THE LIGHTING OF TEXTILE MILLS.

One of the most important factors in the successful operation of a textile mill, from the standpoint of quality and quantity of production, is its lighting, both natural and artificial. Good lighting means good work and satisfied employees, poor lighting means poor work, frequent mistakes and accidents, and surly, discontented work-people. The hygienic value of good lighting is too often overlooked or under-estimated, yet everybody knows from personal experience the difference in their feelings and spirits on a bright clear day and on a dark, gloomy one. People who are compelled to work or live in dark or ill-lighted places are never so healthy or strong as those whose work is done in well-lighted rooms or work-places—witness the stunted growth of a plant in a cellar as proof of this—and good health has a direct relation to the capacity of a person to perform work.

From a consideration of the better physical and mental condition of his employees alone, an investment for securing ample and adequate illumination in his mill will pay the owner in the increased quantity of output and its better quality. Cheerful people can always do better work than low-spirited folks, and nothing else in physical surroundings will depress a person more than confinement in a dark, ill-lighted place. If this is doubted, note the difference in production, and in the mill help themselves, on bright days and on dark days, a few observations will convince anyone that the lighting of a work room has a positive effect on work done there.

Necessity for ample illumination. (1) It scarcely seems necessary to urge that the greatest possible illumination should be provided in all parts of a textile mill, yet too often this is treated in a perfunctory way, or efforts are made to secure the greatest possible floor space and close grouping of machinery without a thought as to whether there will be sufficient light in all parts to enable work to be done properly. Especially in weave rooms, the construction of the mill should rather be long and narrow than wide, unless skylights be provided, so that the looms in the middle of the room will receive proper lighting.

(2) It is requiring too much of help to expect them to turn out good work in a poorly lit work room, faults and imperfections will pass unseen and will be detected too late in the finished goods. Where close matching of colors or threads is necessary, no effort should be spared to secure good lighting—there will be a great saving in time alone, if the work can be done at the machine without having to make frequent visits to a window or a light. In dye rooms, good light is, of course, a necessity.

(3) Not only must adequate illumination be provided for day work, but if the mill is to be run at night, equal provision should be made. The lighting should be of such a nature that sharp shadows and excessive concentration of light will be avoided, and the character of the light should approach that of daylight as nearly as possible, in other words, it should be diffused light. Every machine should be illuminated so that its working parts are in the brightest light, avoiding shadows from columns, belts, etc.

Natural lighting. As the greater part of textile work is done in the daytime, the question of daylight illumination is naturally the most important. Since sunlight and daylight are free, at present at any rate, many people do not think that light costs anything, yet it costs money and thought to secure proper lighting inside of a mill when planning and building it, and it is often a pretty expensive job to alter an old mill so that it will be properly illuminated. The truth is that daylight itself does not cost anything, but the trouble and expense comes in because we first shut it out and then try to bring it in! If we built our houses and factories with due regard to the laws of light and left plenty of channels for the light to enter and be diffused, every foot indoors would be well lit up, but we try to make the light travel around corners, shut it off with walls and partitions and then fill the spaces inside with objects that absorb the little light that is admitted. You can't have light if you don't let it in.

In designing a mill, due attention must be paid to its location. If possible, do not locate it on low ground where the light is shut off from it by higher ground or buildings, and if such a location is the only one available, allow for natural deficiencies by providing as much window space as is practicable, and make the longitudinal direction of the building such that it will receive the most amount of sunlight. If more than one building is to be erected, do not crowd them close together so that they mutually darken one another. Provide ample light shafts, or wells, wherever walls come close together, or if the building is wide for its length and is several stories high.

Mill construction. Nowadays, with modern steel and concrete construction, it is possible to make the outside walls of mills almost skeleton in form, the entire exterior surface being practically divided into open spaces for windows by narrow columns of reinforced masonry or brick work. This form of construction gives the best possible window lighting, as the windows can be made almost the entire height of the space between floors and of any width desired, and there is not so much obstruction of light from the thickness of the window-reveals. If a solid stone or brick form of construction is used, there cannot be as much window opening in the surface of the outer walls as in the former type of construction, because there must be a greater width of masonry between windows to carry the loads of the building, floors, etc.

