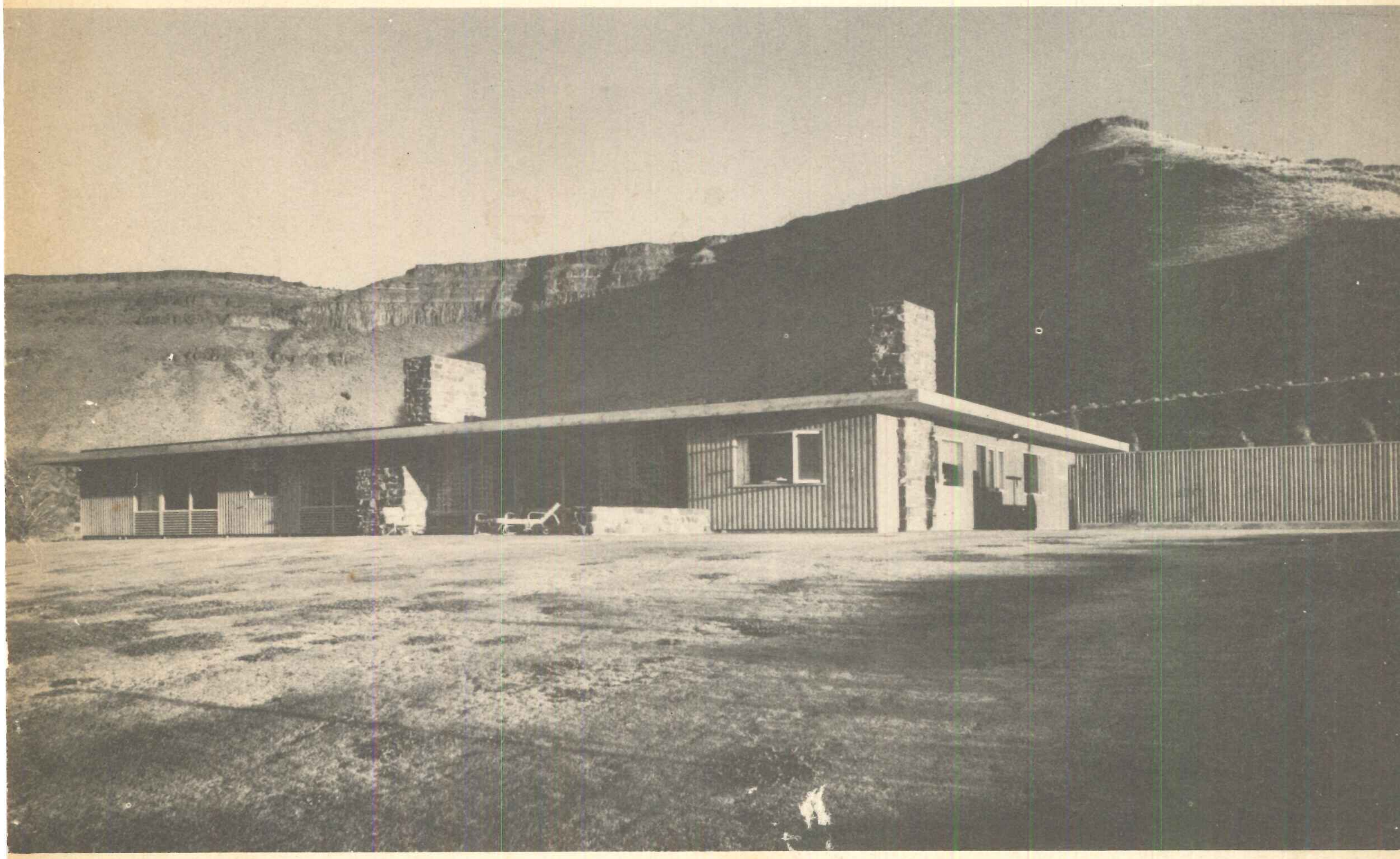
MID-CENTURY HOUSES

with Technical Design Data and Details



presented by the editors of

ARCHITECTURAL RECORD

MID-CENTURY HOUSES

with Technical Design Data and Details

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Technical Articles

A HOUSE IS A HOUSE IS A HOUSE

"In literature, I would say that style is the preoccupation of those who have nothing to say. Whether that is true of architecture I do not know." [1]

"Colonial Williamsburg's small houses . . . not much different from those now being built . . . were practical, asymmetrical, full of corner cupboards and corner fireplaces, and had gadgets to help make the most of limited space." [2]

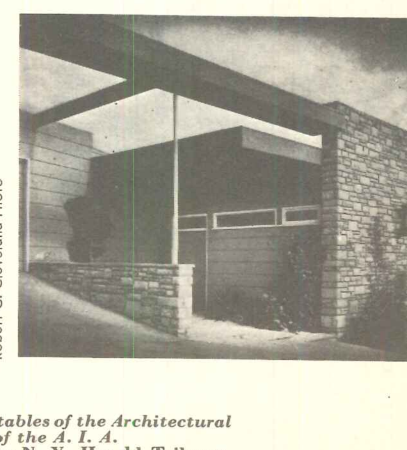
"During the past half-century, our progress in home sanitation, in heating and ventilation, in improved household equipment, has been revolutionary. In that same period, however, we have been retrogressing in space provisions to an almost equally phenomenal extent. Normal and happy and fruitful family life is possible without modern plumbing and deep-freeze equipment. It is not possible without a reasonable modicum of space." [3]

THE authors of these statements, all highly respected individuals with more than superficial acquaintance with architecture, were not talking idly. Each was seriously making his own attack on today's work. What is their justification?

If, forgetting that you're an architect and taking a somewhat detached viewpoint, you can dispassionately examine an average, good, contemporary house — as a scientist might, for instance, examine a mole's burrow to ascertain its habits and appearance — you can reach some ludicrous conclusions. Charles Agle, New York architect and member of the firm of Harrison, Ballard and Allen, did.[4]

Let's start with the American bathroom, conceded to be an index of the highest material standard of living ever achieved by man. Judging by the height of a lavatory, our dispassionate investigator could logically assume that the American adult stood 4½ ft tall; by the traditional position of the mirror, that the user's physiognomy projected at least 14 in. beyond his torso. (How could he imagine the calisthenics, the balancing, involved in plucking an eyebrow or washing the last of the shaving soap out of one's ears?) Then, turning to the toilet seat, he would find that set at a height ideally suited to the functions of an individual 7 ft tall. Again, the tub must be for a four-footer, unless — but this could never be! — the seven-footer were to wrap his knees about his ears. And, ah, yes! Since soap, water and smooth surfaces are almost lethally slippery, the four- or seven-footer must be shod with suction cups.

The laundry would disclose further contradictions. "A remarkably ingenious creature," the scientist might murmur on beholding the automatic laundry machine. "Remarkably equipped, too; or perhaps only the female has the integral lift-truck, rubber-tired wheels and motor required to carry bulky sheets, heavy towels and dirty clothes so far. Yes, such a mechanically developed physique can be the only reason for locating the washer so far from the places where most laundry originates. We know from their factories that these beings understand the rudiments


Robert C. Cleveland Photo

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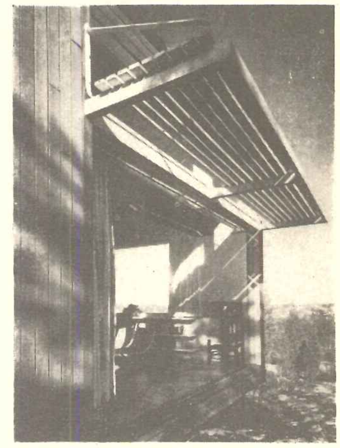
[1] *I. C. Perrot, British journalist, speaking of twenty years at the press tables of the Architectural Association and the R. I. B. A., as quoted in the October 1950* Journal *of the A. I. A.*
[2] *Frederick Gutheim, author, architectural editor and critic, in the* N. Y. Herald Tribune, *March 5, 1950.*
[3] *C.-E. A. Winslow, Chairman, Committee on the Hygiene of Housing, in the foreword to the Committee's recent publication,* Planning the Home for Occupancy.
[4] *In recent articles in the* N. Y. Times, *and in an address before the N. Y. Chapter, A. I. A.*

Lionel Freedman: Pictor



of efficient production flow." (Efficiency! Should houses be efficient?)

Viewing the streamlined kitchen counter with its built-in sink, and considering that its *bottom*, 8 in. below counter level, is the sink's working plane, the investigator would be justified in assuming the user to be fairly short, but with abnormally long arms. This assumption would be reinforced by the position and depth of the conventional base cabinet, and contradicted by the heights of counters and upper wall cabinets.

Ludicrous as these assumptions appear, they could all be made with reason. If, as so many architects believe, their profession is responsible at base for all or nearly all the improvements in equipment evident when today's house is compared to yesterday's, does not the fault lie with architects? To take one example, one hears architects stating that originally the architect demanded for the bathroom surfaces which could easily be cleaned, which would withstand moist atmosphere. American ingenuity and productive capacity have now provided him with ceramics, plastics, metals and glass in profuse variety. There is nothing wrong with these materials, nor with the ingenuity and industry which produce them. Yet in embracing them wholeheartedly architects, including many top-flight practitioners, produce what our insurance companies tell us is a prime source of injury and death — this in a home, which by implicit definition should be a safe haven.

No, it is not the material or the equipment, generally speaking, which is so much at fault; it is the manner of use in relation to the prevailing conditions. This holds even for equipment which is job-assembled or job-built, too. Every household needs storage space for cleaning materials; but why, in any modern house, must the cleaning closet, where are kept the dirtiest household impedimenta, be located in the kitchen where the food we eat is prepared? Why cannot the laundry be placed close to bedrooms and baths, perhaps with sewing and storage facilities directly at hand, to minimize this heaviest household chore?

House design is an endless series of problems in the organization of space and equipment, among other things. If we have accepted marvels of equipment without thoroughly investigating them, without thoroughly integrating them into the whole that the house should be, we have even further cramped the small spaces into which, we are reliably told, we now unwisely cramp our domestic life. We have progressed little in understanding beyond the builders of Colonial Williamsburg's houses, which were designed by builders, not by architects.

One can carry this identical argument into other facets of house design. Take the matter of style, with which the opening quotation is concerned.

George Stille Photo

The architect indolent enough to produce an unthought-out version of "Colonial" and label it a house is guilty not only because modern equipment, materials and techniques seldom do more than cramp his style; it is much more important that the routine of domestic life has changed, and his architectural solution hampers that. We do live outdoors much of the time. And with an appreciation of nature, the desire for verdure and blossom all year leads naturally to inclusion of space for growing plants within our houses. We do have automobiles, and the garage entrance of the house on the suburban fringe is fast supplanting the old-fashioned front door as an entrance. We have fewer servants, and the housewife does more — or all — of her own work. Our guests penetrate our kitchens to help mix cocktails.

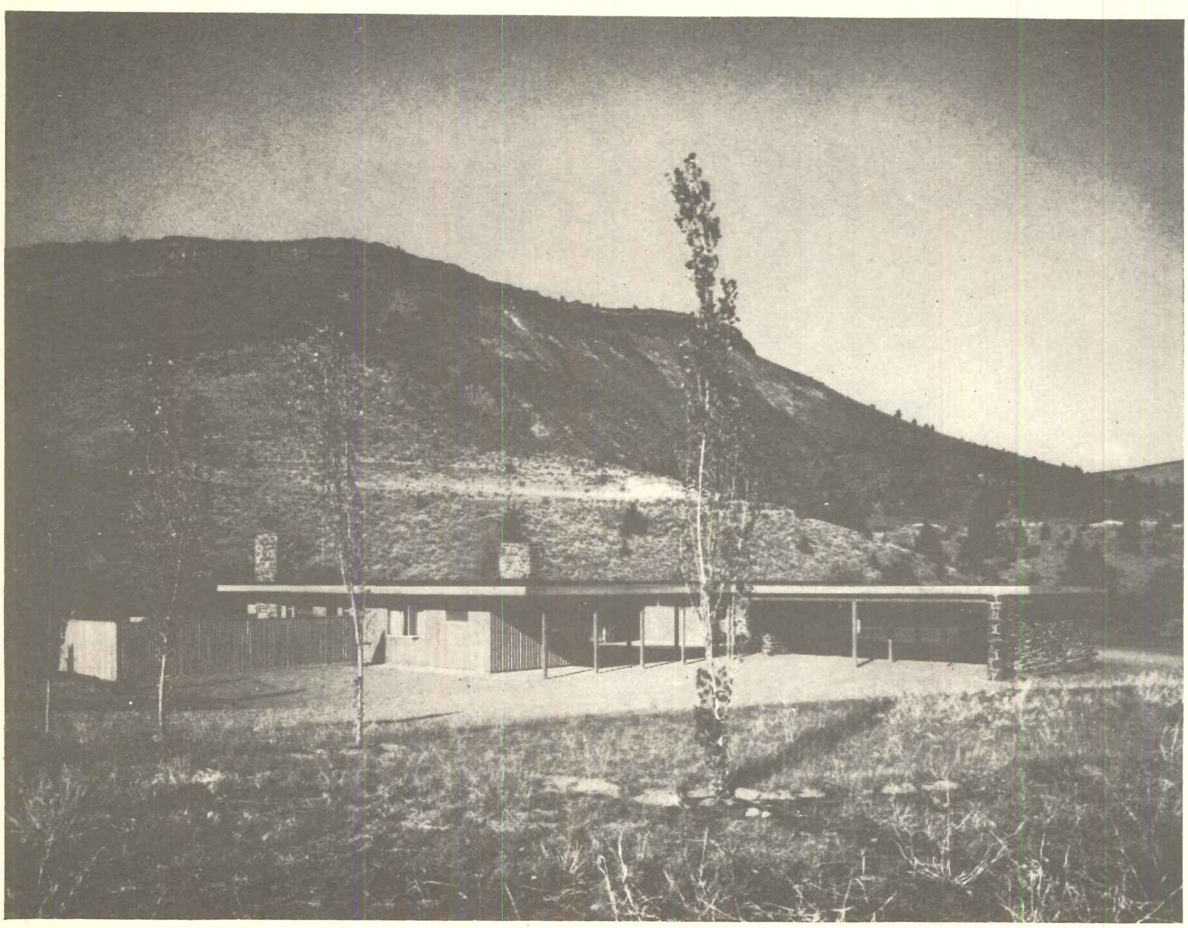
Not that there isn't a place for the honest antiquarian; our true architectural past sadly needs preservation. It is the insincere copy which trades upon the snob appeal of romantically secure past glory that bothers. Also a bother, and equally snobbish when you come to think about it, is grotesque, slavish imitation of a Mondrian or a Picasso in architecture. The architect of a house need not strain to ape the cubist, for he was a cubist long before the painter appropriated his idiom. What is a room, a bookcase or a building but a series of problems in three-dimensional geometry?

— *Frank G. Lopez*

VACATION HOUSE IN OREGON

FOR MR. AND MRS. ROBERT WILSON, WARM SPRINGS, OREGON

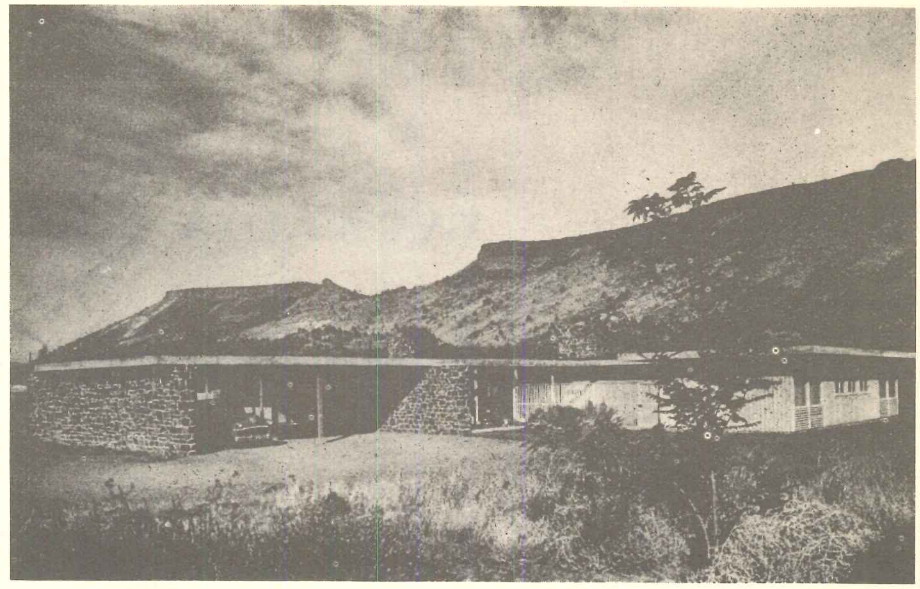
Pietro Belluschi, Architect

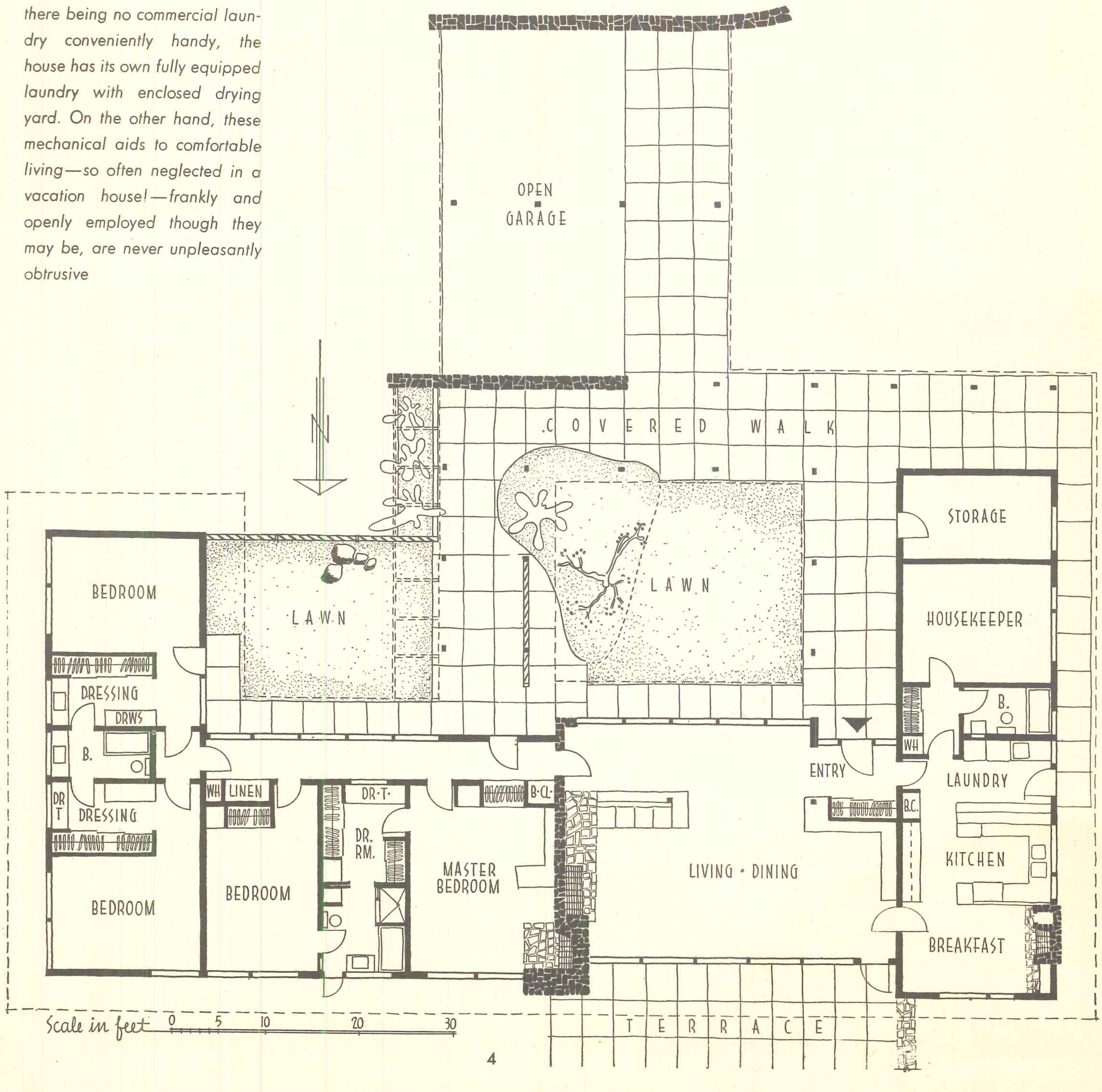


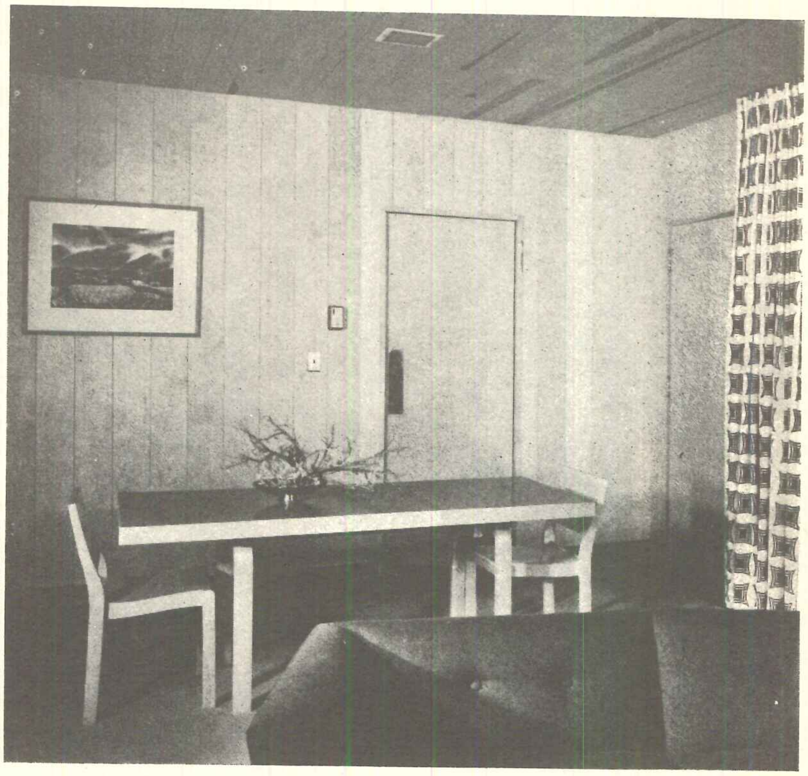
Dearborn-Massar

Situated in excellent hunting, fishing and riding country, on the bank of the Deschutes River, this house is designed for comfortable summer occupancy, for entertaining guests, and for use by the owners a few days each week throughout the year. The family's children come often to ride; there is a separate wing for the owner's parents to use when they wish; overnight guests are frequent

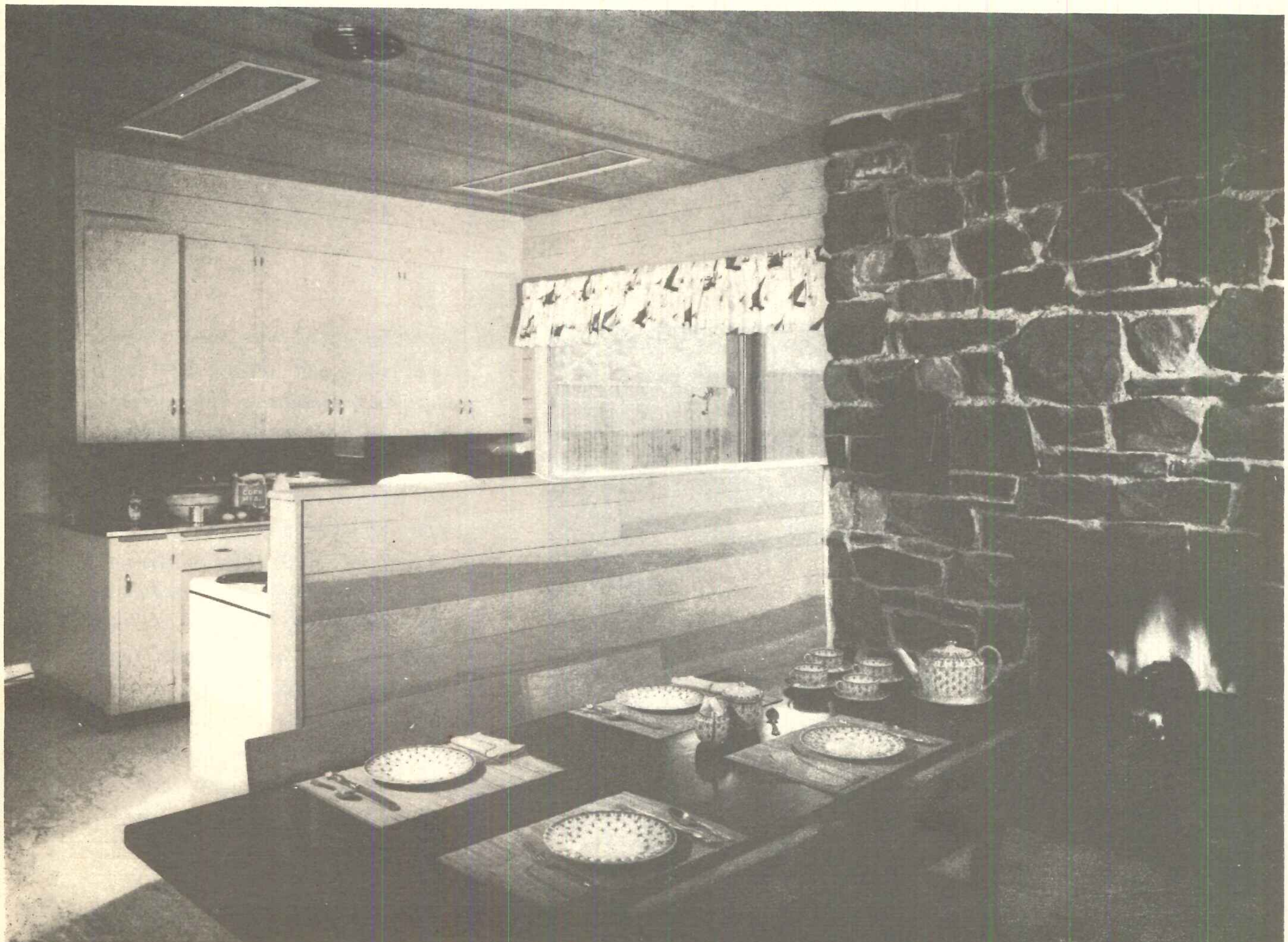
Since there are usually many people around to enjoy the house, living room, dining space and kitchen are ample in size. The house is decidedly informal, but its informality has not been allowed to mean a rugged lack of comfort. Whatever is needed in the way of amenities is frankly included; for instance, there being no commercial laundry conveniently handy, the house has its own fully equipped laundry with enclosed drying yard. On the other hand, these mechanical aids to comfortable living—so often neglected in a vacation house!—frankly and openly employed though they may be, are never unpleasantly obtrusive

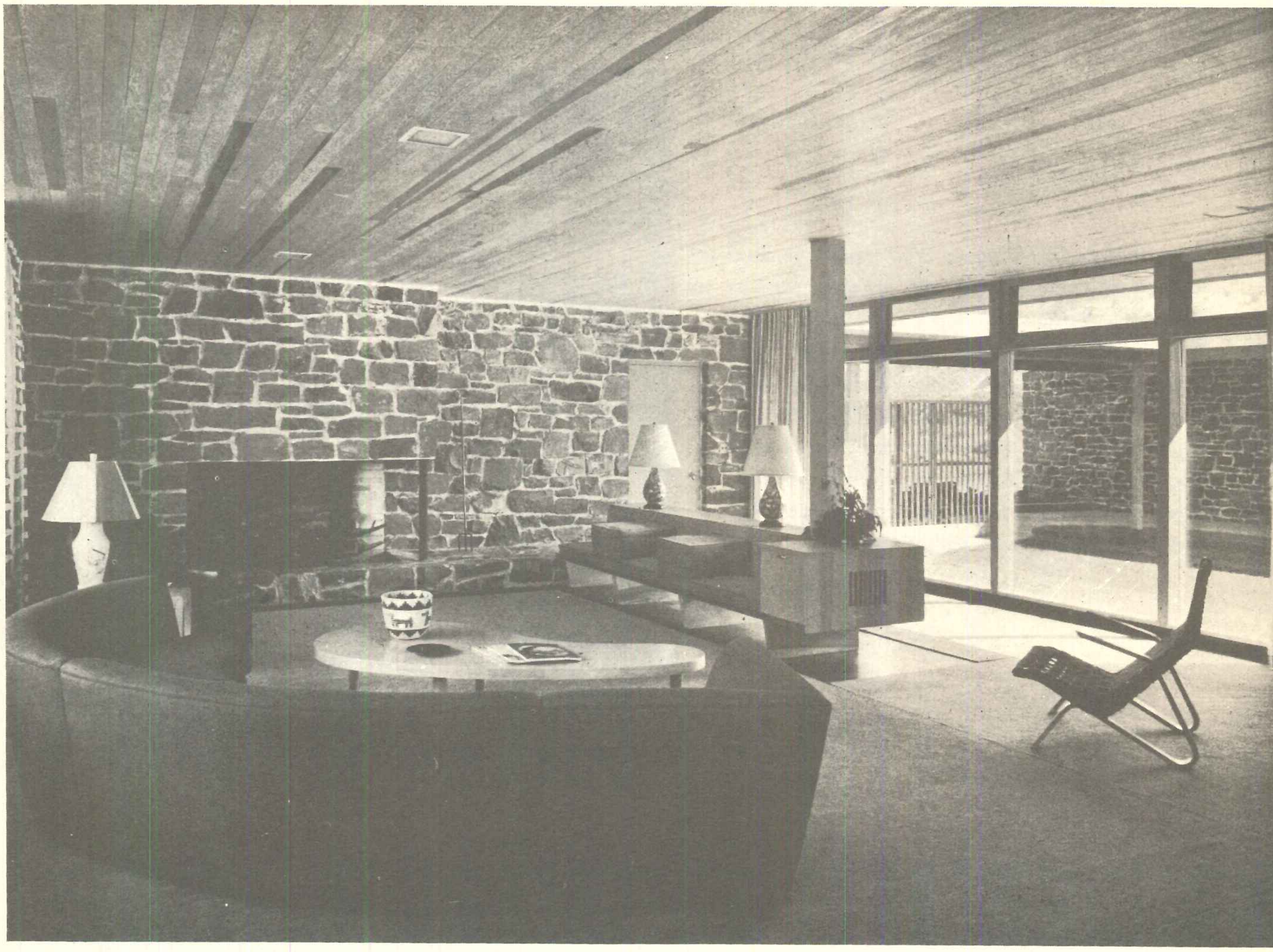


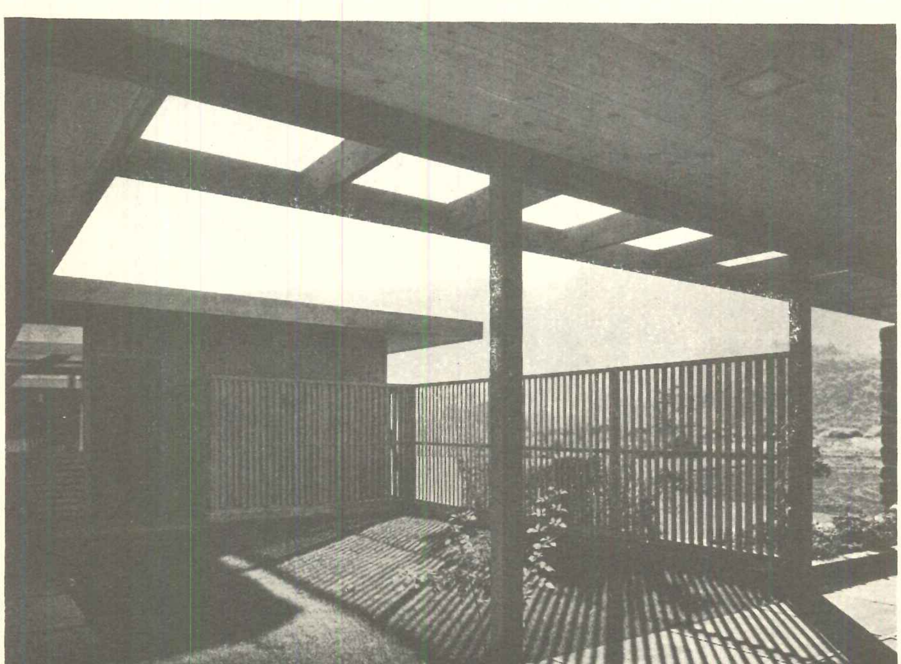




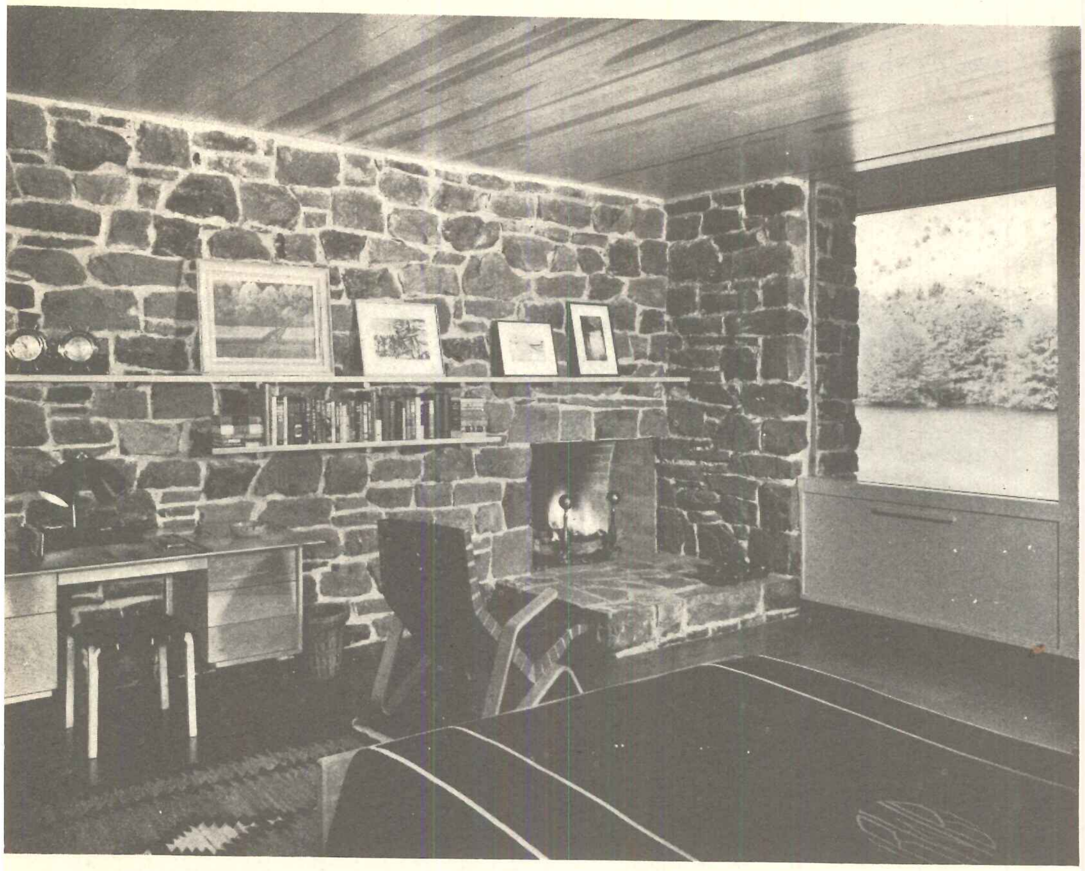
From the more formal dining area (right) one door leads to the breakfast room and kitchen, another to the outdoor terrace where meals may also be eaten The breakfast room-kitchen-laundry (below and facing page) are frankly combined, definitely utilitarian and unashamedly pleasant. These are no sanitary engineered work-areas; the cheerful fireplace wall, the wood cupboards and the rose-pink plastic which covers work-counter tops make this part of the house gay as well as useful

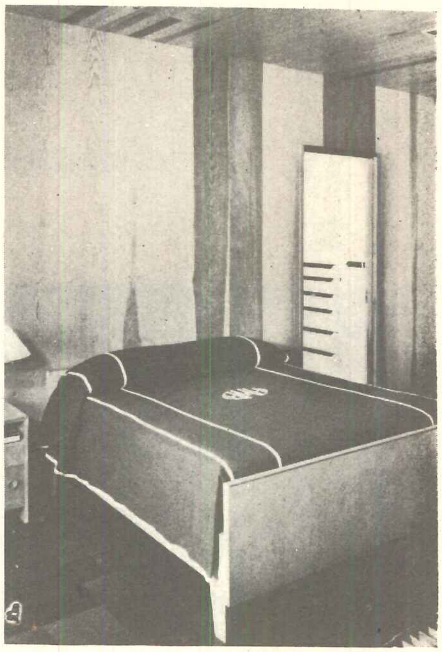






On facing page: three views of the central court; left, private court adjoining the grandparents room; above, living room. Local materials are extensively used: black and gray volcanic stone masonry and rough-sawed pine boards and battens stained a warm gray form the walls. Natural though these may be, there is no self-conscious striving for rusticity but rather a true naturalness. The curved sofa and leather fireside chair are green; the built-in sofa's cushions are coral; the coffee table is natural wood; and the natural cork surfaced concrete floor is radiantly heated by means of electric cable buried in it





There you have the Wilsons' vacation house, built on the banks of the Deschutes River near Warm Springs in Oregon. It belongs in its wide-open setting. Yet curiously there is no insistent effort in its design to blend it into the landscape — none, at any rate, which forces itself upon the occupants. One cannot say of it that a pitched or hipped or gabled roof might have made its outline ape the profiles of the surrounding hills. Such a comment would verge on the silly, and so would any nonsense about its flat roof providing a welcome, relieving contrast to its rugged surroundings.

Neither is it a simple, unsophisticated cottage, nor does it possess any characteristics remotely cute. It is natural, as a place for relaxation should be natural; and how artfully has this human naturalness been achieved! It has its full share of glass walls and ventilating louvers, of contrastingly heavy piles of rough masonry and of unassuming wood, but not once is the contrast permitted to become a shock to the nervous system or does the common contemporary device become a cliche. The bedroom illustrated above is a comfortable bedroom, in which fragile glass butting into solid masonry takes its relative place just as satisfactorily as the plentiful built-ins and storage space do.

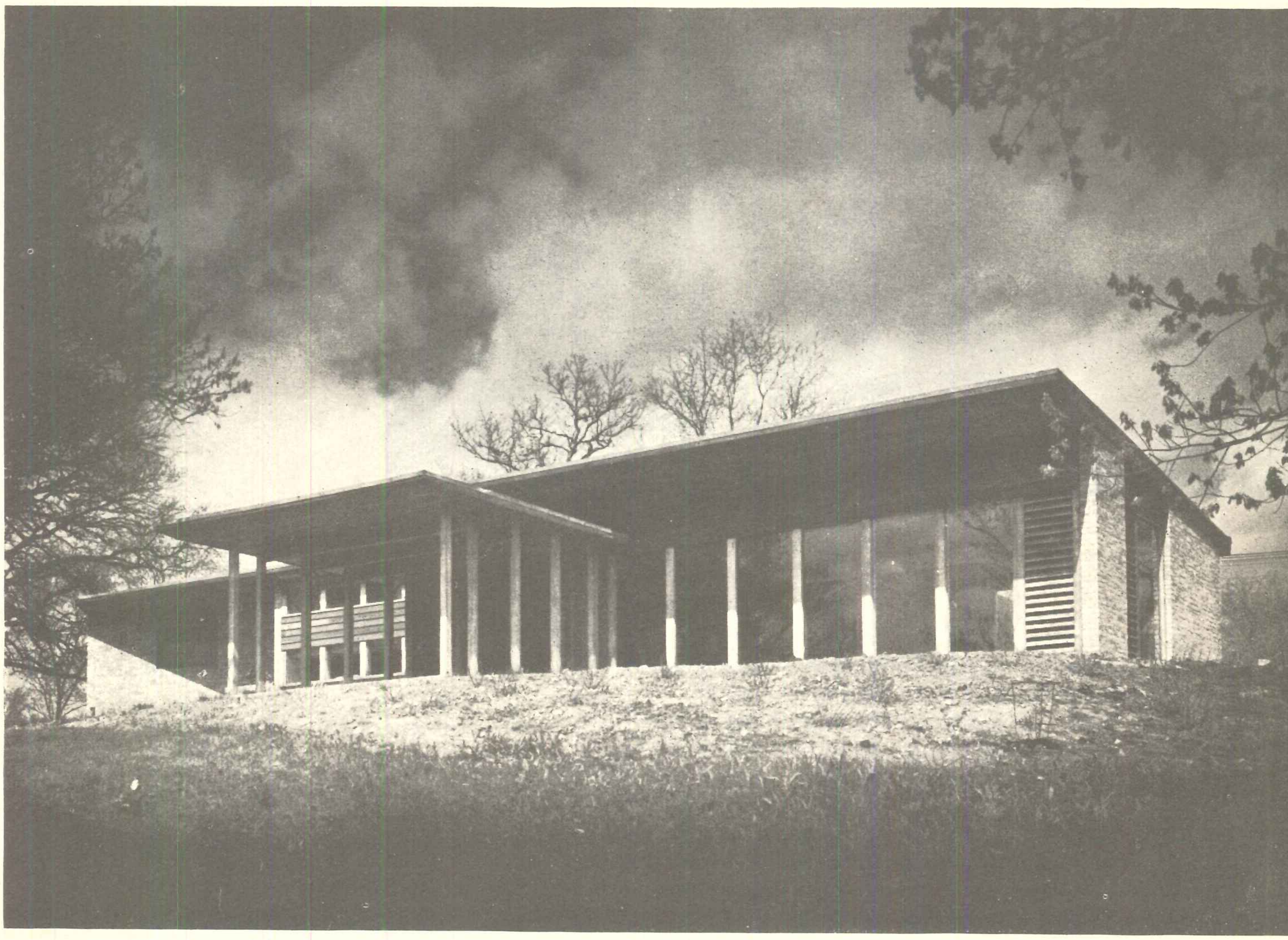
One more comment: to offset the possibility that the wide-open countryside might overawe the occupants, all the living areas focus inward on the series of courts.

Solidly built, with excellent craftsmanship, the house has a more or less conventional wood frame supporting a flat roof with built-up surface. Foundations and floor are concrete; in the slab are buried the electric radiant heating cables. Except for a few casements all glass is fixed, double-pane to provide insulating value. Rooms are ventilated by wood louvers with interior hinged panels. Interior walls and ceilings are pine boards; floors are covered with cork. The roof has 2 in. mineral wool insulation; the floor slab, vermiculite insulation. Sheet metal work is galvanized iron. All wood sills are treated to prevent decay. Kitchen and laundry are fully equipped with garbage disposer built into the kitchen sink, electric range, dishwasher, refrigerator, home freezer, automatic clothes washer, electric dryer, exhaust fan, incinerator built into breakfast room chimney, wood cabinets and laundry hampers, plastic counter tops. Domestic hot water is supplied by two electric heaters

RESIDENCE FOR MR. AND MRS.

HIGHLAND PARK, ILLINOIS

L. Morgan Yost, Architect



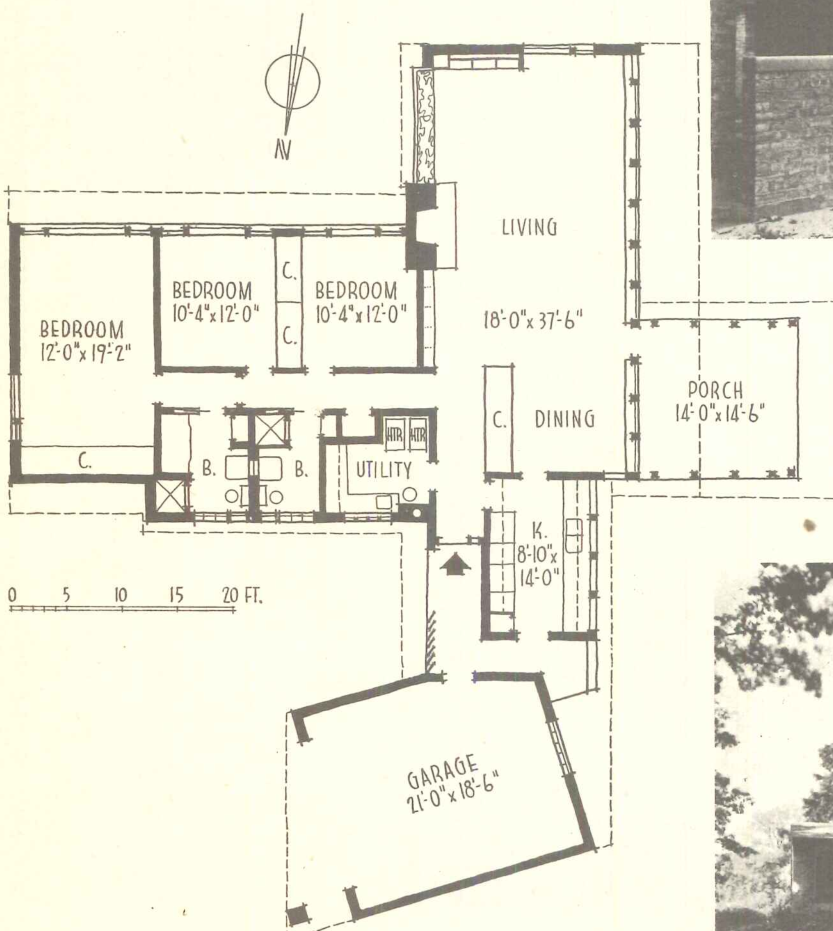
Nowell Ward

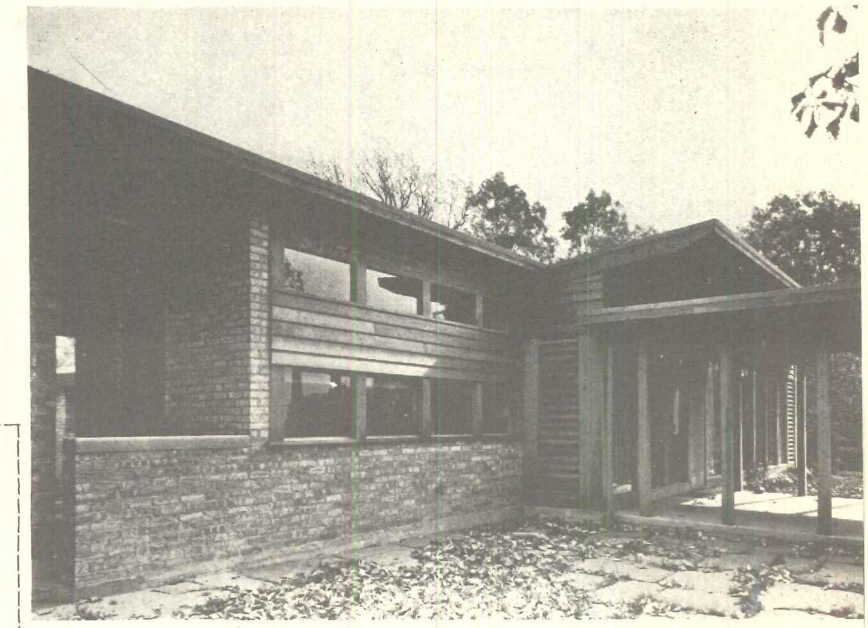
SITUATED on a bluff overlooking the broad Skokie Valley, this house obviously was designed to take full advantage of the view. Its plan, however, indicates that the view alone was not the major consideration. The owners — a couple with a grown son — stipulated that the bedrooms must face a small secluded glen to the south; they also required ample gardening areas around the house, and they insisted that the house be easy to maintain without servants.

The result was a T-shaped plan with living room, dining room and kitchen opened up to the valley view and accented by a projecting porch. The three bedrooms, two baths, and utility room form a separate wing at right angles to the main wing, with all bedrooms facing south toward the glen as required. Prevailing winds plus differences in orientation made two heating systems — one for each wing — imperative, but a centrally located utility room accommodates both heaters.

Construction is brick masonry on concrete trench foundations and a slab floor. Walls are a pink buff, wood is natural cedar. The roof is built up with a light tan gravel topping. Interior walls are generally plastered, floors are oak parquet. Windows are fixed glass with ventilation louvers.

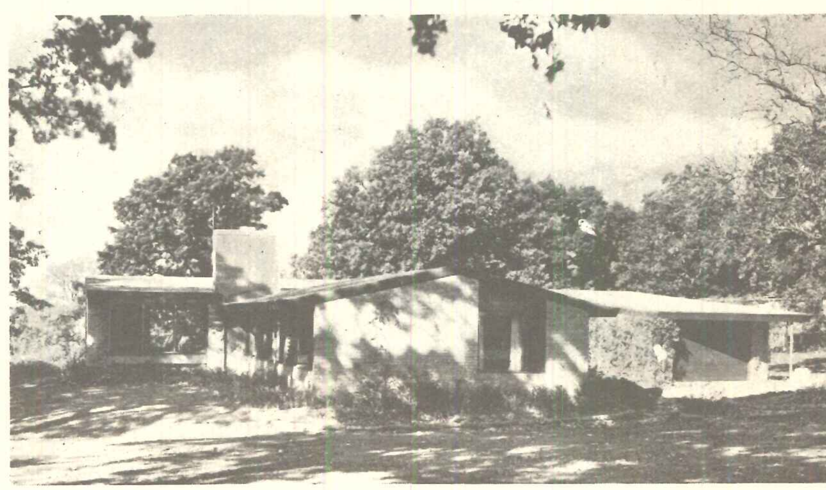
NORMAN C. DENO



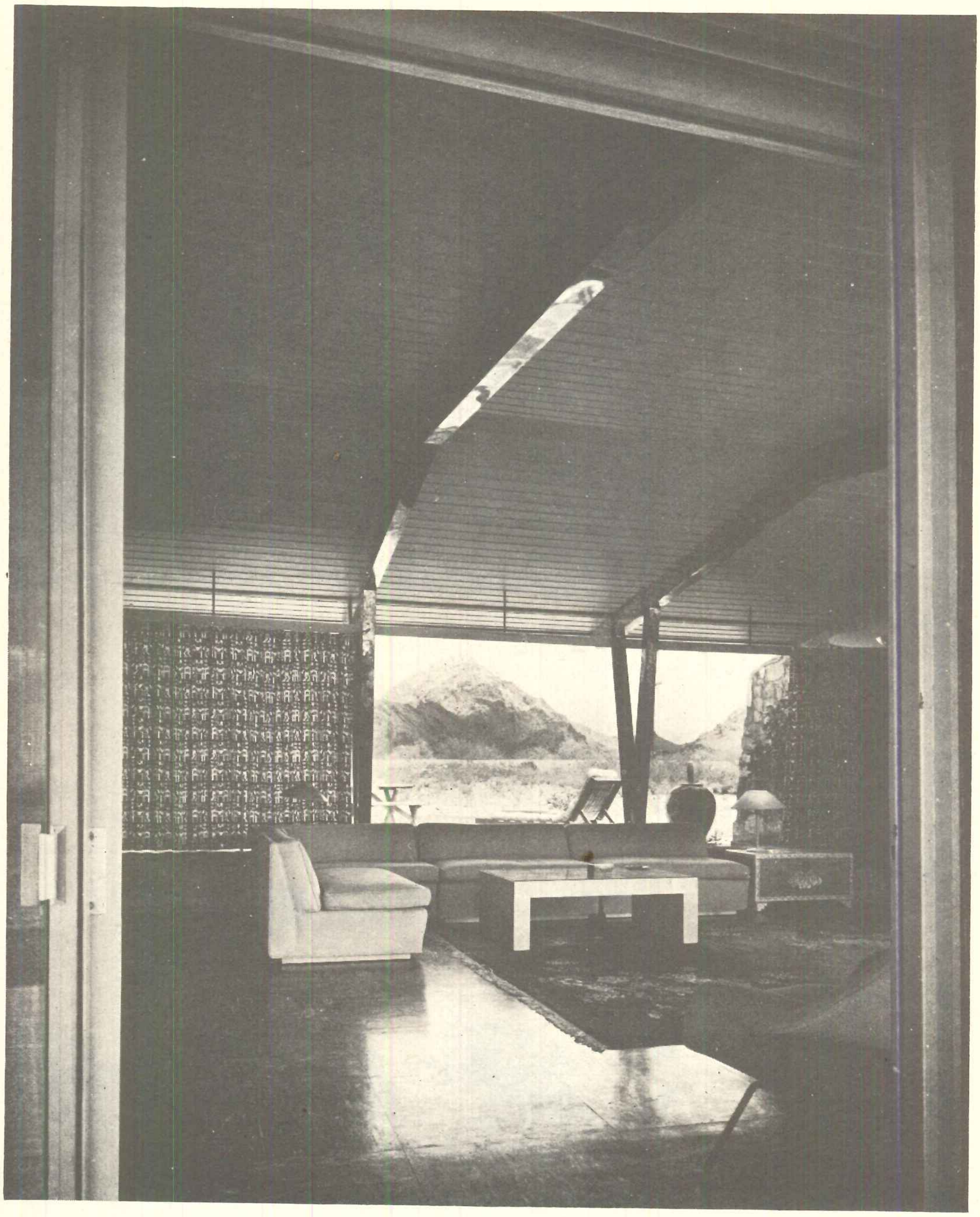


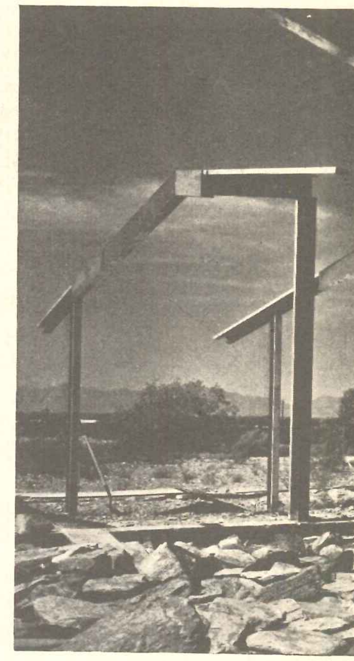
Nowell Ward

John Replinger



Top, right: the kitchen is strategically located, combining view with direct access to both front door and garage. Garage is angled (two views, right) to provide a small entrance court. Opposite: living room faces west, overlooking the valley





Stuart A. Weiner Photos

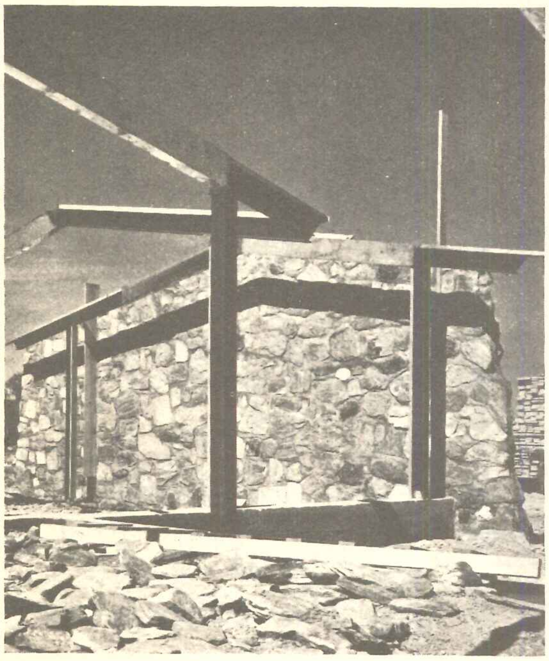
ARIZONA ARCHITECT DESIGNS

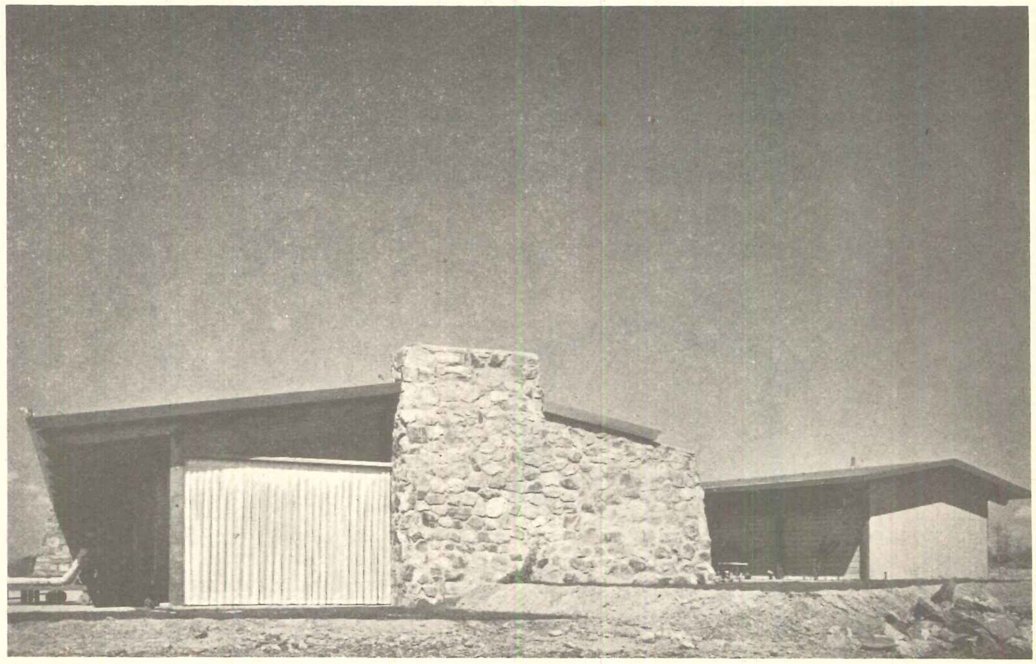
Residence of Mr. and Mrs. Edward L. Varney

Phoenix, Arizona

Edward L. Varney Associates

Architects and Engineers



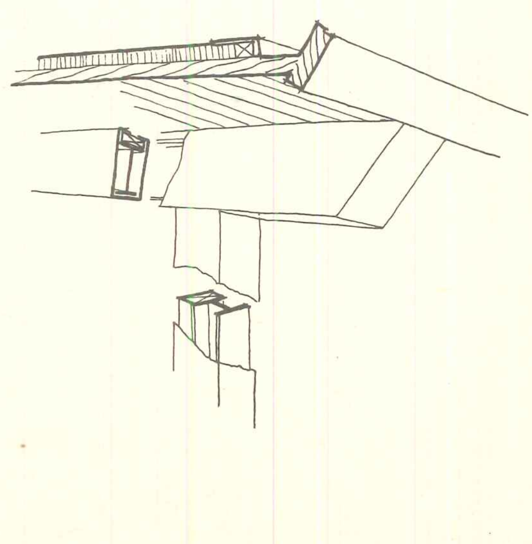


When this house was under construction a year ago, the architect-owner described it as an experiment in the application of light-steel welded rigid frames to residential use. "While this job is not strictly speaking a low-cost house," he said, "I have hopes of developing from it a structure suitable for low-cost mass housing. We have been using this type of structural system for several years in school buildings here in Arizona with some amazing cost results." (Steel was then available.)

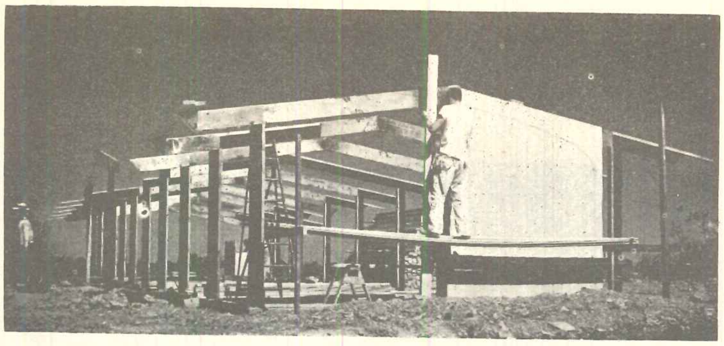
Despite the fact that the house was built in the last quarter of 1950, when building costs in Arizona, as elsewhere, were zooming upward, the per square foot cost turned out to be only $10.18, excluding refrigerated air conditioning, but including $1.00 per sq ft for open terraces — considerably under the average for a house of comparable quality.

The house occupies a 2½-acre desert site just outside Phoenix, high enough to overlook the city to the south, and low enough for dramatic views of the mountains to northeast and east. Planned for a family of five (including two boys and a girl, at present all under ten), the house provides three separate outdoor living areas. One, to the east between living room and children's wing, is designed for sheltered dining and recreation in winter, when the prevailing wind is from the southwest. The second, to the south of the living room, is planned for enjoyment of the cool summer breezes. And the third, to the north, is the children's play area, visible only from their own rooms and (for supervision) the kitchen and maid's room. Every room in the house overlooks either mountains or city. Floor to ceiling glass areas are extensive throughout the house, but all are shielded from direct sunlight after 8:30 A.M. during the hot summer months.

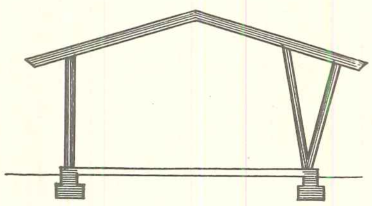
HIS OWN HOME

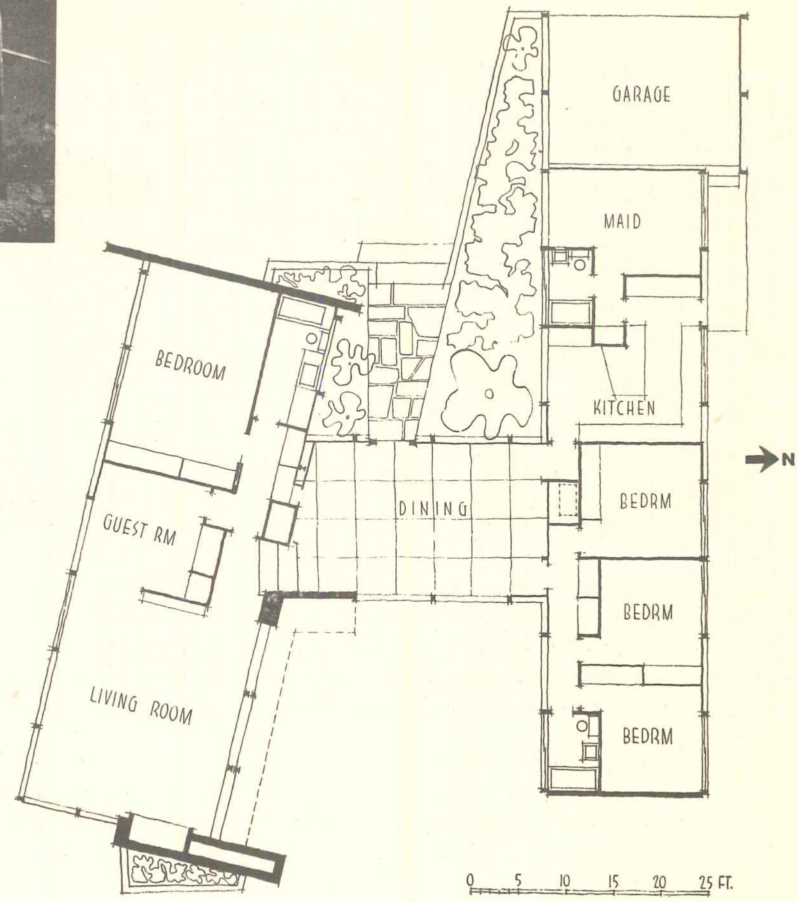


Foundations are poured concrete; floors are concrete on grade. Framing is steel, sheathed with 14-oz copper exposed on interior and exterior. Walls are 2- by 6-in. T & G hemlock, run horizontally and insulated with 2-in. glass fiber. Roof is 2 by 6 T & G, slate surfaced and coated with copper

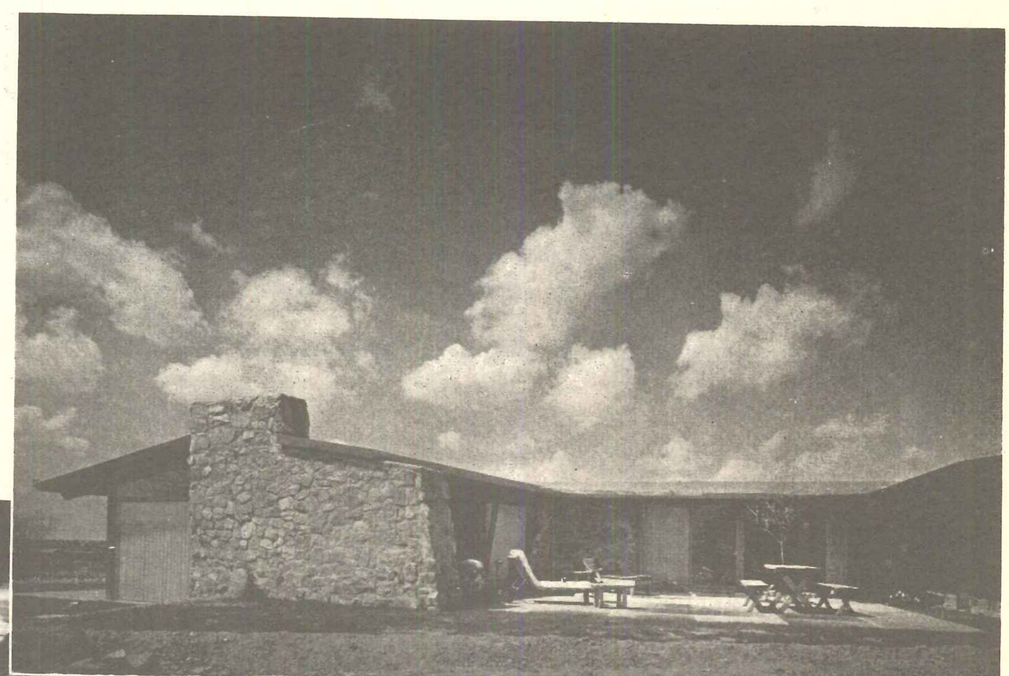


Stuart A. Weiner Photos



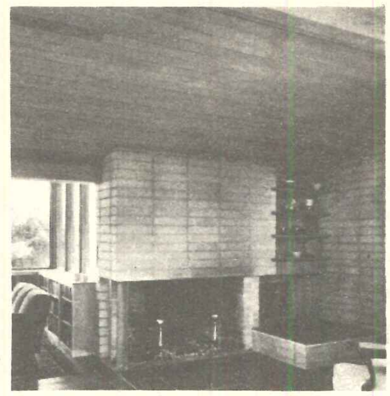


Method of construction is based on strength of welded-steel frame which eliminates necessity of cross-bracing. Diagonal strengthening at north side of south wing permits esthetically pleasing variation at reasonable cost. Above: section through south wing. Right: dining and recreation terrace between wings. Below: the dining room; kitchen door left background



Lionel Freeman: Pictor

Pirkle Jones Photo

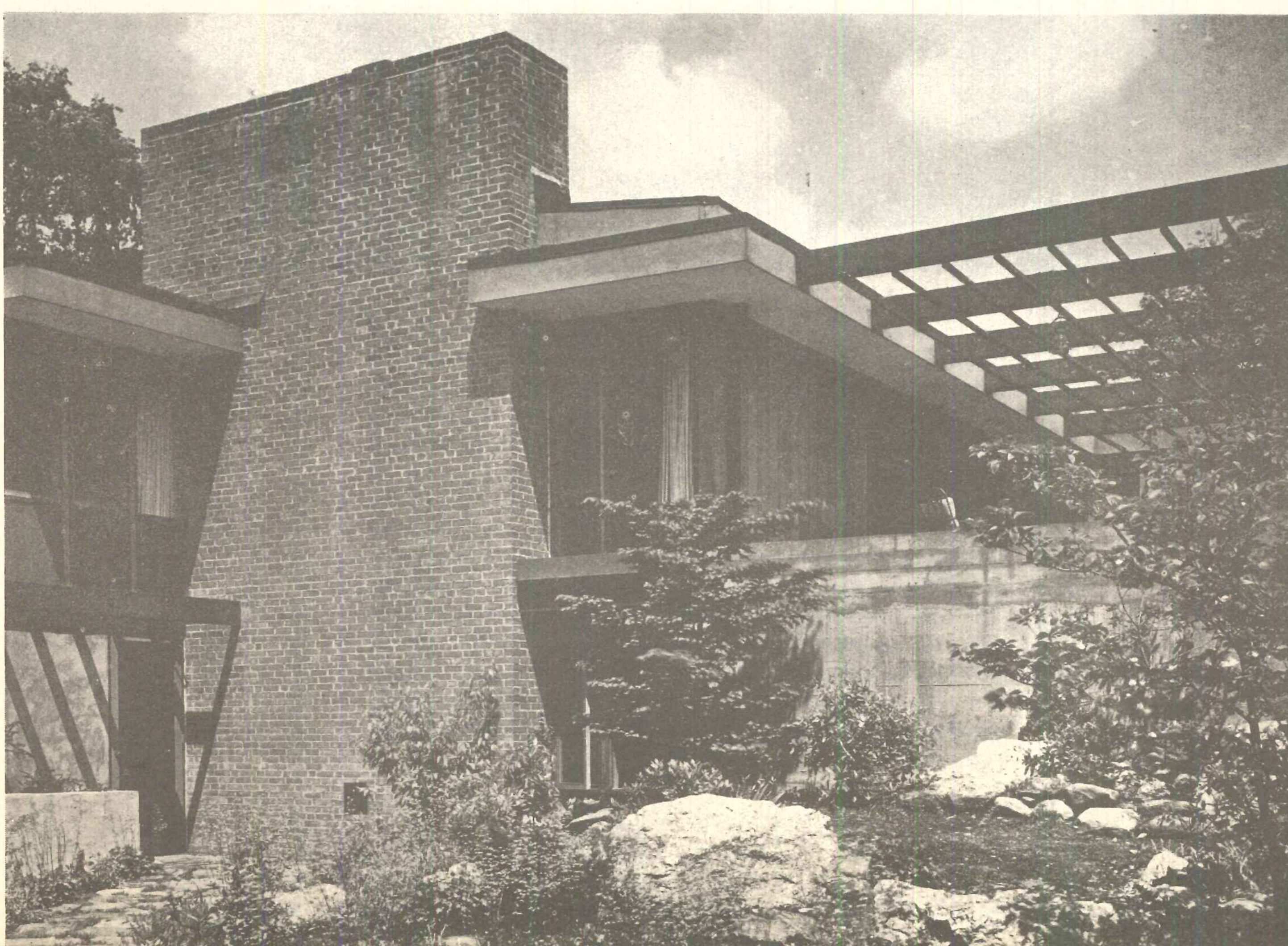


Facing page, eyebrow to keep high sun off a glass wall which both admits a fine view and provides a hazard for junior on his tricycle, far left, two-compartment bath; center, kitchen and dining space separated only by a cabinet (all three by The Architects Collaborative). Right, modern version of the hob seat plus masonry with scarcely visible support (V. K. Thompson, Designer)

HOUSE IN ANDOVER, MASSACHUSETTS

Bernard Kessler, Architect

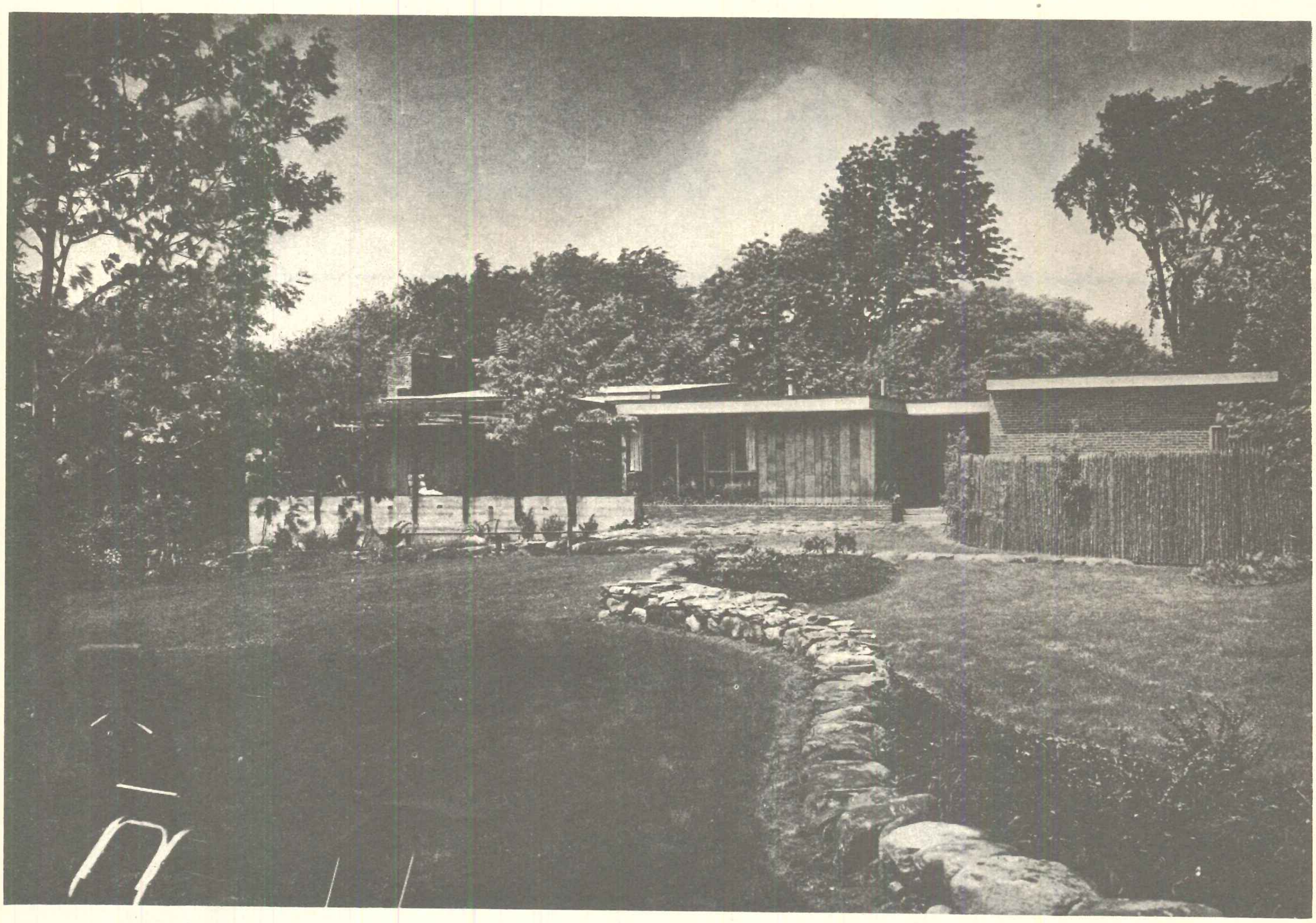
Joseph Molitor Photo



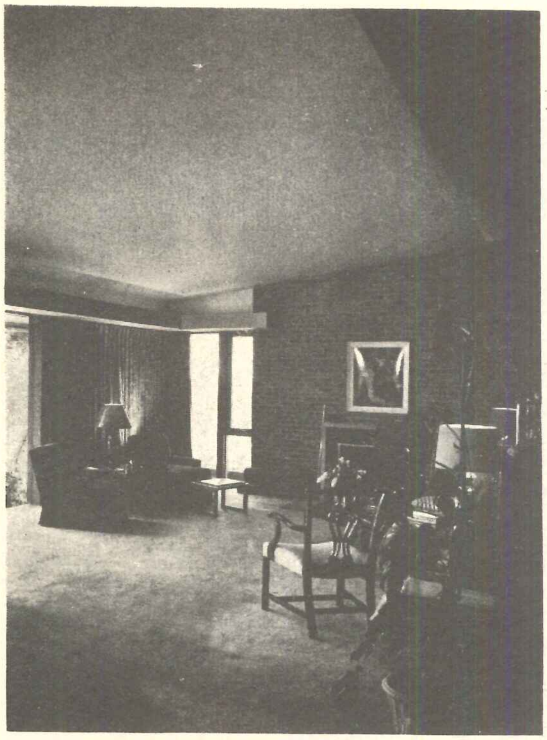
HOUSE IN ANDOVER, MASS.

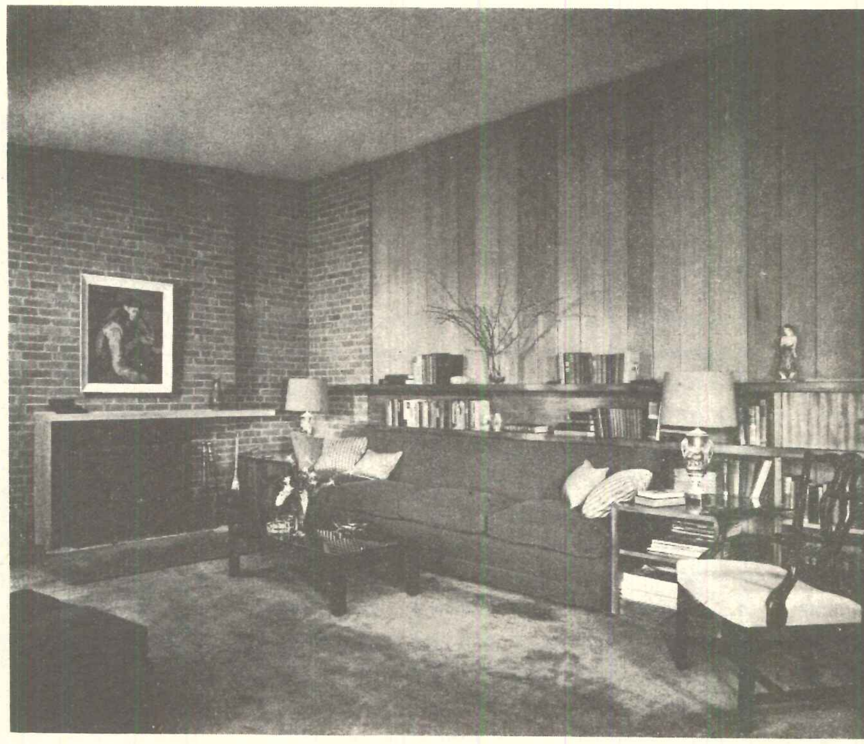
The owners, a couple in middle years, live alone and entertain informally and in small groups composed principally of their children. They insisted on having their bedrooms off the ground; hence the placement of the house on the sloping

Joseph Molitor Photos



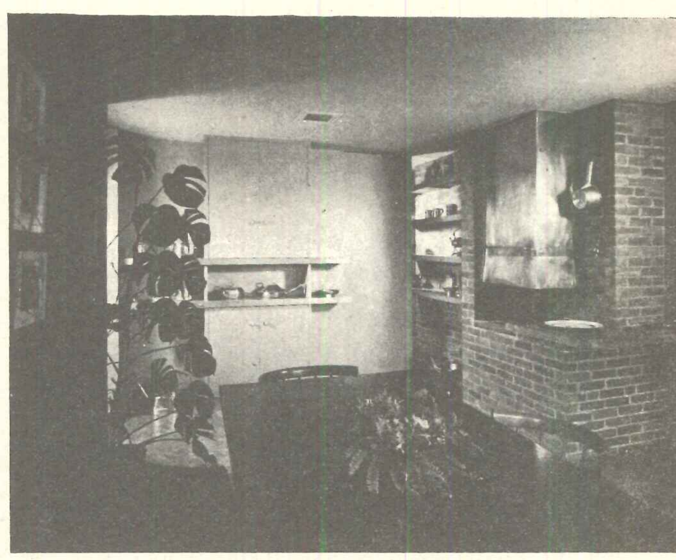
site, with bedrooms five to eight feet above grade. The isolated bedroom with its own interior bath (artificially ventilated) is used for a servant or for guest quarters. The kitchen-dining area, quite unusual and yet extremely sensible for this informal household, is designed to permit husband and wife to share in preparing and serving family meals; both are good cooks. At the same time, a partial wall screens as much as possible of the work area, with its stacked pots, pans, dishes, etc. The ease with which after-meal mess can be closed off from the remainder of the house, and the simplicity with which such a compact space can be cleaned up, should be apparent. The same logic has been applied to the entire house, together with a not inconsiderable talent for assembling the required elements pleasantly. In harmony with its natural setting and thoroughly contemporary, this is a house in which it should be fun, not work, to live.





