Wood-Burning Stoves

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To my brother, Hans.

Introduction

My brother Hans and I grew up with a stylish barrel heater from Eaton's. We got it at Christmas one year while we were still living in a small cabin. It was a big improvement over the old burned out "airtight." It had a cast-iron front and back with a fairly heavy-gauge steel body connecting them, cast-iron legs and smoke outlet, and metal shelves on each side that could be mounted either halfway down or right at the top. We were proud of that heater.

Later we moved the barrel heater into our larger new house, and it functioned well in spite of the badly insulated walls. But the air draft system, being almost the same as that of the "airtight," had approximately the same level of efficiency. After some heat fluctuations in the metal, the caulking between the main body and the front and back fell out, allowing air to escape. Air draft control was almost totally lost.

Since we could no longer control the heat output by the air draft, we had to control the fire with crafty wood-loading techniques—by gauging the quantity of wood to the amount of heat needed and by using wet wood to slow the burning process. Thus, much of the inefficiency was due to continual overheating of the house.

The demise of the heater was due both to our exhaustion from continually juggling with the air draft and wood load in order to get the desired amount of heat, and to an exceptionally cold winter during which the heater was frequently overtaxed. The sides of the heater never really burnt through, but they became dangerously thin and developed tremendous wrinkles from the excessive heat. The combination of red hot sides with a heavy load of wood and ashes in the heater forced the sides to draw inwards while the bottom sagged down. It was a sad sight. The heater was finally replaced with a homemade barrel heater, which, although uglier, was at least airtight enough to control.

Frequently thereafter Hans and I discussed wood heating and possible innovations. Then, in the winter of 1977, Hans designed a large wood furnace for a friend who was building a house in the Smithers area. To test it we installed it in the same house in which we grew up, removing the door frame to get it into the house. Its operation was far beyond what we had expected. The furnace easily burned for a week on one filling of wood without relighting. Once it actually burned for three weeks on a filling without relighting.

This in itself was proof only that the furnace could be controlled, not that it was efficient. Efficiency is difficult to measure accurately, but by roughly comparing the wood consumption of this furnace and the old barrel heater, we knew we were also dealing with a highly efficient wood-burning principle. After further tests and improvements, Hans set up a plant in Smithers, which now manufactures the RSF Energy wood heaters.

Besides covering the essential ideas, insights, and discoveries that have gone into the development of the RSF Energy heaters, this book attempts to give a rounded view of wood burning, introducing various viable alternatives and approaches. It goes beyond the commercial product to include ideas useful to handymen and home builders who wish to create a wood-burning stove according to their personal needs and interests.

Why Burn Wood?

Wood is the traditional fuel for heating houses in Canada, but today most Canadians have little experience with wood burning. Wood heating units are less developed than any other house heating device because they were discarded when modern technology was introduced. They are only now regaining popularity as economic and environmentally safe heating systems.

The aim in heating with wood is to develop a device that burns wood efficiently and does not need constant attention. The output must be controlled and the efficiency maintained over a great range of heat output. Heating with wood will never be as effortless as heating with oil, gas, or hydropower. Since these latter fuels are constantly going up in price, however, firewood is usually much cheaper. There are other noneconomical reasons why you may decide to burn firewood for heat and perhaps also for cooking and baking. You may enjoy the sense of independence, or you may claim that cutting firewood is the only exercise you get. You may be allergic to smoke emitted by mineral fuels. You may dislike the stale air created by most electrical heating units as a result of the red hot elements coming in contact with circulating air and suspended dust particles. You may suspect the aging effects of electromagnetic radiation. The economics of heating your home is an important consideration, but sentiment and health may also play a role in your decision.

Wood Fuel Efficiency

The heat value of all types of wood is proportional to its dry weight; consequently, if measured by volume, heavy woods have a higher heat value than light woods.

Woods vary in other characteristics as well; for example, some types contain a higher percentage of wood coal. A heater that does not make efficient use of wood gas works best with wood having a high wood coal content, such as birch. But if you have a truly efficient wood-burning unit, you will be surprised at the heat output from the low-grade woods.

Moisture in wood invariably reduces efficiency because the water has to be boiled off before the wood can be burned, and a considerable quantity of heat is required to convert water into its gaseous state. A heater that is controllable and has a large firebox works adequately on wet wood, as long as the wood is added while there are still plenty of hot coals in the firebox. The actual heat output will always be less, however, because of the water content. Using wet wood to help control the fire is only necessary for a firebox that is not airtight.

Wood-Burning Systems

The wood-burning tradition began with an open fire in the outdoors, in a cave, or in some sheltered spot. When man began to live in closed shelters, he brought his campfire inside with him. In his quest for convenience he began surrounding the fire with noncombustible material, and gradually the fireplace came into existence. The desire to increase efficiency and to bake food within a tightly enclosed, preheated firebox finally led to the completely encased fire with only an air draft opening and an exhaust flue. The European tile stove is an example of this tradition in an advanced form. Radiant heat was lost but efficiency was gained by restricting the amount of heat that escaped through the chimney. Finally, the more widespread use of steel led to the oxygen-restricted or choked-down fire. Heat was no longer stored in masonry; rather, the air draft was continually controlled according to heat demand.

At this stage, wood heating was temporarily discarded because of the convenience and availability of fossil fuels and hydropower. Being simple, uniform fuels, they were easy to use in the convenience appliances demanded by our modern lifestyle. Newly discovered resources create a glut that cannot be maintained; moreover, fossil fuels are not a renewable resource. Thus we must be prepared to make future readjustments.

Interest in wood heating subsided when fossil fuels and hydropower were provided cheaply enough to offset the time and effort needed to heat with wood. But now people are again beginning to consider the feasibility of burning wood. Because such considerations are usually made on the basis of very primitive wood heating devices, the future of wood as a viable fuel is all but assured. As wood heating comes to the attention of contemporary scientific and technological experts, its efficiency and convenience—and therefore its viability—can only improve.

The choice of a home heating device depends on one's situation and location. The use of oil is being discouraged by our federal and provincial governments and thus is fast losing all viability. A government grant is now available in Canada to pay 50 percent of the cost of replacing fuel oil as the primary heat source in a home. Further information about this grant may be obtained from a government agent or sellers of wood stoves and natural gas furnaces.

Electric heating is convenient, but as an energy resource it is coveted by industry, and we must expect the price to rise in the future. Electric heat may also be unpleasant—the glowing electrical elements seem to be harmful to the air and, in the case of baseboard heaters, the air does not circulate through a filter. Thus, since electric heat users tend to keep their doors and windows closed to conserve heat, the air in their houses often becomes unhealthy. The detrimental effect of glowing electrical elements can be overcome by encasing the elements in a water jacket, but this is an expensive electrical heating installation.

A wood space heater does not filter the air either, but neither does it reduce the air quality. Any oxygen-spent gases created by combustion are expelled through the chimney. As a result, a continuous supply of fresh air enters the house. In addition, a wood heater does not reduce the oxygen content of the living space, as does an unvented fuel-burning appliance such as a gas stove, kerosene lamp, or candle.

Natural gas is convenient and at present quite inexpensive. Considering the time spent gathering and chopping firewood, many believe that natural gas is cheaper. This is true if the wood heating system is poorly constructed and if it is difficult to acquire firewood. But natural gas is available only to those living in an area to which it is supplied. Propane gas, which may be stored and transported in liquid form, works similarly to natural gas but is much more expensive.

If you live close to a coal deposit, it may be your cheapest fuel. However, you must be equipped to handle, store, and burn it. Coal requires a special coal stove or furnace, and since the grates are made of cast iron, which readily breaks down in the presence of heat, they must be replaced periodically. Both coal and its ashes are somewhat unpleasant, and they do not decompose and recycle as readily as do wood and its ashes.

Solar energy is a desirable means of heating a home, and much research is being undertaken to make solar heating installations efficient and inexpensive. In order to be used effectively, however, solar heat must be stored. If an inexpensive means of storing solar heat were discovered, it could, to a large extent, replace other heating systems.

Besides choosing the type of heating fuel, you must choose the system in which you wish to use the fuel, either space heating, gravity flow, forced air flow, or hot water heating. Space heaters are usually installed to heat one room or a cabin. If you have a small, well-insulated house, and if you don't mind keeping the room in which the heater is installed warmer than the remainder of the house, a space heater may suffice. If you keep the other rooms too cool, however, lack of air movement may create a moisture and mildew problem. A wall register or a short gravity flow duct can improve air circulation.

Many people install a wood space heater in the basement in order to keep the heating bill down. This keeps the floor of the main story warm and prevents moisture build-up, but it nevertheless proves to be an inefficient arrangement. The basement must often be heated far above room temperature in order to bring the main floor up to room temperature. This difficulty is mainly encountered in modern, well-built, airtight houses. The air in the main floor cannot escape; therefore, the heated basement air is unable to flow upward.

Forced air heating is the most common heat distribution system used in Canada. In this system air is distributed to all rooms with the aid of ducts and a fan. The temperature of each room is set by adjusting its heat register opening. The air in the house is continually circulated and filtered through the furnace filter. Special filters are available for occupants who are especially sensitive to dust. Wood furnaces and wood-oil and wood-electric combination furnaces are available on the market. RSF Energy now manufactures two CSA-approved wood furnace models that may be installed in combination with any other furnace as backup heat. Forced air furnaces are sometimes installed where a less expensive arrangement would do the job. They became popular while houses were still very poorly insulated and the accurate distribution of heated air assured comfort—along with tremendous waste of fuel. With the present standard of home insulation, a less espensive gravity air flow arrangement, fed from a strategically positioned space heater, would frequently do the job adequately for a smaller home.

Another method of distributing heat is by hot water fed through pipes into each room. Hot water heating is no more efficient than forced air heating or space heating. A hot water heating system holds its heat longer, but this does not mean it is more efficient. The actual fuel input in relation to the useful heat gained depends on the efficiency of the particular model of furnace used rather than the difference between hot water and hot air heating.

There are much less expensive ways of achieving long-lasting, even heat than by installing hot water heating. These include the traditional tile stove, a rock heat collection tank, a well-designed, thermostatically controlled, down-feed wood-burning system, and good house insulation. Many of the discomforts of forced air or gravity air circulation systems are due to bad design. It is useful to study well-designed, simple, and inexpensive systems before looking at complex, expensive ones.

Several wood-burning hot water furnaces are marketed, but a high degree of convenience is not usually achieved. Since the firebox is surrounded by water, its surface temperature must remain around the boiling point of water. This encourages considerable wood tar or creosote build-up within the firebox and heat exchanger; continual servicing is required to combat this problem. Long burning between filling is also not achieved, partially because of the cooling effect of the water on the fire.

The wood-burning hot water furnace is a considerable technological contribution to the wood-burning tradition; yet it is a somewhat naive attempt to combine oil, gas, and coal furnace technology while using wood as the fuel. Wood is probably the most complex of all heating fuels. While gas, oil, and coal contain only a very limited range of hydrocarbons, wood contains everything from very light gases to coal. Nevertheless, a wood heater is a fairly simple device compared to gas and oil furnaces, which have fairly complex constructions to safeguard against the danger of explosion and fires.

Wood can be burned wherever there is oxygen and a means for the smoke to escape. However, if you wish to use a large percentage of the heat value in the wood, and at the same time control the heat output according to demand—encompassing the factors of efficiency, convenience, control, and long, unattended burning times—you need a sophisticated system. A study of the major wood-burning methods of the past will help you design devices suitable to your present needs.

The Campfire

Although the complexity of wood fuel makes it difficult to design an efficient wood furnace or heater, this complexity is what makes wood suitable for the open fire or campfire. If, on a fishing trip, you were to find, instead of wood, a pile of coal, a barrel of oil, or a tank of propane gas, and planned to cook your fish for dinner, you would be at a loss. The coal would not light without a starter fire using other combustibles, the oil could be used only if a continual fuel feeding system were devised, and the propane gas, when released, would escape and, if lit, an explosion would result.

Wood releases its gases gradually as it burns, so that an explosion does not result. This self-regulating property of burning wood enables us to use it in a primitive manner and is a property that may be attributed to its highly complex structure.

If the wood is dry, a campfire is reasonably efficient, since plenty of oxygen is available. But there are two concepts of efficiency: cleanliness of combustion and utilization of heat generated. A campfire may burn much more cleanly than a wood heater; that is, there may be much less tar and fewer unburnt gases emitted. However, the heat produced by the campfire is less efficient than that given off by a wood heater because outside, the heat escapes into the atmosphere. Since the oxygen supply is not controlled in a campfire or an open fireplace, heat output must be controlled by the amount of wood fed to the fire.

The Fireplace

Because of the self-regulating property of burning wood, people use the open fire to heat their homes even in this century and in many developed parts of the world. While fuel oil requires a very accurate fuel-feeding device to keep the fire burning without overheating, a wood fire merely has to have an extra few pieces of wood thrown onto it every now and then; no precision is called for. This feature has allowed us to be somewhat unenterprising in designing wood heating devices. As long as plenty of wood was available and we had the vigor to cut the wood, there was little incentive to bring about a high degree of convenience and efficiency.

However, a fireplace is not much less efficient than a stove with leaking doors, unless a stove vent damper is inserted to prevent gas from escaping through the flue. By restricting the loss of gas, the damper to some extent compensates for the loss of radiant heat. A fireplace also has a damper to control the expulsion of gases through the chimney. It should be closed as much as possible without causing the fireplace to smoke. The test of a well-designed fireplace is its capability to operate on a very narrow damper opening. This calls for an aerodynamically favorable fireplace shape and a flue that draws evenly in spite of pressure differences caused by wind at the chimney cap. The damper must be wide enough to catch the gases at the edges of the fireplace, and the smoke chamber must taper into the flue gradually. A round flue has a more even draw than a square or rectangular one. Another design feature that ensures an even draw is a smoke shelf set about sixty centimeters lower than the damper opening. A large air pocket at the bottom of the flue cushions the pressure fluctuations created at the chimney cap.

Good masonry fireplace construction seems to be a dying art. Metal heatelators—metal fireplaces built into masonry chimneys—have been on the market for some time; they increase efficiency by improving heat transfer from behind the fireplace. Many heatelators are designed to operate with a fairly wide damper opening, however, and thus are not all that efficient. This problem has led to the popularity of the fireplace insert, a heater placed in front of, and partially within, an existing fireplace in order to convert the fireplace into a heater while retaining some of its aesthetic appeal with attractive glass doors. The smoke from the insert firebox must be conducted directly into the fireplace chimney flue; thus, a short pipe must connect the insert outlet to the fireplace damper opening. This is a difficult installation procedure. If the heater is positioned on the hearth directly in front of the fireplace, and the smoke is conducted into the closed-off fireplace chamber, the gases accumulate within it and can explode under unfavorable conditions.

In a highly efficient wood-burning heater, such as the RSF Energy model, glass doors are not practical. There is nothing to be seen beyond a pile of black charred wood. During most of the heating season only moderate heat output is required; thus, the fire burns very slowly. A few coals glow and a few flames may flicker underneath the wood at the back of the heater. In any case, since the heater burns at a low surface temperature, the inside of the glass would become layered with wood tar and any view would be obscured.

The European Tile Stove

On the European continent, where coal was not as plentiful as on the British Isles and where the consciousness of the need for wood conservation developed early, an enclosed wood heating unit has been in use for centuries. The tile stove probably evolved out of the traditional baking oven, which is made of a heavy masonry or clay in order to pick up the heat of the fire. For accurate baking, the wood, in a prescribed state of dryness, is weighed out on a scale, lit within the oven, and permitted to burn itself out. The ashes are then swept to the back of the oven and the bread loaves are laid out in front. The oven door and chimney flue are then closed off and the bread bakes from the heat stored within the oven's mass. A baking oven of this type is an excellent heat source within a stove. Built between the kitchen and the living room it becomes the primary heat source for a small house.

The tile stove gradually evolved into a decorative focal point of the house, through the use of colorful ceramic tiles. Its efficiency and utility were increased by further complexity and sophistication. Because the tile stove was a heat storage facility, there was never any reason to operate it with a choked down or oxygen-starved fire. The fire was given adequate air and burned hot and clean. Since dry wood was invariably used, few chimney creosote problems were encountered. Tile stove designers usually demonstrated a good understanding of a fire's need for secondary air. The draft air often entered where the smoke departed, creating effective afterburning. Smoke channels were also frequently installed to draw additional heat from the departing smoke.

It is difficult to surpass the efficiency of a well-constructed tile stove. There is a growing interest in tile stoves in Canada, and, because fireplaces are ineffective for home heating, tile stoves are taking their place in many homes. It is important, however, to find a qualified craftsman to build a tile stove. Performance can vary considerably, depending on the qualifications of the builder.

Traditionally, the tile stove had a long warming up period, a type of delayed heat output. Tile stove builders claim that this difficulty has been solved, but undoubtedly only with some sacrifice of other performance features. The main drawback of the tile stove is that once the stove masonry has warmed up, there is no way of cooling it quickly if weather conditions change and heat is no longer required.

Knowledge of weather forecasting helps in operating a tile stove. But its principle is still relevant to those designing and improving wood heating systems. By improving heat storage systems, the clean-burning fire with the open draft may yet attain prominence in wood heating systems.

The Franklin Stove

Pioneering on the American continent was not conducive to the development of elaborate, professional masonry structures. Experts were rare, and masonry supplies were too heavy to transport over the vast distances with which the pioneers contended. A metal stove answered their needs. Pioneers often used cook-stoves to heat their homes, but the fire required continual feeding. The Franklin stove provided heat for an evening and at least most of the night without requiring attention.

The Franklin stove offers a variety of features. It is light for transport, can be installed quickly and easily, is decorative, and, when the doors are open, is a pleasant fireplace. Being of metal construction, it yields heat quickly and the top surface may be used for cooking. When the doors are closed it is safe to leave the fire unattended, and with the help of a stovepipe damper the efficiency is improved and the unattended burning periods are lengthened. For a pioneer, accustomed to stone fireplaces made with mud mortar, the Franklin was regarded as a highly convenient appliance.

The Franklin stove is not airtight enough to bring about an oxygen-starved fire, which is just as well, since the Franklin has no secondary air draft system; an oxygen-starved fire would merely create a creosote build-up because of incomplete combustion.

The "Airtight" Heater

The "airtight" heater demonstrates the principle of holding a fire in check by cutting off the air supply. Because it is constructed only of thin sheet steel, an "airtight" heater is usually only airtight when it is new. "Airtight" thus is a misnomer; the heater is unreliably airtight, especially when the fire reaches a level of heat where it begins to distort the metal in the air draft adjustment, permitting the passage of increased draft air. Usually an "airtight" is not expected to last more than a season, but in rare cases, when used by an especially cautious, meticulous owner, it can last for many years. Understanding this is a valuable lesson in the technology of firebox fabrication. When an "airtight" lasts, one invariably finds a heater that is somewhat large for the space it is required to heat, with the lid always carefully positioned and a heavy kettle full of water placed on it to keep it tight and cool. Frequently the owner is retired and spends a lot of his time sitting close to the heater. In some cases a homemade improved air draft control, perhaps with a thermostat in the form of a bimetal, salvaged from the exhaust manifold of an automobile wreck will have been added.

