The effects of irradiation are different in different persons, and they are not always the same in the same person.

INTENSITY OF LIGHT.

It is estimated that 5,500 wax candles would be required to illuminate a surface twelve inches distant as strongly as it would be illuminated by the sun, while the light of a single candle at a distance of 126 inches would equal that of the full moon. The relative intensities of the light of the sun and moon are as 600,000 to 1.

Light from different sources can be compared and measured by the photometer, several forms of which have been devised. The usual way of determining the intensity of light from any source is to compare it with a standard of illumination, a "sperm candle weighing $\frac{1}{6}$ pound, and burning 120 grains an hour," being commonly used for this purpose. Thus it is that a gas flame or an electric lamp is rated at a certain candle power.

Owing to the divergence of luminous rays, the intensity of light decreases rapidly as the illuminated surface is removed from the source of light. This may be readily shown by holding a screen, say 12 inches square, half way between a lamp and the wall. The shadow of the screen on the wall will be 24 inches square. If the light falling on the screen be allowed to proceed to the wall, it will cover the area which was before in the shadow of the screen. This area being four times as large as that of the screen, it is seen that the light which was received on the screen must, when distributed upon a surface four times as great, be reduced in intensity to one-fourth of that falling on the screen. It is thus shown that the intensity of light is inversely as the square of the distance; that is, when the distance of the illuminated surface from the source of light is doubled, it receives one-fourth the amount of light; at three times the distance, one-ninth, and so on.

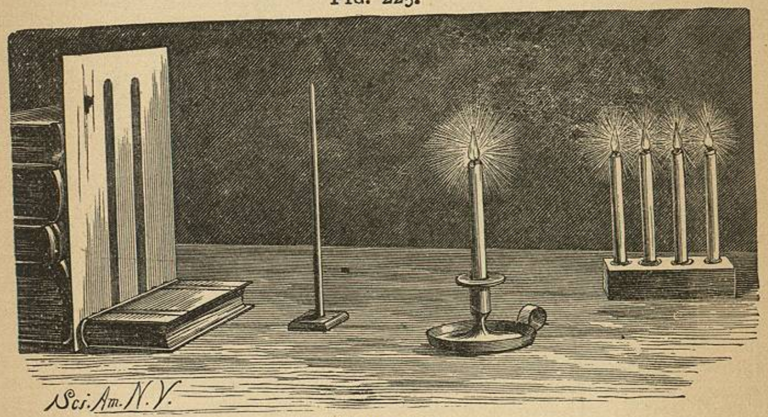
The law of inverse squares may be demonstrated by the extemporized photometer, shown in Fig. 225. In front of a white cardboard screen is supported an opaque rod. The sources of light to be compared are arranged so as to cast

separate shadows of the rod on the screen. If the sources of light when equally distant from the screen form shadows of the same depth, their illuminating power is the same.

When, however, the intensities of the two lights differ, the shadows will differ, and it will be necessary to remove the stronger light to a greater distance to secure shadows of equal depth.

In the experiment illustrated, the single candle being distant one yard from the screen, it is found that the group of four candles must be placed two yards from the screen

FIG. 225.



Photometer.

to secure shadows of the same intensity. Nine candles would require removal to a distance of three feet, and so on. All the candles of the group must be in the same line in the direction of the rod. The eye is able to detect a difference of one-sixtieth in the values of the shadows, provided the lights be of the same color.

OPTICAL ILLUSIONS.

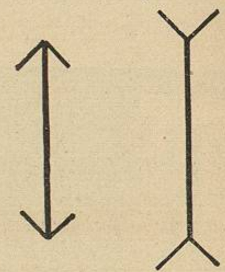
It is sometimes difficult, even for the practiced eye, to accurately estimate distances and dimensions, and to correctly appreciate forms. Very much depends upon the relation of the object viewed to surrounding objects. Two straight parallel lines of equal length would be appreciated by the eye in accordance with the facts, but when a light line is drawn perpendicular to a heavy one of the same length, as in Fig. 226, the eye at once accords the greater length to the lighter line.

In the case of two like parallel lines joined at the ends in one case with outwardly convergent lines and in the other with outwardly divergent lines (Fig. 227), the apparent difference in the length of the lines is considerable.

It often happens in engineering drawing that a sectional

Fig. 226.

Fig. 227.



view will present some curious distortions, which give the drawing the appearance of being incorrect, but which in reality are only illusions. Fig. 228 is an example taken from such a drawing.

In Figs. 229 and 230 are shown examples of line combinations in which series of oppositely disposed oblique lines are joined to parallel lines. In Fig. 229 the latter appear to bend outwardly and in Fig. 230 they seem to bend inwardly;

Fig. 228.

