these cases experimentally. It has repeatedly been noticed after the inoculation of rabbits that opacities similar to those of interstitial keratitis were produced. It seems probable, he said, that some cases of interstitial keratitis are of tubercular origin. The most difficult question is that of phlyctenular disease. It has been said that these cases are caused by the staphylococcus and that by introducing staphylococci into the sac one can produce phlyctenules, but Dr. Hess is convinced that it has nothing to do with the staphylococcus.

DR. C. S. BULL, New York, said that he approached this subject in the beginning from a skeptical standpoint. He is still largely a skeptic, especially as to the effects of tuberculin as a method of treatment. In some of the cases reported in his paper after an interval had been allowed to elapse since the last injection of tuberculin, he injected hypodermically bichlorid of mercury; in another saturated solution of chlorid of sodium. In every one of these cases he got a general reaction, with rise of temperature, sometimes as much as 2 degrees, showing that there are other substances that will produce this reaction. But, he did not in these get any local reaction.

It is alleged, he said, that one must begin with minute doses, watch the effect and if the general reaction be severe, let the interval between the injections become longer and longer. Some years ago he was using the old tuberculin in a number of cases of supposed tuberculosis as a method of treatment and got absolutely no results. The reactions from the new tuberculin are sometimes very severe, and it can not yet be stated positively whether or not the theory of the opsonic index in these cases is of any value, and in the case of new ideas or the application of new remedies it behooves the conservative man to go slow. It is known that many of these cases, especially those of tubercular iritis, heal without any specific treatment. Therefore, Dr. Bull still stands in the position of a skeptic.

A PARABOLIC REFLECTOR FOR THE ILLUMINATION OF TEST-TYPES.*

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Under present-day considerations it is imperative that artificial illumination be used for the lighting of test-types. The quality of the light produced, its location and distribution with reference to its proper reflection, are matters which have to be observed in order to obtain an even and constant illumination over the whole surface of the card. The ideal condition, that of daylight, which we should endeavor to imitate, is one of nearly perfect diffusion. An even illumination over the whole surface of the test-type card, approximating daylight, can only be obtained with artificial lighting by means of a proper reflecting surface. The most common fault with the lighting of test-types is the improper care in the selection of the reflector and the position of the lamps. The reflector has been installed and selected in a haphazard way, and the resulting illumination left to be what it may. As a consequence, with installations of this kind there are spots and streaks of light on the surface of the card, plainly indicating the location of the lamps, and the obvious difference of intensity on the portions of the card farthest removed from the light source. Believing that some attempt ought to be made to design a reflector based on exact scientific principles, so as to give uniform illumination under a simple law, the following problem was undertaken. The principle involved is the reflection from a paraboloid of revolution, viz., a beam of parallel rays falling on a paraboloid or light emanating from the focus of the parab-

olid is reflected by the paraboloid as a beam of parallel rays. It is to be remembered that only when the luminous object at the focus is a point will rays diverging from it be reflected in a parallel beam. The nearest approach to parallelism occurs with the incandescent light, in which case the illuminated surface is very small. As a basis for calculation, one must first determine the point on a plane surface where the illumination is a maximum from the law, that the illumination of a plane surface by a luminous point varies directly as the cosine of the angle of incidence of the rays and inversely as the square of the distance of the luminous point from the surface.

Let P (Fig. 1) be the luminous point, at a dis-

Fig. 1.—Diagram showing illustration of a plane by a luminous point.

tance a above the surface AD. To find the point B where the illumination is a maximum. By above law,

$$I_{ll} = K \frac{x}{(a^2 + x^2)^{3/2}}$$
where K is some constant.

$$\text{Let } u = \frac{Kx}{(a^2 + x^2)^{3/2}}$$

For maximum value $\frac{du}{dx} = 0$,

$$\frac{du}{dx} = K \frac{(a^2 + x^2)^{3/2} - 3/2 x (a^2 + x^2)^{1/2} (2x)}{(a^2 + x^2)^3} = 0,$$

$$\text{or } K \frac{a^2 + x^2 - 3x^2}{(a^2 + x^2)^{5/2}} = 0,$$

$$\therefore x = \frac{1}{\sqrt{2}} a. (1)$$

Let AC = 2.5 ft. (average length (Fig. 2) of card in use). Make AD = 3.25 ft. The value is arbitrary, but found to be the best value, as the longer CD is, the greater would be the length of BF. The value of CD was taken as small as possible and still have the card AC in full view of the patient's eye. Substituting the values of x and a in (1), we have:

$DF = \frac{1}{\sqrt{2}} (AD) = 2.31$ feet. The light is to be placed at F which is to be the focus of the parabola. Let FK = $1/3$ ft., then FM = $2/3$ ft. (law of a parabola).

