A PROPERLY LIGHTED DINING ROOM.
The incandescent gas mantle is hidden under the dome, which is hung just low enough for the eye to escape the glare. The general illumination of the room is pleasing, but the photo is dark because the colored glass of the dome cuts off the actinic rays.

LEARNING TO USE LIGHT

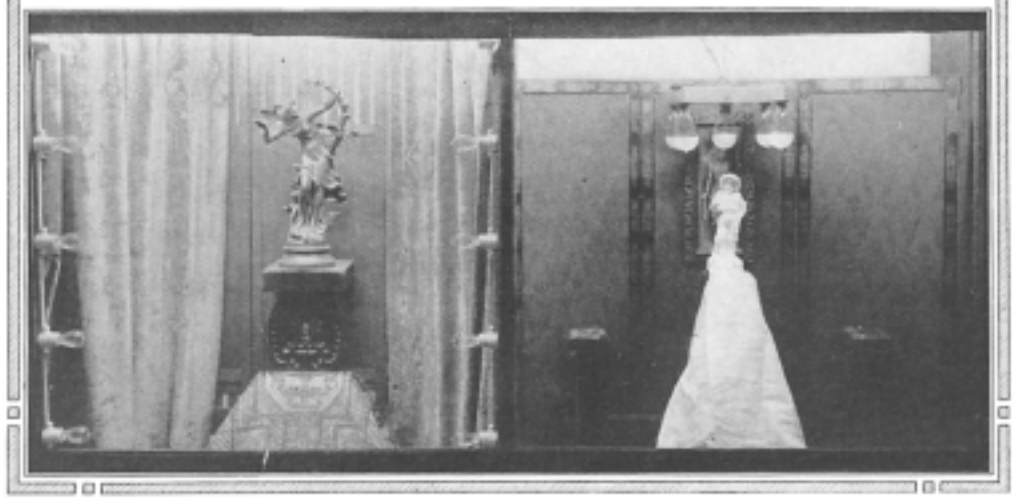
By

CHARLES FREDERICK CARTER

SOMEBODY built a theater not very long ago on North Avenue in an outlying section of Chicago. With the usual commonplace vaudeville program at the usual popular prices the new playhouse soon achieved a handsome deficit. Then the sheriff came.

After the obsequies the new owner sent for an illuminating engineer, who was turned loose in the theater with leave to go as far as he liked in reconstructing the lighting arrangement. When the illuminating engineer had finished the job to his entire satisfaction the doors were reopened on the same old show at the same old prices. Reckless adventurers who risked their money on the first night not only sat through the performance but they returned the next night with recruits, who in their turn brought others. Soon the treasurer had to have an assistant and the doorkeepers contracted ticket takers' cramp.

CONVENTIONAL METHOD OF LIGHTING A SHOW WINDOW.
The glare from the naked lights hurts the observer's eyes and obscures the goods displayed.