The original popularity of the "airtight," however, rested on its low cost and light weight, which enabled the pioneer to transport it to distant cottages and trappers' cabins. Since airtightness is necessary to protect a lightweight heater from premature deterioration, the interest in light heaters was accompanied by the development of the completely airtight heater—that is, airtight enough to control a fire within the heater under all circumstances. Examples of such heaters are the Ashley and the Valley Comfort. These heaters had an accurately fitting door and frame with an asbestos gasket to ensure a good seal. A thermostatic air draft control along with an accurate minimum adjustment was necessary, not only to prevent the fire from going out, but to avoid the excessive build-up of wood tar that sometimes occurs within these heaters and the stove vents and chimneys to which they are connected. But other than protection of the light heater construction, a great deal of usefulness was not gained from the airtight construction of these heaters. If the heater was filled and left to smolder during the mild weather, it burned inefficiently and there was excessive creosote build-up. It seemed to be preferable to build frequent small, vigorous fires that were allowed to burn out.

The Jotul

The traditional Scandinavian heaters demonstrate secondary combustion or afterburning. The Jotul is a reasonably airtight heater that makes air draft restriction possible, but a clear combustion is achieved by directing the gases leaving the fire forward past the air draft inlet before they pass into the stove outlet. Excessive wood tar build-up is avoided, and a high degree of heat output control is achieved. Because of the Jotul's small size, significantly long burning periods between fillings are not achieved. Unfortunately the largest Jotul model has the least effective secondary air draft arrangement.

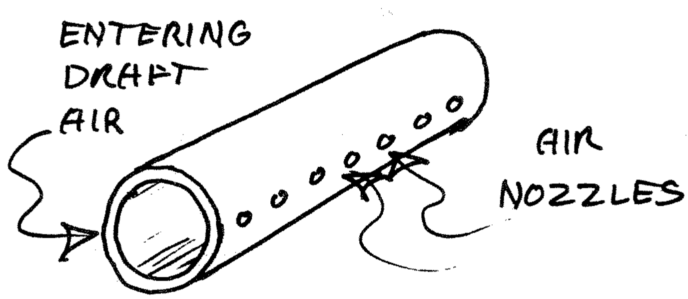
The Jotul wood heater design controls the fire in two ways; it controls air draft intake and it limits the size of the fire within the firebox by supplying the air from the same side of the wood load as the point of departure of the smoke. The fire, being small, is able to burn more cleanly and completely without yielding more than the desired amount of heat. The Jotul design is certainly not the ultimate in wood heat efficiency and convenience, although there is much to be said for its simplicity. For example, the Jotul heater does not take into account draft air preheating, which, when combined with other beneficial design factors, ensures efficiency during low heat output. The draft air preheating arrangement in an otherwise simple firebox design, such as the Valley Comfort, does not achieve efficiency during low heat output. The internal firebox design and the air draft arrangement seem to be our present challenges in creating an efficient and convenient wood-burning device.

The Air Draft System

Air draft control consists of two distinct funtions: primary air draft, which fans the fire, and secondary air draft, which ensures the complete combustion of the gases released from the fuel by the heat of the fire. Your aim, as the wood heater designer, is to control the intake of primary and secondary air—in as simple an arrangement as possible—so that it operates in the correct magnitude and proportions during cool-burning, low output periods, heating-up periods, high output periods, and cooling down periods. If possible, the control should also work for fire-lighting periods, although you may want to consider a separate primary air system, to be used only for vigorous fire fanning during fire-lighting periods, and which may be closed off once the fire is burning well. The open heater door can itself suffice in this function as long as it is not forgotten and left open.

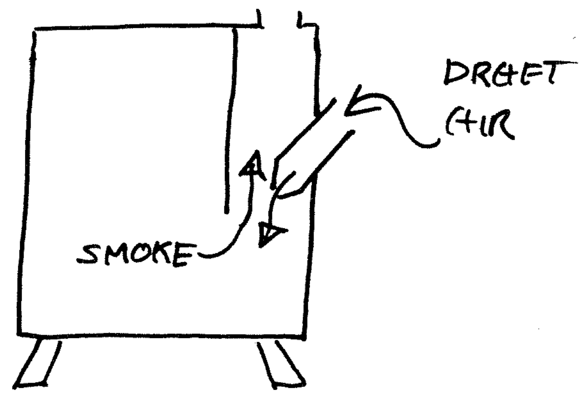
Your focus, however, is on controlling the heater while it is in operation; the air draft system thus must be a fire-controlling rather than a fire-fanning device, and therein lies the fallacy within what we have become accustomed to regard as the basic heater design—the draft air enters the firebox on the lower half of one side and the smoke departs at the upper half of the other side. The air draft is thus arranged for effective fire lighting, and these stoves do, if lit correctly, produce high heat very quickly. But there is little merit in this if it later becomes difficult to limit the fire size.

Fire size and fire fanning are effectively limited by progressive draft and approach draft arrangements. In a progressive arrangement only a small section of the firebox is supplied with air during low draft periods, while a larger section is supplied during periods when the draft is farther open. The progressive draft arrangement may consist of a pipe with holes, the air supply entering only at one end. During choked down periods the air supply tends to enter the fire through the holes close to the air intake end of the pipe because this is its shortest route. As the draft is opened further, the first holes can not handle the volume of air and consequently the draft progresses towards the other end of the pipe, making the fire larger. The shorter air draft route is called the preferential air flow, which, in a progressive draft arrangement, should begin at the smoke exit in order to supply preferential secondary air at that point to ensure that the smoke is completely burned.



An example of a progressive draft arrangement.

In an approach draft arrangement, the incoming air approaches the fire close to the departing smoke, thus supplying the smoke with plenty of secondary air. Such an air draft system does not suffice in lighting a fire, but it is excellent for controlling the fire.

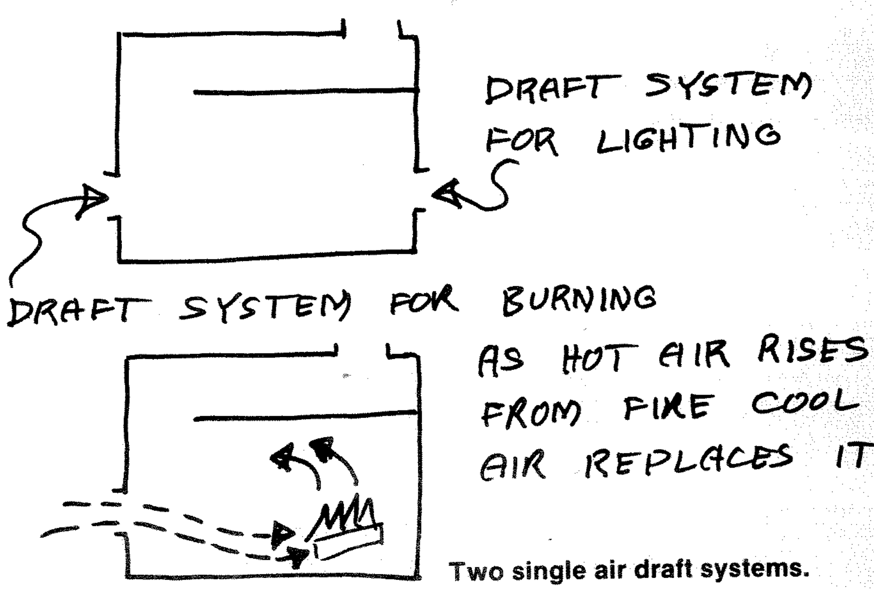


An example of an approach draft arrangement.

The Secondary Air Draft System

The gases and evaporated tars at the tips of the flames are often unable to burn because they have dropped below the kindling point or because they lack the oxygen to burn. This condition causes inefficient wood burning. Efficiency in wood heaters depends primarily on the design of the secondary air system, which must be able to operate effectively under a wide range of circumstances and heat output. Two conditions are necessary to ensure the burning of any combustible substance: access to oxygen and a temperature at or above the substance's kindling point. Furthermore, these two conditions must be coordinated—the oxygen must be present when the combustible material reaches its kindling point. If not, combustion will not take place. In addition, if the secondary air is too cool, it can cool the combustible gases, inhibiting complete combustion. This means that secondary air should be preheated and that it must enter the firebox at the proper location.

In your design of the secondary air draft system you should remember that during periods of vigorous burning and high heat output, secondary air starvation is not a big problem; plenty of primary air is fanning the fire, and thus plenty of air is available for complete combustion. But your secondary air system must be designed to operate effectively during periods when the fire is choked down and little primary air is available. You might consider a single air draft system that preferentially provides secondary air and limits primary air in order to control the fire. The Jotul is a classic and simple example of such a design. Single air draft systems with preferential secondary air are sometimes difficult to light and bring to high heat output quickly. A second air draft, at the back of the Jotul to light the fire, would solve this problem, but this should not be necessary if some skill is used. Once the fire is hot, its heat tends to draw primary air to itself. The hot air rises from the fire, and the resulting low pressure area is replaced by primary air, which fans the fire.



Two single air draft systems.

The Jotul does not preheat its secondary air. This does not drastically reduce its efficiency, but it would do so under some conditions of low heat output.

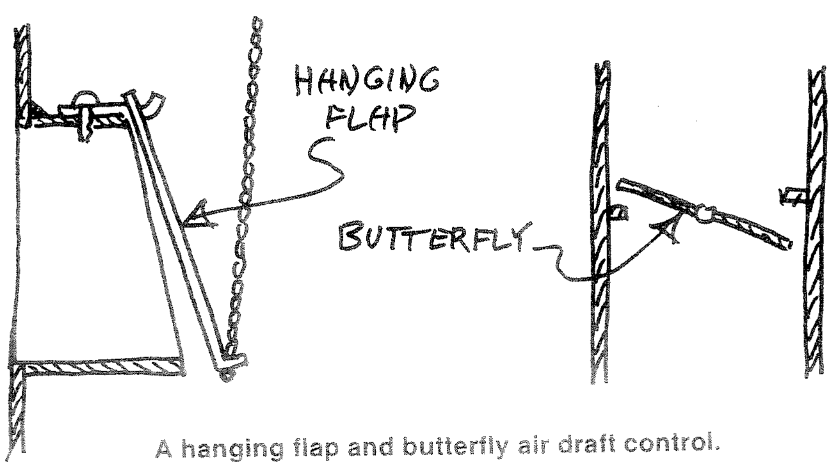
The Outside Air Draft System

Unless the house leaks air, draft air coming from the fireplace cannot escape. If the house is well insulated, a window may have to be opened while the fireplace is in use, allowing warm air to escape also. Draft systems using the outside air have been designed in order to avoid this problem. But if you are heating a well-insulated house with a heater that works on a minimal air intake, such a system is unnecessary.

An outside air draft is recommended for house trailers, because they rely more on an airtight construction than on heavy insulation. Nevertheless, house trailers require a lot of heating and thus a lot of air draft. If an inside air draft is used, a window has to be left open for replacement air. An outside air draft not only solves this problem but also ensures safety, since a wood heater burning in a very airtight house or trailer is potentially dangerous. During the day, when the house door is frequently being opened, the fire is able to burn normally and uninhibitedly. The heat within the flue ensures the upward travel of the flue gases, and any depressurization that occurs while the doors and windows are closed is alleviated every time someone comes through the door. Furthermore, fine cracks always allow air movement to a small degree. At night, however, doors and windows often remain closed, and, because of the departure of gases up the chimney, the living space can become considerably depressurized. Furthermore, the heat is often turned down at night, resulting in the cooling of the chimney flue. A cooler flue means less draw. Cases are on record where the low pressure within the living space overcame the upward draw of the flue, resulting in a downdraft and the expulsion of flue gases into the living space through the air draft opening. This is most likely to occur the moment that an exhaust fan, perhaps the bathroom exhaust, is turned on, depressurizing the living space even more. A slightly opened window will prevent this, but that will not satisfy certification requirements. An approved wood heating unit for a mobile home consequently has the air draft passing into the heater from the outside.

Safety in Air Draft Systems

Regulations state that if any part of the air draft control fails it should automatically assume the closed position. In essence, this means that the air draft should be held open so that it will fall shut by gravitational force if anything fails in the draft control system. A hinged flap hanging on a chain is undoubtedly the safest design, but care must be taken to ensure that the air flap operates freely and that the chain cannot be snarled or caught.

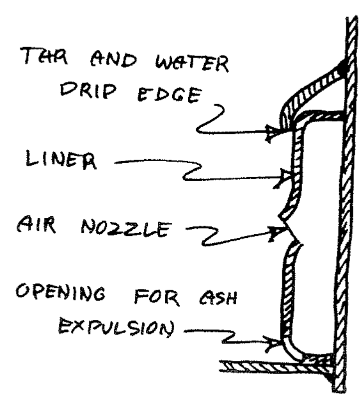


A hanging flap and butterfly air draft control.

RSF Energy heaters include a fusible link in the chain between the bimetal and the air draft flap. If the bimetal jams or fails to close the air draft, the fusible link will melt and drop the air flap before the heater seriously overheats.

Wood Tar and Ashes around the Air Draft System

In designing the air draft system you must consider wood tar deposits, liquid wood tar shedding, and ash deposits. The liquids deposited on the cooler surfaces of the flue away from the hot fire will run down toward the bottom of the firebox. Any openings and confined spaces necessary for the correct operation of the air draft system must be protected from these running liquids. Ashes also must not be allowed to plug up necessary confined spaces. The firebox must be internally designed so that wood tar and water drips off before running into unfavorable places, and confined spaces must have openings at the bottom for ashes to run out.

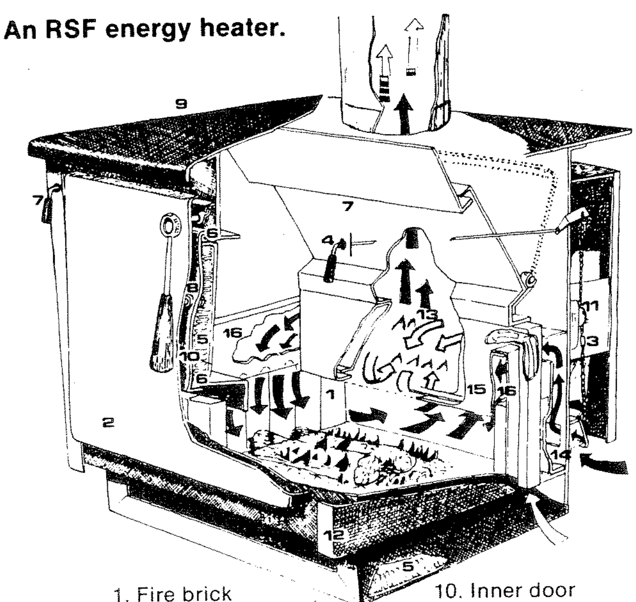


An air draft system with openings for wood tar and water runoff and ash expulsion.

The Air Draft System of the RSF Energy Wood-Burning System

RSF Energy heaters possess two separate air draft systems. In addition, the heater door may be kept open briefly during fire lighting, constituting a third air draft system. But the RSF Energy heater is seldom lit; a bed of hot coals is maintained within the firebox. Such a core of heat draws any available air to itself by the air currents it induces within the firebox. Consequently, an air draft system that vigorously fans the fire is seldom required; the two air draft systems are designed not for fire lighting but for control and efficient burning.

An RSF energy heater.

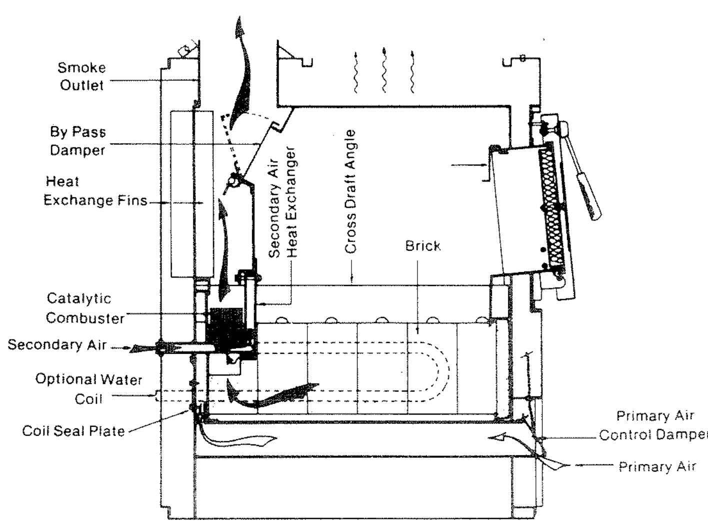


1. Fire brick
2. Outer door
3. Fusible link
4. Draft control
5. Insulation
6. Fortex seal
7. Bypass damper
8. Adjustable center push door
9. Cook top
10. Inner door
11. Bimetallic thermostat
12. Convector side panels
13. After burner
14. Primary air heat exchangers
15. Secondary air heat exchangers
16. Progressive cross draft angles

The main air draft system, which provides most of the RSF Energy heater's primary air draft and some of its secondary air, allows air to enter at the back of the heater. The quantity of air permitted to enter is thermostatically controlled, the system being completely closed when the heater has reached its maximum temperature and wide open when the heater is cold. The draft air is first preheated within an air chamber at the back of the heater and then passes into tubes along each side of the firebox, just above the brick liners, before entering the firebox through slots along the tubes directed toward the base of the firebox. This system is thus a progressive cross-draft arrangement. When the air draft control is partially closed, the draft air begins entering at the back of the firebox, providing preferential secondary air to the flames entering an afterburner at the back of the heater, and progresses forward across the firebox as the air draft control is opened. Consequently, the size of the fire may be increased and decreased at will, even though a large wood load sits above it and feeds down into it.

The second air draft system within the RSF Energy heaters is always open, the air entering one or two holes, which are approximately 2.5 centimeters (1 inch) in diameter, depending on the size of the heater. The air is fed into a preheating chamber positioned between the firebox and the afterburner. The air enters the fire at the base of, or entry to, the afterburner through a continuous slot across the opening or passage between the firebox and the afterburner. Such an arrangement is called an air curtain. It provides fresh air to ensure an adequate supply of secondary air in case the primary air draft is oxygen-spent by the time the gases leaving the fire reach the afterburner. Since this air draft system is always open, it also keeps a steady stream of warm air passing through the chimney flue, which prevents excessive water condensation and the deposit of sticky wood tars.

