Heating Rural Homes With Space Heaters

R. E. STEWART and ROSS A. PHILLIPS

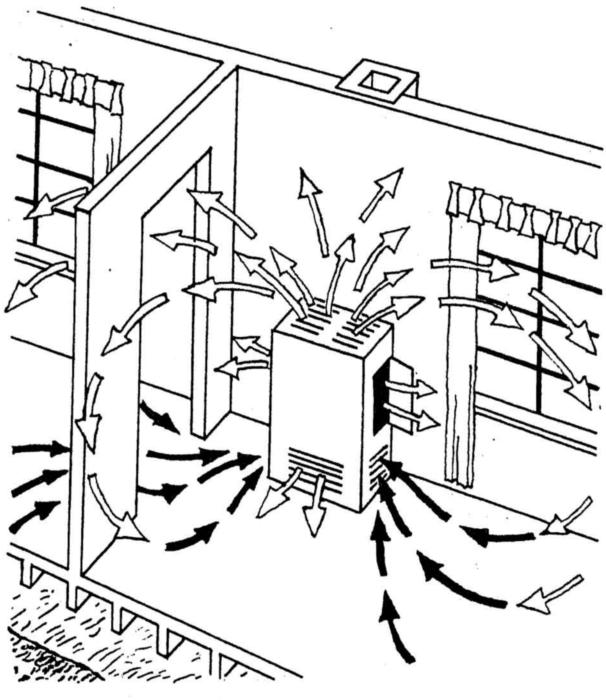

Figure 1.—This diagram illustrates natural gravity convection through a circulating space heater. The warm air rising from the heater is replaced by an inflow of cooler air at the bottom. Warm air is represented by open arrows; cool air by solid arrows. From "Your Farmhouse Heating," Miscellaneous Publication No. 689, U. S. Dept. of Agriculture, 1950.

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Heating Rural Homes With Space Heaters

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It is estimated that approximately 150,000 farm dwellings in Missouri are heated during the winter with space heaters. These homes are heated by coal stoves, wood stoves, and oil heaters. The use of gas heaters is increasing. The question of obtaining satisfactory winter heat with these space heaters in the usual type of farm dwelling has arisen many times, and the purpose of this bulletin is to explain and discuss some of the methods by which greater satisfaction from oil-burning and other space heaters can be secured.*

Types of Heaters. In general, there are two types of space heaters. These are the radiant type heater and the circulating type heater. From tests conducted at the Missouri Agricultural Experiment Station, it appears that there is not a great deal of difference between the two as to heating ability. The radiant heater is commonly used without a jacket of any kind; the surface of the heater is quite hot. It is recommended principally for heating just one room. On the other hand, the circulating heater is enclosed by a jacket whose surface is relatively cool and is perhaps more desirable from the standpoints of safety and appearance. This bulletin will be devoted almost entirely to discussion of the jacketed or circulating heater. See Figure 1, which illustrates the convection currents from a typical circulating space heater.

Types and Costs of Fuels. Commonly used space heater fuels include coal, wood, oil and natural or LP gas. The choice of a fuel will depend on cost, availability, and convenience.

Table 1 can be used to compare costs of various fuels burned in the same house. For example, suppose we wish to compare the cost of fuel oil with LP gas when oil sells for 12c per gallon. Table 1 indicates that LP gas must sell for less than 8.6c per gallon in order to be cheaper than oil. Wood as fuel can be compared with the others by assuming that most well-seasoned hardwoods have about half as much heat value per pound as good coal.[1] A cord of hickory, oak, beech, sugar maple, or rock elm will have about the same heat value as one ton of good coal.

Installation of the Heater. The following recommendations of the National Board of Fire Underwriters are quoted for general guidance:

(1) The heater shall not be placed less than 3 feet from any woodwork or any wooden lath and plaster partition, unless the woodwork or partition is prop-

*The experimental work on which this publication is based was a part of North Central Regional Project NC-9 and was partially financed by funds authorized by Section 9b3 Title I of the Research and Marketing Act of 1946.

[1]USDA Misc. Publication No. 689, "Your Farm House Heating," 1950.

erly protected by metal shields, in which case the distance shall not be less than 18 inches. Metal shields shall be so attached as to preserve air space behind them.

(2) The heater must be set upon an incombustible tray or stove board of sufficient size so that it will extend 12 inches back of and from the sides of the oil tank.

(3) The smoke pipe shall not pass through any floor or through a non-fireproof roof. Smoke pipes shall not be less than 18 inches below any wood lath and plaster or other combustible ceiling unless at least the upper half of such smoke pipe is properly protected by one inch or more of asbestos covering or its equivalent, or by a metal casing spaced 2 inches from the upper half of the pipe. If so protected, the smoke pipe shall not be less than 9 inches from any wood lath and plaster construction, woodwork or other combustible material.