Despite the numerous refinements in this house, it is in spirit far from the modern showcase which so intrigues many architects. Rather, appropriate contemporary ideas and equipment have been adapted and blended in a way which neither denies that the oc-

Joseph Molitor Photos

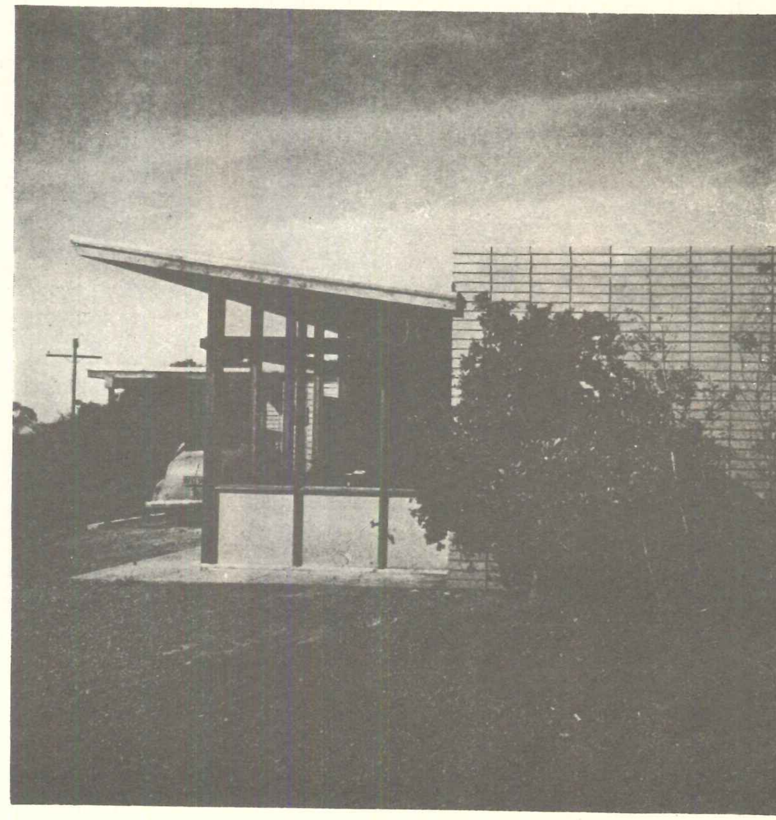


cupants have roots, nor over-emphasizes them. The house, though it is no cottage, has domestic, human scale brought into sharp focus at the indoor barbecue (above) where the master can broil meat while his wife, with cooking muss out of sight around a corner, prepares the rest of the meal. That the house has also a friendly dignity is a compliment to both the owners and the architect

HOUSE FOR DR. MARY G. HAMILTON,

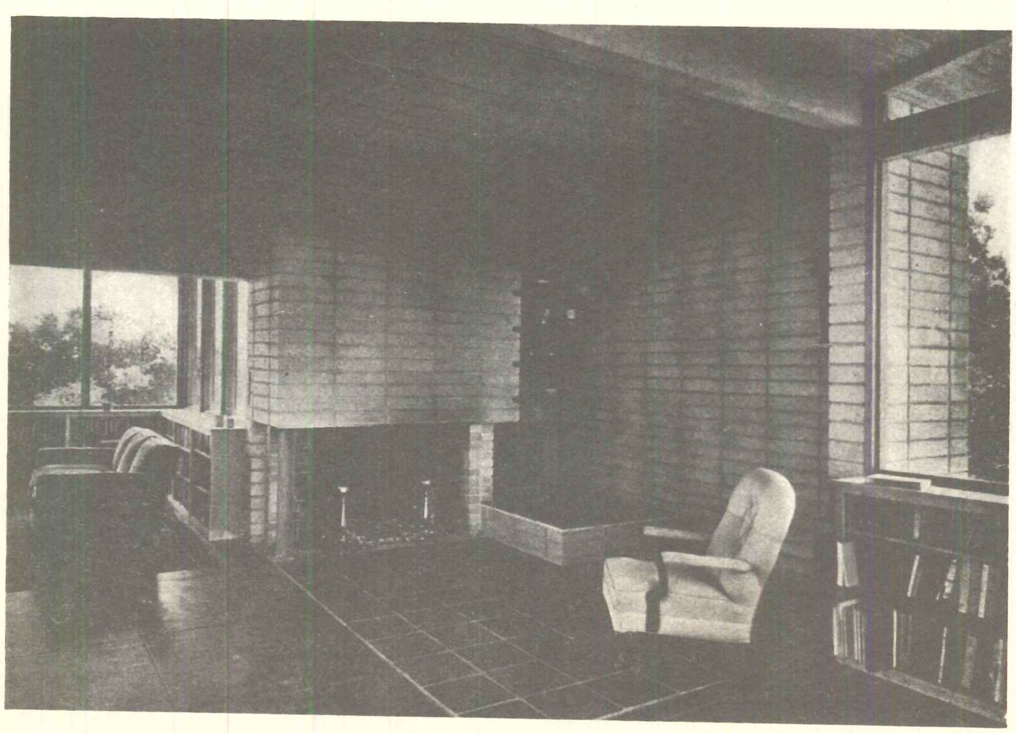
Victor King Thompson

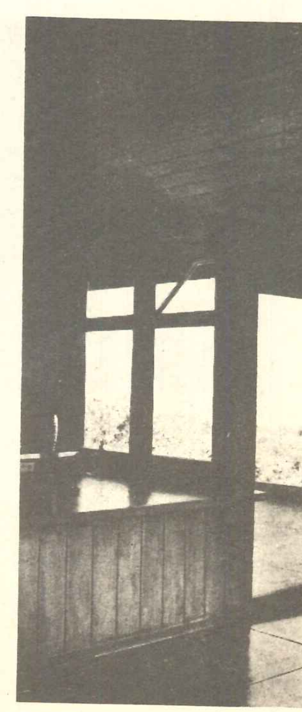
Designer



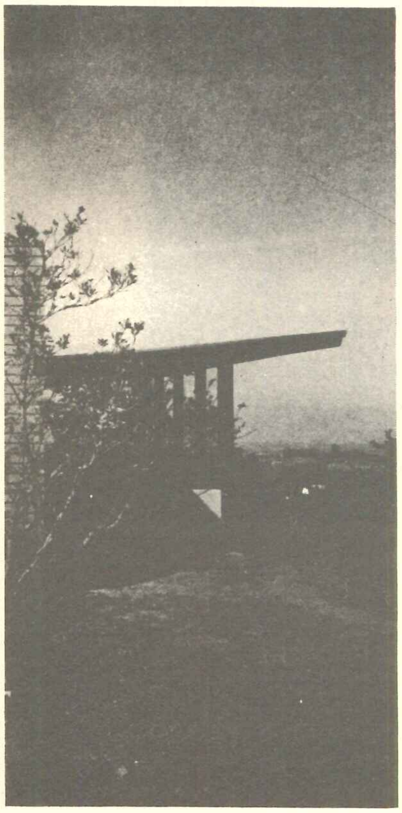
THE owner, a college professor and single, had some definite requirements. She wished to house a small collection of Oriental painting and ceramics and a large library, to do a limited amount of craft work at home, and to retain the original character of the site, which is dotted with large toyon bushes and a few small oaks in clumps. The house was planned to fit between the clumps — none were destroyed — and grading was held to the absolute minimum. Inside, the house was freely organized; all the convenience of the usual room divisions was maintained, but there is not the conventional segregation of spaces. The designer exploited the program fully, adopting the butterfly roof which, less appropriately used, becomes an unassimilated cliche; here its justification is the view, which a flat or gabled roof would have cut off. The house has radiant heating in the floor slab, and has masonry wall areas of buff-colored concrete block, unpainted, between which are modular wood-framed walls.

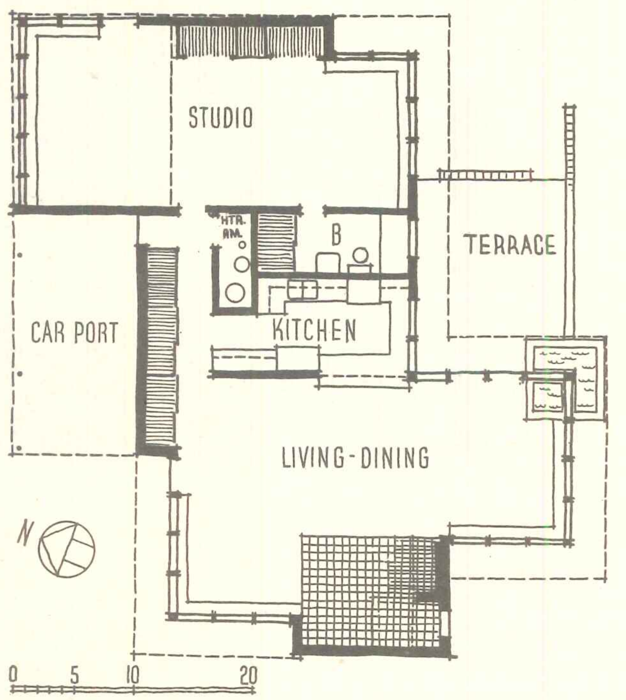
Pirkle Jones Photos

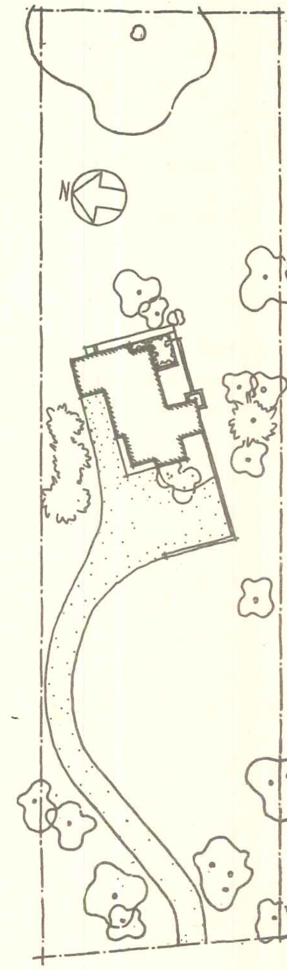




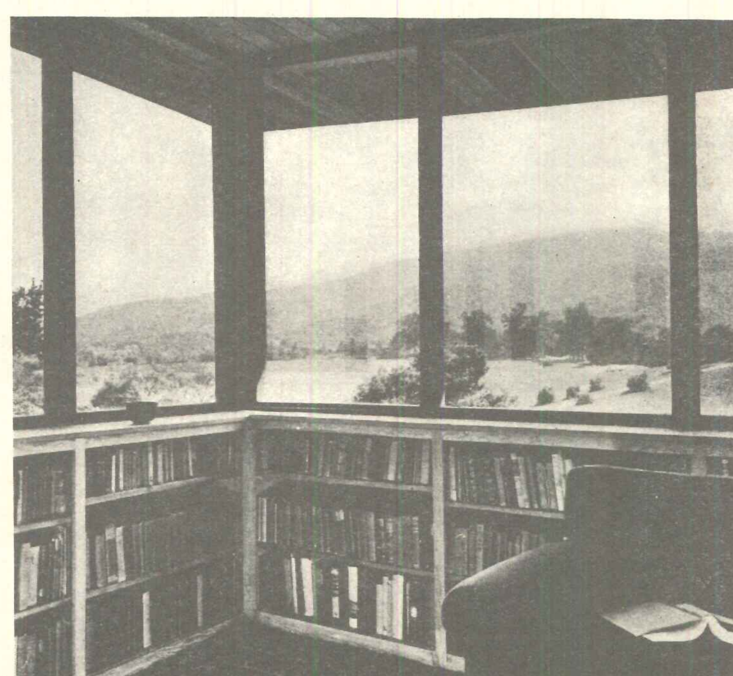
SARATOGA, CALIF.

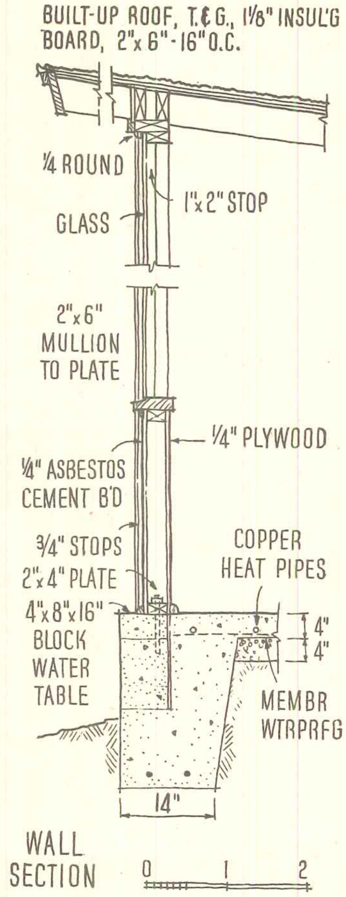


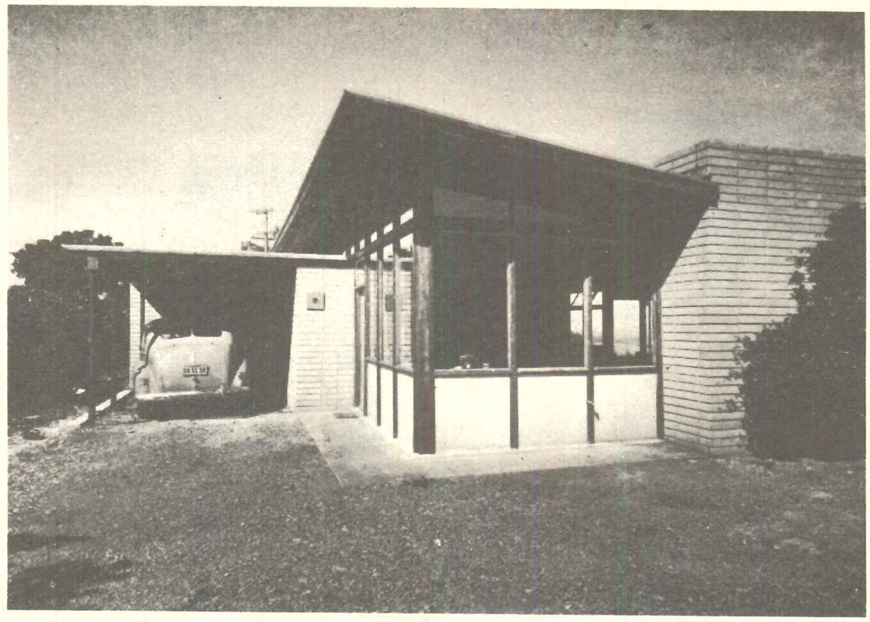




Site, more than two acres on a knoll in the Saratoga foothills, offered excellent views in nearly all directions; hence the glazed walls. Shelves beneath nearly all windows provide for the owner's 2000 books. Terrace pool to attract birds; openings in footings permit water and fish to circulate between indoor and outdoor pools. The solid-walled area surrounding the hearth provides a retreat from the overpowering view



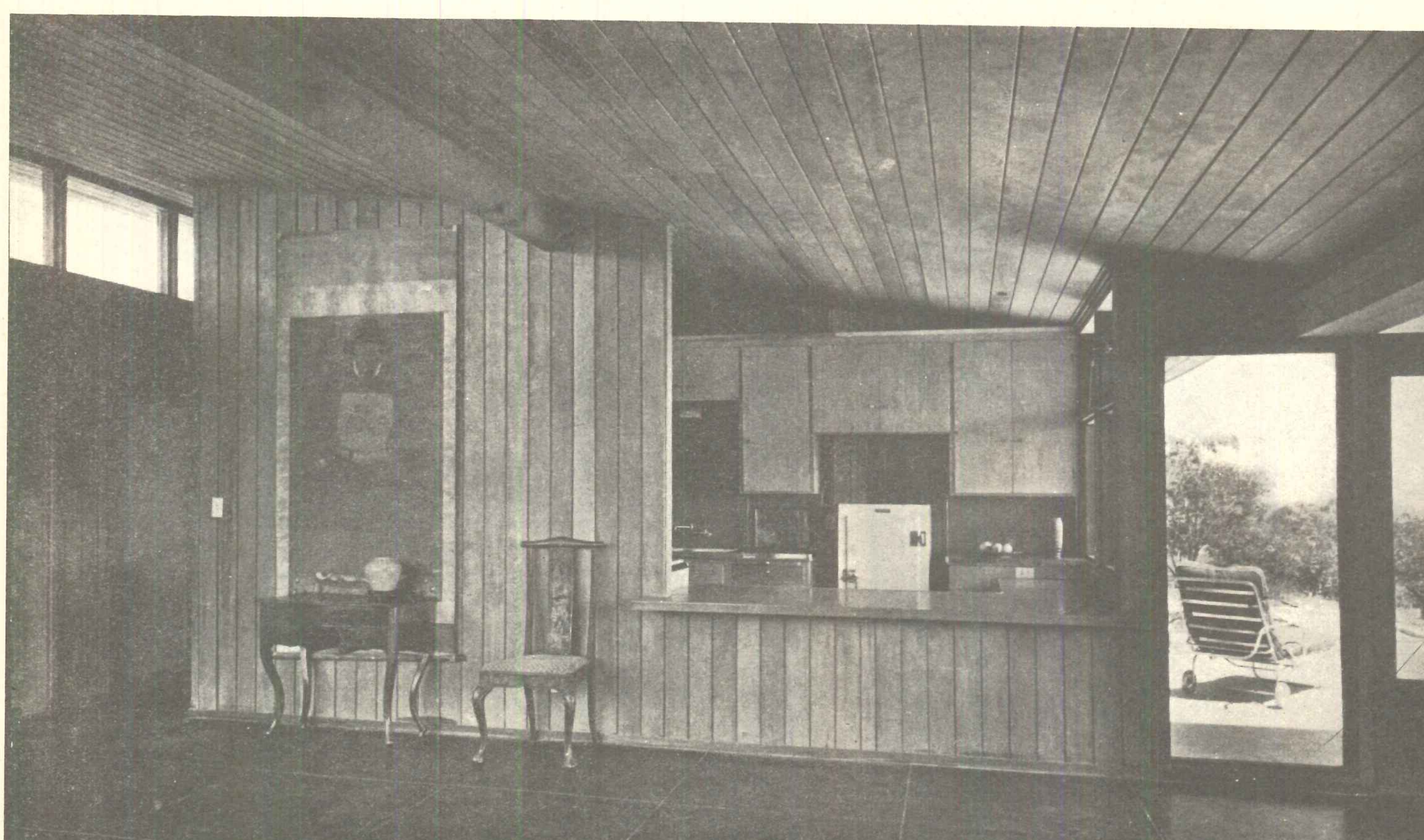




HOUSE IN SARATOGA, CALIF.

Construction module is 3 ft 4 in. in both directions, to fit concrete block and provide 2 by 6 in. redwood mullions in frame walls at intervals close enough to avoid heavy lintels. Eating bar (below) separates kitchen from living space, can be closed off completely by rolling bamboo shade

Pirkle Jones Photos

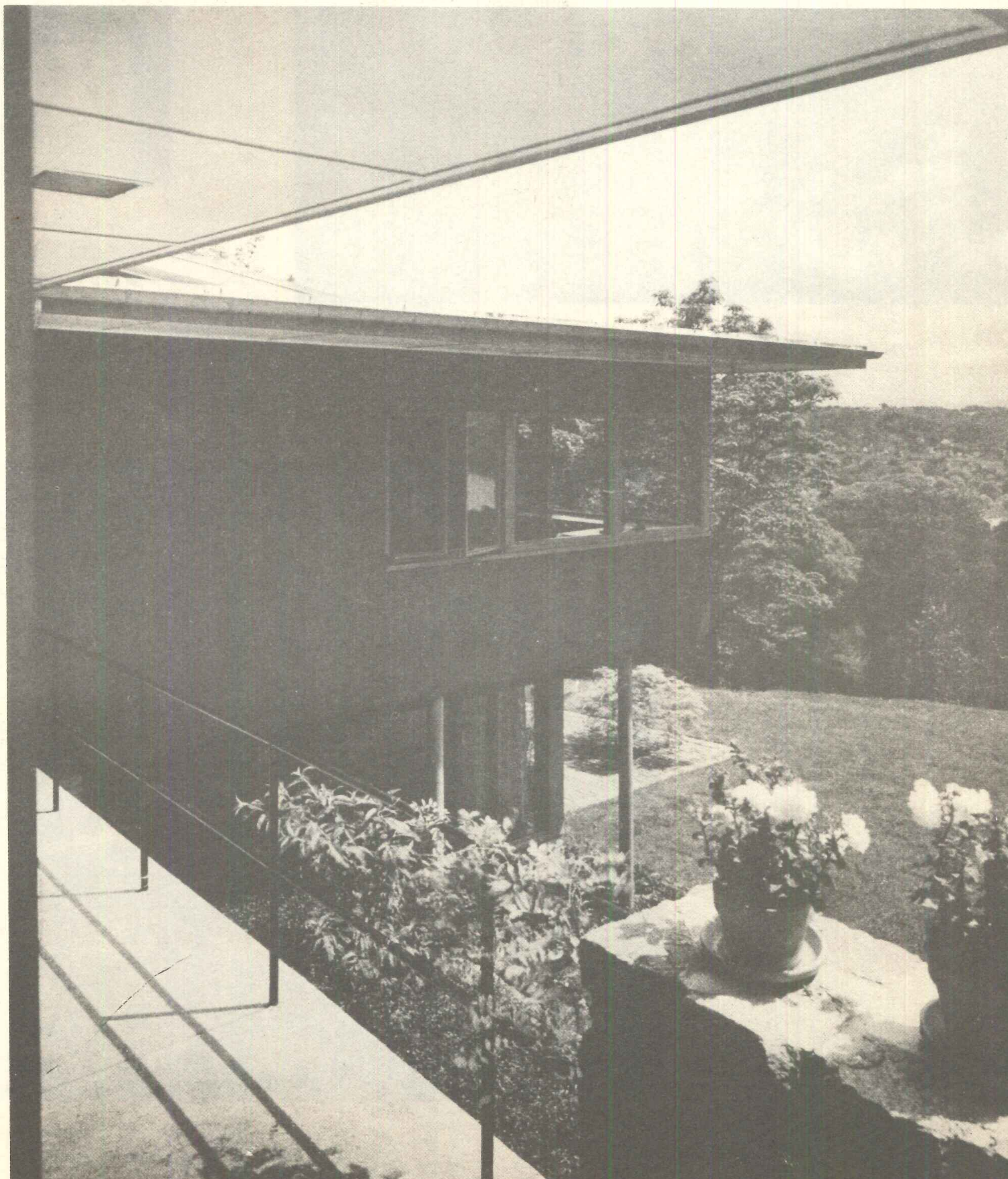


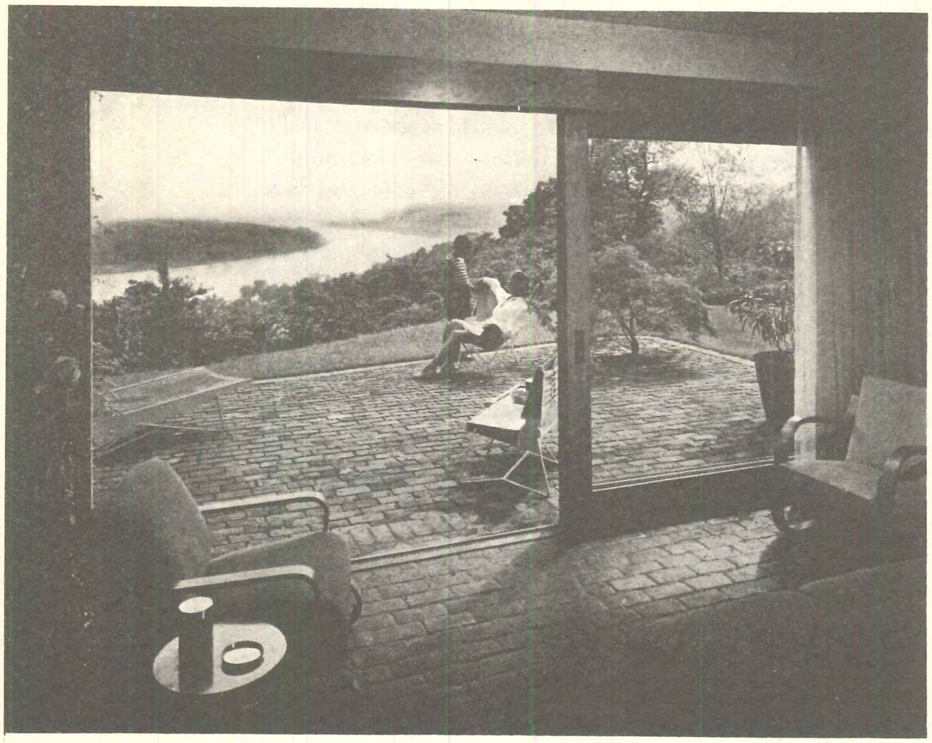
ARCHITECT'S OWN HOUSE, CINCINNATI, OHIO

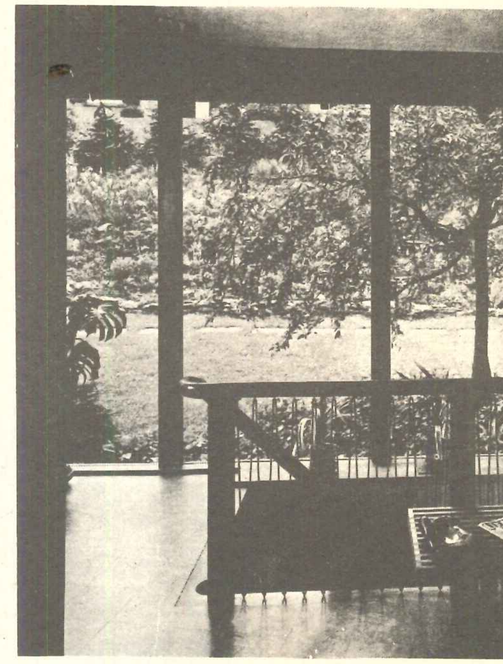
Carl A. Strauss, Architect *John F. Kirkpatrick, Landscape Designer*

FULL utilization of the fairly steep site overlooking the Ohio River and city beyond, and ease of maintenance and housekeeping for a family consisting of the architect, his wife and two sons, were the design criteria here. Access to the site is from the upper level, so carport, entry walk and principal entrance are on the upper level along with bedrooms; living room, etc., are below.

Hedrich-Blessing Photo

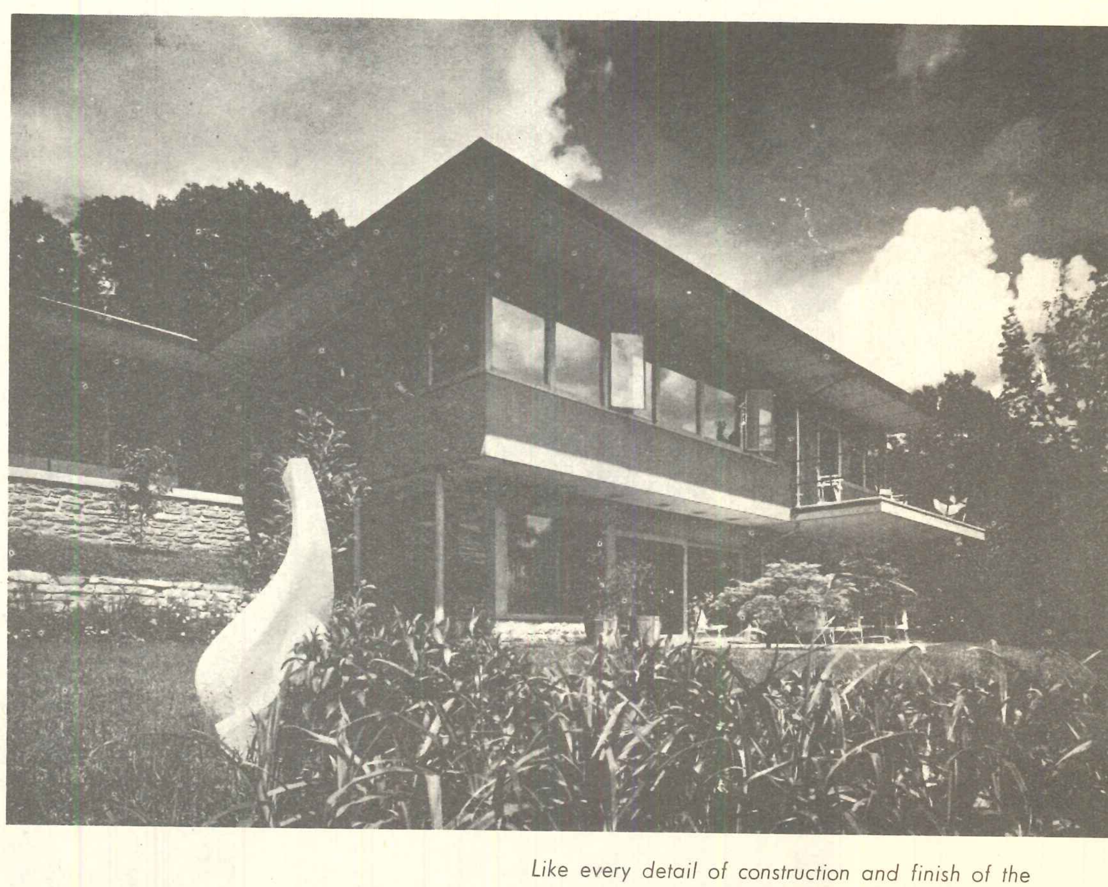




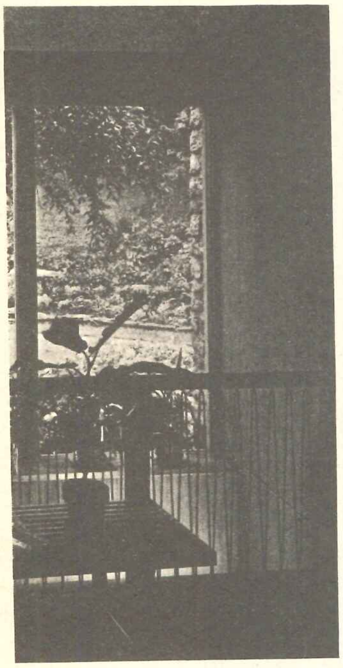


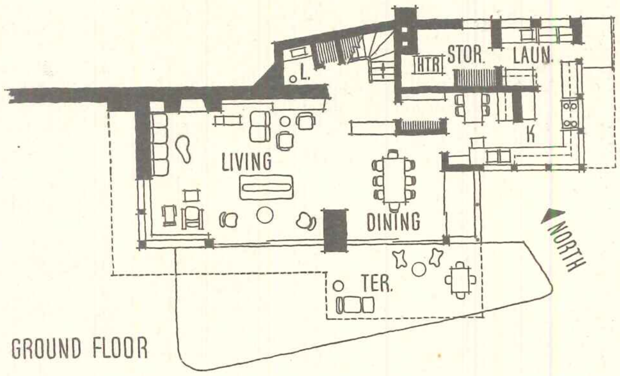
Left, living-dining room, at ground level, has paving-brick floor extended outdoors. Though sliding walls are not screened, direction of prevailing breeze and an infrequent spraying with insecticide almost eliminate insects; the family's pleasure in easy outdoor-indoor access outweighs the nuisance of the occasional stray bug or dog. Above, second-floor entry

Hedrich-Blessing Photos

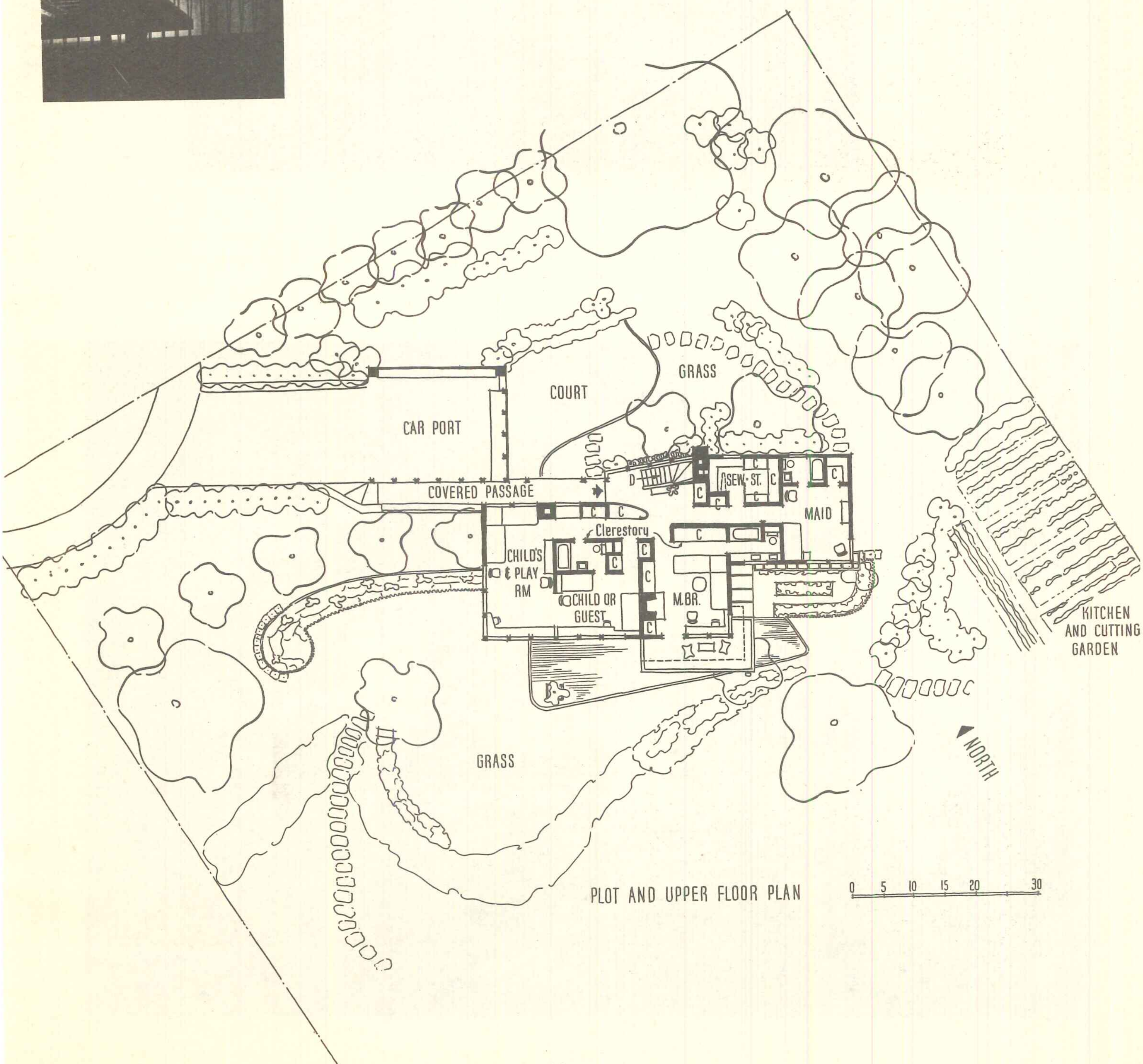


Like every detail of construction and finish of the house, planting is laid out for ease of upkeep



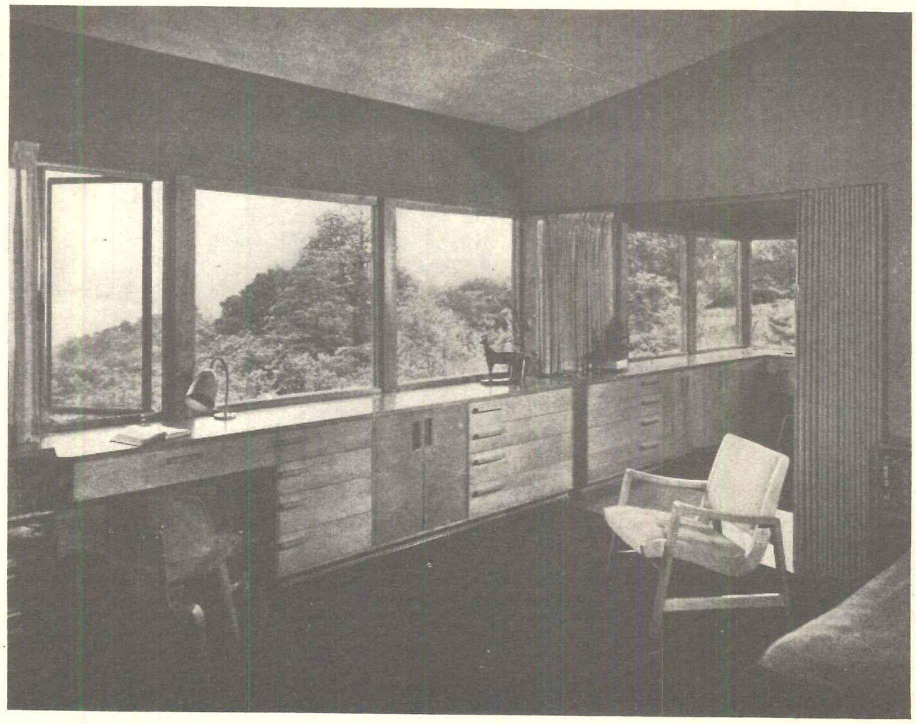


GROUND FLOOR



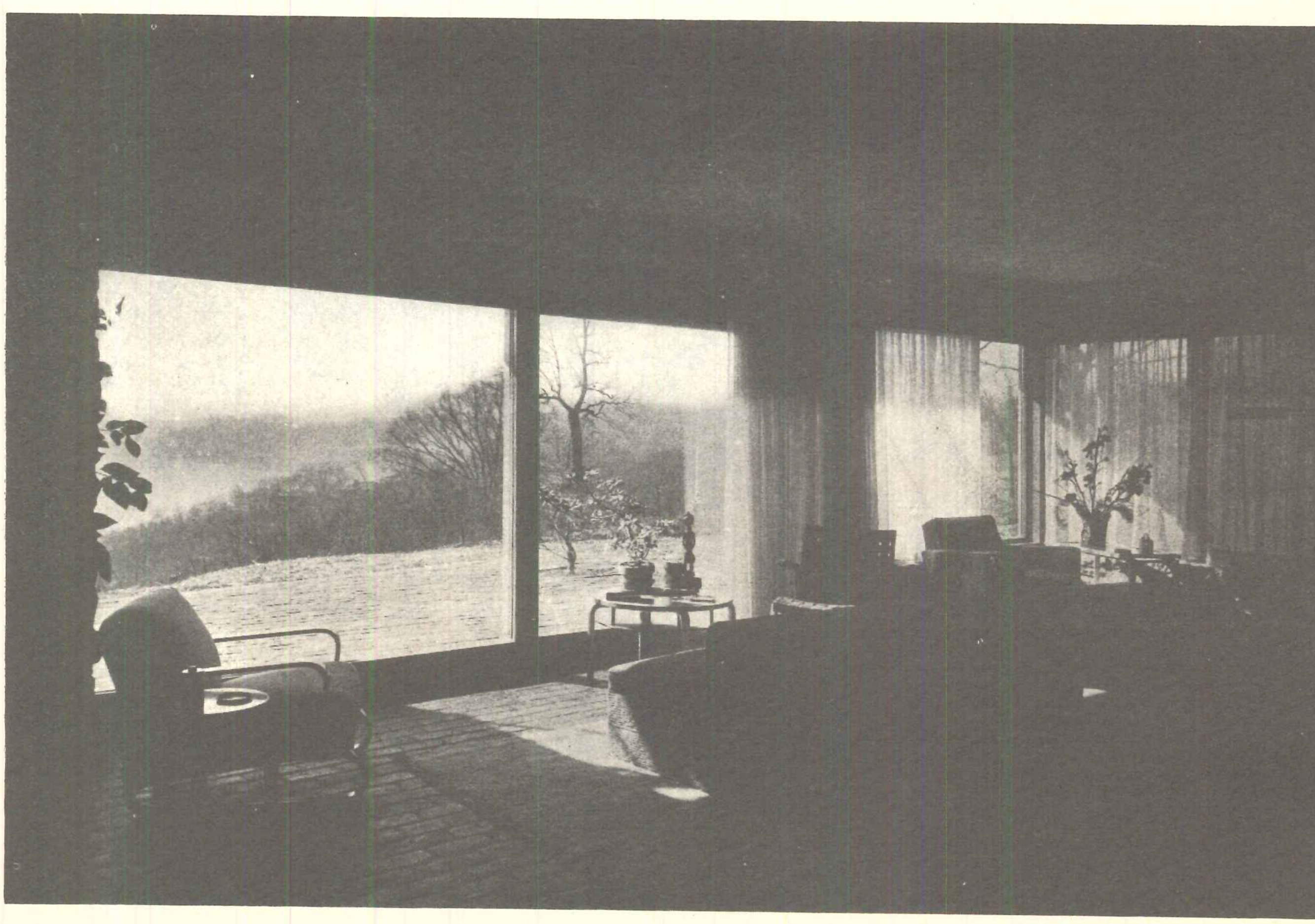
PLOT AND UPPER FLOOR PLAN

Hedrich-Blessing Photo



Boys have two bedrooms which can be separated by a folding wall or thrown together. On upper floor, walls are striated plywood; on lower floor some stone, obtained from excavation, is used

George Stille Photo



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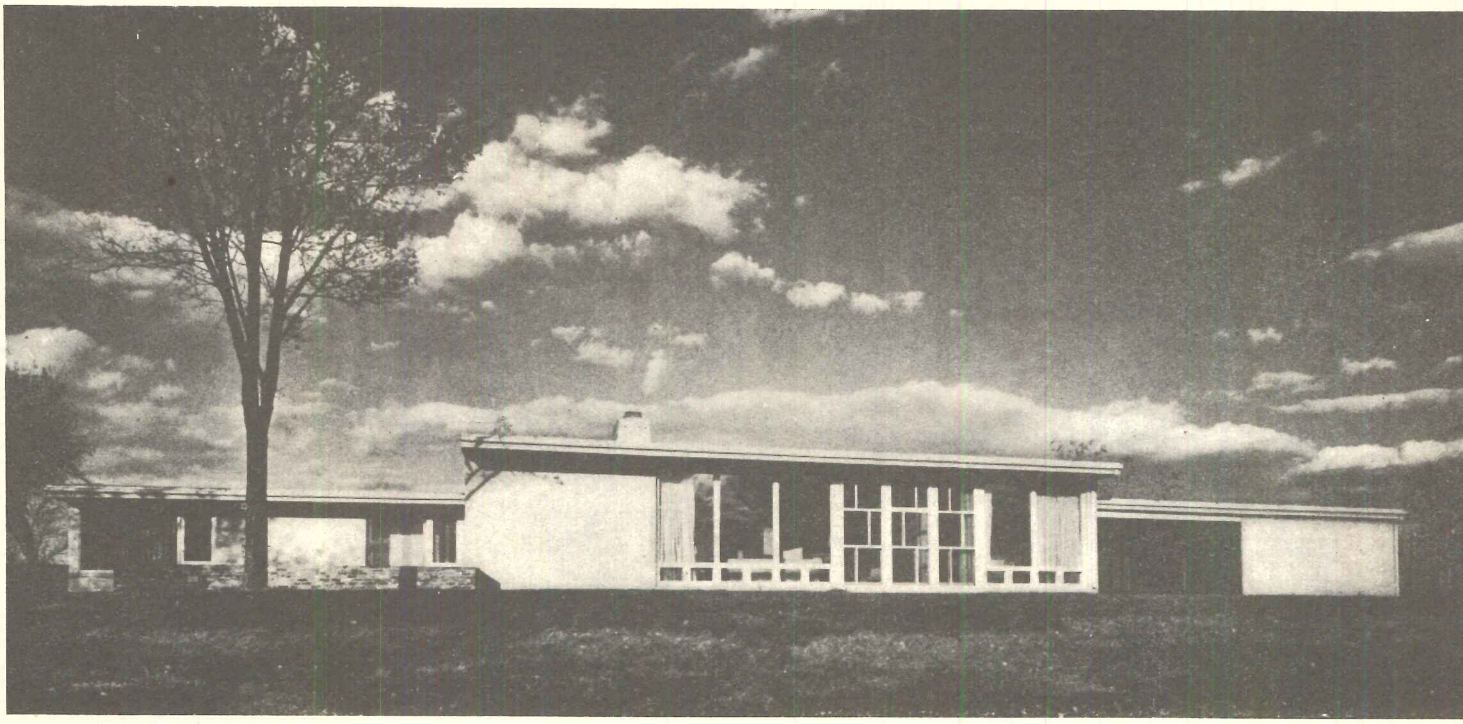
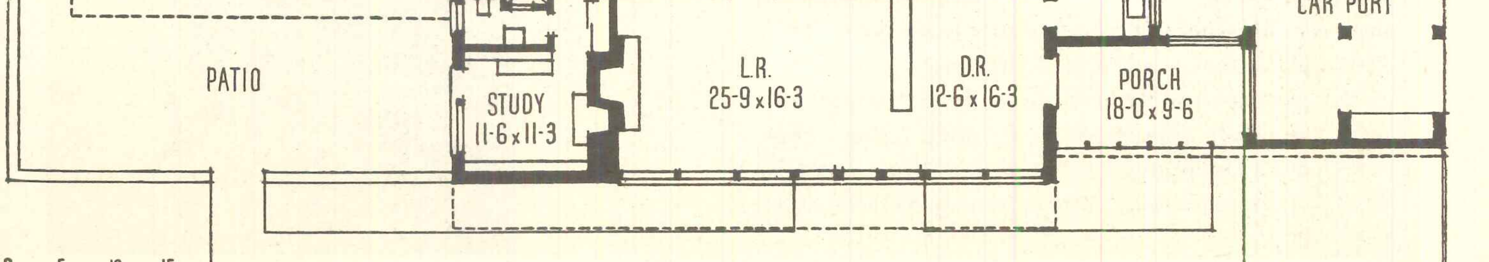


HEADMASTER'S HOUSE, COUNTRY DAY SCHOOL

Frederick Dunn, Architect — *St. Louis, Missouri*

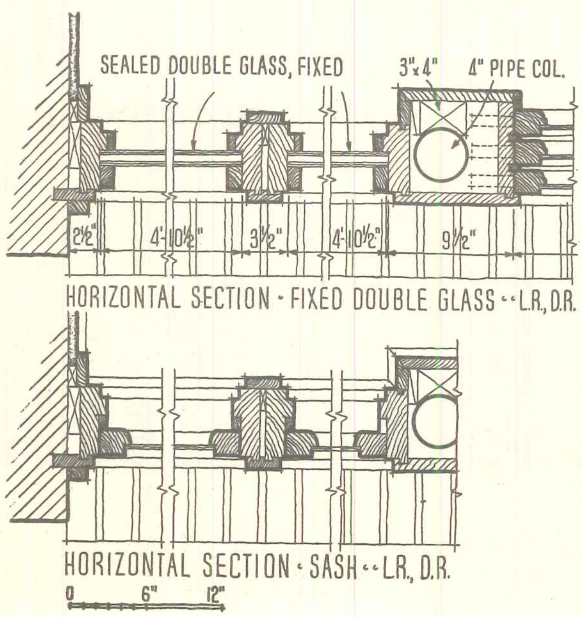
John D. Falvey, Mechanical Engineer
William C. E. Becker, Structural Engineer

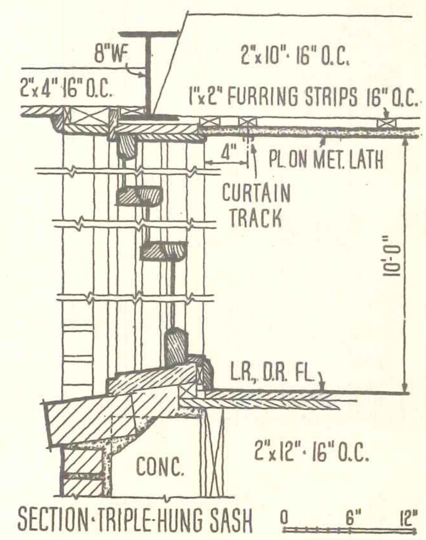
Its plan worked out within the foundation limits of an old and very fancy Colonial house which burned down, this house sits on a knoll on the grounds of the St. Louis Country Day School. Using the old foundations and basement reduced construction costs but complicated planning; hence the north-facing bedrooms and certain other features.

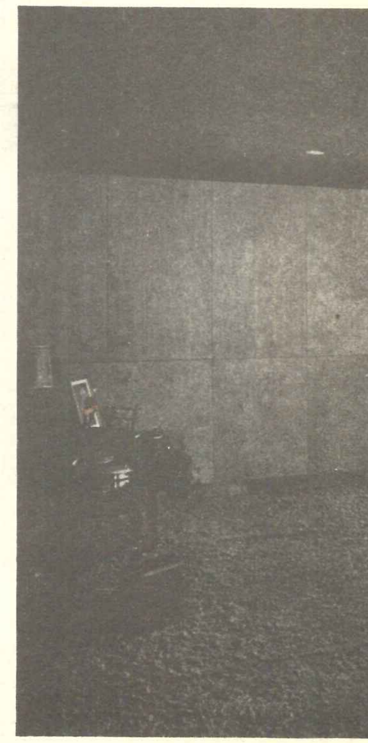


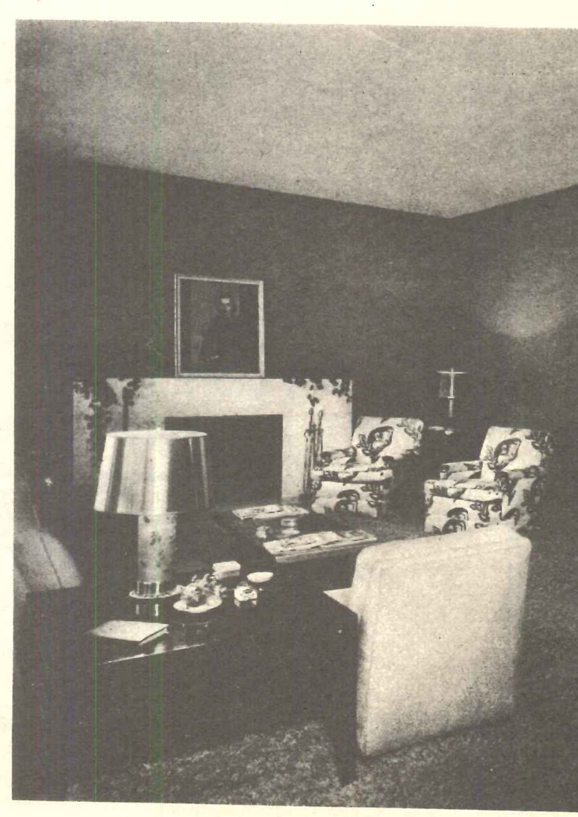
ST. LOUIS HOUSE

Center photo: large living room, from which the dining room is separated only by tall cabinets of curly birch plywood. Left, details of triple-hung sash and double glazing; right, details showing roof line following ceiling levels, which are lower in north rooms. At bottom: fireplace end of living room, and study



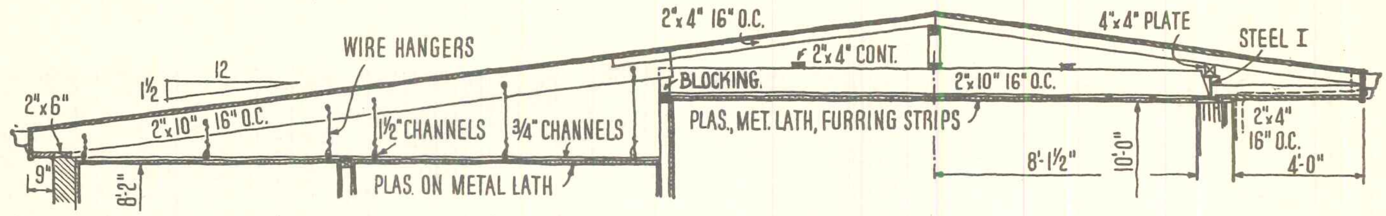




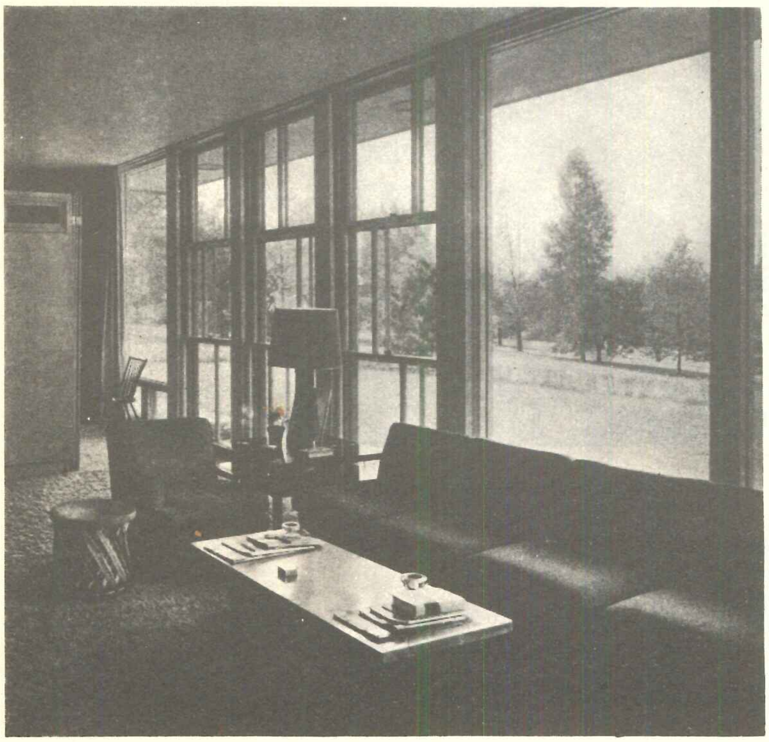


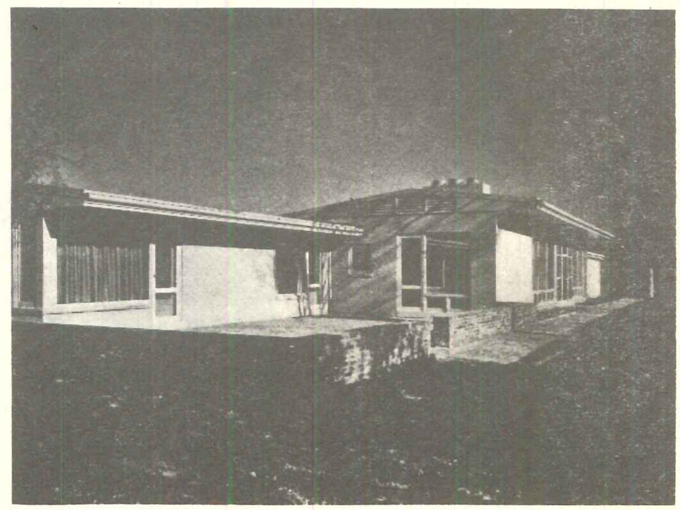
Of necessity, Headmaster and Mrs. Robert N. Cunningham's house is quite formal. In living and dining rooms the south wall is entirely glass; beneath the fixed glazing are hopper sash for ventilation, and set into the wall are three large triple-hung windows. These help maintain comfort in warm weather by providing a means for getting rid of warm air near the ceiling, which is ten feet high in these rooms for both proportion and comfort.

The house has brick bearing walls on concrete foundations. The exterior white lime facing brick is covered with cement paint, and the roof is built-up, surfaced with light-colored aggregate to reflect heat. Interior partitions are wood, with hard plaster finish throughout. Insulation is rock wool, 4 in. thick, and the house has an oil-fired air conditioner, rebuilt from the previous residence, which supplies a 4-zone duct system. Each zone has its independent controls. The house contains 3120 sq ft; total cost was approximately $42,000, or $1 per cu ft.

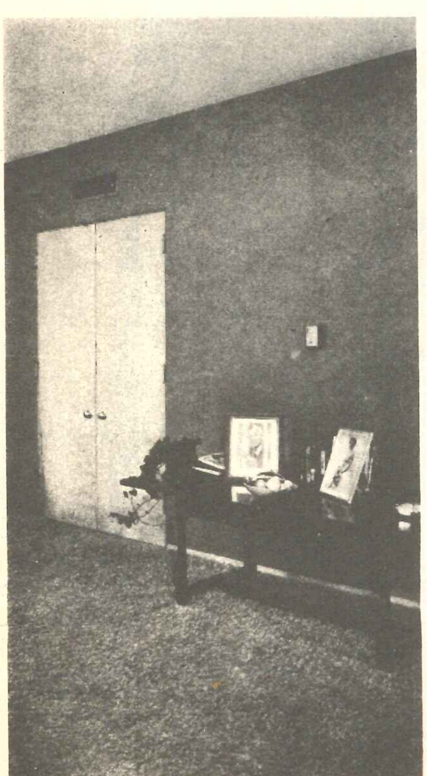


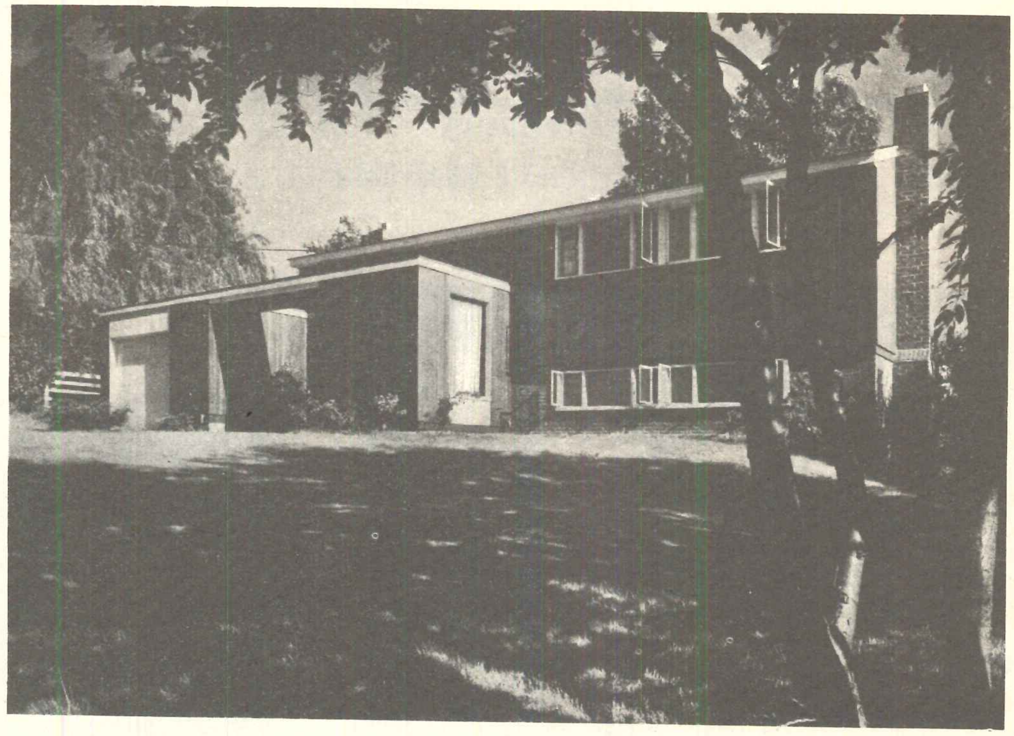
SECTION THROUGH MAID'S ROOM, KITCHEN & DINING ROOM



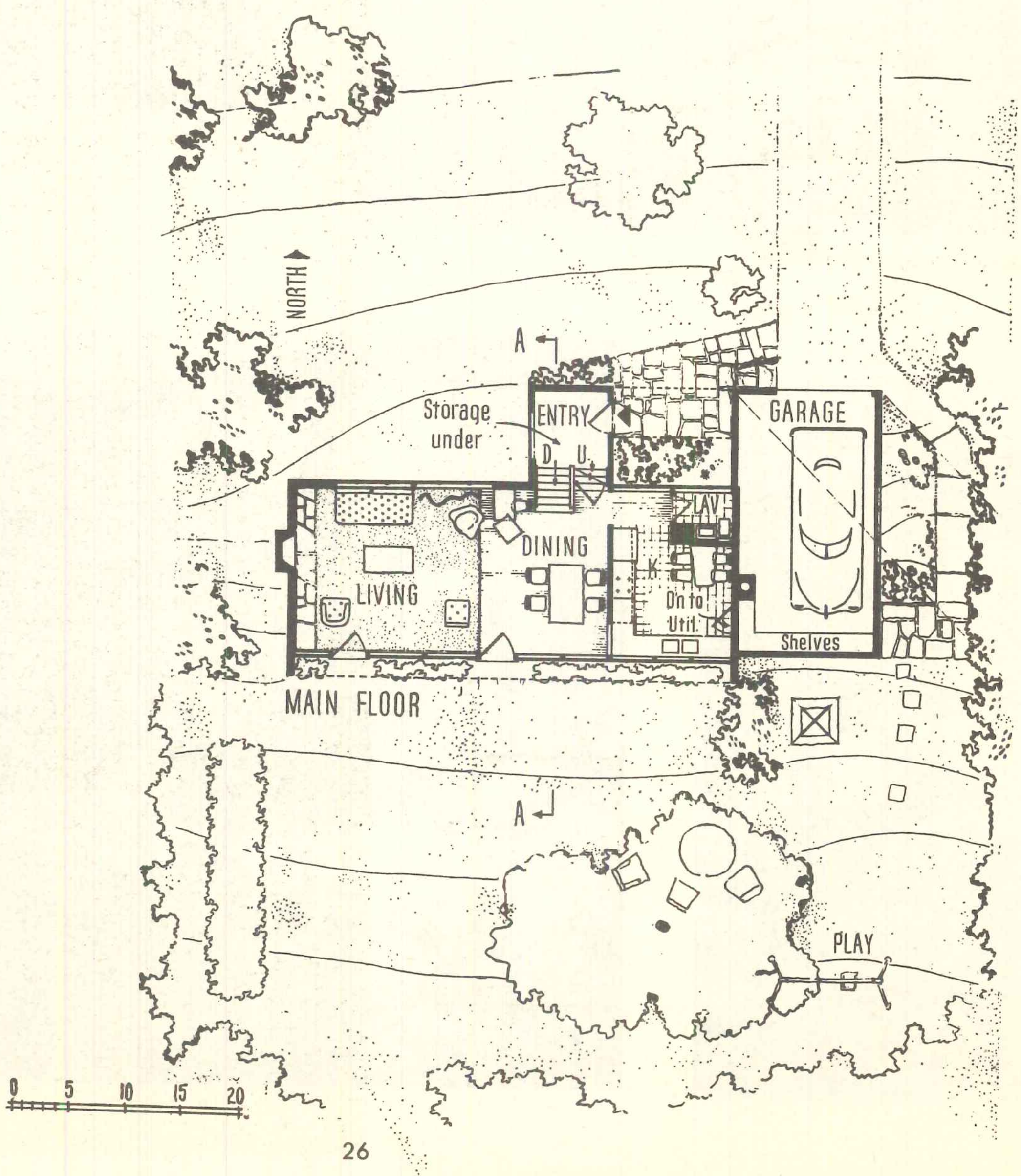


Piaget Studio photos

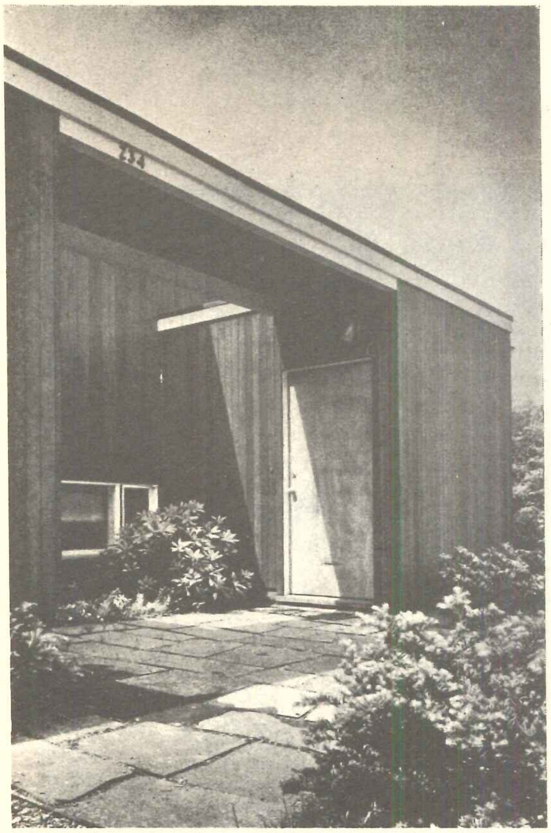




Richard Garrison photos



On a sloping site, one readily apparent economy is what we used to call "split-level" planning. The entry, halfway between main and second floors, is here kept quite open. In combination with the openness of the plan, and continuously glazed walls on the opposite—south—side, this provides perhaps the most striking first impression. Mrs. Grossi finds it a satisfying and permanent one, particularly in contrast to the confinement of the apartment in which the family previously lived. Though a more formal family might be disturbed by the fact that an entering visitor has an excellent view of the dinner table, this does not bother the Grossis

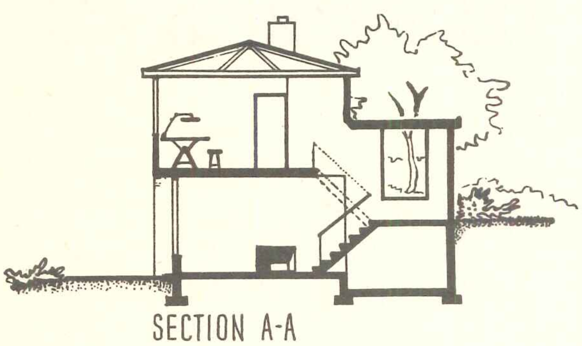


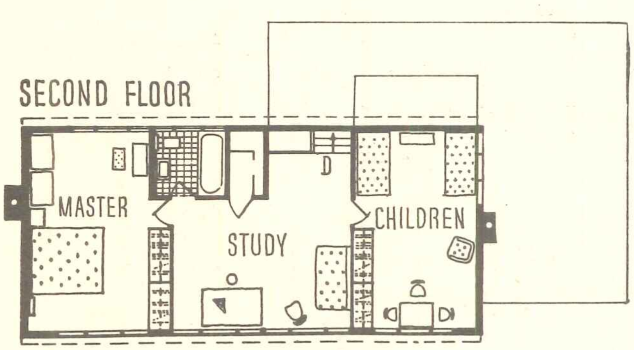
HOUSE IN A NEW YORK SUBURB

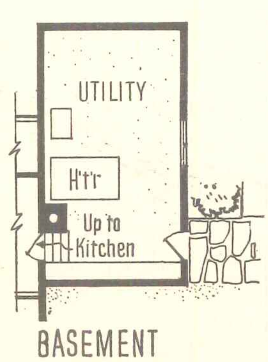
For Mr. and Mrs. Olindo Grossi

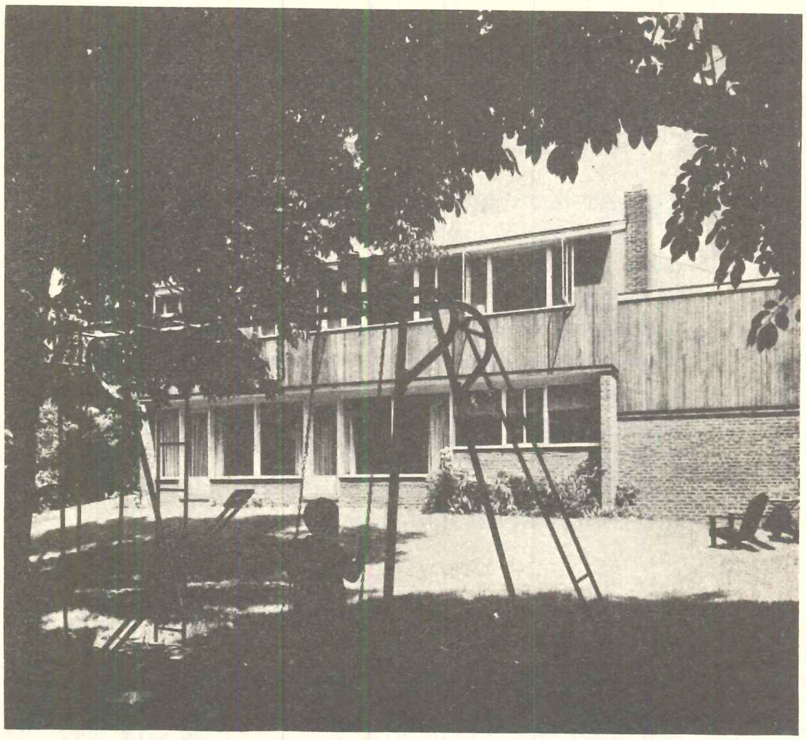
Olindo Grossi, Architect

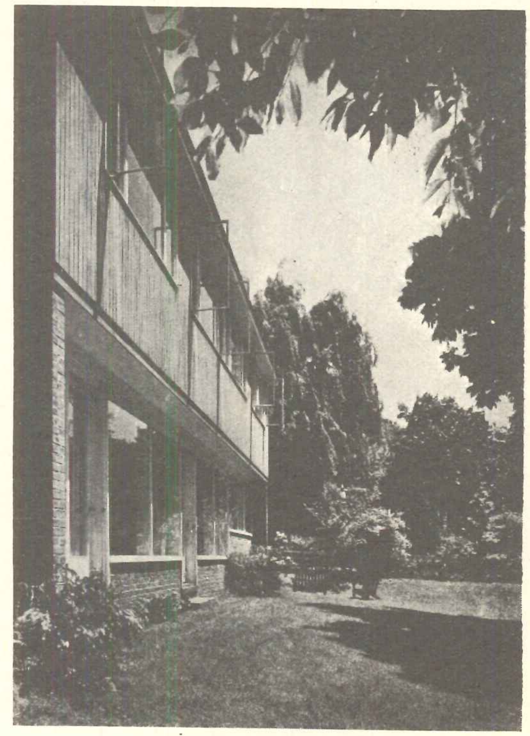
When an architect designs his own house, he's somewhat on the spot; when he is Head of the Department of Architecture (as Mr. Grossi is at Pratt Institute in Brooklyn), the spot becomes most definite. It behooves him to make judicious use of new ideas, techniques and equipment; and since his budget is just as limited as any of his clients' — how many architects or teachers are wealthy? — he must economize wherever possible. In his house his family must be able to live a normal life, and yet it must be available for demonstration. How well has this house succeeded?











Richard Garrison photos

Openness and flexibility characterize this house; there is not even a pretense of a partition between living and dining spaces. A radiant heating system, designed in accordance with average practice and with copper tubing in the plaster ceilings, also contributes to flexibility. Research showed that the two-zoned system functioned well. Served by an oil-fired boiler, each zone has its own indoor thermostat. Cost precluded installation of clock thermostats and outdoor controls; it was found, consequently, that manual operation of thermostats was necessary or else, in winter, the house became too warm in mid-morning, too cool in early evening. Two criticisms: Supplies and return to upstairs zone pass through the exterior three feet of the kitchen ceiling, and when heat is needed downstairs, this ceiling is cold unless upstairs zone is also heating; and the living room coil length, 500 linear feet, made for unequal flow and a large temperature drop in this circuit's water. Nevertheless, the system was found very economical — one year's fuel cost for heat and hot water was $186 — and quite appropriate for a basementless house with so much glass. Upstairs temperatures were consistently two to three degrees higher than downstairs, probably due to convection; average temperature differential, floor to ceiling, was four degrees; the living room's glass wall apparently induced mild air currents which were found very agreeable — and which reversed at night! — and as soon as the winter sun penetrated the interior the heating system did not need to function. From 10 to 4 the oil burner ran only for domestic hot water.

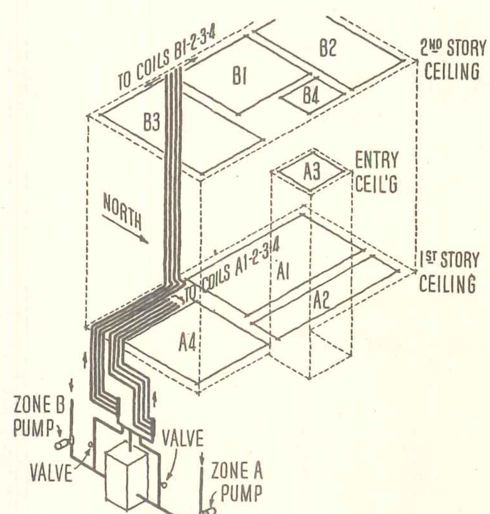


FIG. 1 SCHEMATIC COIL LAYOUT

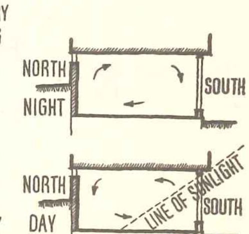


FIG. 2 AIR CURRENTS IN LIVING ROOM

Careful study of the radiant heating system was made by six students in Pratt Institute's Mechanical Equipment courses: Giles Aureli, Howard Bonnington, Sven Gelin, Joseph Hnatov, William Johnke, and John Manley. Their findings are quoted at left

A HOUSE WITH "EMOTIONAL CONTENT"

Residence for Mr. and Mrs. Abel E. Fagen, Lake Forest, Ill.

George Fred Keck— William Keck, Architects *Marianne Willisch, Interiors*

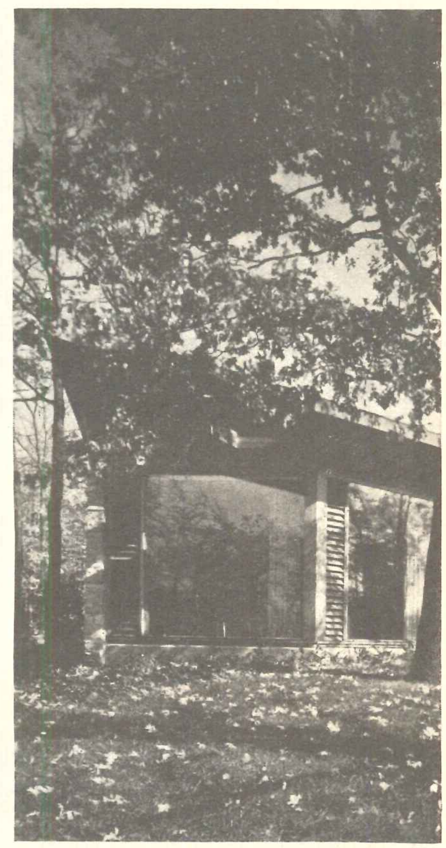
Hedrich-Blessing Photos

RECENTLY those once-heretical words "warmth" and "emotional content" have appeared more frequently in within-the-family discussions of architecture. Now the taboo has been shifted rather toward "functionalism," first because the word was so much over-used, also, probably, because of a growing sense of confusion about its application. In residential design particularly was it difficult to isolate the "function" to be expressed.

Here is a house in which there was no difficulty about words. Fred Keck's account of the planning assignment for the Fagen family speaks of family interests the house was to express, of development of the solar ideas, of spatial feeling to avoid the monotony of rectangular units, of colors and tones and sculptural forms "to enhance this feeling of relaxation." A considerable package of emotional content.

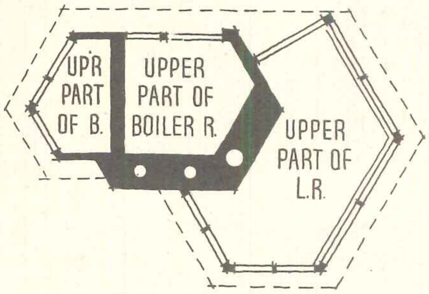
First in the list of family interests to be expressed was outdoor activities around the farm. The farm is of the suburban type, 80 acres, partially

Hedrich-Blessing Photos

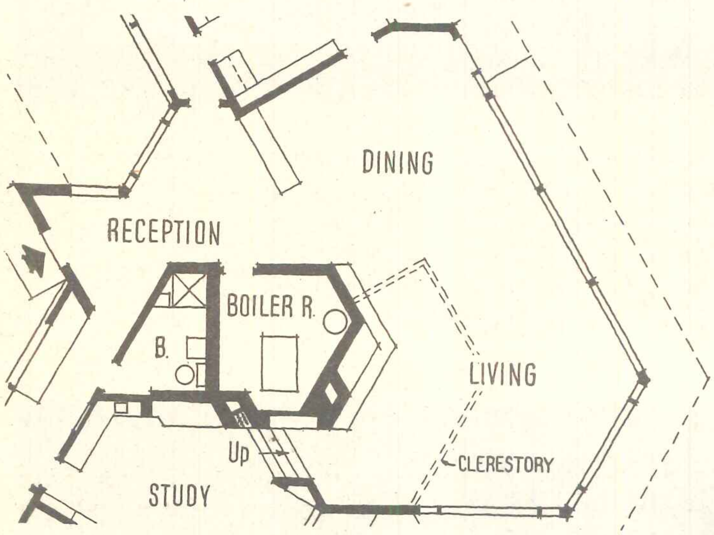


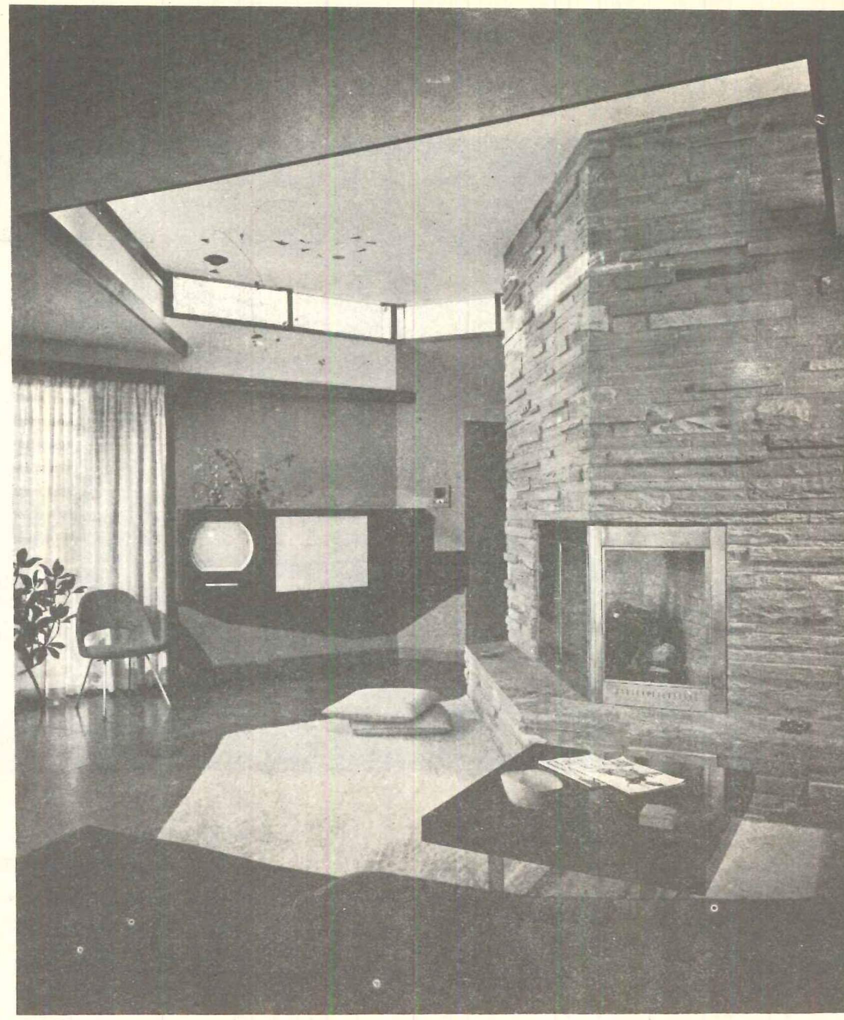
wooded, just outside of Lake Forest, one of the beauty spots of the North Shore. Family comprises parents and three sons, two about ready for college. Mrs. Fagen is especially interested in sculpture and painting, and for the children, music. Entertaining was also mentioned, though the owners had already built a guest house and porch for summertime visitors.

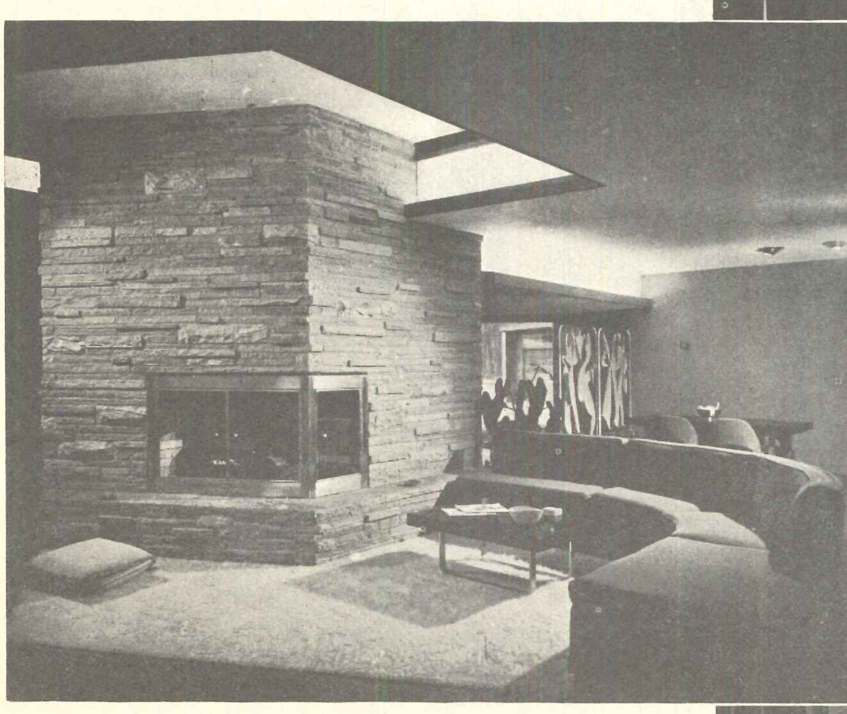
The clients were also sympathetic to the architects' variations on the solar theme. "We made a point," said Keck, "of the angular placement of windows, not only for the view, but also for the feeling of space and for the reflective values of the glass, which add a note to the spatial feeling in the house, and rid it of the monotony of the rectangular unit." The architects also planned a sculptural quality in the spacing of forms and materials. "At the same time it is a comfortable and relaxing house . . . this feeling of relaxation is for me decidedly important, and is achieved by the sun when it is up, and the radiant heat when it is on during colder weather."

