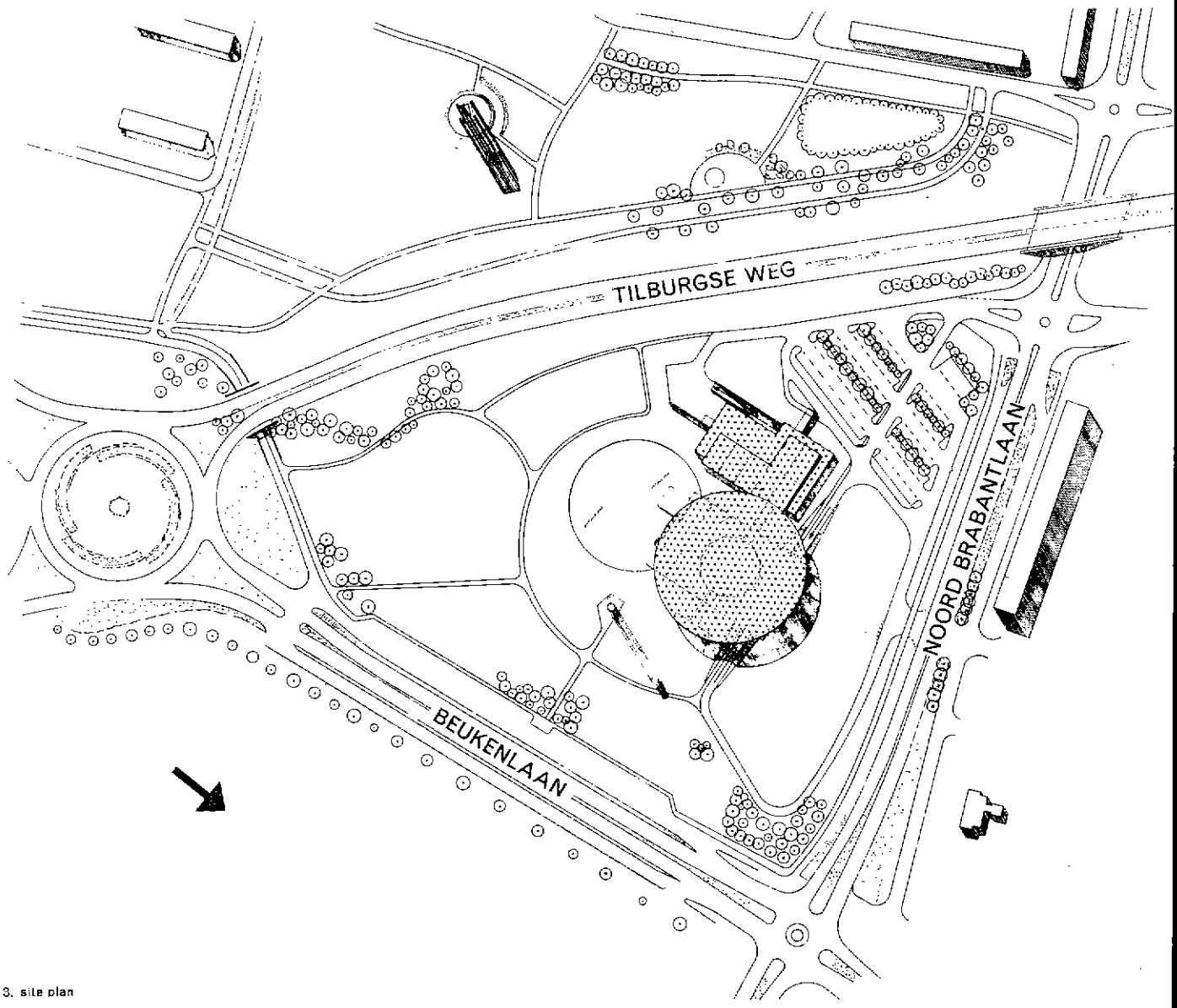
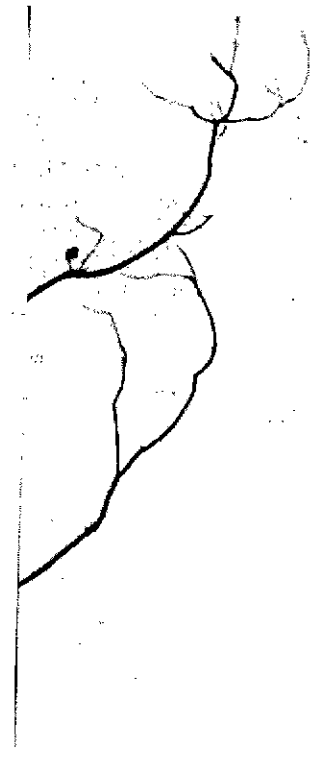
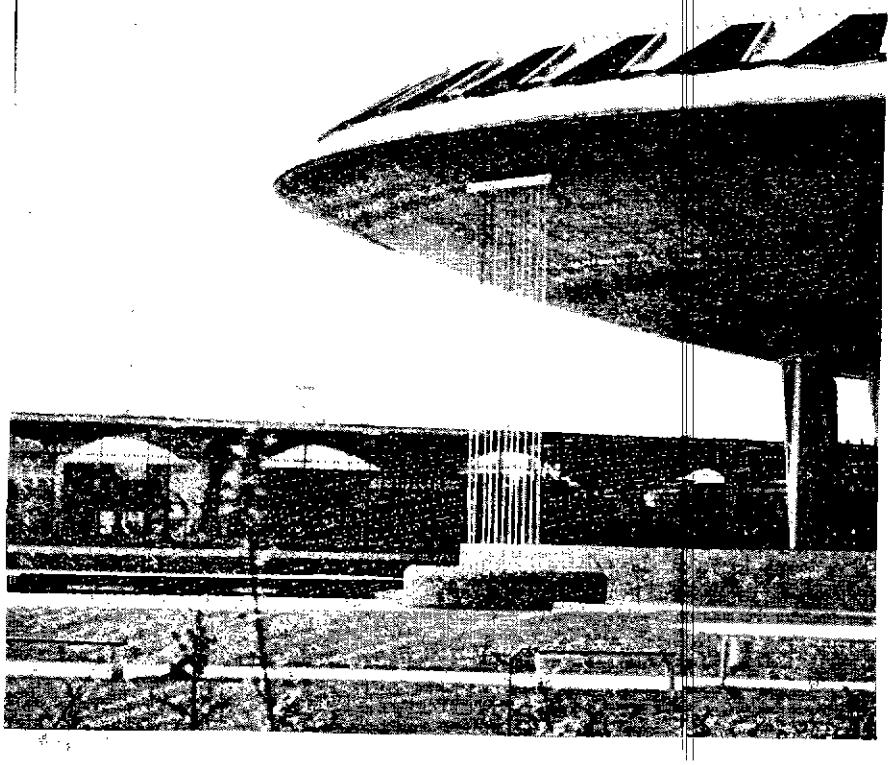


3. site plan

2. spheroid and restaurant





The Evoluon what, where, why and how?

1. Initial requirements

Basically, an exhibition hall was wanted to house exhibits on twenty subjects, each requiring some 150 to 200 square metres of floor-space. It was assumed that there would be between 500 and 1,500 visitors at the exhibition simultaneously (although, in fact, the number of people in the building has been as high as 3,000). The restaurant was to have a seating capacity of 300. The prime requirement, however, was that the Evoluon should consist of one great exhibition space to allow the visitor to be aware at all times of the movement and interest of his fellow visitors. There was to be visual contact with the surroundings of the building, the traffic, the park, the Philips buildings and the sky, at various points inside.

2. Shape

The architect was looking for a striking shape that would provide a new landmark in the city of Eindhoven. It was intended to arouse curiosity and to associate itself in the mind of the viewer with space-travel, weightlessness and other new achievements that will have such a great impact on life in the near future.

3. Situation

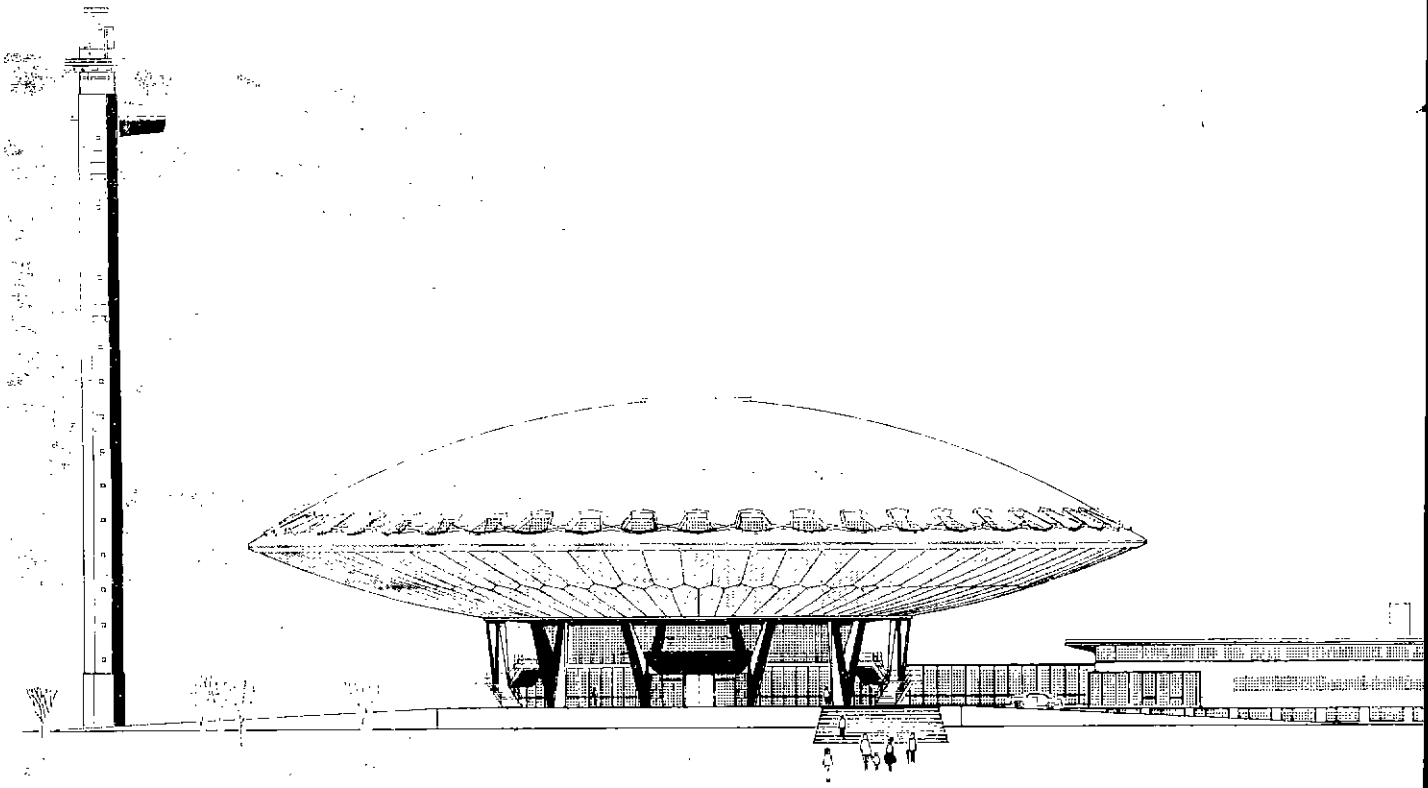
The site provided the starting point. It is triangular, 5.8 hectares in area, and fronting on three busy main highways. It was a gift from the City of Eindhoven to the company on the occasion of the latter's seventy-fifth anniversary, with one condition attached — a public park was to be laid out around the Evoluon. The Evoluon can be seen from all three of the roads fronting it, which is one of the reasons why it was decided to make the main building circular. The actual shape is approximately spheroid, supported on twelve V-shaped pillars. The dome, 77 metres in diameter, is round, the circle being repeated in a pond of the same diameter. The spheroid contains three concentric, stepped galleries, each about 10 metres wide. The total floor area is about 4,700 square metres.