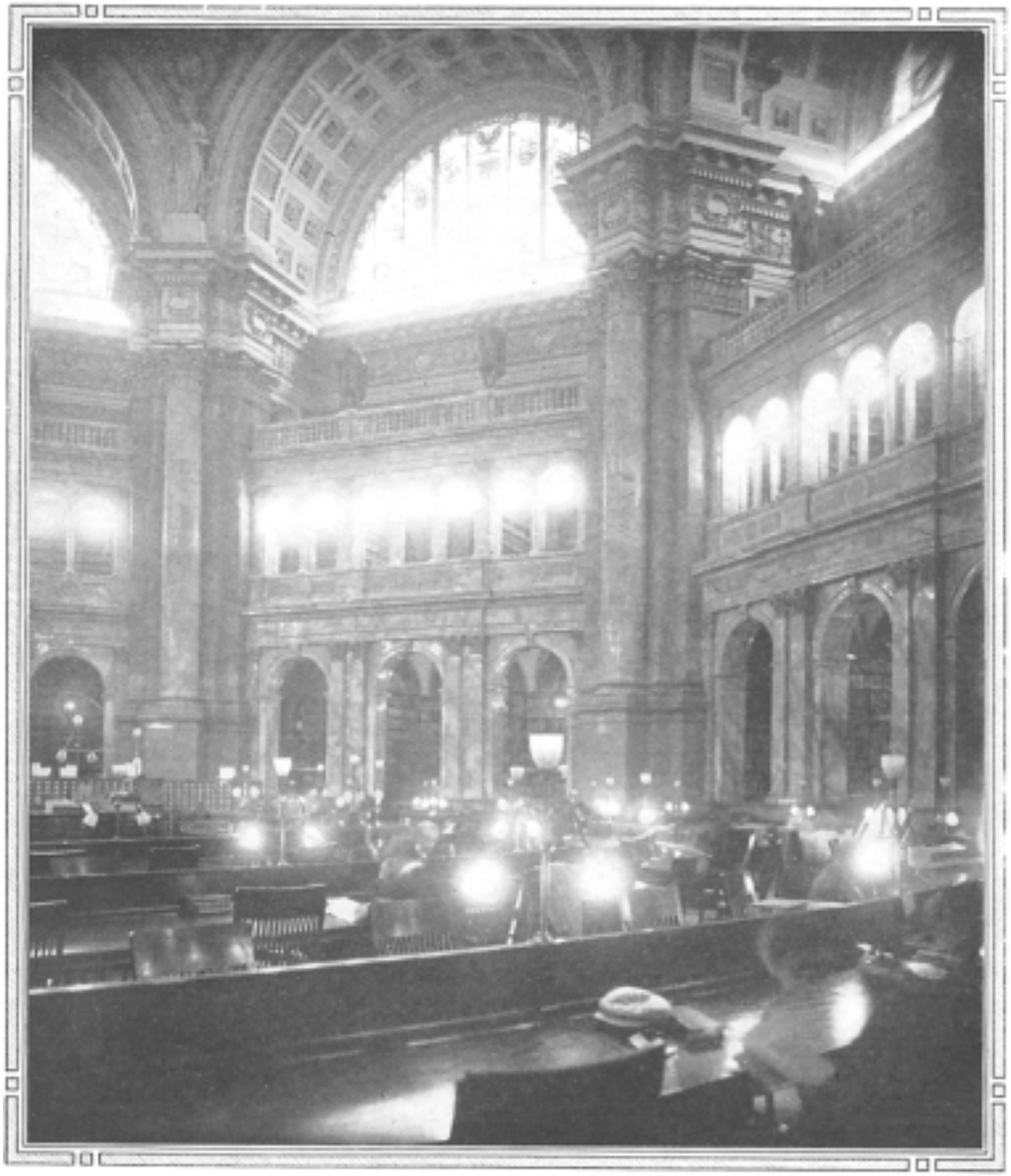


THE SAME WINDOW PROPERLY LIGHTED.
The current has been turned off from the exposed lamps and the window illuminated from a source entirely concealed from the eye.

Now the manager is planning an automobile trip in Europe.

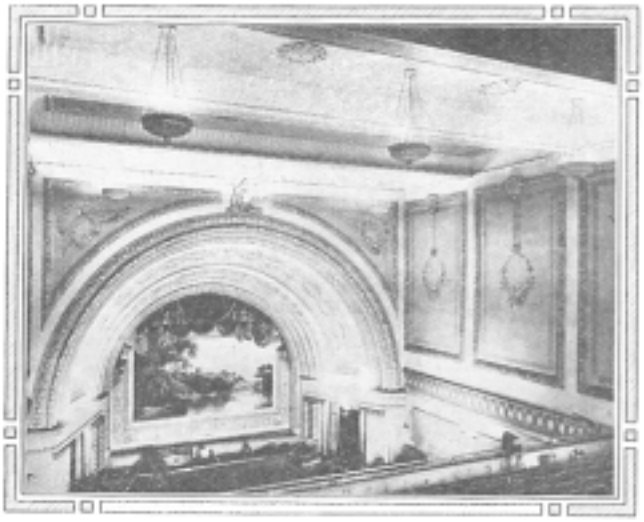
Originally this theater had the usual direct lighting system, which is to say it contained a lot of naked incandescent electric light bulbs scattered around the place with about as much intelligence as a Brule Sioux might be expected to display in their arrangement. Many of them were disposed so that their light struck the audience in the eyes, just as many lights do in more pretentious places of public assembly today. It has been found that a single incandescent light in the range of vision reduces the power to see at least twenty-five per cent. Naked lights more than twenty-five degrees outside the direct line of sight do not interfere with visual acuity, but lights of high intensity even farther removed from range will make people restless and irritable, as any one can testify from his own experience.

