Examples of methods used to calculate required circuits, feeders, and main services may be found in the *National Electrical Code*, a copy of which may be obtained at small cost from your State fire insurance rating bureau, which very likely is in your State capital.

Other helpful guides may be had from the Industry Committee on Interior Wiring and from the National Electrical Manufacturers Association, 155 East 44th Street, New York, N.Y., 10017. One of their pamphlets, "Residential Wiring Handbook," sells for 25 cents.

State universities generally have pamphlets to help you in planning. For instance, a pamphlet, "Electrical Wiring," is available for 15 cents from the Small Homes Council, University of Illinois, Urbana, Ill.

Finally, require your wireman to have his work checked and inspected for safety by an authorized inspector and furnish you with a copy of the certificate of approval. (THOMAS P. BRANCH)

Heating

THE METHODS you use to heat and cool your house depend largely on how comfortable you wish to be and how much you can afford to spend for them.

Central heating or complete house heating systems provide the comfort most Americans want. They are a good investment in all but the lowest cost houses and in warm climates. Thermostats make their operation almost automatic.

FORCED-WARM-AIR systems with blowers to circulate the air mechanically are the most popular. The type with ducts distributes filtered air to all rooms and provides uniform temperatures in a properly built house.

Furnaces for warm-air systems, using gas, oil, or electrical resistance heaters, heat quickly. This is a desirable feature for heating on chilly fall and spring mornings.

A basement is the best place for the furnace. If only crawl space is available, a horizontal type of furnace may be hung under the floor; there should be plenty of room to get to the furnace to service and repair it.

Stoker-fired furnaces often are used in places where coal is cheap. They should be in the basement because of dirt and because coal must be stored nearby. Some are made for floor mounting in a wide hall or another central location, but this type is less desirable.

Automatic oil and coal-fired central heating systems with ducts usually cost 800 to 1,500 dollars installed in the average three- or four-bedroom house. Gas-fired and electric furnaces may cost less.

Electric furnaces need no vents and require no maintenance other than servicing the fan, motor, and filters.

The installed costs of heating systems vary according to type of fuel, the duct system, climate, and labor rates.

When you compare installed costs, do not forget to include the cost of a larger capacity electrical system if one is needed for an electric furnace.

Do not buy too small a furnace because of a slightly lower price; you will not get the quick heat desired at times, you may use more fuel in the long run, and the heat exchanger may not last so long.

On the other hand, too large a furnace is inefficient and may not provide even temperatures.

Get a reputable dealer to figure the size you need.

In most central warm-air systems, the air is filtered through inexpensive replaceable or washable filters.

Electronic air cleaners remove pollen, fine dust, and other irritants that pass through ordinary filters and thus are especially desirable for persons with respiratory ailments. In the most efficient type, particles in the air are electrically charged before the air passes between closely spaced electrically charged plates. The cost installed with automatic washing and drying of the cleaner was about 600 dollars in 1965, or perhaps 25 percent less without the automatic feature.

Compact oil or gas forced-warm-air furnaces may be installed on the floor of the house in a closet or other recess at less cost than a central system with furnace in the basement.

Some have ducts running through the attic to discharge heated air through a diffuser in the ceiling of each room. The ducts should be tight and heavily insulated to save fuel.

Others have no ducts, but discharge the heat from a large register at the top of the furnace. This type is somewhat similar to a circulator heater with fan and heats best in an open-type plan where few partitions interfere with circulation throughout the house.

Without cold air return ducts, temperatures are less uniform. The cold air is drawn along the floor from the cooler outside walls, and floors may be cold. This applies also to circulator heaters even when equipped with electrically driven fans.

Furnaces mounted on the floor of the house may be noisier than basement installations, as the furnace is closer to the occupants.

If you plan to build a house with a concrete floor, you can use a downdraft furnace and form the ducts into the concrete floor. Provide openings for registers along outside walls. This system gives a warm floor and satisfactory heating.

HOT WATER SYSTEMS provide uniform heat, especially with baseboard convectors or a piping system in the floor. They are compact and require little space for the piping. Two-pipe systems are best. In houses with basements, they eliminate ducts, which may interfere with headroom and any plans to finish the ceiling.

The baseboard convector is a hollow unit that looks like a baseboard and replaces the wood baseboard on outside walls. Cool air at the floor is warmed by passing over finned tubes in the unit.

Heating is fairly quick in the modern hot water systems, now often called hydronic systems. Boilers are small, and the hot water is circulated quickly by an electrically driven pump. The cost using baseboard convectors is slightly higher than a good forced-warm-air system.

Steam heating systems are sometimes used in very large residences in cold climates. Generally they are more expensive than other systems.

HEATING the entire house electrically is economical only in communities where rates are low.

Some power suppliers have rates as low as 1 to 1.3 cents per kilowatt-hour (kw.-hr.) above a specified minimum power usage. Seasonal costs of heating vary in different climates.

Your local power supplier can give you typical costs and may give you a guaranteed maximum cost per month or annually.

Baseboard heaters or cables in the ceiling are especially satisfactory for heating the entire house. They provide uniform temperatures and are noiseless. Usually these types are controlled by a wall thermostat in each room.

Some housewives object to the baseboard type because they interfere with floor-length draperies.

Baseboard and ceiling cable installations usually run from 50 to 75 dollars a room.

Electric wall heaters with or without fans and with self-contained thermostats sometimes are used, but may not provide uniform temperatures except in small rooms.

Heat pumps, which heat in winter

and cool in summer, are becoming more popular. They cost less to operate in winter than when heat is supplied entirely by electrical resistance heaters.

