B. BOUBNOFF.

PRODUCTION OF PICTURES IN NATURAL COLORS BY PHOTOMECHANICAL MEANS.

APPLICATION FILED JAN. 13, 1914.

1,190,095.

Patented July 4, 1916.

2 SHEETS—SHEET 1.

Fig. 1

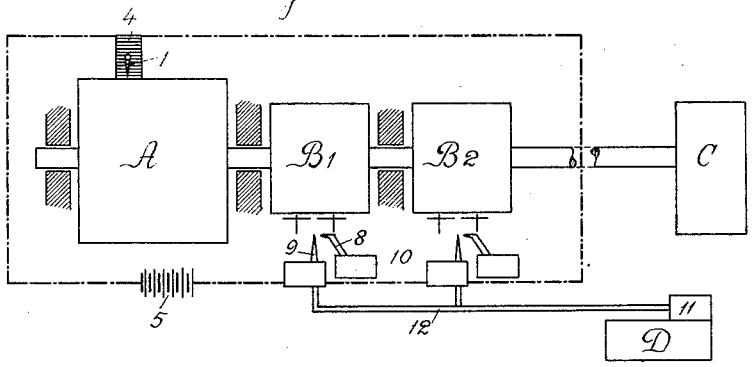


Fig. 2

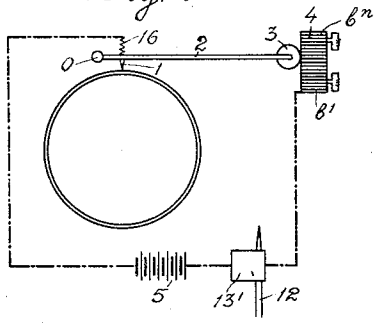


Fig. 3.

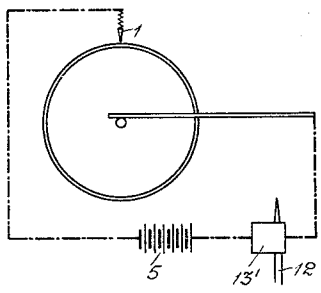


Fig. 4

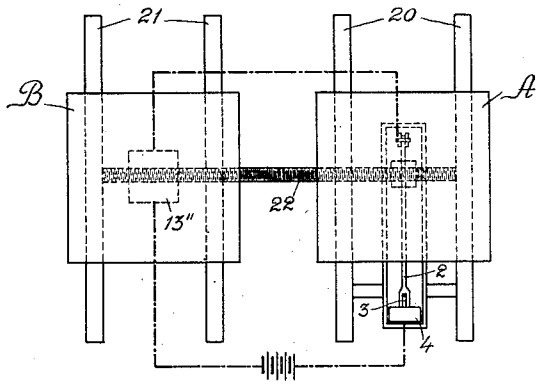
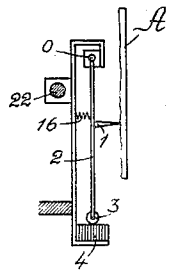


Fig. 5



Witnesses
H. E. Brady.
H. S. J. Lumbar

Inventor
B. Boubnoff
Percy H. Moore
Atty.

B. BOUBNOFF.

PRODUCTION OF PICTURES IN NATURAL COLORS BY PHOTOMECHANICAL MEANS.

APPLICATION FILED JAN. 13, 1914.

1,190,095.

Patented July 4, 1916.

2 SHEETS—SHEET 2.

Fig. 6.

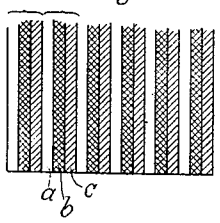


Fig. 7.

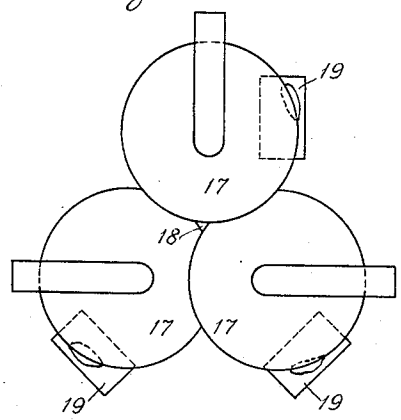


Fig. 8.

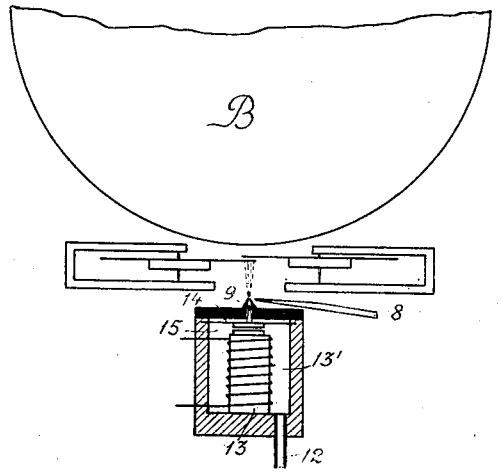


Fig. 11.