The illuminating engineer took down



"THE AMERICAN CHAMBER OF HORRORS."
Reading Room in the Congressional Library at Washington. No matter where the reader sits the glare from several naked Tungsten incandescent lights is bound to hit him full in the eye. A most impressive example of the way not to light a reading room or any other place of public assembly.

every exposed light in the theater, and although the architectural arrangement made it impossible to attain ideal results, he managed to hang the lights so that none could be seen from any part of the auditorium. Instead of a direct glare the light was thrown against the ceiling from which it was reflected in a soft diffused glow at a carefully calculated intensity that caressed and soothed tired eyes like summer zephyr. Every one who came in gave a sigh of relief and just relaxed rather than sat down. The audiences thought they were witnessing the supreme efforts of transcendant genius on the stage when, as a matter



THIS PHOTO, TAKEN BY THE LIGHT FROM THE EYE, BRINGS OUT EVERY DETAIL.

It helps to explain why the Plaza Theater, Chicago, was rescued from failure as soon as this method of illuminating was installed.

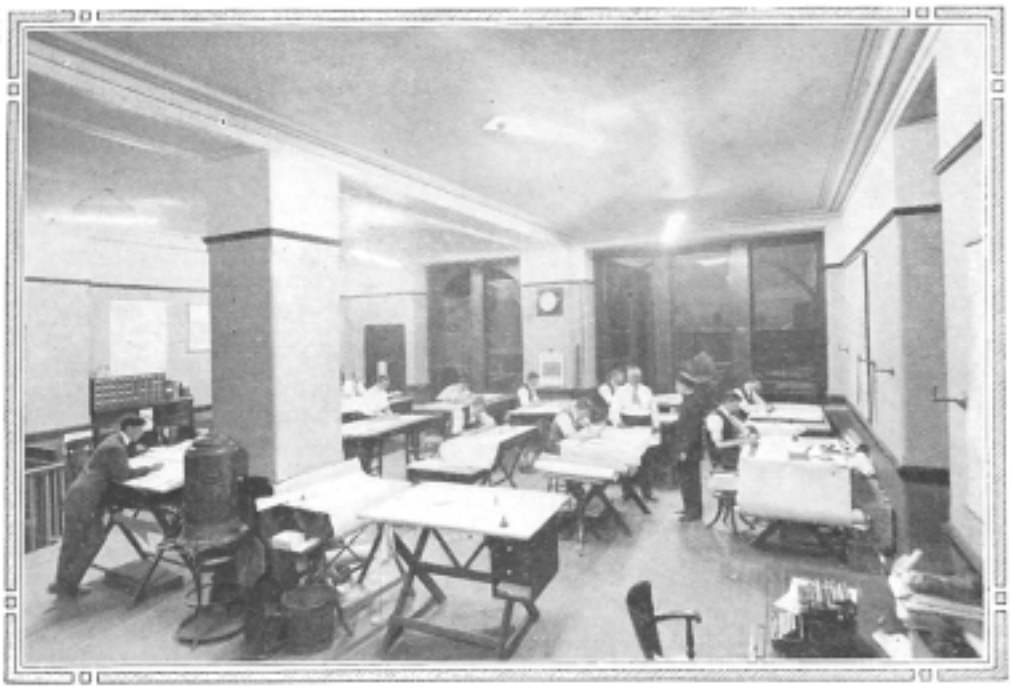
modulated light that put them in such fine humor. It was the new illuminating engineer, not the ancient soubrette, who transformed a hopeless failure into success in its most aggravated form.