In most heaters the deposit of wood tar or creosote is prevalent during periods when the fire is forcibly cooled down or choked off. The heat in the fire releases fuel gases that condense and form tars. In the RSF Energy heaters, vigorous burning within the afterburner occurs for several minutes after the air draft control is closed off. This continued burning occurs because the air curtain supplies fresh air to the departing combustible gases. RSF Energy heaters are noted for their clean chimney flues.



A detailed view of the air flow through an RSF energy heater.

A manual control to arrest the flow of the air curtain would be an advantage on a warm day when the firebox is still half full of wood—the fire could be held more dormant. But such manual controls added to an automatic system can lead to trouble, since they are frequently forgotten and left in the wrong position.

Constructing an Efficient Wood-Burning System

Not only are certification standards of solid-fuel heating systems becoming increasingly sophisticated and stringent, but pressure to enforce the exclusive use of certified heating units is also increasing. You should visit your local fire marshall before beginning to construct your own wood heater. Ask him if he can personally inspect a home-built system and verify its adequacy. Your fire insurance company may also demand such an inspection.

If you wish to build your own heater, you should send for an up-to-date outline of certification standards and study them carefully. For a copy of the Canadian standards write:

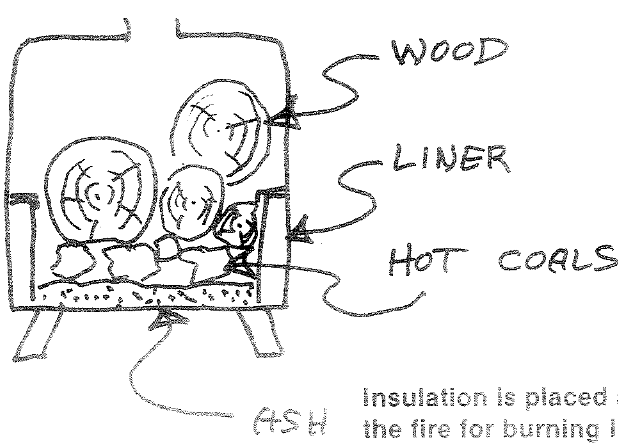
Canadian Standards Association
178 Rexdale Boulevard
Rexdale, Ontario
M9W 1R3

Simplicity and Complexity

Since wood will burn safely in both an extremely simple form, such as a campfire, and in a highly complex device, such as a wood furnace, you, as inventor, may be continually tossed between simplicity and complexity. As the functions and problems concerning wood burning come to your attention, you may find yourself devising complex gadgets to solve each problem as it arises.

Possibly the ultimate gadget is a computer attached to the wood heater that continuously monitors, controls, and adjusts the fire! On taking a second look, however, you may find that a simple device will do the work of your theoretical structure.

To discover and understand simple procedure and processes it is helpful to study past methods of dealing with wood burning. For instance, consider the problem of keeping a campfire burning unattended during the night. Before matches were readily available, fires were difficult to light. Thus, it was important to prevent the fire from burning out when it was not needed so that later it might be revived. Banking the fire with noncombustible materials, such as dirt, sand, or ashes, shut off the oxygen supply and provided insulation to prevent the hot core from cooling. The fire would smolder all night and could be revived in the morning by removing the sand, dirt, or ashes. This technique may be applied in a wood heater—an airtight construction cuts off the air supply, while unburnt wood at the top and ashes at the bottom provide insulation. Some insulation in the firebox liner also helps. Grates, which permit the ashes to drop away from the fire, are a detriment to this function.



Insulation is placed around the fire for burning longevity.

Another way to expand your understanding of wood burning is to observe how experienced people deal with simple or inadequate wood-burning devices. For instance, one man lengthened the burning time of a simple, leaking wood heater by loading the wood first and lighting the fire on top of the load, rather than lighting the fire at the bottom and then loading the wood. This procedure kept the fire smaller and consequently increased its burning time. Don't let a single discovery or observation form the basis to your wood heater design, but make note of such observations and refer to them as you determine the merits of various systems. Ask yourself the following questions:

1. Am I looking at the best alternative to solve this particular problem?
2. What other approaches might also solve this problem?
3. Do the advantages outweigh the complications?
4. Does the gadget in question solve more than one problem?

In judging the merits of any innovation applied to a wood-burning system, do not consider the innovation as an isolated function. The stovepipe, the chimney, the house and its shape, insulation and airtightness, the layout of the land, and prevailing winds are all components of the complete wood-burning system. An open fireplace, for example, requires considerable air leakage into a room, while a wood heater does not. Another example is the house-heating-requirements-to-heater-size ratio. The heater size determines the surface temperature necessary for a given heat output, and the surface temperature has a bearing on the inner surface temperatures of the firebox, afterburner, stovepipe, and chimney. Because of the temperatures of water and wood tar condensation or wood, wood tar, and wood gas kindling, the heater-size-to-heat-output ratio has a considerable bearing on the operation of the system.

Heater Body Construction Materials

The most popular material for wood heater construction is fabricated steel plate, generally made of hot rolled mild steel or a similar material, possibly with a better-quality surface. Fabricated steel plate construction is also appropriate for the handyman who likes to weld. Sheet metal is too thin for a quality firebox. Cast-iron sections, bolted and cemented together, are a type of heater construction that can only be undertaken on the manufacturing level. Even then, if poorly put together, these sections are not airtight. Masonry is expensive and does not lend itself to modern sophisticated technical designs; it is used mainly for decorative purposes with limited practical application, the basic heating unit being a steel fabricated insert built into the masonry. Unless you wish to build a very simple heating unit out of masonry, or a traditional tile stove, your best choice is a welded mild steel or fabricated construction, perhaps with a brick or stainless steel lining.

Mild Steel

There are countless types of mild steel, some readily available and some very specialized. Stove manufacturers do not usually bother with expensive steels. Some use boiler plate, which they believe is designed to withstand the heat and corrosive gases emitted by wood fires better than the low-quality hot rolled mild steel. It must be remembered, however, that boiler plate is primarily designed to withstand pressure.

The most significant factor in a heater's longevity is not the quality of the steel but the temperature and heat fluctuations to which it is exposed, which are functions of the heater design and size, the thickness of the metal, and the heat output and heat fluctuations demanded of the heater. Steel types vary according to strength, hardness, flexibility, and surface quality. Strength and hardness are not a consideration in wood heaters; nor is flexibility a problem, since regular low-cost hot rolled plate will easily take cold bends such as are required for heater fabrication. The quality of the surface of the steel plate is a factor, however. You may require an especially smooth surface on part of your heater, perhaps the top surface. Hot rolled pickled steel plate has a much better surface at little extra cost.

It is important to specify surface quality when ordering your steel; otherwise you may receive steel with a very rough surface or even a heavy layer of rust, when you could get good surface quality at no extra cost. If you have drawn up a reasonably detailed blueprint of your heater and thus know the precise sizes of the pieces of steel you require, you can order your steel trim sheered, which means it will be cut to size to a guaranteed level of accuracy. Trim-sheered steel costs only a little extra, and you not only save the effort of cutting it yourself but also do not pay for the waste that you would otherwise cut off.

Metal Thickness

The thicker the metal used for the heater body, the longer it will last. However, metal thickness is not the primary consideration in firebox longevity. Steel of any thickness will not burn out quickly unless it is red hot or close to it. Hot spots are especially bad because the resulting uneven expansion and contraction throughout the metal surfaces breaks down the metal structure. The average temperature of the metal surface of the firebox is a function of the firebox size and its heat output, which is controlled by the thermostat. Thermostat adjustment is therefore important, but the extent of hot spot damage is largely determined by metal thickness.

The distribution of heat over the surface of a flat piece of metal occurs through heat conduction within the metal. Because it has a small sectional area, a thin piece of metal possesses a proportionally lower capacity to dissipate heat through conduction. Our aim, therefore, must be to find the metal thickness at which heat dissipation is adequate.

The safest way to judge the adequacy of metal thickness is to study fireboxes that have burned for some time under varying conditions and to observe if localized heat buckling has occurred. Heat buckling indicates hot spots. Firebox deterioration is to some extent related to the heater design. A thermostatically controlled unit will manage with a somewhat thinner metal, but much depends on how well the heater's maximum heat output is being controlled.

RSF Energy fireboxes are built of 10- and 12-gauge mild steel and ½-centimeter (¼-inch) plate. This width is sufficient as long as the thermostat is not tampered with or put out of commission. For a nonthermostatically controlled unit, use at least ½-centimeter (¼-inch) plate throughout the firebox.

Welding

Simple rectangular pieces of steel, cut to size, may be purchased at a reasonable cost. Notching and bending costs more, but notches can be made with a cutting torch and thicker-gauge plate can sometimes be bent with sheet metal equipment. A sharp kink always requires considerably more force than a gentle curve. If you cannot arrange to have the metal bent, you simply have to cut and weld.

For a firebox, well-penetrated welds, called beads, are of paramount importance. Poorly made parts may give the heater a crude appearance, but a poorly welded firebox is dangerous. Some beads are not easy to assess, especially those made with the mig welder (an automatic welder with a shielding glass). These beads may look good but have very little penetration; sometimes the bead merely sits on top of a thin layer of rust and impurities on the metal. Here and there a small spot may have penetrated, holding everything together. But a good rap with the hammer may cause the weld to break. Worse still, penetration may be good enough to pass initial tests but inadequate to withstand continuous use. Thus, a fair degree of knowledge and skill in welding is necessary.

Types of Liners

The hottest parts of a wood fire are the glowing coals at its base. The firebox is well protected on the bottom from the heat of these coals by the layer of ashes deposited there. Before lighting a new stove, you should throw in about 2½ centimeters (1 inch) of dirt or sand. When taking out the ashes, you should leave 2½ centimeters (1 inch) to protect the heater floor.

A liner is required around the lower sides of the firebox to protect them from burning out. Liners can be made of replaceable mild steel, cast iron, stainless steel, firebrick, or clay. Mild steel and cast-iron liners regularly burn out as a result of oxidation and the metal fatigue caused by hot spots. Thick, high-quality cast iron can last a lifetime if the heater is not overtaxed. The secret of longevity in any firebox is to use it below capacity; the heater should be a little large in proportion to the space heated. The larger the firebox, the cooler the fire needed to heat a room or house.

Stainless steel has a much better temperature rating than cast iron. Unfortunately, many heater manufacturers use very thin stainless steel, which must frequently be replaced. The problem again is the effect of hot spots, which the thin material cannot dissipate. Hot spots in stainless steel are especially serious because of the excessive coefficient of heat expansion. The material is strained as it expands and contracts unevenly, and it eventually breaks down completely.

Welding stainless steel to mild steel is tricky; the difference in the heat expansion coefficients frequently breaks such welds. In your heater design, you should try to avoid welding the two metals together.

A loose stainless steel liner must be supported along the edges and perhaps in the middle if its surface is very large. If the liner is notched and bent into a box, it is supported along the straight edges and consequently needs support only at the corners and perhaps at the center, which may be supported with a spacer against the firebox housing and by the firewood on the other side.

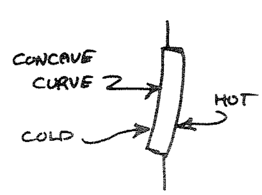
Firebrick is widely used with success. The bricks are placed without mortar and held in position with metal brackets. If they break, they can be readily replaced. One precaution must be taken with firebrick—don't put an ice-covered piece of wood against it because it will break as a result of the temperature change. Clay and special mortars may also be used in fireboxes, but their use is specialized.

The choice of liner to be used in a firebox depends mainly on the air draft system design. Brick and stainless steel, for example, lend themselves to different designs. The tools and materials available, as well as the cost, also influence this decision.

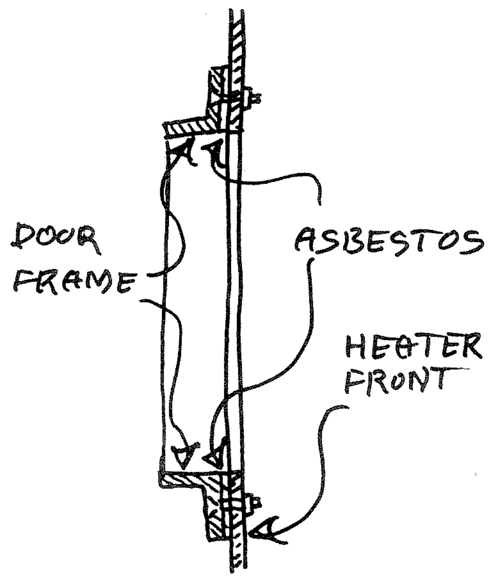
Heater Doors

With an airtight, welded construction, the only real challenge left in making your heater airtight is the door or doors. You must ensure that the door and frame do not warp, that there is a tight seal between the frame and door and the safe catch and hinges, and that there is adequate wood tar shedding.

The firebox should be designed so that the hottest part of the fire is not too close to the door, which means that the air draft should not be placed close to the door. The design of the door frame and door must be based on the temperature to which they are exposed during the normal use of the firebox; a door frame cannot tolerate heat distortion. In addition, it must resist bending under pressure. Thus, the frame needs some depth. The metal closer to the fire, however, will tend to expand to create a concave curve on the sides of the door frame. To prevent this, use a relatively thick door frame material to help draw the heat forward, through conduction within the metal, thereby equalizing the temperature within the door frame metal. Another way of keeping the heat in the door frame even is to bolt it onto the body with an asbestos gasket, which provides some insulation from the firebox housing.



An example of how heat distortion affects the door frame.



SECTION: DOOR FRAME

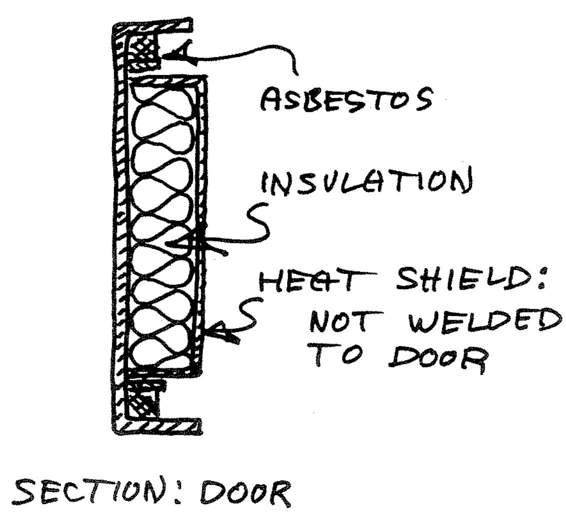
An asbestos gasket provides insulation.

If long burning periods between filling are desired, and if you wish to control the fire within a large firebox, an asbestos door seal between the door and the frame is necessary. Fortex asbestos rope is an appropriate material for this purpose, although other materials are also used. Asbestos rope is not completely airtight, but it will work if the asbestos is in contact with the door and the frame at all points around the perimeter of the door.

Since cast iron is less distorted by heat than mild steel plate, it is often used for heater doors and door frames. Mild steel is certainly adequate for thermostatically controlled heaters, however. Only extreme temperatures and serious heat distortion cause damage to any heater. An airtight heater with a tight door will always control the fire, and if the thermostat is correctly adjusted, it will not go above safe operating level.

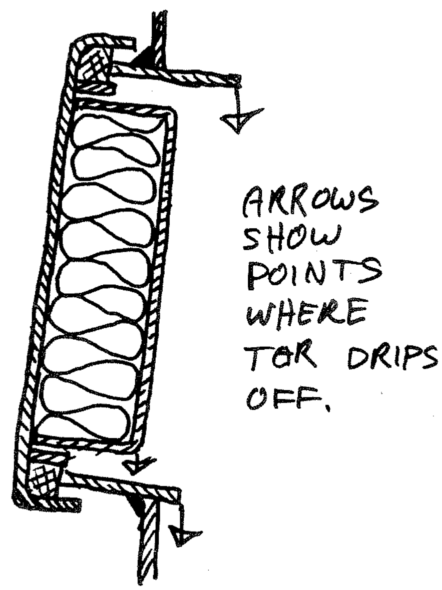
The door itself must not bend under closure pressure. Heat is less of a problem in a door, since it is farther from the fire and better cooled from the outside. It may be further protected by insulation and a heat shield on the inside. The heat shield may have to be replaced occasionally, but the door itself will be protected. If the door is situated in a hotter area on the firebox, the heat shield should be made of stainless steel. Do not weld the heat shield to the door body; it should remain immune from the heat expansion and contraction of the heat shield.

Detail of the heat shield behind the heater door.



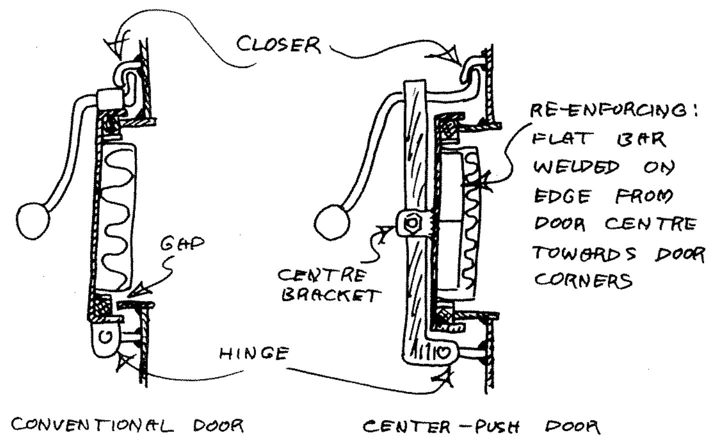
Tar shedding is an important consideration in designing a heater door and frame. During low burning periods, wood tar may condense on the inside of the heater door and on the firebox body around the heater door. This liquid runs down, and if the door and frame are not correctly designed, it will run onto the door seal and possibly leak through it. The tar should be compelled to drip off before this occurs.

Tar shedding.



SECTION: DOOR AND FRAME

The door hinges and the door closer mechanism must be skillfully built. If the door feels tight at the closer or door catch, it does not necessarily mean it is tight at the hinges, unless, as for the RSF Energy heaters, you construct a center-push door closer arrangement, where the door hinge assembly is a separate unit, attached to the door only at the center. If you do this, be sure the door is structurally designed to handle the pressure at the center and devise an adjustable mechanism to attach the door hinge assembly to the door so that the door frame seal can be tightened if necessary. The door hinge assembly should have some spring action to it, so that the door seal is under pressure when the door is closed.



Two types of heater doors.

