June 2, 1942. E. FESS ET AL 2,285,262

PROCESS AND APPARATUS FOR THE PRINTING OF SUBTRACTIVE MULTICOLOR IMAGES

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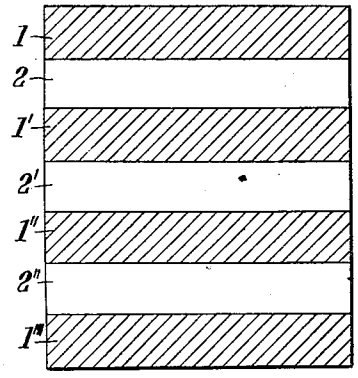
Fig. 1 *Fig. 2* *Fig. 3* *Fig. 4*



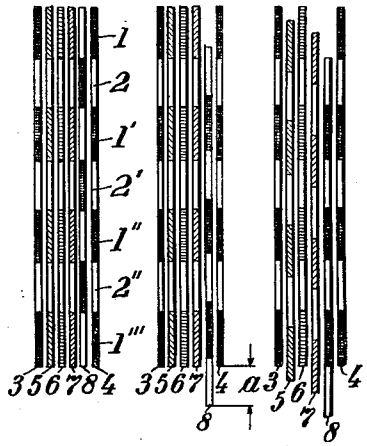
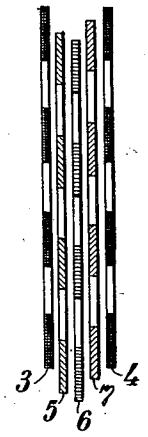


Fig. 5 *Fig. 6*



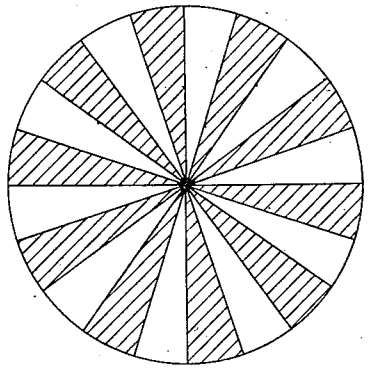


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Fig. 7

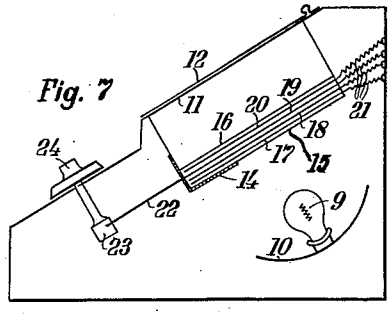


Fig. 9

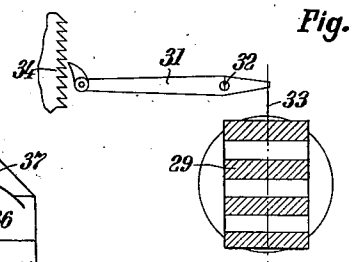


Fig. 10

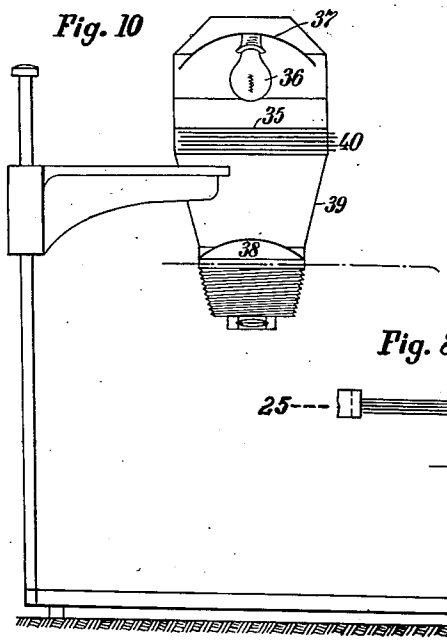
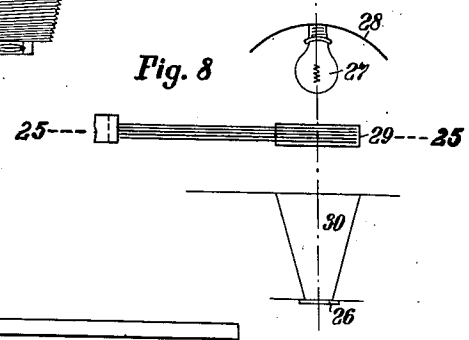


