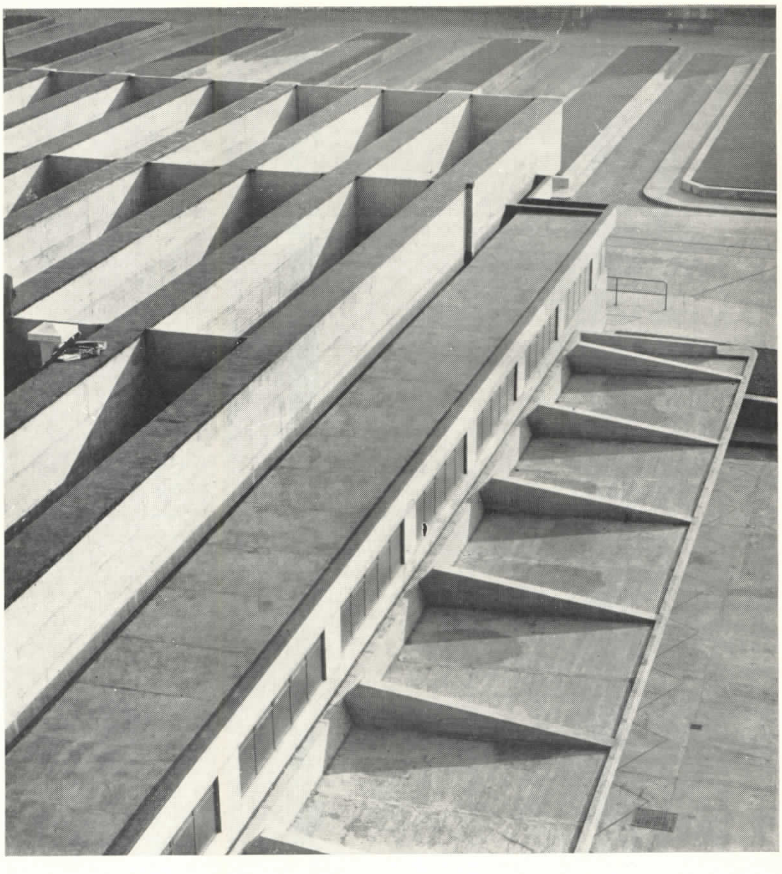
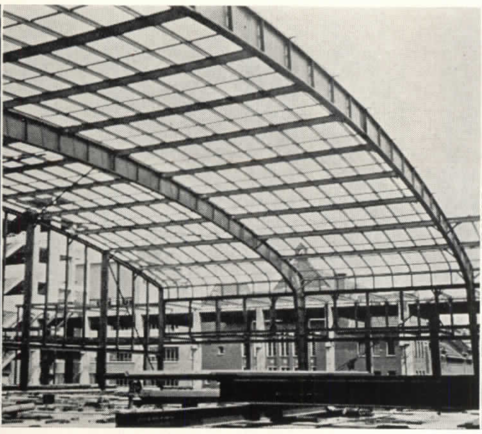
BUILDING NEWS



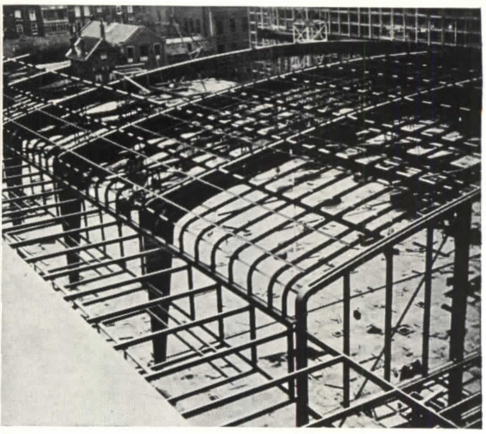
English Chemicals Factory...See pp. 36-39

ARCHITECTURAL
RECORD

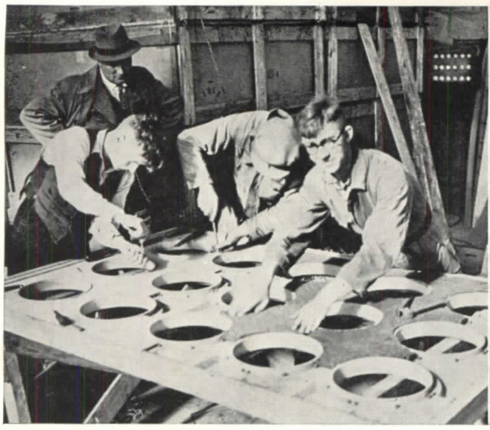
Erection of welded arched girders . . .



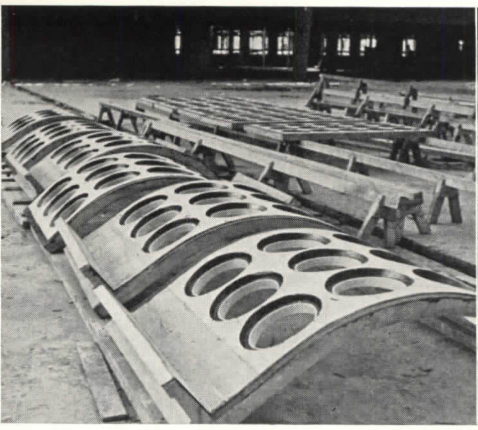
connected by a system of purlins . . .



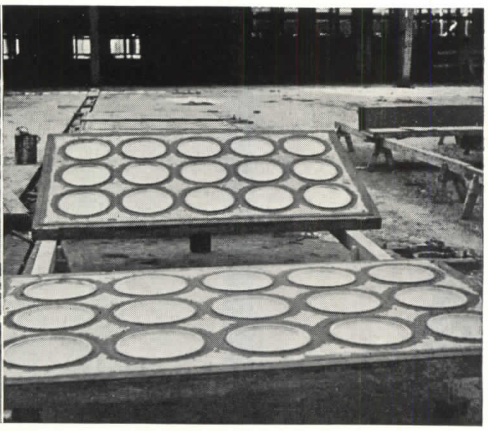
that will support the glass-crete units.



Fiberboard is placed on ceiling surface . . .



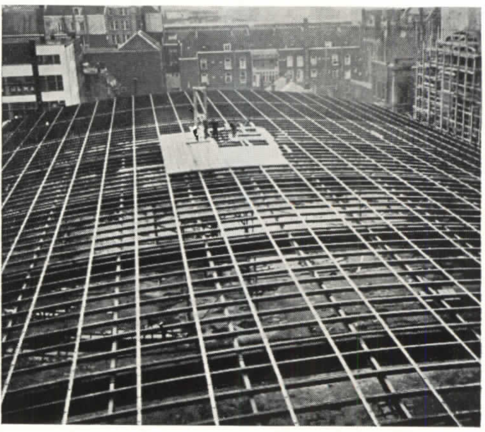
with vibrated concrete on the outside . . .



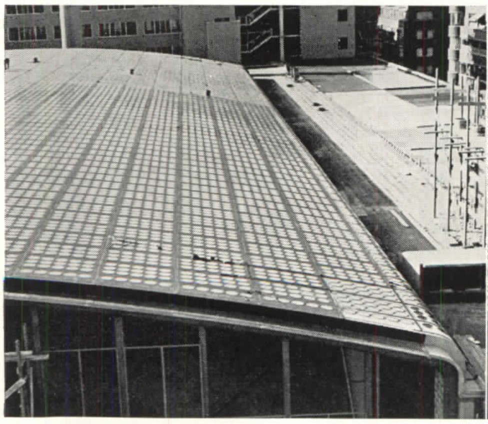
and asbestos-cement frames around lenses.

Glass-crete units are raised to roof . . .

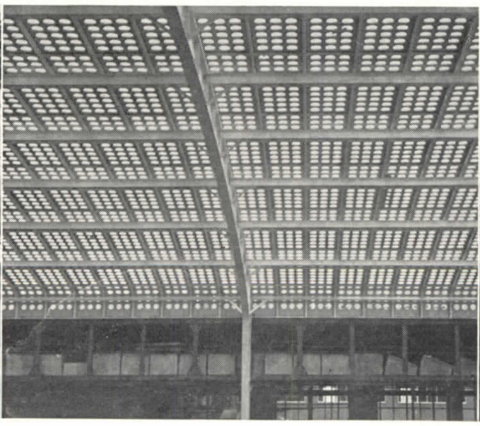
projecting ribs fit into U-shaped purlins . . .



which run between welded arched girders.



View of glass-crete roof completed . . .

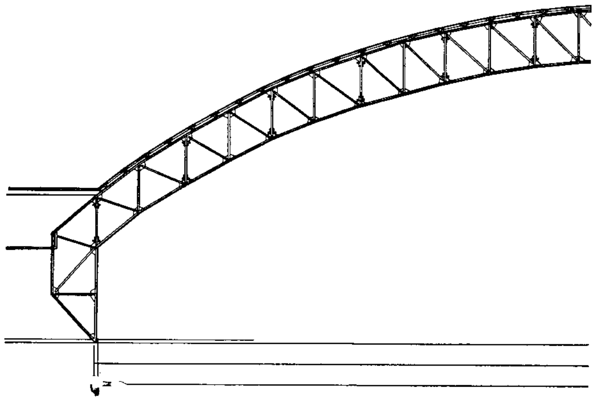


View of ceiling from the inside . . .

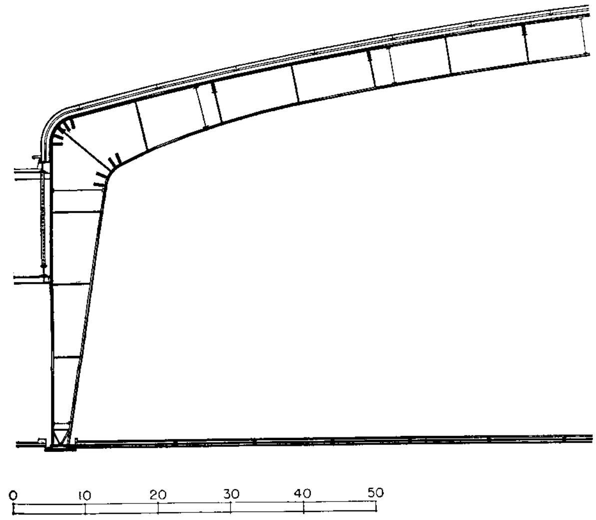
View showing transparent-glass end walls.

LARGEST "GLASS-CRETE" ROOF PERMITS HIGH DAYLIGHT ILLUMINATION

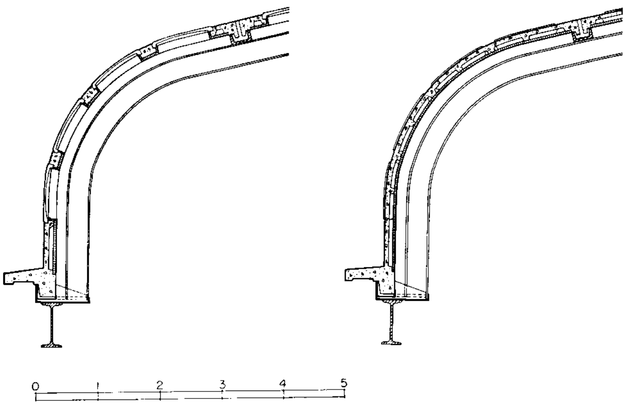
J. F. STAAL, Architect, and JAROSLAV POLIVKA, Engineer



Riveted steel truss of the structure as originally designed. It was to have been approximately 8 ft. deep.



Welded arched girder as built, about 41½ in. deep.



Section details of the welded construction.

THE NOW COMPLETED building of the Corn Exchange of Rotterdam, Holland (See AR, 2/39, p. 70), includes an assembly hall whose glass-concrete roof is the world's largest—50,000 sq. ft. The assembly area, or trading floor, accommodates 1,000 to 1,500 traders, with adequate daylight for examination of goods. The new structure, erected on the main boulevard of Rotterdam, replaces a famous old sandstone building, designed for the corn trade in 1722 by the painter-architect, Adrian van der Werff.

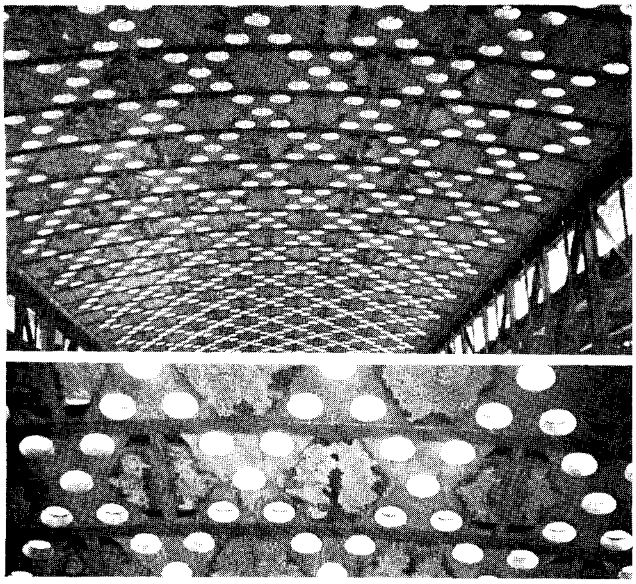
Before the final scheme was agreed upon, the design of the structure underwent several changes. The riveted steel structure originally projected was finally replaced by a welded structure. The riveted frame was to have consisted of six two-hinged, arched trusses, each about 8 ft. deep; greatest height above the floor was to be 42 ft. For this structure, glass-concrete slabs (each 3 ft. 5 in. by 3 ft. 5 in.) were to be used; these were supported by a system of U-shaped purlins, forming small troughs for the glass-crete slabs. Tests were conducted at the Building Materials Laboratory of the Technical University in Prague, under the supervision of Dr. Polivka, engineer for the structure. The slabs, 1 in. thick, resisted a maximum load of 24,000 lbs. per sq. ft., against a design load in the building of only 2,200 lbs. per sq. ft.

In the structure finally erected, the design of the glass-crete slabs followed the original scheme. However, the use of welded arched girders, instead of riveted trusses, reduced the weight and depth of the steel work from 8 ft. to approximately 41½ in.

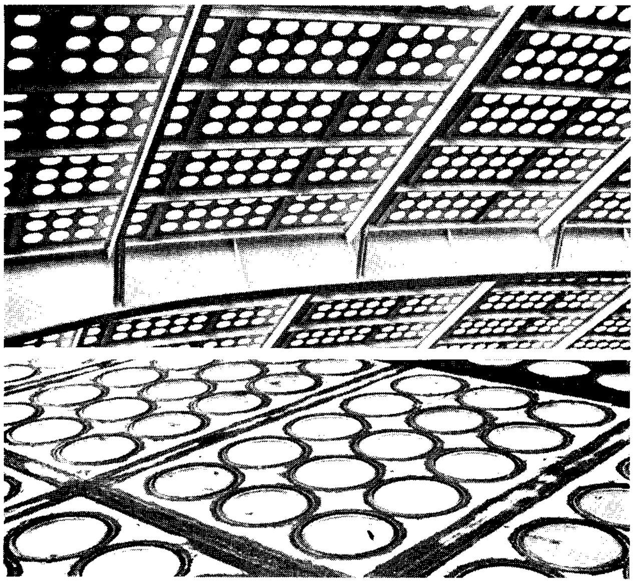
It was essential, in this trading room, to exclude noise from the outside and reduce resonance within. To achieve this, a layer of glass silk was placed between the pressed-glass lens on the outside and the double sheet glass within; the lenses are framed with asbestos-cement, and perforated metal-sheathed fiberboard is placed on the ceiling surfaces between them. This combination of materials has increased sound absorption to 0.36 as compared with 0.06 for rough-finished gypsum plaster, and has decreased reverberation time, originally calculated at 17 seconds, to 2 seconds.

Tests of the thermal insulation gave a reading of 0.55 Btu compared with 1.10 Btu for clear glass ¼ in. thick. Radiant-heat transmission was only 0.28 Btu compared with 0.97 Btu for ordinary glass. For waterproofing, an elastic, heat-resisting mastic of special composition has been used along the lines at which the ribs of the glass-crete slabs fit into the system of purlins.

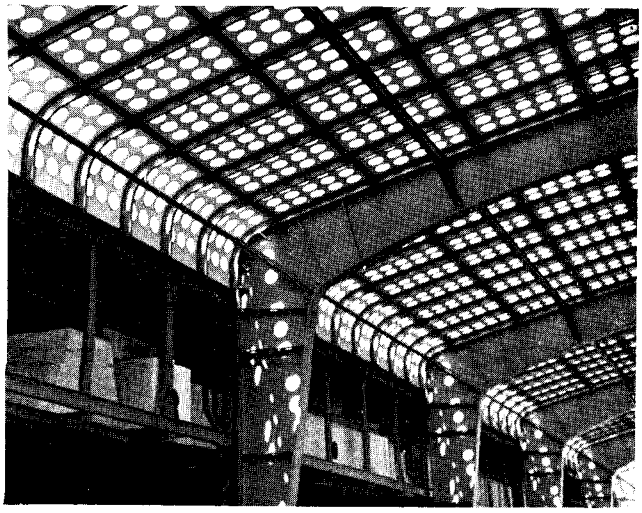
LARGEST GLASS-CONCRETE ROOF



This pattern was chosen for another building of the Corn Exchange. Daytime illumination can be varied by reducing or increasing glass-lens area.



The light which filters through the "glass-crete" is relatively uniform. Compare it, for example, with . . .



the spotty light which comes through unglazed units.

THE LIGHT TRANSMISSION of the glass-crete units and of the completed structure has been investigated. Requirements for visual inspection of agricultural products have made necessary a relatively high daylight illumination at all points in the assembly hall. The interior is painted white for additional brightness. The readings below were obtained in the center of the building at a point 3 ft. above the floor. The daylight factor, 7.35, is high in comparison with that of other buildings requiring high daylight illumination: the daylight factor of the National Gallery in London, for example, is 6.25.

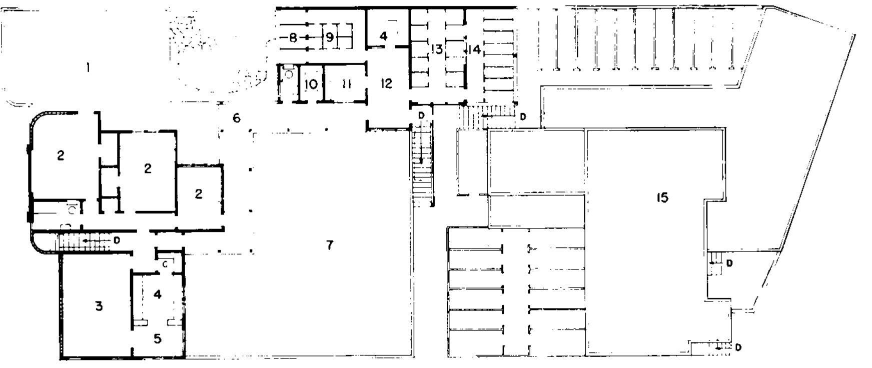
Illumination in Footcandles

Point 1: Daylight factor, 6.68 + 0.67 = 7.35

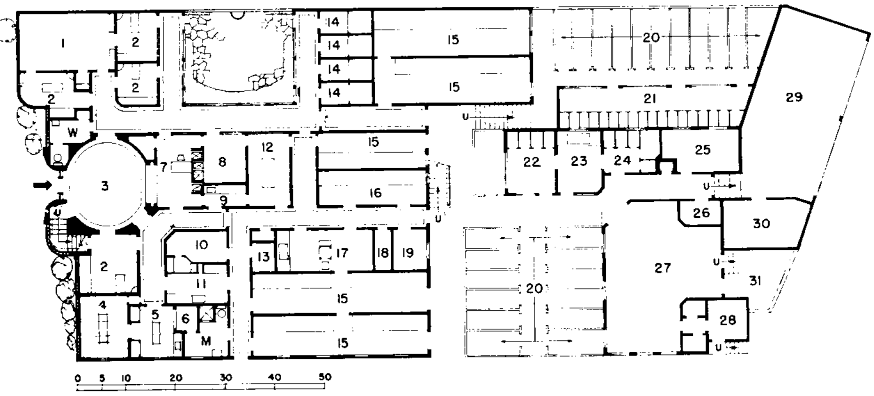
		9 a.m.	12 m. (Cloudy)	3 p.m.	12 m. (Sunny)
January . . .	1	29	59	29	96
	15	44	81	44	132
February . .	1	52	103	52	155
	15	74	125	76	206
March	1	98	144	103	230
	15	118	169	125	302
April	1	125	192	147	360
	15	169	222	184	370
May	1	191	250	199	380
	15	220	265	206	410
June	1	276	282	206	440
	15	198	292	320	420
July	1	206	280	192	400
	15	198	265	184	360
August	1	184	244	169	330
	15	163	222	147	320
September .	1	140	192	122	295
	15	118	165	106	285
October . .	1	106	125	74	280
	15	74	96	52	230
November .	1	59	74	30	184
	15	37	59	22	140
December .	1	29	55	22	88
	15	28	54	22	80

DOG AND CAT HOSPITAL DESIGNED FOR CONTROL OF SOUND AND AIR

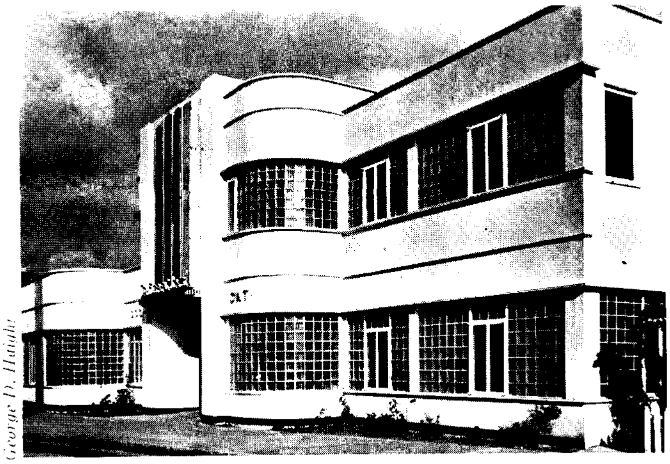
WALTER WURDEMAN and WELTON BECKET, Architects



Ground floor: 1. Private office 2. Consultation 3. Lobby 4. Surgery 5. Preparation room 6. Sterilizer 7. Office 8. Bookkeeper 9. Pharmacy 10. X-ray room 11. Laboratory 12. Doctors' chartroom 13. Harness 14. Private ward 15. Ward 16. Maternity ward 17. Treatment rooms 18. Janitor 19. Linen 20. Open runs 21. Boarding kennels 22. Clipping 23. Bathing 24. Drying 25. Skin ward 26. Morgue 27. Contagious ward 28. Bath 29. Garage 30. Storage 31. Yard



Second floor: 1. Roof deck 2. Interne 3. Doctors' quarters 4. Kitchen 5. Dinette 6. Covered passage 7. Roof deck 8. Open porch 9. Sick ward 10. Linen 11. Treatment 12. Workroom 13. Cat ward 14. Open porch 15. Roof



George D. Haight

THE DESIGN of this dog and cat hospital in Beverly Hills, Calif., involved problems in the control of sound and atmosphere, and the disposal of waste, to find a solution for which, the architects spent six months in research.

Tests were made, for example, in the obstetric ward, to determine the physiological effects of noise: milk was taken from a bitch in a sound-treated ward and also from one in an untreated ward. In every determination, the milk from the animal in the untreated room gave evidence of sourness, while specimens from the sound-treated rooms were normal. It was found that continued noise aroused fear reactions in the animals, which put them in a state of muscular tension; but the elimination of sound reverberation has resulted in a lessening of excitement and barking among them.

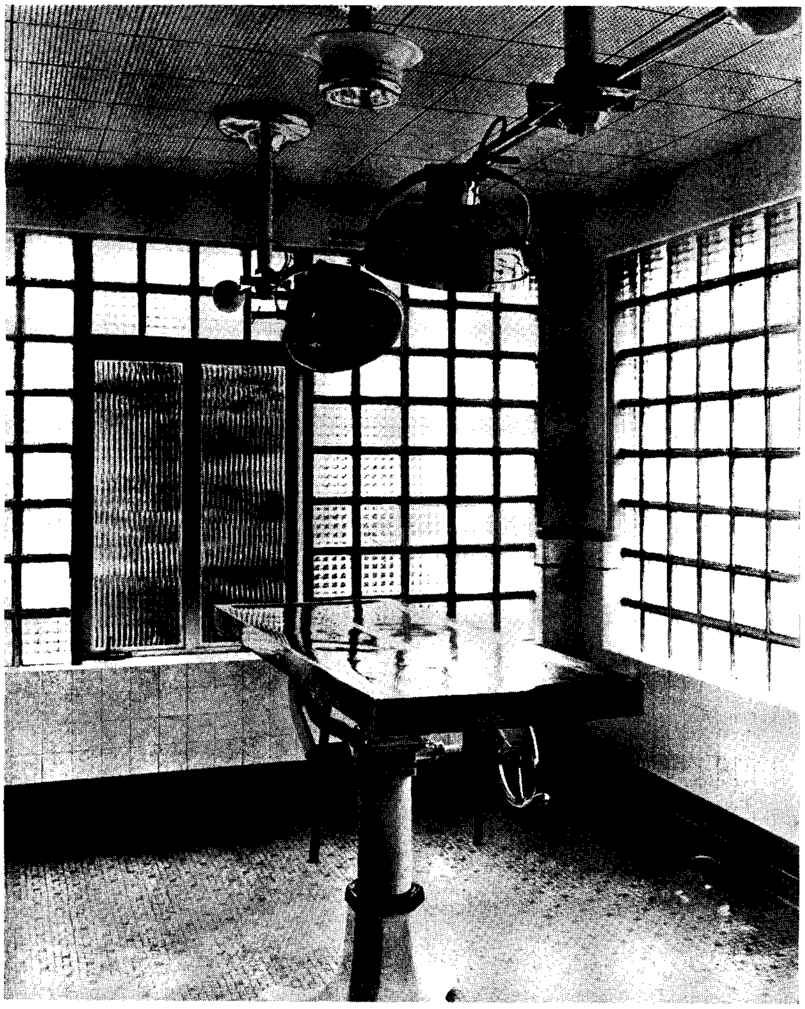
The building is completely sealed, so that no noise escapes to the outside. It became necessary to install an air-conditioning system providing each room with a complete air change every four to eight minutes. This makes it possible to maintain constant temperature, thus helping to eliminate one of the great dangers of distemper—pneumonia.

There is a loudspeaker system with a "talk-back" in every room: this, instead of an intercommunicating 'phone system, was decided upon, because it is inconvenient for doctors to use telephones while working on the dogs; when called, doctors can respond from any spot in a room, without stopping work. A general broadcast, too, is made possible; anyone can be located quickly, with no need for a searching party. Another potential advantage of this system is the ease, which it makes possible, of quieting barking dogs: the attendant at the controls, or the owner at a telephone outside the hospital, can talk to the dog directly; or, if it is desired, the doctor in charge can pick up a conversation in any room in the hospital.

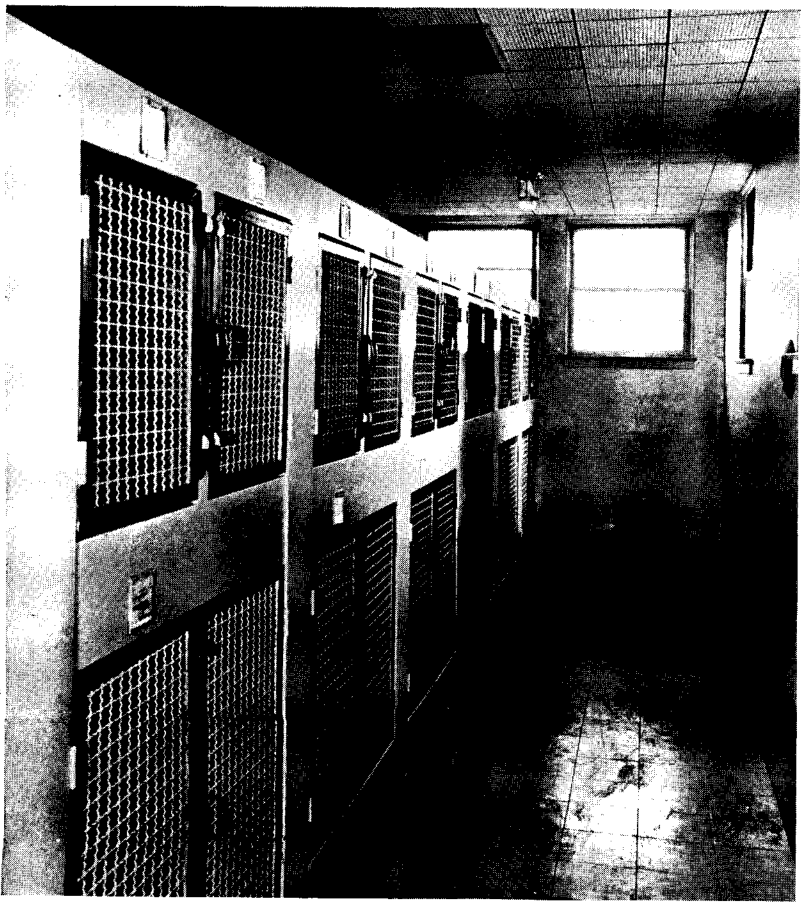
Cages have separate drains, and floors are proofed against uraemic acid. Each exercise pen has its drain and hose bibb, so that separate hosing of a run, when necessary, is relatively easy. The preparation room and surgery are tiled to the ceiling and are well-drained.

The hospital has 58 rooms, with 300 cages or beds. Construction cost, including that of all equipment, was about $200 per bed or cage.

DOG AND CAT HOSPITAL

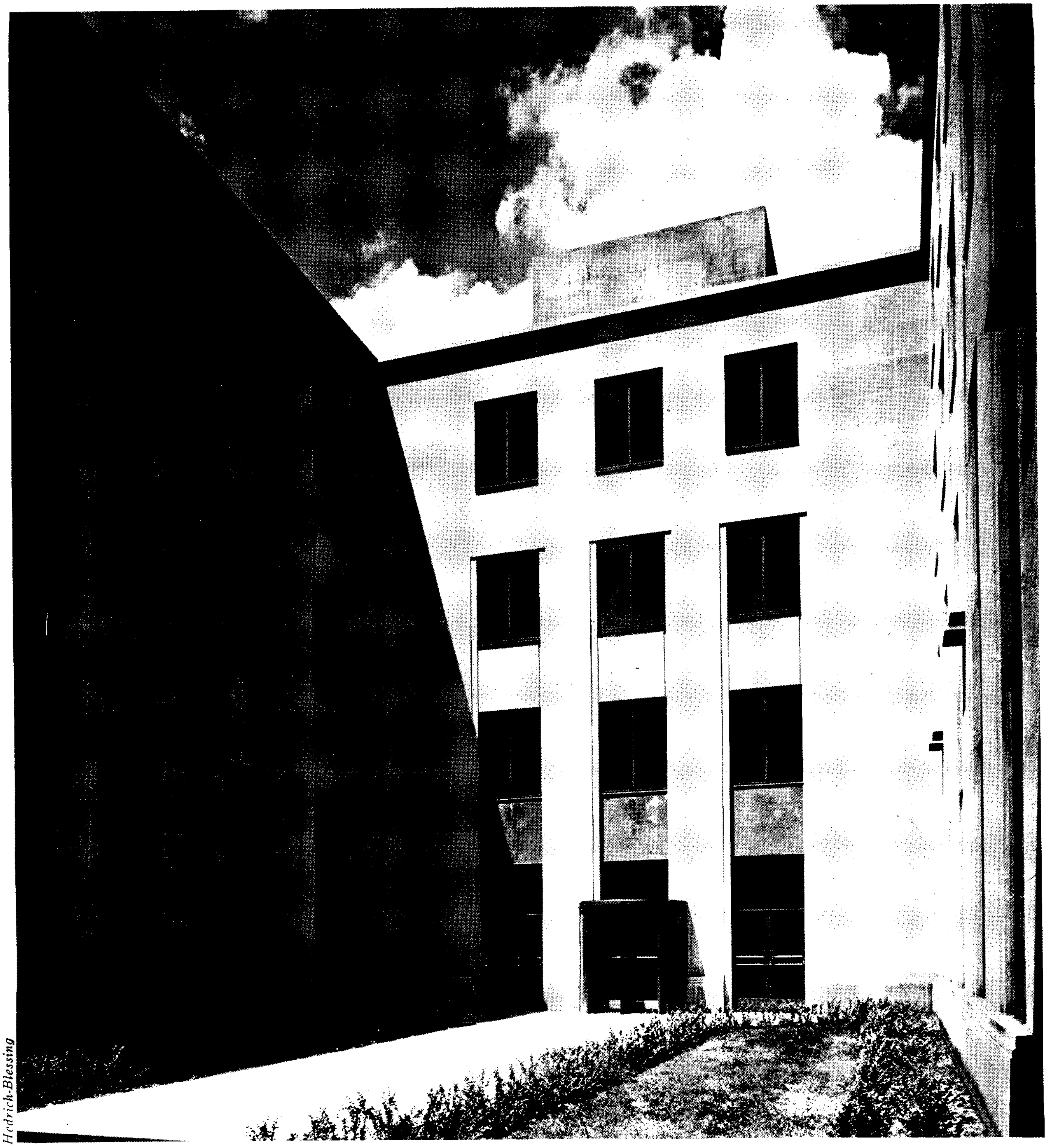


Operating room: exterior walls are of glass brick to eliminate glare; there is an adjoining room for spectators.



Photos by George D. Haight

Kennels for sick animals: A cane-fiber material (Acousti-Celotex) applied to the ceiling deadens the din of barking.

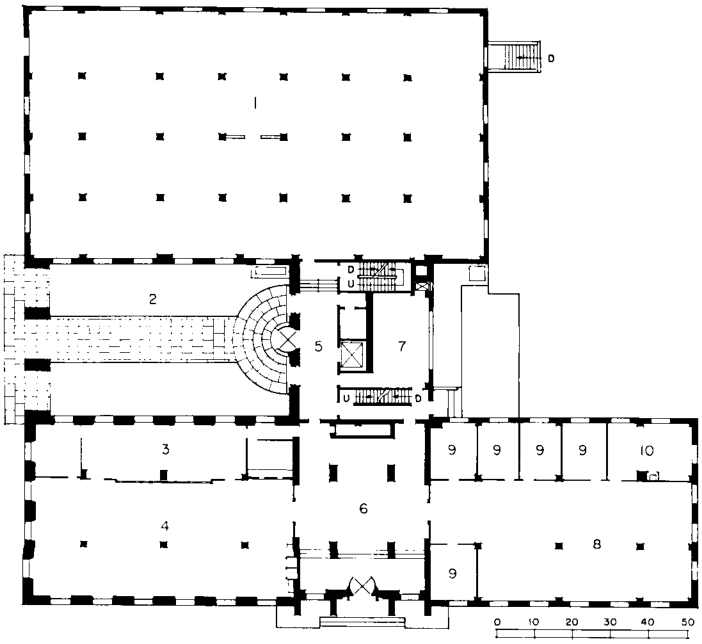

Hedrich-Blessing

BUILDING COMBINES THREE-STORY AND FOUR-STORY SECTIONS

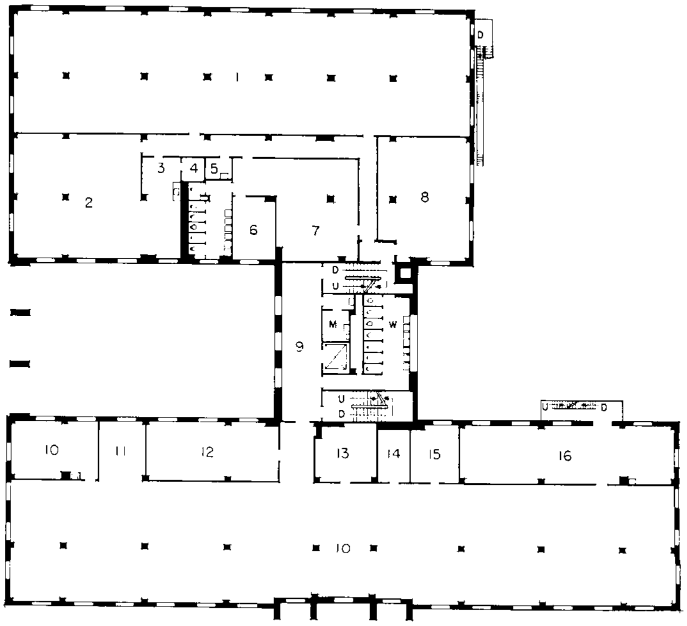
HOLABIRD & ROOT, Architects

THIS NEW BUILDING of the Illinois Bell Telephone Company at Springfield, Ill., is three stories on one side and four stories on the other, a design motivated by the need to house dial-switching equipment and administrative offices in a single building. The switching equipment requires higher ceilings than are necessary for offices; the height of the three-story equipment section is approximately equivalent to that of the four-story office section. A solution was found in the use of an H-shaped plan, office and equipment section each occupying one leg of the H, with stairs and elevators in the cross bar of the H providing the means of circulation.

Photos by Hedrich-Blessing

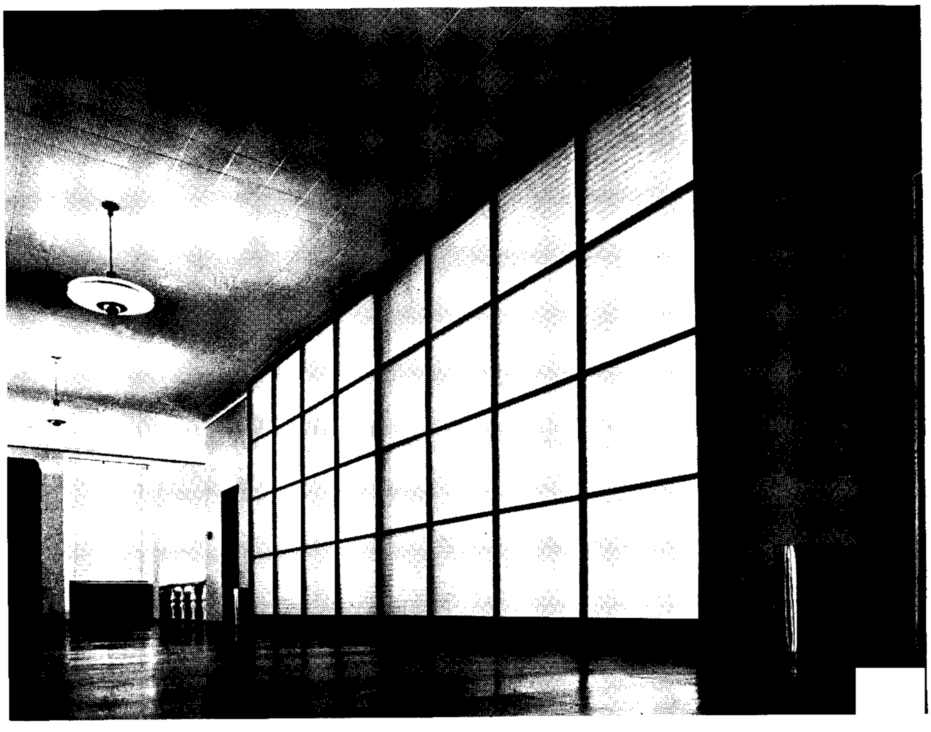


First floor: **1.** Dial equipment rm. **2.** Entrance court **3.** Work space **4.** Business office **5.** Elevator **6.** Entrance lobby **7.** Wire chief **8.** Division commercial **9.** Office **10.** Division commercial manager.

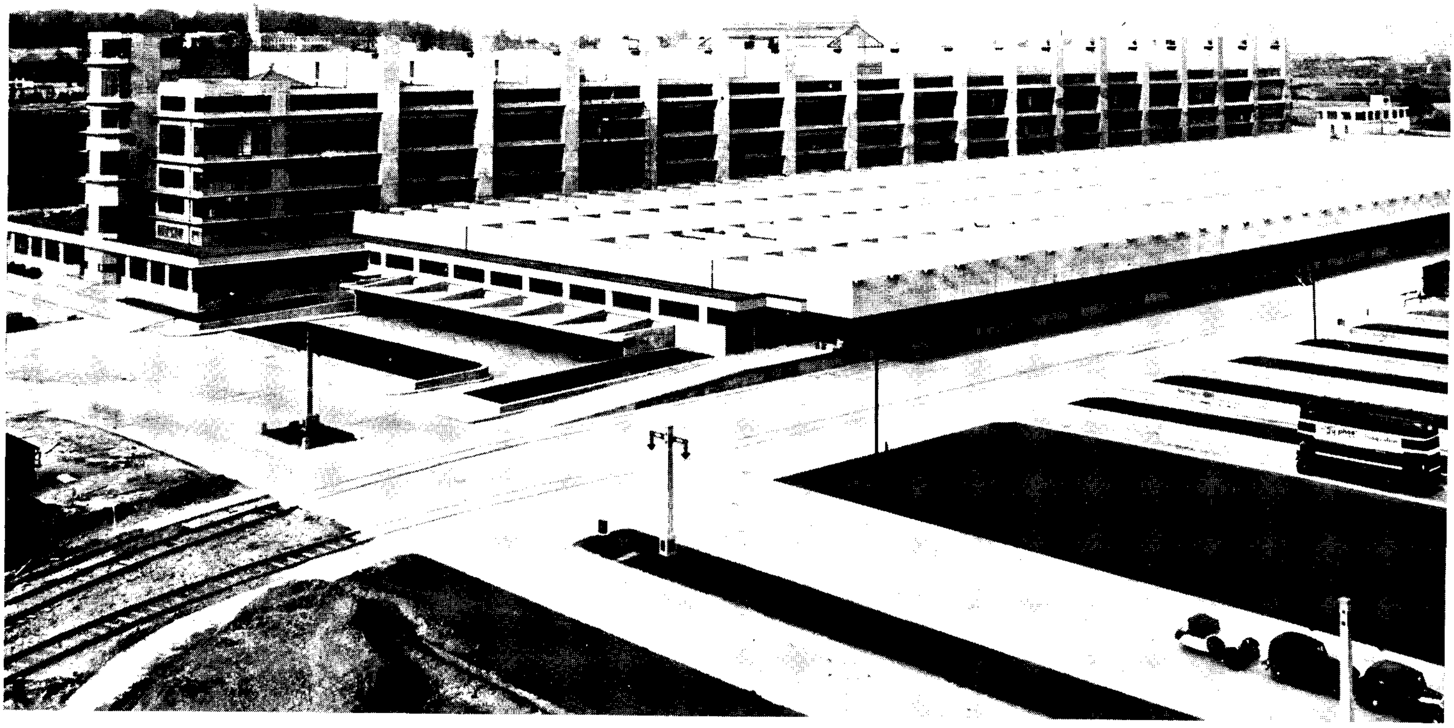


Second floor of dial bldg. and third floor of office bldg.: **1.** Operating **2.** Rest rm. **3.** Kitchen **4.** Store rm. **5.** Closet **6.** Quiet rm. **7.** Lockers **8.** Test & Assignment **9.** Elevators **10.** Division auditor **11.** Payroll **12.** Mailing **13.** Storage **14, 15.** Lockers **16.** Addressograph

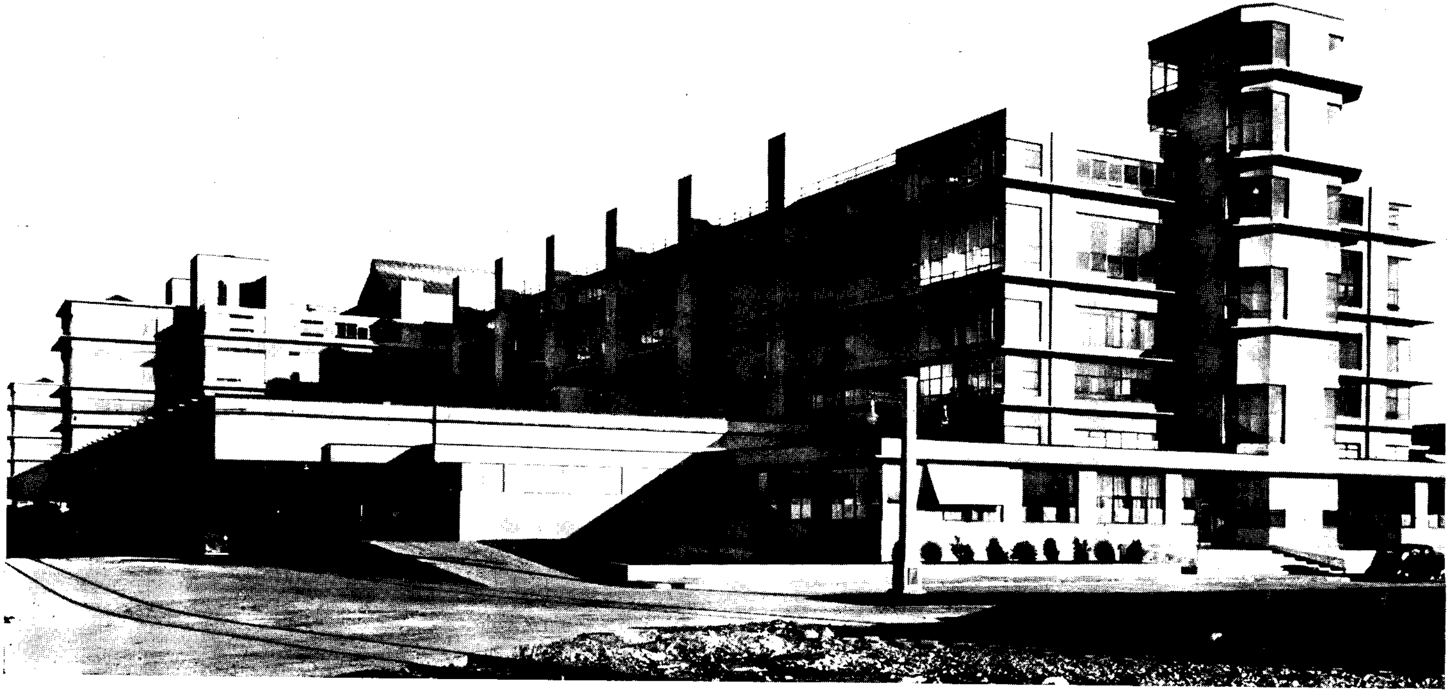
View showing corridor between equipment and office sections, and the stairs and elevators which provide the means of circulation among the levels of the two wings.



