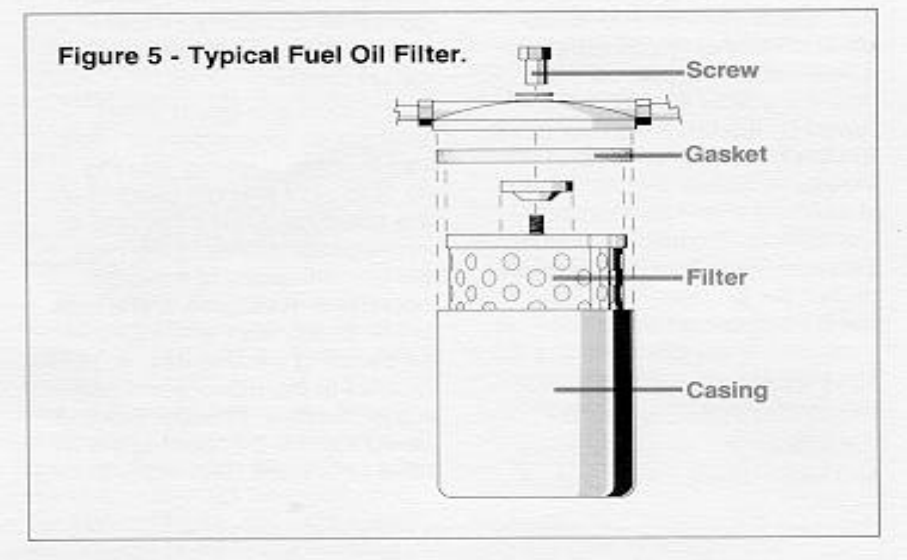
Figure 4 - Forced Hot Water Distribution, Older Style.

*(**WARNING NOTE:** This diagram illustrates general principles of heating and heat circulation. It is not intended to be used as a detailed guide.)*



MAINTENANCE AND INSPECTION A SERVICE PERSON SHOULD DO

Though you can do the maintenance and repair tasks described in your owner's manual, other jobs require the knowledge of a heating contractor. Inexperienced homeowners attempting these tasks may make mistakes that expose them and their families to unnecessary hazards and possibly damage the equipment. We mention these tasks because a heating contractor should do them during a regular maintenance visit. When selecting a contractor, ask about the standard service procedures followed and see if they are similar to those described here. We suggest that a heating contractor service your system every year. The cost will be approximately $50 per visit.



The Furnace/Boiler

1. Clean or replace the burner nozzle (see Fig. 1). With use, the burner nozzle passage ways may become partially blocked or enlarged. In either case, the amount of fuel oil being delivered to the combustion chamber will not be correct and the resulting fuel/air mixture will contain either too much or too little fuel. Both conditions will lower the efficiency of the furnace or boiler.
2. Clean the burner blower (see Fig. 1). Dirt buildup on the blower causes an improper air/oil mixture by cutting down on the amount of air supplied to the unit and lowers the efficiency of the burner.
3. Adjust the burner flame (see Figs. 1 and 2). An improper burner flame level will generate less heat per unit of fuel than the proper flame could produce.
4. Inspect, clean and adjust the ignition electrodes (see Fig. 1). If ignition does not occur because of a problem with the electrodes and the fuel/air mixture continues to be pumped into the combustion chamber, an explosive condition will exist, an obvious safety hazard.
5. Inspect and clean the transformer (see Figs. 1 and 2). The transformer amplifies the electrical voltage supply (from 110 to 120 volts to 5,000 to 10,000 volts) to the electrodes, initiating the spark that starts combustion.
6. Adjust the air volume control (see Figs. 1 and 2). This mechanism controls the amount of air in the fuel/air mixture, a major factor affecting burner efficiency.
7. Inspect and adjust the fuel oil pump, which regulates the amount and the pressure of fuel oil in the fuel/air mixture (see Figs. 1 and 2). Improper calibration of the fuel oil pump decreases furnace or boiler efficiency.
8. Inspect, adjust and clean stack control, a necessary safety device (see Figs. 1 and 2). If the furnace or boiler is operating in a flameless condition, the stack control will shut down the burner. It needs to be functioning well at all times. (Newer units do not have a stack control. They have, instead, a solid state primary control, which incorporates a cad cell, a light-sensitive mechanism that monitors electricity to the burner, shutting the burner down if a flame is not produced. The cad cell should be inspected for dirt and soot accumulation and cleaned as needed. It should also be realligned.)
9. Adjust the draft regulator (see Figs. 1 and 2). Improper adjustment can result in excessive heat loss up the flue.
10. Clean the heat exchanger surfaces (see Figs. 1 and 2). Cleaning improves heat transfer between the heat exchanger and the heating medium (the air or water supply).