(4) Where a smoke pipe passes through a wood lath and plaster, or other combustible partition or walls, a section of the wall or partition shall be removed and the smoke pipe so placed that no part of it shall be nearer than 6 inches to any remaining combustible part of the partition. The section of the parti-

TABLE 1 -- COMPARISON OF HEATING COST* (Various fuels used in the same building)

A	B	C	D			E
NATURAL GAS 100 Btu per cu. ft. Cost cents per 1000 cu. ft.	LIQUIFIED PETROLEUM GAS 100,000 Btu per gal. Cost (cents per gal.)	OIL 140,000 Btu per gal. Heating Unit Designed for oil - Cost (cents per gal.)	BITUMINOUS COAL HAND FIRED (Cost-Dollars per ton) Btu per pound			ANTHRACITE COAL Cost - Dollars per ton 13,000 Btu per pound Medium
			Low 10,000	Medium 17,000	High 14,000	
34	3.4	4.7	4.65	5.60	6.55	8.85
38	3.8	5.3	5.20	6.25	7.30	9.90
42	4.2	5.9	5.75	6.95	8.10	10.90
46	4.6	6.4	6.30	7.60	8.85	11.95
50	5.0	7.0	6.90	8.25	9.60	13.00
54	5.4	7.5	7.45	8.90	10.40	14.05
58	5.8	8.1	8.00	9.55	11.15	15.10
62	6.2	8.7	8.55	10.25	11.95	16.10
66	6.6	9.2	9.10	10.90	12.70	17.15
70	7.0	9.8	9.65	11.55	13.45	18.30
74	7.4	10.3	10.15	12.20	14.25	19.25
78	7.8	10.9	10.70	12.85	15.00	20.30
82	8.2	11.5	11.20	13.50	15.70	21.25
86	8.6	12.0	11.79	14.15	16.40	22.35
90	9.0	12.6	12.30	14.80	17.20	23.50
94	9.4	13.1	12.90	15.45	17.95	24.50
98	9.8	13.7	13.40	16.10	18.70	25.50
1.02	10.2	14.2	13.98	16.82	19.50	26.55
1.06	10.6	14.8	14.50	17.45	10.30	26.60
1.10	11.0	15.4	15.10	18.10	21.00	27.70

INSTRUCTIONS FOR USE OF THIS CHART

Step 1. Locate in the proper vertical column the unit cost prevailing in your locality for Fuel No. 1 (For gas see Section A; Oil, Section C; etc.)

Step 2. Read across the table in the same horizontal line to locate in the proper column the comparative unit cost of Fuel No. 2.

Step 3. If the market price prevailing in your locality for Fuel No. 2 is greater than the cost indicated in Step No. 2, a change to this fuel will increase your total heat bill.

Step 3B. If a market price prevailing in your locality for Fuel No. 2 is less than the cost found in Step No. 2, a change will lower your fuel bill.

*Adapted from "Fuels for Kansas Farms" by H. E. Stover, Kansas State College.

tion or wall so removed shall be replaced by an approved fireproof material only, and an air space of at least two inches shall be preserved on all sides of the pipe.

In the interest of safety, it is imperative that these suggestions be followed carefully.

Circulating heaters are so called because the cooler air near the floor moves toward the heater, is warmed, and then rises upward around the outside of the combustion drum. The warm air passes outward through the top and circulates through the rooms.

Circulating heaters can be used successfully to heat small homes having up to 4, 5, or even 6 rooms. Figure 1 illustrates the path of air passing through the

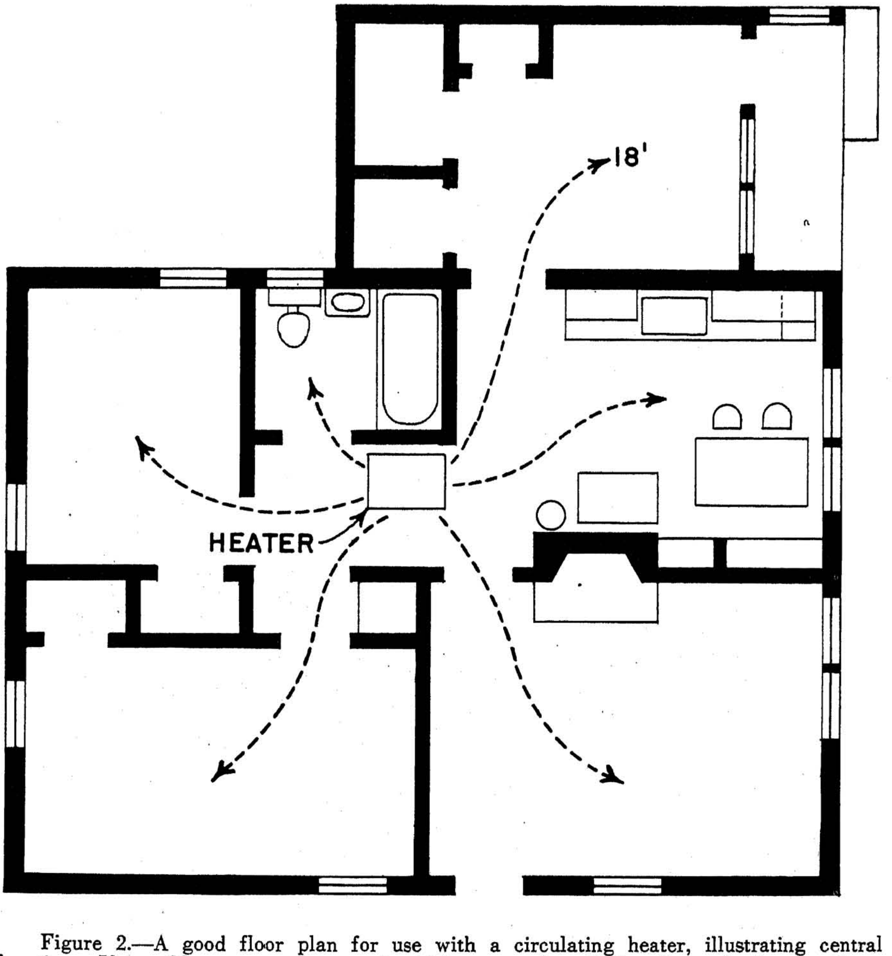

Figure 2.—A good floor plan for use with a circulating heater, illustrating central location. If possible, no room center should be more than 18 feet from the heater. From "Your Farmhouse Heating," Miscellaneous Publication No. 689, U.S. Dept. of Agriculture.

space heater. Usually it is best to locate the heater near the center of the house. This principle is illustrated in Figure 2, which represents a good arrangement of rooms for heating with a circulating heater. Note that the center of the room farthest from the heater is located not more than 18 feet from the heater.