Business office of the first floor. Translucent-glass panels provide maximum light, as well as flexibility for possible changes in plan.



Plant combines multi- and single-story structures, a design motivated by the gravity- and horizontal-flow of production.



Receiving dock. Processed chemicals meet packing operation on ground floor and move to dispatch dock on other side.

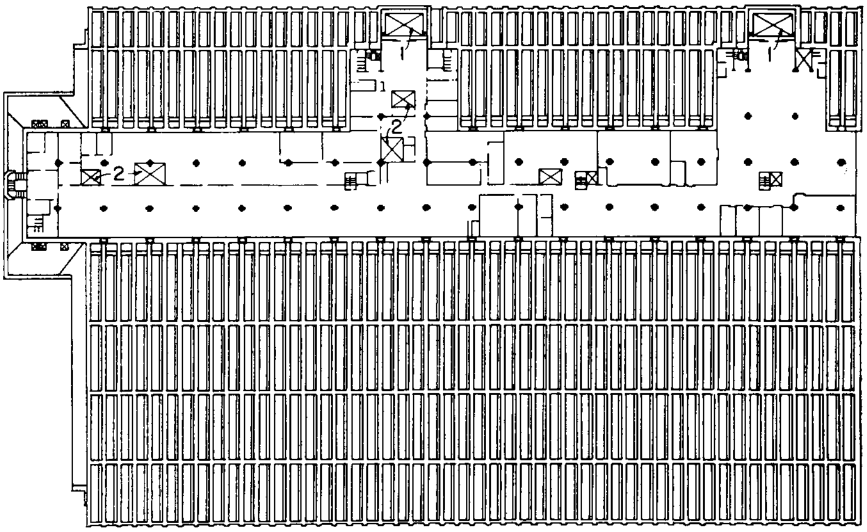
FACTORY DESIGNED FOR BOTH GRAVITY- AND HORIZONTAL-FLOW

Sir E. OWEN WILLIAMS, Architect

THIS PLANT for the manufacture of chemicals in Beeston, England, combines multi-story and single-story structures; the design is motivated by the gravity-flow of the manufacturing process plus the need for the finished products to meet the packing operations on the ground floor, a process which moves horizontally to the receiving and dispatching platforms.

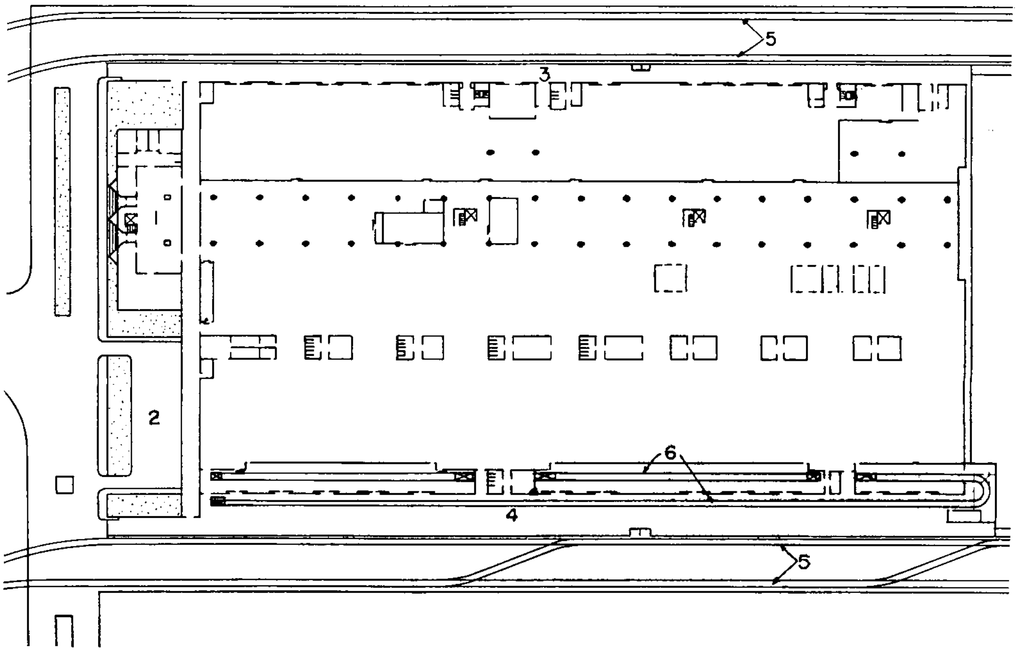
The structure is reinforced concrete. Floor slabs of the multi-story building are designed on a modified mushroom principle, eliminating beams below the soffits and obtaining rigidity from brackets at the heads of columns. The heads of the packing tables on the ground floor are immediately below the side wall of the multi-story building. To avoid the loss of usable space at those points, columns there have been dispensed with; the end of the single-story roof and the multi-story floors is suspended from the roof beams of this part of the building in such a manner that the load is finally transferred to the multi-story columns.

Because particles of the chemicals manufactured are emitted to the atmosphere of the plant, it was essential that the movement of air within the factory be controlled. Warmed, filtered air is introduced at roof level into the single-story section, at the discharge ends of the packing tables, and distributed throughout the building. Open horizontal ducts draw the dust-laden air to vertical flues on the sides of the multi-story building. Fan units at the top of each flue extract and discharge the polluted air to the outside.



Upper floor

1. Hoist well
2. Drying stoves

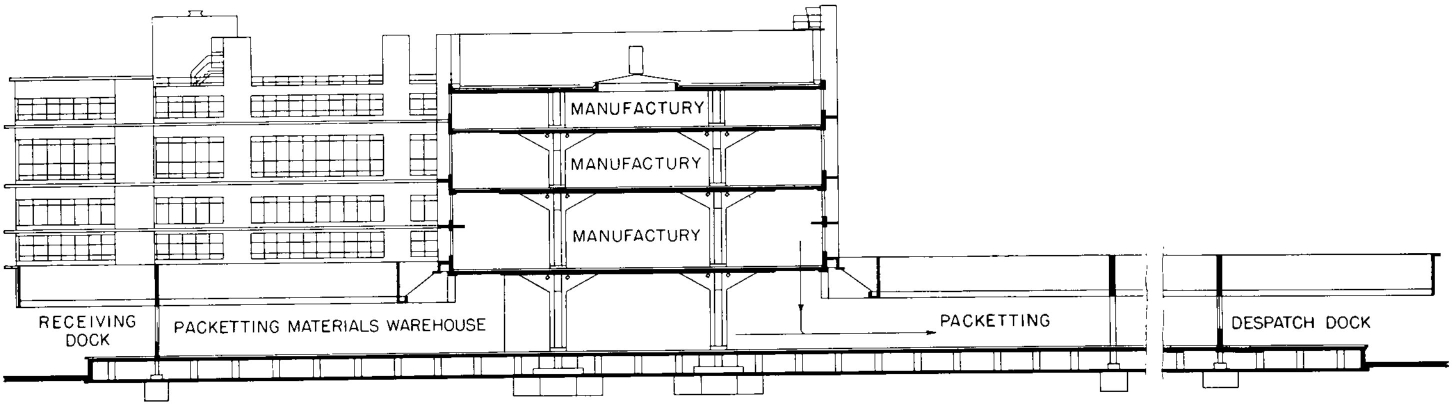


Ground floor

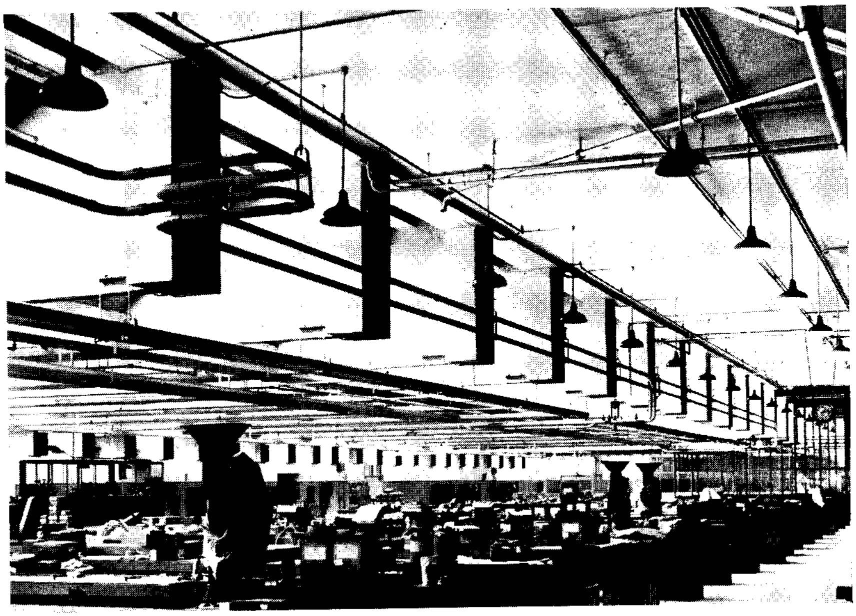
1. Entrance dock
2. Car parking
3. Receiving dock
4. Dispatch dock
5. Rail tracks

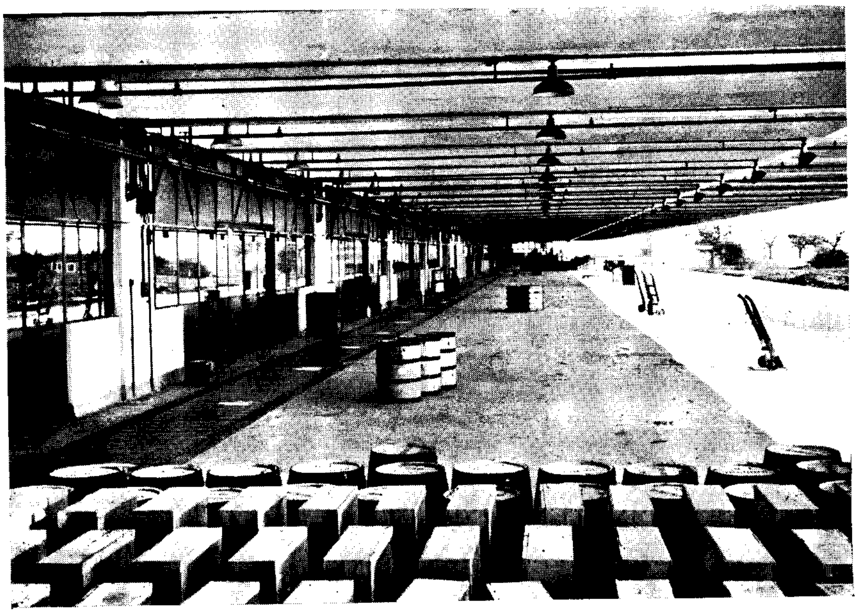
Photos by P. H. Johnson Advt. Service

Daylighting of the single-story structure is accomplished by a series of monitors. Filtered air is introduced at roof level.



Section





Right, above: The packing operation moves along the tables to the dispatch dock at end. Right: View of receiving dock at other end.

The rear side of the house is more open and informal than the front; the terrace opens off living and dining rooms

Photos by Jessie Tarbox Beal

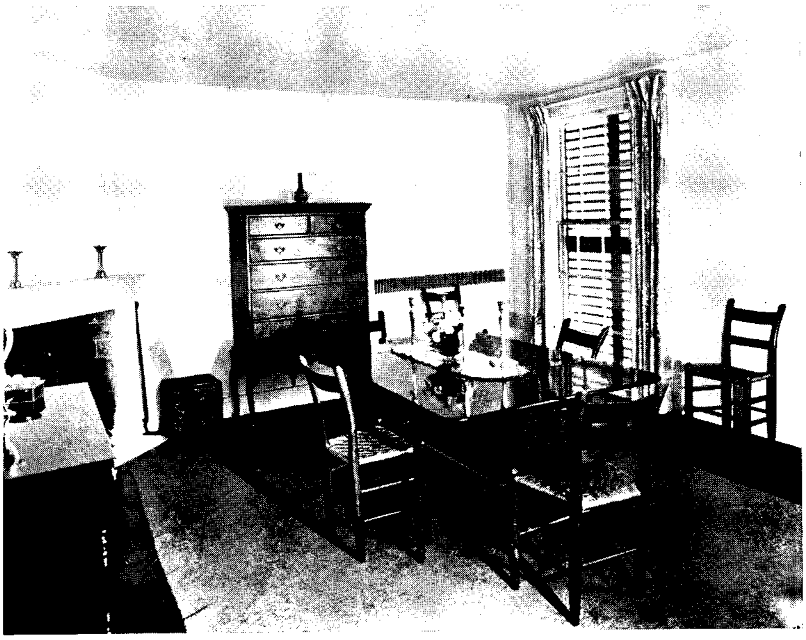
The main entrance is suitably located on this extremely simple loggia which opens onto the auto court and garden.

ILLINOIS: SEMITRADITIONAL HOUSE IS SETTING FOR PERIOD FURNITURE

ROBERT E. SEYFARTH

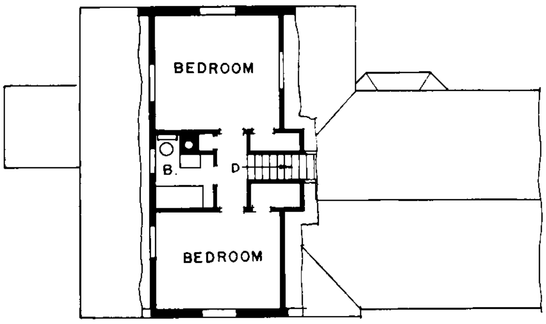
Architect

SITUATED ON a knoll in Barrington, Ill., is this residence for Mr. and Mrs. George Buffington. The house was designed particularly as a setting for the owners' collection of early American furniture. Although the building derives from no specific style, it is reminiscent of the early period of this country's architecture in its simple detail. The plan is, however, more extended than that of the usual provincial house of that period. An auto court leads to the main entrance on the loggia side of the house. The living area is at one end of the first floor with bedrooms at the other end, and on the second floor. Exterior walls are of masonry; interior walls are either plaster, as in dining room, or paneled as in living room.

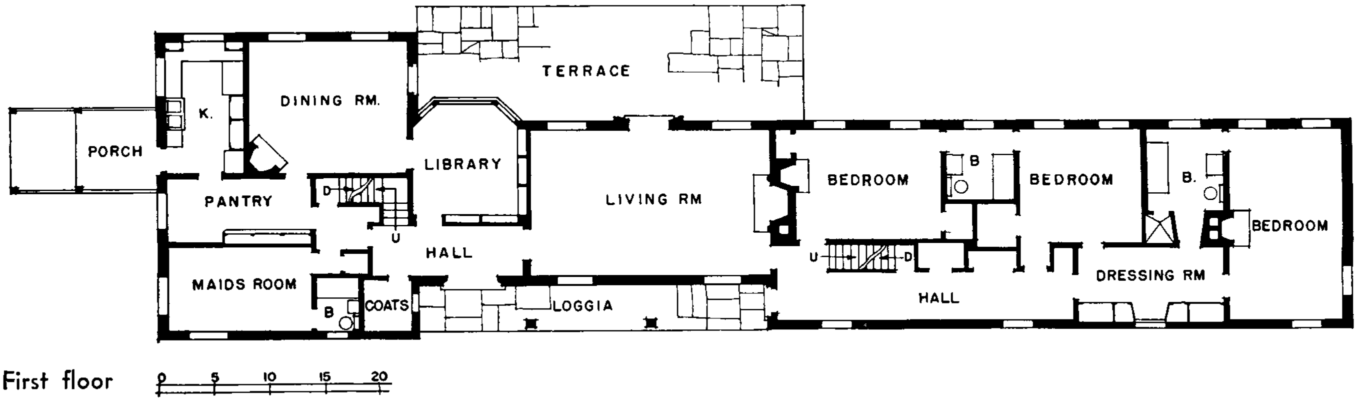


Dining-room walls are left plain, in keeping with simple furnishings.

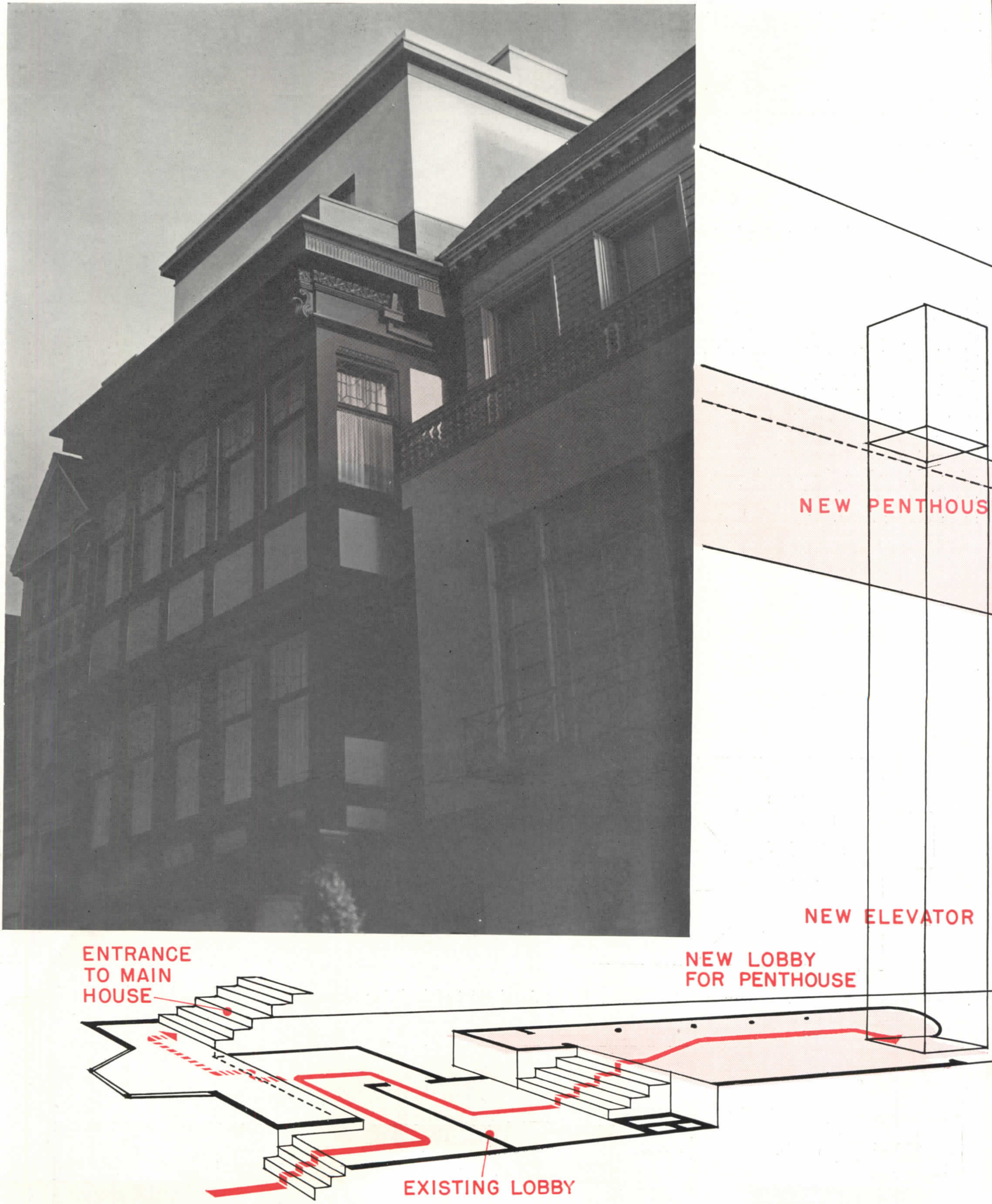
Focal point of the living room, with its wide board panels, is the fireplace.



Second floor



First floor



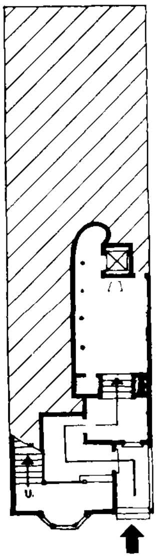
Photos by Roger Sturtevant

SAN FRANCISCO: MODERN PENTHOUSE TOPS PRE-FIRE BROWNSTONE

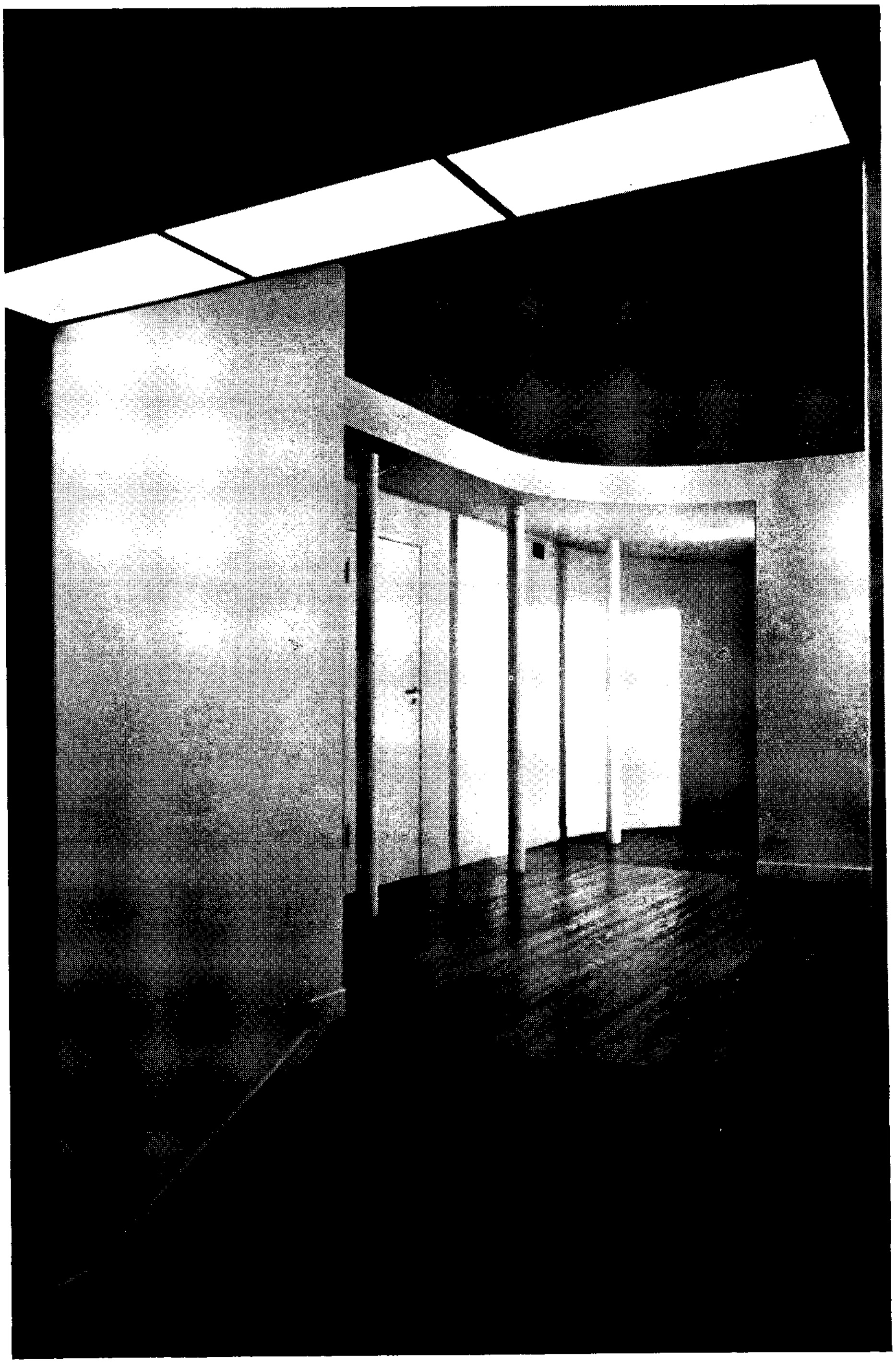
HERVEY PARKE CLARK, Architect

JAMES KEMBLE MILLS, Interior Decorator

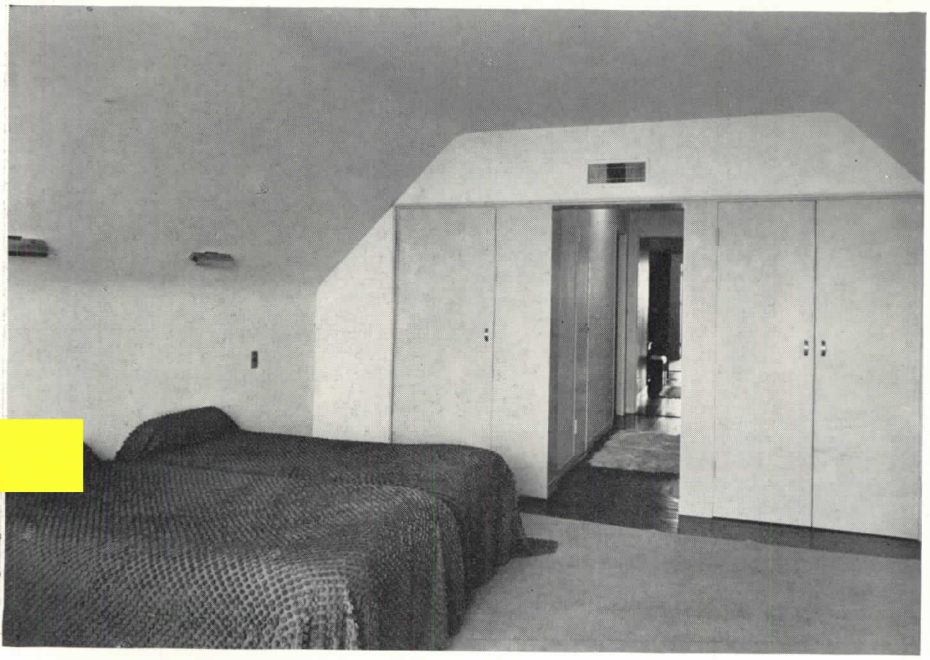
TYPICAL of San Francisco's pre-fire architecture is this residence; from street level its brownstone front gives no evidence of change since 1906. Recent remodeling, however, touched two parts of the house—the elevator lobby, and the attic, now transformed into a penthouse apartment for Mr. and Mrs. E. Covington Janin. The rest of the house, which belongs to Mr. Janin's family, is of period design and has not been changed. In remodeling the first-floor lobby, the entrance to the main house was combined with that of the penthouse. No mere "gas-pipe modern" whim are the round columns; they help support the three upper stories, and replace a former wall, removed to give additional space in front of the elevator. The ceiling is plaster, painted gray; three of the walls are white, and the fourth is canary yellow. The floor is oak, stained dark. The elevator cab has a cork floor, and bleached walnut walls and ceiling.



Plan

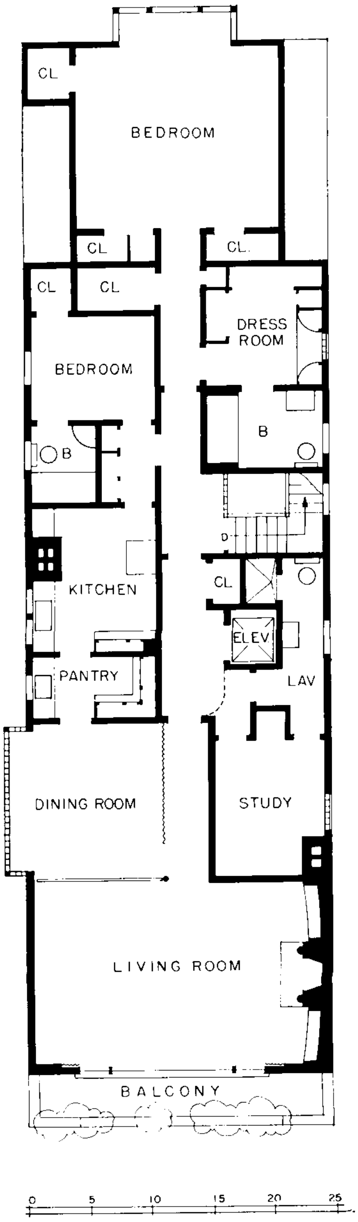


The elevator lobby, although it serves both main house and penthouse, suggests the simplicity and trimness of the penthouse.

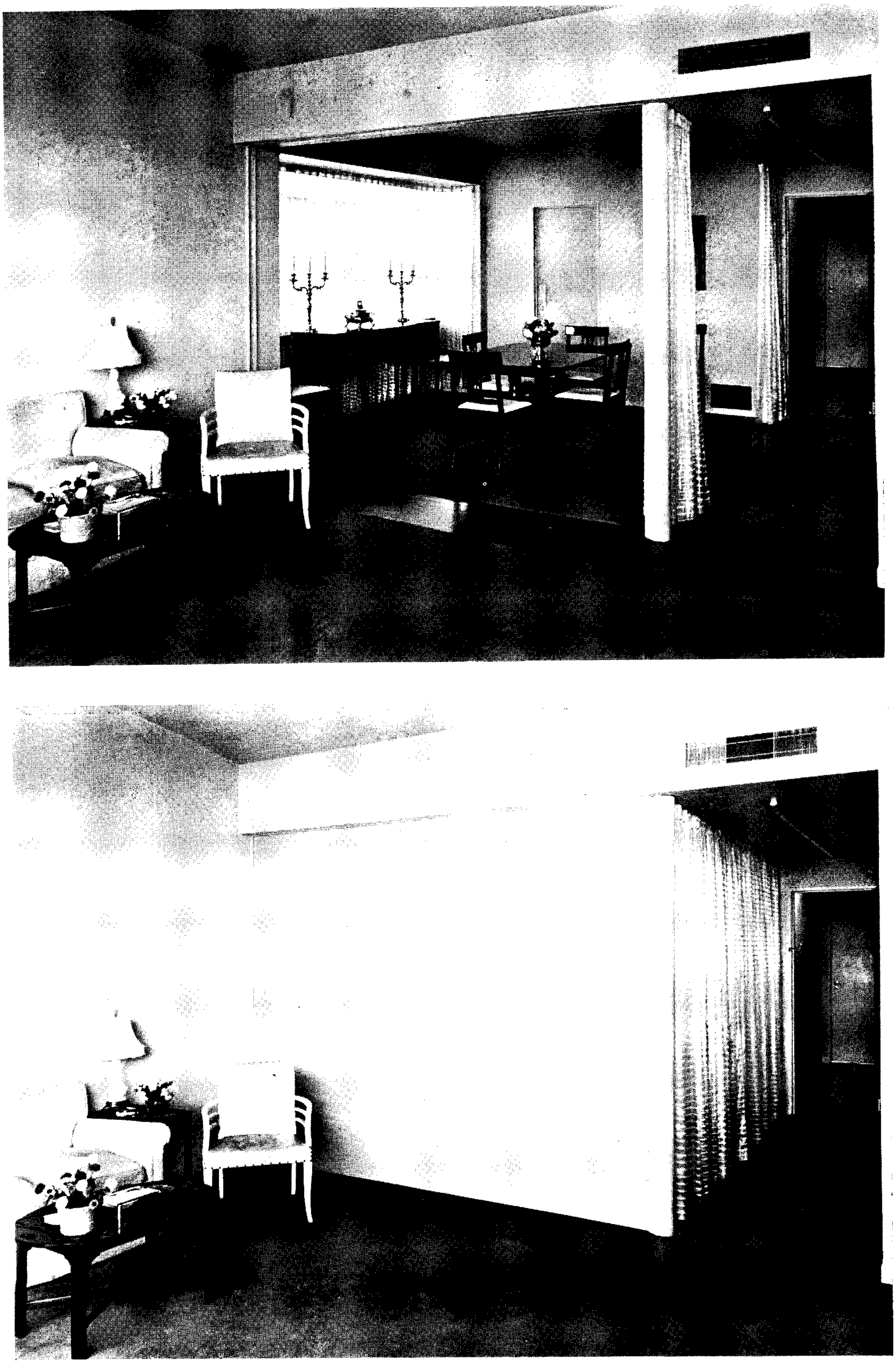


Photos by Roger St

To THE owner, who is an aviator, the sloping ceiling of the existing attic suggested the inside of a transport plane. Although in some rooms the ceilings are flat, the living room and one of the bedrooms retain the original lines. In planning the apartment the efficient and comfortable layout of a trans-ocean plane was taken as the keynote. Beyond this, and the design of the living-room mantel (above) whose rounded edge of waxed magnolia wood suggests a plane's wing, no further resemblance was attempted. The large plate-glass window of the living room frames a dramatic view of San Francisco Bay. Walls and ceiling in this room are gray green. The owner's bedroom (left) in the rear of the apartment gets light and ventilation from service windows on the setback, and light from a generous use of glass brick.



Plan

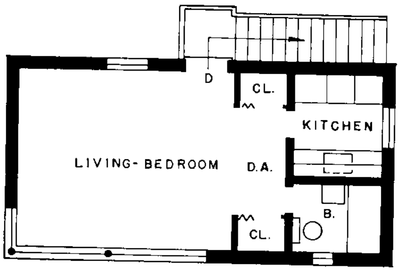


A feature of the apartment is the screen which slides up into the ceiling between living and dining rooms. When closed, this screen permits privacy while the table is being prepared and cleared; when open, it gives a sense of freedom by throwing the two spaces together. A thin translucent curtain between dining room and entrance passageway also contributes to privacy. A 9-ft. tubular lighting fixture in the hall diffuses enough light through the curtain to make further illumination in the dining room unnecessary during serving operation.

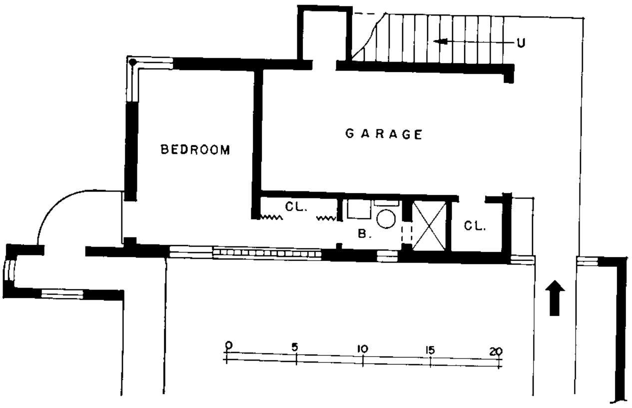
Photos by Ernest Graham

FLORIDA: BACHELOR'S GARAGE APARTMENT APPLIES "TAXPAYER" IDEA

ROBERT M. LITTLE, Architect

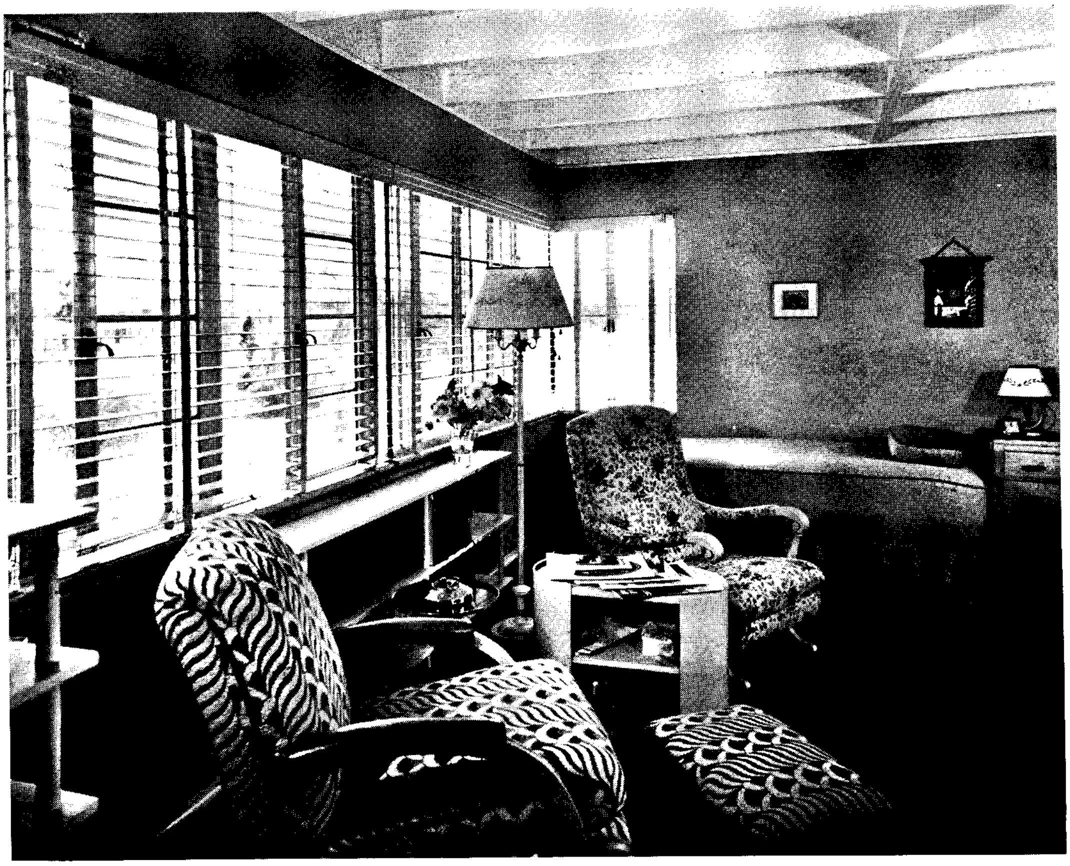


Second floor

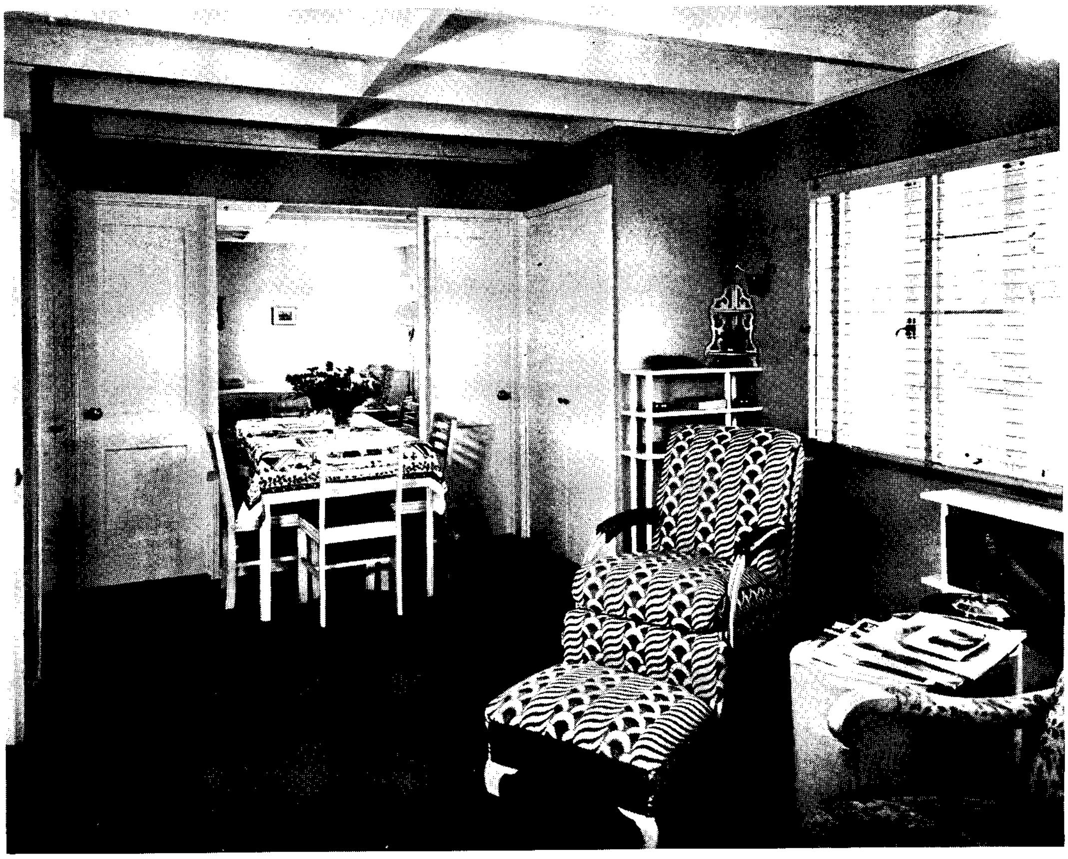


First floor

THE "TAXPAYER" is now a familiar type among commercial buildings; less familiar is the application of its principle to the residential field. This garage apartment for E. H. Tillotson at Fort Lauderdale, Fla., was designed as a secondary building on a lot large enough to contain a future residence. As an income-producing building, it is of value not only to the present owner (who moves into the first-floor apartment during the winter tourist season) but is also an inducement to the prospective purchaser. Each floor has an independent entrance; since the climate permits, a reinforced-concrete outdoor stairway provides access to the second floor. To provide as much unbroken wall space as possible, the window areas have been treated as one unit. Wings at each side serve to lessen the focal effect of the floor-length windows in the downstairs bedroom; in addition, these wings create a necessary horizontal effect and provide a background for landscaping. The building is of 8-in. concrete block, with reinforced-concrete columns and tie beams. The exterior is stuccoed; the interior is furred and plastered. East and south walls of the upstairs living room are painted warm gray; the west wall is pale gray-green. Ceiling and woodwork are painted white.



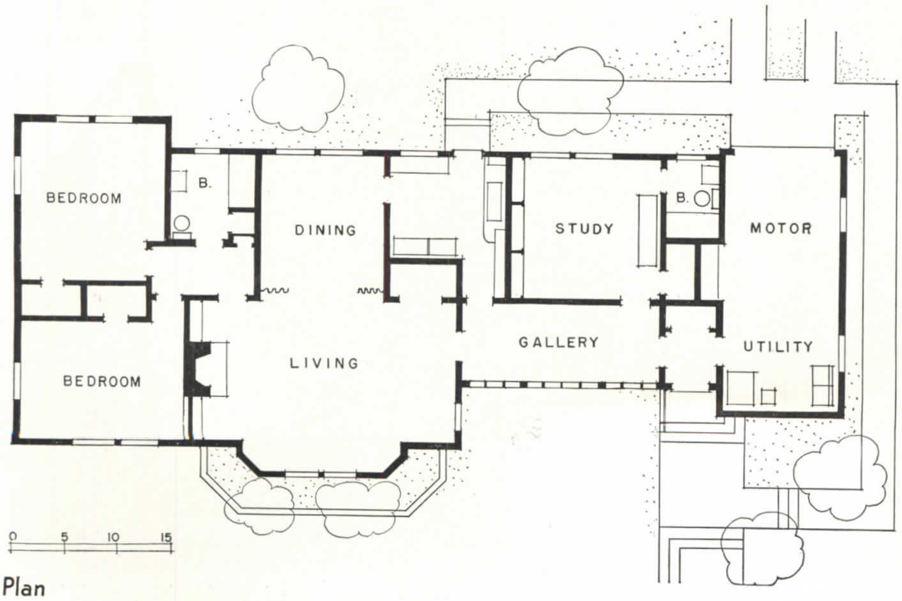
An insulated ceiling with exposed joists reduces apparent height and eliminates attic.



At one end of the living-bedroom is the dining alcove; doors lead to kitchen and bath.