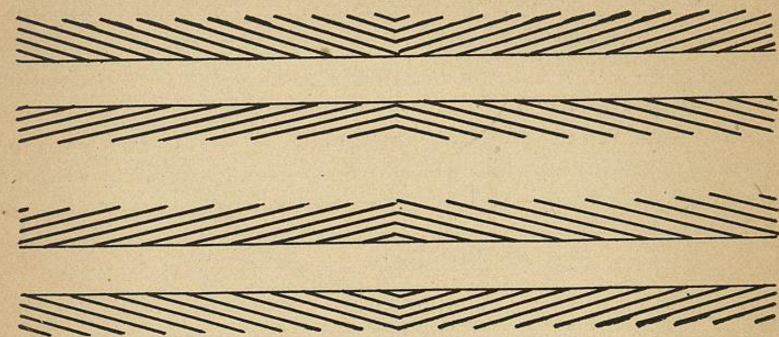
Illusion from Engineering Drawing.

but by looking at the diagrams lengthwise, or through partly closed eyes, the parallel lines appear as they really are.

A more marked example of the effects of oblique lines on a series of parallel lines is shown in Fig. 231.

In Fig. 232 the single oblique line extending above the

Figs. 229 and 230.

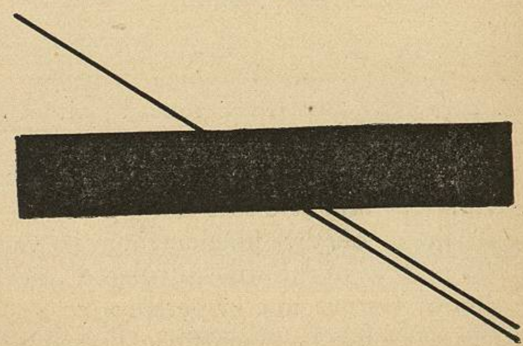


Apparent Deviation by Oblique Lines.

Fig. 231.

Parallel Lines appearing Alternately Convergent and Divergent.

Fig. 232.



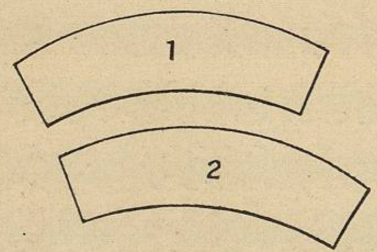
Apparent Displacement of a Single Oblique Line.

black bar appears to be a prolongation of the lower oblique line below the bar. That such is not the case may be shown by placing a card against the line above the bar or sighting it endwise. It will thus be shown that it is a prolongation of the upper of the two lines below the bar.

The curious optical illusions shown in Figs. 233 and 234 were published some time since in a French scientific journal.*

Fig. 233 represents two pieces of paper or cardboard cut into the shape of arcs of a circle. Which is the larger of the two? To this the answer will certainly be: "It is No. 2." But if No. 1 be placed under No. 2, the answer will be just the reverse. The fact is that both are exactly of the same size, as may be seen by measuring them, or by laying

FIG. 233.



Curious Optical Illusion.

one upon top of the other. When the two figures are placed so close together that their edges touch, the illusion is still greater.

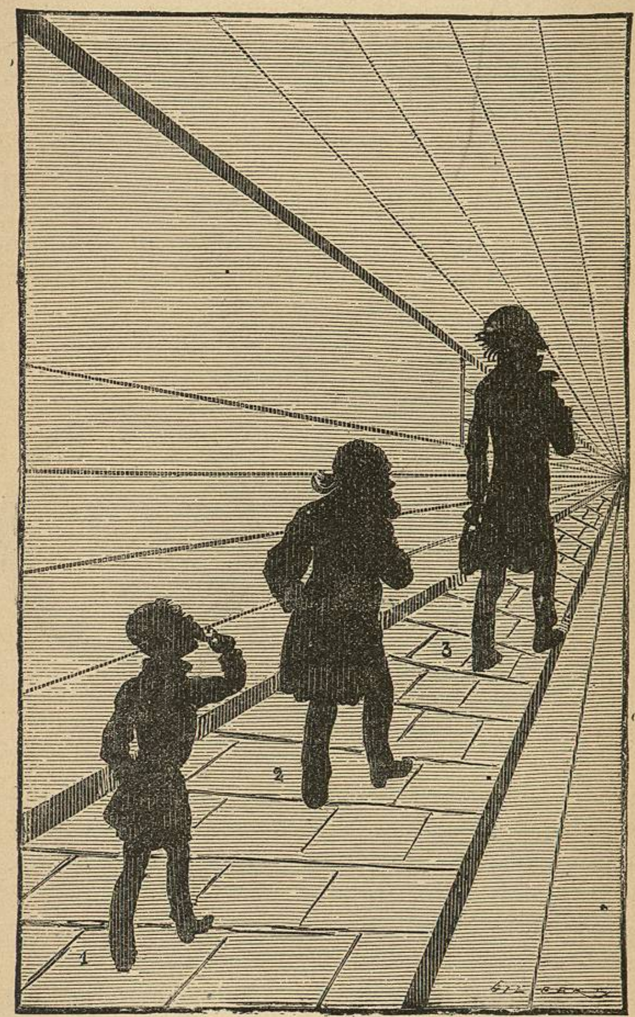
Which is the tallest of the three persons figured in the annexed engraving? If we trust our eyes, we shall certainly say it is No. 3. But if we take a pair of compasses and measure, we shall find that we have been deceived by an optical illusion. It is No. 1 that is the tallest, and it exceeds No. 3 by about 0·08 inch.

