

Oct. 16, 1951

N. W. YELLAND
MULTICOLOR PRINTING

2,571,322

Filed Feb. 12, 1948

5 Sheets-Sheet 1

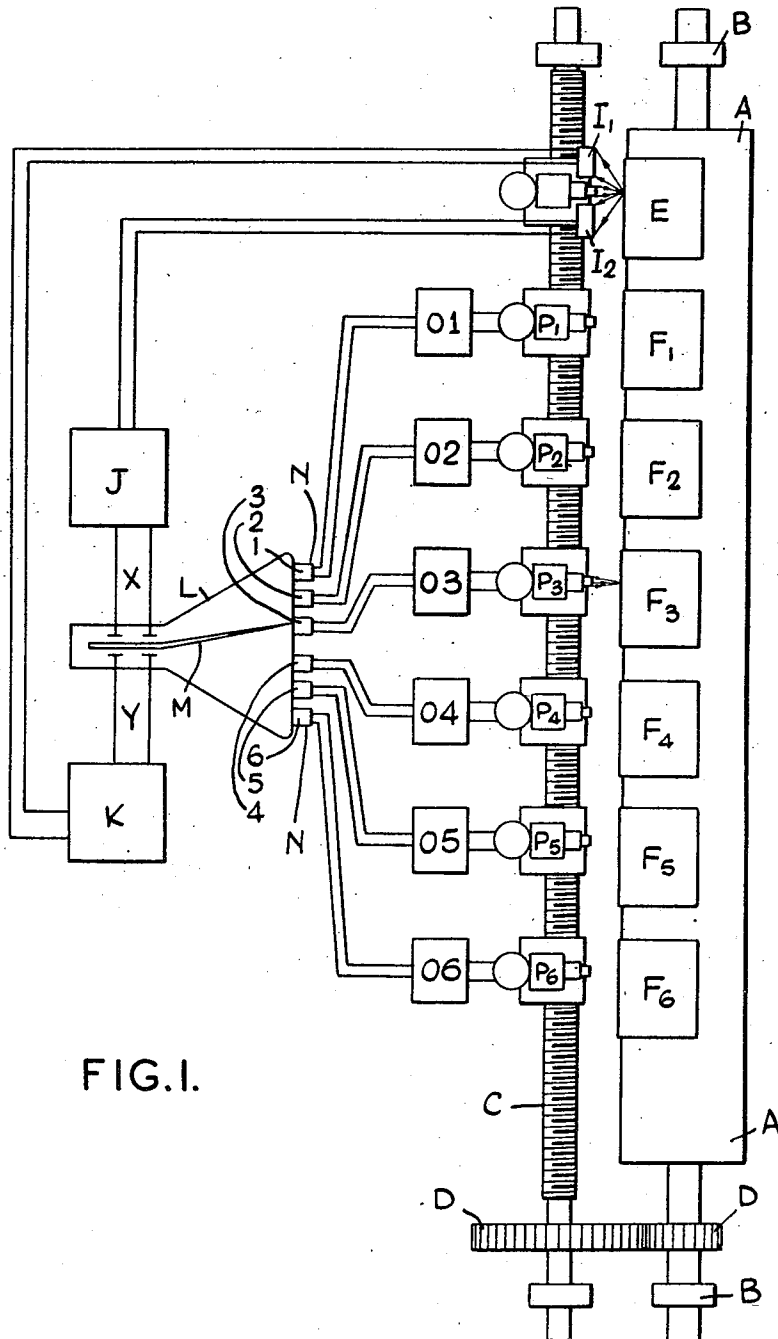


FIG. 1.

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FIG. 2.

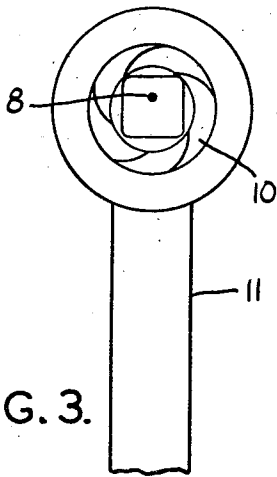
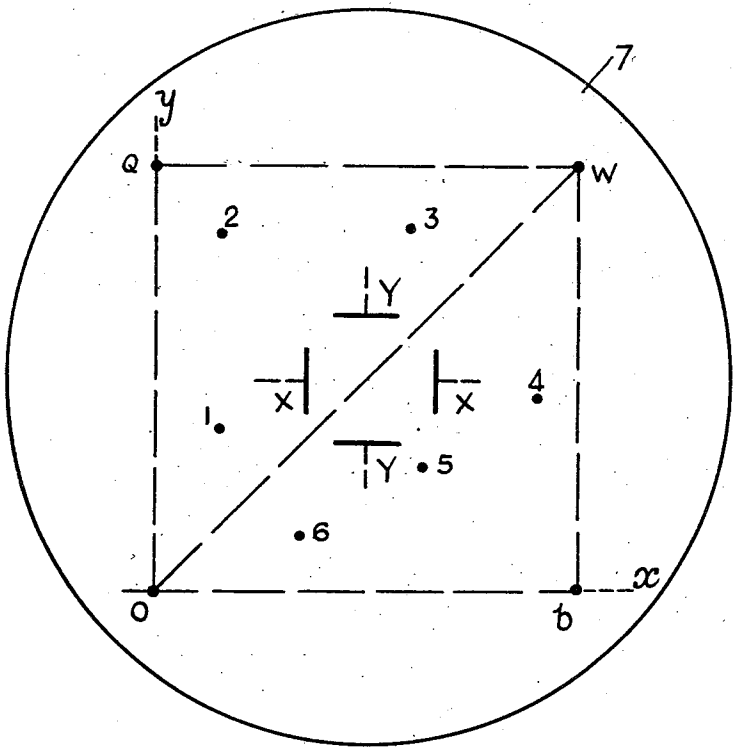


FIG. 3.

