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THE O'NEILL-NAGEL LIGHT-TABLE (A MULTIPURPOSE LIGHT-TABLE) ITS USES IN PHOTO-INTERPRETATION OF COLOR AND OTHER PHOTOGRAPHY*

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A NEW TYPE OF LIGHT-TABLE

IN INTERPRETING aerial photography especially color-transparencies, it was soon realized that the recognition of minute objects, especially colored objects, could be facilitated by using a light-table where light of any color could be easily obtained and where illumination could be varied in insensible gradations from very bright (e.g. 400 to 500 on the scale of a Weston light meter) to very dim (less than 5 on the Weston scale). To meet this need this new type of light-table was designed and built (Figure 1). It is primarily made for use in studying color-photography; but because of the high degree of illumination and the very great variability of the intensity of this illumination, this instrument is also useful in studying black and white photography. Furthermore, this light-table has applications in any industry where an inexpensive source of transmitted light of many (thousands) commercial colors can be used, since this apparatus can be very simply and quickly made to serve as a source of light of any color or of any six or twelve colors, side by side in the same field on the viewing screen. When lights of various colors are shown on the viewing screen, it is possible to determine readily what color can best be used to restore the color balance of an under-exposed or over-exposed color-picture by placing the transparency in the successive areas of the differently colored light.

Some of the Notable Features

Color

1. Provision is made for obtaining, conveniently and cheaply, light of any of the thousands of kinds of color transmitted by commercial dyes, pigments, paints, inks, pure chemicals, stained glass, colored fabrics, paper, plastics, photographic filters, etc. This colored light will be available for studying and interpreting color-photography or any translucent or transparent object. Certain studies of opaque colored objects can also be made by allowing the various colored lights to impinge on such objects directly from the light-table or transferred by mirrors. The "thousands" of different kinds of colored light are obtained by interposing in the filter chamber of the light-table, i.e. the space between the fluorescent tubes and the viewing screen (accessible when the

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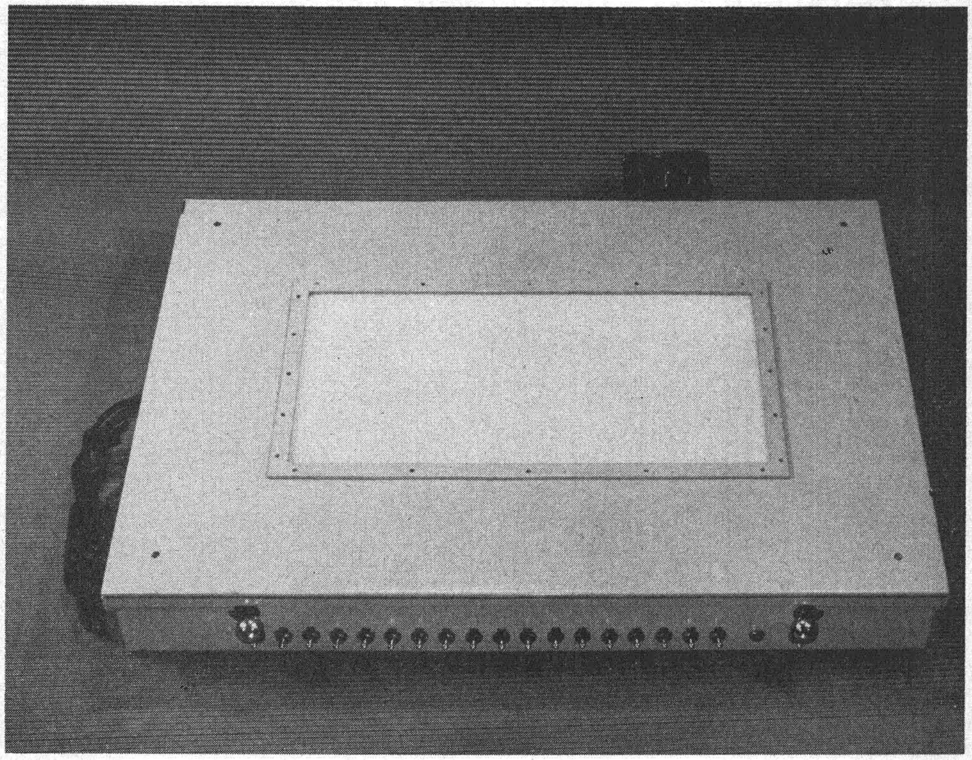

FIG. 1. External View. Viewing Panel seen from above.

front panel is removed as shown on Figure 2), a thin transparent or translucent layer of any colored substance. This can be any of the following:

