

THE LIGHTING OF A LARGE STORE.<sup>1</sup>

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In the fall of 1910, Gimbel Brothers' large New York store, occupying the block between Thirty-second and Thirty-third streets, facing Broadway and Sixth Avenue, was opened to the public. There are ten stories above and three below the surface of the ground; the McAdoo Tunnels, to lower New York and under the Hudson to several stations in New Jersey connecting with one of the basements. The building was designed by D. H.

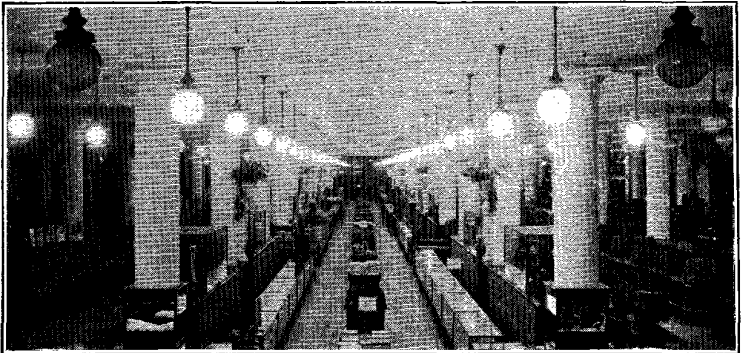


Fig. 1.—Main aisle looking east towards Sixth avenue.

Burnham Company, architects, of Chicago, and built by the Thompson-Starrett Construction Company of New York. Some idea may be obtained of the magnitude of this building from the following statistics furnished by the architects and builders: It has 120 flights of stairs, which if made into one continuous flight, would extend upward 1,680 feet—more than twice the height of the largest building in the world. Over 100,000 square feet of plate glass is used on the outside of the building alone. This would cover a surface larger than three average city blocks. There are 2,406 steel columns in the building, having a combined height of over 6 miles. The rock excavated for the space oc-

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cupied by the sub-basement, basement and basement mezzanine

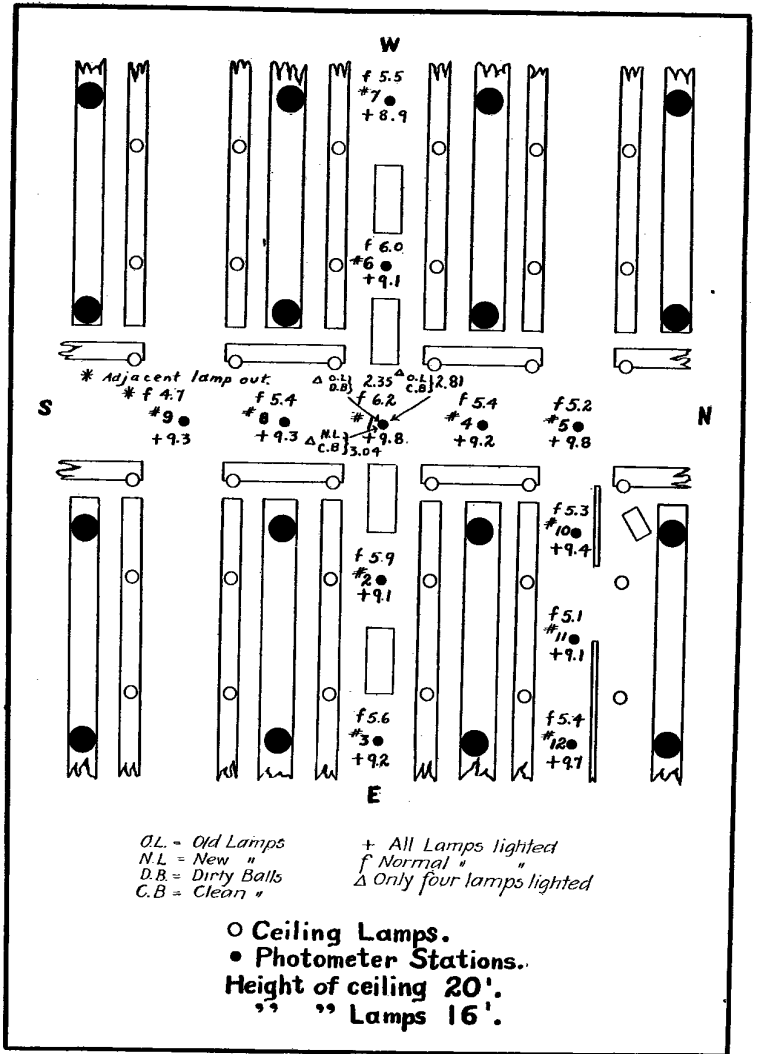


Fig. 2.—Section plan of main floor, showing location of furniture, pillars, lighting units, test stations and illumination data.

totalled 2,970,000 cubic feet. The heating system is one of the largest ever installed in New York. It requires 1,320,000 feet

or 25 miles of circulation pipe to distribute the heat properly. All fixtures, counters, tables, partitions and wood finish throughout

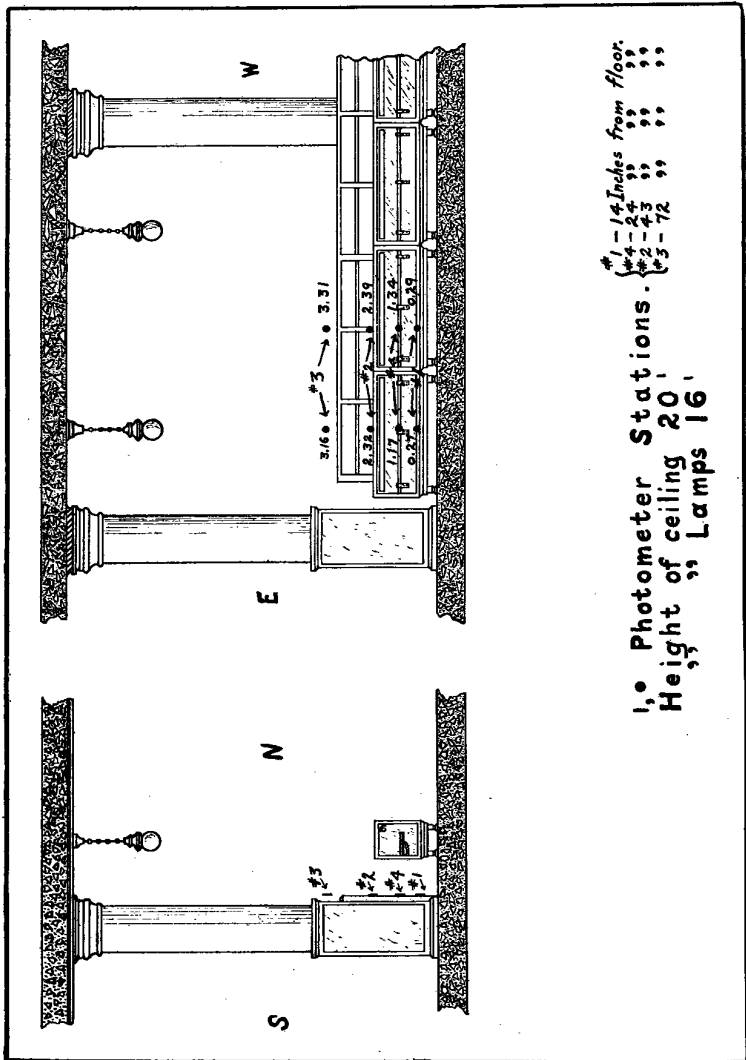


Fig. 3.—Section plan of main floor, (gentlemen's neckwear), showing location of furniture, pillars, lighting units, test stations and illumination data.

the store are of red Mexican mahogany. More than 1,000,000 feet of such lumber were used. Of these fixtures there are 908

show cases, having a combined length of 8,205 feet, 848 wall cases, running 7,652 feet; and 1,376 counters extending 12,642 feet. In addition to these, there are used for displaying stock 985 tables which would, if placed end to end, extend 8,865 feet.

Before proceeding to a discussion of the lighting of this building, the authors desire to congratulate the architects for their

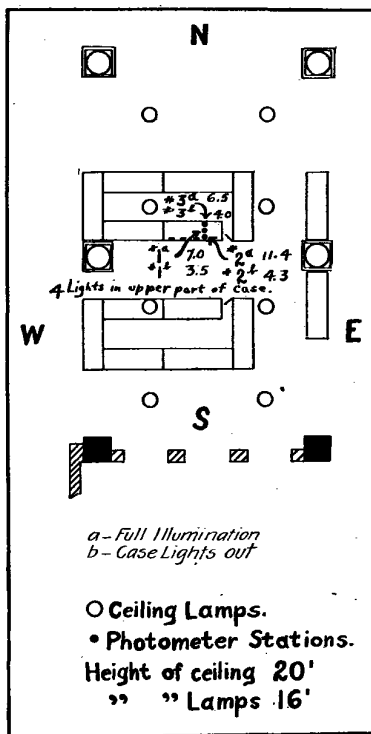


Fig. 4.—Section plan of main floor, (plated silver ware), showing location of furniture, pillars, lighting units, test stations and illumination data.

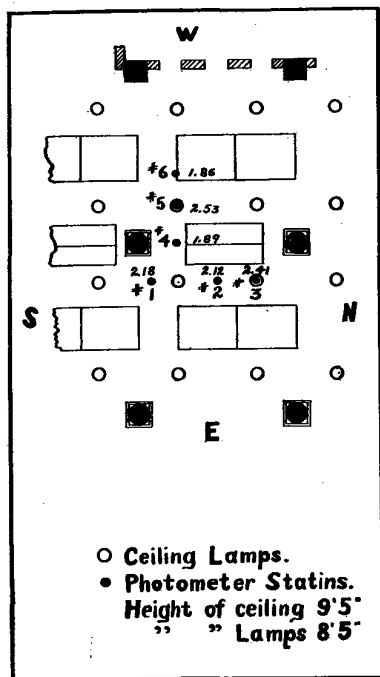


Fig. 5.—Section of main floor, (ladies' untrimmed hats), showing location of furniture, pillars, lighting units, test stations and illumination data.

arrangement (spacing)—of the lighting outlets which permits of ideal light and illumination results being obtained. The outlets are on about 12-foot centers.

A comparatively short time before the completion of this building, the writers were called upon to look over the scheme

of lighting, which, for the most part, had been prepared by an engineer, which scheme, in general, consisted of single pendant chain stem and close fitting ceiling fixtures, using tungsten lamps and equipped with glass spheres of a yellowish orange nature.

After carefully ascertaining the requirements of store light-

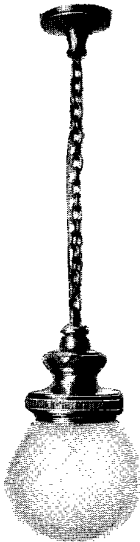


Fig. 6.—Lighting fixture used on first floor.

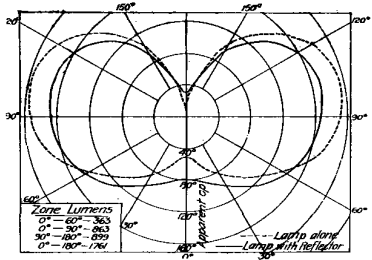


Fig. 7.—Photometric curve of lighting unit used at first on first floor, with frosted tip tungsten lamp.