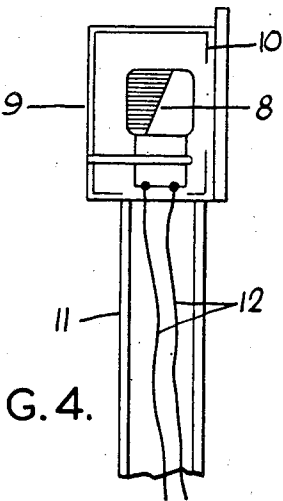


FIG. 4.

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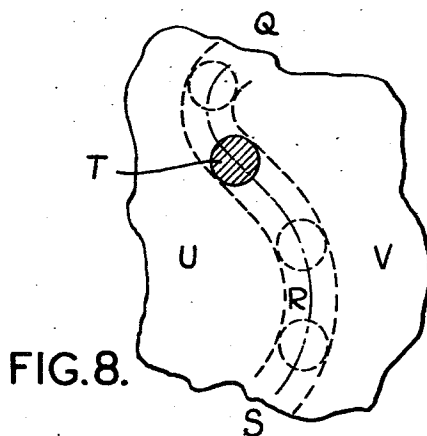
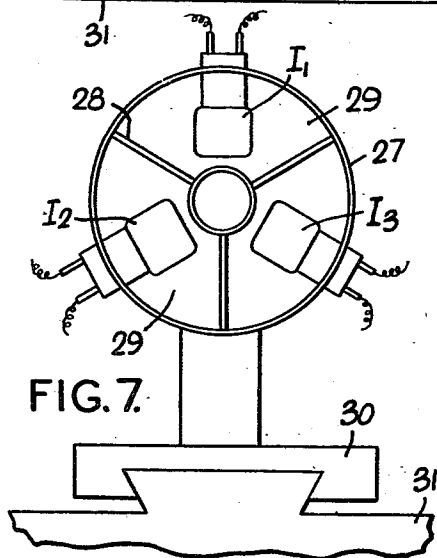
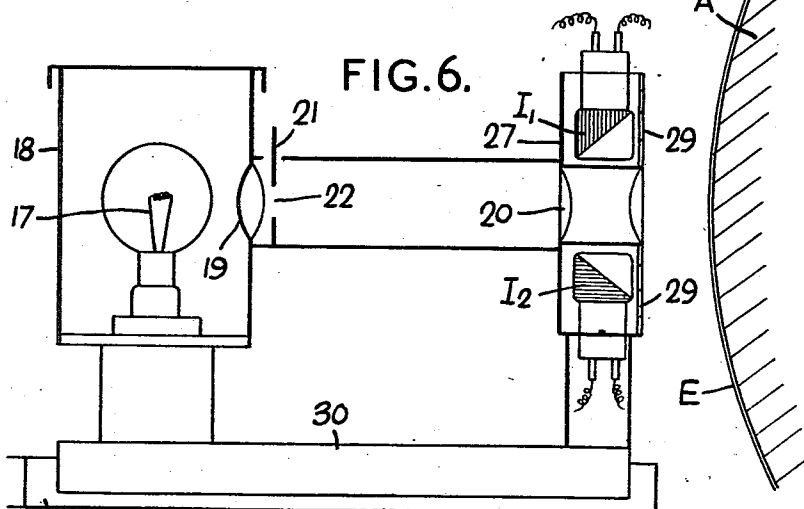
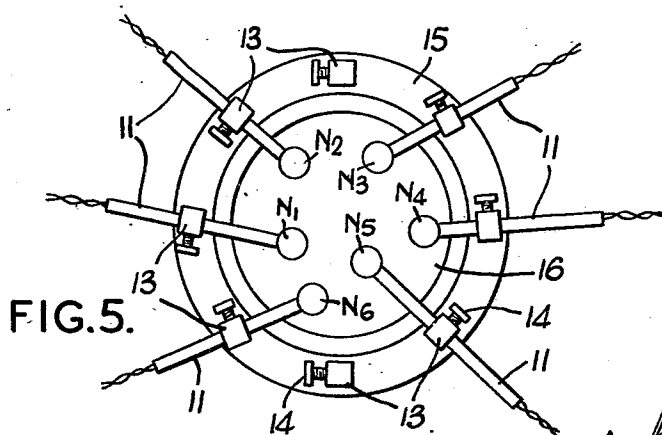
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MULTICOLOR PRINTING

