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RESIDENCE AT KLOOF, NATAL

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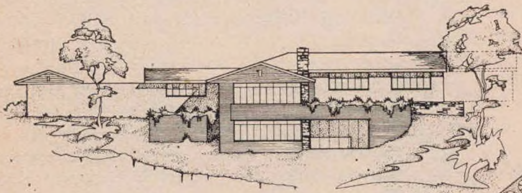
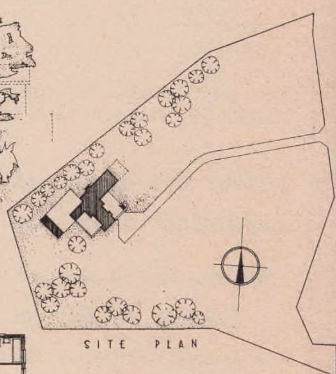
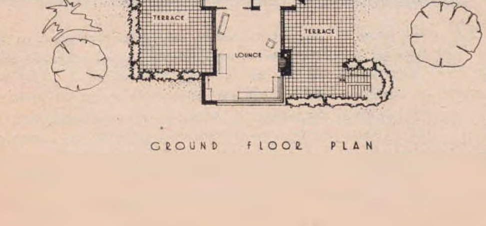


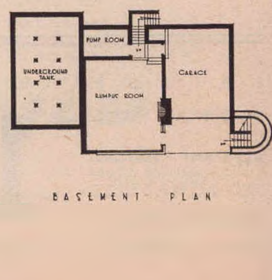
SOUTH EAST ELEVATION



SITE PLAN



GROUND FLOOR PLAN



BASEMENT PLAN

General View looking South-East towards the Coast line.

SITE: Situated on a splendid site of just over three acres on the seaward slope of the Kloof escarpment, seventeen miles inland from Durban, the house commands an extensive view from Durban North to Isipingo, with Pinetown as a foreground.

The levels of the site demanded consideration which resulted in the front portion of the house being double-storeyed whilst the rear remained single-storeyed.

PLANNING: The basement portion was conceived as a rumpus room and garage, two walls of the rumpus room forming the walls of an underground tank of 20,000 gallon capacity The lounge was planned over the rumpus room whilst the slab over the garage and underground tank form terraces on either side of the lounge, which three units are integrated into a living area by means of sliding folding doors, which provide flexibility of use in varying weather conditions

The living zone of the house is confined to the lounge level, whilst the sleeping zone is raised an additional 2' 6" to provide the bedrooms with the privacy of a 6' 0" high window sill externally.

The main units of the plan are orientated south-east for the sake of coolness, and every major room has the benefit of a view.

CONSTRUCTION AND COMPOSITION: The slabs over the rumpus room and garage are of pre-cast rib construction, the ribs being set at 2' 0" intervals to product an interesting ceiling, ideal for patterned dispersion of fluorescent lighting.

Contrasting textures of materials have been used to stimulate interest, the texture of

View of the Dwelling as seen from the East

RESIDENCE AT KLOOF, NATAL

The Lounge

clinkers and local stonework being an excellent foil for the sophisticated simplicity of steel windows, plain wide fascias and rebated brickwork.

Internally the local stone chimney stacks are expressed and face brickwork penetrates from the exterior to contrast with fibrous plaster light troughs, built in fittings and tailored carpets.

REMARKS: The mineral-surfaced Ruberoid roofing was employed as it was found to be the most efficient roofing for the conservation of rain-water, and consequently will be retained until a water supply from the local authority is available, when it will be overlaid with cedar shingles.

The Lounge and Dining Room

View from the North-East


Photo: Ballance Studios

RESIDENCE AT GILLETTS, NATAL

HAMLIN AND PARK - ROSS
MM.I.A., ARCHITECTS

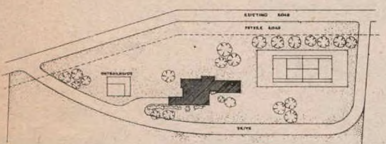
The site comprises an area of approximately seven acres, steeply sloping to the East. The house is situated at the high point, close to the road, on a levelled terrace that was excavated and filled by a previous owner. It was sited on this terrace, and located so as to leave room for a tennis court. By working to the existing excavation, the architects have taken advantage of the different levels and have planned the lounge some seven feet below the general floor level of the rest of the house.

The planning, otherwise, is straightforward, with main rooms facing east taking advantage of the views. The construction follows conventional

Left and Below: Two views of the Lounge showing the Dining Room on the upper level.

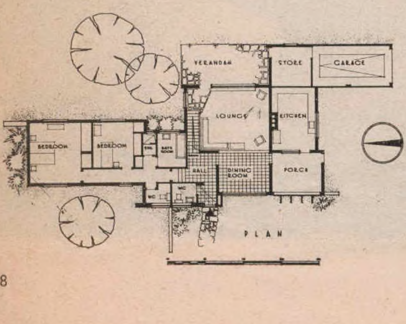
methods. Walls are bagged and lime-washed internally and externally. The roof is of shingles on spruce boarding exposed internally. Flooring in the lounge is wood block and slate; the dining room has quarry tiles and the bedrooms mastipave. Cost was £4,600.

Photo: Whysall Photographic Studios (Pty.) Ltd.



SITE PLAN

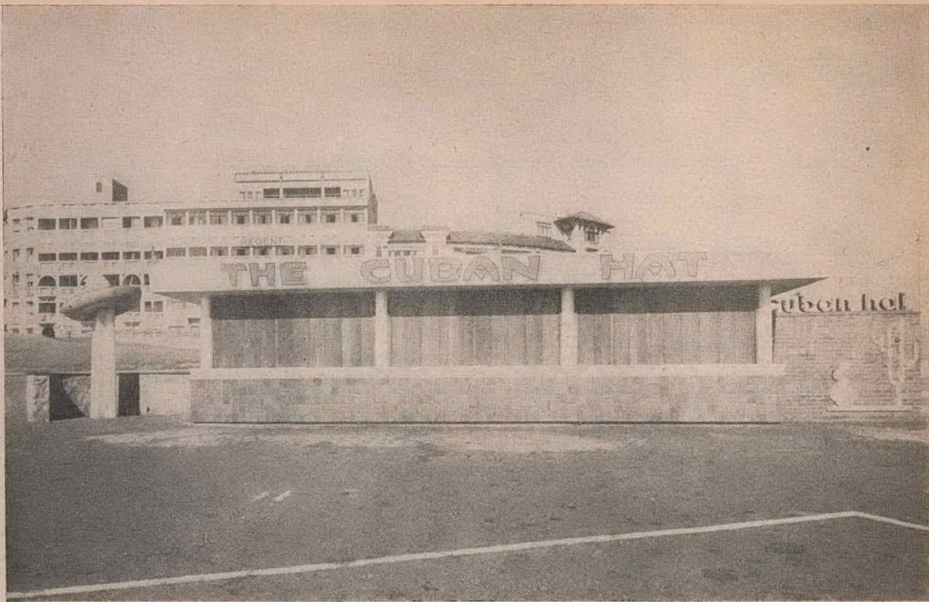
EAST ELEVATION



PLAN

Photo: Balance Studios

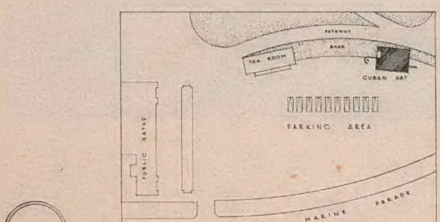
View from North-West with a glimpse of the folding country beyond



THE CUBAN HAT

A REFRESHMENT KIOSK ON THE DURBAN BEACH FRONT

S. N. TOMKIN & PARTNERS, MM.I.A., ARCHITECTS

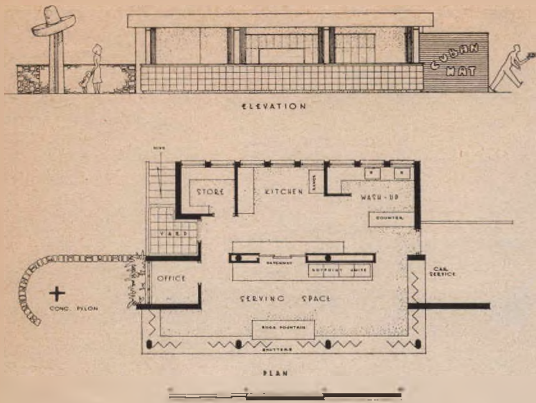


SITE PLAN

A limited area was conceded by the Durban City Council on Corporation-owned property on the beach front. This area of land is normally used for car parking for the general public. The conditions imposed upon the building owners by the Corporation were that the building be vermin-proof, was not to exceed the dimensions given to them and had to be removed within 6 months of notice from the Corporation that they intended the property for use for beach development in that area. No guarantee was given to the building owners that such notice may not in fact be given even before the building was completed.

PLAN REQUIREMENTS:

The owners required a Kiosk which could serve drinks and light refreshments to people in the car park at all hours of the day and until several hours after midnight. The Corporation required that, as far as possible, all workings must be contained within the building as the building is visible on all elevations from public thoroughfares. The main area of the Kiosk is divided into space for the storage and preparation of food and drinks with a wash-up space for crockery etc.,



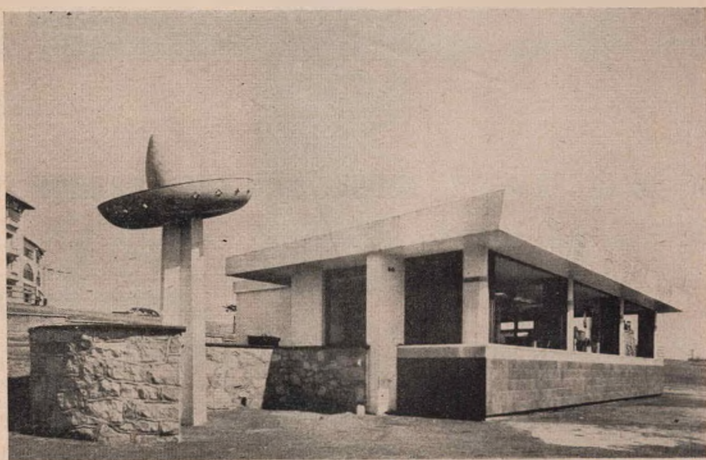
while a small office is provided for the management.

CONSTRUCTION :

The " Hat " is in precast concrete and is lighted with neon tubes within the brim and from under the crown. The counter fronts are in matt brown tiles. The wing wall is in face brickwork with a painted plaster ornament, internally the Kiosk is tiled to a height of 7 ft. The whole of the counter of the Kiosk is fitted with flush laminated folding sliding doors which, together with the two access doors from the yard and the service space, provide the necessary lockup security during closed hours.