To the west of the main structure is the service wing. It is intended to build another to the east to contain a large auditorium.

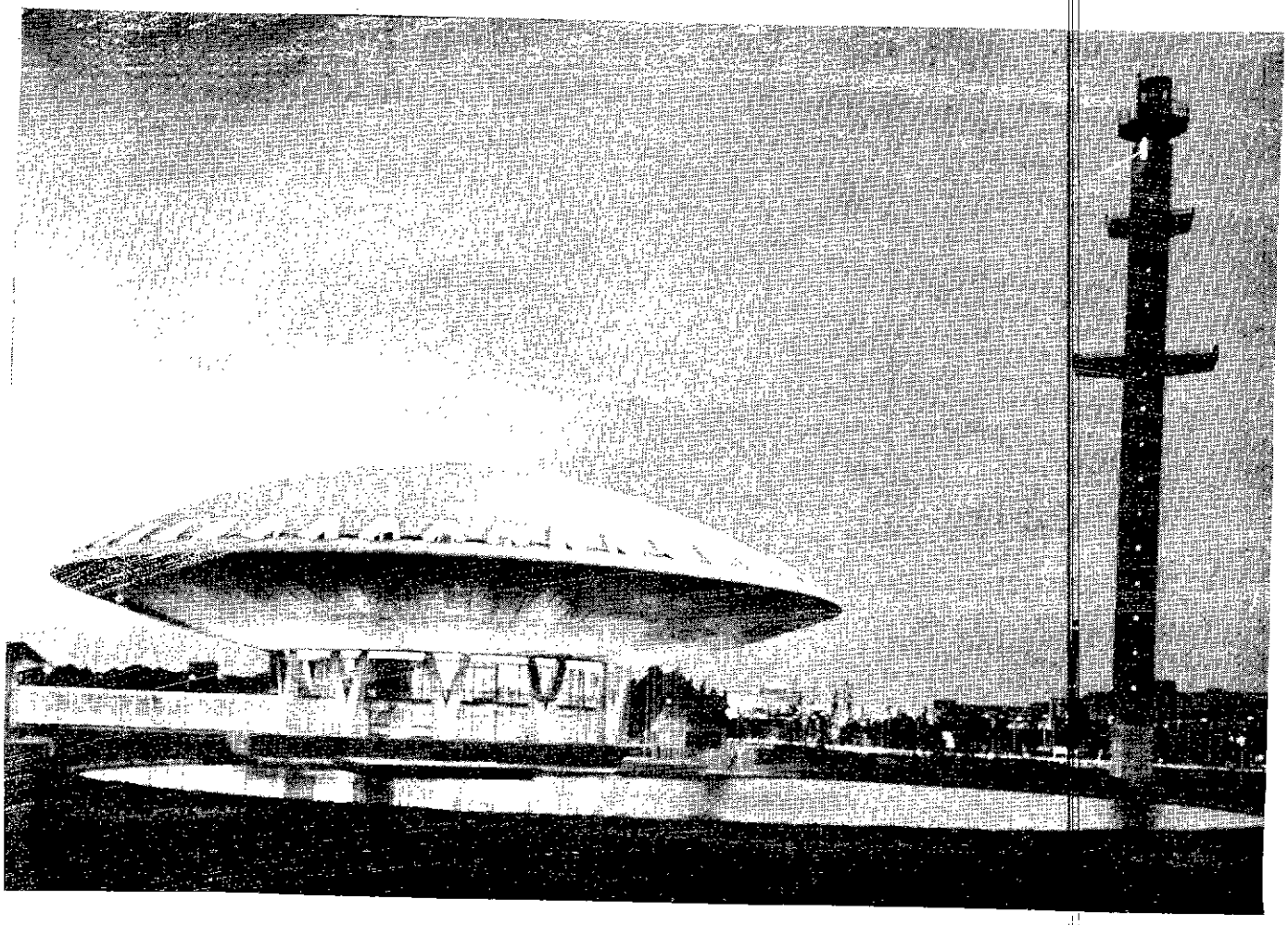
By its sheer size, the main building dominates the site, and its outline is a flowing curve. To provide a contrast, therefore, a straight concrete mast 60 metres high has been erected beside it. This mast is octagonal and has a cross-section of 3 metres.

In the service wing, the visitor will find a restaurant, cloakrooms, toilets, telephone kiosks and an information desk. This wing also contains a reception room ('VIP room'), offices, a temporary, eighty-seat auditorium, a library with a reference section, the 'Introducing Science and Technology' exhibition and a room for small temporary displays. There are also a boiler house, telephone switchboards, rooms housing the electrical installation, kitchens, cold-rooms, stores, workshops, etc.

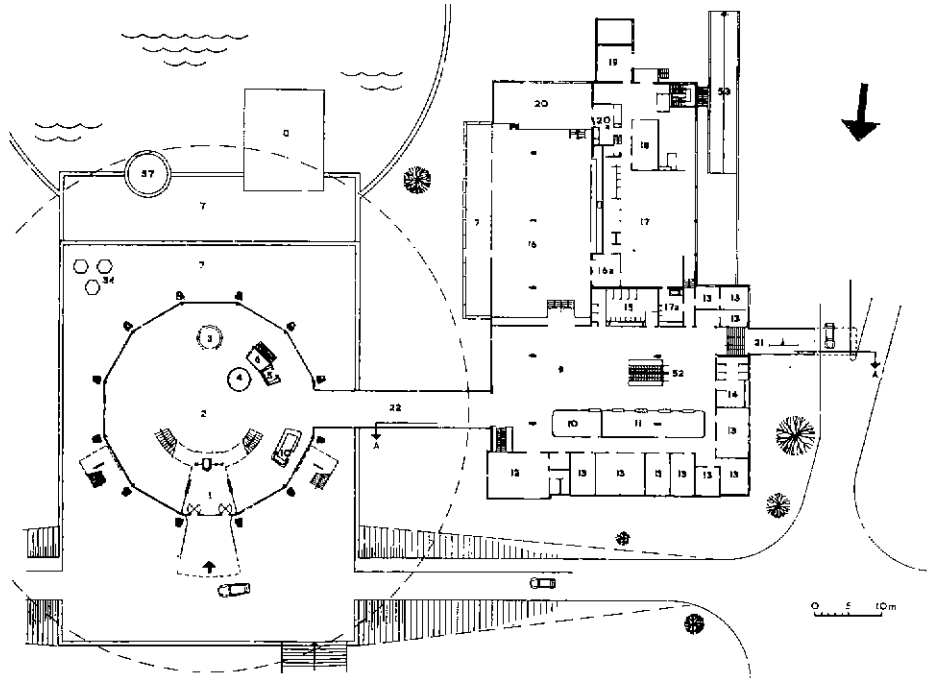
On the outskirts of Eindhoven, within sight of modern office blocks and large industrial estates, rises the Evoluon, which has, in a very brief space of time, attracted a great deal of attention both for its external appearance and for its interior. This booklet describes its architectural and structural features.
The building, which was completed in the year in which NV Philips' Gloeilampenfabrieken celebrated the seventy-fifth anniversary of its foundation, houses an exhibition of the part played by technology in man's evolution. The exhibits illustrate the effects this has had on our work and way of thinking and make special reference to the service rendered to humanity.
The man of to-day and the man of to-morrow are the focal points of the Evoluon. The benefits to man are highlighted and future trends forecast.
The Evoluon exhibition is a permanent, visual symposium of science, technology and engineering in which, while the past is not forgotten, the visitor's eye is continually drawn towards his own world and that of to-morrow's generation.



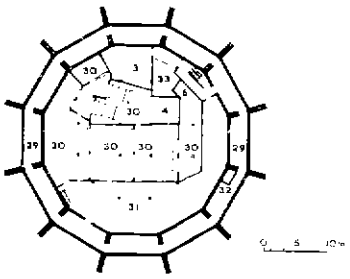
4. view from the park



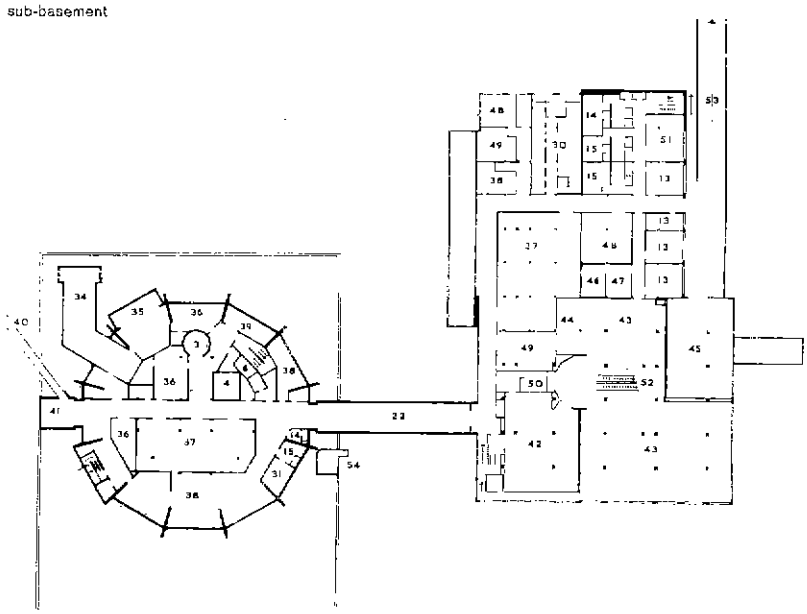
6. ground floor



7. basement



5. sub-basement



4. The main building, design and construction

The main building is made up of the foundations, the pillars enclosing a glass-walled reception hall, the lower 'bowl' with its three galleries and the upper dome.

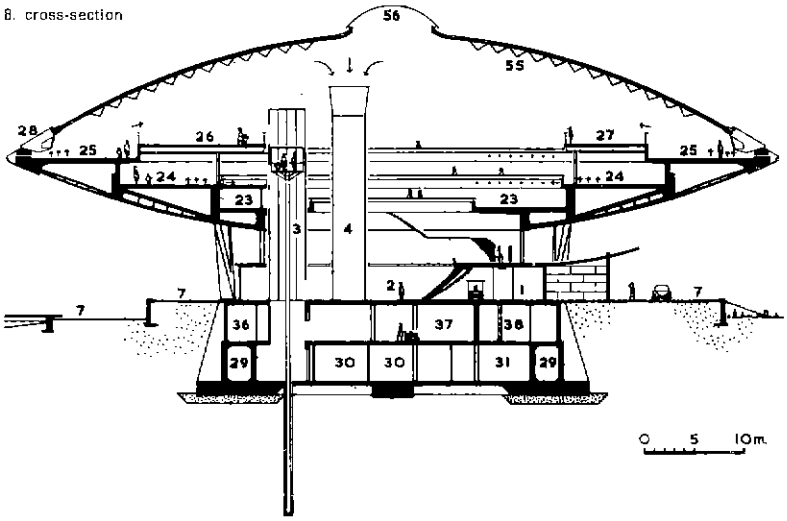
The **foundations,** in the form of a box, consist of two levels below the ground floor. They contain various service areas, including the rooms housing the electrical systems, the transformers and the ventilation equipment, e.g. dust filters, fans and humidifiers. There are also numerous store rooms, workshops, etc. The box is made of concrete and bedded on a layer of sand, with no piles. The 30 metre long tube for the hydraulic lift passes down through the basement floor.