A necessary requirement for obtaining satisfaction is to be sure that the house is not going to lose too much heat. To prevent this, it is common to place insulation in the walls and on the attic floors, and also underneath the floors of houses without basements. Heat losses and infiltration of air can

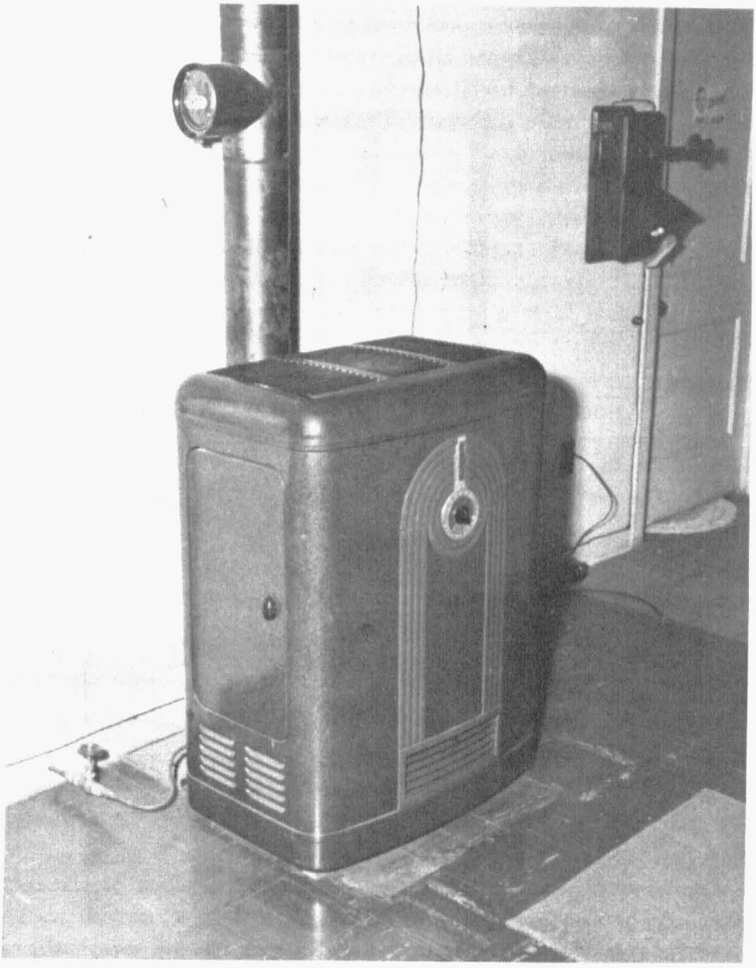

Figure 3.—One type of circulating, oil-burning space heater. Note the draft meter in the smoke pipe. When correctly installed, this meter maintains proper draft automatically. This picture was taken in an experimental farm dwelling near Columbia. Note the feed pipe and shut-off valve for operation from an outside oil storage tank; see Figure 4 also.

be reduced by caulking joints and by using storm windows in the winter. These practices will result in a great saving in fuel cost and increase in comfort.

It is usually difficult to get good heat distribution in rooms in which the ceilings are higher than 9 feet, unless special devices are employed, which will be discussed.

Another important consideration in installation of the heater is draft. The draft in a chimney is created when the air inside the chimney is hotter than the air on the outside. Since hot air is lighter than cold air, when the air inside the chimney is heated, it will rise and create a strong upward current. The hotter the air inside the chimney can be kept, the stronger the draft will become.

No air, except through the draft meter, should enter the chimney which has not first passed through the fire of the stove. If the colder, outside air is allowed to seep into the chimney above the fire, it will directly counteract the upward draft of hot air. Close all openings where outside air may creep into the chimney and hinder the draft. A poor draft can also result when a chimney is obstructed in some way with soot or other objects. A chimney which is not high enough can also cause trouble. Large trees around the house which extend above the top of the chimney may cause poor draft. Usually the chimney should be at least 2 feet above the ridge of the house. In connecting up a heater to the chimney, the horizontal run of pipe from the heater to the chimney should always rise slightly toward the flue opening. A minimum of elbows should be used as they decrease the draft. Ordinarily, only one heater should be used on each flue.

The manufacturer includes a draft meter with oil-burning circulating heaters. See Figure 3. The draft meter is regulated at the factory so that it tends to maintain automatically the proper amount of draft for the heater. The draft meter should always be placed in position and adjusted strictly according to the instructions sent with the heater. Use of a damper other than an automatic draft meter is never recommended.

It is often convenient, when using oil, to install an outside fuel storage tank so that fuel will flow into the space heater by gravity. One method of installing such an outside storage tank is shown in Figure 4. The sediment trap shown in Figure 4 is not absolutely essential, but is desirable.

Where electricity is available in the home, the use of an automatic thermostat to operate the oil burner will become convenient. A kit of parts can be purchased from most heating equipment dealers. The cost is low, and the benefits are remarkable. In using such a kit, the location of the thermostat is important. The thermostat should not be located on an outside wall, behind a door, too close to the heater, or on a wall which has an appreciable amount of sunshine on it for part of the day. Usually it is better to locate the thermostat on an inside wall at least 8 to 10 feet from the heater.