REMARKS :

The signwriting on the roof slab fascia was an addition by the management after the completion of the building.



SOLAR CHARTS FOR THE DESIGN OF SUNLIGHT AND SHADE FOR BUILDINGS IN SOUTH AFRICA

By S. J. RICHARDS*

(With Architectural Illustrations by D. M. CALDERWOOD**)

In a climate with high insolation, such as that of South Africa, it is particularly desirable that careful consideration be given to building design in relation to sunlight and shade. With the aid of a solar chart and a special form of protractor, the solution to most sunlight and shade problems can easily and quickly be worked out, using normal design drawings. Solar charts are given, from which it is possible to read off the angles of the sun with respect to a point on the earth's surface, or with respect to the parts of a building, at any hour and day for all places in South Africa, to an accuracy sufficient for most practical purposes.

SUNSHINE AND BUILDINGS

The present era in building practice is undoubtedly marked by a growing desire on the part of architects, town-planners and the public in general to provide such living and working conditions in buildings as are conducive to human health, comfort and general well-being. It is this desire which has sponsored the urge to give more attention to a reasoned and scientific determination of the requirements of buildings in respect of thermal, audio and visual comfort, and to a consideration of how these can best be procured, both practically and economically, under different conditions. Since solar radiation plays a very important part as far as the thermal and visual aspects are concerned, the designer or planner is finding more and more that he cannot, particularly in a climate such as that enjoyed in South Africa with its abundance of sunshine, afford to ignore the sun or permit its rays to fall unheeded wherever chance and circumstance may allow.

SUNSHINE IN BUILDINGS AND THE PROBLEMS IT PRESENTS

Varied reasons have been put forward in the past as to why the presence of sunlight inside buildings is desirable, yet it is common experience that many situations arise in practice where, for opposing reasons, its presence may be most undesirable. Many householders, for instance, welcome some sun in the living and bedrooms because it gives rise to a pleasant reaction, particularly in winter; yet if sunlight is allowed to enter these rooms too freely, they complain that it causes carpets, coverings and drapings to fade, or that it makes the rooms too hot in summer. Again, during winter months, one would like to admit the maximum solar heat into most types of building, but, if consideration were devoted entirely to this end, one might find that working conditions were adversely affected by glare and excessive contrasts in brightness levels. It may also be found that the sun's rays penetrate during the hot season of the year. The designer's first problem, therefore, is to decide when and to what extent sunlight penetration is acceptable and when it should be excluded.

With some classes of building the sunlighting requirements are not very difficult to establish. In the case of certain hospital wards, solariums, sun porches and children's playrooms, maximum sun is desired either at all times of the day or during preferred hours, because of its anti-bacterial characteristics, its health-giving qualities or its therapeutic value in the treatment of some types of disease. On the other hand, total exclusion of the sun's rays may be demanded in a factory where its presence has a detrimental effect on processes and materials. Alternatively, in some occupations, direct sunlight may be a source of serious problems, such as visual discomfort and eye-strain arising from uneven illumination, accompanied by accident hazards as a result of direct or reflected glare, and working

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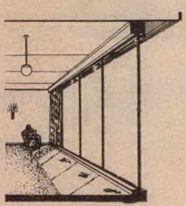
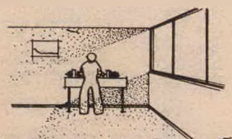
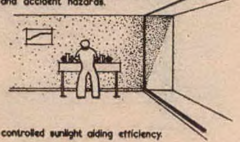
excessive sunlight causing unwanted heat, glare and eye-stain, fading and deterioration of drapery, and other factors.

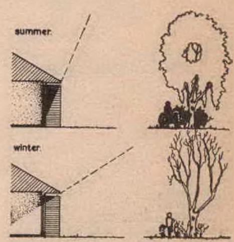




uncontrolled sunlight causing inefficiency and accident hazards.



controlled sunlight aiding efficiency.



exclude summer sun but admit winter sun.

under such adverse conditions must inevitably lead to reduced efficiency, which has its immediate effect on production.

Having resolved when we would like to admit sunshine and when to restrict its entrance, a complex of many problems then presents itself in deciding how best to effect the sunlight control desired. Provision for adequate natural ventilation and comfortable daylighting are also major considerations when the purpose is to make interior environments acceptable during periods of occupation. It is of little real advantage, for example, to devise a form of control which may be wholly efficient in precluding the direct ingress of solar radiation, and then to find that the interior thus protected presents a very dull and gloomy appearance. In planning for control, careful thought must, in addition, be given to such aspects as protection of openings against other weather elements; initial and maintenance costs of control devices; exterior appearance; minimisation of noise penetration through openings; arrangements for privacy if required; non-obstruction of the view from within; accessibility for the cleaning and maintenance of windows and sun control devices, to mention only the more important ones. Summarised in this way, the complexities of the question indeed appear to be somewhat involved, but designers should face the fact that planning for sunlight and shade control is seldom a simple matter or one easy of solution, but a problem requiring careful and considered judgment to find the most satisfactory working compromise. Many techniques for controlling the entrance of direct solar radiation are available and, by intelligent selection and application, it is possible in most cases to produce reasonable solutions, or, at least, to avoid faults which mar an otherwise good design

MODERN ARCHITECTURAL TRENDS AND SUNLIGHT CONTROL

A comparatively recent architectural development is the use of large expanses of glass in many types of structure. There is no doubt as to the many advantages that strip windows or window walls present from the point of view of complete visual ease with the interior surroundings, or of the healthy psychological reaction associated with the sense of openness and freedom that is engendered by large glass areas; but extensive glazing must necessarily call for judicious sun control. Where the chief concern in controlling penetration lies with the elimination of solar heat during the hot season, as is invariably the case in all parts of this country, the most effective means of control is to block the direct rays from the sun before they can pass through glazed areas. The glass itself readily permits a considerable proportion of the sun's radiant heat to pass through it into a room, but acts as a barrier to the escape of this heat once it has been absorbed by surfaces within the room.

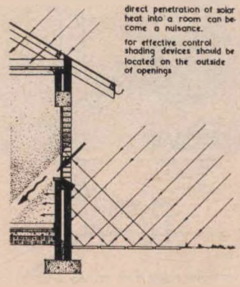
Given the means for accurately plotting the sunlight and shade patterns in and about buildings, much can be done in the planning and design stages to effect a degree of control which will either eliminate the need of internal screening and blinds, or minimise their use. The factors which enter into the problem are the siting, orientation and general arrangement of the building; the positioning of the openings in external walls and the depth of the reveals; the placing of structural projections (balconies, canopies, overhangs, sunbreak walls, etc.) and, finally, the use of special sun control devices (fixed or movable horizontal and vertical fins, louvred or solid projections, awnings, trees and creeper-covered arches or trellises, etc.). By careful analysis of the sun's orientation at various times of day and year in relation to these factors, one is usually able, from the very start of the design of a building, to introduce means for making maximum use of sunlight where and when needed and for limiting its acceptance when its presence is undesirable. Too frequently it occurs that the extent and seriousness of direct sunlight penetration is virtually only fully realised after the building is completed, so that the means of sun control is left primarily, or even entirely, to devices on the inside of windows, such as curtains and Venetian or roller blinds.

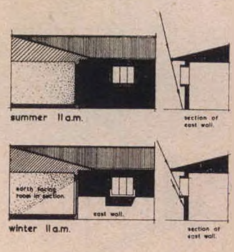
The use of external sunbreaks is no longer confined almost solely to houses, shops and factories, as in the past. There is a current trend in architecture towards their application, on a very much more elaborate and extensive scale, to large blocks of offices and flats, as witness the many examples of "brise-soleil" which is becoming a fairly common feature of large buildings in the hot climates of Brazil and Israel, or again, the very ingenious and striking shade-providing projections with which a number of new buildings in the larger cities of the U.S.A. are being equipped. Where continuous strip-windows and air conditioning are to be incorporated in very large structures, some American architects claim that permament external shading devices, scientifically designed, are an economic feature in that they effect a substantial reduction in cooling loads, which very often results in worth-while savings in initial

mutual shadowing of buildings.

small building in permanent shade owing to incorrect orientation

correct orientation in relation to sunshine eliminates undue shadowing





32½° south · beaufort west.

and operating costs of air conditioning plant. Furthermore, even where the cost of providing shade does appear to be relatively high, it is still claimed that the use of sun-control projections is justified because they make enough difference to comfort conditions to be of real importance.

SUNSHINE OUTSIDE BUILDINGS

The question of sunlight and shade also deserves a more sympathetic consideration in site-development and town-planning. Here, the chief emphasis should be on the mutual shadowing of buildings to ensure as far as possible that no unit or group of units offers permanent obstruction to the winter sunlight which would otherwise reach the lower floors of neighbouring units. When applied to planning, this principle of taking due account of the sunlighting requirements of individual structures concerns not only the spacing, shape and relative arrangement of buildings, but should also receive attention in street lay-out and orientation, where the choice of these is not dictated by other more important factors.

Passing from the structure itself to its immediate surroundings, we are at once reminded that the sunlighting of the ground around some classes of buildings can also be of direct importance to the people who occupy them, because, in addition to promoting plant growth, solar radiation is a speedy drying agent and a reliable aid to cleanliness. For these reasons, there is strong argument to guard against situations in predominantly residential zones where extensive areas of ground surrounding dwellings are heavily shadowed for long periods of the year.

The question of sunlight around buildings is perhaps less of a problem to the architect than it is to the town-planner, since his choice of siting or orientation is usually quite limited. Where he requires to give some thought, however, is in controlling sunlight to meet the wishes of his client. Often this is found necessary in connection with the private residence, where the need is expressed for some sheltered and secluded corner, in the garden or adjoining the house, which should be warmed by the winter sun and yet offer a shaded and cool retreat during hot summer afternoons.

DURATION OF SUNSHINE IN SOUTH AFRICA

The need in South Africa for careful sun and shade studies when designing buildings cannot be overstressed when we consider the predominant part played by solar radiation in our climate. In common with the Argentine, Australia, Arabia, North Africa, the Mediterranean countries, south-western United States and north-western Mexico, the actual duration of bright sunshine for most regions in South Africa, when considered in relation to the maximum duration possible, is fairly high throughout the year. Data[1] recently issued by the Weather Bureau indicate that while all regions in South Africa receive more than half the possible sunshine during the average year, by far the greater part of the country, which includes the Free State, the Transvaal highveld, the central and northern Cape, receives bright sunshine for periods which are equivalent to from 70 per cent. to above 80 per cent. of the possible duration. Compared with the average durations experienced in the temperate climates of Europe and North America (e.g., London with 33 per cent. of the possible duration, Vienna with 40 per cent. and Ottawa with 46 per cent) it is not at all surprising that South Africa boasts of its abundance of sunshine as an encouragement to tourist traffic from these countries. As a matter of interest, the following comparative values for other parts of the world are given: Sydney 49 per cent., Rome 53, Washington 57, San Francisco 65, Haifa 73 and Port Said 79.