Filed Feb. 12, 1948

5 Sheets-Sheet 3



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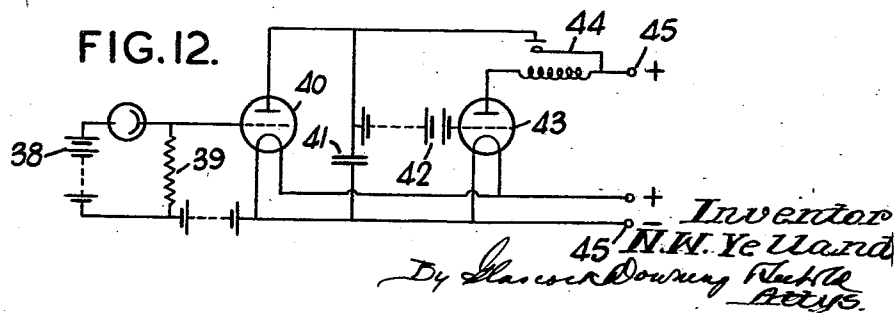
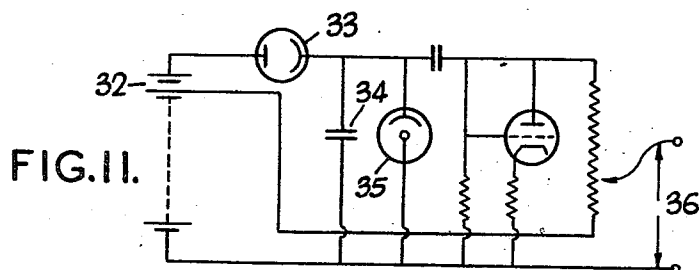
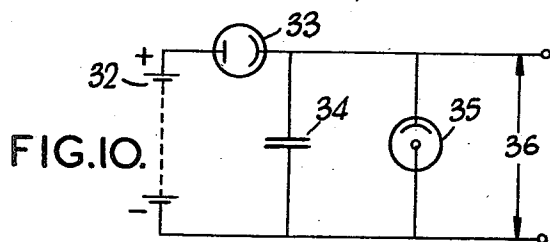
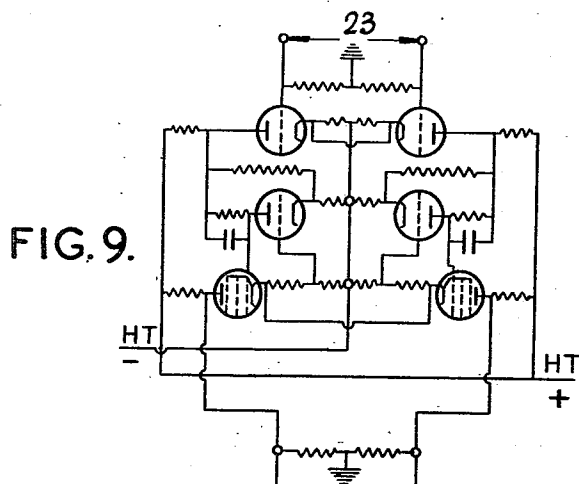
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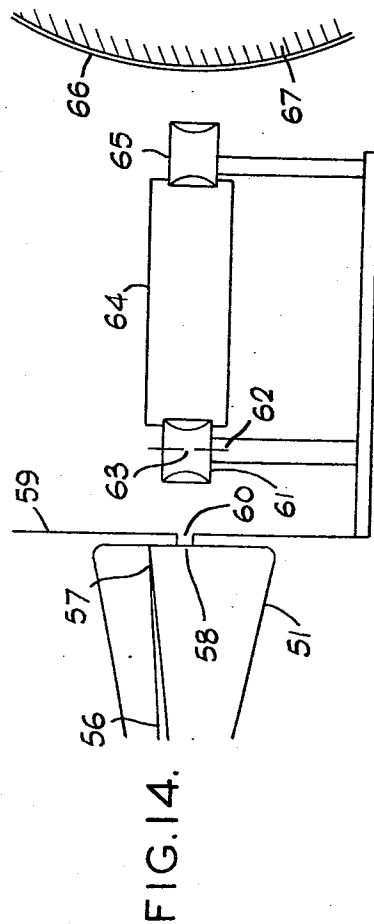
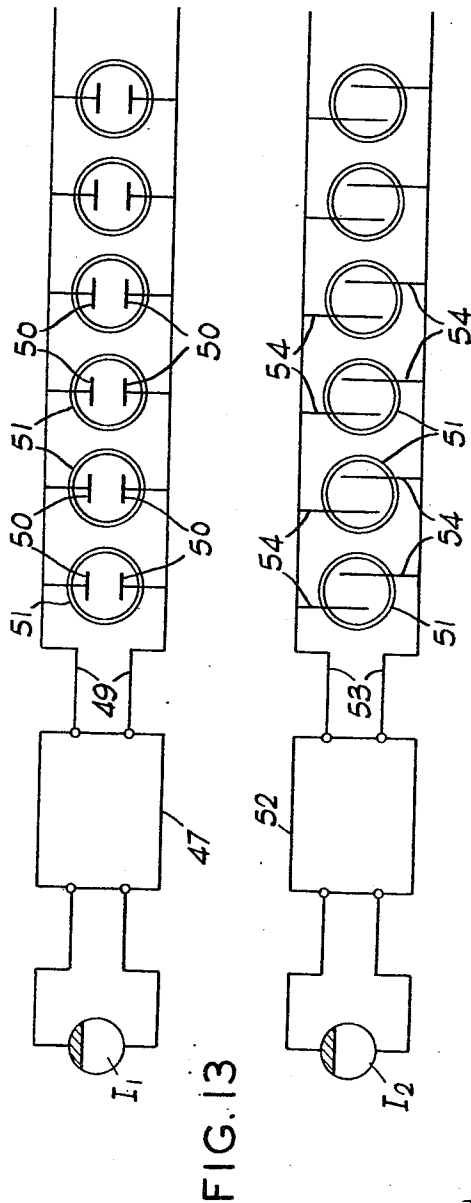
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MULTICOLOR PRINTING

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UNITED STATES PATENT OFFICE

2,571,322

MULTICOLOR PRINTING

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 pany

Application February 12, 1948, Serial No. 7,765
 In Great Britain February 24, 1947

15 Claims. (Cl. 178—5.4)

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This invention relates to the separation of the component colours in the reproduction of multi-colour designs or pictures, and to an improved method and apparatus for effecting such separation.