The **twelve V-shaped pillars** rest on the foundations. They were constructed with the aid of steam-heated steel shuttering. Between them, at ground floor level, are the glass walls enclosing the reception hall and there is a fire escape half-way up. The walls are also pierced by the main entrance and the doorways to the wings.

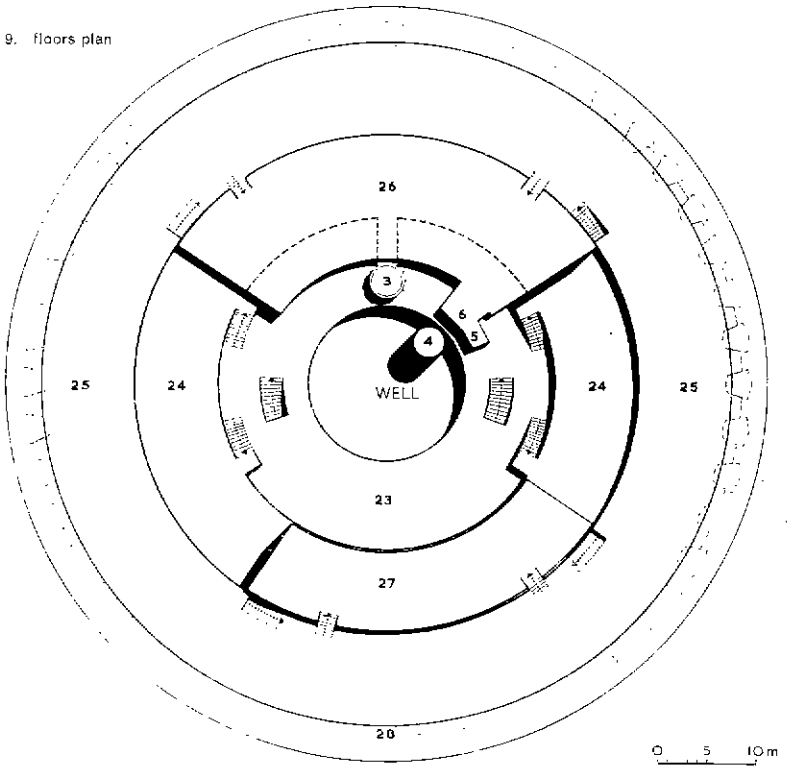
The **lower bowl** of the upper structure is saucer-shaped with a large aperture in the centre. It is supported on top of the pillars on steel 'hinges', each carrying 625 tons. These hinges are essential to allow for the expansion and contraction in the lower bowl due to temperature fluctuations. The bowl itself is made up of three sections of ninety-six prefabricated concrete members held together like the staves of a barrel by a hoop.

Here, this hoop consists of steel tension cables of 12 mm

8. cross-section

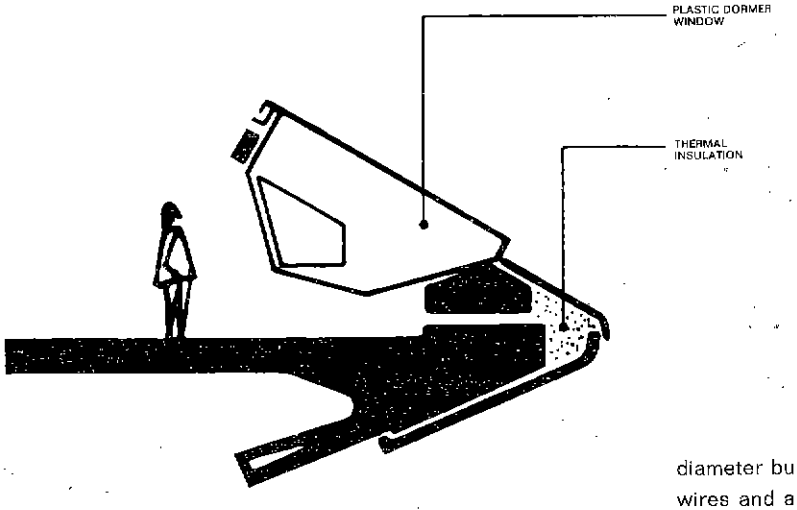


9. floors plan

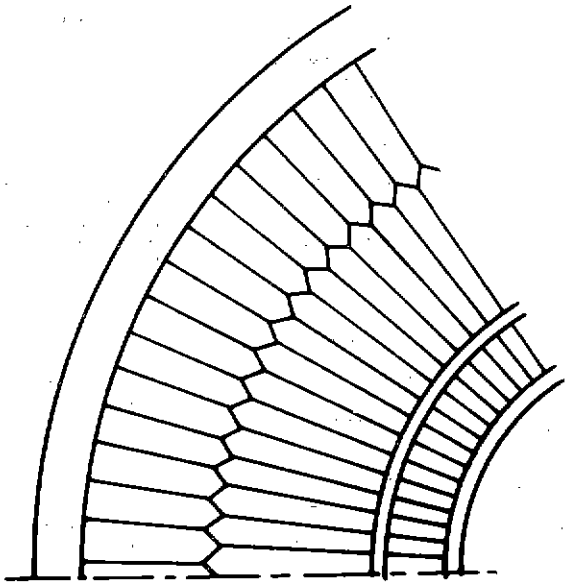


Key:

1. Main entrance
2. Hall
3. Hydraulic lift
4. Exhaust shaft
5. Service lift
6. Ventilation shaft
7. Terrace
8. Band platform
9. Hall of service wing
10. Information desk
11. Cloakroom
12. VIP room
13. Offices
14. Ladies' toilet
14a. Ladies' cloaks
15. Gentlemen's toilet
15a. Gentlemen's cloaks
16. Cafeteria
16a. Cafeteria servery
17. Kitchen
17a. Coffee kitchenette
18. Cold-room
19. Refuse bay
20. Restaurant
20a. Servery
21. Exit
22. Connecting corridor
23. Level 1
24. Level 2
25. Level 3
26. Level 4 south
27. Level 4 north
28. Dormer windows
29. Cable ducts
30. Air conditioning
31. Mechanical workshops
32. Sanitary pumping installation
33. Engine room for lift or pump chamber
34. External air inlet
35. Used air exhaust
36. Maintenance service
37. Exhibition service store
38. Electrical installations
39. Amplifier room
40. Cable duct to technical mast
41. Future passageway to extension
42. Small auditorium
43. Exhibition
44. Information
45. Boiler room
46. Safe
47. Files
48. Workshop
49. Library
50. Projection room
51. Canteen
52. Escalator
53. Ramp
54. Lawn sprinkler pump chamber
55. Roof members
56. Plastic dome
57. Drainage pump

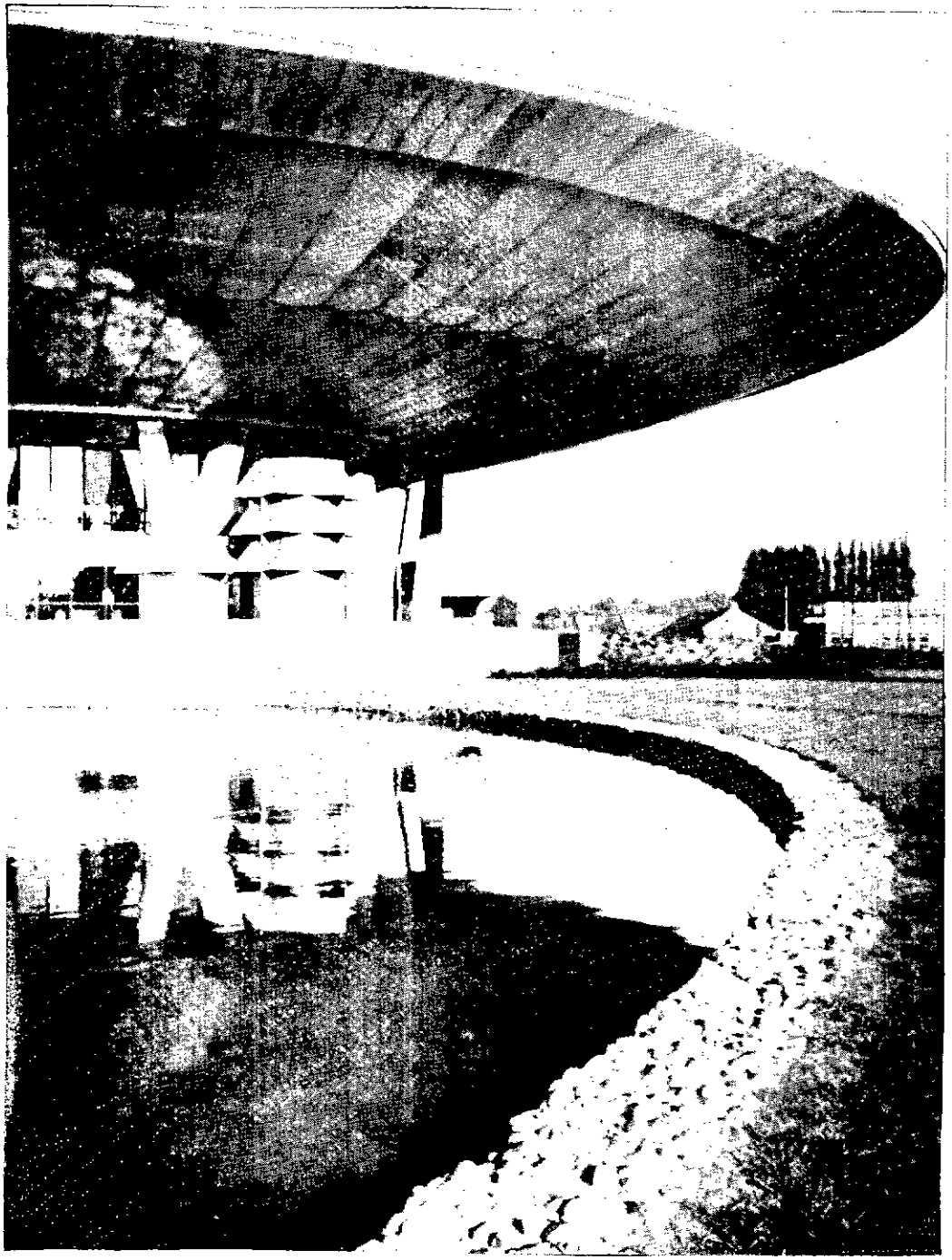


11 Edge section



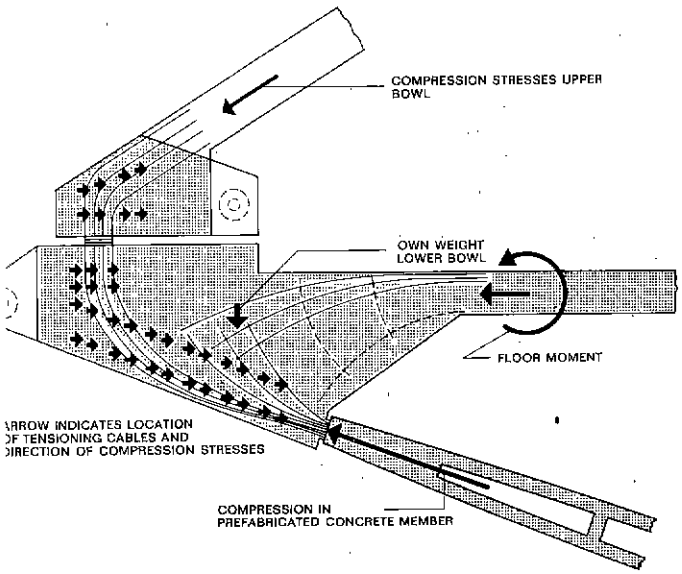
12. partial view from below of lower bowl elements

diameter bunches, each consisting of 5 mm diameter wires and a total length of 169 km. They were run through hollow tubes in the ring beams, stretched tightly after the concrete had set and then secured. The outermost ring in the lower bowl was provided with special thermal insulation, since the stresses in the concrete could otherwise become too great at low outside temperatures (see fig. 11). Thermocouples were installed at ninety-six points on the outside of the beam for the purposes of checking. The temperatures measured are recorded on equipment installed in the basement.
The lower bowl carries the horizontal galleries for the exhibition. They can be reached via the lift or the stairs.
The **upper dome** is made entirely of concrete and consists of an annular concrete beam, once again reinforced by cables, 822 hexagonal members, each weighing 1,200 kg and together forming the surface of the dome, an annular



10. lower bowl

stresses in edge



upper edge and finally a transparent plastic cupola 8 metres in diameter.