Fig. 8



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PROCESS AND APPARATUS FOR THE PRINTING OF SUBTRACTIVE MULTICOLOR IMAGES

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Fig. 11

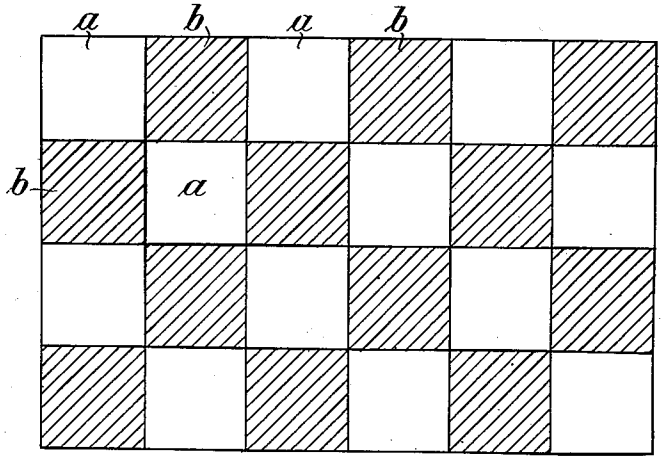
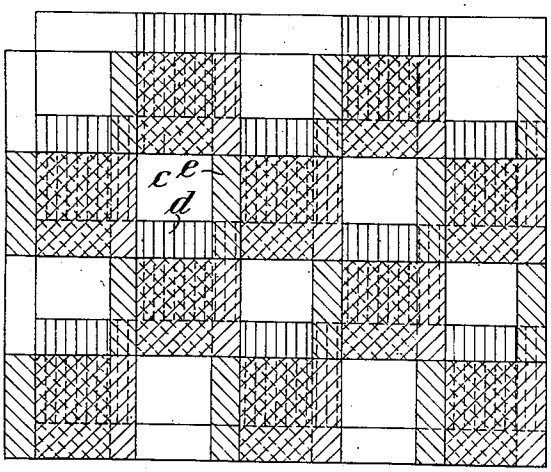


Fig. 12



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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR THE PRINTING OF SUBTRACTIVE MULTICOLOR IMAGES

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Application May 14, 1940, Serial No. 335,143
In Germany May 6, 1939

4 Claims. (Cl. 95—2)

This invention relates to a process and apparatus for the printing of subtractive multicolor images.

It is known to employ colored filters in the primary colors for the printing of subtractive multicolor images and to alter thereby not only the intensity, but also the composition of the light. Furthermore it was proposed to use dyestuffs for the printing-filters which correspond to the dyestuffs of the original with regard to their optical properties.

It is an object of this invention to provide a process for the printing of subtractive multicolor images.

Another object is the provision of a process for printing subtractive multicolor images, whereby the spectral composition and the intensity of the printing light is controlled.

These and other objects will be apparent from the following description and accompanying drawings.

It has been found that the control of the intensity and of the spectral composition of the printing light is attained preferably in such a way, that single filters preferably in the additive and subtractive primary colors are constructed as screens or as sectors and arranged between rigid lattice (grid) diaphragms also built in a screen-like fashion in such a way, that the filter zones are completely covered in zero-position by the light-impermeable parts of the rigid diaphragms and can be moved simultaneously or successively towards one another for the control of the light. The single filter zones are thereby arranged behind one another according to the desired coloring or intensity of the printing light within the light-permeable zones of the rigid diaphragms.

In the practice of this invention different constructions are possible.

Figure 1 shows a screen-like filter. The filter stripes are marked with 1, 1', 1'', 1''', whereas the stripes 2, 2', 2'' represent clear zones. The diaphragms are built in the same way. The stripes 1, 1', 1'', 1''', however, are in this case light impermeable.

Figure 2 is a cross sectional view of a filter- and diaphragm-set, all filters being in zero-position. Nos. 3 and 4 represent the two rigid diaphragms, 5, 6 and 7 the three screen-like filters and 8 a movable diaphragm. It is useful to arrange the filters and the diaphragm 8 in such a manner, to be shifted in a transversal direction to the stripes as much as the width of one filter stripe. The movable diaphragm 8 represents a negative of the rigid diaphragms, so that in normal position the light-impermeable zones of the movable diaphragm lie at the same height as the light-permeable zones of the rigid diaphragm and vice versa.