In the reproduction of multi-colour designs, for instance in the art of multi-colour printing, one of the first steps in the preparation of the necessary printing surfaces consists in separating the respective parts of the design which are occupied by each component colour, in order to reproduce these parts on separate printing surfaces, one for each component colour.

The processes used hitherto for colour separation have been slow and tedious, and involve much hand work by skilled operatives.

The object of the present invention is to provide an improved method of colour separation for use in conjunction with photo-electric scanning, in which the whole operation is carried out accurately and expeditiously by a combination of optical, photo-electrical and mechanical devices.

The invention comprises scanning the original multi-colour design by means of a light-spot, receiving the reflected coloured light by at least one photo-electric cell and utilising the photo cell output to control a set of recording devices corresponding in number to the colours to be separated, so as to render operative at any instant the recording device or devices corresponding to the colour being scanned.

The invention further comprises scanning the original multi-colour design by means of a light spot, receiving the reflected coloured light by a least one photo-electric cell, transmitting the photo-cell output to an indicator device which, depending on the quantity and/or quality of the photo-cell output, activates one or other of a set of detectors, corresponding in numbers to the colours to be separated; further transmitting the output from the detector to at least one of a corresponding set of recording devices, by means of which the parts occupied by each colour in the original design are recorded and exactly reproduced in shape on at least one of a set of recording surfaces, the recording taking place in synchronism with the scanning of the original design.

It is known that colours may be visibly different from one another and may nevertheless produce the same photo-electric current in a photo-cell having a particular kind of colour-sensitivity. If two or more such colours should be present together in a design they would all produce the same deflection of the photo-electric indicator

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and could not then be separated by the means hitherto described.

In order to avoid failure of separation in such cases, I may cause the colour-sensitivity of the photo-cell to be modified as requisite either by substituting a photo-cell having a different form of spectrum distribution of response, or by controlling this distribution by means of a colour-filter or filters, or by a combination of these means.

An additional means to ensure separation of such equi-luminous colours is, where more than a single photo-cell is used in the scanning receiver, to employ photo-cells having different types of colour-sensitivity, and being connected to the indicator so as to produce deflections in different directions. For example a single photo-cell may produce left-to-right deflections and a second independent photo-cell may produce up-and-down deflections. In this case the characteristic positions on the indicator, corresponding with various colours, would lie within a certain area.

A cathode-ray tube constitutes a convenient form of indicator. When such a tube is employed the currents from the photo-cell or cells of the scanning receiver are amplified and are applied to the deflecting system of the cathode-ray tube. Each different colour of the original being scanned then produces a spot at a characteristic position upon the screen of the cathode-ray tube. The several detector-relays, to control the operation of the respective recording elements, must then be adjustably positioned with respect to the screen of the cathode-ray tube.

For use as detector-relays, to be actuated in turn as the cathode-ray beam comes to occupy each of its several positions, characteristic of the respective colours, I may employ a variety of means. For example, I may employ purely electrical means, situated inside or outside the cathode-ray tube, to be actuated directly by the current carried by the cathode-ray beam, so that the cathode-ray beam acts as a selector switch. Alternatively I may employ a number of photo-cells as detector relays, so arranged and positioned as to respond to the light emitted by the luminescent spot of the cathode-ray tube.

If an area in the original design has a colour which is intended to be reproduced by a mixture of two or more printing colours, the indicator will be deflected to a position which is characteristic of that colour. A detector placed in this characteristic position is arranged to activate the re-

cording elements of all the component colours which are required to produce the said colour.

Referring to the accompanying explanatory drawings:

Figure 1 is a diagram illustrating the general arrangement of a form of apparatus in accordance with the invention which is suitable for use in the preparation of printing surfaces for textile printing.

Figure 2 is a diagrammatic end view of a cathode ray tube for use in the arrangement shown in Figure 1.

Figure 3 is an elevation and Figure 4 is a sectional side elevation of a photo-cell detector in its mount.

Figure 5 is an elevation of the means for supporting the photo-cell detectors.

Figure 6 is a diagrammatic longitudinal section of a scanning head.

Figure 7 is an elevation of a scanning head.

Figure 8 illustrates the conditions at a boundary between two colours in the scanning of the design.

Figure 9 is a circuit diagram of an amplifier suitable for use in the apparatus.

Figures 10-12 show suitable circuits for obtaining pulsations in the cathode ray.

Figure 13 shows the electrical connections, and Figure 14 is a diagrammatic section of the projection system, in an arrangement using cathode ray tubes as recording elements.

Figure 1 shows in the form of a schematic diagram, the mutual relations of the various parts of the apparatus which may be employed in a typical embodiment of the invention.

A long cylinder A is mounted in bearings B and driven so that it is rotated smoothly and continuously. The revolving cylinder drives a lead-screw C through change-wheels D either, continuously or intermittently.

The design original E is fastened around part of the surface of the cylinder (the repeat height is considerably less than the girth of the cylinder), and a number of photographic films F, constituting the recording surfaces, one for each colour, are similarly fastened side by side at intervals down the rest of the length of the cylinder.

A lamp and optical projector system G, to produce the scanning light spot, are mounted on a carriage H which is traversed parallel to the cylinder axis by means of a nut engaged with the lead-screw. The scanning light-spot is focussed upon the surface of the multi-coloured original. The combined movements of the rotation of the cylinder and translation of the lead-screw nut and carriage H cause the scanning spot to scan the surface of the original in the form of a helix of very fine pitch.