Other significant points brought out by the Weather Bureau's data on sunshine are as follows:—

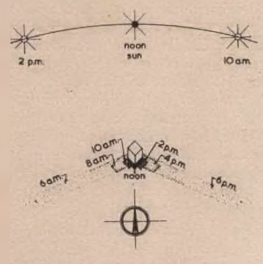
(1) Only along the eastern coastal belt can the duration in any single month normally be expected to fall below 50 per cent. of the possible.

(2) The duration in the south-western Cape varies from about 60 per cent. in winter to between 70 and 80 per cent. in summer.

(3) Over the interior, the variation is from an average of about 80 per cent. in winter to an average of about 70 per cent. in summer.

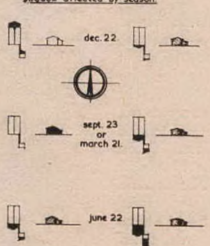
Few architects will deny that the sunshine and shade problem in South Africa has failed in the past to receive the scientific approach it demands. The reason for this can, to a large measure, be attributed to the lack of a simple means for readily determining, in the design stages, what areas in or about buildings will be exposed to, or shaded from, direct sunlight at any time of the day and any season of the year. It is true that much information on the predetermination of the fixed

1. "Sunshine and Cloudiness in South Africa," compiled by the Weather Bureau, Department of Transport, and issued by the Government Printer, Pretoria, 1950.

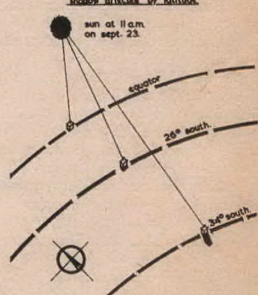


shadow affected by time of day

shadow affected by season



shadow affected by latitude



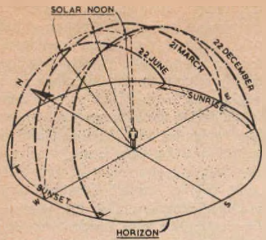


fig. number 1

Diagram illustrating the apparent sun's paths in the sky at different seasons for a specific latitude.

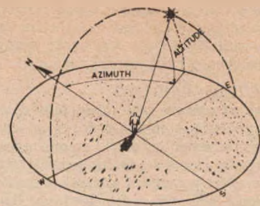


fig. number 2

Diagram illustrating solar azimuth and altitude.

angles of the sun has appeared in the overseas literature from time to time and that, in recent years particularly, this type of information has been carefully arranged in the form of tables, diagrams or graphs for easy reference. But designers will find that few of these aids, if any, are of much value for direct application in this country in the analysis of designs without involving a considerable amount of time. In this paper, solar charts are presented which should prove an easy and quick means for making sun studies of buildings in any part of South Africa, using normal drawings of plan and elevation.

THE SUN'S APPARENT MOTIONS.

Before discussing the charts and their uses it is important to have a clear picture in our minds of the apparent paths followed by the sun in its daily march across the sky. For convenience, we may imagine the earth to be stationary and that, as observers standing at some place on its surface, we see the ground about us as a circular plane of indefinite radius bounded by the horizon. If, also, we conceive the sky as being some hemispherical shell completely covering the plane on which we stand, then the sun, during the course of a day, will appear to follow along the arc of a circle which is symmetrical about the vertical plane running north and south through our observing position (see Figure 1). At so-called solar noon, the sun lies in this vertical plane and then it occupies its highest position for the day. This motion of the sun is made apparent because of the earth turning daily on its axis.

Besides its daily movement, the sun is impressed with a second apparent motion, which the observer will only notice as day follows day and the sun is seen to travel along slightly different but parallel paths each day. Within the period of a year, then, it would seem as if the sun slowly migrates to and fro between extreme southerly and northerly points in the sky. This second motion is due to the annual march of the earth about the sun, which, in effect, causes a relative shift of the sun to the south and to the north of the equator. The angular distance of the sun from the equator at any time is termed the sun's declination. As will be seen in Figure 10, the declination changes continuously between a value of almost $23\frac{1}{2}°$ south at the time of summer solstice on the 21st or 22nd December, to almost $23\frac{1}{2}°$ north at the time of winter solstice on the 21st or 22nd June. Thus to any observer in South Africa, the sun will, during the course of a year, appear to trace out a pattern of daily paths, with the longest and highest corresponding to the day of summer solstice, and the shortest and lowest corresponding to the day of winter solstice. Each pathway lying between these extremes will be followed by the sun on the two days in the year when the sun's declination happens to be the same. One of the days will occur before a solstice and the second will occur an equal number of days after the solstice. On the two days in the year when the declination is zero, i.e., on the 21st March and the 23rd September, the sun remains more or less directly above the equator and day and night of practically equal duration are experienced all over the world, with the sun rising due east and setting due west.

Because of the shape of the earth, the complete pattern of parallel sun paths will be the same for the same latitude, but will differ somewhat from that for other latitudes. In this country, for instance, the further south we proceed, the nearer will the whole pattern dip towards the northern horizon. Except for very slight and, therefore, unimportant variations, it can be assumed that, for any particular latitude, the sun will describe the same path pattern year after year.

THE DIRECTION OF THE SUN'S RAYS WITH RESPECT TO ELEMENTS OF A BUILDING.

It is usual for an observer to define the position in which he sees the sun at any instant in terms of two angles; the one fixing its height in the sky and the other its compass bearing. The first of these angles is referred to technically as the solar altitude and is a measure of the angular elevation of the sun above the observer's horizon, while the second is termed the sun's azimuth, or horizontal bearing, and corresponds to the angle on plan between true north and the sun's line of bearing (see Figure 2).

Provided the altitude and azimuth for any particular position of the sun are known, one can, by means of geometrical projections upon the drawings of a building, determine the direction of approach of the sun's rays in elevation and in plan for any part of the building. However, it will be noticed from Figure 3 that it is not very convenient for the architect to determine, from the sun's position angles, what areas in or about a building are exposed to direct solar radiation, particularly in view of the fact that the solar altitude is measured in the direction of the sun. To expedite the process of sun light and shade analysis, it is much more convenient to make use of the so-called horizontal and vertical shadow angles.

Referring once again to Figure 3, the line b-b in the section c-c gives the direction of the shadow plane that is formed by the front edge of the canopy over the window, i.e., the plane which divides the space shaded by the canopy from the space exposed to the sun. The angle of inclination of this shadow plane, measured from the horizontal, is termed the vertical shadow-angle. In other words, the vertical shadow-angle is the angle between the horizontal and the sun's direction on the section of elevation of the building. Similarly, the line a-a on the plan drawing, being in the direction of the sun's rays, represents the direction of the vertical shadow plane formed by the outer edge of the window reveal. The angle on plan between this line and the normal to the window wall is called the horizontal shadow-angle.

The advantages of working with shadow-angles are obvious, since they can be applied directly to the usual drawings of a building in plan, section or elevation.

THE SOLAR CHARTS AND SHADOW-ANGLE PROTRACTOR[2]

The solar charts presented in this paper may be described as plan diagrams of the sun's path patterns for different latitudes. They are arranged in a form from which it is possible to read off, for all places in South Africa, the sun's altitude and azimuth at any time and date, to an accuracy sufficient for most practical purposes. In this form, they are helpful also in enabling one to visualise fairly correctly the extent of the apparent daily sweep of the sun across the sky. In addition, a special protractor is provided, which, when used in conjunction with either of the charts, enables one to read off both the horizontal and vertical shadow-angles for any orientation of a vertical plane.

EXPLANATION OF THE SOLAR CHARTS

So as to cover all regions in the country, a series of eight charts is given, one for each two degrees of latitude between 20° and 34° South. This selection of representative latitudes was found to be convenient, since most of the large urban areas lie very close to the latitudes chosen. Furthermore, the greatest difference in latitude between any place and a selected latitude is only 1°, so that the errors involved in using the chart of nearest latitude are of little practical consequence.

The mid-point on each chart and the plane of the paper upon which it is drawn, represent respectively the position of the observer and the horizontal plane through this position, while the heavy ungraduated circle with the midpoint as centre defines the observer's horizon. From the angular graduations marked around the circumference of the outer circle, it is possible to read off any direction through the observer's position in terms of the points of the true compass, or as an angular distance east or west of true north.

The sun's paths during the course of the day on selected dates are represented by a series of curved lines running from the easterly to the westerly horizons. These path lines are crossed by hourly time lines. Thus, the point where a time line cuts a sun's path line, represents the plan position of the sun at that particular time and that particular date. A line drawn through the sun's position and the mid-point of the chart will then give the direction on plan of the sun's rays and hence the azimuth. The altitude of the sun above the horizon is given by the relative distance between the sun's position and the mid-point, as measured from the mid-point along the scale marked "solar-altitude." It should be emphasised that the reference point for the altitude scale is the mid-point of the chart, and not the point corresponding to 0° on the scale.

To illustrate the use of these charts, reference will be made to Figure 4, which is a reproduction of the solar chart for latitude 26° South (e.g., Pretoria and the Reef). In this figure

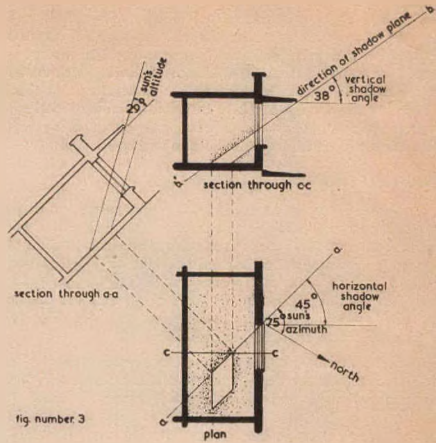


fig. number 3

Plan and section drawings of a room showing the extent of sunlight penetration and the relation between shadow-angles and the sun's altitude or azimuth.

the point S, which is marked by a small circle, shows the position of the sun at 9 a.m. on the 22nd June, and the line through S and the mid-point of the chart cuts the outer graduated circle at a point 45° east of north, indicating the sun's azimuth. The distance of S from the mid-point, when transferred along the solar altitude scale, as shown in the figure, indicates the solar altitude to be 24°.