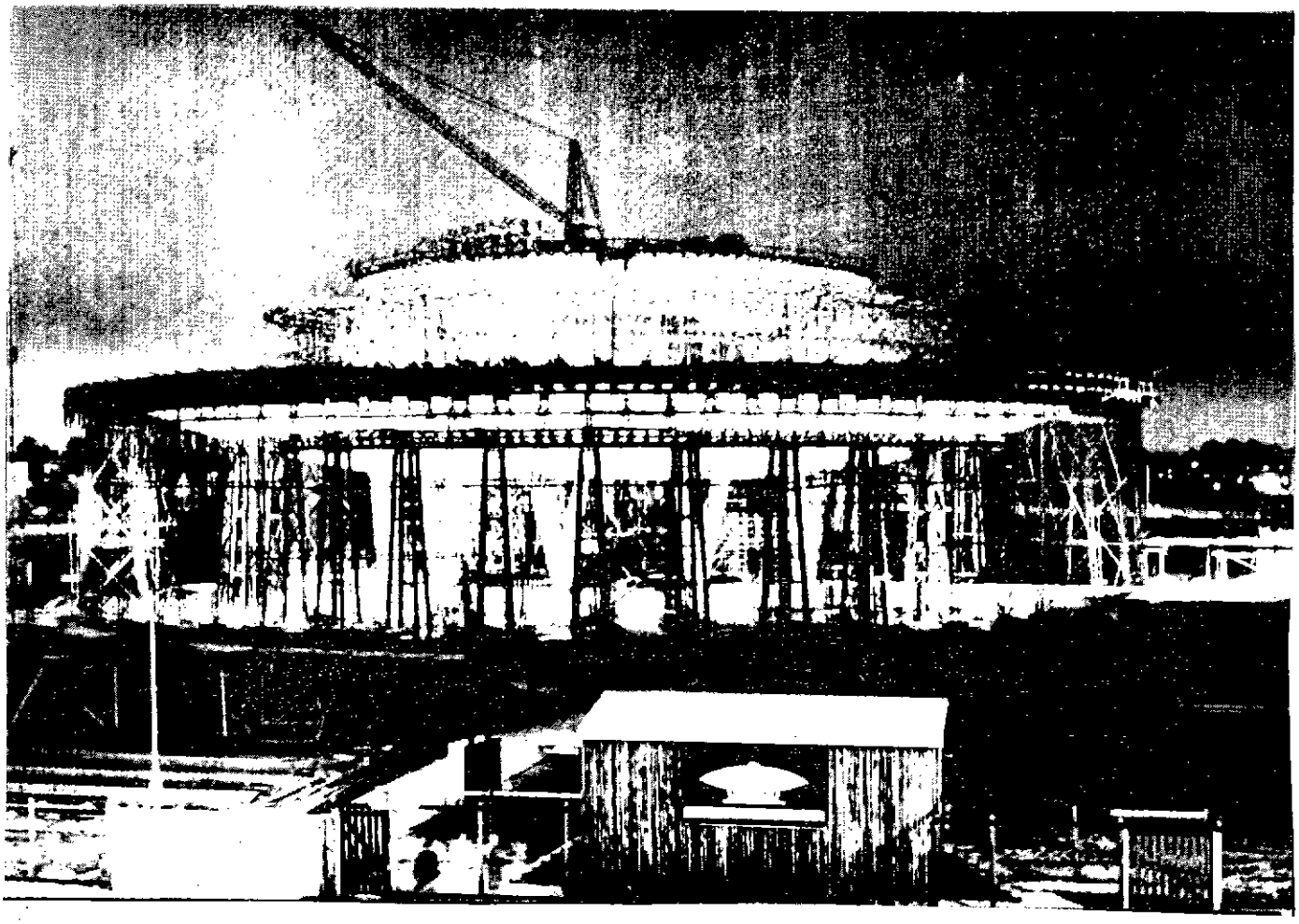
In the edge of the dome there are 48 large openings (see fig. 9 and the upper part of fig. 11). A plastic dormer window, complete with pane, was inserted in each of these openings, giving the visitor a panoramic view. To the east he can see the Philips industrial complex.

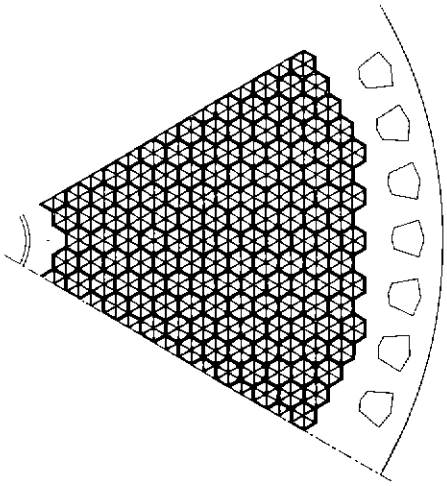
The special nature of the structure required that the sections of the lower bowl be supported during construction (see fig. 15). The supports could not be removed until the cables had been tensioned in the ring beams and the bowl was self-supporting.

The dome was built entirely on scaffolding resting on the lower bowl. Here, too, the scaffolding could not be removed until the dome was made self-supporting by the tensioning of the cables.

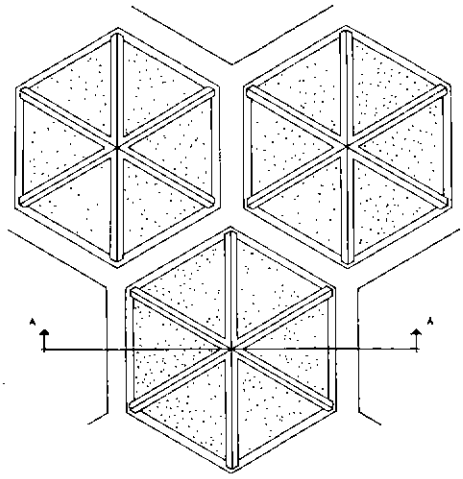
To allow both parts to expand and contract independently, the dome had to be poised freely on the bowl.