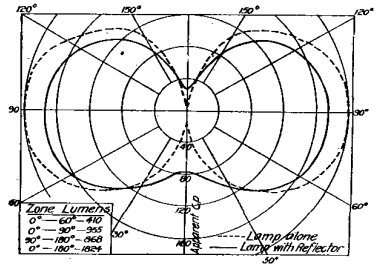


Fig. 8.—Photometric curve of lighting unit now used on first floor, with clear bulb lamp.

ing, and this store in particular, and having made an analysis of the lighting specifications aforementioned, the authors submitted a report to the owners, the gist of which follows:

CONSIDERATIONS.

The first points to be considered in the design of this lighting system are:

First, the effect that is to be produced, that is, the quantity, character, intensity and distribution of illumination.

Second, the lighting scheme should be of such a nature that

neither the light sources, nor the effects produced, will be injurious, or objectional, to the eye.

Third, the light and illumination effects obtained should produce the desired psychological results.

Fourth, the lighting units employed should be effective and harmonious with their surroundings, but not necessarily objects of art, to the point of detracting from the goods on sale.

Fifth, the light sources used should be efficient.

Sixth, the installation should permit of economic maintenance.

#### CRITICISMS.

The following criticisms are based on eight fixture designs, alphabetically indicated as A, B, C, D, E, F, G and H, and models evolved from some of these designs on display at Gimbel Brothers' Philadelphia establishment. All the designs indicated were purely suggestive and, therefore, being in the rough, were not susceptible to rigid aesthetic criticism.

The over-all drop of the A fixture, (that is, the distance from the ceiling to the extreme bottom of the unit) was seemingly correct from a symmetry point of view for use on the first floor. In connection with this fixture a 12-in. yellow orange tinted ball was indicated, having a 6-in. opening, which opening is too small for the passage of the three 100-watt tungsten lamps which have been specified for use therein. The use of three or more lamps in such cluster formation is inefficient. This is understood when it is known that the lamps, by being in such relative positions, intercept a certain portion of the light rays emanating from one another, thereby preventing a considerable amount of the light flux from striking the interior sides of the ball, thereby resulting in unwarranted absorption. Besides, with the use of three lamps, unless the glassware is exceedingly dense, causing great loss by absorption, three points, or spots of light will be visible on the sphere, thus destroying its symmetry. The use of lamps in this manner, in this unit, should not be considered.

As regards distribution of light flux: the distribution of light about a bare, clear, incandescent electric lamp is, usually, greatest in a horizontal direction, when the lamp is hung pendant; end-on, and those angles between  $0^{\circ}$  (end-on) and  $90^{\circ}$  (horizontal)

from which useful illumination is obtained, the flux is not so great. This is corrected by the use of properly designed reflectors. The distribution of light rays about a lamp, when

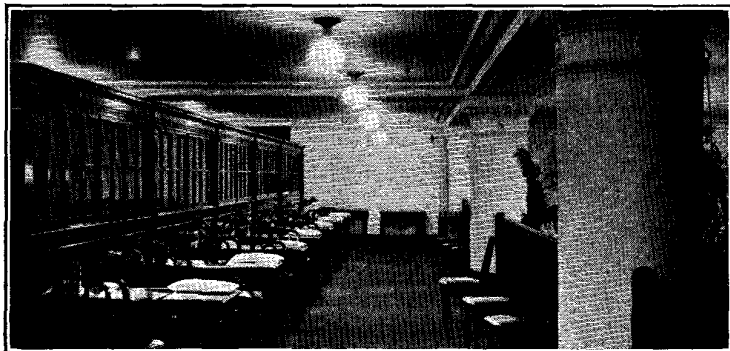


Fig. 9.—Balcony, main floor mezzanine, showing manicuring tables.

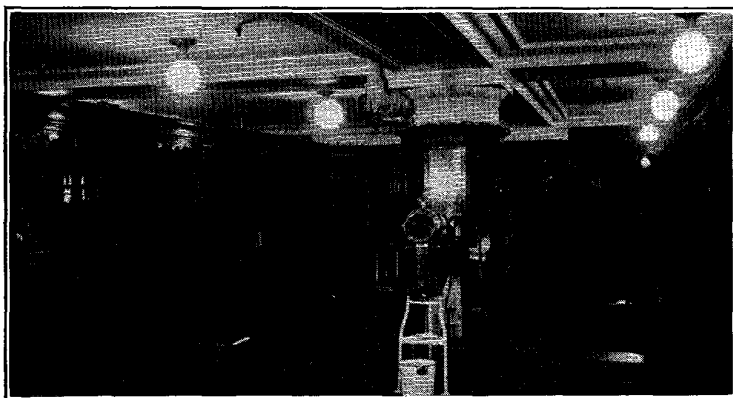


Fig. 10.—Balcony, main floor mezzanine, showing chiropodists' and hair-dressing rooms.

equipped with a diffusing globe, which has comparatively no redirecting qualities, is comparable to that of a bare lamp with the difference that as the diffusing glassware, in order to diffuse light, absorbs a certain percentage of the light flux, depending upon its density, contour, character of surfaces and color, the

illuminating ability of the unit is decreased. If, on the first floor of the New York store, unit A would be used, the ceiling and upper parts of this floor, where no goods are displayed, would be considerably brighter than the shelving and counters, where goods are displayed. The absorption of light by a glass globe, as before indicated, depends on its density, contour, character of

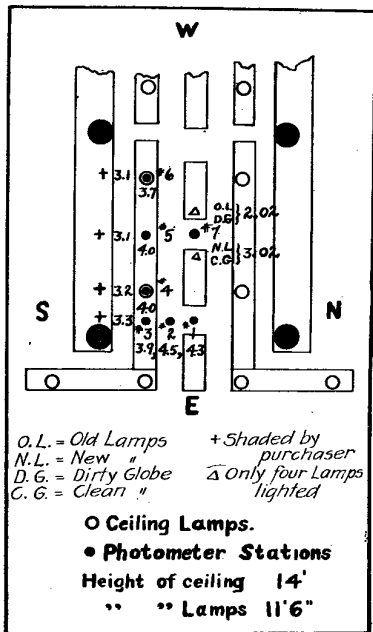
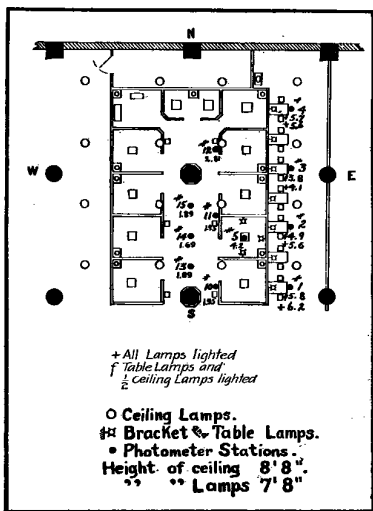


Fig. 11.—Section plan of main floor mezzanine, showing location of hair-dressing and manicuring parlors, lighting units, test stations and illumination data.

Fig. 12.—Section plan of second floor, (infants' wear), showing location of furniture, pillars, lighting units, test stations and illumination data.

surfaces and color. Following are some figures relative to absorption factors which probably, at this point, will be of interest:

TABLE I.—LIGHT ABSORPTION IN PER CENT.

|                       |          |
|-----------------------|----------|
| Clear glass .....     | 5 to 10  |
| Ground glass.....     | 20 to 30 |
| Alabaster glass ..... | 20 to 50 |
| Opal glass .....      | 25 to 60 |
| Milk glass .....      | 30 to 80 |

The foregoing factors vary with different qualities and treat-



TABLE II.—COLOR DISTRIBUTION.

| Original Color of Fabric | Color of Light. |                      |                           |                                |                       |                             |
|--------------------------|-----------------|----------------------|---------------------------|--------------------------------|-----------------------|-----------------------------|
|                          | Red             | Orange               | Yellow                    | Green                          | Blue                  | Violet                      |
| Black                    | Purplish black  | Deep maroon          | Yellow olive              | Greenish brown                 | Blue black            | Faint violet black          |
| White                    | Red             | Orange               | Light yellow              | Green                          | Blue                  | Violet                      |
| Red                      | Intense red     | Scarlet              | Orange                    | Brown                          | Violet                | Red violet purple           |
| Orange                   | Orange red      | Intense orange       | Yellow orange             | Faint yellow slightly greenish | Brown slightly violet | Light red                   |
| Yellow                   | Orange          | Yellow orange        | Orange yellow             | Yellowish green                | Green                 | Brown tinged with faint red |
| Light green              | Reddish gray    | Yellow green         | Greenish yellow           | Intenser green                 | Blue green            | Light purple                |
| Deep green               | Reddish black   | Rusty green          | Yellowish green           | Intenser green                 | Greenish blue         |                             |
| Light blue violet        | Violet          | Orange gray          | Yellowish green           | Green blue                     | Vivid blue            |                             |
| Deep blue                |                 | Gray slightly orange | Green slate               | Blue green                     | Intenser blue         | Bright blue violet          |
| Indigo blue              |                 | Orange maroon        | Orange yellow (very dull) | Dull green                     | Dark blue indigo      | Deep blue violet            |
| Violet                   | Purple          | Red maroon           | Yellow maroon             | Bluish green brown             | Deep bluish violet    | Deep violet                 |

ments of glass and with illuminants giving color values and are to be considered as but representing approximate values.

The glassware specified for the store is of a distant yellow orange tinge, which would not only very materially absorb the light, resulting in a larger consumption of electricity than is nec-

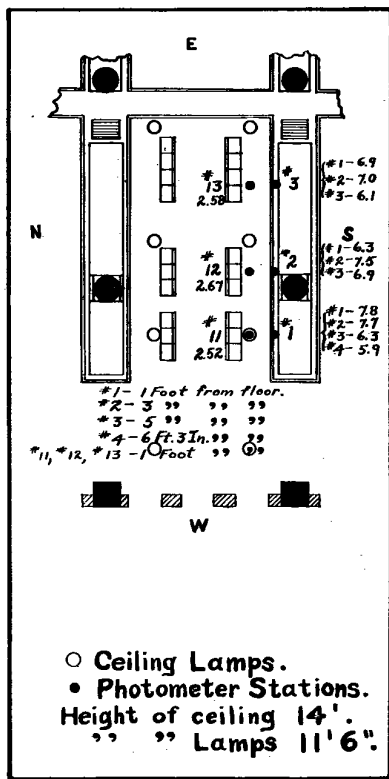


Fig. 13.—Section plan of second floor, (shoe department), showing location of furniture, pillars, lighting units, test stations and illumination data.

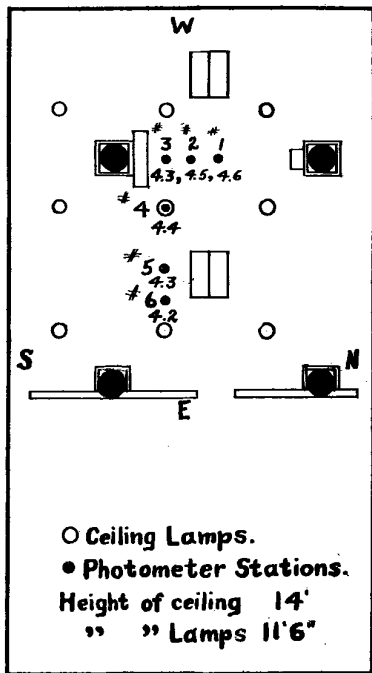


Fig. 14.—Section plan of third floor, (ladies' reception room), location of furniture, pillars, lighting units, test stations and illumination data.

essary but by being highly selective in its absorbing qualities (absorbing to a great extent toward the blue end of the visible spectrum), will distort greatly the true color values of the goods displayed, besides giving a gloomy, dull appearance to the store.