11. Check for combustion leaks. Combustion leaks allow dangerous gases to escape into the furnace room.

12. Perform efficiency tests and make required adjustments. Efficiency tests help the contractor determine burner efficiency and overall furnace or boiler efficiency and point to specific areas where adjustments can be made to increase efficiency. These tests are essential to ensure that your oil furnace or boiler is running at its peak level of performance. Because of their importance, the tests are described and explained in more detail on pages 14-15.

Forced Air Distribution System

1. Align the blower pulley and the blower motor (see Fig. 1). Improper alignment can cause abnormal belt wear and slippage. (Note: most newer oil furnaces do not have pulleys a motor drives the fan directly.)

2. Adjust the blower fan speed (see Fig. 1). Excessive fan speed will cause duct noise and waste electricity. If the fan is set unnecessarily low, an excessive amount of heat will be lost through the supply ducts before it reaches the registers to provide room heat.

3. Adjust and test the fan-and-limit control, which measures the temperature of the air surrounding the heat exchanger. It automatically turns the furnace blower on and off during each burning cycle and shuts the burner down if the heat exchanger becomes overly hot. The control monitors three temperatures: a fan-on temperature, a fan-off temperature and a temperature limit, which is a safety device designed to shut the burner off if the heat exchanger becomes too hot. It is never adjusted or changed-the other two can be, however, For example, the fan-on temperature is usually about 135 degrees F. When the air around the heat exchanger reaches this temperature, the blower fan comes on and moves the heated air throughout the home. The fan-off temperature is usually set at approximately 100 degrees F. When the air surrounding the heat exchanger reaches this temperature, the fan blower stops so it doesn't circulate cool air through the home and cause uncomfortable drafts. To save energy, you may want to ask your heating contractor to lower these two temperature settings to a level closer to the house thermostat setting. As a result, the furnace will supply more heat to the house BUT the air will feel cooler. You may experience some draftiness and discomfort after the changes until you become accustomed to the new settings.

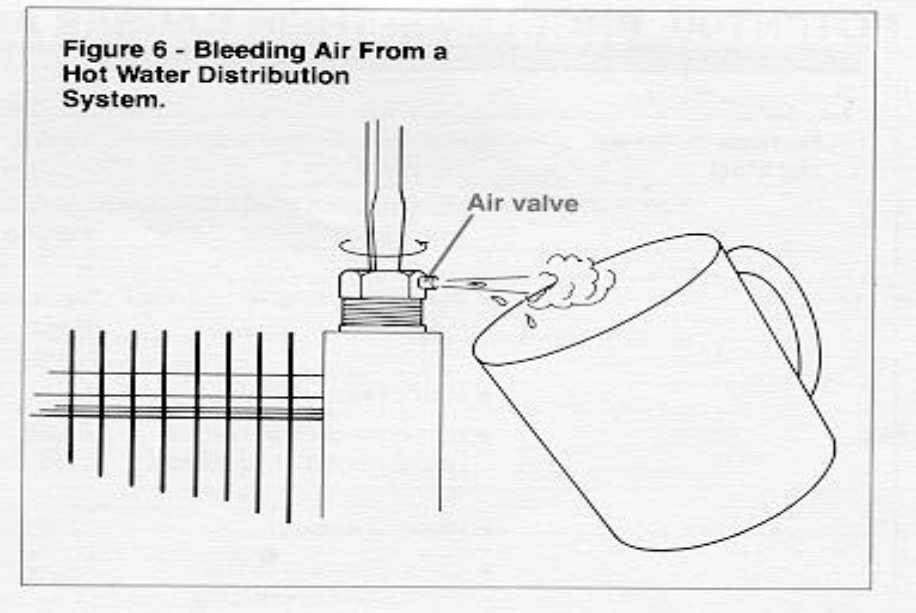


Figure 6 - Bleeding Air From a Hot Water Distribution System.

