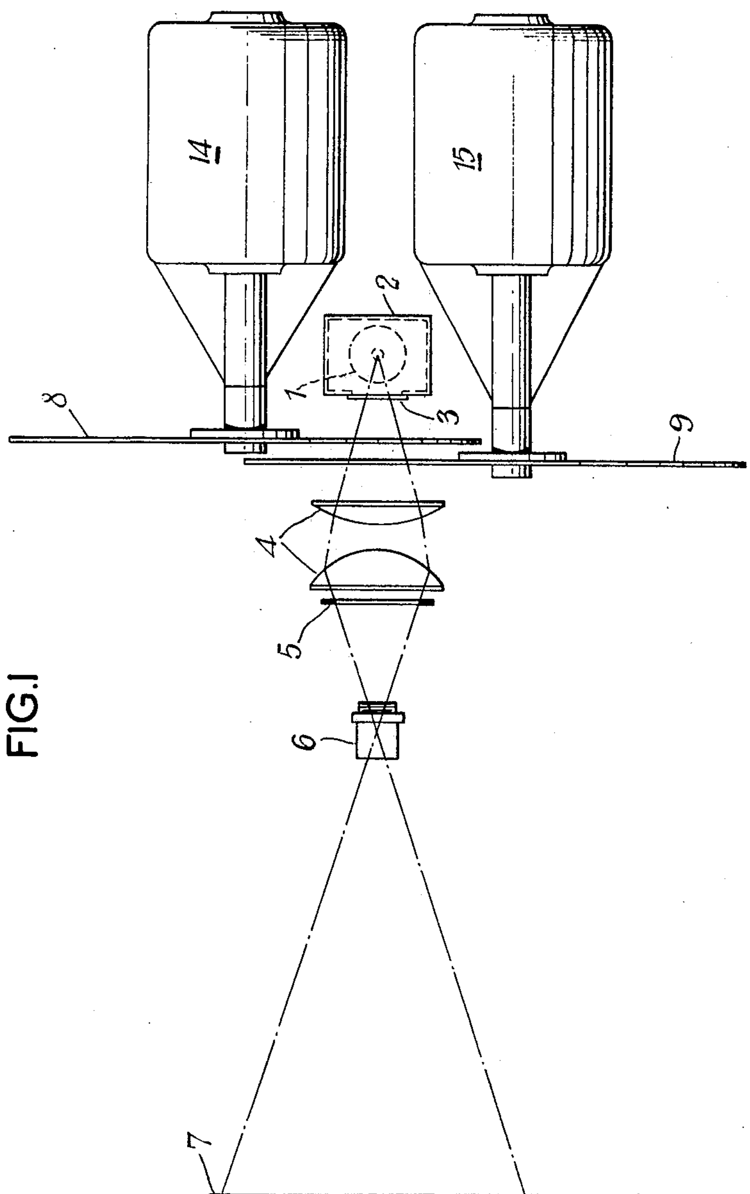
Nov. 22, 1960 J. H. COOTE ET AL 2,960,911