The light from the scanning-spot, reflected by the coloured original, is received by a system I₁, I₂, of two independent and differently colour-sensitive photo-cells, which are connected through separate amplifiers J and K to the deflecting electrodes X and Y respectively of cathode-ray tube L, so that the cathode ray is given a deflection which is characteristic of the photo-cell responses.

The cathode-ray beam M is picked up by one of a set of sensitive photo-cell detectors N₁-N₆ which are fixed one in each of the beam positions characteristic of the respective colours of the original. Each detector is connected through a separate amplifier and control unit O₁-O₆, to one of the recording elements P₁-P₆ each

of which is a light source and projector system arranged to project a light-spot upon one of the recording films F. The lamps employed in these recording elements are of such type that their illumination can be switched on and off with the required rapidity by the signals from the cathode-ray tube detectors. Gas-filled tubes as employed for sound-recording are suitable, or small cathode-ray tubes may be employed.

Each recording element P is fixed to a carriage (or all may be on a single carriage) which is traversed by the lead-screw C in synchronism with the movement of the scanning carriage H, and generally at the same rate. To allow for designs in which the width of the original may not be the same as the required width of the separated colour elements, two lead-screws may however be provided, one to traverse the original scanner and the other to traverse the recording elements at the required fixed ratio of speed. Similarly to allow for cases in which the circumferential dimension of the original is not the same as the required circumferential dimension of the separated colour elements, the end section of the cylinder, which carries the original, may be made detachable so that interchangeable or adjustable cylinders of various diameters may be used to support the original.

The recording films on the cylinder may be covered by film screens, having line or cross-line pattern, to produce any required structure of ground lines in the separated colour records. After exposure the films are developed and used in the normal manner for making the printing surfaces such as intaglio printing rollers or silk screens.

Opaque screens may be placed at intervals along the cylinder to control scattered stray light, and the machine is operated in a dark room or enclosed in a light-tight box.

Figure 2 is a diagrammatic end view of the cathode-ray tube L.

In Figure 2, the circle 7 represents the boundary of the useful area of the screen face. XX represent one of the two pairs of deflector plates that are usually provided in a cathode-ray tube, and YY represent the other pair of deflector plates. In a known manner, electrical potentials applied between the plates XX cause the cathode-ray beam, to be deflected in a horizontal direction, and potentials applied between the plates YY cause the beam to be deflected vertically.

The photo-cell I₂ to which the deflector plates XX are connected has, or by means of a colour-filter is made to have, an excess sensitivity to light of some particular region of the spectrum, for example the cell may be made most sensitive to red light. Similarly the photo-cell I₁ to which deflector plates YY are connected may for example be made most sensitive to blue or green light.

The plates XX and YY may conveniently be biased by means of constant direct-current potentials applied so as to deflect the cathode-ray beam away from the centre to some position O near the periphery of the screen when the photo-cells are giving no current or when they are producing only the small current due to a black area under the scanning light. Excitation of the red-sensitive photo-cell connected to plates XX then causes deflections of the cathode-ray beam in the direction O_x, and excitation of the blue-sensitive photo-cell connected to the plates YY then

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causes deflections of the cathode-ray beam in the direction Oy. In general, various colours all produce some degree of deflection in both directions simultaneously, and the spot of light formed by the cathode-ray beam on the tube screen will appear at some diagonal position characteristic of each colour. The magnification of the photo-cell signal, produced by the amplifiers, is adjusted so that when a white area is under scanning spot, the cathode-ray beam falls at some convenient point such as W, diametrically opposite to O. The position of the cathode-ray beam, representing any colour will then in general appear somewhere in the area OaWb. The points marked 1, 2, 3, 4, 5 and 6 show for example the position of the cathode-ray beam corresponding with six different colours appearing under the scanning head.

An opaque mask is placed over the screen, pierced by holes at the points opposite the positions 1 to 6 respectively. The holes are made of such size and shape as to allow for possible slight actual variations within areas of nominally fixed colour when the designs are being scanned. The detectors N1—N6 are placed so that each receives the light passing through one of the holes.

Figure 3 represents diagrammatically a face view of one of the photo-cell detectors N in its mount, and Figure 4 represents a sectional side view of the same. The small photo-cell 8 is supported in a casing 9 which has one side covered by an adjustable iris diaphragm 10. The casing 9 is supported by a tube 11, through which the connecting wires 12 pass to the amplifier and recording unit.

Figure 5 illustrates the means whereby the photo-cell detectors N1—N6 are adjustably positioned and clamped against the face of the cathode-ray tube. Each photo-cell supporting tube 11 is slidably mounted in the bore of a clamping-block 13 and held fixed when set, by a clamping-screw 14. Each clamping block 13 is pivotally mounted in a ring-shaped frame which encircles the screen 16 at the end of the cathode-ray tube. The pivots of the clamps 13 can be clamped to hold the clamps at any desired angles. Thus the tubes 11 can be slidably adjusted and swung, so as to bring each small photo-cell detector head opposite the desired point of the screen of the cathode-ray tube, and fix it in that position.

Alternatively the detector photo-cells may if convenient be similarly placed in the plane of a real image of the screen, projected by a suitable optical system, instead of in the plane of the screen itself.

Figures 6 and 7 show the scanning head.