One should not expect the thermostat to maintain the same temperature in an outlying room as it does in the room in which it is installed. Temperatures

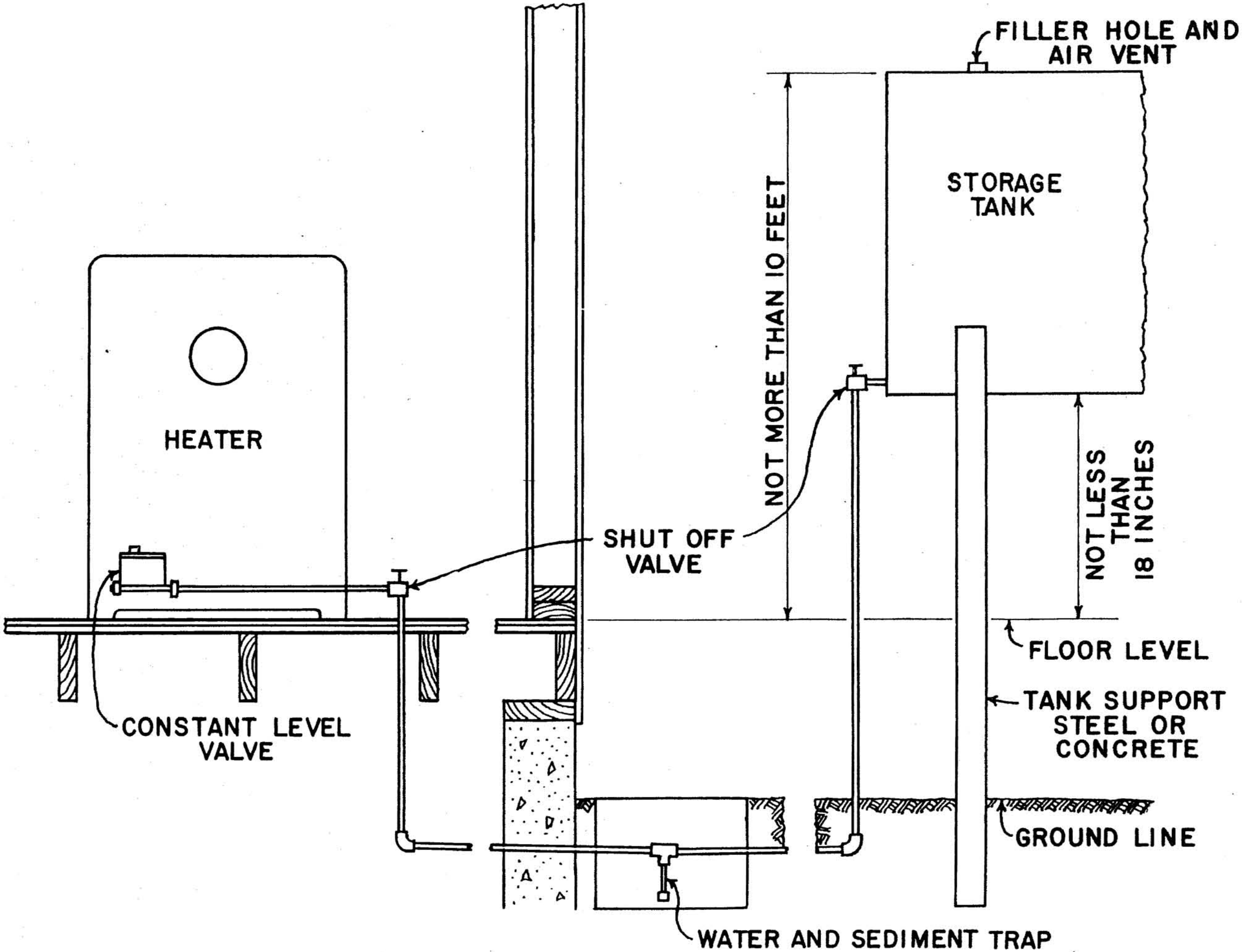

Figure 4.—An arrangement for outside storage of fuel oil. The storage tank should be located so that it can be reached easily in all weather by the tank truck.

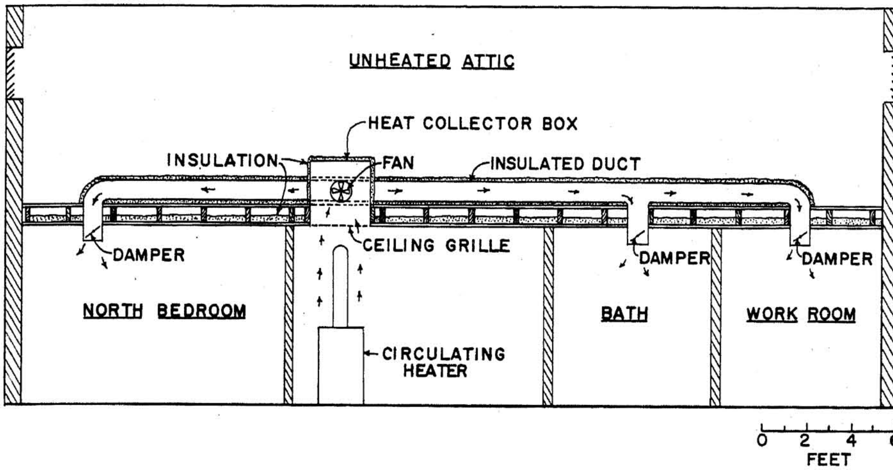

Figure 5.—This figure illustrates a low-cost, warm air distribution method; see also Figure 6. A method similar to this was tested in an experimental farm dwelling near Columbia and found to be effective. The dwelling shown in Figures 5, 6, and 8 is the experimental unit mentioned. It is a one-story, basementless house with concrete slab floor laid on the ground.