Hot Water Distribution System

1. Check the circulator pump coupler for wear and broken coupler springs (see Fig. 2). The coupler connects the motor with the pump. Normally, if the coupler springs are broken, a loud racket occurs; they have been known to be broken, however, with little noise.

2. Check the operation of all safety controls (see Fig. 2), such as the safety relief valve, which would relieve the system if overly high pressure should occur because of overheating.

3. Check and adjust air and water levels in the expansion tank, which provides a reservoir for the safe collection of water as it expands during the heating cycle (see Fig. 2). Note: many new expansion tanks contain bladder or diaphragm devices that control water and air levels automatically.

POTENTIAL PROBLEMS: THEIR CAUSES AND SOLUTIONS

Furnace/Boiler

PROBLEM:	CAUSE:	SOLUTION:
1. Furnace/boiler will not start.	• Room thermostat is set too low.	Turn up.
	• Master switch is off *(see Fig. 1).*	Turn on. The master switch controls the entire electrical system of the furnace/boiler.
	• Burned-out fuse or tripped circuit breaker.	Replace or reset as necessary. If it blows or trips again, consult a heating contractor.
	• Fuel oil tank is empty.	Fill.
	• Burner motor reset button has disengaged *(see Figs. 1* and 2).	Reset. If it disengages again, consult a heating contractor.
	• Water in fuel oil.	Change fuel oil filter *(see Fig. 5).*
	• Stack control or primary control is not operating correctly *(see Figs. 1 and 2).*	Consult a heating contractor.
	• Ignition transformer is faulty *(see Fig. 1).*	Have heating contractor replace.
	• Voltage fluctuation at burner motor *(see Fig. 1).*	Consult a heating contractor.
	• Ignition electrodes are shorted *(see Fig. 1).*	Consult a heating contractor.
2. Burner starts, followed by puffs or flarebacks. Puffs and flarebacks occur when an excessive amount of unburned fuel/air mixture spontaneously ignites because of heat buildup in the combustion chamber.	• Chimney draft too weak.	Consult a heating contractor.
	• Chimney plugged.	Consult a heating contractor.
	• Weak spark at ignition electrodes *(see Fig. 1).*	Consult a heating contractor.
	• Improperly spaced ignition electrodes *(see Fig. 1).*	Consult a heating contractor.
	• Water in fuel oil.	Change fuel oil filter *(see Fig. 5).*
	• Worn or plugged oil nozzle.	Consult a heating contractor.
	• Combustion gases not adequately vented.	Consult a heating contractor.
3. Furnace/boiler produces smoke and odor in furnace room.	• Poor draft.	Consult a heating contractor.
	• Heat exchanger plugged or worn.	Consult a heating contractor.
	• Obstruction in flue or chimney.	Remove obstruction.

continued

PROBLEM:	CAUSE:	SOLUTION:
Forced Air Distribution System *Continued from previous page*		
	• Register grilles dirty/ dusty *(see Fig. 3).*	Clean.
	• Supply ducts are dirty/ dusty *(see Fig. 3).*	Clean.
	• Blower fan compartment is dirty/dusty *(see Fig. 1).*	Clean.
	• Access door to blower fan is open or loose *(see Fig. 1).*	Close and secure.
	• Heat exchanger cracked.	Consult a heating contractor.
6. Rushing noise or vibration in ducts *(see Fig. 3).*	• Air velocity too high.	Consult a heating contractor.
	• Noisy blower noise may be transferred into the ducts.	Consult a heating contractor.
	• Incorrectly sized duct work.	Consult a heating contractor.
1. No heat.	• No power.	Check master switch *(see Fig. 2),* fuse or circuit breaker.
	• Closed oil supply valve.	Open oil supply valve.
	• Dirty or defective thermostat.	Clean thermostat or have heating contractor clean or replace.
	• No oil.	Fill oil tank.
2. Cold baseboard units (convectors or radiators).	• Air in baseboard unit, convector or radiator *(see Fig 4).*	Drain baseboard unit, convectors or radiators.
	• Frozen pipes.	Locate and thaw frozen spot.
3. Leaking water inlet valve *(see Fig. 2).*	• Worn stem packing.	Have a heating contractor replace.
4. Leaking circulator pump *(see Fig. 2).*	• Defective seal.	Have a heating contractor replace.
5. Noisy circulator pump *(see Fig. 2).*	• Coupler broken.	Have a heating contractor replace.
	• Broken impellor.	Consult a heating contractor.
6. Water dripping from safety relief valve *(see Fig. 2).*	• Excess water in expansion tank.	Have a heating contractor adjust air-water levels in the expansion tank.
	• Defective water feed valve.	Consult a heating contractor.
	• Excessive temperature and pressure in boiler.	Consult a heating contractor.

