carriage system of sewerage. The provision of an adequate water supply is rightly insisted upon by all modern centres of population. It is however often forgotten that the final disposal of this water after use for domestic or trade purposes necessarily creates further problems, if serious menace to health is not to occur through the creation of swamps or the piling up of filthy sludge deposits in neighbouring streams and *nullahs*. The claims of agriculture for increased fertilizer supply may be met by the proper utilization of the otherwise nuisance producing residues of town or village.

In devising suitable means for dealing economically with these problems a Water Pollution Research Board for India may well play a part in importance equal to or greater than its prototype in England.

It is only fair to add that several Municipal authorities in India have already shown themselves awake to the importance of such preliminary research work. Nagpur some years ago arranged for scientifically controlled large-scale experiments involving considerable expenditure in order to compare the relative efficiencies of several methods of dealing with their sewage. Bombay and Ahmedabad have appointed Specialist Research Chemists and have provided laboratories for preliminary investigations of the disposal of their sewage and trade wastes.

Bhopal, Indore and Mysore have carried out important researches on a large and practical scale in connection with the conversion of "habitation waste" into "compost" suitable for agricultural use. Should a Water Pollution Research Board be established either as a branch of the Imperial Agricultural Research Council or as an independent body, it will have no difficulty in finding ample work to do and its collaboration will be welcomed by all those who are doing their best, often under rather difficult conditions, to deal with the problems with which they are faced.

How to View a Picture

By A. Narasinga Rao

(*Annamalai University, Annamalainagar*)

A GOOD-SIZED picture is hanging in a vertical plane in front of us. It is required to determine the *proper position* (or positions) at which the eye should be placed so that we may have a *correct view* of the objects represented therein.

Before the question can be answered unambiguously, we have to clarify the concepts described in italics, and state the assumptions under which a solution is sought.

We postulate firstly that the Artist has been so much struck by the beauty of a particular scene that he wants others to share exactly the same experience, and that this constitutes the *raison d' etre* of the picture; secondly, that the picture is drawn according to the laws of perspective and that the colour effects are properly rendered —or that it is a photograph. The observer may be said to have a "correct view" of the picture if his visual impression of the relative positions and dimensions of the objects represented in the picture is identical with that experienced by the artist when he looked at the original landscape. Here we are confronted by the fact that visual geometry is essentially a geometry of directions[1] (since all points in the line of sight are visually identical) and that the visual separation of two points (and hence every estimate of size) is to be measured by the angle subtended at the eye[2] by the two points. It follows therefore that:—

> the "proper position" or positions at which the eye should be placed to look at a picture are just those positions relative to the picture at which the angle subtended by any two points in the picture is equal to the angle subtended at the artist's eye by the corresponding points of the original landscape. ....(1.1)

In the case of a photograph (contact print), the proper position of the eye bears to the photo the same relative position as the lens

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[1] A more detailed discussion of the essential features of visual geometry will be found in my paper "Through a Railway Window", *Proc. Ind. Acad. Sci.*, 1938, **7**, No. 2, p. 156.

[2] I am not so heartless as to postulate that all my observers are one-eyed! A single picture can, however, give only a one-eye-view of the universe. To take account of binocular vision the considerations of this paper have to be applied to each of the two pictures (slightly different) corresponding to the two eyes.