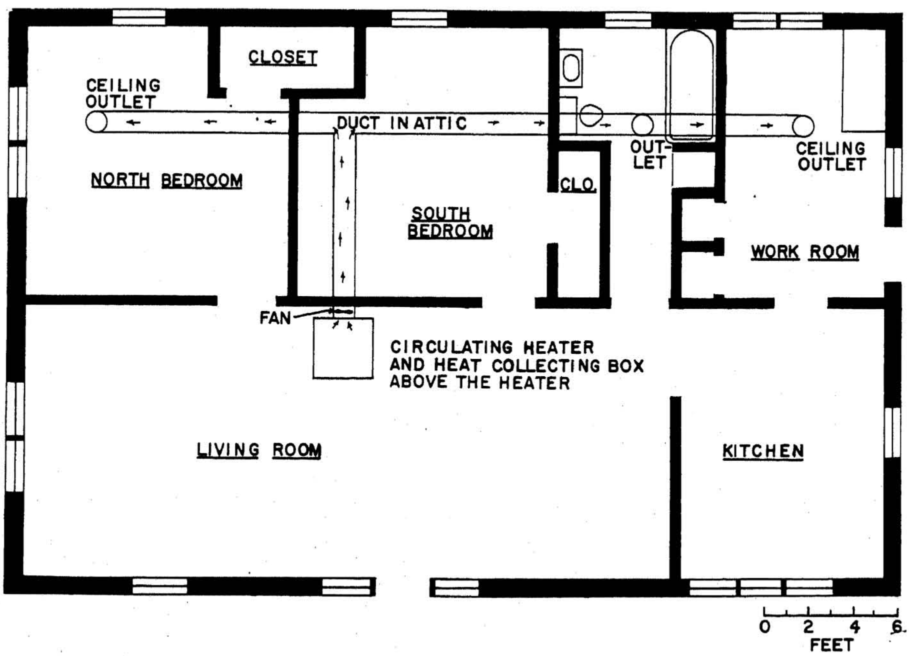

Figure 6.—Plan view of overhead warm air distributor system pictured in Figure 5. The fan used should not be too powerful. A capacity of from 150 to 300 cubic feet per minute seems ample. Ordinarily 8″ round furnace duct is suitable to make the system. The heat collector box can be made of wood or metal. The system is considered desirable for rooms with very high ceilings (9′ or higher).

maintained in outlying rooms depend upon many factors, such as capacity of the heater and structure and arrangement of the house.

Getting Good Heat Distribution. Tests performed recently at the Missouri Agricultural Experiment Station indicate that there are a number of ways in which the temperatures in outlying rooms can be improved. One of these methods is shown in Figures 5 and 6. In Figure 5, a schematic cut-away of an overhead duct arrangement designed to move excess heat accumulating near the ceiling out to different outlying rooms is demonstrated. Figure 6 is a floor plan of the same house showing the plan view of the overhead duct arrangement. The essentials of this system are as follows:

A sizeable opening is first made in the ceiling directly over the circulating heater, and a heat-collecting box mounted in the attic above the hole in the ceiling. Usually it is advisable to cover the hole in the ceiling with a grille of some kind (as in Figure 7) which can be opened or closed as desired. The air ducts are then attached to the box in attic as shown in Figures 5 and 6.

Note that these ducts are shown as being insulated where they run through an unheated attic. Note also the dampers at the terminal ends of each over-

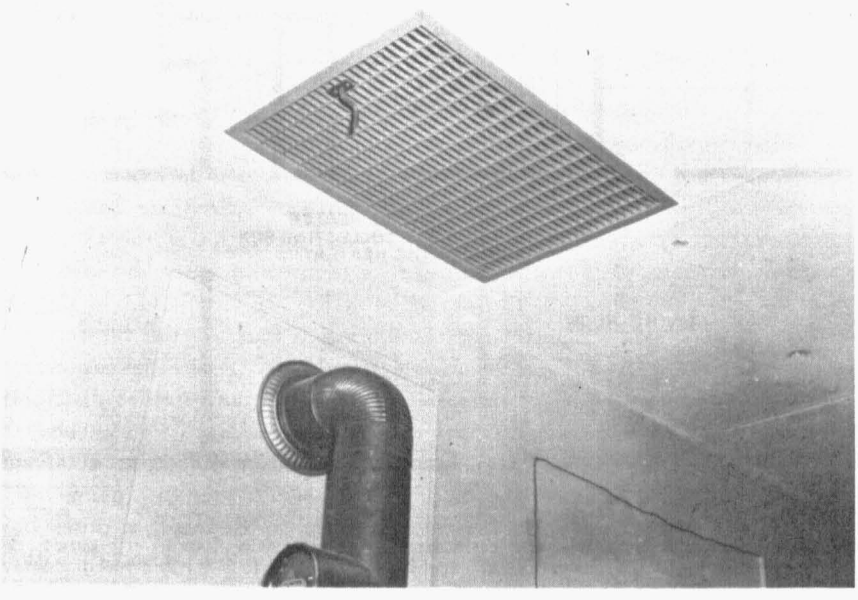

Figure 7.—This illustrates method of locating grille in ceiling above heater, to obtain the system shown in Figures 5 and 6. Note the handle for closing and opening the grille.

head duct. This allows the owner to shut off part or all of the heat into the outlying rooms from this system.