If the mill has an unobstructed exposure on all sides and is not too wide for its length, light wells and skylights will not be necessary, but if the walls are close to those of other buildings, light wells, shafts and courts should be freely provided. The sacrifice of floor space required for ample light shafts or courts is more than compensated for by the better lighting, for, in many instances, the absence of these will necessitate artificial lighting of some parts of the mill all the time, and the cost of this will greatly outweigh the value of a few feet of floor space.

In a mill erected in open country, the only questions to be considered are the provision of ample window space and locating the mill so that it will receive diffused daylight rather than direct sunlight. The design of the mill naturally will be that it is two or three times longer than it is wide—this longer axis should be laid out so that the mill extends about northeast and southwest, if this be practicable, considering the size, contour, etc. of the building site. The side walls, which should be built with as much window space as possible, in a mill thus located will not be exposed to direct rays of the sun except for a short time, the end walls, which will receive the direct sunlight half the day respectively, should be built with few, if any windows. This arrangement will prevent the mill from being flooded with sunlight half the day alternately on each side, requiring shades or awnings during much of the year, and the rooms will be more evenly illuminated by the diffused daylight admitted through unobstructed windows. A further advantage is that the mill will be cooler in summer, less of its wall surface being heated up by the sun.

If two buildings are erected side by side, they should be far enough apart so as not to darken one another. The distance the two buildings should be separated varies according to their height, the taller the buildings, the wider must be the space between them. Builders are apt to place separate mills close together with the idea of saving time and trouble in getting from one to another. It is a poor economy to try to save a few steps or moments of time at the expense of poorly lit work rooms, if necessary, build a covered passageway connecting the two buildings. If the mills have basements, these too should have ample provision for light, else their value for storage, work rooms, etc., will be partly nullified.

These statements are made with a mill of several stories in mind. If the mill be only one story high and covers considerable area, skylights must be used for lighting the central spaces or rooms.

City Mills. The hardest problems in mill lighting occur in mills built in large towns or cities, where ground is valuable and buildings must be concentrated and run up as high as possible. Very often, too, there are already tall buildings on the adjacent building sites which will shut off more or less light from our mill, and it is seldom that a mill so located can have more than one side with unobstructed exposure. The best way out of the difficulty is to build a mill with a central court, or, if this be impossible, to provide ample light shafts. If the ground area permits, a central court is by far the best, since this insures a supply of light on four sides. In the hands of a competent architect, an interior court can be designed that will take away only a comparatively small floor space, and the ground space of the court can be utilized by erecting there a one-story building for engines, etc., or as a store and shipping room, if ample skylights be provided.

When erecting a mill or group of mills, if the ground area is too small to permit construction with a court, then ample light shafts must be provided, both inside the mill and outside, by building the wall with recesses for windows. No rule can be given for the size of light shafts or side recesses, they should be proportioned according to the width of the mill and the height of adjacent buildings, their closeness, light obstruction, etc. Some may say "yes, this is all very nice, but it costs money to build extra walls." So too does artificial light cost money. The difference is that you pay once for building your mill, whereas you not only pay for the installation of artificial light, but you also have the continual daily expense of your lights, which must be kept burning all the time that the mill is in operation.

Another argument would be the loss of floor space, *ergo,* loss in quantity of machinery that can be operated. This is a condition where the least of two ills must be chosen. It is possible for a competent architect to design a mill so that the "cut-ins" or recesses will be located where they will least interfere with placing machinery and yet give the needed light. The same holds good for light shafts. The point to be considered is, whether or not the few extra machines that can be put in a room with no light shafts or recesses will give sufficient extra output to pay for the artificial lighting that must otherwise be provided. The question simply comes down to comparative cost and production, if the floor space alone be considered, and to the cost of the extra walls and windows compared to cost of lighting artificially. In any estimate, the value of good lighting on the quality and quantity of production, through its effect on employees and their ability to work, must also be given consideration. The decision will always be in favor of a construction that will secure the best natural lighting, this costing nothing to maintain if once provided, while the cost of artificial lighting will be a continuing annual expense.