The Figures 3, 4 and 5 show three cross sectional views at different positions of the filters.

In Figure 3 a position of a diaphragm- and filter-set is represented, the light being dosed only according to the intensity without changing its color. The colored filters 5, 6 and 7 are in zero-position, i. e. the colored stripes 1, 1', 1'', 1''' of the filters 5, 6 and 7 lie behind the diaphragm stripes 1, 1', 1'', 1''' of the rigid diaphragms 3 and 4.

The movable diaphragm 8 has been shifted the extent a from the zero-position. For the penetrating light therefore the space $f=a.b.n$ is open, if b signifies the length of the stripes and n the number of light-impermeable stripes of the movable diaphragm.

If a certain spectral region has to be preferred, the filters are shifted as described in Figure 4. If the colors of the filters for instance are chosen according to the subtractive primary colors, different spectral compositions of the light by shifting to and fro of one or two filters may be obtained, which changes, however, the relative total light intensity. If the three filters are moved from the zero-position, the open space resulting from the filter which has been moved the shortest distance effects only a reduction of the light—the subtractive colors together give neutral grey—whereas for the coloring of the light the two filters shifted further on are of importance. This fact may be used for the control of the intensity.

In Figure 5 there are arranged only three filters 5, 6 and 7 between the rigid diaphragms 3 and 4. The intensity control is effected by the shifting of these three filters.

If the filters are chosen according to the additive primary colors—arranged behind one another they form black—this way of intensity control is still more effective. As it is useful in certain cases to vary the coloring without changing the effective total light intensity, the hitherto clear stripes on the filters can be kept in neutral grey color, whereby the transparency of these zones is adjusted in such a way, that the transparency for the total light intensity is not changed when shifting the filters.

In Figure 6 there is shown a further embodiment of the filters. The filters and diaphragms are formed here in the shape of sectors and arranged in such a way, that in zero-position the

filter sectors lie behind the diaphragm sectors. The change of intensity and coloring is attained here by turning the movable filters or the diaphragm-disc.

The construction of the filters and diaphragms according to the present invention has besides the possibility, to attain with three filters every possible spectral composition of the light also the advantage, that only slight shiftings of the filters—maximal value up to the chosen stripe-width—are necessary. Since the number of stripes for a certain filter size increases with decreasing stripe-width, a homogenizing effect of the color of the light is easily attained herewith. Needless to say that the filter cannot be used in a parallel light beam, as then an uneven illumination results. Furthermore existing optical means should not be arranged in such a manner, that an image of the filter is obtained in the plane of the exposure. Preferably useful is to insert light-scattering means, for instance ground-glasses, between the filter and the plane of the exposure. Advantageously the outside of the diaphragm disc, which turns towards the plane of the exposure, is provided with a dull surface.

Figure 7 shows the arrangement of the filter- and diaphragm-set in a printing apparatus.

The light source **9** with the reflector **10** illuminates in the plane of the exposure **11** the biggest possible picture-space. Original and printing material are kept level and in contact in the plane **11** by the cover **12**. Between light source **9** and plane **11** the filter- and diaphragm-set **14** is arranged. **15** and **16** are the rigid diaphragms, **17**, **18** and **19** the movable filters, **20** the movable diaphragm. The springs **21** hold the movable parts normally in zero-position. By means of the four strings **22**, which on the one hand are fastened to each one of the filters or the movable diaphragm, and on the other hand to one of the four rotative shafts **23**, the filters or the diaphragm may be shifted by turning the scale button connected with shaft **23**. The scale shows the amount of shifting.

Figures 8 and 9 show the filter- and diaphragm-set arranged in a copying machine for cinema-films.

Figure 8 shows diagrammatically a front elevation, whereas Figure 9 represents a cross section of the plane **25—25** of Figure 8. Between printing plane **26** and light source **27** with reflector **28** there is again arranged the filter- and diaphragm-set **29**. There is provided as light-scattering means a further ground glass **30**. The movement of the filters and diaphragm is accomplished by the levers **31**, shown in Figure 9, which are rotatively mounted around axle **32** and are connected over the rods **33** with the single plates of the filter- and diaphragm-set **29**. The movement of the levers **31** may be accomplished with the aid of arrangement **34**.