AUBURN, ALA.: TWO-BEDROOM HOUSE FEATURES OPEN ONE-LEVEL PLAN

SIDNEY WAHL LITTLE, Architect

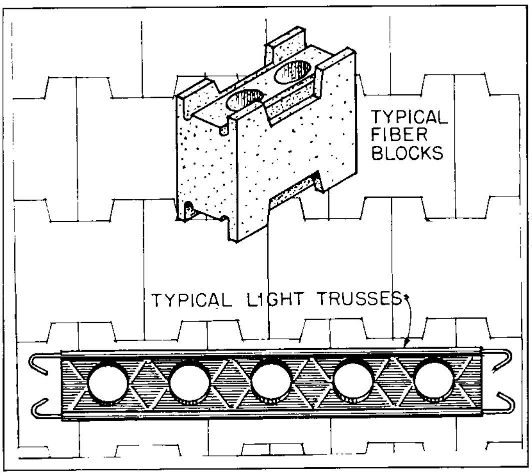


Plan

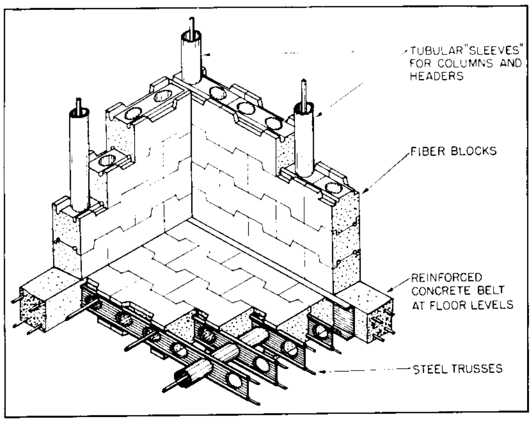
An existing (but only partly constructed) garage on the lot largely determined the plan of this residence for Mr. and Mrs. Edward E. Cureton in Auburn, Ala. The owner did not wish to alter or move the garage; the house, therefore, was designed to be attached to it. The resulting plan offers two interesting features: an isolated but readily accessible study and bath, and a gallery which is used for summer dining as well as a sun room. The exterior is of wide white boards with gray trim. The roof is of aluminum-coated composition shingles. Interior walls are of plaster on gypsum lath, papered. Specially designed soundproof cabinets beside the fireplace house the owner's phonograph and records. The two baths both have copper tubing with pressed-steel fixtures, and linoleum floors. Heating is by gas-fired furnace; insulation consists of 4-in. rockwool.

NEW STRUCTURAL SYSTEM

Reinforced fiber blocks make strong, lightweight, and insulative wall and floor construction



The system depends on these two new prefabricated units.



Isometric view of reinforced fiber floor and wall construction.

	TRUSS NO.	6-1	8-2	8-3	10-4	10-5
WEIGHT Per SQ. FT.	STEEL	1.75	2.02	2.62	3.03	4.18
	FLOOR*	9.35	10.8	11.5	13.8	15.0
SPAN FEET	10	210	315	315	400	400
	11	186	282	286	368	368
	12	156	238	262	338	338
	13	135	202	242	310	310
	14	115	174	225	289	289
	15	**100**	152	202	270	270
	16	88	133	178	250	250
	17	78	**118**	**157**	221	238
	18	69	105	140	199	225
	19	59	95	126	**178**	**213**
	20		85	113	160	202
	21		77	103	146	192
	22		70	94	133	184
	23		64	86	121	176
	24			79	111	164
	25			69	103	151
	26			62	95	140
	27				88	130
	28				82	120
	29				76	112
	30				69	102
	31					92
	32					84
	33					76
	34					70
	35					64

Tabulated loads are gross loads. To get the net live load, the weight of the floor slab (*) plus the finish floor and ceiling per square foot must be deducted from the table figures. Loads are based on 16-in. spacing of trusses.

Floor-load tables for reinforced fiber construction

This system of reinforced fiber construction, patented by Otto Yokes of Highland Park, Mich., broadens the field of reinforced plastic construction by the combination of two new prefabricated units. Light steel-truss reinforcement is bonded into joints of special interlocking fiber blocks, and the assembly is pulled together with tie rods in tubular steel members and sealed with concrete. This composite structure employs steel, concrete, and fiber in the order of their respective advantages and greatest efficiencies. The result is a cellular slab, with all major stresses taken by steel, suitable for wall and floor sections above grade.

Integral thermal and acoustic insulation; fire protection; flexibility in design; quick and cheap erection; elimination of applied insulation, furring, lath, and forms are among other advantages claimed. The units are standardized, factory-fabricated, universally interchangeable, easily assembled by unskilled labor and supplemented by standard building materials.

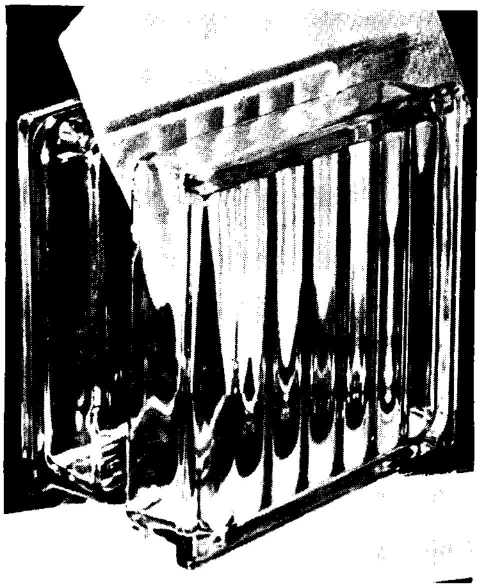
Reinforced fiber floors are extremely light and strong, as shown in the accompanying table. They may be combined with any other type of supporting construction to reduce dead load and foundation requirements. The engineering principles have been thoroughly checked by authoritative engineers and architects as well as by the Detroit Building Department, according to the inventor.

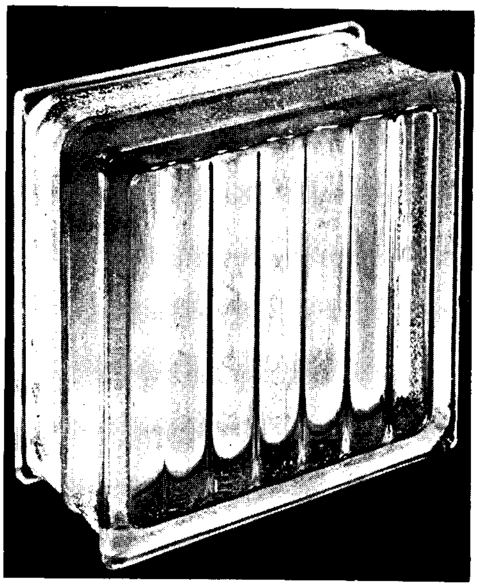
Several years of experimentation determined that corn waste, until now a useless by-product of farming, offered the cheapest and most abundant supply of fiber. A special method of shredding, chemically treating, and processing the dry corn stalks and leaves results in a very light and somewhat resilient fiber which is not subject to damage from flame, vermin, or moisture. This material can be molded, pressed, or rolled into any desired form, and vibration has resulted in increased cohesive strength.

All exposed surfaces of the construction are protected with cement plaster or Gunite after assembly. This coating, together with the comparatively high flashpoint of the fiber and its thermal nonconductance, is reported to protect reinforcing steel from a dangerous temperature longer than concrete. The lighter slab may also permit a nearer approach to the yielding temperature of steel without collapse from dead load.

The assembled and compressed slab, with tie rods connecting the steel channel frame, is surrounded with a concrete belt embedding the projecting ends of the reinforcing members and tie rods, thus permanently sealing the panel. This concrete framing belt around the floor slab also serves as a spandrel beam between the upper- and lower-story walls and acts as a monolithic *junction* between the wall and floor slabs. Tubular steel members are inserted through the cellular slab, where required, to act as headers for openings in floor and to serve as columns in walls. These columns may be filled with concrete to provide additional load-bearing capacity. A special column splice and beam support has been designed to permit a continuous tubular column through several stories. Additional data are available from patentee.

New glass block to reduce sun glare and heat



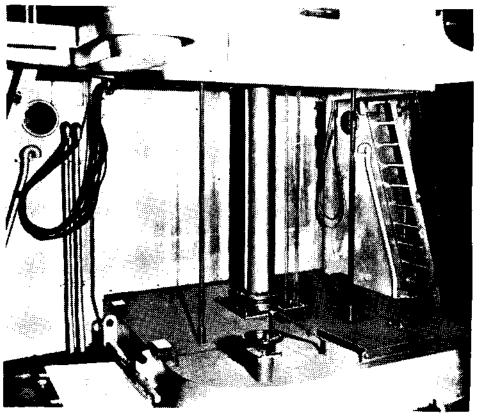


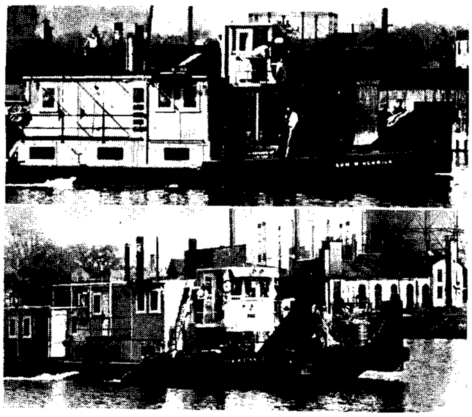
This new glass building block, containing an interior screen of glass fiber to reduce transmission of solar energy, has been announced by Pittsburgh Plate Glass Co. Advantages reported include diffused natural daylight from large wall areas and decreased cooling loads in air-conditioned space.

A sheet of glass fiber is sealed between the two pressed-glass halves of a block, the high sealing temperature causing an insulative partial vacuum in the block when it cools.

Variations in transmissions are available, depending upon the thickness of the sheet. Typical unit transmits 55% of the solar energy passed by clear block, and 75% as much light with increased diffusion.

Towboat pilothouse on hydraulic lift to "duck" low bridges

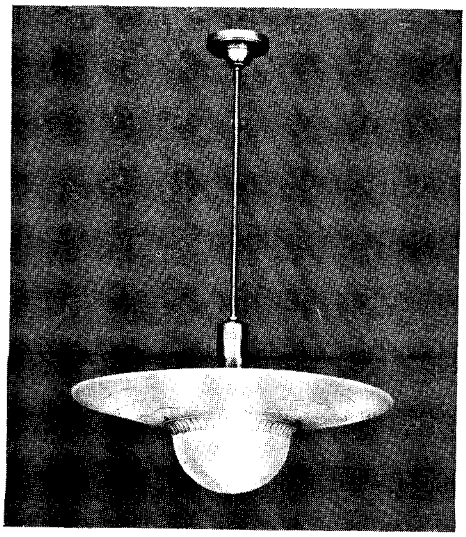




The Rotary Lift Co. of Memphis, Tenn. has found a new use for its Oildraulic lift as shown in the accompanying cut. The pilothouse on the towboat is lowered to pass low Chicago bridges and raised to improve vision in open river. This unique arrangement suggests possible similar use of lifts in the building field where a specific operation may require observation at various levels beyond the normal line of vision.

An electric oil pump installed inside the jack plunger is controlled by push button from the pilothouse.

Semi-indirect luminaire bowl of urea plastic



"Plastolux," a new 300-watt lighting unit designed by E. B. Kirk, Lighting Consultant for Mitchell-Vance Co., is molded of a urea plastic, Beetle, by Mack Molding Co.

The use of plastic permits accurate control and quantity reproduction of scientifically determined form and color, decreases breakage, and results in a lightweight fixture.

Efficient use of reflected and transmitted light and a uniform surface brightness were obtained by a careful design of bowl profile and thickness. Preliminary study of urea samples indicated the amount of light which would be transmitted and reflected at various points of the profile, depending on cross section and incidence of the light.

The central portion is a semispherical shell, 9 in. in diameter, of greater thickness than the rest of the luminaire to reduce glare and to regulate surface brightness. The reflector flares away from this bowl at an angle of 15° to give an advantageous angle of incidence to the important equatorial zone of radiation from the lamp. Through a series of concentric wavy rings, the thickness of the bowl gradually decreases so that the brightness of the edge sections is about the same as the center. Although this reflector measures about 24 in. in diameter, it appears to be much smaller because of the spreading of light.

This nursery playroom has an easily cleaned cement floor which is heated in winter. Frank Lloyd Wright was the Architect.

NEW DWELLING UNITS
NURSERY

NEW DWELLING UNITS: NURSERY

Erle Webster

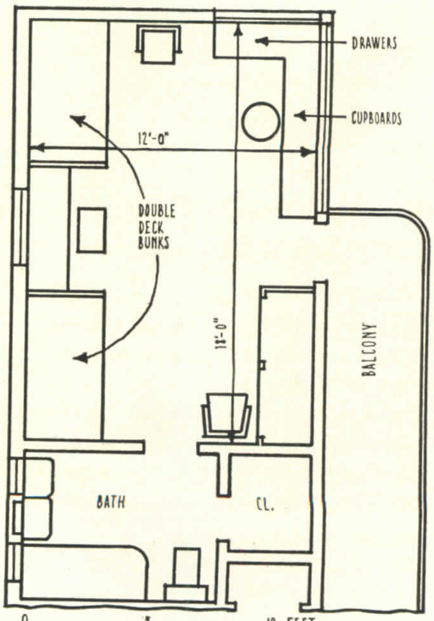
1. ERLE WEBSTER and ADRIAN WILSON, Architects

HONOR EASTON, Interior Decorator

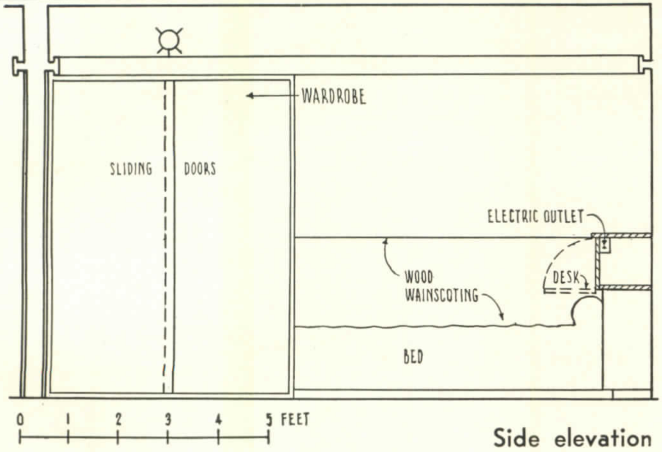
THIS UNIT was designed for three small girls and their nurse; since space was at a premium, it contains two sets of double-decker bunks. Ample storage space for both playthings and clothing is provided in the cabinets and drawers under the windows, and in two large closets. Adjoining the nursery is a bath which has two washbasins instead of the usual one. Access to the room is by a balcony, because the climatic conditions of the region in which the house is located permit such a solution. The general color scheme of the room is carried out in tones of brown: walls and woodwork are finished in a parchment color; bedspreads are of sand-colored damask with warm brown stripes, and the cotton rug is sand-colored. The rattan chair, however, has a blue cushion.

Materials and equipment

Walls and ceiling: stucco, La Habra Stucco Co. Floors: oak. Casework: Douglas Fir. Paint: Fusta Eggshell Enamel, Columbia Varnish Co. Windows: steel sash, Druwhit Metal Products Co. Hardware: Schlage Lock Co. Lighting: Luminaire Co.

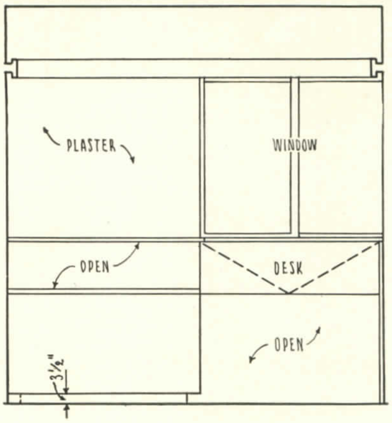


Plan



Plan

Side elevation



End elevation

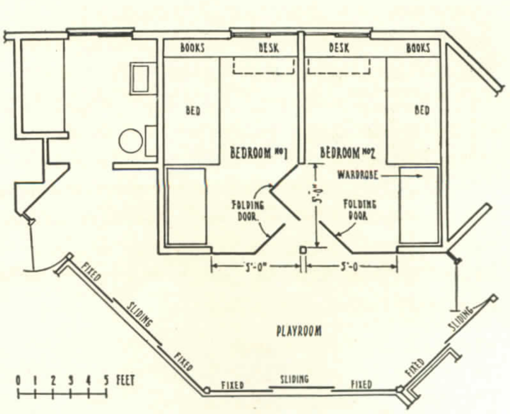
2. HARWELL HAMILTON HARRIS, Designer

CARL ANDERSON, Associate

THIS NURSERY UNIT for two children, a five-year-old boy and a year-old girl, consists of two small bedrooms and a playroom. Each of the rooms opens into the other, and both open into the playroom. All of the furniture in the bedrooms is built-in but, since the children are quite young, all the equipment has not yet been installed. Later the wardrobes shown on plan and elevations will be built, and folding doors will be placed between the bedrooms. Sliding glass panels not only admit light and ample air but allow supervision of the children from adjoining rooms.

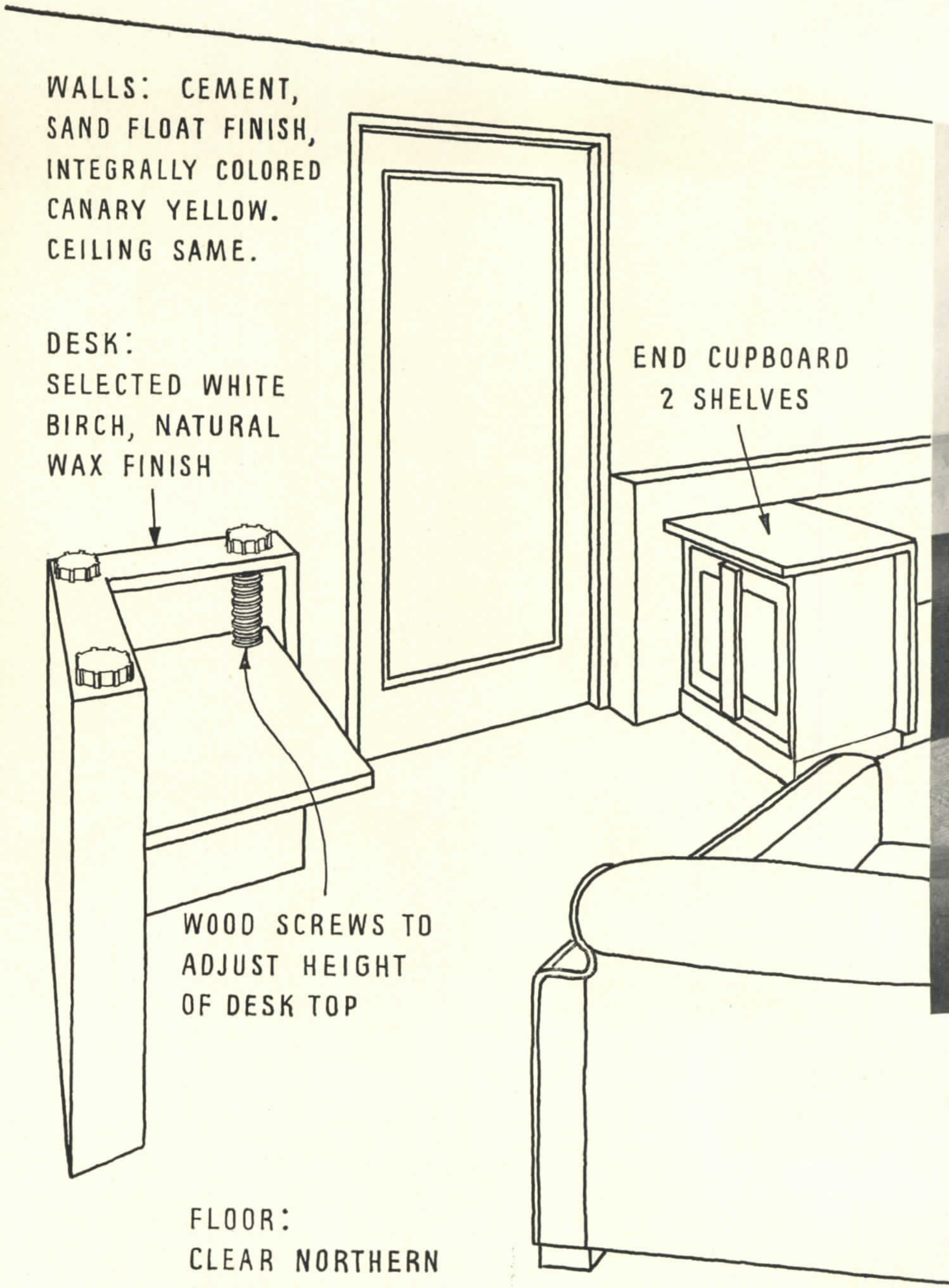
Materials and equipment

Walls: pale yellow stucco, La Habra Stucco Co. Trim: redwood. Floors: pine; rug, Chinese grass matting, California Asia Co. Windows and doors: wood sash, sliding horizontally with sheaves on metal bottom track. Glazing: Pittsburgh Plate Glass Co. Furniture: built-in, redwood; blonde wood chairs and table, designed by Russell Wright, Little Folks Furniture. Lighting: Empire Lighting Co.



Plan

NEW DWELLING UNITS: NURSERY



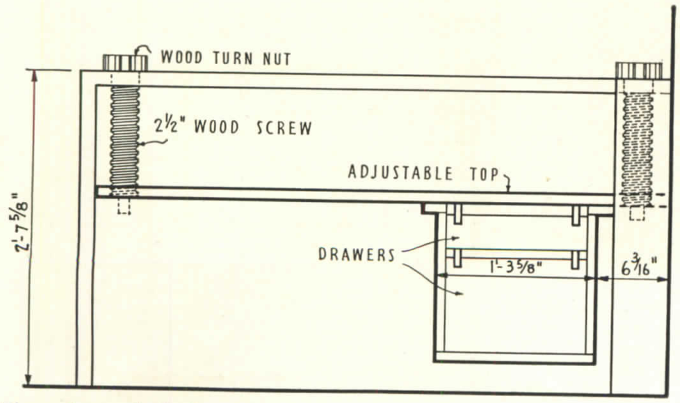
WALLS: CEMENT, SAND FLOAT FINISH, INTEGRALLY COLORED CANARY YELLOW. CEILING SAME.

DESK: SELECTED WHITE BIRCH, NATURAL WAX FINISH

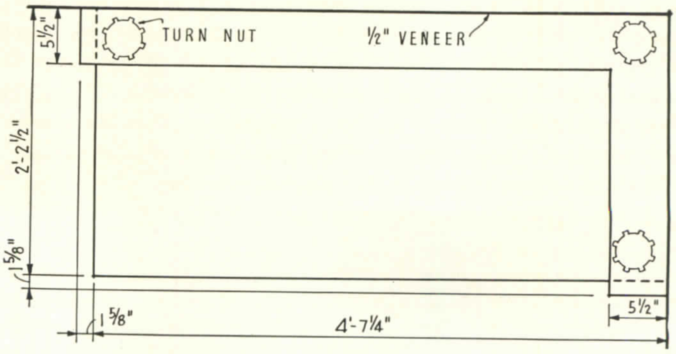
END CUPBOARD 2 SHELVES

WOOD SCREWS TO ADJUST HEIGHT OF DESK TOP

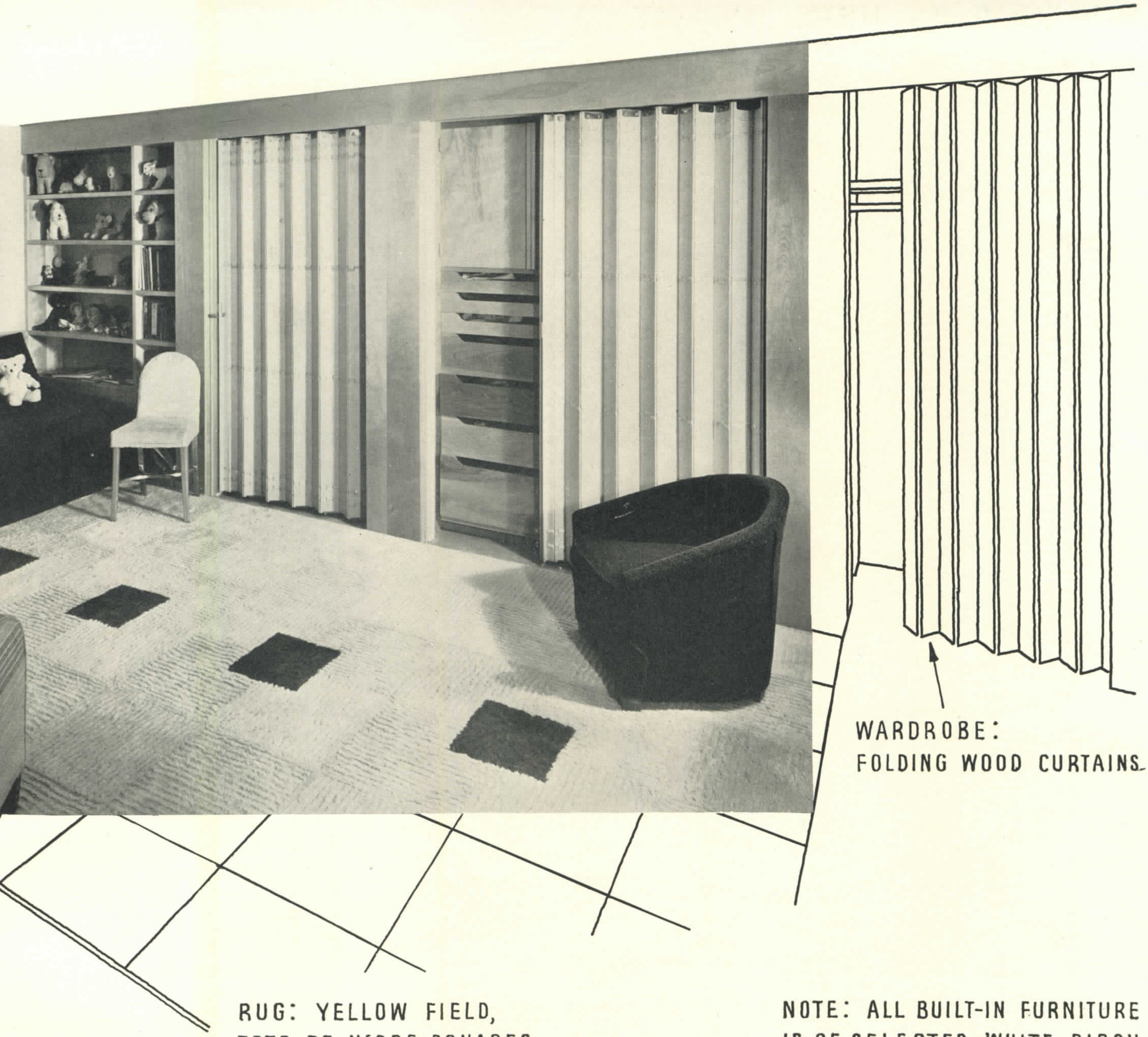
FLOOR: CLEAR NORTHERN HARD MAPLE



Elevation of desk.



Plan of desk top.



WARDROBE:
FOLDING WOOD CURTAINS

RUG: YELLOW FIELD,
TETE DE NIGRE SQUARES

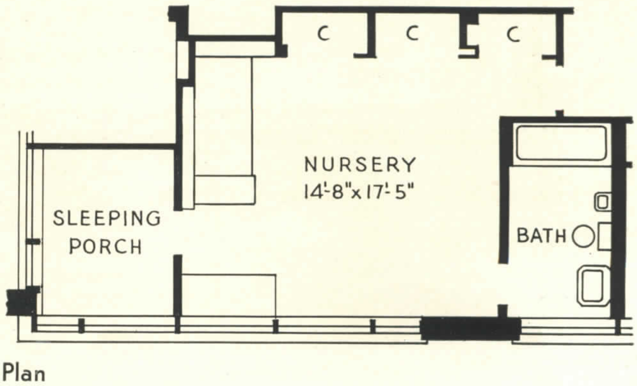
NOTE: ALL BUILT-IN FURNITURE
IS OF SELECTED WHITE BIRCH

3. WILLIAM F. DEKNATEL, Architect

DESIGNED TO MEET the changing needs of a growing child, this nursery unit features a maximum of adjustable built-in furniture. One wall is devoted to storage space—bookshelves (now used for playthings), and a three-part wardrobe, two sections of which have adjustable shelves and poles for hanging; the center section contains trays, drawers, and cabinets. The built-in desk is probably the room's most ingenious piece of furniture; by means of large wooden screws the desk top is adjustable to the child's height so that its use extends over a long period.

Materials and equipment

Furniture: custom-built by A. F. Meckelburg Sash and Door Co. Folding wood curtains: Aeroshade Co. Rug: specially designed, executed by Waite Carpet Co. Lighting: recessed ceiling fixture, Moe Brothers. Walls and ceiling: sand float finish plaster, Keene's cement; integrally colored, Ricketson's colors. Doors: selected white birch, Roddis Lumber and Veneer Co.



Plan

NEW DWELLING UNITS: NURSERY

Fred R. Dapprich

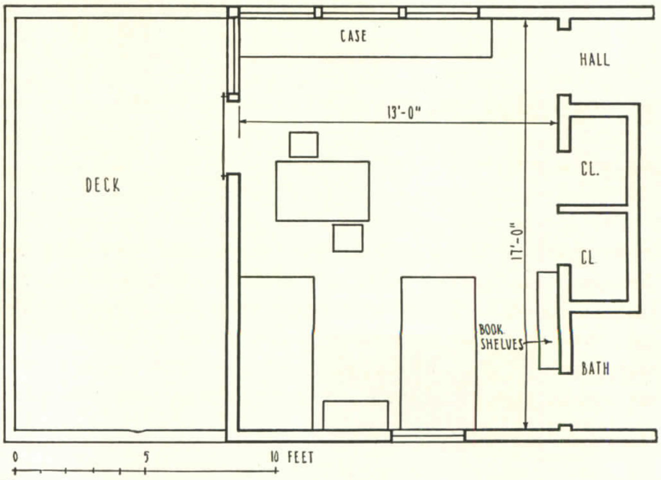
4. THEODORE CRILEY, JR.

Architect

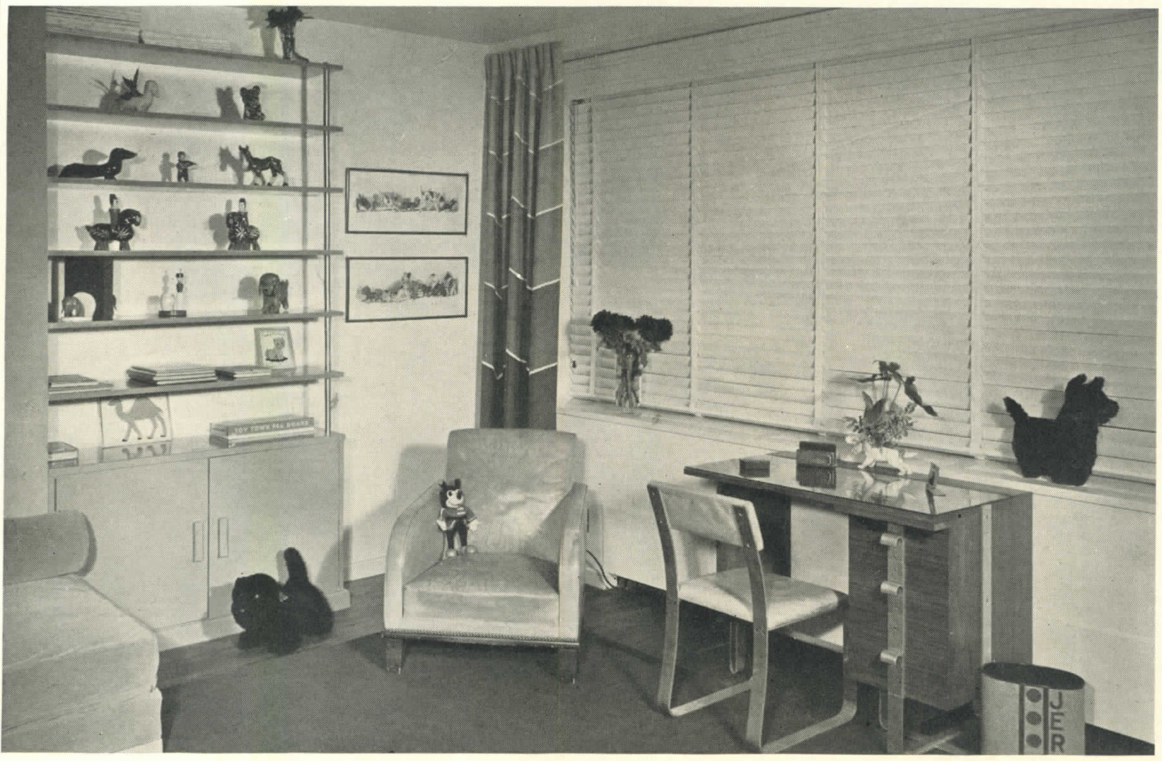
THIS ROOM FOR two boys opens on a roof deck, thus providing plenty of play space outdoors to supplement the indoor area. Windows are grouped together along one wall, with the door to the deck immediately adjoining. Under the windows are ranged plywood cabinets for convenient storage of playthings. Each boy has his own clothes closet. The double desk is of plywood, enameled white, with scarlet wood pulls. Walls and ceiling are of plaster, painted white. Curtains are of faded blue denim; the rug has a red, white, and black figure. The floor is covered with blue marbleized linoleum.

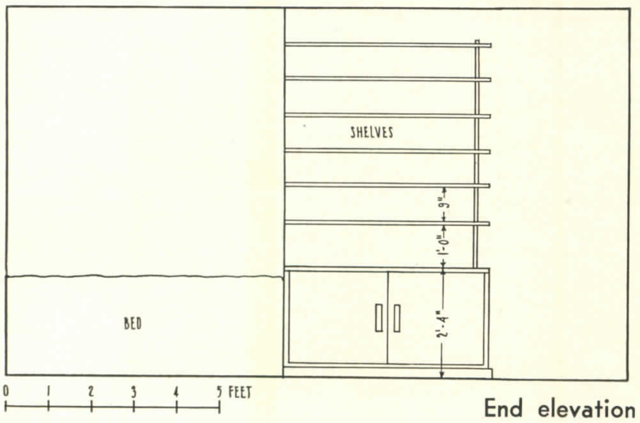
Materials and equipment

Floor: linoleum, Armstrong Cork Co. Walls and ceiling: Hardwall plaster, Blue Diamond Corp. Windows: steel casements, steel-frame screens, Druwhit Metal Products Co. Lighting: flush ceiling fixture, B. B. Bell. Paint: walls, Pittsburgh Plate Glass Co.; enamel on cabinets and desk, Columbia Varnish Co.

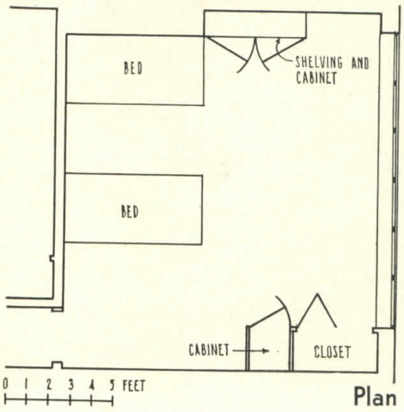


Plan





End elevation



Plan

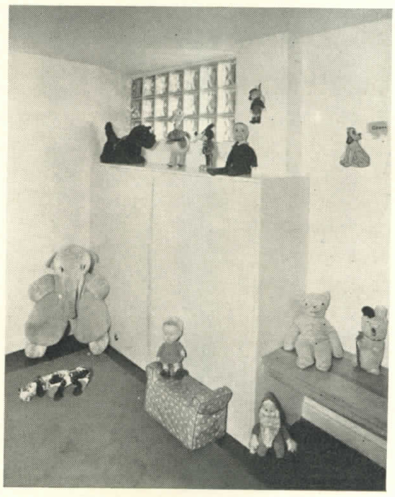
5. HERBERT SPIGEL

Architect

SIMPLY DESIGNED, this bedroom for a small boy uses a strong color scheme. The plaster walls are cobalt blue and white, as are the curtains. Venetian blinds are white, with white tapes. The two chairs are covered in white leather. The room contains two beds, one of which is built-in. Also built-in are the open shelves and cabinets for storage of books and toys. A closet provides storage space for clothes.

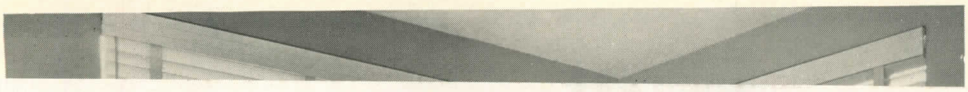
Materials and equipment

Furniture: special design by Madame Majeska, from Modern Age. Windows: metal sash, Hope's Windows, Inc. Wall paint: Pittsburgh Plate Glass Co.

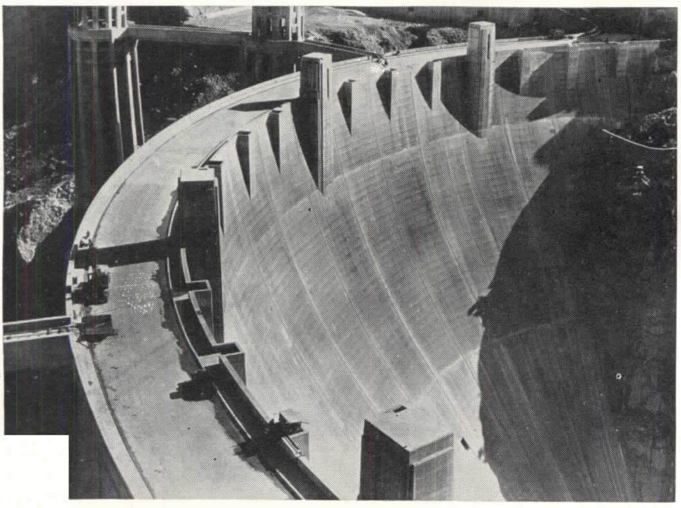


In the basement is the playroom; toys are stored in this built-in unit.

NEW DWELLING UNITS: NURSERY

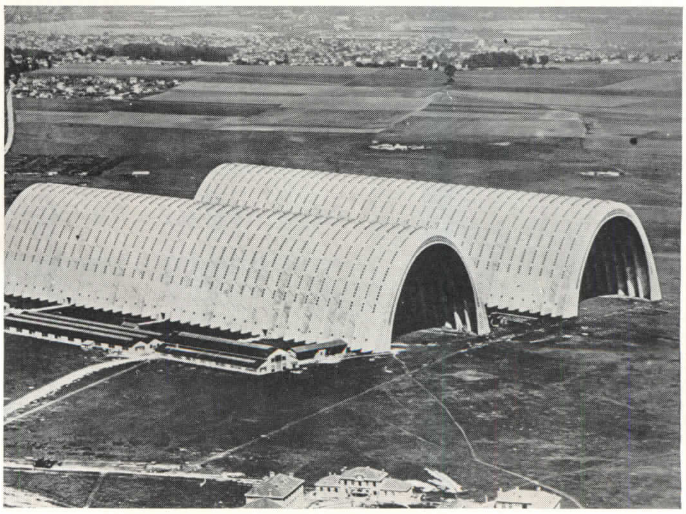


COLOR newest dimension which research is adding to concrete construction: office designed by Walter Dorwin Teague.



Galloway

STRENGTH is being constantly increased by research.



PLASTICITY makes possible great variety in design.

CONCRETE AND BUILDING DESIGN: A SURVEY

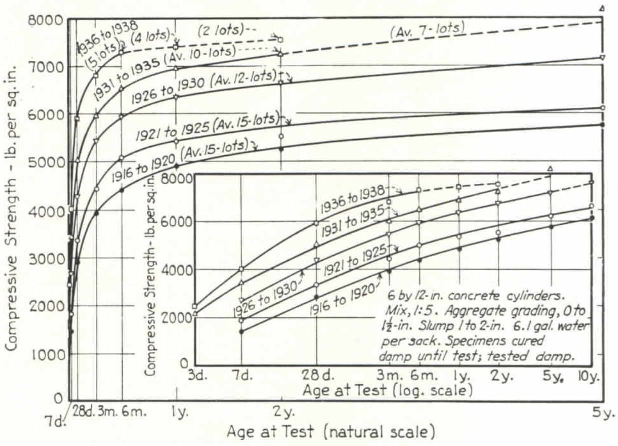
Each building material has its own inherent and special potentialities; and each has its limitations. Industry is constantly at work in an effort to establish the potentialities of each and employ them (singly or in combination) in specialized forms for specialized performance. In this study—fourth of a series on the subject—ARCHITECTURAL RECORD has asked Mr. A. J. Boase, Manager of the Structural Bureau, Portland Cement Association, to survey such developments in concrete.

FROM AN ORIGINALLY rather crude material—dependent upon size and mass for strength—concrete has been steadily improved and the principles under which it functions steadily refined, until today it is easily one of the most precise of all "precision" materials. And so specialized has our knowledge of it become that we now have "hot" and "cold" concretes, "fast" and "slow" concretes, "large" and "small" concretes, etc., etc. This increased knowledge has in turn made possible structures of hitherto impossible dimensions—huge shells so large and yet so sensitive that they breathe with changes in temperature and humidity; slabs as thin as 9/16 in. which carry a load of 60 lbs. p.s.f. (per square foot) over a span of 24 in. (AR, 5/39, p. 80); blocks of concrete, millions of cubic yards in mass; slabs so dense as to require no waterproofing (AR, 2/39, p. 70) or so light and porous (*Aerocrete*) as to compete with many light insulating materials.

Concrete—the material

Just what is it that has brought about these significant and far-reaching trends in concrete construction? It is fundamentally increased knowledge of the material itself. By that is meant knowledge of the individual constituents of concrete, knowledge of the part each plays in the final product, and, finally, knowledge of the application of the material to use in the shop and field.

Not until comparatively recent years has there been any clear conception of the part played by each of the ingredients of portland cement in the hardening process that takes place when water is added to cement in the making of concrete. Within the past decade, vast steps have been made in the knowledge of the chemistry of portland cement and its action in concrete which led to the development and use of low-heat cement in such gigantic structures as Boulder Dam and Grand Coulee Dam. The heat generated by hydration of the cement, while setting in these large masses, was minimized by control in the manufacturing process. By the use of low-heat portland cement, the heat of hydration is generated so slowly that it can be dissipated by the aid of a cooling system without damage to the structure. Because of the desirability of reducing the heat generated where large masses of concrete are involved, precooling of the materials of the concrete mixture is sometimes specified, particularly in localities where the atmospheric temperatures are high and the materials are likely to be rather hot when used. Cooling of the materials may



6 by 12-in. concrete cylinders. Mix, 1:5. Aggregate grading, 0 to 1½-in. Slump 1 to 2-in. 6.1 gal. water per sack. Specimens cured damp until test; tested damp.

Fig. 1. Age-strength relations based on group averages of concretes made with cements purchased at different times from 1916 to 1938.

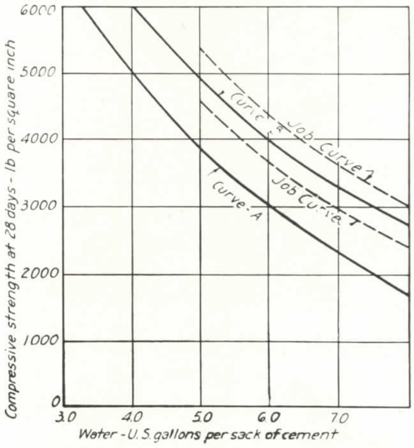


Fig. 2. Effects of quantity of mixing water on strength of concrete.

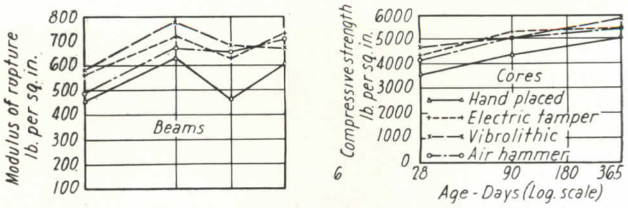


Fig. 3. Compressive strength of cores and modulus of rupture of beams cut from slabs placed by hand and by three methods of vibration.

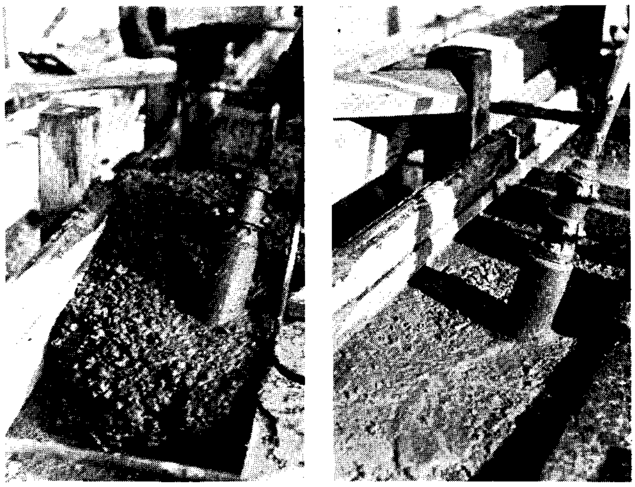


Fig. 4. Before and after vibration of a stiff concrete mix which would be unplaceable with hand rodding.

Fig. 5. Vacuum mats being used to remove excess water from concrete. After a $2\frac{1}{2}$- to 4-minute application of the mats the slab is ready for finishing.