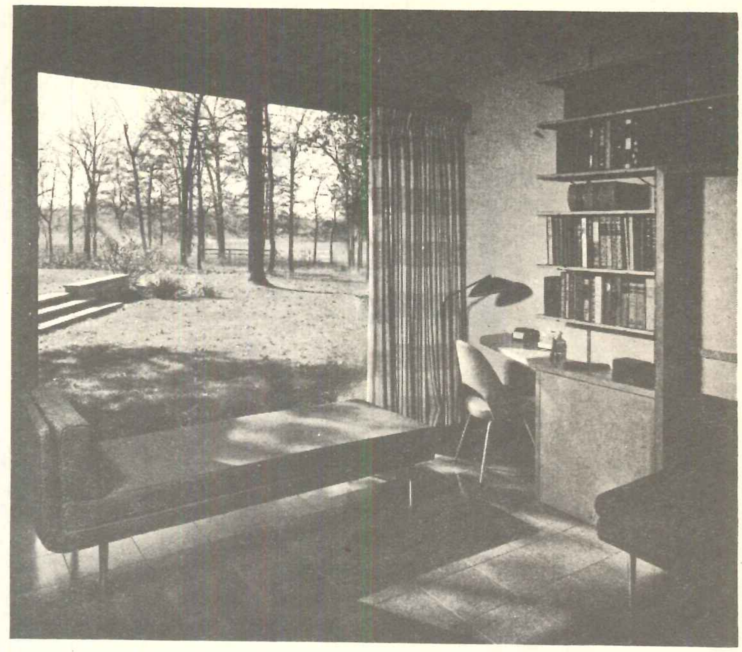


CLERESTORY PLAN



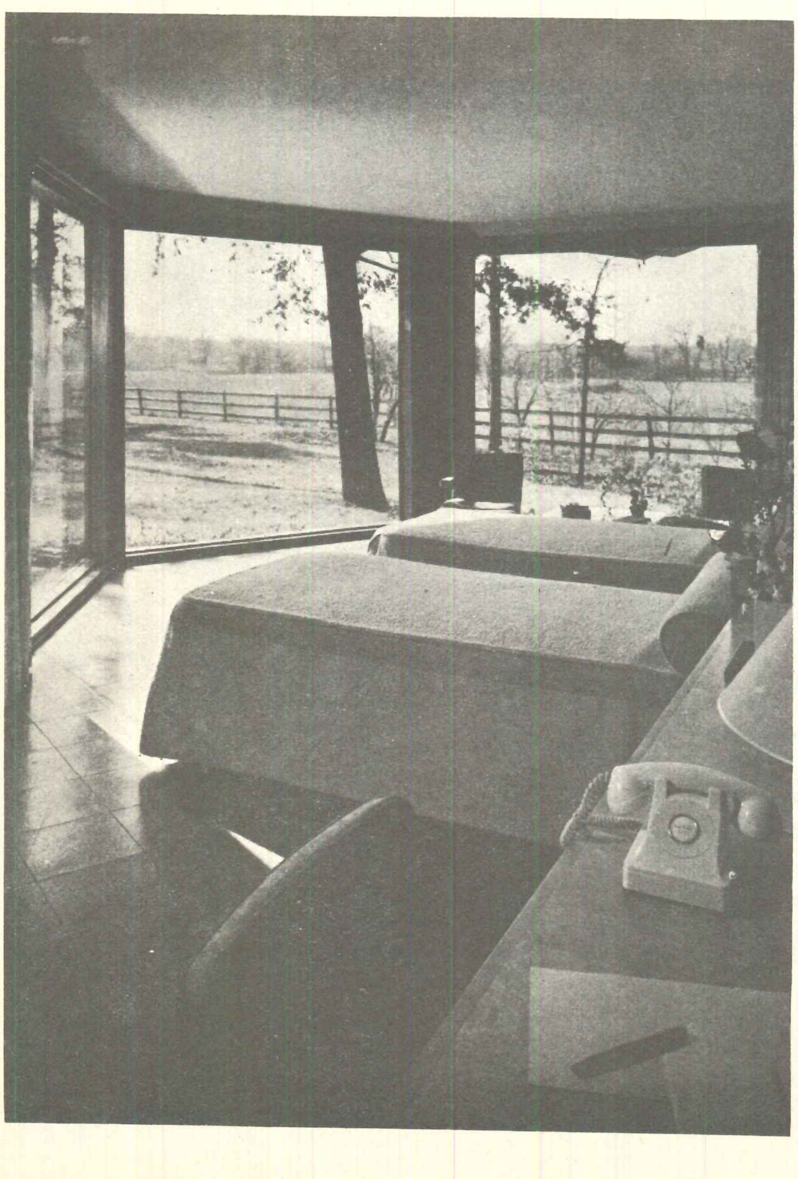


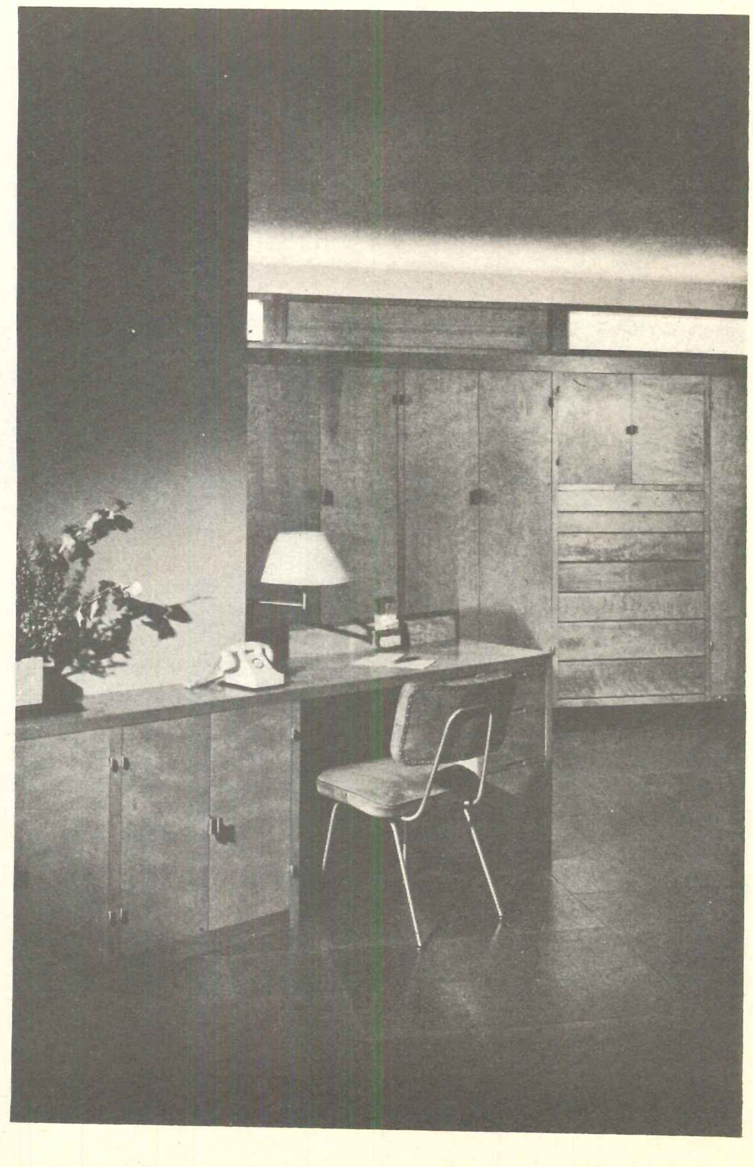




Bedroom interiors of Fagen house have an intimate visual relationship with the outdoors. All-glass walls are angled for views, also for a sense of spaciousness. Rooms have a feeling of warmth not really seen in photographs, compounded of colors and textures, also sunlight and radiant heat. "It is remarkable how little need is found for an oversupply of rugs on floors that are warm in cold weather"

Hedrich-Blessing Photos



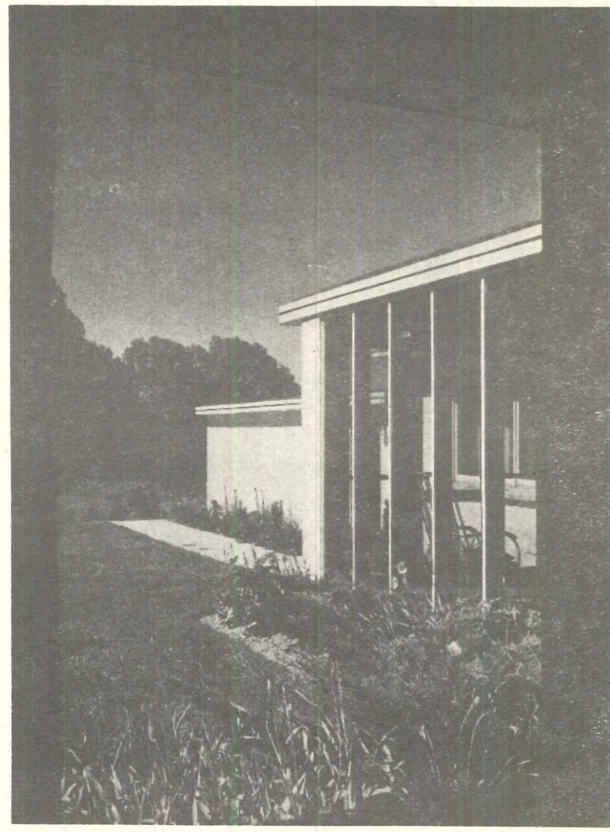


HOUSE MAKES THE MOST OF STOCK MATERIALS

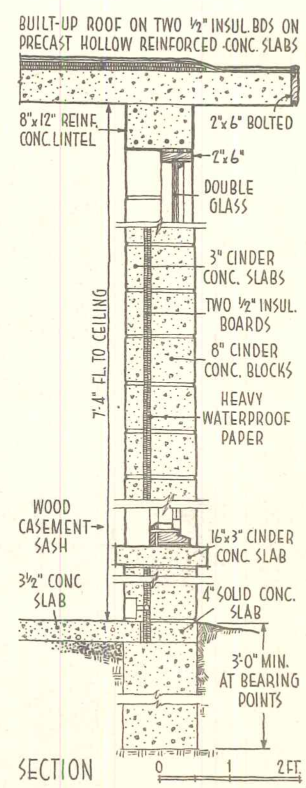
Residence for Miss Veronica McCarthy

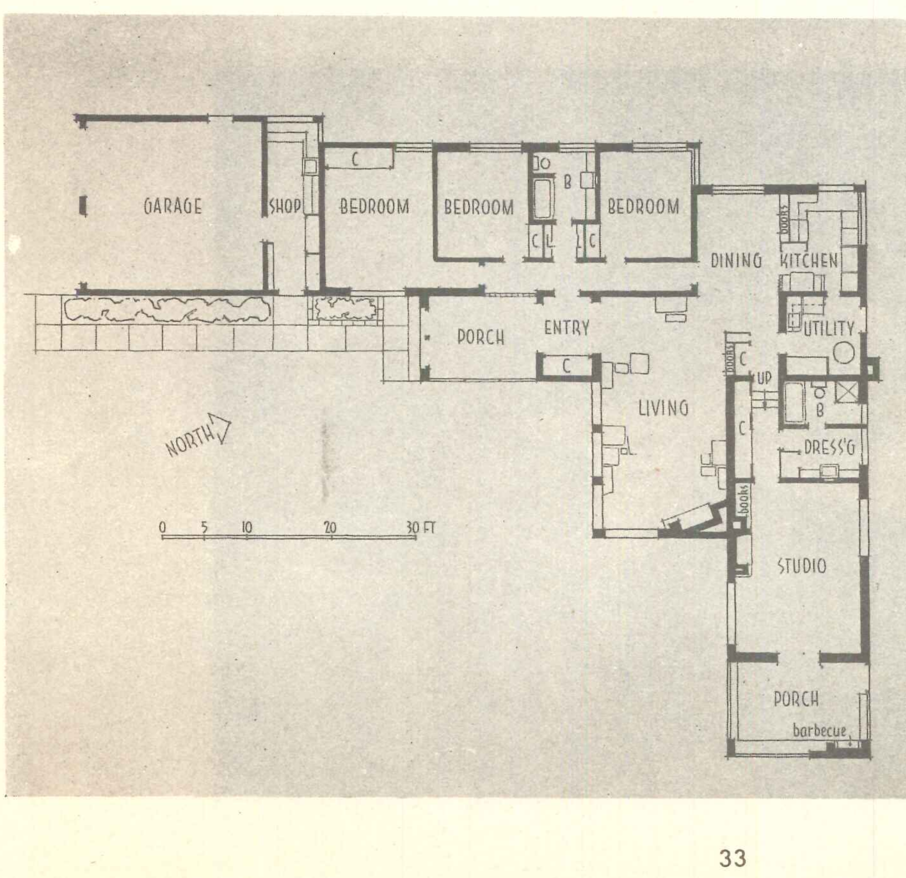
Fairport, N. Y.

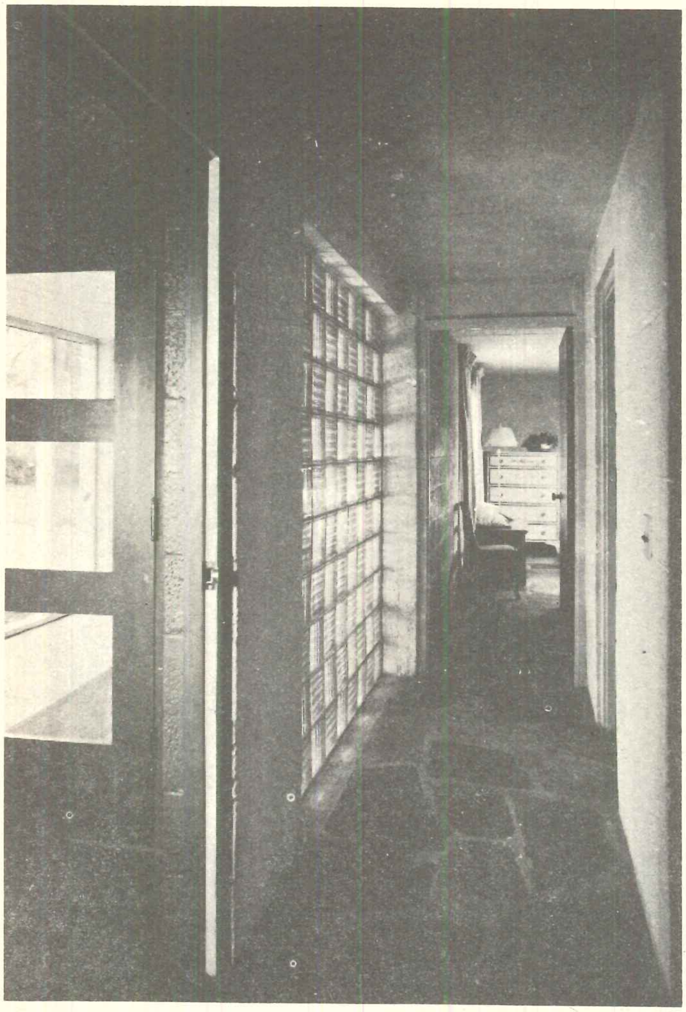
Don Hershey, Architect



An unusual amount of space and equipment at a cost of little more than half that of neighboring residences of similar size was provided in this simply designed house. Results of the architect's idea that construction costs could be lowered substantially by reducing the number of structural components involved are evident throughout the house. Only standard stock materials are employed, as in wall section, below right. The house is, in effect, designed to fully exploit these materials in the most straightforward and economical manner possible. The simplicity and logic with which the materials were treated made both for a low-cost, livable home and also for direct and uncomplex relations between architect and contractor. The ultimate benefactor of course was the client, who was afforded a maximum of space and conveniences for his expenditure. In addition to this, the direct expression of materials — cinder block, prefabricated concrete slabs, Vermont slate — without costly finishes results in a house as pleasingly simple as it is practical.

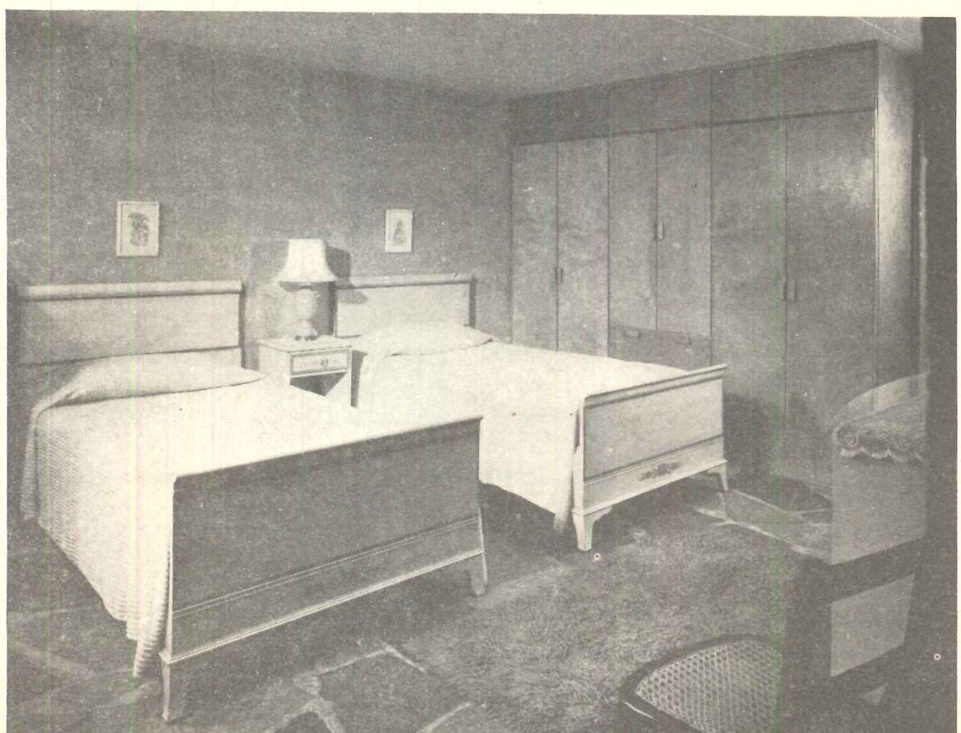


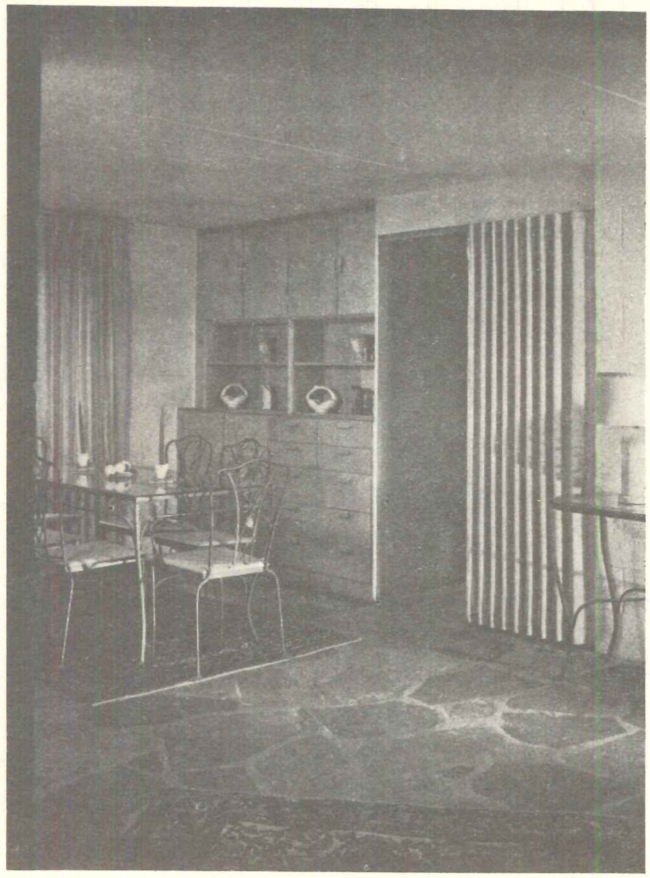




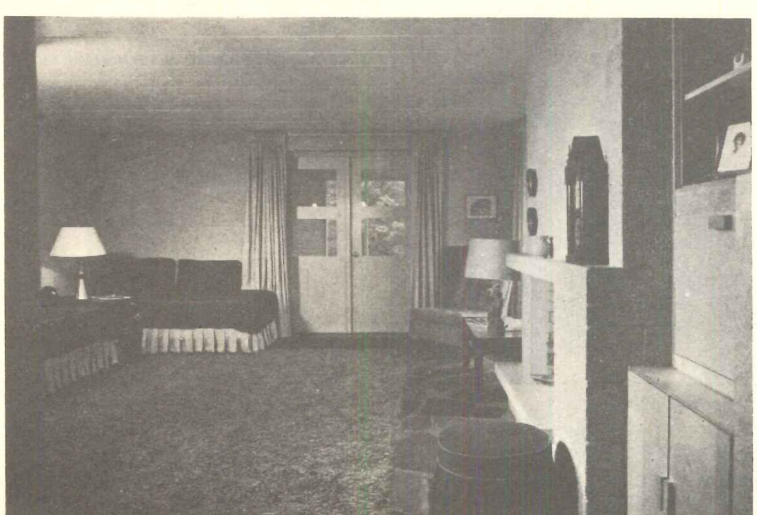
McCARTHY HOUSE

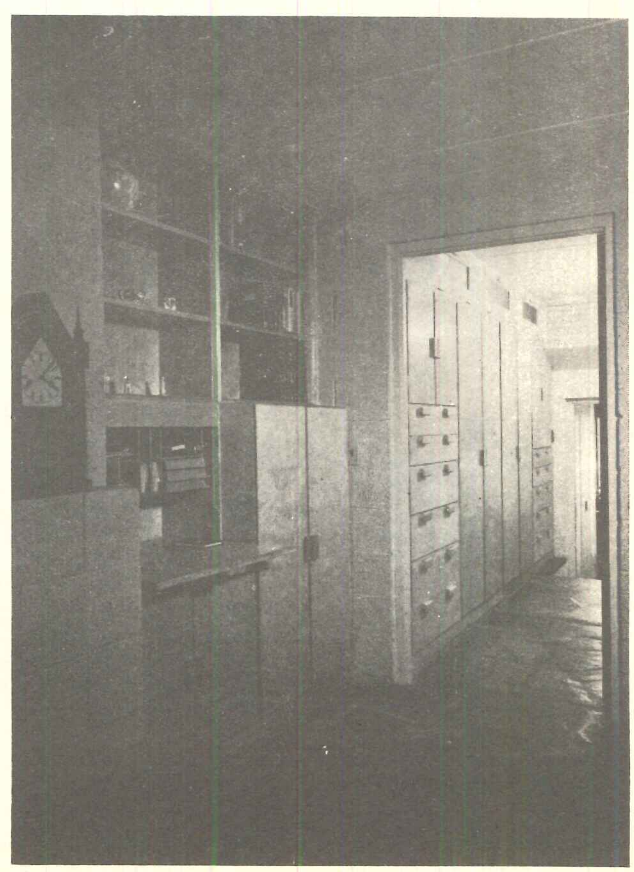
Simplicity with which materials are combined is evident in entrance hall, above, and master bedroom, below. Prefabricated cabinets are used throughout





Living room, above center, and dining room, above right, are adjoining. Comfortable, uncluttered appearance of studio, below left and right, is effected by generous storage facilities

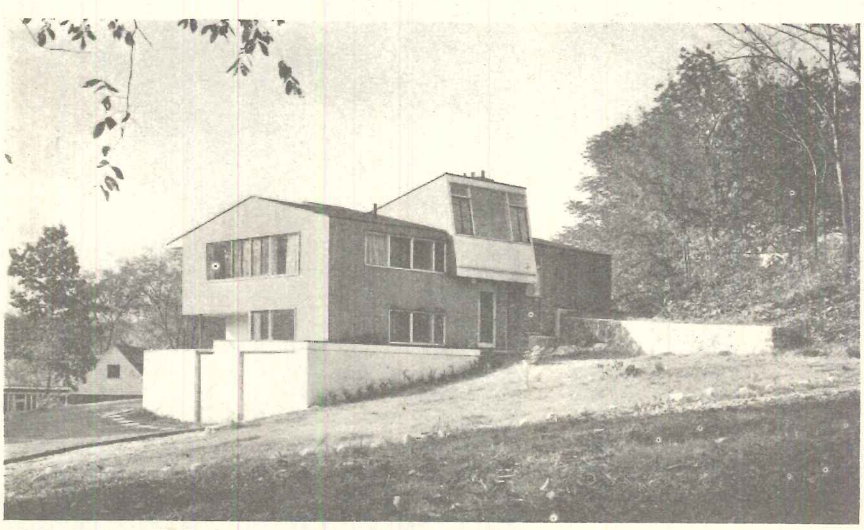




Photos: Joseph Molitor

FIVE-LEVEL HOUSE IN BELMONT, MASS.

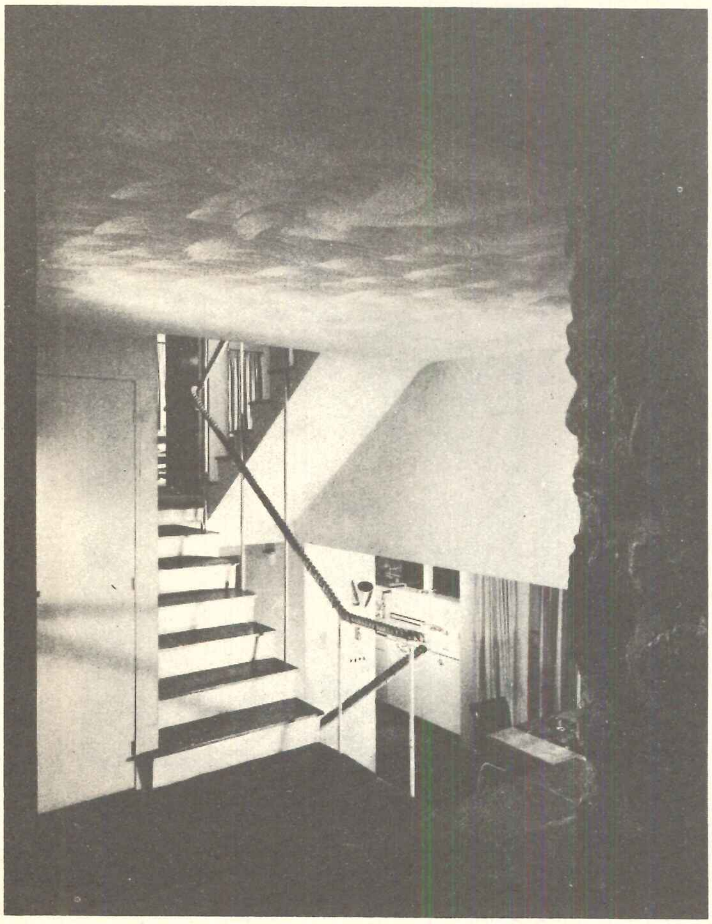
For Dr. and Mrs. Joseph J. Michaels

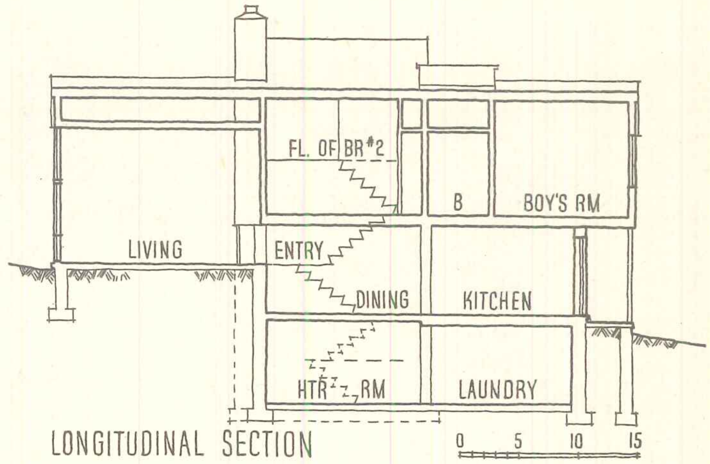


Ezra Stoller: Pictor

Carl Koch Associates
Architects

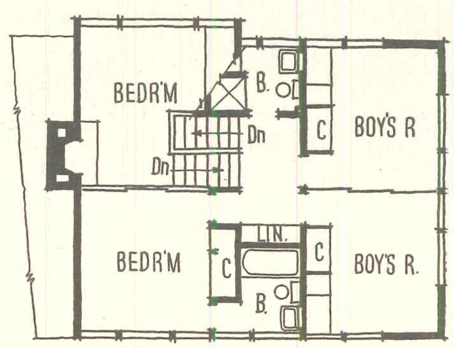
Leon Lipshutz
Associate



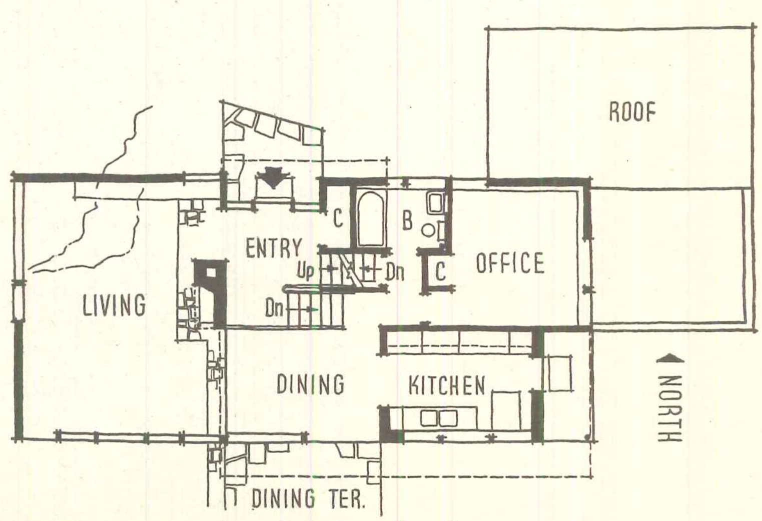


LONGITUDINAL SECTION

The many levels of the house follow land contours and relate similar activities. The lower level contains laundry, utility room and garage. Above this are the dining room and kitchen, with a flagstone terrace, and the office-study. The central level includes entry, living room, and grass terrace to the west. A half level above are the bedrooms. At the top is a studio-bedroom, separated from the master bedroom by sliding panels



SECOND FLOOR



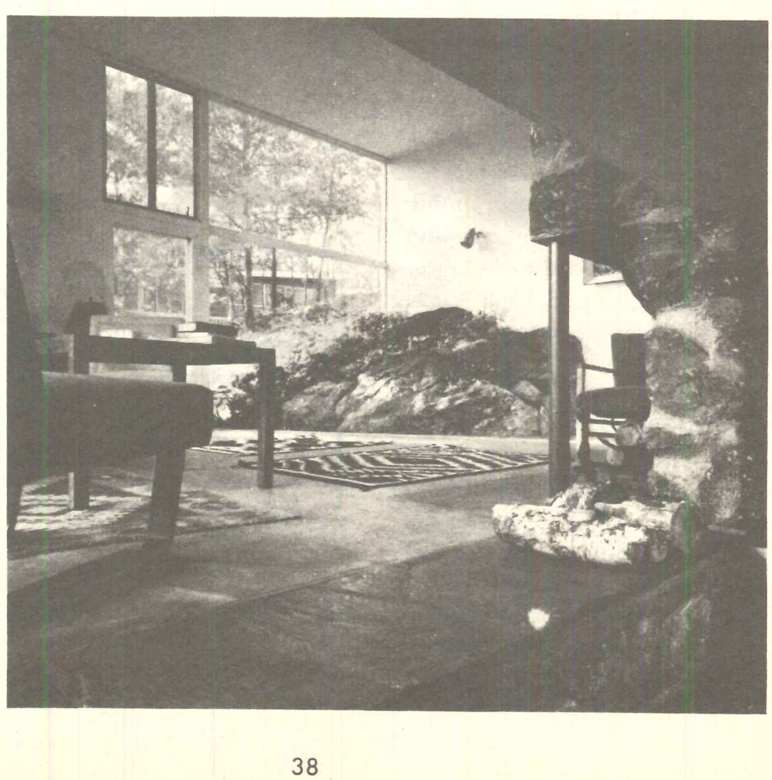
FIRST FLOOR

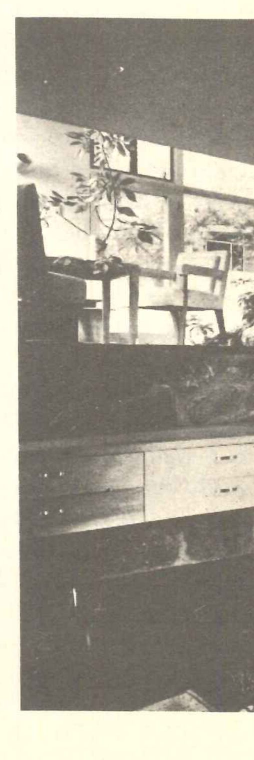
STEEP slopes and rocks on a small corner lot were developed into distinct assets in the planning of this multi-level house. Following the natural lay of the land, the architects have placed major living areas so that each has good orientation and a separate terrace. Large glazed areas were provided to satisfy the clients' desire for a feeling of space and as much direct contact as possible with the outdoors from the living room, dining room and kitchen. With a certain vigor, an outcropping of ledge rock was made into a garden in the west corner of the living room. Extensive use of natural materials, a characteristic of the work of this office, helps key the house to its site.

The Michaels family is an active one, and required rooms which could double for many uses. Dr. Michaels is a well known Harvard psychiatrist and required a study that could double as an office. A studio-bedroom was provided for Mrs. Michaels, who is a painter by avocation. Bedrooms for their two boys, aged ten and twelve, were designed with a folding partition between the rooms to give a large area for hobbies. Sliding panels used in many of the rooms give a sense of space, provide privacy when needed.

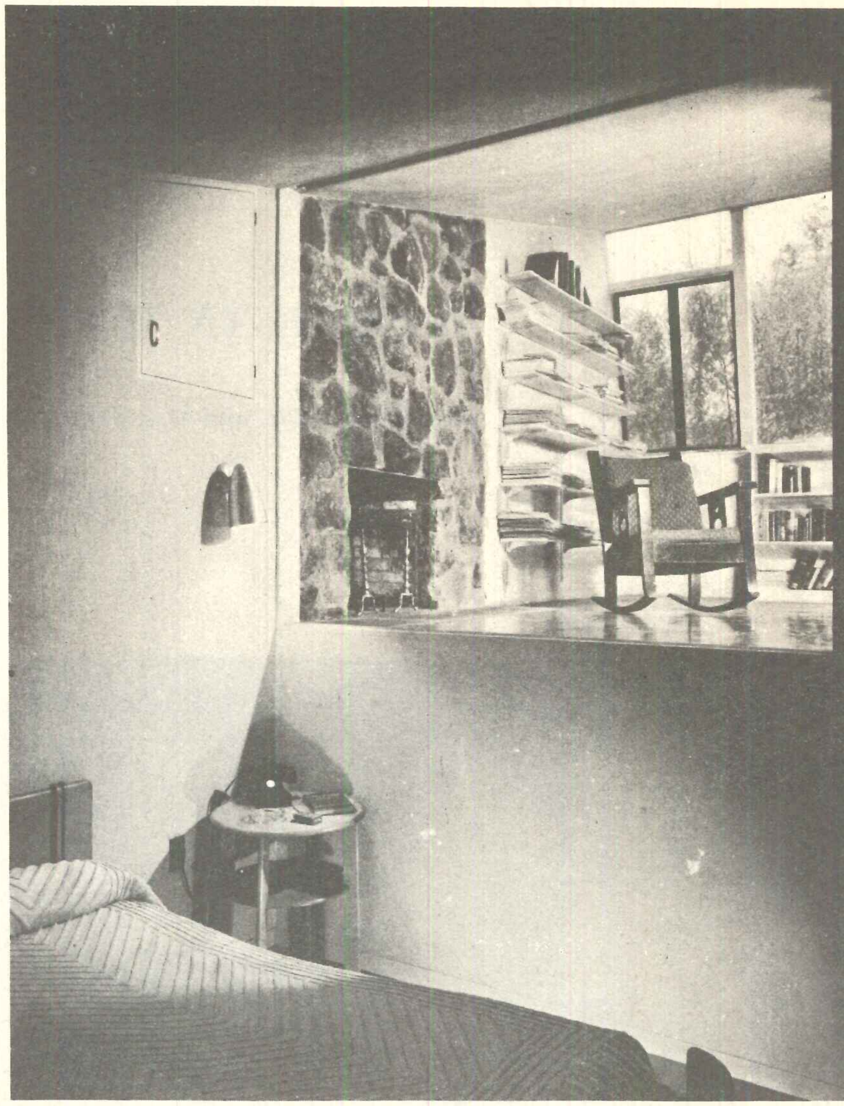
Ezra Stoller: Pictor

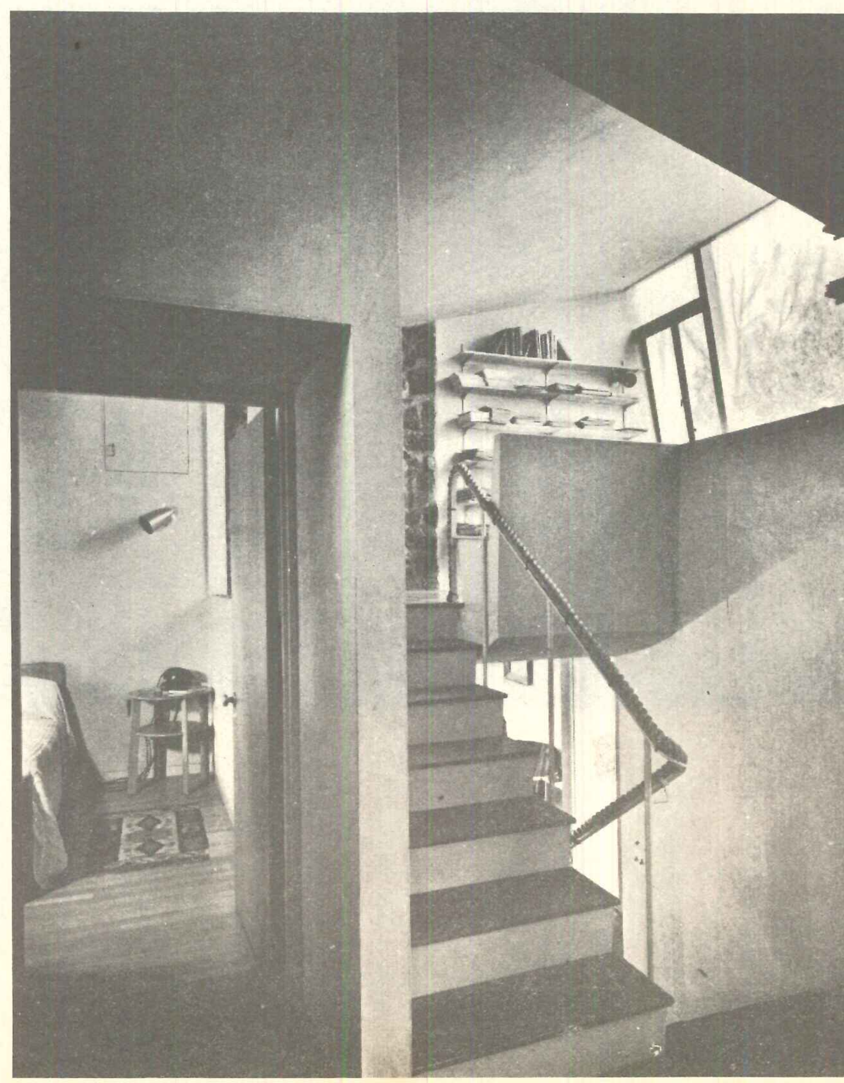
A great sense of openness has been realized in the living and dining areas (above and two photos, right). This was achieved mainly by the use of natural materials and large areas of glass. The ledge-rock garden is echoed by the stone fireplace and dining room walls. Exterior fir siding carries through to form one wall of the living room. The remaining walls are rough, unpainted plaster. Floors in the entry and dining room are flagstone, those of the living room are waxed concrete





The roof line of the house has been carried up over the studio-bedroom to permit large windows for north lighting. A sliding panel (right) between this room and the master bedroom increases the sense of space and affords cross ventilation for hot summer months. Finishes in the bedrooms are kept simple; walls are rough plaster, floors are varnished oak. The multi-level division of the house gives seclusion for the individual activities of the family, and permits short flights of stairs (below) for easy access to the various areas

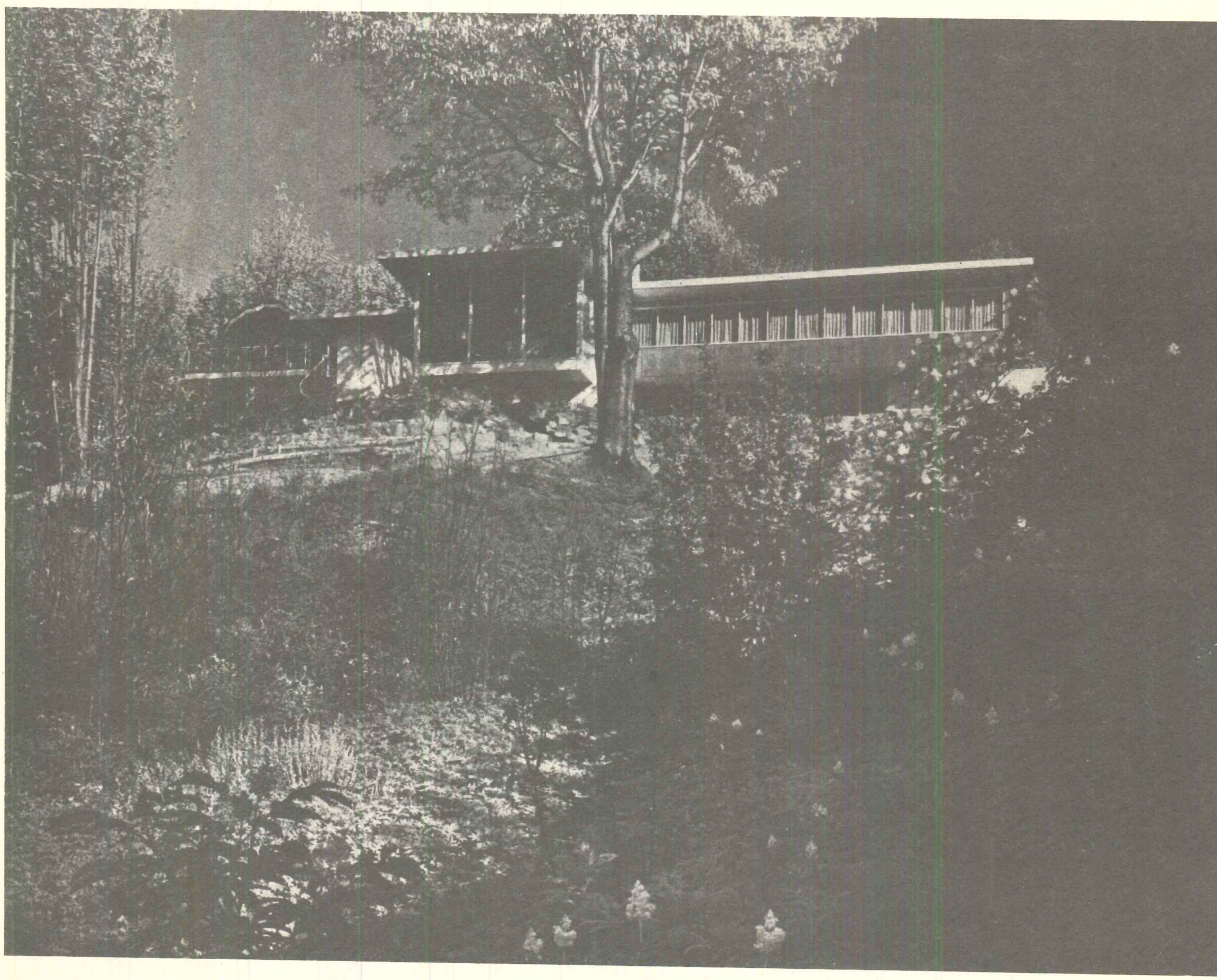




HOUSE IN THE PACIFIC NORTHWEST

Residence of Mr. and Mrs. Trevor Roberts

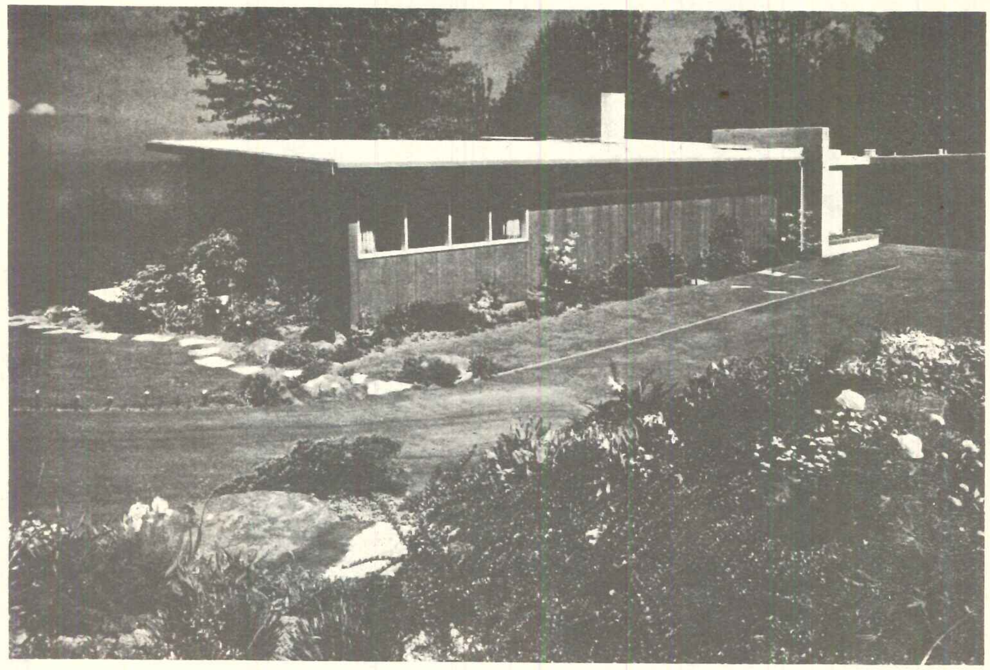
Charles R. Pearson Photos



Young & Richardson

Architects & Engineers

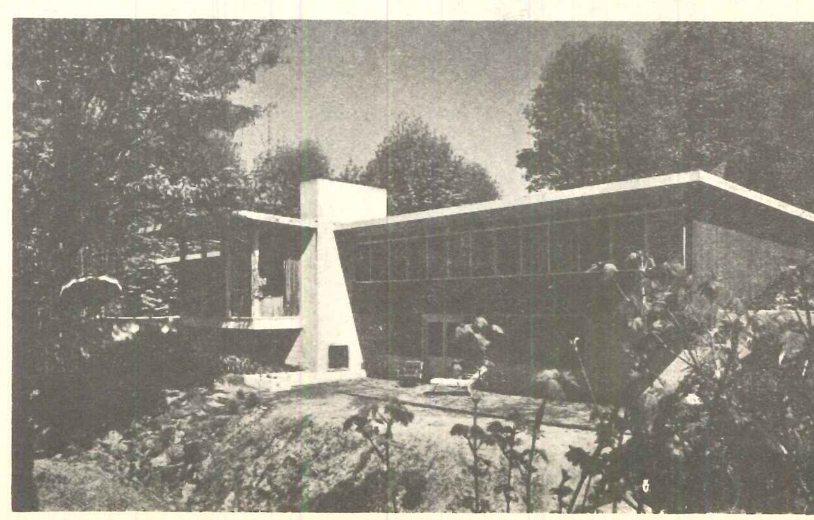
Blue Ridge, Washington



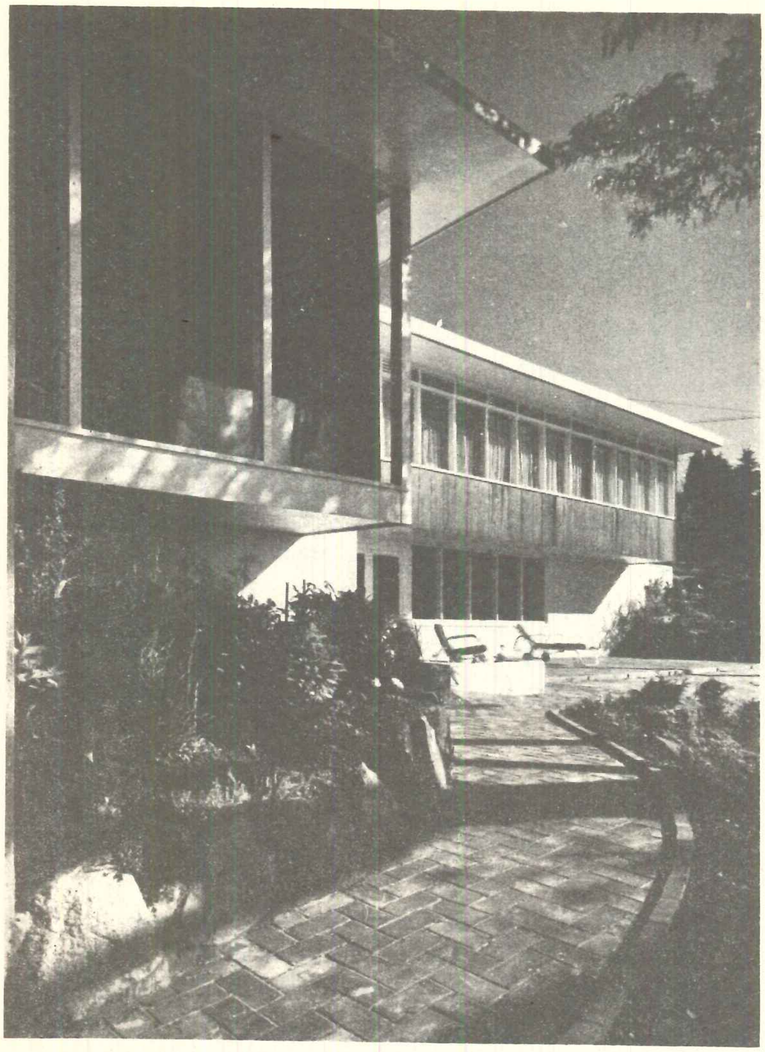
THE OWNERS OF THIS RESIDENCE facing Puget Sound had an unusually long list of special requirements: the house must be of straightforward contemporary design and must have an office-display room for Mr. Roberts, a salesman; it must have a shop for him, since his hobbies are woodworking, carpentry and landscaping; it must have four bedrooms (the family consists of three adults and two children), a playroom with outdoor terrace, and a dining patio. Since the site is a sloping wooded hill overlooking Puget Sound and the Olympic Mountains, the house obviously also had to be oriented toward the view.

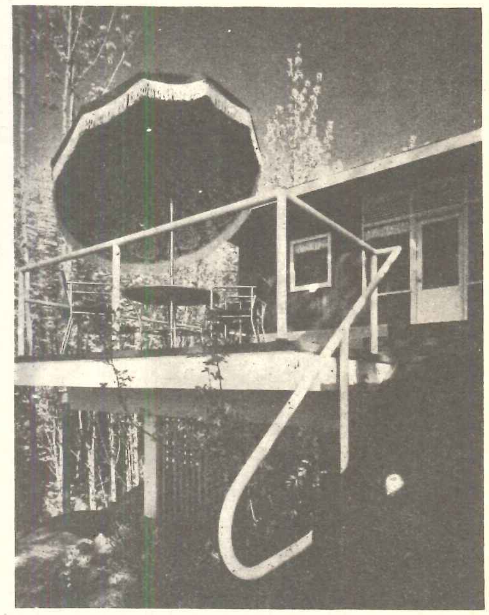
The plan which resulted (page 133), and the way in which it was carried out, subsequently brought Architects Young & Richardson an award from the Washington Chapter, A.I.A. Living and dining rooms, three bedrooms and the kitchen all face the view; so does the large recreation room in the basement. A shop of generous proportions opens through the carport directly to the exterior. The office is strategically located just within the main entrance, virtually cut off from the rest of the house, and accessible from the shop, in effect giving Mr. Roberts a separate suite for his business and hobby requirements. The lower terrace has a built-in barbecue, and doubles as the play terrace and dining patio; the recreation room opens to it.

The house is of wood frame construction on a concrete foundation. Exterior walls are handsplit cedar siding, natural finish. The built-up roof is topped off with white marble chips to give overlooking residences a pleasant aspect — the first roof in the Northwest, the architects report, to be so treated for such a purpose. Heating is hot water panel in the concrete slab and hot water convectors in bedrooms and recreation room.



The sloping site permitted a basement recreation room over 30 ft long, opening to a paved terrace. The owner did much of the landscaping himself





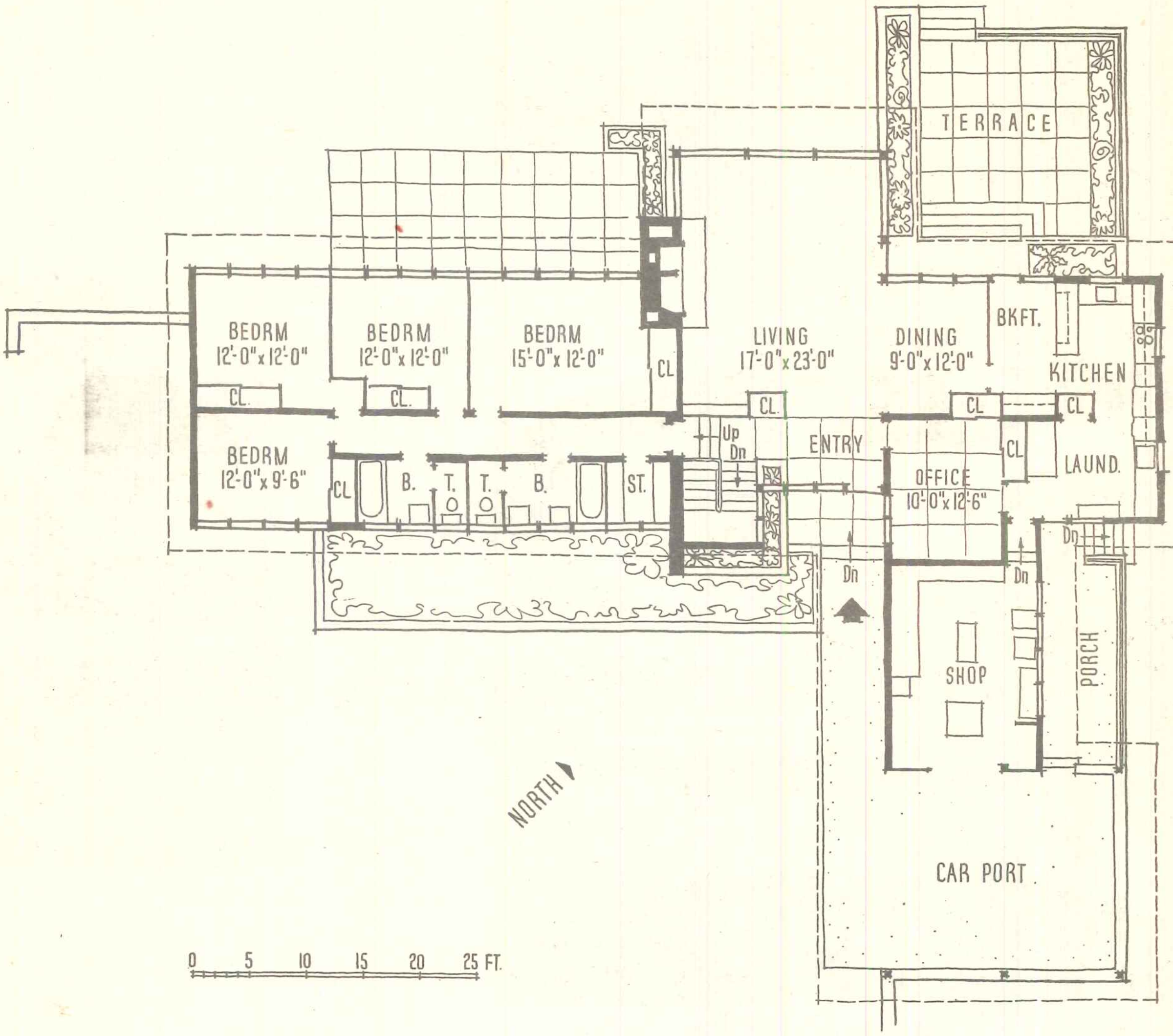
Charles R. Pearson Photos

Above: a brick walk curves under living room windows toward lower terrace

Above right: upper terrace can be reached directly from living room and breakfast alcove as well as from lower level, but is completely secluded

Right: main feature of living room is the glass-walled alcove cantilevered out to take full advantage of the view

Far right: dining area is tied to living room with one wall of vertical T & G fir, but is really a separate room; door at extreme left leads to upper terrace


TERRACE
BEDRM
12'-0" x 12'-0"
BEDRM
12'-0" x 12'-0"
BEDRM
15'-0" x 12'-0"
CL
LIVING
17'-0" x 23'-0"
DINING
9'-0" x 12'-0"
BKFT.
KITCHEN
CL.
CL.
CL
CL
CL
BEDRM
12'-0" x 9'-6"
CL
B.
T.
T.
B.
ST.
Up
Dn
ENTRY
OFFICE
10'-0" x 12'-6"
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PORCH
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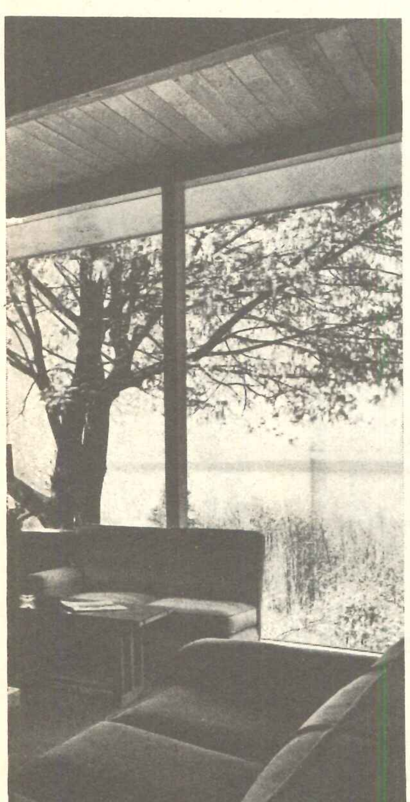
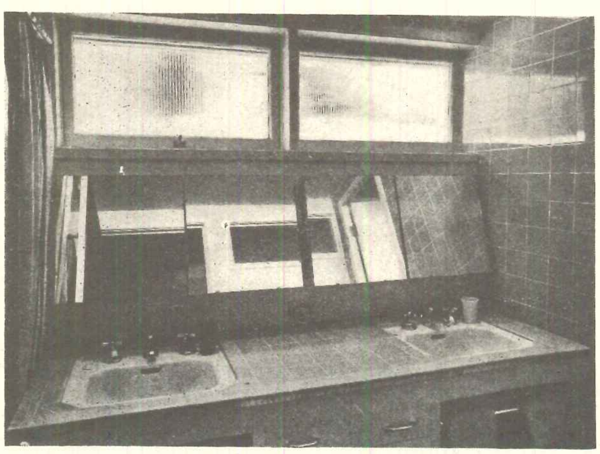
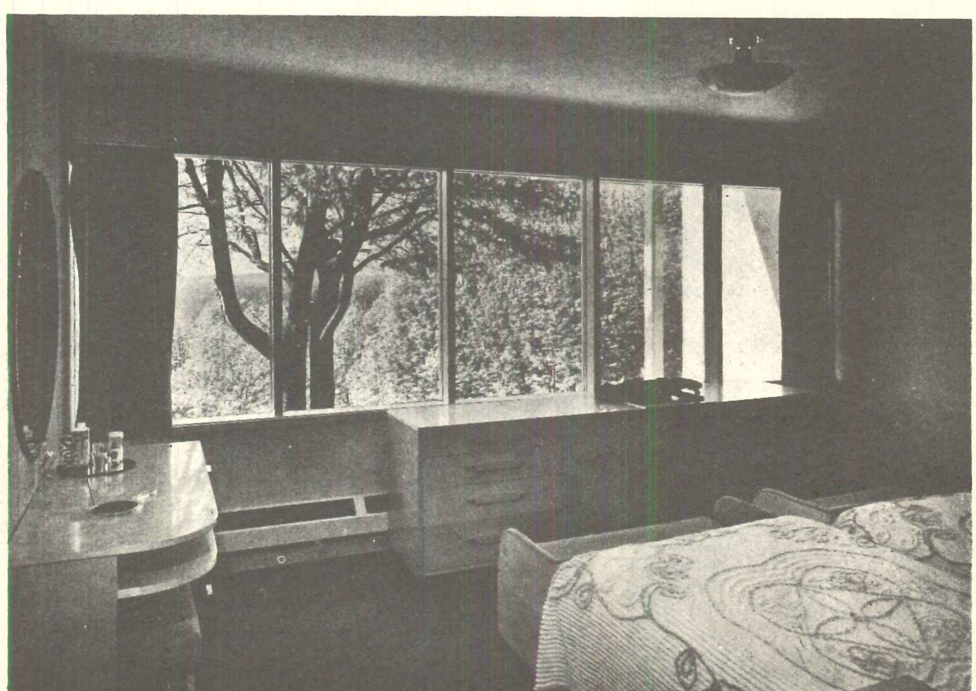
CAR PORT
0 5 10 15 20 25 FT.



Charles R. Pearson Photos



Above: even the kitchen looks out on the Sound. Left: larger of the two baths has well-lighted sloping mirror. Below: three of the four bedrooms face the view



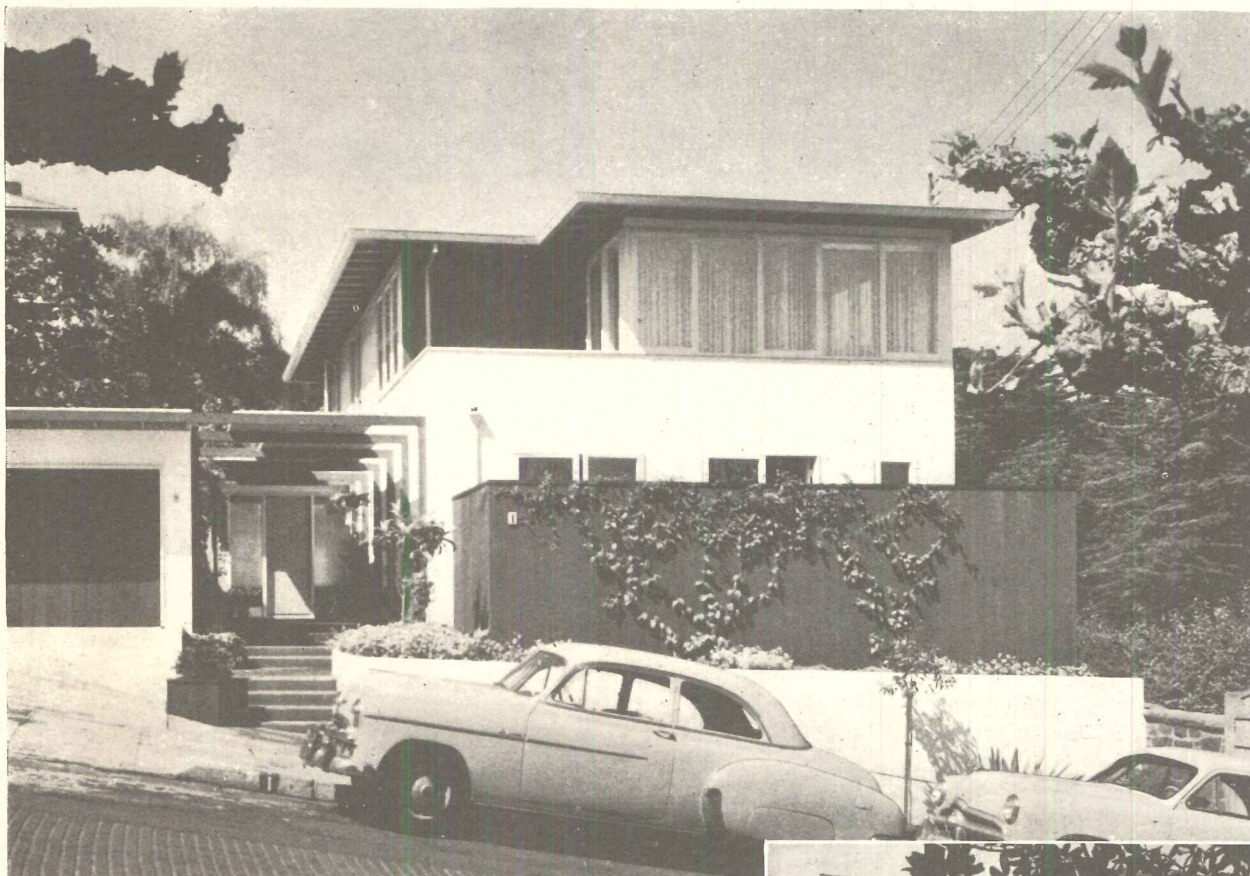
LIVABILITY ON A SMALL, HILLY LOT

RESIDENCE FOR MR. AND MRS. ROBERT P. LILIENTHAL, SAN FRANCISCO

Worley K. Wong, Architect, and John Carden Campbell

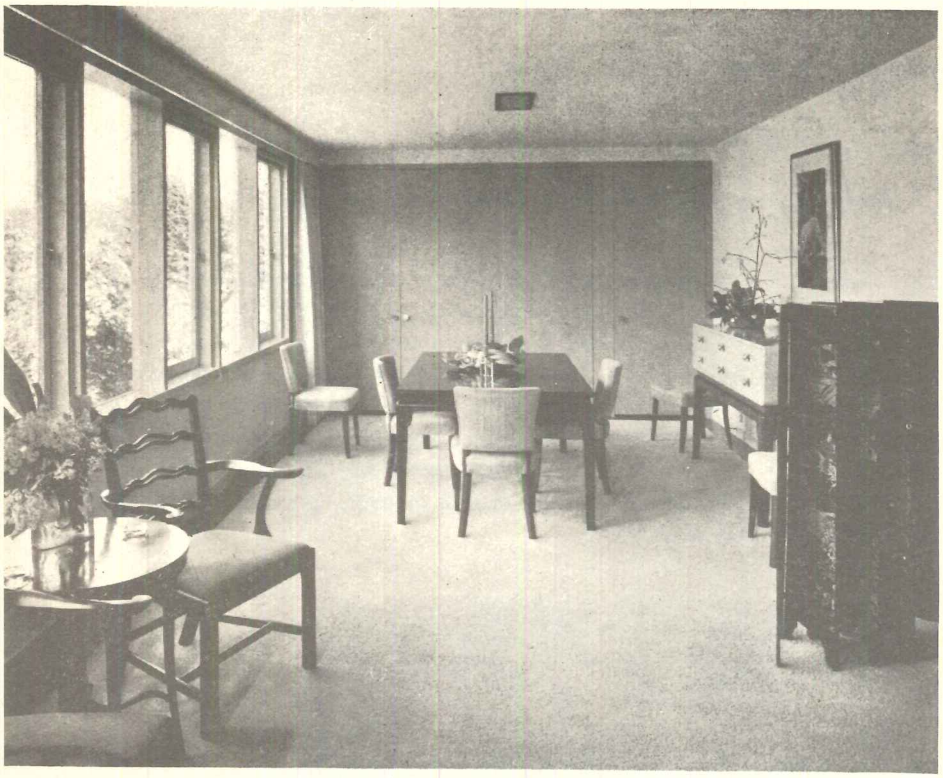
Eckbo, Royston & Williams, Landscape Architects

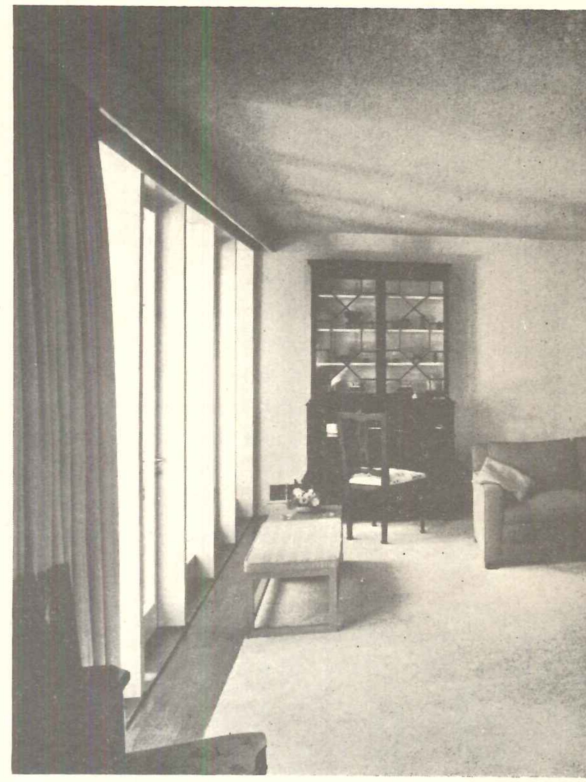
THE PLEASANTNESS of these photographs might well disguise the fact that the designers have achieved something extraordinary in developing the utility of space. This is a large house, with double garage and garden, all on a difficult hillside lot measuring but 52 by 80 ft. In this respect the handling of the front of the lot is especially good — the garage is set as far forward as the grade will allow, and the enclosed service yard frees garden space for maximum use, yet the landscaped entrance court gives the whole a note of gracious welcome. The little entry wing makes the garden join in the visitor's welcome, but also maintains the privacy of the garden. The long narrow plan of the house gives a nice separation of various activities, and comes to a focus at the outdoor living space. Notice, too, that in spite of the confinement of the site the rooms are generously proportioned, and closet and storage space is also on the generous side.

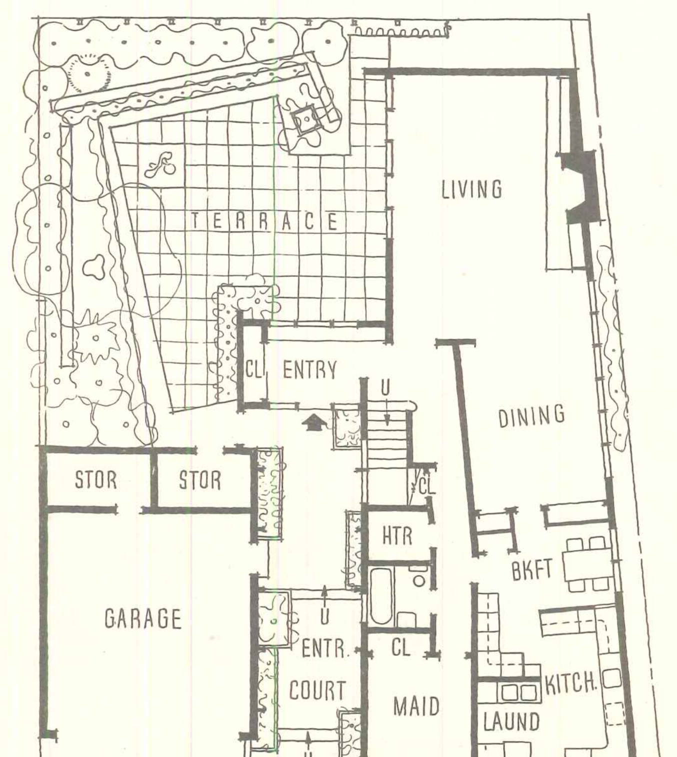


Roger Sturtevant Photos

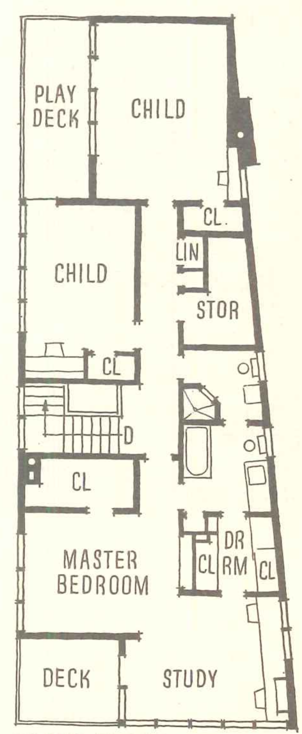
In both the entrance court and the garden, shelves for potted flowers and planting beds provide a great quantity of floral beauty without much sacrifice of space



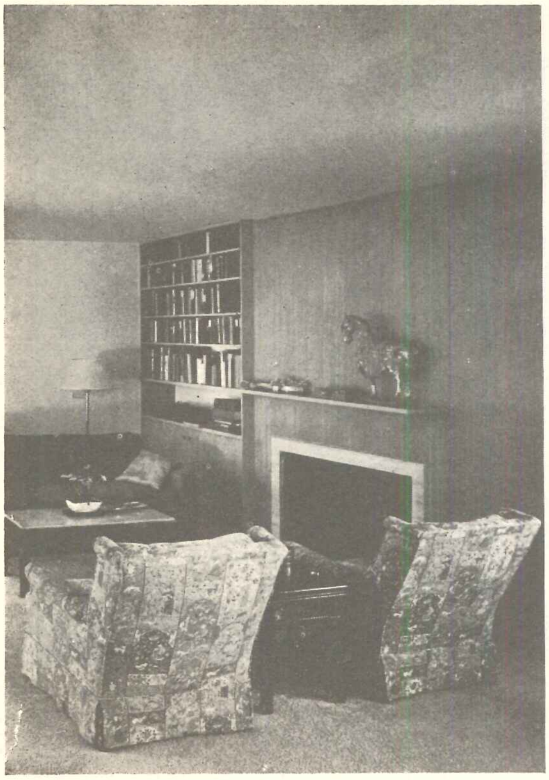


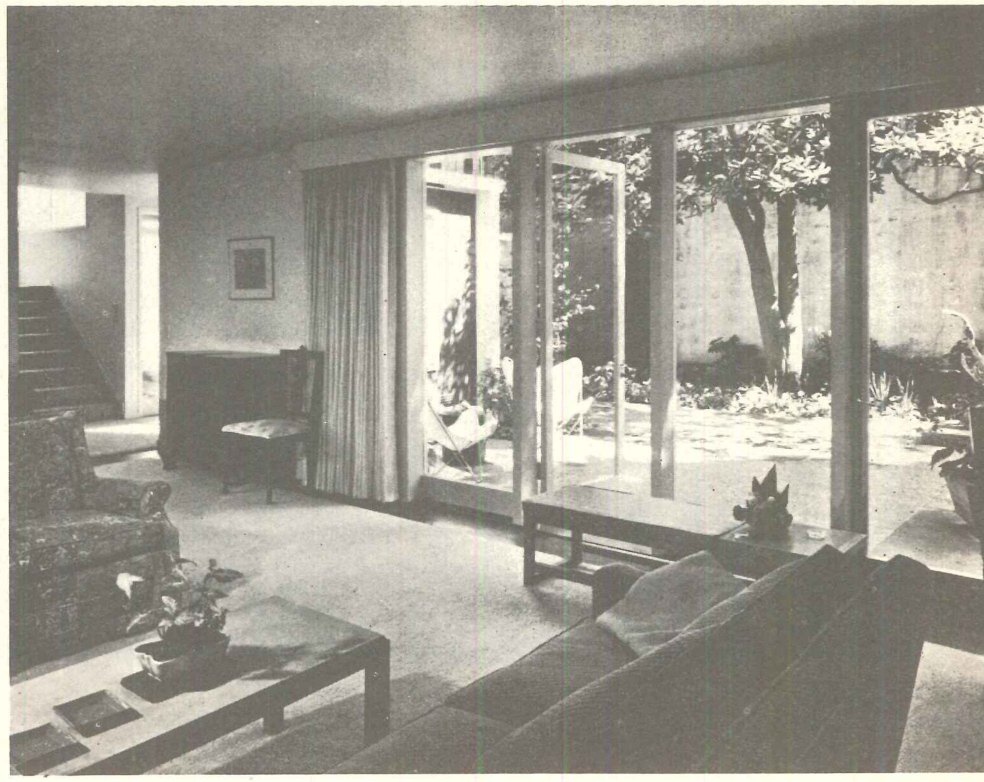


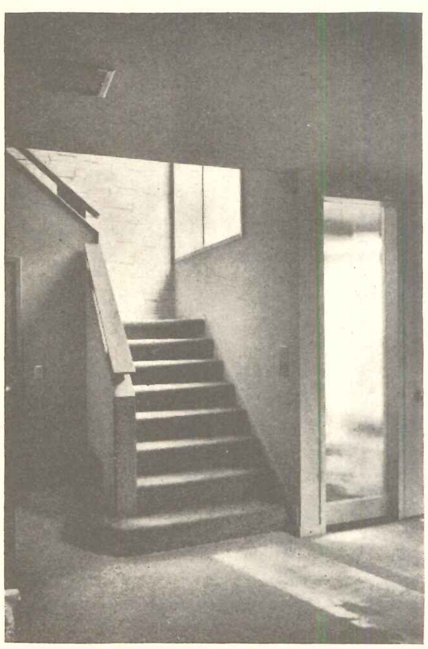
GROUND FLOOR



UPPER FLOOR

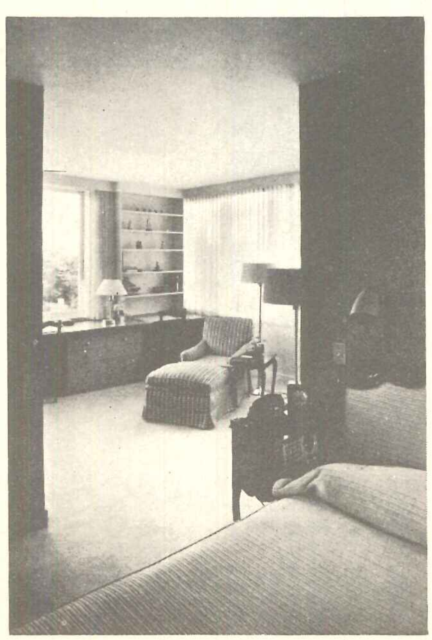


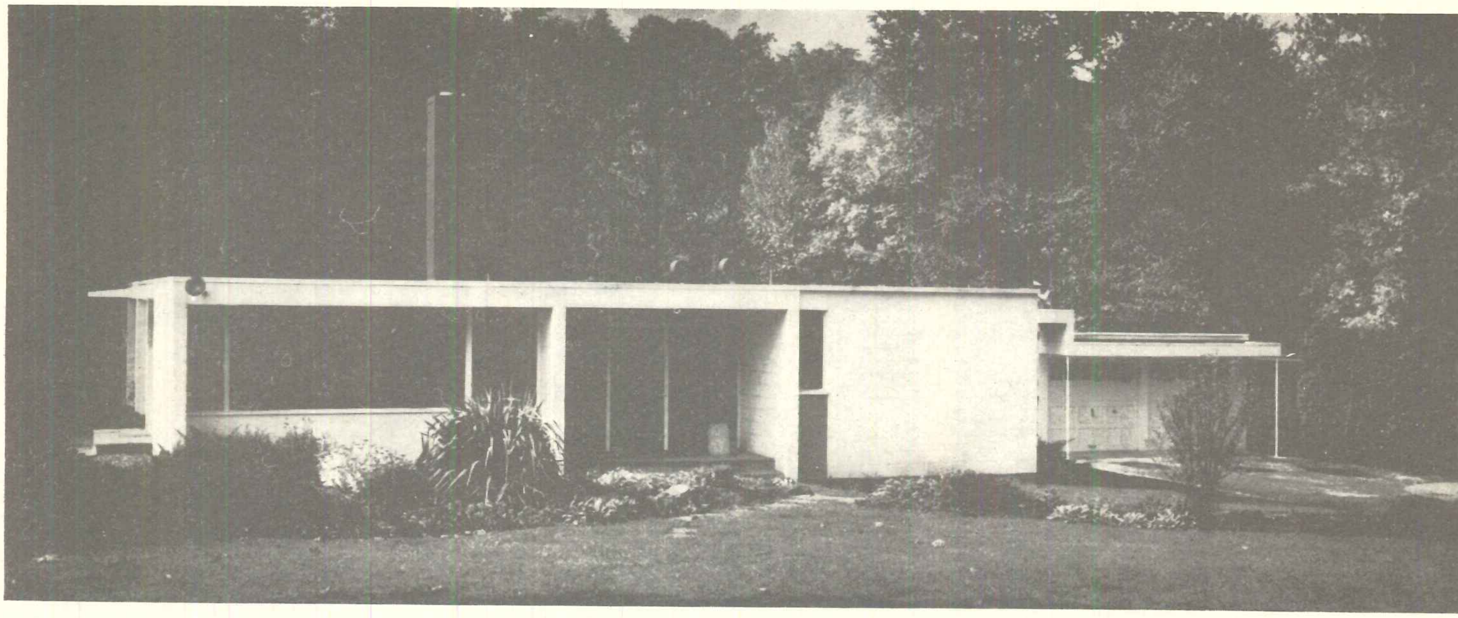




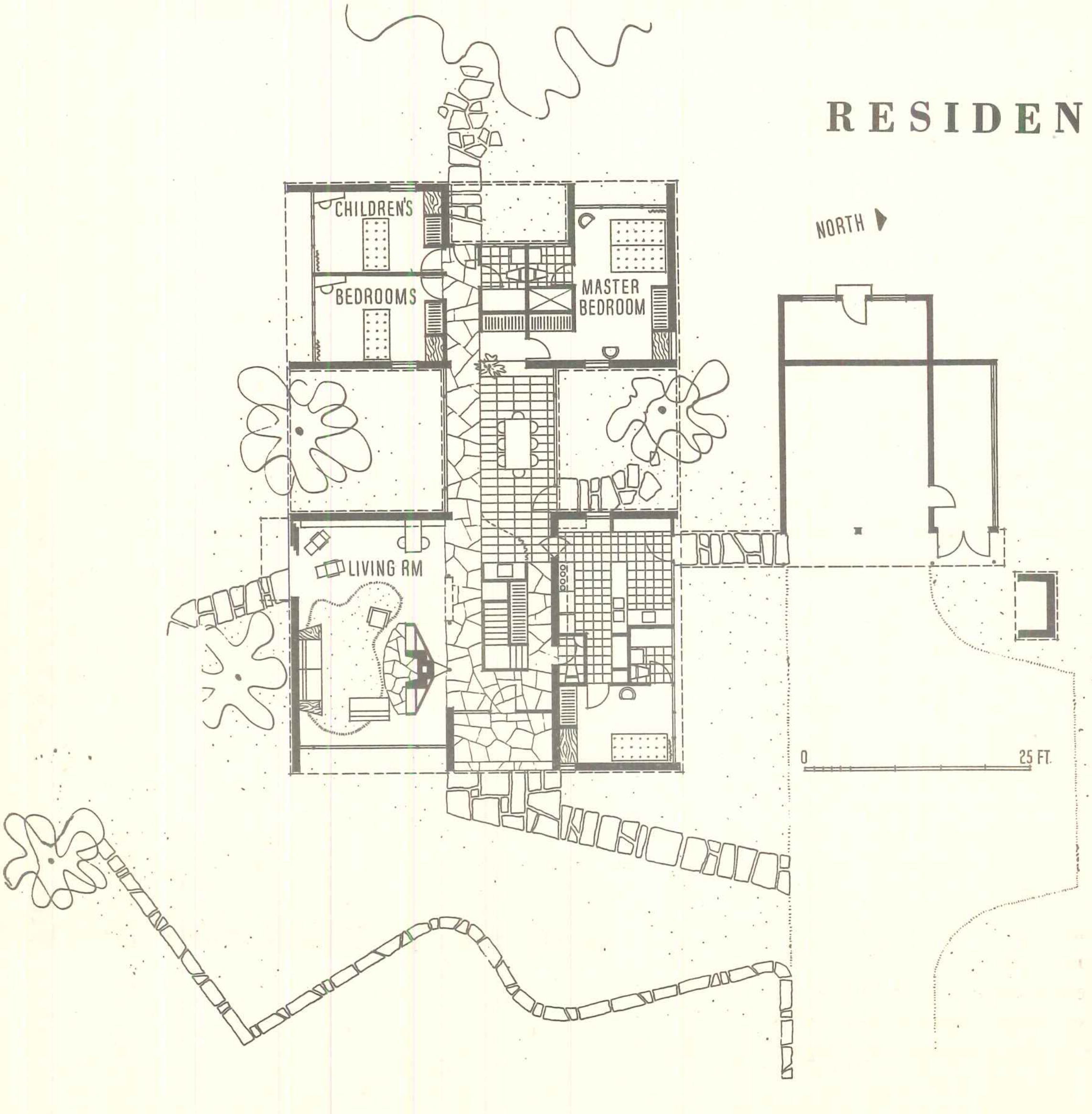
Living room at rear of house is far removed from kitchen or street activities, opens to enclosed outdoor living space. In combination with dining space and garden, it manages a feeling of extensiveness seldom realized on a narrow city lot. Campbell & Wong did the interiors, using most of the owner's existing furniture. Covers and color schemes were changed in some cases, but only two new pieces added

Roger Sturtevant Photos

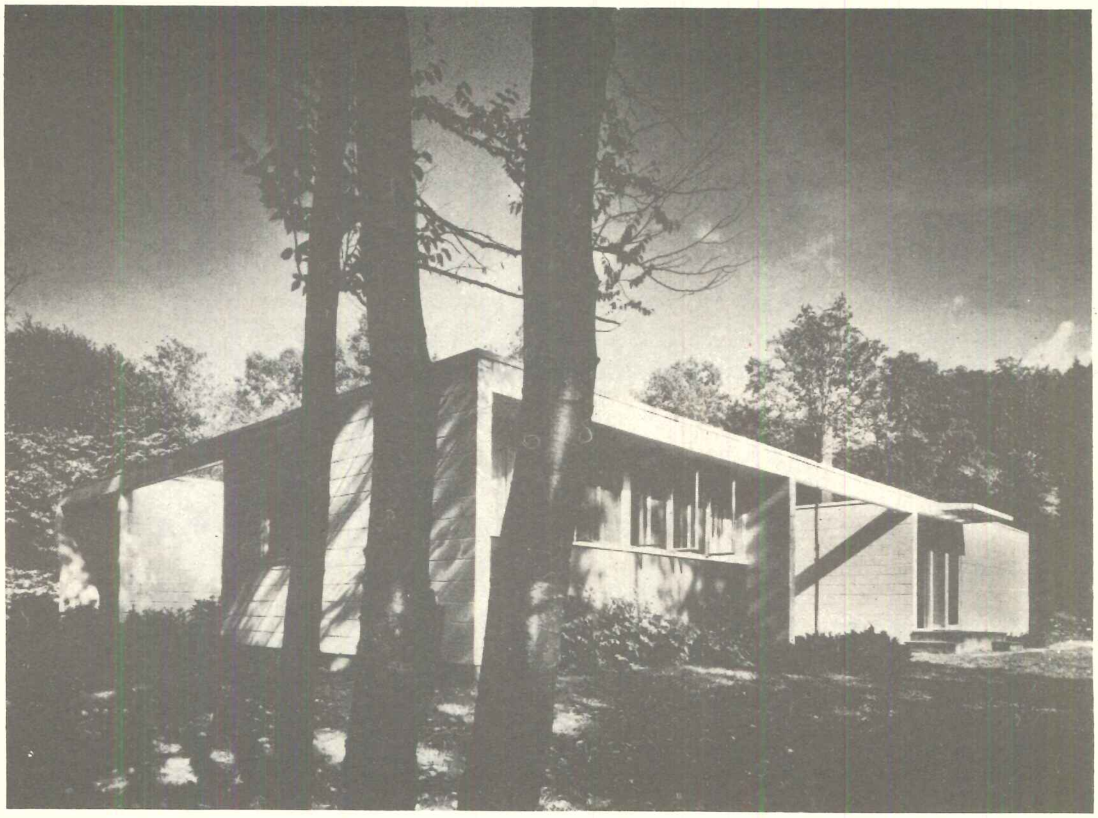




Ben Schnall Photos



RESIDENCE FOR



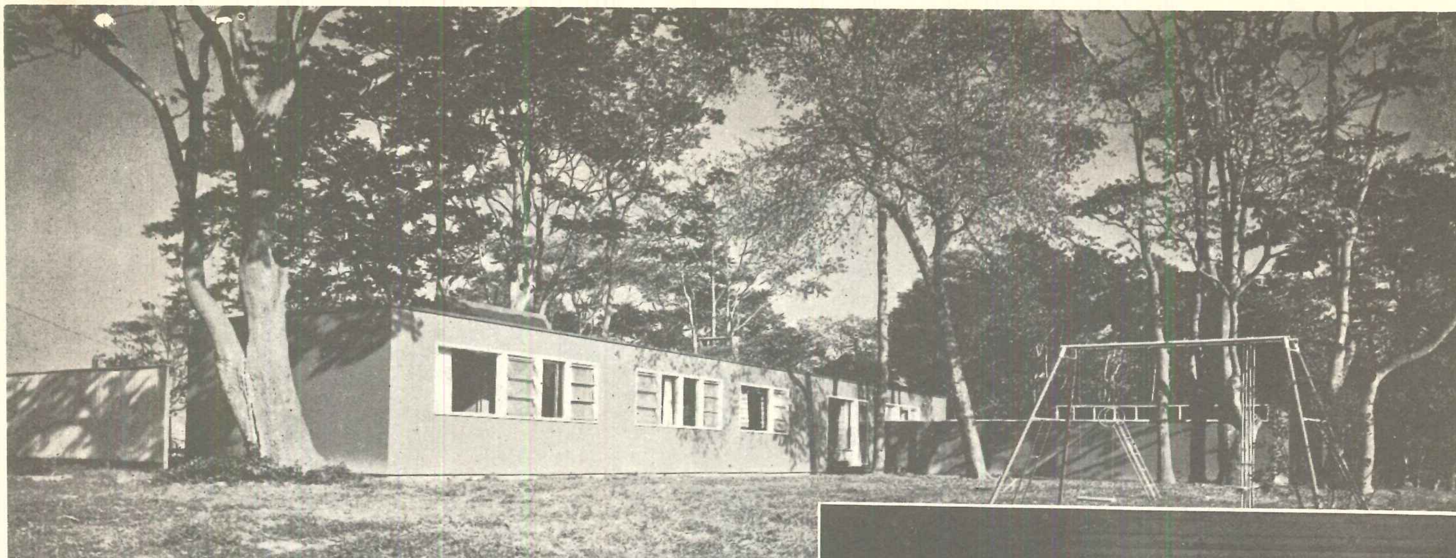
MR. AND MRS. GEORGE PALLEY

Croton-on-Hudson, N. Y.