Referring to Figure 6, light radiated by a lamp 17 in a lamp-house 18 is brought to a focus by a condenser lens 19, upon the aperture of a short focus projection-lens system 20. A diaphragm 21, having an opening 22 which is adjustable in shape and size, is situated in front of the condenser lens 19. A diminished image of the aperture 22 is focussed by the projection lens 20 upon the surface of the multi-colour design E fastened upon the recording drum A. Light reflected back from the design E falls upon photo-cells I disposed around the objective lens 20, the photo-cells being mounted in a flat cylindrical housing which surrounds the lens 20 and is divided into compartments by radial ribs 28. Each compartment is covered by a colour-filter 29 on the side facing towards the design. For focussing the light-spot accurately upon the surface of the design, the scanning-head is mounted upon a

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carriage 30 which can be displaced smoothly along ways 31 as in the cross-slide of a lathe.

Figure 6 shows an arrangement with two photo-cells disposed diametrically opposite one another, as in Figure 1, and Figure 7 shows an arrangement having three photo-cells for the purpose described below.

Figure 8 illustrates the action of the scanning light-spot at a boundary between two colours.

Since the projection lens 20 in Figure 6 projects a diminished image of the diaphragm 21, the size and shape of the spot of light which is projected can be controlled by controlling the aperture 22 of the diaphragm 21. The size and shape of the scanning spot are regulated, with reference to the size and shape of the light-spots which record the separated colour images on the films, in such a way as to produce the desired degree of fitting between the separated colour-images. For example, the adjustment may be made in such a way as to produce the required narrow "allowance" or separation between colours which have to fit together.

In Figure 8, QRS represents on an enlarged scale part of the boundary between contiguous colour areas in the design. The circle T represents an enlarged image of the scanning spot, shown as circular in this case. As long as the scanning spot is wholly within the colour area U the corresponding recording element is energised, and so long as the scanning spot is wholly within colour area V, the recording element for colour V is energised, but so long as the scanning spot rests partly on colour U and partly on colour V, as at the instant depicted in the diagram, neither recorder is energised. For, during the period in which the scanning spot is passing from colour U to colour V, the cathode-ray beam is also passing across the screen from one detector to the other. Consequently when the separated colour records are fitted together again, a gap would be left between the edges of the colours, equal in width to the diameter of the scanning spot less the diameter of the recording spot. Thus the width of this gap may be controlled by controlling the shape and width of the scanning spot.

Figure 9 illustrates diagrammatically the internal connections of one form of amplifier, using thermionic valves, which may be employed, as shown by J and K in Figure 1, to amplify the signals from the photocell scanning head, to control the deflections of the cathode-ray beam. The photo-cell output is applied at 23. Amplifiers of similar type may also be employed as shown by O1, O2, O3, etc. in Figure 1 to amplify the signals from the cathode ray tube screen detectors N (1, 2, 3, etc. of Figure 1) to the required level to control the operation of the recording elements (P1, P2, P3, etc.). The construction of the amplifier follows known conventional lines; it should however be of such type as will produce an amplified steady direct-current output for a small steady direct-current input, besides having a good response to rapid changes at a rate up to 10,000 cycles per second. Any form of amplifier which satisfies the requirements may be used; such amplifiers are not necessarily limited to those which operate by means of thermionic valves.

When two separate photo-cells are employed as hitherto described, to receive the light reflected from the light-spot when scanning the coloured original, the resulting photo-currents, and hence

the resulting independent horizontal and vertical deflections of the colour indicator, constitute a partial specification or measure of the colour of the area which is being scanned. The specification is incomplete since, as is well-known, three independent measures are required to specify a colour completely. If necessary, I may obtain a complete tri-chromatic specification of the colours by using three differently coloured-filtered photo-cells instead of two only, in the receiver at the scanning spot as shown in Figure 7. The third co-ordinate of colour cannot conveniently be exhibited directly upon the two-dimensional screen of the colour indicator, in the same terms as the first two co-ordinates, but in the case where a cathode-ray tube is used as indicator, I may obtain an indication of the third co-ordinate of colour by causing the photo-current of the third photo-cell to control in a known manner either the intensity or the alternating current frequency of the beam current in the cathode-ray tube. Such variation in intensity or frequency may be utilised to control the recording elements so that they may operate with graduated force.

A graduated response is of value in cases where the printing surface is required to deliver graduated quantities of printing colour at different places in the pictures, instead of merely full-colour or no-colour. This requirement arises when there is need to print various tones of the colours, as for example in the reproduction of pictures, etc., which at certain places in the picture require mixtures of the component printing colours in various proportions.

When the frequency of the recording elements is suitably modulated by the scanner, through the medium of the cathode-ray beam in the manner described, the recording element may produce an image in the form of chains of dots instead of continuous lines, the spacing of the dots being varied in accordance with the excitation of the photo-cell scanner. Such an image can be used to produce graduated tones of colour by the half-tone principle and process.

Figure 10 illustrates the basis of one form of circuit for causing a photo-cell current to control a rate of pulsation. Figure 11 illustrates an alternative similar circuit in which a thermionic valve is added to amplify the pulsations. Figure 12 illustrates a further alternative circuit, in which a relay is used.

Referring to Figure 10, 32 represents a battery or other convenient source of current, 33 represents the photo-cell, 34 represents an electrical condenser, and 35 represents a glow tube, such as a neon lamp, having well-defined voltages at which the glow discharge respectively commences and ceases. In operation, the current from the photo-cell 33 charges the condenser 34 until the voltage rises to a certain level, when the lamp 35 begins to conduct, discharging the condenser 34 until the voltage reaches a certain low level, when the lamp is extinguished and the cycle recommences. The time for one cycle depends upon the value of the charging current from the photo-cell. Thus the photo-cell current controls the periodicity of the pulsating voltage which appears across the points 36. This voltage is applied to the modulator grid of the cathode-ray tube.