This is a fair example of what the illuminating engineers are doing whenever they get a chance. It may be added that the chances are coming along about as fast as they can be taken care of. While it is the newest of the learned professions illuminating engineering is attracting more attention than all the rest combined just now. Although the world's first Illuminating Engineering Society was organized in New York as recently as January, 1906, it already has more than a thousand

of fact, it was merely their outraged nerves being soothed by scientifically

HALLWAY OF THE NEW PUBLIC SERVICE BUILDING, NEWARK, N. J., ILLUMINATED BY MOORE TUBES.

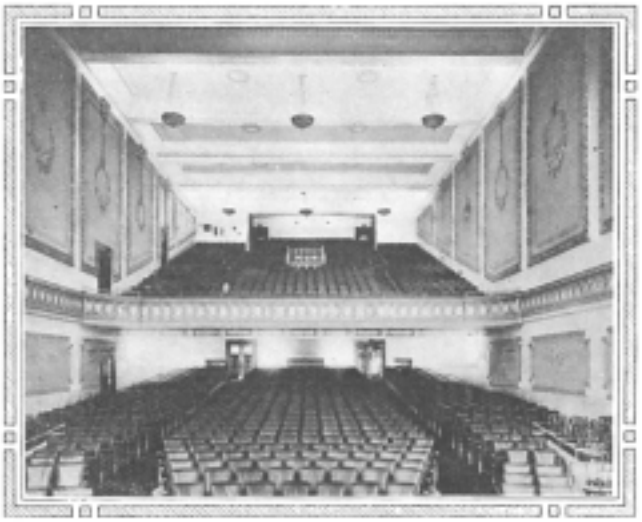
The Moore tube is better than daylight for matching colors.



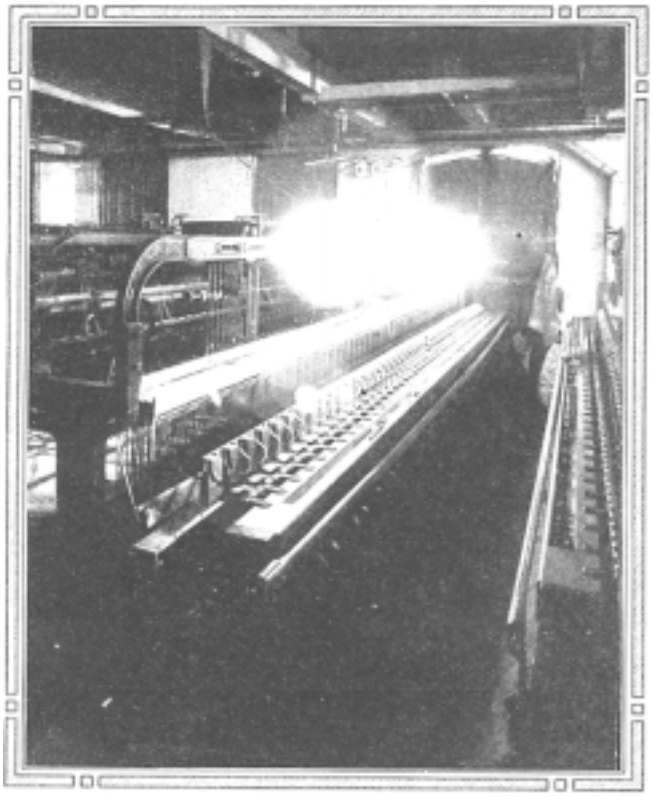
DRAUGHTING ROOM PROPERLY LIGHTED.
Cooper-Hewitt lamps are better than daylight for some purposes. Note the unusual detail.

members, every one of whom seems to be as busy as the proverbial nailer. The parent society has its headquarters in the handsome building which good St. Andrew Carnegie bestowed on the engineering profession in general, while there are flourishing sections in Boston, Philadelphia, Chicago and elsewhere. England followed our example by organizing the first illuminating engineering society in Europe in 1908. These apostles of the new gospel of light are creating such a furore that when Johns Hopkins University, coöperating with the Illuminating Engineering Society, arranged a series of thirty-six lectures on the subject last summer the average attendance was two hundred and fifty.