Table II will convey some idea of the effect of different colored lights falling on various colored fabrics:

The question of predominating color of illumination to be employed in a department store is of paramount importance and will be dealt with in greater detail later on in that part of this paper headed "Suggestions."

Criticisms similar to those made on unit A apply to unit B with the exception that instead of three 100-watt lamps, one 150-watt lamp is specified, with a corresponding increase in efficiency.

The criticisms on units C and D are similar to those on unit B.

The E fixture was seen only through the medium of a blue print, and, as insufficient knowledge had been gained from such observation, no comment on it will here be made.

The F fixture will serve its purpose as an emergency lighting unit if hung within easy reach.

Fixture G consists of combination gas and electric brackets, the gas part of which seems to be such as to meet requirements. The electrical part, however, has been, to a measure, hooded by a shade which has apparently not been designed with any special reference to the proper distribution of light rays, nor is it proportionately correct from an aesthetic viewpoint. If similar kind of glass is recommended for this fixture as for fixture A then similar criticisms are in order.

Fixture H is similar to the electric part of fixture C.

#### SUGGESTIONS—FIRST SCHEME.

*First Floor*:—Each of the outlets on the first floor should be equipped with one 250-watt bowl-frosted tungsten lamp and prismatic intensive reflector satin-finished; the unit to be attached to the ceiling by a chain fixture. The over-all drop of this fixture should be between 4.0 and 4.5 ft.

*Second and Third Floors and Basement Court*:—Each ceiling outlet on the second and third floors and basement court between columns 158 and 154 and 139 and 143 should be equipped with 150-watt bowl-frosted tungsten lamp and prismatic intensive reflector, satin-finished, the unit to be attached to the ceiling by a chain fixture. The over-all drop of the fixture for the base-

ment court, should be 4.0 ft., that for the second floor 2.5 ft. and that for the third floor 2.0 ft.

*Fourth to Eighth Floors, Inclusive:*—Each of the outlets on these floors should be equipped with one 150-watt bowl-frosted tungsten lamp and prismatic intensive reflector, satin-finished, the unit to be attached to the ceiling by a chain fixture. The over-all drop should not exceed 2.0 ft., being preferably from 18 to 20 in.

*Basement, Basement Mezzanine, under and over First Floor Mezzanine, Ninth and Tenth Floors, also Toilets, Locker-rooms, and Stairs:*—Each of the outlets in these various parts of the building where unit D on architects' drawing was intended, should be equipped with one 150-watt bowl-frosted tungsten lamp and prismatic intensive reflector, satin-finished, the unit to be directly attached to the ceiling by a short fixture. The over-all drop of the lighting fixture should be approximately 10 in. Each socket in the straight electric brackets, as well as in the combination gas and electric, fixtures should be equipped with one 40-watt frosted tip tungsten lamp and prismatic asymmetrical globe in standard 2.25-in. holder position.

#### SUGGESTIONS—SECOND SCHEME.

*First Floor:*—Each of the ceiling outlets on first floor should be equipped with one 250-watt clear tungsten lamp and prismatic

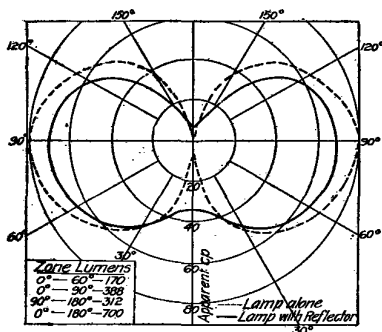


Fig. 15.—Photometric curve of unit now used in parts of the second and first floors.

reflector-ball, the lower hemisphere of which should be satin-finished; the unit to be attached to the ceiling by means of a chain fixture. The overall drop should be 4.5 ft.

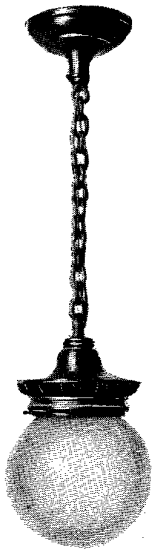


Fig. 16.—Lighting unit used on second and third floors.

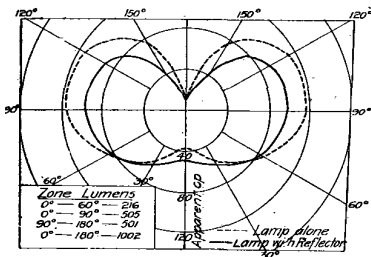


Fig. 17.—Photometric curve of unit installed on second and third floors.

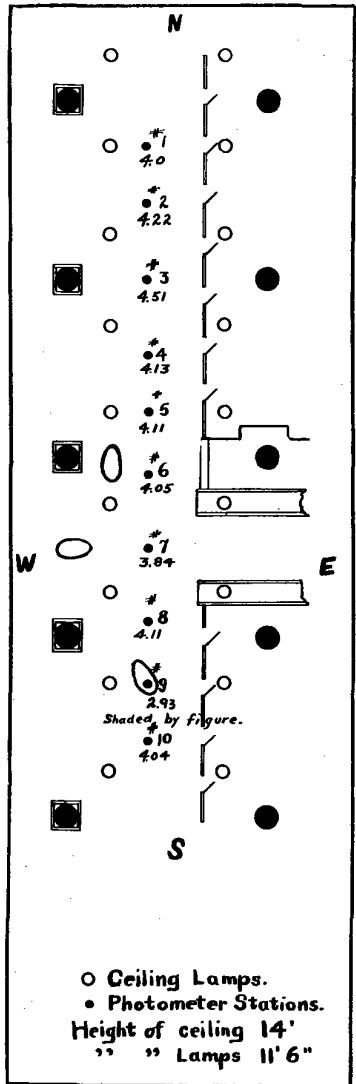


Fig. 18.—Section of third floor, (ladies' cloak and suit department), showing location of furniture, pillars, lighting units, test stations and illumination data.

*Second to Eighth Floors, Inclusive*:—Each of the ceiling outlets on these floors should be equipped with one 150-watt clear tungsten lamp and prismatic reflector-ball, the lower hemisphere of which should be satin-finished, the unit being attached to the ceiling by means of chain fixture. The overall drop of the fixture for the second floor should be 2.5 ft.; and for the third to eighth floors, inclusive, the drop should be 2.0 ft.

*Basement, Basement Mezzanine, under and over First Floor Mezzanine, Ninth and Tenth Floors, also Toilets, Locker-rooms and Stairs*:—Each of the ceiling outlets in these various parts of the building, where unit D on architects' drawing was in-



Fig. 19.—Fourth floor, packing department.

tended, should be equipped with one 150-watt clear tungsten lamp and prismatic reflector-ball, the lower hemisphere of which should be satin-finished, the unit being attached to the ceiling by means of a chain fixture. The overall drop of the fixture should be 17 in.

Each socket, in the straight electric brackets, as well as in the combination electric and gas fixtures, should be equipped with one 40-watt frosted tip tungsten lamp and prismatic asymmetrical reflector globe in standard 2.25-in. holder position.

#### SUGGESTIONS—THIRD SCHEME.

*First Floor*:—Each of the outlets on the first floor should be equipped with one 250-watt clear tungsten lamp and special prismatic reflector (collar ground off) resting on the lamp in-

side a 14-in. lightly-ground glass sphere with 10-in. opening, the

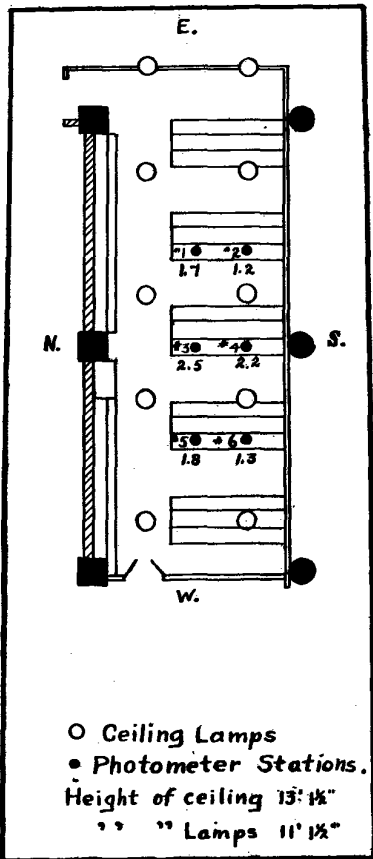


Fig. 20.—Section plan of fourth floor, (packing department), showing location of furniture, pillars, lighting units, test stations and illumination data.

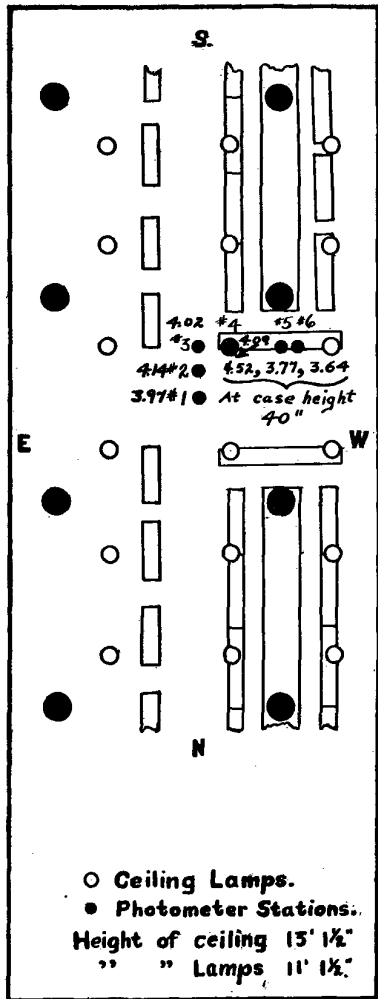


Fig. 21.—Section plan of fourth floor, (gentlemen's hats), showing location of furniture, pillars, lighting units, test stations and illumination data.

unit being attached to the ceiling by a chain fixture. The overall drop of this fixture should be 4.5 ft.

*Second to Eighth Floors, Inclusive:*—Each ceiling outlet on these floors should be equipped with one 150-watt clear tungsten lamp and prismatic reflector resting on the lamp, inside a 12-in. lightly-ground glass sphere, with 8-in. opening, the unit being attached to the ceiling by means of a chain fixture. The overall drop of the fixture for the second floor should be 2.5 ft. and that for the third to eighth floors inclusive, 2.0 ft.

Each socket in the straight electric brackets, as well as in the

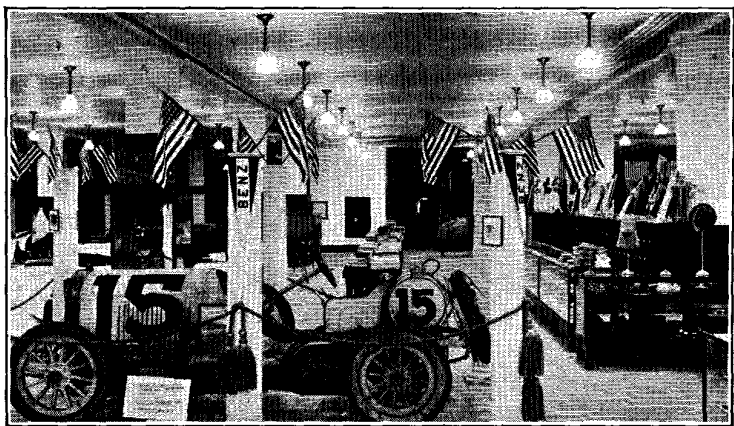


Fig. 22.—Fourth floor, gentlemen's hats.

combination gas and electric fixtures, should be equipped with one 40-watt frosted-tip tungsten lamp and prismatic asymmetrical reflector globe, in standard 2.25-in. holder position.