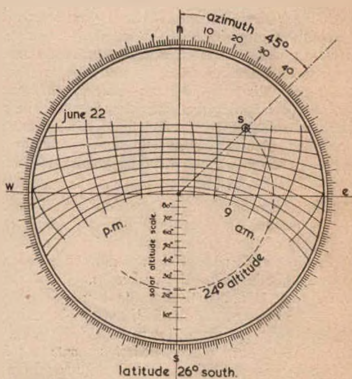


fig. number. 4

2. The charts and protractor are based on the ones specially devised for conditions in Australia, New Zealand and adjacent islands, as given in "Sunshine and Shade in Australasia," by R. O. Phillips, Duplicated Document No. 33, Commonwealth Experimental Building Station, Sydney, 1948.

The solar altitude could be determined more readily by using the shadow-angle protractors, as will be explained later, or, alternatively, if a series of concentric circles was first described about the mid-point of the chart in such a way that the circumference of a cirle passes through each of the divisions marked on the altitude scale. These concentric circles have purposely not been drawn on the charts to avoid confusion, and also because solar altitudes are seldom required, it being more advantageous in analysis to use vertical shadow-angles.

DATES SELECTED FOR SUN PATH LINES

Since it is the sun's declination which determines the angles of the sun for any particular place and time of day, it is considered that the most convenient sun's path lines to show on the charts are those for which the declinations differ by some constant amount. For this reason, therefore, the path lines shown on all charts are for the dates of the solstices and for the days when the solar declinations are 0°, 5°, 10°, 15° and 20° north or south (see also Figure 10).

It will be noticed from the charts that, except near the solstices, the number of days between successive sun path lines varies between 13 and 19, with an average of about 15. Bearing this in mind, it is an easy matter to interpolate between lines so as to determine the sun's position on any intermediate date. Precise accuracy in carrying out the interpolation is not warranted in practice, since it is generally of little consequence whether a shadow or patch of sunlight falls on a predetermined area at a given hour on the exact date for which the design was arranged, or whether this event occurs a day or so before or after that date.

TIME OF DAY

Times, indicated by the hour lines on the solar chart, are apparent solar times, 12 o'clock midday occuring when the altitude is greatest, the azimuth then being either zero or 180°. Except on four days in the year, at places on longitude 30° east, the apparent solar time for any locality differs from the standard or clock time in South Africa by an interval which varies from day to day and with the longitude of the locality. Hence, if we are interested in an examination of sun and shade patterns at specific standard times, a conversion from standard to apparent solar time is necessary before making use of the charts. Most sunlighting problems can, however, be studied on the basis of solar time only, but there are instances, such as the exclusion of sunlight from a working surface during normal working hours, when it may be particularly desirable to plan in terms of standard time.

To make the conversion involves two time corrections. Firstly, there is a correction of a constant amount, which depends on the longitude of the site. It is determined by allowing one minute of time for each quarter degree difference in longitude between the longitude of the site and longitude 30° east, and is subtracted from standard time if the longitude of the site is less than 30° east, or added to it if the longitude is greater than 30° east. Thus for Cape Town, where the longitude is approximately $18\frac{1}{2}°$ east, the correction amounts to minus 46 minutes. Table 1 gives the latitudes and longitudes of the principal towns in the Union, together with the time corrections for longitude which are applicable in each case.

The second correction, known as the equation of time, varies from day to day, and is due to non-uniformity in the movement of the earth along its orbit around the sun.

TABLE 1

Latitudes, Longitudes and Time Corrections for Longitude for the Principal Towns in the Union

	Latitude °S	Longitude °E	Time* correction for longitude in minutes
Durban - - - - - - -	29.9	31.1	+4
Pietermaritzburg -	29.6	30.4	+2
Pretoria - - - - - -	25.8	28.2	—7
Johannesburg - - -	26.2	28.1	—8
East London - - - -	33.0	27.9	—8
Bloemfontein - - -	29.1	26.2	—15
Port Elizabeth - - -	34.0	25.6	—18
Kimberley - - - - -	28.7	24.8	—21
Cape Town - - - -	18.5	18.5	—46

* To be added algebraically to the standard time when converting to apparent solar time.

Equation of time corrections on the days for which the sun's paths are depicted in the charts are given in Table 2, while for any intermediate date, the equation of time can safely be obtained within an accuracy of about one minute by interpolation. Having determined the appropriate correction for equation of time, it should be added algebraically to the correction for longitude and then the combined correction should be applied to standard time to deduce the corresponding solar time. For example, suppose the apparent solar time coinciding with 4 p.m. standard time on the 6th of October, is required for Cape Town. The correction for longitude we have already seen is minus 46 minutes, and from Table 2 the correction for the equation of time is seen to be plus 12 minutes. The algebraic sum of these two quantities is minus 34 minutes, which, when applied to the given standard time, shows the corresponding solar time to be 3.26 p.m.

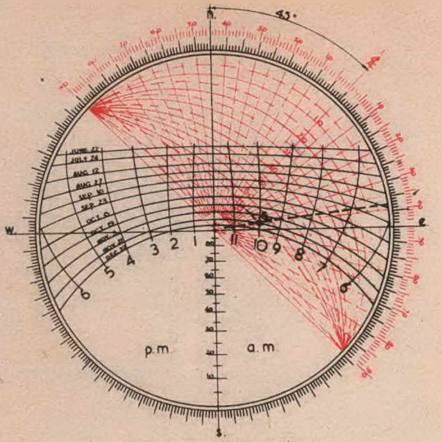
Unless strict account of time is demanded, it will be found easier to neglect the day-to-day correction, which after all varies between fairly small limits (approximately between plus and minus 15 minutes) and to apply only the correction for longitude, which for some places amounts to almost an hour. By adopting this procedure, the correction is always the same for a particular place and amounts to a relative shift of all the time lines on a solar chart, either to the left or to the right, by an interval equivalent to the longitude time correction.

TABLE 2

The Equation of Time on Selected Dates

Date	Equation* of time in minutes	Date	Equation* of time in minutes
December 22 - - -	+ 1	June 22 - - - - - - -	— 2
January 21 - - - -	—11	July 24 - - - - - - -	— 6
February 8 - - - -	—14	August 12 - - - - -	— 5
February 23 - - -	—14	August 28 - - - - -	— 1
March 8 - - - - - -	—11	September 10 - - -	+ 3
March 21 - - - - -	— 7	September 23 - -	+ 8
April 3 - - - - - - -	— 3	October 6 - - - - -	+12
April 16 - - - - -	0	October 19 - - - -	+15
May 1 - - - - - - -	+ 3	November 3 - - -	+16
May 20 - - - - - -	+ 4	November 22 - - -	+14

* To be added algebraically to the standard time when converting to apparent standard time to obtain apparent solar time.



latitude 26° south.

fig number 6a

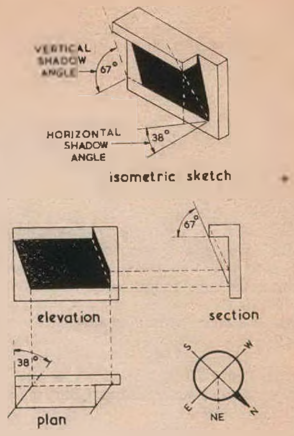


fig. number 6b

Sunrise or sunset on the charts is represented by the intersection of a sun's path line with the horizon circle, and the time at which they occur can be judged from the relative positions of the hour lines. For more exact times of sunrise and sunset, reference should be made to the set of tables drawn up by the Union Observatory authorities[3].

THE SHADOW-ANGLE PROTRACTOR

For convenience of reference and use the Figure 5 together with the Solar Charts have been reproduced in a fold section at the end of this paper.—Editor.

As already indicated, the shadow-angle protractor, a full-scale drawing of which is shown in Figure 5, is used with charts to determine both horizontal and vertical shadow-angles. The protractor can be considered as a special form of plan diagram drawn on the same scale as that of the charts, but one in which the base line represents a vertical surface and the curved lines represent a series of imaginary sun's path lines such that, if the sun should follow along any one of them the resultant vertical shadow-angle remains unchanged. The graduations on the curved lines identify the vertical shadow-angle to which the curved lines correspond.

The designer can make his own protractor* by simply tracing Figure 5 on a piece of tracing paper or other transparent material. When used, the protractor is placed on a selected solar chart with the centre of the protractor directly over the mid-point of the chart. The protractor is then turned about its centre until the base-line assumes the orientation of the vertical plane or surface which it is supposed to represent. This will occur when the centre-line of the protractor cuts the angular scale marked around the solar chart at the point corresponding to the desired aspect; e.g., if the vertical surface faces north-east then the centre-line of the protractor should point to the division marking north-east (i.e., 45° east of north) on the angular scale around the solar chart (see Figure 6a).

The appropriate vertical shadow-angle for any position of the sun previously located on the chart can now be read off on the curved line scale of the protractor. At the same time, the horizontal shadow-angle can be determined from the point at which a line through the protractor's centre and the sun position on the chart cuts the graduated scale around the circumference of the protractor. For these angles to be ascertained without having actually to draw any lines on the solar chart, radial lines at 5° intervals are included in the protractor.

A point about the protractor which is worth noting is that the scale of vertical shadow-angles at the centre-line of the protractor coincides exactly with the scale of solar altitudes on the charts. Thus, the protractor can be used to read off solar altitudes from the solar charts.

SUGGESTED WAYS OF USING THE CHARTS AND PROTRACTOR

As an example in the use of the protractor and solar charts, suppose in dealing with a building situated in Pretoria (latitude 26°S), we wish to find the extent of the shadow cast by an overhang on a wall with a N.E. aspect at 10 a.m. on the 21st November. The protractor is positioned on the appropriate solar chart with its centre-line oriented to 45° east of north, as shown in Figure 6a; from the relationship which the specified sun's position marked S on the chart bears to the scales on the protractor, we find the vertical and horizontal shadow-angles to be 67° and 38° respectively. How these angles are applied to the section and plan drawings for setting out the boundaries of the shadow on elevation is demonstrated in Figure 6b.

3. "Times of Sunrise, Sunset and Local Apparent Noon," Government Printer, Pretoria, 1950.

* It is anticipated that the National Building Research Institute will shortly be able to make a celluloid form of shadow-angle protractor available at small cost.

The second example (see Figures 7a, b and c) illustrates how the protractor and charts may be used to determine the times of the year and day when sunlight could penetrate into a room. The room considered is assumed to be in Pretoria and to have a window facing N 30° E with the side of a neighbouring building directly opposite it, as shown in Figure 7a.

Lines defining the limiting directions for sunlight to be able to enter the room are drawn on the plan through diagonally opposite edges of the window reveals, and, by measurement, these lines are found to make angles of 79° on either side of the centre-line through the window. It is evident, therefore, that the reveals offer protection from the sun at all times when the horizontal shadow-angle for the window wall is greater than 79°. Similarly, the limiting or cut-off horizontal angles, defined by lines drawn from the corners of the obstructing building to the nearest outer edge of the window jambs, are found to be 19° for the one side and 38½° for the other. A tracing of the plan is now made and placed on the shadow-angle protractor so that the centre of the window is over the centre of the protractor, with the window wall and base line parallel, as indicated in Figure 7b. Radial lines are then drawn on the tracing to correspond to the different limiting horizontal angles previously determined.