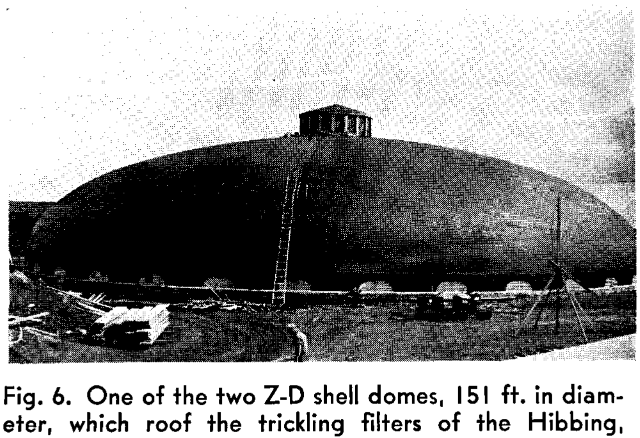


Fig. 6. One of the two Z-D shell domes, 151 ft. in diameter, which roof the trickling filters of the Hibbing, Minn., sewage-treatment plant. Z-D shell domes designed by Roberts and Schaefer Co., Engineers.

be accomplished by blowing air blasts on the moist coarse aggregate, or by refrigeration of the mixing water.

In building construction, control of heat generation in the concrete is not of importance as it is in large engineering structures, but wherever very large masses of concrete are involved, as in dams and other huge engineering projects, attention is being given to this problem with a view to improving the performance and enhancing the durability of the structures.

But the heat-generating property of portland cement is only one of many about which much information has been made available so that designers may more intelligently design structures for the specific uses for which they are intended. Among the most significant developments having a direct bearing on design trends are the improvements in the manufacturing process of portland cement which have brought about increases in strength. Research has shown which ingredients in portland cement contribute most to the strength of the concrete, so that—by selection of the raw materials, more accurate blending of ingredients before they enter the kiln, careful control of burning within the kiln, and more thorough and finer grinding of the clinker—the strength-giving property of portland cement has been materially increased.

Concretes made with present-day cements, compared with those of even 10 years ago, and very markedly with those of 20 years ago, show compressive strengths two to three times as high. This is brought out clearly in Fig. 1, in which it will be noted, for example, that the average 28-day compressive strength of 15 lots of cement between 1916 and 1920 was about 2900 lbs. p.s.i., whereas the average of 5 lots from 1936 to 1938 shows a comparable strength of 5900 p.s.i.

The greater strength of concrete commonly obtained on the job as a result of using higher-strength portland cements, and better methods of mixing, is recognized by code-making bodies. In the 1928 American Concrete Institute Code, the assumed strength of concrete made with 6 gal. of water to a sack of cement was 3000 lbs. p.s.i. at 28 days, while today the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete conservatively assumes a 6-gal. concrete will have a minimum strength of 4000 p.s.i.

Increased knowledge of the importance of the aggregates in concrete has likewise contributed to making concrete a more dependable material. Too often in the past anything which could be called sand, gravel, or crushed stone was used for concrete aggregate with unfortunate results. The deleterious effect of shale, chert, coal, and similar substances, and the unsoundness of certain aggregates when subject to freezing and thawing, were not recognized. The importance of grading of the aggregates in producing a workable and dense concrete, with a finish suitable for exposed surfaces, is being increasingly emphasized in modern specifications.

Concrete is, and always will be, very largely a field-made product. This very fact gives it much of its adaptability and makes it well suited to contemporary problems of building design. But concrete's being primarily a field product necessitated *control* of the qualities of strength, durability, watertightness, etc., in the finished product. Though not of recent

Fig. 7. Longitudinal barrel shells make up the roof of the Armstrong Tire and Rubber Co. factory, Natchez, Miss. Within the building, bays are 40 ft. wide and columns are 50 ft. apart in the longitudinal direction. J. T. Canizaro, Architect; Roberts and Schaefer Co., Engineers.

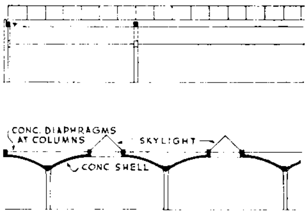


Fig. 8. Butterfly-type concrete shell roof for spans up to 40 by 60 ft.

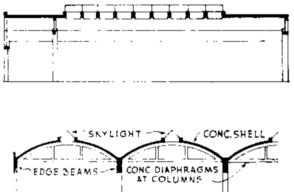


Fig. 9. Barrel-type concrete shell roof for spans up to 60 by 200 ft.

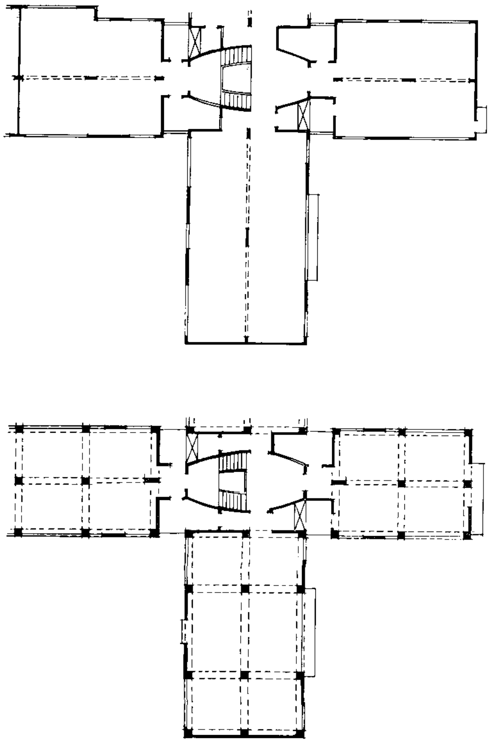


Fig. 10. Framing of Highgate Apartments (above). Typical framing (below) of building similar to Highgate Apartments, using wall columns and spandrel beams.

origin, the development which has had the most potent effect since the invention of portland cement and reinforced concrete, was the discovery of the water-cement ratio principle of proportioning concrete. Because proper application of this principle to the making of concrete enables a designer to determine in advance the qualities of concrete, structures like the Hershey Sports Arena (AR, 6/37, p. 31), the Naval Testing Basin (AR, 9/39, pp. 34-37), and the George Westinghouse Bridge, Pittsburgh, have been made possible. Higher working stresses, which make possible smaller sections of structural members (hence less dead load) which, in turn, make long span structures in concrete economically feasible, are being more and more commonly used; control of the water-cement ratio is largely responsible. Fig. 2 shows effect of the quantity of mixing water on the strength of concrete. The "A" curve, first published in 1918, is representative of the cements of that time; the "B" curve is representative of present-day cements. When materials to be used on a specific job are known in advance, tests can be made and a job curve drawn as shown to establish design values.

Concrete placing

When plain concrete only was used for mass structures, stiff mixtures were placed in thin layers, each thoroughly compacted with heavy tampers. The result was strong, dense, durable concrete. With the advent of reinforced concrete and the resulting use of thinner sections, plastic mixes became necessary. Through lack of knowledge, overly wet mixes were sometimes used and inferior concrete resulted.

When the part played by each ingredient in concrete, including the water, was understood, it was realized that stiffer mixes were desirable and a demand for an economical method of placing stiffer mixes of lower water content was created. High-frequency vibration was the solution of the problem. The use of vibrators on a very large volume of concrete, including some of the largest dams, bridges, and buildings ever erected, has demonstrated that vibration is both practical and economical, and makes possible higher-strength concrete of uniformly better quality. Fig. 3 shows the compressive strength of cores and modulus of rupture of beams cut from slabs placed by hand and by three methods of vibration.

The less water present in the concrete when in place (so long as there is a sufficient amount to hydrate the cement fully), the stronger will be the concrete. Recognition of this fact led to the development of the vacuum process for removing unwanted water from the concrete after it is placed. About 2½ gal. of water are all that is required to hydrate a sack of cement. But this amount of water is insufficient to make a sufficiently plastic mix, even with the aid of vibration. By removing a portion of this extra water by means of vacuum mats or forms, the cement paste in the concrete is less diluted, the water-voids are reduced, and the concrete has greater compressive strength. Future absorption is also reduced. Fig. 5 shows a typical illustration of its use on the floors of a large housing project. (See also AR, 6/37, p. 38.)

This same principle of removing some of the mixing water from the concrete after it is in place has led the Reclama-

Verne O. Williams

Fig. 11. Concrete walls, formed against plywood, were used in the Miami Beach, Fla., post office. Howard Lovewell Cheney, Consulting Architect for Procurement Division, Treasury Department.

Fig. 12. Notable success in the use of concrete in the Columbia, Miss., high school. N. W. Overstreet and A. H. Town, Architects.

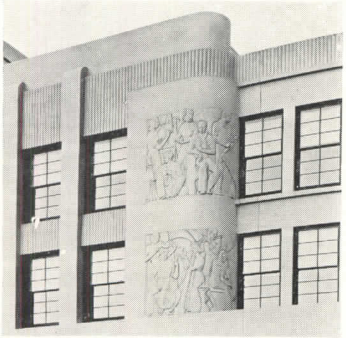
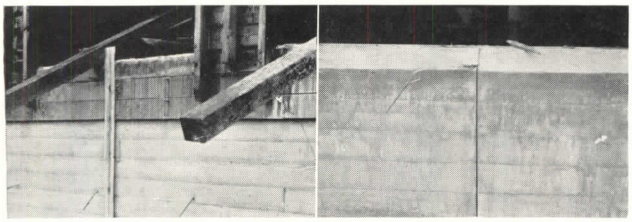


Fig. 13. Curved bas-relief panels of Bellingham, Wash., high school were cast in place in plaster molds. Floyd A. Naramore, Architect.



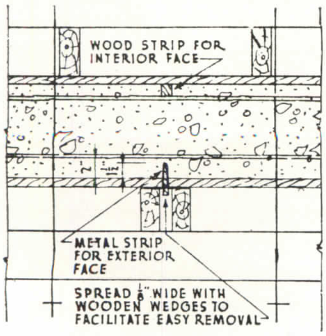


Fig. 14. Details of weakened plane joints used in Bellingham, Wash., high school. The finished joint is a narrow, unobjectionable vertical line filled with non-staining calking compound.

tion Bureau to specify forms lined with absorptive material for the Friant Dam, to be built on the San Joaquin River in California. Absorptive forms have been used to a limited extent in building construction, and indications are that the many beneficial results obtained through their use will result in their adoption more generally. A recent instance of such use is the new Los Angeles Union Passenger Terminal, a concrete structure in which cane fiberboard was used as a form liner.

Structural developments

Distinguished from the advances in concrete simply as a material are those developments which have to do with its use and its application to the solution of building problems. Among the most important of such developments is the prestressing of reinforcement.* Where dead load must be minimized in the construction of long-span girders and roof trusses, prestressing offers intriguing possibilities. Indicative of these possibilities is a girder designed by E. Freyssinet, noted French engineer. The girder (which was a small scale model for test purposes of much larger girders since constructed) was 65 ft. 6 in. long, 2 ft. 9 in. deep at the ends, 3 ft. 10 in. deep at the center, and was an average of 4 in. thick. The reinforcement in the test girder was stretched so as to produce a tension of about 78,000 lbs. p.s.i. The girder—which weighed only 150 lbs. per ft.—was loaded to 940 lb. per ft. in addition to its own weight. Under this load, with the steel stressed to 78,000 lbs. p.s.i., the concrete had a compressive stress of 2,056 p.s.i. and a shearing stress of 710 p.s.i. The deflection of the girder was equal to that of a steel girder of the same shape working at 7,100 p.s.i. only. Reinforced with steel having an elastic limit of 156,000 lbs. p.s.i. this girder, carrying a load seven times its own weight, has a factor of safety of 2 in regard to the steel and 4 in regard to the concrete.

Great strides have been made in the use of shell structures in this country within the past few years. A vast new field has been opened to reinforced concrete through the use of this type of construction. The Hershey Sports Arena, the domes of the sewage-treatment plant, Hibbing, Minn. (Fig. 6), and the roof of the Armstrong Tire and Rubber Co. factory, Natchez, Miss. (Fig. 7), are examples of space structures commonly known in this country as *Z-D barrel-shell roof* and *Z-D shell domes.*

Shell structures consist of a very thin membrane curved in one or two directions which is unable to take transverse bending. Edge members and diaphragms are used to stiffen the shells and to take care of the discontinuity at longitudinal horizontal edges, thereby bringing about a three-dimensional action in space.

There are three basic types of Z-D shell roofs:

1. The butterfly type (Fig. 8) for spans up to 40 by 60 ft.
2. The barrel-shell type (Fig. 9) for spans up to 60 by 200 ft.
3. The shell dome (Fig. 6) which may be built up to 200 ft. in diameter and more.

Another development of far-reaching influence is the general application of indeterminate structure analysis to the frames of concrete buildings. In the beginning, concrete

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*Although this phase has seen its highest development to date in Europe, concrete design in this country must inevitably reflect it.

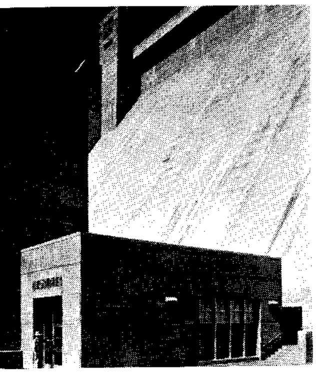


Fig. 15. Norris Dam and Power House. The direction of the form boards was altered in adjacent panels, which were separated by V-joints to give scale to the structure and a bold wall pattern. Roland A. Wank, Principal Architect, Dept. of Regional Planning, T.V.A.

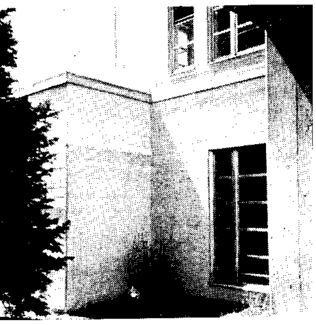


Fig. 16. The wide board texture of the walls remains as it came from the forms in the Fine Arts Center, Colorado Springs, Colo. The untreated natural concrete surface produces the warmth of color and texture desired. John Gaw Meem, Architect.

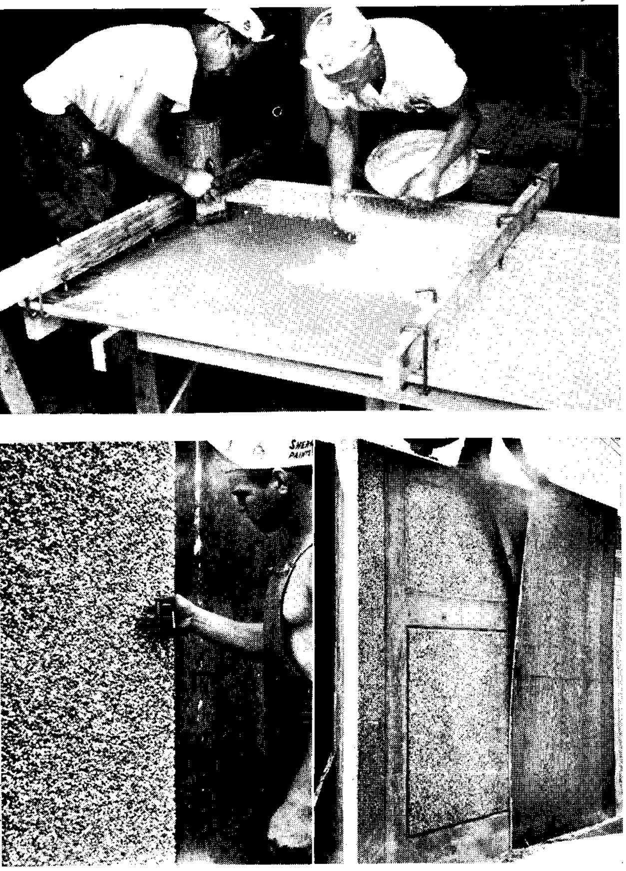


Fig. 17. Exposed aggregate surfaces for concrete walls by the bond-transfer method. Above, application of adhesive and aggregate to plywood form liner. Lower left, panels are attached to structural form with $\frac{3}{4}$-in. brads driven with a small brad gun. Lower right, structural forms are stripped; then liners are peeled off.

building frames were designed as wood- and steel-frame buildings had been designed before them. But concrete frames are inherently *continuous, the joints between beams and girders and between girders and columns resisting moment,* whether taken into account or not. It is therefore fundamentally wrong to design such structures as though made up of an assembly of isolated members having connections free to rotate. Such practice will no longer be permitted under the American Concrete Institute Building Code and many modern municipal codes are adopting similar requirements. The Report of the Joint Committee recognizes that more exact methods of analysis are now available than heretofore and strongly urges their use. Simplified methods of frame analysis are now available. By applying the principles of continuity to design of buildings, economies are effected in construction, and a more adequate and rational design is obtained.

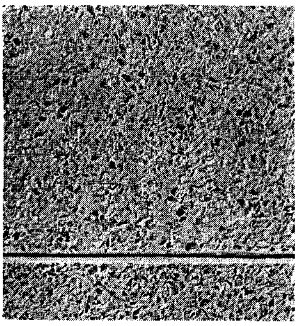
Indicative of what may be accomplished by taking full advantage of continuity in design is the Highgate Apartment in London. Here concrete serves as the structural, surfacing, and decorative medium. The exterior walls are reinforced concrete, 4 in. thick, insulated with 1 in. of asphalt-impregnated cork to which plaster is applied. The 4-in. walls are constructed without wall columns and are built integrally with $4\frac{3}{4}$-in. floor slabs. Interior partitions are of reinforced concrete, 8 in. thick, and act as columns supporting a connecting beam 8 in. wide. Fig. 10 shows the type of framing for the Highgate Apartment and a typical layout with wall columns and spandrel beams for a similar building. The advantage of the former is obvious.

Architectural concrete

It is well known that concrete has come to be adopted quite generally throughout the United States and Canada as an architectural material. Concrete's first serious bid for acceptance as a modern architectural material was made about 30 years ago. Early in this century a new and restless generation of architects sought to simplify traditional forms and to evolve entirely new ones. Being a plastic material, concrete was readily and effectively molded into new line and mass.

At first the use of architectural concrete was largely confined to the West Coast; but within the past five years knowledge of the technique has spread rapidly, with the result that architectural concrete is no longer a west-coast monopoly. Contractors have learned how to build forms that will not leak, to make construction joints that are inconspicuous; they have learned how to proportion concrete to avoid sand streaks and stone pockets, how to place concrete so there will be no fill planes. In other words, concrete has been lifted from the position of a purely structural material (to be covered by a veneer of other products) to an architectural material in its own right.

Materials have also been an important factor. The advancements already discussed in the knowledge of concrete ingredients and the making of concrete have had an incalculable influence. The development of plywood, various fiberboards, and other form materials has had much to do with the increased use of concrete architecturally. Wood and plaster molds give free reign for the execution of detail;



Official U. S. Navy Photo

Fig. 18. Precast slabs, 2 in. thick, were used as forming for the structural concrete on the Naval Experimental-model Basin buildings, Carderock, Md. Texture of the slabs is composed of closely spaced particles of white quartz exposed by brushing.

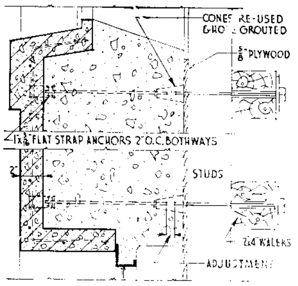


Fig. 19. Section through spandrel showing details of anchoring slabs for use as forming on Naval Experimental Basin buildings.

Courtesy Hampden Building Tile Co.

Fig. 20. Large, quartz-faced slabs, 2 in. thick, backed up with concrete masonry units reduce joints to a minimum on this building of Ansonia Manufacturing Co., Ansonia, Conn. Brown and Von Beren, Inc., Architects.

Edgar B. Smith

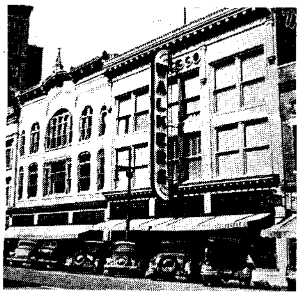


Fig. 21. The new exterior of Walker Department Store, Wichita, Kan., is of 1¾-in. precast slabs, up to 4 by 6 in. in size, faced with dark green crushed marble exposed by brushing. Lorentz Schmidt, Architect. At left, exterior before remodeling.

surface textures may call for the use of rough or dressed lumber, plywood, Presdwood, Celotex, and similar materials, or may require brush hammering, sandblasting, wire brushing, or tooling.

Where color is desired, for cast-in-place concrete, development work is in progress on a method for integrally incorporating selected aggregates in the concrete with a minimum of special facilities. The method is known as the "bond-transfer method", and has been under study for a little more than two years. Briefly, it may be described as follows: The facing material, either special aggregates or a thin layer of mortar containing the special aggregates, is uniformly distributed over form-liner material, being bonded thereto by an adhesive. After a drying or curing period, these prepared panels are fastened to the structural forms. Four to six days after the concrete is placed, depending on curing temperatures, the forms and then the liners are removed. During this curing period, the aggregate or mortar facing becomes securely bonded to the concrete and if the proper technic is followed, a 100% transfer is obtained. After removing the liners, the aggregate is exposed by rubbing the surface with abrasive stones, by sandblasting, or by brush hammering. Finally the surface is cleaned with acid and thoroughly washed. Accompanying pictures (Fig. 17) illustrate the basic steps of the "bond-transfer method." When this method is perfected, it is apparent that the architect will be given a range of colors and textures through the use of natural and manufactured aggregates which will give full scope to any design he may conceive.

Precast concrete units

Recent improvements in cast-in-place concrete have been paralleled by equally marked developments in precast concrete. Viewed more and more strictly as a form of concrete produced under factory conditions permitting the application of refinements in methods and materials, this type of product is becoming a useful complement to cast-in-place concrete.

An especially interesting application is its use for the double purpose of forming and decorative veneer for the structural concrete wall. (AR, 6/38, pp. 63-64; 9/39, pp. 34-37.) By this method it is possible to give to architectural concrete a surface composed of white portland cement, colored pigments, or special aggregates, where the inclusion of any of these materials throughout the full thickness of the concrete wall would be impracticable.

There are two methods of using precast units as forming: One eliminates all wooden forming on the outside face of the wall and depends upon the precast slabs, internally held, to carry the pressure of the freshly placed concrete (Fig. 19). A recent job using cast stone in this fashion is in the Navy's ship-model testing-basin buildings at Carderock, Md., where 2-in. slabs ranging in size up to 100 sq. ft. were used. The slabs were faced with white quartz aggregate, exposed by brushing to produce the desired texture (Fig. 18). In the other method the slabs are held in line and supported by studs on the outside face of the wall which are tied through the joints to the inner form.

This utilization of the ability of concrete to be precast in large, thin units has but recently been started. Large units

Wasinger

Fig. 22. Highly polished slabs, 2 in. thick, made with a mixture of blue and green granite chips, were used in remodeling this store in New York City.

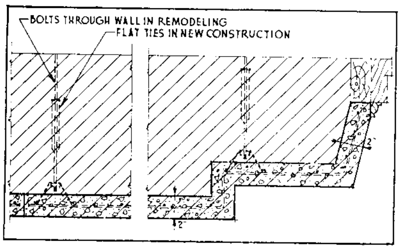


Fig. 23. Details for erection of large, thin precast slabs in new and old construction.

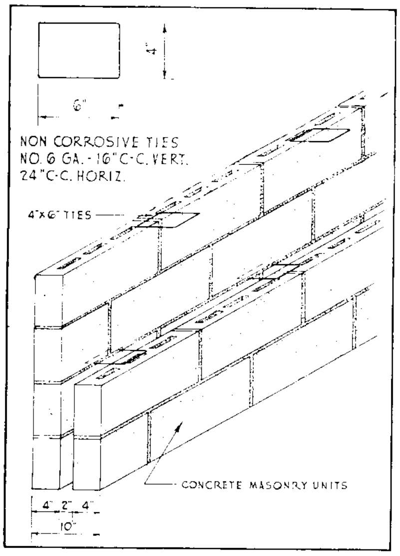


Fig. 24. Hollow double concrete-masonry wall construction, approved by F. H. A., consists of two 4-in. hollow concrete-masonry walls, separated by a 2-in. air space, and tied with a closed rectangular tie of No. 6-gage rust-resisting or rust-protected wire, spaced 24 in. horizontally and 16 in. vertically.

Silverstein Photos

Fig. 25. Interior and exterior faces of hollow double concrete-masonry walls are usually finished with a portland cement paint.

not only lend themselves to modern architectural types, but they expedite construction under ordinary methods and reduce to a minimum that bugaboo of all masonry work—joints. One recent job involving 900 sq. ft. was done with only 16 precast slabs. The special anchoring required for such large units is provided for by loops or other devices molded into the back of the slabs. One very satisfactory system of anchoring is shown in Fig. 23.

For many years manufacturers of "cast stone" confined their efforts to duplication of the familiar textures and finishes of ordinary stonework. In so far as this involved cutting and rubbing, it eliminated the extremely hard aggregates, and it is these which offer the greatest possibilities for color and texture. Through the development of a technic involving close control of the sizing and placement of the aggregate particles and their subsequent exposure by brushing, a surface of unusually pleasing texture and excellent wearing qualities is produced at reasonable cost. This method of finishing permits the use of even the hardest aggregates, and thus opens a whole field of beautiful stones which have heretofore not been available for architectural purposes. This type of finish is natural to concrete.

An entirely new source of color for architectural treatments is provided through manufactured aggregates. These are ceramics and certain porcelains, and have all the color range as well as the recognized durability of these types of material. As might be expected, the price per ton is rather high, but when used as a facing on precast slabs, the cost per sq. ft. of surface is moderate, and especially so in relation to the effects obtainable. These manufactured aggregates were developed expressly to meet a need for brighter, more varied, and more permanent colors for concrete.

The technic of their use, from the standpoint of design, is essentially that of mosaics or flat architectural glass, rather than that of terra cotta. Ordinarily, colors in flat ornamental designs are separated by ridges on the mold which leave shallow incisions in the finished surface. These incisions, if noticeable at all, serve merely to sharpen the details of the pattern.

Use of vibration in the manufacture of precast concrete has been largely responsible for the development of a highly polished type of material which is finding increasingly wide application where fine effects are desired at moderate cost (Fig. 22). A durable polish can be applied to concrete only when the aggregate is of the granite type and the surface has a minimum of cement paste showing. With proper grading of aggregate and vibration, it is possible to produce cast stone with a surface composed of 85% aggregate particles in which a tinted cement matrix can scarcely be perceived. As would be expected, this type of concrete is unusually dense and strong, compressive strengths of 15,000 lbs. p.s.i. being readily attained. The standard thickness is 2 in., with few restrictions as to size.

Concrete masonry and floors

The ever-recurring demand for more and more economy in wall construction, especially in the erection of houses (both single-family and large-scale), has resulted in considerable thought being given to developing lower-cost types of concrete masonry. Concrete-masonry manufacturers have met demand by supplying units adapted to requirements of residential architecture. Extensive use is being made of concrete masonry, as well as cast-in-place concrete walls, which are simply painted with portland cement paint as the exterior finish.

The hollow double wall has been developed to afford greater resistance to passage of heat and cold. This type often consists of two 4-in. concrete-masonry walls, separated by a 2-in. continuous air space and tied together with metal ties (Fig. 24). The chief economy of this method of construction lies in the fact that plaster, or furring and plaster, may be omitted and both the interior and exterior faces of the wall may be given a portland cement-paint finish (Fig. 25).

This type of wall construction has recently been tested at the National Bureau of Standards and has proved to possess a high degree of structural stability, and is now recognized by the Federal Housing Administration as an acceptable method of construction.

The development of lightweight concrete masonry has greatly extended its use as back-up for other materials. Two types of brick-faced concrete-masonry walls have been developed: one with the brick on edge, and the other using split brick (Fig. 26). Both are bonded to a concrete-masonry backing. For a nominal 8-in. wall, a 6 in. thick back-up unit is used. For a 12-in wall, a 10 in. thick back-up unit is employed. Because of the lesser quantity of face brick required, this construction offers a considerable saving in material as compared to the conventional brick-faced wall.

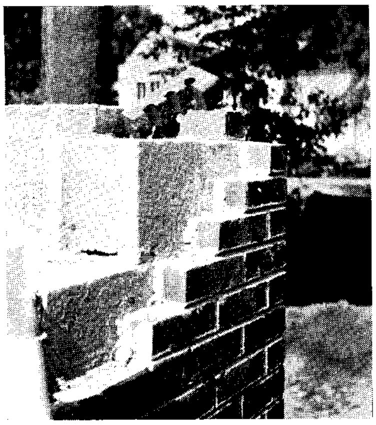


Fig. 26. Brick-faced concrete masonry using split brick. A saving in construction cost results from smaller quantity of face brick required.

Concrete joists have had a marked influence on the use of concrete floors in residences and other light-occupancy buildings. A recent innovation in the manner of placing precast floor joists will doubtless find favor with architects and builders, especially where exposed beams are desired. A variation is obtained by placing two joists side by side or with a small space between them—the intervening space being filled with concrete—and then increasing the space between the pairs of joists as shown in Fig. 27. This wider spacing of joists gives the appearance of beams rather than that of joists, as is the case when the joists are spaced singly in the usual manner.

Fig. 27. Where beamed ceiling effect is desired, two concrete joists are placed side by side with an increased space between pairs of joists.

Where the conventional smooth ceiling is desired, a method of precast-unit floor construction has been developed using a hollow unit 6 in. thick and 12 in. wide (Fig. 28). These are cast in one piece in a length sufficient to span the distance between supports. Each unit is cast with two longitudinal round cores about 4 in. in diameter. Laid side by side, the precast units cover the entire floor area. Due to the fact that these units are cast in accurate forms, they are true in dimension, and the joints between the units are close-fitting and true to line.

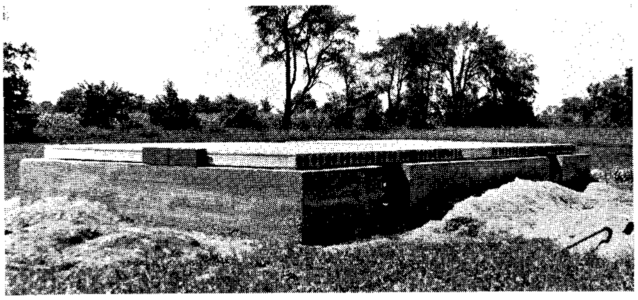


Fig. 28. Installation of hollow precast floor units.

The underside of the units presents an attractive ceiling surface which may be finished by applying cement paint (Fig. 29). Any slight variation in joints between the units in the top of the floor can be corrected by grinding with a standard terrazzo grinding machine. Generally the surface of the floor is surfaced with all-over carpeting, linoleum, or similar material. However, a wood floor finish may be easily applied if desired.

Fig. 29. The underside of the floor construction with hollow precast concrete units presents a smooth ceiling and may be finished by applying cement paint.

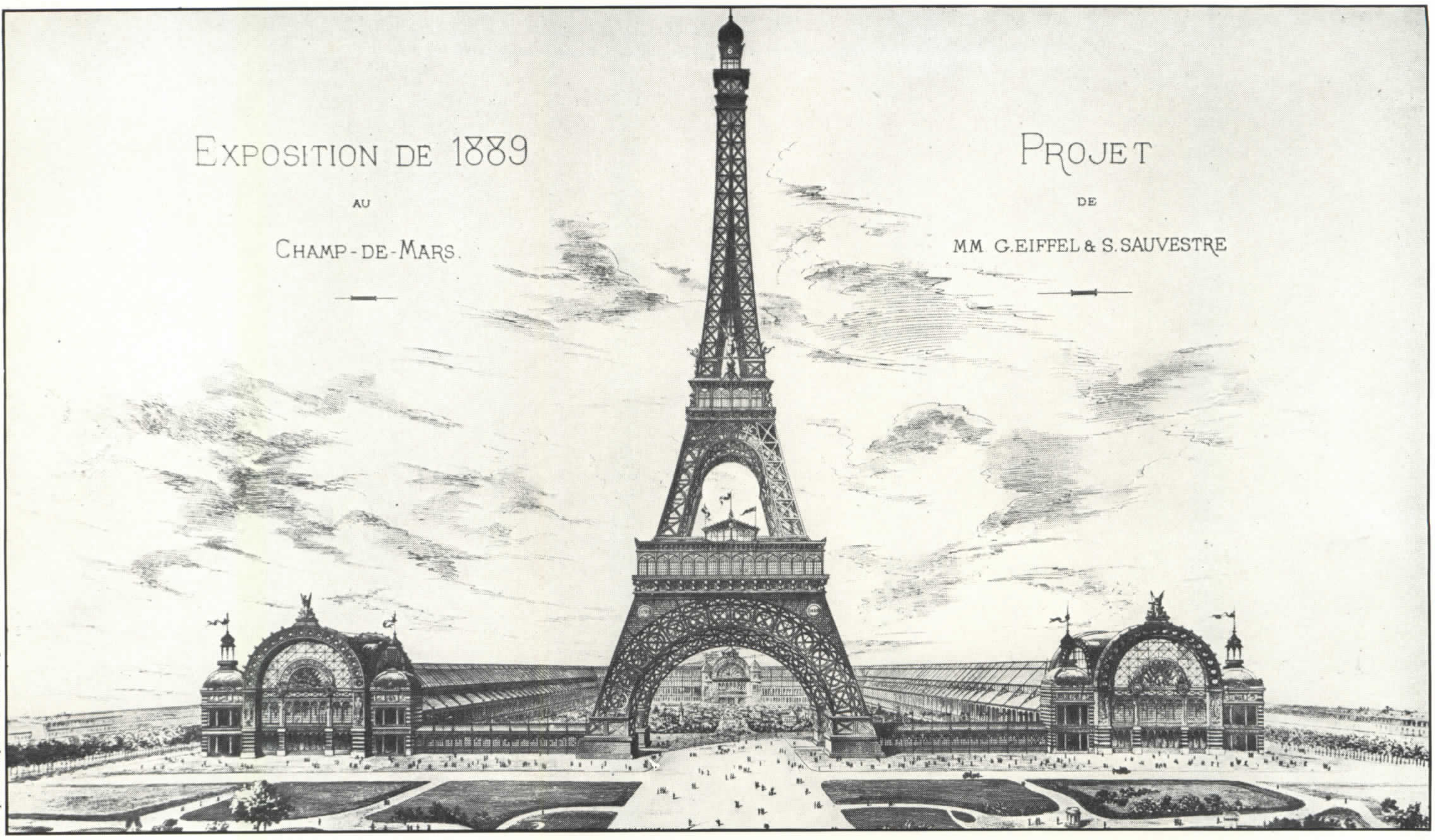


Fig. 1. Gustave Eiffel's presentation drawing for the 1889 Paris Exposition: S. Sauvestre was the associate architect.

THE EIFFEL TOWER: A VICTORY FOR PROGRESSIVE DESIGN

National Park Service

Fig. 2. The framework of the Statue of Liberty, dedicated in 1886, was designed by Gustave Eiffel.

THE HISTORY of architecture is replete with building designers who were so far "ahead of their times" as to be vindicated only at a later date—and usually long after their death. But much smaller is the number of designers who have been able to overcome the cultural and technical opposition of their period, and force their projects through to completion. Gustave Eiffel is one such designer, and his famous tower in Paris one such project. Conceived in the middle Eighties of the last century by the energetic and outspoken engineer, the project was begun in March 1887 and finished for the Paris Exposition of 1889; and the Republic of France is this year celebrating its fiftieth anniversary.

From its very inception until long after its completion, the Tower was the center of a controversy so spirited as to appear almost incredible in retrospect. Charges and countercharges were hurled. Prominent Frenchmen in all walks of life plunged into the fray. Alexander Dumas, the younger, and Guy de Maupasant, were among the famous artists and writers who signed a manifesto protesting its erection; and the poet Verlaine is said never to have visited that portion of Paris after its erection. Newspapers took up editorial positions on the subject, one of them—*Le Figaro*—going so far as to publish special issues on the subject. Several owners of property between the Champ de Mars (location of tower) and the Seine, instituted suit against Eiffel, insisting that the courts prohibit construction of so dangerous a structure.

What contemporary architects and engineers thought of Eiffel's project is not so well recorded. Gustave Eiffel had achieved an international reputation as a designer of precedent-breaking structures. Already completed was his famous bridge at Garabit, France, from which he evolved the general framing principles applied in the Tower (Fig. 4). It was he who implemented the grandiose scheme of the sculptor Bartholdi for the 306 ft. high Statue of Liberty (Fig. 2). He had already designed railroad stations all

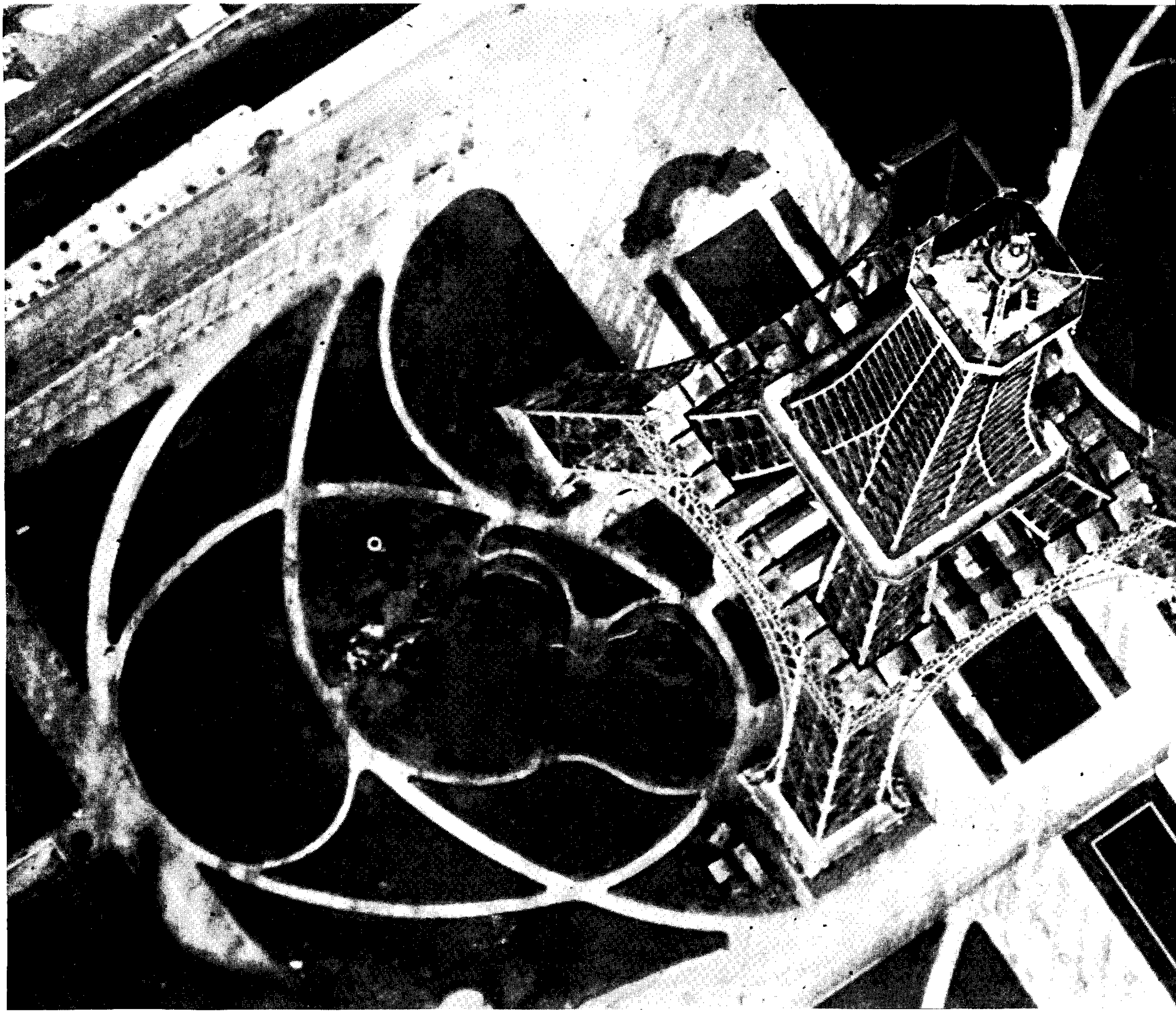


Fig. 3. First aerial view of the Tower, a photograph taken from a captive balloon.

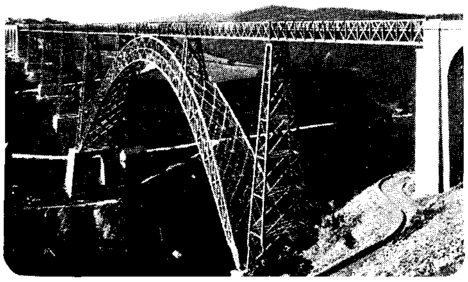


Fig. 4. Eiffel's bridge at Garabit, in which he perfected the design principles later used in the Tower. Note that as the arch widens in plan, it narrows in section.

over the world, a great department store in Peru, and the locks of the ill-fated French canal in Panama.

Whatever opposition he encountered among his colleagues, it was—unlike the artists' and writers' manifesto—wisely not confirmed in print. Photographs of that period indicate a constant stream of architects and engineers, top-hatted and frock-coated, gravely inspecting the excavations, the foundations, the superstructure. By the time the Tower was finished, there was little doubt as to where technical opinion stood (although Charles Garnier, architect of the Paris Opera, was at that late date circulating a petition to have it demolished by the French Government). Thomas A. Edison was quick to praise Eiffel as a "brave builder of so gigantic and original (a) specimen of modern engineering, from one who has the greatest respect and admiration for all engineers." And Eugène Henard wrote that "the numerous examples of metal construction which have been built by the Exposition of 1889 . . . demonstrate victoriously that iron is one of the most precious aids to modern architecture."*

Gustave Eiffel almost single-handedly overcame all opposition. He shrewdly observed that "in spite of the violent attacks to which my project had been exposed, public opinion was on my side, and that crowd of unknown friends were ready to honor this bold

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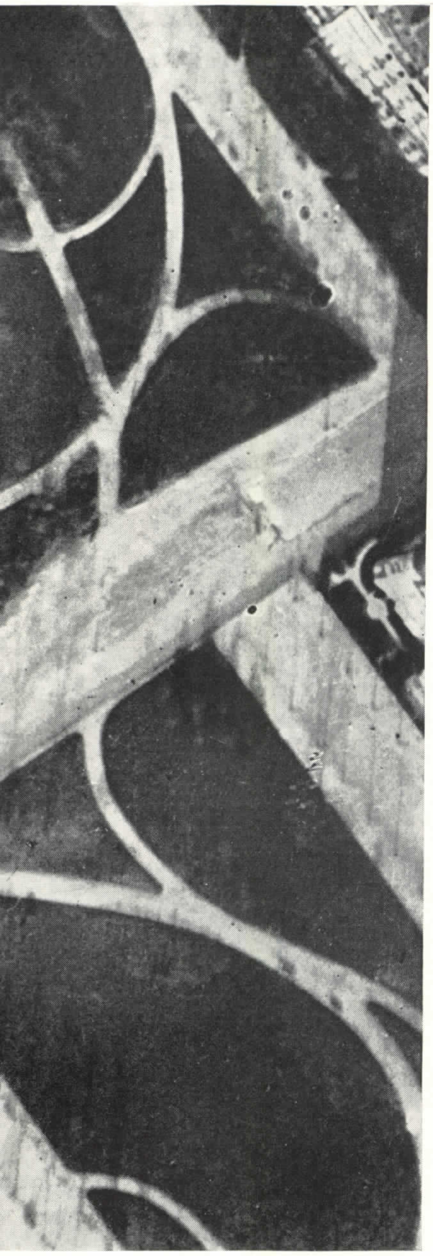
*"La Tour de 300 Metres", Le Genie Civil, July 6, 1889.



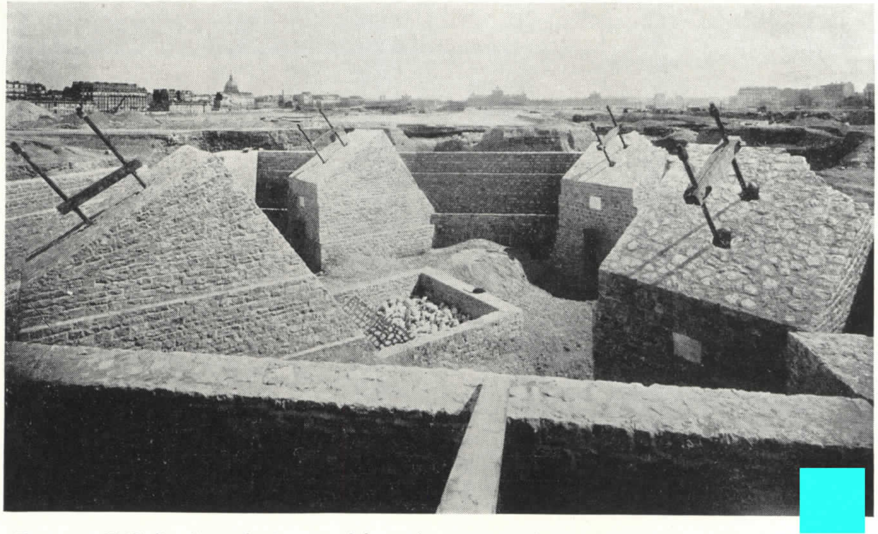


Fig. 5. Eiffel's foundations, although executed in stone masonry, anticipate reinforced-concrete design to a surprising degree. Photo taken April 20, 1887.