#### COMPARISON OF SUGGESTED PLANS.

From Scheme No. 1 on the first floor, an illumination of from 10 to 12 foot-candles, on the shelving and counters would be obtained. The intensity of illumination obtained on the first floor of a large department store in the middle west is from 8 to 10 foot-candles. The aforementioned intensity is of a brilliant and inviting nature, materially adding to the advertising value of the store and, on account of the manner in which it would be obtained, would not have objectionable glare features. A store so lighted denotes the company's confidence in the quality of its goods. Inasmuch with this equipment as the rays of the tungsten lamp



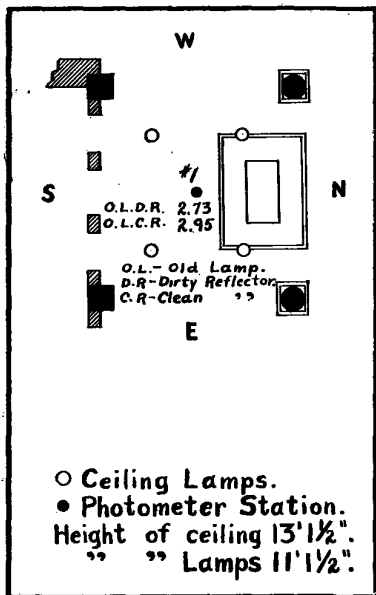


Fig. 23.—Section plan of fourth floor, (toy department), showing location of furniture, pillars, lighting units, test stations and illumination data.

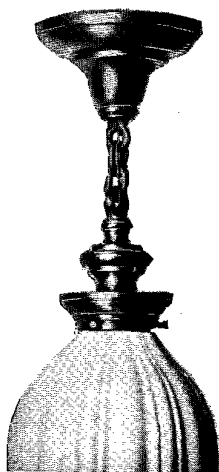


Fig. 24.—Lighting unit used in basement under balcony on fourth and seventh floors.

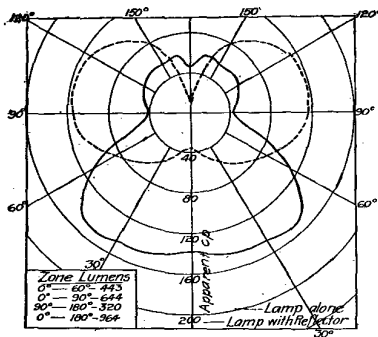


Fig. 25.—Photometric curve of opal reflector with 150-watt bowl-frosted tungsten lamp.

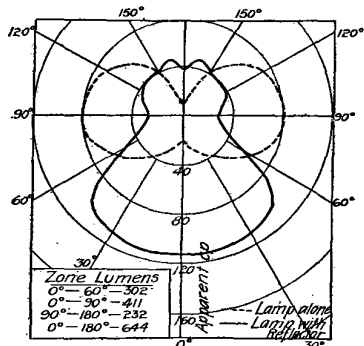


Fig. 26.—Photometric curve of opal reflector with 100-watt bowl-frosted tungsten lamp.

would be reflected, with very little modification, to the working plane, the quality and color of the light would be maintained. On the upper floor where 150-watts per outlet are to be used an illumination intensity of from 8 to 10 foot-candles would be obtained. Scheme No. 1, everything considered, is easily the best proposition to entertain. Scheme No. 2 carries out the ball idea and is considerably more effective and efficient than the use of ordinary diffusing spheres, in that the balls suggested are scientifically constructed, the upper half consisting of a series of totally-reflecting prisms which assist in redirecting the light rays through the satin-finished lower half, thus giving rise to well-diffused, efficient illumination. The chief drawback of an installation of these balls is that the 12-in. sphere (unless it is desired to go to the expense of installing 14-in. spheres on the first floor) would have to be used throughout the several floors inasmuch as the next smaller size prismatic reflector-ball has not a sufficiently large opening to permit the use of 150-watt Tungsten lamps. Scheme No. 3 is the one for ground glass spheres, and is similar to that specified by the engineer with the difference that instead of using on the first floor, three lamps inside of each sphere, one is used; over this lamp there should be placed a reflector which, by directing the light rays to points below the horizontal, would increase materially the useful illumination on the working plane. On the upper floors this same general idea could be carried out, but a 150-watt lamp is recommended instead of the 250-watt.

In order that some tangible idea may be formed of the relative values of the systems here considered, such systems are compared one with another, using Scheme No. 1, as representing 100 per cent. efficiency. These values indicate approximately the relative per cent. of illumination produced on the goods for equal consumption of electricity.

TABLE III.—EFFICIENCY OF ARRANGEMENTS.

|   | Per cent. |
|---|-----------|
| Clear prismatic reflectors.....                             | 100       |
| Satin-finished prismatic reflectors.....                    | 85        |
| Prismatic reflector-balls.....                              | 55        |
| Light ground glass balls with prismatic reflector inside... | 40        |
| Light ground glass balls without reflectors .....           | 35        |
| Yellow orange tinted balls .....                            | 25        |

NOTE:—The aforementioned figures are approximate values.

*The quality or character (color) of illumination for use in various departments:*—It is a well known fact that goods which are shown off to advantage under an illuminant having a certain color value, appear quite different when displayed under another form of source possessing a different color. In a store where goods of so many different natures are shown, it would appear that the color of light employed, in the various departments, should be of a nature to show the goods to the best possible advantage. As an illustration,—cut glass would appear very dull under an illumination produced by an opal globe, while illuminated with the direct rays of a tungsten lamp it would sparkle, giving off prismatic effects which would

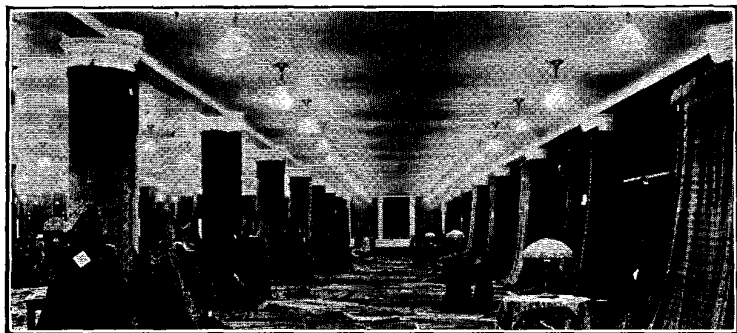


Fig. 27.—Sixth floor, rug department.

materially enhance its beauty. In showing off delicate silks, such as ribbons, etc., it is highly important that conditions approach daylight as near as possible, so that the delicate shades may be matched and shown off as they would actually appear in daylight provided they are to be used by day. Inasmuch, however, as such material is, for the most part, worn in the evening, under artificial lighting, it would appear to be a mistake to purchase goods under daylight conditions, without being able to appreciate how such fabrics would appear when actually used. It is the personal opinions of the writers that it is well to provide a place, easily accessible, where artificial light, approaching daylight, is available for color matching, etc. This, then, would permit the general use of illuminants comparable

in color with those employed in the homes, hotels, theatres, etc., where the material generally would be used. In the clothing departments of many stores, it is oftentimes a difficult matter to distinguish blues and dark greens from blacks, etc., which is a most undesirable condition of affairs. In the carpet department, the yellow and red rays are probably the most effective; and so it goes throughout the entire store. Inasmuch as appearance is of considerable importance it is undesirable to use a number of different kinds of illuminants and accessories; be-

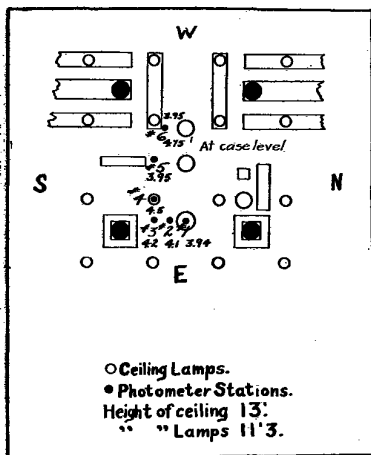


Fig. 28.—Section plan of fifth floor, (kitchen utensils), showing location of furniture, pillars, lighting units, test stations and illumination data.

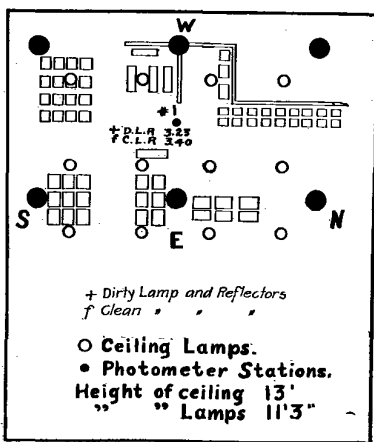


Fig. 29.—Section plan of fifth floor, (household furnishings), showing location of furniture, pillars, lighting units, test stations and illumination data.

sides carrying accessories for such diversified equipment would increase maintenance costs.

To a degree various colors may be obtained from tungsten lamps. Better results are obtained with open reflectors than from enclosing mediums unless such mediums be of clear glass. Such color differences may be had if lamps of different voltages are employed. In explanation of color variation it may be said that a tungsten lamp, say of the 250-watt type, may be operated at what is termed top voltage, middle voltage and bottom voltage. If burned at middle voltage,—standard tungsten lamp light quality, or color, will be obtained.

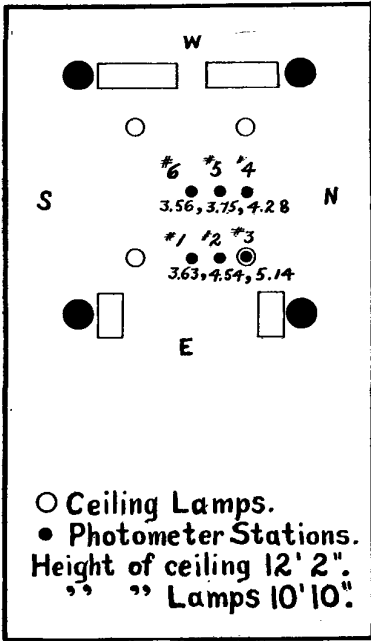


Fig. 30.—Section plan of sixth floor, (rug department), showing location of furniture, pillars, lighting units, test stations and illumination data.

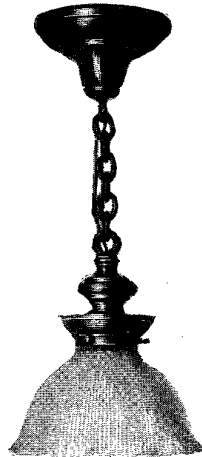


Fig. 31.—Lighting unit used in basement mezzanine, fifth and sixth floors.