COLOUR PHOTOGRAPHY PRINTING DEVICE

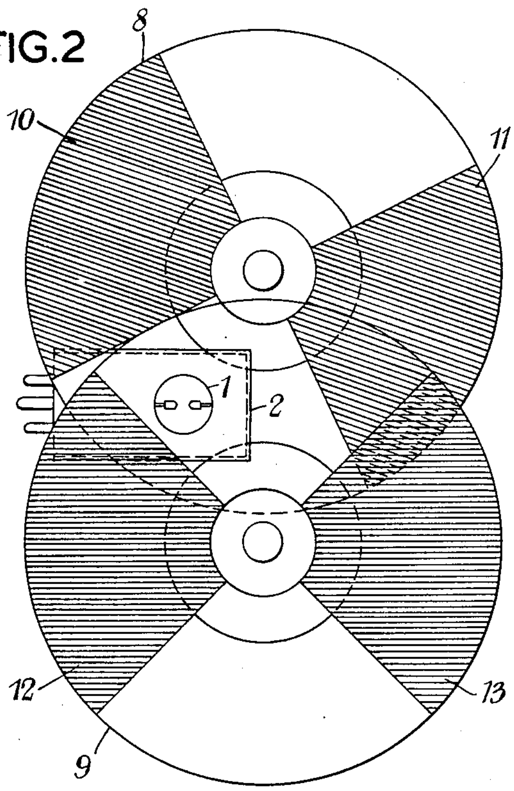
Filed Jan. 23, 1958 3 Sheets-Sheet 1

FIG.1



Inventors
John Howard Coote
Arthur Philip Jenkins
by Stevens Davis Miller & Mosher
their attorneys

FIG.2



Inventors
John Howard Coote
Arthur Philip Jenkins
by Stevens Davis Miller & Mosher
their attorneys

FIG. 3

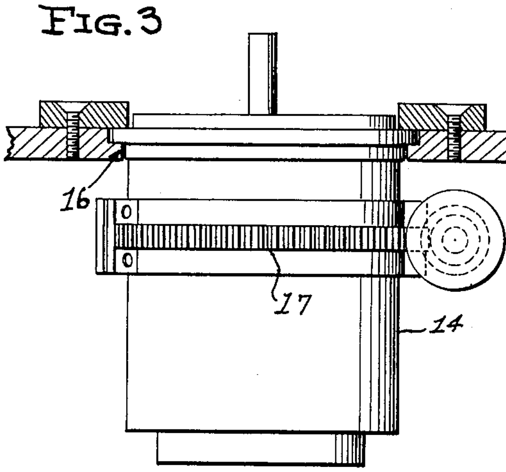


FIG. 5

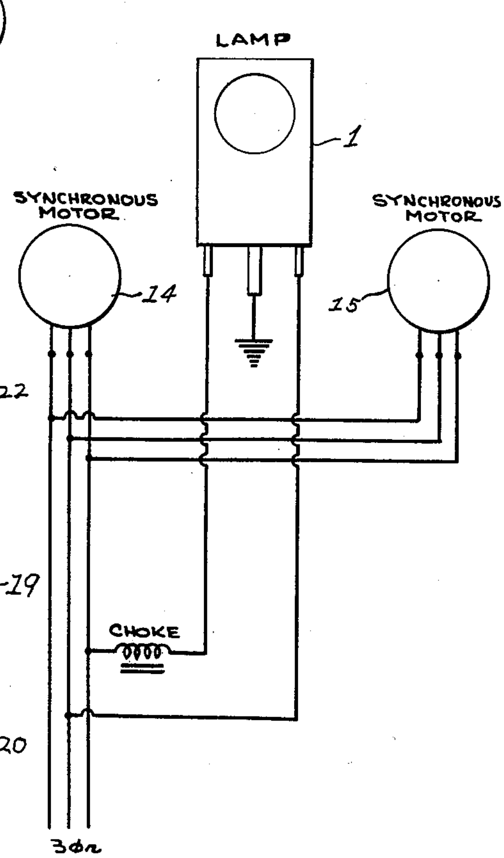
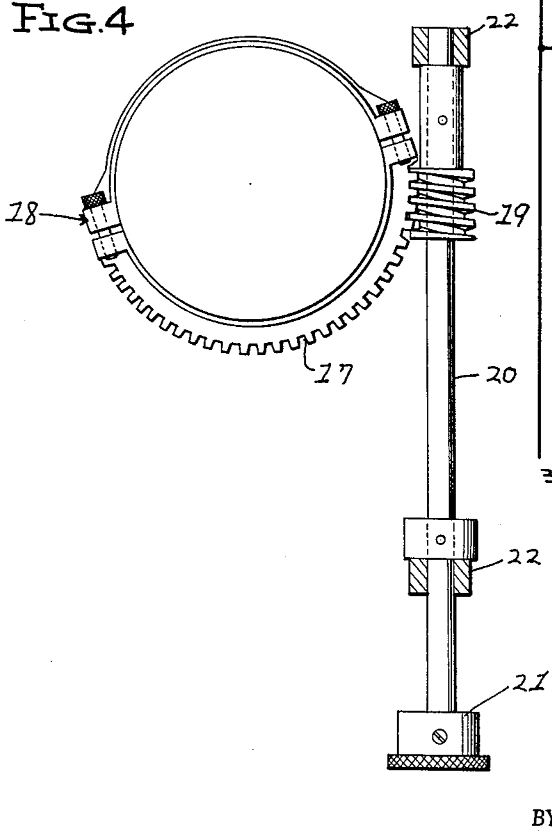