The system would be completely ineffective without the fan located somewhat as shown. Many supply houses sell fans specifically constructed for mounting in round ducts ranging in diameter from 6 to 12 inches, and it is relatively easy to obtain the ducts and mount a fan in them, and insulate them. This has the effect of changing the normal gravity circulating air system into a forced air system.

This procedure need not be confined to single story homes. It is entirely possible to construct such a system in a two-story home, by placing the heat collecting box adjacent to an upper story partition, and running the air ducts also adjacent to partitions.

This system could be used very well, it is believed, to heat upper story bedrooms. Often the heat is not needed in these bedrooms until a few hours before bedtime, and could be shut off for the rest of the time. In such arrangements, it is possible to use regular forced air system registers at different locations of the ducts in the upstairs bedrooms. These registers have a neat appearance and can be opened and closed easily.

Another method of improving the heat circulation of a circulating heater is shown in Figure 8. This system of underfloor ducts can be used both with basementless and basement houses. For the basementless house, the system could be installed only if there is sufficient space beneath the house. Where there is a basement, it would be relatively easy to install the duct system together with the registers shown in Figure 8. In locating the floor registers, they should be placed as far from the heater as possible and preferably near a window. The underfloor ducts are brought to a common center in a pit or box located directly underneath the heater.

By enclosing the heater jacket to the floor, it would then be possible for the heater to draw its cold air not from the surface of the floor, but from the underfloor duct system. This will raise the temperatures at the floor. The underfloor duct system can be improved to a remarkable extent by installing a blower in the pit underneath the heater with the air circulation in the same direction as the normal convective circulation. That is, the blower is arranged to draw air from the floor registers and blow it over the heater.

With such a system, it is possible to approach temperature distribution somewhat comparable to that obtained with expensive forced air systems. The size of the blower need not be excessive. A capacity of 500 to 1000 cubic feet per minute is considered adequate.

Where the heater rests on a floor grille, as in Figure 8, a stove board cannot be used. In this case, the grille should be made of metal, with the surrounding floor protected by sheet asbestos. The house in Figures 8 and 11 has a concrete slab floor, and has no need for special protection. See also Figure 11 for a view of a heater resting on a floor grille.