The Chimney

The chimney is part of the air draft system. Since warmer air will rise in surrounding cooler air, chimney flue gases travel upward, drawing air into the draft opening and into the fire. The amount of draw is a consequence of the temperature and construction of the flue. In constructing a chimney you must first consider the requirements of the fire under various conditions and then design a flue that also draws sufficiently to prevent smoke from getting into the room when the heater door is open for wood loading. Sufficient flue draw depends on various factors, including cross-sectional area, shape, height, insulation, elbows, chimney cap, height above roof, land contours, prevailing winds, and other stoves connected to the chimney.

Cross-sectional area determines the volume of air that a flue can handle at a given gas speed. Gases flowing within a pipe have a maximum speed that can be surpassed only by a considerable increase in driving force. The shape of the flue determines its maximum "comfortable" speed. Flue gases spiral, so round flues function better than square or rectangular ones. The cross-sectional area of a square or rectangular flue must be about one and a half times larger than that of a round flue to attain the equivalent draw.

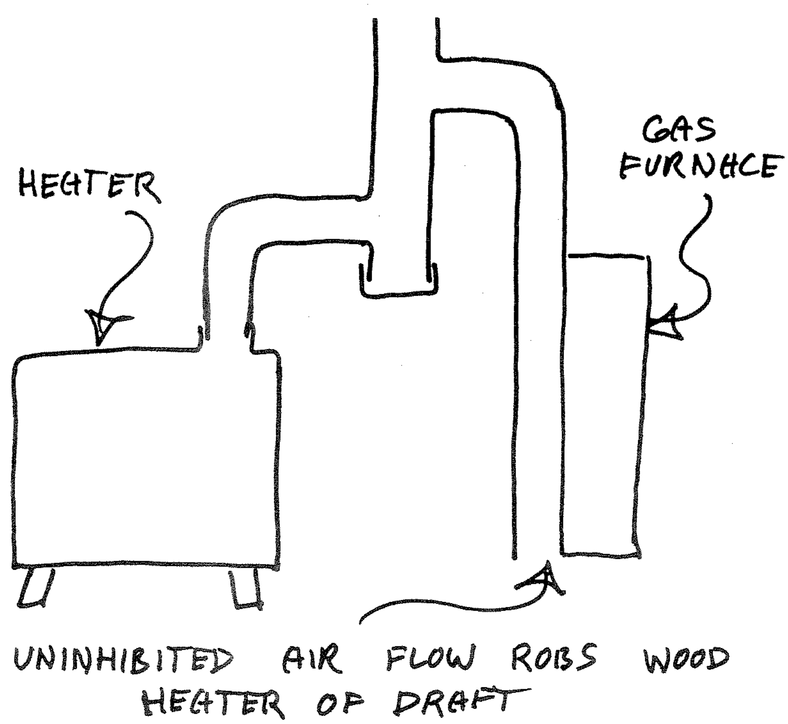
Flue height also determines a chimney's drawing power, but twice the height will not yield twice the drawing power, since the speed of the flue gas does not double. Furthermore, flue gases cool as they rise; thus, the top half of the chimney does not draw as well as the bottom half. An extra length of flue, however, can make a difference if your chimney is not drawing sufficiently.

A well-insulated flue will draw reliably and evenly. A chimney constructed outside the house will never draw as well as one constructed inside, especially while the fire is being lit. When the flue is no warmer than the outside air, it will not draw at all. An uninsulated stovepipe makes the worst possible chimney, since it negates the long burning time and control of the heater.

Elbows in the flue or leading to the flue inhibit its draw. If you require many elbows in your stove hookup, you should consider a larger flue to counteract the effect of the elbows.

Although chimney caps help to even out the chimney draw during inclement weather, they are a slight inhibition to the expulsion of flue gases from the chimney. Some fire marshalls insist that the chimney cap be used, but in many cases there is little point in it. The chimney cap does help, however, if you are on a hillside or in a valley and the wind comes off the hill and drives down into the chimney.

Adding a second heating unit, or another gadget that requires an exhaust system, to the same flue will invariably reduce the draw. The reduction will be fairly insignificant if the unit is airtight, but in the case of a gas furnace, in which the movement of the flue gases is practically uninhibited, little draw remains for any other heater. A gas furnace in this respect is similar to a fireplace, which must have its own flue. Before connecting several units to the same flue, you must understand the operation of each unit involved and how it will affect the system as a whole.



Uninhibited air flow robs the wood heater of its draft.

Chimney Safety

Chimneys are rated by various classes. Wood-burning devices require a class A chimney, meaning a chimney that is as good as, or better than those of other heating units.

Safety depends not only on correct installation, but also on understanding the system and servicing, checking, and maintaining it regularly. You must, for example, know if and when a chimney fire could be expected and be present at the time. Check for sparks being expelled from the chimney, especially if the chimney fire is at the top of the flue. If a chimney fire occurs when a considerable layer of wood tar is deposited within the flue, it can damage the chimney lining. Regular sweeping will prevent chimney fires. The intervals between sweepings depend entirely on the particular heating system, which is why you must know the peculiarities of your unit.

Information on chimney installation, servicing, and safety is probably best obtained from your fire marshall. He would also be able to help you assess the adequacy of an old chimney.

Down-Feed

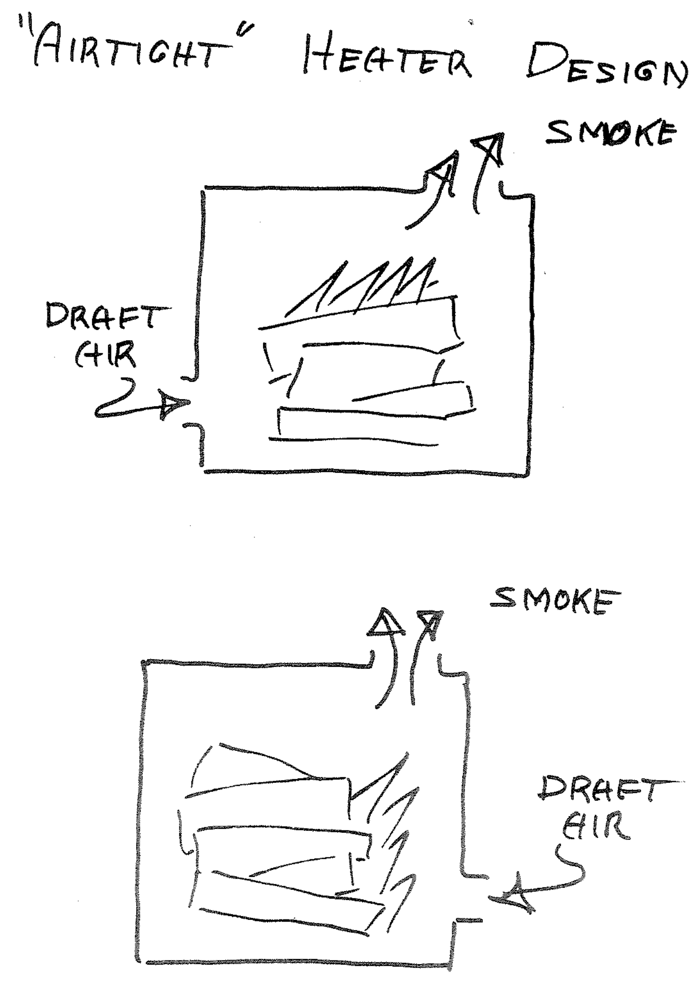
There are a number of ways in which a fire may be controlled. The fire may be cooled by pouring water onto it—as the water evaporates, it takes up heat and cools the fire. Burning wet wood can control the fire for the same reason. Such methods of control should not be incorporated into the design of a wood heater; they fall into the category of emergency measures or fire safety. A wood fire is a chemical reaction between oxygen in the air and the hydrocarbons in the wood, yielding carbon dioxide and water and sometimes some carbon monoxide. Since wood and air are the components of the reaction, the best way to control a fire is to control the air intake or the wood supply or both. Controlling the air alone, however, is not ideal. Because gases and tars leave the fire and escape up the chimney, a choked-down fire is inefficient. Thus, a way of controlling the wood supply to the fire should be devised.

Control of fuel supply works easily in sawdust burners, since sawdust may be fed by a rotating worm or some hopper arrangement. But with cordwood, burned in a simple heater or fireplace, controlling the fuel supply means hand feeding the fire when heat is required. In a down-feed system, however, cordwood may be fed into a fire automatically within the firebox itself. The fire burns at the bottom of the firebox, and the wood feeds downward into the fire as the wood fuel below it is burned away.

An extreme example of a down-feed system is a large pipe leading from the firebox to the outside of the building, with an airtight door at that end. The firewood is fed into the pipe from the outdoors and slides down into the fire as it is burned away within the firebox.

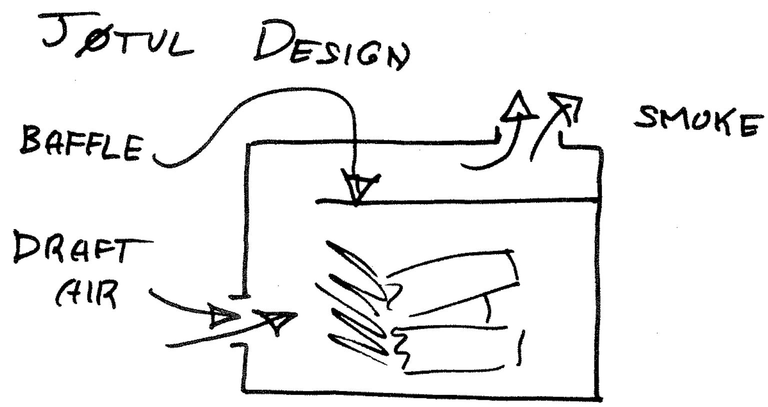
The success of the down-feed system is based on the relative positions of the air draft inlet and the smoke exit, since they influence the size of the fire. If the air draft is located opposite the smoke outlet, the fire is continually fanned by the incoming air and all the wood burns or smolders, depending on the quantity of air available. If the air draft is on the same side as the smoke outlet, the fire is limited to one side of the wood load. In the Jotul or cross-feed design, the fire feeds its way to the back of the heater. In the down-feed design, the fire only burns at the bottom. The backdraft down-feed design limits the fire even more. Finally, the draft may be located in the center to ensure that it always reaches the down-feeding wood—

that is, to bring the air inlet nozzle closer to the hot coals for effective fire fanning.

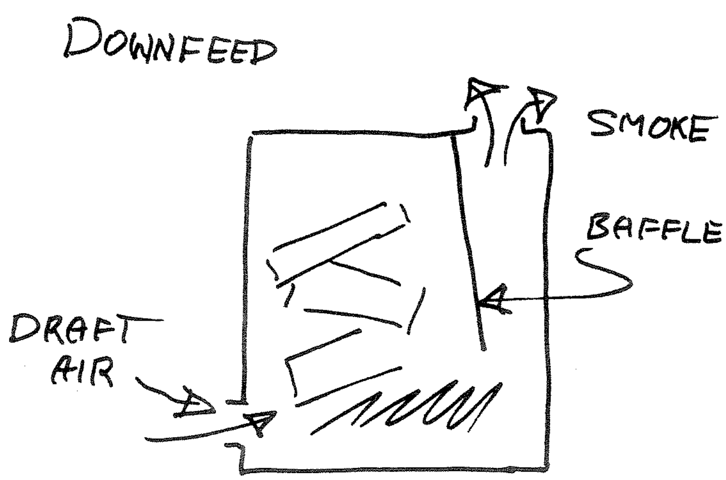


The updraft and the backdraft firebox designs.

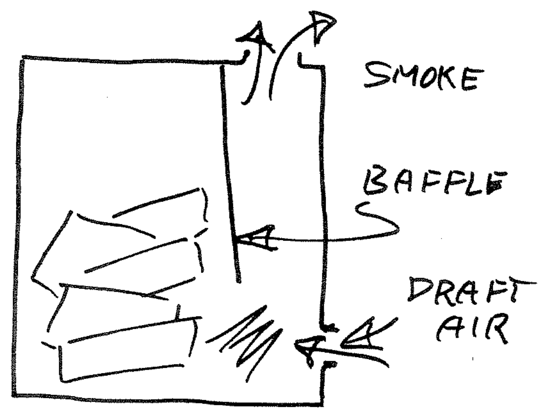
Cross-feed and down-feed designs.



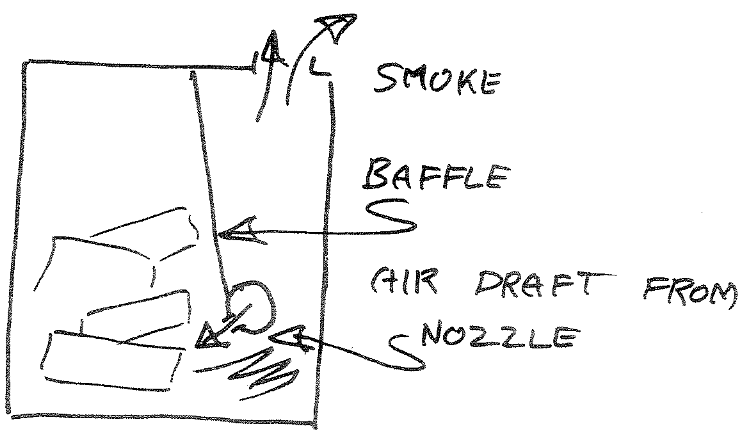
Jotul, or cross-feed.



Basic down-feed.



Backdraft down-feed.



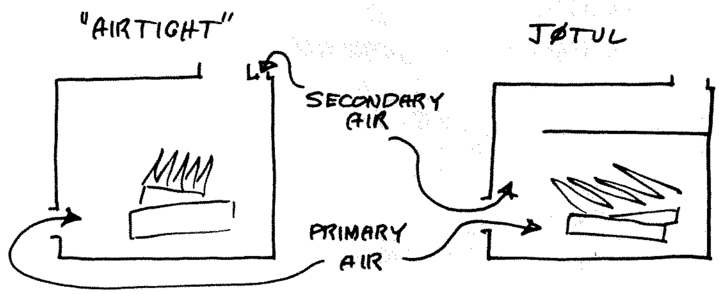
Centerdraft down-feed.

Achieving Long Burning

A controlled fire that burns for a long period without going out involves the following important factors: a secondary air draft system that is efficient at low heat output, a limited fire size within the firebox, a large firebox, an airtight firebox and heater door, an effective fire-fanning process during fire pickup periods, preheating of the intake air, the correct chimney size and length, chimney and firebox insulation, and thermostatic control.

Anything that contributes to efficiency at low heat output will contribute to long burning. But few secondary air systems work well at low heat output. Success depends on the heater's capacity to limit the actual size of the fire. The bulk of the wood in the firebox must be held relatively dormant, while the expelled gases must be burned before leaving the fire. To encourage these gases to burn, they should, before leaving the firebox, come as close as possible to the hottest part of the fire in order to reach the kindling point. At this point they must also have access to oxygen to make combustion possible. If the area in which combustion occurs is reduced, you can also expect to reduce the heat output without losing efficiency —that is, without losing unburnt gases into the atmosphere.

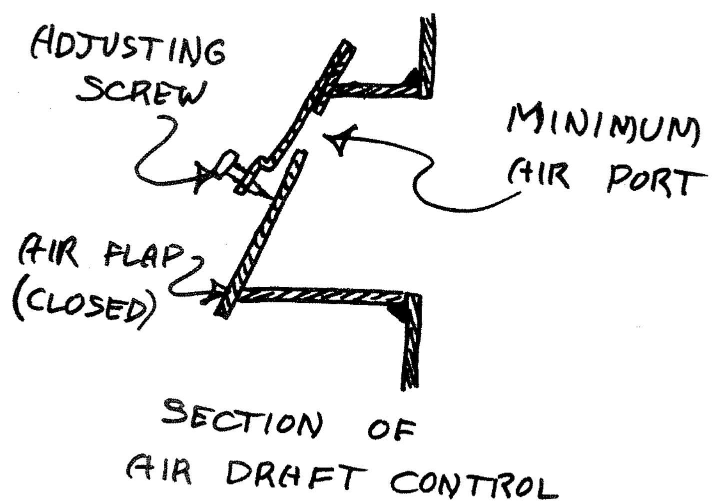
The hottest part of the fire is that part being fanned by the primary air. To achieve long burning, primary and secondary air must be very close together. This principle can best be illustrated by studying the difference between the conventional "airtight" heater and the Norwegian Jotul heater. In the traditional "airtight" heater, gases are burned only at high heat output. When the fire is choked down, the wood gases are too cool to ignite when they reach the secondary air portal. To achieve long burning, the size of the fire must be kept at a minimum; thus, all the components relating to the fire—namely, primary air, secondary air, fuel, and kindling temperature—must be confined to a small area.



An example of the difference in air flow between the conventional "airtight" heater and the Jotul heater.

Once you have achieved a small fire within a large wood load that feeds into it, you may consider a large firebox to accommodate a large amount of wood, thereby lengthening your burning time. However, you must remember that the more wood there is in the firebox, the greater the fire hazard if something fails or if the furnace door is accidentally left open. A large quantity of dry wood burning out of control creates a great deal of heat. Therefore, a well-constructed firebox with a safe door is of paramount importance.

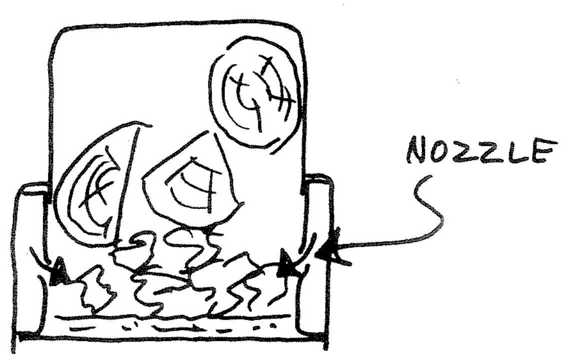
The other extreme is the situation in which the fire has been choked down for some time and is barely burning. When the room has cooled to a point where the thermostat opens the draft control in an attempt to recover what is left of the fire, how can the fire be revived? Any draft system should be supplied with a minimum adjustment that ensures some air passage during low burning. This setting is made according to the drawing power of the chimney, the type of wood being used, and simple trial and error.



Minimum air draft adjustment.

An effective method of fanning half-dead coals is an electric fan, but this is not a viable alternative. If the fire fails to recuperate, the fan will continue to run anyway. If the draft air is drawn from within the room, considerable warm air will be lost. In any case, over-reliance on electric gadgetry should be avoided.