FIG. 4



INVENTORS
Jack Howard Coote
Arthur Philip Jenkins
BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

United States Patent Office

2,960,911

Patented Nov. 22, 1960

2,960,911

COLOUR PHOTOGRAPHY PRINTING DEVICE

Jack Howard Coote and Arthur Philip Jenkins, Ilford, England, assignors to Ilford Limited, Ilford, England, a British company

Filed Jan. 23, 1958, Ser. No. 710,727

Claims priority, application Great Britain Jan. 31, 1957

1 Claim. (Cl. 88—24)

This invention relates to colour filter devices. It has particular relation to means for accurately adjusting the colour quality of a light source used in the production of colour prints and will be described with primary reference thereto.

When making colour prints or duplicates from colour transparencies or negatives, it is necessary to control the colour balance of the reproduction to obtain a satisfactory result. Colour balance has to be controlled to compensate for differences in printing materials and in printing light sources.

Colour processes now commonly use multilayer photographic material which includes three superimposed emulsion layers arranged to record blue, green and red light respectively. The colour balance of a print is usually controlled by using a printing light comprising suitable ratios of blue, green and red light.

It is common practice to use a light source, such as a tungsten filament lamp, which emits blue, green and red light, and to control the ratio of the three colours by interposing colour filters in the light beam. For example, a pale magenta (minus green) filter would be used to reduce the amount of green light reaching the printing material.

Since the human eye is highly sensitive to small differences in colour, the colour balance of the colour print must be very closely controlled. This means that the ratio of blue, green and red light which forms the printing light source must be very precisely adjusted. Normally this requires that colour filters of suitable densities must be chosen from a large range of filters in which colour density increases by suitably small steps. A typical set of colour correction filters may comprise yellow, magenta and cyan filters of densities ranging from .03–1.0 (as measured with light of complementary colour) in increments not greater than 0.05. It is, however, a matter of substantial commercial difficulty to manufacture colour filters with sufficiently accurate reproducibility for colour printing purposes.

Where a commercial printing house employs a number of colour printers or enlargers, it also becomes difficult, if not impossible, to obtain a perfect match for colour balance on all the machines without stocking a large number of separate filters and devoting much time to the selection of an optimum combination.

It is an object of the present invention to provide apparatus which includes a source of "white" light (i.e. containing blue, green and red radiation) in combination with means for modulating the light to control the ratio of one, or when necessary, two of the colours in relation to the third.

The present invention makes use of a gaseous discharge lamp (or its optical equivalent as hereinafter set forth) as the source of printing light. An electric lamp of this type, when energised by alternating current, rises to maximum brightness and fades to substantial extinction

in every half-cycle of the current supply. Since at the end of each half-cycle the lamp is substantially extinguished, it will be appreciated that the lamp in fact emits discrete "flashes" of light at a frequency double that of the alternating current supply. However, "flashes" are not sharply divided and the general effects is that the brightness increases substantially from zero to its maximum value at about the middle of the half-cycle and then fades away towards the end of the half-cycle. The present invention makes use of this rise and fall in brightness to provide an improved form of closely controllable filter system.

Instead of a gaseous discharge lamp there may be employed a continuous emission source of light in association with a graduated density filter which moves in the path of the lamp so that the beam transmitted from the filter cycles through an increase to maximum brightness and a fall to minimum brightness (e.g. zero brightness) at a high cycle frequency. It will be appreciated that this is the optical equivalent to a gaseous discharge lamp.