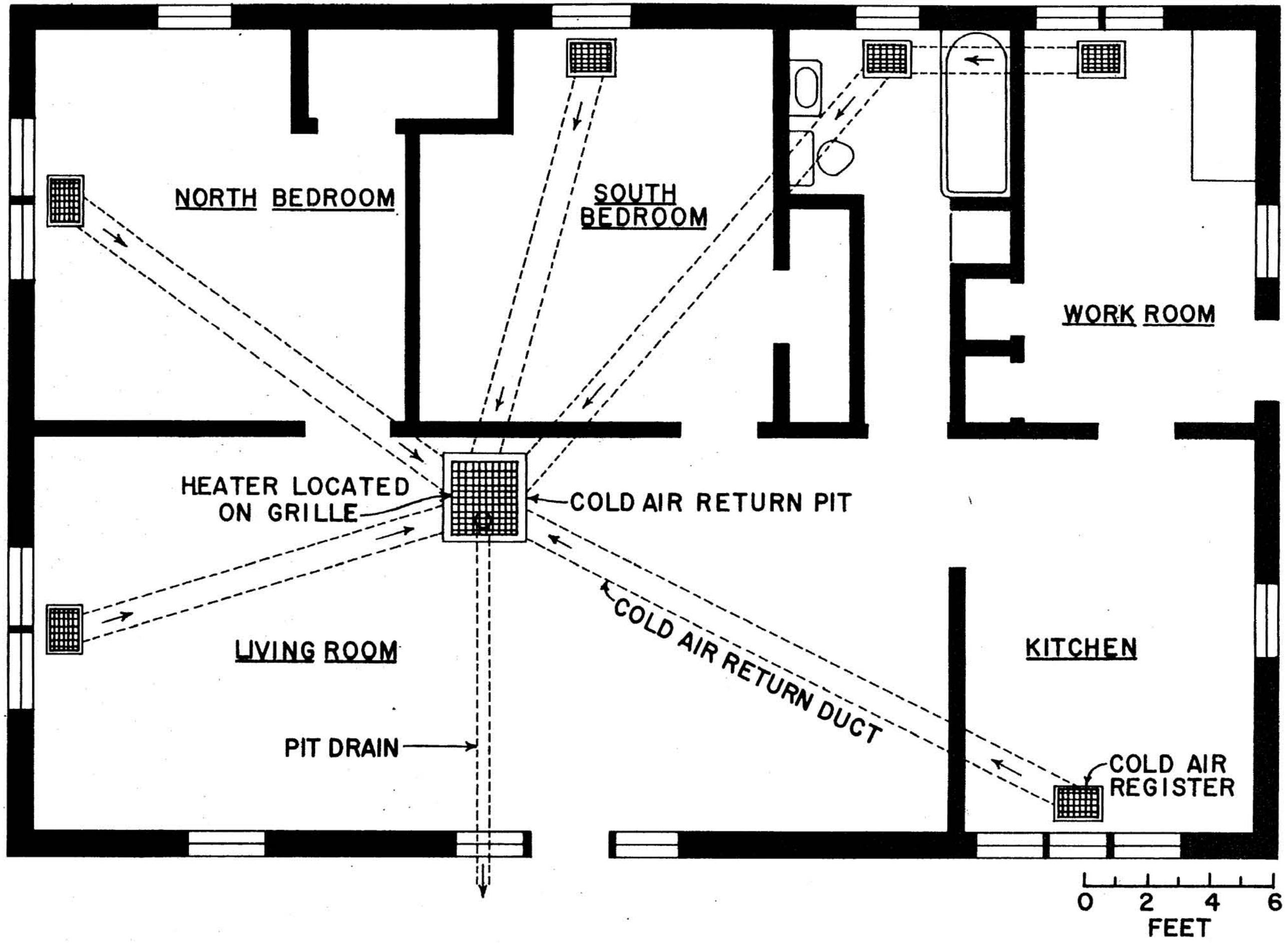

Figure 8.—This plan view shows a method for returning cold air to the base of the heater without allowing it to pass over the floor. Floor registers are located in each room, usually below a window. The heater is placed on the grille. Preferably, the base of the heater should fit the grille rather closely. For a house built on a concrete slab laid on the ground, the cold air pit should have a closable drain. Also, the edges and bottom of the slab should be insulated carefully. Each cold air register should be capable of being closed. This system can be improved by installing a small blower in the cold air return pit. The blower should move the air up and over the heater; that is, in the direction of natural gravity (convective) circulation.

The circulatory flow of heated air from the heater to outlying rooms can be aided greatly by the device shown in Figure 9. This method consists of making openings above the doors to allow the heated air to circulate, even though the doors are closed. Application of this method would be especially desirable in bedroom doors. Usually, it is best to make the openings as large as possible, at least 8" x 16".

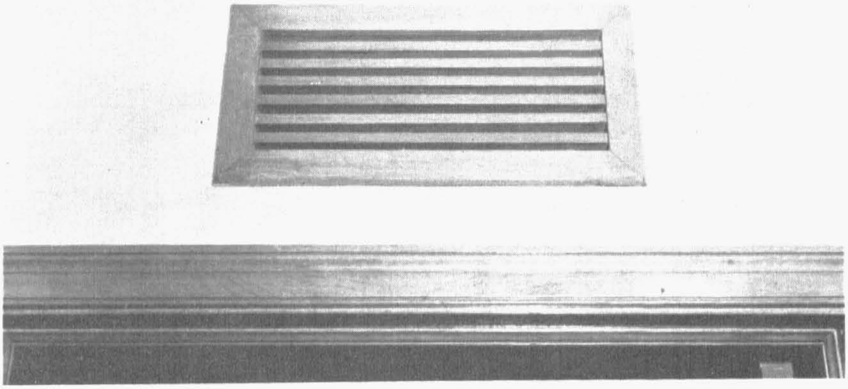

Figure 9.—Louvered transom openings over doors will allow warm air circulation even though the door is closed. These openings should be made large as possible.

Sometimes it is possible to greatly improve circulation by mounting a small fan over the door rather than having merely an opening. This will help to heat the bathroom, for example, where temperatures higher than normal are desired, as in Figure 10. Where an overhead duct system as in Figures 5 and 6 is used, there is no particular necessity for openings over the doors. These openings are recommended for use where no overhead ducts are furnished for distributing the heat.

An extremely simple and easy method of improvement of heat distribution is shown in Figure 11. By placing a 10 to 14-inch fan on the floor behind the heater and allowing a blast of air from the fan to blow upward and over the heater, an improvement in warm air distribution will usually be noted. This improvement will be most marked in the room in which the heater is located but will also extend, to a degree at least, to outlying rooms.

Since most people are likely to have this type of fan for summer use, this method of using a fan in the winter to increase comfort should be convenient. In an emergency the same principle can be applied to heating outlying rooms by hanging a fan from the top of the door entering into the outlying room. This tends to move the high temperature air near the ceiling into the outlying room.

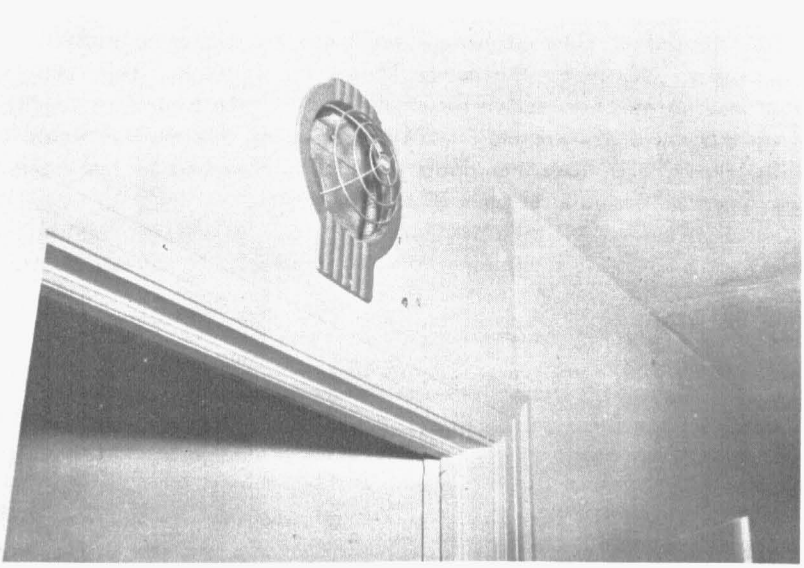

Figure 10.—A fan built into the wall above a door can move warm air into an outlying room. Fans are manufactured and sold expressly for this purpose.