It certainly was high time for the illuminating engineer to appear. The capital invested in the manufacture of gas in the United States amounts to $1,600,000,000, while that invested in the



UNDER THE BALCONY DIRECT LIGHTING IS STILL USED IN THE PLAZA THEATER.
Note the difference between this part of the interior and the remainder, which is illuminated by the indirect system.



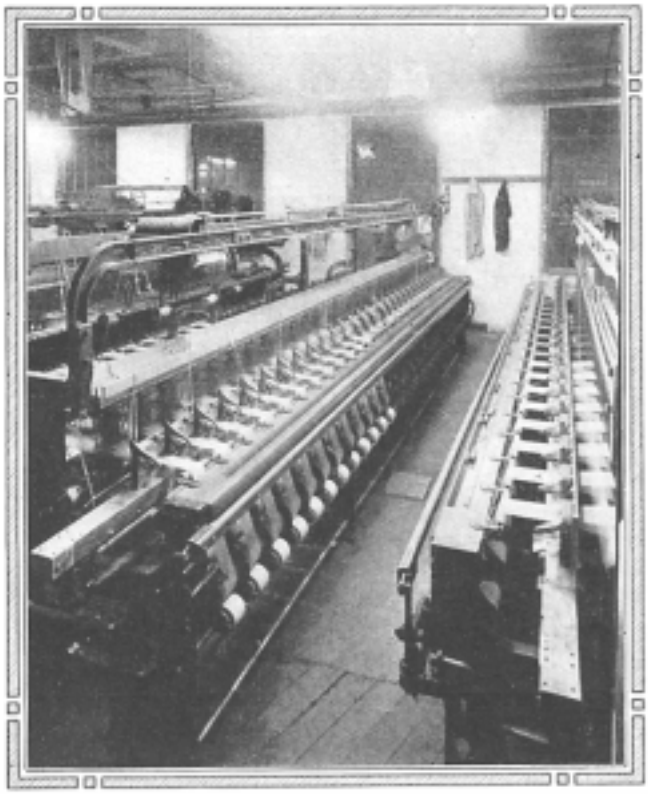
IMPROPERLY LIGHTED SILK RIBBON LOOM IN A PATERSON, N. J., MILL.
Ordinary incandescent lights by which the operatives work all day were used to take this photograph. Compare with illustration opposite

production and distribution of electric light is $2,000,000,000. Of the vast sum expended annually for artificial light twenty-five million dollars, at the most conservative estimate, is wasted; for while there has been no lack of able electrical engineers and gas engineers, their efforts have been confined exclusively to the economical production of gas and electric current. Their concern ended when gas of good quality was delivered at the burner and current at the lamp socket. The illuminating engineer devotes his attention to the use of light in contradistinction to its production.

Illuminating engineering is rather a complex art, for it embraces architecture, decoration, color effects, optics, physics, physiology, and psychology in addition to the commercial aspects of lighting. While much remains to be learned, the progress already achieved makes recent ignorance of the elementary principles of lighting seem appalling. As recently as two years ago the only thing considered was the specific density of illumination, regardless of anything else. But now it is understood that the quality and direction of light, quite as much as the quantity, have a most important effect upon the eye. The color of the light, too, is carefully considered in adapting illumination to the specific purpose for which it is required. There is a great difference in the color of artificial lights. The old carbon filament incandescent lamp, the flaming arc and the plain gas flame give a yellow light, the mercury lamp a greenish light, the tungsten incandescent lamp a so-called white light, while the Moore vapor tube approximates daylight so closely that it can be used in matching colors with perfect satisfaction. Each form of light is adapted to some particular use. It is the business of the illuminating engineer to select the right light for each purpose and see that it is used in the proper way. The problem of artificial lighting, as defined by Dr. C. P. Steinmetz, the distinguished electrical engineer in a recent address before the Illuminating Engineering Society, comprises the consideration of the source of light, the flux of light issuing from it, the distribution of the light flux in space, or the density of the light flux in space, particularly at the objects illuminated, the density of the light flux reflected from the illuminated objects and the effect produced thereby on the eye. This latter consideration leaves the field of physics and enters the realm of physiology, which is not as amenable to exact experimental determination as the former, hence available knowledge is far more limited than in physical science. One of the main difficulties of illuminating engineering is that

it embraces two different sciences, physics and physiology.

