# UNIT 1 FIRST VILLAGE

## Introduction

First Village is a small, planned environmental community located 6 miles south of Santa Fe, NM. All homes in the community are solar-heated, and all employ water-saving technology as well.

Unit 1 (Figure 13) is a 2300 ft^2, two-story home which employs passive gain principles along with active solar-collecting and storage devices to accomplish its space-heating. All rooms face onto a large, triangular-shaped, 20-foot-high greenhouse located on the south side of the building. The south wall of the greenhouse is constructed entirely of glass, and the other two walls are constructed of adobe, providing thermal mass for the solar storage and separating the heat-collection area of the greenhouse from the living spaces behind them.

Heated air from the top of the greenhouse is circulated by fans through two rock beds situated beneath the house and then back into the greenhouse. The heat stored in the rock beds radiates through the floor, supplementing the heat from the greenhouse at night and on sunless days.

Backup heating is provided by baseboard electric heaters regulated by individual thermostats in each room. In addition, a separate flat-plate collector array is located near the house for domestic hot-water heating.

## Design of House and Solar Heating System

The overall design of the house was devised by the architect, William Lumpkins (Sun Mountain Design), and the builders, Wayne and Susan Nichols (Communico). The solar design, utilizing a south-facing greenhouse, mass walls, and fan-powered radiant rock beds, was patterned after an early application of these principles by Hal Miguel in his Tesuque, NM residence.

House. Figure 14 illustrates the floor plan for the first and second floors of this house. The L-shaped house features three bedrooms and two baths on the second floor, and all of the bedrooms open onto a balcony which overlooks the greenhouse (Figure 15). On the first floor, a breakfast nook is located at the southeast corner to catch the early morning warmth, and the living room is conveniently located at the southwest corner to accept the late afternoon sun.

The south-facing is provided with approximately 400 ft^2 of thermopane mounted at a 60° angle. The triangular-shaped floor area has a central circular staircase located in the north corner with a vent window at the top. This staircase provides access to the second floor and also acts as a chimney to cool the space in summer.

The south wall of the greenhouse is entirely glass; the other two walls are adobe (mud bricks 4 inches thick, 10 inches wide, and 14 inches long, set with mud mortar). The wall is 14 inches thick at ground level and 10 inches at the upper level. The adobe walls provide the thermal mass for solar storage and separate the heat-collection area of the greenhouse from the living spaces.

One distinguishing feature of this house is that the heat-collection area is not used as a day-round living space. Although the temperature in the greenhouse may drop to 45 to 48°F on a cold (5 to 15°F) winter night, experience has shown that most plants have no trouble with this environment.

The north-facing side of the house is sunk 4.5 feet below ground level, and the below-grade walls are constructed of 8-inch concrete block with all of the cells grouted with cement. These walls are waterproofed with plastic roofing cement and have 2 inches of rigid polystyrene stuck to the tar. The above-grade walls are constructed of 2- by 8-inch stud frame on 16-inch centers and are insulated with a layer of 1.5-inch fiberglass batt along with a layer of 6-inch fiberglass batt applied with the vapor barrier on the interior of the wall. In addition, the rear wall is rounded to provide less resistance to harsh winter winds.

Solar Heating System. Figure 16 illustrates a simplified heating diagram for the house. The solar heating system has two major components. The principal system uses passive gain through the south-facing glass to provide direct gain to the greenhouse space during the day and also to heat the two-story adobe mass wall that separates the greenhouse from each of the living spaces. The heat absorbed into this mass wall during the day eventually works its way through the wall into the living spaces at night.

One advantage of the mass wall is that it acts to average the fluctuations between the surface temperature on the darkened adobe mass wall during the day and the temperature in the unshuttered greenhouse at night. These temperatures range from a 110°F surface temperature during a sunny day down to about 45°F on a very cold (O°F) winter night, with an average wall temperature of about 73°F.