There is an important point to be borne in mind when building light shafts up through the floors of a mill—these shafts must be built of fire-proof materials and of closed construction throughout, and must not communicate, through passageways or openings, with any floor, nor must they be used for elevators, hoisting, etc. The sides should be metal tiling, re-inforced concrete or plaster, or other forms of good fire-proof construction, the glass should be a good quality of "wired glass," *i. e.*, glass in which is imbedded a mesh work of strong wire. These windows or glazed openings must be built in solid so that they cannot be opened by the help, leaving only one protected opening on each floor that can be used for access to the interior of the shaft, for painting, etc.

Under no circumstances should the light shafts be used for ventilation or communication or be open in construction; under such conditions, a fire on a lower floor will be apt to spread rapidly to other floors, the shaft acting as a chimney to draw up the flames and smoke with powerful draft. The light shafts should be used for lighting and nothing else, the practice sometimes seen of putting stairs or fire-escapes in light shafts is criminal folly. If built throughout of fire-proof and fire-resistant materials and constructed so that there are no openings nor communication on any floor, such fire shafts will add little, if anything, to the insurance risk. It is wooden shafts with ordinary wooden sash windows that have brought light shafts into bad repute, for they are fire traps.

The top of the light shaft may be either open or closed with skylights; in the latter case, the skylight should be rain-proof and have ventilators for ventilating the shaft. A superior type of ventilator for skylights is the Burt Glass Top Ventilator, which has a glass top instead of the usual metal, thus causing the least possible amount of light obstruction, while at the same time ample ventilation is secured. These ventilators are made in a special type to fit on glass skylights, with water-proof joints and setting, the ventilator itself being rain-proof, and are worthy of attention. The Royal Ventilator is also another good type. In fact, wherever skylights are used, these ventilators may be installed with good results, since they cut off the minimum of light. Skylights should have ventilators in almost every location, since this prevents much of the condensation of moisture that will occur on a cold day when the air inside is warm and humid.

Assistants to Lighting. Since light will travel only in a straight line, unless reflected or refracted, many corners of a room may be dark, although there be windows, skylights, etc. In no way has the problem of diffusing light throughout interior spaces been aided in solution more than by a study of the refracting possibilities of light. By interposing a suitable refracting material in its path, light from outside may be "bent" (or refracted) and thrown in straight horizontal rays wherever wanted. One of the best systems of this utilization of daylight by refraction is that known as the Luxfer Prism System, which consists of the use in windows, etc., of a special form of glass sheets, one side of which is moulded into rows of prisms of various angles to suit conditions. When this glass is used in a window, or other opening, the rays of light, which would otherwise enter at an angle and strike the floor and be lost, are refracted so that they enter the room in horizontal beams, thus lighting up the farthest positions. The Luxfer Prism glass has long since passed the experimental stage and its value has been amply demonstrated.

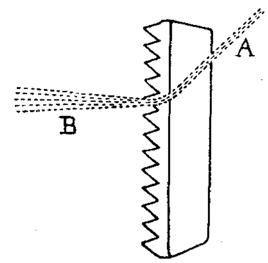

FIG. 1.

The manner in which Luxfer Prism Glass acts on light is shown in Fig. 1. In this illustration the slanting ray of light *A* strikes the Luxfer glass at an acute angle, passes into the glass and is refracted out in a straight line by the prisms, as shown at *B*. None of the penetrative effect of the light ray is lost, and very little is absorbed by the glass itself, and it will illuminate the far end of the room equally as well as the part near the window.

It must be understood that Luxfer Prism glass does not *increase* or *magnify* the illuminating power of the light it transmits, all it does is to *utilize* the light that would otherwise be lost, by changing its angle of direction and throwing this light into the interior of the room, etc. This effect often increases the volume of light received in a room from five to ten times more than the amount it would receive from a window with ordinary glass. The variety of ways and places that refracting glass can be used should make the study of its adaptation in textile mills one worth attention.

In considering the use of Luxfer Prism glass, its cost should not be compared with the cost of ordinary glass alone, some estimate must be made of the cost of the artificial lighting which its use makes unnecessary. It is plain that if Luxfer Prism glass in the windows will light a room that previously had to be illuminated with gas or electricity, its actual cost will be lessened by the cost of the artificial lights for the length of time the glass remains unbroken.