The vertical limiting angles due to the eaves and to the top of the opposite building, when set out as in the section of Figure 7a, are measured and found to be 60° and 25° respectively. The former of these two angles fixes the vertical shadow-angle above which the sun's entry will always be prevented by the eaves, and the second angle defines the vertical shadow-angle below which the sun will be cut off by the adjoining building. With the tracing still in position on the protractor, lines are drawn along the shadow-angle curves for 60° and 25° and the appropriate areas, representing no sunlight penetration, can be shaded in.

The tracing is now removed and correctly aligned and oriented on the chart for latitude 26°S, as shown in Figure 7c. Having done this, the times of day and year when sun will enter the room are at once apparent.

As a further exercise, Figure 8 illustrates a seasonal study of the depth to which the available noon sunlight will penetrate along the working plane in a supposedly north-facing office in Cape Town (latitude 34°S). It also demonstrates the setting out for study of the extent and movement of the sunlight pattern on the working plane during the course of the morning on the day of deepest penetration. The vertical and horizontal shadow-angles corresponding to the various times and dates under the circumstances are as follows:—

Date	Time	Shadow-angle	
		Vertical	Horizontal
December, 22 -	noon	79½°	0
March, 21 - - -	noon	56°	0
June, 22 - - - -	noon	32½°	0
June, 22 - - - -	11 a.m.	32°	16°
June, 22 - - -	10 a.m.	30½°	30½°
June, 22 - - -	9 a.m.	25°	43°
June, 22 - - -	8 a.m.	15°	53½°

The principles demonstrated above can be used for plotting the shadows cast by one building on another or for assessing the relative values of the insolation on different sides of a building. Both factors are important when deciding siting, orientation and general arrangement. Also, they can be applied in

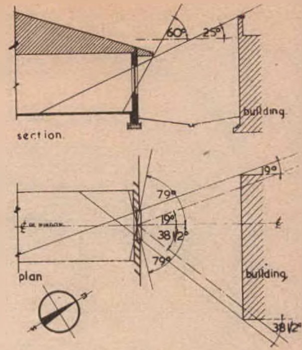


fig. number 7a

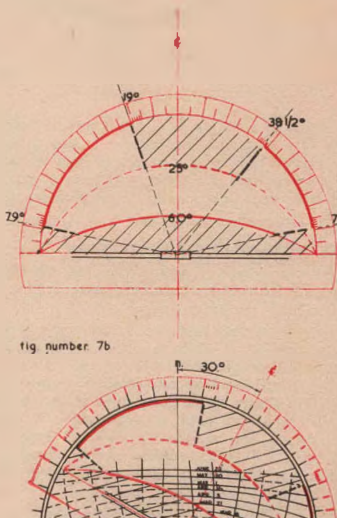
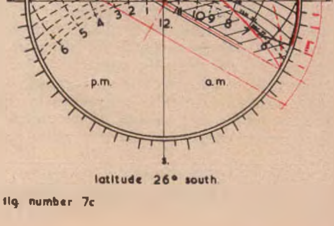
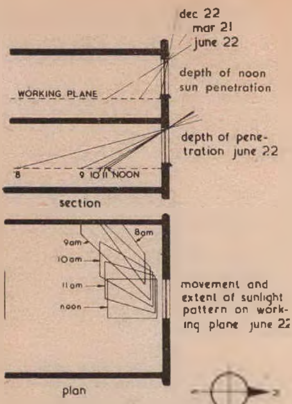


fig. number 7b



latitude 26° south

fig. number 7c



cape town 34° south

fig number 8

A study of the depth of sunlight penetration and the movement and extent of the sunlight pattern on the working plane in an office.

designing for sun control and for assessing the relative efficiencies of screening devices.

GENERAL

The map, Figure 9, is included for quick reference in selecting which chart to use for a particular location and for evaluating longitude time corrections. In the latter connection, lines of longitude are shown where local solar times differ by intervals of 10 minutes from that on the standard time meridian, which corresponds to longitude 30°E. The map will also be found useful in cases where recourse must necessarily be made to the magnetic compass for determining the direction of true (i.e., geographical) north at a particular site. According to the geographical position of the site, the dotted curved lines running diagonally across the map show approximately by what angle magnetic north lies to the west of true North. Thus at Cape Town the compass needle points about 24° west of true north. Some caution is, however, necessary when making use of the map in this respect, since magnetic anomalies, due to magnetic deposits in the local geological structure, are not shown. Where the existence of these is known or suspected, it would be better to obtain more accurate information from the Trigonometrical Survey Office.

A difficulty associated with problems of sun control immediately presents itself when the purpose of the control is to exclude direct solar radiation in summer, but to admit it during winter months; to decide during exactly what periods of the year sunlight should or should not be permitted to enter

fig. number 9

Map* of South Africa showing (a) lines of latitude for which solar charts are given, (b) lines of longitude where local solar times differ by intervals of 10 minutes with reference to the standard time meridian or longitude 30° East, and (c) lines in red indicating by what angle magnetic north lies to the west of true north.

* "Isogonic Map of South Africa, Epoch 1948-0" reproduced under Government Printer's Copyright Authority No. 915 of 28/12/50.

a building. Before considering the question, it must be agreed as to which constitutes the more serious problem—summer heat or winter cold. In this matter the author holds the view that generally throughout South Africa the minimisation of solar heat gains during the hot summer months should take precedence over other aspects of the problem. The reasons for adopting this view are that the period of winter cold is generally of much shorter duration than the period of summer heat, while, of the two climates, summer or winter, that experienced in the day time during a normal winter is perhaps the less severe in its effects on indoor comfort. Of far greater significance, however, is the fact that some means of artificial heating is nearly always available even for the poorest of homes, whereas the costs of mechanical cooling are in most cases prohibitive.

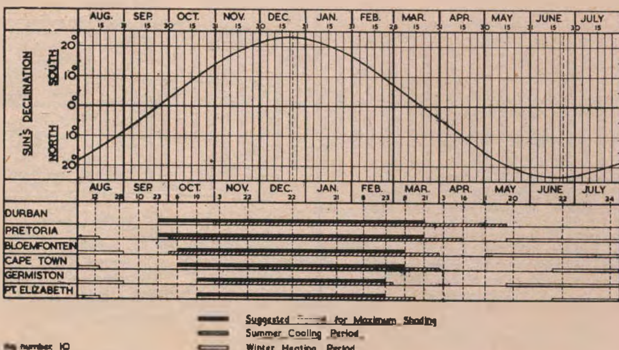
The difficulty is made evident when we consider the relationship between the apparent seasonal movement of the sun due to changes in its declination and the time of occurrence of the highest air temperatures for the year. Because the annual variation in declination is symmetrical about the solstices, it follows that the middle of whatever period one chooses for maximum shading must occur at the summer solstice on December 22. On the other hand, the highest air temperatures in any region and, therefore, the approximate middle of the local summer season, occur much later, the extent of the delay varying from about 40 days on the south and west coasts to about 15 days over the highveld areas.[4]) If, therefore, one designs for the total exclusion of sunlight until the end of the local summer, the sun may also be excluded for a considerable time during spring when the air is normally quite cool. The best solution must necessarily be based on a reasonable compromise between having to admit sun long before the hot weather is over and having to exclude it long before the hot weather begins. It would be wise, also, to choose the dates marking the beginning and end of the design period for maximum shading to correspond with one of the sun's path lines given on the charts.

As a guide for design in the six most populated areas in the Union, Figure 10 gives suggested periods for maximum shading based on the duration of what is considered at the National Building Research Institute as the period of the year when cooling is desirable in buildings in these areas*. The Figure also shows clearly the displacement between the two periods and how they are related to what is considered as the winter heating period and to the variation in the sun's declination.

Finally, the details of a specific design are given and discussed as an example of the application of some of the principles of sunlight and shade analysis previously described. A hypothetical case is chosen, in which it is assumed that a client has approached with the proposition of designing a house for a site he has purchased in Pretoria. It is further assumed that the requirements which the client expressly desires are (a) two bedrooms on the east side, with control of sunlight penetration, to eliminate early morning sun on the beds; (b) a fairly large living room incorporating an extensive all-glass opening and a section of fairly solid walling to suit a built-in bench or fitting, and (c) an opening from the living room on to a covered stoep, which in turn should lead to an open terrace, both stoep and terrace being required for use in the afternoons during most of the year. The solution is shown in detail in Figure 11, which also includes some sketches to illustrate the salient points in the analyses of the various sunlight and shade aspects.

4) see "Temperature" — an analysis of air temperature data for the Union compiled by the Weather Bureau and published by the Government Printer, Pretoria, 1942.

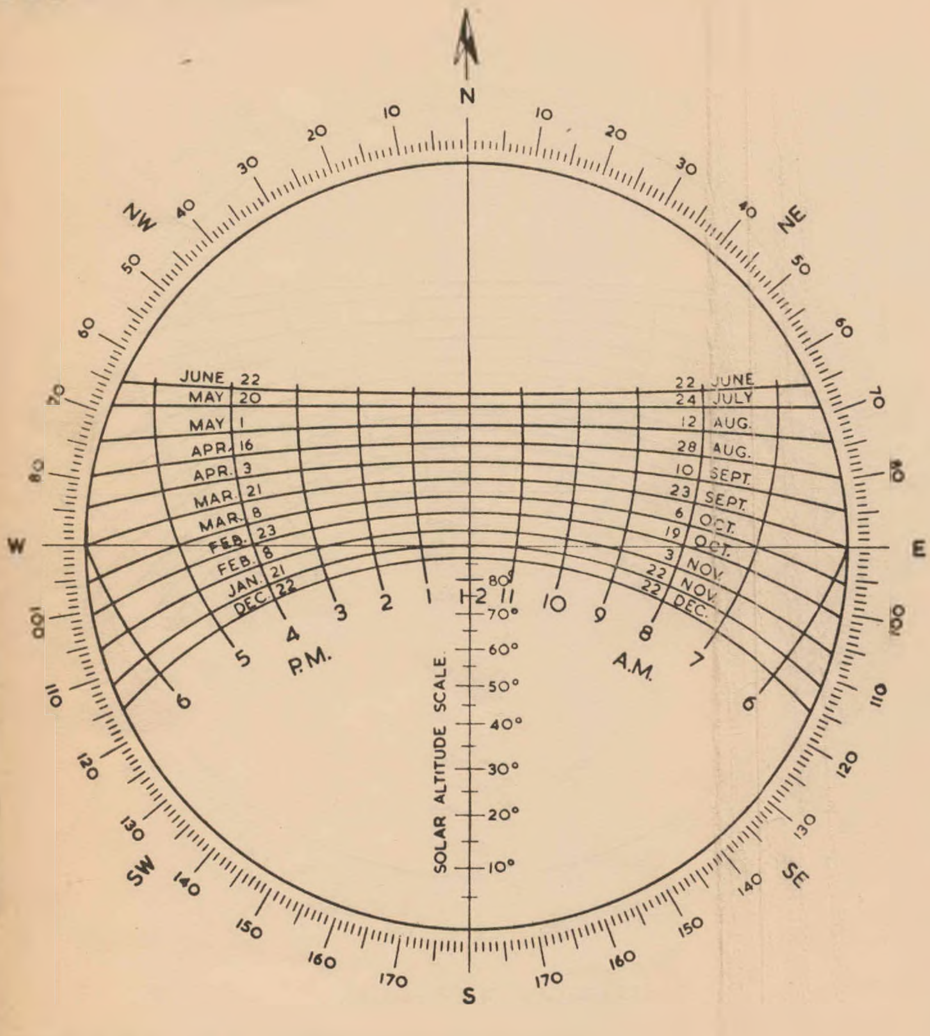
* For each centre, the duration of both the summer cooling and winter heating periods was determined from an analysis of outdoor air temperature data taken over a 10-year period from records at the Weather Bureau. The selected summer cooling period represents approximately the period in the average year when the daily maximum temperature can be expected to exceed 75°F. Similarly, the selected winter heating period represents approximately that part of the year when the daily mean temperature will normally be less than 55°F. On this basis Durban was found to have no winter heating period. Details of the analysis will shortly be published by the Institute.