The easiest way to get an illustration of Dr. Steinmetz's definition is to walk along a retail street in any good sized town until you come to a show window lighted according to the principles of the new art. You will not need to be told when you come to it. Instead of a fringe of naked incandescent lights all around the window obscuring everything in it and hurting your eyes so that you avert your head and hurry past, the sources of light are completely concealed. The only light coming from the window is that which is reflected from the objects viewed, and that is the proper way. No illumination is now considered satisfactory if the eye is exposed to the direct rays of a bright light, for this is both uncomfortable and inefficient.



THE SAME LOOM PHOTOGRAPHED BY THE COOPER-HEWITT LIGHT.
The human eye is just as sensitive to the difference in lighting as the lens of the camera.

In these days when every one has so much to say about efficiency, illuminating engineering is of the first importance. In order that employes may work rapidly and well they should be protected from needless fatigue. About the quickest and surest way to tire out a roomful of people is to flood the room with a uniform light at high intensity. Where work is to be done by artificial light the general illumination should be moderately low with local lights of higher intensity above the work bench or desk. And, by the way, the average desk light or reading lamp is too low.

The color of the light, too, plays an important part in tiring people out. Fatigue occurs far more quickly with orange and yellow rays at high intensities than from green and bluish green light like that from the mercury vapor lamp. Nothing equals the bluish white of diffused daylight.

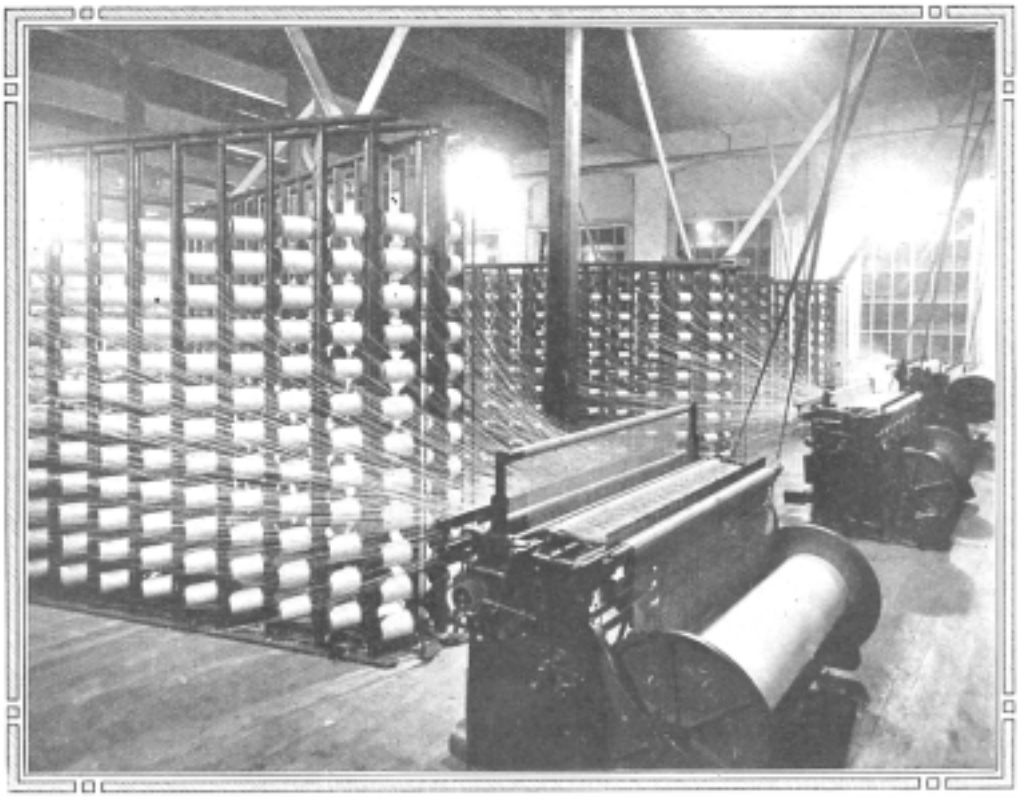
In other ways color plays an important part. If there were such a thing as an untidy housekeeper she would doubtless be glad to know that colors resulting from age and dirt may be obscured if not altogether hidden by using a reddish yellow light like that from a carbon filament electric light or a candle, for these rays harmonize with the typical yellow or brownish shade of dirt. The bluish green mercury light, on the other hand, exaggerates blemishes and dirt, while the white arc light is nearly as bad. Mercury and arc lights are also too harsh and disagreeable for use in the ball room. There the yellow carbon filament is the best.