Natural Pigments in Plants

a) The leaf or petal of a plant, in the fresh and living condition or a leaf very rapidly dried and pressed between blotters in an ordinary tropical botanical press (†) *and kept in the dark except when actually in use.* This is a simple way of obtaining the kind of light transmitted by chlorophyll *A* and *B* in all green leaves of land plants, and the various colors (carotinoids, anthocyanins, etc.,) found in autumnal and very young leaves and in the mature, living leaves (during the entire growing season) of certain strains of cultivated plants that show colors other than green, such as the copper-beech (*Fagus sylvatica* vars.), blood-leaf Jap maple (*Acer palmatum* vars.), purple hazel (*Corylus avellana* vars.), golden box (*Buxus sempervirens* var.), Joseph's Coat (*Coleus* vars.), the crotons of the tropics (*Codiaeum* vars.) etc. Due allowance must be made for changes in all the labile vegetable pigments that take place in drying, fading and shifting of the hydrogen ion concentration. (Under "j" is described a way of using the vegetable pigments in solution.) As an example of the use of a leaf as a filter, the red light transmitted by the brilliant red leaves of the black gum (*Nyssa sylvatica Marsh.*) makes the recognition of trees of black gum on aerial photographs (Aug. 15 to Sept. 15) strikingly easy. Most leaves for use as colored filters are too thick for light to pass through and should be split while fresh before drying.

† A convenient rapid way of drying plants is by the use of a combined electric dryer and insect-killing cabinet invented by one of the authors. (*Rhodora*, 40: 1–4. 1938)

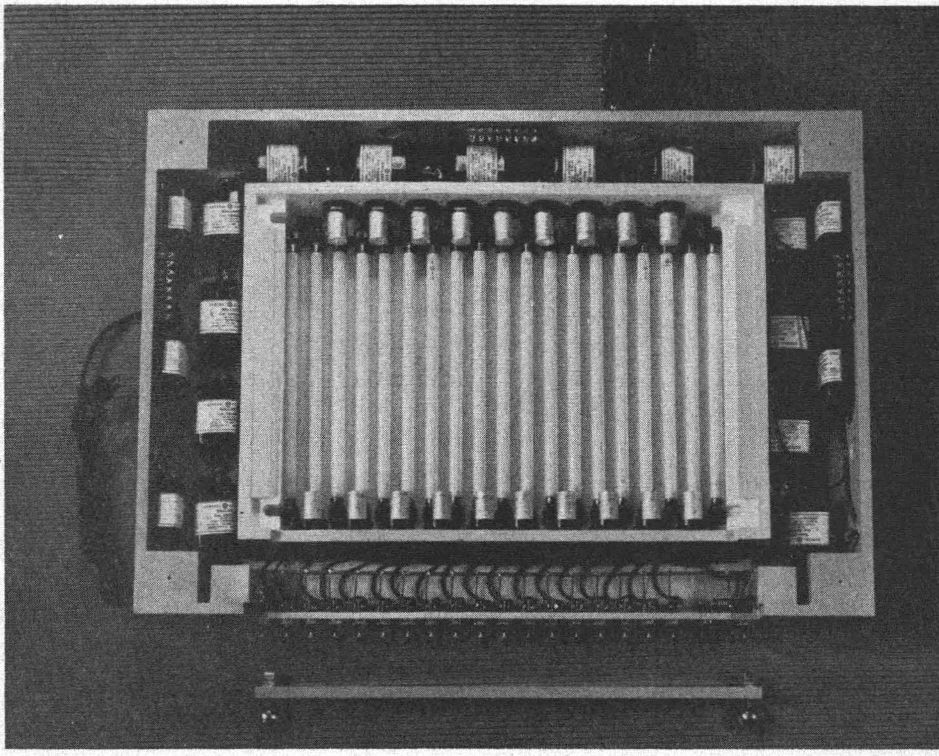

FIG. 2. Internal View. Electric Fan at top. Front Panel detached.