According to the present invention apparatus for controlling the colour of a beam of light emitted by a source which increases to maximum brightness and then falls to minimum brightness at a high cycle frequency comprises a colour filter element, means for intermittently introducing said element into the beam of light at a frequency which is related to the cycle frequency of the source by an integral factor, and means for adjusting the relative phase relationship between the said source and the said filter element.

According to a particularly valuable aspect of the present invention photographic printing apparatus includes a source of printing light which is a gaseous discharge lamp, or its optical equivalent as just set forth, means for passing across a beam of light from said source, to be used for printing, a filter element made up of uncoloured areas and coloured areas, at a frequency which is related to the cycle frequency of the source by an integral factor, and means for adjusting the relative phase relationship between the source and the filter.

By alteration of the relative phase relationship just referred to, the position of the filter and therefore the relative areas of uncoloured and coloured portions thereof lying in the path of the beam at the instant of maximum brightness, will be varied, and accordingly the integrated colour saturation of the light transmitted by the filter system will be varied.

In the preferred form of the invention the filter is mounted in, or consists of, a disc carried on a shaft parallel with the axis of the beam of printing light so that as the disc rotates the filter is caused to pass across the said beam. For convenience in explaining the invention the disc will be presumed to consist of four 90° segments, two of them transparent and clear and the other two coloured, e.g. magenta, the clear and coloured segments alternating. This is in fact a system of practical value. By driving the disc by means of a synchronous motor it may be readily arranged (the alternating current supplying both the motor on the one hand and the discharge lamp or a controlling filter for a continuous emission lamp on the other hand) that the movement of the disc is synchronised with the "flashes" of the light source.

It will be appreciated that in a system as just described, since the same portions of clear and coloured filter will always be present during the period of flashing of the light source, the colour saturation of the beam transmitted by the filter will be constant.

However, when the phase relationship between light source and disc is altered, different relative areas of clear and coloured filter will be present during the period of flashing of the light source, so that the colour saturation of the beam transmitted by the filter system will be constant but different from that in the former case. This will be appreciated from the fact that in the extreme positions it can be arranged that at the peak transmission brightness either a wholly coloured portion of the filter will be in the beam or a wholly uncoloured portion of the filter will be in the beam.

In the case where the disc has two clear sectors and two coloured sectors of 90° each, the disc may be rotated by a synchronous motor at 3000 r.p.m. from a 50 cycles per second mains supply. The phase relationship between the light output from the source and the sectors of the filter disc can be changed by rotating the body of the synchronous motor around its axis. By this means it is possible to adjust the relationship of the sectors of the disc and the alternating output of light from the source so that most of the light emitted during any one cycle will pass either through the coloured sectors or the clear sectors of the disc.

The angular disposition of the body of the synchronous motor and with it the filter disc attached to its shaft, can be smoothly controlled to provide an infinitely variable adjustment of the effective colour density of the disc.

The range of effective density over which adjustment can be made is from nearly zero to about 80% of the full density of the coloured sectors in use. The angular displacement of the motor involved in providing this range of adjustment is 90° in the case of a disc rotating at 3000 r.p.m.

By employing a filter disc made up of eight alternating coloured and uncoloured sectors of 45° each, and a rate of rotation of 1500 r.p.m. a similar result can be obtained, but in this case the angular displacement necessary to provide the full range of adjustment is reduced to 45°. It will thus be appreciated that the system may be varied in relation to the number and angle of the sectors and the rate of rotation of the disc.

In an alternative form of the invention the phase variation may be effected by control over the peak output timing of the source, the angular relationship of the disc remaining unchanged.

In practice it is often necessary to use two differently coloured correction filters, and in such cases two filter discs of the type described will permit smooth and independent adjustment of any two filter colours.

The ratio of blue, green and red light may be controlled automatically by using monitoring photo-cells, each controlling one colour, and arranged to control (via servo-motors) the angular position of the rotating discs, thus maintaining the ratio of blue, green and red light at a pre-determined value.