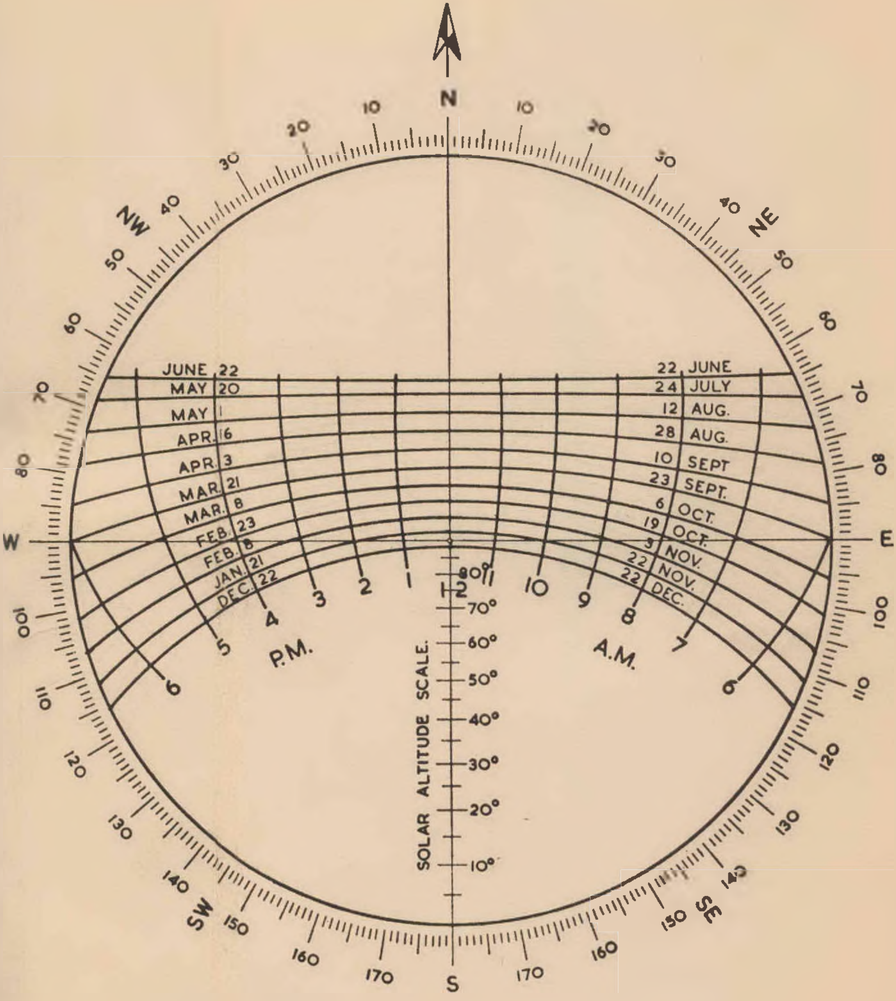
Variation of the sun's declination in relation to suggested periods of the year for maximum shading in respect of the more important centres of the Union, and to the summer cooling and winter heating periods for these centres.

fig number 10

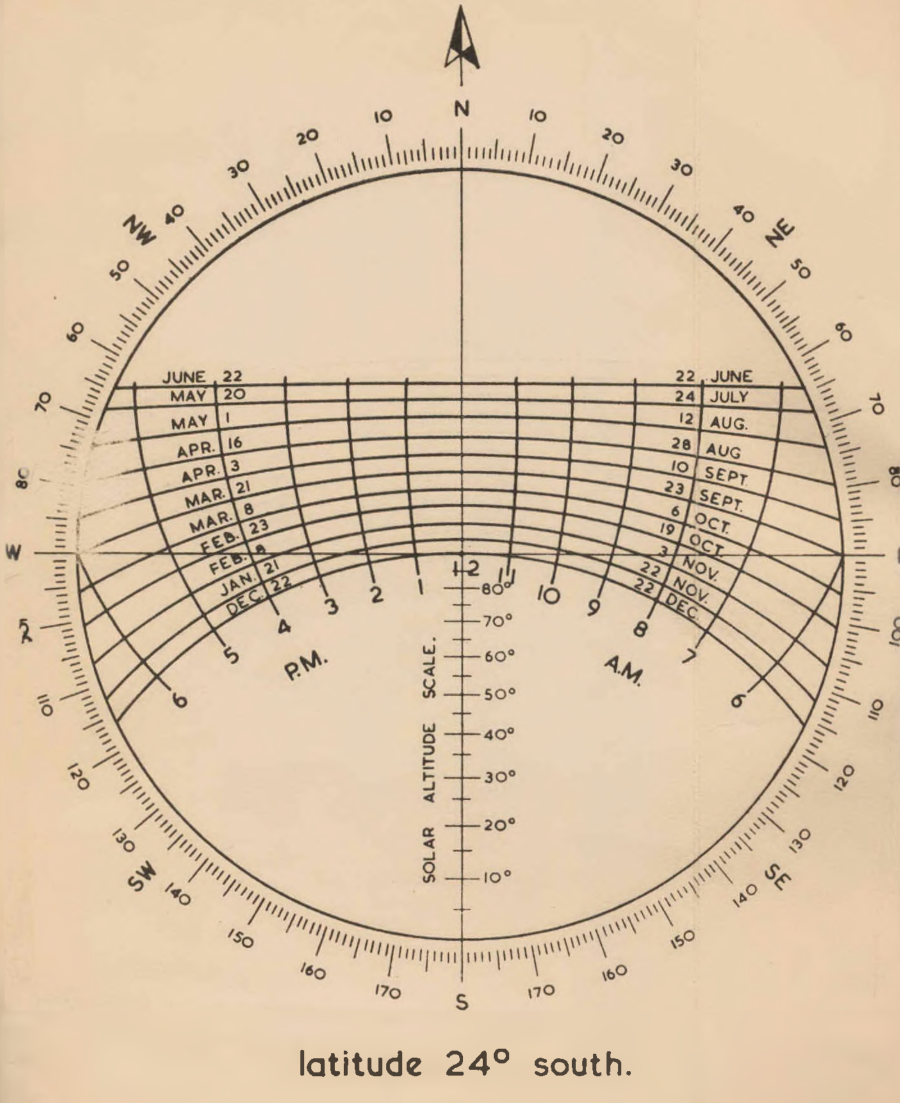
SOLAR CHARTS



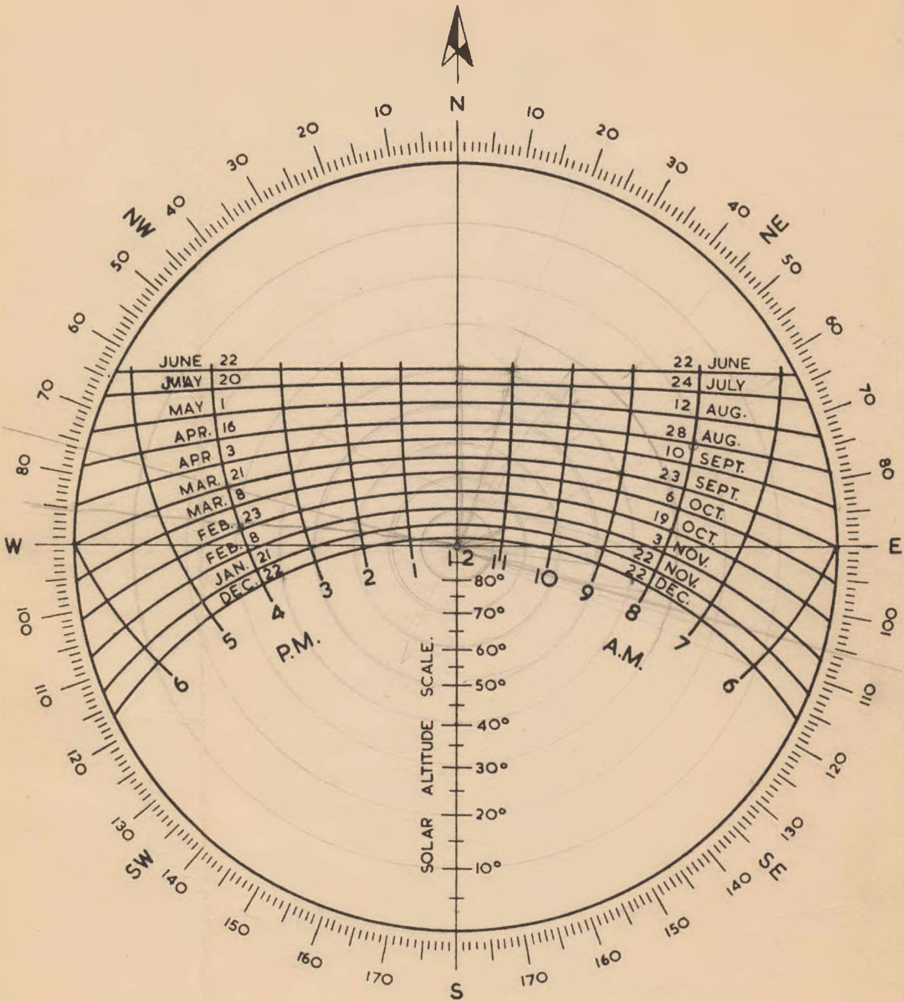
latitude 20° south.