15 The Evolution at the scaffolding stage

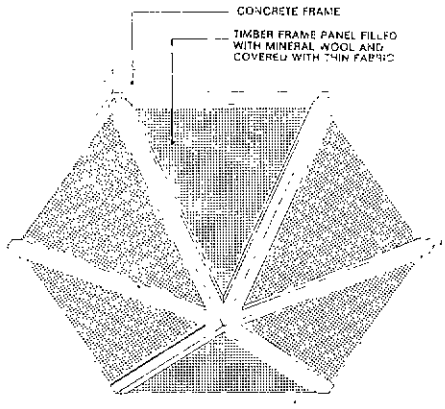




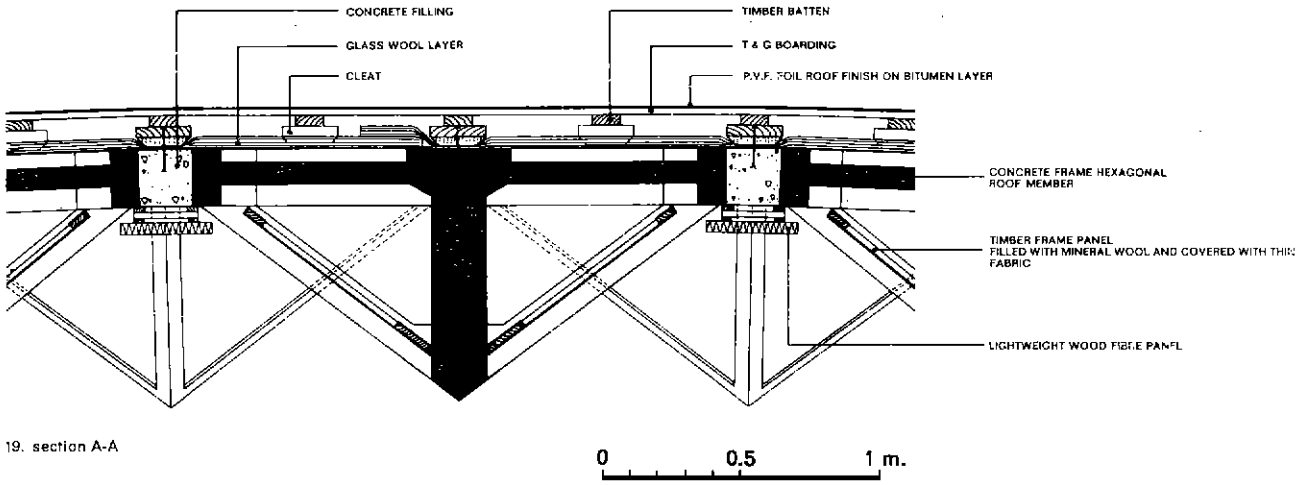
16. partial view of roof from below



17. upper dome prefabricated concrete hexagonal members



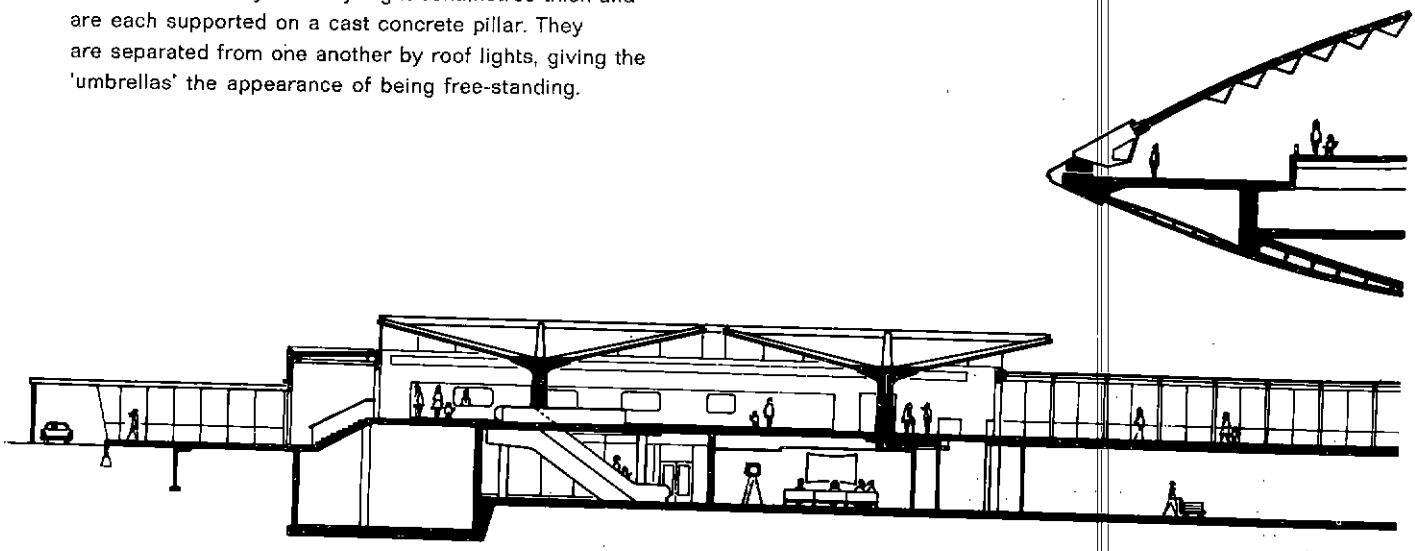
18. prefabricated roof member



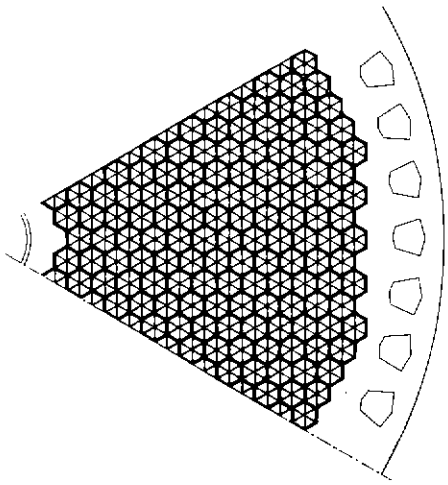
19. section A-A

5. The service wing

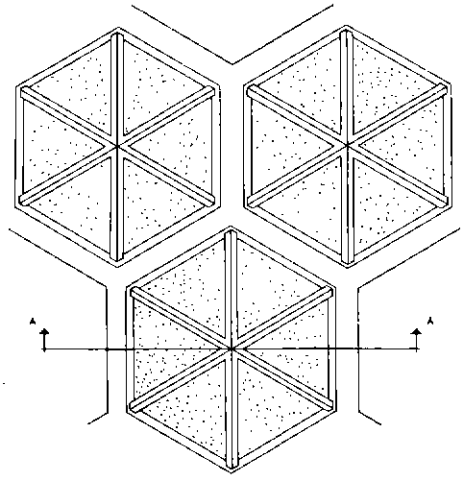
This part is largely a conventional structure. The ceiling of the foyer and restaurant is composed of reinforced concrete hyperbolic paraboloid units measuring 18 x 9 metres. They are only eight centimetres thick and are each supported on a cast concrete pillar. They are separated from one another by roof lights, giving the 'umbrellas' the appearance of being free-standing.



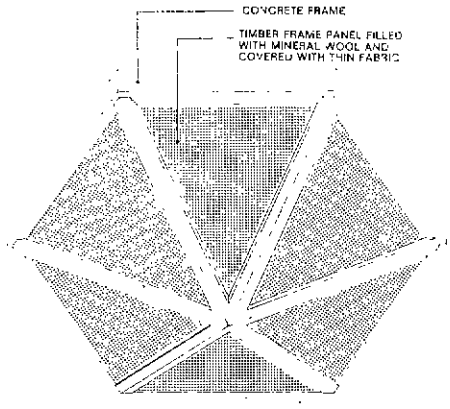
20. section through service wing



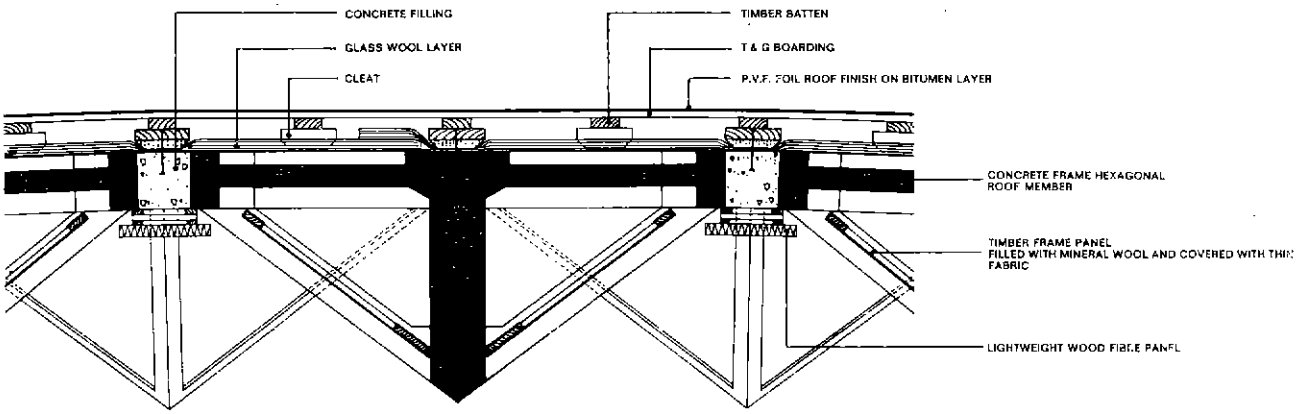
16. partial view of roof from below



17. upper dome prefabricated concrete hexagonal members



18. prefabricated roof member



19. section A-A

0 0.5 1 m.

5. The service wing

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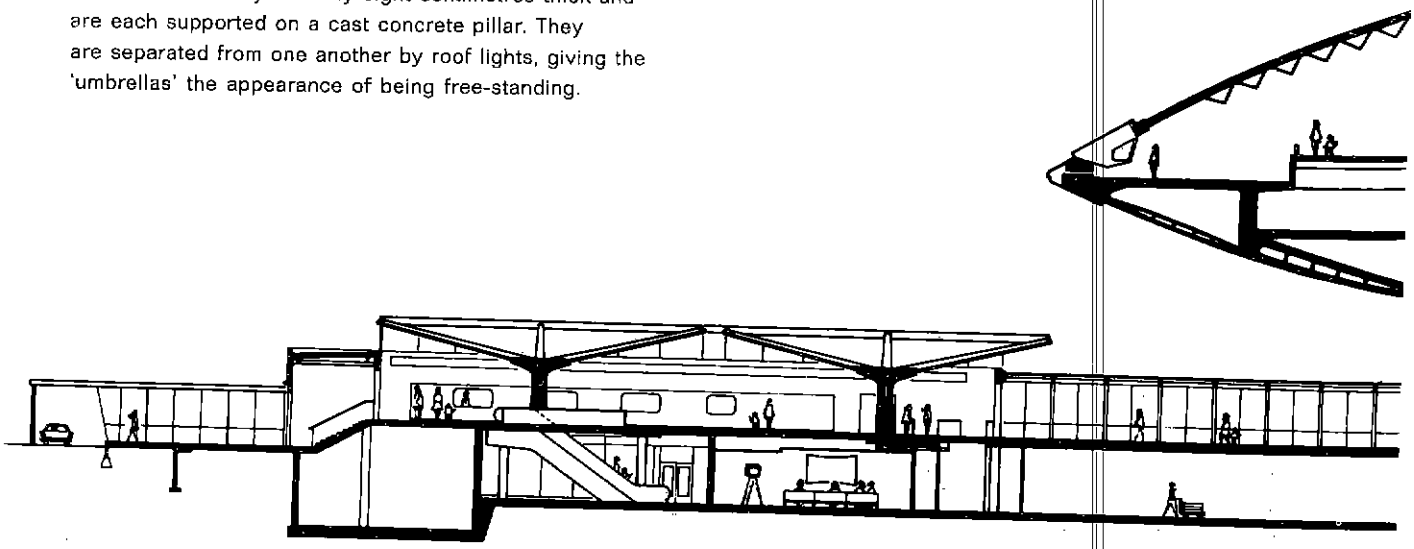


20. section through service wing

21. hyperbolic paraboloid units

22. "umbrella"

23. entrance

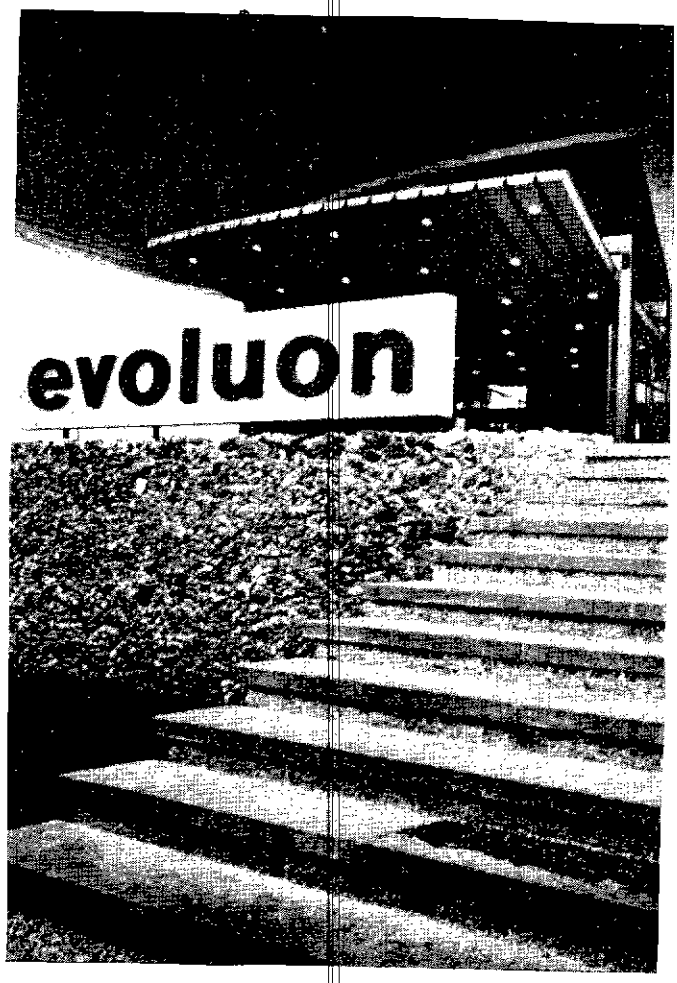
6. Examples of finishes used

The floors

Spheroid	a. layer of washed gravel 2½ cm thick, treated with two layers of epoxy coating. b. synthetic carpeting
West wing	a. layer of washed gravel 2½ cm thick, treated with two layers of epoxy coating. b. linoleum. c. carpet.
Terrace	a. washed gravel tiles treated with one layer of epoxy coating. b. main steps, basalt.

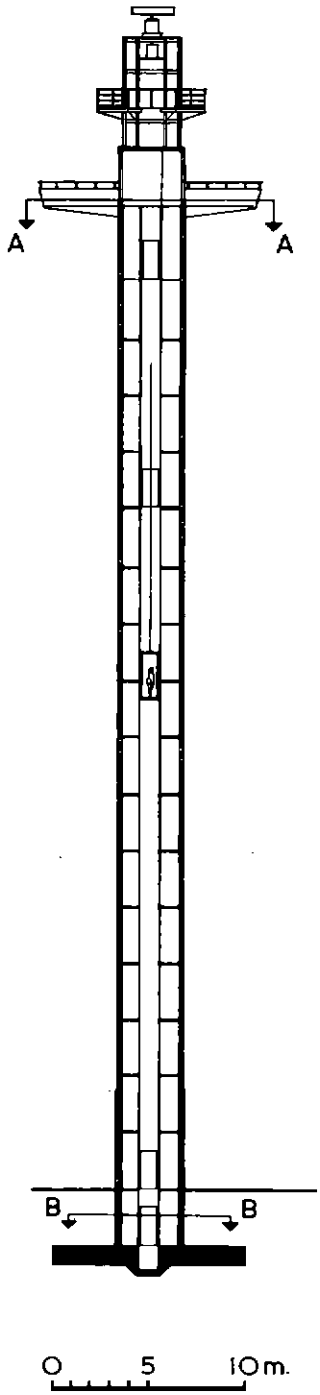
Walls

Reception hall and restaurant	double glazing (thermopane).