The second component of the solar heating system consists of two horizontal rock beds located under the living room and dining room. These beds are 2 feet deep and 10 feet wide, and one is 19 feet long while the other is 15 feet long. The rock beds contain 24 yards of 4- to 6-inch round, riverbed rock and are capable of storing enough heat to carry the house through a couple of sunless days.

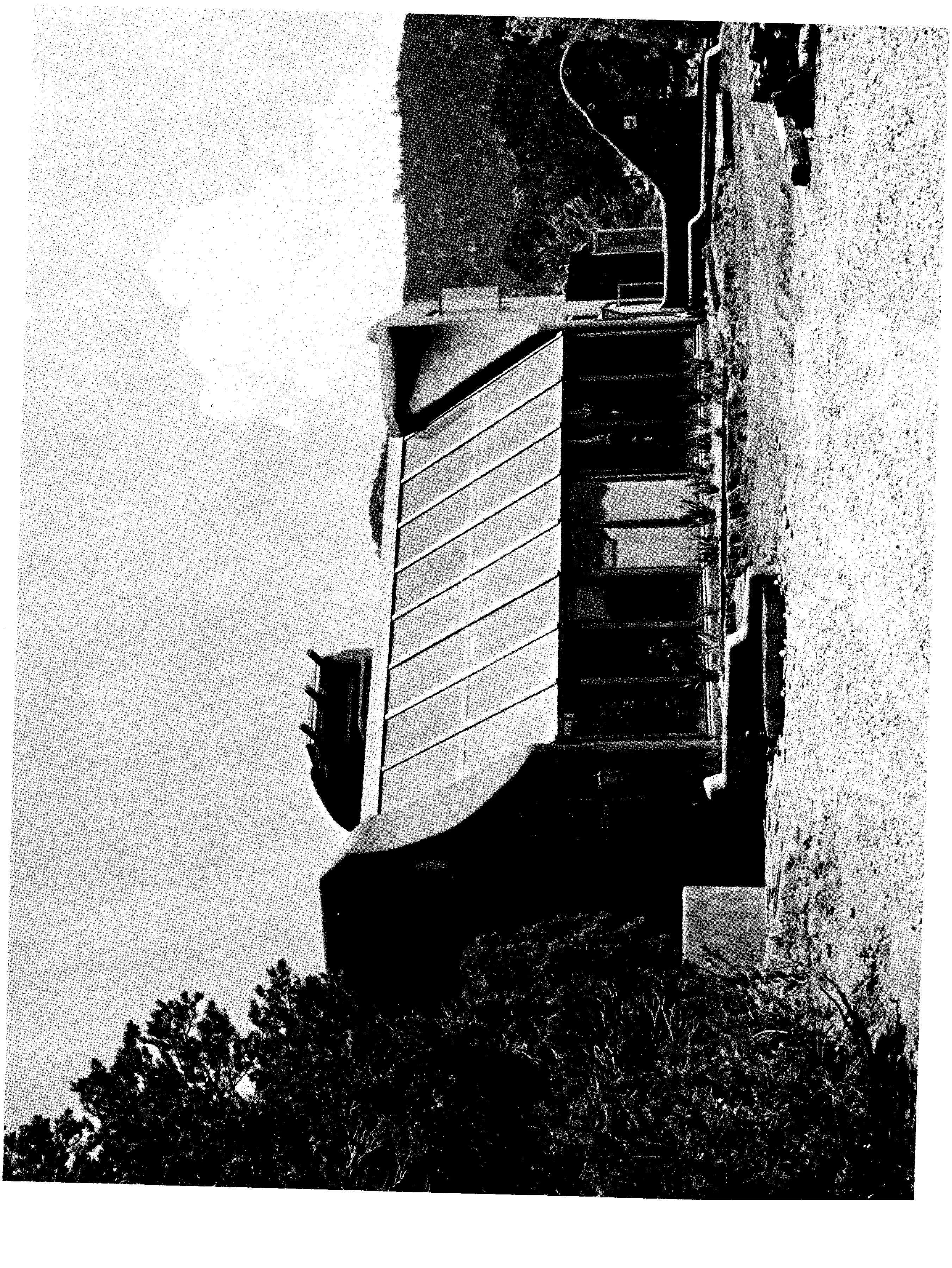

Fig. 13 Unit 1, First Village

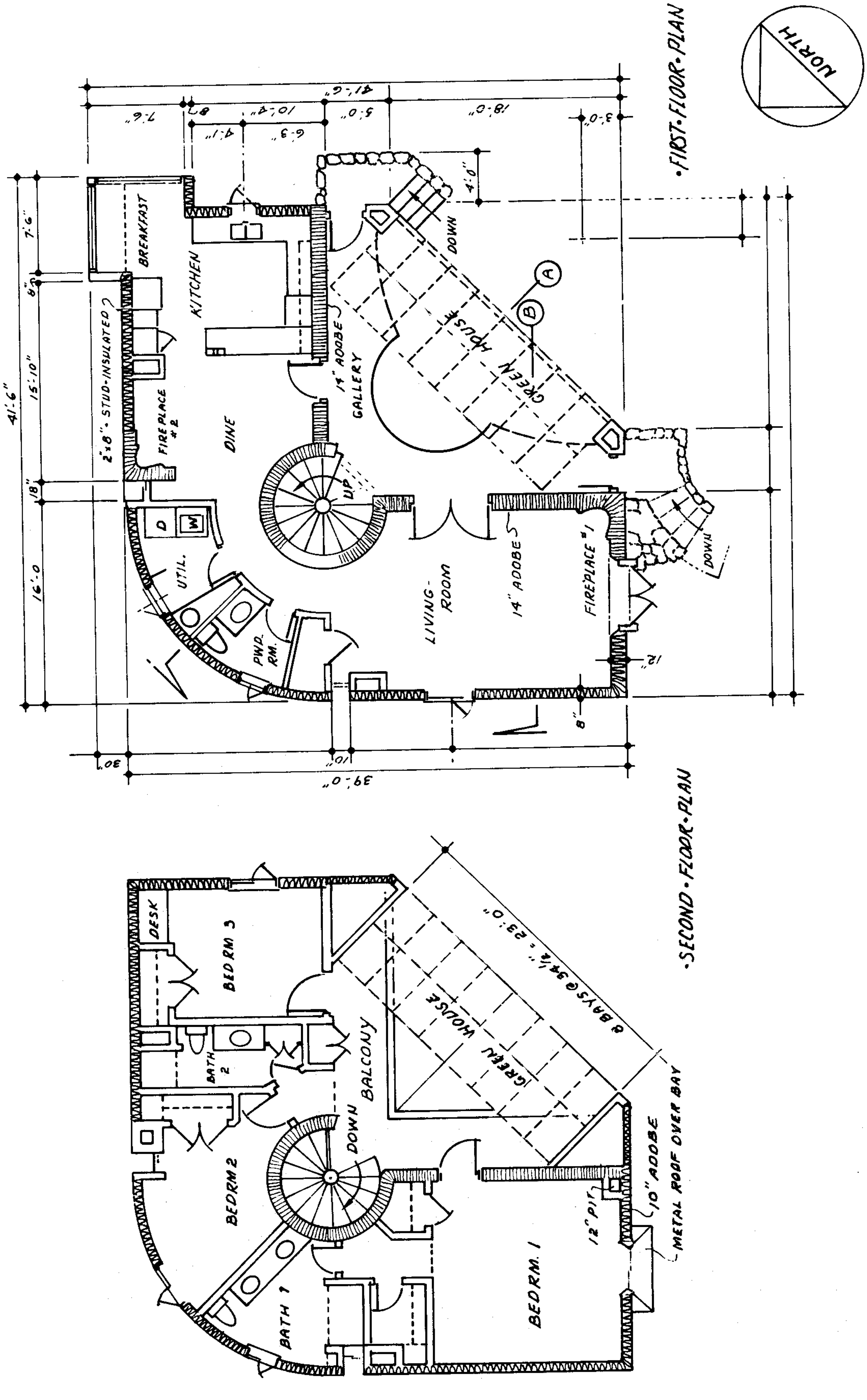


Fig. 14 Unit 1, Floor Plan

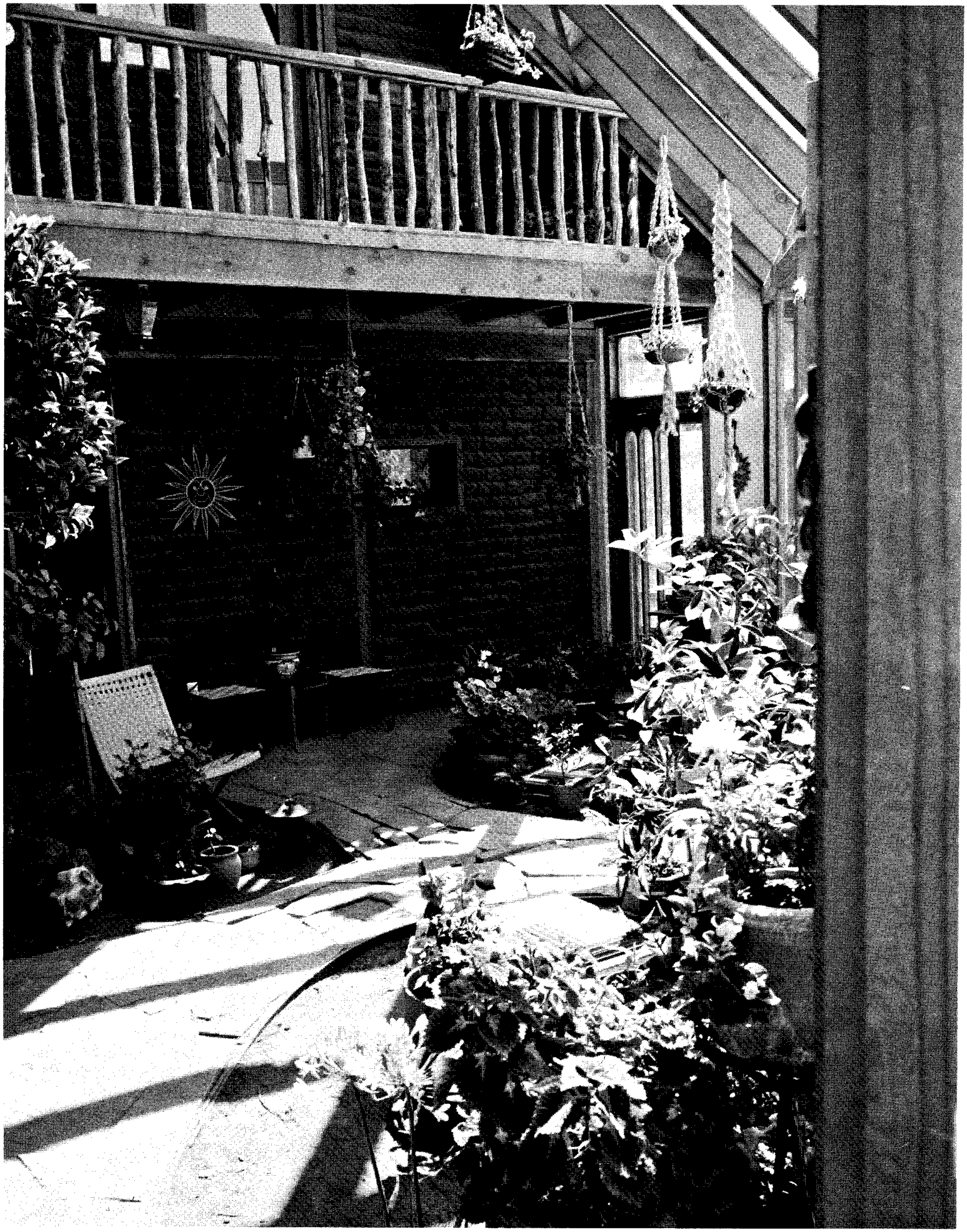

Fig. 15 Balcony Overlooks Greenhouse

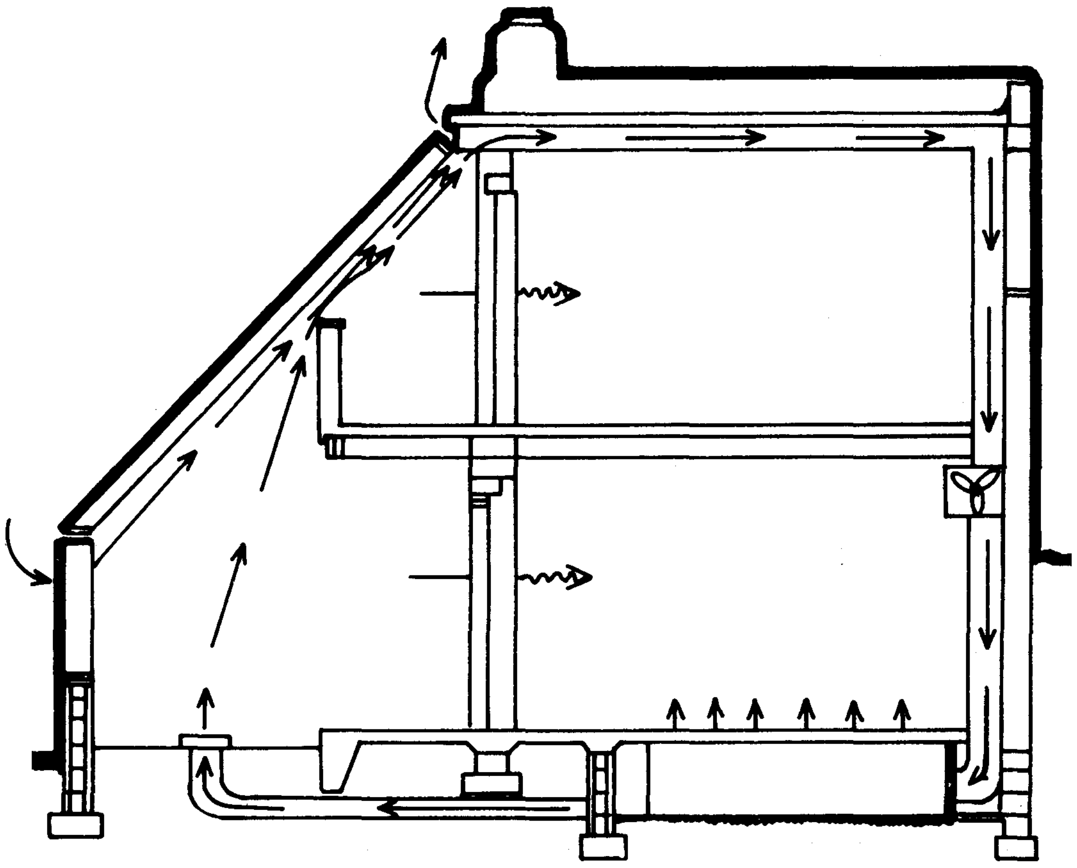

Fig. 16 Solar Heating System

Air is pulled out of the top of the greenhouse by two 1/3-hp fans (one for each rock bed), blown through the rocks, and circulated back into the greenhouse. The controls are simple -- a differential thermostat and two backdraft dampers.

The heat trapped in the rock bed conducts up into the room through a 6-inch concrete slab cap and a quarry tile floor. The temperature of the floor along with that of the rock beds ranges between 85°F during the day to about 78°F after a cold night or 70°F after a sunless day.

Backup heating is provided by baseboard electric heaters with individual thermostats provided in each room. A two-panel, flat-plate collector array is located near the house for domestic hot-water heating.