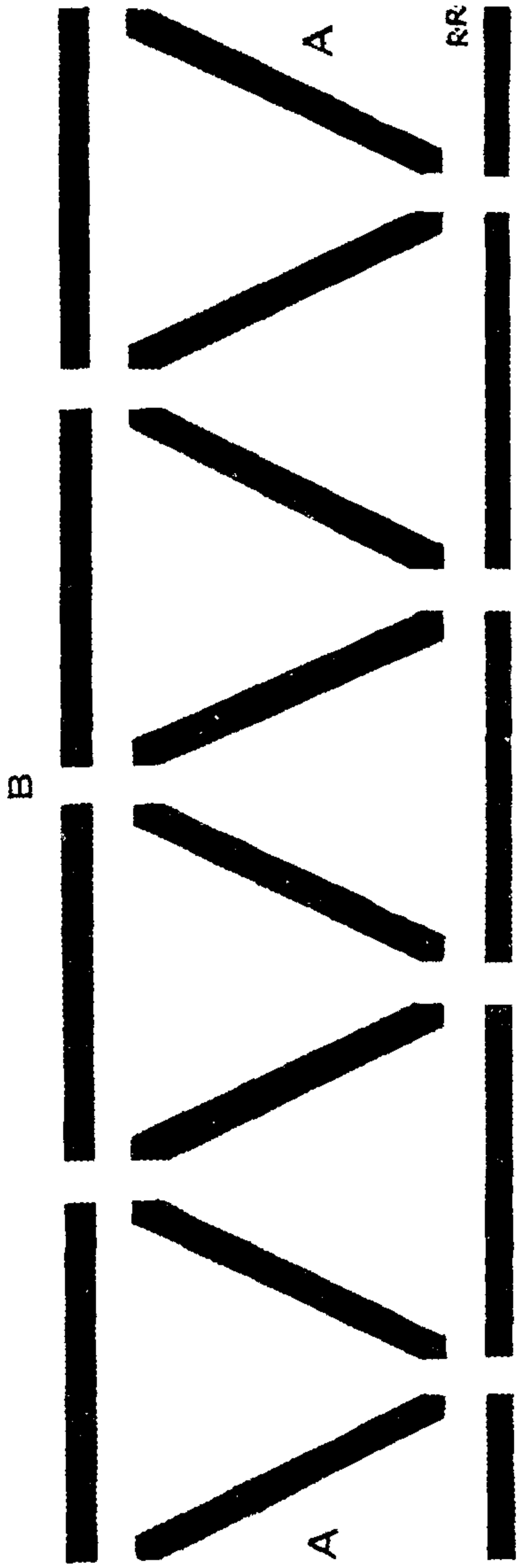

FIG. 1

of the camera to the plate. In the case of a painting, it is the actual position of the eye of the artist relative to the picture; for since it is drawn according to the rules of perspective, the picture may be considered to be the conical projection of the landscape with the eye as vertex of projection.

The questions at issue are:—

(i) Is there only one "proper position"—the one mentioned just now—at which the eye should be placed to get a "correct view"?

(ii) Can such a position be obtained from the data given by the picture itself?

We shall see that the answers to both these questions are in the affirmative.

2. To answer the first query let us assume that there are two possible "proper positions" E_1 and E_2 for the eye of the observer; and let A, B be two points in the picture. By (1.1) the segment AB subtends the same angle at E_1 and E_2, this being the angle subtended at the artist's eye by the two points of the landscape represented by A and B. Hence, if the circle ABE_1 be drawn and rotated about AB, the quartic surface thus generated will pass through E_2. Since this property must hold for every pair of points in the picture, all such surfaces must pass through E_2. It is easily seen, however, that the only common point E_2 is the reflection of E_1 in the plane of the picture. If it is agreed that the observer is to stand in front of the picture and not behind it, there is only one possible position E_1 for the eye which will give a *correct view* of the picture.

Methods for Determining the Proper Position

3. I shall now show that in some cases at least the internal data given by the picture itself will suffice to determine the point E_1, when coupled with our knowledge of what the various patterns represent.

The picture is supposed to be in a vertical plane. The foot of the perpendicular from E_1 on the plane of the picture is called the centre of vision and a horizontal line h drawn through it the "horizon line" corresponding to distant objects at ground level. This line is recognisable in most pictures, but even where it cannot be easily made out, it may be determined if we have in the picture two pairs of lines which are known to represent parallel lines on the ground. Thus suppose we have a quadrilateral pattern ABCD which represents a rectangular object such as a tank, or a tennis court. If the pairs of opposite sides of ABCD meet in P, Q then the horizon line h is PQ. The "proper position" for the eye is in the horizontal plane through h and must be so situated as to project ABCD into a rectangle on any other horizontal plane. Hence the required position lies on the circle described on PQ as diameter. If we have two such patterns which represent rectangles (or one which represents a square) the possible proper positions for the eye of the observer are given as the intersections of two such circles, and will thus be two points E_1 and E_2 which are reflections of each other in the picture plane.

As another example, suppose h has been determined, and also that there is an elliptic pattern Γ in the picture which represents a circular object on the ground or any horizontal plane, such as a circular patch of garden or the mouth of a well. E_1 and E_2 will now be determined as possible vertices which will project h to infinity and Γ into a circle on any horizontal plane. The following construction[3] determines E_1 and E_2:—

Take the pole O of h with respect to the conic Γ and draw two pairs of lines OP, OP′ and OQ, OQ′ through O conjugate relatively to Γ and let them meet h in PP′ and QQ′. Draw two circles on PP′ and QQ′ as diameters in the horizontal plane through h. These will intersect in two points E_1, E_2 which are reflections each of the other in the picture plane. The proper position at which the eye of the observer should be placed is that one which is in front of the picture.