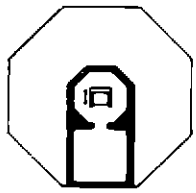
7. Technical mast

The concrete shaft is about 55 metres high and was erected in nine days with the aid of stainless steel shuttering. Metal cross-pieces project from the mast at heights of 36, 48 and 52 metres to carry a variety of equipment, including floodlights to illuminate the dome, aerials and television cameras transmitting views of the traffic around the building to receivers inside.
At the top, the mast carries a two-storey steel construction on which is fitted a rapidly rotating radar installation.
An eighty-metre-high crane was used to hoist the steel superstructure to the top of the mast, which, in a very high wind, sways to the extent of eight centimetres.
Two clocks are mounted on the column. These were a gift from the citizens of Eindhoven to the company on the occasion of its seventy-fifth anniversary.
An underground cable duct connects the technical mast to the basement below the spheroid.

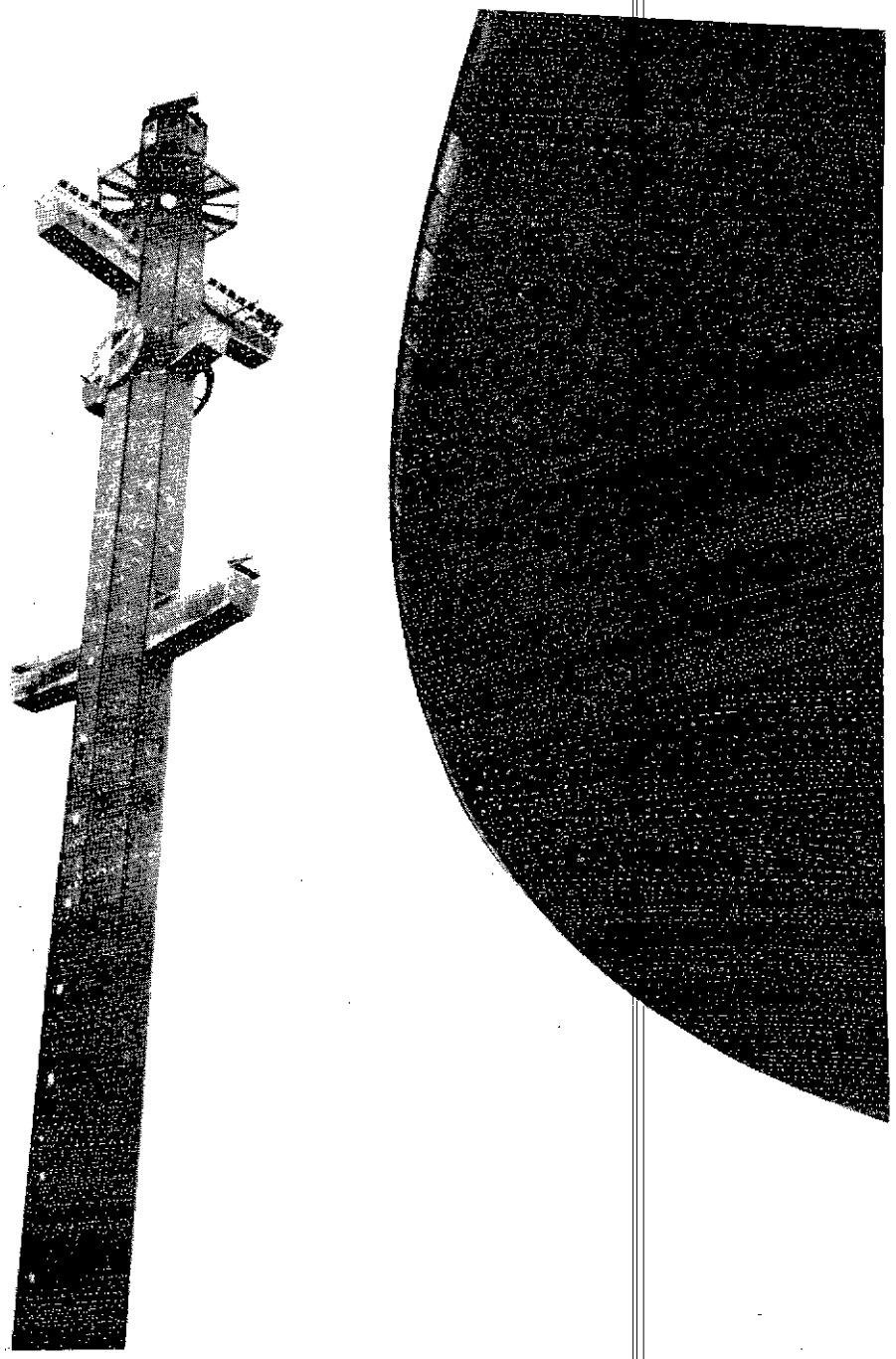


24. section through technical mast

25. section A-A



26. section B-B



27. technical mast and spheroid

8. Technical provisions

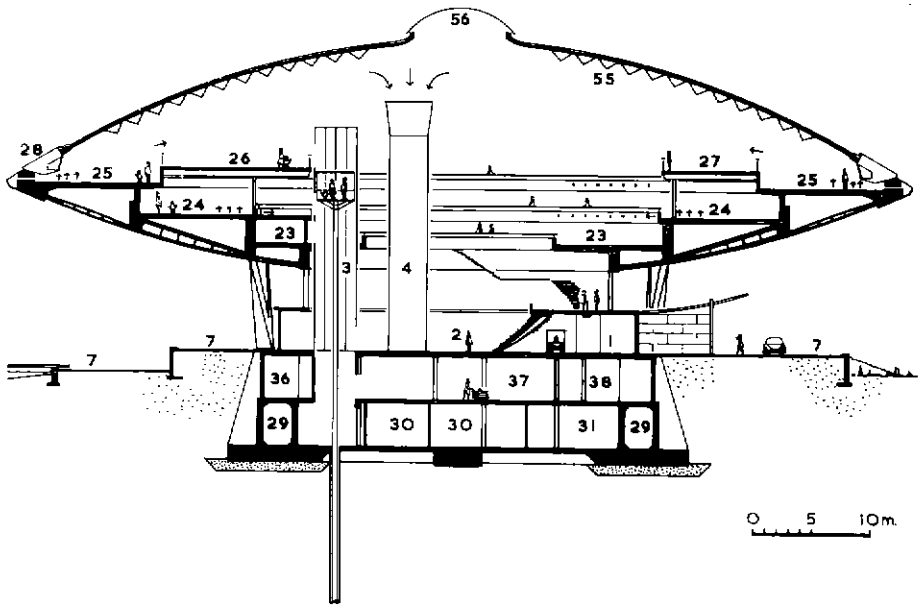
Mechanical

The spheroid is fully air-conditioned. The air, a mixture of at least 15 % fresh and 85 % recirculated air is filtered in the ventilation room and, where necessary, cooled, humidified or warmed. Cooling is done with fresh air, water or a refrigerating unit, while the air is humidified by steam injection, the relative humidity generally being maintained at 50 %. If the outside temperature drops below 10 °C, the relative humidity is reduced gradually to 28 % at —12 °C to prevent condensation in the roof structure.

Hot water for the air heater is provided by a natural-gas-fired boiler installed in the service wing.

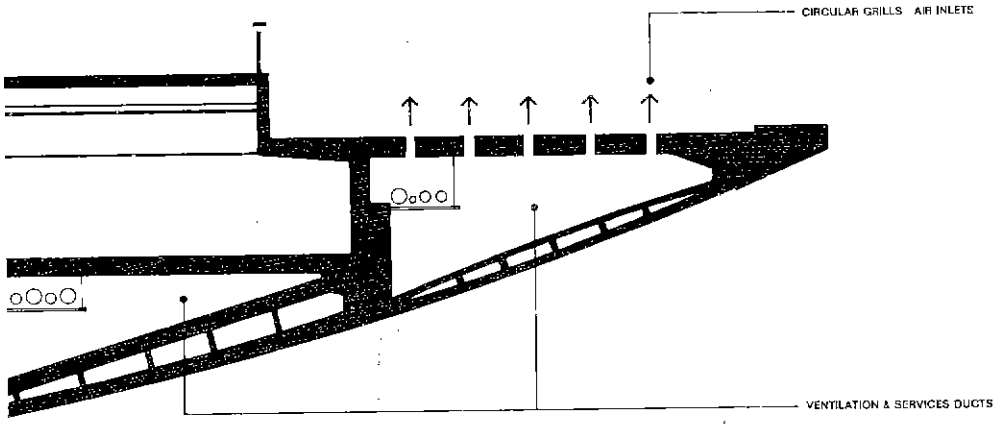
The treated air is forced upwards through a shaft to the circular passages beneath galleries 2 and 3 (see fig. 28). From there it is passed to channels terminating in outlet

28. cross-section



grilles in the parapets and to hundreds of small circular grilles built into the floors of the galleries. It is primarily this latter system, which is not yet in very wide use, that will, in summer, keep visitors' feet cool and thus stave off fatigue for a considerable time. The air-conditioning system is so designed as to produce neither noise nor draughts. The air ducts are lined with a glass fibre material which is a good heat and sound insulator.