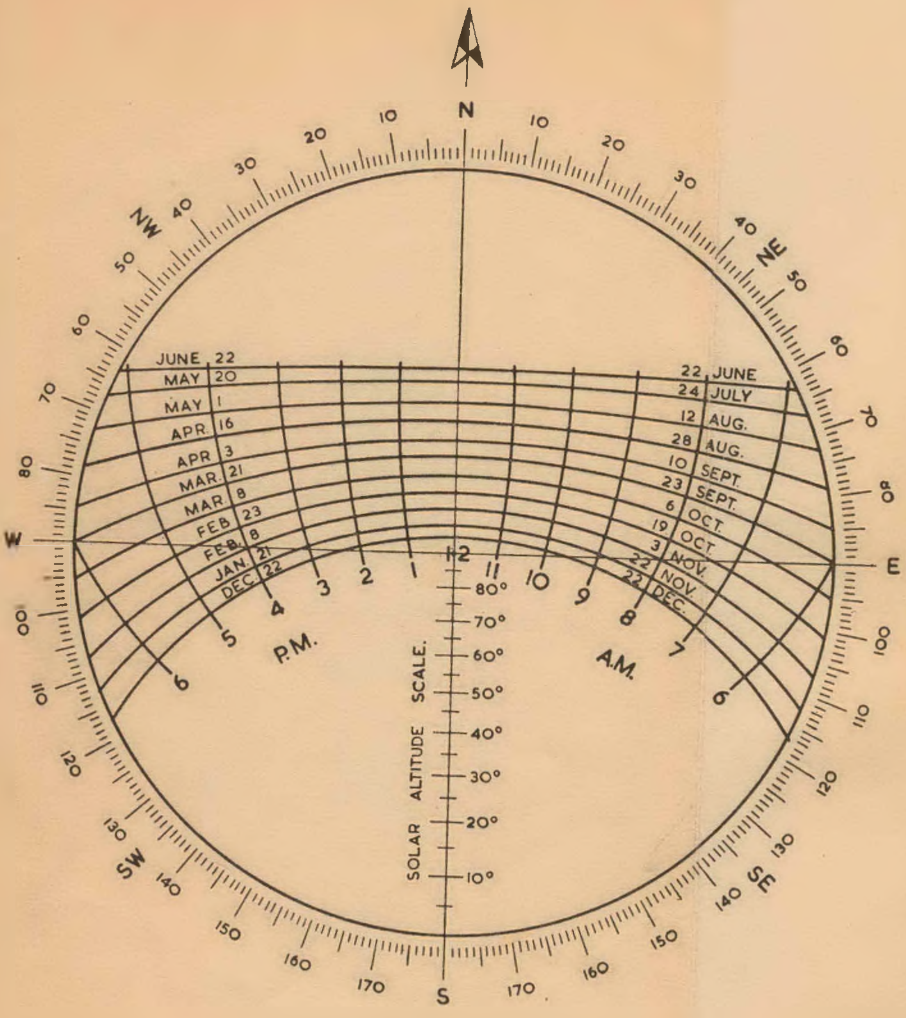
latitude 22° south.



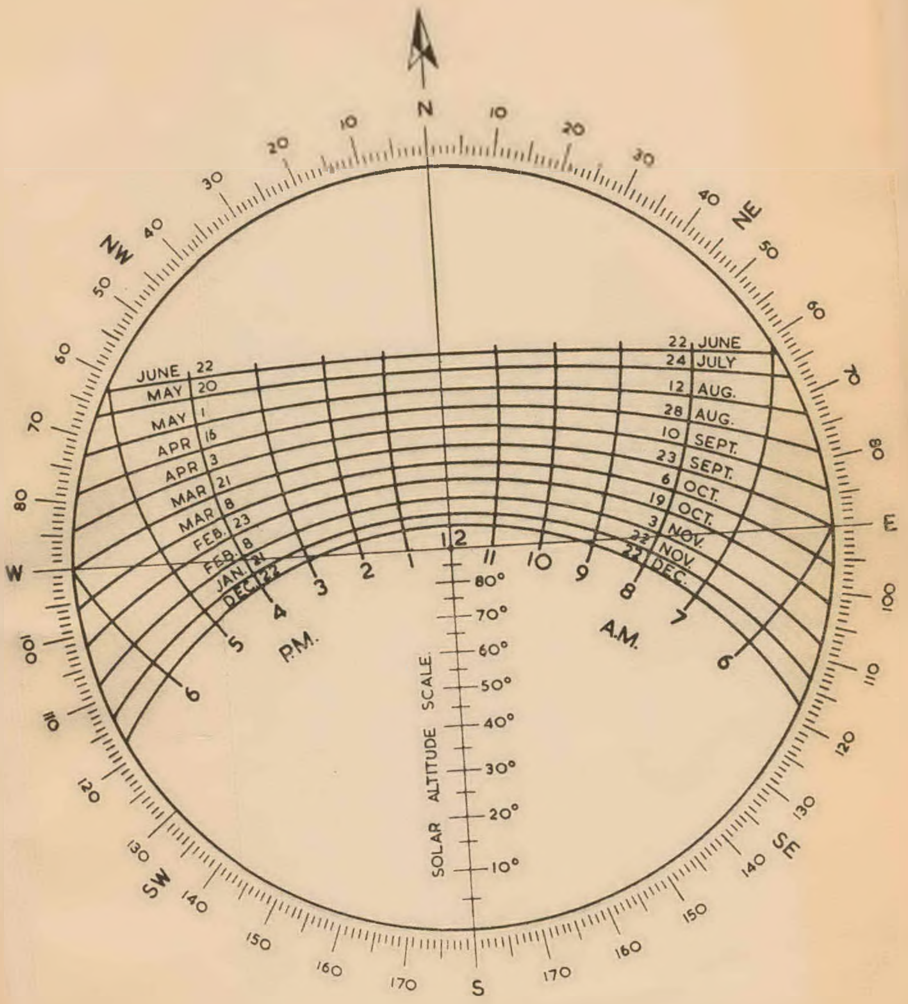
latitude 24° south.



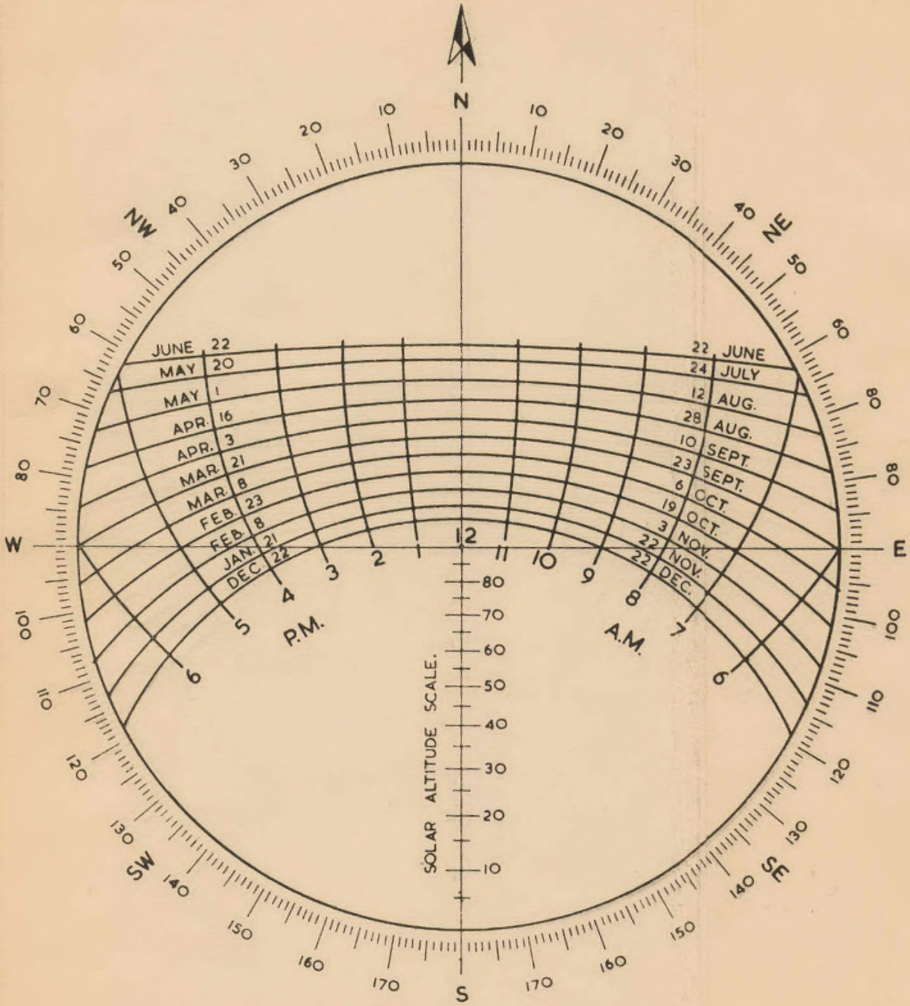
latitude 26° south.



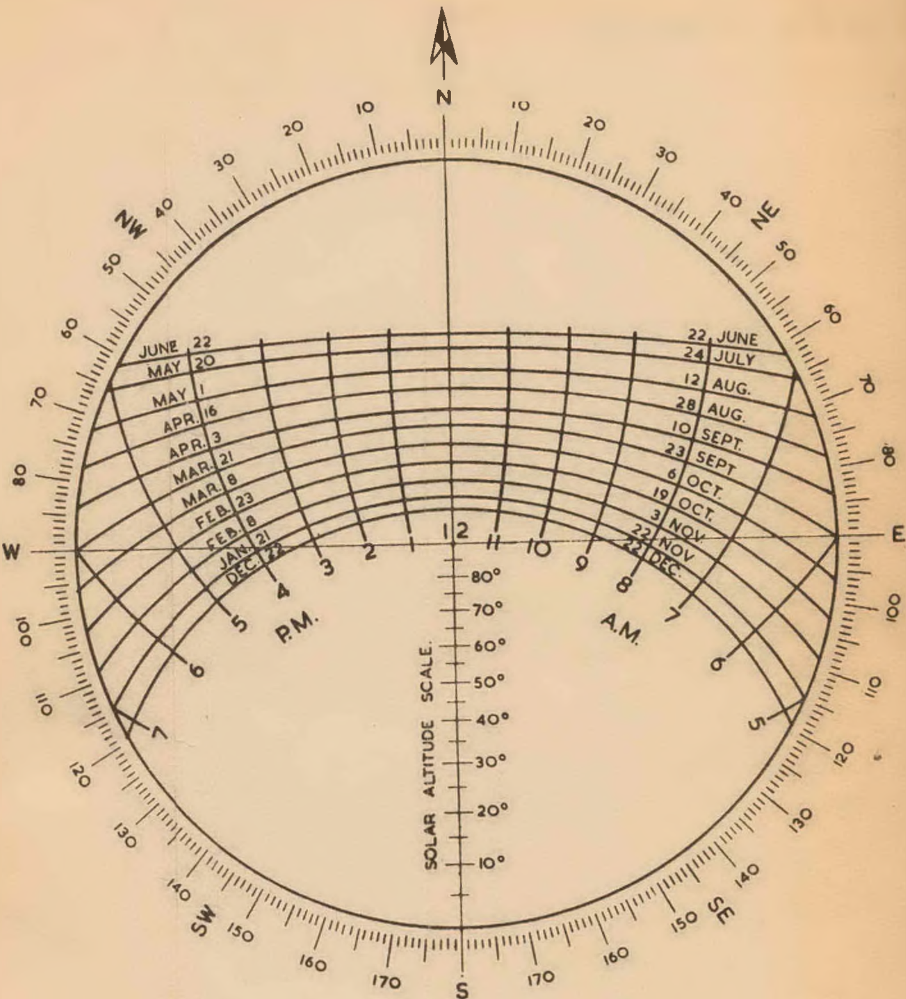
latitude 28° south.



latitude 30° south.



latitude 32° south.



latitude 34° south.