As the main object of this note is to point out the possibility of determining E rather than to give detailed rules for the purpose, I do not elaborate this point further.

A New Optical Paradox

4. Even though the changes in the relative proportions of the parts due to a slight change in the position of the eye often escape attention, it is still of the highest theoretical interest to realise that there is but one position E from which a picture should be viewed so that we may repeat the artist's experience. It is even more startling to find that no other view of the

[3] Filon, *Projective Geometry*, 1935, p. 184.

picture corresponds exactly to the landscape painted by the artist even when the position of the artist is left unspecified; in other words, if the view of the picture from any point F other than E be compared with a painting of the original landscape from every conceivable point of observation—their totality having the same cardinal number as the continuum—not even one of these will agree with the picture.

To prove the last statement, let us assume that the view of the picture from E corresponds exactly to the view of the original scenery from O, and also that the view of the picture from F corresponds to the view of the same scenery from some point P. If A, B, C are three points in the original scenery which are coplanar with O, they are represented in the picture by collinear points *a*, *b*, *c*. Now *a*, *b*, c will appear collinear from any other point of observation F, and hence according to our assumption, A, B, C must be coplanar with P. Thus every plane ABC through O passes also through P. This is obviously impossible if P is different from O.

The reason why the changes discussed above do not readily attract attention is that the mind thinks of a picture in terms of patterns, each of which has a specific significance rather than in terms of the proportions of the various parts. It is not difficult, however, to draw a diagram consisting of disconnected lines in which the patterns are not already drawn and presented ready-made to the eye but are left to be formed by the mind. A change in the proportion of the parts may in this case change the pattern itself so that the picture will be subject to a startling change when the position of observation is altered. I give below such a figure (Fig. 1) which, when placed flat on a table and viewed in the direction AA, presents an appearance similar to the pattern[4] in Fig. 2. However, if the same figure be viewed from the direction BB,

FIG. 2.

the effect of foreshortening is to give it the visual appearance of Fig. 3. To obtain

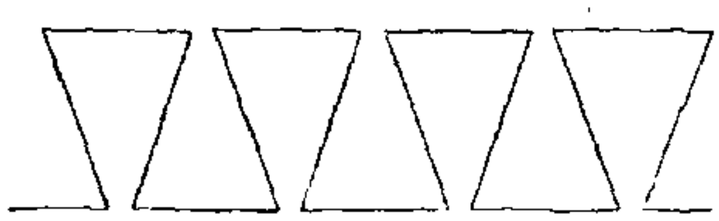

FIG. 3.

satisfactory results, the eye should be at a convenient distance from the picture at a height only slightly higher than that of the table.

[4] That when viewed from a distance a set of disconnected lines may look as if they were joined and formed a continuous pattern has been noticed by the Samskrit Poet and Dramatist Kalidasa: Vide *Abhignana Sakuntala*, First Canto, Verse 9.

OBITUARY

Mr. N. G. Majumdar, M.A., F.R.A.S.B. (1897–1938)

WE regret to announce the sad and untimely death of Mr. Nani Gopal Majumdar, M.A., Special Officer for Exploration of the Archæological Survey of India, who was murdered under most tragic circumstances on 11th of November 1938, near Johi in the Dadu District of Sind. Mr. Majumdar was deputed from 1st of October 1938 for a period of six months to complete a survey of the prehistoric sites of the Indus Valley Civilization which he had so successfully carried out from 1927–31. Soon after starting work in Upper Manchar Lake area, he was shot dead on the morning of the 11th November by a band of armed dacoits which attacked his camp.

Majumdar was the eldest son of Dr. B. Majumdar of Jessore, and was born on the 1st of December 1897. After a successful scholastic career he passed the B.A. Examination with Honours in Sanskrit in the first division of the Calcutta University and was awarded a Silver Medal and a scholarship. In 1920 he passed the M.A. Examination in Ancient Indian History and Culture in the first division and was awarded a Gold Medal for securing the first rank. His post-graduate studies in the newly organised Ancient History Department of the University were devoted to researches in Sanskrit and Epigraphy, and he derived full benefit from his association with teachers of the calibre of the late Mahamahopadhyaya Haraprasad Shastri, C.I.E., and Professor D. R. Bhandarkar. *En passant* it may be mentioned that it was apparently the