OIL FURNACE OR BOILER EFFICIENCY TESTS

Efficiency tests are the best means available to determine if your oil furnace or boiler is functioning at its maximum efficiency level and thus providing you with the most heating output for your energy dollars. Efficiency tests indicate the amount of heat output you are receiving in relation to fuel input into the system.

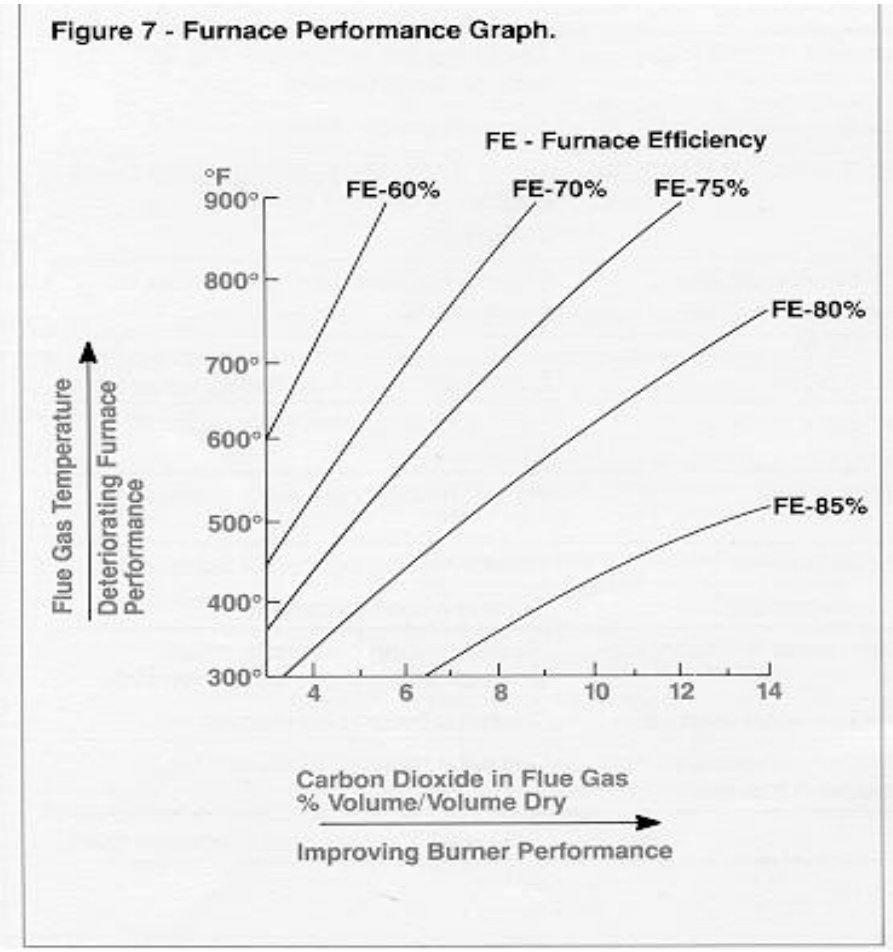
Efficiency tests should be done by a heating contractor because performing them and making necessary adjustments requires specialized knowledge. In addition, the equipment needed to perform them is specialized and relatively expensive. Four tests should be conducted to ensure that a furnace achieves maximum efficiency.

Efficiency tests are a series of flue gas measurements: a draft volume measurement, a smoke test, a carbon dioxide ($C0_2$) percentage reading and a flue gas temperature reading. The first two tests are done to make burner adjustments, and the others provide a measure of the overall efficiency of the system. The equipment required for these tests includes a draft gauge, a smoke tester, $C0_2$ indicator and a flue gas thermometer.