Fig. 6. Although worked in wrought iron, Eiffel's detailing of structural members would be quite adaptable to modern riveted steel construction. Photo taken July 18, 1887.

enterprise as soon as it took form. The imagination of men was struck by the colossal dimensions of the edifice, especially in the matter of height."* And when the French Government, only half-convinced of the soundness of his project, voted him $292,000 of an estimated cost of well over $1,000,000, Gustave Eiffel supplied the balance from his own pocket.

His faith in popular recognition on his project proved well-justified. In the single Exposition season of 1889, gate receipts netted almost 6,000,000 gold francs (approximately six-sevenths of the cost); and the tower has continued to be France's most popular

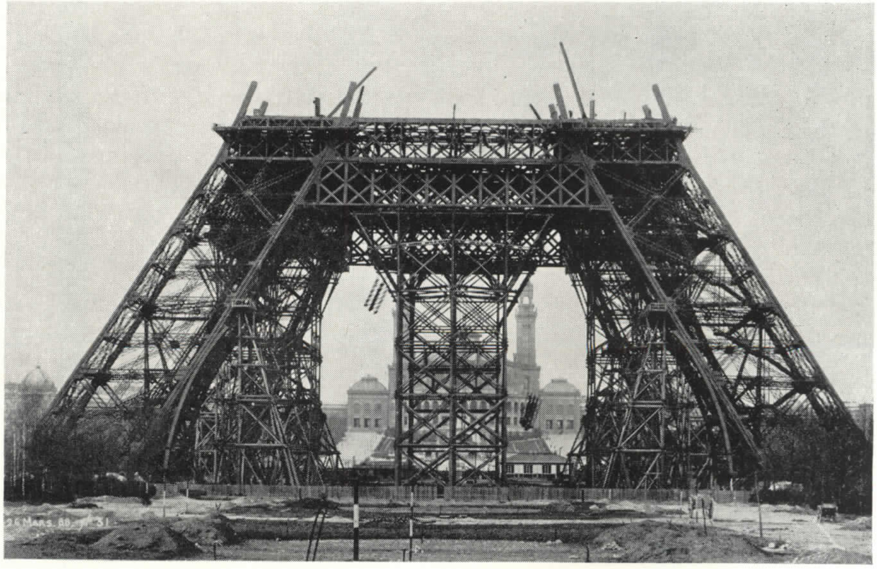


Fig. 7. When the superstructure reached the first platform level, Eiffel's worst worries were over and worst critics silenced. Photo taken March 26, 1888.

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*"The Eiffel Tower", by G. Eiffel; 1889 Report of the Smithsonian Institute, Washington, D. C.

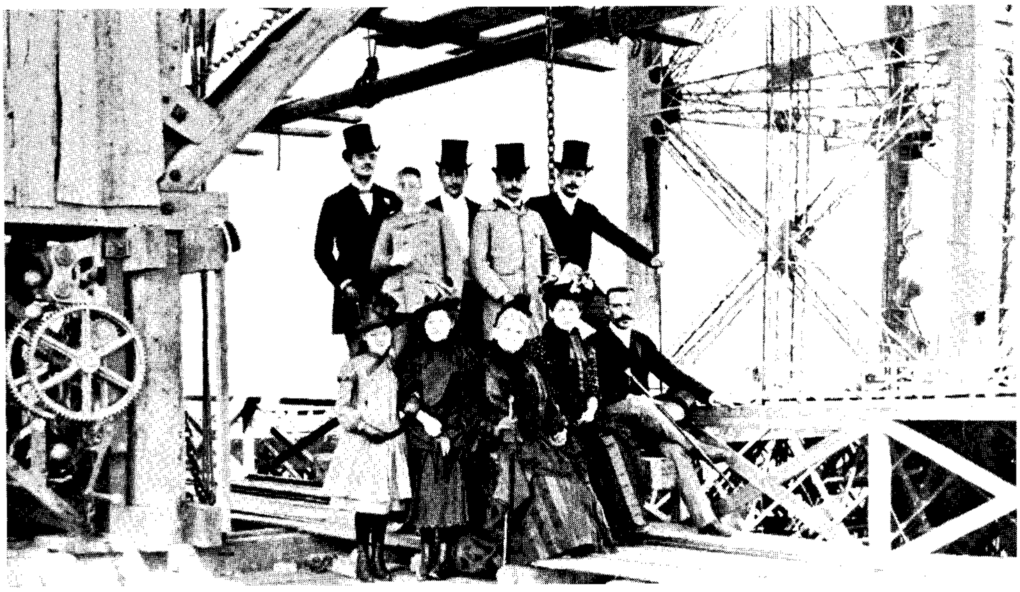

Fig. 8. Most dramatic illustration of technological lag against which he fought is the contrast between Eiffel's light and economic metal superstructure (right) and heavy, archaic timber scaffolding (left). Photo taken during construction.

public structure, leading even Versailles and the Louvre with over 18,000,000 visitors to date.

Dramatic as were the public issues revolving around the Tower, however, Eiffel's mastery of the technical problems confronting him is even more interesting. In beginning a structure of this magnitude, he was faced with an absence of almost all those factors which the modern building designer considers essential—a wide choice of specialized materials, industrial sources which could guarantee their prompt and regular delivery, trained workmen, developed fabrication methods, etc., etc.

In evolving his general design, Eiffel drew particularly upon his bridge-building experience (Fig. 4). By 1885 he had come "to believe that it was possible to construct these (pylons) without any great difficulty to a much greater height than any hitherto made. . . . The fundamental idea of these pylons or great archways is based on a method of construction peculiar to me, of which the principle consists of giving to the edges of the pyramid a curve of such a nature that this pyramid shall be capable of resisting the force of the wind, without necessitating the junction of the edges by diagonals, as is usually done." Coincidentally, Eiffel selected his materials; and it is worth noting that—although the spread of the Bessemer process had already made steel generally available—Eiffel chose wrought iron, whose properties he found "so remarkable, since it may be as readily employed in tension as in compression, and can be put together perfectly by riveting . . . the execution presents no insurmountable difficulties. Moreover, metal constructions can now be planned with such accuracy as to sanction the boldness which results from full knowledge."

And although portland cement was widely used and its reinforcing with steel already discovered, he conservatively stuck to stone masonry for his foundations, which rested in turn on concrete mats (Fig. 5). Although he emphasized his faith in these foundations, he evidently felt they were not ideal and cannily provided slots for 800-ton hydraulic presses in each of the four piers.

In the actual construction of the Tower, he solved many of his problems in an astonishingly modern manner. He made a clear distinction between shop and field operations, and had the entire 7000 tons of iron work completely shop-fabricated—including the punching of all holes and much of the riveting. This enabled him to use a relatively small group (250) of unskilled men at the site.

But the most dramatic aspect of Eiffel's design lies not so much in the materials he used as the way in which he used them. Satisfied though he may have been with stone masonry, his foundation design anticipates contemporary reinforced-concrete work to a marked degree (Fig. 5). Indeed, the 4-in. wrought-iron bars, which serve to fix superstructure to foundations, also, "by means of iron cramps, unite almost all parts of the masonry"—i.e., serve as a sort of reinforcing. In the same fashion, his design of the various wrought-iron members anticipates—in both profile and general shape—contemporary members of modern structural steels. (Fig. 6).

He designed his own scaffolding system, making elaborate provisions for the workmen's safety. "It was feared that, unaccustomed to a very high scaffolding, few could be found not subject to vertigo. But in the Tower they did not work high in the air with an open and dangerous footing. They were on platforms 41 feet wide, and as calm as on the ground."*

Eiffel devised his own winches and rigging; and it is precisely here that the technicological lag against which he fought is most clearly illustrated. For there is a time lag between the framing of the tower itself and the scaffolding and rigging of at least half a century (Fig. 8). By a careful organization of fabrication and erection processes, Eiffel was able to get control over the design, quality, and delivery-timing of *his iron* work. But the industrial resources of his time simply did not permit a scaffolding and rigging system of similar efficiency.

A review of Eiffel's work on the Tower seems thus worthwhile on at least one basis. It indicates that—although there has never been a period when all the technical, economic, and cultural factors involved in the design and construction of a building are *evenly developed*—there are occasional designers who, by the very breadth of their understanding of these factors, can master them. An encouraging thought, in times like the present.

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*"The Eiffel Tower", by William A. Eddy; Atlantic Monthly, June 1889.

CURRENT TRENDS OF BUILDING COSTS

Compiled by Clyde Shute, Manager, Statistical and Research Division, F. W. Dodge Corporation, from data collected by E. H. Boeckh & Associates, Inc.

CURVES INDICATE trend of the combined material and labor costs in the field of residential frame construction. The base line, 100, represents the U. S. average for 1926-1929 for residential frame construction.

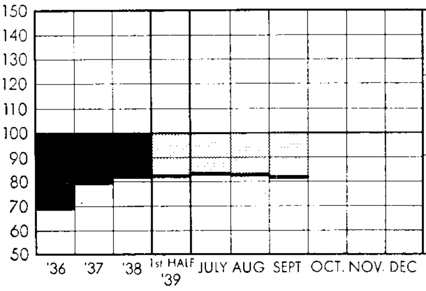
Tabular information gives cost index numbers for the nine common classes of construction. The base, 100, in each of the nine classes represents the U. S. average for 1926-1929 for each particular group. The tables show the index numbers for the month for both this year and last.

Cost comparisons, as percentage differences for any particular class of construction, are possible between localities or periods within the same city by a simple process of dividing the difference between the two index numbers by one of them. For example: if index for city A is 110 and index for city B is 95 (both indexes for A and B must be for the same class of construction), then costs in A are approximately 16% higher than in B $\left(\frac{110-95}{95} = 0.158.\right)$ Conversely it may be said that costs in B are approximately 14% lower than in A $\left(\frac{110-95}{110} = 0.136.\right)$

Similar cost comparisons, however, cannot be made between different classes of construction since the index numbers for each class of construction relate to a different U. S. average for 1926-1929.

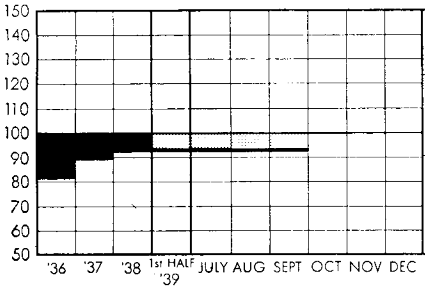
CONSTRUCTION COST INDEX U. S. average, including materials and labor, for 1926 - 1929 equals 100.

ATLANTA



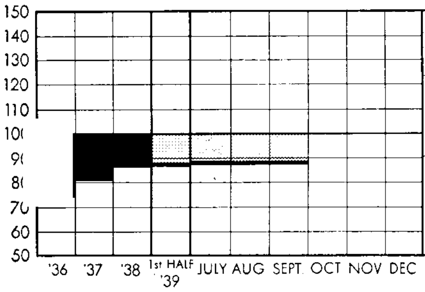
	Sep.'38	Sep.'39
Residences		
Frame	82.3	81.9
Brick	85.6	85.4
Apartments		
Br & Wood	85.9	85.3
Br & Conc.	96.1	94.6
Br. & Steel	96.3	94.1
Comm. & Fact.		
Frame	80.0	79.5
Br. & Wood	88.3	88.2
Br. & Conc.	98.2	97.0
Br. & Steel	96.7	93.0

BALTIMORE



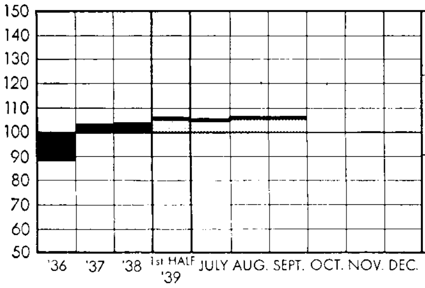
	Sep.'38	Sep.'39
Residences		
Frame	91.7	93.2
Brick	94.5	95.0
Apartments		
Br & Wood	93.7	95.5
Br & Conc.	97.5	100.1
Br & Steel	97.4	99.8
Comm. & Fact.		
Frame	91.7	93.7
Br & Wood	95.1	96.8
Br & Conc.	97.8	101.2
Br. & Steel	98.1	102.5

BIRMINGHAM



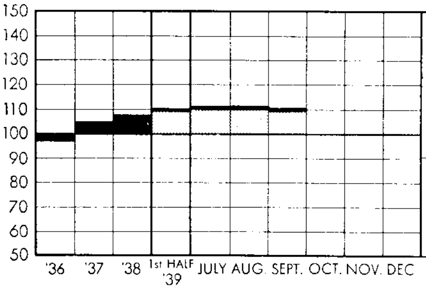
	Sep.'38	Sep.'39
Residences		
Frame	85.7	87.7
Brick	88.9	90.8
Apartments		
Br & Wood	89.3	91.4
Br & Conc.	95.1	96.4
Br. & Steel	92.0	96.5
Comm. & Fact.		
Frame	83.1	84.4
Br & Wood	93.7	94.9
Br. & Conc.	96.1	96.2
Br & Steel	94.5	95.9

BOSTON



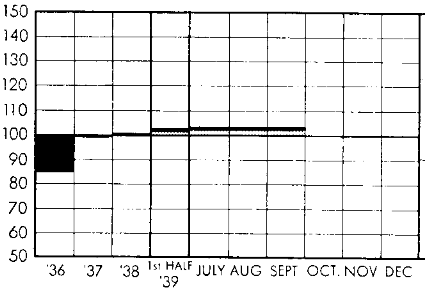
	Sep.'38	Sep.'39
Residences		
Frame	105.9	106.1
Brick	111.3	110.3
Apartments		
Br & Wood	109.1	109.8
Br & Conc.	115.8	115.9
Br & Steel	112.8	113.0
Comm. & Fact.		
Frame	105.6	105.6
Br & Wood	110.1	111.4
Br & Conc.	118.2	118.4
Br. & Steel	116.9	117.4

CHICAGO



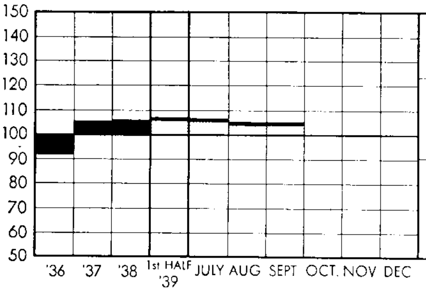
	Sep.'38	Sep.'39
Residences		
Frame	109.5	110.0
Brick	111.7	112.3
Apartments		
Br. & Wood	110.2	110.8
Br. & Conc.	122.3	124.0
Br. & Steel	117.8	118.8
Comm. & Fact.		
Frame	112.9	113.4
Br. & Wood	108.8	109.5
Br. & Conc.	126.9	128.4
Br. & Steel	121.4	122.7

CINCINNATI



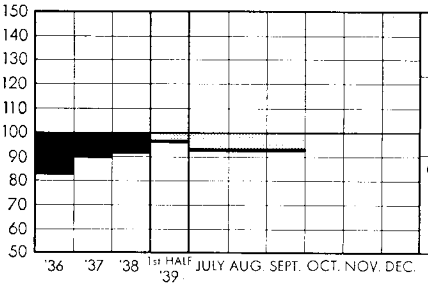
	Sep.'38	Sep.'39
Residences		
Frame	99.1	103.3
Brick	102.7	106.4
Apartments		
Br & Wood	102.5	105.8
Br & Conc.	112.1	114.8
Br & Steel	108.6	110.7
Comm. & Fact.		
Frame	98.6	103.0
Br & Wood	114.6	107.3
Br & Conc	114.3	118.2
Br & Steel	112.6	113.4

CLEVELAND



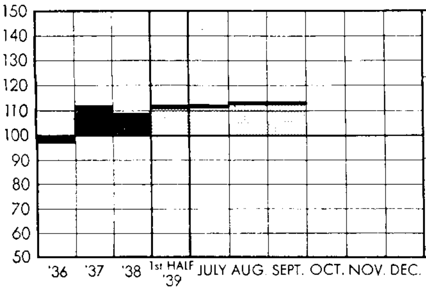
	Sep.'38	Sep.'39
Residences		
Frame	105.2	104.2
Brick	109.1	108.3
Apartments		
Br & Wood	109.0	108.1
Br & Conc.	114.5	115.6
Br & Steel	112.0	112.6
Comm. & Fact.		
Frame	106.3	105.0
Br & Wood	109.6	108.9
Br & Conc.	116.7	118.8
Br. & Steel	116.8	117.7

DALLAS



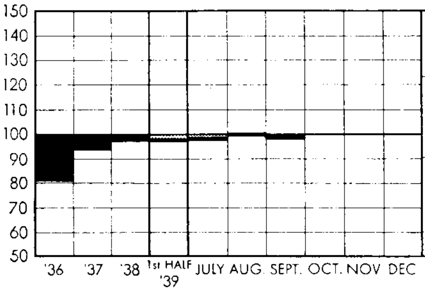
	Sep.'38	Sep.'39
Residences		
Frame	91.9	93.2
Brick	93.0	94.7
Apartments		
Br & Wood	93.5	95.8
Br. & Conc.	98.5	97.8
Br. & Steel	98.5	99.6
Comm. & Fact.		
Frame	91.4	92.5
Br. & Wood	93.9	95.2
Br. & Conc.	98.2	98.7
Br. & Steel	100.3	101.3

DENVER



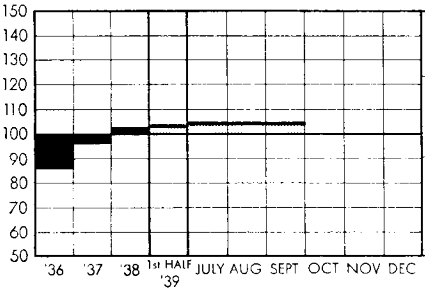
	Sep.'38	Sep.'39
Residences		
Frame	111.0	112.4
Brick	111.4	112.4
Apartments		
Br. & Wood	106.3	111.6
Br. & Conc.	114.7	116.7
Br. & Steel	113.1	114.6
Comm. & Fact.		
Frame	113.4	114.8
Br. & Wood	107.9	109.3
Br. & Conc.	116.0	119.1
Br. & Steel	115.7	117.3

DETROIT



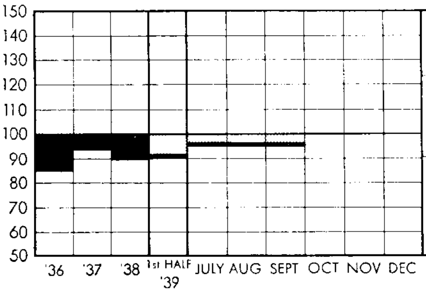
	Sep.'38	Sep.'39
Residences		
Frame	96.2	99.6
Brick	100.8	103.1
Apartments		
Br & Wood	101.1	103.3
Br & Conc.	108.1	108.0
Br. & Steel	107.1	107.0
Comm. & Fact.		
Frame	95.8	99.5
Br. & Wood	103.0	104.3
Br. & Conc.	109.4	109.3
Br. & Steel	111.9	110.3

KANSAS CITY



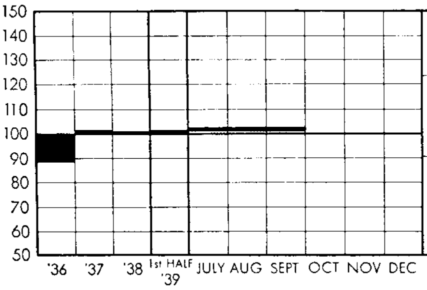
	Sep.'38	Sep.'39
Residences		
Frame	102.1	104.0
Brick	107.9	109.5
Apartments		
Br & Wood	107.7	109.3
Br & Conc.	118.0	118.0
Br & Steel	115.0	115.0
Comm. & Fact.		
Frame	101.6	103.0
Br & Wood	110.9	112.6
Br & Conc	121.3	121.5
Br & Steel	119.1	119.8

LOS ANGELES



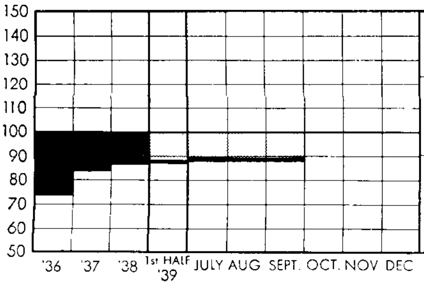
	Sep '38	Sep.'39
Residences		
Frame	91.1	95.8
Brick	96.9	97.5
Apartments		
Br & Wood	96.8	97.8
Br & Conc	103.1	104.0
Br & Steel	104.0	105.2
Comm. & Fact.		
Frame	95.6	95.4
Br & Wood	95.5	97.2
Br & Conc	104.1	105.5
Br & Steel	103.2	106.5

MINNEAPOLIS



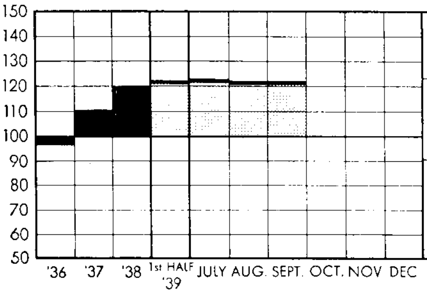
	Sep.'38	Sep.'39
Residences		
Frame	100.4	101.6
Brick	106.4	104.8
Apartments		
Br & Wood	103.2	104.0
Br & Conc.	112.7	113.6
Br & Steel	110.5	110.7
Comm. & Fact.		
Frame	101.2	102.3
Br & Wood	102.8	103.5
Br. & Conc.	116.3	117.2
Br & Steel	114.3	114.5

NEW ORLEANS



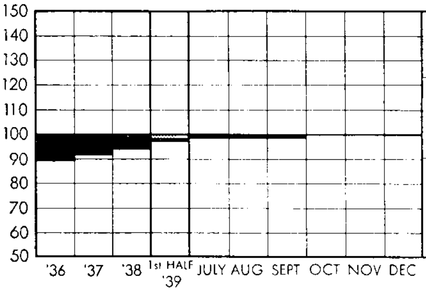
	Sep.'38	Sep.'39
Residences		
Frame	86.8	88.6
Brick	87.9	90.4
Apartments		
Br & Wood	89.0	91.3
Br & Conc.	92.8	96.0
Br & Steel	96.0	98.6
Comm. & Fact.		
Frame	85.5	87.8
Br. & Wood	89.6	91.8
Br. & Conc.	91.9	96.1
Br. & Steel	96.0	99.1

NEW YORK



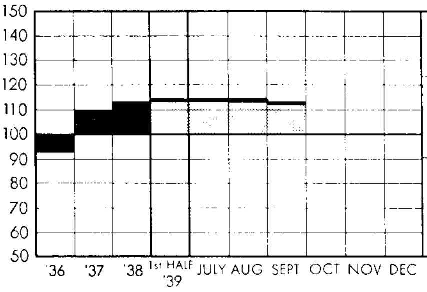
	Sep.'38	Sep.'39
Residences		
Frame	120.5	122.0
Brick	122.8	123.5
Apartments		
Br & Wood	120.8	122.7
Br & Conc.	129.9	130.8
Br & Steel	125.1	126.0
Comm. & Fact.		
Frame	123.9	125.2
Br & Wood	117.9	120.1
Br. & Conc	132.7	133.7
Br. & Steel	129.0	130.2

PHILADELPHIA



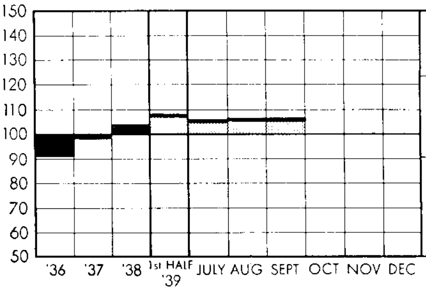
	Sep.'38	Sep.'39
Residences		
Frame	95.0	99.1
Brick	100.4	102.3
Apartments		
Br & Wood	100.5	102.8
Br & Conc.	105.1	105.6
Br & Steel	102.5	104.4
Comm. & Fact.		
Frame	93.9	97.6
Br & Wood	103.4	105.2
Br & Conc.	107.5	106.8
Br & Steel	104.0	106.0

PITTSBURGH



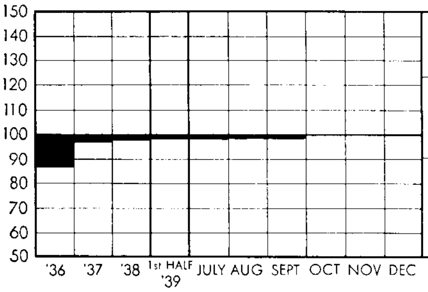
	Sep '38	Sep.'39
Residences		
Frame	113.2	113.5
Brick	116.8	116.1
Apartments		
Br & Wood	115.0	115.7
Br & Conc	117.0	117.5
Br & Steel	113.5	114.2
Comm. & Fact.		
Frame	113.4	113.9
Br & Wood	116.0	116.5
Br & Conc	118.8	119.2
Br & Steel	116.4	116.9

ST. LOUIS



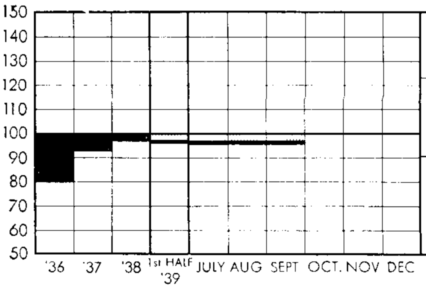
	Sep.'38	Sep.'39
Residences		
Frame	105.1	105.9
Brick	108.8	109.3
Apartments		
Br & Wood	108.7	109.0
Br & Conc.	118.5	118.4
Br & Steel	116.2	115.9
Comm. & Fact.		
Frame	105.4	106.5
Br & Wood	109.0	109.7
Br & Conc	119.8	119.6
Br & Steel	119.8	118.3

SAN FRANCISCO

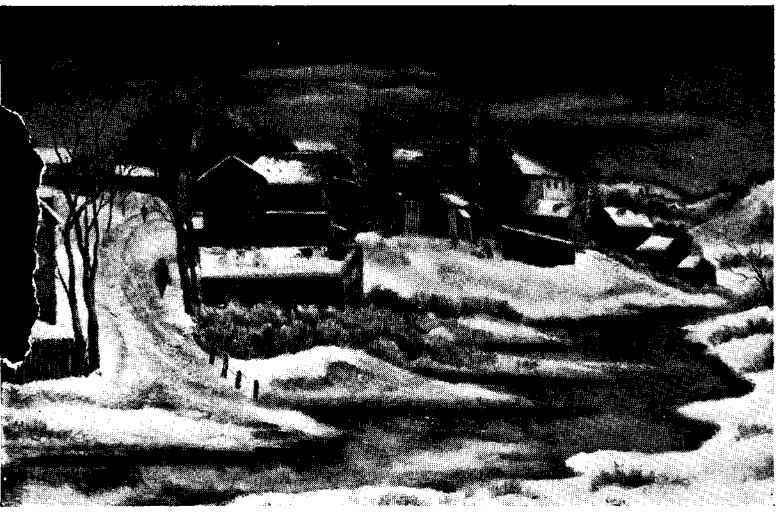


	Sep.'38	Sep.'39
Residences		
Frame	97.5	98.7
Brick	105.4	104.7
Apartments		
Br & Wood	102.3	104.3
Br & Conc.	116.0	116.8
Br & Steel	112.5	113.5
Comm. & Fact.		
Frame	95.9	97.1
Br & Wood	105.9	107.2
Br & Conc	121.0	121.2
Br & Steel	116.2	114.4

SEATTLE



	Sep.'38	Sep.'39
Residences		
Frame	95.4	96.0
Brick	103.4	103.8
Apartments		
Br & Wood	103.0	103.1
Br & Conc.	119.9	118.5
Br & Steel	115.6	114.1
Comm. & Fact.		
Frame	92.8	93.7
Br & Wood	107.8	107.8
Br. & Conc.	126.2	124.5
Br. & Steel	120.4	117.0



"Winter Morning," by Emil Ganso, from *American Art Today,* in both the Catalog and the Portfolio of 16 color reproductions.

REVIEWS OF NEW BOOKS

AMERICAN ART TODAY, edited and published by the National Art Society. New York. Catalog: 354 pp. 9 by 11¾ in. Price $3.50. Portfolio of 16 color reproductions 11½ by 14 in. Price $1.50.

AMERICAN ART TODAY, the official catalog of the contemporary American art exhibition at the New York World's Fair, should prove an outstanding contribution to the "World of Tomorrow." Perhaps never before, in the history of exhibitions of painting, sculpture, or the graphic arts, has a work of this size and importance appeared. It is almost poetic justice to find that the Fair, which had originally been planned without any thought of specific buildings dedicated to the showing of art, should end with a contemporary exhibtion of this sheer magnitude and—to cap the climax—with this colossal publishing job by the newly formed National Art Society.

When an exhibition contains the work of over 1,150 artists, no one is ordinarily hopeful of obtaining a catalog in which more than a fraction of them are pictorially represented. The publishers of *American Art Today,* however, undertook to illustrate one example of the work of every artist represented in the show, in a clear and good-sized reproduction. They have succeeded in accomplishing this almost impossible task in a book that is well-composed, solidly bound, and competently printed.

It might seem, at first glance, that so much material could only confuse the earnest seeker after information as to the character of American art today, but this is not the case. The catalog, which contains 32 pages of explanatory text, begins with an extensive chart of the various regions of the United States from which the works were drawn, together with the names of the jury members responsible for the selections. An examination of these names reveals the fact that the juries are composed primarily of artists, with here and there a museum director or critic acting in an advisory capacity—a rather unusual and democratic reversal of the ordinary procedure. In other words, this exhibition is not the result of the taste of any single individual or clique, but rather a reflection of the collective taste of American painters, sculptors, and print makers.

After the jury listings, the catalog presents a simply but effectively written analysis of the exhibition by its director, Holger Cahill. In this essay, Mr. Cahill attempts to set forth the scope of the exhibition, the position of the artist in American society, as well as what is meant by such terms as "regionalism" or "the American scene." With this accomplished, he proceeds to break the exhibition down into the various technical divisions represented therein: the conservative or traditional painters, the "modernists," the "social-content" artists, etc. From the point of view of clarification, this essay is one of the most valuable contributions in the entire catalog.

In addition to Mr. Cahill's comprehensive explanation, each of the three sections of the mass of illustrations that follows is prefaced by a brief introduction on the part of the painters', sculptors', and graphic artists' committees. The painters are represented by Stuart Davis, Jonas Lie, and Eugene Speicher; the sculptors by John Gregory, Paul Manship, and Wiliam Zorach; and the graphic artists by John Taylor Arms, Anne Goldthwaite, and Hugo Gellert.

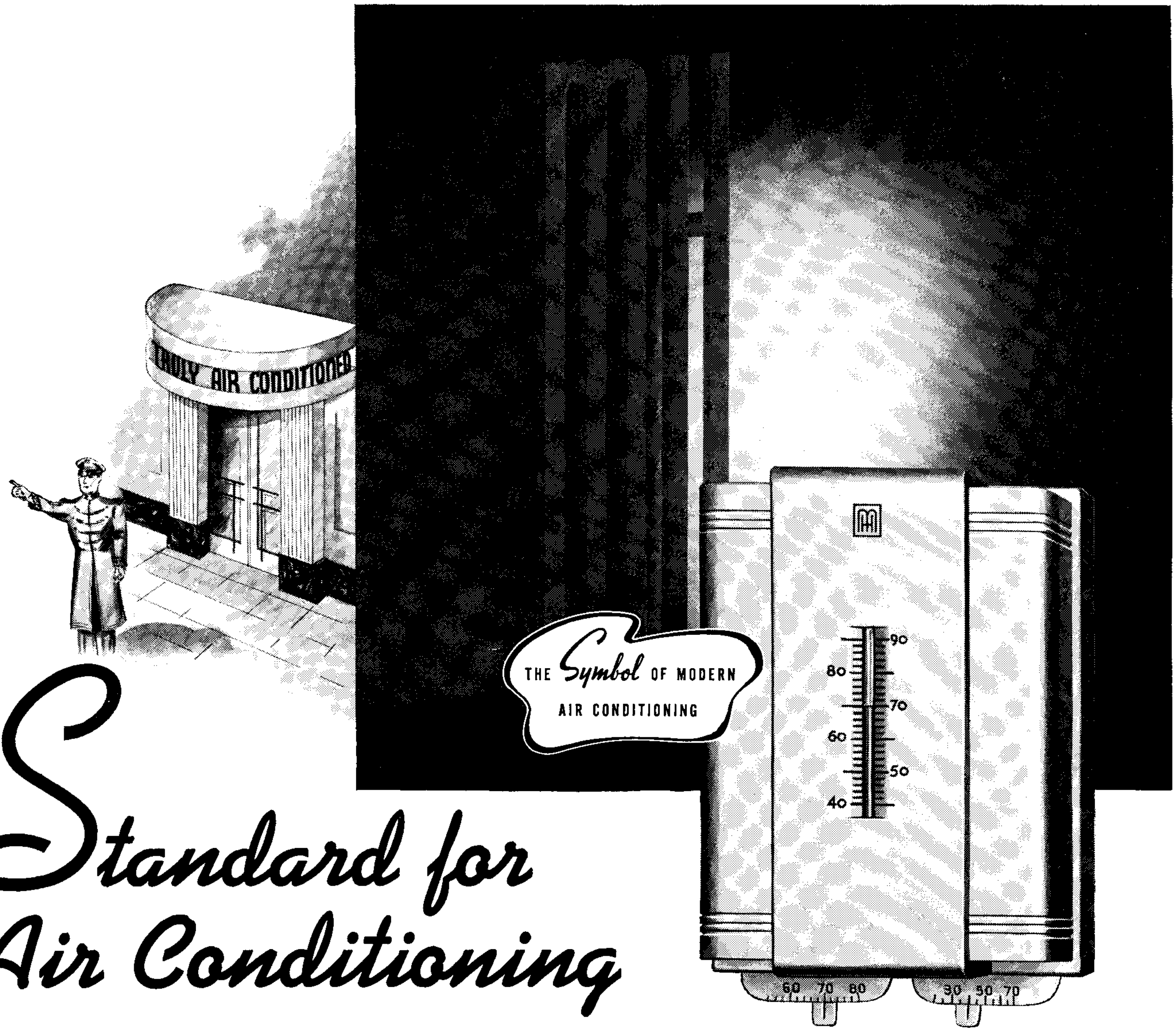
In looking over this entire production, it becomes increasingly clear that this exhibition marks the beginning of a process of crystallization in American art. For the past few years, art in America has been changing from a strictly metropolitan and haphazard kind of thing to something more integrated with the life of the whole country.

Less than a decade ago, the situation of American art was indeed desperate, a condition reflected in the absract and highly individualistic character of the artist's production. For the most part, the painter, sculptor, or graphic artist followed the old-fashioned techniques of the academies or followed the various branches of French or German modernism. In other words, the American artist had relatively little to do with America.

Today, as we survey the results of the first nationwide census of American art in *American Art Today,* it is evident that a good many things have happened. American art is no longer an exclusively big-city product, but is being produced with fine results in countless small centers.

As we thumb the pages of the *American Art Today* catalog, we see how American artists, and particularly the painters and print-makers, have taken to the fields and the highways, have invaded the factory and workroom, have gone into the slums and onto the docks. These things constitute life in America, and consequently its art has become the expression of all of these elements and not merely a type of abstract still-life or figure composition.

(*Continued on page* 118)



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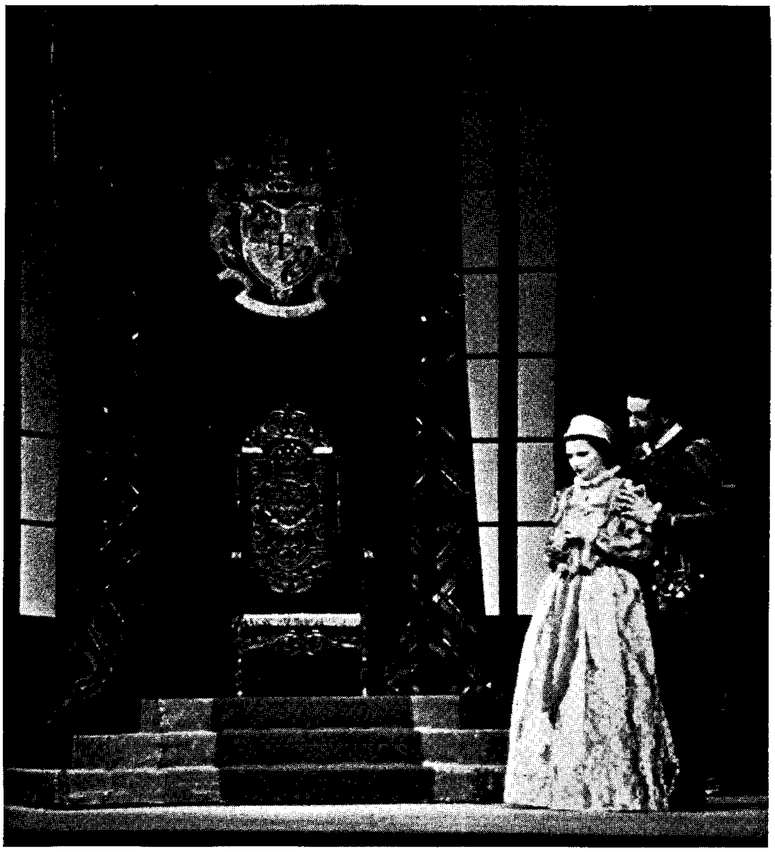
BUILDING TYPES



Dept. of Dramatics, Amherst Colle

COMMUNITY THEATERS

FORTHCOMING ISSUES: 1939 — November, Houses; December, Hospitals. **PRECEDING ISSUES:** 1939 — September, Apartment Houses; August, High Schools; July, Houses; June, Factories; May, Houses; April, Retail Stores; March, Housing Developments; February, Elementary Schools; January, Restaurants.

BASES OF DESIGN

Courtesy of Dept. of Dramatics, Amherst College

Production of "Mary of Scotland" in Kirby Memorial Theater, Amherst College; McKim, Mead, and White, Architects

FOR COMMUNITY THEATERS

Material in the following study was developed by Michael M. Hare, who has been an associate of the architectural firm of Corbett and MacMurray, and who, as a theater design consultant, has worked with Lee Simonson, one of the country's foremost theater and stage design specialists. Mr. Hare was project designer for the theaters in Memorial Union, University of Wisconsin, and several other middlewest theaters. Acknowledgment is also made to Harold Burris-Meyer and Edward C. Cole for assistance in preparing the sections on lighting and acoustics.

INDEX

THE COMMUNITY theater as a type is characterized by active community participation in its productions. Individuals in the community not only compose the audience, but many of them take part both in actual performances and in preparations for them. Because of this, presentations of the community theater become social occasions; contact with the theater acquires an intimate and personal character that is lacking in the types of entertainment offered by commercial theaters and movie houses.

With the establishment throughout the country of numerous "little" theaters, "summer" theaters, and theatrical presentations by schools, clubs, and other institutions, this evolving type of activity has come in recent years to demand satisfactory housing. As a form of extrascholastic educational activity in which both minors and adults engage, its development has been noted by authorities in widely varying fields. Governmental agencies, educational institutions, and private organizations have recognized the activity's value and, to an extent, its needs. Although most community theaters are not at present dependent on profits for their existence, there are many opportunities for them to become at least self-supporting.

Examples of such recognition include: presentations by the Federal Theater; provision of community theater facilities in high schools (see Building Types, AR, 7/39); erection in colleges of theaters adapted for both conventional and advanced dramatic forms; and construction of dramatic, music, and fine arts centers by individuals, private organizations, and communities.

In many cases, the community theater may be only a part—though an important and highly specialized part—of a larger development which houses varied avocational activities. Depending upon local conditions, these may include arts and crafts shops or studios, galleries for local, traveling, or permanent exhibits, small museums, clubrooms, dance floors, and similar spaces. Such provisions may be grouped in one or more buildings about the theater as a center, or may be decentralized and spread over the community which they serve.

Again, theater facilities may often be provided in cooperation with established local institutions. A program which permits multiple use of the theater plant obviously increases its usefulness; also, its costs, both initial and maintenance, may be allocated to several organizations rather than assumed by one. For example, in a New Jersey town, a community theater was built into a school by the local board of education, in consultation with local dramatic organizations. Both the dramatic societies, which rent the theater as they need it, and the school, which uses the theater in its educational program, thus have access to better facilities than either could afford independently.

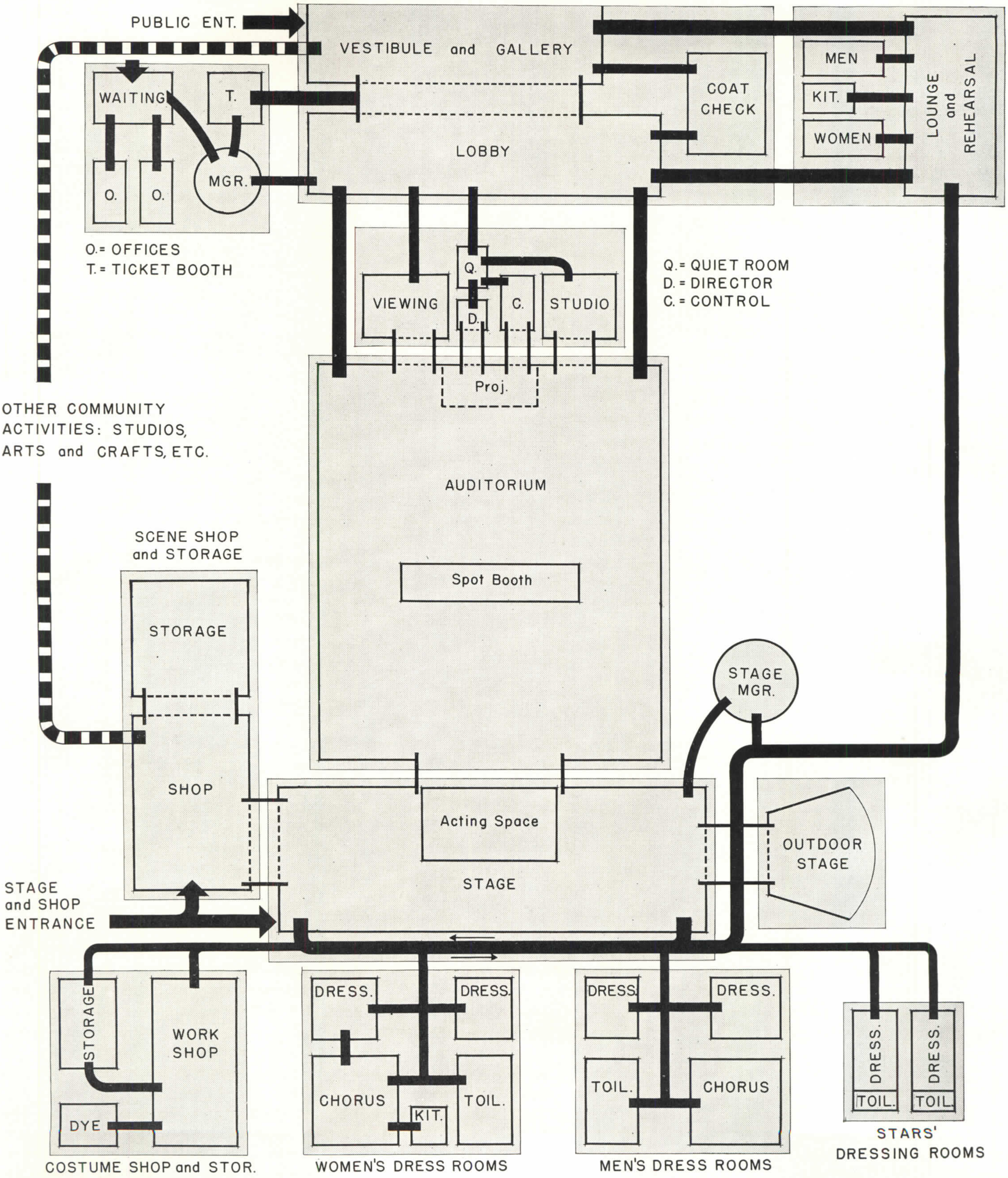
GENERAL REQUIREMENTS

Requirements for community theaters, although derived from the same sources and from the same historical background as those of the commercial, or "professional", theater, exhibit fundamental differences. Emphasis upon creative effort leads to demands for a different type of accommodation than does the necessity for financial profit. Two general types of creative community activity, directly related to the theater, require special provisions.

Audience activity is great before and after a performance and between acts, due to the social nature of the occasion. Spaces for lounging, talking, smoking, for viewing exhibits of backstage work, are all necessary. Easy access to such spaces is of prime importance. At times, audience and actors may intermingle; for this a combination of lounge and rehearsal room is needed. Since refreshments may be served, a small kitchen or serving pantry is essential.