Remember that a good flue is a powerful exchange unit, moving air by "gravity flow." Hot air rises and is replaced by surrounding cooler air. You should make the best possible use of this fanning effect. The best fire fanning is achieved by the nozzle effect. By adjusting the nozzle on a water hose, you alter the velocity of the water being ejected from the hose. This principle also applies to air draft design. The size and direction of the openings through which the air is injected into the firebox should be carefully considered. They should be directed where you anticipate the hottest coals during the low burning periods. The optimum size of these nozzles must also be carefully estimated. Only experimentation will show the best final design. Begin with fairly small holes or a narrow slot; if you cannot get a high enough output from your heater, gradually increase the size of the holes or slot. Several nozzles are usually required, since the location of the coals to be fanned cannot be accurately predicted. Begin with a nozzle area (adding up the area of all the holes) one-tenth the area of the actual draft control opening. Then increase the area if necessary. Much depends on other factors in the design of the heater, including the size of the chimney, but if the holes are too large you lose the fanning effect.



The draft air is preheated behind the liner and expelled through the nozzles.

The draft control should be as airtight as is reasonably possible, although some deliberate leakage should be allowed for minimum air draft adjustment to prevent the fire from going out. The draft control of a properly designed air draft system need not be as airtight as that of a poorly designed air draft system.

Preheating the intake air also helps to prevent a fire from going out. The most effective preheating is around a metal liner, since the glowing coals are in contact with it. The extent to which draft air preheating is related to long burning is unknown. If you have difficulties in keeping a fire burning and cannot trace it to any other cause, you could work on better preheating of draft air.

Probably more important than preheating intake air is insulating the heating unit against external temperature fluctuations. An uninsulated chimney automatically disrupts the operation of any wood heating system, especially if much of the chimney flue is outside the building. Masonry chimneys, if built to specifications, are generally well enough insulated, but metal chimneys must have a double wall with insulation material in between. For even drawing, the flue must have an even temperature that is somewhat higher than the surrounding temperature.

Some additional improvements may be achieved by using insulated stovepipes between the heater and the chimney flue. Such pipes have stainless steel on the inside, which gives them a longer lifespan than the conventional stovepipes. These pipes may be obtained from the supplier listed in the glossary.

Stovepipes leaving the heater should be reasonably tight. Efficiency and draft are lost if air is drawn from the room into the chimney through leaking stovepipe joints. The actual operation of the heater itself should not be affected by this leakage, unless it is excessive.

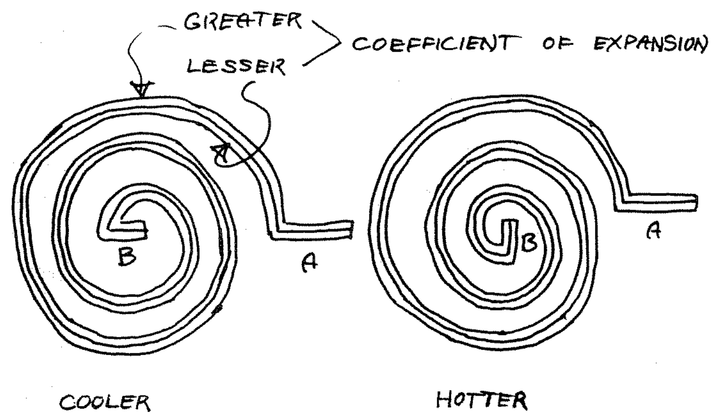
In addition to the size and insulation of the chimney flue, the insulation of the firebox, around the glowing coals, affects the fire's longevity. If the heat is drawn from the coals too quickly, they tend to go out at low draft settings. For instance, the first few times a fire is lit in a heater in which the ashes have been completely removed, combustion is difficult to maintain on a low draft setting because of the lack of insulation below the glowing coals. As soon as a good layer of ash is deposited on the firebox floor, the problem solves itself.

A brick firebox liner helps maintain even combustion and heat output. Some heaters rely primarily on firebox insulation and a mass of heated material to achieve even burning. For more sophisticated air draft systems, a great deal of firebox insulation should not be necessary. You should also remember that too much insulation between the fire and the room lowers the efficiency of the heating unit.

Thermostats

Massive heaters manage fairly well without thermostats because the material around the fire dampens their temperature fluctuations. But reasonable skill is needed to maintain the desired room temperature, and in warmer weather it is difficult to keep the fire going. To avoid overheating the room, the fire is continually permitted to burn out and then is relit when more heat is desired. Thermostats eliminate this problem and help make heating with wood more convenient.

Thermostatic draft control essentially reduces or closes the draft opening when the temperature is above the adjusted setting and increases or opens the draft opening when the temperature has dropped below the desired setting. The controlled air draft thus either fans the fire to produce heat or allows it to die down. Thermostats can be totally mechanical, or they can operate on electricity. Mechanical thermostatic control either relies on gas expansion and contraction or, more commonly, operates on a bimetal that relies on metal expansion and contraction.



Bimetal coils.

A bimetal is made of two strips of different metals, each of which has a different expansion coefficient. These strips are welded together, flat surface to flat surface. Since the two metals expand and contract at different rates when exposed to temperature changes, their shapes alter. Thus, as the bimetal is heated it bends toward the metal of lower expansion coefficient, and as it is cooled it bends toward the metal of higher expansion coefficient. In order to gain a large alteration in position from a temperature change, the bimetal is bent into a coil. The relative position between A and B alters considerably with temperature change. This alteration is commonly used in the thermostatic control of both mechanical and electrical thermostats.

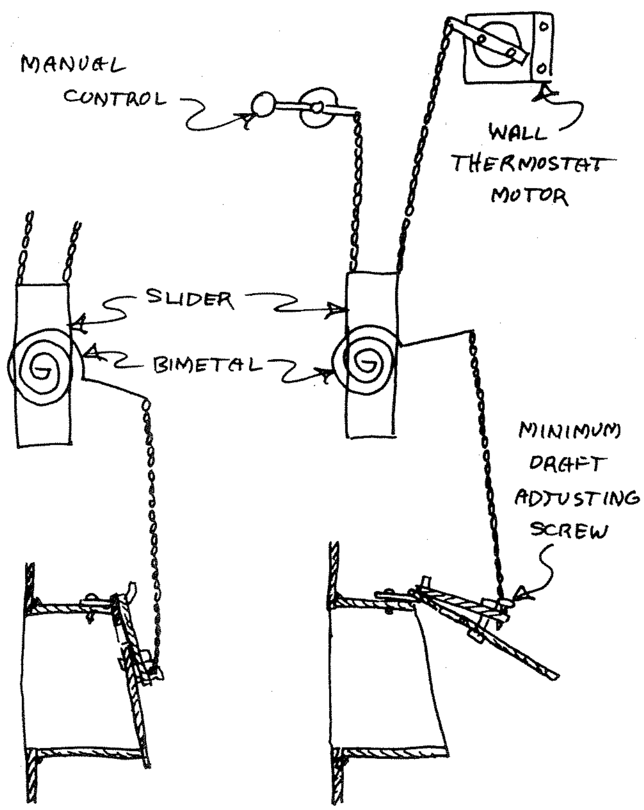
A bimetal works on gradual change, but in electrical thermostats this gradual alteration is usually converted into an on/off operation through an on/off switch that is tripped by the bimetal. The switch on the thermostat operates a draft control motor, which pulls the draft up when the switch is closed and lets the draft down when the switch is open.

Heater and Wall Thermostats

For accurate thermostatic control, both a heater thermostat to control the temperature of the heater and a wall thermostat to control the room temperature are needed. The heater thermostat confines the heater within a safe operating output level if it is forced to burn at full capacity for a long period. Thus, the two thermostats are a safety feature. If the house is very cold, the heater must bring it up to room temperature and could overheat itself before the wall thermostat responds, especially if the wall thermostat is some distance from the heater. The heater thermostat prevents this danger.

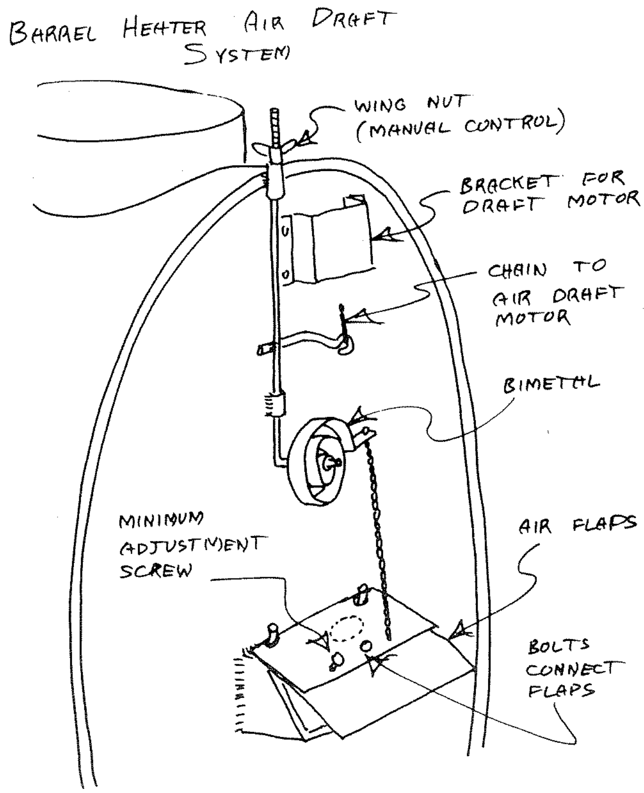
For a central heating installation, which relies on electricity to operate a fan, it is common to incorporate only electrical thermostats for both furnace protection and room temperature control. For a heater, which should be able to work without electricity, you should consider a bimetal for heater protection and possibly add an electrical wall thermostat to maintain accurate room temperature. If the electricity goes off, the heater should be workable on a manual control, using only the bimetal heater thermostat. The two thermostats must work in tandem—if the room thermostat is in the "on" position but the heater is burning at its maximum safe heat output, the air draft should nevertheless be closed. The distance between the center of the bimetal coil and its outer extremity determines the degree to which a vertical movement is achieved on the draft flap. The length of the chain between the bimetal and the air draft control flap determines the maximum heater output.

Avoid haphazard thermostatic arrangements. A heater without a thermostat demands the continual attention of a qualified operator to set the air draft control correctly and safely for varying situations. Thermo-



The electrical and manual control thermostat system.

stats eliminate the need for this attention, which to a large extent concerns safety. If the automatic installation does not provide at least an equal degree of safety in the system, however, it should be avoided.

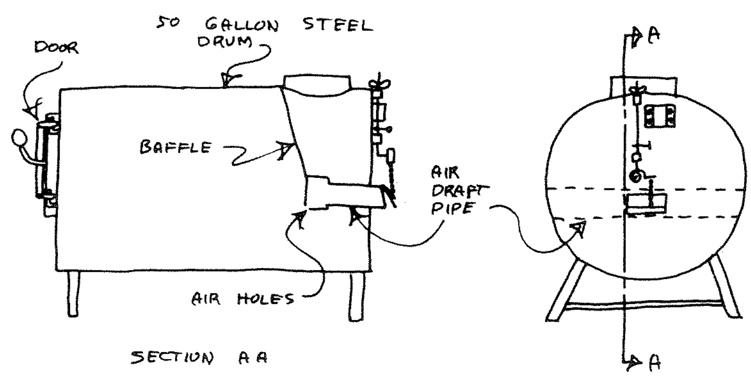


The barrel heater air draft system.

The Barrel Heater

A heater built out of an oil drum, usually a 185-liter (50-gallon) drum, is one of the least expensive heaters you can build. These heaters are usually contructed to sit horizontally on four legs, with a door and a simple air draft at one end and a smoke outlet at the other end. Sometimes the brick or steel liners are placed within the barrel. Because the oil drum is airtight, the heater is very controllable if the door and air draft are also airtight.

A more sophisticated air draft system along with a down-feed baffle (a wall or screen) can contribute considerably to the performance of a barrel heater. The preceding diagram shows a simple approach draft system that permits the barrel heater to operate for long periods between fillings at low heat output. A thermostatically controlled air draft flap may be mounted at the intake of the air draft system. If more effective fire fanning is desired during fire-lighting periods, a second manually controlled air draft may be mounted on or underneath the door. This air draft must close tightly, however, to ensure the correct operation of the thermostatically controlled air draft.



Front and side view of a barrel heater.

Domestic Hot Water Heating

With the exception of home heating, domestic hot water heating consumes the largest amount of heat energy in the average home. If it is not too expensive to install, a water heating system to replace or supplement the conventional electrical or gas hot water tank soon becomes a considerable saving. Because the amount of heat required from a wood heater or furnace varies according to the outside temperature, it is difficult to design a domestic hot water heating device to be attached to a wood home heating system that supplies all the needed hot water year round. For this reason, some of the earlier wood-heated domestic hot water heaters were constructed exclusively for that purpose and were only lit if hot water was needed. Another approach is to construct a small solar hot water heater in addition to the system attached to the wood-heated system. Thus, when the sun shines and little or no heat is generated by the wood heater, the solar heating device takes over.

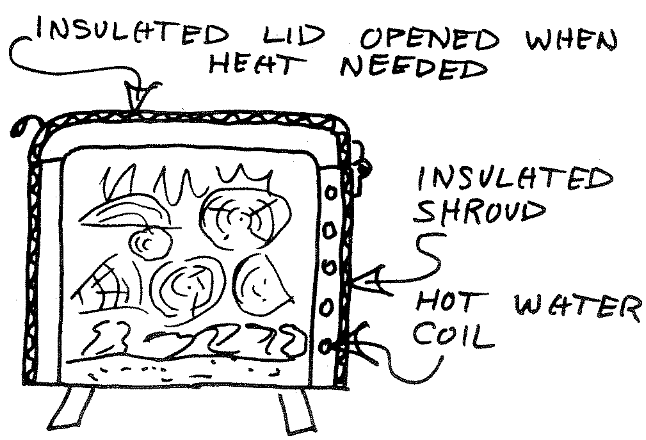
At present it is common to see a fairly simple domestic hot water heating installation added to a wood heater or furnace. It may not serve the whole purpose, but if it is well designed it can take care of well over 50 percent of the average household's domestic hot water needs. In the winter, if use of hot water is well distributed over the day, it can take care of all the domestic hot water needs.

Hot Water Coil

A hot water coil is a water pipe positioned in the vicinity of heat so that the temperature of the water within it is able to rise. The heated water in the coil circulates into a hot water storage tank, and the cool water at the bottom of the tank flows into the coil. Thus, the water is gradually heated. There are two types of hot water coil installations: a relatively short coil situated within the firebox where the fire is hottest, or a larger coil situated outside but against the side of the firebox or stovepipe, where a fair amount of heat is generated.

A coil within the firebox has the advantages of being out of sight, short, and able to function with the slightest fire. Some efficiency is lost as a result of the condensation of wood tar on the coil caused by the presence of cool water within the coil. Coils in the firebox also burn out more readily than those outside the firebox, especially if the coil is not full of water.

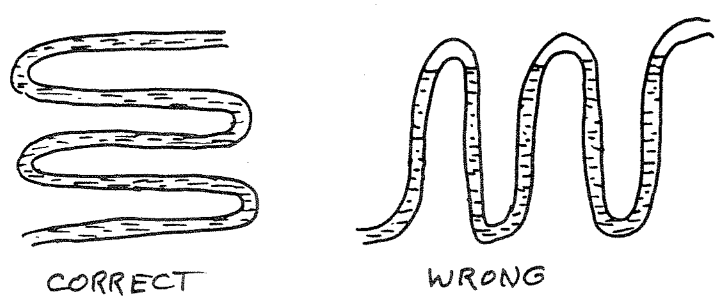
A hot water coil outside the firebox must be much longer to be effective, but since it remains clean, it picks up the available heat more efficiently. It is less effective during periods of low heat output, but if the heating unit is surrounded by an insulated shroud or masonry, the airspace between the heater and the shroud will usually be fairly hot. In this situation the hot water coil outside the firebox is more effective.



An effective position of the hot water coil.

Hot water coils can be made of steel pipe, copper, or stainless steel. Use 2-centimeter (¾-inch) pipe or larger, to allow speedy circulation. If you use copper and must connect the pipe within the firebox, do not use regular solder; use silver solder. If you bend the pipe into the appropriate coil and lead the ends out of the firebox, you can avoid soldering, but there must be a good seal where the coil travels in and out of the firebox. Air drawn in could disrupt the air draft systems of the heater.

To ensure correct water circulation, the coil must be shaped so that the water never travels downhill. Otherwise high points are created where steam might collect, and steam creates air locks that would stop water circulation, causing the water within the coil to reach the boiling point.

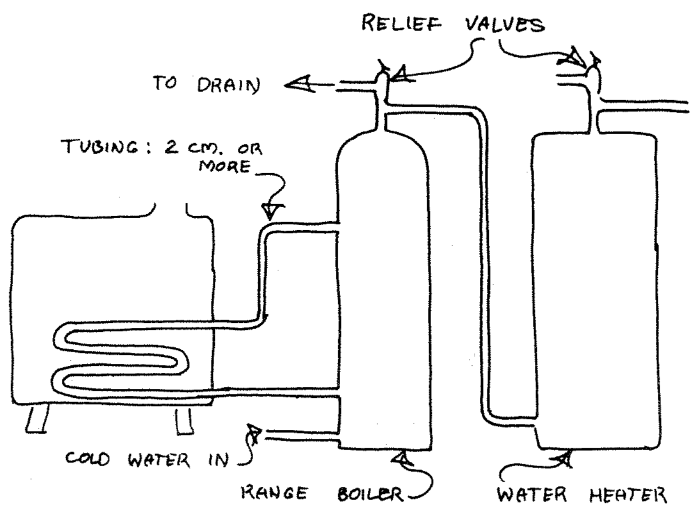


Preventing air locks in the heat coil.

From the top end of the heating coil, the pipe should continue uphill until it reaches the relief valve, after which it may drop down into a tank or range boiler that is gradually heated as a convection current between coil and tank takes place.

The hot water coil should be connected to a separate tank or range boiler, which must have its own relief valve in case steam is created and excessive pressure is generated. The water from the range boiler may be drawn into a conventional electric or gas hot water tank. If the wood-heated water is below the thermostatic setting of the conventional hot water tank, it will be heated further to bring it up to temperature.

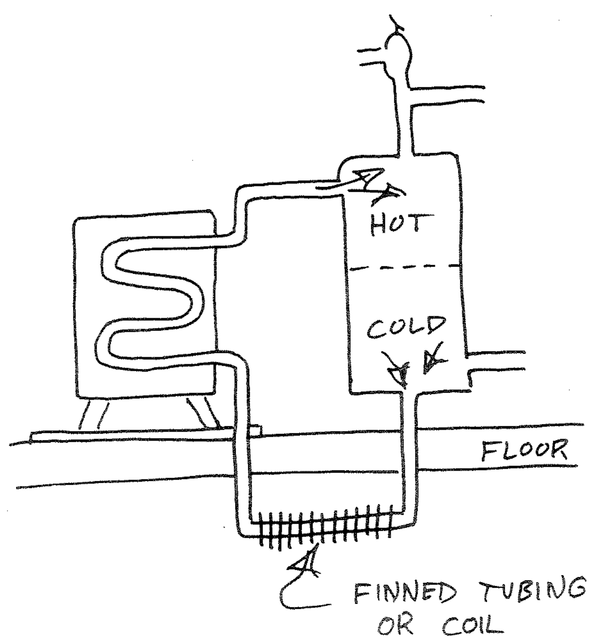
The range boiler should be as close to the hot water coil as possible. If it is distant, you could try making it work by increasing the pipe size to assist water circulation. The range boiler must not sit lower than the coil. If the heater is on the main floor and the tank is in the basement, you will not achieve proper circulation. If the heater is upstairs, better circulation will result.