The first cost will be the only cost, artificial light costs every day it is used.

One of the best and cheapest ways to secure adequate light from the windows of a mill would be to use sheets of Luxfer Prism glass in the upper sashes instead of ordinary glass. This glass would be specially valuable for windows opening into narrow courts or where a high wall is opposite and separated by a narrow space from the mill, or for use in light shafts; in these cases the entire window should be glazed with the Luxfer Prism glass. As explained, this glass refracts slanting rays of light, which are the only ones received in narrow courts, etc., and throws the light in straight beams right across the room. Another advantage is that this glass being semi-opaque to direct view, privacy can be secured by its use in windows in place of plain glass, at the same time the amount of light being increased many times.

For basements or rooms partly underground, the Luxfer system is indispensable; by the use of Luxfer sidewalk prisms set in concrete in place of the usual "bull's eye" lights on the sidewalk, the darkest basement may be made light and available for any purpose. Where the basement is deep, it should have its openings into the sidewalk vault glazed with Luxfer prism glass, the so-called "lucidux" being used. The location of the various windows and the amount and direction of the light they receive should be taken into consideration. The best way is to describe the conditions and results required to the Luxfer Prism Company direct, as it makes a specialty of this form of construction.

Window Construction. Windows not only have the duty of furnishing light to the interior of a building, they have also the function of protection against wind, rain, etc. A still further duty that should be performed by windows is that of protection against fire, but unfortunately, this is seldom thought of. In a city mill, surrounded by other buildings, every window is a danger point in case of a fire in any of these; ninety per cent. of the fires in buildings adjoining one that is burning are due to communication through unprotected windows, which afford free passage to the flames. When surrounded by other and combustible buildings, the rate of insurance paid is in direct proportion to the amount of exposed window surface. Put on strong fire-proof shutters and see how quickly the insurance rate will be lessened. In the great fires at Baltimore and San Francisco, every building with unprotected windows, even the so-called fire-proof buildings, in the path of the fire suffered, the flames entering the windows and gutting the interiors. Now it is often impracticable, and always expensive, to equip a mill with fire-proof shutters, and there is always the probability that the shutters will be open just at the time they are most needed, but it is only common sense economy to protect these weak spots somehow. In lieu of fire-proof shutters, the best alternative is fire-proof windows.

Fire-proof, or more accurately, fire-resisting windows, can now be secured at a moderate cost. In such a window, all the wood work of the sashes, frames, etc., is replaced by metal, pressed steel being the cheapest and easiest to secure, and the glass should be the so-called "wire glass." Pressed steel window frames, sashes, etc., can now be had from many manufacturers, either galvanized or painted, and they are much cheaper than copper. Zinc is not suitable and should not be used, as it melts too easily if exposed to heat, and would leave the window opening unprotected. The wire-glass should be of good quality and heavy enough to resist heat. The advantage of wire-glass is that even if the glass be cracked by heat, the pieces of glass will be held together by the wire netting imbedded in it, the glass retaining its form at any temperature short of melting the wire and glass themselves. Luxfer Prism glass previously mentioned is now made with a wire mesh protection and this should be used wherever exposed to danger from fire.

If fire shutters are used, they should be actually fire-resistant, not mere wooden shells covered with thin sheet-metal or tin. To be worth the investment, fire-proof shutters should be of heavy metal, properly hung so that they will not sag down or fall when exposed to heat, and they should have stout bolts for secure fastening. To derive any benefit from their protection, these shutters should be closed as soon as the mill is vacated by employees and kept closed until work starts up the next day. Some persons should be assigned the special duty of closing these shutters at night and should be held strictly responsible for their security. Employees should be taught by drill to fasten and close the fire-proof shutters when the alarm of fire is given.

Fire-proof shutters are more a make-shift for mills already built than for those being erected. When building a new mill, the fire-proof windows previously described will be found a good investment, both from added security and lessened annual cost for insurance. At the present high prices for lumber, metal window fittings are not comparatively expensive, while their greater cost, if any, is offset by the saving in repairs, durability, etc.

(*To be continued*)