Sanders & Malsin, Architects

WHEN A HOUSE IS DESIGNED, as was this, chiefly for summer and weekend use, it should be as open and informal as possible. This one was planned as the successor to an earlier one on the same site which had burned to the ground except for the chimney. The first house had been two stories in height, and the chimney had been correspondingly tall; in this new version the chimney was left intact, and towers unexpectedly above the low roofline.

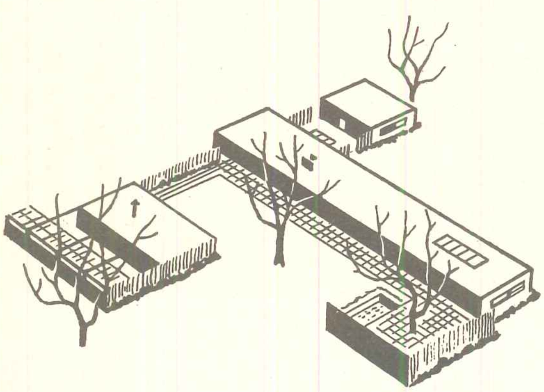
The bi-unit plan shown opposite was developed to meet the demands of a family which, entertaining a great deal and therefore needing a large dining room, nevertheless did not wish to waste space for dining facilities. By dividing the house into two wholly separate units — one for living and service, the other for bedrooms — and joining the two by a rather narrow passage containing the dining area, the architects not only solved the entertainment problem but also achieved an exceptionally open effect. And having achieved that effect they emphasized it by giving each wing a separate color for its below-window panel: yellow for the living room, bright red for the children's wing, gray for maid's room, blue-black for common areas, brown for owner's room. Other exterior walls are white-painted concrete block.



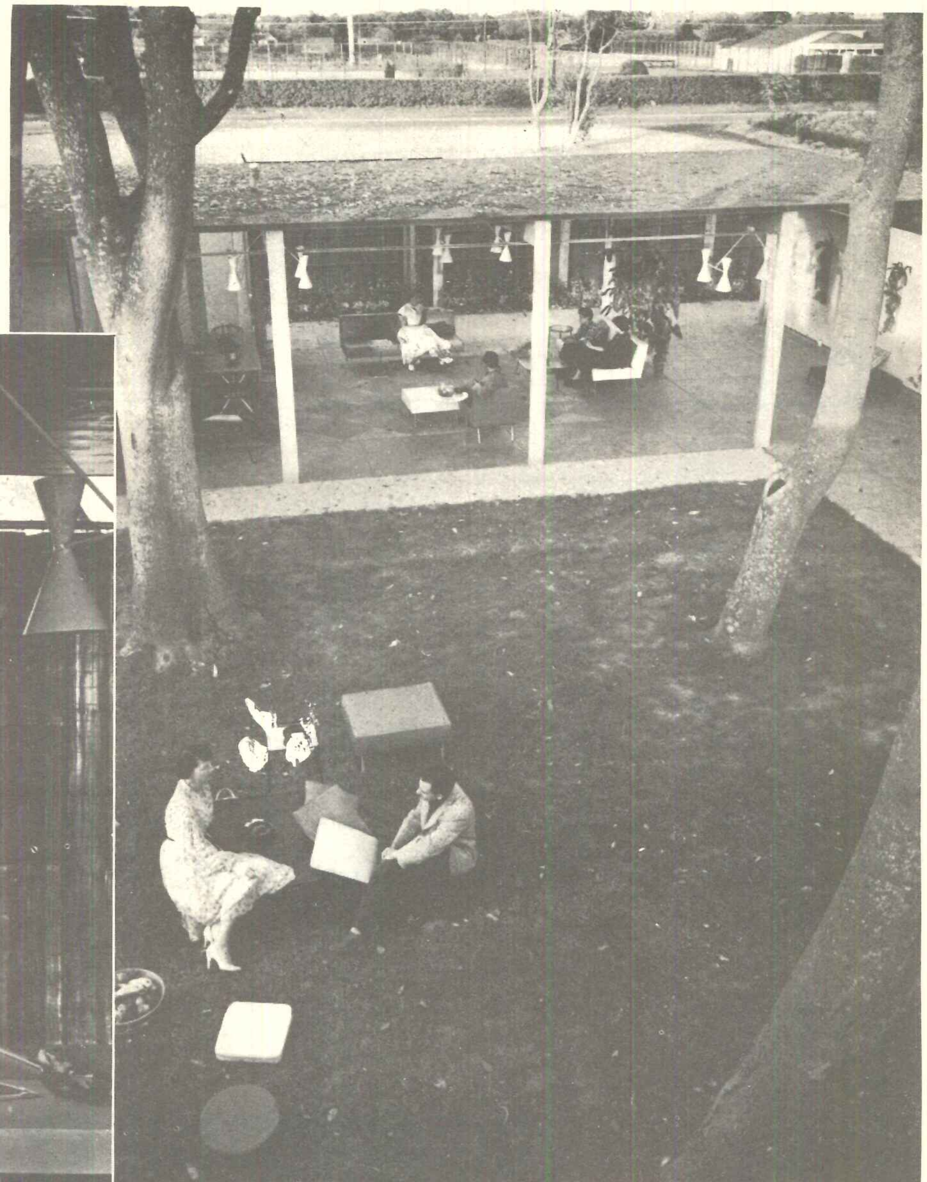
HOLIDAY HOUSE

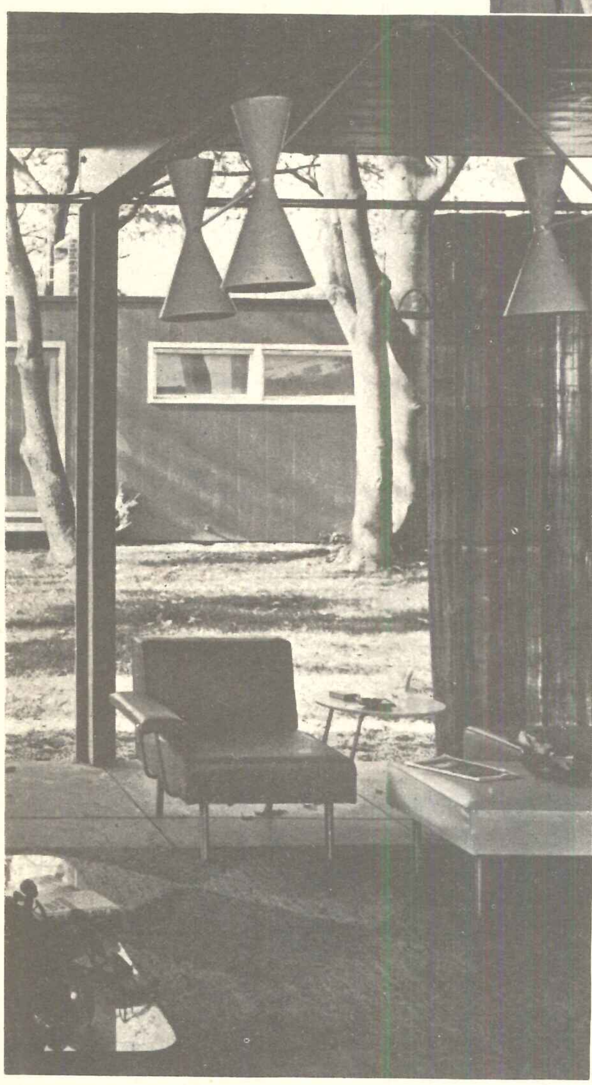
QUOGUE, NEW YORK

George Nelson, Architect



Photos by Ezra Stoller: Pictor, courtesy of Holiday Magazine, The Curtis Publishing Company Copyright 1951



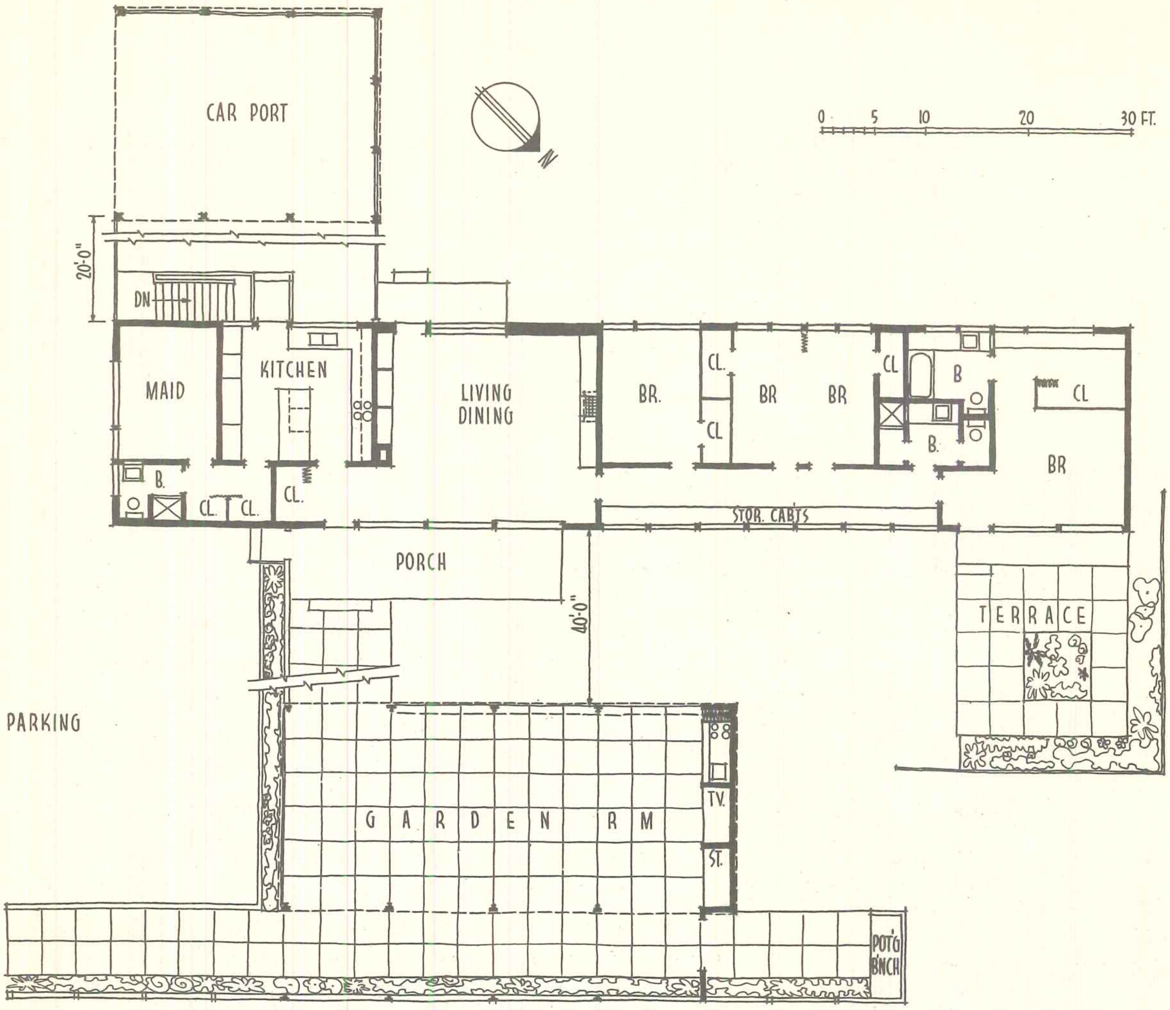


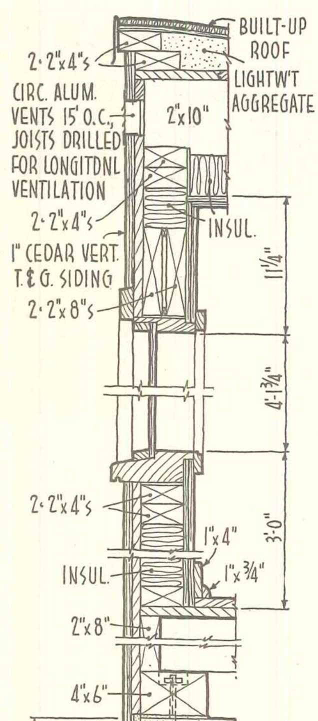
Fences and paving connect house, garden house and garage, define outdoor living areas. Photos center and above: garden house, inner court. House proper, 100 by 20 ft, is simplest structure possible. Entire compound is set back 100 ft on acre site

THIS UP-TO-THE-MINUTE HOUSE, the first of an originally proposed series of "Holiday Houses" sponsored by *Holiday Magazine*, was designed to explore methods of increasing and organizing interior and exterior space, together with inclusion of numerous types of equipment, to produce an atmosphere conducive to full enjoyment of today's increased leisure time, and to lighten housekeeping chores. It is also a vacation house, with the attention to recreation facilities which this implies.

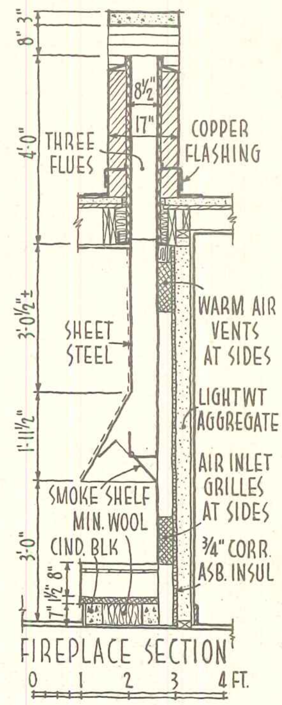
In his solution, since it was a demonstration house, Nelson has concentrated his expenditure for mechanical equipment, and realized extra recreation space through skillful use of outdoor areas. The house is frankly large and luxurious, and has a high level of craftsmanship, together with a marked simplicity of design and construction. However, of the total living space of 100 by 100 ft, only a small portion is actually enclosed, considerably reducing relative costs. A compound of secluded living areas was created by use of screening fences to link house with garden room and a carport.

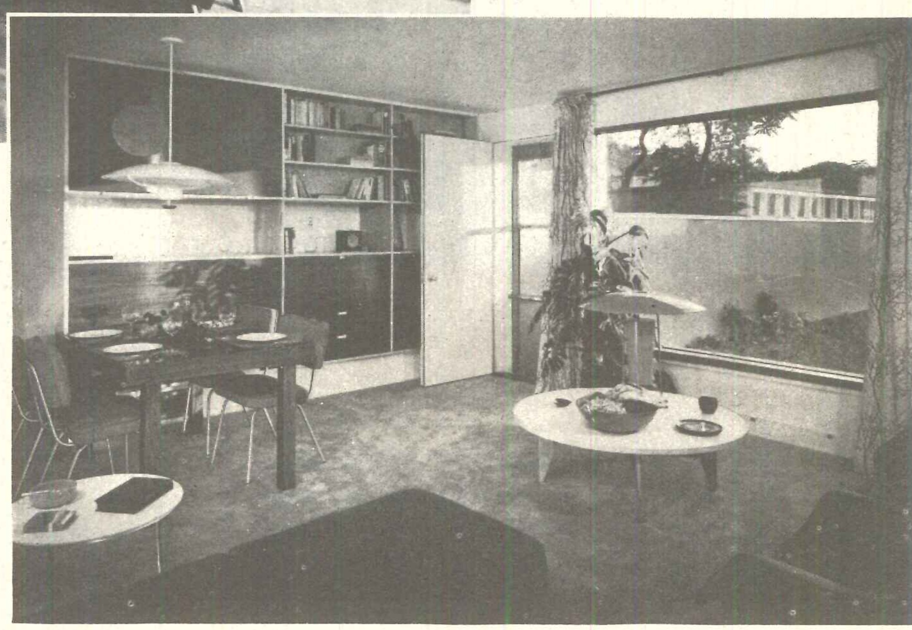
For planning purposes, a hypothetical family of adequate means, with two children, was used as a client. Nelson feels that the task would have been easier with an actual client to limit and personalize the design, and to give more definition to the problem.

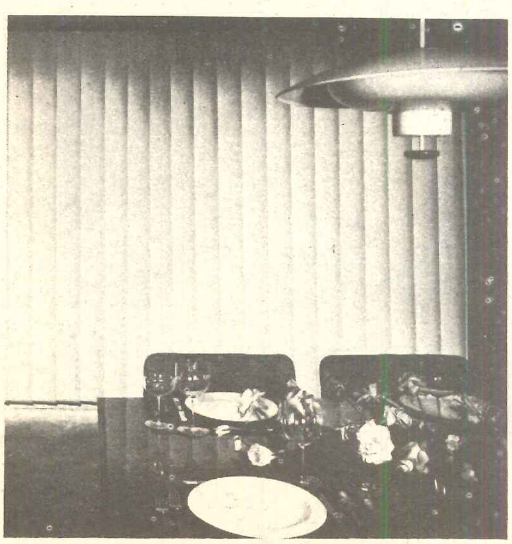




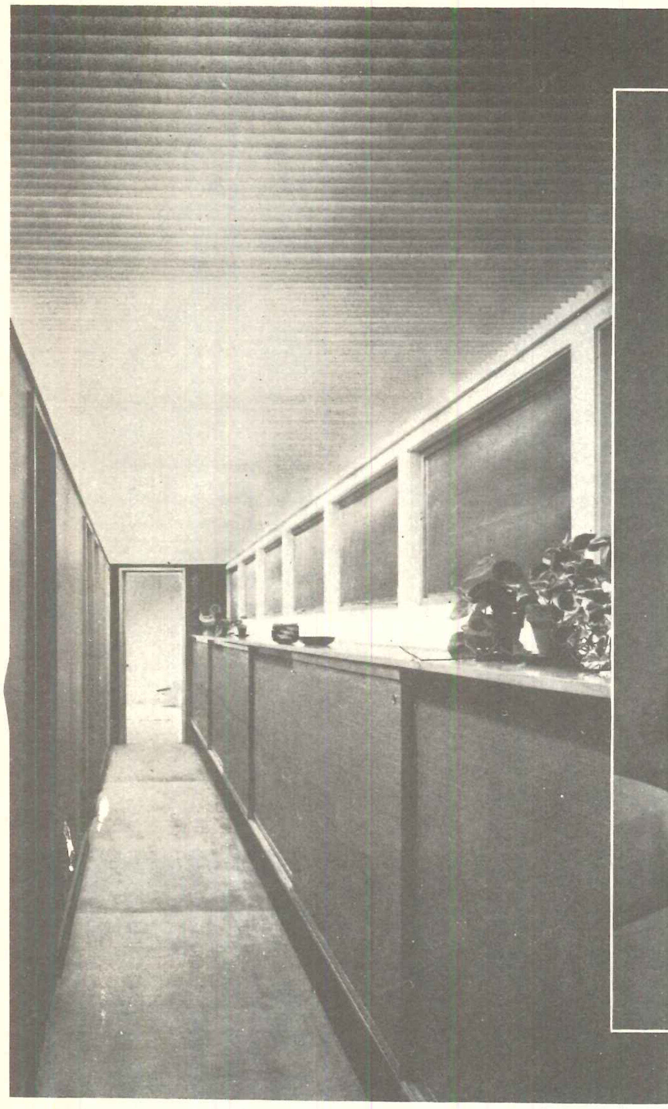
Ezra Stoller: Pictor

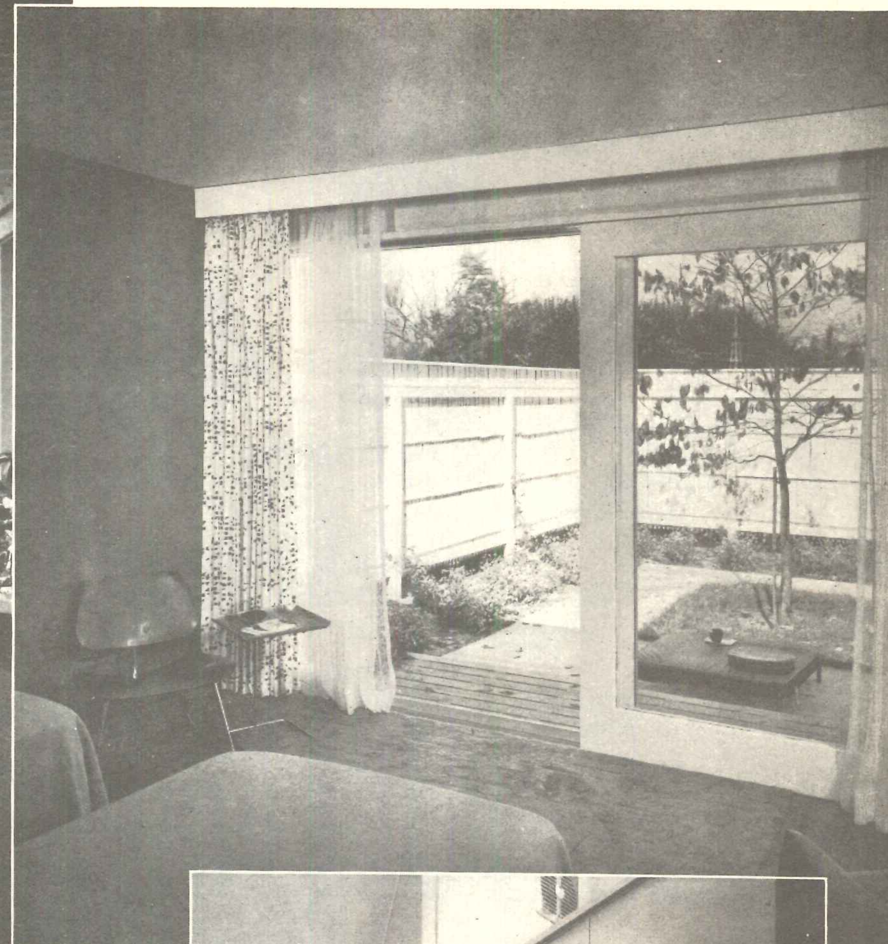


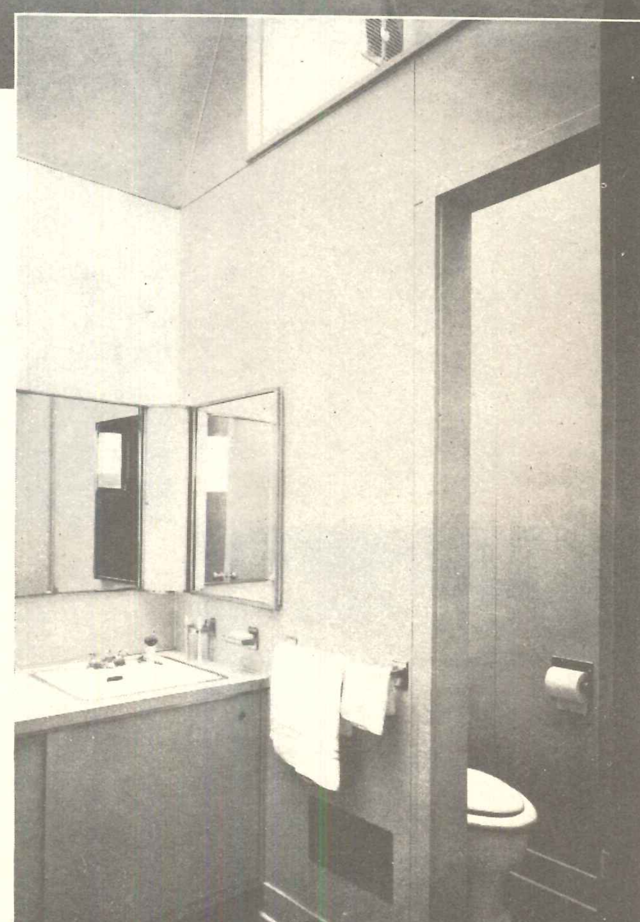




Focal point of the house plan (upper left) is the living-dining area. It is flanked by the two main garden areas and the bedroom and service wings. Sitting area (above center) is dominated by black sheet-iron chimney (detail above). Slate-top bench which extends the hearth is most useful for entertaining, as is built-in storage in dining area (above). All lights are dimmer controlled. The room is easily closed in or opened to outside. Motor-operated window toward carport (above) opens onto small private terrace for dining; it sinks into foundation cavity, pulling screen into place. Draperies are also motor-operated. Opposite wall has adjustable cloth blinds (left). Garden room has built-in kitchenette, television, lights which slide in ducts between beams. The conventional dry wall construction is shown in typical wall section, far left







Equipment was carefully selected in full co-operation with manufacturers, who, considering the attendant publicity, in every case provided the best of their products. This has greatly increased the house's value and the level of performance. It has, of course, also increased its monetary value. On the other hand, the manufacturers' desire to provide the best of equipment led to a number of changes and other difficulties which greatly increased the architect's costs. While it might have been simpler and less expensive to have procured items through regular channels, this procedure would not have made it possible to experiment with the types and quality of materials that were made available.

The wood frame structure is conventional and straightforward in design. Foundations are concrete block. Siding is cedar, stained. The basic interior finish is wallboard; in the living room, this is covered with white-painted sized burlap. Floors are hardwood, with linoleum or tile in kitchen and baths, asphalt tile in workshop. The heating system employs an oil-fired air conditioner. Special equipment includes an intercom system to all areas, dimmers for many of the lights.

HILLTOP RESIDENCE OF JAMES DINWIDDIE

LAFAYETTE, CALIFORNIA

John Ekin Dinwiddie, Architect
and Richard Maxwell

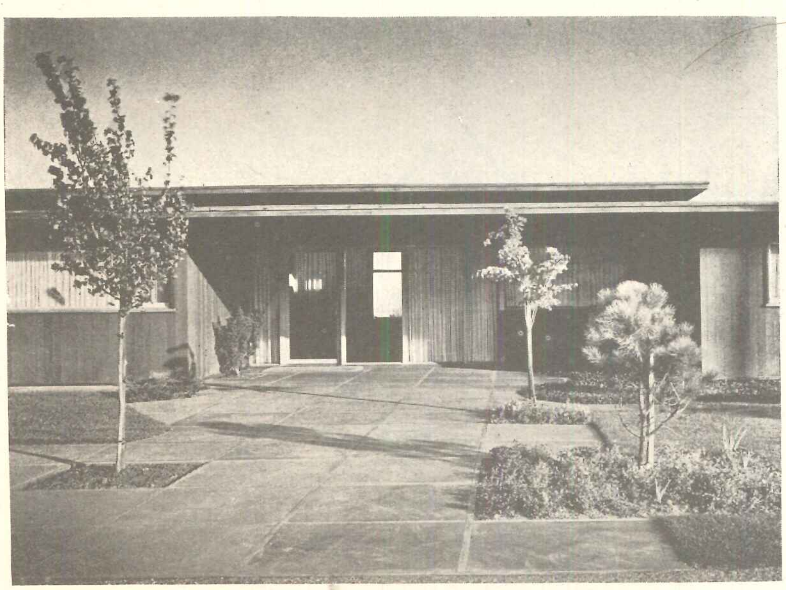
Robert Royston of
Eckbo, Royston & Williams, Landscape Architect

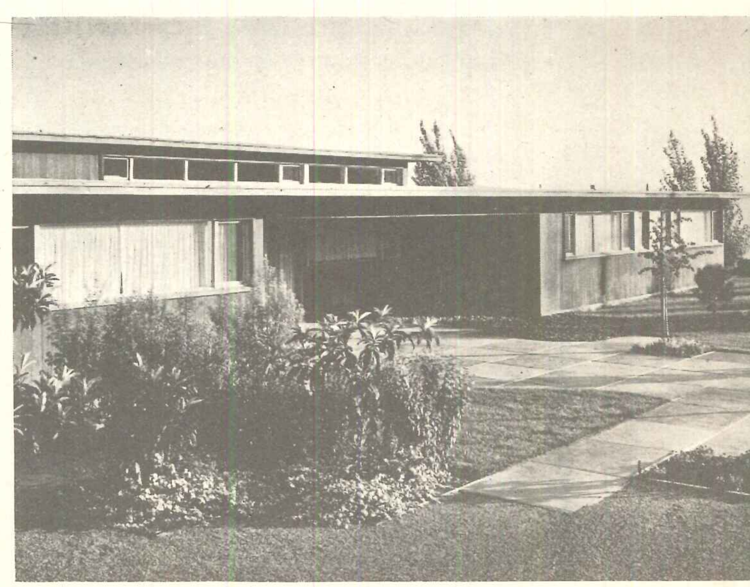
LIKE MANY HOUSES in California, this one, designed for the architect's brother, occupies a hilltop site and boasts a broad view. To take advantage of this it is long and narrow, with the living-dining areas, den and master bedroom all at the "back" of the house, facing the view. Walls on this side are almost wholly of glass.

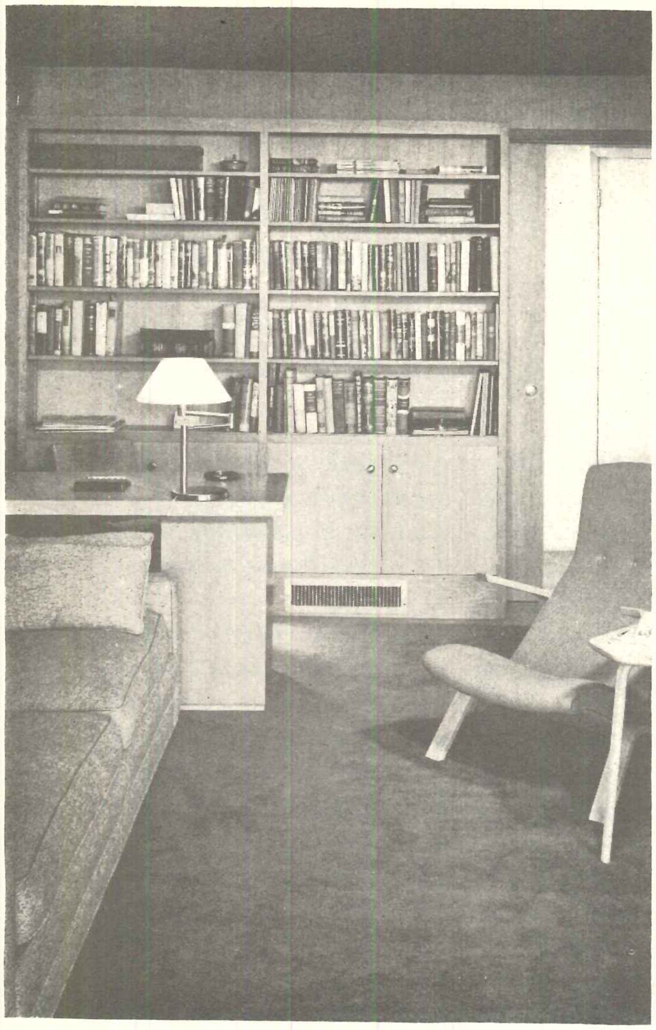
At first glance the plan (next page) seems simple. Further study, however, shows why the architect considers this house one of his best jobs to date: there is a general feeling of openness, yet each area has been given maximum privacy. The family wing is a unit quite by itself, with master bedroom and den completely shut off from the entrance court and foyer. Living and dining areas flow into each other along the terrace side, but are firmly separated for most of their width by the fireplace wall. The guest room, with its own bath, is adjacent to the main entrance. And the entire service wing is placed at a 45 deg angle to the rest of the house.

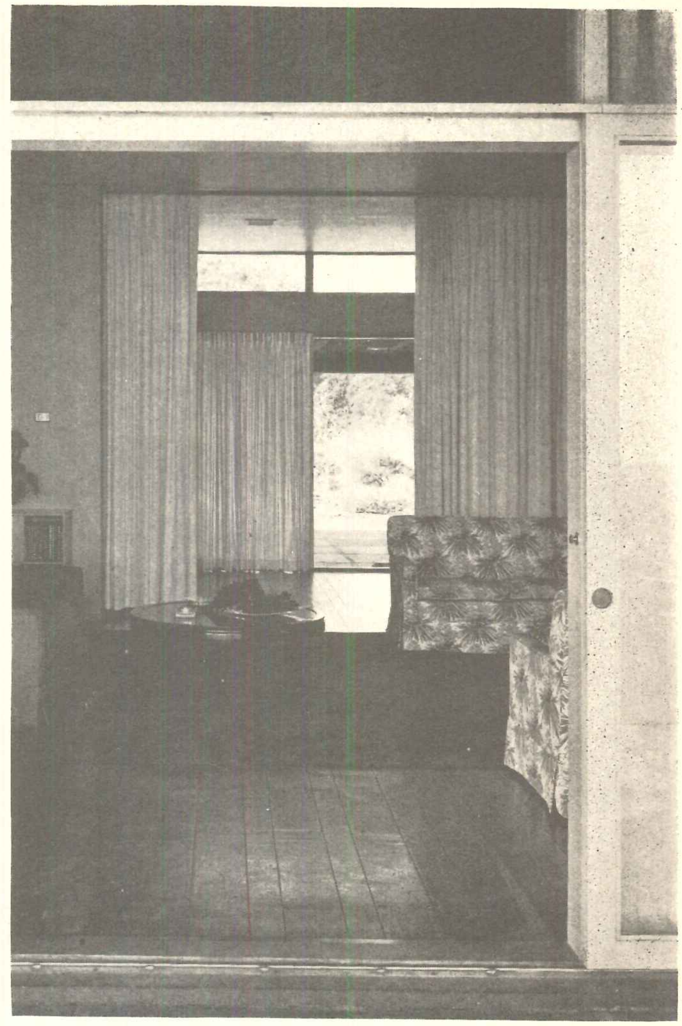
Of wood frame construction, on a reinforced concrete foundation, the house has exterior walls of redwood and a tar and gravel roof. Interior walls are gypsum board, floors are oak.

Morley Baer Photos

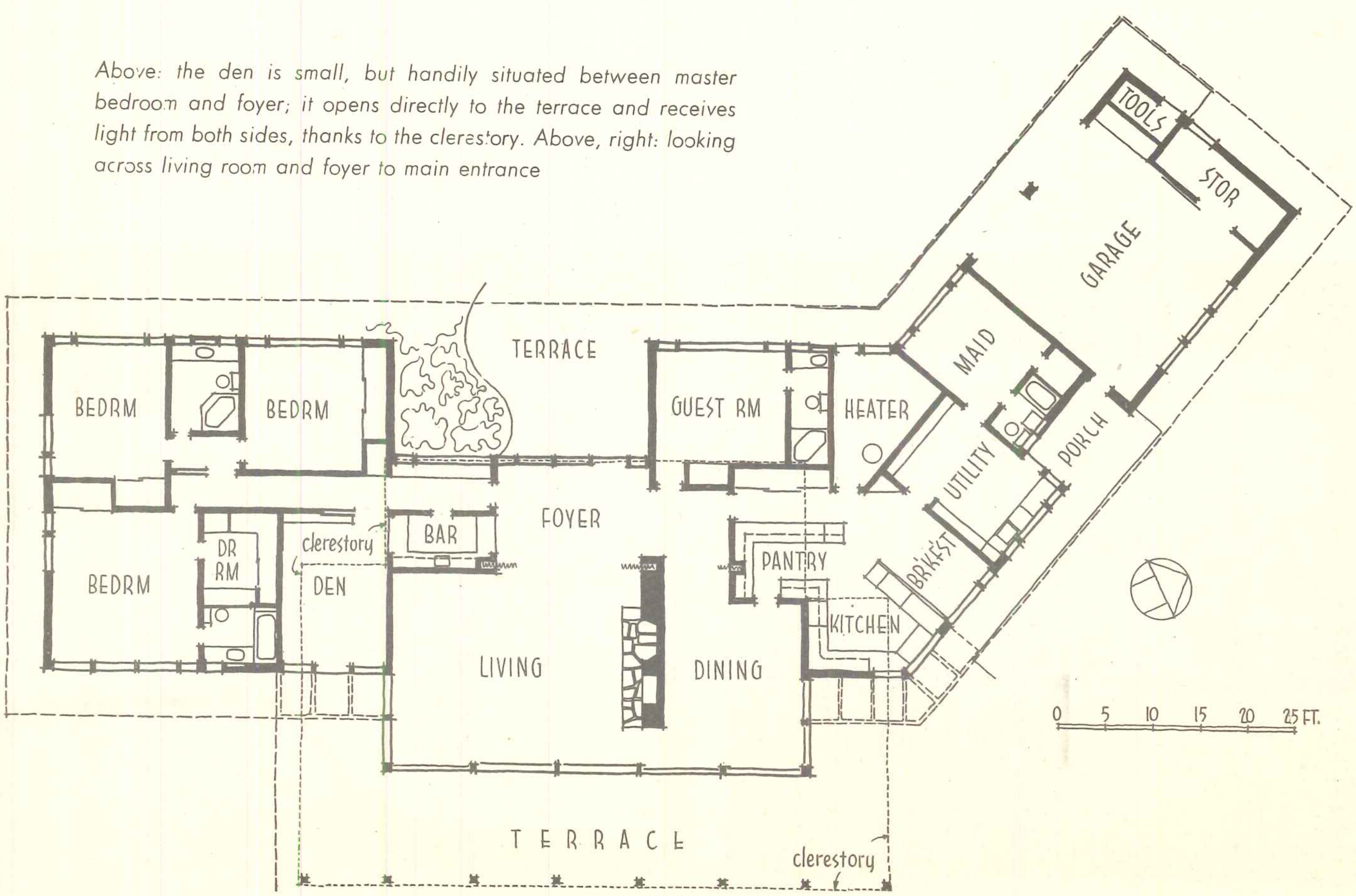






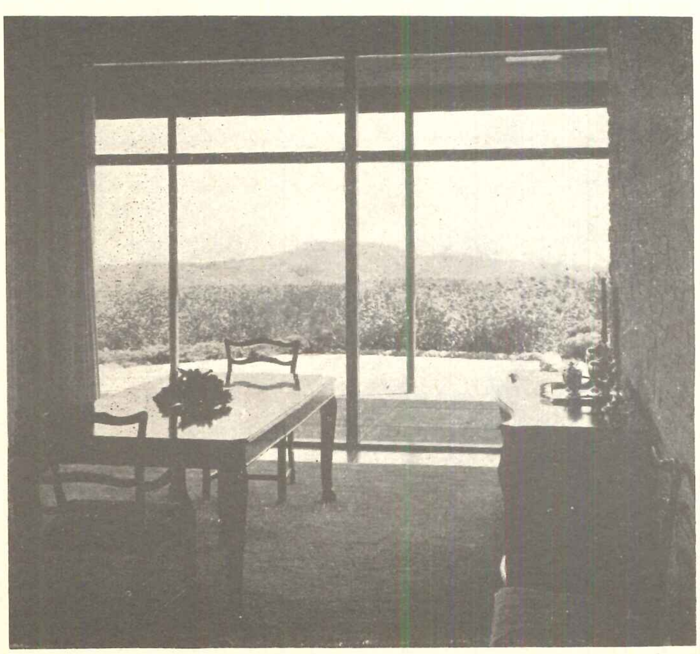


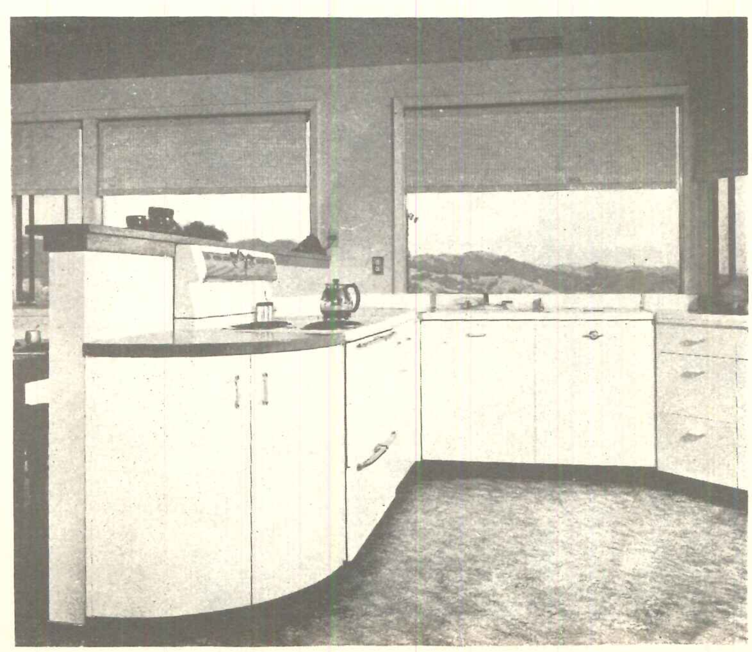
Above: the den is small, but handily situated between master bedroom and foyer; it opens directly to the terrace and receives light from both sides, thanks to the clerestory. Above, right: looking across living room and foyer to main entrance

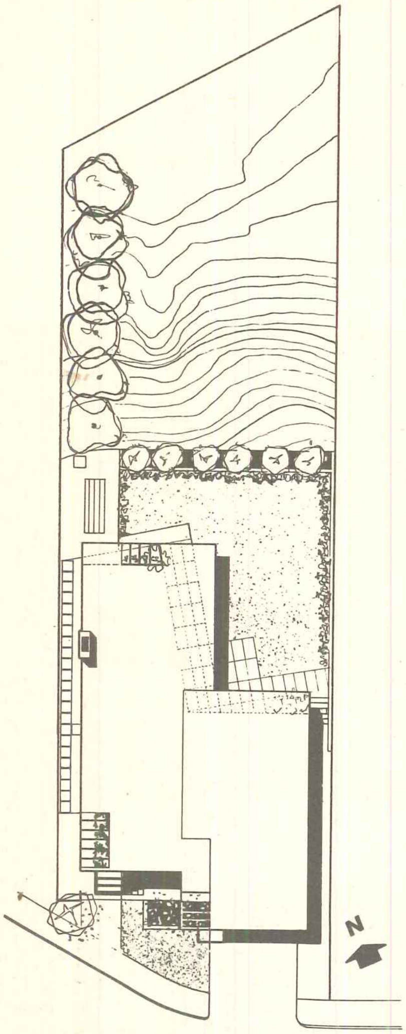


Above: living room looking toward dining room; fireplace wall effectively separates the two, but continuous glass wall and lack of doors give feeling of openness. Below, left: the dining room is wide open to the view. Below, right: kitchen, pantry and breakfast room are separated only by counters for an extremely compact, efficient unit; placement of kitchen at center of angle between wings gives maximum air, light and view

Morley Baer Photos



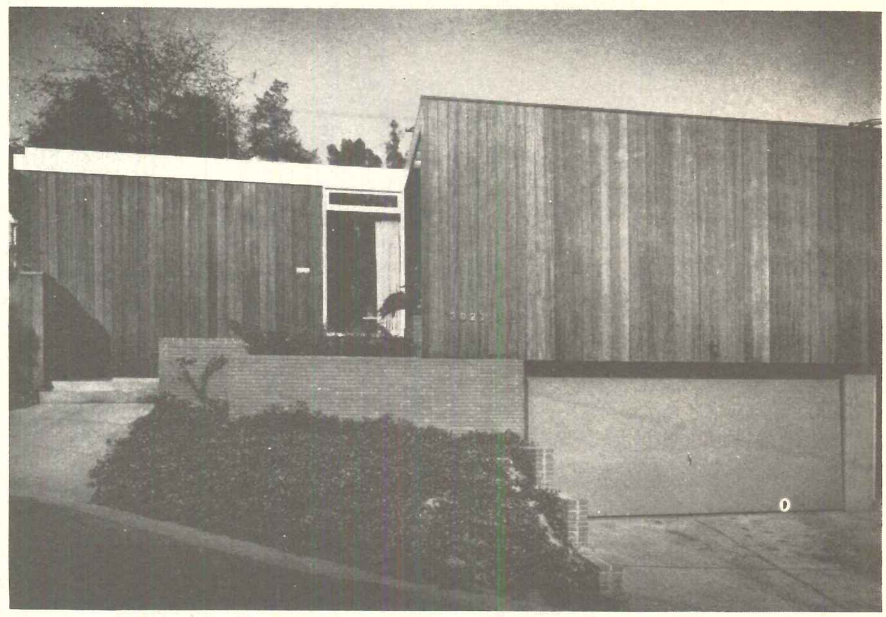


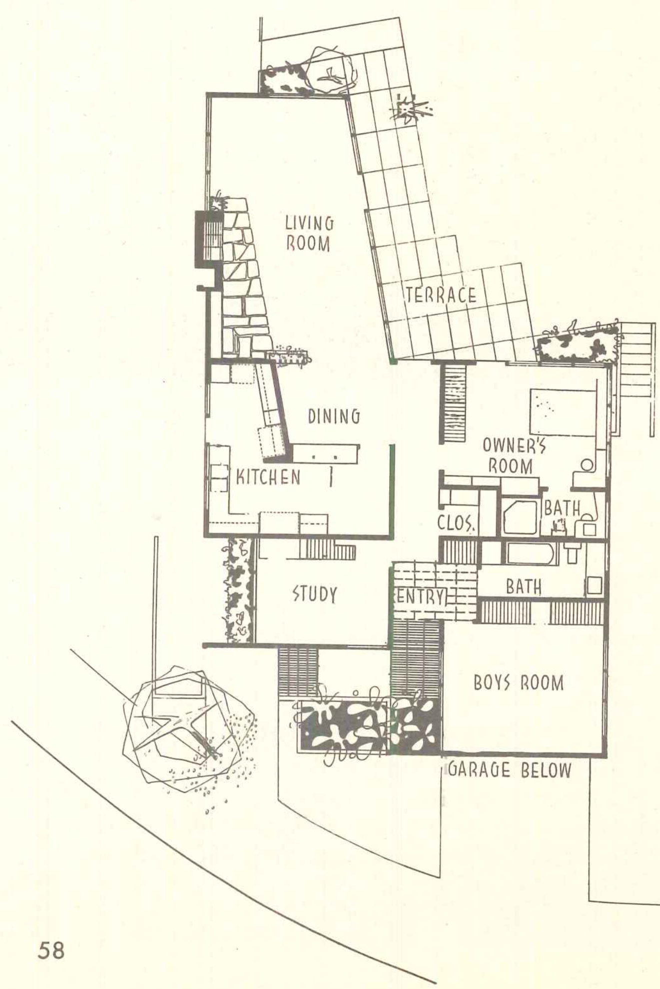


ARCHITECT DESIGNS OWN HOME FOR

Residence of Mr. and Mrs. Eugene Kinn Choy

Los Angeles, California





NARROW HILLSIDE LOT

Eugene Kinn Choy, Architect

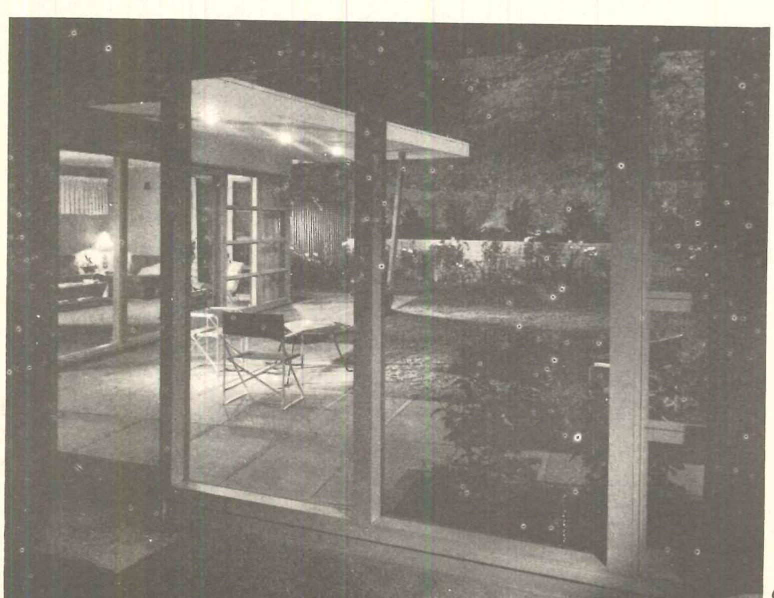
William M. Rowland, Landscaping Consultant

Julius Shulman Photos

A HILLSIDE LOT only 50 ft wide, sloping in two directions and curving at a 30 deg angle along the front turned the planning of this house into a test of the architect-owner's ingenuity. Complicating the problem still further, changes in floor level were ruled out because of the family's two small children (both boys, one four and the other six). A shaded garden-terrace with complete privacy was considered essential, and privacy for the diversified activities of parents and children was still another requisite.

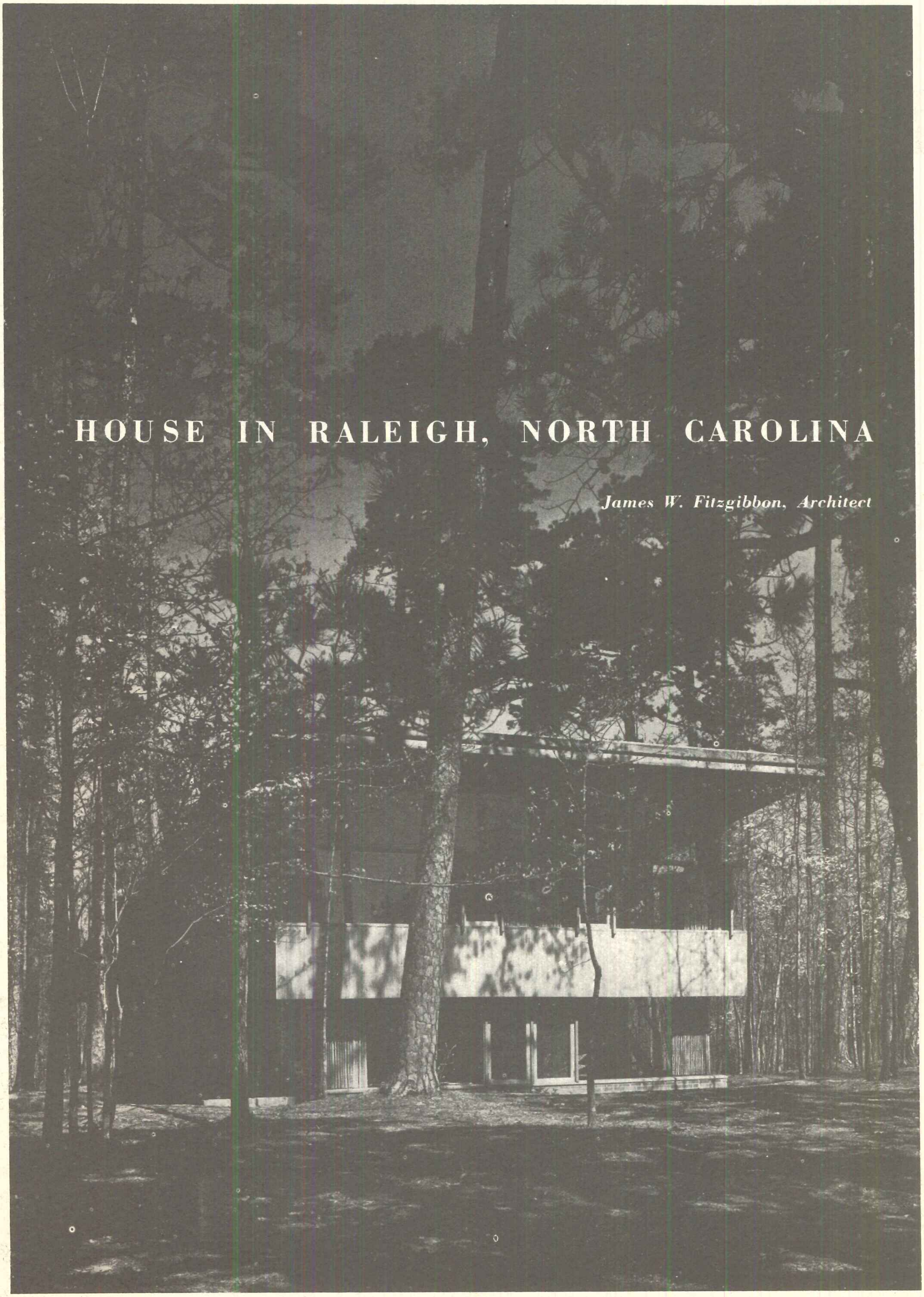
To achieve a one-level house with a secluded terrace at the rear, a shelf had to be cut into the hill. The downward slope of the site at the front then permitted placing of the garage on a lower level. The living-dining area is at the rear, facing the terrace; it is not directly visible from the entrance, and is completely free from cross-traffic. The master bedroom also is at the rear, facing the terrace, but is so located that no part of the house is more than a few steps away. The boys' bedroom is almost completely isolated from the rest of the house. The study, which doubles as a guest room, is similarly isolated by location, and given even more privacy by the use of sound-absorbing materials in ceiling, walls and floor.

Living room (above) has floor-to-ceiling windows along one whole side and parts of two others to emphasize feeling of openness; dining area opening from living room and two-way cabinet between dining and kitchen areas (right) serve the same purpose. Master bedroom (below, right) has built-in bed and shelf-cabinet headboard, dressing-table and mirror, dresser-drawers and mirror, wardrobe and storage shelves. Below: wall along terrace

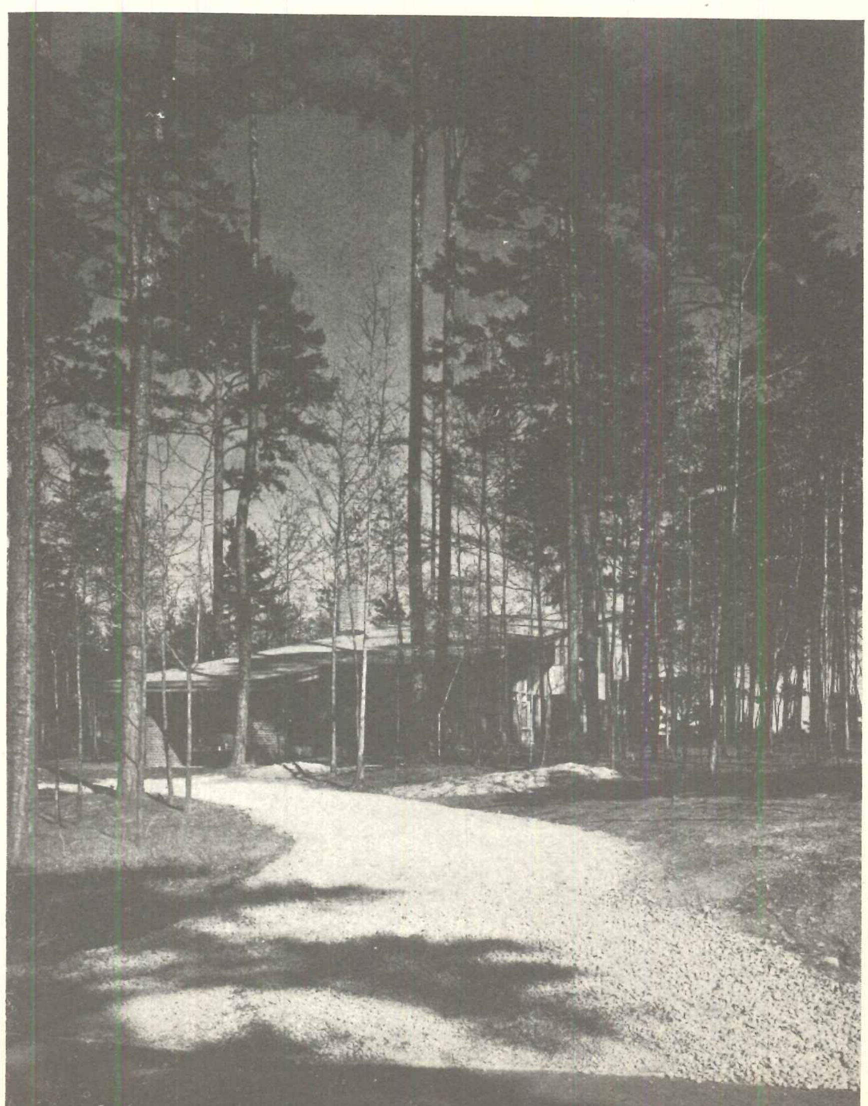


HOUSE IN RALEIGH, NORTH CAROLINA

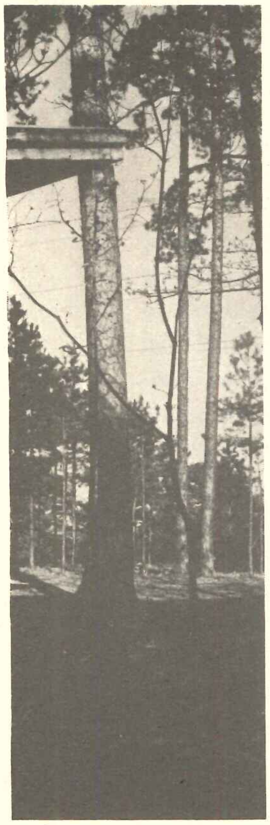
James W. Fitzgibbon, Architect

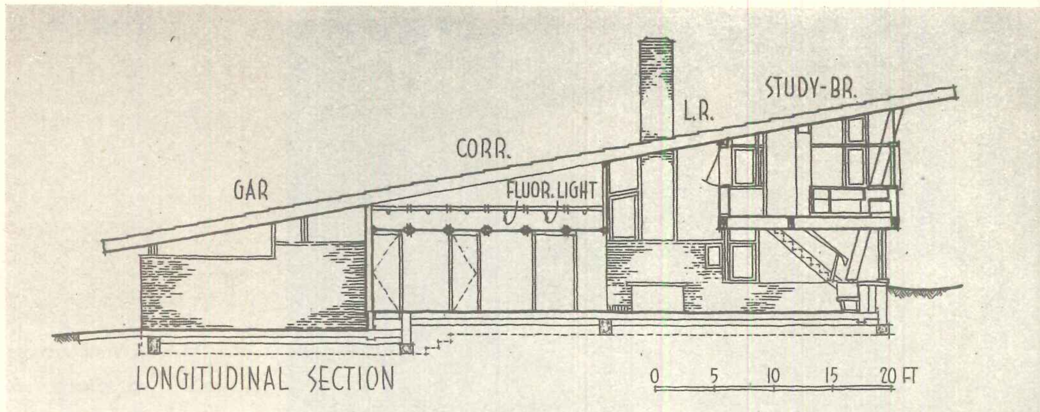


Joseph W. Molitor Photo



Joseph W. Molitor Photos

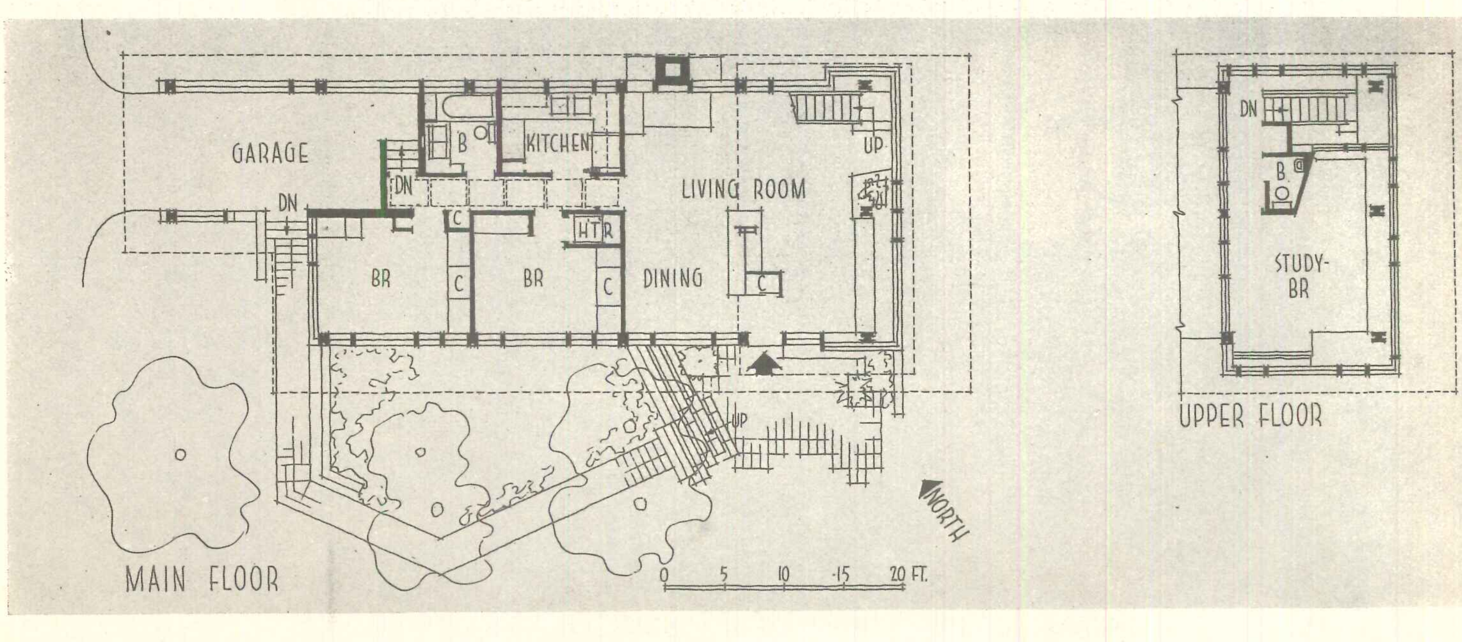


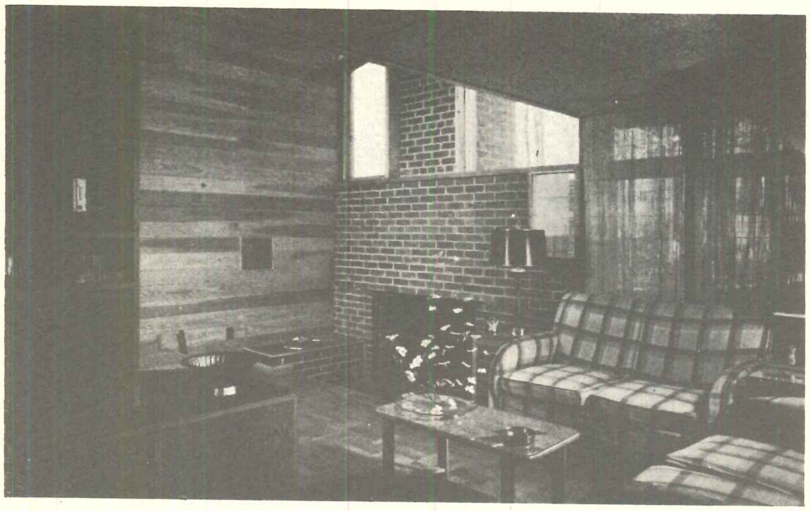


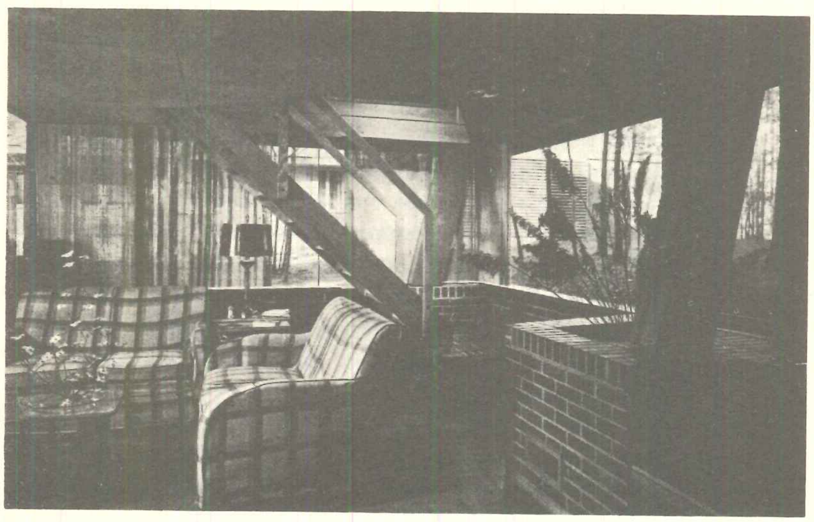
Materials and structure key this house to its site, echo natural surroundings. A sophisticated handling of the design preserves these qualities, yet lifts it above mere rusticity. The house slopes up from the low street front (below left) to encompass view at rear (above left). Main entrance is at side (above center)

AN UNUSUALLY CLOSE RELATIONSHIP to its sloping, pine-dotted site characterizes this Raleigh, North Carolina residence of Mr. and Mrs. Ralph R. Fadum. From a low, unobtrusive street facade, the structure's roof slopes up, recalling the land contour, to afford two-story living areas at the rear which take full advantage of views across an adjoining golf course. The living room is half-sunken to avoid awkward changes of level within the house. The naturalness of the landscape is also reflected in the materials selected for the house — exterior walls are natural finish brick and cypress, interiors are cypress and douglas fir.

A light, suspended quality is given the design by the structural system used. The house is supported by a series of built-up wood columns, anchored by steel plates; roof girders fit between sections of the columns. Walls are mostly screen-like glazing, with much of the conventional sash eliminated. The suspended effect is greatly increased from the rear by slanting the columns to the interior, where they connect with built-in cabinets. Frank A. Walser was contractor.





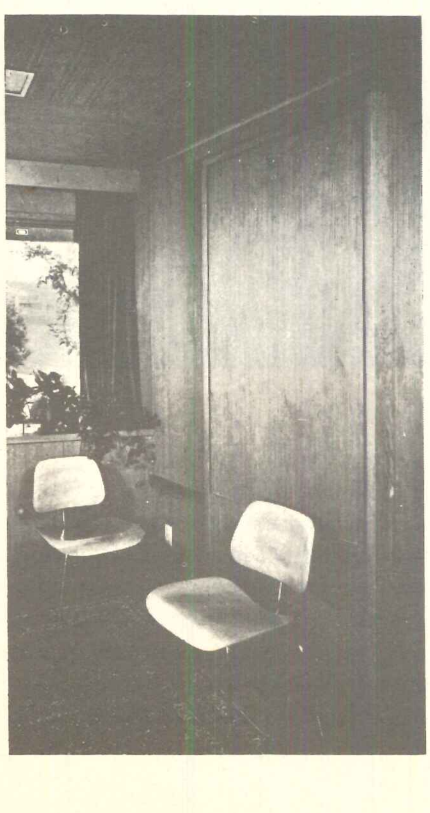


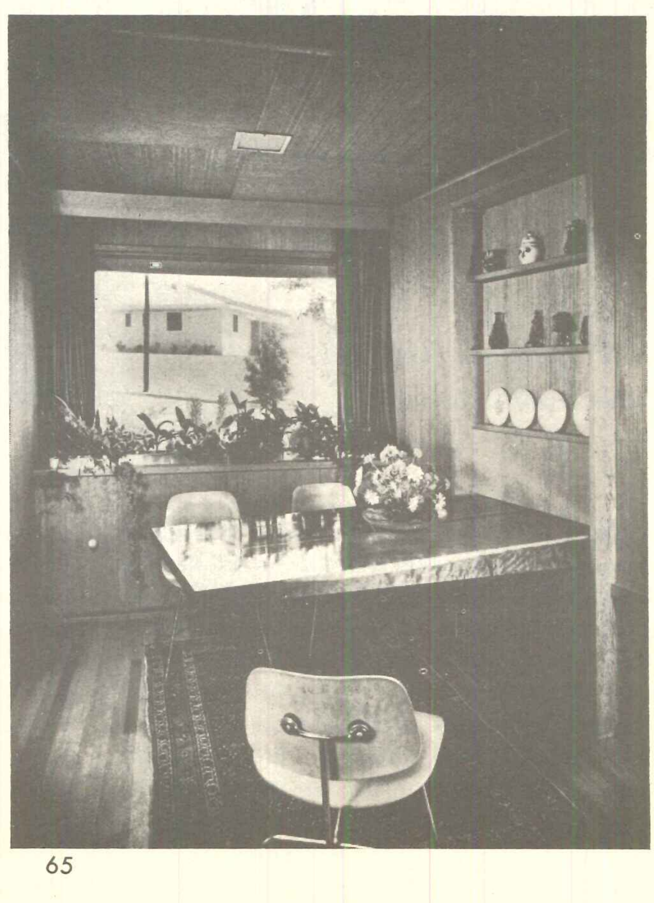
NORTH CAROLINA HOUSE

The living room (below and left) focuses on view across golf course. The building was placed well back from the course for privacy and protection from golf ball hazards. A central built-in cabinet separates the living room from the dining area (far right), which runs full height of structure. Heating is by hot air, with an oil-fired furnace located in a central closet. Upper level study is heated by opening sash above dining area. The effect of lightness is carried through the design by such details as the elevation of stair and column bases on short metal brackets (see detail below center). Even the kitchen (right) shares view of woods

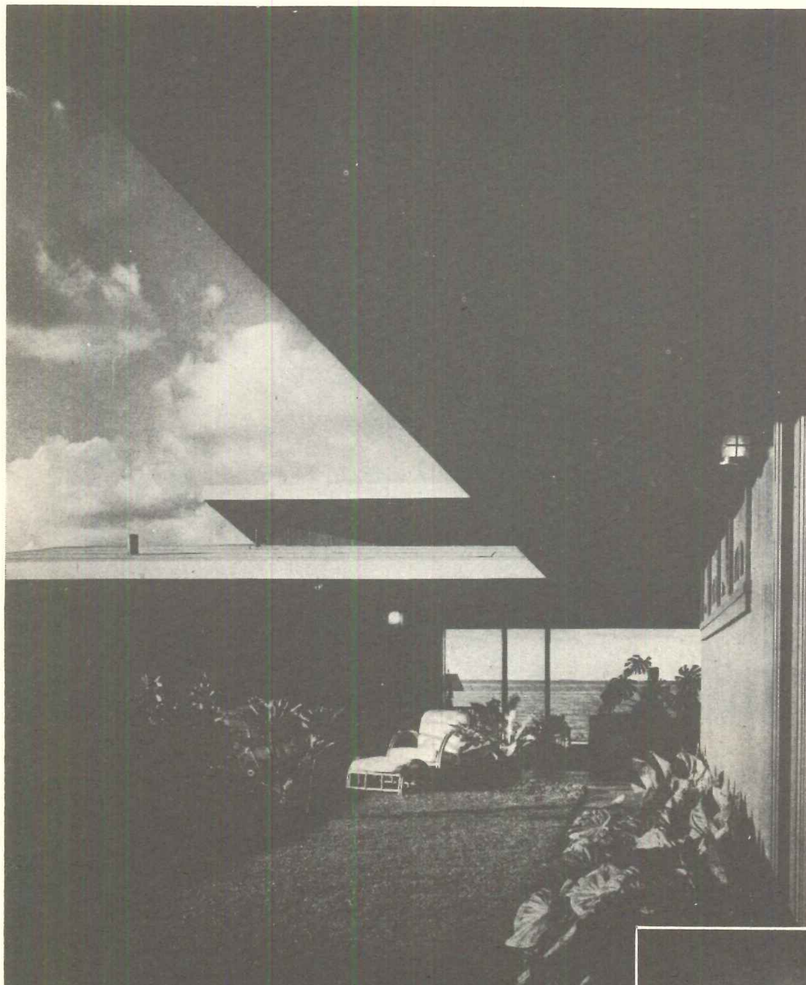
Glass wall between living room and loggia (shown open above) permit living areas to be joined with out of doors. Built-in dining table (below) folds into wall pocket

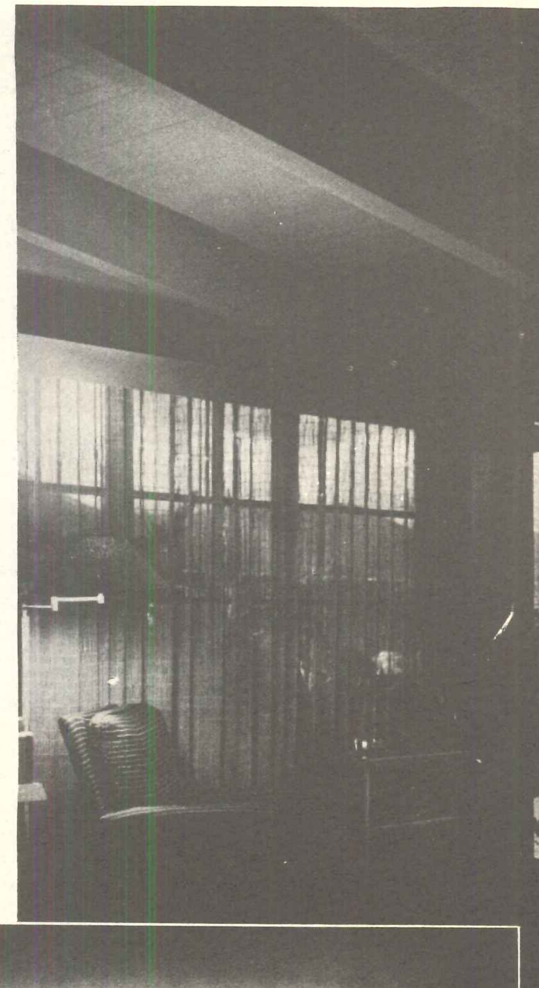
Julius Shulman Photos

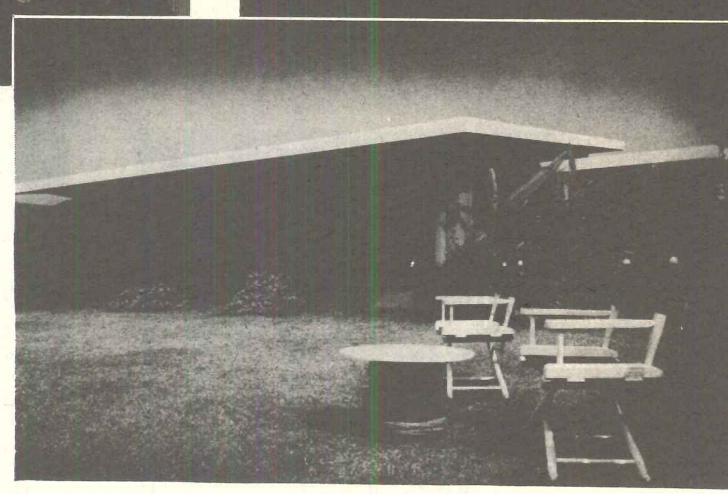




SMALL HAWAIIAN HOUSE DESIGNED







Residence for
Colonel and Mrs. R. Throckmorton

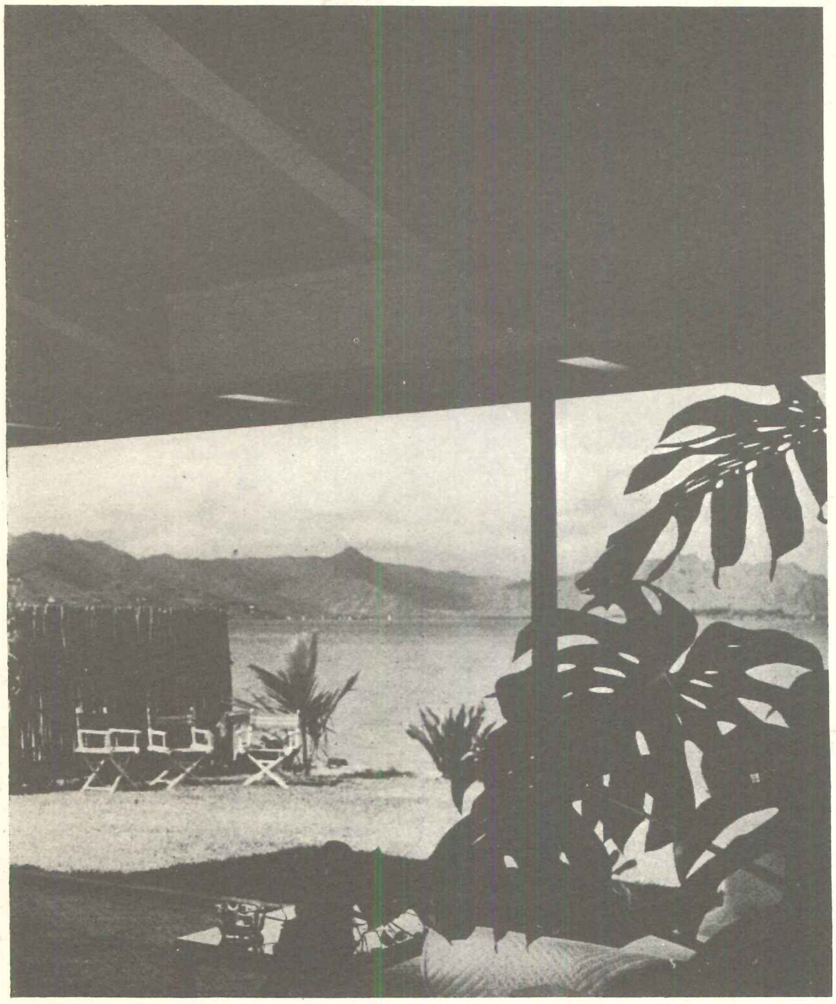
MIKIOLA, KOOLAUPOKO, OAHU, T.H.

Cyril W. Lemmon, Architect
Douglas Freeth, Associate

A GOOD ANSWER to the growing problem of providing spaciousness at reasonable cost is found in the plan of this small Hawaiian house. The scheme basically consists of a very large room for living and sleeping, plus minimized service areas and a small room either for guests or the owners. Such a plan, of course, is feasible only for clients with no children, or as in this case, a retired couple who obviously prefer simple informal living, and whose children are married and living away in homes of their own.

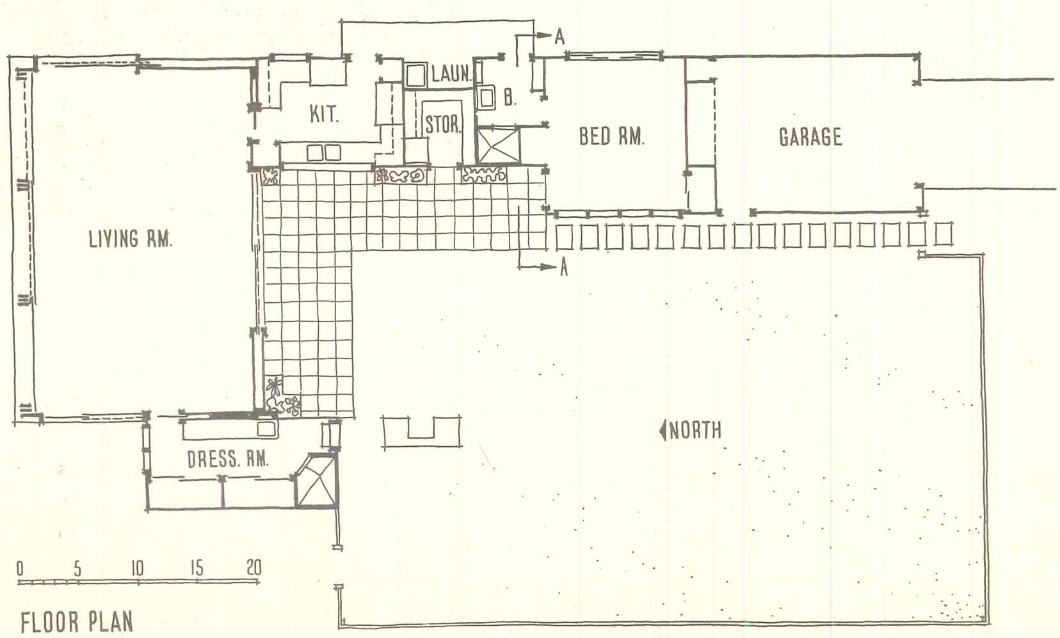
The mild Hawaiian climate and tropical landscape also add greatly to this conception of a house, by permitting maximum use of outdoor areas and by giving a sense of luxury to an otherwise simple structure. The whole side of the living room facing the sea and half the opposite side open by sliding glass doors to terraces and gardens. Enclosed corridors and a central heating system are eliminated.