Two steps have to be taken before conducting the tests. First, a hole must be drilled in the flue pipe close to the body of the furnace/boiler and ahead of the draft regulator. This hole will be used to insert the test equipment and provide readings. After the tests are completed, it can be replugged with a sheet metal screw. Second, immediately before testing, the furnace or boiler must be brought up to its normal operating temperature. This can be accomplished by turning the house thermostat above its normal reading for 10 to 15 minutes. The tests are then conducted.

The first test conducted measures the amount of draft or the speed of the movement of combustion gases up the chimney. The test indicates how forcefully the gases are being moved out of the house. The test probe of the draft gauge is inserted into the flue pipe hole and the reading recorded. A high draft reading indicates that the hot gases are being drawn up the flue too quickly and excessive heat is being wasted through the chimney. A low draft reading, on the other hand, indicates the gases are not being vented quickly enough. To correct draft problems, the heating contractor will adjust air intake to the burner and combustion chamber and the balance weight on the draft regulator door.

Figure 7 - Furnace Performance Graph.



The second test is a smoke test, which indicates the soot content of the flue gases. The probe for the smoke tester is inserted into the flue pipe hole and a specified amount of smoke is drawn through filter paper. The darkened filter paper is then compared to a smoke test scale (ranging from 0 to 10) supplied with the test kit. Anything higher than 2 on the scale means the air/fuel mix is poor and an excessive amount of unburned fuel is escaping up the chimney. The heating contractor will adjust the air supply to the burner to achieve a more smokeless flame.

Measuring and adjusting the furnace or boiler's draft and achieving a low smoke test number set the stage for accurate $C0_2$ and stack temperature tests. These final two tests are used to calculate the operating efficiency of the unit.

The contractor measures the $C0_2$ content of the flue gas to determine if excess air is present in the flue. It is accomplished by inserting the $C0_2$ indicator probe into the flue pipe hole and extracting a specified amount of flue gas. The reading should register somewhere between 0 and 14 percent. If the percentage of $C0_2$ is low (less than 8 percent, for example), the air/fuel mix is high in excess air, and valuable heat is being wasted out the flue or chimney. The heating contractor should adjust the air/fuel mixture.

Finally, the flue gas temperature is taken to determine the unit's ability to utilize heat and not waste it. It is measured by inserting the flue gas thermometer into the flue pipe hole. A high flue gas temperature, such as 500 to 550 degrees F or over, indicates an excessive amount of heat is escaping up the chimney, thus wasting energy dollars. Low temperatures, on the other hand, such as 300 to 350 degrees F. or lower, indicate that corrosive condensation may be occurring in the chimney. The contractor will correct either situation.

The results of the $C0_2$ and flue gas temperature tests are applied to a chart similar to the one shown in Fig. 7, which provides an indication of furnace or boiler efficiency. The $C0_2$ percentage reading is located along the horizontal line of the graph and the flue gas temperature is located along the vertical line. The point inside the graph where lines from these plotted points intersect indicates furnace efficiency. An efficiency percentage below 75 percent indicates that the flue gas temperature is too high and the percent $C0_2$ in the flue gas is too low.

We strongly urge that you have a heating contractor perform the efficiency tests annually. The cost of hiring a contractor varies, but on the average, it runs approximately $50 for a regular maintenance visit. The contractor should be able to estimate the time needed and thus the additional cost for conducting the tests. The potential savings on your annual heating bill from the adjustments could very well pay for the call and perhaps save some extra dollars as well.

Many other Extension publications are available on housing, home maintenance/care and energy conservation. Call, write or visit the Cooperative Extension Service Office in your county for more information. Following is a list of related publications available there or by writing to the MSU Bulletin Office, P.O. Box 6640, East Lansing, MI 48826-6640.