An effective position of the range boiler.

Boiling Water in the System

If the water in the hot water system occasionally reaches the boiling point, this need not be a problem if the system is correctly installed. The pressure will merely be released via the relief valve, and some hot water will be expelled through the bypass. If boiling occurs frequently, however, you should install a hot water radiator, consisting of copper tubing with fins. The finned tubing on the market usually does not have a sufficient pressure rating for household plumbing, so you may have to make this finned tubing yourself or merely use a coil of tubing. The radiator should be mounted somewhere between the range boiler and the entry at the bottom of the hot water coil. A second room, the basement, or a crawl space could be heated with such a radiator, depending on the layout of your domestic hot water system and your house. The radiator would cool the water coming into the heat coil if it is already hot; thus, when the hot water in the tank has arrived at the bottom, the heat coil would not continue to raise the temperature of the water.



A radiator within the hot water system.

Installation

Wood heating devices used to be installed arbitrarily. The occupant was expected to use the system in accordance with the degree of safety it possessed. Since wood heating has regained popularity, installation guidelines similar to those for other heating systems are being developed. But since the installation guidelines for wood heating systems are still in the developmental stage, you should, before proceeding with your own installation, acquire the most recent literature on the subject from your fire marshall. If you live in British Columbia, he will likely provide you with the most recent issue of a booklet called *Safe Installation & Use of Solid-fuel Burning Appliances.* This booklet may also be obtained by writing to the address given in the glossary under Installation Guidelines.

When you are installing a wood heating system, the factors to consider are: type and condition of the chimney, stovepipe clearances, chimney draw specifications for the heating unit, floor protection, clearances between the heating unit and surrounding combustibles (depending on the type of unit being installed), and furnace duct clearances from surrounding combustibles. Wood heaters in mobile homes are given special guidelines.

If you have a chimney in your house that has been out of use or has formerly been used only for gas, oil, or a small open fireplace, be very cautious about attaching a wood stove or furnace to it. Carefully study the chimney and any adjacent partitions or walls. If you are unable to make a reliable judgment, get a specialist. You must also consider if the chimney will provide the necessary draw. Heater installation layouts within existing houses may necessitate the use of a long stovepipe from the heater to the chimney, reducing the draw and causing smoke to flow out of the heater door when it is opened.

When installing stovepipes, be careful to provide sufficient clearance from combustibles for fire protection. The recommended distance is 46 centimeters (18 inches) from stovepipes to combustibles, but leave more clearance between the ceiling and a horizontal section of stovepipe. When installing a fairly long section of stovepipe, also consider the effect of heating and cooling on the stovepipe joints. The connection may be tight when you are installing the pipes, but during use they continually heat up and cool off. As a result, the pipes may loosen, and, if they are not attached with screws, they could fall apart. Stovepipes must also be connected so that any liquid running down the inside remains inside; the liquid must be shed much like water is shed by roof shingles. Use elbows and T's that are watertight.

The installation clearances required for any wood heating unit depend on the type of unit being installed. You should attempt to design a home-built unit within a category given in the available guideline code. When studying clearance guidelines, be careful to consider all possible difficulties. You may think you can place a large heater directly in front of a brick wall, for example, but this could be disastrous if you did not consider what was behind your brick wall. A wooden structure touching the bricks on the other side could reach the kindling point.

Wood forced-air furnaces and their ducts do not follow the same specifications as oil, gas, or electric furnaces. If you have your furnace installed by a specialist, be sure that he is familiar with wood furnaces specifically. If he is not, read the instructions yourself and discuss them with him. The main issue is the clearance specifications of the hot air plenum and ducts directly above and close to the furnace.

Operating a Wood Home Heating System

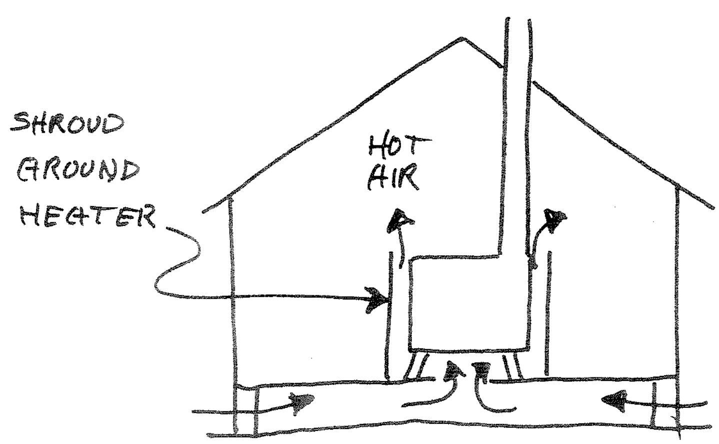
Wood heating will never be as convenient as oil, gas, or electrical heating; the user must always be involved and have a technical understanding of the system. In many respects, wood heating is like any other form of heating. The method of air distribution must be suited to a particular home, and safety precautions must be taken. Since the source of heat is usually above the kindling temperature of many building materials, the danger of fire must be considered both in design and in usage. But firewood is not merely poured into a tank and forgotten until the tank needs refilling; the continual involvement of the home owner is required to keep a wood heating system in operation.

Most home owners who decide to save on heating fuel by installing a wood heating system needlessly resign themselves to a great deal of inconvenience and continual involvement. Some enjoy working with a wood fire and maintain the pace; others gradually rely more and more on their former heating system to do the job. Few people, however, realize the potential convenience of wood heating.

The answer lies in purchasing or building an appropriate wood heating system, installing it, and operating it with an understanding of wood heat. It is an approach that is true to the tradition of the Canadian pioneer, who was a jack-of-all-trades, taking care of all aspects of his household. This tradition is re-emerging as the home handyman realizes that wood heating is technically less complex and less dangerous than other forms of home heating. But understanding wood heat is more than an ability to deal with necessary servicing and alterations of the system; it also leads to a knowledge of how to avoid the needless effort and inconvenience that wood users too frequently endure.

Home Insulation

Insulation often determines whether a simple or complex heating system is required. The best heating device will give little comfort if it is out in the open. Designing an effective heating system for a drafty house involves its own particular technical considerations—draft problems, for example, can be overcome by installing the heater so that it pressurizes the house. Air drafts will pass from inside outward but not vice versa. You lose efficiency but gain in comfort.



Pressurizing your house with a wood heater.

A house is only insulated once, but wood must be cut continually to heat the house. Proper insulation is preferable to devices designed to create comfort in spite of poor insulation.

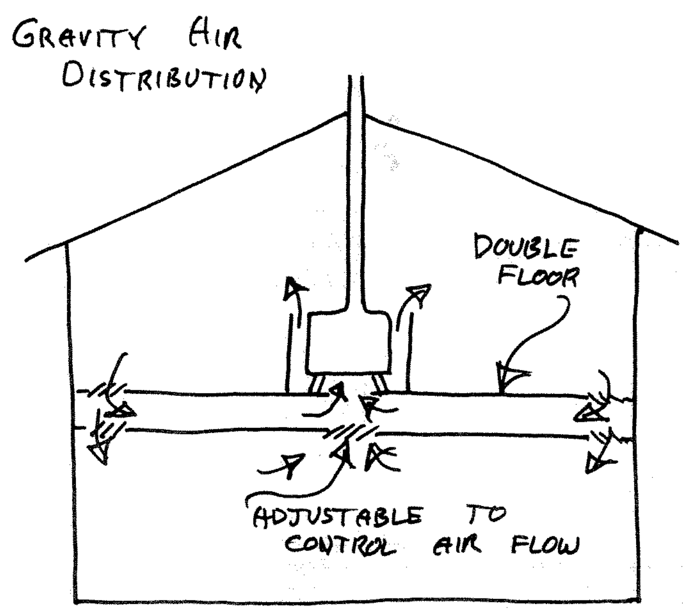
When speaking of home insulation, you must differentiate between the actual insulation factor and the amount of air leakage or air draft. There are four factors in maintaining a warm house: the insulation of the walls, roof, and floor; the amount of draft (air leakage); the type of windows (single, double, or triple pane); and the curtains or shutters preventing heat loss through radiation.

Gravity or Forced Air Distribution

The need for forced warm air distribution is frequently a symptom of poor insulation. If the furnace is not centrally located or if it is in an area that you wish to keep cooler than the rest of the house, such as the basement, then forced air distribution may be necessary. But most forced air heating systems move the air too quickly. The faster the air is set in motion, the more it will be cooled by passing windows and other cool surfaces of the outside shell of the building.

For an average-sized single dwelling, it should be possible to heat without a fan while the system operates without electricity. Good house design and insulation facilitate heating without a fan. The heating system should be centrally located, and the room that is to be warmest should be closest to the heat source.

A gravity heat distribution system is useful if you require more heat in a distant room. The heat would be directed there via a large gravity flow duct. You could also install a simple gravity flow system to service the entire house. If you have a basement that you wish to keep fairly cool, it is best to have the heat source on the main floor and have either a double floor or one or more large ducts under the floor. An opening should be cut in the floor under the heater. Registers along the walls would permit the cool air from the room to enter the ducts or the space between the double floor. If you insist on having the furnace in the basement, you could bury the ducts below the basement floor. A duct under the basement floor must be watertight, and the house flooring drainage must be lower than the bottom of the duct. Many possibilities in gravity air distribution can be devised, but whether or not they are feasible is a matter of balancing the cost with the convenience.

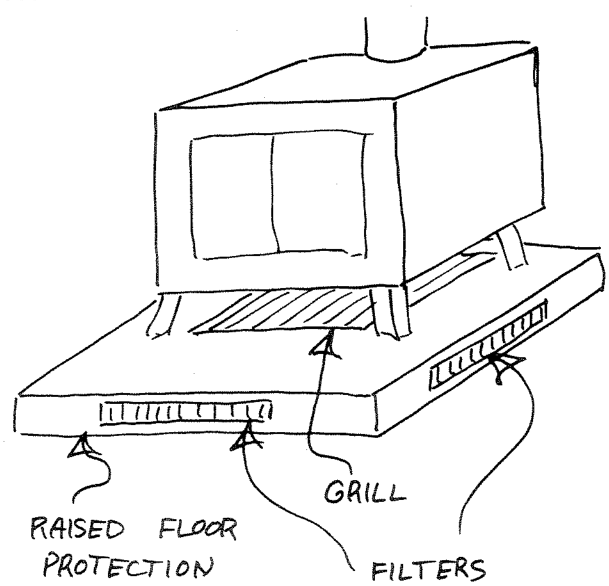


A gravity heat distribution system.

Wood Heat and Dust

Dust created by wood heating can be virtually avoided by a well-planned wood storage and transporting arrangement and a chimney that is large enough to draw off smoke while wood is being loaded. A warm flue or a fan stategically positioned within the firebox can help draw off wood ash that puffs up when one is shoveling ash out of the firebox.

Overall dust control is required when heating with a wood space heater. Since contemporary houses are airtight, dust is no longer drawn away along with leaking air. The modern homekeeper also no longer shakes out carpets, blankets, and bedsheets, having become accustomed to central heating arrangements that continually filter air. A wood space heater, like an electrical baseboard heater, does not filter the air, and unless one vacuums with a high-quality vacuum cleaner, a continuous accumulation of dust is encountered.



Filtering the air with a wood heater.

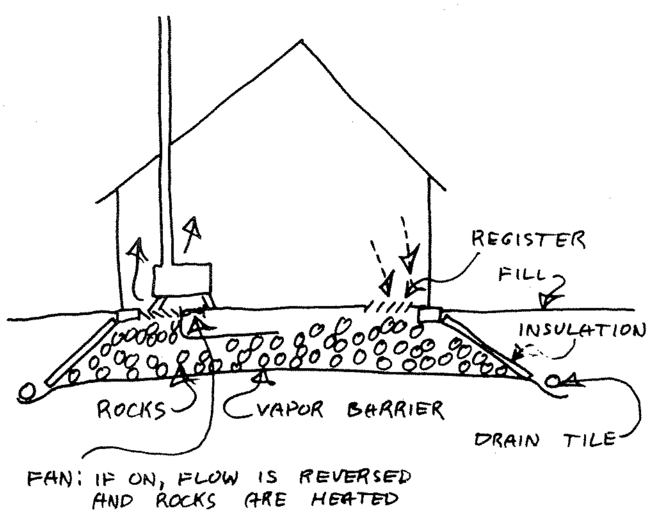
There are gadgets on the market that filter dust. One of these units could offer the best solution for you. However, since a space heater sets up a continuous convection current of air, a well-positioned filter will remove dust effectively and perhaps better than a furnace filter, since the air will have a more gradual continuous flow.

A Rock Foundation

A rock foundation can support the house without using cement, replace the gravity ducts used in a basement, and also be used as a heat equalizer and a storage place for both wood and solar heat. You should use rocks of the size screened out of road gravel. These are available from any gravel-screening operation.

You must first take care of drainage problems below the rock foundation and then provide a vapor barrier before placing the rocks. The solution to these problems depends on the climate, soil, and environment in which you are building and the expense and effort you wish to expend. Several layers of plastic or tar paper placed on a sawdust, sand, or cull lumber cushion would be adequate as a vapor barrier. You should either place the rocks by hand or put down a layer of sand to protect the plastic or tar paper from the impact of the rocks and from sharp corners. Do not put sawdust or lumber down above the vapor barrier, because it will decay and create a smell in the house.

After dumping one meter of rocks, place the beams or logs upon which the floor and walls are to be built. These beams must be carefully leveled. From the base of the walls, and sloping gently downward, place underground insulation (perhaps polystyrene) with a water-proof roof. The rock foundation thus becomes an enclosed, isolated compartment that can store heat in addition to acting as a heating duct.



A rock foundation for heat storage.

Cooking and Heating with the Same Fire

A wood range has a small firebox directly underneath the cooking surface. A small, vigorous fire is kindled that quickly heats the cooking surface. Sometimes the cooking surface has fins underneath that draw the heat into the metal more efficiently.

Wood ranges in the conventional design are relatively efficient, but to heat a house with them can be tedious, since they continually have to be refueled. Attempts have been made to combine cooking and heating more conveniently in the "Quebec heater," but such a unit is rather uncomfortable for cooking during warm weather. Because the heat is not as efficiently drawn to the cooking surface, the house is often overheated when one is cooking over a long period.

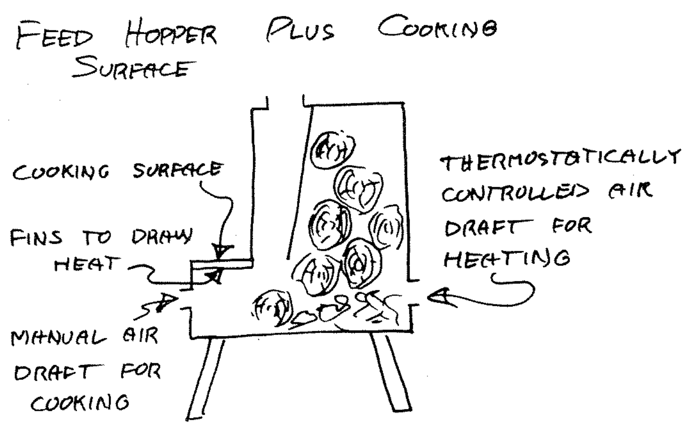
An English coal range, the AGA, has solved this difficulty by surrounding the whole heating unit with insulation. The heat can be let into the room by opening lids and is confined within the unit by keeping the lids closed. An insulated shroud is the only truly effective way of allowing cooking and baking to take place in a wood range/heater or wood range/furnace combination. If appropriate ducts are inserted, the surplus heat can also be drawn outdoors during the summer and indoors during the winter.

If a single wood-burning unit could do all the cooking, baking, heating of domestic hot water, and even clothes drying (the hot air within the unit may be ducted into an electric clothes dryer, which could then be run on the "cold" setting), such a unit could replace several others. This might be a saving, but it would have to be carefully designed so as not to become a cumbersome monstrosity.

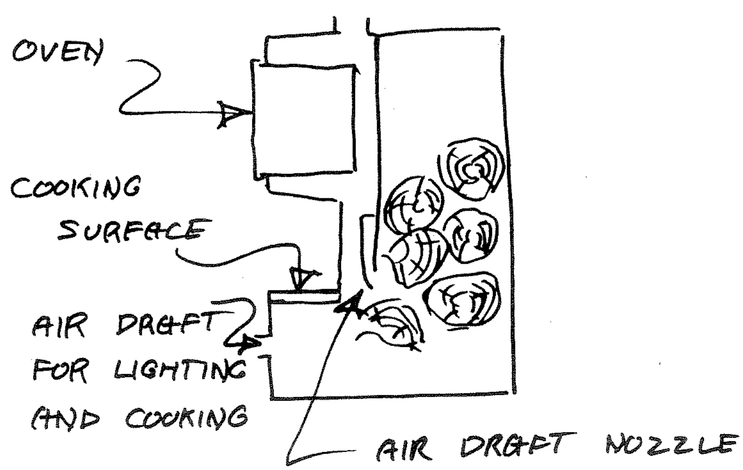
Cooking on a Down-Feed Stove

On a down-feed heater, the top surface is the coolest part of the stove; consequently, it is inadequate for cooking or heating water. The hottest part of the fire is located where the air enters the fire; thus, if cooking is to be done using a down-feed wood-burning system, a flat cooking surface must be located in the vicinity of the air draft.

Before cooking, some of the hot coals at the base of the wood load may be raked underneath the cooking



A feed hopper with a cooking surface.



Cooking and baking with a down-feed stove.

surface with a specially designed tool. The air draft control in front of the cooking surface is then opened while one is cooking and immediately closed again when one is finished. Considerable research could be done with systems of this type to develop a convenient combination unit.