FOR SPACIOUSNESS



R. Wenkam Photos

The main room of this house serves as living room, dining room, study, and for sleeping when there are house guests. A combination bath-dressing room is provided off the main room for such occasions. The size of the house is extended by a lawn toward the sea, and by a lanai and enclosed garden to the south, where they are protected from sea winds

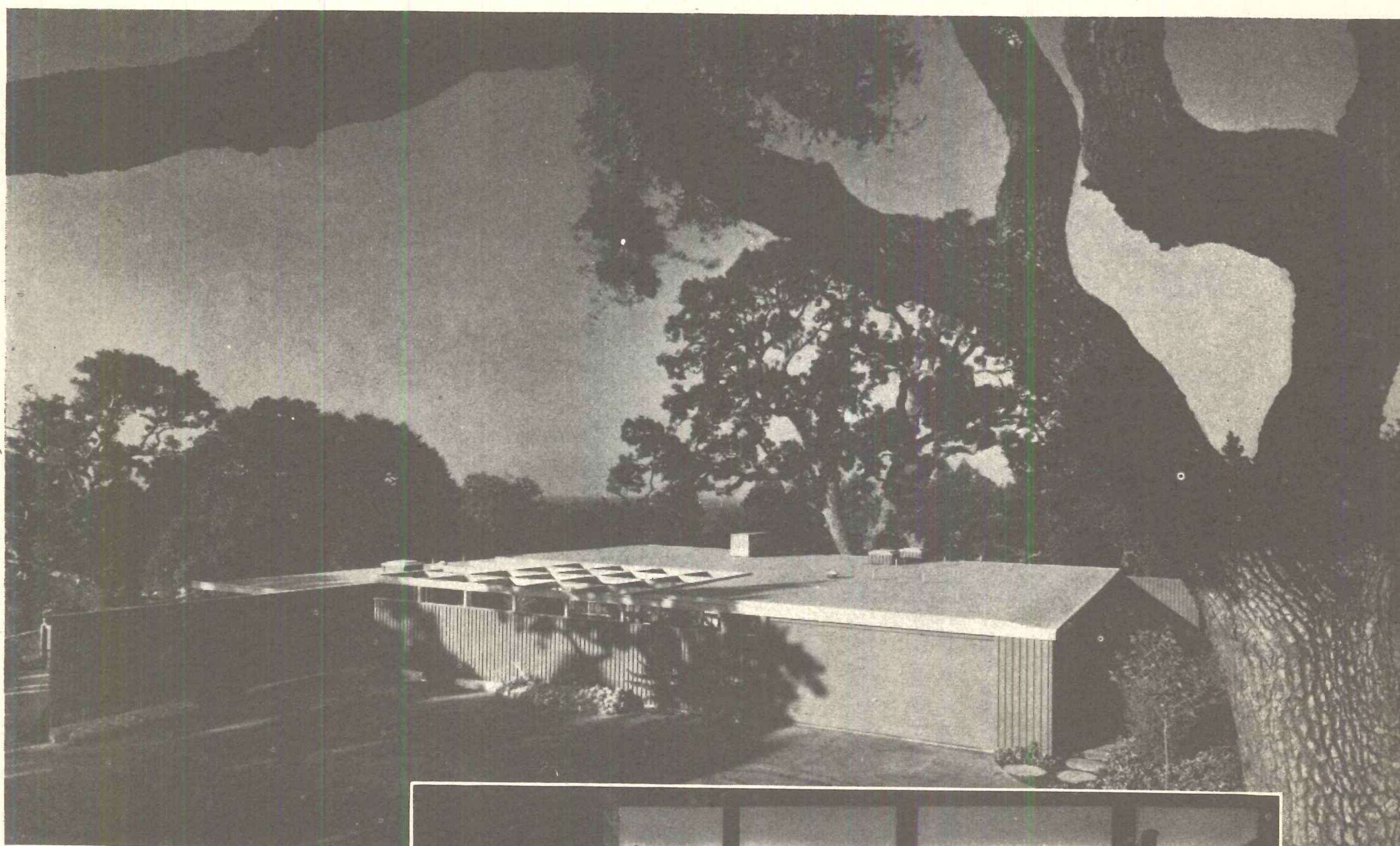


SIX EAST AND WEST COAST HOUSES

A Presentation Prepared by John Hancock Callender, A.I.A.

WEST COAST — ATHERTON, CALIFORNIA

Residence of Mr. & Mrs. Kurt E. Appert
Joseph Allen Stein, Architect
Eckbo, Royston & Williams, Landscape Architects



Ernest Braun Photos

BEARING NO TRACES of "Bay Regionalism," this house nevertheless could hardly have been built anywhere else. The beneficent climate and a beautiful site were obviously basic conditions of the design.

To say merely that the location of the house on the site was determined by the existence of several splendid oaks, would be to miss the essential element in this design, which is the complete integration of building and site. In the illustration shown below it is apparent that house, tree, and terrace are esthetically and functionally integral parts of a single composition. The crisp lines of the house, its lightness and its geometrical precision, are beautifully contrasted with the magnificently rugged oak. Shade from the tree, in turn, softens climate and the shaded site, these outdoor living areas are usable almost all of the time. The patio, protected on three sides by the house and on the fourth by a fence, can be used when the weather is too cool for outdoor comfort elsewhere.

The main entrance is from the motor court, through the patio (screened by planting from the private area) and into the loggia which gives access to all rooms. From the entrance there is a striking view through the living room to the terraces and gardens beyond. The loggia is nothing more than the conventional entry and bedroom corridor which have been skilfully combined and slightly expanded to form one of the principal features of the plan. In that portion of the loggia which

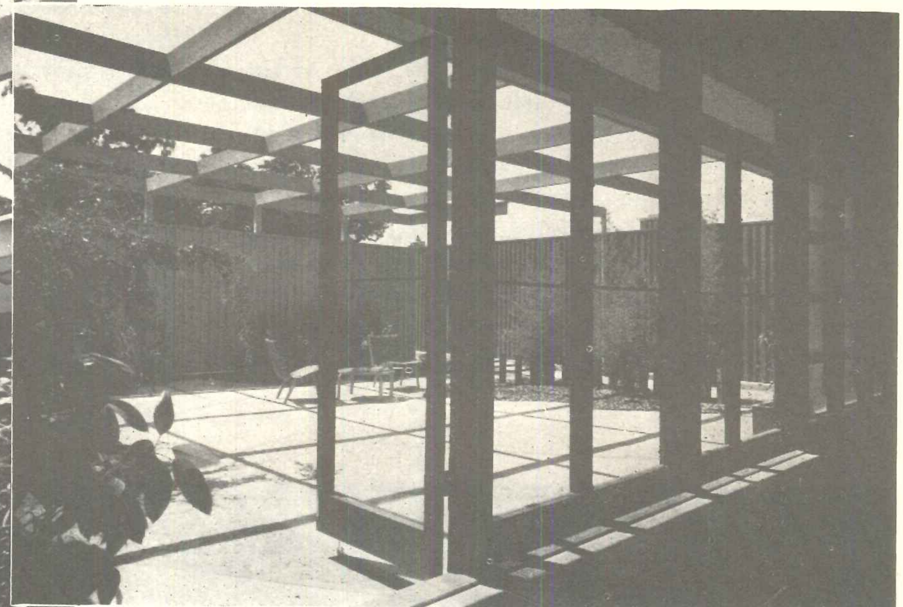
the severe lines of the house and makes the adjacent paved terrace one of the pleasantest "rooms" in the house.

The house proper — that is, the enclosed area — is not very large. Rooms are of modest size and the only small extravagance in the use of space is the pleasant entrance loggia. Yet this house provides a degree of luxurious living that is generally associated with much more elaborate establishments. The reason, of course, is that the usable space extends far beyond the walls of the house. Each room has its own terrace extension and the total paved outdoor area is actually greater than the floor area of the house. Because of the favorable

serves as entry, the privacy of the occupants is protected by means of a solid door and fixed obscure glass. Elsewhere the loggia opens freely to the patio and incidentally provides cross ventilation for the bedrooms and the living room.

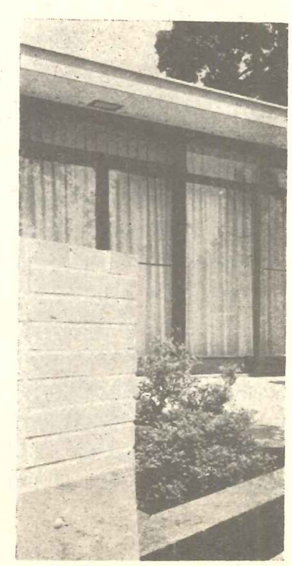
The San Francisco area is justly famous for the quality of its residential architecture and the original work of its landscape architects. Less generally appreciated is the high degree of collaboration that has been attained between these two professions. The happy results of such a collaboration is exceptionally noticeable in this house, where it is difficult to find the line that separates the work of architect and landscapist.

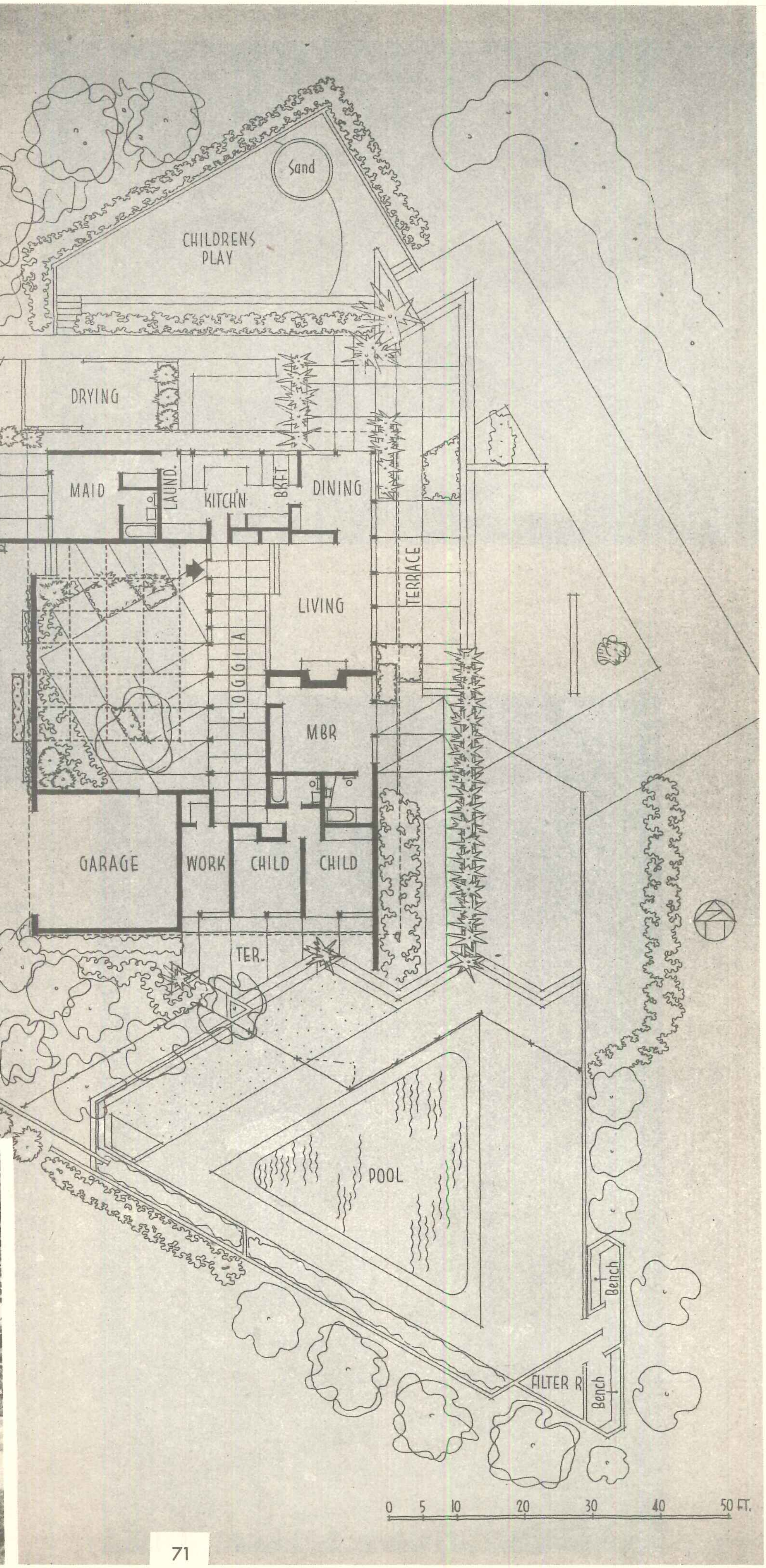
ATHERTON, CALIFORNIA



Ernest Braun Photos

Left: main entrance. Above: looking from loggia into patio; entrance walk is behind plant screen at right. Below right: children's bedrooms face south and have their own terraces and playground. On the north side of the house, there is another play area which can be supervised from the kitchen. Note on plan opposite that all baths are windowless with vents




Sand
CHILDRENS PLAY
DRYING
MAID
LAUND.
KITCH'N
BKFT
DINING
TERRACE
LIVING
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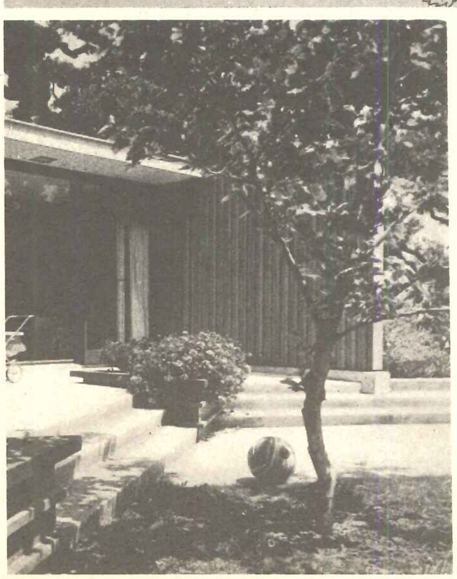
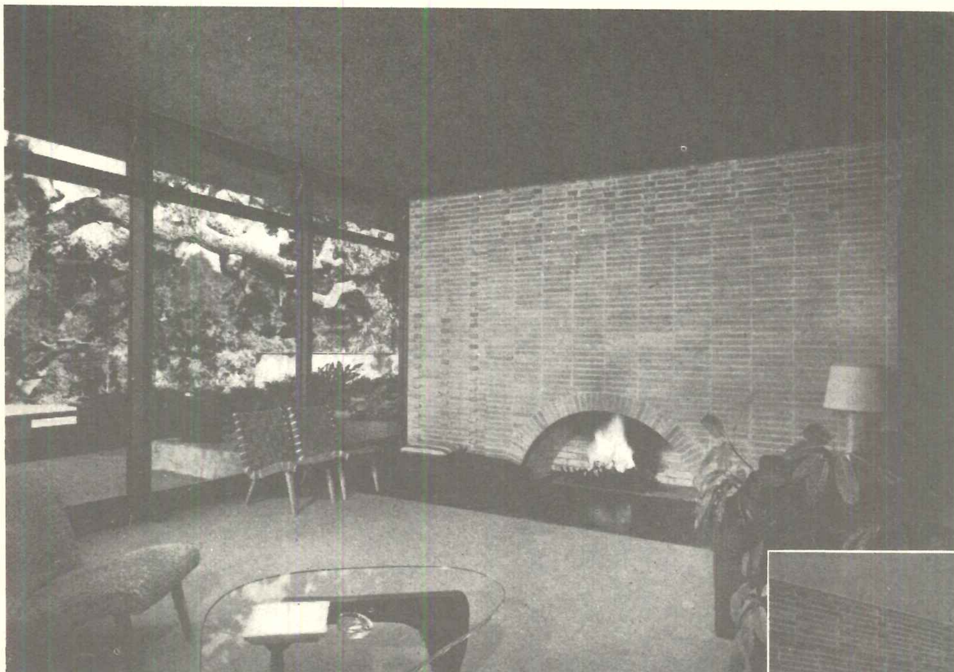
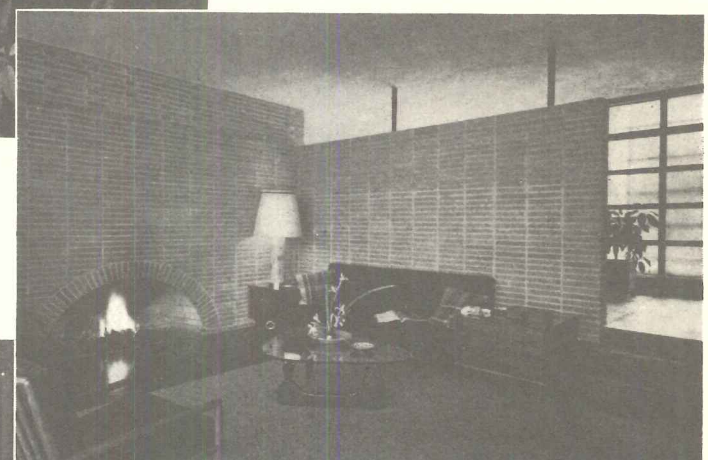
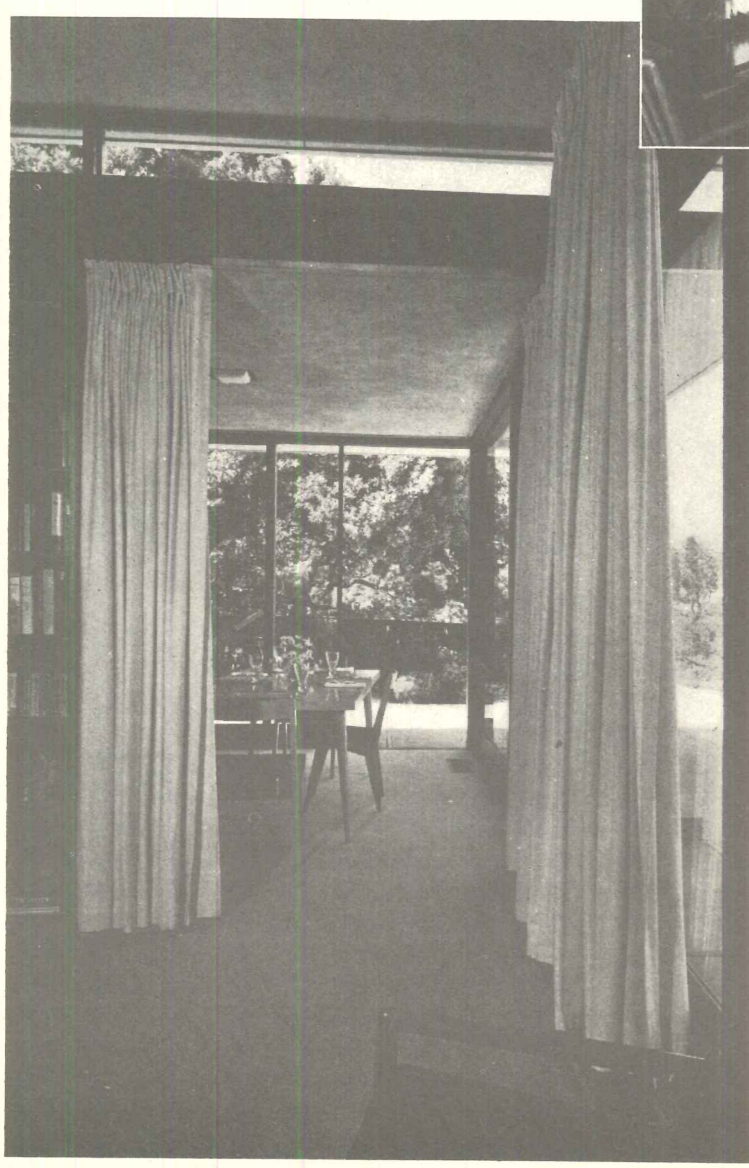


ATHERTON, CALIFORNIA



Ernest Braun Photos





Above left: effective contrast of masonry, glass, and plant materials. Note that the big oak is also an important element in the interior design. Masonry walls on two sides of the living room serve to anchor the airy structure to the ground and give a feeling of security. Left: looking from living room into dining room and beyond to dining terrace. Skilful use of the change in levels permits the living room to have a high ceiling and clerestory windows. Bookshelves form the only separation between living and dining rooms. Glass wall is continuous across dining room, living room and master bedroom. Large sliding glass doors open all of these rooms to the terraces

OLD GREENWICH, CONNECTICUT — EAST COAST

Residence of Mr. and Mrs. Walther Prokosch

Walther Prokosch, Architect

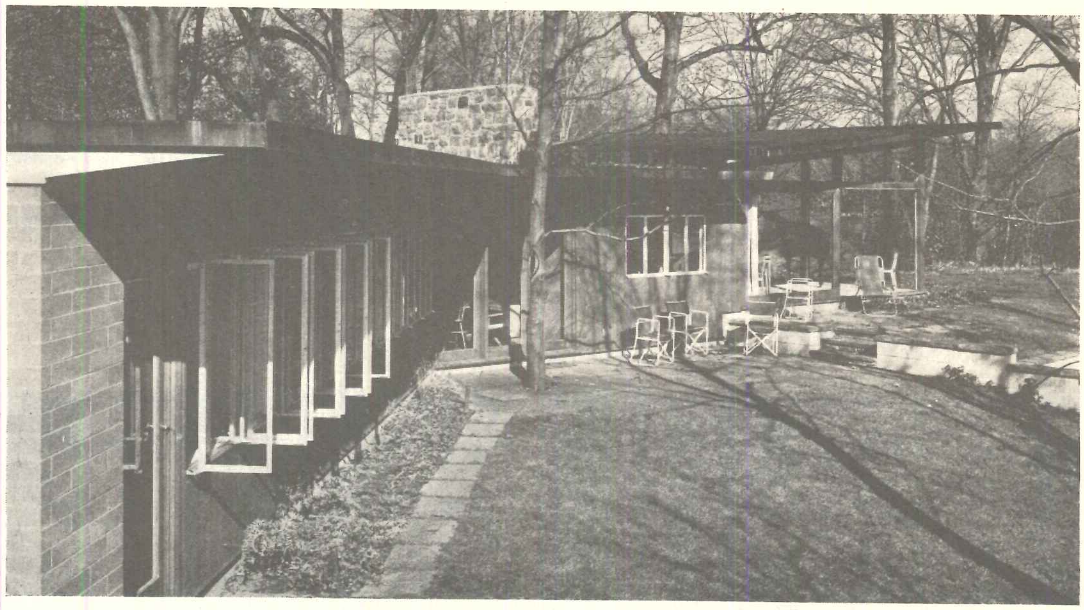
Joseph Molitor Photo

THE COMPLETE INFORMALITY of this house and the important place that children have in it are immediately apparent upon entering the large entrance hall. This room with its pleasant view through to the terrace and the small valley beyond, is also used for informal dining and as a children's playroom. A folding partition to cut off the playroom was originally intended but never installed. Both indoor and outdoor play areas are conveniently supervised from the kitchen.

The house stretches along the crown of a wooded knoll, with all rooms facing away from the road toward the south and the view. By fitting the car shelter inconspicuously into the hillside with informal stone steps leading up to the house, the natural beauty of the rugged site has been preserved.

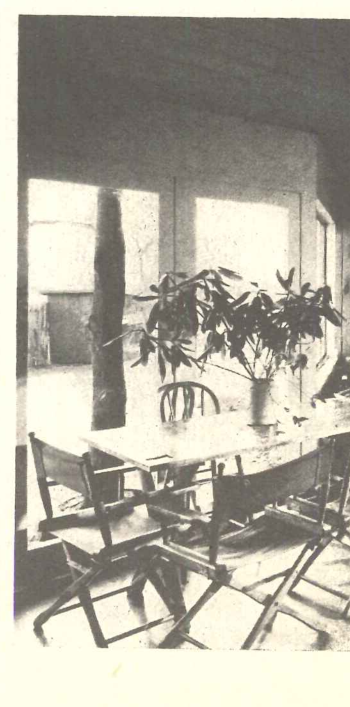
To compensate for four very small bedrooms, the living room is huge, taking with ease a grand piano, dining table, sofa and several lounge chairs. Further spaciousness results from the high sloping ceiling and the two glass walls with their big sliding doors opening onto terraces.

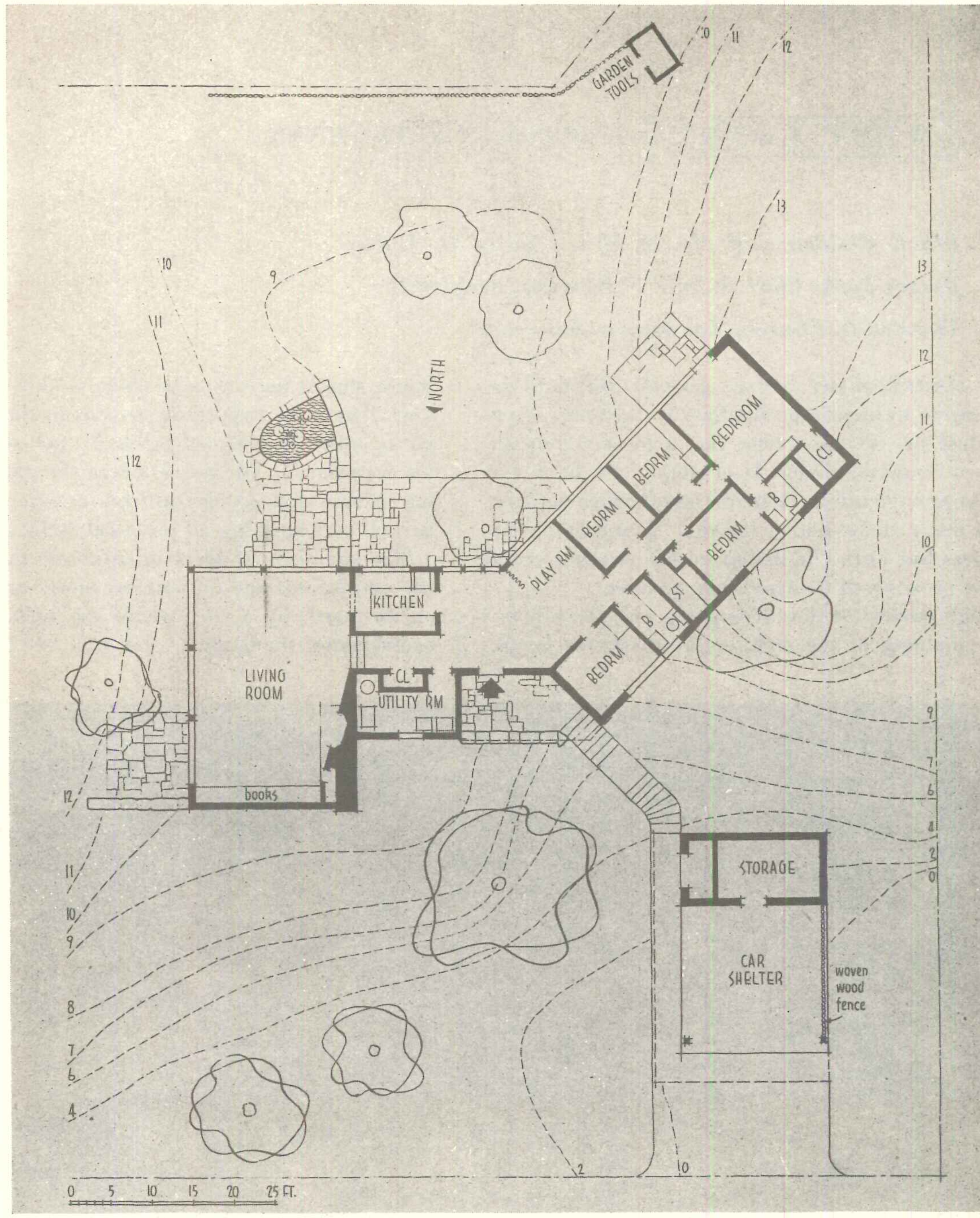
Masonry walls are cavity type, 4 by 4 by 16 in. concrete block, plastered or painted inside. Pine siding is used on frame walls and also for ceilings of major rooms. Heating is by wrought iron pipe in 3-in. concrete slab over 3-in. vermiculite concrete on 10-in. gravel.



Above: glass doors to entry-playroom are behind the tree which helps the overhanging roof to shade the terrace in the summer. Kitchen windows overlook play terrace. Living room and terrace are at higher level. Plan: polite dining in the living room is facilitated by a serving hatch from the kitchen. Equipment includes electric water heater, dishwasher, laundry and dryer

Joseph Molitor Photos

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BEDROOM
BEDRM
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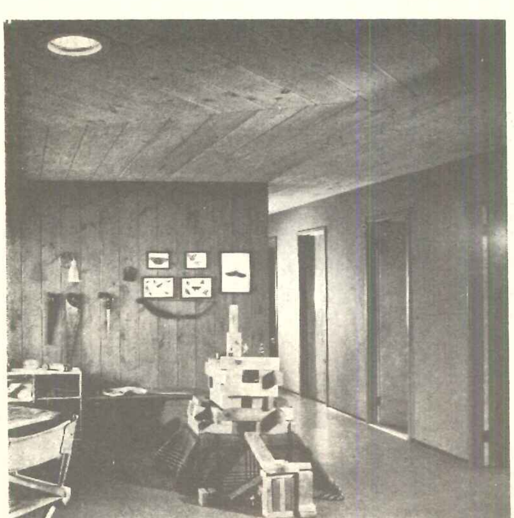


WEST COAST — APTOS, CALIFORNIA

Beach Residence of Mr. & Mrs. Charles O. Martin

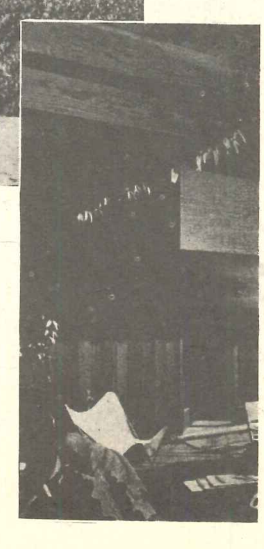
Hervey Parke Clark & John F. Beuttler, Architects

Thomas D. Church, Landscape Architect

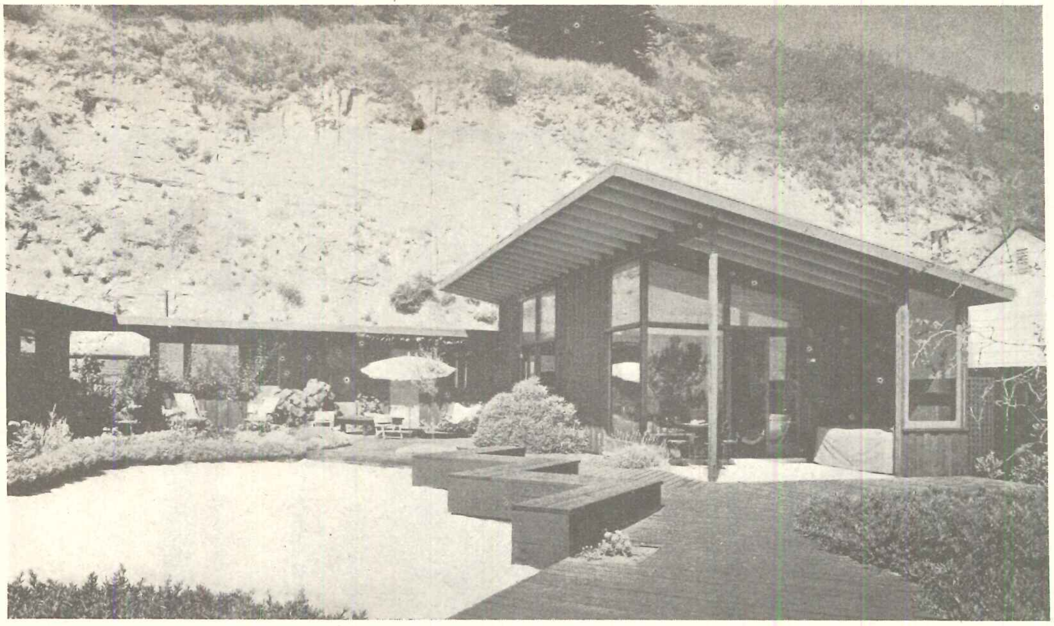
Many contemporary houses provide for outdoor living as an important auxiliary to the house. In a beach house the reverse is true, the house is merely an auxiliary to outdoor living. It is simply a cabana expanded to provide full facilities for comfortable outdoor life. The heart of the house, the real "living room," is not indoors but out. The design of this outdoor room lies in the province of the landscape architect.

The high quality of the landscaping and the sophisticated simplicity of the architecture mark the beach house shown here as a product of the San Francisco area. The most important element in the design is the patio, which is designed primarily for use, secondarily for appearance. The house serves the patio by providing privacy and protection from occasional cold winds as well as furnishing all practical facilities.

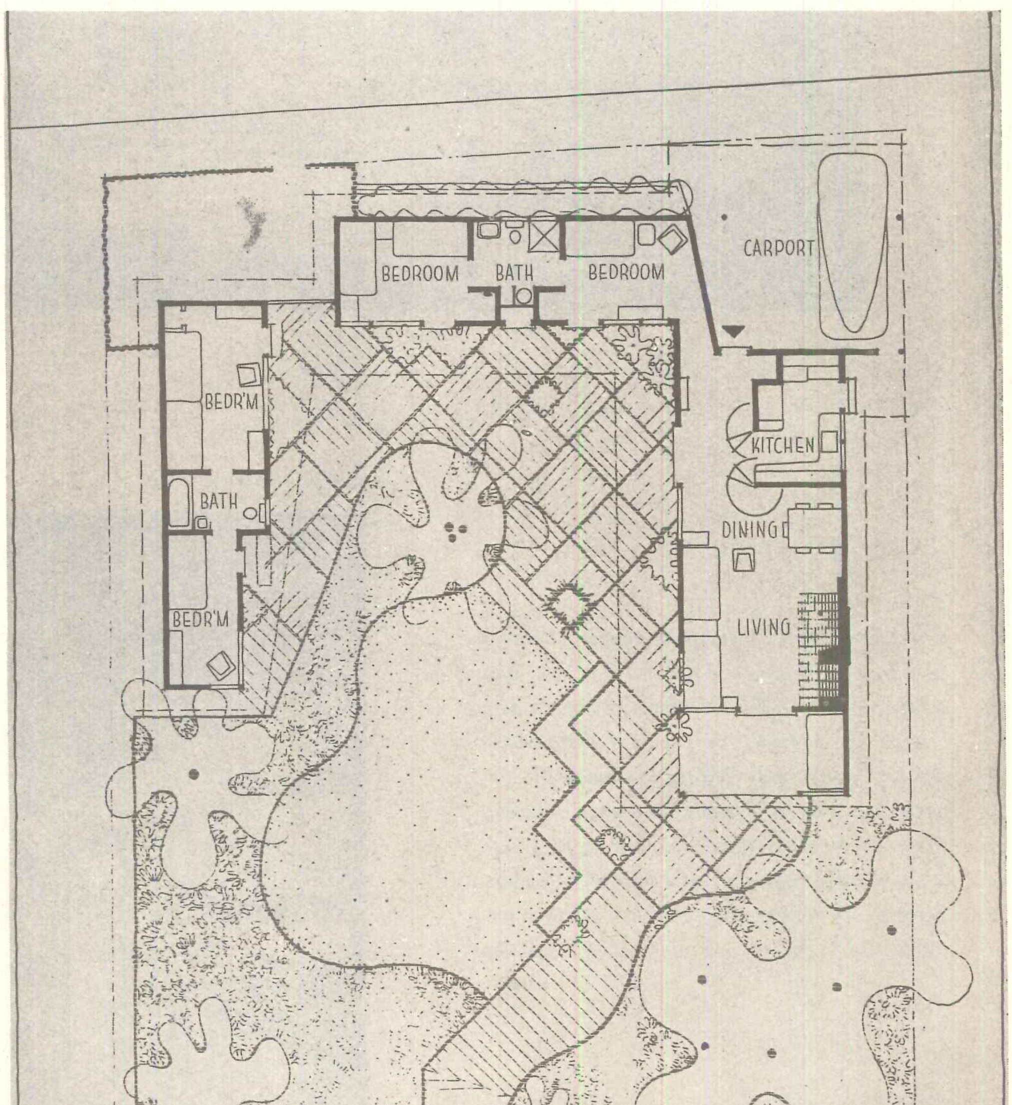
The site permits ideal orientation: the house faces the sun, the sea, and the summer breeze and is protected on the north by a cliff, which also makes a dramatic backdrop for the house as seen from the beach.



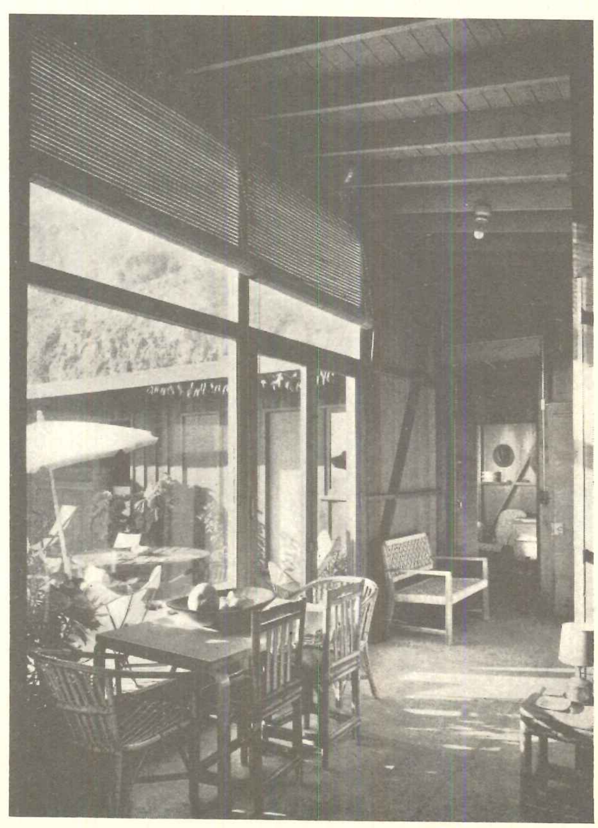
Roger Sturtevant Photos



Maximum privacy on the small lot has been achieved by means of the U-shaped plan with its enclosed patio. All rooms open on the patio which is used for circulation as well as for outdoor living. Provision has been made for the owners and their two grown daughters and several week-end guests. The west bedroom wing was an existing building which was adapted to the overall scheme



Roger Sturtevant Photos



Construction is of the simplest: exposed framing of 4 by 4 in. redwood posts 4 ft 0 in. o.c. and single wall of 1 by 12 in. redwood boards with 1 by 6 in. battens. Joists and roof sheathing are of fir, painted. Wiring is exposed. Concrete floor slab over membrane waterproofing forms the finished floor. Roof is topped with white marble chips for reflection of sun heat. Gutters and leaders are copper. Heat is furnished by fireplace and electric wall heaters

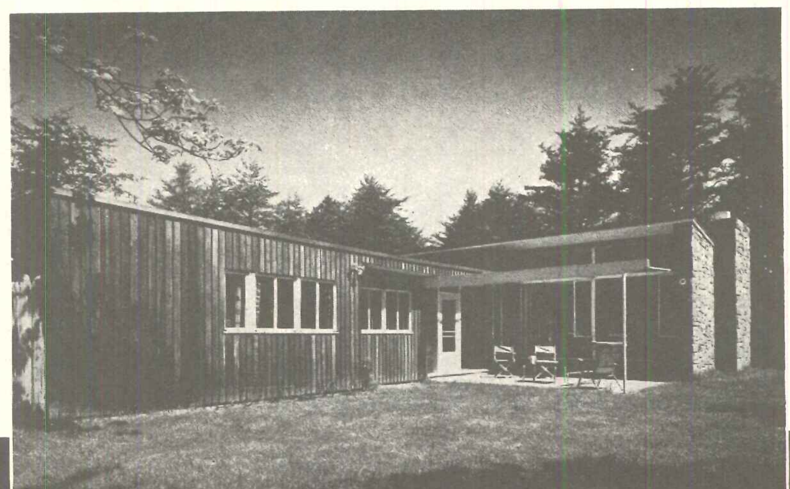
Residence of Harry N. Hirshberg, Jr.

Arthur H. Keyes & Basil Yurchenko, Architects

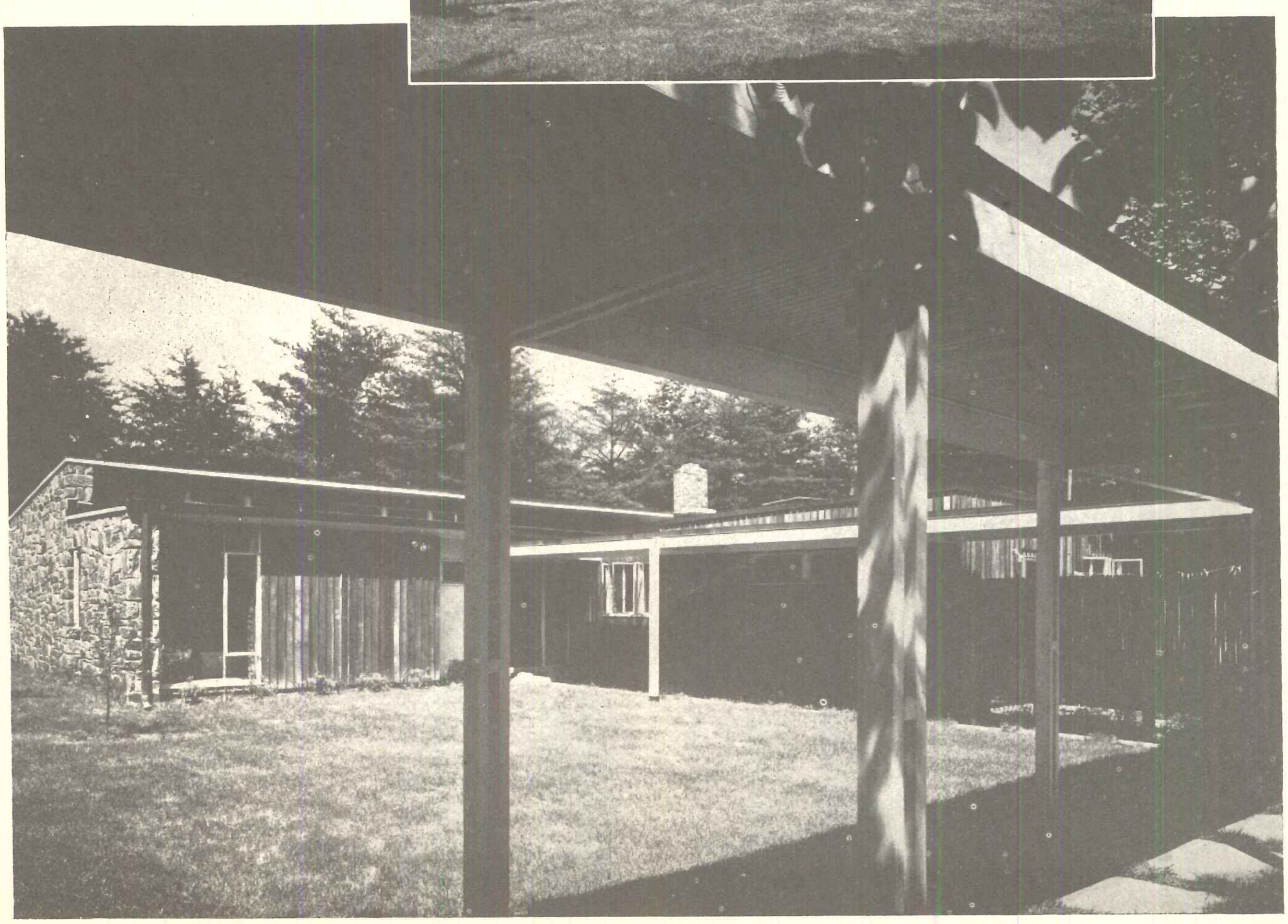
THE ARCHITECTS were presented with the always difficult problem of designing a house for a site on the north side of the street. Their solution was to place the main living areas as far from the street as possible. Planting protects the privacy of the dining terrace and the living room with its glass wall facing the street. Privacy from the approach side is provided by the projecting service wing. The dining room and kitchen face the side lot line and the master bedroom and study are on the rear (north), where privacy is not a problem.

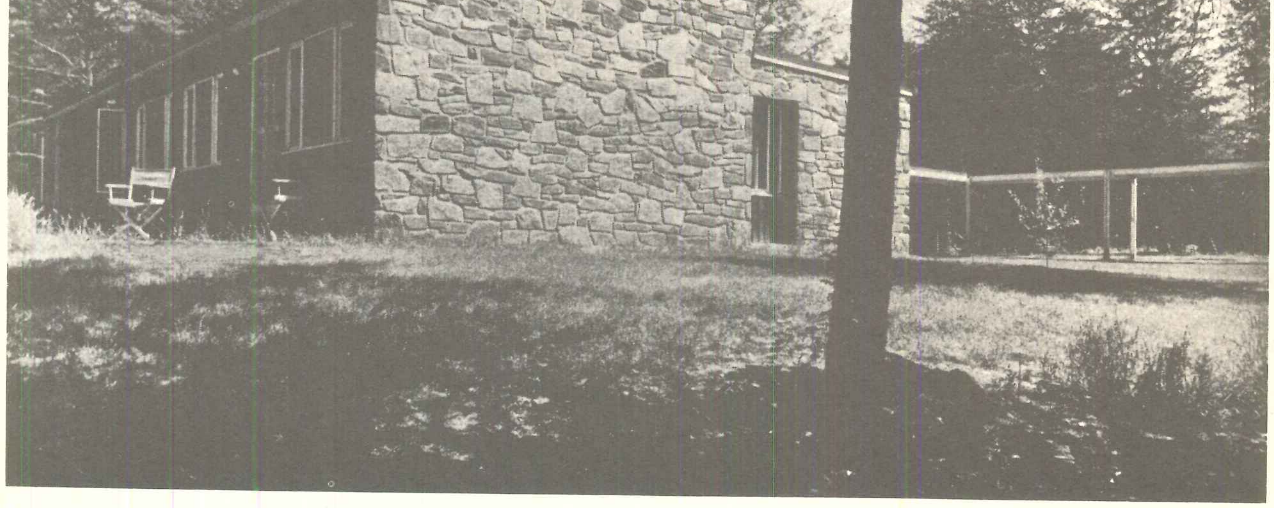
The house is designed for the future addition of two more bedrooms and a bath, which will be reached by a corridor through the present guest room.

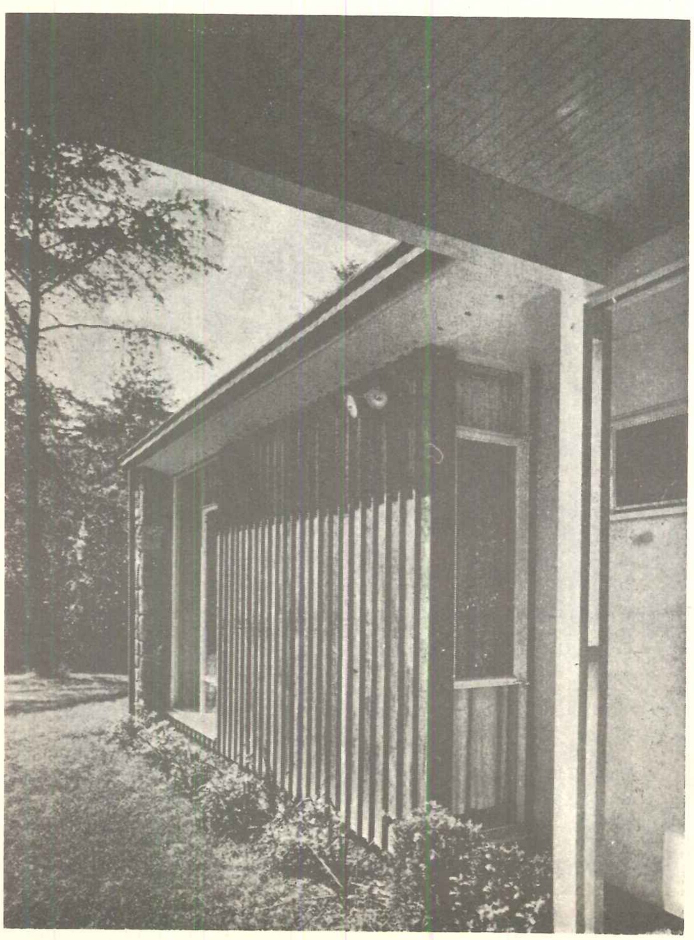
The isolated garage and the covered walks add to the apparent size of the house and serve to make an interesting spatial composition. The relation of garage to house will be more apparent after the expansion of the bedroom wing.



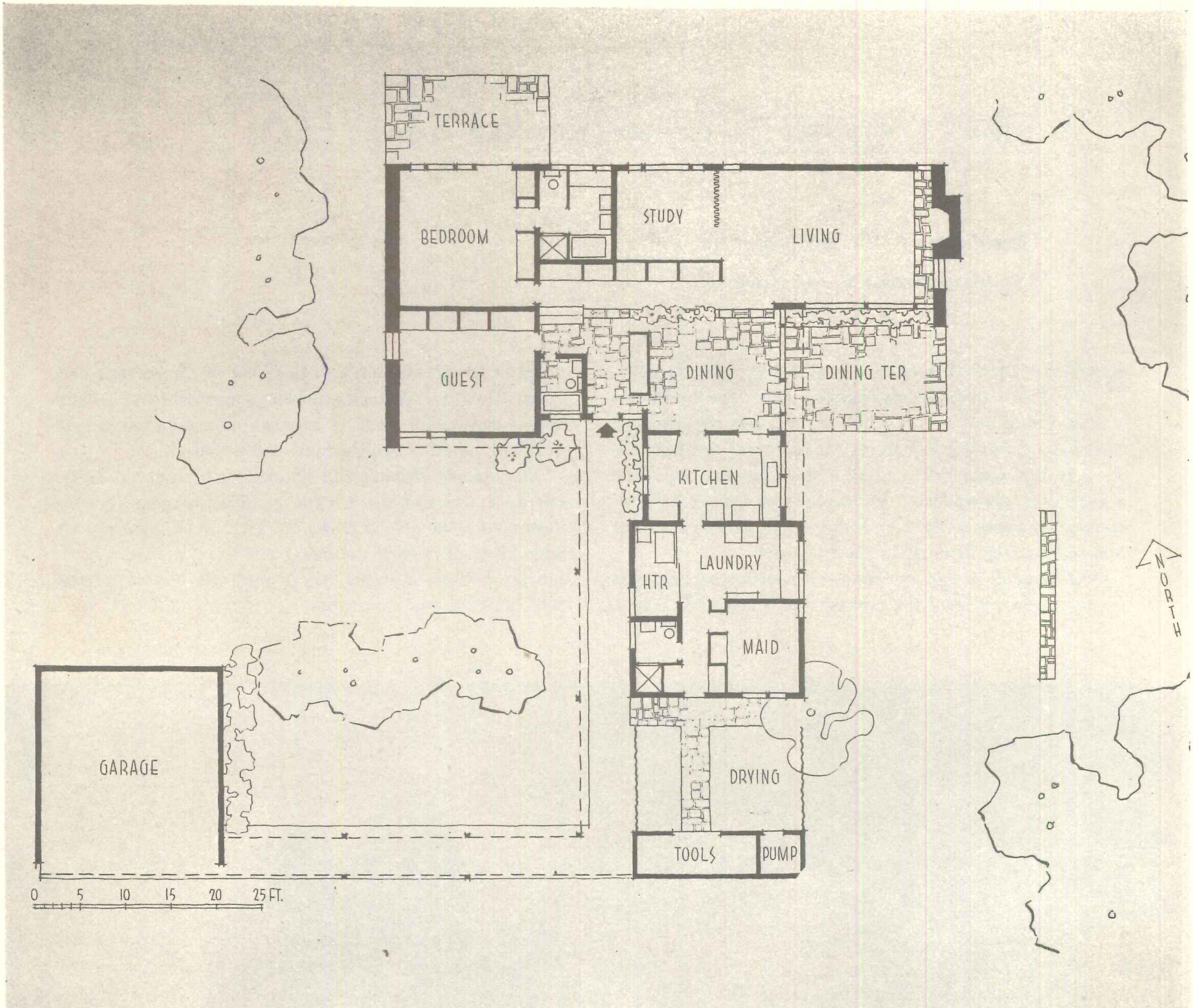
Robert Lautman Photos







Clerestory windows give cross-ventilation to the master bedroom and also admit winter sunlight into that room and into the cabinet-lined corridor leading to the living room. All rooms have cross-ventilation and an attic fan removes excess heat from the kitchen, laundry, and heater room. Window shown on plan next to fireplace was omitted in actual construction (below)


TERRACE
BEDROOM
STUDY
LIVING
GUEST
DINING
DINING TER
KITCHEN
LAUNDRY
HTR
MAID
GARAGE
DRYING
TOOLS
PUMP
NORTH
0 5 10 15 20 25 FT.

EAST COAST — CROMPOND, NEW YORK

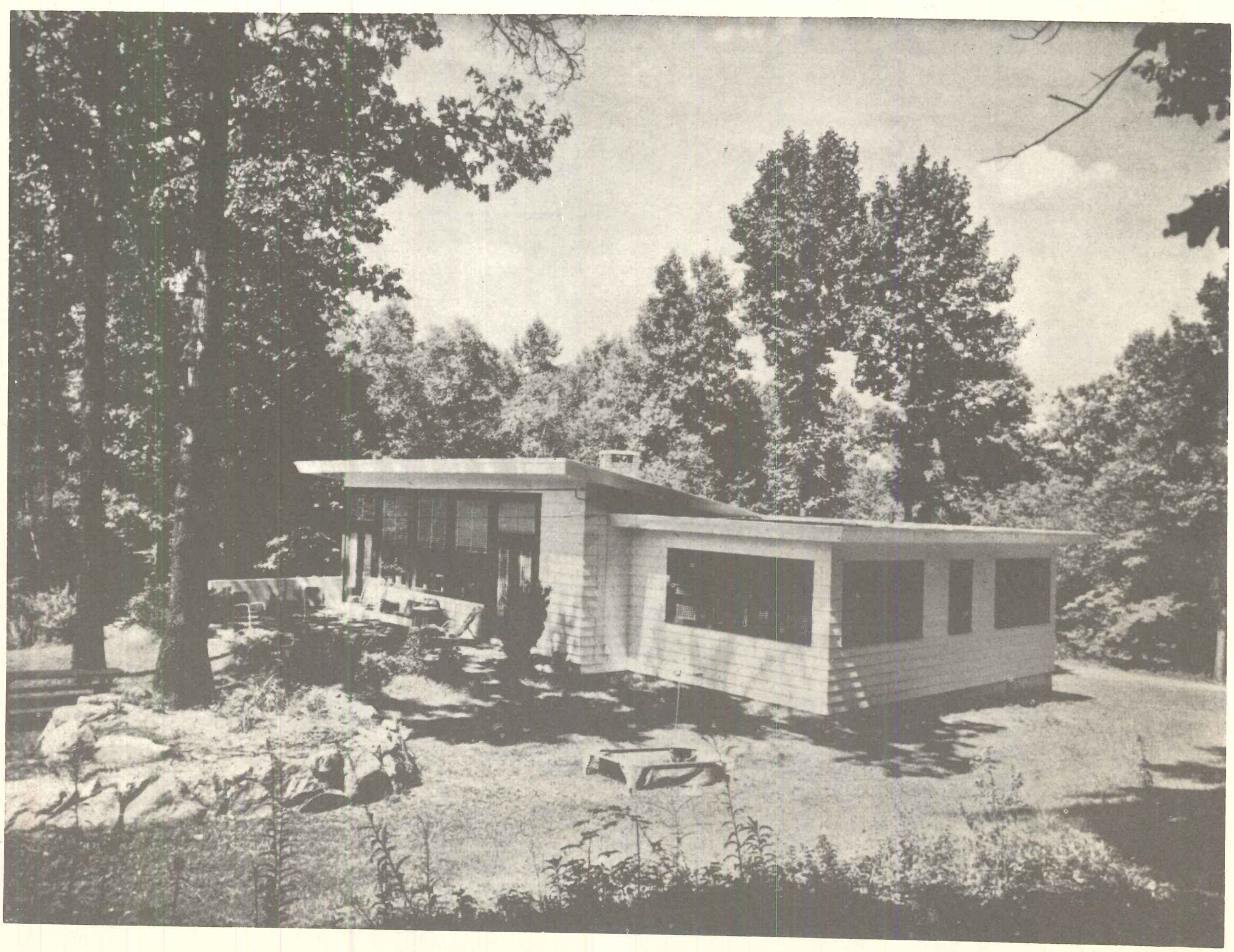
Residence of Mrs. Benjamin Halprin

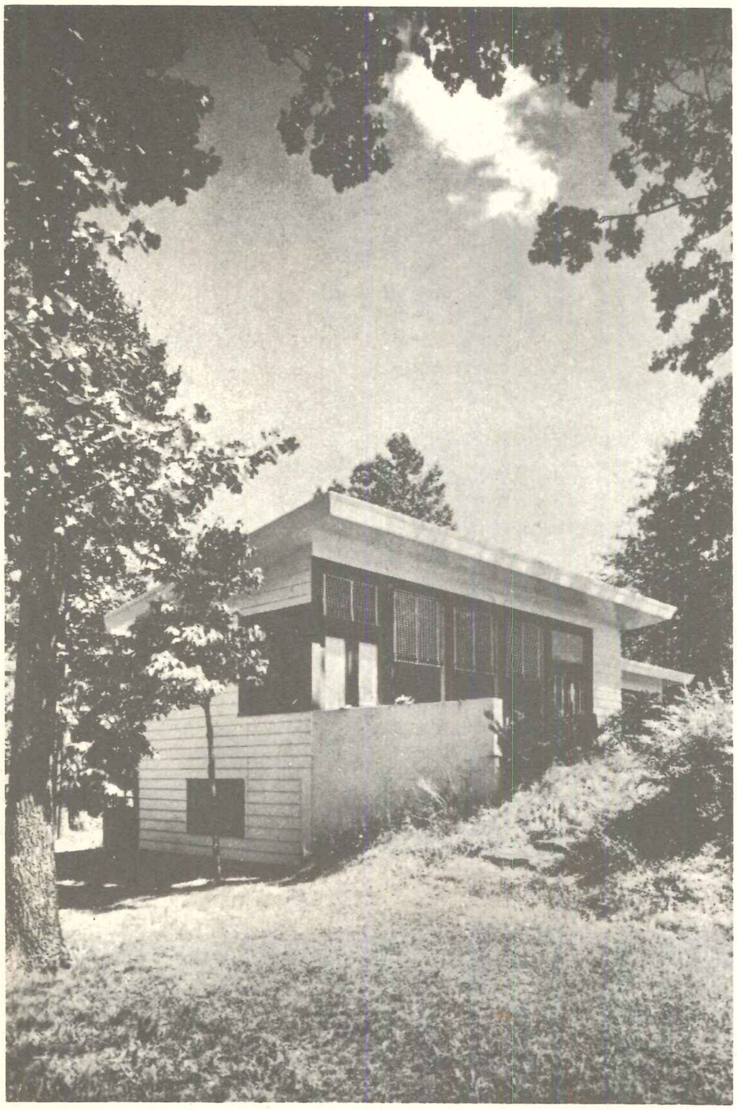
Stanhope Blunt Ficke, Architect

THE PARTI FOR THIS PLAN was established by the owner's desire to have maximum sun in the bedrooms and morning sun in the kitchen, and her requirement that indoor and outdoor living areas should overlook the view to the west, over a small lake to distant hills. The owner does considerable informal entertaining and requested spacious living and dining areas, as well as direct access from the kitchen to the front door.

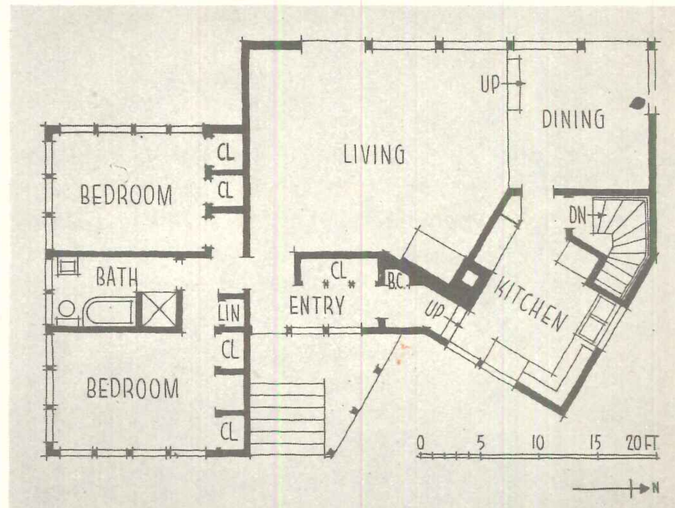
The original design included a drive-through carport along the east side of the entrance and bedroom, and a third bedroom and bath to the west of the present bedrooms. In the architect's opinion these additions, which were omitted for reasons of economy, would undoubtedly enhance the appearance of the house.

The steeply sloping site required a high stoop at the entrance, but had the advantage of permitting a partial basement to be placed under the kitchen. The basement, which has an outside door at grade level, provides space for the heater, laundry, shop, and storage for garden tools and terrace furniture.

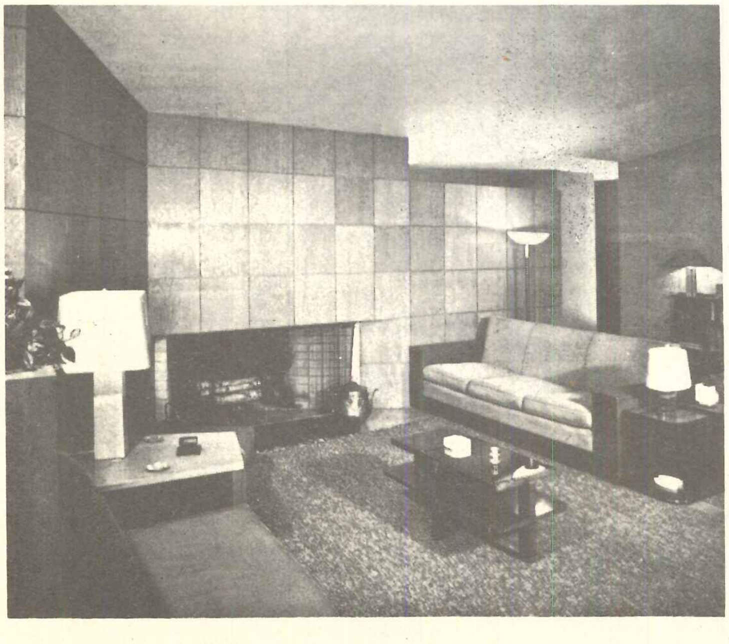


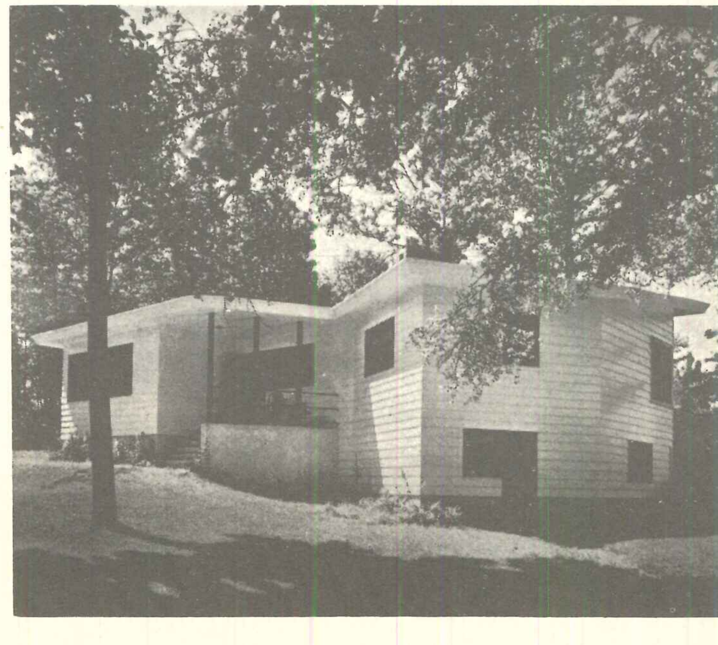


Bill Maris: Pictor



Kitchen and dining room are on a slightly higher level than the other rooms. All rooms have cross-ventilation. Corridor to future bedroom will utilize space now occupied by closets; new closets will be built between the two rooms. The view above gives an idea of the difficulties encountered because of the steep site





RAYMOND, WASHINGTON — WEST COAST

Residence of David M. Fisher

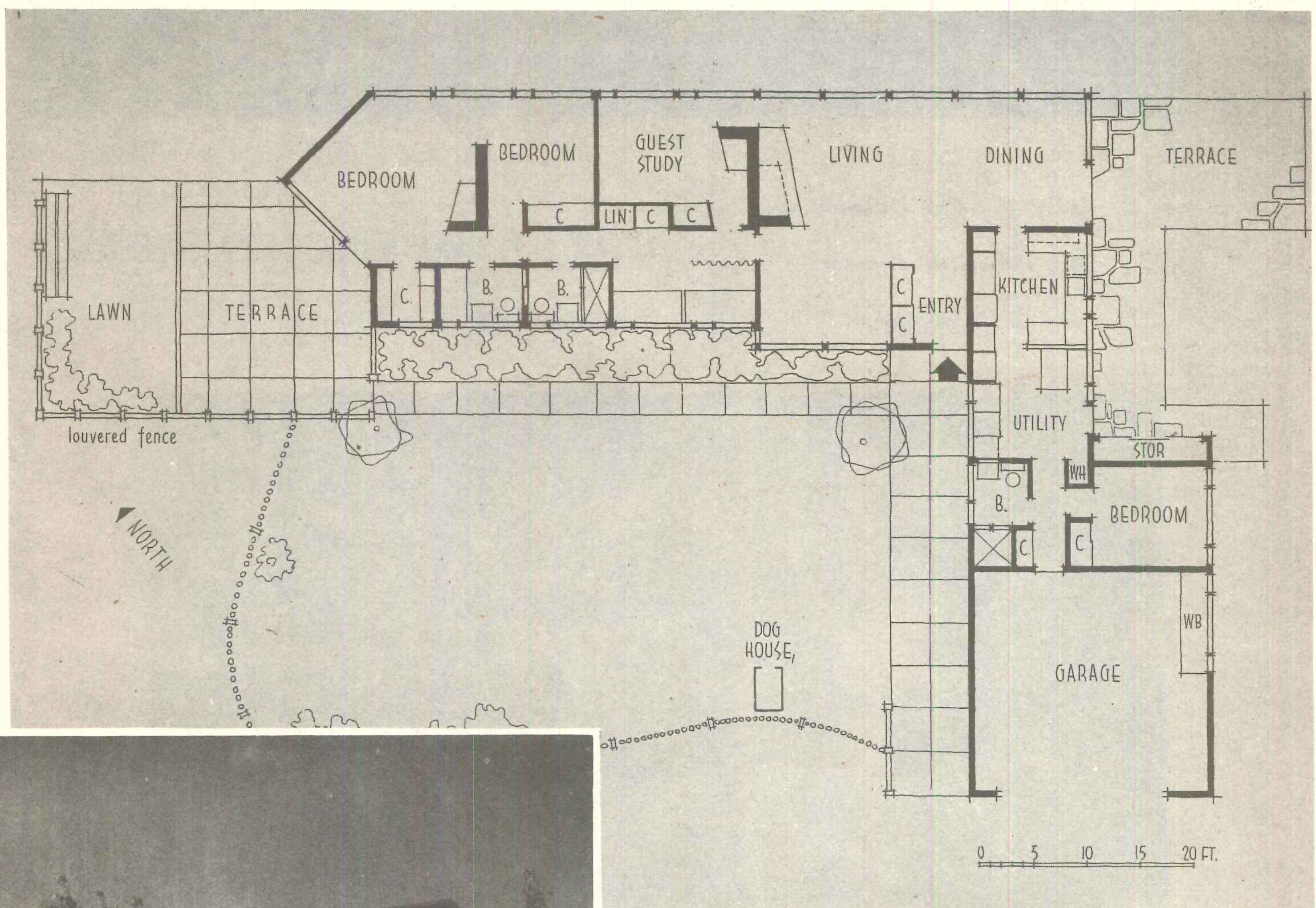
Paul Thiry, Architect

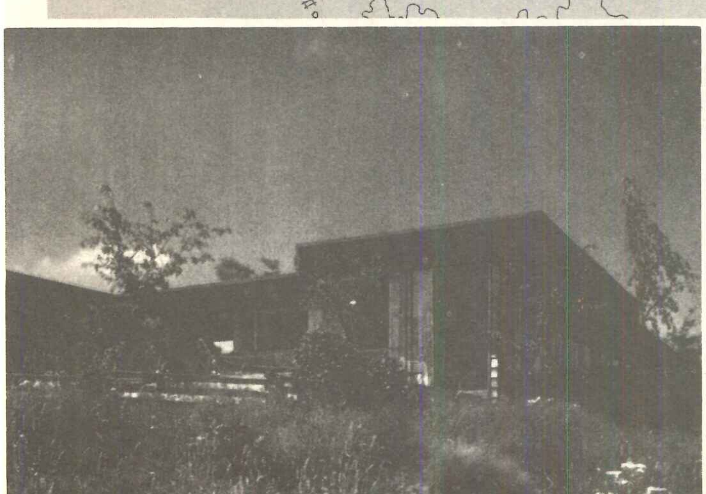
L. N. Roberson, Heating Engineer

THIS ALL-WOOD HOUSE for a lumberman is located in the heart of the Douglas fir country. The site is on a hill overlooking the town, the Willapa River, the harbor, and the lumber mills which, according to the architect, "add their smoke to the colorful haze at sundown." All major rooms face this view.

Southwest storms with abundant rain and overcast skies are frequent. These conditions are said to be ideal for growing Douglas fir, but they do not favor extensive outdoor living. However, terraces have been provided on the southeast adjacent to the dining room, and west of the master bedroom.

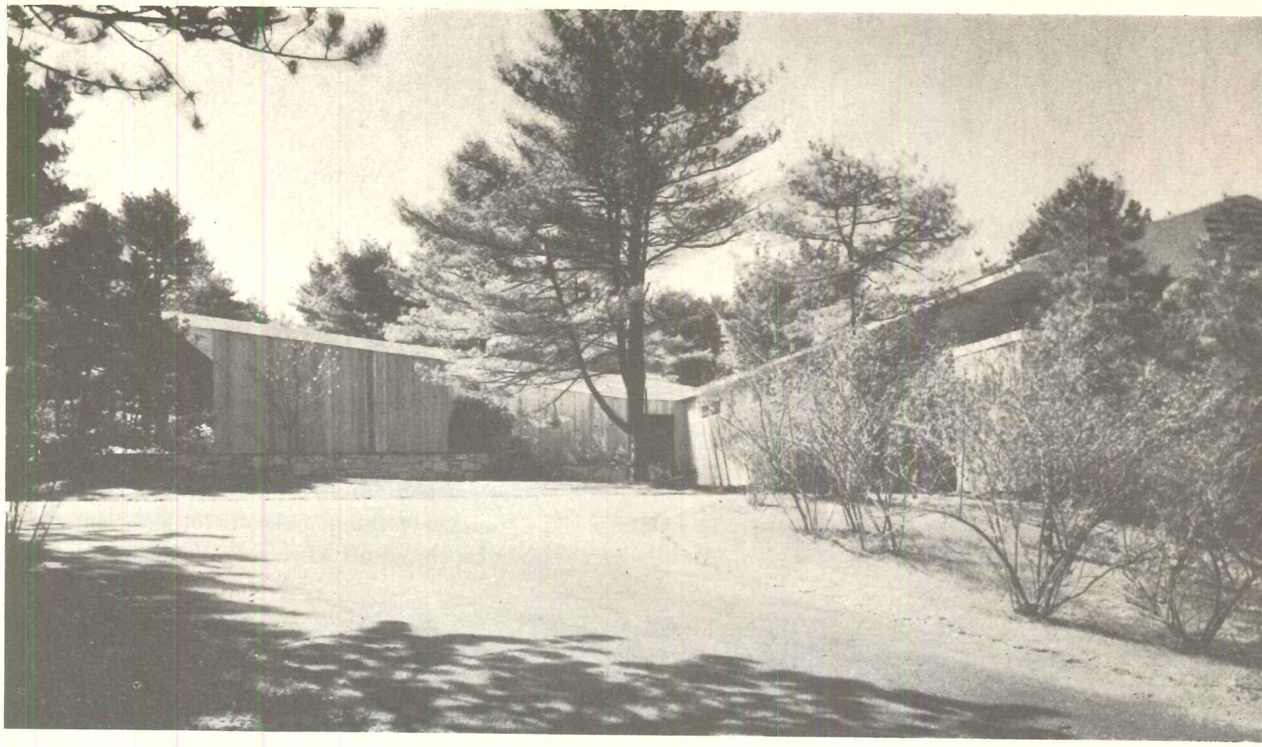
The owners are frequently visited by their children and grandchildren. Overflow guest accommodations are provided in the alcove off the bedroom corridor, which can be closed off when desired by a folding partition.





Charles R. Pearson Photos

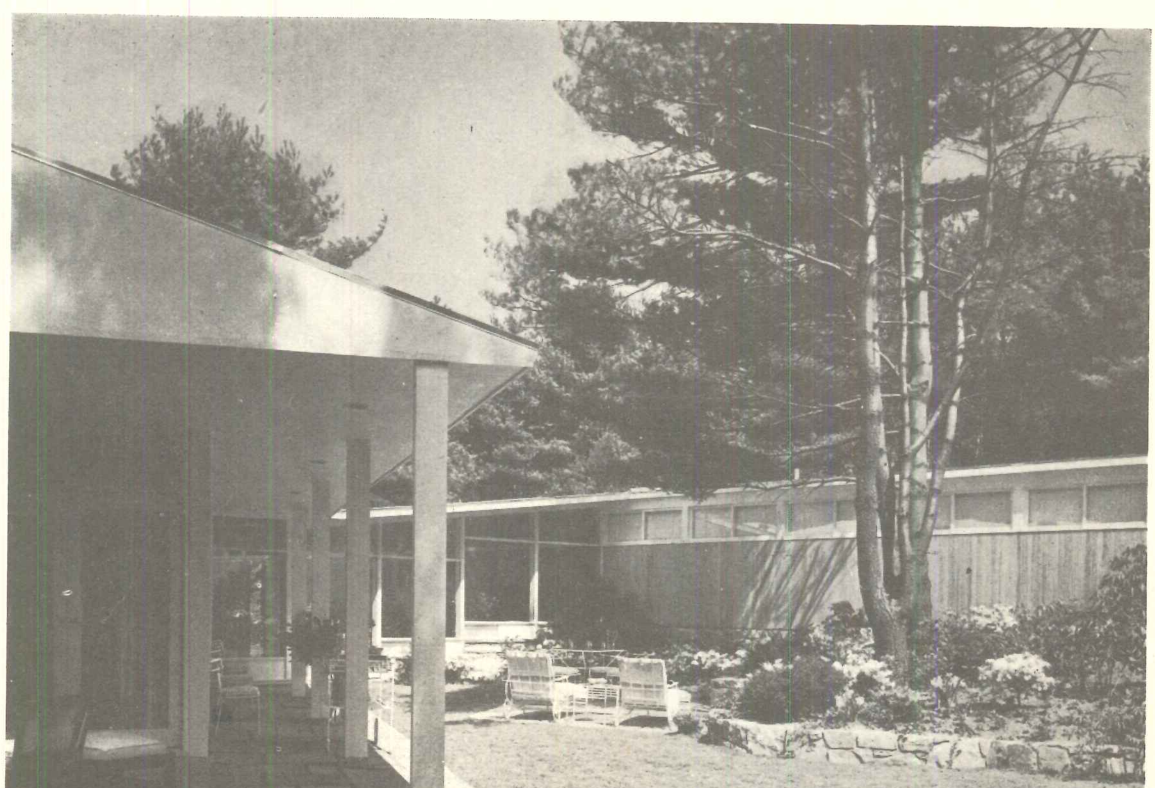
Master suite consists of two bedrooms separated by free-standing fireplace, dressing room, bath, and private terrace enclosed by louvered fence. There are also fireplaces in living room and study



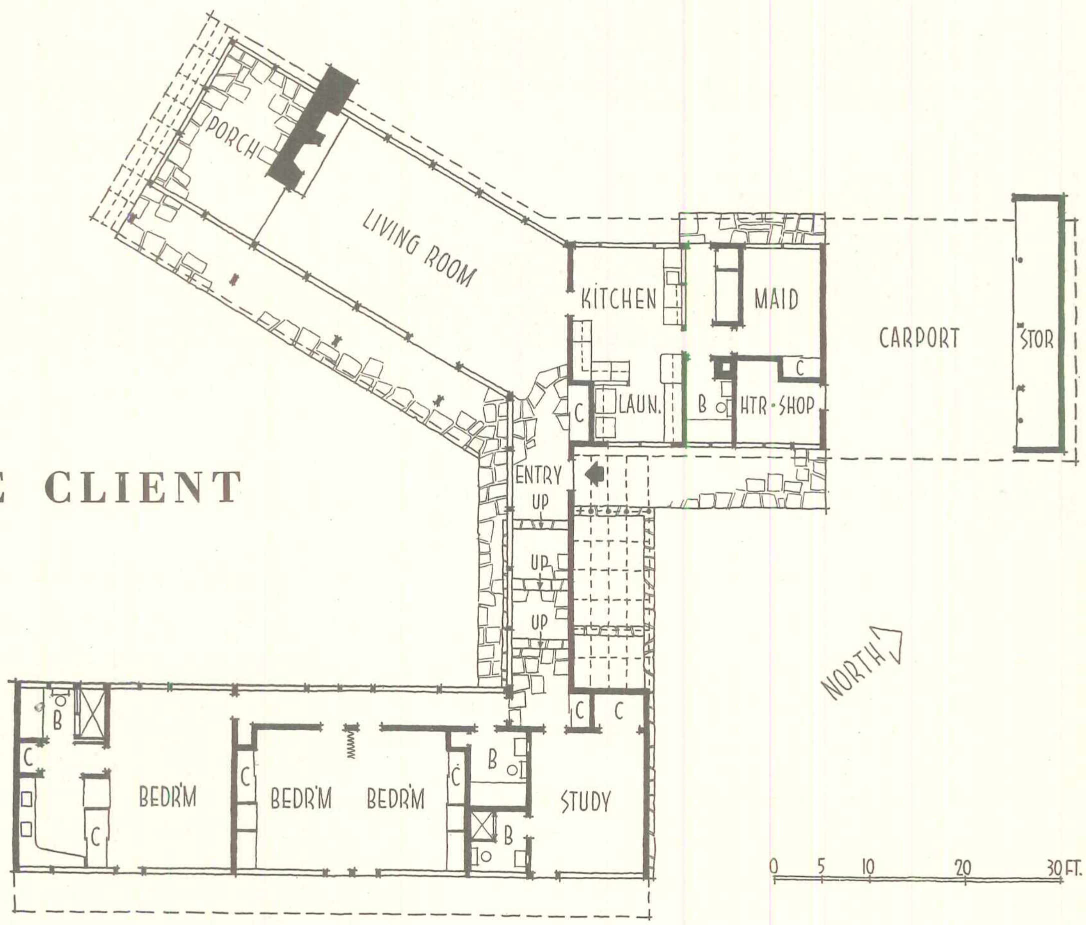
John Hancock Callender and
Allen & Edwin Kramer
Associated Architects

HOUSE DESIGNED FOR

Upper Brookville, Long Island, N. Y.

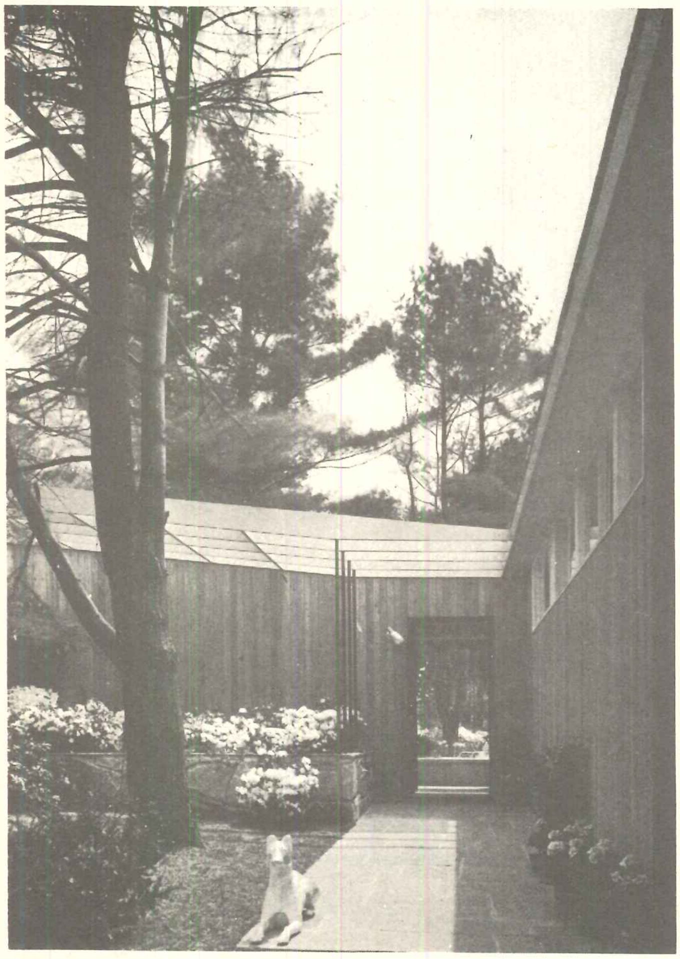


Photos: Tom Leonard



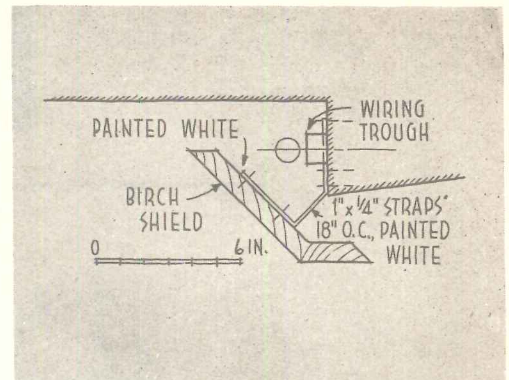
A MAGAZINE CLIENT

THIS EXTREMELY PLEASANT AND LIVABLE HOUSE, officially known as "House & Garden's House of Ideas," suggests one idea that is perhaps especially worthy of note. Its design seems to indicate a careful fusion of many better qualities of two widespread style influences — the crisp, clean lines of the International Style, and the rambling openness of the popularized Ranch House Style. Yet, it has eliminated the severity of the one, and the ungainliness and awkward combination of materials frequently found in the other. The house was conceived and sponsored by *House & Garden Magazine* in collaboration with John Hancock Callender and Allen & Edwin Kramer, Associated Architects, and constructed by Cy Williams, Inc. The landscape architects were Umberto Innocenti and Richard K. Webel.