In an alternative form of the invention there are used, instead of discs as aforesaid, reciprocating filters which are inserted into and withdrawn from the light beam at a frequency which is related to the frequency of the source by an integral factor, and means are provided for adjusting the ratio of time that the filter is in the beam to the time it is out of the beam.

While the invention is of particular value in the production of colour prints, it may also be employed for photographic printing using printing material which develops to black/white images but which is varied in contrast according to the colour of the printing light, such materials being known per se.

An embodiment of the present invention providng two filter discs is diagrammatically illustrated in the accompanying drawings in which—

Figure 1 shows the apparatus in elevation.

Figure 2 shows the lay-out of discs and lamp viewed along the axis of the system.

Figure 3 is an elevational view of one of the motors, showing the supporting and adjusting means for the motors.

Figure 4 is a planned view of the adjusting means.

Figure 5 is a diagrammatic view of the wiring arrangement between the motors and the lamp.

Referring to these drawings, the apparatus comprises a gaseous discharge lamp **1** in a box type housing **2** provided with a window **3**. The beam of light from the lamp is passed through condenser lenses **4** and the transparency **5** which is to be copied. An image of the transparency **5**, thus illuminated, is thrown, by objective lens **6**, on to print material **7**. The path of the rays is shown in conventional manner.

Located between the lamp assembly **1**, **2**, **3** and the condenser lens unit **4** are two discs **8** and **9**. Each of these is made up of four sectors, two of which are coloured (in disc **8** sectors **10** and **11** and in disc **9** sectors **12** and **13**), and the other two of which are uncoloured. The colour of the filter sectors **10**, **11** differs from that of filter sectors **12**, **13**. The discs **8** and **9** are each mounted centrally on the axis of a synchronous motor, **14**, **15**.

Each of the synchronous motors **14** and **15** is mounted for bodily adjustment about its axis. Figs. 3 and 4 show certain details of the motor supporting means, the motor body **14** being rotatably mounted and supported by the supporting means **16** and the motor body having a worm wheel **17** fixedly circumposed thereon by a suitable clamping means **18**. A worm gear **19** is fixed on a rotatable rod **20** and is in meshing engagement with the worm wheel. The rod **20** is rotated by means of the knob **21** and is suitably supported by bearings **22**.

As will be seen from Figure 2 there are occasions, during rotation of the discs, when uncoloured sectors on the discs will coincide in front of the lamp (this is the situation as illustrated), and occasions in which coloured sectors will coincide in front of the lamp. In use the synchronisation of the filter positions with the lamp cycle is arranged as already explained. The precise effect of each filter disc may be adjusted by rotating the housing of the synchronous motor which drives it.

What we claim is:

Apparatus suitable for photographic printing which comprises a source of light consisting of a gaseous discharge tube, a filter device located in the path of a beam of the said light, said filter element consisting of a disc having alternate coloured sectors and uncoloured sectors, a synchronous motor powered by the same alternating current supply as is used to power the gaseous discharge tube and connected to rotate the said disc at a frequency which is related to the cycle frequency of the gaseous discharge tube by an integral factor, support means for said motor and means for adjusting the position of the body of the synchronous motor round its axis in order to change the relative phase relationship between the cycle frequency of said source and the cycle frequency of the rotating filter device.

References Cited in the file of this patent

UNITED STATES PATENTS

2,049,556	Chapman et al.	Aug. 4, 1936
2,059,884	Mannes et al.	Nov. 3, 1936
2,393,316	Edgerton	Jan. 22, 1946
2,478,907	Edgerton	Aug. 16, 1949
2,565,399	Simmon	Aug. 21, 1951
2,671,377	Downes et al.	Mar. 9, 1954

FOREIGN PATENTS

670,441	Germany	Jan. 18, 1939
1,135,521	France	Dec. 17, 1956

OTHER REFERENCES

D'Arcy et al.: An article, "Application of the Xenon Arc to the Armed Forces 16 m./m. Projector," by D'Arcy et al., in Journal of the SMPTE, September 1945, vol. 63, pps. 98–104.