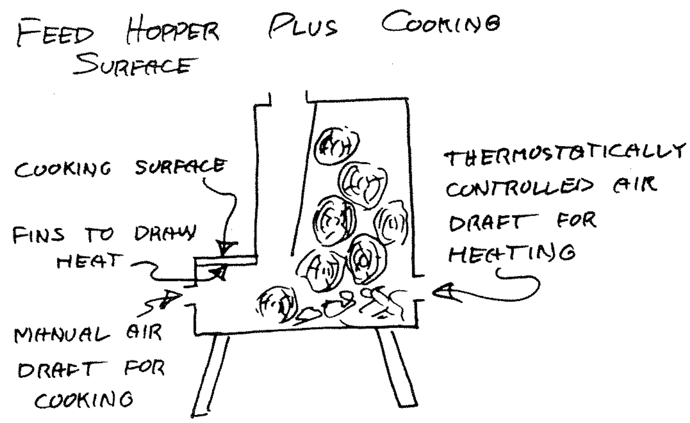
Safety Precautions

Wood is a very safe heating fuel. If house fires have been caused by wood heating systems, it is in part an indication that they have not yet reached a level of sophistication comparable to that of other forms of home heating, which, if similarly underdeveloped, would cause devastating explosions and electrocutions. Since wood heating requires the active participation of the home owner to keep it going, house fires are frequently the result of the owner's negligence in studying and understanding the system he is using. The owner's participation is the most significant difference between wood heating and other conventional forms of heating. An oil, gas, or electric furnace is usually safest if it is serviced by a professional.

Wood heating does not require considerable work and effort. If the system is constructed and installed with a thought to convenience, very little effort is called for. You must be continually alert, however, for system malfunctionings. Jay W. Shelton's book *Wood Heat Safety* is an excellent source to help you gain the necessary competence to deal safely with wood heating systems.

The owner of a wood heating system should observe the following rules:

1. Never walk away leaving the heater door open



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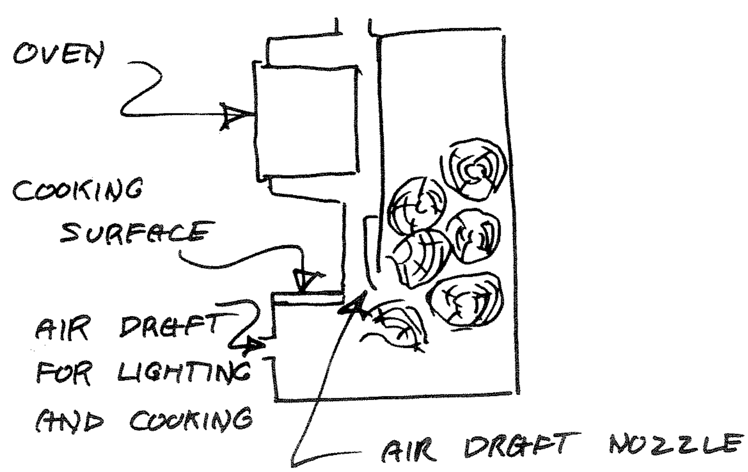

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while a fire is burning within the heater. A common mistake is to leave the heater door open while you are getting a few sticks of wood from the woodshed. Some emergency could prevent you from getting back to the heater.

2. Adjust the door if it is not tight. If you cannot adjust it, do not treat the heater as if it were airtight; that is, build only small fires in it.
3. Know the creosote-building characteristics of your wood burning system.
4. Know what is controllable in your heating unit; do not build a fire you cannot control.
5. Do not burn garbage indiscriminately in your heater. Paper and cardboard are all right, but some plastics form acids that corrode the firebox and flue.
6. If a chimney fire starts, close all air inlets such as the air draft control and the barometric draft control that may fan the fire within the chimney. Unless you are certain you can control the situation, get everyone out of the house and call the fire department.
7. Use a metal container when cleaning out ash, and do not leave it sitting on a combustible surface.
8. Keep a fire extinguisher at hand.
9. Mount a smoke detector alarm close to the heater.
10. Replace stovepipes when there are signs of deterioration.

In addition, the operator must know the problems he may encounter when lighting the fire and when opening the heater door while the fire is burning.

Lighting the Heater Fire

When the chimney and house are cold, you have little draw in the chimney. Thus, when lighting the fire, you should get paper and dry kindling set up in the firebox, light the paper, close the heater door, and open the air draft. Things happen slowly until some heat gets into the chimney.

If you are unlucky enough to get a downdraft in your flue—which is very rare in a properly designed chimney—and the room is filling with smoke, close the draft and take a walk, or, if you have a vacuum cleaner handy, attach the pipe onto the connection for blowing and blow air into the draft opening. This will reverse the direction of gas travel in the flue.

If you have a tall house with an open window at the top or a lot of air leakage in the upper half of the building, you can get reverse action if your chimney is colder than your house. The house will develop a draft much like that of a chimney, and the chimney will replace the air that departs at the top of the building. If there is any danger that this will occur, close the windows upstairs and open the door downstairs before lighting the heater.

Opening the Heater Door

Never open the heater door quickly, especially after the heater has been choked down for some time and the flue gases are moving very slowly. Open the door a crack and wait thirty seconds to give the flue gases a chance to speed up, then slowly open the door.

Another potentially dangerous situation is the build-up of combustible gases during a short period of open draft after a lengthy period of closed draft. Air inter-mingling with unburnt gases when the flue is not warm enough to draw them away creates an explosive mixture. Opening the heater door may create an explosion, shooting flames out of the open crack. This is not dangerous, but you should be prepared for it. Open the door slowly and do not stand directly in front of it.

Common Operating Problems

In devising your wood heating system, choose the simple design over the complex one, unless the complexity is clearly justified. Complexity frequently brings with it further unforeseen complications that must be overcome by further complexity. In wood heating devices it is not uncommon to find simple, inexpensive units outperforming complex, expensive ones. You must research a new idea carefully before making a judgment on it. Furthermore, you must be careful when attempting to apply a system that has been successful elsewhere. A heater may burn satisfactorily in one house and build up considerable creosote in the flue of another house. At times it requires very detailed analysis to find the cause.

Most operating problems do have solutions, however, either through a slight alteration or by taking special precautions specific to the system. If you find it difficult to diagnose a difficulty in the operation of your wood-burning system, discuss it with friends and qualified people. Give yourself time before making a complex alteration, and do not jump to erroneous conclusions.

Puffing

When choked down and burning with a low heat output, some heaters occasionally explode within, sending a puff of smoke out of every crack, including the stovepipe connections above the heater. This can be attributed to either insufficient fire fanning by the air draft system or to too many elbows between the heater and the chimney.

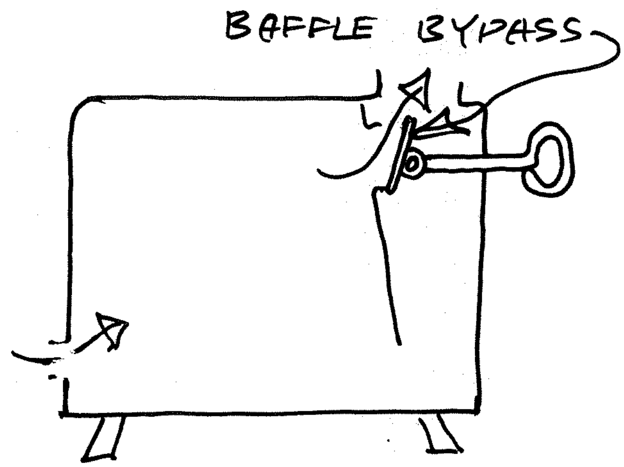
In the first case, the air drifts slowly into the firebox and fails to fan and brighten the smoldering coals. Instead, it mingles with the unburnt gases, creating an explosive mixture. In the absence of a flame to keep such mixtures ignited and burnt away, a build-up occurs that explodes when finally ignited. A correctly directed nozzle-shaped air draft will fan the coals sufficiently to keep a flame going, and explosive mixtures will burn before they accumulate.

In the second case, each elbow restricts air flow. If the fire has been choked down for some time, the flue will be fairly cool and its drawing capacity will be minimal. A round flue with no elbows serves best at this time. Elbows create a lag that gives gases in the heater time to accumulate and explode.

If you have a problem with puffing, first increase your minimum air draft adjustment, perhaps also trying a different firewood during low burning periods, before embarking on major design alterations.

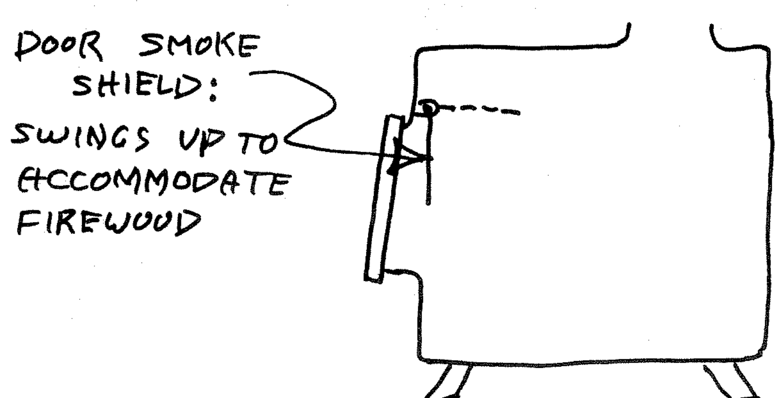
Baffle Bypass and Smoke Shield

Besides being adequate for the draft system, the chimney flue must draw sufficiently to handle the open door when wood is being loaded, especially in a wood heater with a down-feed system, since the smoke must travel downward underneath the baffle before going up the chimney. Some heaters, including the RSF Energy heater, have a bypass at the top of the baffle to solve this problem, but this must operate well and be fairly airtight. A slightly larger flue will also help.



An example of a baffle bypass.

The direction of smoke travel is less important than the volume of smoke. A swinging smoke shield to reduce the door opening helps to reduce the volume of smoke that must be handled by the flue while the door is open. Consequently, a smoke shield can replace a baffle bypass.



A swinging smoke shield may be used in place of a baffle bypass.

Flue Fans

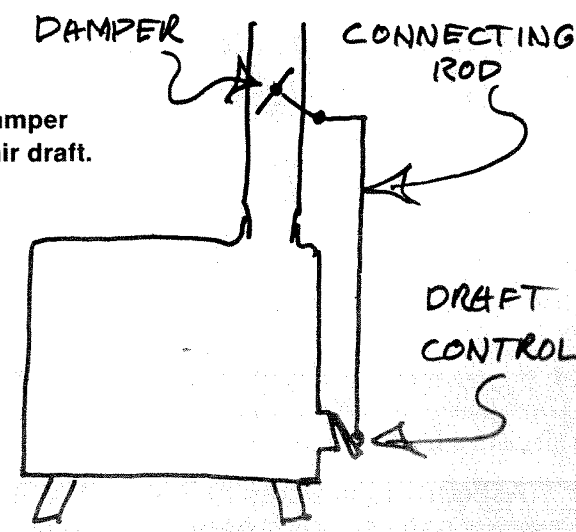
The problem of a smoking heater door can also be solved by an in-line flue fan that may be switched on while one is loading wood or lighting the fire. This alternative should be avoided when one is designing a heating system, but it offers a solution for an inefficient system that is already installed.

When installing a flue fan, be sure to install one that can handle the heat of the departing flue gases and that does not restrict the gas flow while the fan is off.

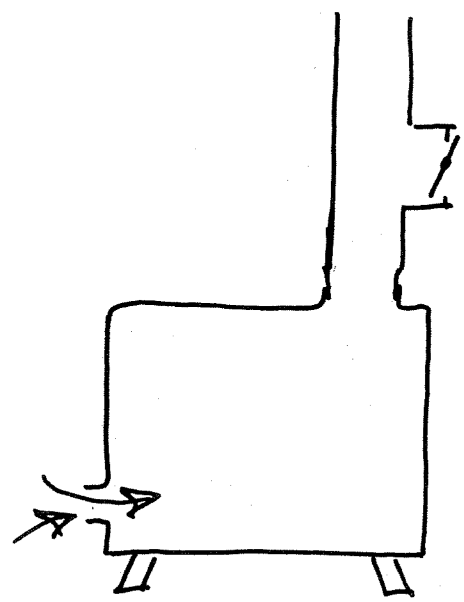
Dampers and Barometric Draft Controls

A damper can control the air draft if the chimney is drawing excessively and the heater is not airtight enough to slow down the fire, but it cannot be installed with a thermostatically controlled air draft system unless it is connected to the thermostat and operated in unison with the air draft control. Such an installation is rare but may be warranted.

A chimney damper controls the air draft.



Normally you should try for a chimney that draws enough but not excessively. If you have a chimney that draws too much, you can use a barometric draft control, which can be adjusted to regulate the actual draw from the heater itself. The remainder of the draw is taken from the room, which means some loss in efficiency. However, several customers of RSF Energy heaters, with long, airtight, well-insulated chimneys, have had a surprising increase in efficiency through incorporating a barometric draft control.



A barometric draft control takes up any excessive draw from the flue.

Asbestos Door Seal

Asbestos is not totally airtight, so if the chimney draws excessively and if the asbestos seal on the firebox door is very long, excessive loss of air may cause the fire to burn out of control. This problem may be solved with a barometric draft control to limit the drawing power of the chimney.

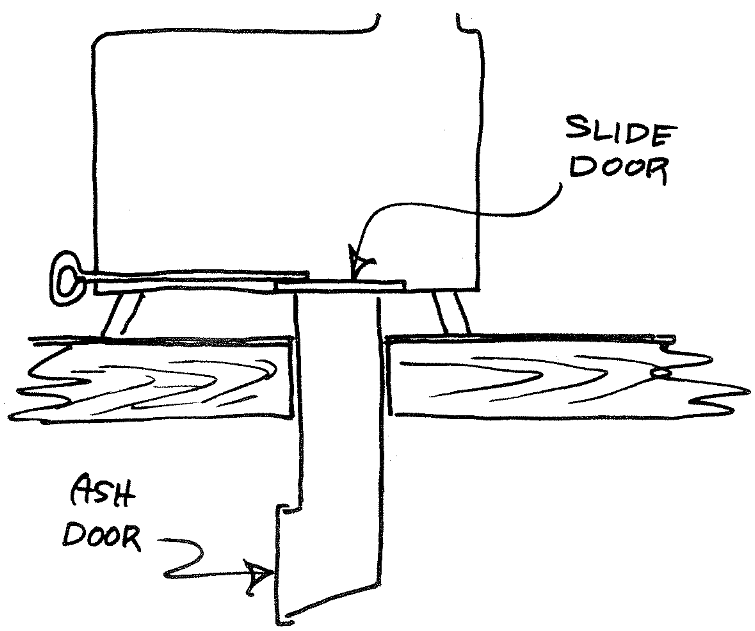
When the door is closed, make certain that the asbestos seal is under pressure its entire length. Some adjustment in the hinges and door catch must be possible in order to maintain this pressure. The hinges and catch must also be reliable enough to prevent the heater door from opening in your absence.

Ash Pan And Grate

A grate and ash pan are usually added features possessed by more expensive heater models. An ash pan has its advantages, but a grate in a wood-burning device is inefficient because unburnt wood coals as well as ashes fall through it into the ash pan. By volume, usually over half of the "ashes" in an ash pan are unburnt material. This means that ash pans must be emptied frequently. Heaters without ash pans can often go several months before the ashes must be emptied, and, if they are permitted to burn out completely before ash removal, there is no reason to lose much wood coal.

A grate also undermines long burning at low heat output. The insulating property of the ashes directly under a fire permits the fire to smolder without going out, establishing and maintaining a core of heat. If a grate is used, the hot air under a fire soon moves away by convection and is replaced by cool air. This cool air will put the fire out if, due to a closed air draft control, there is no oxygen. If you insist on an ash pan, it is best to have one without a grate—the fire will merely burn on top of the ash pan. You may still need an extra door for ash pan removal and replacement.

An alternative to an ash pan is an ash dump leading into the basement or crawl space, as is found in many fireplaces. Make sure that the ash dump and clean-out door are airtight, as air drawing into these areas would disrupt the regular air draft system. A regular ash clean-out door, sold for use as a chimney clean-out, would probably not be efficient for a stove.



An ash dump leading into the basement.

Wood Tar and Creosote Build-Up

Wood is a highly complex fuel. Tar is formed during certain burning conditions. It leaves the fire in gaseous form, and, if it escapes ignition, it will find a cooler surface on which to condense, either inside the heater or somewhere on its way up the flue.

Wood tar is not the only substance leaving the wood fire that later condenses; one of the primary products of combustion is water. Hydrogen, one of the main elements of wood, combines with oxygen in the air to form water. During periods of low burning the chimney is often cool enough to condense water. The water, colored black as a result of the tar, will run down inside the chimney. The chimney flue and stovepipes thus must be designed to accommodate this shedding of tar and water. Considerable moisture can run down into the heater and evaporate again during periods of more vigorous burning. A chimney with an ash clean-out can collect water and wood tar during periods of low burning.

A common complaint in wood heating is the plugging of pipes and flue during periods of low burning. This problem can be solved by one of the following methods:

1. Keep the flue so hot that wood tar condensation is not possible.

To achieve a hot flue, the fire must be allowed to burn at a high rate and the flue must be well insulated. This method has been successfully applied in most of the traditional European heating systems. Since they are built out of stone, brick, or tile, they possess a great capacity to store heat. A clean, hot fire heats the masonry and is permitted to burn vigorously until it burns out. The masonry then heats the house. The fire must be kindled well before the warmth is actually required, as it could be a couple of hours before the house is fully heated.

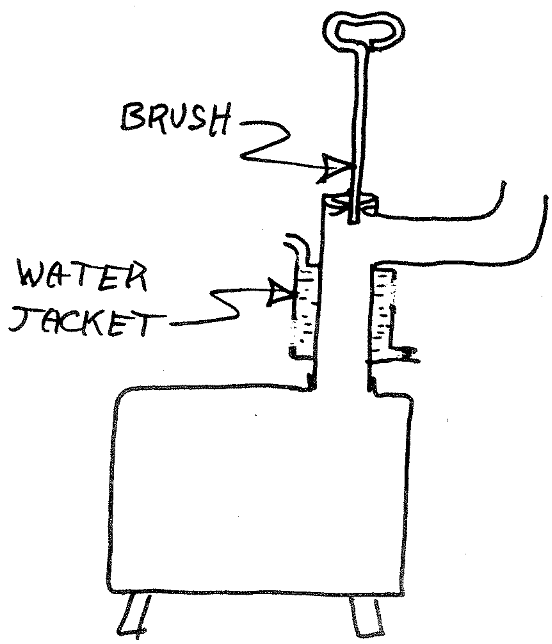
A study of wood heating units shows that efficiency is much more easily achieved for a single heat output setting than for a range of heat outputs. Wood heating units are like internal combustion engines that reach their peak efficiency at a very limited range of power output.