Shadows also have an important part to play. In fact one of the principal aids in distinguishing objects is the differences in brightness. If there were no shadows but only a perfectly diffused illumination of high intensity it would be hard to see clearly. In order to have

shadows there must be directed light from one or a number of sources and not merely diffused light coming from all directions. There must be enough directed light to mark the edges of objects by shadows and also enough diffused light to enable one to see clearly in the shadows. The directed light should come from above at a considerable angle with the horizontal so as to limit the length of the shadows. There are cases, however, when a combination of directed and diffused light will not answer. In a flour mill or a foundry, for example, where everything is of the same color diffused light would be practically useless; but in a draughting room where all the objects requiring distinction are in one plane a directed light casting shadows would be equally objectionable.

To light the home with comfort and economy requires a combination of concentrated illumination of fairly high intensity at the dining or reading table with a general illumination of low intensity. The lighter the walls and ceiling are the more light they reflect to give the required diffused general illumination and so less direct light will be needed. As artificial light is deficient in blue and green rays walls and ceiling of a bluish or greenish shade gives them greater reflecting power for daylight than for artificial light, which is generally desirable.

The simplest conception of illumination is that it is the flow of light received per unit of area of a given surface. The unit of measurement of light flux is the lumen, or foot-candle, which is the same thing. To find the number of lumens generated by most ordinary lamps it is sufficient to multiply its candle power by ten. Sources of light do not give the same intensity of light, or candle power, in all directions. In practice only about



PERFECTLY LIGHTED COTTON MILL.
The detail brought out in this photograph is really quite remarkable. The camera is simply a mechanical eye.

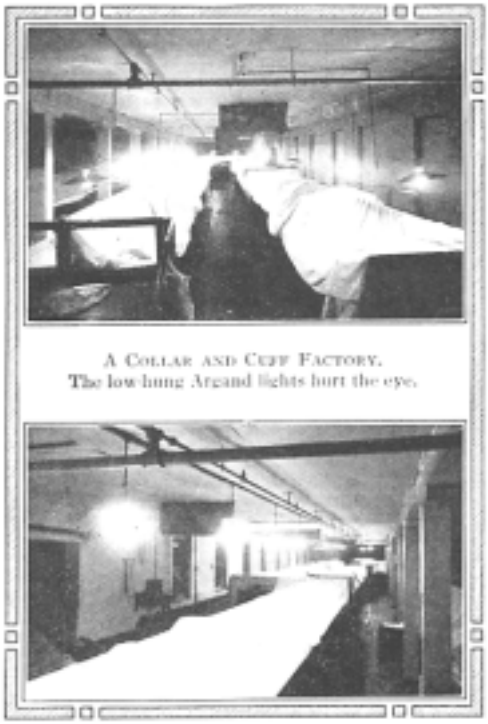
STORE WELL LIGHTED BY INCANDESCENT GAS MANTLES PROPERLY PLACED.

forty or fifty per cent of the lumens generated is effective on the floor. And by the way, a mere statement of candle power is not only insufficient to give an idea of the value of a source of light, but it may be incorrect and misleading. The only correct way to specify the quantity of light is to give the lumens. Candle power is merely the measure of intensity and not the measure of quantity any more than the steam pressure in a boiler is a measure of the quantity that boiler yields. So candle-power does not express the matter.