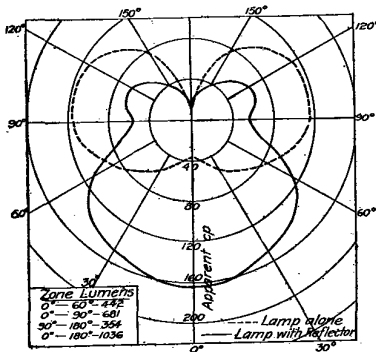


Fig. 32.—Photometric curve of satin-finished prismatic reflector with 150-watt bowl-frosted lamp.

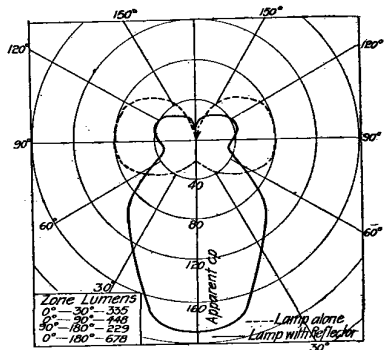


Fig. 33.—Photometric curve of satin-finished prismatic reflector with 100-watt bowl-frosted lamp.

If burned at top voltage a whiter light will be the result with 20 per cent. loss in life, while if burned at bottom voltage a light richer in yellow and red rays will be obtained and the life will be increased by about 23 per cent. Table IV shows the effects of the three voltages on tungsten lamp ruled at 25, 40, 50, 100, 150 and 250 watts.

TABLE IV.—PERFORMANCE OF TUNGSTEN LAMPS AT TOP MIDDLE AND BOTTOM VOLTAGE.

| Normal rating<br>(Total Watts) | Wattage limits | Top voltage      |                    | Middle voltage              |                  |               | Bottom voltage                 |                  |               |                             |
|--------------------------------|----------------|------------------|--------------------|-----------------------------|------------------|---------------|--------------------------------|------------------|---------------|-----------------------------|
|                                |                | Watts per candle | Nominal m. h. c.p. | Hours useful and total life | Watts per candle | N. m. h. c.p. | Hours of useful and total life | Watts per candle | N. m. h. c.p. | Hours useful and total life |
| 25 watt..                      | 20 to 34       | 1.33             | 18.8               | 1,000                       | 1.39             | 17.4          | 1,300                          | 1.45             | 16.1          | 1,700                       |
| 40 watt..                      | 34 to 49       | 1.25             | 32.0               | 1,000                       | 1.30             | 29.9          | 1,300                          | 1.35             | 28.0          | 1,700                       |
| (small bulb)                   |                |                  |                    |                             |                  |               |                                |                  |               |                             |
| 40 watt..                      | 34 to 49       | 1.25             | 32.0               | 1,000                       | 1.30             | 29.9          | 1,300                          | 1.35             | 28.0          | 1,700                       |
| (large bulb)                   |                |                  |                    |                             |                  |               |                                |                  |               |                             |
| 60 watt..                      | 50 to 72       | 1.20             | 50.0               | 1,000                       | 1.25             | 46.5          | 1,300                          | 1.30             | 43.5          | 1,700                       |
| 100 watt.                      | 85 to 120      | 1.15             | 87.0               | 800                         | 1.20             | 80.8          | 1,000                          | 1.25             | 75.2          | 1,300                       |
| 150 watt.                      | 125 to 175     | 1.15             | 130.3              | 800                         | 1.20             | 121.1         | 1,000                          | 1.25             | 112.8         | 1,300                       |
| 250 watt.                      | 200 to 300     | 1.10             | 227.3              | 800                         | 1.15             | 210.0         | 1,000                          | 1.20             | 195.0         | 1,300                       |



Fig. 34.—Sixth floor, art gallery showing oil paintings.

*Window Lighting.*—Unquestionably the most efficient and economic manner of lighting windows is through the medium of

lamps equipped with individual reflectors, inasmuch as by the use of scientifically-designed reflectors, the greatest percentage of light flux emanating from a bare lamp is re-directed in the most useful directions, whereas if a so-called trough reflector is used, and the lamps are not individually treated, the reflection becomes more general and less specific. Individual reflectors should

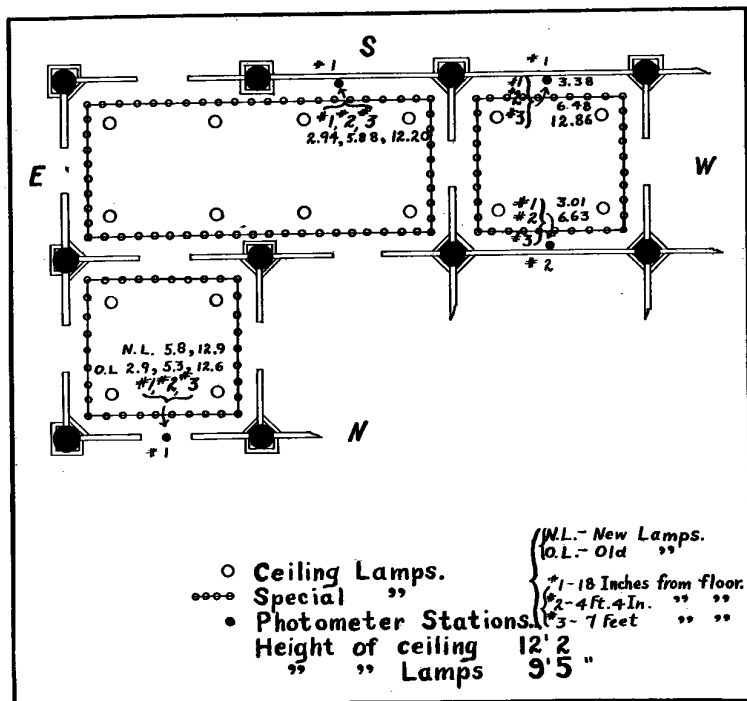


Fig. 35.—Section plan of sixth floor, (art gallery), showing location of furniture, pillars, lighting units, test stations and illumination data.

be used in windows for the same general reasons that single lamps should be used inside of spheres, because where two or more lamps are used under a reflector, a portion of light rays emanating from one lamp is intercepted by the other lamp and is thereby, to a measure, wasted. The individual steel reflector should be placed at the angle formed by the ceiling and front glass, a valance suspended from the ceiling, between reflectors

and plate glass window, will hide the lighting equipment, thereby making the windows more pleasing.

*Elevators.*—It is highly important that sufficient illumination be provided on floors of elevators so that passengers can readily see the position of the elevator floor when entering or leaving the car, thus considerably eliminating causes for accidents. In order that an illuminating unit could be suggested for the elevators, which would harmonize with their design, and at the same time produce the necessary illumination on the floor, further data would have to be supplied. Too much stress cannot be laid upon the necessity of giving thought to this phase of the lighting installation. This is a detail that in a great number of



Fig. 36.—Fifth floor, cut glass department.

buildings is almost entirely overlooked, with the result that the lighting units which are suggested are woefully inadequate.

*General Notes.*—It is respectfully suggested that, in deciding on the lighting installation for this establishment, the advances which have been made in the art and science of illuminating engineering during the last few years be considered so that such development may be employed advantageously in this store. Numerous lighting equipments installed in stores have been designed with only a few hit or miss ideas of their illuminating value, and it is hardly necessary to state that a number of these installations, proving inadequate, have been discontinued and more modern arrangements installed in their place, in some instances at a cost of many thousand of dollars.



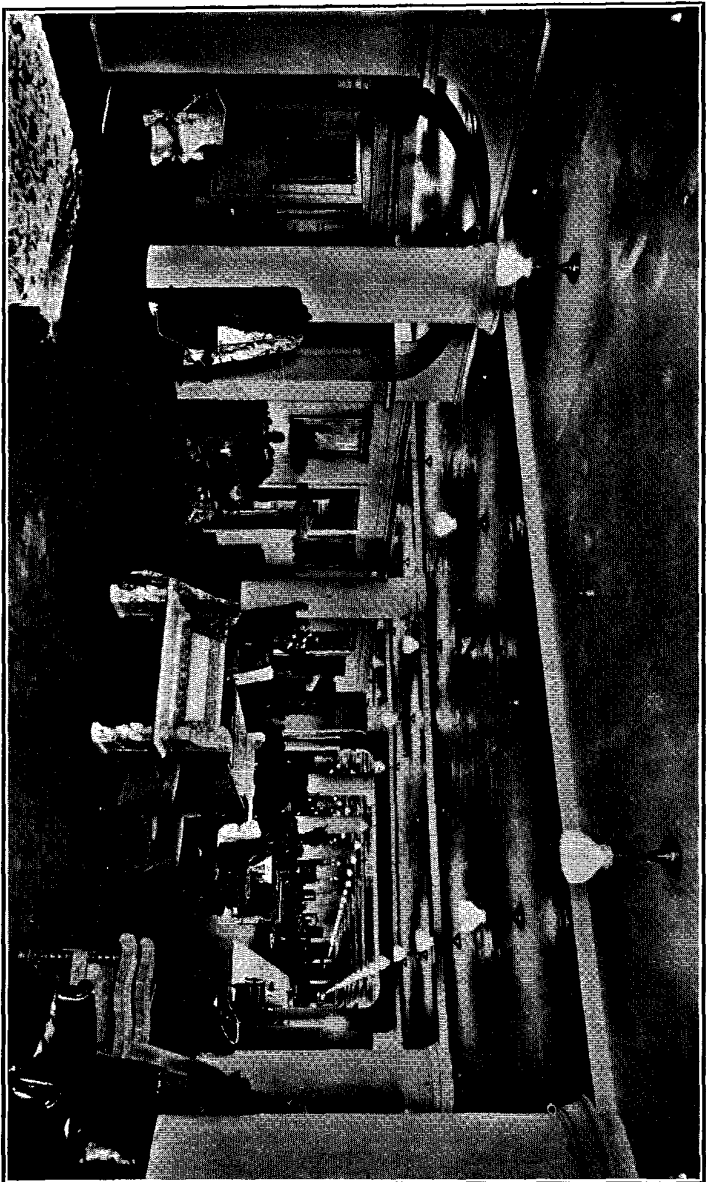


Fig. 37.—Seventh floor, furniture department.

After the aforementioned recommendations had been made, it was learned that the contract for the lighting fixtures had already been let. The fixture manufacturers, being approached by the owners to see if some changes could not be affected along lines suggested by the authors, very kindly agreed to do all in their power to obtain the desired results. Inasmuch, however, as arrangements had already been made for a considerable part of the lighting equipment it was impossible to carry out the suggestions wholly. The changes made were the use of

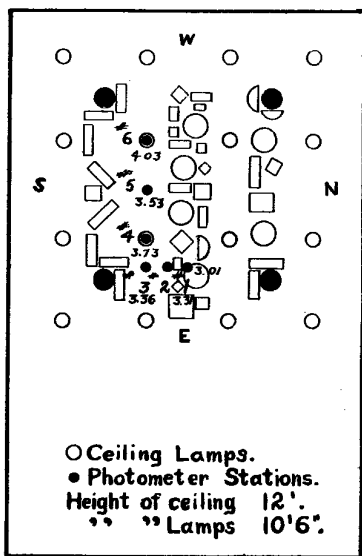


Fig. 38.—Section plan of seventh floor, (furniture department), showing location of furniture, pillars, lighting units, test stations and illumination data.