By experimenting it was found that the best distance for FK, the distance from the focus to the vertex, was 4 inches, or $1/3$ ft. If FK were much smaller, then the width of the reflector would be too small, and a larger value of FK would make the width unnecessarily large.

$$y^2 = 4px \text{ (the parabola).}$$

Therefore $4/9 = 4p (1/3)$, therefore $4p = 4/3$ and $y^2 = 4/3x$, is the equation of the parabola with focus at F.

The width of the parabola must be as great as CG and from similar triangles ACG and DBF, the value of

*Read in the Section on Ophthalmology of the American Medical Association at the Fifty-eighth Annual Session, held at Atlantic City, June, 1907.

CG = SR is found to be 1.9 ft., or approximately 2 ft. From the equation of the parabola $y^2 = 4/3x$, when $y = 1$, $x = 3/4$, that is KL = $3/4$ ft. and FL = $5/12$ ft. The focus is $(1/3, 0)$, and LK = $3/4$ ft., and LS = 1 foot.

Having determined on the kind of reflector and the illuminant, the next step in the problem is to find the distribution curve, in order properly to place the reflector so as to secure uniform illumination on the test-card. To the kindness of Mr. J. R. Cravath, an illu-

Fig. 2.—AC, card; SKR, reflector. Scale $\frac{1}{4}$ in = 1 foot.

minating engineer, I am indebted for the following data with reference to the light distribution from an ordinary commercial parabolic reflector, using an incandescent lamp: The curve in Fig. 3 is Fig. 16 B, taken from a paper on "Data on Indoor Illumination," by Mr. J. E. Woodell.¹ This gives a photometric curve, showing the light distribution about one of the common parabolic reflectors known as the "D'Olier," No. 35. The reflector constructed on the foregoing calculations will not give a

Fig. 3.—Photometric curve showing light distribution about one of the common parabolic reflectors known as the "D'Olier" No. 35.

distribution of light similar to this in all planes, but it is safe to assume that in a plane at right angles to its axis the distribution of light is somewhat similar to that obtained from the D'Olier reflector shown in Fig. 3. In order properly to understand the theory of placing

1. Read at the October, 1906, meeting of the Illuminating Engineering Society.

reflectors so as to secure an even illumination of test-cards, take an example, using the photometric test shown in Fig. 3. The dotted curved line which gives the distribution of light in a vertical plane at right angles to the lamp axis comes nearest to representing the conditions with the reflector constructed. The characteristic of this reflector, as well as of many other concentrating reflectors, is that the maximum candle power is obtained directly underneath the lamp when the lower edge of the reflector is placed in a horizontal position. The candle power rapidly falling off as the angle from the vertical increases.

This fact is of very great value in enabling us to place reflectors so as to illuminate test-cards and pictures evenly. It is of the utmost importance to have a uniform illumination over the entire surface of the test-card, because if the top is more highly illuminated than the bottom there is a possibility that it will affect the acuity of vision. In fact, if the top of the card is more brightly illuminated than the lower part, the lower part seems dark by contrast, even though the illumination on the lower part might be ample if the brightly illuminated upper part were not in view. Taking now the photometric curve of the reflector, as shown in Fig. 3,

Fig. 4.—Curve showing distances in feet at which an equal illumination in foot candles would be produced by a "D'Olier" parabolic reflector. AB is proper position of card. Scale $\frac{1}{2}$ inch = 1 foot.

the problem is to determine the position in which to place the reflector so as to illuminate the test-card uniformly, and at the same time have it in a position where it will not be between the patient and the card, and also where the light will not shine in the patient's eyes. This can easily be done, for the reason that the illumination

on any surface is according to the formula $I = \frac{cp}{d^2}$ where

I equals the illumination on the surface in foot candles, cp equals the candle power of the ray, and d equals the distance of the surface from the source of light. Now it will be apparent at a glance that the lamp in such a reflector can be so placed with reference to a test-card that the rays of maximum intensity from the reflector will fall near the bottom of the card, while the rays of less intensity will fall near the top, and we can thus approximate uniform illumination of the card, even though the top of it may be much nearer the source of light than the bottom.