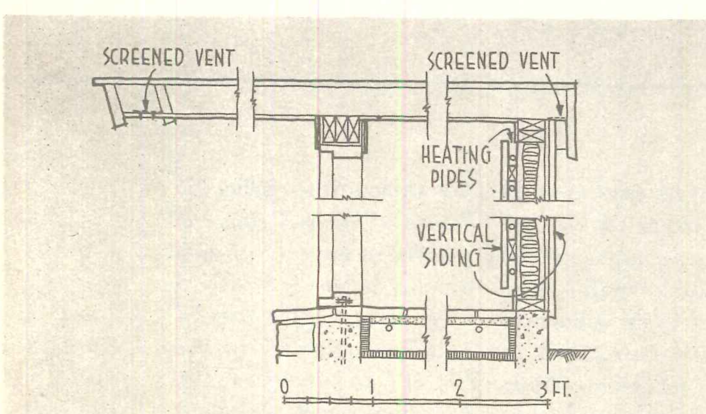


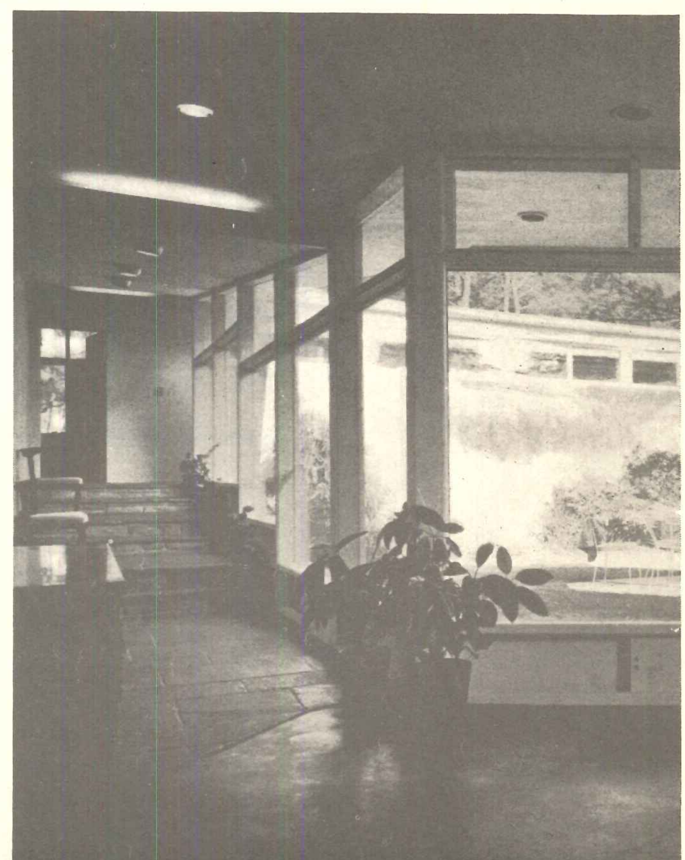
Photos: Tom Leonard

HOUSE FOR A MAGAZINE CLIENT



The entrance facade (left) has a closed-in look, was planned to give dramatic impact as front door opens on vista of outdoor courtyard. Entrance corridor (below) connects bedroom and living room wings, serves as transition in grade levels. Difference in corridor and living room ceiling heights is concealed by light trough (detail above). Entire house is heated by radiant coils in floors, supplemented in corridor by coils behind wall panel (below left)

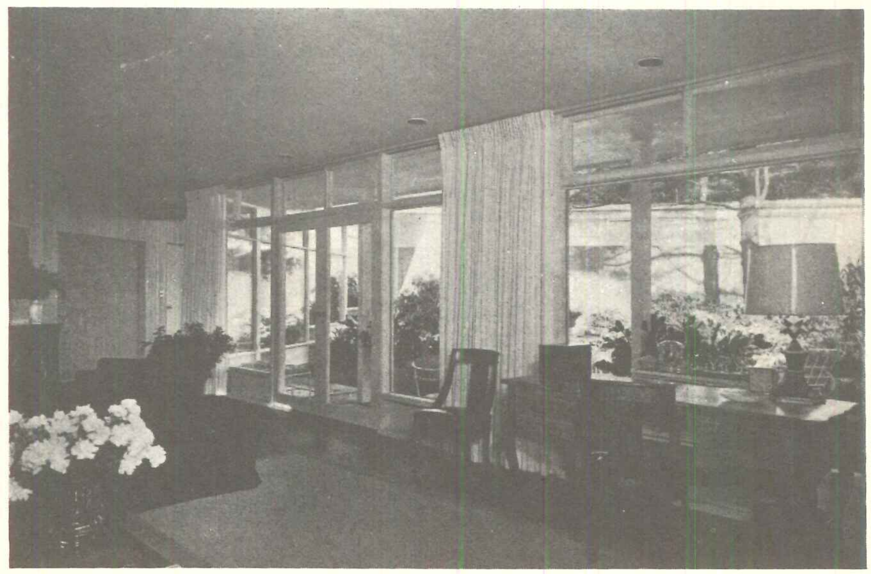




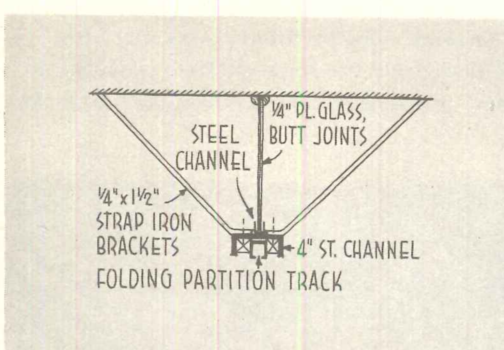
Careful, well studied planning and detailing are conspicuous throughout the house. Exterior walls are vertical cypress planks finished in clear creosote; trim is painted crisp black and white. The roof is of a special built-up type, consisting of aluminum foil, vegetable mastic and white marble chips. Rough stone is sparingly used to edge planting areas and for the chimney.

The house was planned for an "average family of four," and consists of three distinct wings for living, sleeping and service facilities, disposed around a central outdoor living area. A great sense of space and openness exists in each of the rooms, brought about chiefly by use of half partitions, glass panels, and window walls. Each room also has its own outdoor terrace.

Interior walls and ceilings are finished with painted gypsum board; floors are concrete slab, finished with flagstone or one of a variety of tiles. Interior furnishings were done separately by Macy's, New York. Heating is by copper tube radiant floor panels, split into three zones with outdoor bulb and indoor thermostat controls. The boiler is oil fired. All walls, ceilings and slab edges are insulated. An intercommunication system is installed throughout the house. Flush downlights are used in most of the rooms.

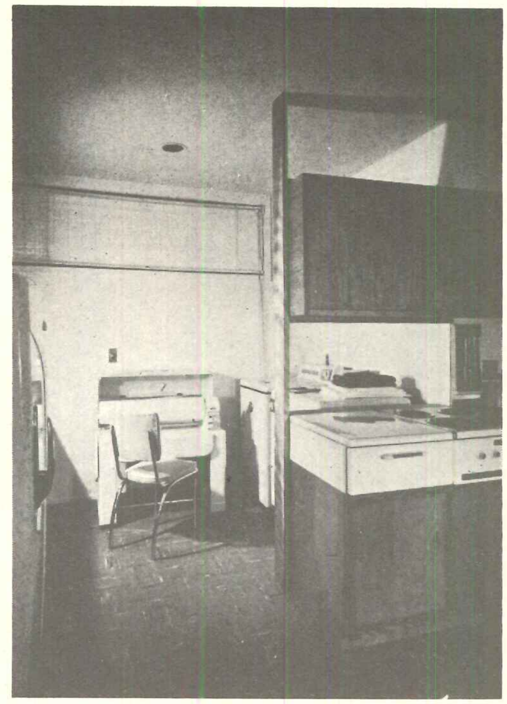


Space is added to living areas by covered walk, porch and central courtyard. Panels at top and bottom of window walls open for ventilation. Photo below: side exterior view of carport, kitchen, living room

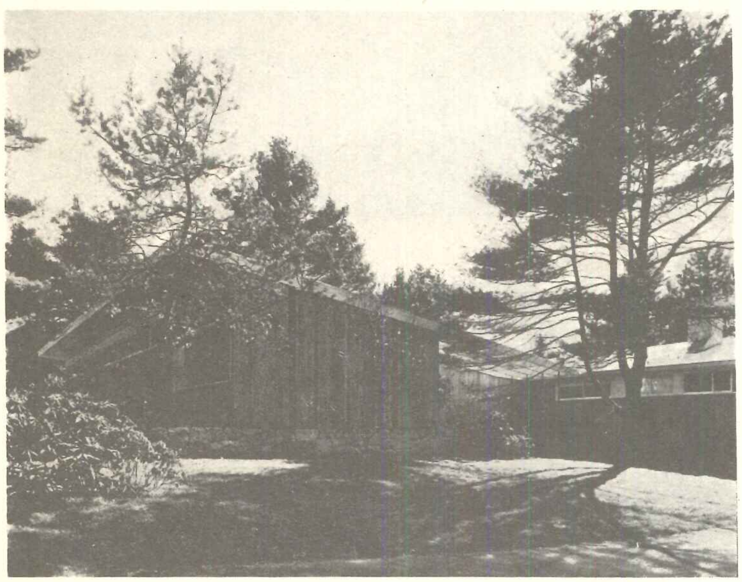


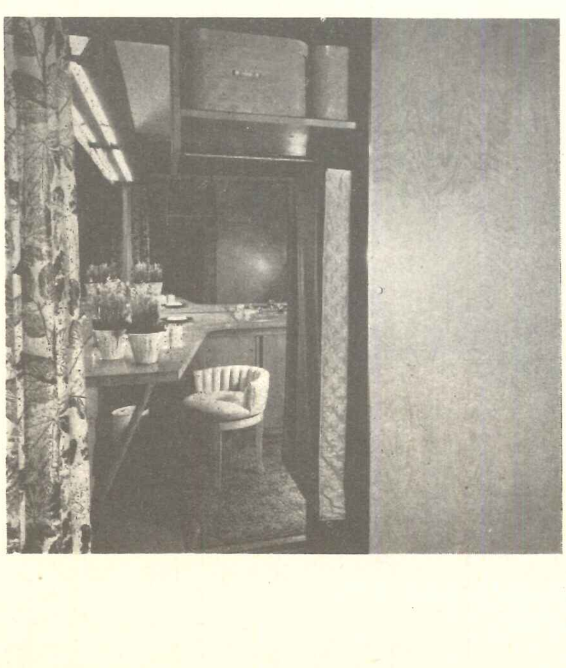
Children's bedroom (above) can be divided by folding partition; a glass panel (detail above) simplifies problem of joining track with sloping ceiling. Master bedroom is separated from dressing room by two-way closet (two photos right). Each bedroom has terrace

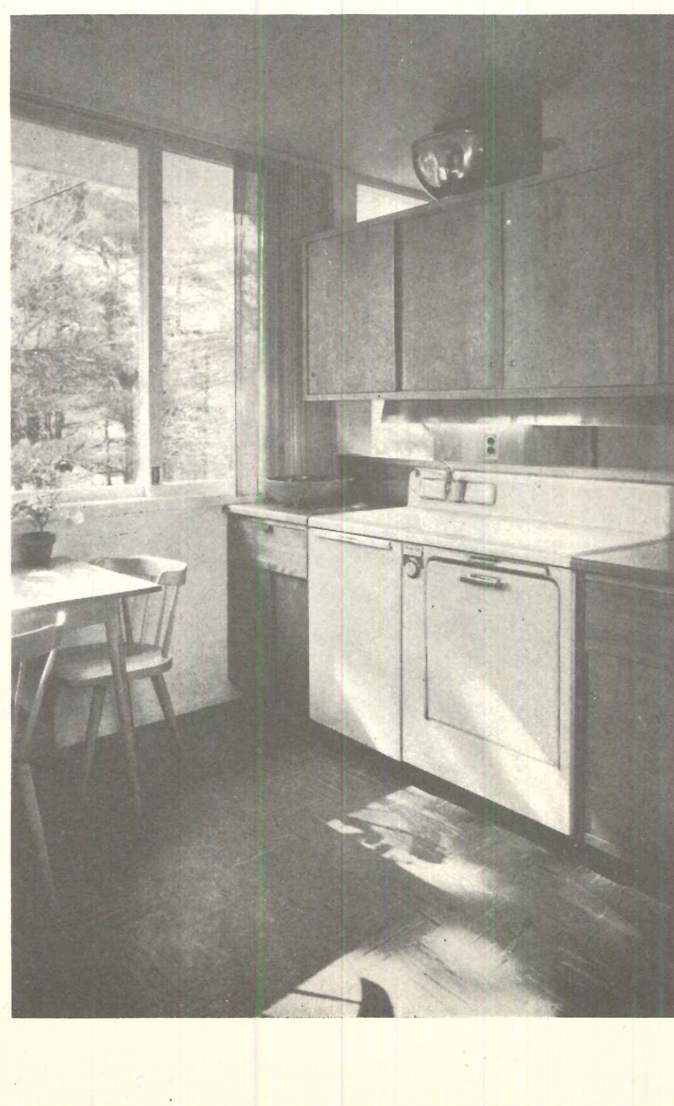
The sense of openness which carries through entire house is continued in kitchen by use of suspended cabinets, plate glass behind range and sink (right, top and bottom). A larder is provided adjacent to service entrance for storage of groceries. Exterior view (below) shows bedroom wing at left, service wing at right

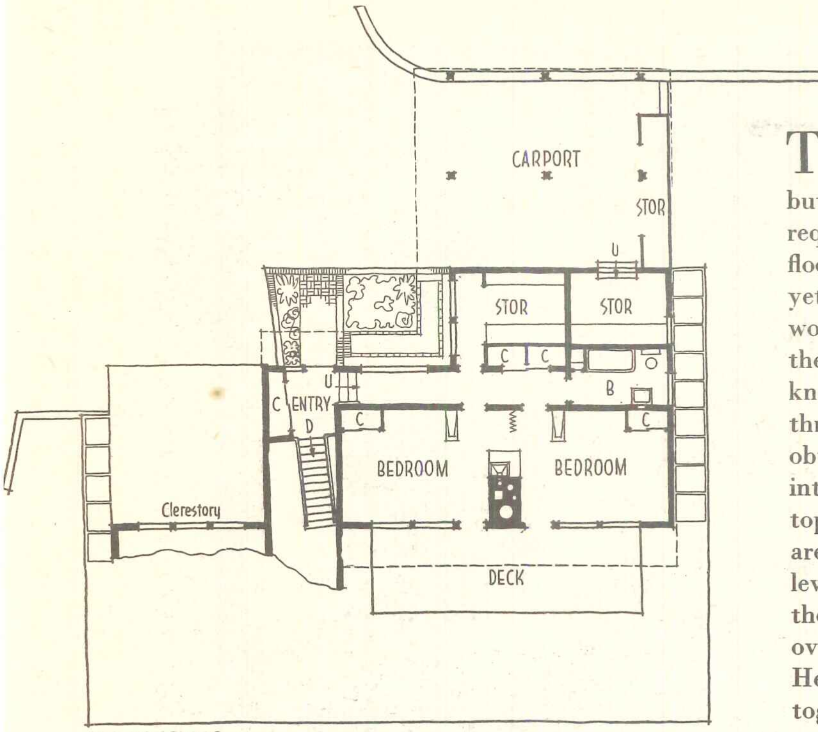


Photos: Tom Leonard









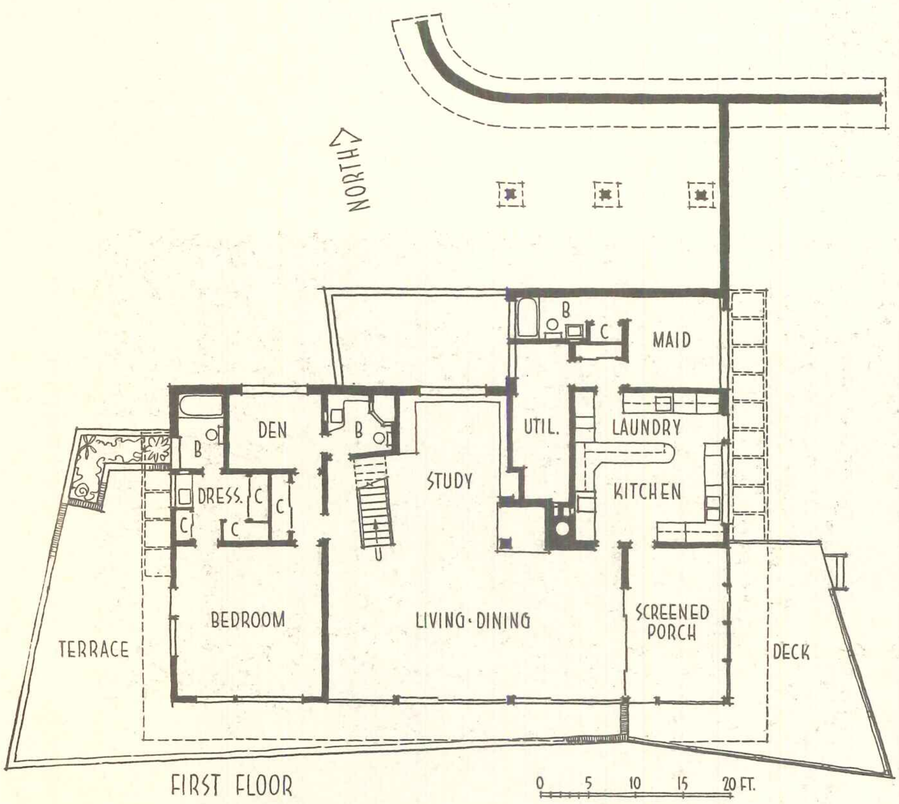
SECOND FLOOR

THE CASCADING FORMS and roof lines of this hillside house not only express the character of the setting, but also reflect skillful handling of the client's basic requirements. The owners desired an essentially one-floor house, secluded from the main road at the front, yet affording terraces for all rooms and good views of woods, creek and waterfall to the rear. The house was therefore kept low at the front, and placed where a knoll shields it from the road. Rooms were divided into three levels. Principal areas are on the lower floor to obtain the best views; entry and carport are on an intermediate level. The children's bedrooms are on the top floor, where they may be closed off when the children are away at camps and schools. The variety of roof levels provides a series of open decks, a clerestory for the master bedroom, a skylight for the open stairs, and overhangs for all windows. The site was landscaped by Henry Fletcher Kenney, with the idea of blending together the house and the woods.

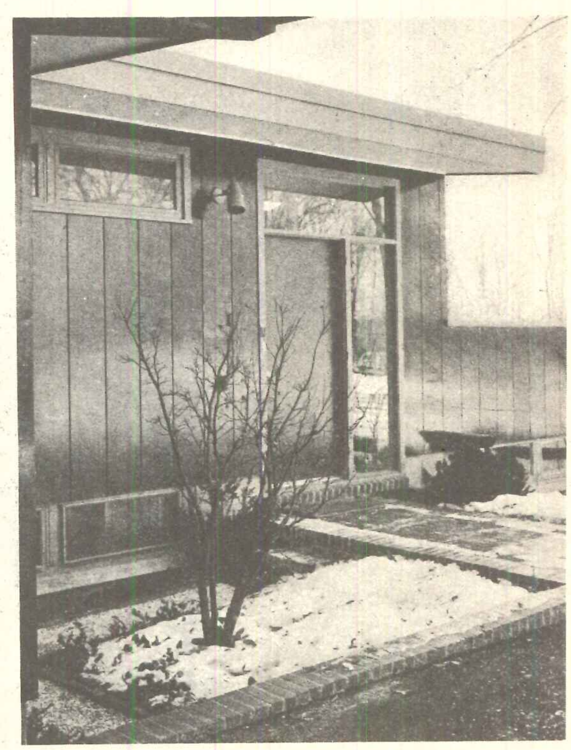
SPLIT-LEVEL HOUSE FOR CINCINNATI, OHIO

Residence for Mr. & Mrs. J. Ralph Corbett

Carl A. Strauss, Architect



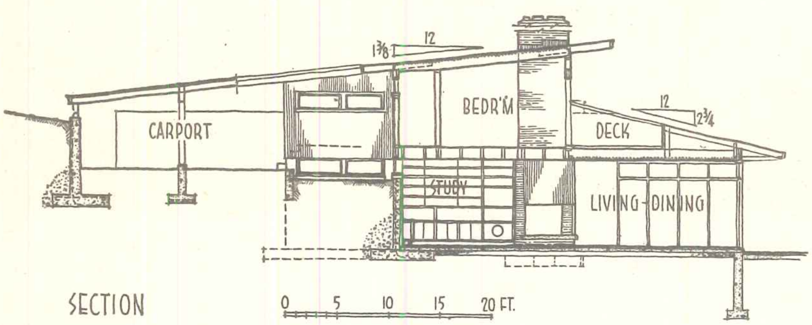
FIRST FLOOR



The house is built on a concrete slab, with wood frame construction. Exteriors are natural finish redwood. Trim is painted blue-gray

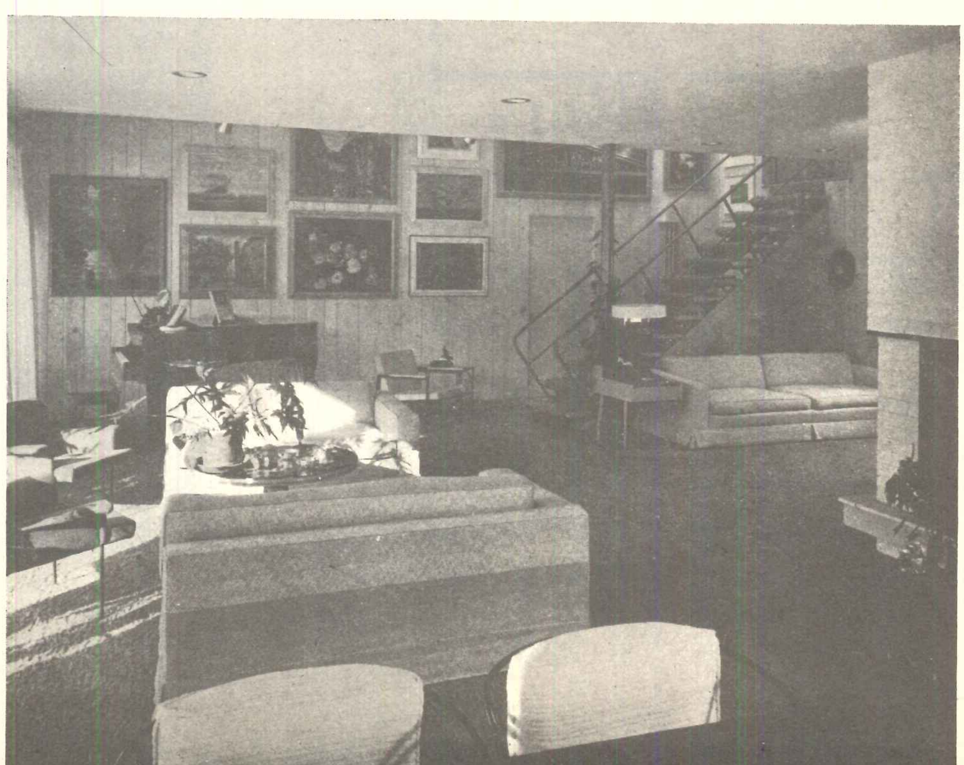
Photos: George Stille

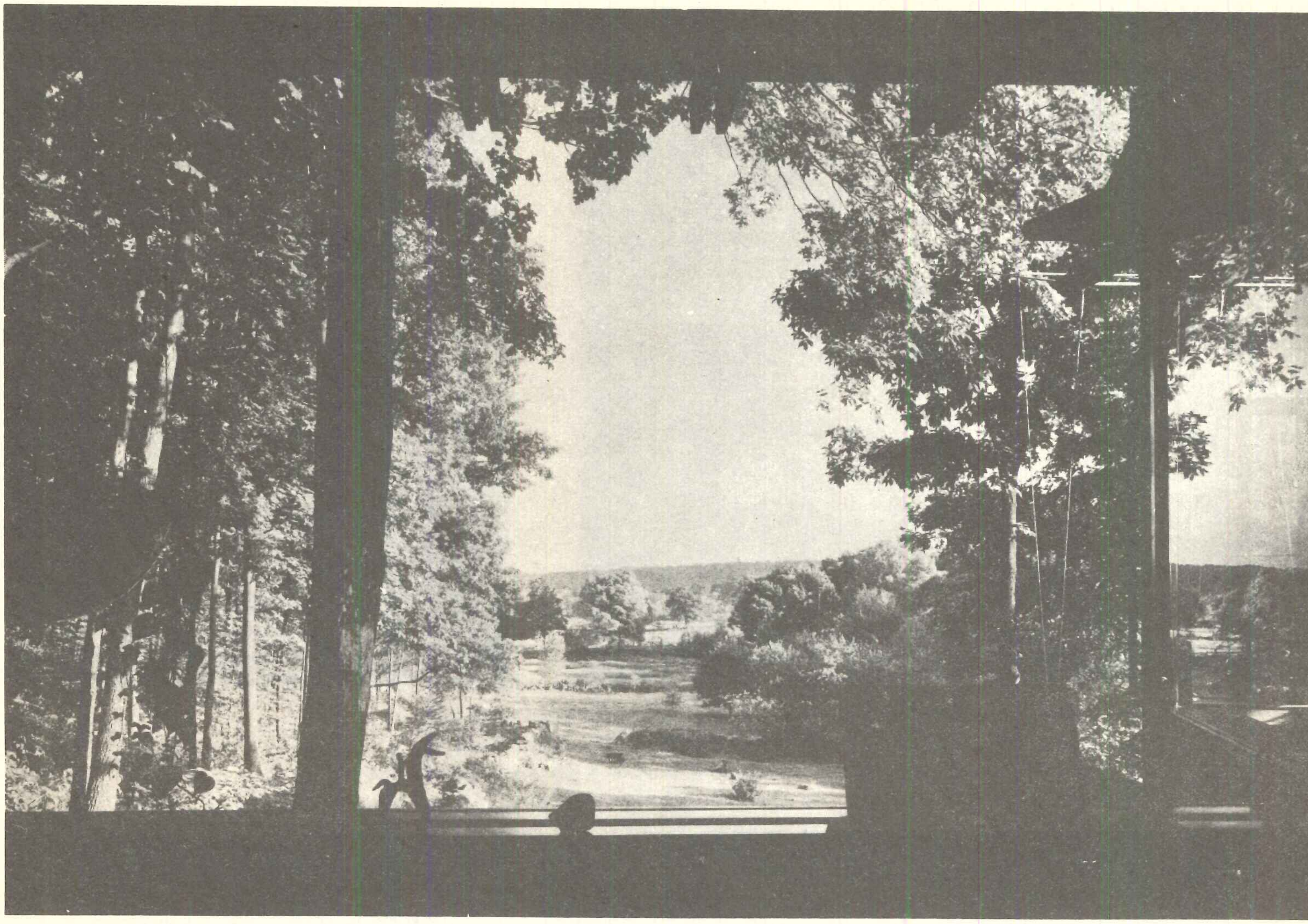
SPIT-LEVEL HOUSE



Principal living areas form single, open room with two walls of sliding sash. Corner fireplace is visible from all parts of room. A convertible screened and glazed porch beyond dining area has combination heating and lighting units in ceiling to permit year-round use. The rest of the house is heated by radiant ceiling panels. The furnace is oil fired. Study alcove and stair well are pine paneled, other walls plaster

Photos: George Stille



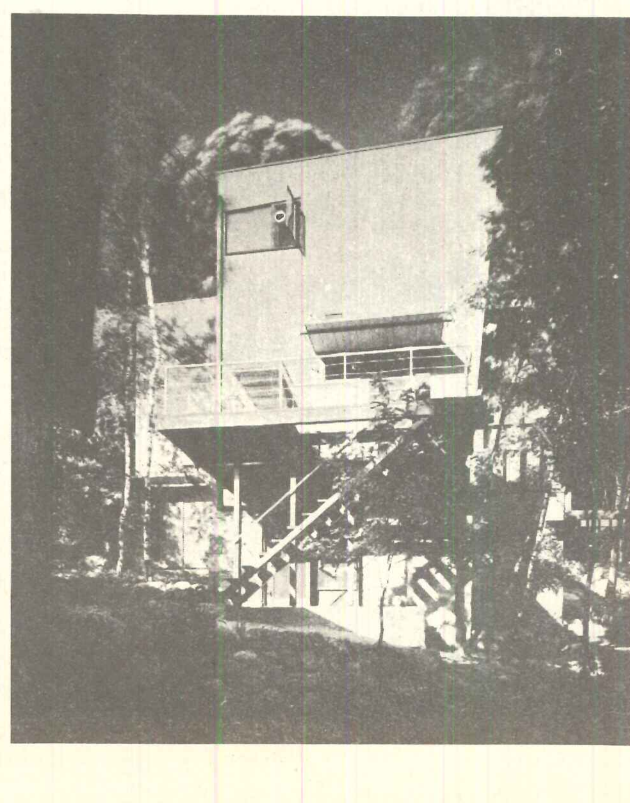


Ezra Stoller: Pictor

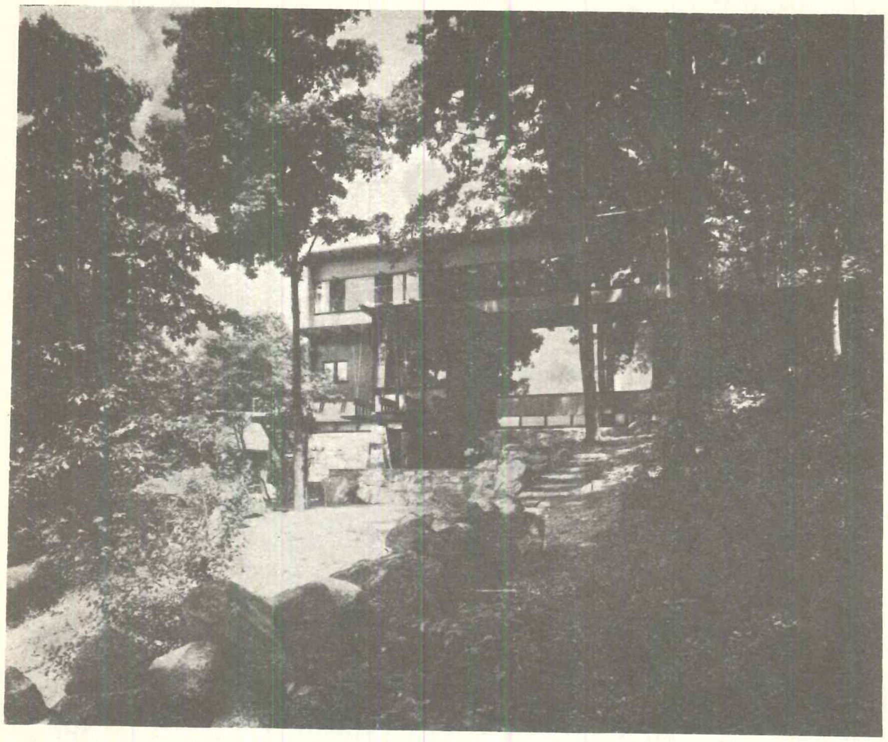
HOUSE FOR

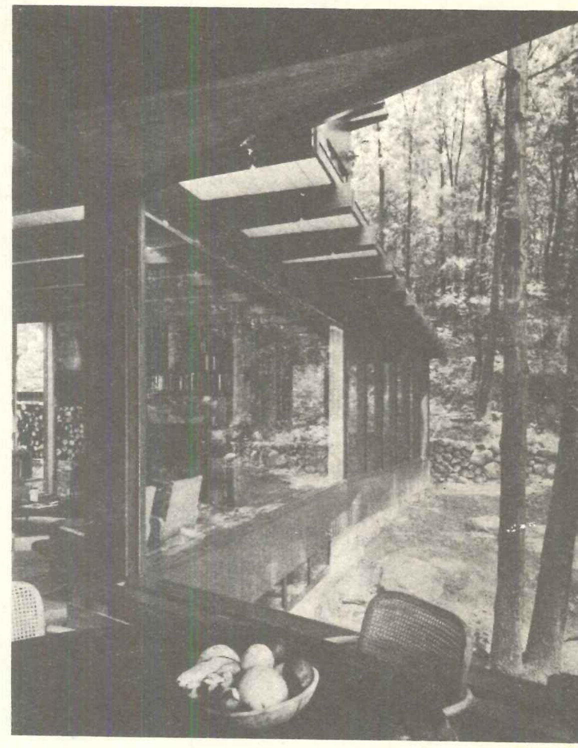
MR. & MRS. CHAUNCEY RILEY

NEW CANAAN, CONNECTICUT



Chauncey W. Riley
Architect





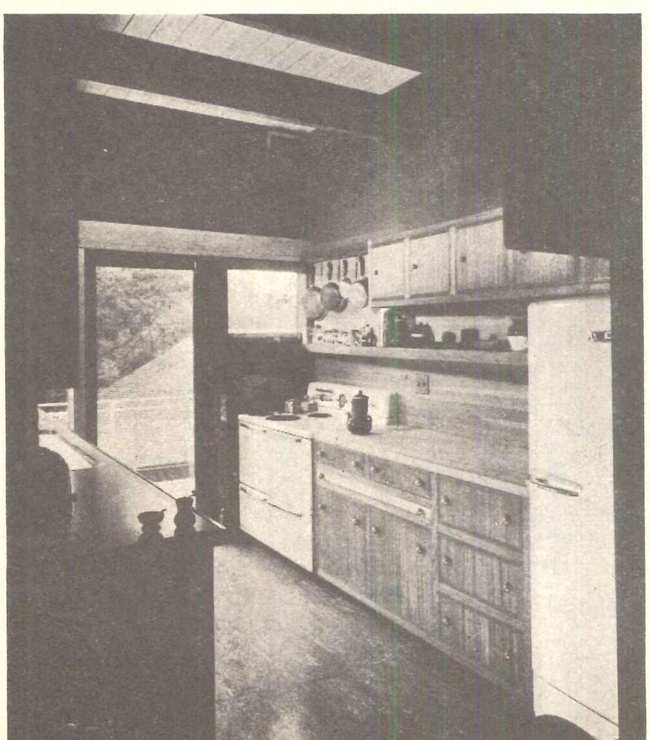
Above, left, exterior from south showing screened porch at east end under trees; center, dining bay, looking along glass wall of living room; right, dining bay and wall beneath shelter the terrace. Below, left, living room with screened porch beyond; center, kitchen; right, looking toward dining bay and kitchen

Ezra Stoller Pictor

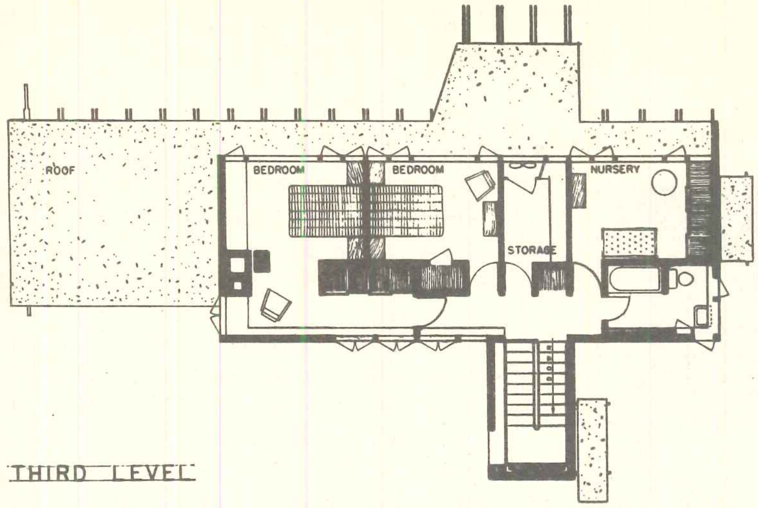
"My client," says Chauncey Riley, the architect of this house, "was Mrs. Riley." She and Mr. Riley both commute to New York, which rendered essential quick access to the garage and thence to the highway. Although the site and view demanded a vertical house, the ease associated with one-floor houses was appreciated, and so the stairs were designed to attain complete comfort. This is the reason the stair hall (see next page for details) was taken outside the house proper.

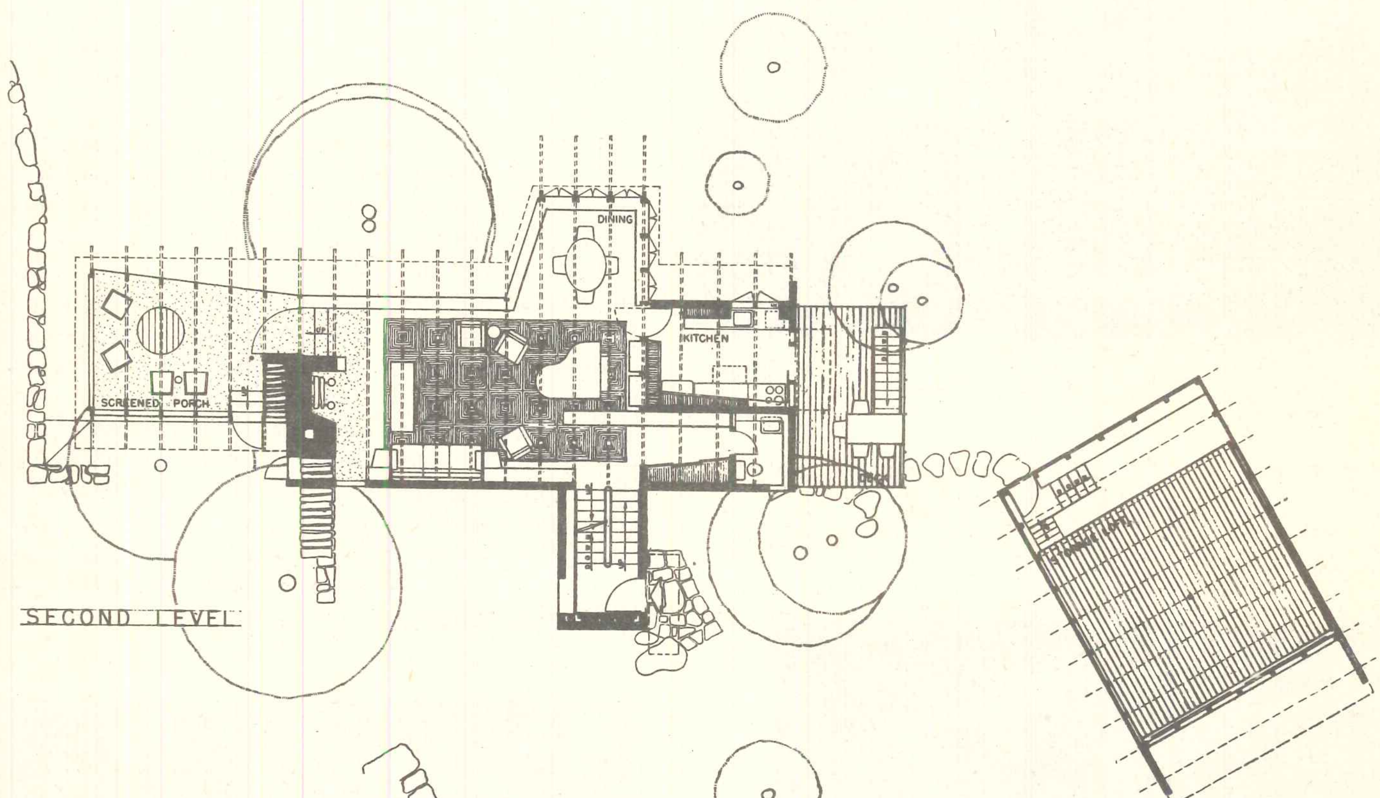
Woody growth on the site was carefully thinned so the deciduous trees would provide summer shade but not obstruct winter sun; the moon, the Rileys discovered, is highest in midwinter, lowest in midsummer, and this reverse of sun positions makes moonlit evenings enjoyable all year. On summer evenings, also, there is constant movement of air down the hillside toward the pond below; air flowing through the screened north-south walls of the porch — its east wall is glass to keep out damp east winds — makes it a pleasant, insectless sitting place. In daytime the prevailing summer breeze is southwest, so the two walls of the dining bay facing in this direction have operating sash.

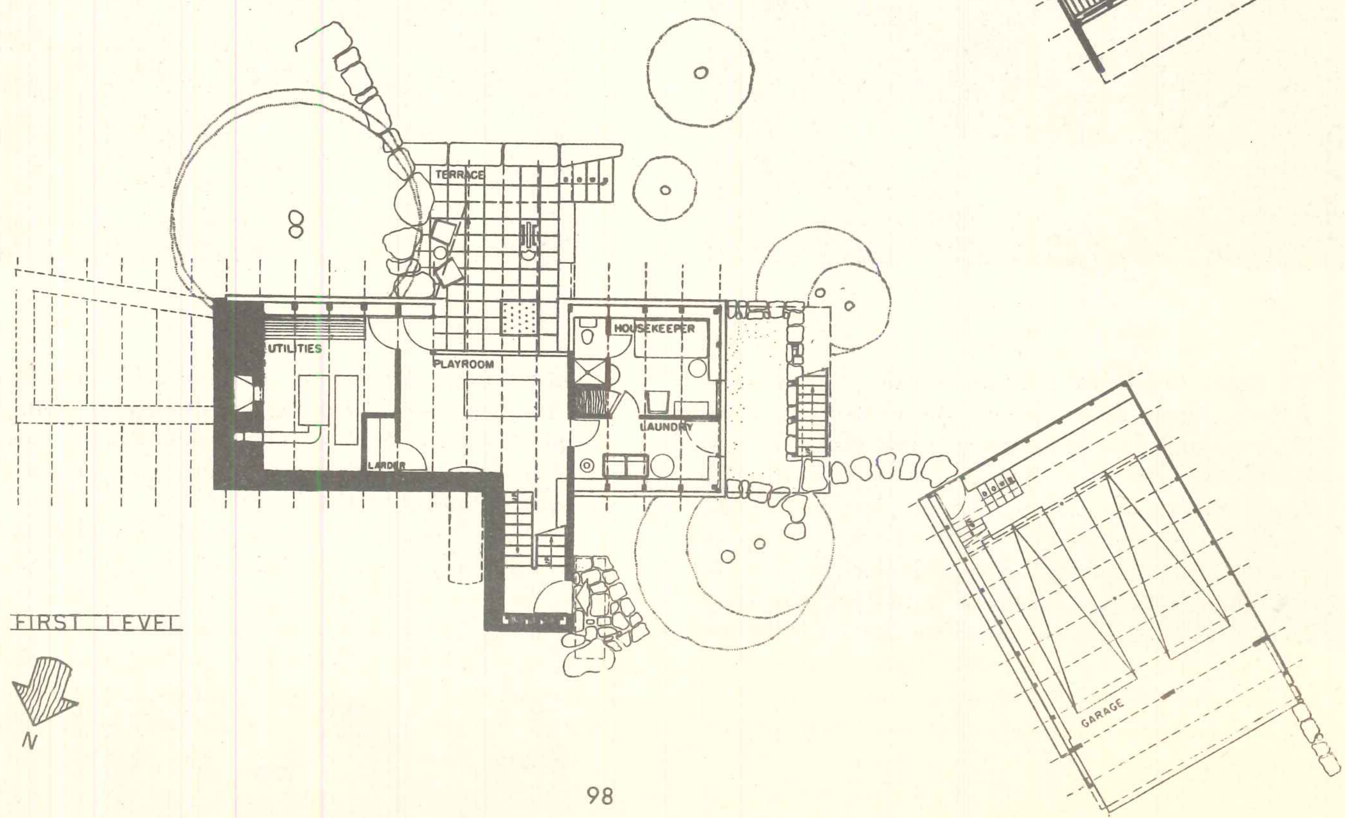
The interior was thoughtfully studied to capture within the character of the countryside. Some plywood finish was used (for instance, all kitchen cabinet work is mahogany plywood); but flooring, exposed framing members and trim are all unfinished solid fir, whose color is deepening in the sunshine. Doors are mahogany, simply waxed. Much furniture is built in; all this was thoroughly detailed. Stone found on the site forms the chimney. Exterior materials are vertical fir siding painted russet, dark green fir trim, and the same stone masonry so disposed as to blend the house into the land and its traditional stone fences.



The steep site, with its one location precisely right for overlooking the southerly view of meadows, small pond and distant hills, dictated a vertical house. Small photo taken from end of garage shows main entrance at left, and outdoor stair to service porch which doubles for outdoor dining and nursery







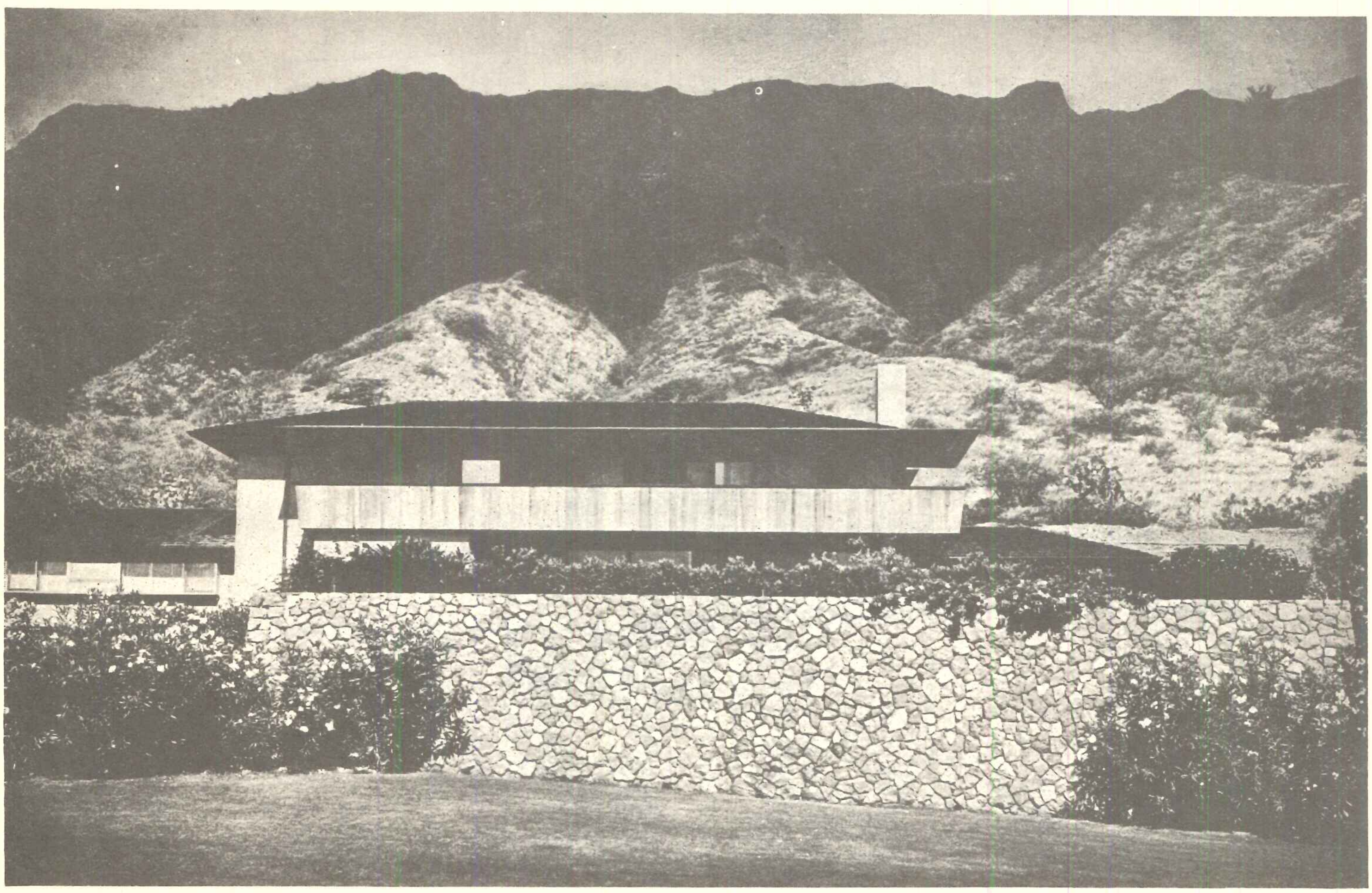
RESIDENCE OF MR. AND MRS. E. J. GREANEY

Honolulu, T.H.

Vladimir Ossipoff, Architect

R. O. Thompson, Landscape Architect

Robert Ansteth's, Ltd., Interior Decorator



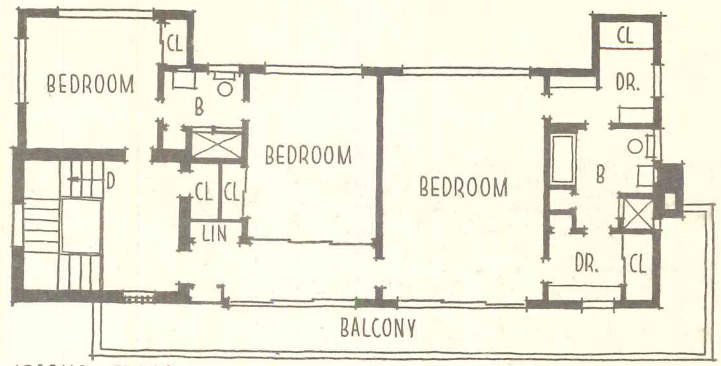
R. Wenkam Photos

IN PLAN, this house is characteristic of Hawaii, with sliding glass doors opening the main living area to surrounding lanais, or terraces. At first glance, however, it does not seem at all typical of the open architecture of the Islands. True, it has a balcony, but the high stone wall gives it a closed-in look which is surprising, particularly as the house faces the ocean. The reason is this: the house is situated on the slopes of the famous Diamond Head — slopes so steep that retaining walls were required along two sides of the property. (The stone used for the walls was excavated on the site, and the excavation in turn was used to form the lanai at the rear of the house.)

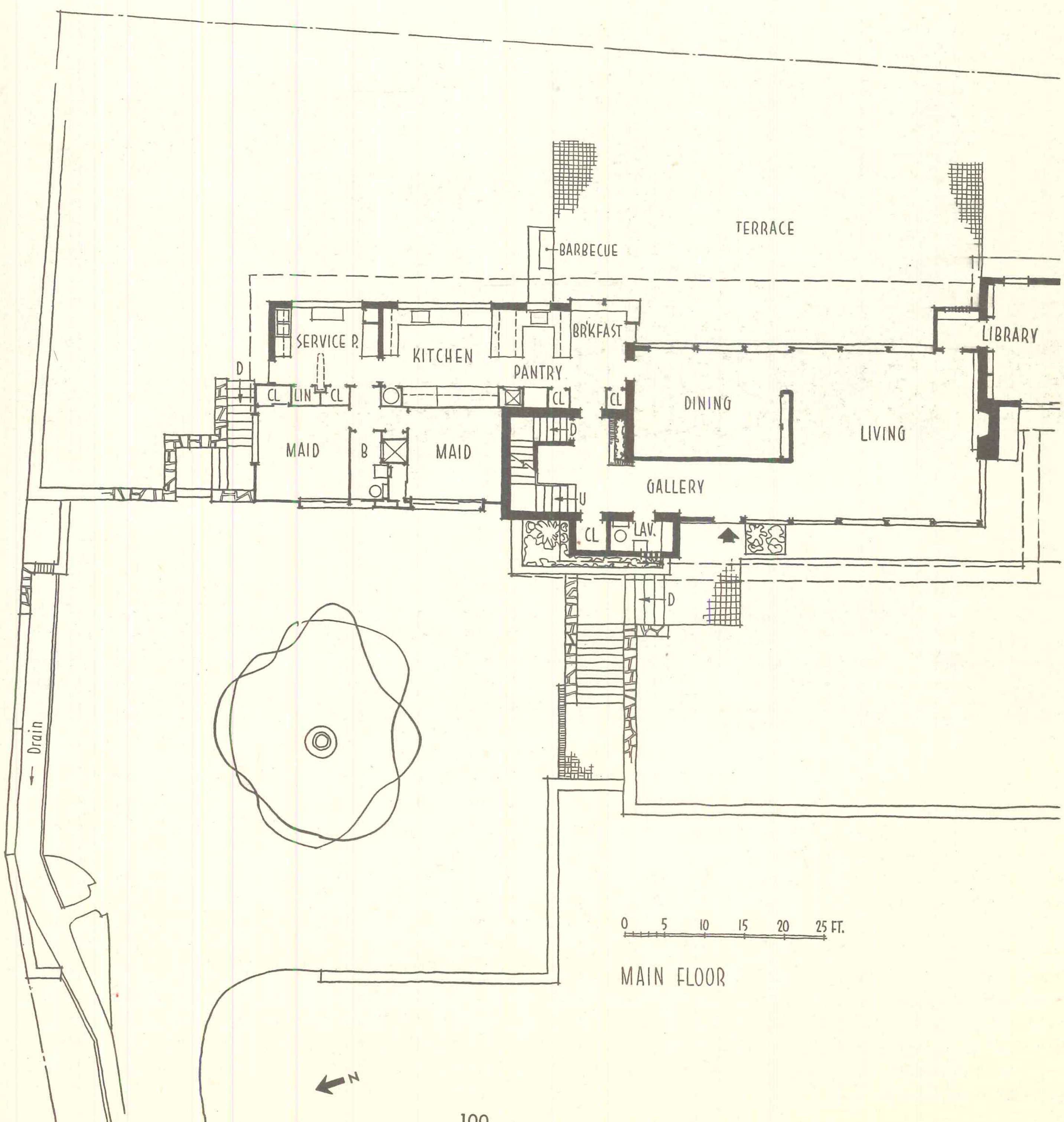
The architect obviously gave considerable thought to how the house would look against its background. As the photo shows, the horizontal emphasis, the varied levels, and the low hipped roof echo the contours of the mountain itself.

Exterior of the house is hollow cement block and rough Northwest pine which has been given a weathered finish; the tan of the pine blends with the warm dark brown of the stonework. The roof is cedar shakes, the foundation masonry and concrete. Ceilings are acoustic plaster and, upstairs, a local cane fiberboard with a pleasant texture and both thermal and acoustic insulating qualities.

The site is both steep and irregular, sloping from 132 to 116 ft along northern edge and from 138 to 106 ft along southern. Elevation of the turn-around is 118 ft, that of the house and terraces 126. Garage is under the service wing

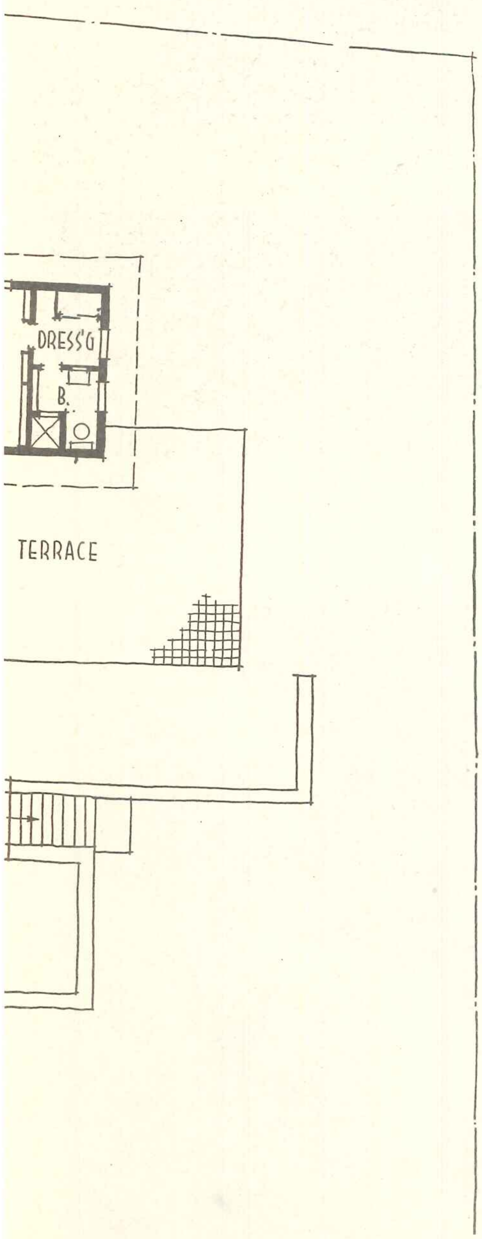


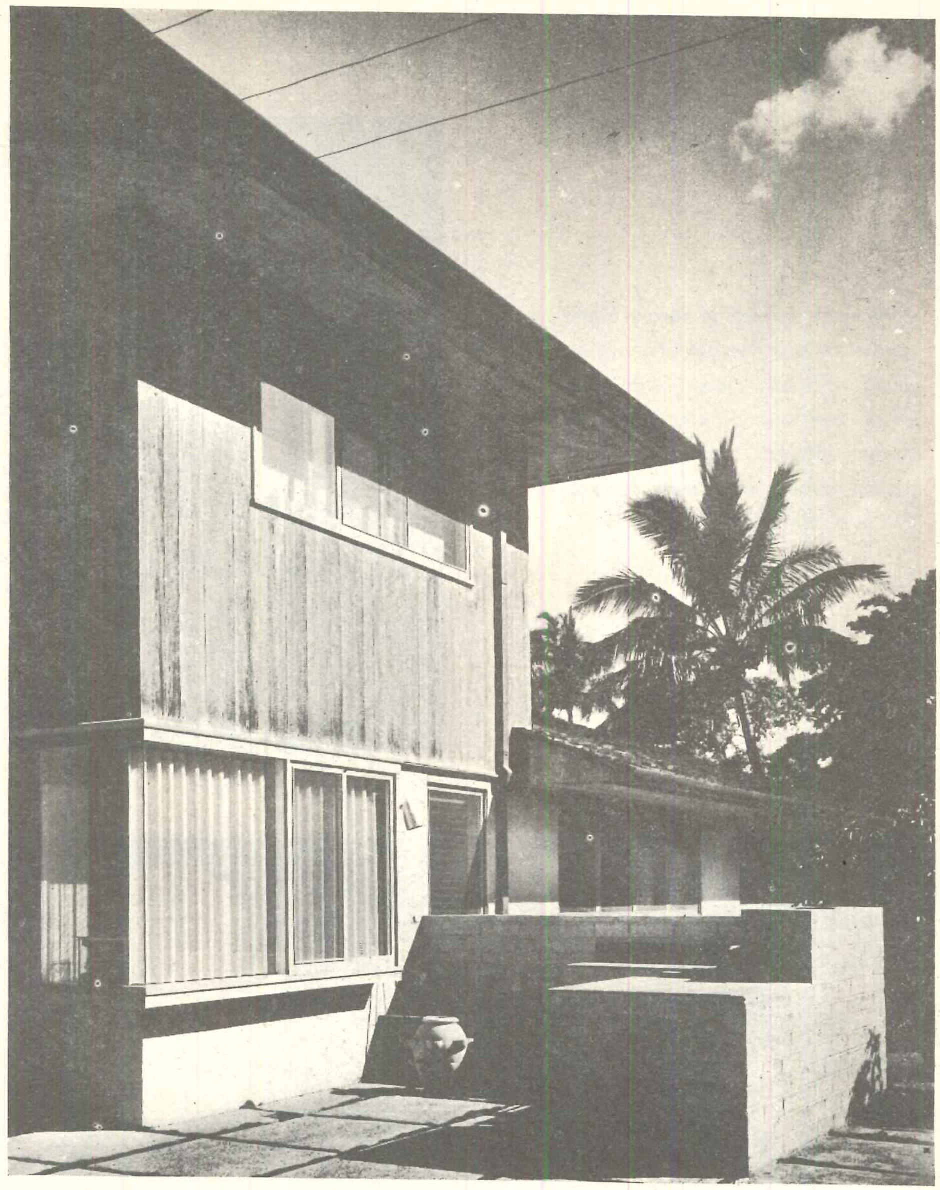
SECOND FLOOR



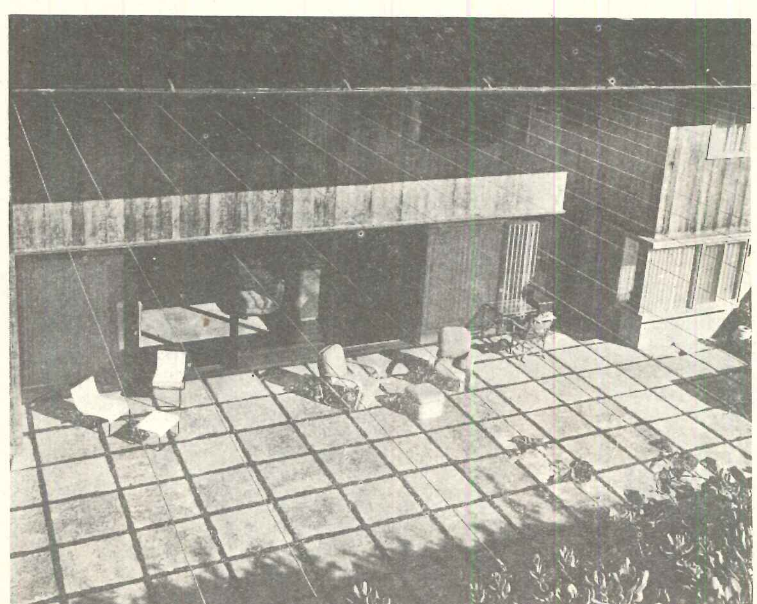
MAIN FLOOR

Right: barbecue is at one end of rear lanai, out of the way, but handy to kitchen. It serves effectively to terminate sitting area and shut off service wing from terrace





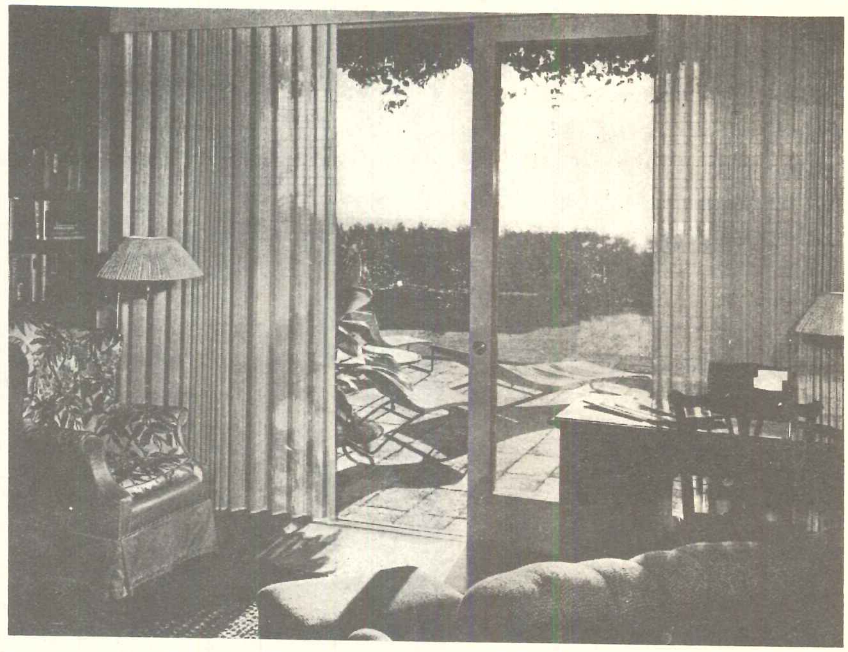
R. Wenkam Photos



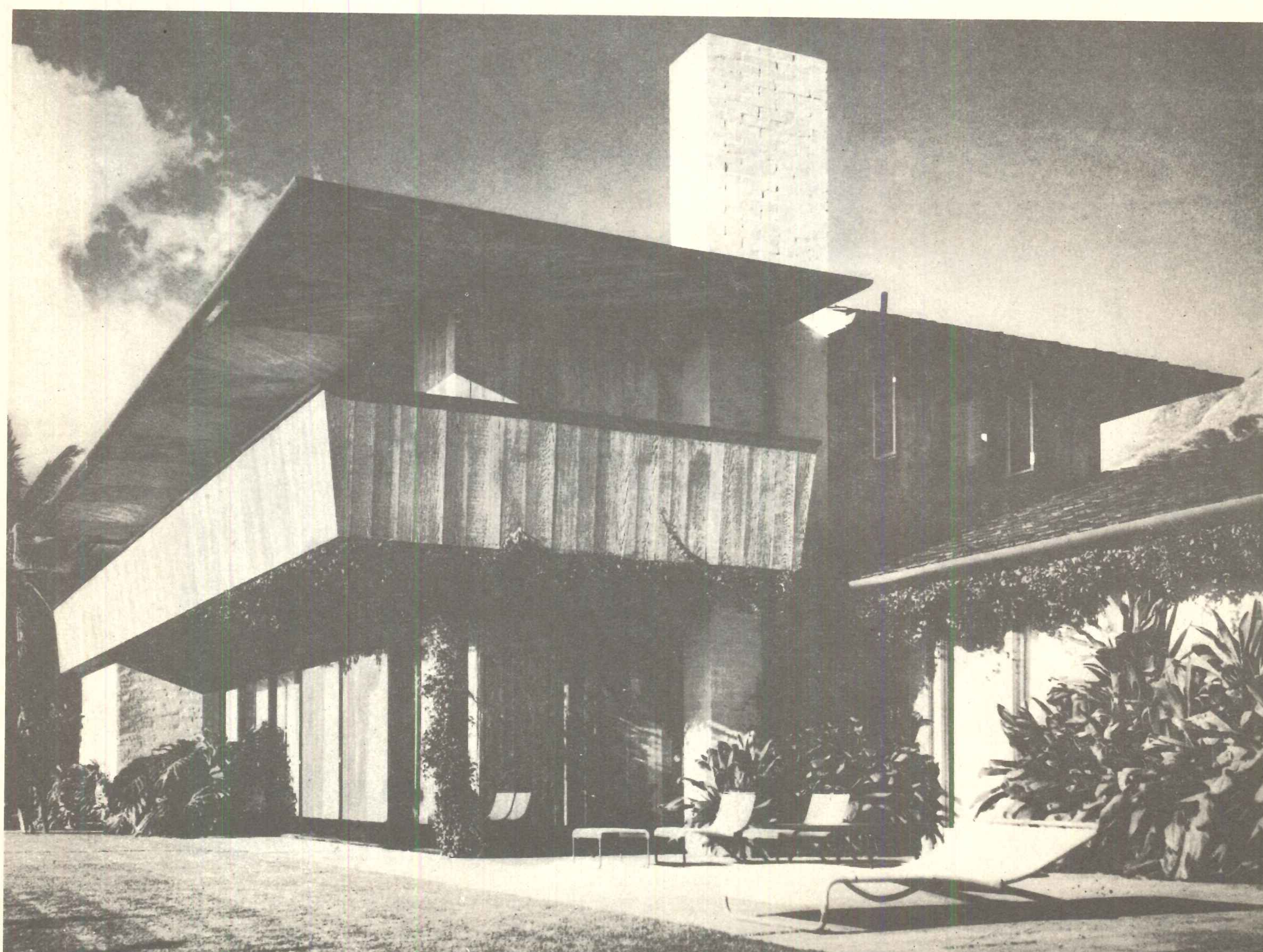
Upper or rear lanai is paved with concrete blocks using a coral aggregate; joints are planted with a Japanese moss grass. Wires above are to carry vines to provide needed shade in middle of day

GREANEY HOUSE

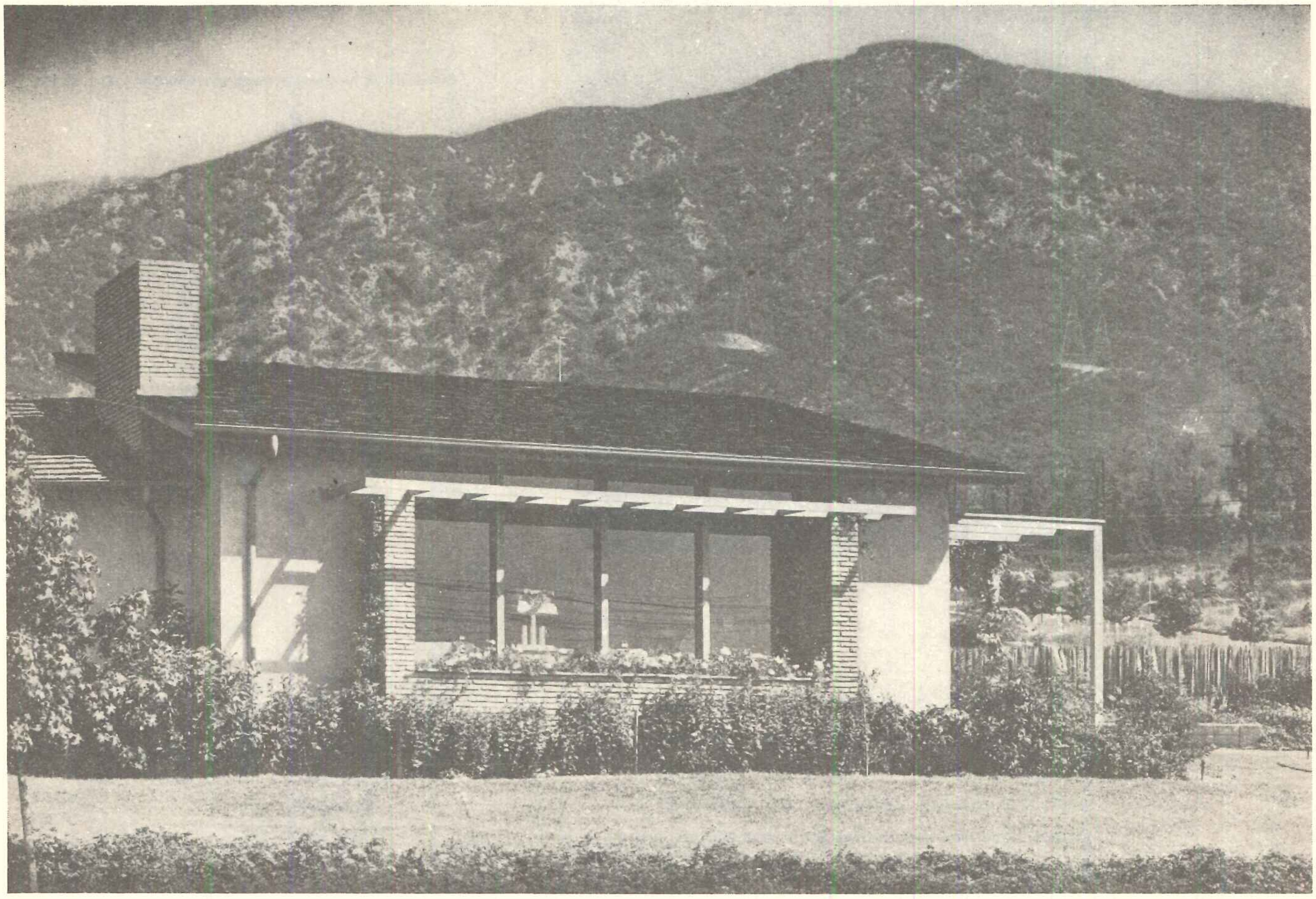
Sliding glass doors in library (right) and elsewhere throughout house are hung with split Hong Kong reed. Floors are ohia, a Hawaiian hardwood. Below: another view of upper terrace, with living room at left and library at right



R. Wenkam Photos



Julius Shulman Photos



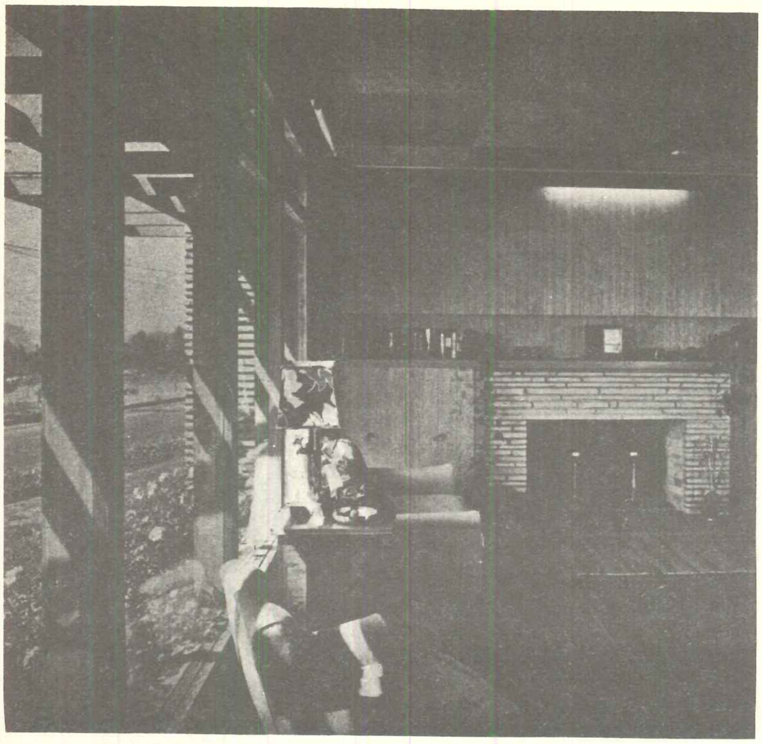
HOUSE DESIGNED FOR MR. ROBERT MAIN

LA CANADA, CALIFORNIA

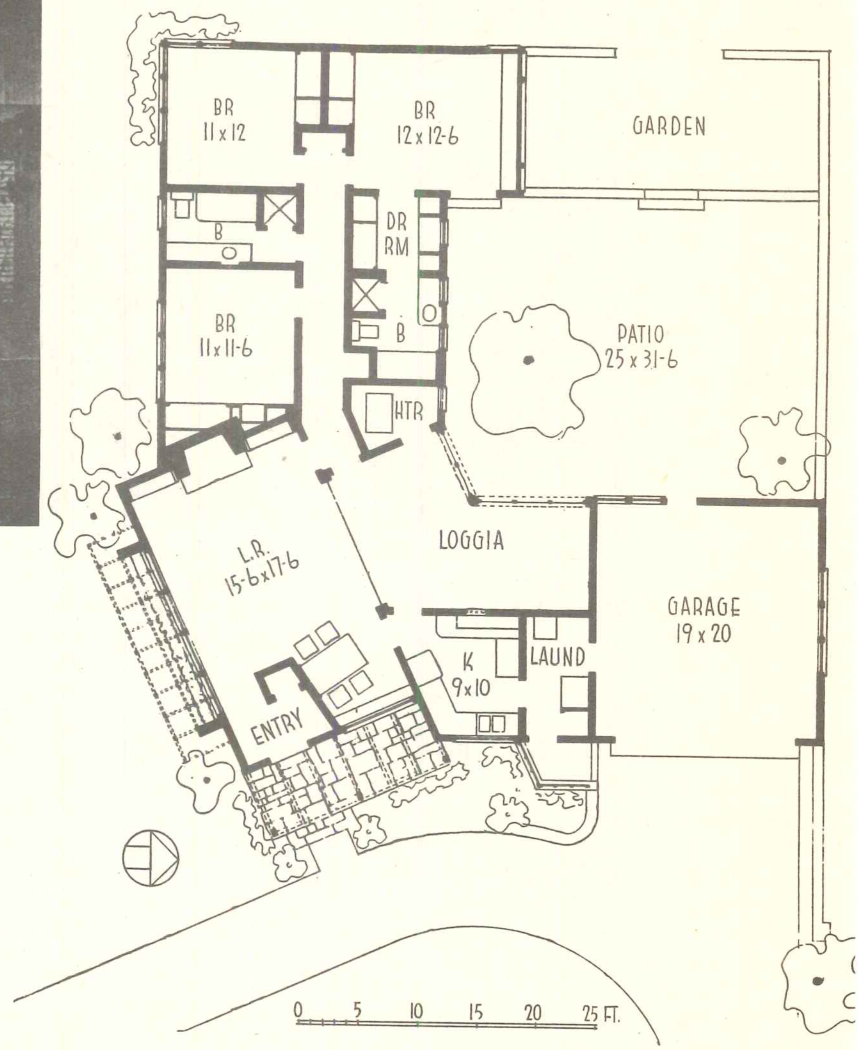
Frederick Hodgdon, Architect

THIS RAMBLING HOUSE in the foothills of La Canada is oriented to overlook both the city lights of Pasadena to the southeast, and mountains to the northwest. Windows line the two long walls of the living rooms to gain views in each direction. Service areas and bedrooms are placed in flanking wings to define a glassed-in loggia and an open patio to the rear of the house. A plate glass partition separates living room and loggia, and may be raised to the ceiling to combine indoor and outdoor areas.

The main facade of the house features a brick planting box, topped by a wood trellis, which frames and emphasizes the large window. Textures of the brick and a shake shingle roof are used to contrast with the stucco exterior. Interiors are finished with plywood panel walls and hardwood floors. A number of built-in items are incorporated in the house, including a dining table which folds into a pocket in the wall, storage cabinets, and a fluorescent lighting cove around the living room and dining alcove ceilings. Heating is by radiant coils installed in the plywood-surfaced ceilings. The furnace is placed in a central closet.



ROBERT MAIN HOUSE



Window wall in living room (above) is placed to face view of Pasadena. Trellises shade the window and set off entrances, as well as display profusion of California plants. Interiors are surfaced in textured plywood; ceiling panels are set with grains in alternating directions

MODULAR COORDINATION IN FRAME HOUSES

By James T. Lendrum, Acting Director

Small Homes Council, University of Illinois

Articles and Time-Saver Standards in recent issues have discussed the principles of Modular Coordination, based on the 4-in. module. Now, Professor Lendrum tells how the Small Homes Council has adapted the system to frame construction.

We consider modular coordination a tool whereby the draftsman or designer can predict with a high degree of accuracy, and very easily, some of the conditions which are going to appear in the field — greatly reducing cutting and fitting. It is also a tool with which the foreman or craftsman can check the accuracy of his work at any point and thereby be assured that subsequent operations can be done with greatest ease.

One difference between our work at the Small Homes Council, which admittedly has been primarily in frame construction, and masonry construction is in the size of the working module. The standard 4-in. module, which is so effective with masonry, loses some of its value in frame structures because of the increased size of the individual pieces going into the house and because of the reduction in the number of these pieces.

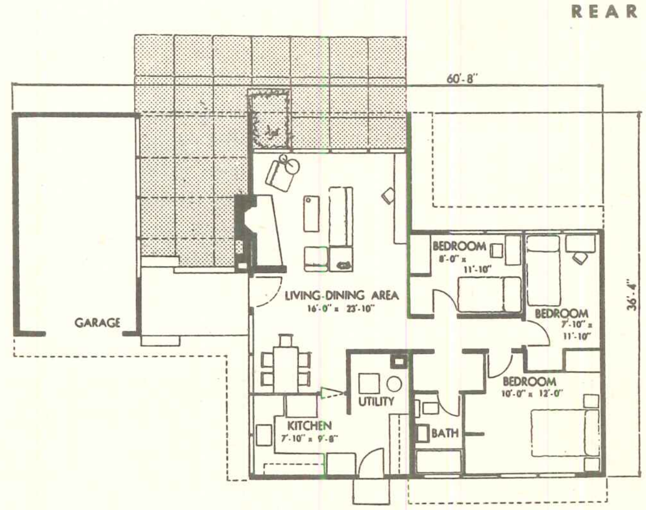
Practically, we operate in a rather simple fashion, and the only requirement that is absolutely necessary in order that any architect might duplicate our results is a mental one. You must agree to accept the mental discipline — it is something like stopping smoking or going on a diet; it is easy to talk about and often easy not to do, but once you have mentally accepted the responsibility, it is not hard.

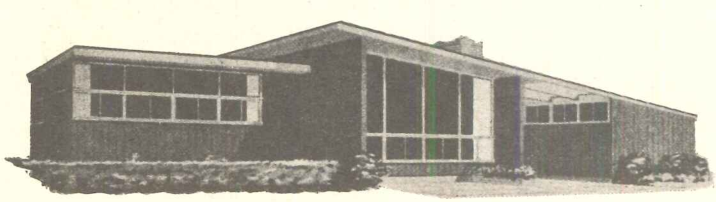
Convenient Modules

A 4-ft module would be ideal from a construction standpoint, since it corresponds with stock sizes of sheet materials. It is not impossible from a planning standpoint, but often we find a 2-ft or half module is desirable, and on occasions, we think in terms of a 16-in. or a 32-in. module, corresponding with 16-in. stud spacing. Of course, these are all multiples of the basic 4-in. cube.