If a relatively simple wood heater is positioned within a rock storage area insulated from the living space, its heat can be vented into the living space, possibly with thermostatically controlled shutters or registers. The firebox may then be allowed to burn at its optimum efficiency and at those conditions which do not result in the deposition of wood tar within the chimney flue. When considering the problem of wood tar or creosote deposits, you may find two heat output settings that work—one in which the chimney is too hot and one in which the chimney is too cold for creosote condensation.

2. Keep the flue so cool that wood tar condensation takes place before gases reach the flue.

There are three ways of achieving a cool flue:

a. Excessive air may be passed through the flue to cool it, as in a fireplace or by the use of a barometric draft control. The higher speed of gases passing through the flue also helps to avoid the deposit of tars. However, efficiency is lost by this method.
b. A special creosote-condensing device may be inserted between the heater and the chimney. A water jacket is a very effective condenser. Such a condenser unit must be equipped with a handy cleaning device, which must be applied frequently.
c. A low heater surface temperature keeps wood tar within the unit because condensation occurs before gases enter the flue. A low surface temperature is achieved by using a large heater in relation to the space heated and is possible only if the unit is sufficiently airtight and controllable to avoid



A creosote-condensing device.

overheating the space being heated. This third method of controlling wood tar deposit is the most efficient in keeping all fuel exhaust within the heating unit, eventually burning it, and thus using it for heating purposes.

3. Create a deliberate chimney fire regularly to burn out the wood tar deposits.

If the flue is normally cool, permitting the wood tar to be deposited close to the heater, and if the flue and stovepipes are well built, chimney fires are a feasible method of controlling wood tar deposit. At the necessary intervals the fire is turned up so that the wood tar close to and within the heater is ignited. Chimney fires are not advisable if tar deposit occurs at the top of the chimney flue.

4. Burn the wood tar before it leaves the fire; that is, design an efficient air draft system for all burning conditions.

If wood tar is provided with oxygen while it is still in the gaseous state and before its temperature drops below the kindling point, it will burn before it leaves the fire. Success in achieving this lies in the secondary air draft system. The cleanliness of a flue is thus a test of the success of a secondary air draft system.

Tar Shedding

Anywhere within a wood heating system where there is smoke, there will be wood tar deposits during some burning situations, especially if the fire is highly controlled. Since these deposits may be in liquid form, they can run down the inner walls of the system. This poses no difficulty if the firebox, afterburner, stovepipe, and chimney are properly designed. All openings, doors, and cracks must be protected so that the tar is unable to run out of them. The tar must end up either in the firebox or in a clean-out that may be serviced, and they must be watertight at the base. Important fixtures are the draft opening and the firebox door. Sometimes a protective device must be situated above the draft control opening, to ensure that tar drips off and does not run out of the heater. Masonry chimneys have sometimes been found to leak. Wood tars within them pass through the liner and plug up the space between the liner and the masonry, then find a way through a crack in the masonry. Ideally, the flue liners in a masonry chimney should interlock, each upper section fitting into the one beneath.

At a certain point wood tars are either dissolved or suspended in water, which carries them a distance and deposits them when it evaporates. Wood tars running out of your heating system are unsightly and create an unpleasant odor.

Conclusion

Wood is in many respects the preferred home heating fuel. Most people who burn wood speak of the comfort it offers. It does not spoil the air, as electrical heating installations often do. It does not have an objectionable smell, as does stove oil. Any dirt or dust it creates is easy to clean, unlike coal dust or oil soiling. Wood is inexpensive, as are wood heating installations, a major advantage over solar heating. In Canada, heating with wood means that you are able to gather your own fuel without competing for a resource that is widely needed and in short supply. Wherever there are forests, wood is being wasted. And since forests are found in most areas, it is relatively easy to transport the fuel from its source.

A properly installed wood heating system performs as well as any other form of heat. It brings any home to the desired temperature. It does not leave some rooms cold or damp, nor does it create musty corners. Dampness is the result of a primitive, poorly thought-out arrangement. The personal effort that the operator must expend to gain the required performance is a consequence of the quality of the installation and the competence of the operator. This is where the chief difference between wood heating and conventional forms of heating lies—in the involvement and knowledge required of the user of wood fuel.

When using wood for heating or cooking, you must understand how wood works as a fuel. You must know how to light fires, how to control them, and how to assess the properties of your firewood, how it lights and burns. You must understand the inner workings of your wood-burning system well enough to detect telltale signs of hazards and operational difficulties. Sometimes you are even called upon to make innovations. Unfortunately, these tasks are often time-consuming, and, as a result, many people have discarded wood heating. But they have given up too soon. There are many excellent wood heating arrangements that require very little labor.

Glossary

Afterburner: A chamber within or adjacent to the firebox, designed to burn wood gases by supplying them with additional oxygen while they are still above the kindling point.

AGA: An English coal range noted for its long burning and ability to control heat output. It operates on a down-feed system and has a thermostatically controlled air draft. The complete unit is insulated; heat is released into the room only when insulated lids or oven doors are opened.

Air draft control: A device that determines the quantity of air entering into the firebox.

Airtight: A firebox that, while burning at its maximum, can be reliably cooled down simply by closing the air draft. This does not necessarily mean that the firebox must have all gas-tight welds.

"Airtight" heater: A wood heater in the shape of an upright can, slightly squashed at the sides so that the top and the bottom are oval. Its body and liner are constructed of sheet metal. It is probably the least expensive wood heater on the market, but it usually does not have a long lifespan and under certain conditions it will not reliably control a wood fire.

Approach draft: An air draft layout wherein the incoming draft air approaches the smoke leaving the firebox.

Ash pan: A removable container placed underneath a grate, designed to catch the ashes that fall through the grate.

Baffle: A partition within the firebox partially sectioning off a portion of the chamber, thereby compelling the gas traveling toward the smoke outlet to take a more determined route.

Barometric draft control: A device somewhat resembling a stovepipe "T" that is attached in line between the stove and the chimney. The protruding part of the T-like unit contains a flap that is closed when the pressure within the chimney is high and open when the pressure is low. The point and extent of opening is set by a counterbalance on the flap. Barometric draft controls may be purchased at hardware stores, sheet metal shops, or any shop that deals with wood or oil burning.

Bimetal: Two equally sized strips of metal of different expansion coefficients welded together, flat surface to flat surface. The device alters shape as it undergoes a temperature change and returns to its former shape when the former temperature is restored. Some automobile engine exhaust manifolds contain a bimetal coil that could be used to thermostatically control a heater air draft if it was of a reasonably heavy construction. A leader in the field of thermostatic bimetals is: Crest Manufacturing Company, 5 Hood Drive, P.O. Box 85, Lincoln, Rhode Island 02865. Telephone: (401) 333-1350.

Cast iron: Steel with a low carbon content that is shaped by being poured into a form while being heated to a liquid state.

Central heating: Heating a multiroom building or several buildings with a single heating system. A forced air furnace is a central heating device.

Chimney: A channel whereby smoke or the products of combustion are directed away from the building so that their heat does not endanger the building and their polluting effect is not objectionable to the inhabitants. In addition, a chimney may be regarded as a gravity-operated air fan. Since it is a vertical, hollow structure and since its temperature during use is higher than that of its surroundings, the movement of gases within the chimney is in an upward direction.

Solid-fuel-burning systems require a class-A-rated chimney. These may be built out of masonry, or a prefabricated insulated metal chimney may be purchased. Specifications for the construction of masonry chimneys are easily acquired from building inspectors or fire marshalls.

Chimney cap: A roof over the chimney outlet that prevents rainwater from entering the chimney flue and to some extent equalizes the chimney draft during windy conditions.

Cook-stove: A device that produces heat for cooking. A well-designed cook-stove concentrates the heat where it is most accessible for cooking with minimum waste heat or room heating. Designing a wood cook-stove offers an exceptional challenge.

Cross-feed: Normally refers to an elongated firebox in which the fire is started at one end and, as it burns, works its way gradually to the other end of the firebox.

CSA: Canadian Standards Association, 178 Rexdale Boulevard, Rexdale, Ontario. M9W 1R3. CSA is a company licenced to provide CSA marks on products it has tested for quality. For some products, marking is done on a voluntary basis, and in other cases "it forms the basis or acceptance by inspection authorities responsible for enforcement of regulations."

Damper: A disk mounted within a stovepipe that may be turned so that it is positioned in line with the flue gas travel to permit maximum gas flow, or it may be positioned crosswise to flue gas travel to inhibit its flow. Dampers may be purchased from any hardware store.

Down-feed: A firebox layout in which the fire burns at the bottom of the wood load. The wood feeds into the fire by gravity as it is burned at the bottom.

Firebox: The chamber within a heater, stove, or furnace in which fuel combustion or burning takes place.

Firebox liner: A heat-resistant and sometimes insulated material placed within a firebox, where most of the heat is generated. It protects the walls of the firebox from overheating and premature deterioration and provides some insulation around the glowing coals to help maintain combustion during periods of low output. Liners are sometimes also placed within afterburners to improve gas combustion.

Firebrick: Brick that is able to withstand high temperatures without deteriorating. Firebrick may be purchased from building supplies or masonry outlets.

Fireplace: Traditionally refers to an open fire arrangement within a room. The smoke is drawn up a large chimney flue, or, in a very primitive arrangement, it may merely pass through a hole in the roof. Contemporary fireplaces are often equipped with steel or glass doors so that the unit can function as a primitive wood heater when the doors are closed.

Flue: The opening within a chimney through which gases are able to travel.

Flue draw: A flue's capacity to move gases over the range of burning situations of the heating unit or units that are attached to the flue. Many factors, such as chimney size, shape, height, and location, influence this drawing capacity.

Forced air heating: A central heating layout that distributes warm air with the aid of a fan.

Fortex asbestos packing: A noncombustible and heat-proof gasket that will seal a firebox door when positioned between the door and the door frame.

Manufacturer: TBA Industrial Products Ltd., Sealing Materials Division, P.O. Box 40, Rochdale, Lancs., England 0L12 7EQ. Telephone: (0706) 47422. Telex: 63174.

Distributor: Albion Asbestos Packing Ltd., 2195 Ekers Ave., Montreal, Que. Telephone: (514) 731-3241. 32 Corville Rd., Toronto, Ont. Telephone: (416) 249-8533. 2725 Lake City Way, Burnaby, B.C. Telephone: (604) 420-1124.

Furnace: A heating system designed to heat a multi-room building or perhaps even several buildings. A correctly designed and installed furnace can be regulated so that the desired temperature is achieved in each room.

Fusible link: A chain link that is manufactured from an alloy that melts at a desired temperature. It can be incorporated into a chain and will cause the chain to let go if the melting point of the fusible link is reached.

Grate: A firebox floor with openings that are large enough to permit the spent fuel ash to fall through. Most grates, especially those in coal burners, will trip in order that the spent fuel, even when still in large particles, may be shaken through the grates. When spent, wood coal forms only a powdery ash. A firebox grate is necessary for coal burning, but it is usually not essential for wood burning.

Gravity flow: The movement of gases or liquids created by gravitational force, such as the creation of air currents by temperature differences. A gas or liquid at a higher temperature always occupies more space than the same gas or liquid at a lower temperature under equal pressure. The warmer gas or liquid is consequently lighter per volume and will rise when placed adjacent to the cooler liquid or gas.

Heater: A device designed to raise the temperature of a room or building.

Heater thermostat: A thermostat strategically positioned to maintain the desired temperature of a heater.

Hot water coil: A section or coil of pipe or tubing, mounted within or around a firebox or stovepipe. This pipe or tubing is connected to a tank, one end to the top and the other end to the bottom. If the hot water coil is heated, a convection current or gravity flow takes place, eventually heating up the water within the tank.

Hot water jacket: A chamber filled with water surrounding either a firebox, a smoke chamber, or a section of stovepipe. The water in the chamber is heated when the heating unit is in operation.

Installation guidelines: A useful publication, *Safe Installation & Use of Solid-fuel Burning Appliances,* is put out by the province of British Columbia. It can be obtained from: Office of the Fire Commissioner, Ministry of the Attorney-General, Suite 1, 2780 East Broadway, Vancouver, B.C. V5M 1Y8. Telephone: (604) 251-3131.

Insulated stove vent: Stovepipe possessing some insulation quality in order to reduce wood tar or creosote deposits. A supplier is Norwegian Wood Stove, Box 219, Clarkson P.O., Mississauga, Ont. L5J 3V1.

Jotul heater: A Norwegian-built wood heater with a simple but effective afterburning arrangement. A baffle directs the smoke forward close to the air draft opening to encourage more complete combustion.

Kindling point: The temperature at or above which the combustion of a substance will occur.

Mild steel: Steel that has not undergone any hardening process. There are many types of mild steel. In constructing a wood stove, the quality of the surface should be considered. Inexpensive hot-rolled mild steel has a scale on it that can be rough. Hot-rolled pickled and cold-rolled steel have superior surfaces. The thickness of the steel chosen is a factor determining its longevity within a firebox.

Primary air: Air approaching a burning fuel to maintain or increase combustion.

Progressive draft: An air draft layout in which the air takes a short, less restricted route if only a small influx of air is permitted. As the influx of air is allowed to increase, part of the air accepts a longer, more restricted route because the easy route can handle only a limited quantity of air.

"Quebec" heater: An early attempt to combine cooking and heating, this system had a fairly large oval firebox with an oven mounted beside it. Most wood ranges have a small firebox that must be filled often if it is to be used to heat a room or house.

RSF Energy heaters or furnaces: Renewable Solid Fuel Energy heaters and furnaces, noted for their efficiency and especially for their long burning periods between fillings. They were developed in Smithers, B.C., and are now also manufactured in Ontario. They can be obtained from: RSF Energy Ltd. 3352 Yellowhead, P.O. Box 3637, Smithers, B.C. V0J 2N0. Telephone: (604) 847-4301, or from: George A. Harding Ltd. 61 Telson Road, Markham, Ont. L3R 1E4.

Secondary air: Air supplied to the tips of the flames of a burning fuel, providing extra oxygen and consequently bringing about more complete combustion of the fuel.

Smoke: The products of combustion that pass up the chimney. A chemical analysis of smoke is very complex, but large quantities of water vapor, carbon dioxide, carbon monoxide, wood gas, wood tar droplets, and ash particles are found in it.

Smoke shield: A piece of metal hanging immediately behind the wood loading door of a heater in order to reduce the door opening size, thus reducing the chance that smoke will enter the room. The smoke shield is hinged at the top so that it can be pushed out of the way when wood is being loaded.

Stainless steel: An alloy containing mainly steel, which is highly resistant to oxidation or corrosion. There are many types of stainless steel.

Stove: A device that produces heat for either cooking or heating.

Thermostat: A device that controls a heating unit so that it remains within a determined temperature range.

Tile stove: A wood, coal, or peat stove built of special ceramic tiles and special heat-resistant mortars. The doors, grates, and fireboxes are usually cast iron; the smoke is drawn through several chambers before passing up the chimney, thus accounting for the efficiency of the tile stove. The fire within the tile stove is usually not choked down. A clean, vigorous fire is burnt for a short period, heating up the masonry, which in turn heats the room for a long period. Tile stoves have been traditional in Europe for at least five hundred years. Increasing numbers of tile stove builders may now also be found in Canada and the United States.

ULC: Underwriters' Laboratories of Canada, a certification agency similar to the CSA. Address: 7 Crouse Road, Scarborough, Ontario. Telephone: (416) 757-3611.

Wall thermostat: A thermostat strategically positioned to maintain the desired temperature of a room.

Warnock Hersey Professional Services Ltd.: A testing laboratory that can provide certification for wood heating systems. Address: 125 E. 4th Ave., Vancouver, B.C. V5T 1G4.

Wood range: A wood-burning unit designed to cook and bake food with wood heat.

Wood tar or creosote: A complex substance or a group of substances given off by a fire in which combustion has been incomplete. It is given off initially in a gaseous form, but as it cools it condenses and becomes fairly solid. It is often quite sticky, partially because of water content. Wood tar may be ignited and burnt to a powdery ash.

For Further Information

Installation Requirements for Solid Fuel Burning Appliances

Write:

Department of Construction and Land Use
400 Municipal Building
Seattle, Washington 98104

The Office of the Fire Commissioner
Ministry of Attorney-General
Suite 1, 2780 East Broadway
Vancouver, British Columbia V5M 1Y8

Additional Requirements for Water Heating Coils for Solid Fuel Fired Appliances

Write:

Canadian Standards Association
178 Rexdale Boulevard, Rexdale
Ontario M9W 1R3

Maximum Allowable Temperatures for General Construction Materials (Non-Electrical)

Write:

Canadian Standards Association
178 Rexdale Boulevard, Rexdale
Ontario M9W 1R3

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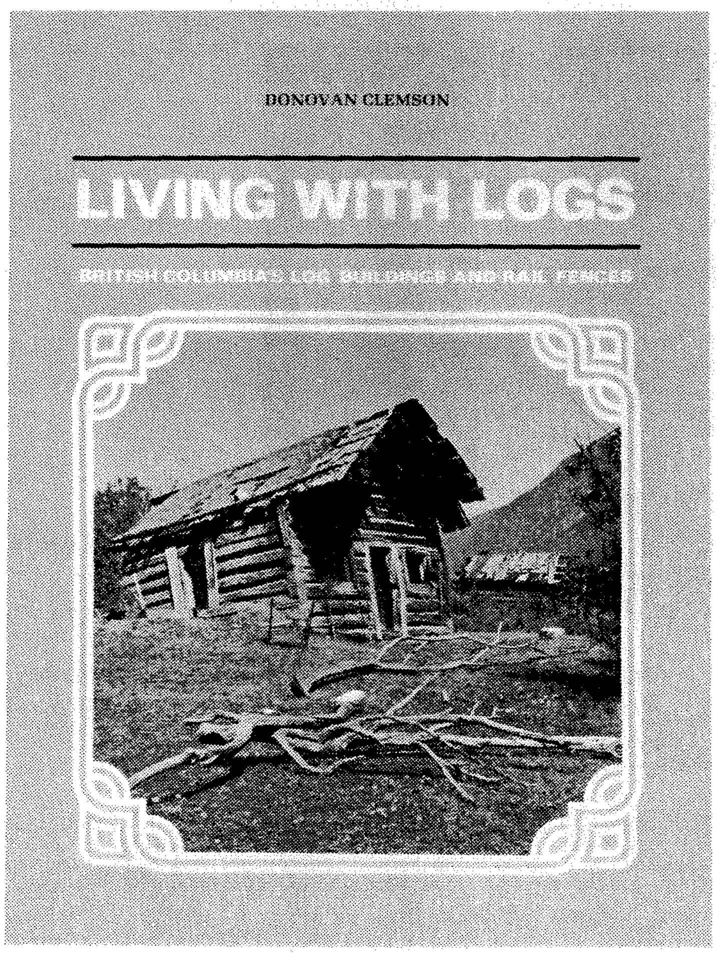

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