The proper position of the source of the light with

reference to the card can be determined by trial in a few seconds, but it is also interesting to work out the problem mathematically and see how nearly theory will check up with practice. To determine the proper position of the reflector by calculation, a curve of equal illumination is plotted for the reflector, as proposed by Mr. E. C. White² in a paper on "Application of Photometric Data to Indoor Illumination." Let us take the right-hand side of the dotted curved line in Fig. 3. Fig. 4 is a polar coördinate curve in which the distance from the center represents the distance in feet at which an even illumination in foot candles would be produced by a reflector giving a photometric curve, such as is shown in Fig. 3. The plotting of such a curve is a simple matter when we have the photometric curve as a basis, since the equal illumination curve is determined by the formula $d = \sqrt{\frac{cp}{I}}$ where d equals the distance in feet of the surface illuminated from the source of

Fig. 5.—Sketch showing reflector in position on wall in its relation to test type.

the light, cp equals the candle power of the ray, and I equals the illumination in foot candles. If I is taken as a constant quantity, then $d = \sqrt{cp}$ and the equal illumination curve represents simply the square root values of the photometric curve. Fig. 4 is plotted on a scale which gives the distances in feet from the lamp at which a uniform illumination of 3 foot candles, this value being assumed for purpose of calculation, would be obtained from the reflector shown in Fig. 3. Having this uniform illumination curve, we can at once draw in parallel to the curve the proper position or angle for the test-card. The proper position of the test-card is thus represented by the line AB in Fig. 4. As the line AB is at an angle of about 25 degrees from the vertical, and since the test-card is always hung vertical, it is to be noted that the reflector should be tipped at an angle of about 25 degrees from the horizontal, and that the top of the test-card should be about 15 degrees below a horizontal plane passing through the lamp. This

corresponds very closely to the position found to be the best with the reflector described above.

The reflector (Fig. 5) can be made of either copper, galvanized iron or tin. The reflecting surface is coated with aluminum paint, and on either side of the reflector, at the focus of the parabola, is placed an ordinary electric lamp socket. A piece of gas piping, 9/16 of an inch in diameter, with a thumb-screw attachment at the reflector end and a wall bracket at the other end, holds the reflector in place. The wires from the electric light socket are run through the piping, so as to be out of the way, and joined together with a plug for connection.

I wish to thank Messrs. F. A. Hardy and Company for their assistance in the construction of the reflector.

DISCUSSION.

DR. WILLIAM M. SWEET, Philadelphia, said that the reflected light is preferable to direct light. With a reflected light an illumination is obtained that does not tire the eyes.

DR. MORTIMER FRANK, Chicago, said that with this reflector one can get any candle power from 3 to 50. The photometric curve in the paper was calculated for 3 candle power.

A CASE OF FATAL HEMOLYSIS FOLLOWING DIRECT TRANSFUSION OF BLOOD BY ARTERIOVENOUS ANASTOMOSIS.*

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AND

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Since the report by Crile¹ in November, 1906, of several cases of severe anemia in which direct arteriovenous anastomosis and transfusion of blood was made use of in the treatment of the anemia the method has been tried, at times with favorable results and at others without much apparent change in the course of the disease.² No serious ill effects have been reported so far as having been caused by this method of treatment, and we, therefore, believe that the following report of a case of fatal hemolysis after two transfusions of blood from different individuals should be placed on record in order to show that the procedure is not without danger and that until our knowledge of the hemolytic action of different sera is more exact it should be used with caution.

Patient.—C. J. G., aged 33, white, married, born in England. Referred April 16, 1907, by Dr. Frank Harris, Trenton, N. J., to the Hospital of the University of Pennsylvania, service of Dr. Stengel. Complained of bleeding from gums.

History of Present Illness.—Some time before October, 1906, it was noticed that the patient's complexion, though naturally pale, was becoming paler, though he had been in apparently good health up to that time. Tinnitus aurium, and a very slight intermittent nightly bleeding from the upper gum began at this time. He had been able to be about on his feet, but had gradually grown weaker during this period. Dizziness, palpitation of the heart, and pains in legs were occasionally present. He had gained six pounds in weight in the last ten weeks; for a time he noticed that his vision was dim. The bleeding from the upper gum was at first noticed at night only, but it gradually increased in severity, occurring day and night for ten weeks preceding his admission, though intermittently, and during the last four days preceding admission con-

2. Read before the October, 1906, meeting of the Illuminating Engineering Society.

* From the William Pepper Laboratory of Clinical Medicine.
1. THE JOURNAL A. M. A., Nov. 3, 1906.
2. Watts: Johns Hopkins Med. Bul., May, 1907.