Energy Conservation

E-0953, *Replacing and Repairing Screens* (free)
E-0954, *Replacing Broken Window Glass* (free)
E-1103, *Insulate your Unfinished Attic* (free)
E-1104, *Weatherstrip your Doors and Windows* (free)
E-1105, *Insulate your Basement Walls* (free)
E-1141, *Window Treatments for Thermal Comfort* (free)
E-1196, *Low Cost Weatherproofing* (free)
E-1301, *Low Cost Ways to Reduce your Fuel Bills* (free)
E-1302, *Save Fuel: Check your Heating Systems* (free)
E-1384, *A Checklist for Energy-Saving Homes* (free)
E-1521, *Maintaining Your Septic System* (free)
E-1573, *Caulking and Weatherstripping* (free)
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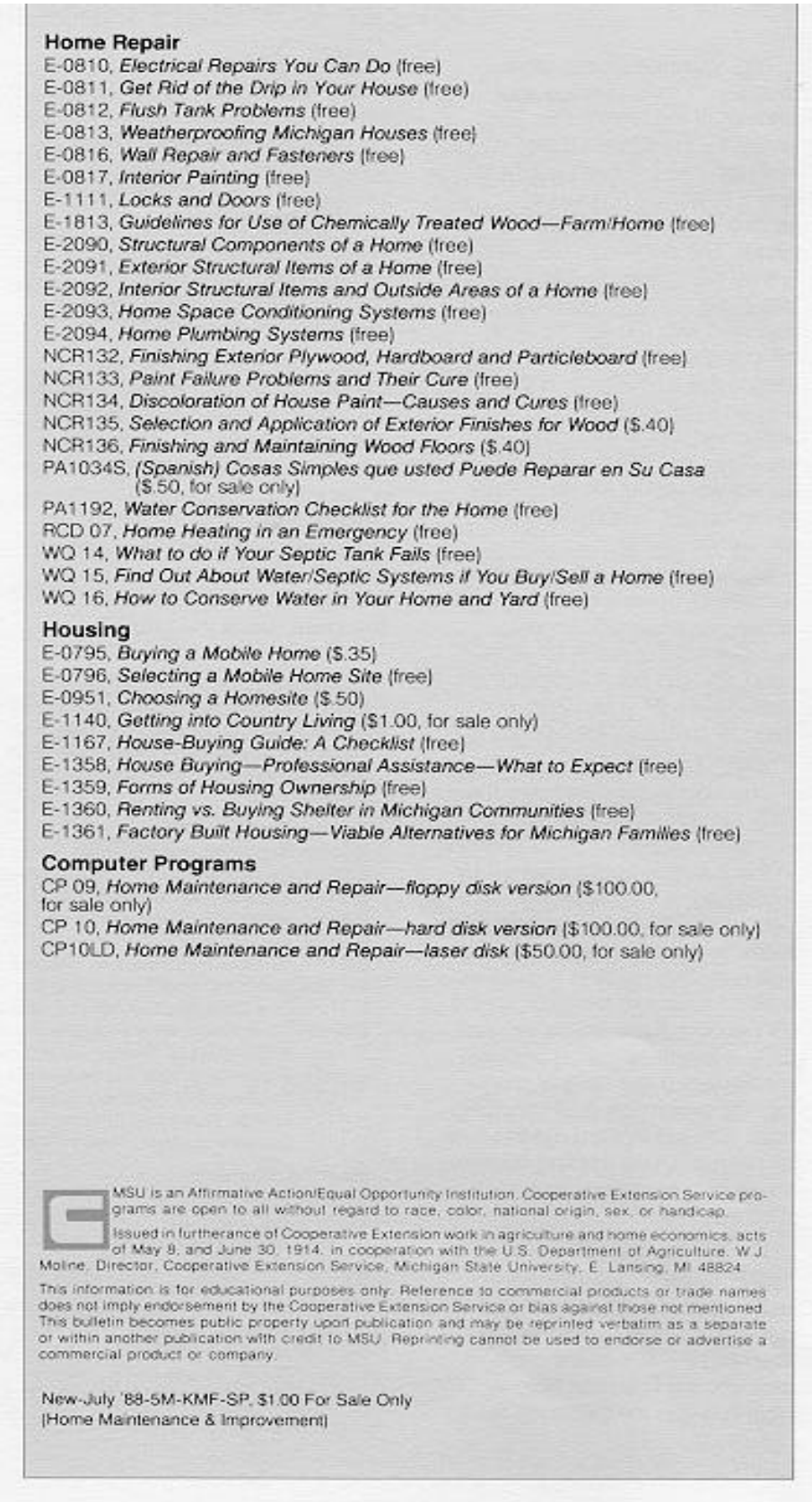

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