Production activities consist of preparation for and presentation of the performance. In a community theater, scenery, costumes, and properties are mostly prepared within the theater plant. Separate workshops are ordinarily provided, one for costumes, and

(*Continued on page 81*)



Organization of a community theater. If community activities not directly related to the theater are to be included, it is desirable to provide access from them to gallery exhibition space; and to isolate their quarters, along with the noisy stage or scene shop, in order to simplify the problem of reducing background noises in auditorium. Additional stage and shop entrances may become necessary. Parts of radio unit (viewing room, studio) may also serve as discussion rooms.

TYPICAL SPACE REQUIREMENTS

SPACES	AREAS* (sq. ft.)	REMARKS
Vestibule and gallery	1200	Less area would hamper use of space as gallery and meeting place. Area may be increased in proportion as auditorium capacity exceeds 800. Good lighting is necessary.
Checkroom	240	Minimum unless checkroom does not serve auditorium or unless patrons do not check overcoats.
Lobby	1000	See *Vestibule;* mechanical ventilation needed here.
Ticket office	50	Minimum; for larger houses additional administration office (50–80 sq. ft.) is required. Ticket windows (2) and wall space (approx. 4 by 8 ft.) are necessary.
Lounge—rehearsal room	750	Minimum size, equal to acting area of stage; mech. vent. needed.
Administrative	350	Minimum; area varies. Outside light and air needed.
Men's toilets	250	Consult codes; areas ample for 800 capacity; either mech. vent. or outside light and air needed.
Women's toilets	250	
Auditorium	5600	Minimum for conventional seating; may increase to 7000–8000 sq. ft. for aisleless seating. Area includes forestage (removable seats). Outside light undesirable.
Radio studio	300	Can be reduced to 200 sq. ft.; no outside light; mech. vent. needed.
Control room	70	Minimum; mech. vent. needed.
Director's room	20	Minimum, but adequate.
Quiet room	30	Acts as sound insulation between circulation and radio unit.
Projection room	200	Ample, includes toilet and lavatory; consult code requirements.
Spotlight booth	400	Area may be divided into three booths: one on center with stage, one at each side of auditorium.
Stage	3500	Ample; 2800 sq. ft. minimum; 3500 usual avg. except for encircling stage (page 83). Air conditioning in conjunction with auditorium desirable; no outside light; top of stage house louvered (consult codes); if conventional stage, minimum height, floor to grid, is 70 ft.
Stage workshop	1500	Sometimes reduced to 1200 sq. ft. Outside light, if clear glass, preferably from north; if obscure, orientation unimportant.
Scene storage	1000	Minimum; larger if possible.
Costume workshop	420	May reduce to 300 sq. ft.; north light desirable.
Costume storage	210	Minimum; no outside light; preferably ventilated; must be dry.
Costume dyeing	80	Minimum; no outside light required; unless outside air provided, must be mechanically ventilated.
Six dressing rooms†	680	Each room requires access to two lavatories; size not changed with size of building; stars' dressing rooms each need private toilet and shower; all preferably air-conditioned.
Make-up room†	130	Minimum; used also for dressing, requires two lavatories; preferably air-conditioned.
Two chorus rooms†	440	Reasonable minimum; three lavatories needed in each; preferably air-conditioned.
Two bathrooms	300	Reasonable minimum.
Stage manager	150	Minimum.
Discussion room	750	Can be used for rehearsal; area determined by acting area.

*Based on auditorium capacity of 800.

†Dressing, chorus, make-up rooms require mirrors, preferably 3-sided type, movable; and overhead lighting, mirror-lighting equipment.

(*Continued from page* 79)

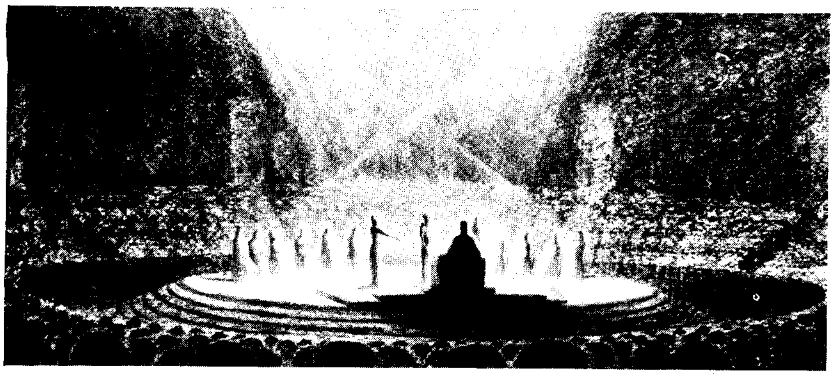
one for scenery and properties. Used materials are salvaged insofar as possible, stored within the plant, and reused. Ample storage space is needed.

Presentation problems may be solved differently in the community theater than in its commercial prototype. Both types demand ample stage space; but, whereas in the "professional" theater, urban real-estate values have forced a vertical development with lofty stage houses for lifting scenery vertically ("flying"), tiered dressing rooms, and often inadequate wing space, the community theater, built on less expensive land, may be expanded horizontally. Scenery can be shifted horizontally, perhaps on wagon stages. Proscenium size and shape may be variable. Such flexibility and multiplicity of uses are not only financially desirable, but some theater authorities call them essential for the theater's progress. Types of stages such as the "Intimate" and "Infinidome", illustrated on pages 82 and 83, which are considered impractical in the average commercial theater, become available.

Limitations. Because the theater has such highly specialized requirements, this study is limited in scope to those items within the creative center which are strictly community theater needs.

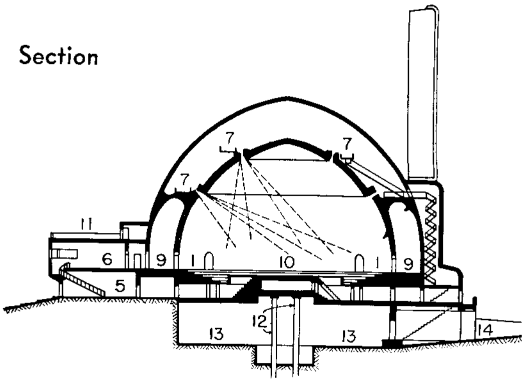
Although there is, in the commercial or "professional" theater, a strong movement afoot to revive the almost defunct "road show", it is a moot point whether the educational value and income to be derived from revived "road" would justify building community theaters in the same image as the professional theater. The same is true to an extent of the extremely active commercial "summer theater". Emphasis in the community theater being on amateur participation in all phases of the theater, there is to be expected less efficiency of personnel, and a necessity for greater flexibility of facilities, than in commercial theaters.

Capacity of the auditorium for the type of theater here discussed averages approximately 800 persons, often less. If, for financial reasons, provisions for road shows must be included, minimum seating capacity has to be increased to 1,200, preferably 1,500 persons. This increase brings many disadvantages, among which are lack of intimacy and lack of flexibility in auditorium shape and stage type.



In this type, the audience surrounds the stage.

Section



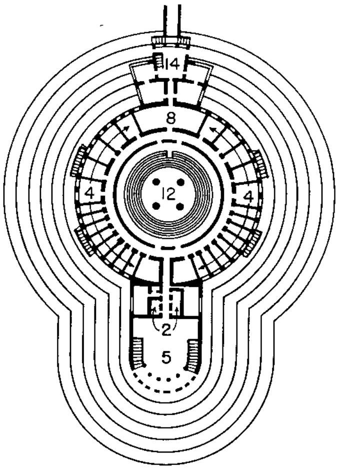
PROJECT FOR THE INTIMATE THEATER

NORMAN BEL GEDDES, Designer

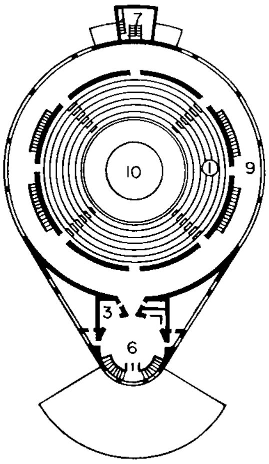
All of the 800 seats in this scheme command equally good views of the stage. Since seating space is only six rows deep. and completely encircles the stage, audience and performers are intimately associated. Seats spaced 4½ ft. back-to-back permit each seat row to be used as an aisle, as in "Continental" seating.

Many departures from conventional stage procedure are necessary. For scene changes, stage is lowered to basement behind a curtain of light or during a momentary blackout.

Stage is lighted from two concentric galleries between the dome's inner and outer shells. Lights comparable to footlights may be installed in a rail in front of the first row of seats. Light sources are invisible to the seated audience.



Ground floor



Auditorium level

LEGEND

1. Auditorium
2. Box office
3. Checkroom
4.. Dressing room
5. Foyer
6. Lounge
7. Electrician
8. Assembly
9. Promenade
10. Stage
11. Terrace
12. Hydraulic plungers
13. Scene shifting
14. Stage entrance

Stage presentations in the community theater are widely varied in type; each type may require special combinations of auditorium and stage space, with resulting variations in planning for public spaces, shops, dressing rooms, etc. Dramatic productions may include puppet shows, "straight" drama or comedy, musical comedies, revivals of the classics, or may range far beyond the accepted conventional drama forms to encompass impressionistic drama, space-time presentations, and possibly others not yet evolved.

Musical performances may require accommodations for a full orchestra or band, a chorus, or a soloist. The dance, too, may range in form from the Greek through ballet to such moderns as Martha Graham; dance forms are constantly changing. Other types of presentations, such as motion and talking pictures, and planetaria, have also to be considered.

Since it is obviously impossible to provide individual accommodations for all these kinds of productions, it is best to provide a theater as flexible as possible. Walls between stage and auditorium may be built-up of movable sections, to provide a multiplicity of proscenium arrangements. Multi-level acting areas may be provided. The audience may surround the stage, or the stage may at least partly encircle the audience. A forestage (acting space in front of the usual proscenium location) may be built on elevators, to permit its use as orchestra pit, seating space, or acting area. The stage proper may be of the conventional type with a lofty gridiron; it may be horizontal, with wagons for shifting scenery, or both types may be combined.

However, the structure's completeness may be limited for financial reasons, or it may be necessary to remodel an existing building. It should be borne in mind that such a procedure as "doing over the old barn" may defeat the community theater's purpose, may in the end be a foolish and costly experiment. But if ultimate objectives are clearly outlined, and immediate construction is planned to permit future expansion, the end result may be entirely satisfactory.

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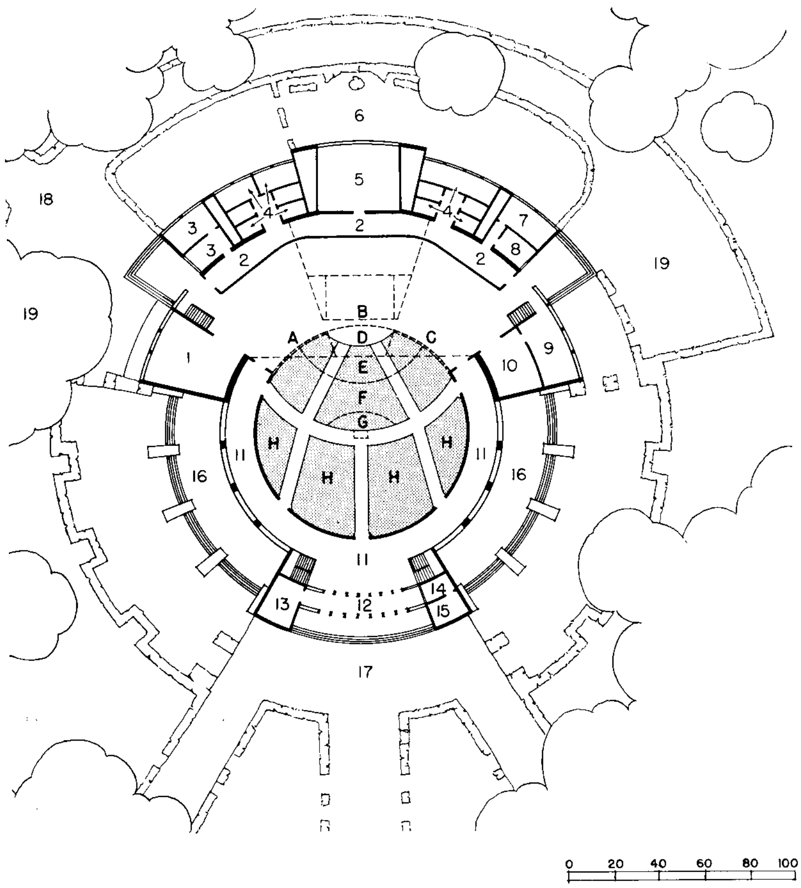


CONVENTIONAL PRODUCTIONS, ballet, multiple-proscenium productions. 975 seats. Stage: Width (avg.), 100 ft.; depth to cyclorama, 40 ft.; height to grid, 60 ft.; proscenium opening, 16 by 34 ft.; up to 90 ft. of flexible proscenium available.

LEGEND: **1.** Shop **2.** Crossover **3.** Stage manager's office **4.** Dressing rooms **5.** Rehearsal - Green Room **6.** Garden for No. 5 **7.** Director's office **8.** Electrician's office **9.** Storage **10.** Stacking **11.** Foyer and promenade **12.** Vestibule **13.** House manager's office **14.** Box office **15.** Business office **16.** Outdoor promenade **17.** Main entrance driveway **18.** Service driveway **19.** Parking for actors, employees, etc.

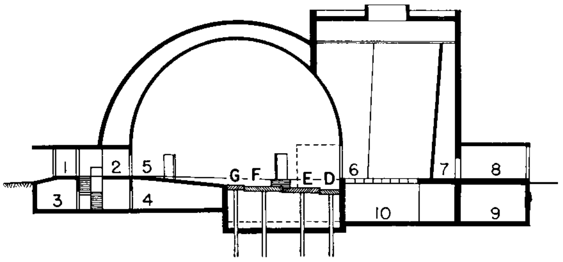
PROJECT FOR THE INFINIDOME, SPRINGFIELD, MASSACHUSETTS

MICHAEL M. HARE, Designer

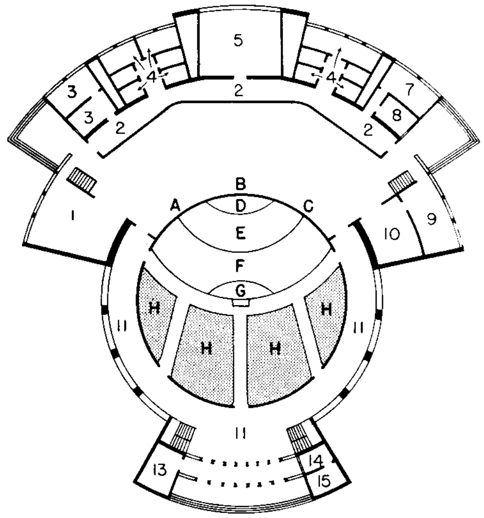
WALTER PROKOSCH, Architect

BLANDING SLOANE, Consulting Theater Artist

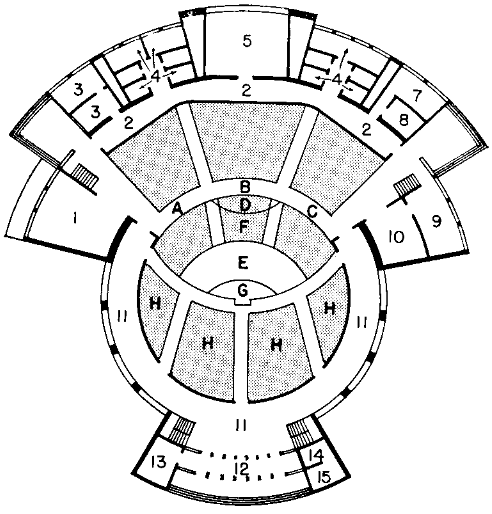
THE INFINIDOME was originally conceived by Blanding Sloane, former Director of Theater Projects for the Eastern States. In essence, it is an extremely flexible combination of theater and planetarium. Several elevator-equipped portions of the auditorium floor permit variations in seating and acting space to suit almost any type of production. The stage can accommodate both "road" shows and other dramatic forms and has multiple proscenium openings.



Section: **1.** Vestibule **2.** Foyer **3.** Toilets **4.** Storage (chairs, etc.) **5.** Auditorium **6.** Stage **7.** Cyclorama **8.** Rehearsal - Green Room **9.** Costumes **10.** Traps

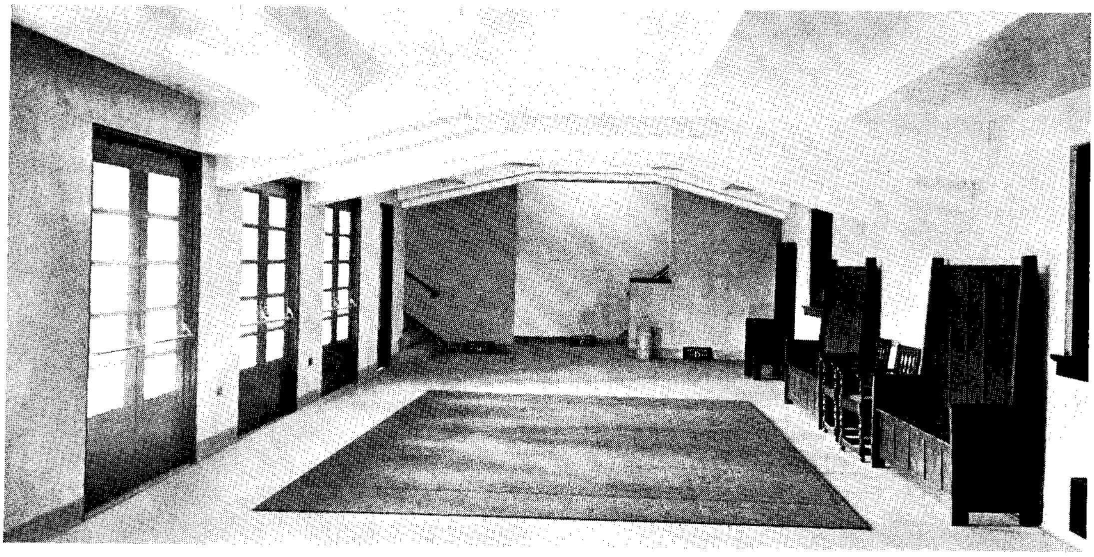


INFINIDOME: 675 to 875 seats. One, two, or three elevator stages, adjustable in height. Dome used for space effects—projection of scenery, figures, etc. PLANETARIUM: 975 seats. Stages E and F lowered, reversed, and raised similarly to arena production. Elevator at G for planetarium projector.



ARENA: 1,325 seats. One or two elevator stages in center; seats removed. Pit provided around central stage for entrance of actors. Stages E and F lowered to basement and reversed to face center of dome.

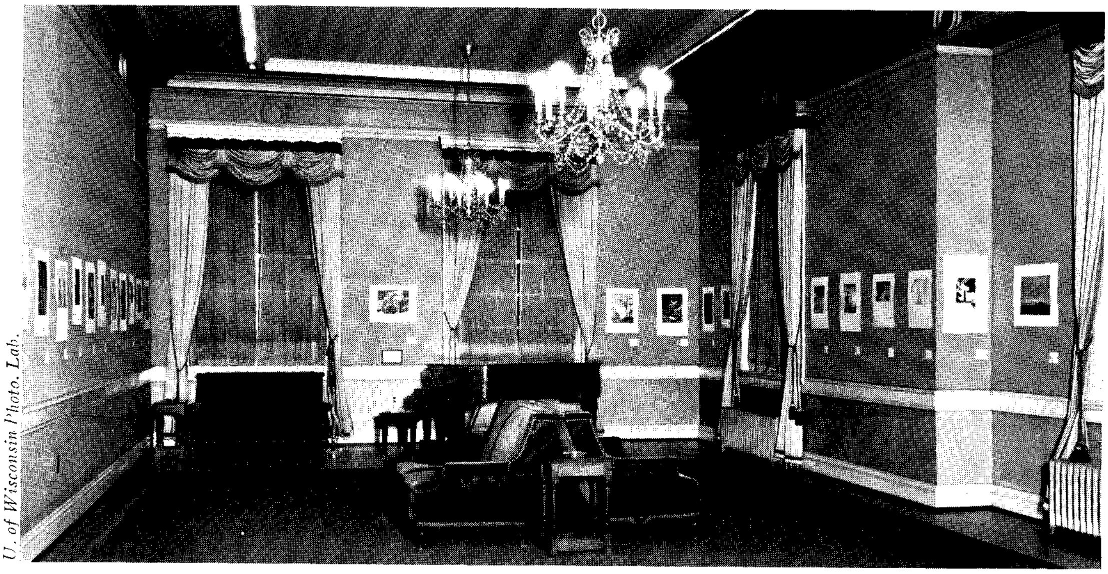
PUBLIC AND AUXILIARY SPACES



Lobby, Iowa State University Theater; doors are omitted at auditorium entrances.

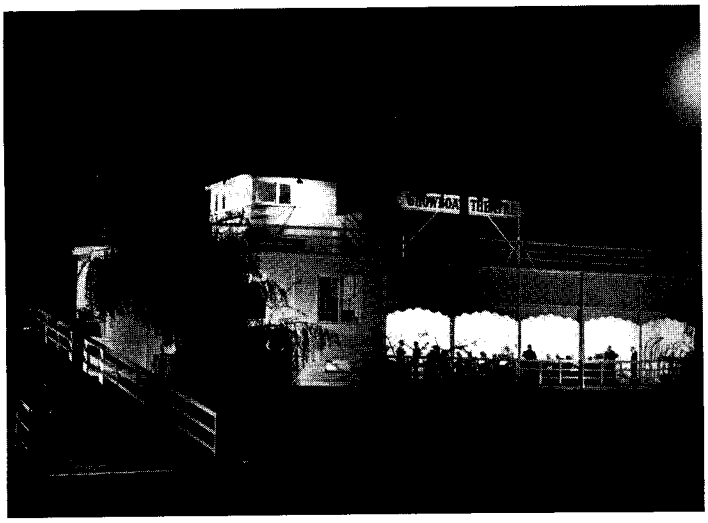
Courtesy Yale Univ. Dept. Drama

Green Room, Yale Theater, here houses a small discussion group.

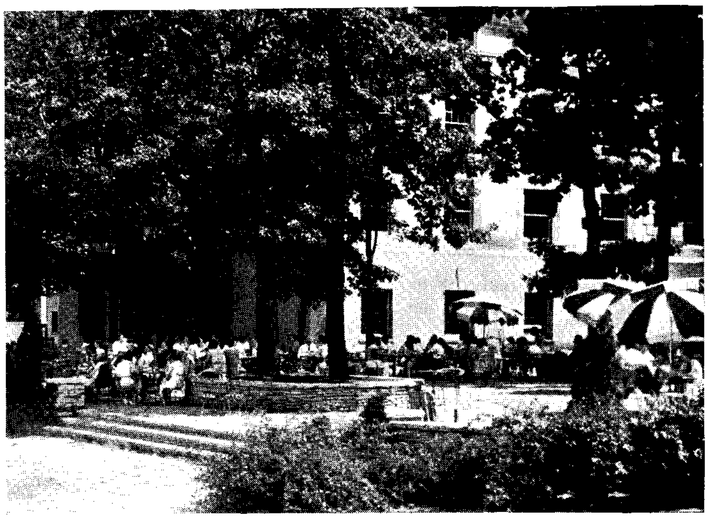


U. of Wisconsin Photo. Lab.

Gallery and Lounge, Wisconsin Memorial Union, Arthur Peabody, State Architect



Outdoor promenades, Showboat Theater, Univ. of Washington



Julius C. Edelstein

Terraces, Wisconsin Union, Arthur Peabody, State Architect

Public circulation. A prime requisite for public areas in the community theater is ease of movement. Access between the various parts needs to be as free as possible, to permit their full use by the audience before the show, between acts, and after the final curtain. Code requirements as to doors and exits are minima for safety; the community theater needs even greater circulation facilities. Depending upon site, nature of surrounding developments, disposition of plan elements, and requirements for acoustics, lighting, etc., the number of openings to vestibule, lobby, auditorium, and lounge may be increased far beyond the minimum.

Access to auditorium. If possible the principal entrances from the lobby to the auditorium should be arranged without doors. In order to achieve this it is necessary to make a careful acoustical analysis; in all probability sound-deadening material will be required on the walls of approaching corridors or lobbies, to prevent parallelism.

Types of spaces. It is always desirable to have both vestibule and lobby. In most cases, it would be well to provide a separate lounge which on occasion may be used for social meetings, lectures, discussion groups, etc. The lounge may also serve as rehearsal space.

Vestibule. The lighting in the vestibule adjoining the street may be quite brilliant. Telephone booths should be provided, accessible from the vestibule. In general the addition of other features, such as small book stores, etc., which will attract the public to the theater as a part of their daily lives, is desirable.

Ticket office should, if possible, both command the entrance to the inner lobby and at the same time permit the lines to form without obstructing it. There are preferably two ticket windows, one for reserved seats and one for current seats. Necessary also is sufficient free wall space for a small ticket rack which can be made locally.

Lobby. While the theater in the large city has no particular need for oversize lobbies, in the community theater the performance must be considered as a social occasion, as well as dramatic entertainment. Therefore, the lobby should be arranged to show off groups of people and their clothes to advantage.

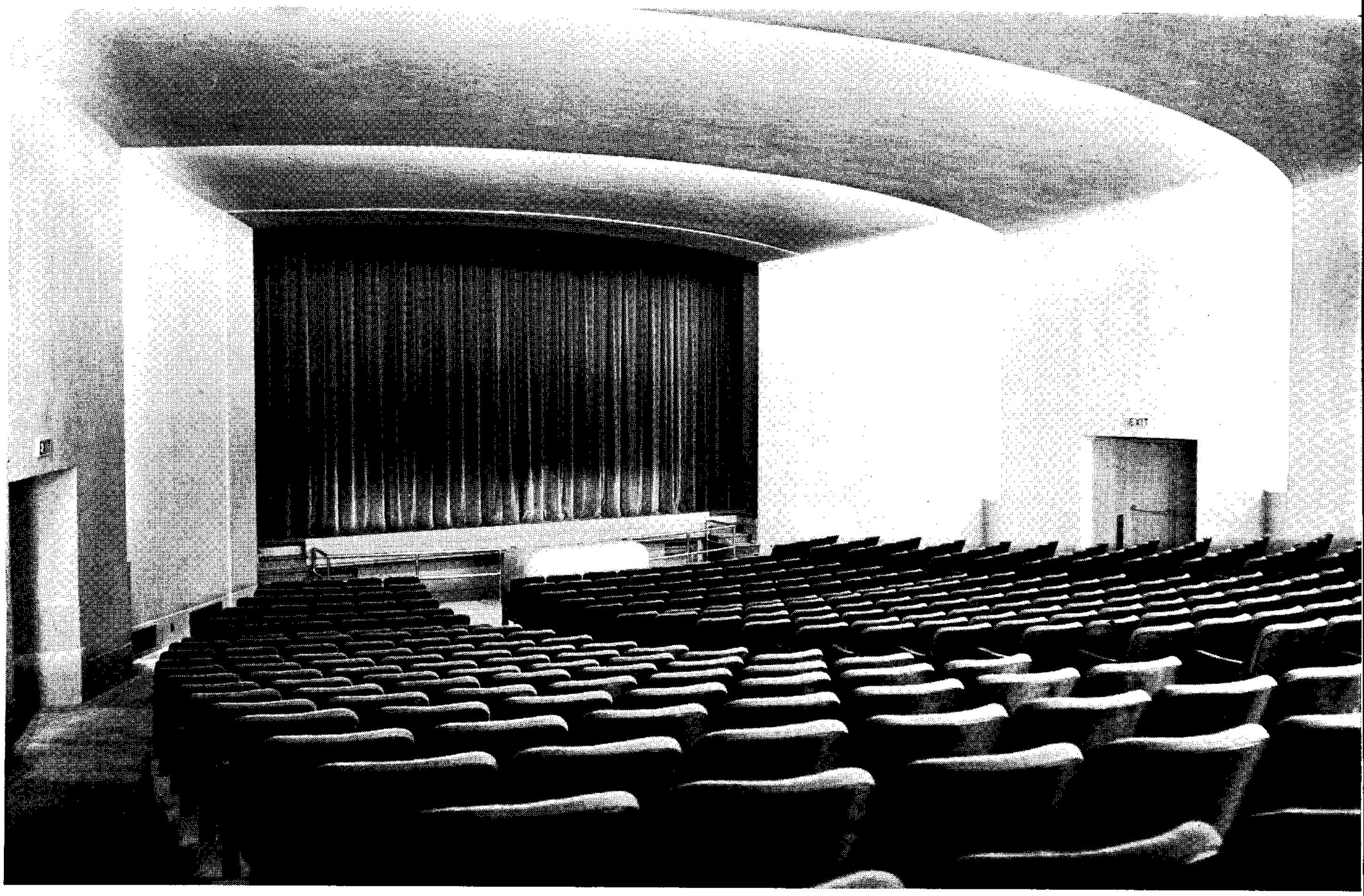
A combination of exhibition space and lobby is easy to achieve, and is generally desirable in the community theatre. It is hoped that the community will take an interest in the production of a play as well as in its presentation, and, therefore, exhibition space is desirable to show the various developments: costume designs, sketches for stage settings, etc., even though the space is not used as an actual art gallery.

Checkroom should be either adequate or omitted entirely. If included it should open from the main lobby and provision should be made to have a sufficient number of attendants and a sufficiently large opening to the lobby so that standing in long lines after the performance is not necessary. In community theaters the expense of the proper number of attendants may become a problem. The checkroom serves not only the theater, but also other facilities in the building, and therefore should have an entrance to the main vestibule.

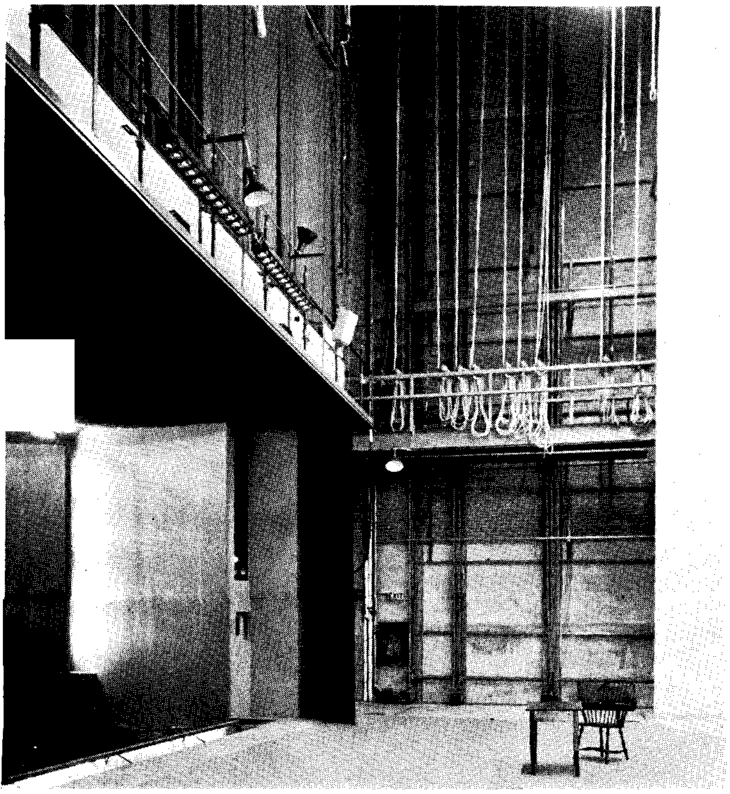
Auxiliary spaces include areas not always essential to the theater, but usually desirable. Projection rooms are fairly well standardized. If provisions for radio broadcasting are desired, for either instruction and study of new dramatic techniques, or actual broadcasting, the minima outlined on pages 80 and 81 may be provided. Discussion or viewing rooms are similar to radio studios, and, like them, usually need loudspeakers. Here an instructor and class, or the theater director and assistants, may discuss a production freely while it is in progress.

Playwrights' rooms have seldom been incorporated; but in the theater at the State University of Iowa (pages 95-98), several are contemplated.

AUDITORIUM AND STAGE

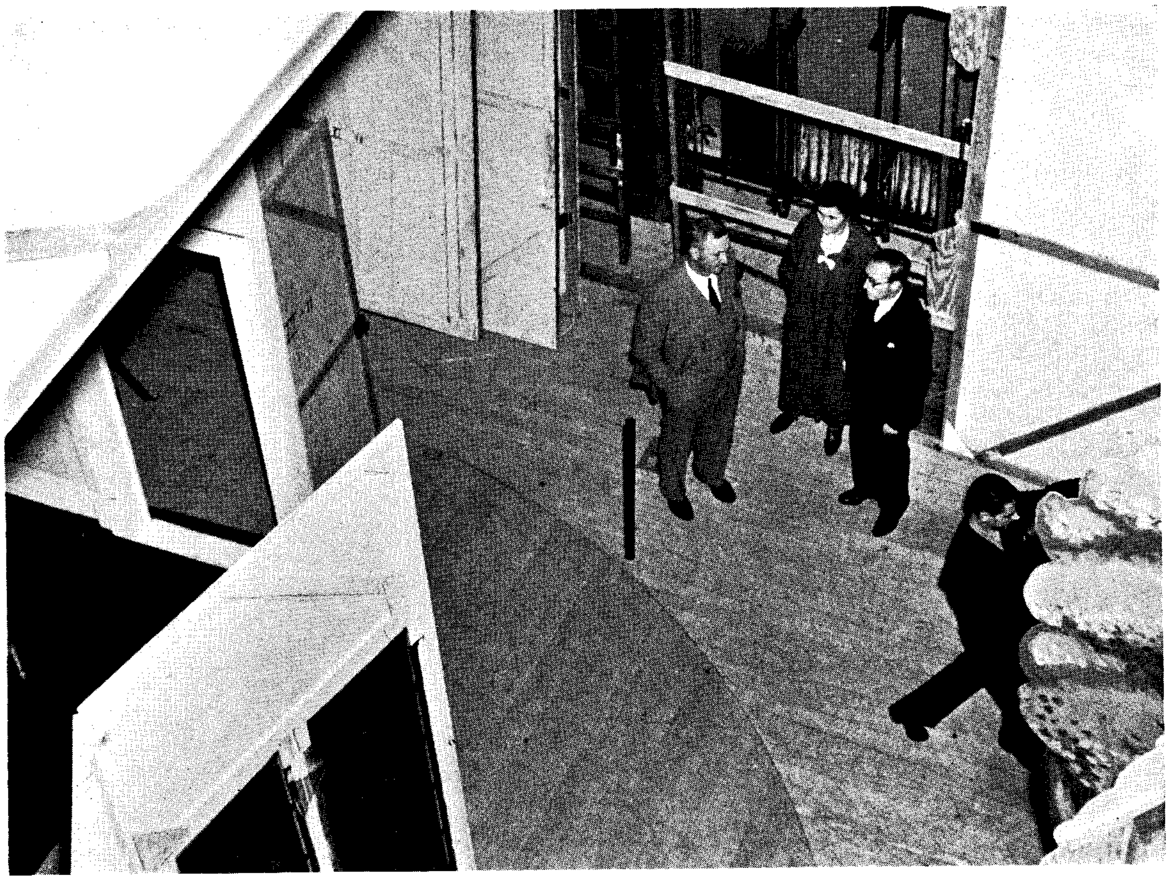


Auditorium, Kirby Memorial Theater, Amherst College; McKim, Mead, and White, Architects.



Photos courtesy Amherst College Dept. Dr

Stage in Kirby Memorial Theater is typical of conventional equipment, including overhead gridiron for flying scenery, pinrail for securing ropes, light bridge over proscenium and auditorium ceiling, and side-wall cuts for stage lighting. Coved lumiline lights for auditorium illumination are not visible to a seated audience. Other stage types (multi-proscenium stages, forestages, and stages which partially encircle the audience) are shown in the following pages.


Charles Bell

Revolving stage used in University of Washington's Showboat Theater

Maximum seating distance. Even in theaters of 1,200 to 1,500 capacity, the last seat is preferably not over 75 to 100 ft. from the stage, and much less in smaller houses. When balconies are used, the front of the balcony is preferably within 50 ft. of the stage.

Sight lines. The apron of a forestage may be excluded from view to prevent sight lines angled sharply downward from rear seats. In auditoria of 800 or less capacity, when balconies are not used, a complete view of the forestage should be possible. Side proscenia of encircling stages do not require perfect sight lines; balconies may help improve them. Sight lines for the side seats in the auditorium should permit a minimum of two-thirds of the main acting space to be seen through the conventional proscenium; conversely, care should be taken that areas beyond the acting space are masked.

Seating facilities. Seat spacing preferably always exceeds the minimum of the New York Code of 32 in., back-to-back; and, if possible, seats are not less than 20 in. on centers. Use of "Continental" seating, in which each seat row becomes an aisle, should be limited to small auditoria, where it does not force the rear row to be located too far from the stage. Aisle widths and number of aisles are generally determined by building codes.

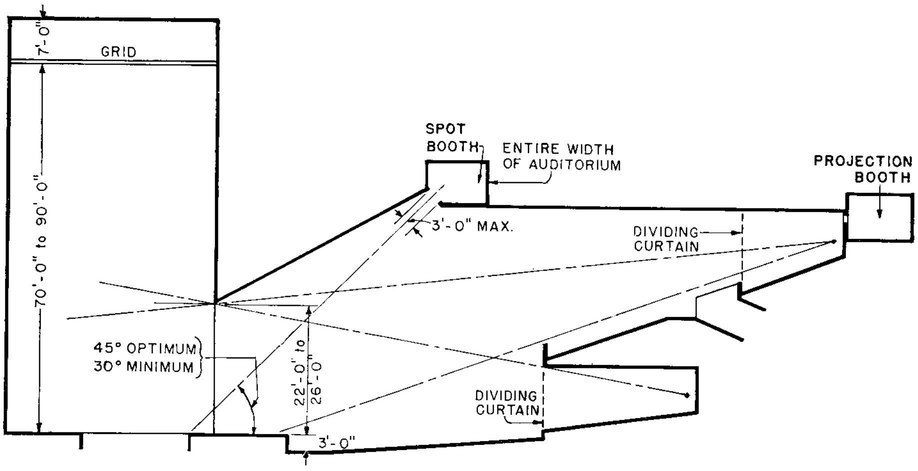
Auditorium capacity and type. Need to vary the capacity of an 800-seat auditorium is not urgent. However, when necessary, this may be accomplished with curtains, placed in such a way, perhaps under the lip of a balcony or at a natural break in the auditorium, that they do not appear to change the essential proportions of the auditorium. Empty seats visible to actors are a detriment to good performances. Experts should be consulted as to the acoustical effect on the auditorium. A solid partition will very probably cause havoc in the acoustics.

Advantages or disadvantages of stadium houses versus balconies are subject to much discussion. The best opinion seems to agree that a stadium house for a capacity of over 800 or 1000 will have a rear row of seats too far from the stage for "comedies of errors," although satisfactory for spectacle pieces.

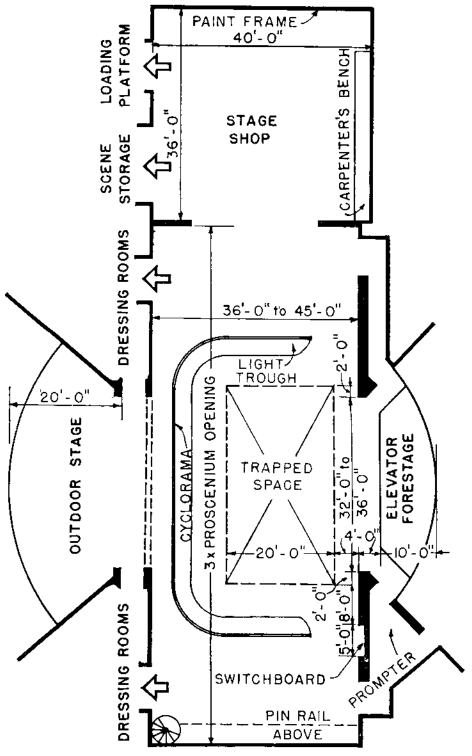
Auditorium lighting. The object of lighting in the auditorium is to concentrate attention upon the stage, even before the curtain goes up. In most cases, such equipment as white lumiline lights, with reflectors, in coves hidden from view, will prove most satisfactory. Numerous examples of the use of recessed "downlights" also exist. Fluorescent lighting, though efficient, is difficult to use because it cannot be dimmed. The color of the light should be neutral though warm. Chandeliers are usually considered objectionable.

Stage area. Space is the most vital consideration. It is necessary that the stage be so arranged that up to five sets can be set up and stacked in succession, without being seen during the performance; and that this be done without acrobatics on the part of amateur stage hands. Furthermore, open-air (plein-

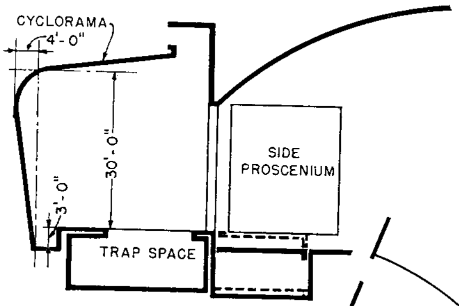
(Continued on page 89)



Section



Plan, conventional type of stage



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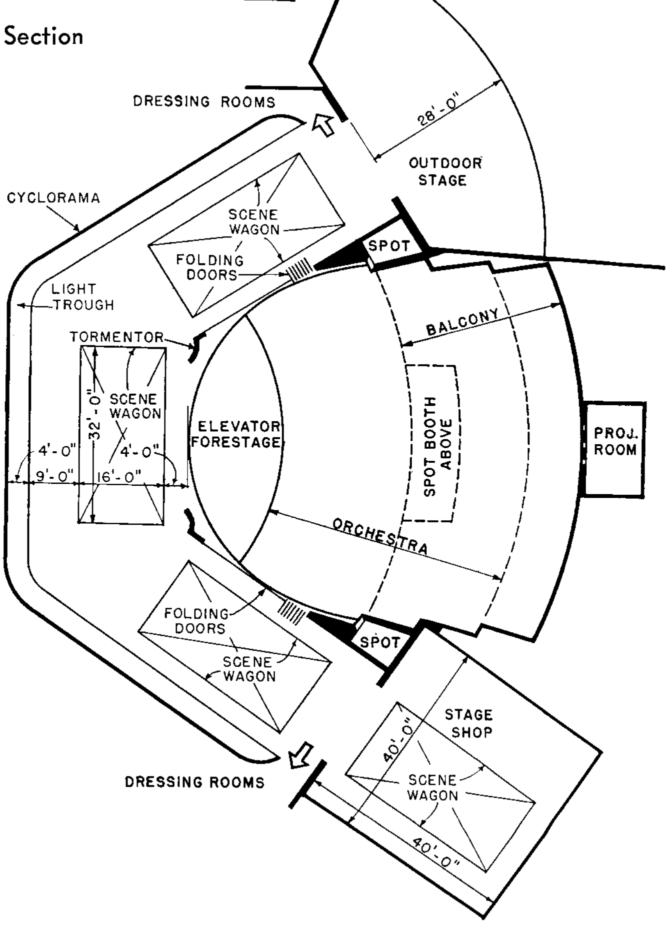
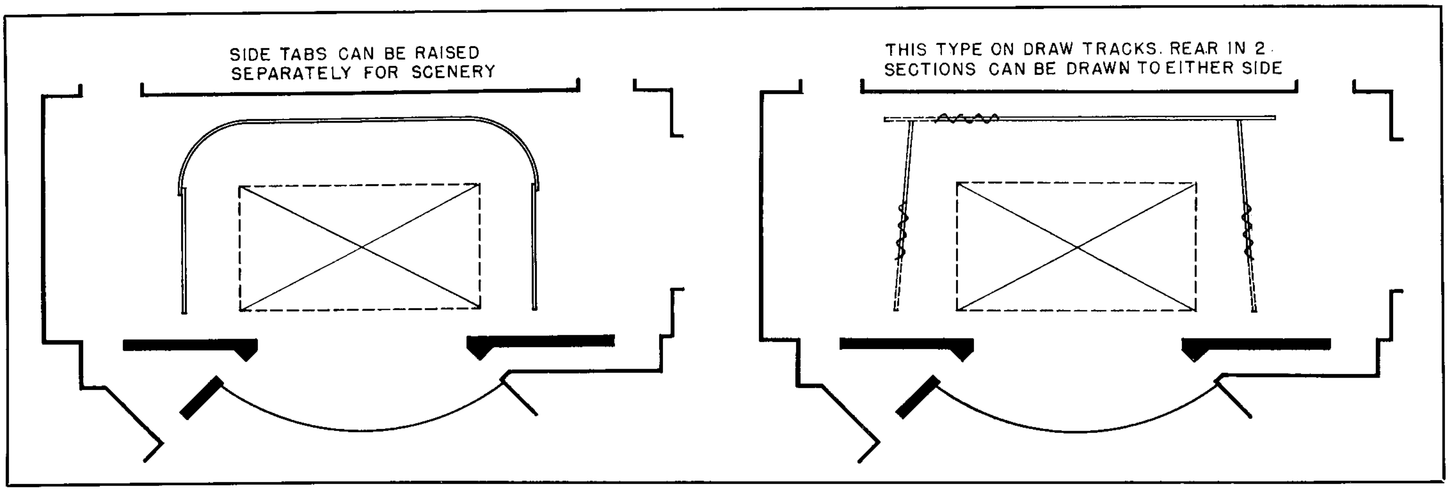


Heavy dotted line in section of encircling stage indicates variable position of forestage. Cyclorama shown in conventional stage must be flown when scenery is brought in from shop. Trapped space on conventional plan, and center position of scene wagon on encircling stage, indicate acting areas. Scene wagons travel on tracks whose positions must be carefully plotted so wagons will clear cyclorama and tormentors. Since one purpose of the encircling stage is to facilitate other productions than the usual "picture-framed" type, emphasis on proscenium as a frame should be reduced to a minimum.