Synthetic or Aniline Dyes

b) Thin sheets of any of the numerous kinds of plastics colored with aniline dyes. (e.g. Colored "cellophane" has the advantage of being extremely cheap and available in hundreds of colors, actually on the market.)

c) Any water-soluble dye in the shape of a suspension in a clear colloid coated on plates of glass or plastic. The dye can be suspended in gelatin (as in Wratten filters), agar, pectin, gum arabic, egg white, starch gel, dextrin, etc. Such a suspension can be coated on glass and a second sheet or cover glass superposed. Methacrylates make acceptable substitutes for cover glass. Water-soluble and alcohol-soluble dyes can also be placed in suspension in glycerine, glycol, etc., and kept between sheets of glass as a temporary filter.

d) Any alcohol-soluble dye incorporated into any "spirit varnish" and coated on sheets of transparent material. Copals, damars or "water-white" resin of the southern long-leaf pine (*Pinus australis Michx.* mistakenly *P. palustris Miller*) dissolved in alcohol are suitable materials.

e) Any oil-soluble dye in the shape of a suspension in a clear varnish coated on sheets of transparent material. These dyes can be dissolved in appropriate solvents (xylene, turpentine, etc.) and then incorporated in any clear commercial varnish or in a laboratory-made clear suspension of one of many plastics and then coated on squares of glass. For example, diazoaminobenzene (orange) in dilute solution in xylene can be incorporated in ethyl methacrylate in the same solvent.

Inorganic Pigments

f) Thin layers of inorganic pigment in the shape of stained glass, e.g., the *glass filters commonly used in photography, the cobalt glass used in making the flame test for potassium.* These filters have the advantage over the synthetic dyes in that they are permanent to light. The "sharpest-cutting filter" so far used by the authors is the didymium glass filter, i.e., its spectro-photometric curve is the steepest.

g) *Mineral pigments, finely-ground and incorporated in thin layers of a clear varnish or plastic.*

h) *Mineral pigments or synthetic dyes incorporated in paper or dyed on textiles of close weave.* These are less satisfactory than any of the preceding but can be used satisfactorily for some purposes.

i) *Paints or inks in very thin or very dilute layers on sheets of transparent material.* These can be used to secure translucent colored light.

j) *Inorganic colored ions, dyes or natural vegetable coloring matters in solution placed in flat cells of glass or plastic.* This enables the interpreter to make use of the light-permanent inorganic cations, such as Cu'', Co'', Fe''', Ni'', Cr''' and anions, such as, $—Cr_2O_7$, $—MnO_4$, etc. By the use of different solvents for the same dye or other colored substance, different spectro-photometric curves can be obtained for the same substance, e.g., iodine in carbon bisulfid transmits rose-purple light but iodine in ethyl alcohol transmits brown light.

k) *Thin layers of pigments of mixed origin ("para-toners" "lakes").* Both organic and inorganic substances can be used in one or more of the above methods.

l) *Finally, another type of filter can be made by photographing the colored object and using the color picture of that colored object as a filter.* A green leaf is photographed at so close a range that the whole field will be green. The resulting color picture should be a green filter corresponding to chlorophyll *A* and *B*. Similarly, an aerial color picture of a solid stand of forest could also be used as a chlorophyll filter. The difference between the latter and the picture of the leaf made at close range would be for the most part the difference caused by skylight reflected from the glossy surface of the leaves and the effect of haze. It is believed that due allowance for these factors can be made as a result of such a study, in at least a practical way. Commercial color films are too thick for this purpose. A specially thin-coated film is necessary unless a very bright source of light is used to augment the right table.

Filters and Lamps

2. Provision is made for using commercial light filters of any kind, or such as may be improvised as just mentioned in no. 1, in conjunction with other tubular electric lamps. In place of the usual fluorescent tubes, there can be substituted other electric lights filled with rarefied gases, neon, argon, nitrogen, helium, etc. Such lights, made on the Geisler tube principle require special installation. When this is done, the kind of light transmitted by the filters is correspondingly altered. Whole sections of the spectro-photometric curve shown by a given filter using the mercury lamp, will be lacking and in certain cases a more "sharply-cutting" filter effect will result. By superposing the graph showing the spectro-photometric curve of the lamp used over the graph showing the curve of the filter used over a source of bright light, such as the viewing screen of this light-table, the photo-interpreter can form a fairly accurate idea of the light obtained by the combined use of such a lamp with such a filter.

Areas of Colored Light

3. Provision is made for obtaining 6 to 12 areas or patches of light of different

colors on the viewing screen or top window of the light-table. Such areas are for practical purposes about 6″×4″ for 6 areas and 3″×4″ for 12 areas.

Restoration of Color Balance

4. Provision is made for determining roughly what color or colors will restore the color balance to an under- or over-exposed color transparency with a view to remedying the picture by attaching a thin film of this color.

Highest Contrast

5. Provision is made for choosing which photographic filter will give the highest contrast between the colored object and its surroundings when photographed on black and white film. This is determined by allowing the different kinds of light transmitted by the variously colored filters placed in the filter chamber, to pass through the viewing screen and a superposed color transparency of the colored object. In this way it can be seen which filter gives the greatest contrast on color film, and to some extent on black and white film.