When printing a cinematographic film, the slight movement of the filters is of great advantage, as here in relatively short time, during the dark interval of two pictures, the new adjustment of the filter- and diaphragm-set has to be carried out.

In Figure 10 the filter- and diaphragm-set is arranged in an enlarging apparatus. The construction of Figure 6 is thereby used. The filter- and diaphragm-set **35** is arranged here between light source **36** and reflector **37** and lens **38**. With the aid of the levers **40** projecting from the chamber **39** and connected with the rotative filters, the color and the intensity may be controlled, if necessary, according to a scale.

In the construction of the filters according to Figures 1 to 4 a change of the spectral composition of the light is always connected with a change of the total light intensity by shifting of the diaphragm **8**, as the diaphragm holds back a certain amount either of the filtered or of the unfiltered light. If this change is to be avoided, the construction of the filters and the direction of their movements has to be selected in such a way, that not only the filtered, but also the unfiltered light is partly weakened by the diaphragm, whereby nothing is changed on the spectral composition.

Figure 11 shows a construction according to the above mentioned principle. The filters and diaphragms are built like a chess-board. *a* signifies colorless openings, *b* light-impermeable zones of the diaphragm, or colored, light-permeable zones of the filters.

The filter plates are movable in one direction, whereas the diaphragm is moved vertically to it. By these means the adjustment as shown in Figure 12 is possible. In this figure zone *c* is partly covered by filter zone *d*. Of both these zones there is covered up a certain portion by the diaphragm *e* inserted from the side, so that the proportion: filter zone to clear zone remains always constant.

Similar constructions may be also used for the optical printing of films.

We claim:

1. In an apparatus for printing subtractive multicolor images, a source of light, a reflector projecting the light emitted by said source of light onto a printing plane, and a set of diaphragms and filters for controlling the intensity and the spectral composition of the printing light comprising two rigid diaphragms having alternate opaque and transparent sections and between said rigid diaphragms a plurality of filters having corresponding alternate colorless transparent sections and colored transparent sections, each of said filters in a different one of the primary colors, said filters being capable of being shifted with relation to one another and said rigid diaphragms, said colored filter sections in zero-position being completely covered by said opaque sections of the rigid diaphragms.

2. In an apparatus for printing subtractive multicolor images, a source of light, a reflector projecting the light emitted by said source of light onto a printing plane, and a set of diaphragms and filters for controlling the intensity and the spectral composition of the printing light comprising two rigid diaphragms having alternate opaque and transparent sections and between said rigid diaphragms at least one adjustable diaphragm likewise having alternate opaque and transparent sections and a plurality of filters having corresponding alternate colorless transparent sections and colored transparent sections, each of said filters in a different one of the primary colors, said filters and said adjustable diaphragms being capable of being shifted with relation to one another and said rigid diaphragms, said colored filter sections in zero-position being completely covered by said opaque sections of the rigid diaphragms.

3. In an apparatus for printing subtractive multicolor images, a source of light, a reflector projecting the light emitted by said source of light onto a printing plane, and a set of diaphragms and filters for controlling the intensity

and the spectral composition of the printing light comprising two rigid diaphragms having alternate opaque and transparent sections in the form of sectors and between said rigid diaphragms at least one adjustable diaphragm likewise having alternate opaque and transparent sectors and a plurality of filters having corresponding alternate colorless transparent sections and colored transparent sectors, each of said filters in a different one of the primary colors, said filters and said adjustable diaphragms being capable of being shifted with relation to one another and said rigid diaphragms, said colored filter sectors being completely covered by said opaque sections of the rigid diaphragms.

4. In an apparatus for printing subtractive multicolor images, a source of light, a reflector projecting the light emitted by said source of light onto a printing plane, and a set of diaphragms and filters for controlling the intensity and the spectral composition of the printing light comprising two rigid diaphragms having alternate opaque and transparent sections and between said rigid diaphragms at least one adjustable diaphragm likewise having alternate opaque and transparent sections and a plurality of filters having corresponding alternate colorless transparent sections and colored transparent sections, each of said filters in a different one of the primary colors, the sections of said diaphragms and filters being arranged like a chess-board, said filters and said adjustable diaphragms being capable of being shifted with relation to one another and said rigid diaphragms, said colored filter sections in zero-position being completely covered by said opaque sections of the rigid diaphragms.

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