Referring to Figure 11 this shows a circuit similar to that of Figure 10, with the addition of a conventional resistance-capacity coupled triode valve to amplify the voltage pulsations before

applying them to the modulator of the cathode-ray tube. The primary photo-current may, if necessary, also be amplified.

Referring to Figure 12, the current delivered by the photo-cell 37 and battery 38 develops a voltage across the resistance 39, which is amplified by the triode valve 40 and controls the rate of discharging of the condenser 41. The condenser voltage opposed by the large grid bias battery 42, determines the grid voltage of the valve 43 and controls the pulse operation of the relay 44. Voltage pulses appear across the points 45, the periodicity being determined by the magnitude of the current from the photo-cell.

Similarly, when the intensity of the light produced by the recording element is controlled by the scanner, for example when a cathode ray tube is used as a recording device and the signal from the third photo-cell, suitably amplified by an amplifier such as that shown in Figure 9, causes a voltage to be impressed upon the modulator or control grid of the tube to control the current in the cathode ray beam, the record will be made in graduations of photographic density. Such a record can be used to control the depth of etching of an intaglio printing surface by known methods, as in photogravure.

In particular cases, such as the majority of designs intended for textile printing, the original is painted in a limited number of different colours, and an equal number of printing surfaces are required, one for each colour. The invention is especially suitable for use in such cases, an apparatus as shown in Figure 1 being primarily intended for this purpose, but the application to mixture effects, such as multi-colour half-tone or photogravure is not excluded.

Figure 13 shows the electrical connections of the apparatus which may be adopted when it is desired to employ a number of small cathode-ray tubes, one for each colour, as the recording elements, and Figure 14 illustrates the kind of optical projection system which would be employed with each small cathode-ray tube.

Referring to Figure 13, 11 represents one of the colour-sensitive photo-cells of the scanning head. The photo-cell 11 is connected through an amplifier 47, to output connections 49 to which are connected the vertical deflection plates 50 of a set of cathode ray tubes 51, which replace the lamp and projecting systems P1—P6 in Figure 1. Similarly, 12 represents a second colour-sensitive photo-cell in the scanning head. 12 is connected through an amplifier 52 to output leads 53 to which are connected the horizontal-deflection plates 54 of all the cathode-ray tubes 51.

Thus as the colours under the scanning-head alter during scanning, the deflection of the beam in every cathode-ray tube alters in the same way, both horizontally and vertically. Each tube 51 is separately provided with independent adjustable direct-current bias voltages on both pairs of plates, so that its beam 56 is normally deflected to a point 57. Each tube has its two bias voltages adjusted so that its cathode-ray beam 56 is brought to a fixed point 58 of the screen, whenever the associated colour appears beneath the scanning light-spot. An opaque mask 59 is placed over the screen face of each cathode-ray tube, pierced by a hole 60 which is brought opposite to the aforesaid fixed point 58. Thus a spot of light appears on the face of each cathode-ray tube opposite the hole in the mask whenever the corresponding colour is being scanned. This spot of light is utilised as the recording element. The

point 58 need not be the centre of the tube face, and may be altered from time to time to bring fresh parts of the phosphorescent coating into use.

The light emitted by the luminous spot on the screen is collected by a condenser lens 61, which includes an adjustable diaphragm 62. The light from the condenser lens 61 passes through the enclosing tube 64 and is focussed upon the aperture of a projection lens 65. The lens 65 projects an image of the illuminated aperture 62 upon the surface of the recording film 66 attached to the surface of the recording drum 67.

Although this invention is intended primarily to be employed in the graphic arts, namely as a means of colour separation in the preparation of printing surfaces for multi-colour printing, I do not intend to exclude other applications, as for example in picture transmission.

What I claim is:

1. Apparatus for making separate records of component colours in the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, comprising means for scanning the original design by means of a light spot, photocells for receiving light from the original and yielding an output determined by the colour being scanned, a cathode ray tube having two sets of deflecting electrodes, each receiving the output of one of the photocells, whereby when any individual colour is being scanned the cathode ray is deflected to a position characteristic of that colour, a set of detectors corresponding in number to the distinct colours of the design, associated with the cathode ray tube at positions characteristic of the colours and each adapted to be activated by the cathode ray when the corresponding colour is being scanned and a set of recording devices corresponding in number to the colours to be printed, each controlled by one or more detectors so as to be operated when the corresponding detectors are activated.

2. Apparatus as claimed in claim 1, in which the detectors are photo-cells, each arranged to receive the cathode ray when it is deflected to a position characteristic of one colour or colour combination.

3. Apparatus as claimed in claim 2, in which the recording devices comprise lamps and projectors for projecting light spots on to sensitive surfaces, each lamp being associated with a photo-cell detector so that the output therefrom can cause it to light up.

4. Apparatus as claimed in claim 3, in which the lamps are gas-filled discharge tubes.

5. Apparatus as claimed in claim 1, in which the photo-cells are of different colour sensitivities, or are associated with different colour filters.