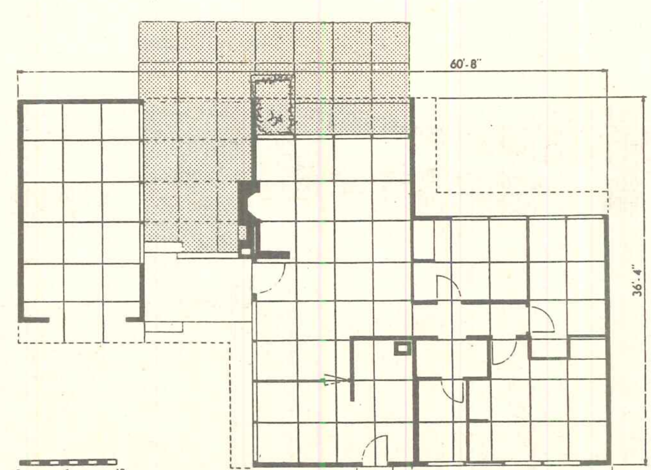
In one detail only do we vary from most people who are using sheet materials in frame construction. We use the 4-ft module (or the 2-ft or 32-in., etc.) to

REAR

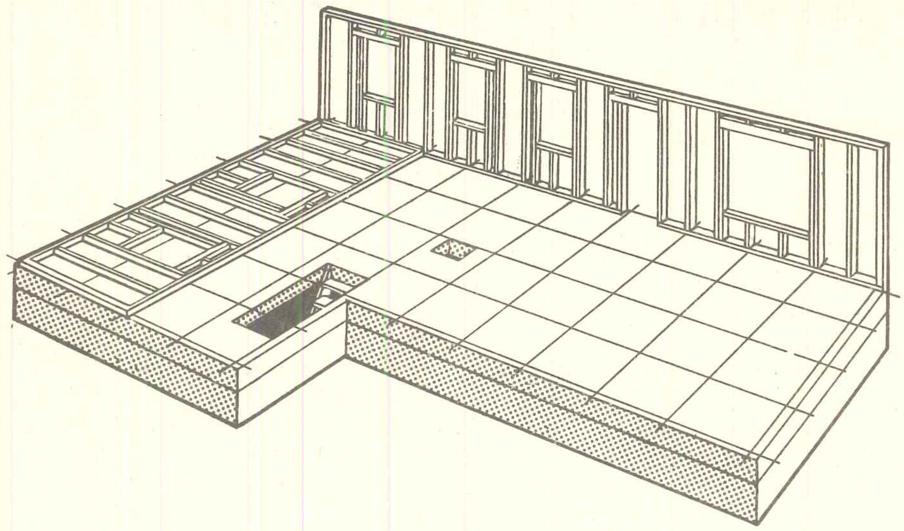


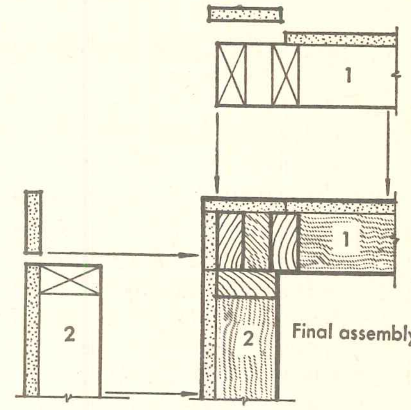


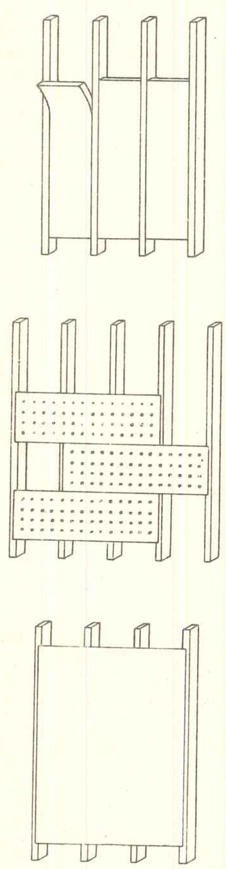
REAR VIEW



The lower plan shows how a 4-ft module has been used to design a house based on the system of unit planning of the Small Homes Council. In this system, standardized plans for rooms or groups of rooms (made up of a certain number of 4-ft squares) can be combined in different ways to form a variety of complete house plans





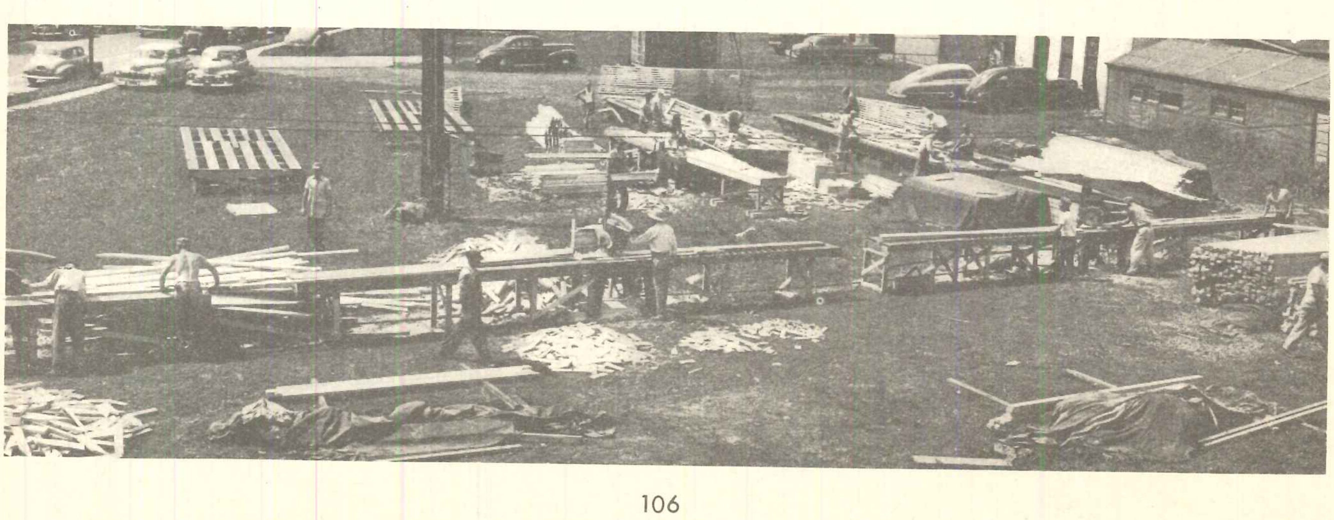


The only variance from common application of sheet materials for frame construction is that the 4-ft module (or 2-ft or 32-in.) is used to the nominal inside face of the wall rather than to the exterior face. This is shown above in an example of tip-up wall construction. Sheet and insulation materials (left) either inside or out fall directly into place, and may be applied before walls are erected. The end stud (above, right) must be off-set to allow for wall assembly

the nominal inside face of the wall rather than to the exterior. This was chosen after a number of field experiments which included actual construction of buildings, because it allowed very definite flexibility in the assembly process and not because of a modular relation. It perhaps is an outstanding example of the interrelation between modular design and improved construction practices.

Given a 4-ft planning module to the inside face of the wall, anyone can lay out, even without previous experience, a perfect modular wall — it is automatic. The sheet materials, either inside or out, fall into place perfectly. Stud spacing, either 16-in. or 24-in. on center is natural. Only one adjustment must be made in an entire wall, and that is the end stud which (see top figures this page) must be offset to allow for an assembly process. Since the wall is so simple are there any difficulties? The answer is yes — openings.

Modular coordination ties right in with engineering methods for frame construction of houses. Assembly line fabrication of wood trusses is demonstrated below



MODULAR COORDINATION— Frame Houses

Prepared with the cooperation of the Small Homes Council, University of Illinois

PLANNING AND DESIGNING of frame houses under the Modular Coordination system follows in general the precepts previously discussed for masonry construction. These sheets present some considerations for wood construction, together with methods used by the Small Homes Council of the University of Illinois and incorporated in their studies of the "industry-engineered" house.

The latter project combined use of Modular Coordination with pre-cutting and pre-assembling of frame members to study possible economies in small home construction. Substantial savings were indicated in material, and in time and labor for cutting and fitting. Platform type of framing is more easily adapted to standardization of modular details than braced or balloon frames, but the principles can be applied to any method. To achieve over all economies, some parts must be cut to fractional dimensions, but in any case, their placement is greatly simplified.

Standard sizes of wallboards for dry-wall construction, insulation bats, and plaster lath are all satisfactory for Modular Coordination. American Standard Yard Lumber Sizes are also convenient for use with the system. Lengths are generally available in 2-ft increments. Nominal stud sizes differ from actual dimen-

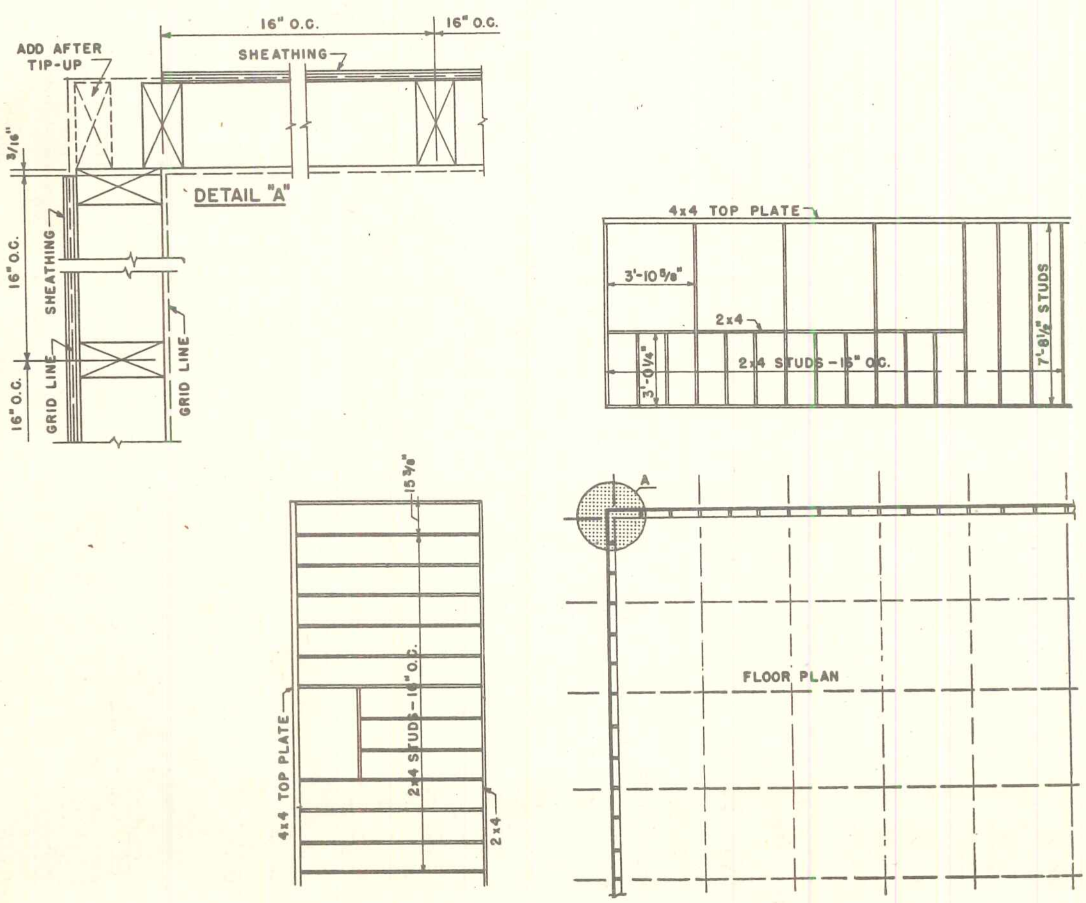
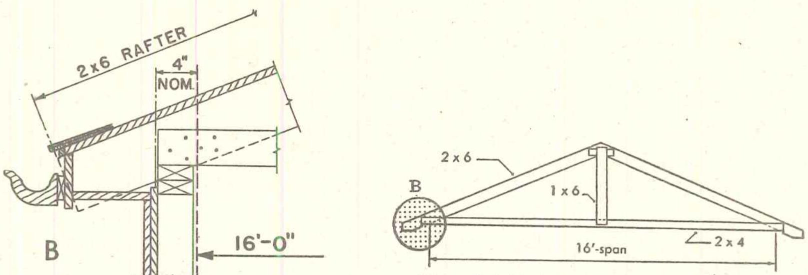


Figure 1.

Use of a 4-ft module, referenced to the nominal inside face of wall coincides with stud spacing and wallboard sizes, as shown in partial floor plan above. Wall sections are planned for pre-assembly and tip-up. Heights accommodate 8-ft interior panels. Detail "A" shows corner assembly used with this type of construction

MODULAR COORDINATION— Frame Houses

Prepared with the cooperation of the Small Homes Council, University of Illinois



16'-Span Nailed Roof Truss (Designed for 2'-spacing) 5/12 Pitch

Figure 2.

Pre-assembled roof trusses simplify modular construction; spans and 2-ft spacing correspond with 4-ft module. Detail B, above left, shows joining of truss with nominal 4-in. stud wall

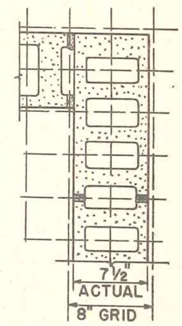


Figure 3.

Use of 8-in. grid for layout of concrete block foundation wall reduces cutting of units

sions by amounts equal to mortar joints, facilitating use with modular masonry where needed. The following table gives standard sizes and thicknesses of structural insulating board products:

Product	Sizes	Thicknesses
Building Board	4x6', 4x7', 4x10' 4x8', 4x12', 4x9'	½", 1"
Sheathing	4x8', 4x10' 4x9', 4x12'	½", 25/32"
	2x8'	25/32"
Lath	18"x48"	½", 1"
Tileboard (Panels)	12"x12", 12"x24" 16"x16", 16"x32"	½", ¾", 1"
Plank	Widths: 8", 10", 12", 16" Lengths: 8", 10", 12"	½"

Selection of Module

As with masonry construction, the basic module used for coordination of materials in frame construction is 4-in. However, due to the larger sizes and fewer number of materials used, a 4-ft unit is generally found more convenient for layouts, particularly for use with sheathing board and interior panels. Other multiples of 4 in. are often used to conform with stud or other unit spacing.

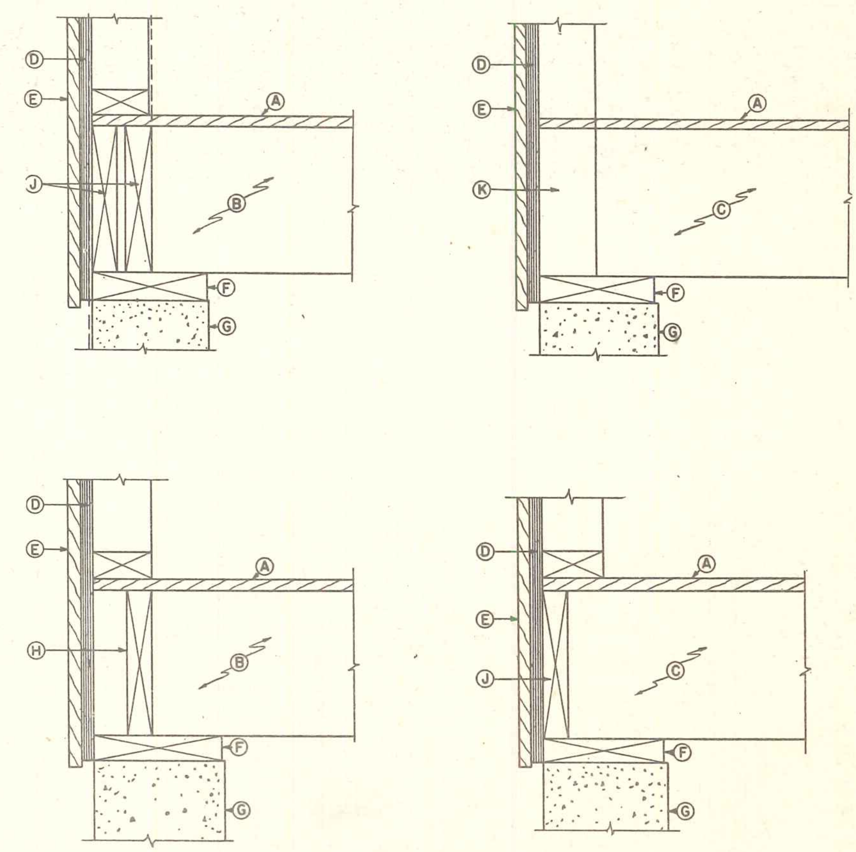


Figure 4.

Standard sized joists may be cut as at C or blocked as at B to fit modular layouts.

A. *Subfloor*
B. *2 x 10 joists at 2 ft increments*
C. *2 x 10 joists cut to length. Waste used as solid bridging*
D. *Sheathing*
E. *Siding*
F. *2 x 8 sill*
G. *8 in. concrete block*
H. *Blocking*
J. *Header*
K. *2 x 4 studs*

MODULAR COORDINATION— Frame Houses

Prepared with the cooperation of the Small Homes Council, University of Illinois

Grid placement has generally been found most convenient when a grid line is referenced to the nominal inside face of a wall. This permits use of standard interior panels with practically no cutting, and permits flexibility in exterior wall details. Any grid position adopted should be used consistently throughout the job. Modular details for wall corners often determine the best grid position, so that studs maintain a uniform spacing for finish materials. A 4-in. grid is often used for the correlation of modular details. Generally when walls are centered on grid lines, studs and joists are centered on grid lines. This may be modified if necessary to provide nailing for finish material.

Typical House

The details shown on these pages are of a typical small house planned for modular coordination and preassembly methods. Interior bay sizes are 16 by 24 ft to conform with stock panel sizes.

Organization of Materials

Foundation walls of poured concrete, or ground slab floors are easily made to conform with modular sizes. If concrete blocks are used, savings can be made if dimensions are referenced so that no blocks need be cut.

Floor joists should be studied to average the greatest savings between cost of labor and materials. As shown in Figure 4, use of a 4-ft grid referenced to the inner face of the exterior wall necessitates cutting of the joists or use of a double header or blocking.

The wall framing details shown on Sheet 9 are based on assembling sections of the exterior wall and tipping them up into position to reduce construction costs. Heights of the wall sections in this case are planned to accommodate interior panels.

Pre-assembled roof trusses, generally spaced on 2-ft centers, give considerable savings in small house construction. Their use permits erection of the outer shell of the house, and installation of flooring, ceilings and wall panels with a minimum of cutting. Interior partitions are then assembled and tipped into place.

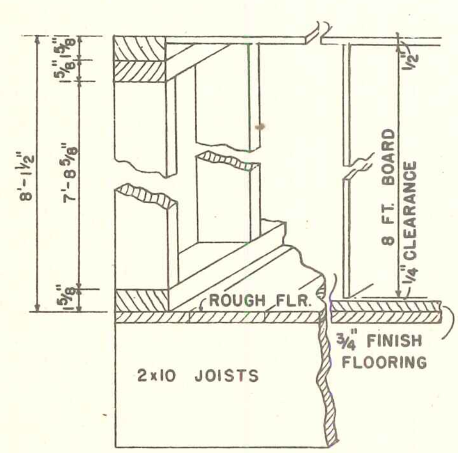
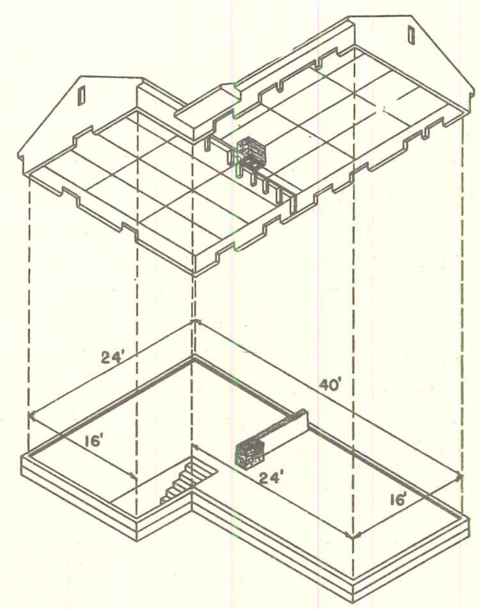


Figure 5.

Detail shows relationship between 4 by 8 ft sheet board material and interior wall framing. A ¼-in. clearance eases installation



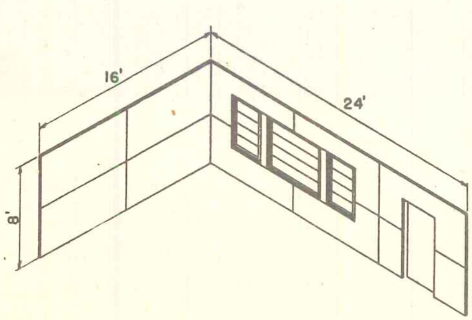


Figure 6 *(above).*

No cutting is required for ceiling panels except at chimney, girder and bearing partition. Savings are made if finished floors and ceilings are applied before erection of interior partitions. All measurements indicated are from the inside faces of the exterior walls

Figure 7 *(left).*

Cutting of wall panels is minimized by modular room sizes. Material cut from door and windows could be used for closets

NATURAL FINISHES FOR EXTERIOR WOOD

By F. L. Browne, Chemist, Forest Products Laboratory, Madison, Wisconsin

NATURAL FINISHES for exterior wood siding have become increasingly popular, and when applied and maintained correctly usually have been found attractive and satisfactory. On the other hand, natural finishes applied without the knowledge of what they require often have been disappointing. Woods that have a rich brown or red color of their own, such as redwood and western red cedar, lend themselves particularly well to natural finish, though woods of paler color, such as cypress, pine, knotty pine, and Douglas fir are sometimes finished in that way.

Natural Finishes Need Frequent Renewal

The first thing to learn about natural finishes is that they are much less durable and, therefore, must be renewed much more frequently than coatings of paint. Paint should go at least four years before needing renewal, but natural finishes nearly always need renewal at least once a year. On parts of a building that are fully exposed to sunshine and rain, natural finish usually needs renewal every six months until it has been done three or four times, after which the intervals may be somewhat longer, though seldom more than 12 months. On more sheltered parts of the building, yearly renewal may suffice, and in deep shade, the intervals may be even longer.

Need for renewal of finish becomes evident when the luster or glossiness originally imparted to the wood by the finish fades to the dullness of unfinished wood. Another test is to splash water on the surface to see whether the water rolls off quickly in droplets or spreads on the wood and is soon absorbed. In the latter case, fresh application of finish is in order. Needed renewal of finish must not be delayed too long. If it is postponed unduly, the wood begins to acquire a gray color that turns still darker gray when more finishing eventually is done. To restore the desired color after serious grayness has developed, the surface must be scraped or sandpapered until the wood is bright again. If the wood is allowed to bceome roughened and cupped as well as grayed by weathering, the restoration of a smooth, bright surface becomes very laborious. For that reason, the timely renewal of natural finish simply cannot be neglected. Similar neglect of coatings of paint is less serious.

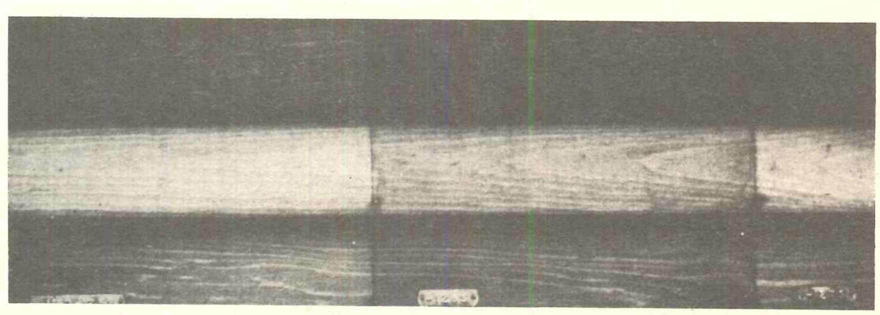
There is no way of keeping wood very long with exactly the color and nearly complete absence of gloss with which it comes from the lumber yard. A finish that could do so would enjoy a good market. Any protective finish that can be applied necessarily penetrates slightly into the wood, displaces air from wood cells, and seems to deepen the color of the wood even if the protective material has no color of its own. Moreover, by filling the pores in the wood, the protective material makes the surface smoother and, therefore, imparts at least a moderate degree of luster or glossiness. As time passes, there is further change of color because sunlight gradually darkens the color of most woods by changing yellows and reds toward brown. Even the weakened sunlight that gets through windows eventually darkens interior woodwork. If, in addition, the protective finish itself darkens with age, as most of them do, still more change in color must be expected.

Natural finishes may be divided into three broad types, oil finishes, wood sealer finishes, and the varnish finishes. They differ in the composition of the material used, in the appropriate methods of application, in the resulting appearance, and in important characteristics of performance.

Oil Finish

Oil finish has the lowest degree of luster or gloss. It also darkens the color of the wood more than other natural finishes do because the oil penetrates farther into wood. Also, the oils are inclined to continue darkening with age more than most sealers or varnishes do. The darkening, however, can be largely corrected by incorporating a little pigment in the oil as is described later.

The simplest and oldest oil finish is ordinary linseed oil, either raw oil or boiled. Unless the work can be done in warm, dry weather, it is best to use boiled oil or else to add about one-sixth of a pint of liquid paint drier to a gallon of raw oil. Most painters also like to add some volatile thinner to linseed oil, thinking that it makes the oil penetrate deeper. That is not the case, but thinning the oil helps to avoid leaving any excess oil on the surface. Turpentine, mineral spirits, or other thinner sold for mixing with paint may be used, but not more than a half gallon of thinner should be added to a gallon of oil.



Portion of a Forest Products Laboratory test panel at Madison, Wis., treated with a "redwood finish." It has been exposed to the weather for 7 months, facing south. The top board is redwood followed by white pine and cypress. Experts recommend refinishing once a year after the second application

Natural finishes for major areas of wood exteriors are a relatively new development. This report deals with the various misunderstandings and difficulties that have come up in the Forest Products Laboratory's consultations with architects and others. When the requirements and limitations of natural finishes are considered in advance, and the necessary precautions have been taken, natural finishes have been found both practicable and pleasing.

The oil may be applied by brushing, spraying, or mopping. For new wood, two good coats are needed. But it is most important to see that all of the oil sinks into the surface of the wood. If, after the second coat has been applied and has stood 20 to 30 minutes, there are any glossy places where excess oil stands on the surface, it should be wiped off before it has time to harden. Coatings of linseed oil that stand on the surface are unsatisfactory, not only because they are too glossy, but because they are inclined to run or to wrinkle when drying. These coatings of oil are too soft, tend to hold dirt, and become mildewed easily. In renewing the oil finish after it shows signs of wear, one fresh application should suffice.

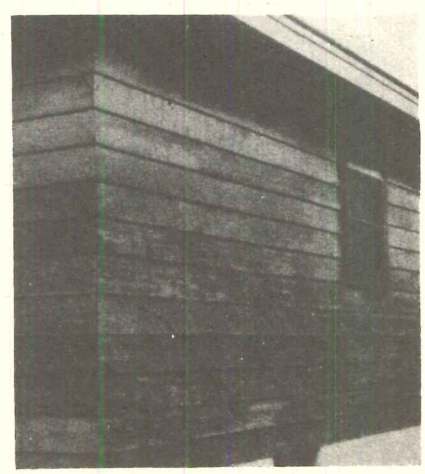
Commercial products are often called log oils or log cabin oils because the natural finishes for exterior woodwork first became popular for summer cottages built of peeled logs. These commercial products are usually made of bodied linseed oil, tung oil, or other drying oils and thinners. Bodied oils have been heated or treated chemically to increase the viscosity greatly, after which a greater proportion of thinner must be added to restore suitable viscosity for application. The bodied oil finishes do not penetrate so deeply into wood as raw or boiled oil, and, therefore, do not darken the color of the wood so much. The product approaches the properties of a wood sealer more and more closely as the degree of bodying is increased.

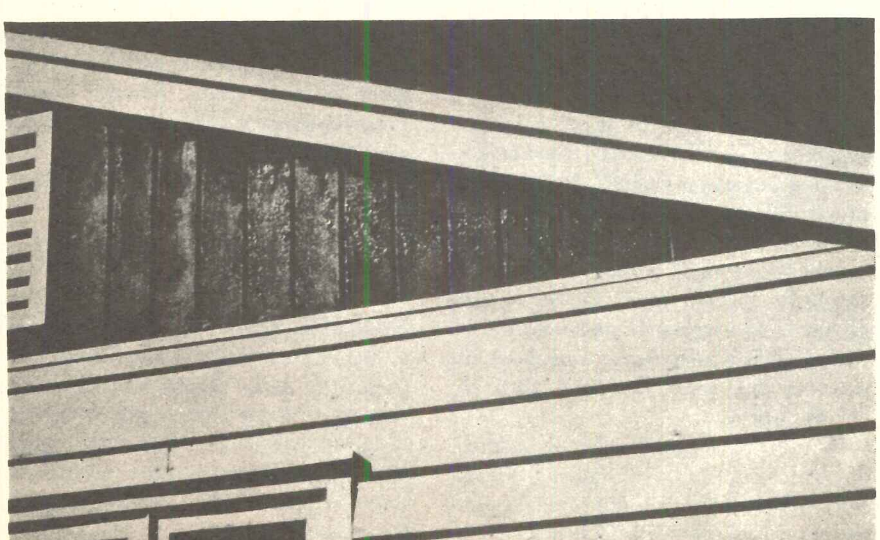
The commercial oil finishes should be applied and maintained just as has been described for the raw linseed oil finish. Since a bodied oil is more apt to leave an excess standing on the surface than raw oil is, special care should be taken to wipe off the excess before it becomes hardened.

The oil finishes give their best service in dry places where there never are any prolonged periods of dampness. Where dampness may linger for some time, the oils are subject to attack by molds, usually called mildew. A dark, almost black discoloration may result. Mildew can be prevented by incorporating suitable preservatives in the oil finish. Some, though by no means all, of the commercial oil finishes already contain preservatives. If so, the kind and amount should be stated on the label.

Suitable Preservatives. If linseed oil or a commercial product not containing preservative is used, there are two ways of incorporating suitable preservative. One way is to mix one of the concentrated solutions of pentachlorophenol or other chlorinated phenols with the linseed oil, instead of adding turpentine or paint thinner. If the directions on the preservative say that it is to be mixed with three times its volume of fuel oil for use as a wood preservative, it may be mixed one volume of concentrated preservative to three volumes of linseed oil for a linseed oil finish. The other way of accomplishing the purpose is to apply one of the water-repellent preservatives to the wood before the linseed oil finish is put on. In the second case, most renewals of the finish can be done with the linseed oil alone, for the treatment with water-repellent preservative need not be repeated for three or four years.

Adding Pigments. The oil finishes may be further modified to advantage by incorporating a small amount of pigment in them. Usually a pigment of reddish-brown color simulates the color of the heartwood of redwood or red cedar.





Some natural finishes whiten (loss of adhesion) and scale when applied to rather large areas of exterior siding. At left is a 3-year-old house in Arizona which had been refinished 1 year before the photo was taken. Above is an 18-month-old house in Madison, Wis., which had been refinished only 6 months before

The pale color of any sapwood present in the lumber is thereby changed to resemble the heartwood more closely, and such woods as pine or Douglas fir are given a richer color. Moreover, better maintenance of color is achieved because the presence of the pigment tends to mask the gradual darkening in the color of the wood itself. If renewal of finish should be delayed until some boards become slightly grayed from weathering, the pigment helps to restore the desired color, provided the graying has not been allowed to go too far. Finally, presence of a little pigment usually adds appreciably to the durability of the finish. Of course, the amount of pigment must be small, well short of the point at which it would give a painted or even a stained appearance.

A number of the commercial oil finishes on the market contain pigments. Linseed oil or prepared oils without pigment can be pigmented just before use by adding a small proportion of burnt sienna ground in oil. About one-half pint of sienna-in-oil to a gallon of oil may be right, but the exact proportions are best determined by trial on sample cuttings of the wood.

Wood Sealer Finish

Like the oil finish, the wood sealer finish is a penetrating finish that should not be permitted to build up on the surface into a glossy coating. Sealers do not penetrate wood so deeply as oils do. For that reason, the sealers usually darken the wood less and give the surface more luster or glossiness than the oils do. The sealers, however, are less glossy than varnish finishes unless too much sealer is applied and the excess is not wiped off.

In composition, wood sealers are much like varnishes except that the sealers contain more thinner and less nonvolatile matter. Both are made as a rule by cooking resin and drying oil together in suitable proportions, incorporating driers, and thinning to proper consistency. Many kinds of resin, both natural and synthetic, may be used. The difference between a sealer and a varnish lies more in the method of application than in the composition. Wood sealer finish, like the oil finish, sinks into and saturates the wood surface without forming a continuous coating of appreciable thickness over it, as varnish finish does.

If excess sealer finish is not wiped off, what may start out as a sealer finish will end up, after one or two renewals, as a varnish finish. A good spar varnish or marine spar varnish will give sealer finish if thinned with about an equal volume of turpentine or other paint thinner and applied like the oil finish.

Although most wood sealers are more resistant to mildew than the oils are, sealer finishes are more readily attacked by fungi than are paints. Wherever there may be lingering dampness, it is advisable to have a preservative in the sealer finish. Some of the commercial products already contain preservative. Otherwise, preservative may be incorporated in a sealer finish by either of the two methods suggested for oil finishes.

Some commercial wood sealers contain pigments for the same desirable purposes already described for oil finishes. The user may also add pigments to sealers lacking them by following the methods suggested for pigmenting oil finishes.

Varnish Finish

Unlike either oil finish or sealer finish, varnish makes a highly glossy coating of appreciable thickness covering the wood. Varnish may not darken the color of the wood to begin with much more than a sealer does, but with the passage of time, there may be more darkening caused by change in the varnish itself than would be the case with a wood sealer.

Varnish is applied by brushing or spraying. At least three coats are needed for new wood, but for renewal, one coat at a time is sufficient. On new wood, the first coat may be thinned moderately with turpentine or other paint thinner. Shellac must not be used for the first coat on exterior surfaces, even over the knots in knotty pine. Succeeding varnish coats are expected to stand out without penetrating the wood and, of course, none of the varnish is wiped off.

Where there is dampness at times, varnish finishes need preservatives against mildew much like sealer finishes. Unless the varnish already contains a preservative, it is advisable to apply a water-repellent preservative to the wood before starting to put on varnish. It is seldom practicable to add a concentrated preservative to a varnish because varnish cannot stand much addition of thinner. Similarly, it is not good practice to add pigments to varnish. If pigmentation is desired, it is best to apply a pigment oil stain to the wood first and then to varnish over it.

On the whole, experience with varnish finish on large areas of exterior woodwork such as siding has not proved satisfactory. Often the varnish finish develops milky, opaque patches where the coating has lost its adhesion to the wood without breaking open. Some varnishes craze or crack in an unsightly manner, after which renewal of the finish is difficult.

Finishing Hardwoods

The methods of natural finishing described so far are suitable for all of the softwoods and for hardwoods with pores no larger than those in birch. Hardwoods with pores larger than those in birch, however, usually need special treatment for the pores after water-repellent preservative, if used, has been applied, but before oil, sealer, or varnish is put on. The treatment for pores is the application of a paste wood filler.

Paste wood filler is applied by thinning it with paint thinner to a consistency suitable for brushing, like paint, but brushing across the grain of the wood rather than with the grain.

For varnish finishes on hardwoods with large pores, use of wood filler is necessary to avoid danger of premature failure of the finish. For wood sealer finishes, the use of filler is strongly recommended, though it may not be essential. For oil finishes filler may be omitted.

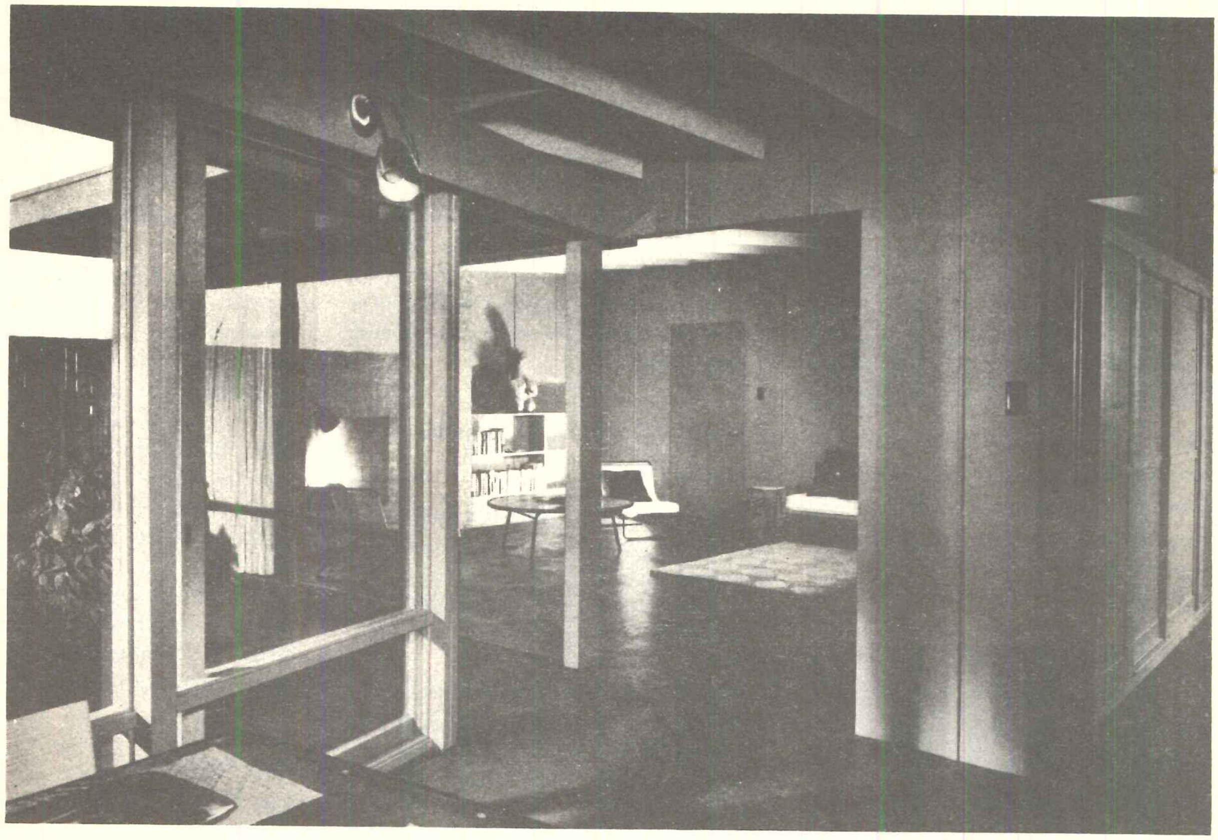
Finishing Doors and Windows

Doors and windows usually need more careful maintenance of protective finish than is necessary on wood siding. Paint or trim enamel affords the most reliable means of maintaining the needed protection. Careful consideration should be given to the choice of paint or trim enamel for the exterior surfaces of doors and windows even when natural finish is selected for the siding. Paint of a color matching that of the naturally finished siding may be used if desired.

But if natural finish is wanted for doors or windows, it is probably best to apply a full varnish finish consisting of three or four coats, because varnish gives better protection against weathering than oil or sealer finishes do.

Rust Stains

Woods that contain tannins, such as redwood, red cedar, oak, and chestnut, readily produce a black color when brought in contact with iron rust and a little moisture. Other extractives present in many woods may also form strongly colored compounds with iron. Exterior woodwork, therefore, should always be fastened in place with corrosion-resistant nails, screws, or other fastenings.



Julius Shulman Photo: Courtesy Douglas Fir Plywood Association

INTERIOR APPLICATIONS OF PLYWOOD

A technical discussion of plywood characteristics, installation and finishes. Reference data appears in the Time-Saver Standards

By Frederick F. Wangaard

Associate Professor of Forest Products, Yale University

Long before the term "plywood" came into being, 18th century European contemporaries of Thomas Sheraton were gluing up cabinet panels of three layers of wood "the middle pieces being laid with the grain across, and the other two lengthwise of the panel to prevent its warping." A United States patent issued to John Mayo in 1868 reveals a surprising comprehension of the properties of plywood.

Many developments in the art of veneer cutting, in the formulation of adhesives, in the fabrication of plywood panels, and in the application of plywood to thousands of uses have occurred since John Mayo's description of plywood was written.

The following discussion is concerned specifically with the types and grades of softwood and hardwood plywood as currently manufactured to meet the requirements of Commercial Standards for interior use.

Physical and Mechanical Properties

Shrinkage

Natural wood is characterized by generally favorable strength-to-weight ratios in the direction parallel to its grain, but is much less strong and stiff perpendicular to the grain. Similarly, wood is highly stable in dimension in the longitudinal direction when subjected to moisture content changes, whereas its frequently objectionable shrinkage and swelling across the grain are well known.

As a consequence of its cross-ply construction, plywood shrinks and swells far less in width than does solid wood. For the same reason, however, its lengthwise shrinkage and swelling are somewhat greater than for solid wood.

In many parts of the United States, the moisture content of interior woodwork fluctuates from 6 per cent in winter to 12 per cent in summer. Consequently, under such conditions, solid wood shrinks or swells approximately .04 per cent longitudinally, 2 per cent tangentially (parallel to the growth rings), and 1½ per cent radially (perpendicular to the growth rings). Specific values, of course, differ for individual kinds of wood. Shrinkage values for individual American woods are presented in several government bulletins and other publications.

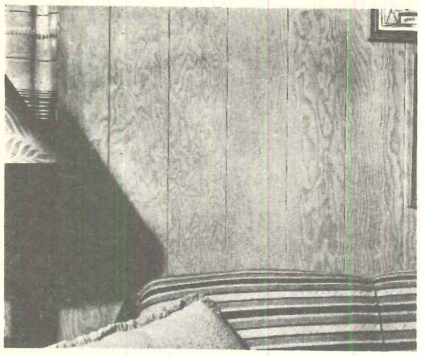
In terms of a 4 by 8-ft panel subjected to a seasonal variation in moisture content from 12 to 6 per cent, solid wood of a species having total shrinkage values of 7.2 per cent and 0.12 per cent, across and along the grain respectively, would shrink 0.82 in. in width and .03 in. in length.

In contrast, a 3-ply plywood panel of uniform ply thickness would shrink only .08 in. in width, while its lengthwise shrinkage would be .10 in. Plywood is thus seen to shrink only 1/10 as much as solid wood in width.

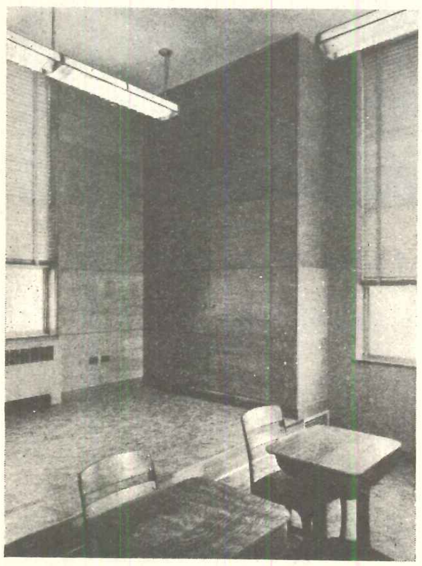
The conventional odd-ply construction of plywood is necessary to obtain balanced construction to retain a warp-free panel under various moisture conditions. Balanced construction simply refers to symmetry of construction about the core ply so that corresponding plies on either side of the core are alike with respect to species, type of veneer (rotary-cut vs. quarter-sliced, etc.), direction of grain, thickness, and moisture content at the time of manufacture.

In practice, limited departures from these listed requirements of balanced construction are sometimes permitted, particularly with reference to a difference between species employed for face

Courtesy Douglas Fir Plywood Association



Above: grain in scored Douglas fir plywood panels has been softened with a wipe finish of white paint. Below: birch, an economical architectural plywood, was used by architect Emilio Di Rienzo in this music room



Ben Schnall Photo: Courtesy U. S. Plywood Association

and back plies in decorative panels, but the production of warp-free plywood requires recognition of the principle of balanced construction.

Strength

The importance of the distribution of strength properties afforded by the cross-plies is appreciated when it is understood that the tensile strength of solid wood is 25–60 times as great parallel to the grain as across the grain. In compression, solid wood is 3–10 times stronger parallel to the grain than it is perpendicular to the grain. Stiffness is 12–20 or more times as high in the grain direction as opposed to that in the transverse direction.

Furthermore, solid wood is characterized by relatively low resistance to shear parallel to the grain, and shear strength of plywood is considerably enhanced as a result of its cross-ply construction. The tendency of solid wood to split along the grain at mechanical fastenings placed close to edges or ends of a piece, or to check or split as a result of seasoning stresses, is also greatly reduced in plywood as a consequence of the resistance afforded by the firmly bonded cross plies. Page 187 of the Time-Saver Standards contains approximate methods of calculating strength and stiffness of plywood.

Types of Interior Plywood

Douglas Fir

Fir plywood grades are based upon the quality of veneer permitted in the face and back plies. All veneer is rotary-cut and displays the characteristic irregular grain pattern of flat-grain lumber.

Plywood grades are identified on the basis of the veneer grades employed in faces and backs. Four veneer grades are recognized, A, B, C and D (see page 193) that are adapted to interior use as wall coverings, ceilings, partitions, floors, and similar applications.

Of these, the A-D grade, known as Ply-panel, is most widely used for interior finishing where only one surface of the panel is exposed. This grade is suitable for painting, light stain glazing, and other fine finishing. It may also be used as a base for wallpaper.

Interior grade A-B plywood is a new grade and makes available a panel with finest appearance quality face and a moderate quality back. Cabinet doors in utility rooms, kitchens, and storage areas are among its uses.

Interior grade B-D plywood, known as Plybase, is an entirely new grade with face plies of the same paintable quality as the back in the A-B grade just described. Its tight solid face is intended to provide a backing for use under linoleum, but it may also prove suitable as a base for wallpaper or for canvassed and painted walls.

Softwoods other than Douglas fir which are available for many of the same uses include ponderosa pine, knotty western white pine, and Sitka spruce.

Hardwoods

Hardwood plywood for interior use is classed as Types II (Water resistant) and III (Dry bond). Unlike fir plywood, which is all veneer, hardwood plywood may be of all-veneer or of lumber-core construction. Its description is exceedingly more complex than that of Douglas fir plywood in that hundreds of woods, both domestic and imported, are available as face veneers, many of them characterized by wide variations in appearance both as a result of natural growth variations and of different methods of cutting.

In general, the straight grained, less highly figured woods are rotary-cut or flat-sliced to obtain plain face veneers, often of attractive color and texture, or cross-band and core stock. Woods characterized by interlocked or other irregular grain are usually quarter-sliced or back-cut on a staylog to reveal beautiful stripe, mottle, or flake figures. Hardwood plywood is specified as to species and grade of face and back veneer; grades of hardwood veneer are 1, 2, 3 & 4. (See page 193.)

Each of the hundreds of hardwoods employed as plywood faces is characterized by its individual combination of color, grain pattern, texture, and figure.

Interior Uses

Walls

Douglas fir plywood of the Plypanel grade is adapted to wall paneling which is to be painted, finished in natural color, given a light stain glaze, enameled, or covered with wallpaper. The Plybase grade approaches Plypanel in surface tightness and should be suitable as a wallpaper base or for canvassed and enameled walls. For better construction, panels 3/8 in. thick are recommended over studs on 16-in. centers, but 1/4-in. panels are often used for reasons of economy. The 1/4-in. panels are completely satisfactory for application over old plaster walls.

Hardwood plywood is adapted to the same applications as Douglas fir and, in addition, affords an almost infinite variety of rich and luxurious effects, which are possible only through the use of fine figured hardwoods. In general, only the plainer woods, such as gum, are given any but a stained or natural finish. The 1-3 grade of 1/4-in. thickness is commonly employed for most economical construction taking advantage of the natural beauty of the wood, although thicker panels are structurally advantageous when applied over studs on 16-in. centers.

The finest plywood available for use as wall paneling of the type usually employed in commercial and public buildings is the architectural grade of lumber-core panel, which is 13/16-to 1-in. thick with one decorative face of grade 1 veneer. Although 4 by 8-ft panels are widely used, the diversity of architectural effects which may be secured with decorative hardwood plywoods applied either vertically or horizontally offers almost unlimited possibilities for smaller sizes, which are, incidentally, more economical. Panels longer than 8 ft are obtainable at some premium in cost, may sometimes be found advantageous in situations where a particular effect is desired.

Application of birch panels, shown in several photos, illustrates the beauty obtainable through the use of economy grade hardwoods. Plywoods of this type are the result of the recent development of mass production in the manufacture of hardwood plywood. As a result of manufacturing economies introduced in producing these lower priced hardwood panels, certain refinements in the selection and matching of veneers are lacking as compared with the grade 1 faces described in the Commercial Standard.

Ceilings

The opportunities for the use of plywood in ceilings are not so diverse as in the case of wall paneling. Nevertheless, many of the advantages of plywood paneling are applicable to ceilings, as it permits large, unbroken crack-free areas when joints are properly treated and the panels are painted or covered with paper. For this type of treatment, the Plypanel and Plybase grades of Douglas fir in panels ⅜ or ¼-in. thick and comparable grades of plain economical hardwoods, usually of ¼-in. thickness, are generally employed. Panels that reveal the grain of the wood are frequently used as ceilings in recreation rooms and in "expansion room" remodeling, where they are usually given finishing treatments similar to those used on wall paneling.

Built-Ins

Plywood is ideally adapted to the fabrication of built-in cabinets, wardrobes, counters, and other of the dozens of conveniences that distinguish a well designed home. In employing Douglas fir, the Plypanel grade is usually selected when only one surface is to be exposed, as in facings, ends, linings, and drawer bottoms. The A-A grade, or sometimes the A-B grade, is preferred for doors and single thickness wall sections where both sides are visible. Hardwood plywood with one or two good faces is similarly adapted to the same uses. Exterior plywood should be specified for counters around kitchen sinks or built-in bathroom lavatories. Plywood of ¾-in. thickness is most commonly used for cabinet doors and shelves, although panels of ⅝ and ½ in. are also used.

Floors

Plywood finds application both as a sub-floor and finish flooring. Its most common use, however, is as sub-flooring or as a base for linoleum and other floor coverings.

The Plyscord (Sheathing) grade of Douglas fir plywood in ½ and ⅝-in. thickness is employed as sub-flooring with joists on 16 and 20-in. centers respectively when a finish strip flooring of wood is also used. Plybase fir plywood of ⅜ or ¼ in. thickness is often used over sub-flooring as an underlay for linoleum, rubber, or asphalt tile, but when employed as a combination sub-floor and base for these surfacing materials or for wall-to-wall carpeting, ½-in. to ¾-in. panels should be used, depending upon joist spacing. The use of Plybase or Plypanel grades of fir plywood of ¼ or ⅜-in. thicknesses is also popular over old, worn flooring in remodeling work, producing an ideal base for various surfacing treatments as discussed above.

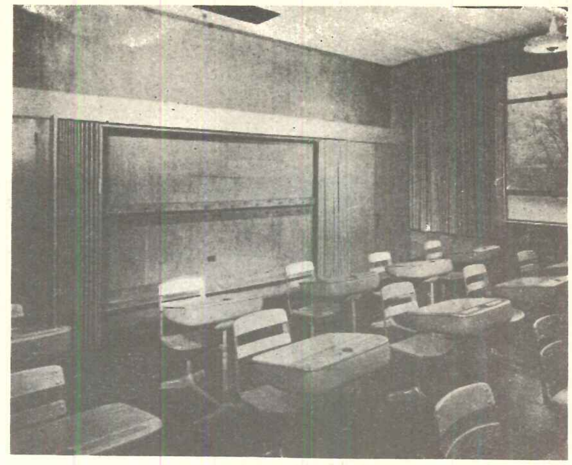
Application Methods

Proper wall panel arrangement is basic to the successful application of plywood both from the standpoint of appearance and economy of material. The discussion in the Time-Saver Standards is directed principally toward consideration of thinner plywoods and is not applicable to the architectural grade of lumber-core plywood.

Metal moldings faced with veneer to match paneling are available for a number of widely used species, and offer an attractive solution to the treatment of joints in ¼, ¾, and $\frac{3}{16}$-in. panels.

As a preliminary to actual installation of plywood paneling, the panels should be stored in stickered piles for a few days under conditions of the room where they are to be used. This period of conditioning serves to insure against problems arising from moisture pick-up or loss. In new construction it is desirable, and many building codes require, that 2 by 4-in. firestops be inserted between the studs about four feet from the floor. Such horizontal members, together with the studs, serve for the attachment of plywood panels.

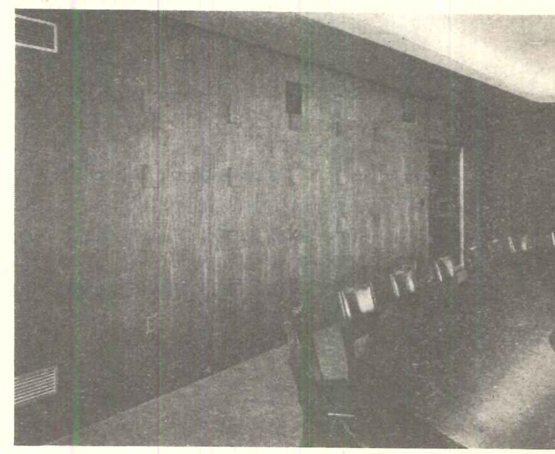
Plywood panels may be nailed directly to the studs, which should first be plumbed or, in somewhat better practice, a ¼ by 2½-in. plywood furring strip may be nailed along its center line to the stud and the panel attached through the furring to the stud. Panel


Ben Schnall

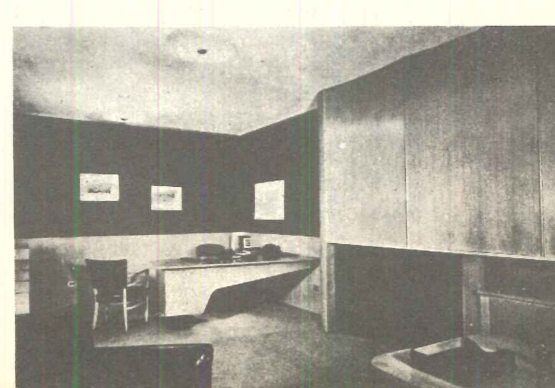
Above: oak plywood at back of classroom relieves concrete block walls in low-cost school, Robert A. Green, Architect

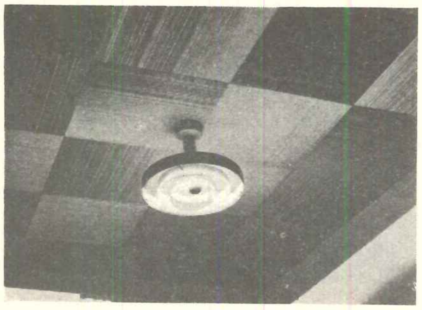

Ben Schnall

Above: red oak plywood on front and rear walls and covering beams adds warmth to church also designed by Robert Green


Courtesy Roddis Plywood Corp.

Above: rift-grain oak in this office demonstrates a striking application of decorative hardwood plywood. Below: broken-stripe, figured mahogany in executives' dining room. Cram and Ferguson, Architects


Courtesy U. S. Plywood Association



Above: striated plywood blocks form an interesting pattern for indirectly lighted ceiling. Below: fir plywood offers smooth, solid base for finish flooring. Workman is laying floor covering over 3/8-in. stock

joints are thus protected against the effects of possible shrinkage or settling. The use of 6d finish or casing nails spaced 6 in. apart at the outer edges of the panel and at 12-in. intervals on intermediate studs is recommended for plywood 3/8 and 1/2-in. thick. Four penny and 8d nails at the same spacing are similarly recommended for 1/4 and 3/4-in. thicknesses respectively. An alternative recommendation for 1/4-in. hardwood panels is to use 3/4-in. No. 19 brads, which make an even less conspicuous hole than the 4d finish nail. Most satisfactory, although not essential, is the attachment to the furring strips (or studs) by means of glue, which is applied immediately prior to nailing. Electronic heating methods have also been developed that permit the rapid cure of resin adhesives. Through the use of a portable "spot welder," rapid attachment of panels is possible without the use of nails.

In remodeling work, plywood is often applied over old plaster walls. Attachment may be provided through the use of 1/4-in. plywood furring strips 2 1/2-in. wide, which are nailed to the studs. Horizontal furring should be spaced so as to provide support at panel edges and about 2 ft apart, while vertical furring is used only at panel edges.

In applying plywood to masonry walls, 1 by 2-in. furring strips can be nailed or pegged to the masonry at 16-in. intervals. Six penny steel cut nails spaced at 12 in. are recommended. A 1/4-in. air space at top and bottom of the panels for circulation may be desirable if moderate dampness is a problem. Additional protection against moisture can be secured by applying asphalt building paper to the face of the furring. Panels should also be back primed with a resin sealer before erection, although if condensation of moisture or seepage is severe, the interior types of plywood will not prove satisfactory.

Plywood ceiling installations are essentially the same as walls. Panels should always have backing at the edges as well as intermediate support at 4-ft intervals, which is provided by the joists and by cats which are inserted between the joists. Panels may be applied with the face grain either along or across the joists.

When, as in remodeling, ceiling panels are installed over plaster, 1/4 by 2 1/2-in. plywood or 1 by 2-in. wood furring strips should first be applied by nailing through the plaster to the joists. Furring strips that run across joists should be spaced about 2 ft apart, whereas in the direction parallel to the joists furring strips are needed only at panel edges. Recommendations previously given relative to nailing schedules for walls are equally applicable to ceiling installations. A number of plywood floor construction details are shown on page 195.

Finishing

Modern finishing treatments for plywood emphasize (1) the natural effect of the grain, color, and figure of the wood obtained through clear finishes, or (2) the light effects which may be achieved without losing the distinctive characteristics of texture, grain, and figure by subduing the normal grain contrast of the wood with pigmented sealers.

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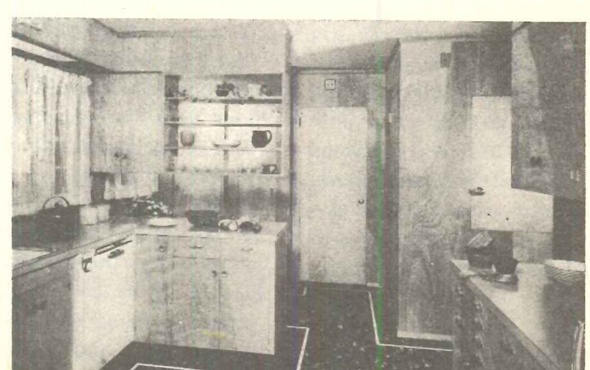
Application of plywood in homes varies from the richly paneled living room of walnut at left to the functional and economical use of unselect birch for the walls and cabinets in the kitchen at right. The second photo illustrates the popular trend to built-in units of plywood. Architects: left, Daniel Schwartzman; right, R. Kilburn



INTERIOR PLYWOOD: 1—Simplified Design Method

By Frederick F. Wangaard

Associate Professor of Forest Products, Yale University

The following sheets form a compilation of technical information on plywood prepared by the author and assembled here for convenience. The suggested simplified methods of calculation apply reasonably well with usual plywood types under ordinary conditions of service, but they are not entirely valid for all types of plywood or constructions, or for all spans and span-depth ratios. They are not applicable to structures proportioned so plywood is in the buckling range: the results will be too high.

As shown in Table I, approximate methods of calculating plywood strength and stiffness neglect any contribution to tensile strength, compressive strength, or stiffness made by plies stressed across the grain. Only in the case of shear through the thickness of the panel is the full cross-sectional resistance of square-laid plywood considered.

Application of the methods outlined in Table 1 involves the use of unit stresses for solid wood of the quality employed in the various plies. Basic stress values for clear solid wood of a number of species commonly employed in plywood are given in Table 2. These values have already been adjusted for variation, long-time duration of stress, and include a factor of safety. Stress values for extreme fiber in bending, compression parallel to grain, and compression perpendicular to grain have also been increased 25 per cent over those originally published to adapt them to interior use applications. Such basic stress values, however, require modification by a reduction factor according to the weakening influence of any defects that may be present in order to determine the appropriate unit stress value. Once this is known for the particular plies involved, calculation of plywood strength is possible following the methods given in Table 1. Unit stresses have been prepared for the standard grades of Douglas fir plywood and are recommended for direct application according to the methods outlined in Table 1.*

* *Technical data on plywood, section 2, rev. 1948. Douglas Fir Plywood Assn., Tacoma, Wash.*

TABLE 1. Design method and allowable stresses for plywood [1]

Property	Direction of stress wrt direction of face grain	Area to be considered	Unit stress to be used
Tension	Parallel or perpendicular	Parallel plies[2] only	Unit stress for extreme fiber in bending
	± 45°	Full cross-sectional area	One-sixth uni stress for extreme fiber in bending
Compression	Parallel or perpendicular	Parallel plies[2] only	Unit stress in compression parallel to grain
	± 45°	Full cross-sectional area	One-third unit stress in compression parallel to grain
Bearing at right angles to plane of plywood		Loaded area	Unit stress in compression perpendicular to grain
Load in bending	Parallel or pendicular	Bending moment M = KSI/c[3]	Unit stress for extreme fiber in bending
Deflection in bending	Parallel or perpendicular	Deflection may be calculated by the usual formula[4]	Unit value for modulus of elasticity
Deformation in tension or compression	Parallel or perpendicular	Parallel plies[2] only	Unit value for modulus of elasticity
Shear through thickness	Parallel or perpendicular	Full cross-sectional area	Double unit stress in horizontal shear
	± 45°	Full cross-sectional area	Four times unit stress in horizontal shear

[1] *From Forest Products Laboratory Report R1630, rev., Madison, Wis. 1946.*
[2] *By "parallel plies" is meant those plies whose grain direction is parallel to the direction of principal stress.*
[3] *Where S = unit stress for extreme fiber in bending; I = moment of inertia computed on basis of parallel plies only; c = distance from neutral axis to outer fiber of outermost ply having its grain in the direction of the span; K = 1.50 for three-ply plywood having the grain of the outer plies perpendicular to the span; K = 0.85 for all other plywood.*
[4] *Deflection may be calculated by the usual formulas, taking as the moment of inertia that of the parallel plies plus one-twentieth that of the perpendicular plies. (When face plies are parallel, the calculation may be simplified, with but little error, by taking the moment of inertia as that of the parallel plies only.)*

TABLE 2. Basic stresses of clear wood to be used in calculating strength of plywood for interior service [1]

Species	Extreme fiber in bending	Horizontal shear	Compression grain	grain	Modulus of elasticity
	psi	psi	psi	psi	1000 psi
Basswood	1550	100	150	1000	1100
Beech	2750	185	620	2000	1600
Birch, Yellow	2750	185	620	2000	1600
Elm, American	2000	150	310	1300	1200
Fir, Douglas	2750	130	400	1800	1600
Gum, Red or Black	2000	150	400	1300	1200
Mahogany, Central American	2500	185	540	1750	1300
Maple, Hard	2750	185	620	2000	1600
Oak, Red or White	2550	185	620	1700	1500
Pine, Ponderosa or Western White	1600	120	310	1250	1000
Poplar, Yellow	1600	120	280	1200	1100
Redwood	2200	100	310	1700	1200
Walnut, Black	2600	185	480	1950	1500

[1] *Adapted for the most part from Forest Products Laboratory Report R1715,* Recommendations for basic stresses. 1948.

INTERIOR PLYWOOD: 2—Panel Sizes and Weights

By Frederick F. Wangaard

Associate Professor of Forest Products, Yale University

One of the obvious advantages of plywood lies in its relatively large size and light weight panels. Stock panels of interior plywood are available in a variety of widths, lengths, and thicknesses as shown in Table 3. Table 3 indicates that the sizes in greatest demand are 36 and 48-in. widths in lengths of 72, 84, and 96 in. Panels of the shorter lengths shown in the table are often adapted to specific architectural uses and are advantageous from the standpoint of economy in comparison with the re-cutting of larger panels. Although not widely used, Douglas fir panels up to 4 by 12 ft are included among the standard sizes. Many hardwoods are also obtainable on special order in panel lengths up to 12 ft.

The light weight of plywood panels contributes to their ease of handling and application. Weights of plywood panels correspond to the density of the woods used in the various plies. Weights per sq ft for Douglas fir plywood of standard thickness are shown in Table 4. It is seen that a 4 by 8 ft, ¼-in. panel weighs approximately 25 lbs. Because of the various combinations of species employed in hardwood panels, it is not possible to present detailed tables of weights for each thickness, but in as much as the woods most commonly used as inner plies in hardwood panels are similar to fir in density, Douglas fir weights may serve also as rough approximations of hardwood plywood weights.

TABLE 3. Standard panel sizes of interior plywood

DOUGLAS FIR

Lengths	Widths	Thickness (in.) and Number of Plies					
		3/16, 3 ply	¼, 3 ply	⅜, 3 ply	½, 5 ply	⅝, 5 ply	¾, 5 Ply
60	30	X	X	X	X	X	X
	36	X	X	X	X	X	X
	42	X	X	X	X	X	X
	48	X	X	X	X	X	X
72	30	X	X	X	X	X	X
	36	X	O	O	O	O	O
	42	X	X	X	X	X	X
	48	X	O	O	O	O	X
84	30	X	X	X	X	X	X
	36	X	O	O	O	O	X
	42	X	X	X	X	X	X
	48	X	O	O	O	O	X
96	30	X	X	X	X	X	X
	36	X	O	O	O	O	X
	42	X	X	X	X	X	X
	48	X	O	O	O	O	O
108	30	X	X	X	X	X	X
	36	X	O	O	O	O	X
	42	X	X	X	X	X	X
	48	X	O	O	O	O	X
120	30	X	X	X	X	X	X
	36	X	O	O	O	O	X
	42	X	X	X	X	X	X
	48	X	O	O	O	O	O
144	30	X	X	X	X	X	X
	36	X	X	X	X	X	X
	42	X	X	X	X	X	X
	48	X	X	X	X	X	X

HARDWOODS

Lengths in.	Widths in.	⅛, 3 ply	3/16, 3 ply	¼, 3 ply	5/16, 5 ply	⅜, 5 ply	½, 5 ply	⅝, 7 ply	¾, 7 ply	13/16, 5 ply lbr. core	⅞, 5 ply lbr. core	1, 5 ply lbr. core
48	24	X	X	O	X	X	X	X	X	X	X	X
	30	X	X	O	X	X	X	X	X	X	X	X
	36	X	X	O	X	X	X	X	X	X	X	X
	42	X	X	X	X	X	X	X	X	X	X	X
	48	O	X	O	X	O	X	X	O	O	O	X
60	24	X	X	O	X	X	X	X	X	X	X	X
	30	X	X	O	X	X	X	X	X	X	X	X
	36	O	X	O	X	X	X	X	X	X	X	X
	42	X	X	X	X	X	X	X	X	X	X	X
	48	O	X	O	X	O	X	X	O	O	O	X
72	24	X	X	O	X	X	X	X	X	X	X	X
	30	X	X	X	X	X	X	X	X	X	X	X
	36	O	X	O	X	O	O	X	X	O	O	X
	42	X	X	X	X	X	X	X	X	X	X	X
	48	O	X	O	X	O	O	X	O	O	O	X
84	24	X	X	O	X	X	X	X	X	X	X	X
	30	X	X	X	X	X	X	X	X	X	X	X
	36	O	X	O	X	O	O	X	X	O	O	X
	42	X	X	X	X	X	X	X	X	X	X	X
	48	O	X	O	X	O	O	X	O	O	O	X
96	24	X	X	O	X	X	X	X	X	X	X	X
	30	X	X	X	X	X	X	X	X	X	X	X
	36	O	X	O	X	O	O	X	X	O	O	X
	42	X	X	X	X	X	X	X	X	X	X	X
	48	O	X	O	X	O	O	X	O	O	O	O
120	24	—	—	—	—	—	—	—	—	—	—	—
	30	—	—	—	—	—	—	—	—	—	—	—
	36	—	—	—	—	—	—	—	—	—	—	—
	42	—	—	—	—	—	—	—	—	—	—	—
	48	—	—	O	—	—	—	—	—	O	O	—

x indicates standard size *o indicates sizes most commonly used*

TABLE 4.

Weights of Douglas fir plywood

Thickness in.	Lb per sq ft
3/16	0.640
¼	0.790
⅜	1.125
½	1.525
⅝	1.825
¾	2.225

INTERIOR PLYWOOD: 3—Grades

By Frederick F. Wangaard

Associate Professor of Forest Products, Yale University

Douglas Fir

Fir plywood grades are based upon the quality of veneer permitted in the face and back plies. All veneer is rotary-cut and displays the characteristic irregular grain pattern of flat-grain lumber. Four *veneer* grades are recognized.

Grade A (Sound) veneer is free from knots, splits, and other open defects, but streaks and discolorations, sapwood, and neatly made patches are accepted. When a face consists of more than one piece, it is reasonably matched for grain and color at the joints. It has a smooth surface suitable for painting.

Grade B (Solid) veneer presents a surface free from open defects, but, in addition to the defects permitted in Grade A veneer, this grade admits circular wood plugs or synthetic plugs having hard level surfaces, and sound tight knots up to 1 in. diam. Slightly rough, but not torn, grain and other minor sanding defects are permitted in this grade, which is paintable.

Grades C and D are used in backs and interior plies of panels in which appearance affects serviceability and permit such additional defects as knotholes, open pitch pockets, and splits of prescribed sizes.

Plywood grades are identified on the basis of the veneer grades employed in faces and backs. There are four grades of Douglas Fir plywood that are adapted to interior use as wall coverings, ceilings, partitions, floors, and similar applications. These grades are **A-A (Sound 2 Sides — Int.), A-B (Sound/Solid — Int.), A-D (Sound 1 Side — Int.); and B-D (Solid 1 Side — Int.).**

Of these, the **A-D grade**, known as Plypanel, is most widely used for interior finishing where only one surface of the panel is exposed. This grade is suitable for painting, light stain glazing, and other fine finishing either masking, subduing, or accentuating the natural grain contrast of the wood. It may also be used as a base for wallpaper.

Interior grade A-A plywood has two faces of top appearance quality and is intended for uses that require both sides to be finished. Such panels find application in cabinet doors, booth partitions, and store displays.

Interior grade A-B plywood is a new grade and makes available a panel with finest appearance quality face and a moderate quality back. Cabinet doors in utility rooms, kitchens, and storage areas are among its uses. The back of this grade is of paintable quality and, if minor defects are filled, it can be finished to virtually a defect-free appearance.

Interior grade B-D plywood, known as Plybase, is an entirely new grade with face plies of the same paintable quality as the back in the A-B grade just described. Its tight solid face is intended to provide a backing for use under linoleum, but it may also prove suitable as a base for wallpaper or for canvassed and painted walls.

Softwoods other than Douglas fir which are available for many of the same uses include ponderosa pine, knotty western white pine, and Sitka spruce.

Hardwoods

Hardwood plywood for interior use is classed as **Types II (Water resistant), and III (Dry bond)**, in Commercial Standard CS 35–49. Unlike fir plywood, which is all veneer, hardwood plywood may be of all veneer or of lumber-core construction (Table 3). Its description is exceedingly more complex than that of Douglas fir plywood in that hundreds of woods, both domestic and imported, are available as face veneers, many of them characterized by wide variations in appearance both as a result of natural growth variations and of different methods of cutting.

In general, the straight grained, less highly figured woods are rotary cut or flat-sliced to obtain plain face veneers, often of attractive color and texture, or cross-band and core stock. Woods characterized by interlocked or other irregular grain are usually quarter-sliced or back-cut on a staylog to reveal beautiful stripe, mottle or flake figures. It is with veneers of the latter type that "back-matching" or "slip-matching" of veneers from the same original flitch to produce panel faces of beautiful symmetry or remarkable uniformity is most successful.

Hardwood plywood is specified as to species and grade of face and back veneer. There are four grades of hardwood veneer: **Grade 1 (Good)** veneer specifications vary slightly from species to species, but may be illustrated by the requirements for comb-grain white oak: veneer may be sliced or sawn, each face matched for color and grain at the joints. A few small burls and pin knots (less than ¼ in. diam.), small mineral streaks, and inconspicuous small patches are permitted. Other defects such as knots other than pin knots, discolorations, worm holes, and splits are not permitted in Grade 1. Sapwood is excluded in the oak specification but is admitted in many species without limitation.

Grade 2 veneer covers all species. Matching for grain or color is not specified. The principal quality required is freedom from open defects and decay. Mineral streaks, stain discoloration, patches, and sapwood are not considered defects in this grade. This grade is the minimum adapted to exposed surfaces for interior construction.

Grade 3 permits sound tight knots and burls, knot holes, bark pockets, and splits or open joints of limited size, and **Grade 4 (Reject)** tolerates knot holes up to 1½ in. diam. and comparable open defects. Grades 2 and 3 are commonly employed in plywood as inner plies and backs, although Grade 4 veneer is sometimes used as backs.

Each hardwood is characterized by its combination of color, grain pattern, texture, and figure. In addition, many display a wide variation in veneer characteristics.

INTERIOR PLYWOOD: 4—Species, Installation

By Frederick F. Wangaard

Associate Professor of Forest Products, Yale University

Some of the more important hardwood plywood species appear in the following tabulation which, although far from complete, may serve as a guide in the selection of plywood from the standpoint of architectural treatment of the material.

Light colored woods

Plain

- Selected white gum
- Yellow poplar

Variegated figure or grain pattern

Mild

- Selected white birch
- Selected white maple
- Rotary-cut or plain-sliced oak
- Duali
- Magnolia (Ailon)

Pronounced

- Curly maple
- American elm

Stripe figure or grain pattern

Mild

- Comb-grain oak
- Korina (Limba)
- Primavera
- Bayott
- Bosse
- Iroko

Pronounced

- Quartered Philippine mahogany (White lauan, Almon, Bagtikan)
- Avodire
- East Indian satinwood
- Zebrawood

Dark colored woods

Plain

- Selected red gum

Variegated figure or grain stain

Mild

- Selected red birch
- Plain-sliced mahogany (African or Central American)
- Plain-sliced walnut

Pronounced

- Figured walnut
- Brazilian rosewood
- Figured mahogany (African or Central American)
- Brown ash
- Kenya

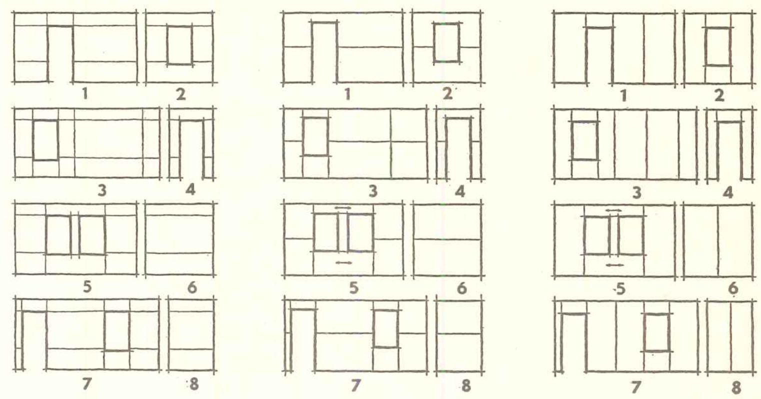
Stripe figure or grain pattern

Mild

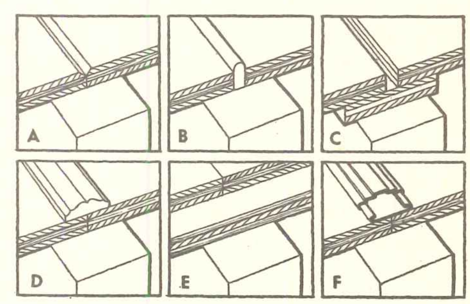
- Quartered walnut
- Paldao

Pronounced

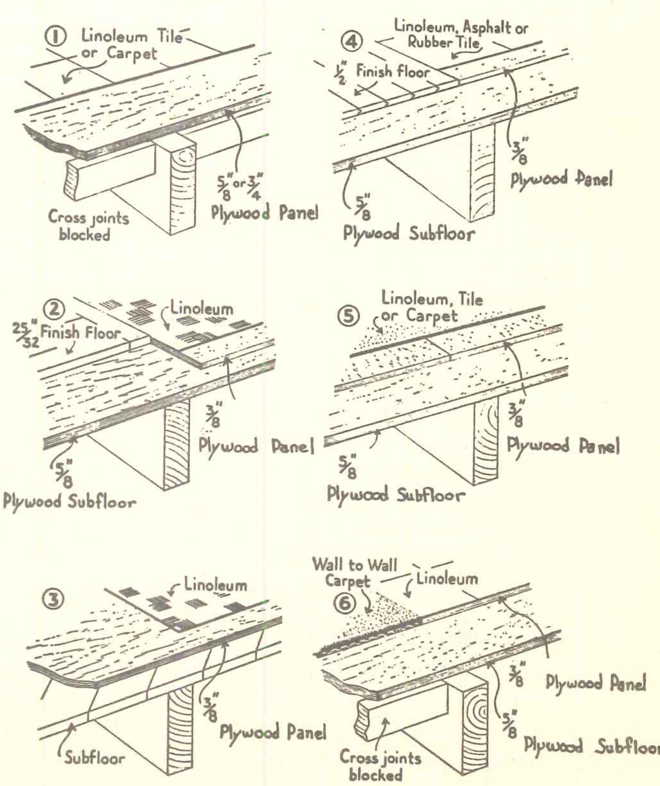
- Quartered figured red gum
- Quartered mahogany (African or Central American)
- Quartered Philippine mahogany (Red lauan, Tanguile)
- Bubinga
- Orientalwood
- East Indian rosewood
- Sapele
- Andiroba



Variations for handling wall panels: right, vertical arrangement; center, two-panel horizontal arrangement; left, combination arrangement. Vertical joints are best placed at all openings, and wall spaces divided in orderly pattern. When width of opening exceeds 4 ft, panels are often placed horizontally



*Suggested plywood joint treatments include: **A.** "V" joint formed by beveling panel edges. **B.** Inset bullnosed molding for raised joint. **C.** Recessed joint. **D.** Standard wood molding over butt joint. **E.** Plywood sheathing used as nailing or gluing base. **F.** Snap-on metal molding.*



Plywood floor construction details include use of the Plypanel or Plybase grades of Douglas fir as combined subfloor and underlayment for linoleum, tile or carpeting (1); the use of the unsanded Plyscord grade as sub-flooring with wood strip finish flooring (2); and combinations of Plyscord subflooring and Plypanel or Plybase underlayment with various types of floor covering (3–6)

TRENDS IN WARM AIR HEATING

Part 1: Houses

METAL SHORTAGES combined with high building costs are encouraging novel designs of warm air heating in houses. This does not imply that these systems are only substitutes. It does mean that they lend themselves to the application of non-critical materials, that the structure itself can be made part of the heating system to reduce costs, and that a deterrent to their more widespread use has been the lack of correlated performance data and of knowledge concerning how air behaves in unorthodox distribution systems.

This article reviews many new types of warm air heating and shows examples of non-critical materials being used. It also reports the results of some current laboratory research and field investigations to show that these systems meet present-day comfort standards, and that proper attention must be given to the design of the system, including site selection as well as location of ducts. Most of the discussion will be devoted to the basementless house, but other examples show systems for houses over crawl spaces and houses with basements.

Concepts of warm air heating have had to be revised in line with modern house building practices such as the concrete floor slab, extensive use of glass, application of the panel heating principle, the desire to save cubage and to cut the cost of the mechanical system, and the desire for greater flexibility in planning.

Non-Critical Materials

It was natural that many non-metallic materials would be used for ducts in concrete slabs, as well as traditional galvanized ducts and less conventional galvanized downspouts (see ARCHITECTURAL RECORD, Dec. 1948, pp. 135–6), the governing factors being the type of system, availability and cost of materials, and local labor practices.

Following is a list of non-metallic duct materials and some systems being used that require practically no metal: (1) cellular clay tile, (2) clay pipe (sewer tile), (3) concrete pipe, (4) plastic pipe, (5) pre-cast hollow concrete slabs, (6) fiber pipes impregnated with plastic, (7) asbestos pipe, (8) wood sleepers over a concrete slab (warm air panel), (9) furred down ceiling of wood and gypsum board (ceiling panel), and (10) crawl space heating.

Space Saving Equipment

Some of the new warm air heating systems in which air is admitted to the rooms have many inherent advantages. They can provide ventilation, banish odors, and control humidity. They respond rapidly to outside air temperature change. They permit cooling as well as heating. Air blankets windows to counteract the effect of their low temperature.

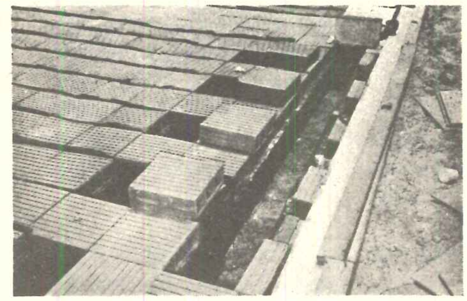
Air's biggest disadvantage is its low density and specific heat, which means that a much larger conductor must be used to deliver heat by air than by water or electricity. This need not be a disadvantage where the warm air supply and return ducts are part of the structural slab, but it could be with conventional forced warm air. High velocity warm air systems with small 4-in. ducts have been developed to overcome this difficulty, especially in houses of more than one story.

Warm Air Perimeter Heating

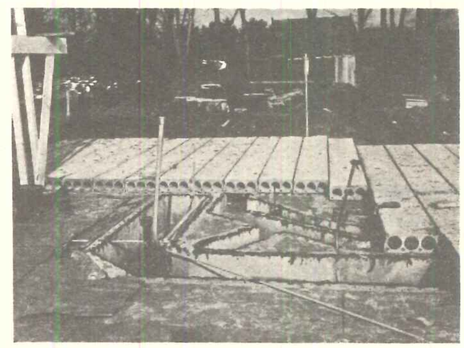
In this article the term "warm air perimeter heating" designates systems which heat primarily by convention, forming a curtain of warm air in front of windows and at the outside walls of the house at the point of greatest heat loss. It is estimated that from 60 to 80 per cent of the heat loss from a basementless house occurs here. There are three "perimeter" methods of heating concrete slabs.

Perimeter Loop System. The perimeter loop system utilizes a continuous duct loop around the perimeter of the house, located 2 in. beneath the concrete and from 3 to 5 in. in from the edge of the

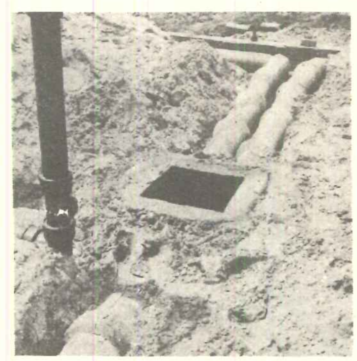
Non-Critical Duct Materials



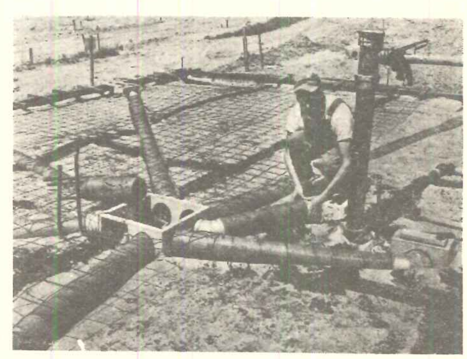
Stock, three-cell clay tile



Hollow-core structural concrete slabs

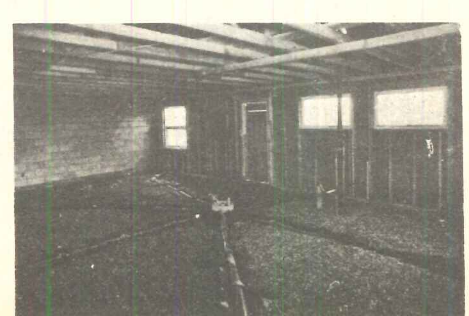


Concrete pipe



Above: Plastic impregnated fiber tubes

Below: Vitreous clay pipe



slab. This loop is then connected to a warm air plenum in the concrete slab by means of feeder ducts. Warm air is delivered into the rooms through registers placed in the floor beneath the windows and opening into the perimeter loop duct.