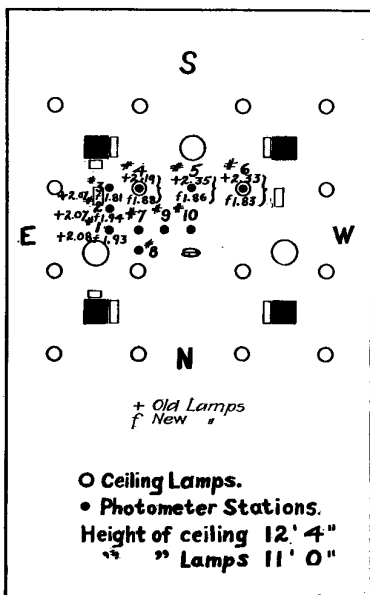


Fig. 39.—Section plan of eighth floor, (main restaurant), showing location of furniture, pillars, lighting units, test stations and illumination data.

lightly-ground glass 14-in. balls with single units on the first floor, instead of the yellow orange tinted glass-ball with three lamps, as suggested by the engineer; the use of 10-in. ground glass-balls, instead of the tinted sphere in the basement, main floor under balcony, main floor mezzanine; second, third, floor as suggested by the engineer; the use of 10-in. ground

glass-balls instead of the tinted sphere in the basement, main floor under balcony, main floor mezzanine; second, third, eighth floors; the use of opal reflectors in basement, under balcony, fourth and seventh floors; prismatic reflectors in basement mezzanine; fifth and sixth floors, with individual steel reflectors in the art galleries and display windows.

#### SUPPLY OF ENERGY.

For supplying energy for the large connected lamp and motor load in the building, the rating of which aggregates approxi-



Fig. 40.—Eighth floor, main restaurant.

mately 10,000 hp., the New York Edison Company erected a substation in the sub-basement. The equipment installed consists of seven 1,000-kw. rotary converters with the necessary step-down transformers and high-tension switches. Three-phase, 25-cycle alternating current, at a tension of 6,600 volts, is brought under-ground from the Waterside stations, and this is converted to direct current at a potential of 240 volts for the three-wire system in the building. A direct-current switch-board located in the sub-basement is joined with the building distribution board by heavy tie connections. In addition there are several 1,000,000-circ. mil concentric cables for connection with the Edison distribution mains, so that in case of trouble with the substation apparatus these feeders will supply energy

from the street service to the building, thus ensuring continuity of service under all conditions. Aside from taking care of the lighting load, the Edison service is also used for thirty-six passage elevators and ten freight elevators.

#### ILLUMINATION TESTS.

After the opening of the Gimbel store, the New York Edison Company authorized the Electrical Testing Laboratories of New York, to conduct illumination and other tests in this building, in order to arrive at a knowledge of the results which were actually being obtained. These tests, which were conducted during a period of several weeks, were made under the immediate super-

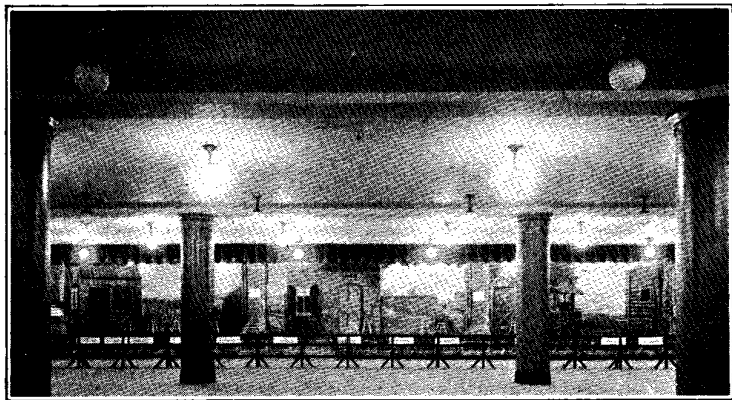


Fig. 41.—Eighth floor, auditorium.

vision and direction of the authors. Tests were made in various parts of the store, each test station being represented by a plan or elevation. Upon these diagrams, test stations have been indicated and the illumination at each station has been shown in foot-candles; with a few exceptions, there is a diagram for each area. Measurements were made in horizontal and vertical planes as directed. The test stations were located with a view of securing the most typical and most useful values, rather than with a view of determining the total flux on any given plane through measurements at equally spaced stations. In all test areas except as noted, the lighting was provided by means of tungsten lamps;

various kinds of glassware were employed; the voltage at which the lamps were operating during the tests was determined by means of photometric measurements at the sockets. To facili-

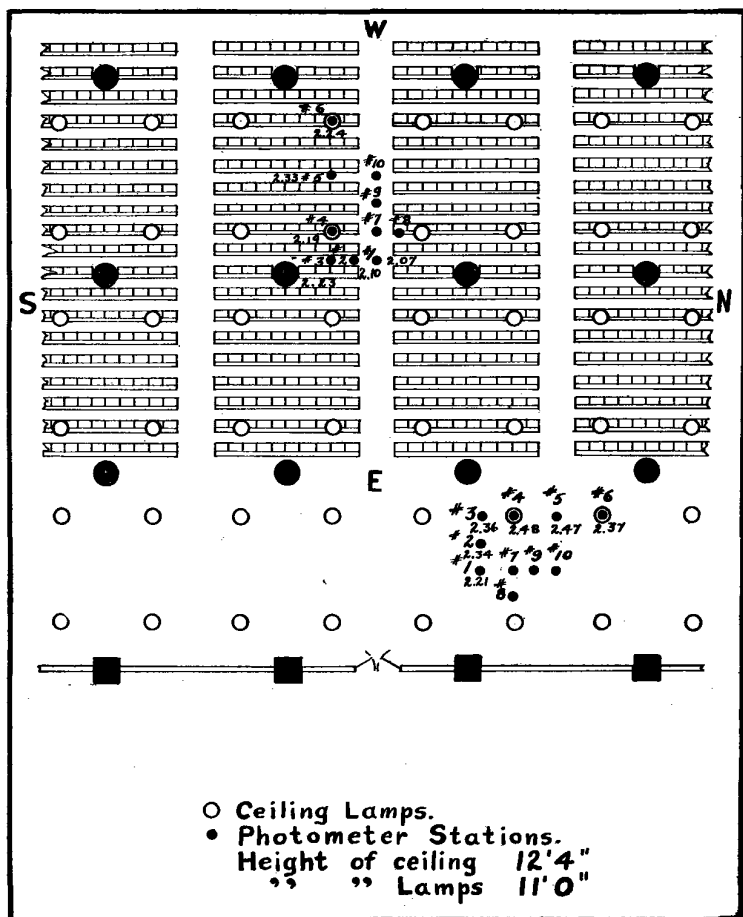


Fig. 42.—Section plan of eighth floor, (auditorium), showing location of furniture, pillars, lighting units, test stations and illumination data.

tate comparisons among the various tests, all values of candle-power and foot-candles have been corrected for variation from 120 volts at the lamp socket. The lamps and glassware were

TABLE VI.—VERTICAL ILLUMINATION.

| Test area    |                         | Lighting installation |                        |                                   |                             | Foot-candles—Verticle plane. Height of tes |         |           |         |           |         |           |         |
|--------------|-------------------------|-----------------------|------------------------|-----------------------------------|-----------------------------|--|---------|-----------|---------|-----------|---------|-----------|---------|
|              |                         |                       |                        |                                   |                             | 14 inches                                  |         | 18 inches |         | 24 inches |         | 43 inches |         |
| Floor        | Depart-<br>ment         | Ceiling<br>height     | Light<br>source        | Auxiliary                         | Light source<br>above floor | Minimum                                    | Maximum | Minimum   | Maximum | Minimum   | Maximum | Minimum   | Maximum |
| Main .....   | Gentlemen's<br>neckwear | 20 ft.                | 250 watt<br>bowl frst. | 14-in.<br>ground<br>glass<br>ball | 16 ft.                      | 0.3  | 0.3     | ..        | ..      | 1.2       | 1.3     | 2.3       | 2.4     |
| Second ..... | White<br>goods          | 14 ft.                | 150 watt<br>bowl frst. | 10-in.<br>ground<br>glass<br>ball | 11 ft. 6 in.                | 0.5  | 0.6     | ..        | ..      | 1.1       | 1.2     | 1.6       | 1.9     |
| Fourth ..... | Book                    | 13 ft. 1.5 in.        | 150 watt<br>bowl frst. | 150 watt<br>opal refl.            | 11 ft. 1.5 in.              | 0.3  | 0.5     | ..        | ..      | 0.6       | 1.0     | 1.1       | 1.7     |
| Fifth .....  | Kitchen<br>utensils     | 13 ft.                | 150 watt<br>bowl frst. | Prismatic<br>reflector            | 11 ft. 3 in.                | 0.3  | 0.6     | ..        | ..      | 0.5       | 0.5     | 1.0       | 1.4     |
| Sixth .....  | Art<br>galleries        | 12 ft. 2 in.          | 40 watt<br>clear       | Metal<br>reflector                | 9 ft. 5 in.                 | ..   | ..      | ..        | ..      | ..        | ..      | ..        | ..      |
|              | White<br>room           | .....                 | .....                  | .....                             | .....                       | ..   | ..      | 3.0       | 3.4     | ..        | ..      | ..        | ..      |
|              | Painting<br>gallery     | .....                 | .....                  | .....                             | .....                       | ..   | ..      | ..        | 2.9     | ..        | ..      | ..        | ..      |
|              | Carbon<br>room          | .....                 | .....                  | .....                             | .....                       | ..   | ..      | ..        | 2.9     | ..        | ..      | ..        | ..      |
| Second ..... | Shoe                    | 14 ft.                | 150 watt<br>bowl frst. | 10-in.<br>ground<br>glass<br>ball | 11 ft. 6 in.                | 6.3  | 7.8     | 7.0       | 7.7     | 6.1       | 6.9     | 5.9       | ..      |

TABLE VI.—VERTICAL ILLUMINATION.

|   |                          | Foot-candles—Verticle plane. Height of test stations |         |           |         |           |         |           |         |           |         |           |         |           |         |
|---|--------------------------|--|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|
|   |                          | 14 inches  |         | 18 inches |         | 24 inches |         | 43 inches |         | 52 inches |         | 72 inches |         | 84 inches |         |
| n | Light source above floor | Minimum  | Maximum | Minimum   | Maximum | Minimum   | Maximum | Minimum   | Maximum | Minimum   | Maximum | Minimum   | Maximum | Minimum   | Maximum |
|   | 16 ft.                   | 0.3  | 0.3     | ..        | ..      | 1.2       | 1.3     | 2.3       | 2.4     | ..        | ..      | 3.2       | 3.3     | ..        | ..      |
|   | 11 ft. 6 in.             | 0.5  | 0.6     | ..        | ..      | 1.1       | 1.2     | 1.6       | 1.9     | ..        | ..      | 2.2       | 2.4     | ..        | ..      |
|   | 11 ft. 1.5 in.           | 0.3  | 0.5     | ..        | ..      | 0.6       | 1.0     | 1.1       | 1.7     | ..        | ..      | 1.2       | 2.6     | ..        | ..      |
|   | 11 ft. 3 in.             | 0.3  | 0.6     | ..        | ..      | 0.5       | 0.5     | 1.0       | 1.4     | ..        | ..      | 1.0       | 2.3     | ..        | ..      |
|   | 9 ft. 5 in.              | ..   | ..      | ..        | ..      | ..        | ..      | ..        | ..      | ..        | ..      | ..        | ..      | ..        | ..      |
|   | .....                    | ..   | ..      | 3.0       | 3.4     | ..        | ..      | ..        | ..      | 6.5       | 6.6     | ..        | ..      | ..        | 12.9    |
|   | .....                    | ..   | ..      | ..        | 2.9     | ..        | ..      | ..        | ..      | ..        | 5.9     | ..        | ..      | ..        | 12.2    |
|   | .....                    | ..   | ..      | ..        | 2.9     | ..        | ..      | ..        | ..      | ..        | 5.3     | ..        | ..      | ..        | 12.6    |
|   |                          | 12 in.   |         | 36 in.    |         | 60 in.    |         | 75 in     |         | (Gallery) |         |           |         |           |         |
|   | 11 ft. 6 in.             | 6.3  | 7.8     | 7.0       | 7.7     | 6.1       | 6.9     | 5.9       |         | 2.2       |         | 7.1       |         |           |         |

## TESTS OF VERTICAL ILLUMINATION.

Table VI shows results of illumination tests in departments where intensity of illumination on the vertical plane was considered to be most indicative of the useful illumination. These measurements were made at various heights above the floor, as required, in consideration of the objects to be accomplished in the various departments. Only minimum values are given in the summary.