6. Apparatus for making separate records of component colours for the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, comprising means for scanning the original design or picture by means of a light spot, at least one photo electric cell for receiving light from the original and yielding an output determined by the colour being scanned, a set of detectors corresponding in number to the distinct colours of the original, a device for deflecting a ray when energized electrically, means for applying the entire photo-cell output to the said device, whereby the latter directs a ray to one of the detectors in accordance with the colour being scanned, and

a set of recording devices, one for each separate record, each controlled by a detector so as to be actuated when such detector receives a ray.

7. Apparatus as claimed in claim 6, having a rotatable drum to which a coloured original and a number of light-sensitive surfaces can be secured, a light source and optical projection system for projecting a scanning spot on to the coloured original, a number of recording devices each arranged to illuminate one of the sensitive surfaces when activated, and means coupled with the drive of the drum for traversing the scanning system and the recording devices as the drum is rotated, so that the original and the sensitive surfaces are scanned in the form of a helix of very fine pitch.

8. Apparatus as claimed in claim 6, in which a detector at a position characteristic of a colour intended to be reproduced by a mixture of two or more printing colours is arranged to activate the recording devices of all the component colours which are required to produce the said colour.

9. Apparatus as claimed in claim 6, in which the deflecting device is a cathode ray tube, the photo-cell output being applied to the deflecting electrodes of the tube, and having an optical system for producing an image of the cathode ray tube screen, the detectors being located in the plane of such image.

10. Apparatus for making records for use in textile printing from an original design executed in a finite number of distinct colours, comprising means for scanning the original design by means of a light spot, at least one photo-electric cell for receiving the light reflected from the original design, a cathode ray tube, means for applying the photo-cell output to the deflecting electrodes of the tube to deflect the beam to one of a number of positions each characteristic of one of the colours being scanned, a set of detectors corresponding in number to the colours of the original design, located one at each of said characteristic positions, and a set of recording devices corresponding in number to the colours of the original design, each associated with one of said detectors to be controlled thereby for operation when the cathode ray beam strikes such detector, whereby a number of records equal to the number of colours of the original design is obtained, each record including all the areas executed in one colour.

11. Apparatus for making separate records of component colours for the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, comprising means for scanning the original design or picture by means of a light spot, at least one photo-cell for receiving light from the original and yielding an output determined by the colour being scanned, a set of cathode ray tube recording devices, and means for applying the entire photocell output to the deflecting electrodes of all the tubes, the tubes being differently biased so that the photocell output characteristic of a given colour will bring the cathode ray of the tube for recording that colour to the appropriate position for illuminating a sensitive surface.

12. Apparatus as claimed in claim 11, in which each cathode ray tube has its screen covered by an opaque mask with an aperture for allowing light to reach the sensitive surface.

13. Apparatus for making separate records of component colours for the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, compris-

ing means for scanning the original design or picture by means of a light spot, three photo cells for receiving light from the original and yielding an output determined by the colour being scanned a set of detectors corresponding in number to the distinct colours of the original and located in positions characteristic of said colours, a cathode ray tube having horizontal and vertical deflecting electrodes, means for applying the output of one of the photocells to said horizontal deflecting electrodes and for applying the output of a second photocell to said vertical deflecting electrodes, for deflecting the cathode ray on to the detector corresponding to the colour being scanned, and a set of recording devices, one for each separate record, each controlled by a detector so as to be actuated when the cathode ray impinges on the detector, the output of the third photo cell being used to modulate the frequency of the cathode ray, for the purposes of activating the recording devices intermittently for producing an image in the form of chains of dots.

14. Apparatus for making separate records of component colours for the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, comprising means for scanning the original design or picture by means of a light spot, three photocells for receiving light from the original and yielding an output determined by the colour being scanned, a set of detectors corresponding in number to the distinct colours of the original and located in position characteristic of said colours, a cathode ray tube having horizontal and vertical deflecting electrodes, means for applying the output of one of the photocells to said horizontal deflecting electrodes and for applying the output of a second photocell to said vertical deflecting electrodes, for deflecting the cathode ray on to the detector corresponding to the colour being scanned, and a set of recording devices, one for each separate record, each controlled by a detector so as to be actuated when the cathode ray impinges on the detector, the output of the third photocell being used to modulate the current in the cathode ray tube, for the purpose of controlling the recording devices so that they operate with graduated

light intensity for producing a record having graduation of photographic density.

15. Apparatus for making separate records of component colours for the reproduction of designs or pictures containing areas each coloured in one of a limited number of distinct colours, comprising means for scanning the original design or picture by means of a light spot, a cathode ray tube having horizontal and vertical deflecting electrodes, two photocells receiving light from the original and yielding outputs determined by the colour being scanned, the outputs of the photocells being applied to the horizontal and vertical deflecting electrodes respectively for deflecting the cathode ray to a position characteristic of the colour being scanned, a set of detectors corresponding in number to the distinct colours of the original and located at the characteristic positions to which the cathode ray is deflected, a set of recording cathode ray tubes, one for each separate record, each controlled by a detector so as to be actuated when the cathode ray impinges on the detector, and a third photocell receiving light from the original, the output of which is used to impress voltages upon the modulator or control grids of the recording cathode ray tubes, to control the current in the cathode rays therein and hence the intensity of the recording light spots, for use in producing records for use in intaglio printing.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,185,139	Wurzburg	Dec. 26, 1939
2,185,806	Finch	Jan. 2, 1940
2,253,086	Murray	Aug. 19, 1941
2,253,292	Goldsmith	Aug. 19, 1941
2,278,940	Murphy	Apr. 7, 1942
2,375,966	Valensi	May 15, 1945
2,413,706	Sunderson	Jan. 7, 1947
2,415,051	Thompson	Jan. 28, 1947