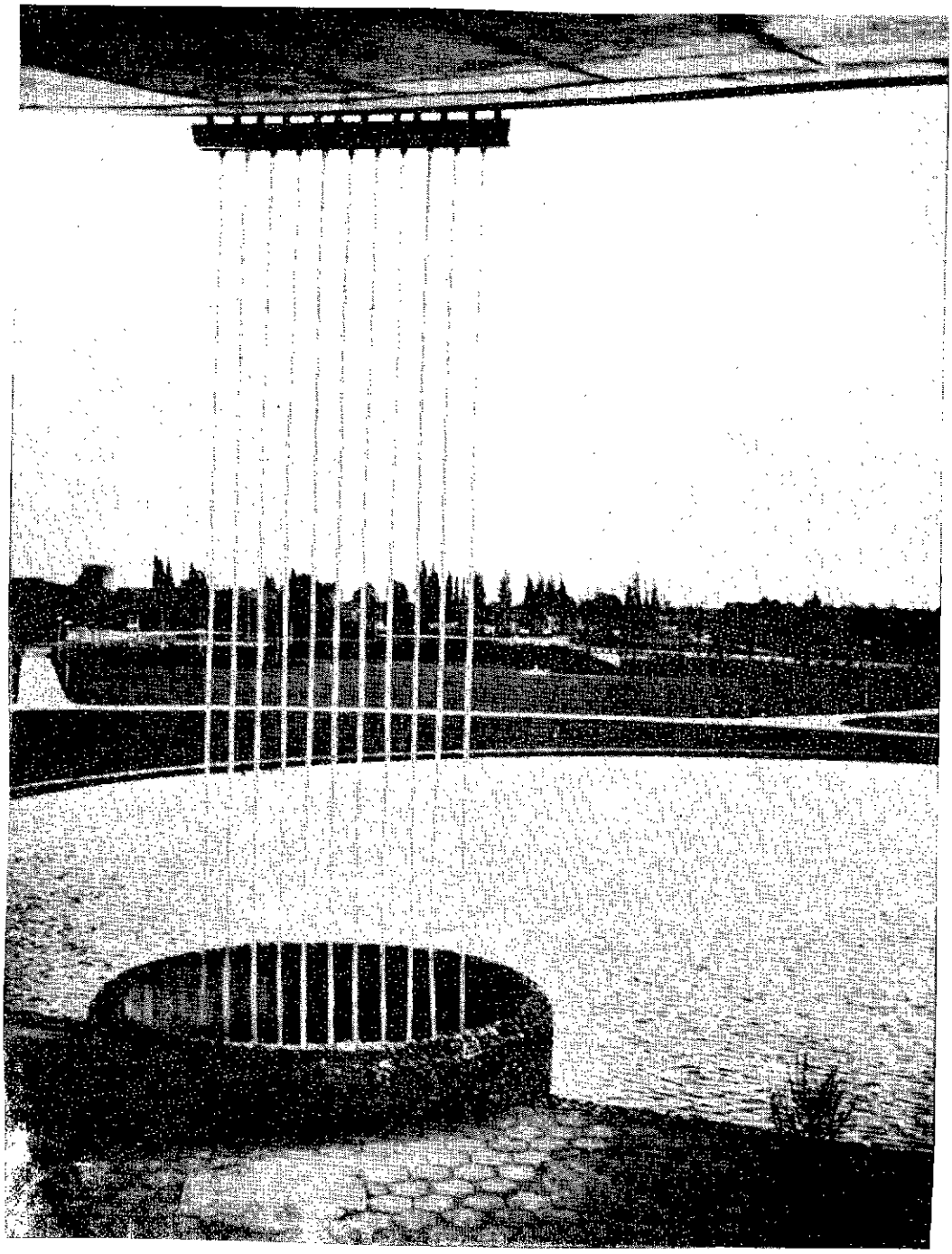
The spent air collects at the top of the dome and is exhausted from there through the round concrete exhaust shaft to the basement, where part of it is once more circulated. The installation is automatically controlled by pneumatically operated valves located in the basement and thermostats placed inside and outside the building. Rainwater from the dome is carried off by a gutter via eleven plastic pipes to the pond.



29. section of edge showing service ducts

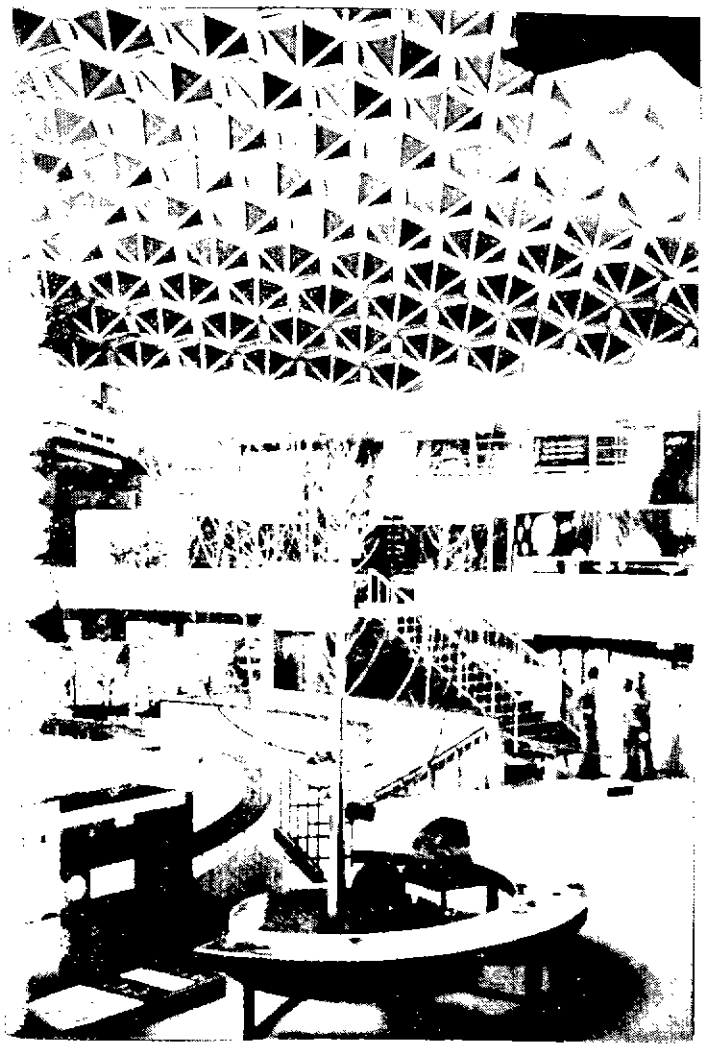
9. The electric lighting and power installation
is supplied by three transformers, one of which is always kept in reserve. These transformers are each capable of supplying 630 kVA, while there is also an emergency lighting unit providing 100 kVA. The lighting system is closely keyed to the architecture and the exhibits.
The lighting level in the building is rather muted and is locally supplemented by brightly lit displays. The terrace outside is brightly floodlit, partially in colour.
The power installation supplies the kitchen, lifts, air-conditioning system and the exhibition, the total current taken being about 700 kVA. Besides the telephones, the communications equipment also includes closed-circuit television, a general paging and background music installation and a radio paging system.
There are circular spaces between the bowl and the galleries used as ventilation and services ducts, openings being provided in the floor for the connection of the exhibits to the electrical system. The building is also equipped with an automatic burglar alarm and with a smoke detecting installation which will directly alert both the municipal and the works fire brigades.

The lifts and escalators
A piston-type lift, with a capacity of forty persons, takes the visitors to the upper galleries. It is hydraulically operated by a piston rod fitted in a thirty-metre-long tube passing through the basement floor.
The piston rod raises the steel platform bearing the glass lift car a distance of about twenty metres between the ground floor and the top gallery in a glazed shaft. There is also a service lift to take goods and service staff from the ground floor to the first gallery. It can also be used as an emergency lift. Two escalators with glass balustrades carry people to the special areas beneath the foyer of the service wing.