The explanation of the phenomenon is very simple. Placed in the middle of the well calculated vanishing lines, the three silhouettes are not in perspective. Our eye is accustomed to see objects diminish in proportion to their

* *La Nature.*

distance, and, seeming to see No. 3 rise, concludes therefrom that it is really taller than the figures in the foreground.

FIG. 234.



An Optical Illusion.

The origin of the engraving is no less curious than the engraving itself. It serves as an advertisement for an English soap manufacturer, who prints his name in vanishing perspective between each of the decreasing lines, and places the cut thus formed in a large number of English and American newspapers.

Here is a row of letter S's and one of figure eights, taken at random.* At a casual inspection the reader might say the letters were symmetrically made—that is, the top and bottom lobes of the figures and letters the same size—though upon a close inspection he would either say that it was

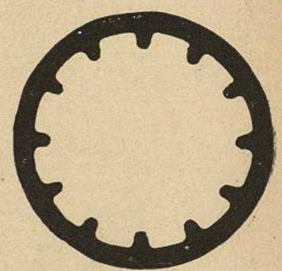
S S S S S S S

8 8 8 8 8 8 8

doubtful whether any difference existed or he would notice the true relation that exists, the top lobe being the smaller.

Fig. 235.

Fig. 236.



Professor Thompson's Optical Illusion.

Let him, however, turn this page upside down, and the most cursory glance possible will show him their shapes, and the dissimilarity between the upper and lower halves will strike him with astonishment if he never tried the experiment before.

One of the most interesting of optical illusions is that devised by Prof. Silvanus P. Thompson. This is illustrated by Figs. 235, 236, and 237. The first of these figures is composed of a series of concentric rings about a twentieth of an inch wide and the same distance apart. If the

* Mr. G. Watmough Webster, in *British Journal of Photography*.

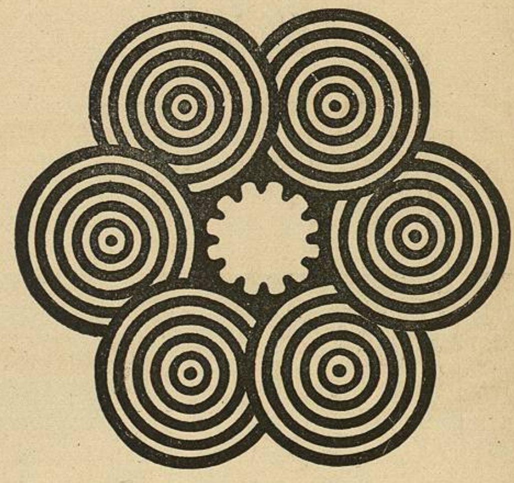
illustration is moved by hand in a small circle without rotating it, *i. e.*, if it is given the same motion that is required to rinse out a pail, the circle will revolve around its center in the same direction that the drawing moves.

A black circle (Fig. 236) having a number of equidistant internal teeth is provided for the second experiment, the drawing being moved in the manner above described, but in a contrary direction.

In Fig. 237 is shown a combination of the toothed and concentric circles.

By means of photographic transparencies Mr. Thomp-

Fig. 237.



son has shown these figures on a screen on a large scale, and by moving the plates as before described, the figures on the screen were made to rotate.*

When viewed in a microscope under certain conditions, the minute markings of some of the diatoms appear as hexagons, while under other conditions, and with a first-class objective, they appear spherical.

M. Nachet, the French microscopist, has published a

* A. O., on p. 133, vol. 41, *Scientific American*, furnishes an explanation of the phenomena of these circles.