Summer cooling is adjusted by high and low vents in the greenhouse which may be opened to exhaust heat and to draw cooling air through the house. In addition, the setback living spaces are shaded in the summer, thus avoiding direct heat gain. The principal contribution to summer comfort is the large mass of the building, especially the internal adobe mass wall. The average summer temperature in Santa Fe is comfortable ~ about 70°F - but day-night fluctuation is large. The building mass levels out the fluctuation resulting in a comfortable environment. Although the greenhouse temperatures vary greatly (65 to 95°F), the mass wall protects the living spaces from these extremes.

### Construction and Cost

Construction of the house began in January 1976 and was completed in August 1976 at a total cost of approximately $104,000. Part of the cost was offset by an $8,000 grant (representing about two-thirds of the cost of the solar portion of the house) awarded directly to the builders by HUD during the first cycle of the 1974 Solar Demonstration Act. To the best of the builder's knowledge, this house was the only primarily passive house funded during that cycle and was also the first house in the program to sell.

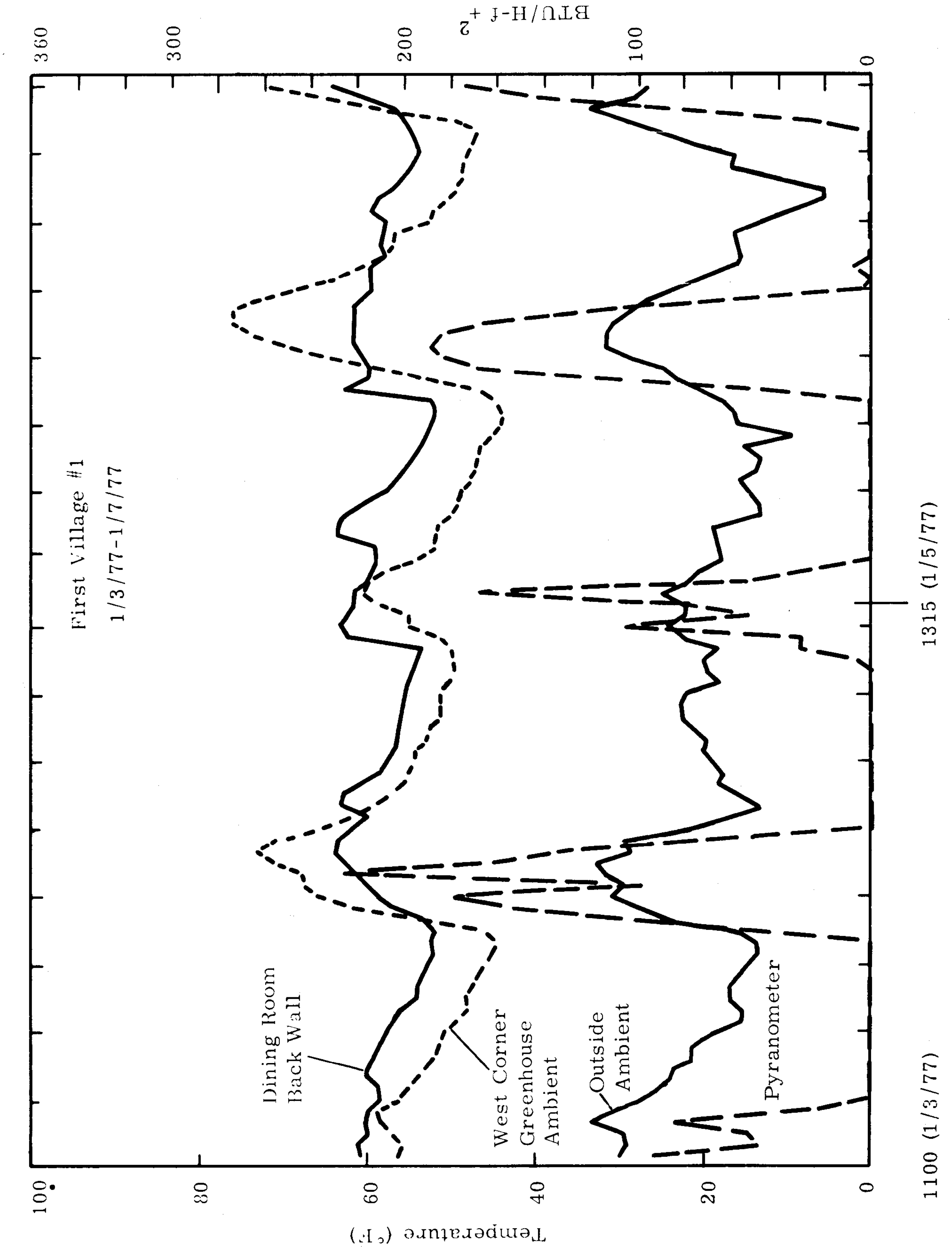


Fig. 17 Representative Temperature Data, January 3-7, 1977

## Performance

Test data obtained from **14** different points around the home on a Honeywell 16-point temperature recorder have shown that the house is apparently performing according to design requirements. Figure 17 shows a plot of data gathered during the period from January 3 to January 7, 1977. These data are generally representative of the lowest outside temperatures normally experienced in the Santa Fe area and illustrate the thermal stability of the house. During most of the winter, internal temperatures both upstairs and downstairs normally held in the upper 60's, and the rock storage beds (which supply heat through the floors) normally maintained a temperature of 70 to 74°F on sunny days.

Apprehensions of summer overheating due to the sloping greenhouse have not been borne out. Greenhouse temperatures sometimes reach temperatures of 90 to 95°F near the top. However this sets up a strong convection thru the large window at the top of the stairway preventing any higher temperatures. The living spaces are effectively protected from the greenhouse by the adobe mass wall. The peak temperature observed in the lower level of the house during the 1977 summer was 75°F despite peak outside temperatures of 95°F. Peak afternoon temperatures of 80°F have been recorded in the upstairs bedrooms but they quickly drop after sunset to 70°F or less.