Consult your local power supplier before adding large electric heaters or installing a complete system. You may need larger service entrance wiring and distribution panel.

Portable electric and gas heaters are recommended mainly for supplemental heat.

You should inspect the flexible tubing connecting portable gas heaters to the gas supply line often to make sure there are no cracks developing which could cause leaks. Gas heaters are safer if vented to the outside.

Portable electric heaters should have an automatic switch to shut off the electricity if the heater is tipped over.

YOUR HOUSE must be properly insulated to get comfortable, uniform temperatures and comfortable heating bills.

Four inches of insulation in the ceiling and 3 inches in walls is the minimum recommended for most types of heating.

Electricity costs more per unit of heat (British thermal unit, or B.t.u.) than other fuels. If you use electrical heating, place at least 6 inches of insulation in the ceiling and 4 inches in walls and in floors with vented crawl space.

Some manufacturers stamp their insulation with an "R" value. A high "R" value means thicker, better insulation. For electrical heating, use an "R" value of 19 in ceilings, 11 in walls, and 13 in floors as a minimum.

In the colder climates, more insulation is desirable, particularly in ceilings. In new construction, be sure to insulate around the perimeter of concrete slab floors on grade.

Vapor barriers are essential in most areas of the country; otherwise, moisture passing through the construction from inside to outside may condense; that reduces insulative value and eventually causes the insulation and structure to deteriorate.

Some insulation batts and blankets are made with vapor barriers, but it is almost impossible to seal all joints. Place an additional barrier between the inside finish and the insulation. Use polyethylene film, metal foil, or duplex kraft paper with asphalt between laminations.

Seal all joints, even around light switches and electrical outlets, with special tape.

Some paints on interior surfaces are fairly effective. Two or three coats of alkyd gloss, semigloss primer-sealer plus enamel, or rubber-resin lacquer paint are needed.

Cover the ground of a crawl space with heavy plastic film, roll roofing, or other vaporproof material to reduce transfer of moisture from the ground to the wood floor above. Asphalt-saturated building felt is not effective.

You should also weatherstrip windows and doors and calk cracks between the frames and the siding or masonry walls to reduce air leakage.

Flexible weatherstripping of felt, rubber, or plastic may be easier to install on doors than interlocking metal or spring metal friction types but may need replacing oftener.

Storm windows and doors are essential in cold climates. For example, about 14 times as much heat goes through a single pane of glass per square foot as a wood frame wall with 3 inches of insulation.

Thus, if the house has large areas of glass, the total heat loss is high even with insulated walls unless the loss is reduced by use of storm windows or double-pane insulating glass.

You feel colder, too, with the single thickness of glass, because the body radiates heat to the cold glass surface.

Glass storm windows present problems of breakage and of storage in summer. Storm windows of plastic film are cheaper and light in weight, but the plastic has limited life. They must be handled carefully to avoid puncturing.

Storm windows must fit tightly. If they leak air, you lose the effectiveness

of the dead-air space formed between the windows.

HUMIDITY CONTROL in the house is difficult.

The average person is comfortable if temperatures are within 73° to 77° F., and the relative humidity is between 25 and 60 percent.

Because high humidities may cause condensation on windows and sometimes cold walls in winter, humidity of less than 40 percent is desirable.

Exhaust fans operated occasionally in the bathroom, kitchen, and laundry room help remove moisture.

Condensation can be reduced if the heating system is designed so that warm air sweeps over window areas. Tight storm windows help solve the problem.

Electrically driven dehumidifiers are helpful in winter and summer if the humidity is too high. They reduce mildew and dampness during summer, especially in basements where moisture tends to condense on the cooler walls and floors.

Keep windows closed when dehumidifiers are operating.

If the humidity is not high enough in winter, use a humidifier in the furnace if you have a warm-air heating system.

Some humidifiers have absorptive plates that extend into the airstream from the humidifier water pan. The plates need replacing occasionally. The mechanical atomizing type of humidifer is better but is more expensive.

Vapor barriers in the construction and tight doors and windows will help retain moisture in the house. (JOSEPH W. SIMONS)

For further reading:

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U.S. Department of Agriculture, *Electric House Heating.* REA Bulletin 142–1, 1960.

——— *Your Farmhouse—Heating.* Miscellaneous Publication No. 689, 1962.

Witz, R. L., French, E. W., and Guest, R. W., *Comparison of Methods of House Heating.* North Dakota Agricultural Experiment Station, ASAE Paper No. 59–918, Fargo, 1959.

Cooling the House

SOME TIPS that will help you keep your house cooler in summer:

Orient the house (if you are building) with its long axis east and west if possible. If you do not plan to have mechanical air conditioning, make certain of good cross-ventilation and orient the house to take advantage of prevailing breezes. Arrange shrubs and hedges so they will not shut off the breezes.

Avoid large glass areas in east and west walls, where they are harder to protect against sun.

Shade the south windows with wide eaves or overhangs.

Shade the house with deciduous trees and shrubs (which lose their leaves) and let in sunshine during the winter.

Use awnings over the windows or louvered bar screens if it is not feasible to have trees or overhangs for shade.

Use light-colored roofing materials, light paint on exterior walls, and light-colored shades and draperies or curtains.

Insulate the house if it is not already insulated. Use the same thicknesses of insulation for cooling as for heating.

High-pitched roofs are cooler than low-pitched ones.

Avoid large paved areas next to the house because they may reflect the sunrays into the house.

WINDOW OR ATTIC FANS may be used where nighttime temperatures drop sufficiently to cool the house.

One air change in the house each minute is needed in most places. Use