Plan, encircling stage (wagon-type)



Two of the many types of cycloramas; one on the right is difficult to adjust

(*Continued from page* 87)

air) scenes require the appearance of great height. Again, a high stage loft and an expanse of unimpeded wall space are desirable for storing current sets. This means confining openings to one wall if possible, or at the most, two. It is also necessary that the stage provide a "crossover," i.e., a passage for actors across the stage, either behind the stage through a corridor, possibly through the stage shop, or behind the cyclorama.

Acting facilities. The *acting area* extends slightly more than the width of the proscenium, and is, at the least, 20 ft. deep. It should be trapped throughout its extent, with unimpeded space below.

All types of stages are preferably provided with an ample forestage. Even though this is not carried to an extreme, it is desirable for performances which are to be seen in the "round" rather than through a picture frame, and for soloists or lecturers. It can include provisions for removable seats, thus varying the auditorium's capacity.

The stage manager requires at least a desk, with direct access to stage, and to dressing rooms. The prompter needs a small space from which he can hear and follow action without being seen.

Scenic provisions. *Cycloramas,* or background surfaces, are illustrated by diagram and are susceptible to great variation, both as to material, number of units, and shape. In planning for the type of cyclorama to be used, provision must be made for moving scenery horizontally. Permanent solid cycloramas, made of plaster, are particularly desirable for use only as a back wall of an encircling stage. Curves must be acute, and as a rule it will be found desirable to tilt the cyclorama back slightly to reduce objectionable sound reflection.

The *gridiron* consists of a number of structural steel shapes, suspended from 70 to 90 ft. above the stage floor. Its exact location and composition are best determined by a stage equipment specialist. The *pinrail* is located along one wall of the stage, and serves as a means of securing grid lines. It is commonly 14 to 15 ft. above the stage floor.

Two doors, each at least 8 by 12 ft., are usually required for loading scenery. One should open to the scene shop, the other to a street or alley. The latter door may be omitted when no provisions are made for road shows.

Revolving or elevator stages may also be desirable, but are often too costly.

Nonconventional stages. If great flexibility is required in the stage, as would seem desirable for the community theater, a greater amount of stage area and cubage may be added to the wings. With certain exceptions, it is obvious that a given amount of cubage up in the air does not have the multiplicity of use that it will have at stage level. The result may be a long, circular, low stage surrounding the better part of the audience, closed off from the auditorium by a series of panels which may be shifted at will. Gridiron is usually eliminated, unless funds are available for both grid and "encircling" stage.

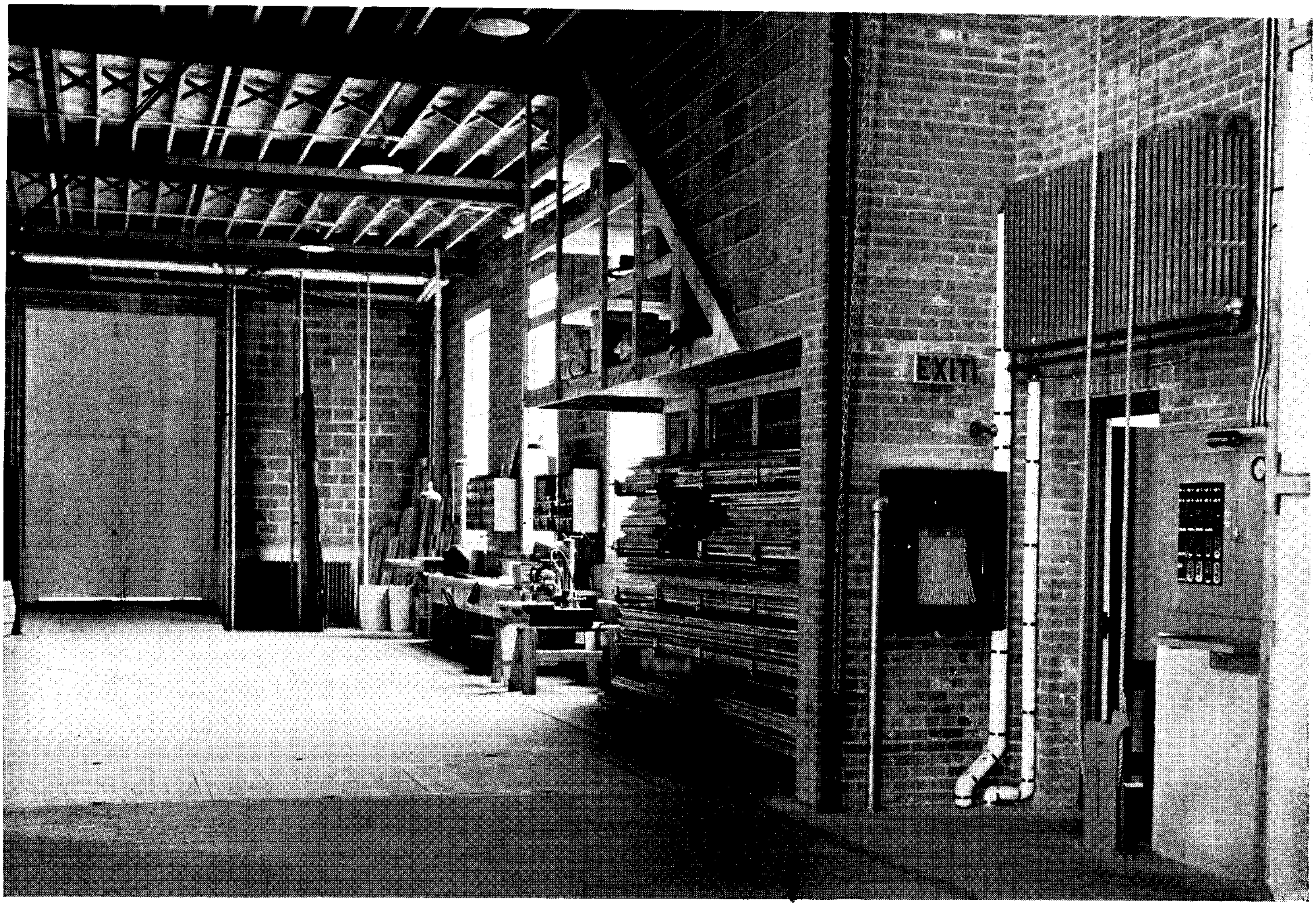
With this "encircling" type of stage, additional storage space should be provided adjacent to the shop; and scenes may be shifted on wagons. When the encircling stage is used with all panels open, wagons are dispensed with and scenery is formalized. If structurally possible, the entire proscenium should be unimpeded by fixed columns. However, two columns placed at either side of an imaginary proscenium may be very useful for concealing vertical banks of lights. These light housings (in this case the columns) are called "tormentors", and are preferably movable.

Diagram of the encircling stage shows three spaces for two wagons (excluding the shop). If there is unlimited space, more wagons may be made available; but the ensuing complications are considerable and the gains small. The encircling stage becomes less practical as the size of the auditorium increases. Even with auditoria for 800, good sight lines are difficult to obtain unless stage area is substantially increased. It should be noticed, however, that productions which need side stages do not require perfect sight lines.

One may conclude that encircling stages are both economically and functionally desirable for the smallest auditoria, while for those of 800 seats and up, their cost may become prohibitive. A study of the Iowa Theater (p. 95) will show that the wagon system, even without a grid, can be practical.

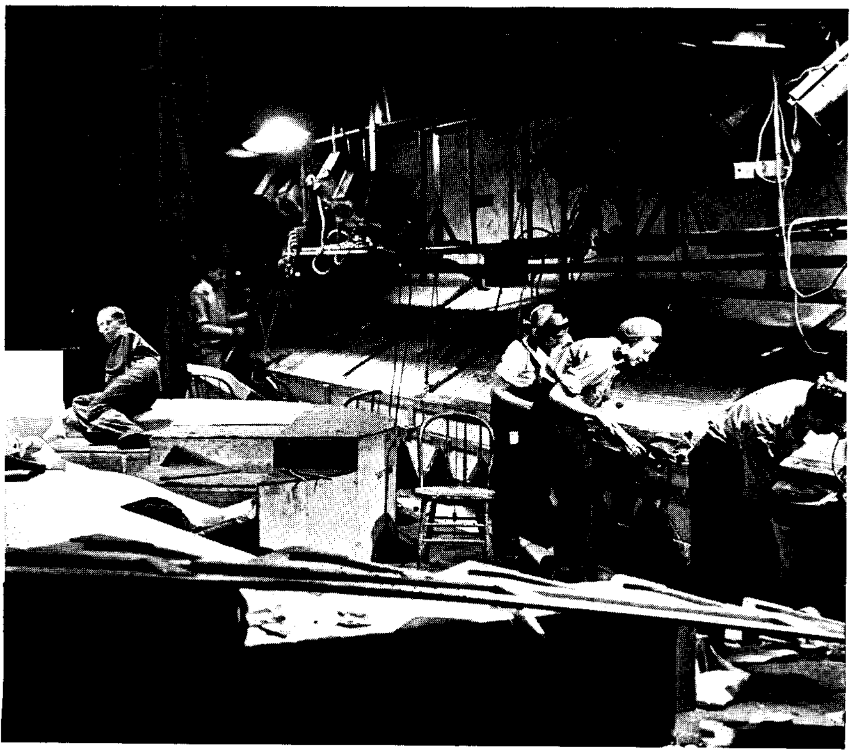
Outdoor stage. Size of outdoor auditoria varies considerably. The stage, of necessity, is somewhat formalized. If possible it should have immediate access to the inside stage, preferably through the wall, unless this arrangement is prevented by a built-in cyclorama.

WORK SHOPS, DRESSING ROOMS, STORAGE



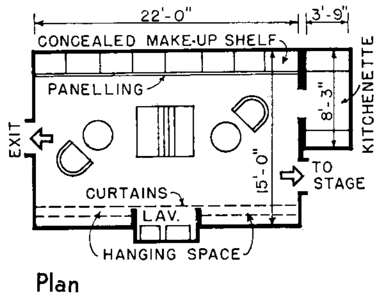
Howard, courtesy Amherst College

Scene and property shop, Kirby Memorial Theater, Amherst College. Within the shop, ample wall space is needed.

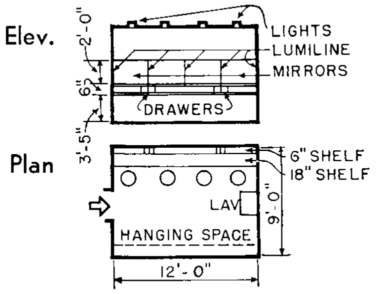


Courtesy Yale Univ. Dept. Drama

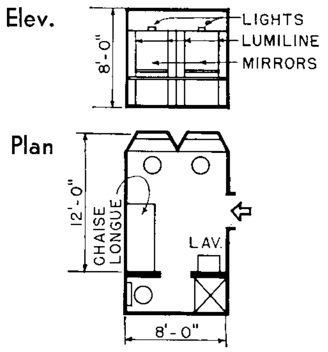
Scenery construction, Yale University Drama School. In the community theater this type of activity is of great importance, and permits many persons in addition to actors to take part in the preparation of productions.



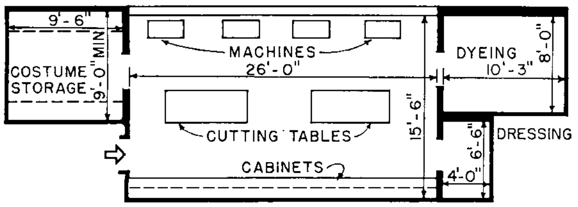
Combined Green Room and dressing room for women's chorus (20 people). The Green Room is an actor's recreation and discussion space, to which a few visitors may be admitted. Lights and mirrors are similar to those in other dressing rooms.



Typical dressing room for four people. Overhead lights are necessary for adjusting wigs and costumes, and for final inspection of make-up. Lights at mirrors are preferably designed to illuminate the actors' faces evenly, rather than to light the mirrors.



Typical "Stars' " dressing room for two people. Triple mirrors are desirable. Chaise longue is desirable but not essential. Adjoining toilet should contain a shower and water closet.



At left, plan of typical costume shop. Good light, preferably natural, is essential for sewing machines. In many respects the costume shop is similar to the sewing department of a modern high school.

In the stage shop, shown on page 88, are made scenery and properties. Facilities for woodworking, metalworking, and painting, and storage space for lumber, nails, tools, canvas, and painting materials, are all needed.

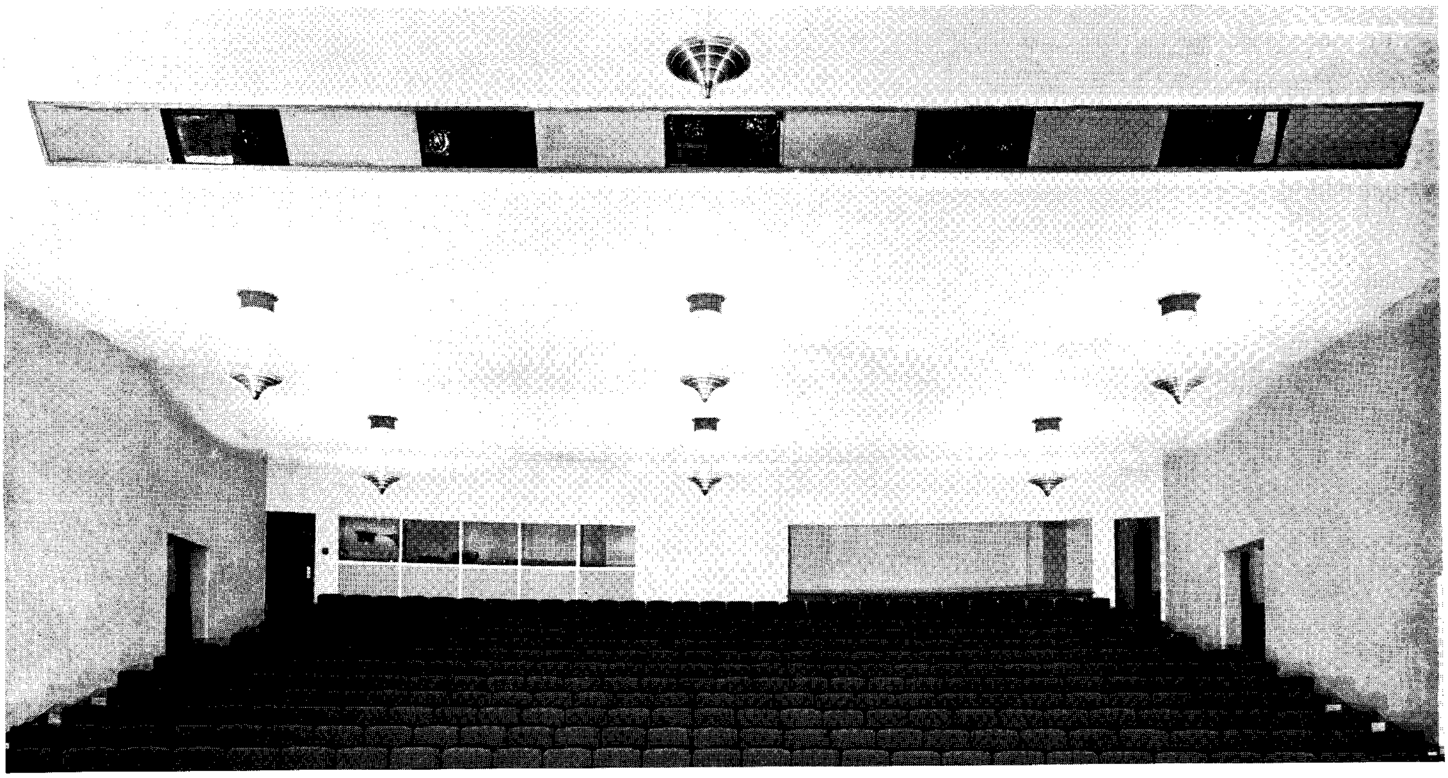
Stage shop. Adequate area, as illustrated in the tables on page 81 and sketches on page 88, is a prime consideration. Equally important is the height to be allowed for the paint frame. When the conventional type of stage, with gridiron, is used, the height for a paint frame is at least 30 ft. Even with the comparatively low "encircling" stage, a 30-ft. paint frame is necessary, since the effective height of scenery remains the same. It is possible to rig the paint frame on the rear wall of the auditorium, or on a stage wall. However, when this is done no scenery can be painted on the frame during productions or during rehearsals. The shop is the center of most of the dramatic activities and includes subdivisions for carpentry, electrical, metal, and painting work. It should be provided with good outside light, preferably diffused. It should immediately adjoin the stage storage space, the desirable clear ceiling height of which is 15 ft. Less height can be used in storage spaces, but this necessitates laying flats on their sides, which is considered unsatisfactory.

Costume shop. This, too, is a vital element in the community theater, because, of necessity, most of the costumes are made on the premises. The dyeing room and costume-storage space should adjoin the costume shop.

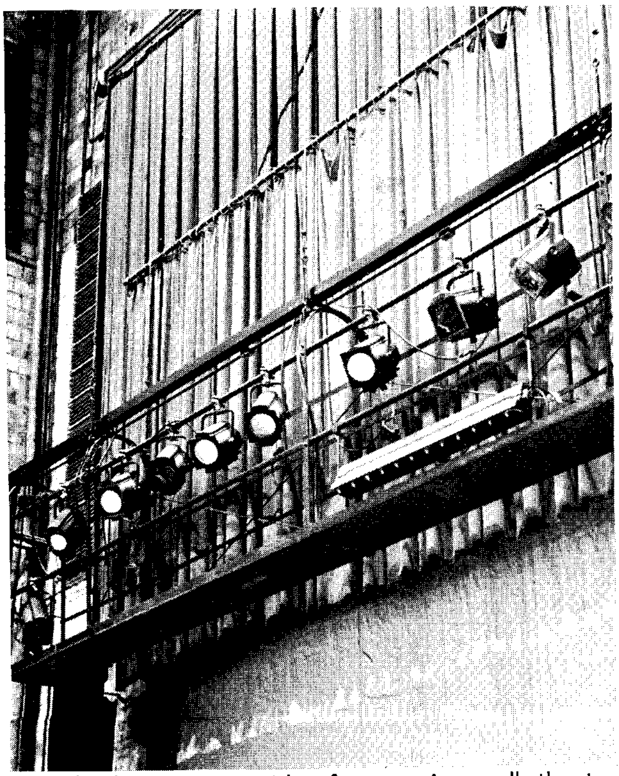
Dressing rooms. Requirements for individual dressing rooms vary, depending upon the likelihood of producing professional shows, and the funds available. Most satisfactory would be provisions for 18 to 20 actors in a number of dressing rooms, each providing for 3 to 4 actors; and two chorus rooms, one for men and one for women, each providing for about 20 actors. One chorus room may be used as a Green Room or lounge for actors.

Rehearsal rooms. The number of rehearsal rooms is determined entirely by how much use is made of the building and how often the stage is available for rehearsal. Rehearsal rooms should be in the same proportion and somewhat larger than the acting area of the stage; and, acoustically, should reproduce stage conditions as closely as possible. The public lounge, adjacent to the auditorium lobby, may also serve for rehearsals.

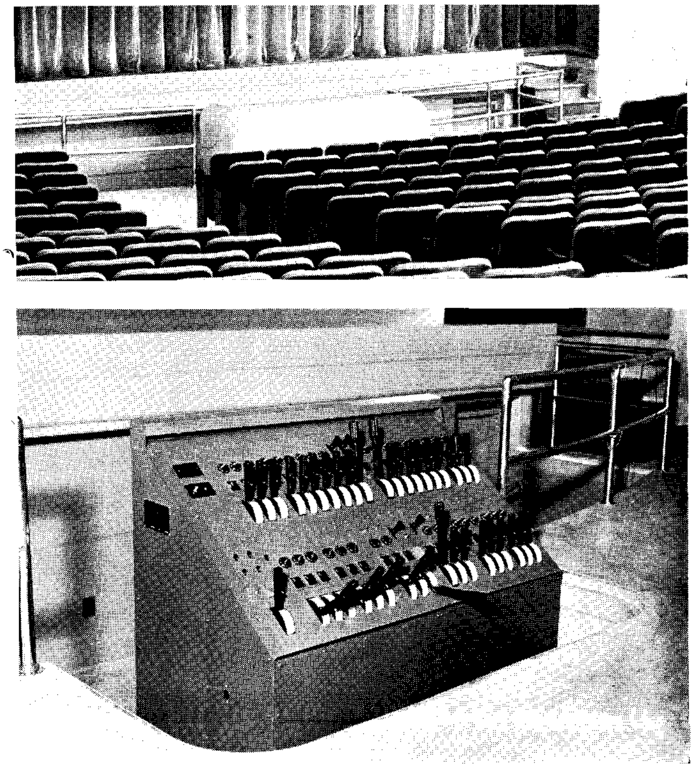
STAGE LIGHTING PROVISIONS



Auditorium, theater at State University of Iowa, George L. Horner, Architect. Light-control room is located at left rear. Note ceiling cut. If pendant fixtures are used to light auditorium, simple design and concealment of light sources are necessary to avoid distracting attention from stage.

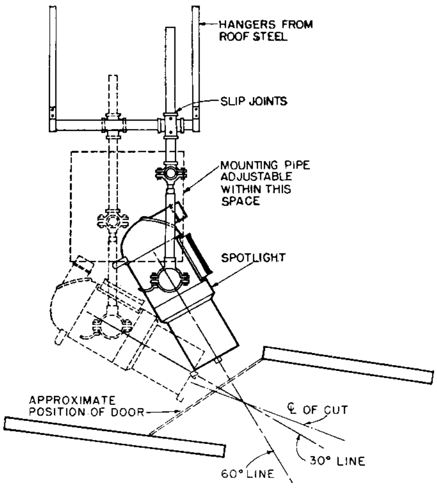


Light bridge on stage side of proscenium wall, theater at State University of Iowa. Such equipment is usually specified by experienced consultants. Note also radiators on proscenium wall—a typical solution of the heating problem.

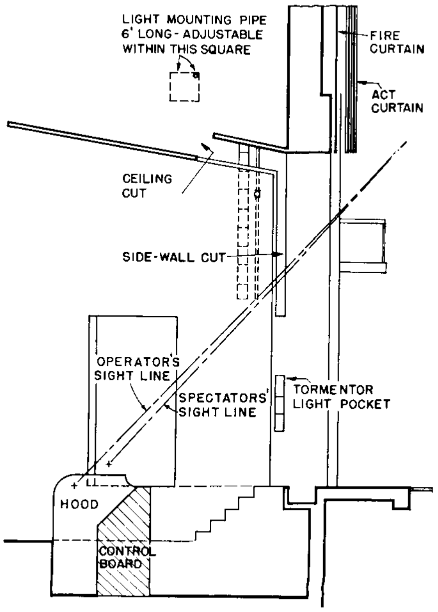


Courtesy Dept. of Dramatics, Amherst College

Top, general view, and bottom, closeup, with hood removed, of light-control board in orchestra pit, Kirby Memorial Theater, Amherst College, Stanley McCandless, Consultant. Control by thermionic tubes, as in the new Brettall system, permits even more compact installations.



Method of determining dimensions of ceiling slots for proposed Williams College Theater; Cram and Ferguson, Architects; Stanley McCandless, Lighting and Theater Consultant. One such ceiling slot, located where a 45° line from the front of the acting area intersects the ceiling, is essential for stage lighting. Additional slots are desirable but not essential. Since lights tend to get smaller as they are improved, clearances which are satisfactory at present will not hinder future installations.



Section at proscenium showing an auxiliary ceiling cut, which also extends down the sides of the proscenium, to permit an extremely flexible combination of ceiling and tormentor lighting. Access is provided from backstage fly-gallery, and from space in proscenium splay.

Stage lighting must provide for four functions: visibility, naturalism, design, emotional control. Lighting instruments and control apparatus provide for the control of: (1) intensity, (2) color, (3) direction, (4) spread of beam (to limit the area lighted), and (5) movement of light. Some flexibility in provisions is necessary to take care of advances in equipment and techniques.

High visibility of an actor's face is of first importance. It can best be provided by light which strikes the actor from the front, diagonally above, balanced by light from the opposite diagonal. This combination delineates form, produces an appearance of natural illumination, and illuminates shadows, yet projects objectionable "spill-over" light where it is least distracting to the audience.

Actors in the back, or upstage, portions of the acting area—a space the width of the proscenium and from one-third to one-half as deep—can be lighted on the cube diagonal from instruments located on the stage side of the proscenium wall. Actors in the downstage or forestage portions of the acting area, forward of a line approximately 10 ft. behind the curtain, must be lighted from positions about the auditorium.

Slots in the ceiling, extending the entire width of the auditorium, equipped with permanent apparatus for mounting spotlights, supplied with sufficient current outlets, and accessible for operation from walkways in the ceiling, offer the best positions in the auditorium for placing acting-area lights.

Maximum flexibility in mounting positions necessary to achieve those elements of naturalism, emotional control, and the arbitrary elements of design which depend upon front lighting, involves the following:

1. Extension of optimum ceiling slot down sides of auditorium.
2. Ceiling and side proscenium (or "tormentor") slots for gauze lighting, transformations, disappearances, fog, and clouds.
3. Spotlight booths at rear of balcony, preferably at either side of projection booth.
4. Special effects, as the lighting of front curtains, can be achieved most efficiently by lights from the balcony front.
5. Other ceiling slots, farther back in the auditorium, at approximately 15 ft. intervals.

In designing ceiling, side, and tormentor slots, and recesses in balcony facia, the architect must first know the types of instruments that are to be used. Their size and balance dictate provisions for mounting. Much tolerance is not required. He must then provide:

1. Clear space for all necessary movement of lighting instruments through a predetermined directional range.
2. Surface jogs or setbacks, to permit light beams to pass from instruments to stage without spilling unwanted light on wall or ceiling surfaces.
3. Access to all concealed lighting positions from backstage by direct routes separate from audience traffic.
4. Space for operators in each lighting position.
5. Mounting apparatus, adjustable to allow the use of various types and sizes of instruments.

Footlights, cyclorama trough, and control board are also the concern of the architect because they affect the structure of the apron, part of the stage floor, and the orchestra pit.

Of the *footlight* types available, indirect reflecting types require the deepest and widest troughs and are probably unexcelled for community theatres since they provide adequate intensity and color range and the best color blending downstage, a great advantage in intimate productions.

The *cyclorama trough* is essential with a permanent cyclorama or dome and often desirable with hung cycloramas. Its size and position are preferably established by detailed planning of the cyclorama lighting before the trapped area can be laid out, or the stage floor structure designed.

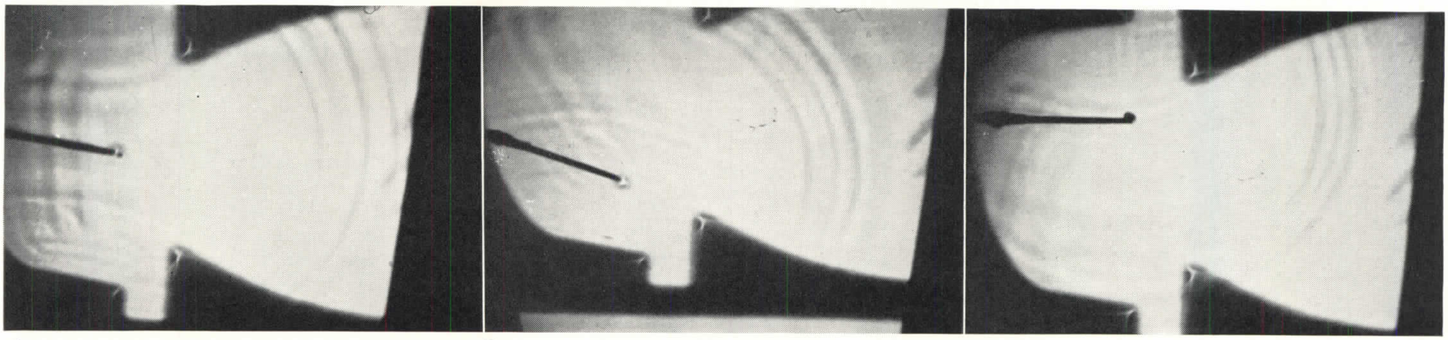
Stage-lighting control in the community theater is most successfully obtained by a permanent, simple control system with a silent switchboard, small enough for one man to operate.

For efficient control a location in the auditorium, not on the stage, is desirable. But lighting control from the rear of the balcony gives the operator a view comparable to that from the worst seat in the house. Controls should be as close as practicable to the stage, centrally placed, and masked from the view of an audience. Use of an elevator forestage has to be considered in locating the control board.

Under such conditions the best equipment is not necessarily the resistance-board type, but auto-transformers, or thermionic circuits, especially if used in conjunction with cross-transfer panels.

Condensed from a portion of a forthcoming book by Harold Burris-Meyer and Edward C. Cole. Acknowledgment is also made to Stanley McCandless, of the faculty of Yale University.

ACOUSTIC REQUIREMENTS



1 2 3

Ripple-tank test of a plan-model; single gravity waves show approximate sound distribution. 1, Actor "down center"; note distance between initial and first following wave. This distance raised to full scale would cause an echo; cyclorama design needs correction. 2, Initial and reflected waves, actor "down right"; and 3, Actor "down left", show no serious defects.

THE OBJECTIVE of acoustic planning in theaters is to make certain that the audience can hear—clearly and without effort—any sound which is part of the show, and, conversely, that interruptive noises originating within or without the theater are rendered inaudible.

The auditory component of the show may include sounds which range in intensity from the threshold of audibility to the threshold of feeling, and in frequency from approximately 16 to more than 16,000 cycles per second. Also, location of the source is variable; and all sounds from all sources and locations must be transmitted equally over the audience without undesirable distortion. Such an ideal is difficult to attain; but a satisfactory approximation of it is not beyond reach.

Acoustic planning entails provision for proper sound *distribution*, and *reverberation*. Elimination of interruptive noise requires a degree of sound *insulation* and, in some cases, sound *isolation;* also, equipment (such as heating systems) has to be designed and installed in a manner which aids in suppressing the background-noise level.

Complete planning for acoustic control is a matter for technical study by acoustic engineers or physicists. Yet the engineer or physicist may know little of the theater's peculiar demands; and often, therefore, the resulting theater may be acoustically good under a single set of conditions, but bad under all others.

Shapes of spaces, and surface treatments, are two recognized methods of control. It is probable that, in the abstract, some shapes may be acoustically better than others. But shapes which may appear acoustically bad on paper are often found to be satisfactory as a result of tests. Many factors besides acoustic necessities control proportions of an auditorium.

Sound distribution. Because part of a sound wave goes straight from source to auditor and part is reflected from ceiling, walls, stage scenery, or cyclorama, it therefore follows that stage and auditorium act acoustically as coupled spaces and need to be studied simultaneously.

The principal distributing surface is the auditorium ceiling. The ceiling under the balcony, the rear and splayed walls of the auditorium, and the cyclorama are the other useful surfaces. Ceilings must reflect sound to the audience either directly or via walls. However, sound must not be concentrated in certain spots, must not reflect back and forth between parallel surfaces, or get to the audience out of phase with the direct wave. Back wall and plaster cyclorama shapes depend principally on the necessity for preventing echoes and undesirable focal points for sound waves.

Sound travels only about 1150 ft. per second in air. Therefore the distance traversed by the first wave reflected from any surface should not exceed that of the direct wave by more than approximately 50 ft. or the audience will hear everything twice.

Tests for even distribution may be made on scale models by means of ripple tanks, by spark photographs, or by tracing reflections of a small light beam. Tests are preferably repeated for 6 to 12 sound-source locations on the stage with various curtain trims, and for all other anticipated sources. If reverberation calculations indicate a need for absorbent surface treatment, locations can be determined by tests.

Poor distribution will usually result when an under-balcony ceiling slopes up toward the back of the auditorium, or a back wall follows the curve of the seats.

Dead spots sometimes result where direct and reflected waves come out of phase and cancel; reflected waves may be undesirably focused from a ceiling vault; and echoes may occur when reflected waves travel too long a path before reaching the audience.

Satisfactory distribution probably exists when the sound-wave pattern is rapidly broken up, and waves of approximately equal size, from all directions, cover the audience area.

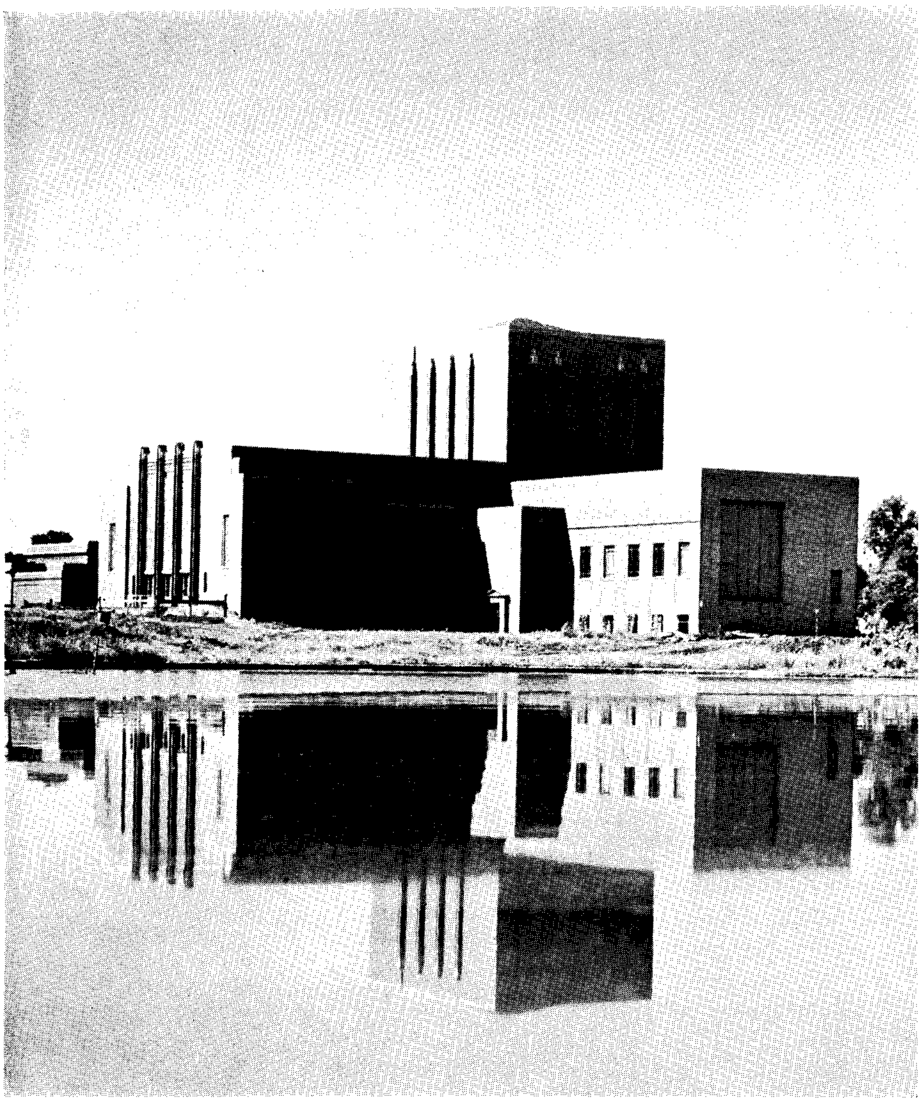
Reverberation time varies with the pitch of sounds, and with sound-absorption characteristics of the theater. In an auditorium of about 100,000 cu. ft. (700 to 800 seats) optimum reverberation times are approximately 1.4 seconds at 512 cycles, 2.4 seconds at 128 cycles, and 1.4 seconds at 2048 cycles. This range represents compromises between optima for various kinds of productions. Better, yet sometimes impractical, would be a means of varying absorption and thus controlling reverberation (see AR, 7/38, p. 55). It is considered good practice to permit the audience to supply most of the necessary sound absorption. Other means, in order of preference, are: carpet, decorative hangings, and, last, permanent wall-surfacing materials. Since audiences vary in size, it is desirable to specify auditorium seats which have the same sound-absorptive characteristics empty or occupied.

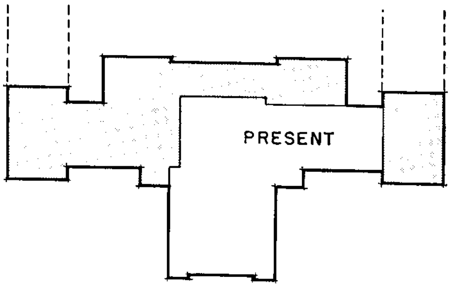
Condensed from a portion of a forthcoming book on theater planning by Harold Burris-Meyer (Director of the Stevens Theater, Director of Research in Sound in the Theater, and Asst. Prof. at Stevens Inst. Tech.) and Edward C. Cole (Technical Director, Yale University Theater, Asst. Prof. Dept. Drama, School of Fine Arts, Yale Univ.)

CASE STUDIES—REGIONAL THEATER IN IOWA

UNIVERSITY THEATER
STATE UNIVERSITY OF IOWA
IOWA CITY, IOWA

DEPT. GROUNDS AND BUILDINGS
GEORGE L. HORNER, Architect
GEORGE R. PARIZEK, Engineer





Theater unit, first portion of the Dramatic Arts Building in the Fine Arts Department, is built on made land on the banks of the remodeled Iowa River. Gray portions of plan at right show locations for future theater laboratory and shop additions. Dotted lines indicate contemplated classroom wings.

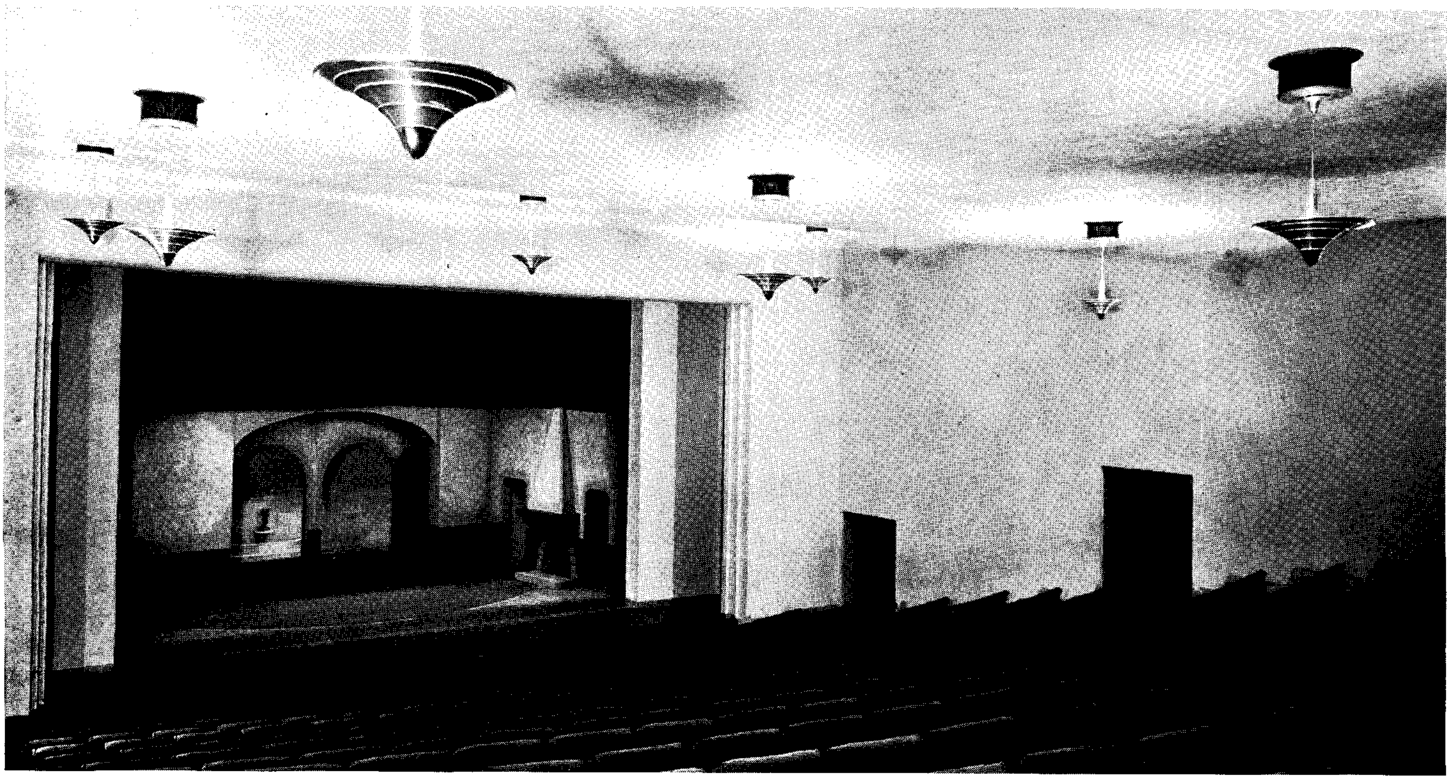
THE FINE ARTS SCHOOL of the State University of Iowa, created in 1929, contains three departments: Graphic and Plastic Arts; Music; and Dramatic Arts. The school serves a regional need as well as the more limited types of academic requirements. It provides an opportunity for idiomatic, indigenous creative art; and, in the drama department, a chance for contact with a theater audience which the commercial theater cannot hope to reach. According to the expressed opinions of many theater consultants, directors, and playwrights, it is in such developments as these that the future of the theater lies (see also AR, 1/37, p. 3).

Approximately 40 university courses are to some degree linked to the University Theater. These range from studies in dramatic production, direction, costume design, scene design, lighting, and acting technique, to courses on radio technique, history of drama, and speech pathology.

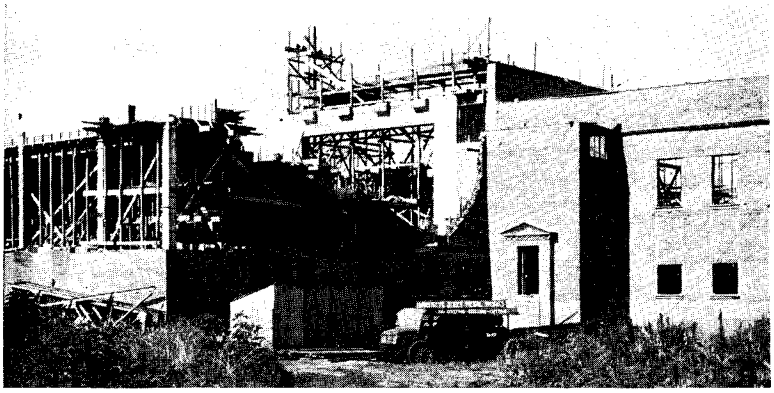
At present, productions are given in Iowa City only. It is hoped that, within a few years, companies can be sent to various parts of the state. During the school year, productions for the public are given once a month, for five performances each. For the school only, other productions are given every week. The typical audience is composed of students, faculty, and townspeople, with a generous sprinkling of out-of-town people. There is a 250-car parking lot on ground adjacent to the theater.

Most of the productions presented to date have been "straight" drama, although the theatre has, at times, been used for dance recitals and opera.

The theater's director, Prof. E. C. Mabie, acted as consultant in planning the structure. Within the proposed theater laboratory will be included a Shakespearian Theater and other facilities for experimental dramatic forms.



In the auditorium, aisleless (Continental) seating is used to unify the audience and increase intimacy.



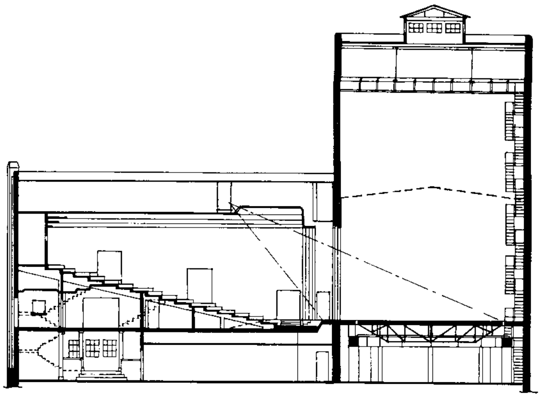


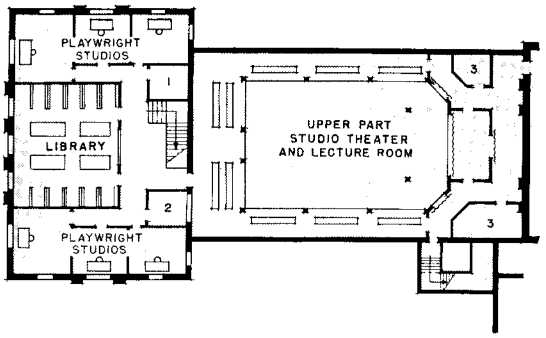
Photo taken during construction, and diagrammatic section, show use of ramps and stairs which distribute the audience from lobby to auditorium. Circulation is simple. Doors between lobby and auditorium are omitted.