In the installations where alternate rows of lamps are ex-

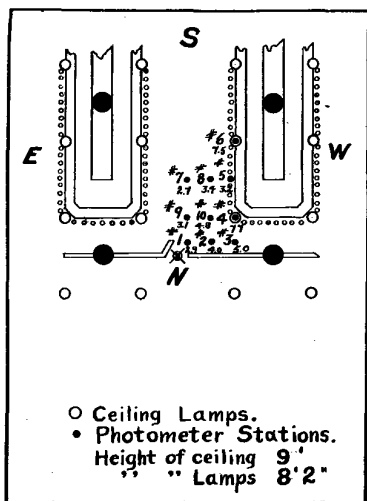


Fig. 48.—Section plan of basement mezzanine, (dairy lunch), showing location of furniture, pillars, lighting units, test stations and illumination data.

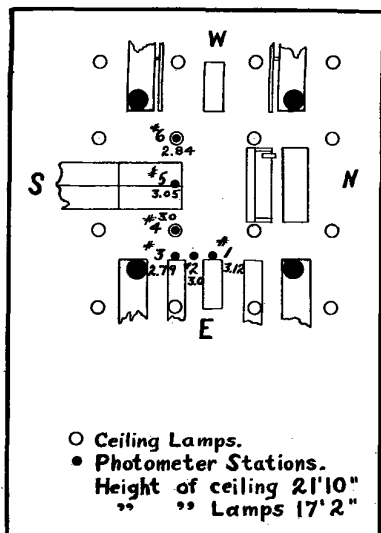


Fig. 49.—Section plan of basement in well, (notion department), showing location of furniture, pillars, lighting units, test stations and illumination data.

tinguished, as noted below, the illumination is, of course, much reduced. When the row of extinguished lamps is parallel with the plane of reference, there is relatively small influence upon the uniformity. This applies to the neckwear and white goods departments.

When the row of extinguished lamps is transverse with respect to the plane of reference, the uniformity is affected unfavorably. Such instances are found in the book and kitchen utensil departments.



## NOTES ON TEST AREAS.

*Gentlemen's Neckwear—Main Floor.*—Half general illumination throughout floor; row of lamps over counter extinguished. (Fig. 37.)

*White Goods—Second Floor.*—Half general illumination throughout floor; row of lamps over counter in use.

*Books—Fourth Floor.*—Half general illumination throughout floor; alternate rows of lamps in use.

*Kitchen Utensils—Fifth Floor.*—Half general illumination throughout floor; alternate rows of lamps burning. (Fig. 28.)

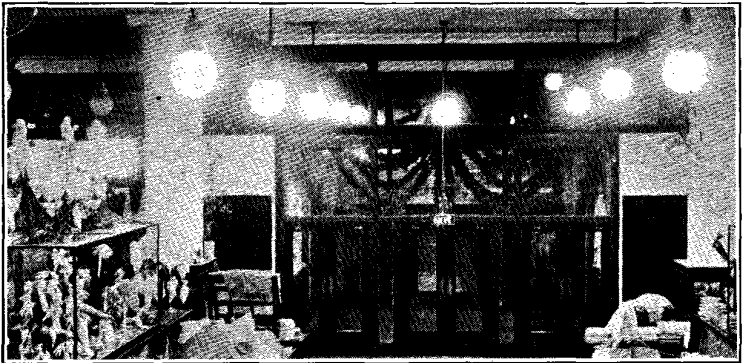


Fig. 50.—First floor, main entrance.

## SHOW WINDOW ILLUMINATION.

Window No. 21 was selected for test purposes. The ceiling is 10 ft. 8 in. above the bottom of the show-case, and the lighting is by 60-watt clear tungsten lamps with 30-degree steel reflectors. The results of the test are indicated in Table VII.

TABLE VII.—SHOW WINDOW ILLUMINATION

| Test plane<br>above floor | Horizontal |      | Foot-candles<br>Normal |      | Vertical |      |
|---------------------------|------------|------|------------------------|------|----------|------|
|                           | Min.       | Max. | Min.                   | Max. | Min.     | Max. |
| Level .....               | 10.7       | 15.0 | 11.5                   | 14.9 | 4.3      | 6.7  |
| 2 .....                   | 15.4       | 16.7 | 16.3                   | 17.1 | 8.0      | 8.1  |
| 4 .....                   | 15.5       | 18.7 | 17.8                   | 17.4 | 13.0     | 13.6 |
| 6 .....                   | 13.8       | 19.2 | 23.2                   | 24.0 | 17.8     | 19.5 |

TEST OF LIGHT ABSORPTION DUE TO DUST.

Certain casual tests were made to determine the extent of the improvement effected by cleaning the lamps. These are barely more than suggestive, as only one test station was in-

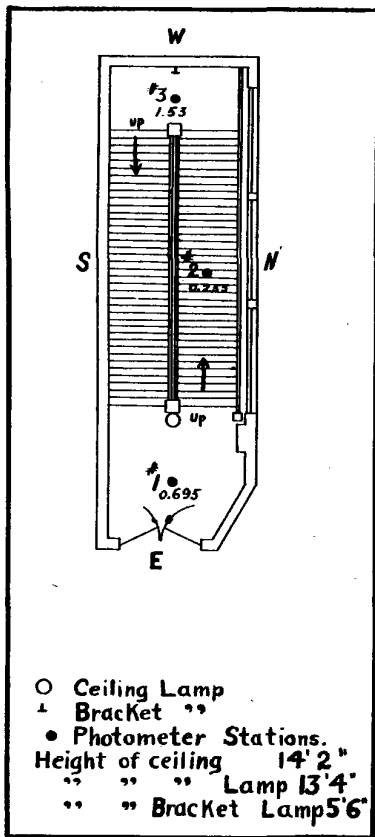


Fig. 52.—Steel reflector used in window on street level.

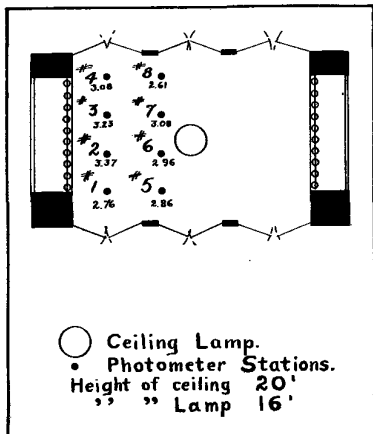


Fig. 51.—Section plan showing typical stairway, showing location of lighting units, test stations and illumination data.

Fig. 53.—Section plan of first floor, (main entrance), showing location of lighting units, test stations and illumination data.

vestigated in each department before and after cleaning the lamps and the glassware. The results of these tests appear in Table No. 8. In addition to these simple tests, the effect of re-

TABLE VIII.—LIGHT ABSORPTION DUE TO DUST.

| Test area               |                     |                | Lighting installation |                          |                         | Height of test plane | Horizontal foot-candles    |                            |                            |
|-------------------------|---------------------|----------------|-----------------------|--------------------------|-------------------------|----------------------|----------------------------|----------------------------|----------------------------|
| Floor                   | Department          | Ceiling height | Light source          | Accessory                | Light source from floor |                      | Equipment dusty, old lamps | Equipment clean, old lamps | Equipment clean, new lamps |
| Main <sup>1</sup> ..... | General merchandise | 20 feet        | 250-watt bowl frosted | 14-in. ground glass ball | 16 feet                 | 33 in.               | 2.4                        | 2.8                        | 3.0 <sup>2</sup>           |
| Second .....            | Infants wear        | 14 feet        | 150-watt bowl frosted | 10-in. ground glass ball | 11 feet 6 in.           | 33 in.               | 2.0                        | ..                         | 3.0                        |
| Fourth .....            | Toy                 | 13 feet 1½ in. | 150-watt bowl frosted | Opal reflector           | 11 feet 1½ in.          | 33 in.               | 2.7                        | 3.0                        | ..                         |
| Fifth.....              | Hardware            | 13 feet        | 150-watt bowl frosted | Prismatic reflector      | 11 ft. 3 in.            | 33 in.               | 3.2                        | 3.4                        | ..                         |

<sup>1</sup> Average total lumens, old lamps..... 1560

<sup>1</sup> Average total lumens, new lamps..... 2020

<sup>2</sup> Clear lamps.

placing the lamps with new lamps in two of the installation was determined.

It is interesting to note the effect of dust on ground glass balls opal and prismatic reflectors. With the 14-in. ground glass ball the depreciation, in useful illumination, due to the accumulation of dust, is approximately 16 per cent. While it was not convenient to obtain data on the 10-in. ground glass ball of a similar nature, it is reasonable to assume that the loss is ap-

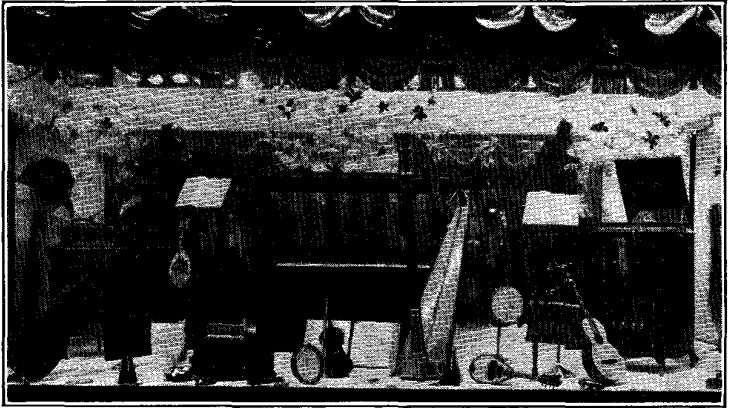


Fig. 54.—Show window lighting.

proximately the same. With the opal reflector the loss was found to be approximately 11 per cent., while with the prismatic reflectors, the loss was approximately 6 per cent.

A further analysis of Table VIII shows that for equal wattage the satin-finished, prismatic reflector gives approximately 14 per cent. greater useful illumination than the opal reflector, and that for equal illumination the satin-finished, prismatic reflector gives approximately twice the useful illumination as that obtained from tungsten lamps enclosed in light ground-glass spheres.