Formerly the whole matter of lighting was left to the architect. He prescribed the number, location and candle power of the lights and selected the fixtures. All this was settled before the color scheme of the

CONCEALED SYSTEM OF LIGHTING EMPLOYED IN BAPTIST CHURCH AT ROME, N. Y.
Results have been highly satisfactory.

interior was decided upon. The result was that the illumination often fell far short of, or greatly exceeded, requirements. It was the usual thing to place excessively bright lights in the ordinary field of vision with the result that the eyesight of the whole race of city dwellers was being permanently injured. The percentage of children with defective vision is increasing every year. Oculists say it is caused by bright lights. To quote from an address delivered by Dr. H. H. Seabrooke before the Illuminating Engineering Society, "America apparently leads the world in brilliancy of artificial illumination, and certainly leads the world in ocular exhaustion, discomfort, and congestion."



A Collar and Cuff Factory.
The low-hung Argand lights hurt the eye.

The Same Room, Photographed from the Other End.
The Argand burners had been replaced by inverted gas mantles at a proper height above the work benches.

Within the last two years a wonderful change has taken place in everything connected with illumination. The most obvious indication of this change is the blaze of light that flashes up every evening in the streets of every city and town from the Atlantic to the Pacific and from the Soo to the Rio Grande. "The Great White Way," otherwise Broadway, New York, has been talked about so much that no town now considers itself on the map unless it has a "Great White Way." Why, there is a village in Minnesota, Nashwauk, that according to the census of 1900 had a population of 684, which has a "Great White Way." It has made such a hit that it is to be extended this year. In fact, everywhere the discovery is being made that good public lighting is a valuable municipal asset.

Indoors, too, everybody is lighting up in response to the flattering seductions of the public lighting corporations. For the gas and electric light companies have learned by experience that the short and easy road to prosperity consists in pleasing their customers. Good service is now recognized as of more importance than price. Customers are given not merely prompt and courteous attention, but they receive genuine assistance in getting the best possible results from the money they spend for illumination. This, of course, is a broad application of the principles of illuminating engineering. The interesting thing about this policy from the corporation standpoint is that it is boosting business as nothing else ever has boosted it.

Everything connected with illumination seems to be flourishing. The most prominent feature in a notable year of progress in electric lighting was the development of the tungsten incandescent light. Tungsten is decidedly the best material for incandescent lamp filaments that has yet been found. The trouble with it at first was its extreme fragility. The slightest jar, or even a rude stare, would shiver a tungsten filament to fragments. But now they have learned how to make tungsten ductile and its use is increasing enormously. The production of tungsten last year, was 1,824 tons worth $832,992, practically all of which was used for making electric lights. In Europe practically half of the incandescent lights have metal filaments, chiefly tungsten. Tungsten already leads

the way in street lighting with magnetite arc lights in second place. Tungsten is even replacing Pintsch gas for train lighting. Vapor tubes are being more extensively used, while Dr. Peter Cooper-Hewitt has invented a phosphorescent reflector for his mercury lamp which transforms its reflected rays from a greenish to a reddish hue, making the color more suitable for general use.

For a time it looked as if gas as an illuminant was to be left at the post in America, though it is in high favor abroad, notably in Berlin where 1,693 high pressure gas lamps are used for street lighting. But the gas people are wide awake now and are getting all the business that is coming to them. More progress was made in gas illuminating last year than in the four preceding years. One of the finest office buildings in Chicago is lighted throughout exclusively with gas. Two hundred billion cubic feet of gas was made and sold in 1908 and the consumption is increasing rapidly. Acetylene is booming, the petroleum refiners are prospering and even the candle makers are doing very nicely. But the people who are flourishing most are the manufacturers of the various accessories of illumination. Installations ten years old are now considered obsolete, and hence must be replaced. Globes and shades are no longer turned out any old way, like tacks, to be sold for what they will fetch. Nowadays "glassware" is prescribed by the illuminating engineer like a dose of medicine. This keeps the manufacturers so busy they have no time to cut prices and so they are making a little money.

A logical sequel to the general enlightenment on the subject of illumination was the organization in New York on March 25, 1911, of the American Association for the Conservation of Vision, with Dr. F. Park Lewis, of Buffalo, as president, to deal with the whole question of light in the school and the home.

All these things together give some grounds for hoping that the human race, in its frantic search for wherewith to pay the grocer and the landlord, may not be driven altogether blind by unintelligent use of the means of seeing.