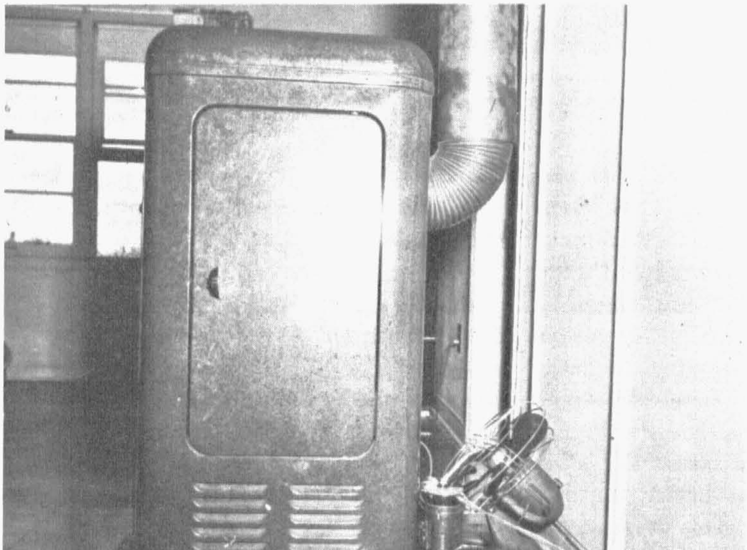

Figure 11.—A fan placed behind heater improves warm air distribution. Note the automatic operation attachment secured to the fuel control valve. This enables use of a thermostat to operate the heater. These attachments are readily available through dealers in oil-burning heaters.

Some circulating heaters are purchased without built-in fans. Manufacturers often offer fans which will fit their circulating heaters as optional equipment. Tests of this type heater at the Missouri Station indicate that a great improvement in heat distribution can be obtained by use of these built-in fans. Their use tends to lower the temperature near the ceiling and increase it near the floor, which is always desirable.

Selecting a Circulating Heater. In Figure 12 is shown a graph of cubic feet in the house plotted against Btu capacity of the heater. Circulating heaters are usually rated in terms of Btu per hour capacity. Figure 12 applies to oil-burning space heaters only, used in the states of Illinois, Missouri, and parts of Kansas.

A Btu (British thermal unit) is commonly defined as the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit.

To make use of Figure 12, follow this description. Before buying a space heater, measure the house and determine the cubic capacity to be heated. Then enter the graph with the number of cubic feet in the house as indicated in Figure 12. In the example shown by the dotted line, we assume

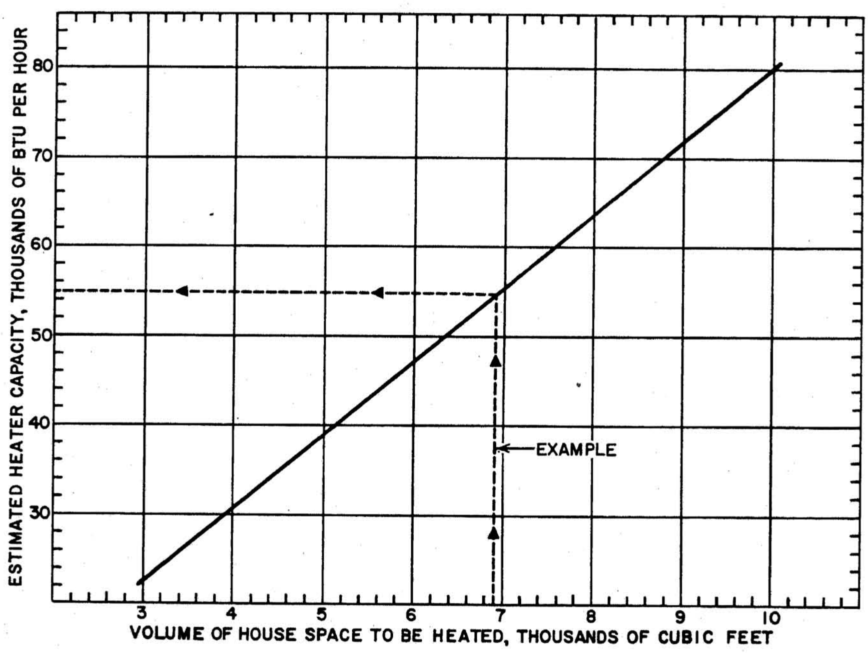

Figure 12.—This graph can be used as an aid in estimating oil-burning heater capacity for a given size of house. It applies to Missouri, Illinois and most of Kansas. An example is shown where a house having 6900 cubic feet of space to be heated would require a heater capacity of 55,000 Btu per hour. Adapted from information published by the Institute of Cooking and Heating Appliance Manufacturers.

that the house has a cubic capacity of 6900 cubic feet. Entering the graph at 6900 on the horizontal axis, go up until the heavy line is intersected, and then over to the vertical axis. This shows that the capacity of heater needed is at least 55,000 Btu per hour. In case a given capacity of heater needed according to the graph is not obtainable, the next larger capacity which is available should be chosen.

Summary. The following points are offered for consideration:

(1) For satisfaction in winter heating, regardless of the system used, the house should be reasonably tight and insulated.

(2) The heater size should be chosen such that its capacity is adequate to heat the house under normal winter conditions. To insure this, the dealer from whom the heater is purchased should be informed of the size and condition of the house in which the heater is to be used.

(3) Installation of the heater demands particular care with regard to draft and location of the heater.

(4) Outlying rooms can be heated more satisfactorily by installation of special overhead and underfloor ducts.

(5) In installing the heater, careful attention should be paid to underwriters' recommendations, since many fires are caused by improper heater and flue installation.

Although the methods of warm air distribution discussed in this bulletin are based on tests of oil-burning heaters, the methods can be applied equally as well to heaters using other types of fuel.