SOLAR CHARTS
UNFOLD

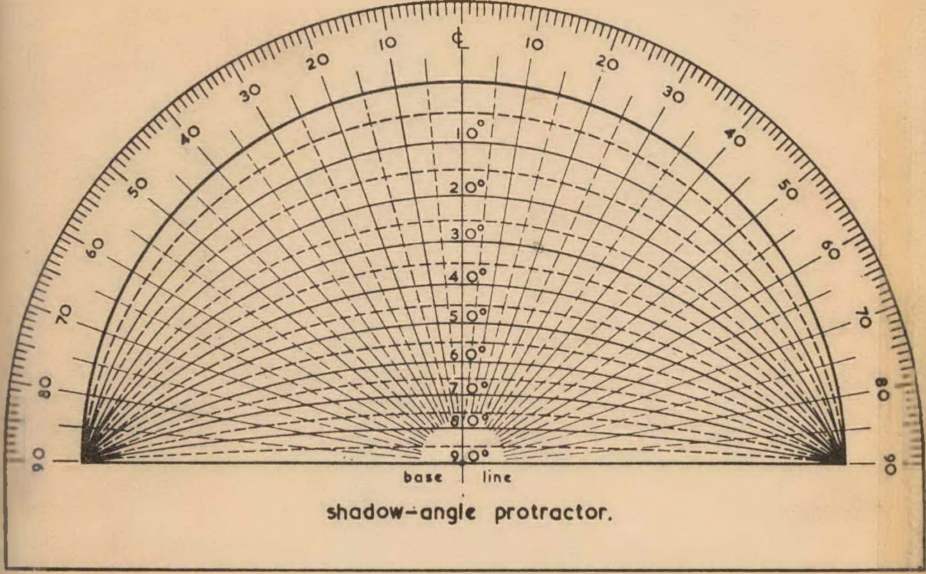
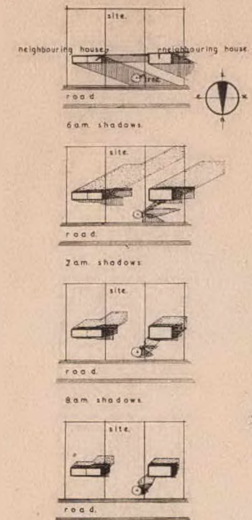


fig. number. 5

The shadow-angles for a given wall are found by placing the protractor over a solar chart, with centres coinciding and the base-line oriented to represent the wall. The point on the chart is located for the selected position of the sum. The graduations on the radial. and curved lines through this point show, respectively, the horizontal and vertical angles which the sun's rays make with a line perpendicular to the wall.

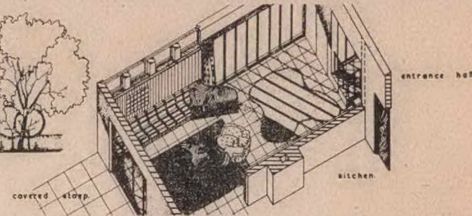
investigations of the siting in relation to the early morning sun.



shadows for june 22.
" " sept. 23 & mar. 21.
" " dec. 22.

site plan.

east elevation.

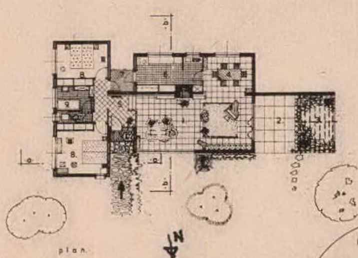


axonometric sketch of living room showing the position of the sun on 22nd. of june, at 3 p.m.

north elevation.

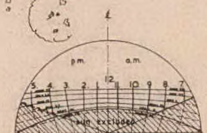
section thro' lounge b-b.

lounge.

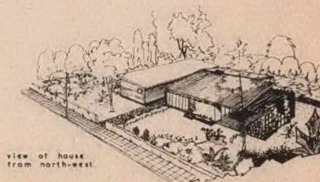


plan.

1. lounge.
2. covered stoep.
3. open terrace.
4. dine.
5. entrance.
6. kitchen.
7. rear porch.
8. bed-rooms.
9. bath room.
10. w.c.



north glass wall of lounge - sun diagram.



view of house from north-west.

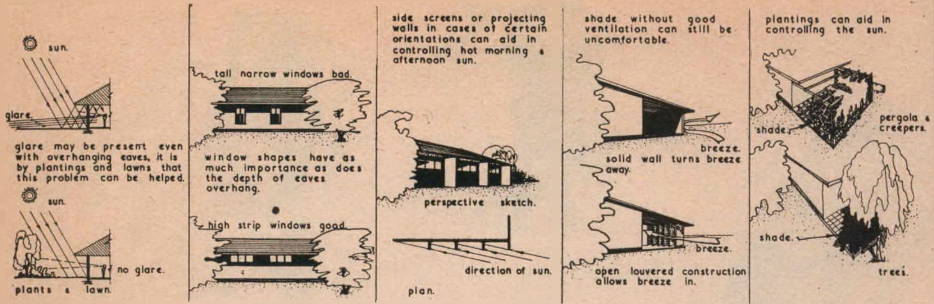
section of bedroom -a-a-.

6 a.m. no sun on bed.
7 a.m. sun on bed from oct. 19 till feb. 23.
8 a.m. sun on bed thro' july 24 to may 20.

n.b. by placing beds against east wall no sun will reach beds until after 8 a.m. all year round.

climate & the plan.
sunlight study lat. 26°s.

fig. number. II.



Sketches illustrating some simple methods of sun control which are easily incorporated in house design to help make the home more comfortable.

How the wishes of the client were accommodated is shown as follows:—

(a) An examination of the shadows cast by the existing dwelling on the east side indicated no preference for siting as a means of sunlight control for the bedrooms. The windows in these rooms were, therefore, placed high in the wall and one of the sketches shows the times when sun could be expected to reach the beds for alternative furniture arrangements.

(b) The large expanse of glass provided in the living room is screened from the direct rays of the sun for a period in summer in accordance with the recommendation contained in Figure 10. It was, however, pointed out to the client that the entry of the late afternoon sun at other times of the year might prove rather a nuisance and that it might, therefore, be advisable to have some type of control on the west side of the window in the form of a projecting vertical screen, or, more economically, by carefully considered plantings. The wall provided for the built-in seat arrangement also houses the curtain for the large window.

(c) The covered stoep leads off the lounge through folding doors and is related to the surrounding garden, while providing privacy and a certain amount of protection from the summer thunderstorms which normally blow up from the south-west. A suitable kind of deciduous creeper or vine, trained to cover the pergola over the open terrace, would take care of the sunshine question in this area.

This example demonstrates that proper control of sunlight penetration can in many cases be obtained at little or no addition to the normal costs of construction, if planned for in the design stages. In this connection, the sketches in Figure 12 give point to some simple features in house planning which should go a long way towards making living conditions more attractive.

NOTES AND NEWS

TRANSVAAL PROVINCIAL INSTITUTE

MEMBERSHIP

The following new members have been registered as Practising Members: Mr. L. W. Baart, P.O. Box 153, Bulawayo, S.R., and Mr. T. C. Nel, 135 Johann Street, Pretoria. The following new members have been registered as Salaried Members: Mr. W. E. Clark of Pretoria, Mr. F. George, of Johannesburg, Mr. J. A. N. Groenewald, of Pretoria and Mr. D. H. Rodd, of Johannesburg.

TRANSFERS

Mr. C. A. J. Ensor, a practising member, has transferred from the Cape Provincial Institute. Mr. G. A. Gundersen, a salaried member, has transferred from the Natal Provincial Institute. Mr. N. J. Harris has transferred from the practising to the absentee practising class. Mr. R. Wigmore Barlow has transferred from the absentee practising to the practising class.

RESIGNATIONS

Mr. N. J. Greer and Mr. T. Crosby have resigned from the Institute with effect from May, 1951.

PARTNERSHIPS

Mr. W. von Berg has entered into partnership with Mr. W. Groening, under the style of W. von Berg, the practice continuing at 903, Maritime House, Loveday Street, Johannesburg.

The partnership formerly known as F. H. Moerdyk and Partners has changed its name to Moerdyk, Kock and Orsmond, the address being 701-4, P.F.A.C. Buildings, 15 de Villiers Street, Johannesburg.

Messrs. Stegmann & Porter have entered into partnership with Messrs. G. A. Christos and R. Wigmore Barlow, under the style Stegmann & Porter, practising at Portland Place, Jorissen Street, Braamfontein, Johannesburg.

CHANGE OF ADDRESS

Mr. K. H. Gardner, A.R.I.B.A., M.I.A., has changed his address from "Atami," Mains Avenue, Kenilworth, Cape, to "Storisende," Seaview Road, Muizenberg, Cape.

Mr. I. Aronowitz, A.R.I.B.A., M.I.A., has changed his address to 201 Carmel House, Gladstone Street, East London.

PARTNERSHIP

Mr. John L. Gouldie, A.R.I.B.A., A.M.T.P.I., M.I.A. (S. & N.R.), has been taken into partnership by Corrigall, Crickway and Partners of Pietermaritzburg, Pretoria, Port Elizabeth and Salisbury, and will manage the Salisbury office of this firm at 12, Park Street, Salisbury, Southern Rhodesia.