THE AUDITORIUM seats 500 people, in a stadium arrangement of Continental seating. Seats are 21 in. wide, 40 in. back-to-back, and tilt automatically. The auditorium and stage were acoustically planned so that sound-absorbent surfacing was limited to one 20-ft. square panel on the back wall of the stage. The orchestra pit was omitted; this, and the type of seating, were designed to achieve a maximum of intimacy between stage and audience. It is planned to include radio facilities in future additions.

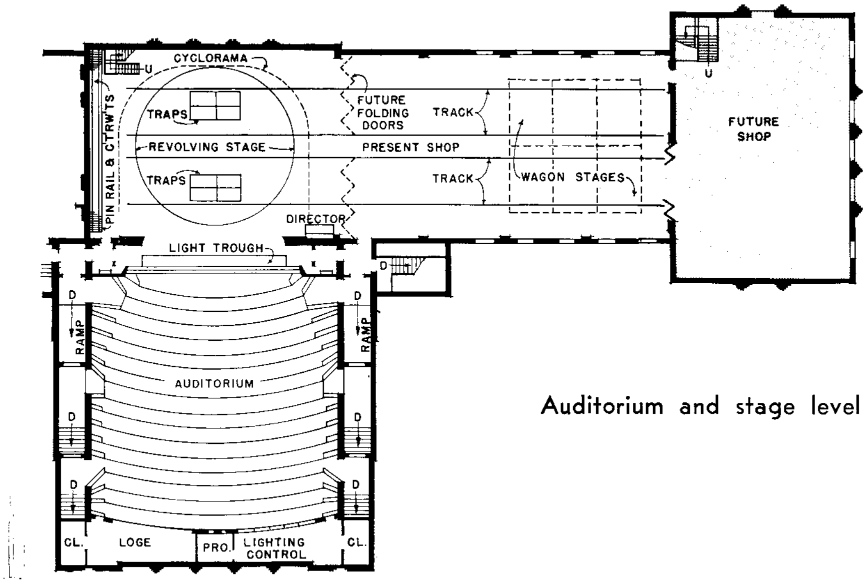
Unshaded portions of the accompanying plans indicate the present building. On stage, scenery is shifted by means of wagons, or may be flown to the grid. Ordinarily, wagon stages run on a single pair of tracks, and wing space is required on both sides of the acting area; but inclusion of a revolving stage permits two pairs of tracks, and makes left-hand wing space available for future laboratory theater building.

Scenery, costumes, and some properties are produced by students. The shop has power-operated woodworking equipment. Stage equipment includes a motorized light bridge, grid, 25 fly lines (with provisions for more), pinrail, and revolving stage with controls at the stage manager's panel on stage.

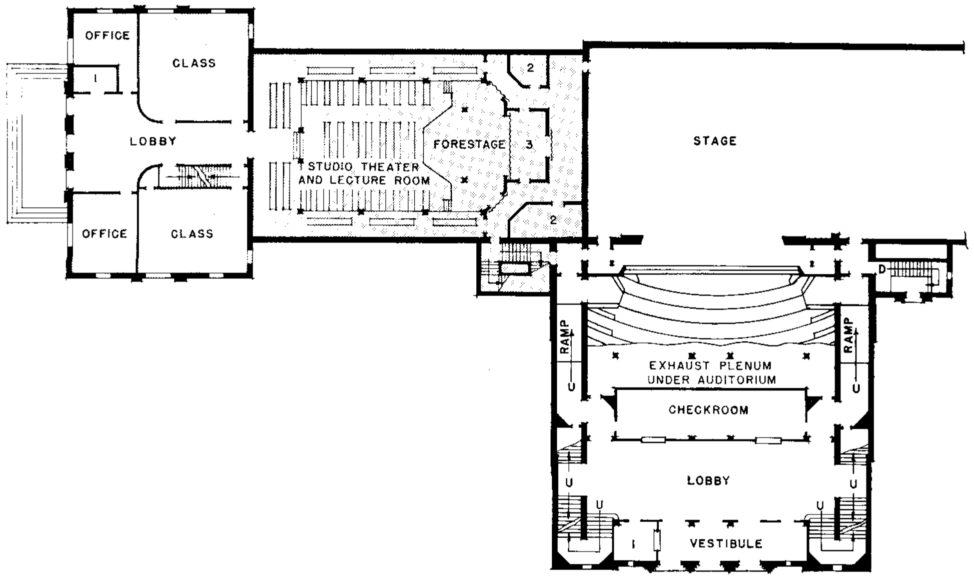
Stage and auditorium lights are controlled from the rear of the auditorium. There are approximately 250 individual circuits, 48 dimmer circuits, with cross-connecting panel and remote control electronic dimmer. Special remote control over circuits not energized through the control board and emergency control over all circuits are available at the stage manager's control panel.



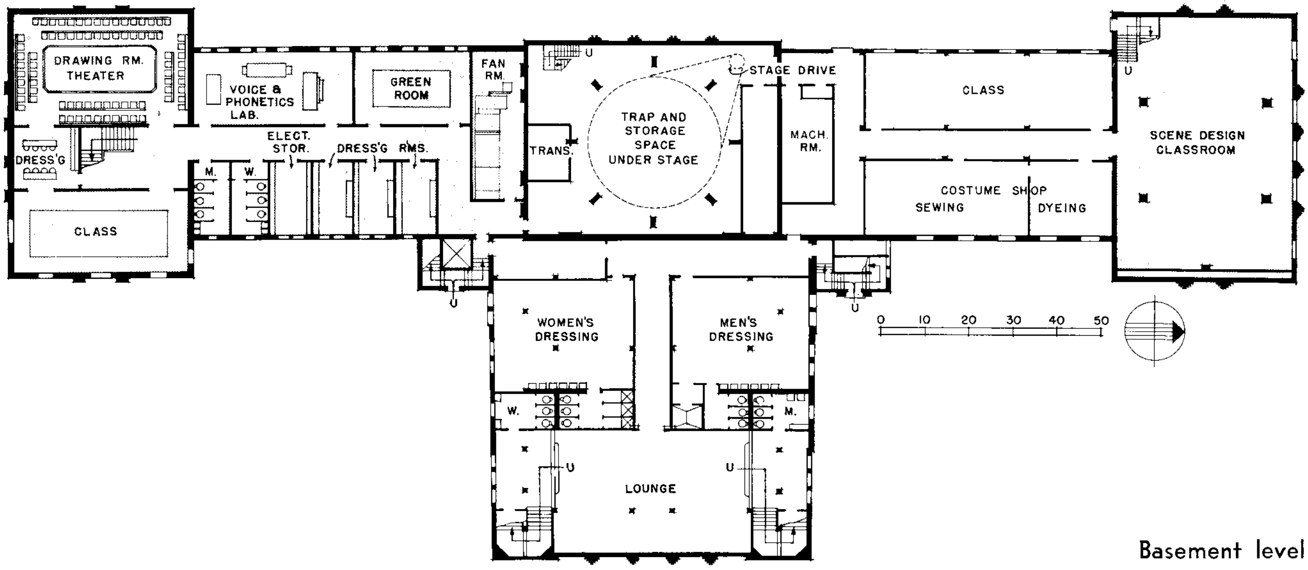
Second floor, future theater laboratory: 1, 2. Viewing and discussion rooms. 3. Dressing rooms.



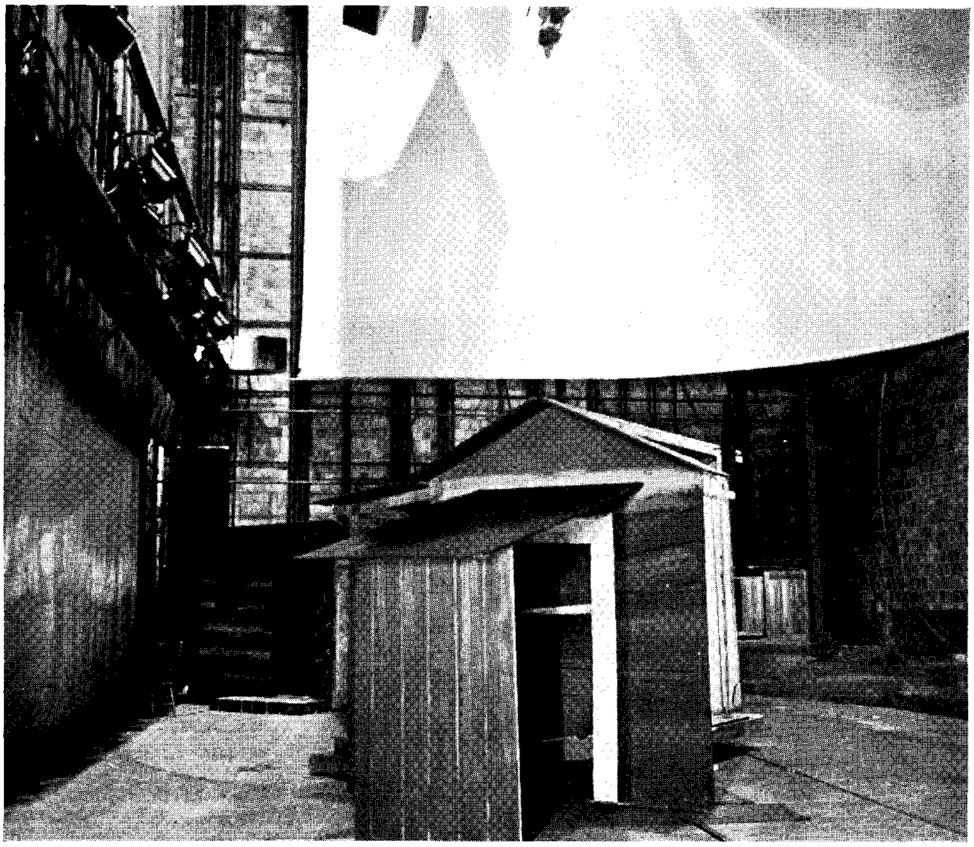
Auditorium and stage level



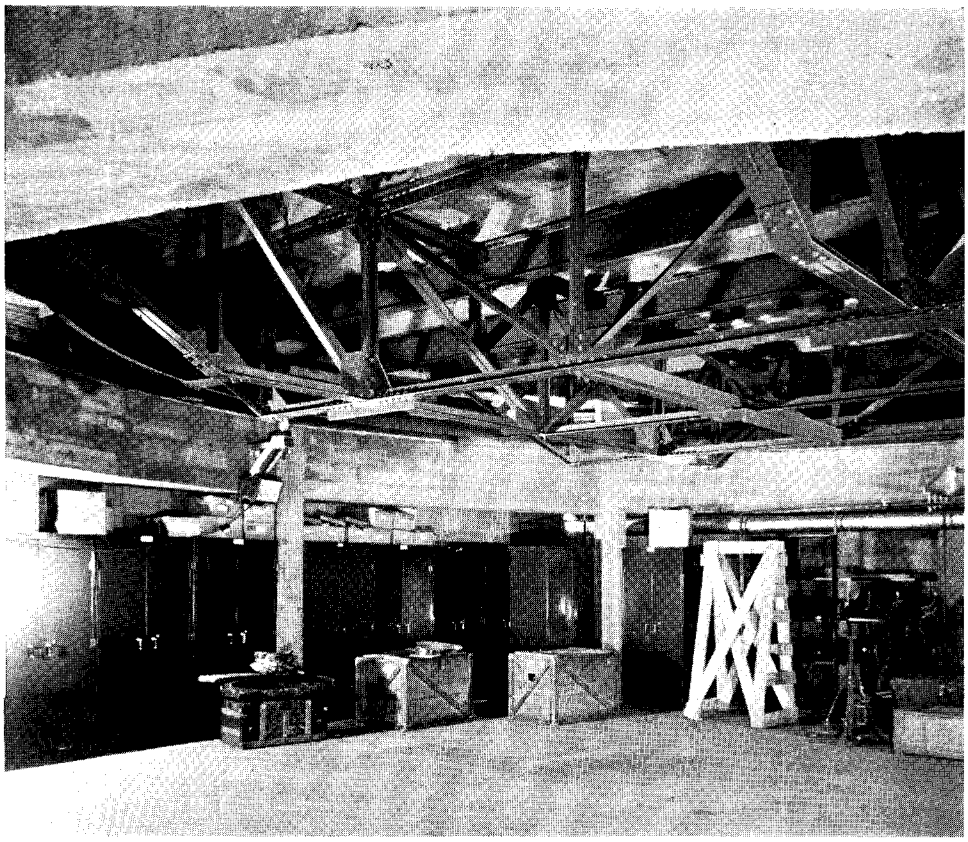
Lobby (ground) level. Future additions are shown in gray. Studio Theater stage will have a two-level, multiple-opening proscenium. 1. Ticket booth. 2. Dressing rooms. 3. Rear stage.



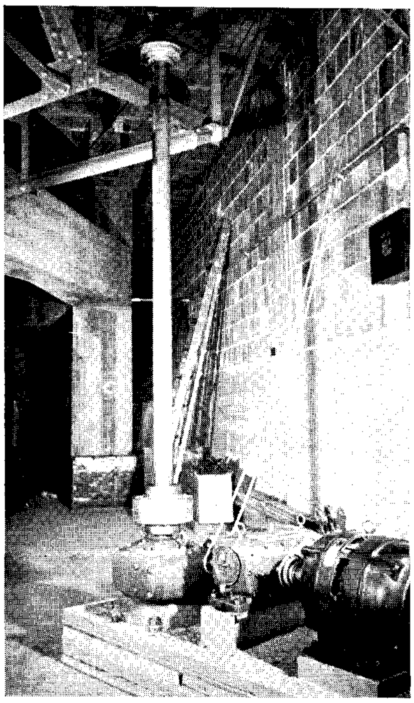
Basement level



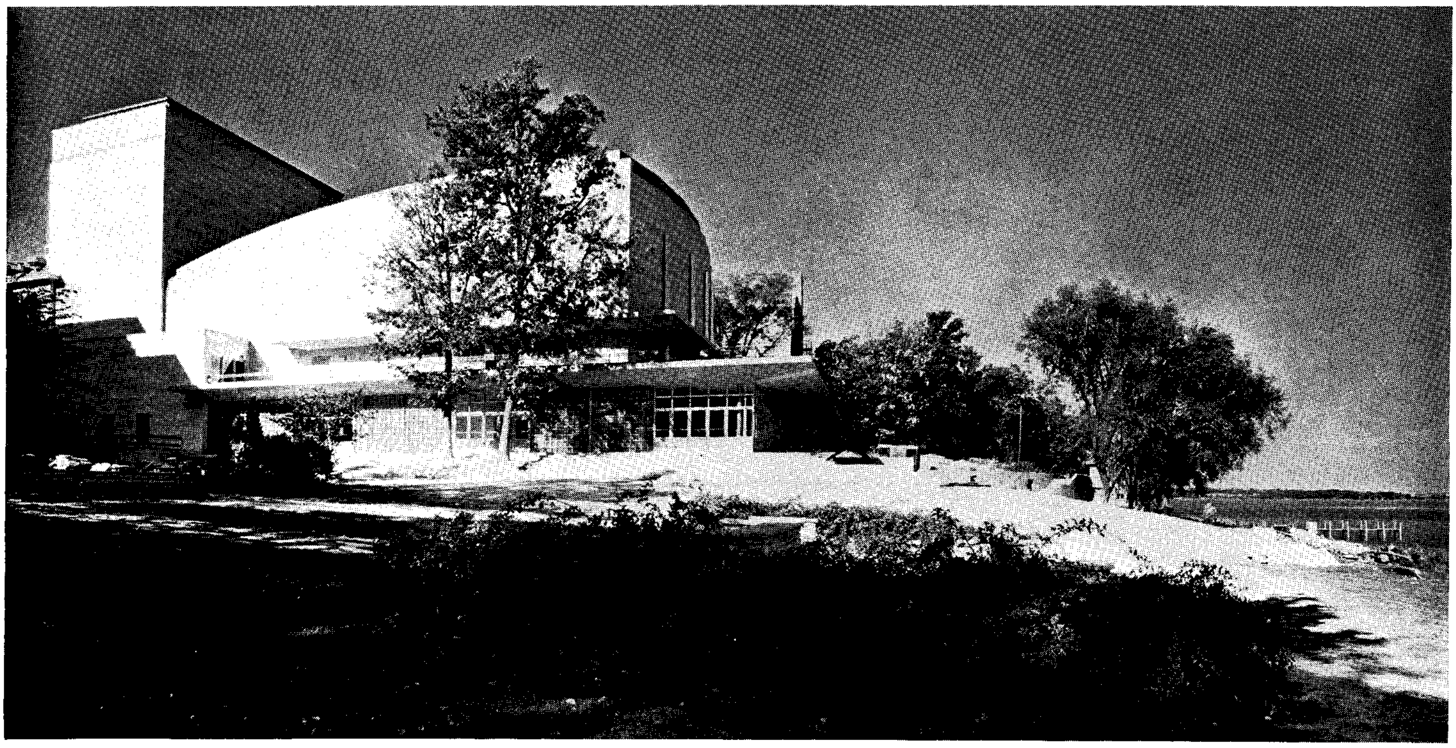
Cloth cyclorama is raised while scenery is moved on to revolving stage.



Below the revolving stage, clear trap-space is left.



Revolving stage drive mechanism



THEATERS IN MEMORIAL UNION, WISCONSIN UNIVERSITY, MADISON, WISCONSIN

MICHAEL M. HARE, Project Designer; LEE SIMONSON, Theater Consultant; CORBETT AND MACMURRAY, Architects; STATE BUREAU OF ENGINEERING, Resident Architect

WITH THE ADDITION of a new wing to its Memorial Union, Wisconsin University acquires what is probably the most complete community theater center to date. It is designed to integrate the theater with the widest possible range of cultural and recreational interests. Provisions for the dance, concerts, painting and sculpture studios, bowling alleys, and a camera club, are included. Theater facilities include a large stage and auditorium for public performances, and a small laboratory theater for experimental dramatic forms, study of radio and cinema technique, and the University broadcasting station. The large theater is intended for use by the population of Madison (60,000) as well as the student body (11,000).

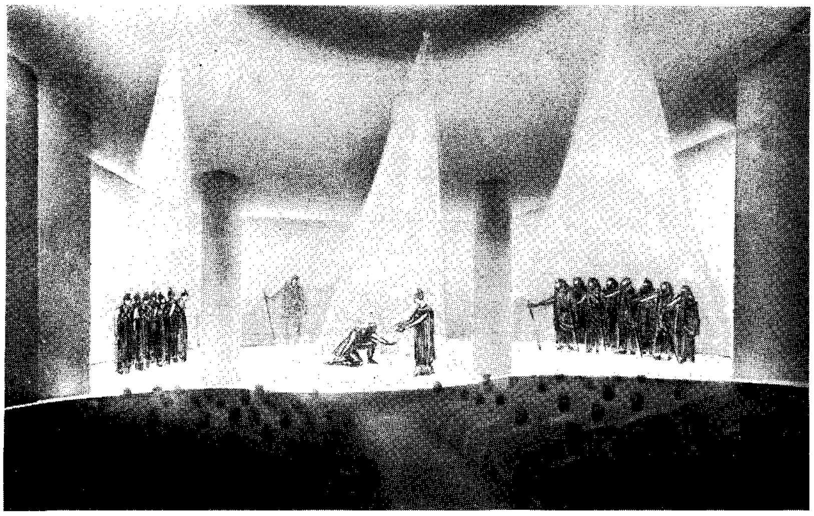
Seating capacity of the large auditorium can be varied from 1300 to 700 by drawing curtains across both orchestra and balcony. The laboratory theater seats 185. The large stage is 35 ft. deep, 75 ft. wide, with a completely trapped acting area, 40 by 20 ft., an elevator forestage, and a gridiron 70 ft. high.

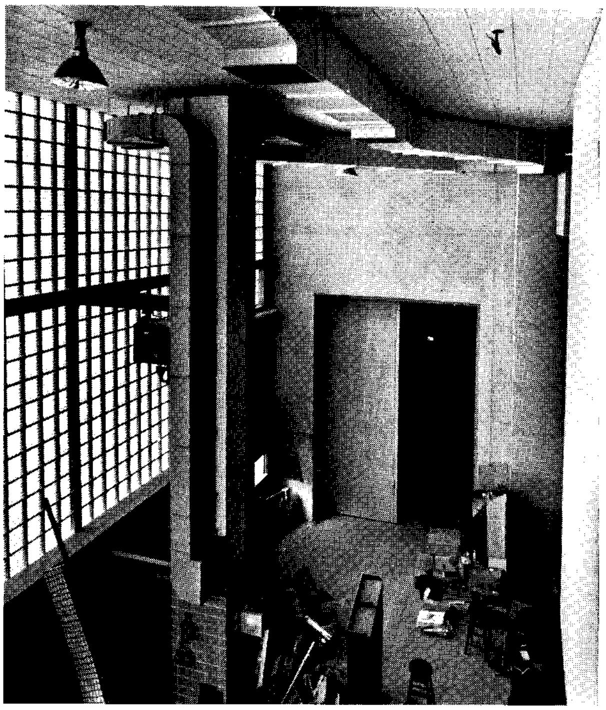
Stage and auditorium lighting controls operate through dimmer banks located below the stage, and are activated by remote control. A portable control panel may be taken into the auditorium, connected through the auditorium floor, and used for light rehearsals. Lighting changes can be accurately pre-set. An intercommunicating telephone connects the stage manager with director (in auditorium), fly gallery, light booths, and workshops.

Acoustic planning problems were multiplied by the fact that several parts of the building are to be in simultaneous use. Broadcasting, lectures, scene construction, costume design, and bowling may all be going on during a performance. Noise from such sources has been reduced by sound insulation and isolation. Shapes of auditorium walls and ceiling were determined by acoustic requirements.

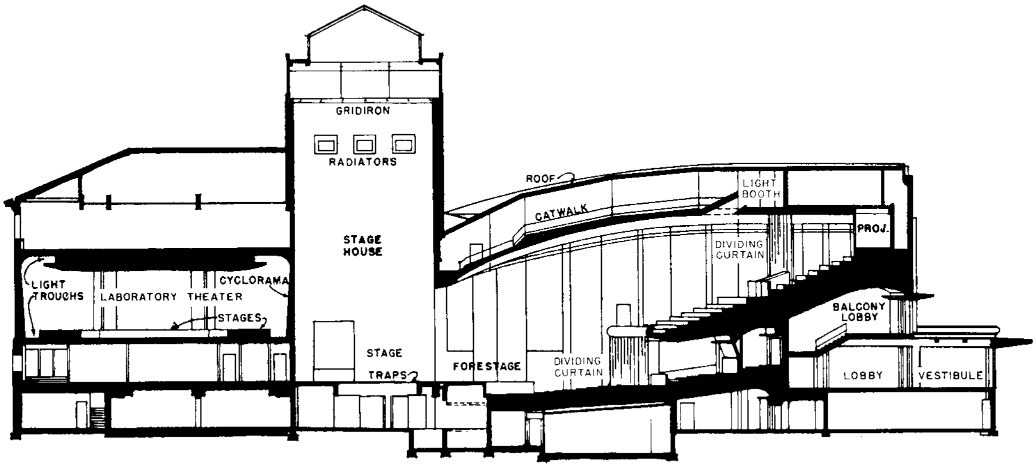
Estimated cost of the addition is $815,000.00.

WISCONSIN UNION THEATERS (continued)

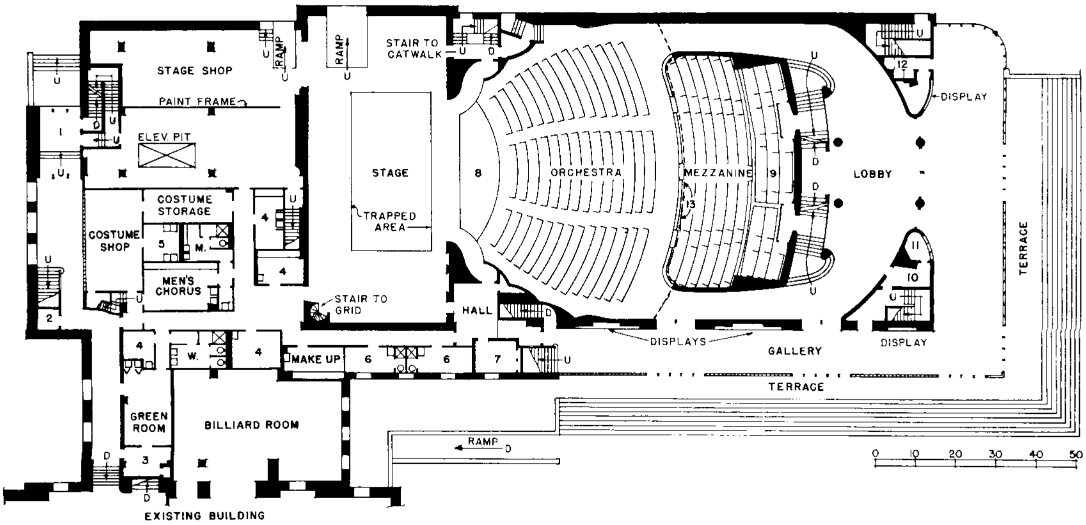




Above, rendering of encircling stage in laboratory theater, in use. Folding panels vary the openings of the side proscenia according to the production's needs. Structural columns at sides of center proscenium house tormentor lights. Spotlight cut in ceiling is semicircular in plan, to provide sources of illumination for entire stage. At right, view of stage shop.

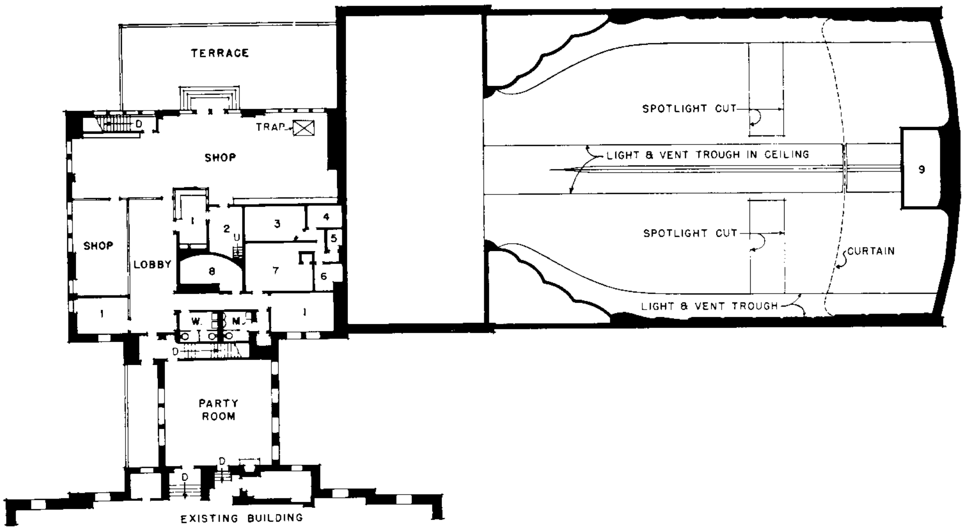


Section through both theaters. Note position of *dividing curtains* with which large auditorium capacity can be varied. Loges at rear of orchestra mezzanine have disappearing glass fronts which permit their use as discussion rooms during performances.

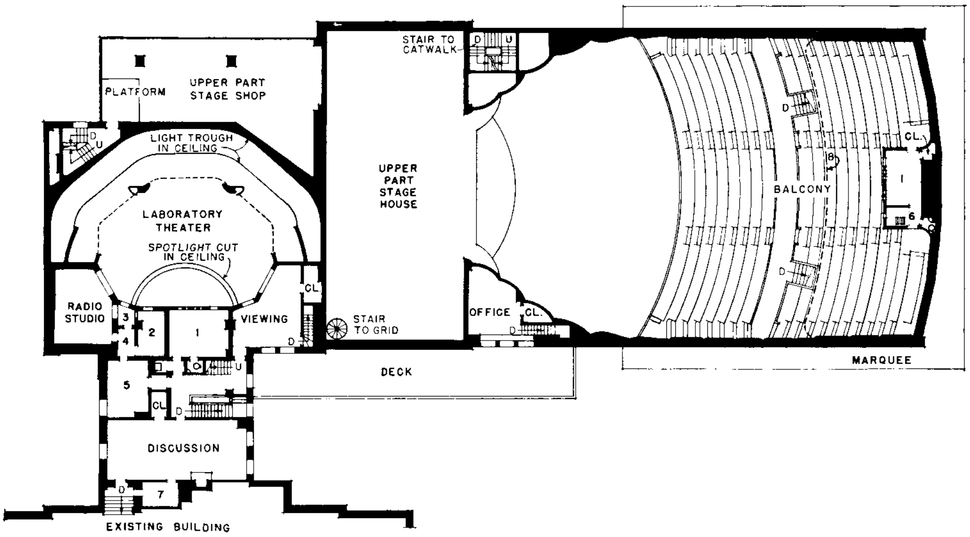


Ground floor: 1. Vestibule. 2. Closet. 3. Kitchen. 4. Dressing rooms. 5. Dyeing room. 6. Stars' dressing rooms. 7. Office. 8. Elevator forestage. 9. Loges or viewing rooms. 10. Manager. 11. Tickets. 12. Telephones. 13. Dividing curtain.

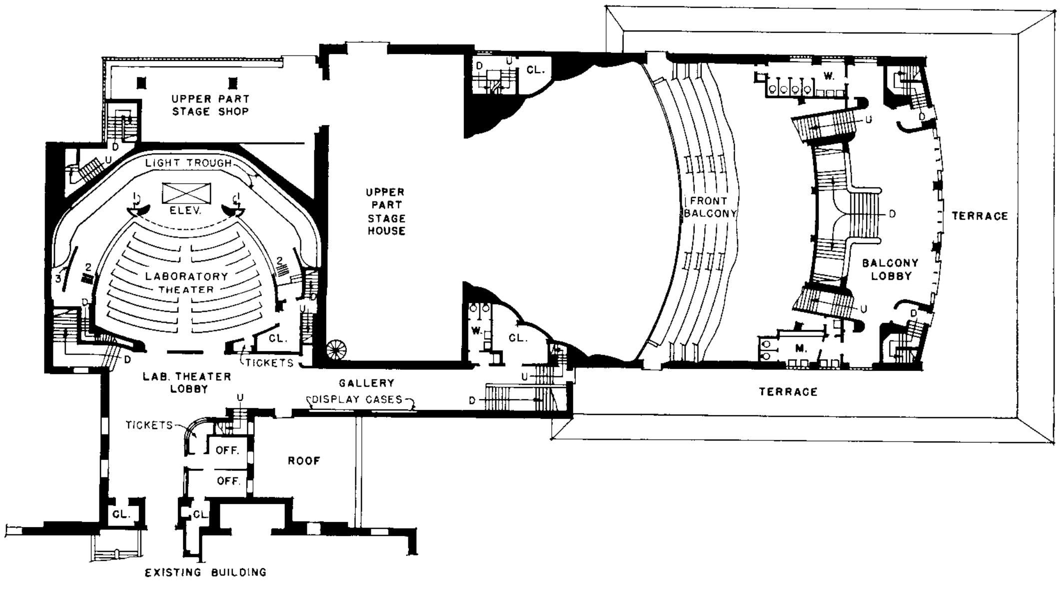
Gallery, or vestibule, is glass-enclosed and has wall space for exhibitions. Below the shops are bowling alleys and a ping-pong room; below the large theater are trap and storage space, offices, rehearsal rooms, a lounge, and a kitchenette.



Top floor, showing location of ceiling cuts in main auditorium: **1.** Office. **2.** Storage. **3.** Photo enlarging. **4.** Contact printing. **5.** Film loading. **6.** Negatives. **7.** Photo workroom. **8.** Laboratory-theater light booth. **9.** Projection room.



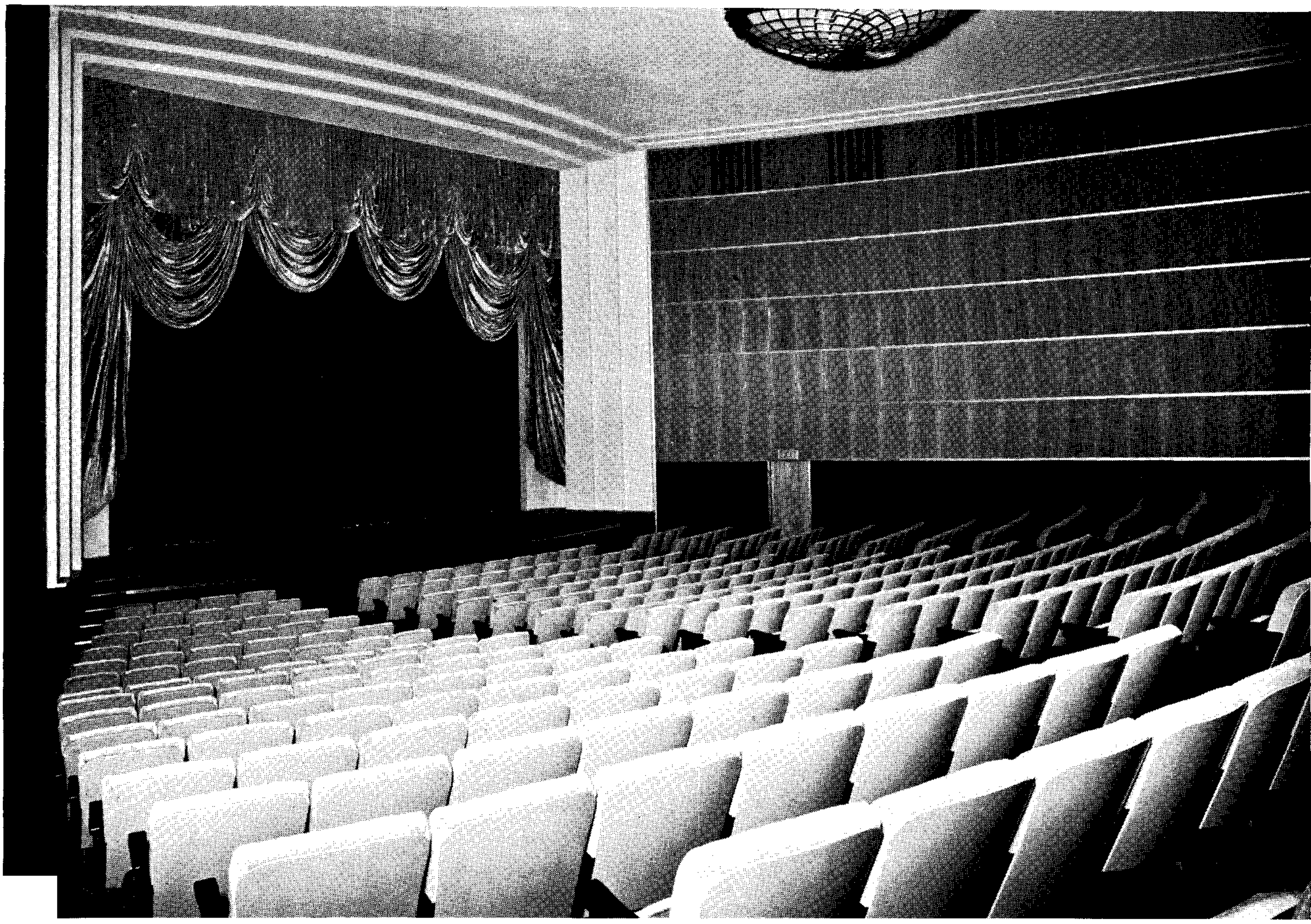
Second floor: **1.** Projection room. **2.** Control room. **3, 4.** Directors' rooms. **5.** Quiet room. **6.** Rewind room. **7.** Kitchenette. **8.** Dividing curtain.



First floor: **1.** Tormentor lights. **2.** Folding proscenium doors.. **3.** Sound baffle.

Scenery on the laboratory-theater stage consists of pylons, platforms, and similar properties, which are shifted by means of the elevator. Cyclorama is built-in.

COMMUNITY ARTS CENTER



Laura Gilpin

COLORADO SPRINGS FINE ARTS CENTER

JOHN GAW MEEM, Architect

In this fine arts center are incorporated music and art studios, shops, and exhibition galleries for the use of various community organizations. Although the theater's space requirements cause it, to an extent, to dominate, gallery and studio facilities were the prime consideration. A great number of individuals participate in all the creative activities for which provisions are made.

These provisions are grouped into five principal parts of the plan: an art school, art and special museums, "little" theater, library, and music center.

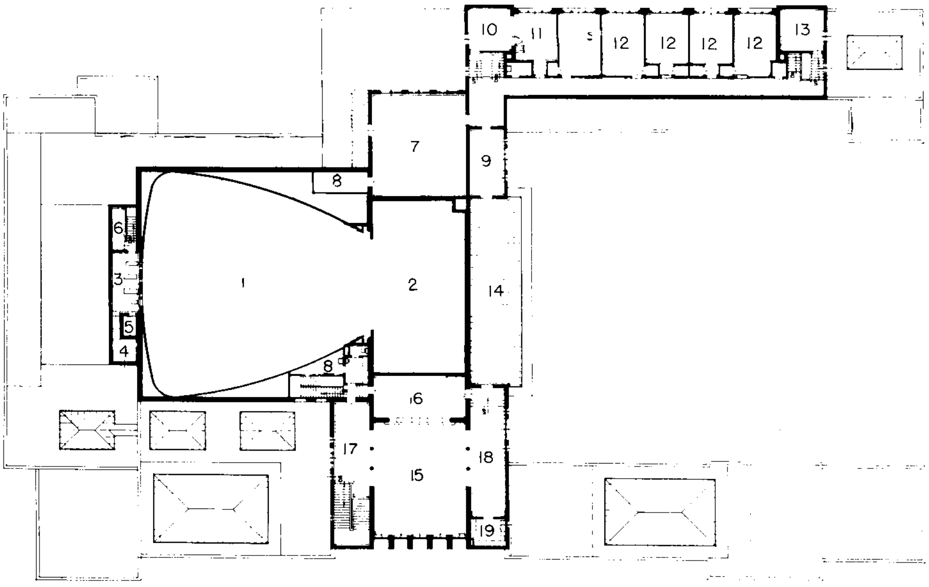
Galleries and exhibition halls, directly accessible from the lobby, have ample space for social gatherings, and offer opportunities for theater-goers to view the Center's exhibitions. Kitchenettes are available for food service. The terrace on the north, and the garden in the east court, are also suitable for public use.

The theater and stage are of conventional type. While in some respects the building's dramatic facilities are somewhat cramped—for instance, in the limited wing space off stage—they nevertheless represent a considerable advance. Carpenter, costume, and stage shops are provided; the stage floor is trapped; dressing rooms are mostly at stage level. The stage shop serves for rehearsals.

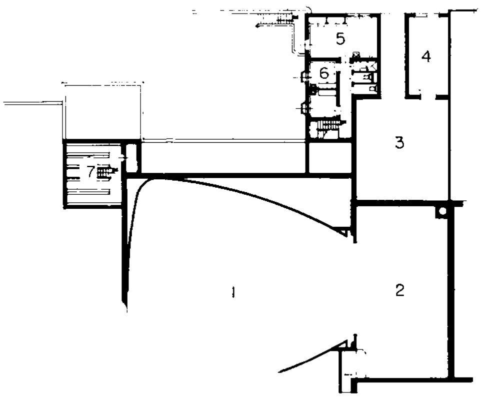
The auditorium, which seats 400, has walls surfaced with alternating horizontal strips of flexwood and aluminum. Ventilating grilles are incorporated in the wall treatment. An orchestra pit is included, but no forestage. There is no balcony.

The art school contains several studios for creative work, an art-materials store, and an office for the director, Boardman Robinson; lecture rooms were omitted purposely. The special library is intended for study and occasional exhibits; and has a vault for rare books, and a private room for the donor. There are separate art and music libraries.

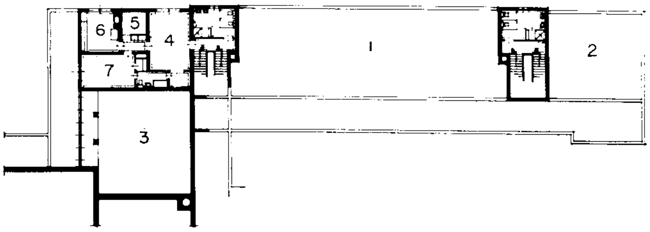
The music center is concentrated in the area over the entrance lobby. The music room seats 125 persons. A special lift serves to hoist pianos from the theater stage to the music-room stage. A promenade overlooks the east court.



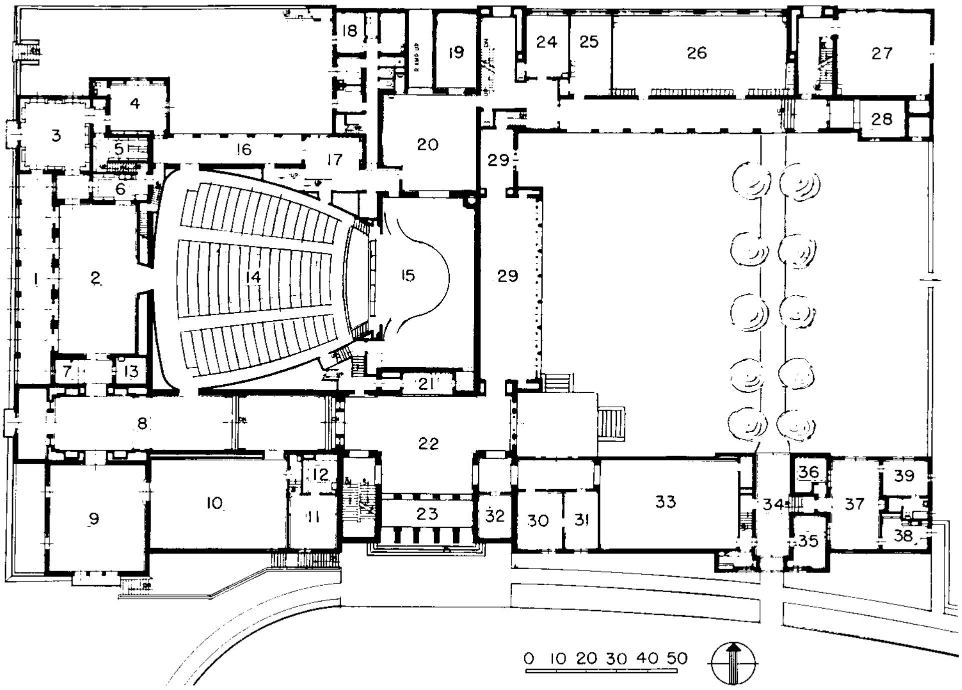
Second floor: **1.** Upper auditorium. **2.** Upper stage. **3.** Projection. **4.** Generator. **5.** Rewind. **6.** Storage. **7.** Life studio. **8.** Chair storage. **9.** Studio director's office. **10.** Balcony. **11.** Art library. **12.** Studios. **13.** Office. **14.** Promenade. **15.** Music room. **16.** Stage. **17.** Foyer. **18.** Library. **19.** Kitchen.



First intermediate floor: **1.** Upper auditorium. **2.** Upper stage. **3.** Upper shop. **4.** Upper shop. **5.** Costumes. **6.** Dressing. **7.** Bookstacks.



Second intermediate floor: **1.** Upper studios. **2.** Upper studios. **3.** Upper shop. **4.** Janitor's living room. **5.** Fan room. **6.** Kitchen. **7.** Bedroom.



First floor: **1.** Loggia. **2.** Lounge. **3.** Library. **4.** Private office. **5.** Stacks. **6.** Tea service. **7.** Alcove. **8.** Foyer, exhibits. **9.** Southwest museum. **10.** Indian museum. **11.** Curator. **12.** Preparation room. **13.** Janitor. **14.** Auditorium. **15.** Stage. **16.** Porch. **17.** Green Room. **18.** Dressing rooms. **19.** Carpenter. **20.** Stage shop. **21.** Information. **22.** Lobby. **23.** Vestibule. **24.** Private studio. **25.** Litho studio. **26.** Studio. **27.** Sculpture studio. **28.** Art store. **29.** Gallery. **30.** Director's room. **31.** Secretary. **32.** Coats. **33.** Current exhibits. **34.** Zaguan (entry). **35.** Packing room. **36.** Storage. **37.** Director's living room. **38.** Kitchen. **39.** Bedroom.

The lounge, or auditorium lobby, has an excellent view.

Photos by Laura Gilpin

Music room, looking toward the stage.