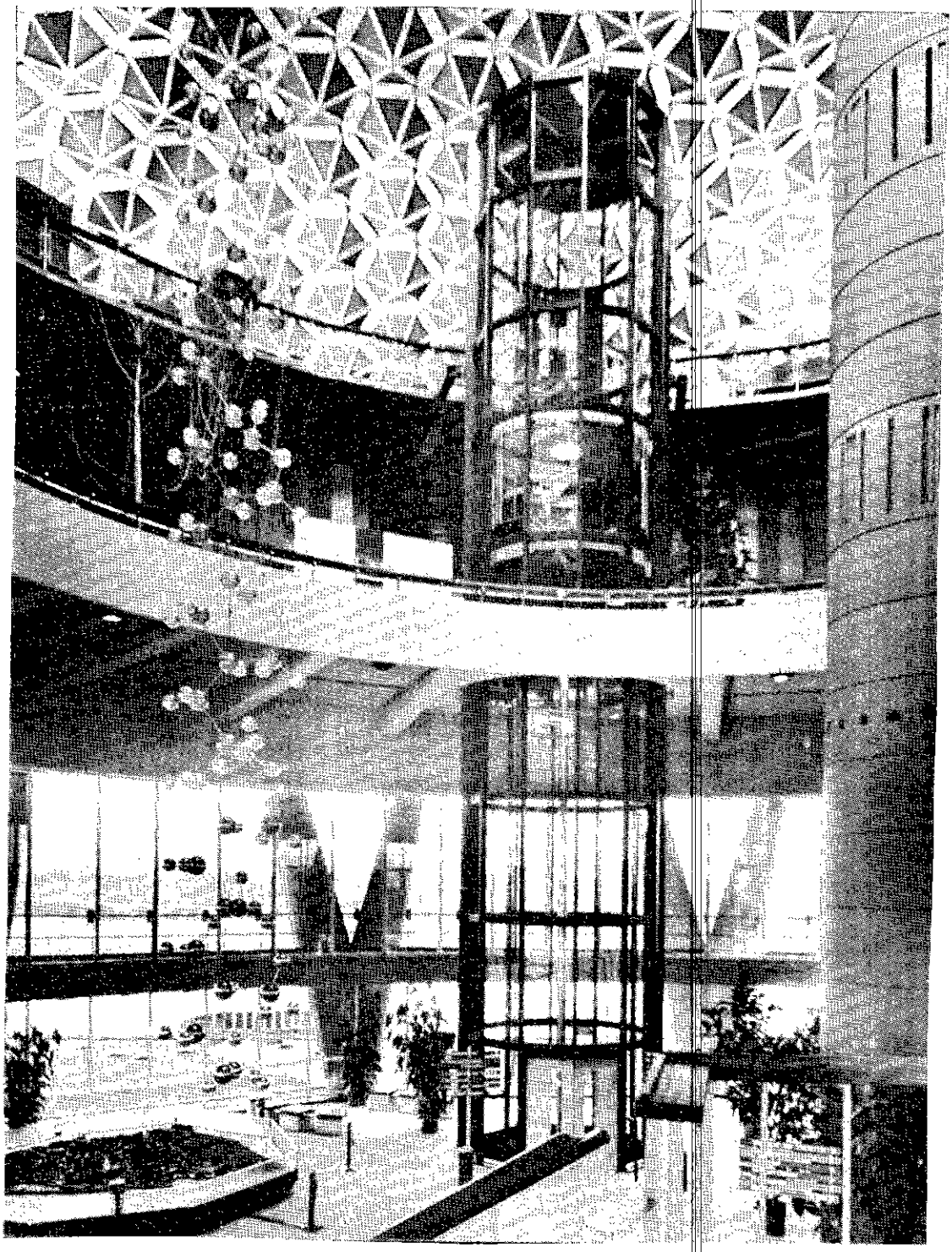


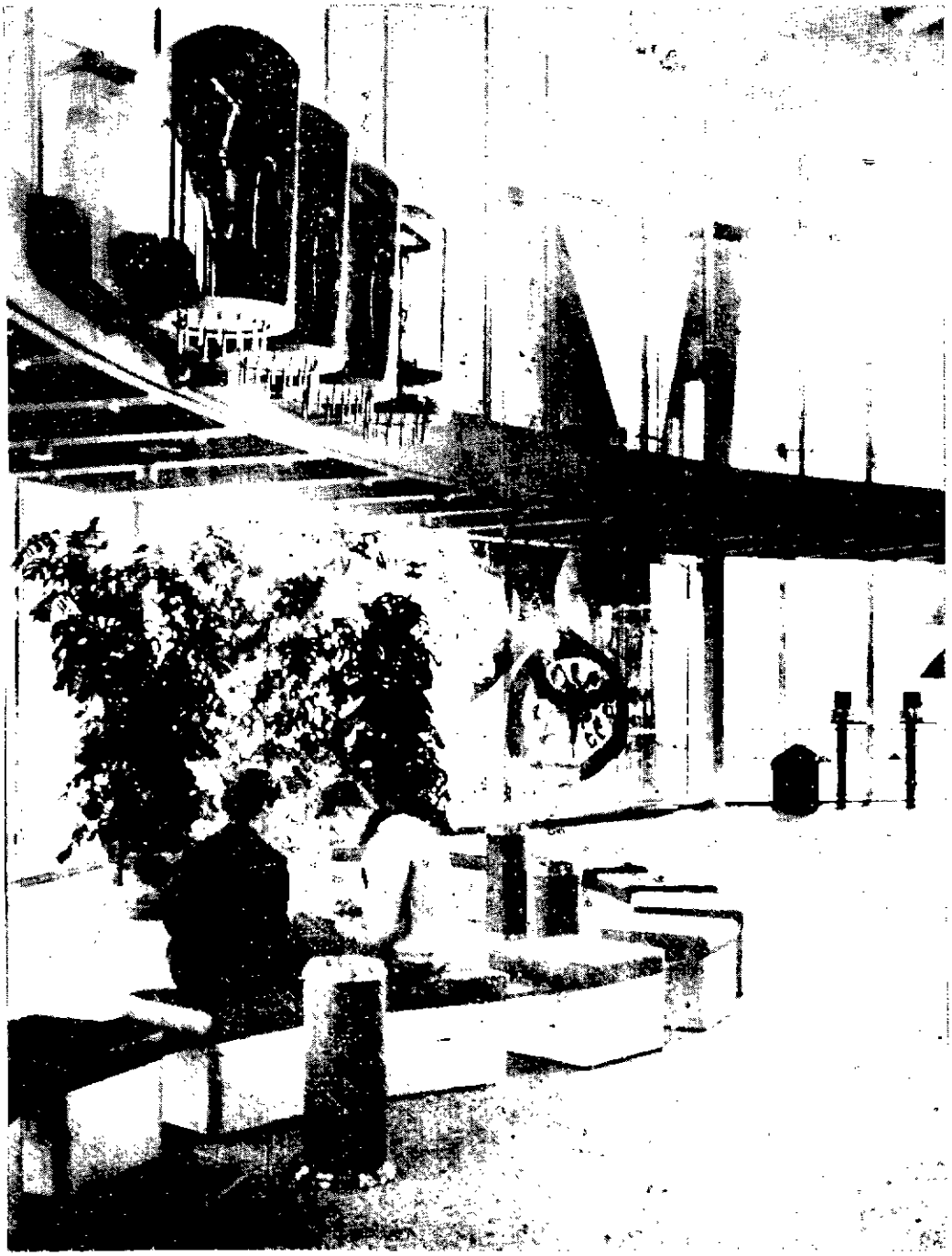
30. rainwater disposal

31. interior, spheroid

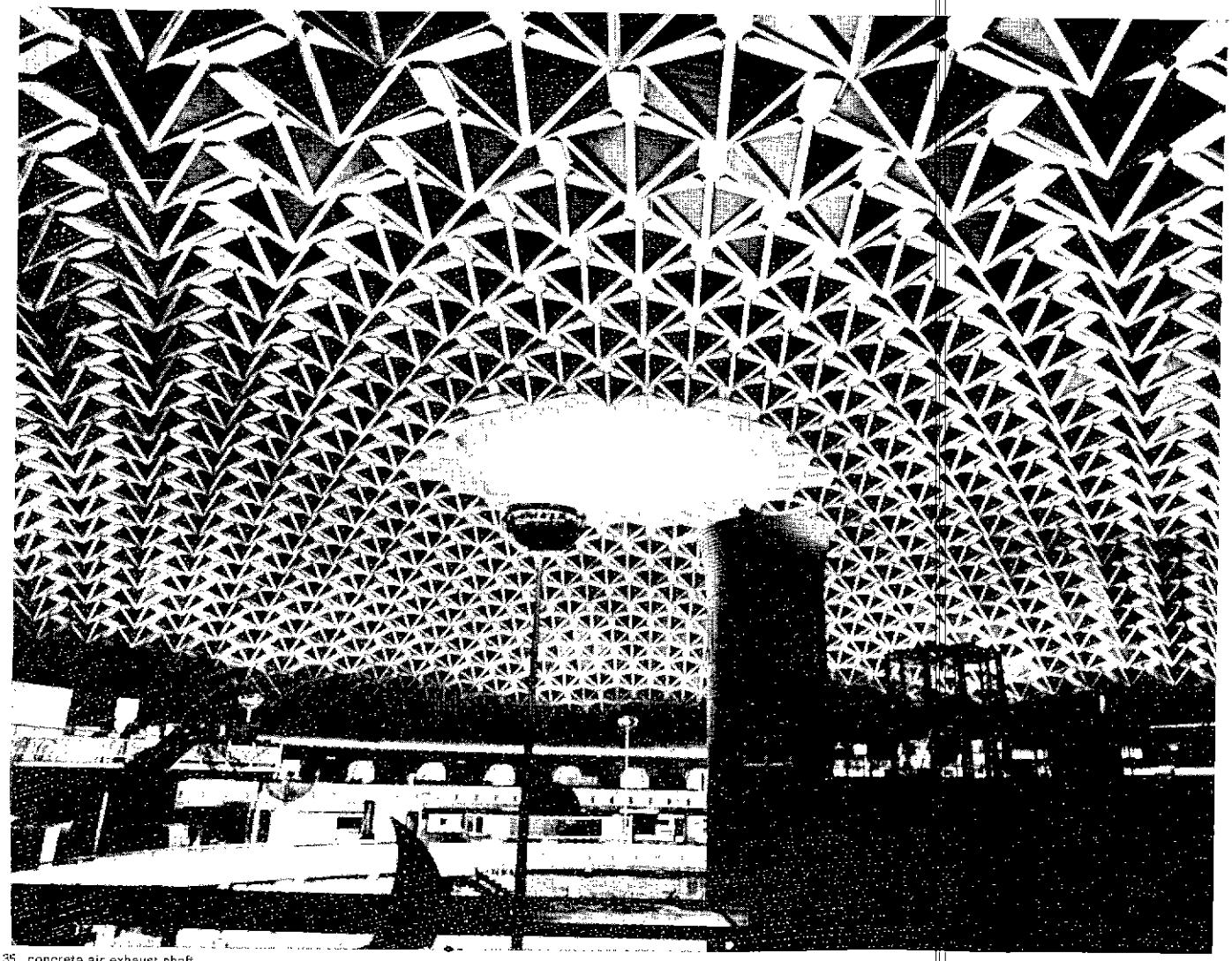


32. ceiling-roof





36. entrance hall - visitor counting tubes



35. concrete air exhaust shaft

10. Acoustic provisions

Ceilings

Spheroid

The concave shape of the roof made it necessary to use a heavy-duty sound absorbing material. The frame of the pyramid-shaped roof members was filled with panels of mineral wool contained in a wooden framework and covered with thin fabric.

The spaces between the roof members of hall ceiling and the corridor to the service wing were filled with lightweight wood-fibre sound-absorbing material (see fig. 19).

West wing

The concrete hyperbolic paraboloid units in the restaurant are clad with a rough layer of lightweight wood fibre held in place by spaced hardwood boarding.

Walls

Spheroid

Part of the wall of the first gallery is panelled with a layer of lightweight wood fibre in a wooden frame and with a sheet of coarse material stretched over it. The glass wall of the throat between the spheroid and the roof of the reception hall is zig-zag to prevent the sound from becoming concentrated. Furthermore, there are two transverse glass walls in the hall itself to prevent sound from 'travelling around'.

33. visitors hydraulic lift
34 view from an upper exhibition gallery down to entrance hall and stairs

The people involved

Architect L. C. Kalff, b.i., assisted by the Eindhoven architect L. L. J. de Bever BNA, was responsible for the design. The data and calculations for the concrete construction were provided, and the actual work done by the NV Hollandse Beton Maatschappij of The Hague. TNO of Delft also contributed a great deal towards the calculations and tests made.

The Building Design and Engineering Department of NV Philips' Gloeilampenfabrieken was responsible for drawing up the building plans, designing the mechanical and electrical engineering installations, coordinating design, construction and time control with the aid of a detailed time schedule and budget control.

The exhibits and demonstrations inside the building were designed by a team of Philips staff under the guidance of the British specialist James Gardner, with J. Kleiboer, the exhibition expert, as consultant.

The park was landscaped by the Amsterdam landscape architect C. P. Broerse, BNT.

Other contractors and suppliers included:

de Vries Robbé & Co.	steel construction
Burgers' Verwarmingsindustrie NV	central heating, air conditioning and sanitary enginee
Svenska Fläkt Lucht- en Warmtetechniek NV	air conditioning
NV Rasenberg & Zn.	site work
M. Custers NV Machinefabriek en constructiewerkplaats	steel construction
Aa Dee Machinefabriek - staalbouw	steel construction
Verkoopass. Durisol Mevriet NV	roof cladding and light domes
Key en Kramer NV	roofing
NV Glas- en verfhandel Hub de Haan	glass
Schildersbedrijf C. de Haan NV	paintwork
Pas' stijlmeubelen NV	woodwork and joinery
Comm. Handelsvenn. Loka	acoustic panels
Fa. Pellis en Zn.	woodwork and joinery
v. Stokkum NV	stone
Fa. O. Toffolo en Zn.	flooring
Gebr. Beekx	woodwork and joinery
Vroom & Dreesman NV	floor coverings
Nolte Electrotechn. en Mech. Ind. NV	electrical engineering
Handelscompagnie NV	electrical installations
Kwekerij Gustaaf	landscaping
Timmerfabriek Gebr. Kooyman	woodwork and joinery

and many other firms and institutions besides.

The works of art listed below were commissioned from the following artists:

Daan Wildschut	tapestry in the VIP room (presented by Messrs. de Vries Robbé of Gorinchem);
Brigitte Altenburger	glass panels in the connecting corridor (presented by Messrs. DAF, motor manufacturers of Eindhoven);
Willem Heesen	glass sculpture at entrance to reception room (presented by PNEM of 's-Hertogenbosch);
Prof. F. Carasso	bronze main entrance doors (presented by Philips Direct Export overseas agents);
Carlo Andreoli	glass decorations in hall of Evoluon;
Mank Esscher	wall decorations in small auditorium (presented by Messrs. Shell of The Hague);
George Patrix	light decorations on restaurant wall;
Herbert Baumann	stone sculpture in front of Evoluon entrance (presented by Messrs. Hollandse Beton Maatschappij NV)
Gerrit Benner	painting on east wall in the restaurant (presented by Messrs. Unilever);
Willem Heesen	4 glass panels in the service wing hall (presented by Association of Directors of Electricity Companies in Holland);
Charles Eyck	painting on west wall — podium restaurant (presented by Messrs. Burgers, heating industry of Eindhoven).

8. A few statistics - spheroid

Architectural	21.000 (metric) tons	total weight, including:
	14.000 (metric) tons	of concrete cast in situ,
	3 x 96	concrete members of lower bowl weighing 1½ to 15½ (metric) tons each,
	822	concrete roof members weighing 1.2 (metric) tons each,
	12	V-shaped columns,
	625 (metric) tons	load on the foot of each column,
	169 km	steel stressing cable,
	11.800 sq.metres	gross floor area } in spheroid and
	8.000 sq.metres	net floor area } service wing,
	31.65 metres	height above ground level,
	77 metres	diameter of spheroid,
	½ hectare	roof area,
	45.670 cu.metres	volume of spheroid,
	4.730 cu.metres	volume entrance hall under spheroid.
Lifts	3000 kg or 40 persons	capacity of piston-type.
	½ metre/sec.	speed of travel.
	3.50 metres	diameter of glass shaft.
	900 kg or 12 persons	capacity of service lift.
Mechanical	6.5	changes of air per hour in spheroid.
	100 %	possible ventilation.
	85 %	possible recirculation of used air.
	220.000 cu.metres	volume of air displaced per hour in spheroid.
Electrical	2.500.000 kcal	boiler capacity per hour.
	220 and 380 V	supply to exhibits.
	200	loudspeakers.
	1.650	various fittings.

Period of construction August, 1964, to August, 1966.