High Illumination

6. Provision is made for a high degree of illumination of the viewing screen. When all 19 lights are burning, the center of the viewing screen reads 400 or higher on the Weston photo-meter while the corners show a reading of 180.

Study of Prints

7. Provision is made for studying photographic prints in almost the same way as black and white transparencies (positives). This is made possible by the intense illumination. If the printing paper is too thick for the light to pass through a dark print, sponging such a print with n-propyl alcohol or even a light engine oil will make it more transparent.

Wide Range of Illumination

8. Provision is made for a wide range of degree of illumination on the viewing screen, as a whole or for different parts of it. Since each of the 19 transverse equally-spaced light tubes is individually controlled, the number of illuminating effects is necessarily very large. For example, with only one tube switched on, 9 different effects can be obtained. (Thus, if lamp no. 1 or 19 is burning the effect is the same). If left-right reversal cannot be used, then 19 effects are possible with any one tube burning. If any two tubes are burning, 171 different illumination patterns are obtainable. Since any 3, 4, or more tubes may be switched on at one time, it can be readily seen that a large number of illumination patterns are available. The amount of generally diffused and reflected light received on the viewing screen, as contrasted to that light received from the fluorescent tube directly beneath, is shown by the following, the light intensity being given in the scale of the Weston photometer:

When all tubes are burning, center of viewing screen	400
When only the 3 central tubes are burning, center of screen	180
When all tubes are burning, any of the 4 corners	180
When 18 tubes are burning, but no. 19 is off, meter directly over 19 reads	170
When 17 tubes are burning, but nos. 19 and 18 off, meter directly over 19 reads.	110
When 16 tubes are burning, nos. 17, 18, 19 are off, meter directly over 19 reads.	75
When 10 tubes are burning, but numbers 10 to 19 are off, meter directly over 19 reads	10

Hetero-stereo Pairs

9. Provision is made for the study of various kinds of "hetero-stereo" pairs. One member of a stereo color pair may be over-exposed and the other under exposed. The light can be adjusted so that each gets the best illumination. One member of the stereo pair can be a dark black and white print while the other can be a color transparency. The light can be adjusted to take care of such an extreme case.

Even Temperature

10. Provision is made for an even temperature to avoid unnecessary desiccation of films or prints when placed on the viewing screen and the consequent curling and injurious effects of heating. At ordinary room temperatures when the light-table has been in continuous operation for thirty minutes with all 19 lights burning but with the fan in operation, the temperature on the surface of the viewing screen is increased 1 to 2 degrees F. Without the fan running the temperature at the same spot on the viewing screen rose 30° F., or 17° C. in five minutes. At the end of 20 minutes, the viewing screen was too hot to touch. Ventilation ports on the sides and back of the light-table allow the free escape of the heated air set in motion by the fan.

Compactness

11. Provision is made for compactness. The instrument is $30\frac{1}{2}''$ long, $21\frac{1}{2}''$ wide, and 4″ high. The viewing screen is $18\frac{1}{4}'' \times 9\frac{1}{4}''$, i.e. large enough for a pair of the usual 9″×9″ stereo pairs. If this light-table be mounted on a low table or stand, the unnecessary craning and balancing uncomfortably on a high stool, required so frequently of a photo-interpreter, can be entirely avoided.

List of Materials Used in the Construction of This Light-Table

1 Herbach and Rademan TM 1108 Blower (fan)
19 General Electric Co. 58G649 Ballast
38 GE 95×432 lamp holders
19 GE 95×299 starter holders
19 GE FS 5 starter
19 GE Eight Watt Fluorescent Tubes
3 Eight-terminal connection strips
20 Single pole double throw toggle switch
1 jeweled pilot light
1 length AC cord and plug, and wire for hook-up
5 Covers or shields for ventilation ports
1 pc $\frac{1}{8}'' \times 9\frac{3}{4}'' \times 18\frac{3}{8}''$ flashed opal glass
2 pcs 16 13/16″×19″ single thickness window glass or plastic
1 set of door spring catches on removable panel
2 pulls for above
1 sheet of clear plastic $\frac{1}{8}'' \times 9\frac{3}{4}'' \times 18\frac{3}{4}''$ as an extra protection, placed under the opal glass or viewing screen to prevent accidental breakage of the tubes should any object break through the opal glass viewing screen in the window of the top of the light-table.
Sufficient wood, screws and enamel.