## Operational Cost

The house has been maintained at comfortable temperature levels for almost a year with minimal cost. Utility bills have consistently amounted to less than $10 per month even under the most adverse conditions, and usually the amounts were minimum service charges.

## Observation

The owners have been very pleased with the performance of the house and have experienced only a few minor inconveniences. The solar hot-water system has not functioned satisfactorily, but this has been attributed to a controller malfunction, and this condition is being corrected.

An early concern was expressed that the house might overheat at times, but the problem has not materialized.

The builder, Wayne Nichols, has expressed some ideas concerning marketing concepts which he feels are important to builders and prospective buyers. He recommends a systems approach to promoting and marketing passive solar homes and stresses that new technology must be introduced in the proper context. He believes that public acceptance of solar energy concepts will come only after the concepts are first presented in custom houses and then will filter down to tract-type homes.

## Conclusion

The solar greenhouse concept employed in Unit 1, First Village has worked very well. The solar heating system in this house is actually a hybrid passive/active system. The passive portion of the system heats the home and the thermal storage wall on sunny days and allows the fans to remove extra heat into storage. The active portion of the system (the fans) makes it possible to store the heat in rock beds to increase the carry-through time of the solar heating.

## Acknowledgment

Information for this section was extracted from a paper by Wayne Nichols entitled "Unit 1, First Village," which appeared in *Passive Solar Heating and Cooling Conference and Workshop Proceedings,* LA-6637-C, Albuquerque, NM, May 18-19, 1976.

Additional information was obtained directly from personal interviews with Mr. Nichols and with the current owners of the house, Dr. and Mrs. Doug Balcomb.

## Additional Information

Unit 1, First Village was featured in an article entitled "Two-Story Greenhouse is Three-Way Heater for This Santa Fe Adobe," which appeared in the May 1977 issue of *Sunset* and in an article in the November 1976 issue of *Popular Science.*