#### SPECIFIC INTENSITY OF SURFACES.

Certain tests of specific intensity of ceiling, and in one case of shelves, were made. The portion of ceiling investigated was



TABLE IX.—SURFACE INTENSITIES.

| Floor  | Department   | Ceiling                  | Specific intensity<br>C-p. per sq. in. |         | Remarks            |
|--------|--------------|--------------------------|--|---------|--------------------|
|        |              |                          | Minimum                                | Maximum |                    |
| Eighth | Smoking-room | Ceiling                  | 0.0015                                 | 0.0041  |                    |
| Eighth | Auditorium   | Ceiling                  | 0.0012                                 | 0.0037  | (Normal condition) |
| Eighth | Auditorium   | Ceiling                  | 0.0021                                 | 0.0045  | (Chairs removed)   |
| Sixth  | Rug          | Ceiling                  | 0.0034                                 | 0.0067  |                    |
| Second | Shoe         | Ceiling                  | 0.0042                                 | 0.0056  |                    |
| Second | Shoe         | Gray boxes<br>on shelves | 0.0038                                 | 0.0086  |                    |

that immediately over a test station selected for the illumination

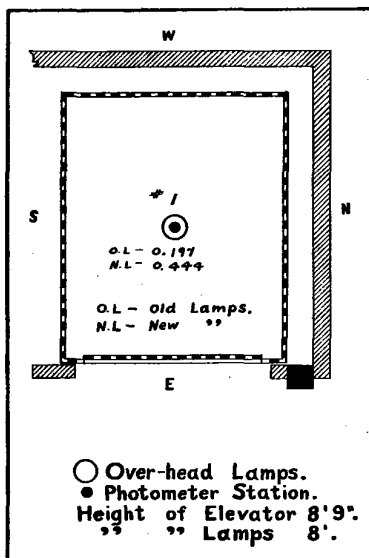


Fig. 56.—Section plan showing elevator No. 41 with location of lighting units, test stations and illumination data.

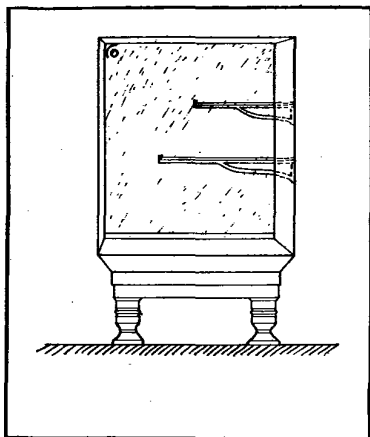


Fig. 57.—Plan showing end view of cases.

tests. In the shoe department, in addition to measurements of the brightness of the ceiling, measurements were made of the specific intensity of gray shoe boxes on the shelves. These were viewed normally. The results of these tests appear in Table IX.

In addition to these measurements of specific intensity, similar determinations were made on the main floor. These appear in Table X, where the values of candle-power per square inch

TABLE X.—SPECIFIC INTENSITY—MAIN FLOOR.

| Surface                                    | Angle of View                     | C-p. Per Sq. In.            |
|--|-----------------------------------|-----------------------------|
| Ceiling                                    | Vertical                          | 0.013                       |
| Pillars                                    | 20 to 35 degrees above horizontal | 0.010                       |
|  | Horizontal                        | 0.0016                      |
| Distant elevator doors and metal trimmings | Horizontal                        | 0.0016                      |
| Merchandise displayed in cases             | About 30 degrees below horizontal | 0.0024 (without case lamps) |
| Merchandise displayed in cases             | About 30 degrees below horizontal | 0.0088 (With case lamps)    |
| Aisle floor                                | Vertical                          | 0.0051                      |

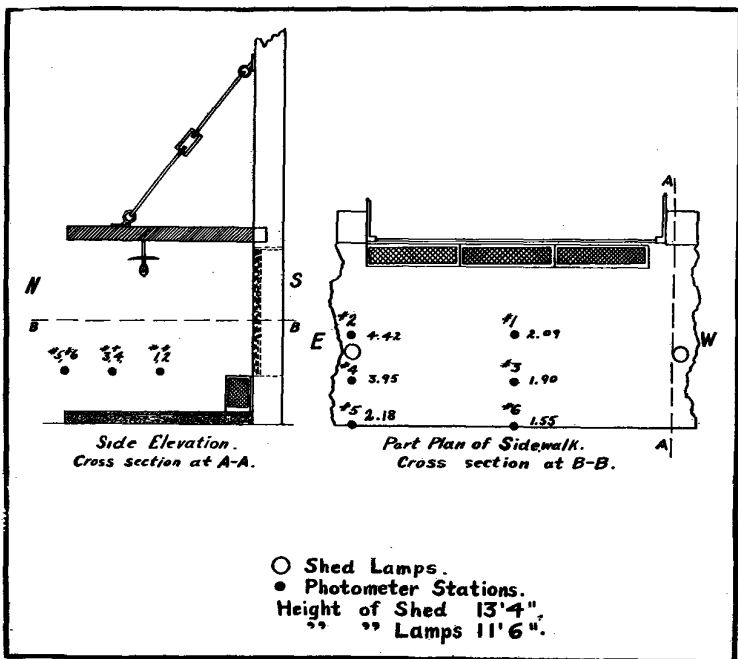


Fig. 58.—Showing plans and elevation of outside of shipping department.

are means of a few random measurements of the surfaces indicated.

As indicated in Table X, the ceiling and pillars of the main floor in particular and of other floors in general, are bright. On the main floor this is due first, to the fact that the finish

is of high light-reflecting power, and second, to the fact that in most cases the light sources diffuse the light rather generally and do but little in the way of directing it downward. The view of a shopper or employee, when not directed toward some article of merchandise, is likely to embrace a larger area of the bright ceiling and wall than of the darker finished cases, shelves and merchandise. This introduces a condition of glare which it was anticipated might have the three effects of reducing the ability to see, distracting the attention from merchandise and causing eye fatigue. The last factors too are difficult to determine and no efforts were made to investigate them. Tests were made to determine the effect upon visual power, and so far as they were carried out, indicated no very material deleterious

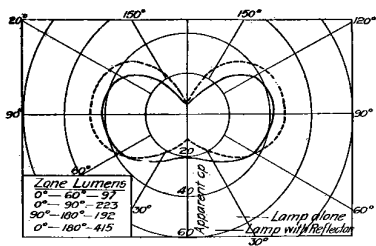


Fig. 59.—Photometric curve of 10-in. ground glass-ball with 60-watt bowl-frosted tungsten lamp.

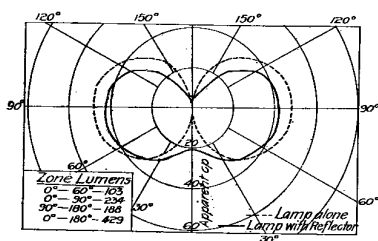


Fig. 60.—Photometric curve of 10-in. ground glass-ball with 60-watt clear bulb tungsten lamp.

effect. It is recognized that attempts at such determinations are likely to be involved in difficulty because of the many uncertain elements which enter into the problem; hence it is not asserted that there is no reduction in ability to see, due to the glare from the bright ceiling and pillars. It is merely stated that efforts to detect and measure such effect were unsuccessful.

The authors have yet to investigate certain experimental equipment designed with a view of eliminating undesirable effects, as, for instance, the large brightly illuminated white areas of ceilings and pillars. They had hoped to have incorporated some of their findings on the visualizing efficiency of the installation in this paper, but as the experimental work involved not only photometry and illuminometry, but a study of the physio-



logical and psychological phases as well, the work has assumed such proportions that they have been unable to satisfy their

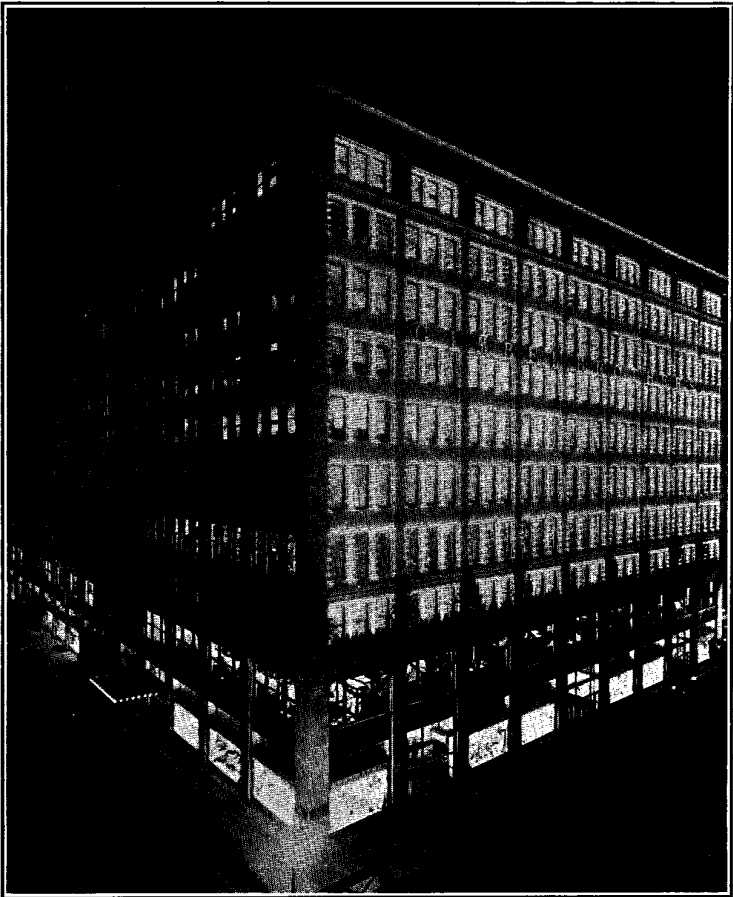


Fig. 61.—Exterior view of the store showing Christmas lighting.

desires at this time. It is hoped that, in a subsequent paper, this very important phase of lighting, as related to stores, will be treated.

The authors take this means of heartily thanking, for their

greatly appreciated co-operation which has been of material assistance in the formation of this work, Messrs. Gimbel Brothers, the New York Edison Company and the Electrical Testing Laboratories.

#### DISCUSSION.

*Mr. P. S. Millar:*—The paper is essentially a description of the lighting installation of the Gimbel store, and a recounting of tests made of the lighting as it stands. So definite and specific is the description that there was needed only the opportunity which was afforded to observe the lighting effects to make it complete. Any description of this character must deal largely with facts rather than with opinions. That being the case, the paper does not provoke the spontaneous criticism and discussion that takes place when the papers deal almost exclusively with matters of opinion. With a perspicacity which is at the same time commendable and regrettable, the authors have very carefully refrained from expressing opinion of the lighting effects which have been obtained in the building.

This is one of the few well lighted department stores in this country. The quantity of light is ample, perhaps in some cases excessive. The quality of the light is as good, probably, as could have been obtained, when one is committed to the policy of using only one type of illuminant in the store. It is at this point that I hesitated in reading the paper. The requirements of lighting in a department store are so diversified that it would appear desirable to utilize several of the many different kinds of electric illuminants which are available.

The authors of the paper have pointed out that at least one room in the store should be equipped to furnish an equivalent of daylight. It seems to me we may go further and say that a number of rooms in a department store should have available such lighting effects. They should be equipped with alternative lighting systems, so that one may duplicate either daylight, or average artificial light. Many of the goods purchased in a store must be used in the daytime as well as in the night time—hence the desirability of such an arrangement.

In the paper it is stated that the ceiling and pillars of the