Radial System. The radial system also utilizes registers placed in the floor beneath the windows, but differs from the perimeter loop system in that a separate warm air conduit is installed from each register location to the warm air plenum cast in the concrete slab. Floor surface temperatures between registers may not be as warm as with a perimeter loop system.

Lateral System. The third method is the lateral system, in which a series of small, parallel ducts are installed in the floor from a central distribution duct that runs the entire length of the building to two collecting ducts on either side of the building. It is estimated that heat from the loop system and the radial system is about 30 per cent radiant and 70 per cent convection.

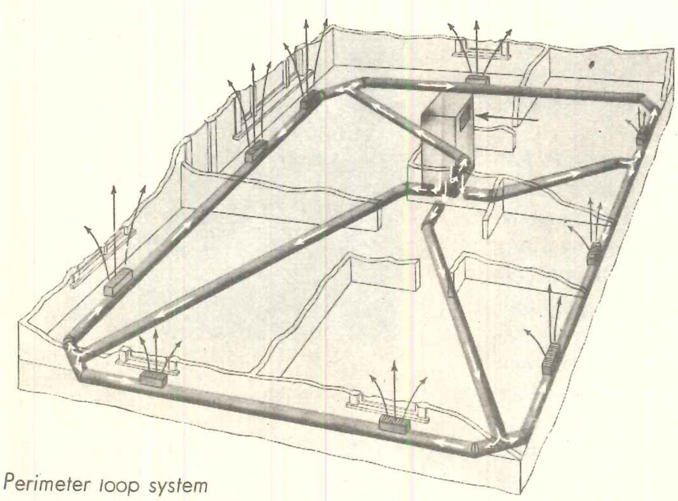
Design Considerations. Air flow through the perimeter duct must be adequate and the temperature must be high enough to maintain comfortable floor temperatures. With a low velocity air flow, the temperature drop in the ducts is too great. Most of these systems are designed for duct air velocities, particularly in radial ducts, of between 600 and 800 ft per min.

Radial feeders must be spaced at intervals along the perimeter duct not greater than 25 to 30 ft, and there should never be more than three outlets between any two feeders. A register must never be located closer than 2 ft to the intersection of a feeder duct and the perimeter loop duct. Usually it is best to have an intersection of a radial feeder duct and a perimeter loop duct at the point of greatest heat loss.

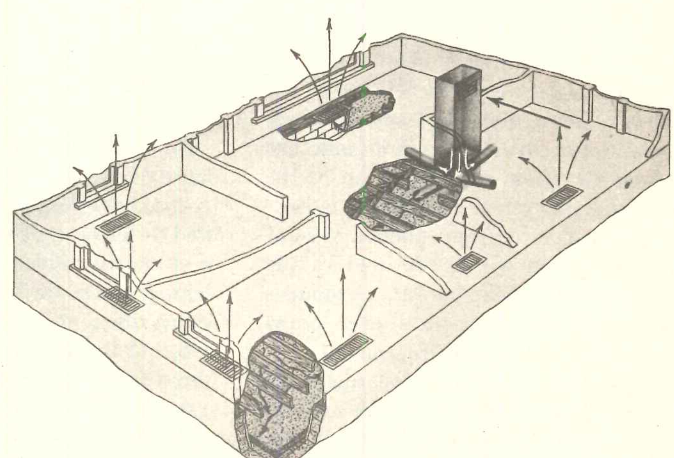
The feeder ducts should slope downward toward the plenum so that they will be at least 5 to 6 in. beneath the slab at the point where they enter the plenum. This pitch places the feeder ducts farther beneath the floor surface at their hottest point so that the floor surface temperatures will not be excessive. Registers should be placed from 5 to 7 in. in from the inner surface of the outer wall.

Crawl Space Heating. In houses built over a crawl space, it may serve as a warm air plenum. The warm air is delivered into the crawl space from the furnace through a suspended sheet metal duct, which extends down from the furnace into the crawl space, and then through short ducts that direct the air into all corners of the house. If the furnace is centrally located, a minimum of four ducts, probably 6 ft long and 6 or 8 in. in diameter, will be sufficient. If the furnace is located at one end of a long, rambling building, it may be necessary

continued on page 124



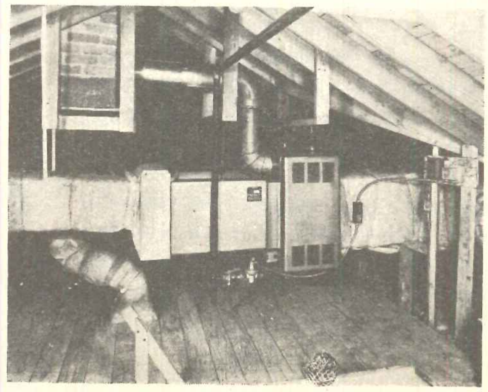
Perimeter loop system

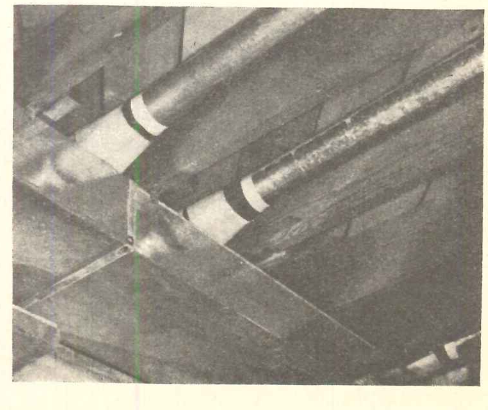


Crawl space plenum system

Space-Saving Equipment

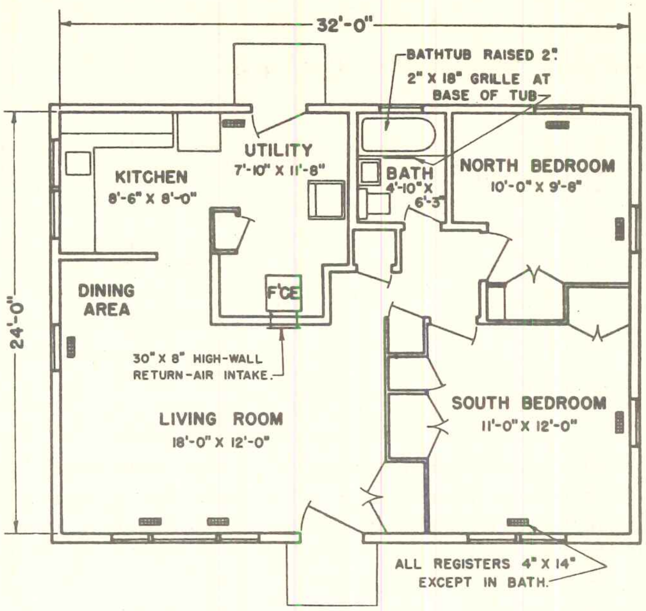
Left: vertical, downflow furnaces fit compactly into a small utility room. In small houses, the return air flows freely through the rooms and back through a louvered opening in the door of the utility room. Center: horizontal furnaces save space when installed in an unused attic. Right: high velocity systems blow air through small 4-in. ducts

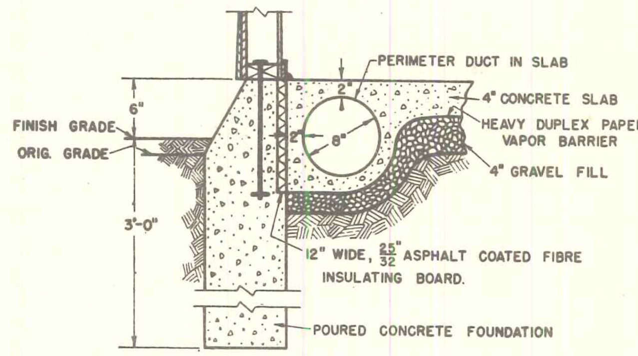




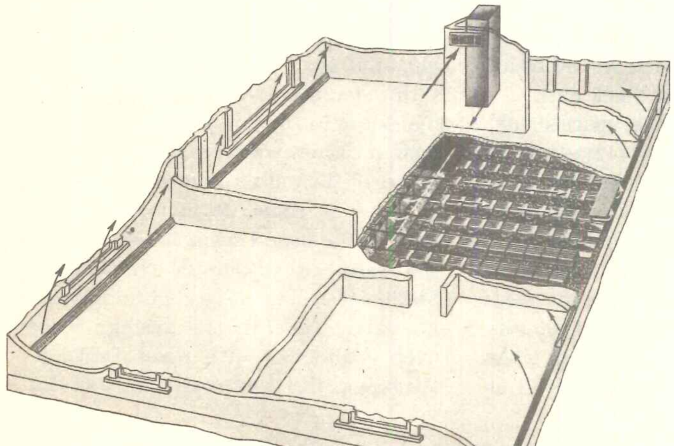
Graphs and a table on this page and the next show the performance of a perimeter loop heating system with radial feeders installed in Warm-Air Heating Research residence No. 3 at the University of Illinois. This type of system is illustrated in the drawing farthest left across the page. The system consists of an 8-in. warm-air duct embedded in the concrete slab in the form of a single loop around the periphery, and a series of 8-in. radial feeder ducts, connecting the perimeter duct with a subfloor plenum. Four arrangements of feeder ducts were studied as indicated in the sketches on this page marked A, B, C, and D. At the bottom of the page are given the floor to ceiling air temperature differentials for a typical winter day. And on the next page, floor temperatures are shown for duct arrangement "A".

The tests are part of a continuing research program under the sponsorship of the National Warm Air Heating and Air Conditioning Association.

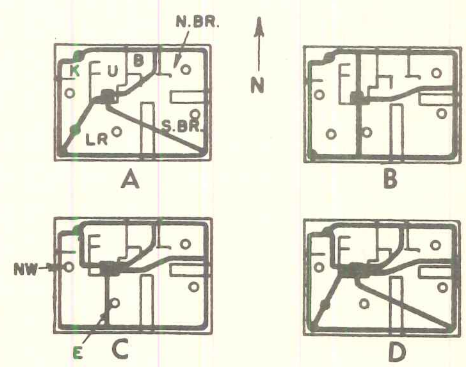




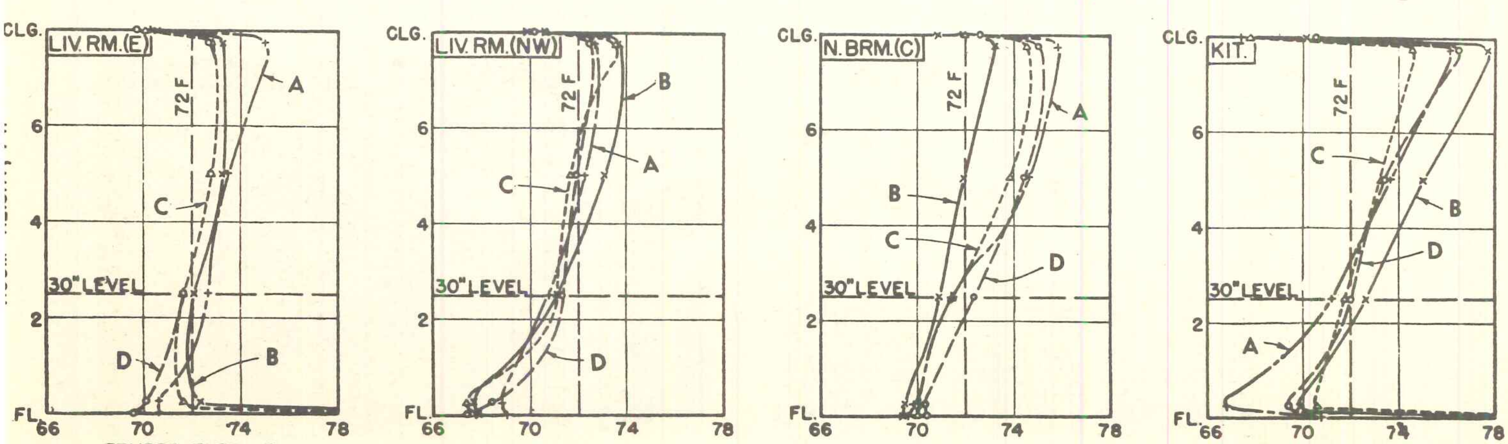
Above: plan of Warm Air Research Residence No. 3 at the University of Illinois and section through floor slab showing warm air duct located at periphery of the slab; note insulation and vapor barrier

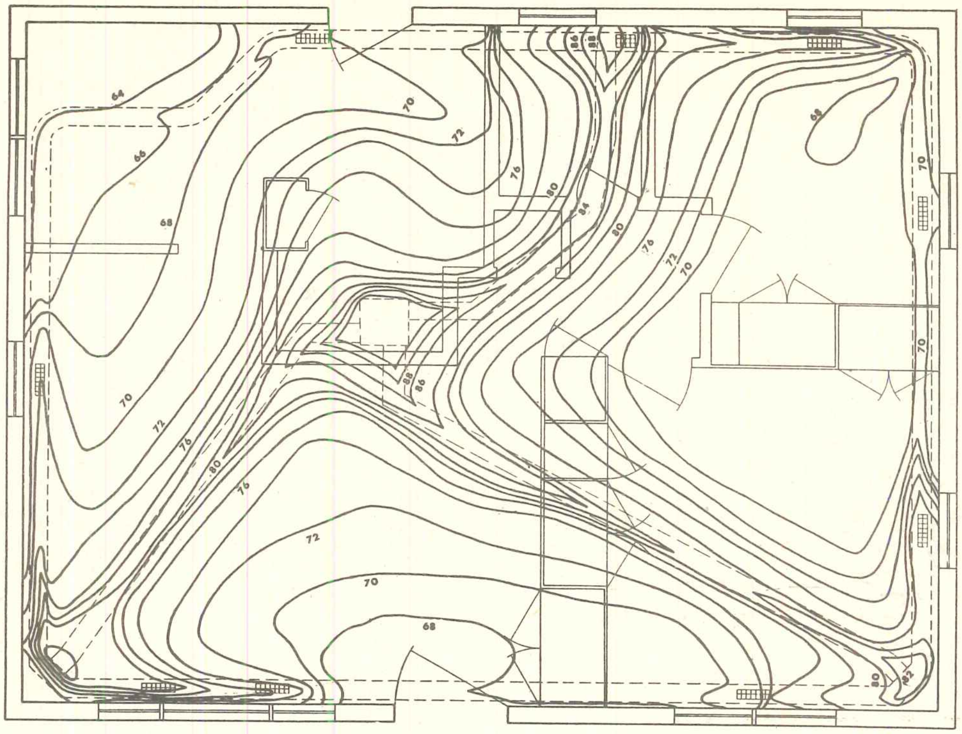


Lateral system



Right, below: four duct arrangements were tested to determine their effect on room air and floor surface temperatures. Below are floor to ceiling air temperatures for this weather: no sun; wind 2–7 mph; outdoor temp. 18–21 F. Average differential for D was only 2.7 F, attributable to greater panel effect





Floor surface temperatures for Residence No. 3 with outdoor temperature 30–35 F, no sun

Heat Balance for Perimeter Arrangement "A"

Items	Measured Values, Btu per Hr
Subfloor Loss	6,280
Above-Ground Losses	16,100
Total Heat Loss	22,380
Heat Supplied Above Ground	
a. Warm air from floor registers	9,350
b. Panel Heating effect	3,090
c. Furnace casing heat transfer	1,100
d. Flue pipe heat transfer	370
e. Electrical energy	1,190
f. Heat from Occupants	1,000
	16,100

Note: Values based on outdoor temperature of 35 F and wind velocity of 10 mph, SW. No solar heat gain occurred.

to install one or two ducts (8 to 12 ft long or longer) to get the heated air into the far corners of the crawl space.

The air is then delivered into the rooms through registers placed in the floor beneath the windows and connected directly with the open crawl space. There is no duct work connecting each individual register to the furnace.

Crawl Space Treatment. It is fundamental that the site be well drained and properly graded, and every precaution be taken to avoid the collection of ground water in the crawl space or around its foundation walls.

The crawl space area up from the foundation wall must be air-tight.

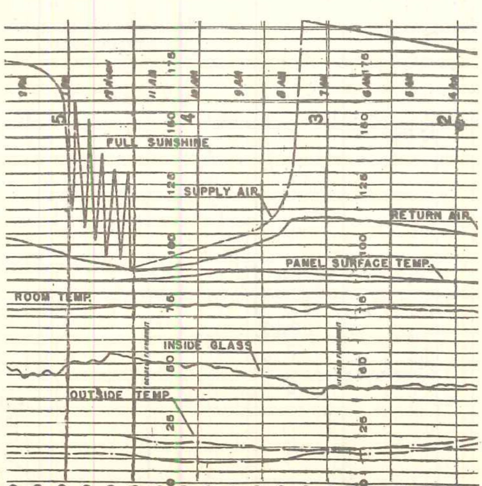
The inner surfaces of the foundation walls should be insulated, and at least one surface should be treated to act as a vapor barrier. The *U* factor of foundation walls should be about that of the walls in the habitable area. Outside wall surfaces between the joists should be insulated with a 2 or 3 in. thick batt.

The ground in the crawl space should be covered first with a coarse gravel about 2 or 3 in. thick, particularly if the house is located on ground with a high water table. The gravel should be covered with roll roofing of at least 55 lb weight with the edges lapped and sealed, and the membrane brought up the side walls 6 in. and sealed to them. The moisture membrane is covered with 1 or 2 in. of sand or coarse gravel for mechanical protection and to keep the heat from direct contact with the roofing.

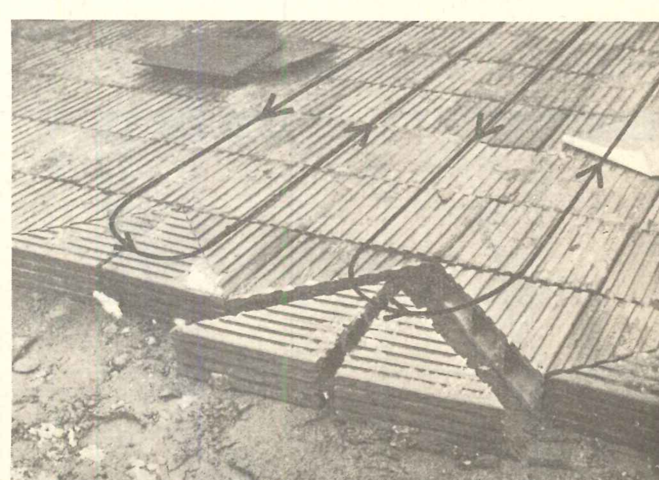
Field tests have shown that ceiling temperature differentials, measured 3 in. above the floor and 3 in. below the ceiling, are from 1 to 3½ F, and that floor surface temperatures in the center of the rooms are in the low seventies, and the floor surface temperatures within a few inches of the walls averaged about 65 F.

There is some drying out of the wooden structural members exposed to the warm air within the crawl space. Shrinkage is an accelerated action of a normal process. In the average house over a basement with wood floor construction, this shrinkage goes on for

Portion of graph showing results of tests on a "split" system with air flowing in sinuous pattern through cellular clay tile and admitted to the living room under windows. Note that room air temperature changes only slightly with full sun



Photograph is of a typical warm air floor panel. Stock, unglazed tile was employed, 12 by 12 by 4 in. Notice that the tile was cut to form a "U" turn. Tile is covered by 2½ in. of concrete



several years. In the crawl space warm air system, it will take place in the first year.

Warm Air Panel and Split Systems

Some engineers advocate panel heating, or, the "split" system in which the air follows a sinuous pattern in the floor or ceiling panel and then is "bled" into the room through small openings near windows.

For large houses where the total heat loss exceeds 100,000 Btu/hr, one independent heating system can take care of the total heating load, if a panel or "split" system is used. But with "perimeter" systems, when the heat loss is greater, two or more independent systems are required; and the systems can then be zone controlled.

These engineers also believe that most of the heat from the air should be dissipated in floor or ceiling panels, resulting in surface temperatures around 85 F and 100 F respectively. Temperature of air to rooms approaches that of the room.

One consulting engineering firm describes their floor panel heating system for residences, comprised of cellular clay tile topped with 2½ in. of concrete, as follows:

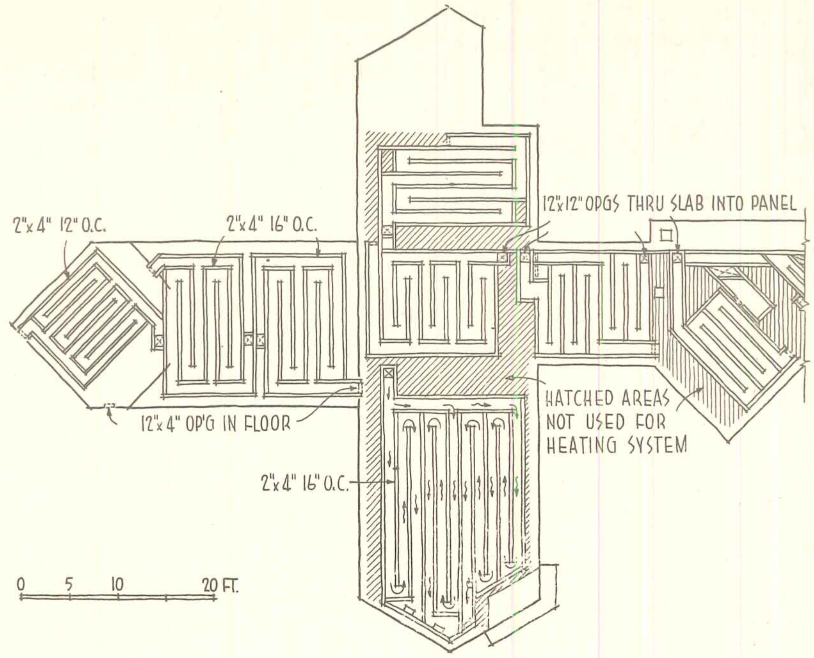
The residential installation is controlled by room thermostat and conventional warm air bonnet control except that continuous fan circulation is not used. When the thermostat signals for heat, the burner provides constant heat input to the slab until the thermostat has been satisfied. The fan is controlled by a high-low limit setting. If the fan ran continuously after the thermostat shut off the burner, the slab would continue to store heat, and the house would become too warm.

Night set-back is not recommended because then the system is forced to operate in the morning for a good while after sunrise when the outside temperature and solar effect is gradually increasing. Overheating will result.

With a fixed room thermostat setting, the off period of the burner is from 8 a.m. to around 4 p.m. During this period, the solar heat is absorbed by the floor slab, which consists of a 2½ in. concrete mass and the tile air space below providing a low heat storage. High heat storage is prevented.

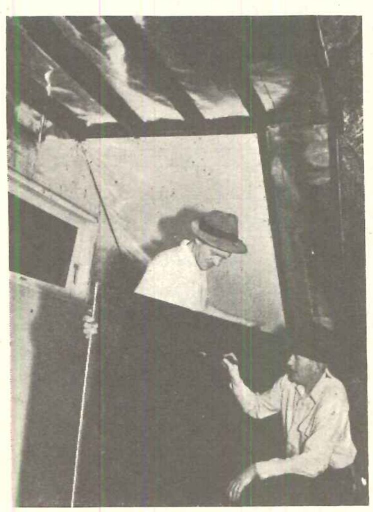
Other systems making use of noncritical materials include a floor panel system with wood sleepers laid on a concrete floor slab, and a plywood subfloor above. Ceiling panels are being constructed with gypsum board furred down from ceiling joists, and the furring strips act to guide the air in a sinuous pattern. See the two sketches on this page.

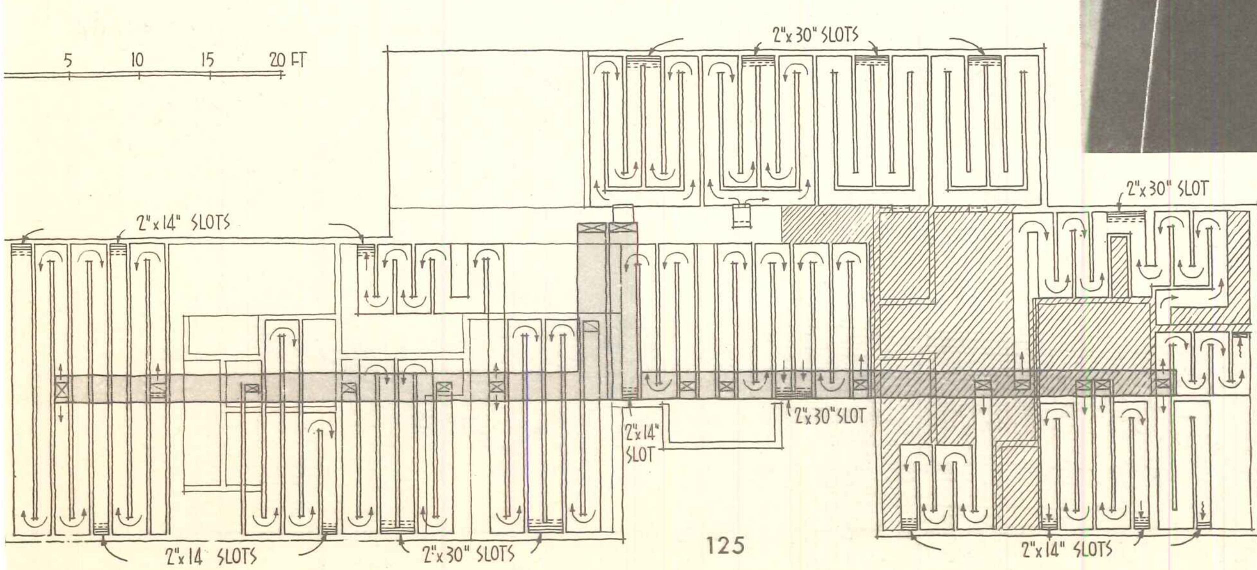
The editors wish to acknowledge the help of the following people in providing material for this article: C. W. Nessell and Randall Nelson, National Warm Air Heating and Air Cond. Assoc.; R. W. Roose, University of Illinois; and Richard P. Goemann of John D. Dillon, Consulting Engineers.



Above: portion of a large house laid out with a floor panel system consisting of wood sleepers over a concrete slab, all covered by a plywood subfloor. Trench underneath distributes heat to panels

Below: layout of a typical ceiling panel system. Furred down ceiling is used similar to photo (note reflective insulation). Gray tone indicates large distribution duct to front panels. Slots admit air near outside walls





ARCHITECTURAL ENGINEERING

TECHNICAL NEWS AND RESEARCH

HEATING SYSTEMS FOR HOUSES

By William J. McGuinness
Professor of Architectural Engineering
Pratt Institute

Cast Iron Baseboard Heating Systems: 1

Comparison With Other Systems

Baseboards distribute heat better than standing radiators and are less conspicuous. Properly installed, there is less wall streaking because of the top seal strip and non-concentrated convection currents. Lower parts of rooms are warmer, as shown in Charts A and B, making it most adaptable to basementless construction. Response to starting and shutting off is quicker with baseboards than with radiant heating.

Heating Medium

Hot water forced circulation is the most adaptable heat source for baseboards and can be used in any of the three circuits sketched. Operation is like any hot water system using conventional radiation and operation cost is about the same. If there is a minimum wall space for base, heat losses can be cut by further insulation, double glazing, etc.

Adaptability to Old Buildings

Baseboards can be used in conversion jobs where gravity hot water systems are in use. Two pipe steam systems in larger buildings can be used with baseboards, but in one-pipe systems, the long run of condensing radiation makes it almost impossible to get the condensate out the same end as the steam enters.

Steps in Design

1. *Determine Heat Loss.* The usual calculations for hourly heat loss in BTU should be completed and recorded for each room in the sketch.

2. *Select Baseboards And/Or Radiators.* The order of preference for baseboard location is a) under windows, b) on outside walls, c) on inside walls. As a trial length, outside walls are measured and recorded in each room. Heat loss of the room per ft of baseboard should be computed. The max required output (515 BTU per ft in the living room) sets the water

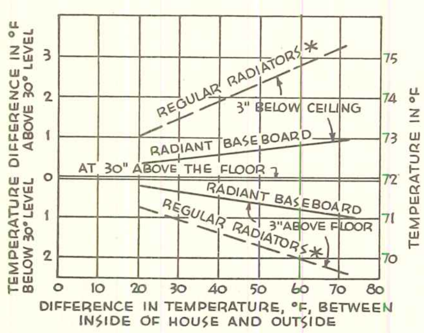


Chart A. *Room air temperature at various levels: at 70 deg inside to outside temp., a difference of 2 deg between floor and ceiling is shown for baseboards against almost 6 deg for radiators. *Small tube recessed radiators*

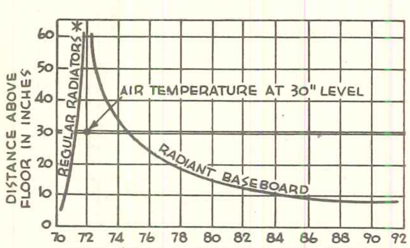
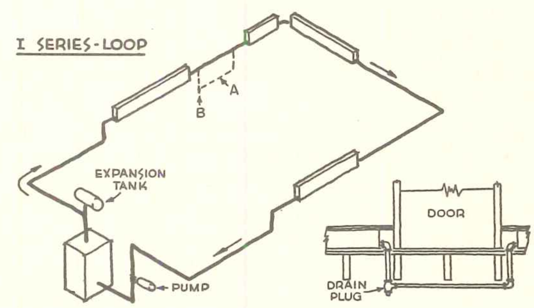
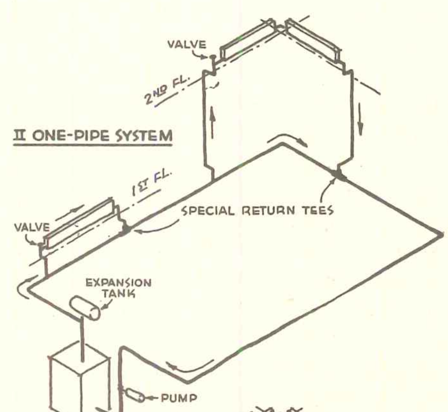
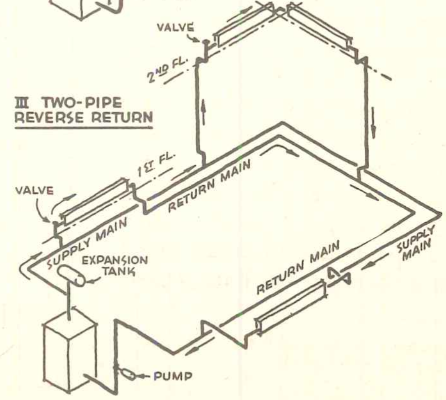


Chart B. *Radiant baseboard keeps lower walls warmer, overcomes cold floors. Overall mean radiant temp. is not higher with baseboards because radiators produce a hot ceiling. Studies made when temp. indoors at 30 in. level was 72 deg, outdoors 32 deg*







Circuits and Piping (Right)

I. Least expensive to install. Adequate heat but no individual control of units. If pipes drop to avoid doorways as at point A, drainage must be provided at point B.

II. Most popular for small and average size installations. Control of individual units by valves.

III. Best for large installations. Each base element controlled separately and receives water at max. temp. directly from supply main

Note: Charts A and B from University of Illinois Bulletin No. 358 — A Study of Radiant Baseboard Heating.

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HEATING SYSTEMS FOR HOUSES

By William J. McGuinness

Cast Iron Baseboard Heating Systems: 2 — Types of Heaters

temperature which must be used throughout the system. In this case 200 F (the max recommended by some manufacturers) is chosen as the average water temperature and results in base lengths which fit the space. Base of the desired height and type may be selected from Tables 5–8 to make up heat losses. Cast iron radiators may be used with cast iron baseboards. Table 3 gives a heat emission of 210 BTU per hr for 1 sq ft of radiation at 200 F. Dividing the loss in the kitchen and bathroom by this rate (there is not room in these spaces for baseboard) we find that 26.7 and 10.9 sq ft respectively are needed. From Table 4 radiators may be selected to make up this footage. It is necessary in selecting baseboard lengths to leave space for expansion, piping and end cover boxes for valves.

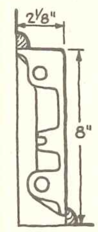
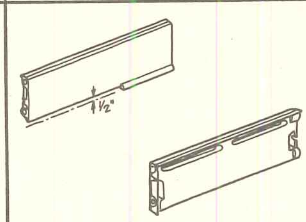
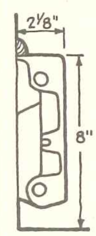
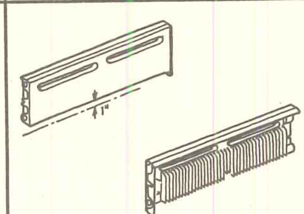
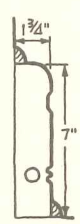
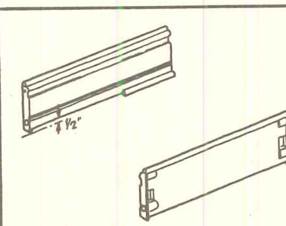
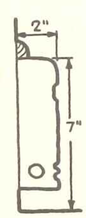
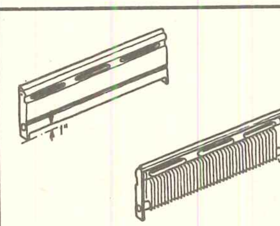
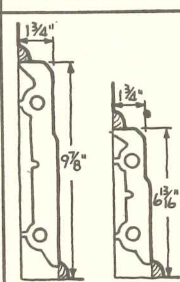
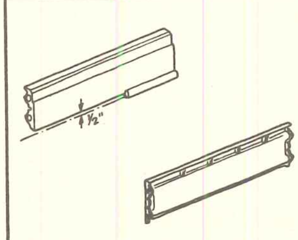
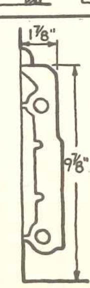
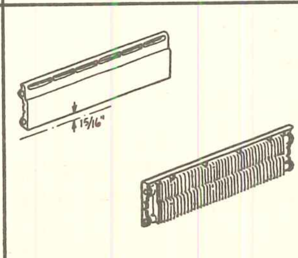
3. *Select Boiler.* A boiler with a net rating of 45,000 BTU per hr will be adequate for this system. Boilers are made large enough to supply the pick up, pipe loss and domestic hot water needs, unless these are unusual.

4. *Select Air Cushion Tank.* To facilitate expansion in the system, allow 1 gal of tank volume for each 30 sq ft of radiation. Dividing 222.9 sq ft by 30, the min volume usable is 7.4 and the next larger stock size tank will be selected.

5. *Select Pump Size.* Tables used are based on a temperature drop in the system of 20 F. Since this is the drop we have chosen, use Table 9 to select a pump size. Since our heat loss is below 50,000 BTU per hr, a 1 in. standard pump is acceptable. The head developed by the pump in supplying water to make up the heat loss at the given temperature drop may be found from Table 10. For a 1 in. pump and nearly 50,000 BTU per hr, the head will be about 5.25 ft.

6. *Determine Main Size.* In determining the length of the system it is usual to allow 12 ft for each heating element in addition to the measured length of the main. The total of these

Table I - BASEBOARD HEATER UNITS

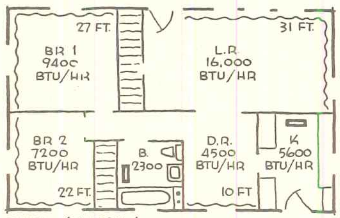
MFR. TYPE & I-B-R RATING	DIMENSIONS	VIEWS FRONT / BACK	SQ. FT./FT. RATING
AMERICAN RADIATOR R LOW 1.25			1.25
AMERICAN RADIATOR RC LOW 2.08			2.08
BURNHAM R LOW 1.25			1.25
BURNHAM RC LOW 2.08			2.08
CRANE R HIGH 1.77 LOW 1.25			HIGH 1.77 LOW 1.25
CRANE RC HIGH 2.92			2.92

I-B-R means Institute of Boiler and Radiator Mfgrs. Col. 4 in table gives manufacturers' ratings.

HEATING SYSTEMS FOR HOUSES

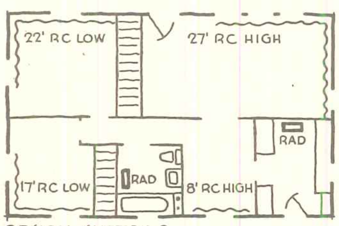
Cast Iron Baseboard Heating Systems: 3 — Design

By William J. McGuinness



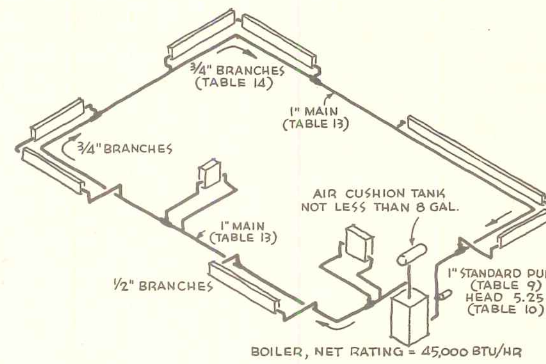
DATA, SKETCH 1

Heat loss and outside wall length



DESIGN, SKETCH 2

Length and type of baseboard



DESIGN OF A RADIANT BASEBOARD HEATING SYSTEM USING ONE-PIPE FORCED HOT WATER

Temp. drop of water in system 20°

Length of System:

Measured length of main	*130*
Radiator allowance	
(6 heating elements x 12)	*72*
(Use 200' in Table 11)	*202*

Table 2

DATA, SKETCH 1				DESIGN, SKETCH 2		
1 SPACE	2 BTU/HR HEAT LOSS	3 LINEAR FT. OF EXTERIOR WALL AVAILABLE	4 BTU/LIN. FT. OF EXTERIOR WALL	5 TYPE AND HT. OF BASEB'D SELECTED	6 LENGTH OF BASE TO BE USED	7 SQ. FT. OF RADIATION
L.R.	16,000	31	515	RC HIGH	27'	78.8
D.R	4,500	10	450	RC HIGH	8'	23.3
K.	5,600	NONE, USE RADIATOR	—	RADIATOR	22"-4T-16SEC	28.8
BR 1	9,400	27	347	RC LOW	22'	45.8
BR 2	7,200	22	327	RC LOW	17'	35.4
BATH	2,300	NONE, USE RADIATOR	—	RADIATOR	22"-4T-6SEC	10.8
TOTALS	45,000					222.9

for the example given is 202 ft. Using this length and the head of 5.25 ft enter Table 11 and find that 1 in. is the right size for a main that will supply the BTU's required.

7. *Determine Branch Sizes.* Using the lengths of the baseboards in each room, it is found from Table 12 that branches are to be ½ and ¾ in. as recorded on the final piping diagram. Size of branches for small-tube cast iron radiation as used in the kitchen and bath is found from Table I, Section B, Architectural Record, Nov. 1949, p. 157. Using the total heat loss of 45,000 BTU per hr and main size of 1 in., ½ in. branch size is satisfactory for each of the radiators.

References

For larger jobs, the reader is referred to: IBR Installation Guide No. 5, *Baseboard Heating Systems* of the Institute of Boiler and Radiator Mfgrs. (60 E. 42nd St., New York 17, N. Y., 50 cents) through whose courtesy the tables have been partially reproduced here; *A Study of Radiant Baseboard Heating in the IBR Research Home* by Alonzo P. Kratz and Warren S. Harris, Engineering Experiment Station Bulletin Series No. 358, Univ. of Illinois, Urbana, Ill., 35 cents; *Heating a Basementless House With Radiant Baseboard* by R. H. Weigel and W. S. Harris, article in Heating Piping and Air Conditioning, Nov., 1948.

Table 3 — HEAT EMISSION RATES

AVERAGE RADIATOR TEMPERATURE	BTU/HR PER SQ FT
170	150
175	160
180	170
185	180
190	190
195	200
200	210
205	220
210	230
215	240

Table 4 — SMALL TUBE CAST IRON RADIATORS

NO. OF SQ FT OF CAST IRON RADIATION PER SECTION (STANDARD SPACING 1¾")		
NO. OF TUBES PER SECTION	HEIGHT	SQ FT OF RADIATION PER SECTION
3	25	1.6
4	19 22 25	1.6 1.8 2.0
5	22 25	2.1 2.4
6	19 25 32	2.3 3.0 3.7

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Cast Iron Baseboard Heating Systems: 4 — Baseboard Rating Tables

By William J. McGuinness

Table 5 — TYPE R — LOW HEIGHT

Length of Assembly Ft	Rating Sq Ft*	Rating, Btu/Hr., at Various Average Water Temperatures									
		215 F	210 F	205 F	200 F	195 F	190 F	185 F	180 F	175 F	170 F
2	2.5	600	570	520	510	490	460	440	410	390	360
3	3.75	900	850	810	770	730	690	660	620	580	550
4	5.0	1200	1140	1080	1030	980	920	870	820	770	730
5	6.25	1500	1420	1360	1290	1220	1160	1090	1030	970	910
6	7.5	1800	1710	1630	1540	1470	1390	1310	1240	1160	1090
7	8.75	2100	1990	1900	1800	1710	1620	1530	1440	1360	1280
8	10.0	2400	2280	2170	2060	1960	1850	1750	1650	1550	1460
9	11.25	2700	2560	2440	2320	2200	2080	1970	1860	1740	1640
10	12.5	3000	2850	2710	2570	2450	2310	2190	2060	1940	1820
11	13.75	3300	3130	2980	2830	2690	2540	2410	2270	2130	2010
12	15.0	3600	3420	3250	3090	2940	2770	2620	2470	2320	2190
13	16.25	3900	3700	3530	3350	3180	3010	2840	2680	2520	2370
14	17.5	4200	3990	3800	3600	3430	3240	3060	2890	2710	2550
15	18.75	4500	4270	4070	3860	3670	3470	3280	3090	2910	2740
16	20.0	4800	4560	4340	4120	3920	3700	3500	3300	3100	2920
17	21.25	5100	4840	4610	4380	4160	3930	3720	3510	3290	3100
18	22.5	5400	5130	4880	4630	4410	4160	3940	3710	3490	3280
19	23.75	5700	5410	5150	4890	4650	4390	4160	3920	3680	3470
20	25.0	6000	5700	5420	5150	4900	4620	4370	4120	3870	3650
21	26.25	6300	5980	5700	5410	5140	4860	4590	4330	4070	3830
22	27.5	6600	6270	5970	5660	5390	5090	4810	4540	4260	4010
23	28.75	6900	6550	6240	5920	5630	5320	5030	4740	4460	4200
24	30.0	7200	6840	6510	6180	5880	5550	5250	4950	4650	4380
25	31.25	7500	7120	6780	6440	6120	5780	5470	5160	4840	4560
26	32.5	7800	7410	7050	6690	6370	6010	5690	5360	5040	4740
27	33.75	8100	7690	7320	6950	6610	6240	5910	5570	5230	4930
28	35.0	8400	7980	7590	7210	6860	6470	6120	5770	5420	5110
29	36.25	8700	8260	7870	7470	7100	6710	6340	5980	5620	5290
30	37.5	9000	8550	8140	7720	7350	6940	6560	6190	5810	5470

Table 6 — TYPE R — HIGH HEIGHT

Length of Assembly Ft	Rating Sq Ft*	Rating, Btu/Hr., at Various Average Water Temperatures									
		215 F	210 F	205 F	200 F	195 F	190 F	185 F	180 F	175 F	170 F
2	3.5	850	810	770	730	690	650	620	580	550	520
3	5.3	1270	1210	1150	1090	1040	980	930	870	820	770
4	7.1	1700	1610	1540	1460	1390	1310	1240	1170	1100	1030
5	8.8	2120	2010	1920	1820	1730	1630	1550	1460	1370	1290
6	10.6	2550	2420	2310	2190	2080	1970	1860	1750	1650	1550
7	12.4	2970	2820	2680	2550	2420	2290	2170	2040	1920	1810
8	14.2	3400	3230	3070	2920	2780	2620	2480	2340	2200	2070
9	15.9	3820	3630	3450	3280	3120	2940	2780	2630	2470	2320
10	17.7	4250	4040	3840	3650	3470	3280	3100	2920	2740	2580
11	19.5	4670	4440	4220	4010	3810	3600	3400	3210	3020	2840
12	21.25	5100	4840	4610	4380	4160	3930	3720	3510	3290	3100
13	23.0	5520	5240	4990	4740	4510	4250	4020	3790	3560	3360
14	24.8	5950	5650	5380	5110	4860	4590	4340	4090	3840	3620
15	26.5	6370	6050	5760	5470	5200	4910	4640	4380	4110	3870
16	28.3	6800	6460	6150	5840	5550	5240	4960	4670	4390	4140
17	30.1	7220	6860	6530	6200	5900	5560	5260	4960	4660	4390
18	31.9	7650	7270	6920	6570	6250	5900	5580	5260	4940	4650
19	33.6	8070	7670	7300	6930	6590	6220	5880	5550	5210	4910
20	35.4	8500	8070	7680	7300	6940	6550	6200	5840	5490	5170
21	37.2	8920	8470	8060	7660	7280	6880	6500	6130	5760	5430
22	39.0	9350	8880	8450	8020	7640	7210	6820	6430	6040	5690
23	40.7	9770	9280	8830	8390	8000	7530	7120	6720	6310	5940
24	42.5	10200	9690	9220	8750	8330	7860	7440	7010	6590	6200
25	44.25	10620	10090	9600	9110	8670	8190	7740	7300	6860	6460
26	46.0	11050	10500	9990	9480	9020	8520	8060	7600	7140	6720
27	47.8	11470	10900	10370	9840	9370	8840	8360	7890	7410	6980
28	49.6	11900	11300	10760	10210	9720	9170	8680	8180	7690	7240
29	51.3	12320	11700	11140	10570	10060	9500	8980	8470	7960	7490
30	53.1	12750	12110	11530	10940	10400	9830	9300	8770	8230	7760

** Based on the common standard emission rate of 240 Btu per hour per sq ft at 215 F.*

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Cast Iron Baseboard Heating Systems: 5 — Baseboard Rating Tables Continued

By William J. McGuinness

Table 7 — TYPE RC — LOW HEIGHT

Length of Assembly Ft	Rating Sq Ft*	Rating, Btu/Hr, at Various Average Water Temperatures									
		215 F	210 F	205 F	200 F	195 F	190 F	185 F	180 F	175 F	170 F
2	4.2	1000	950	900	860	820	770	730	690	650	610
3	6.25	1500	1420	1360	1290	1220	1160	1090	1030	970	910
4	8.3	2000	1900	1810	1720	1630	1540	1460	1370	1290	1220
5	10.4	2500	2370	2260	2150	2040	1930	1820	1720	1610	1520
6	12.5	3000	2850	2710	2570	2450	2310	2190	2060	1940	1820
7	14.6	3500	3320	3160	3000	2860	2700	2550	2410	2260	2130
8	16.7	4000	3800	3620	3430	3270	3080	2920	2750	2580	2430
9	18.75	4500	4270	4070	3860	3670	3470	3280	3090	2910	2740
10	20.8	5000	4750	4520	4290	4080	3850	3650	3440	3230	3040
11	22.9	5500	5220	4970	4720	4490	4240	4010	3780	3550	3350
12	25.0	6000	5700	5420	5150	4900	4620	4370	4120	3870	3650
13	27.1	6500	6170	5880	5580	5310	5010	4740	4470	4200	3950
14	29.2	7000	6650	6330	6010	5720	5400	5100	4810	4520	4260
15	31.25	7500	7120	6780	6440	6120	5780	5470	5160	4840	4560
16	33.3	8000	7600	7230	6870	6530	6170	5830	5500	5170	4870
17	35.4	8500	8070	7680	7300	6940	6550	6200	5840	5490	5170
18	37.5	9000	8550	8140	7720	7350	6940	6560	6190	5810	5470
19	39.6	9500	9020	8590	8150	7760	7320	6930	6530	6130	5780
20	41.7	10000	9500	9040	8580	8170	7710	7290	6870	6460	6080
21	43.75	10500	9970	9490	9010	8570	8090	7660	7220	6780	6390
22	45.8	11000	10450	9950	9440	8980	8480	8020	7560	7100	6690
23	47.9	11500	10920	10400	9870	9390	8860	8380	7910	7430	7000
24	50.0	12000	11400	10850	10300	9800	9250	8750	8250	7750	7300
25	52.1	12500	11870	11300	10730	10210	9630	9110	8590	8070	7600
26	54.2	13000	12350	11750	11160	10620	10020	9480	8940	8400	7910
27	56.25	13500	12820	12210	11590	11020	10410	9840	9280	8720	8210
28	58.3	14000	13300	12660	12020	11430	10790	10210	9620	9040	8520
29	60.4	14500	13770	13110	12440	11840	11180	10570	9970	9360	8820
30	62.5	15000	14250	13560	12870	12250	11560	10940	10310	9690	9120

Table 8 — TYPE RC — HIGH HEIGHT

Length of Assembly Ft	Rating Sq Ft*	Rating, Btu/Hr, at Various Average Water Temperatures									
		215 F	210 F	205 F	200 F	195 F	190 F	185 F	180 F	175 F	170 F
2	5.8	1400	1330	1200	1210	1140	1080	1020	960	900	850
3	8.75	2100	1990	1900	1800	1710	1620	1530	1440	1360	1280
4	11.7	2800	2660	2530	2400	2290	2160	2040	1920	1810	1700
5	14.6	3500	3320	3160	3000	2860	2700	2550	2410	2260	2130
6	17.5	4200	3990	3800	3600	3430	3240	3060	2890	2710	2550
7	20.4	4900	4650	4430	4210	4000	3780	3570	3370	3160	2980
8	23.3	5600	5320	5060	4810	4570	4320	4080	3850	3620	3410
9	26.25	6300	5980	5700	5410	5140	4860	4590	4330	4070	3830
10	29.2	7000	6650	6330	6010	5720	5400	5100	4810	4520	4260
11	32.1	7700	7310	6960	6610	6290	5930	5610	5290	4970	4680
12	35.0	8400	7980	7590	7210	6860	6470	6120	5770	5420	5110
13	37.9	9100	8640	8230	7810	7430	7010	6630	6260	5880	5540
14	40.8	9800	9310	8860	8410	8000	7550	7150	6740	6330	5960
15	43.75	10500	9970	9490	9010	8570	8090	7660	7220	6780	6390
16	46.7	11200	10640	10130	9610	9150	8630	8170	7700	7230	6810
17	49.6	11900	11300	10760	10210	9720	9170	8680	8180	7680	7240
18	52.5	12600	11970	11390	10810	10290	9710	9190	8660	8140	7660
19	55.4	13300	12630	12020	11420	10860	10250	9700	9140	8590	8090
20	58.3	14000	13300	12660	12020	11430	10790	10240	9620	9040	8520
21	61.25	14700	13960	13290	12620	12000	11330	10720	10110	9490	8940
22	64.2	15400	14630	13920	13220	12580	11870	11230	10590	9950	9370
23	67.1	16100	15290	14560	13820	13150	12410	11740	11070	10400	9790
24	70.0	16800	15960	15190	14420	13720	12950	12250	11550	10850	10220
25	72.9	17500	16620	15820	15020	14290	13490	12760	12030	11300	10650
26	75.8	18200	17290	16460	15620	14860	14030	13270	12510	11750	11070
27	78.75	18900	17950	17090	16220	15430	14570	13780	12990	12210	11500
28	81.7	19600	18620	17720	16820	16010	15110	14290	13470	12660	11920
29	84.6	20300	19280	18350	17420	16580	15650	14800	13960	13110	12350
30	87.5	21000	19950	18990	18020	17150	16190	15310	14440	13560	12770

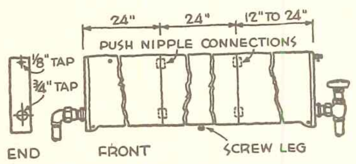
* Based on the common standard emission rate of 240 Btu/Hr per sq ft at 215 F.

ARCHITECTURAL ENGINEERING
TECHNICAL NEWS AND RESEARCH

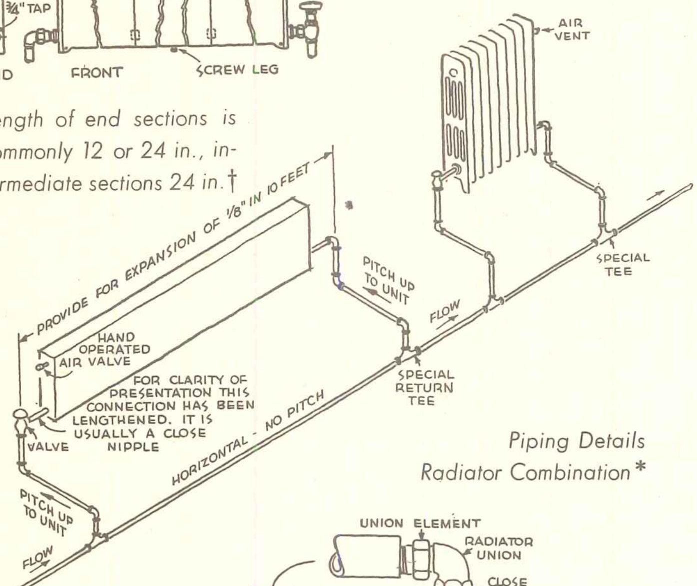
HEATING SYSTEMS FOR HOUSES

Cast Iron Baseboard Heating Systems: 6 — Design Details

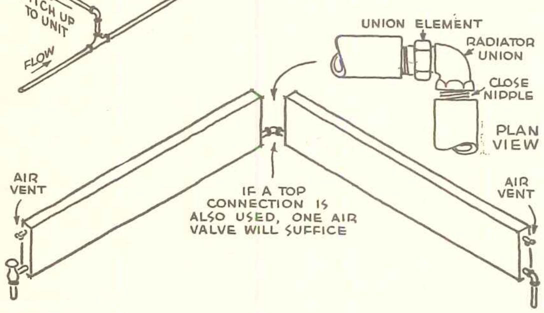
By William J. McGuinness



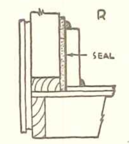
Length of end sections is commonly 12 or 24 in., intermediate sections 24 in.†



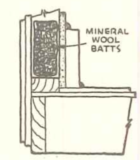
*Piping Details Radiator Combination**



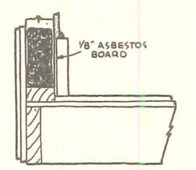
* *American Radiator Co. Details*

A


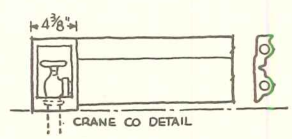
A. Air Seal. *Building paper, aluminum foil or asbestos paper must be placed behind base heaters to prevent streaks on wall. It is turned down under top moulding*

B


B. Insulation. *Full insulation is advisable to reduce heat loss and shorten base length. Use of batts behind base is necessary*

C


C. Recessing. *Bulk of base may be reduced by recessing in amount of plaster thickness. Base must be backed by a 1/8 in. board*



Valve enclosure lengths:
American Radiator—6 3/4 in.
Burnham —5 in.
Crane —4 3/8 in.

Table 9 - TRIAL PUMP SIZE

Total Load on System Btu/Hr.	Standard Pump
Up to 50,000	1"
50,001 to 100,000	1 1/4"
100,001 to 150,000	1 1/2"
Over 150,001	1 1/2"

Table 10 - PRESSURE HEAD DEVELOPED BY PUMP
Note: This Table is based on conservative averages. Consult manufacturers' data for closer accuracy.

Total Load Btu/Hr.	PRESSURE HEAD IN FT. OF WATER — Standard Pump		
	1"	1 1/4"	1 1/2"
25,000	5.50	6.25	6.75
50,000	5.25	6.00	6.75
75,000	4.75	5.75	6.50
100,000	4.50	5.50	6.50
125,000	4.00	5.25	6.25

Table 12 - BRANCH SIZES FOR BASEBOARDS
Based on the use of one-pipe fittings in the main

Location of Baseboard	If Baseboard is 10 ft. or less in Length	If Baseboard is Longer than 10 ft.*
1st Floor Below Main	3/4"	3/4"
1st Floor Above Main	1/2"	3/4"
2nd Floor Above Main	3/4"	3/4"

Table 11 - MAIN SIZES — IRON PIPE OR TYPE L COPPER TUBE
FOR PRESSURE HEADS BETWEEN 4.8 and 6.7 FT. OF WATER

Measured Length plus radiator allowance, Ft.	Capacity in Btu/Hr. — 3/4" Pipe	1" Pipe	1 1/4" Pipe	1 1/2" Pipe
100	34,000	64,000	116,000	176,000
110	33,000	63,000	113,000	172,000
120	32,000	61,000	110,000	168,000
130	31,000	60,000	107,000	164,000
140	30,000	58,000	104,000	160,000
150	30,000	56,000	101,000	156,000
160	29,000	54,000	99,000	153,000
170	28,000	53,000	98,000	150,000
180	27,000	52,000	96,000	147,000
190	27,000	51,000	94,000	144,000
200	26,000	50,000	92,000	141,000
210	25,000	49,000	90,000	139,000
220	25,000	48,000	89,000	136,000
230	24,000	47,000	87,000	134,000
240	24,000	46,000	86,000	132,000
250	24,000	45,000	84,000	130,000
300	21,000	41,000	78,000	120,000
400	19,000	36,000	68,000	105,000
500	16,000	33,000	62,000	95,000
600	15,000	30,000	56,000	88,000

† *It is recommended that not more than 40 lin ft. of baseboard be connected to the main with a single supply and return riser.*

ARCHITECTURAL ENGINEERING
TECHNICAL NEWS AND RESEARCH

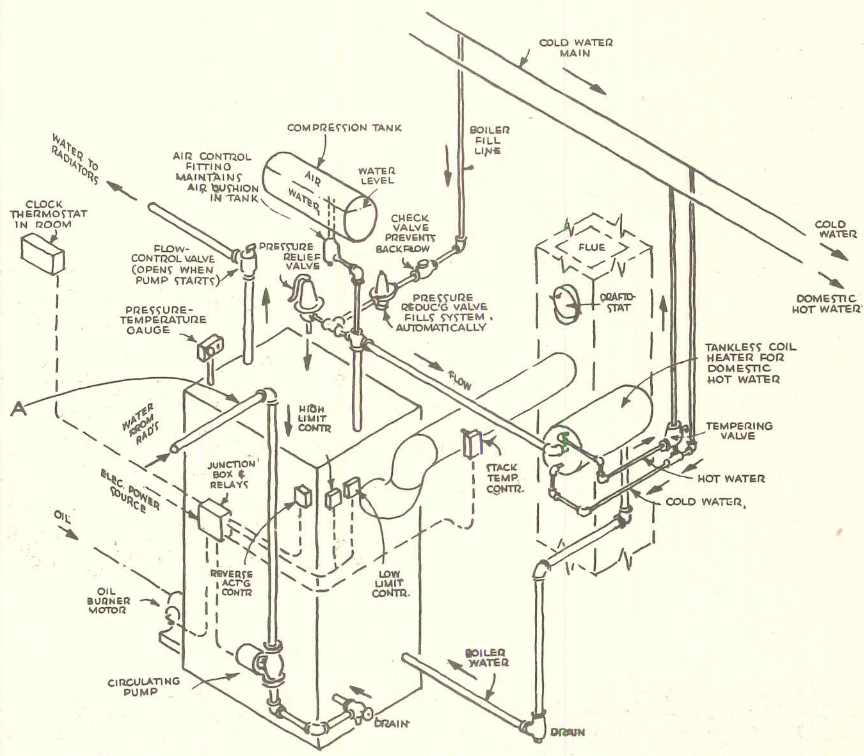
HEATING SYSTEMS FOR HOUSES

Forced Hot Water Systems: 1—One-Pipe; Types, Equipment

By William J. McGuinness, Professor of Architectural Engineering, Pratt Institute

Selection of a Type of System

Most residences can be served satisfactorily and most economically by a one-pipe forced circulation system with a single loop main. Larger residences call for the use of a multi-circuit one-pipe system consisting of a main without any radiator branches supplying several branch mains each serving a section of the house and returning through a single return line and circulating pump to the boiler. The addition of extra flow control valves and pumps can easily turn this into a zoned system good enough for the largest house or for a small apartment building or similar structure. In very large installations or those calling for the greatest efficiency the two-pipe, reversed-return, forced-circulation system is certainly the most efficient, because the return water is handled very positively by a separate return main and is not able to cool the water flowing to other radiators in the circuit.



TYPICAL OIL-FIRED BOILER AND EQUIPMENT

For one- or two-pipe forced hot water systems

Note direct main connections (A, no swing joints); expansion not sufficient to cause trouble. Circulating pump is in return line, in either vertical or horizontal run according to pump requirements

Operation

1. When room thermostat calls for heat, oil burner and pump turn on simultaneously
2. If water drops below limiting temperature (160°), reverse-acting control turns off pump until oil burner has raised water temperature
3. Low-limit control turns on oil burner whenever water falls below 160°
4. High-limit control turns off oil burner when water temperature exceeds a high limit (often 200°), thus stabilizing water temperature during capacity operation
5. When room thermostat is satisfied, pump and oil burner turn off
6. Stack temperature control, an emergency control, shuts down burner if it does not ignite promptly
7. Pressure relief valve, an emergency control, opens to relieve any pressure in excess of a set value (often 30 lb. per sq. in.). This valve should be set above boiler, otherwise if it failed it would drain boiler, subjecting boiler to cracking

Characteristics of Hot Water Heating

Forced systems in which the boiler water is kept hot by water temperature controls are very fast in response to calls for heat. They are much faster than one-pipe steam systems. When the thermostat is satisfied, the circulating pump stops, but the heat emission of the radiators continues at a slowly diminishing rate which is much better than the speedy stopping of a steam system in which all the steam in a radiator has condensed and drawn air into the radiator. The possibility of circulating water at temperatures less than the actual design temperature makes hot water an ideal medium for moderate weather.*

Economy of Installation and Operation

The cost of a pump, flow control valves, special return fittings and larger radiator often make the installation of a hot water system more costly than a steam one-pipe system. Because of the heat-retaining qualities of the circulated water it is usually cheaper to operate a hot water system than it is to operate a one-pipe steam system.

Fittings, Pipe and Covering

Copper tubing is very popular and adaptable to hot water systems and in a great many instances is replacing steel. In these cases bronze and copper solder fittings are often used. It is usual to cover all steel pipe for the conservation of the heat, but

** A properly designed hot water system is quieter in operation than the best one-pipe steam system. It is free from the frequent complaint that one-pipe steam systems push into the room odor-laden air from the radiators whenever steam comes up.*

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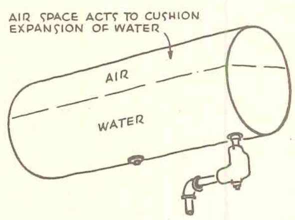
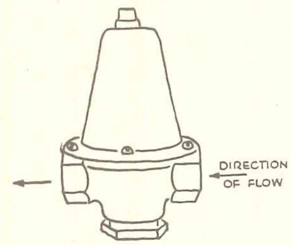


COMPRESSION TANK WITH AIR CONTROL FITTING

SELECT TANK SIZE TO FIT SYSTEM

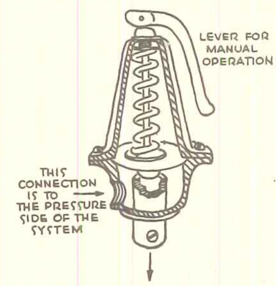
Capacity in sq. ft. of radiation	Tank capacity gallons	Tank dimensions
to 300 sq. ft.	15	12″ x 30″
300 to 500 sq. ft.	18	12″ x 36″
500 to 700 sq. ft.	20	12″ x 42″
700 to 1000 sq. ft.	24	12″ x 48″



PRESSURE REDUCING VALVE

Fill line to boiler; adds water when pressure drops below 12 lb. per sq. in.

Other side connected to city water pressure (40 to 50 lb. per sq. in.; too high for system) Full system is needed; it's easy to forget to add water to boiler. This valve adds it automatically

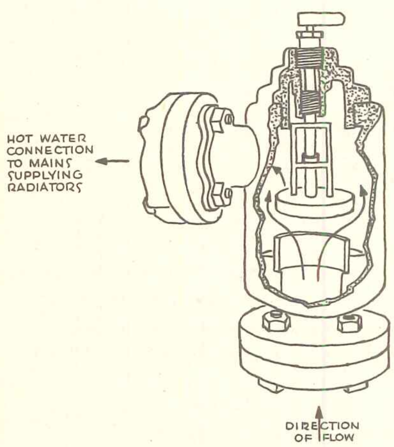


PRESSURE RELIEF VALVE

Spring-loaded diaphragm raises when system pressure exceeds 30 lb. per sq. in., permitting water flow through center tube

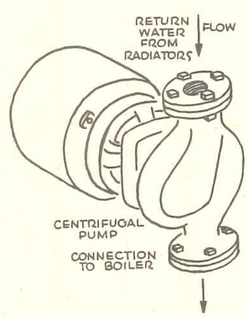
Drip. Valve seldom opens under proper operation, however, drip can empty into dry well or sink, *not* sewer

In systems where compression tank replaces high-gravity tank, pressure-relief valve is needed because system is otherwise closed. If air cushion in compression tank is too small (through improper operation), this valve operates to relieve system and prevent bursting of parts



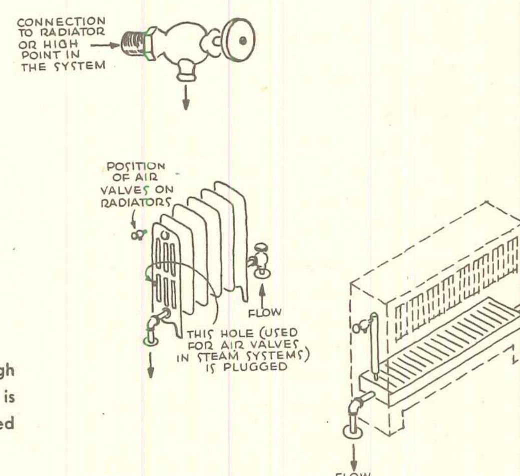
FLOW CONTROL VALVE

When circulating pump starts, water flow raises the valve seat. When the pump is not operating, it closes against circulation. This is important in summer when hot water must be retained in boiler (for domestic hot water) but must not flow through radiators



CIRCULATING PUMP

Electric motor turns on, forcing water through system, when heat is called for and if water is hot enough (160°). Select pump as directed in TSS page on "Design"



AIR VENT

When opened, pressure forces out air in the high place. When water starts to flow this valve must be closed. Automatic vents are available at slightly higher cost. Note (lower drawing): air vent must be extended high above cast iron or copper convectors to keep air out of the water passages

copper pipe is usually left exposed because it loses heat by radiation at a rate very much slower than steel.

Maintenance

The elimination of air is one of the most important things in the good operation of a hot water job. If the elimination is manually accomplished at the radiators it should be done several times during the heating season. The water level in the compression tank should be adjusted at the same time if this function is not automatic. It is important to provide proper lubrication for the pump. All equipment such as flow control valves, pressure relief valves etc. should be checked for proper adjustment.

The author and editors wish to acknowledge with thanks the assistance of several manufacturers of heating equipment, and of the Institute of Boiler and Radiator Manufacturers. For heating problems beyond the scope of these Time-Saver Standards, the reader is referred to the Institute of Boiler and Radiator Manufacturers, 60 E. 42 St., New York 17, N. Y.

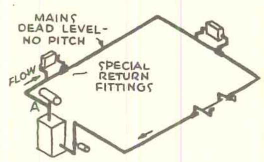
HEATING SYSTEMS FOR HOUSES

Forced Hot Water Systems: 2—Design of One-Pipe Systems

By William J. McGuinness

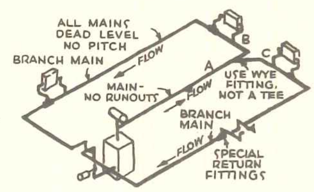
ONE-PIPE SYSTEMS

Radiators receive water from main and discharge back into same main



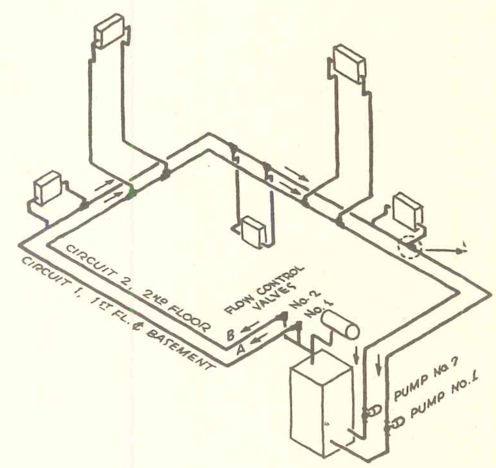
ONE-CIRCUIT ONE-PIPE SYSTEM

Approx. 7 radiators or 40000 Btu maximum



MULTI-CIRCUIT ONE-PIPE SYSTEM

Main *A* is sized to serve entire system; mains *B* and *C* are sized to serve respective circuits; same size held through to boiler. This system, with additional circuits, can serve the largest residence



ZONED ONE-PIPE FORCED HOT WATER SYSTEM

Zoning

An advantage of forced-circulation hot water heating is adaptability to zoning. When Zone 1 calls for heat, pump No. 1 starts; flow control valve No. 1 opens, permitting flow in circuit 1. Flow control valve No. 2 remains shut preventing circulation in circuit 2. If instead, Zone 2 called for heat, pump and valve No. 2 would operate with flow in circuit 2 and not in circuit 1. Simultaneous action is possible. Separate thermostats operate pumps 1 & 2. Joint use is made of one boiler whose water is kept hot by water temperature controls

Basement and Second Floor Heating

Aside from zoning, sketch also illustrates several uses of special return tees

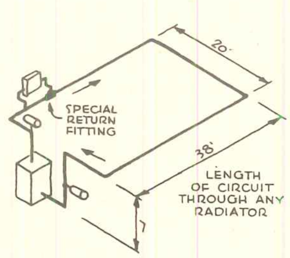
1. *For 1st floor radiators,* use of one special return fitting is common & riser size is found in Table 3, Section E. Two fittings are possible, in which case riser size is found in Table 3, Section A, and is smaller for same capacity

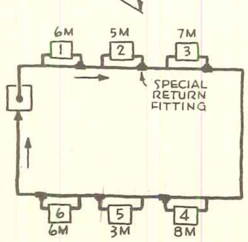
2. *For 2nd & 3rd floor radiators,* use of two special return fittings is common & riser is found in Table 3, Sections B & C. If one fitting is used, larger riser is chosen from Table 3, Sections F & G

3. *For downfeed risers to basement,* use of two special return fittings is necessary; size of riser is shown in Table 3, Section D

1. Average Water Temperature and Temperature Drop

In the following typical example, an average water temperature of 197 F will be assumed and the temperature drop in the system will be taken as 20 F. Water will leave the boiler at 207 F and return at 187 F.





2. Water Flow Required to Make up Hourly Heat Loss in the System

The total heat loss is 35,000 Btu per hour. Dividing this by 9600 (see TSS on design of a two-pipe system) the answer is 3.63 gal. per minute.

3. Length and Equivalent Total Length of System

The length of the circuit through any radiator is:

Length	38
	38
Width	20
	20
Height	7
	7
Runouts (rad.)	8
	138 ft.

To arrive at the total equivalent length of system including the resistance of fittings, multiply by 1.5 (add 50 per cent). Total equivalent length is 207 ft.

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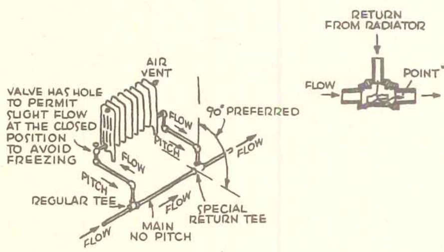
TECHNICAL NEWS AND RESEARCH

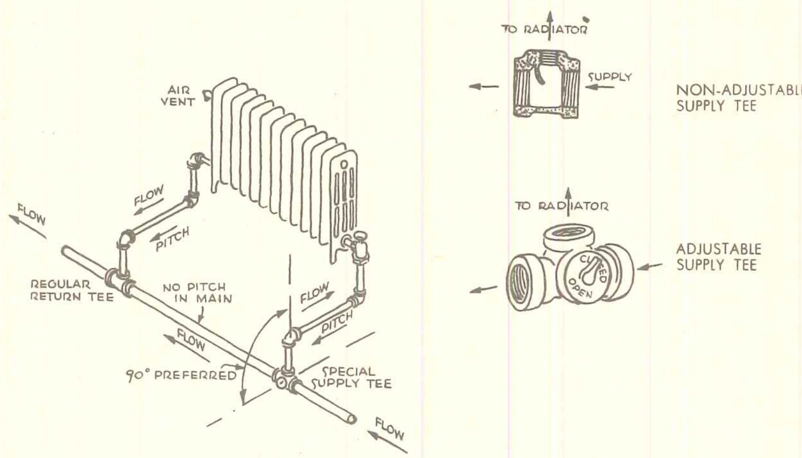
HEATING SYSTEMS FOR HOUSES



SPECIAL RETURN TEE

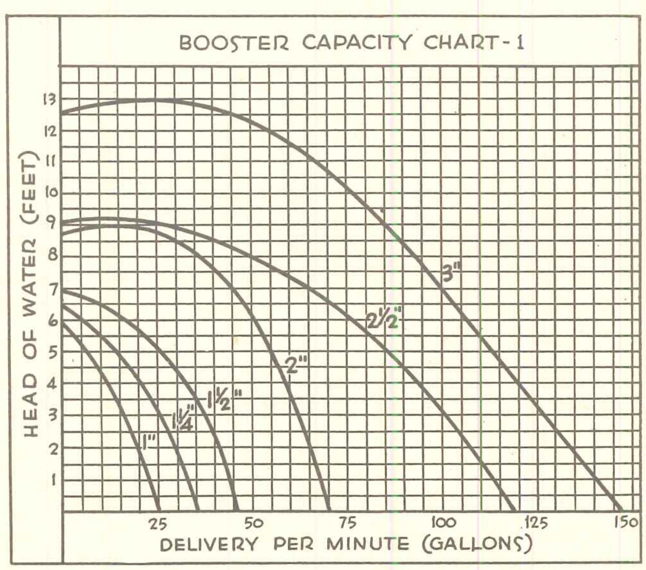
For one-pipe systems only; insert constricts flow, diverts some supply water into supply tee. Venturi action at *R* pulls water out of radiator. Note that colder water flows at bottom of main; hence radiator branches should be 90° to horizontal

Courtesy Bell & Gossett Co.



SPECIAL SUPPLY TEES can be used instead of special return tees

Courtesy H. A. Thrush & Co.



4. Select a Pump

Referring to Chart 1, it is found that the selection of a 1¼-in. pump will result in the need to maintain in the system frictional resistance the equivalent of 6.2 ft. of head.

5. Pressure Drop in the System

Section A of Table 1 indicates that for 6 ft. of head (the closest to our requirement) and a length of 200 ft. the friction loss will be 350 millinches per foot in the system.

6. Selecting Size of Main

In the 350-millinch column, Table 1, Section B, it will be found that a 1-in. main will carry 59,000 Btu per hour which is adequate. Our loss is 35,000 Btu. It is to be noted that 1 in. is a minimum for mains in one-pipe systems. In one-pipe systems the main size, selected on the basis of the total capacity, is carried at this size through the system and back to the boiler.

7. Sizing Runouts and Risers

Risers in one-pipe systems must be a little larger than for two-pipe systems. Table 2 lists the sizes needed for various capacities.

The largest radiator in the system carries 8000 Btu per hour and will

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TECHNICAL NEWS AND RESEARCH

HEATING SYSTEMS FOR HOUSES

Forced Hot Water Systems: 4—One-Pipe Design Tables Continued

By William J. McGuinness

require ½-in. supply and return. Because this is a minimum it will be used for all the radiators. In larger systems there would be a noticeable difference between the risers in one- and two-pipe systems.

8. Selection of Radiators

An average temperature of 197 F will result in emission of 200 Btu per square foot of cast iron radiation or cast iron convectors. Dividing the hourly heat loss in each room by 200, the number of square feet of radiation can be determined. Radiator No. 1 will have to provide 30 sq. ft. In the entire system there will be 175 sq. ft.

9. Selection of Boiler

For 175 ft. of connected radiation it is possible to select a hot water boiler, specifying the type of firing. Allowances for pipe loss, pickup and normal domestic hot water requirements are usually included by the manufacturer in his ratings.

TABLE 1 — PIPE SIZING TABLE FOR MAINS

1 PIPE FORCED CIRCULATION HOT WATER SYSTEMS WITH SPECIAL RETURN FITTINGS

SECTION A

BOOSTER HEAD PRESSURES	TOTAL EQUIVALENT LENGTH OF PIPE IN FEET								
2′	40	48	60	68	80	96	120	160	240
2½′	50	60	75	86	100	120	150	200	300
3′	60	72	90	103	120	144	180	240	360
3½′	70	84	105	120	140	168	210	280	420
4′	80	96	120	137	160	192	240	320	480
4½′	90	108	135	154	180	216	270	360	540
5′	100	120	150	171	200	240	300	400	600
5½′	110	132	165	188	220	264	330	440	660
6′	120	144	180	206	240	288	360	480	720
6½′	130	156	195	223	260	312	390	520	780
7′	140	168	210	240	280	336	420	560	840
7½′	150	180	225	257	300	360	450	600	900
8′	160	192	240	274	320	384	480	640	960
8½′	170	204	255	291	340	408	510	680	1020
9′	180	216	270	308	360	432	540	710	1080
9½′	190	228	285	325	380	456	570	760	1140
10′	200	240	300	342	400	480	600	800	1200
10½′	210	252	315	360	420	504	630	840	1260
11′	220	264	330	377	440	528	660	880	1320
11½′	230	276	345	394	460	552	690	920	1380
12′	240	288	360	411	480	576	720	960	1440

SECTION B (Based on 20° Temperature Drop)

PIPE SIZE	MAIN CAPACITIES (In Thousands of BTU)								
	MILINCHES								
	600	500	400	350	300	250	200	150	100
1″	80	71	64	59	53	48	42	37	31
1¼″	170	160	140	130	118	102	90	78	63
1½″	260	240	210	185	175	156	140	121	94
2″	500	450	410	360	322	294	261	227	182
2½″	810	750	670	610	551	523	460	385	310
3″	1600	1400	1300	1150	1000	900	800	680	550
*3½″	2300	2100	1850	1650	1500	1350	1190	1020	825
*4″	3200	2900	2600	2300	2100	1950	1700	1350	1140

* Trunk main capacities only. Fittings are not made larger than 3″.

NOTE — The figures shown in these tables apply to both steel pipe and Type L copper tubing, as capacity differences are not sufficient to cause design errors.

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HEATING SYSTEMS FOR HOUSES

Forced Hot Water Systems: 3—One-Pipe Design Tables

By William J. McGuinness

TABLE 2—PIPE SIZING TABLE FOR RISERS

1 PIPE FORCED CIRCULATION HOT WATER SYSTEMS WITH SPECIAL RETURN FITTINGS

(Based on 20° Temperature Drop)

CAPACITY OF RISERS WITH TWO FITTINGS (In Thousands of BTU)

	PIPE SIZE	MILINCHES 600	500	400	350	300	250	200	150	100
		Upfeed Risers—First Floor (See Note 1)								
A	½″	23	22	19	18	17	16	14	12	10
A	¾″	43	41	37	33	30	28	26	22	20
A	1″	80	73	64	60	55	50	45	39	32
A	1¼″	180	140	120	110	100	93	80	74	62
		Upfeed Risers—Second Floor (See Note 2)								
B	½″	16	15	14	13	11	10	10	8	7
B	¾″	31	28	25	24	22	21	18	15	13
B	1″	58	52	45	43	37	33	32	28	25
B	1¼″	122	108	92	90	79	72	68	59	50
		Upfeed Risers—Third Floor (See Note 2)								
C	½″	14	12	11	10	9	8	8	7	6
C	¾″	26	24	23	21	19	18	16	14	12
C	1″	47	43	38	36	34	31	29	28	25
C	1¼″	99	91	81	77	70	66	59	56	46
		Downfeed Risers (See Note 3)								
D	½″	16	15	14	12	11	9	8	FOR LESS THAN 200 MILINCH RESISTANCE. BASE CALCULATIONS ON PUMP WITH HIGHER HEAD PRESSURE.	
D	¾″	33	30	26	24	20	18	14		
D	1″	58	52	43	41	34	29	25		
D	1¼″	117	106	86	83	69	59	49		

NOTE— The figures shown in these tables apply to both steel pipe and Type L copper tubing, as capacity differences are not sufficient to cause design errors.

CAPACITY OF RISERS WITH ONE FITTING (In Thousands of BTU)

	PIPE SIZE	MILINCHES 600	500	400	350	300	250	200	150	100
		Upfeed Risers—First Floor								
E	½″	16.5	15	13	12	11	10.6	10	9.2	8
E	¾″	29	27	25	24	21	19	18	17	15
E	1″	50	48	44	41	37	35	33	31	28
E	1¼″	95	88	78	76	69	62	55.6	48	40
		Upfeed Risers—Second Floor								
F	½″	11	10	9	8	7	7	6	6	4
F	¾″	20	19	17	16	14	13	12	11	11
F	1″	34	32	29	28	25	24	22	21	18
F	1¼″	70	68	59	57	51	49	45	43	36
		Upfeed Risers—Third Floor								
G	½″	9	8	7	7	6	6	6	5	4
G	¾″	18	16	14	14	12	12	11	10	9
G	1″	31	29	28	27	24	22	21	20	18
G	1¼″	63	60	56	52	48	45	43	41	36

READ THESE NOTES CAREFULLY BEFORE SIZING RISERS

NOTE 1. 1st FLOOR UPFEED RISERS—Capacities shown in the table are based upon horizontal branches not more than 3 feet long, with stubs 18″ long, or a total of 9 feet of pipe. 6 elbows, one valve and one union ell, and one C.I. radiator are added for the equivalent length.

For each additional 10 equivalent feet of pipe, move 2 milinch columns to the right.

NOTE 2. 2nd and 3rd FLOOR UPFEED RISERS—Capacities shown are based upon horizontal branches not more than 3 feet long, with risers 10 feet high and 20 feet high respectively. 8 elbows, one valve and one union ell, and C.I. radiator are added for the equivalent length.

For each additional 10 equivalent feet of pipe, move 2 milinch columns to the right.

NOTE 3. DOWNFEED RISERS—Capacities shown are based on a drop of seven feet to the *center of the radiator*, with not over 3 feet total in horizontal branches, 6 elbows, one valve and one union ell and one C.I. radiator. For every additional 2 feet of vertical drop, move one column to the right in milinch table.

On downfeed jobs the main MUST be pitched up and a vent installed on end of main.