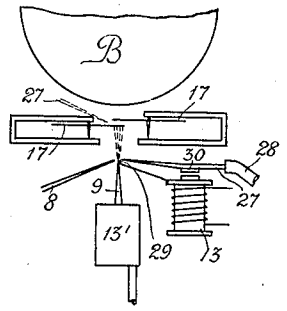


Fig. 9.

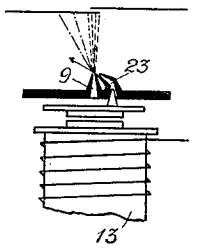
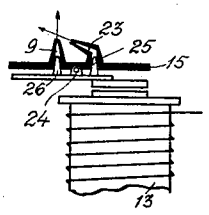


Fig. 10.



Witnesses
H. E. Brady.
H. S. Gilmlar

Inventor
B. Boubnoff
Percy H. Moore,
Atty.

UNITED STATES PATENT OFFICE.

BORIS BOUBNOFF, OF PETROGRAD, RUSSIA.

PRODUCTION OF PICTURES IN NATURAL COLORS BY PHOTOMECHANICAL MEANS.

1,190,095. Specification of Letters Patent. Patented July 4, 1916.

Application filed January 13, 1914. Serial No. 811,854.

To all whom it may concern:

Be it known that I, BORIS BOUBNOFF, a subject of the Emperor of Russia, residing at Wassily Ostrow, 11 Line, No. 44, Petrograd, Russia, have invented certain new and useful Improvements in the Production of Pictures in Natural Colors by Photomechanical Means; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention has relation to a process of, and apparatus for, the production of pictures in colors true to nature and consists in first making a negative by the aid of special light-filter and making from this negative a copy in relief by the employment of a light sensitive layer, the copy in relief being utilized for the production of colored positives.

In this process only one exposure is necessary for the production of colored pictures, and only one copy in relief from the negative. The production of the colored positive simply by spraying the corresponding colors in register is very easily effected. Since a considerable number of such positive pictures can be produced simultaneously, this process constitutes a simple means for the rapid and cheap production of colored pictures. Moreover, an important feature is, that the chemical composition of the colors used for the spraying is of no importance, and therefore colors can be chosen of which the shade does not alter under the influence of light, time, damp, etc.

In order to render the details of the proposed process perfectly clear, it will be described in connection with an apparatus suitable for carrying it out.

The diagram Figure 1 of the accompanying drawing shows the complete arrangement of such an apparatus, while Fig. 2 represents the portion thereof controlling the spraying process in diagrammatic end elevation. Fig. 3 shows a modification of this portion of the apparatus and Figs. 4 and 5 a further modification. Fig. 6 shows, as has already been mentioned, a colored striped filter for the photographic apparatus. Figs. 8, 9, 10 and 11 represent different forms of construction of a color-spraying apparatus in side elevation, while Fig. 7 shows a detail of this apparatus in plan.

The apparatus (Figs. 1, 2, 7 and 8) consists of a cylinder A and one or more cylinders B^1, B^2 . . . The backing with the copy in relief is fixed on the cylinder A, while the backings on which the colored positive pictures are to be produced by the spraying in succession and in register of the corresponding primary colors are drawn on cylinders B^1, B^2 . . . The cylinders B^1, B^2 . . . are mounted either with the cylinder A on a common shaft driven by the motor C, or are mechanically connected therewith in such a manner that a coördinated rotary movement of all cylinders takes place.

The exposure of the negative is effected through a filter made up of successive groups of narrow strips of color. If the primary colors of the spectrum generally employed in the three color process of photography be used, the light filter consists of fine parallel orange, green and violet colored strips arranged in the order mentioned. The width of three strips (a group) is a fraction of a millimeter (*e. g.* 0.2 mm.)

The exposure is made on an ordinary orthochromatic plate and a negative is obtained, which is also in strips in the sense that the exposure has taken place in strips through the orange, green and violet colored strips of the light filter. From the negative obtained in this manner, the copy in relief is produced photographically, being, at the same time, enlarged if necessary. The thickness of the light sensitive layer may be preferably considerably greater than in the case of ordinary photographic papers. The distribution of the irregularities on this picture corresponds to the distribution of light and shade on the negative. The production of the colored positive on a backing of paper or the like by means of this copy in relief, is effected in the following manner: In the first place, while using a suitable color, all the surfaces of the picture are produced in succession that correspond to a definite color on the light filter in such a way, that the color is impressed (sprayed) not only at the parts corresponding to the definite color of the light filter, but also at the portions of the adjacent strips which correspond to the remaining colors of the light filter. The width of the impression, therefore, corresponds to the total width of the strips *a*, *b*,

c, of the light filter (Fig. 6) forming a group. A monochrome positive picture is thereby obtained which has no strips, but is of the same color over the entire surface, though the thickness of the layer varies in different places. Thereupon a monochrome picture in one of the remaining primary colors is transferred in register upon the monochrome picture already obtained. This operation is repeated to produce a third and, if necessary, a fourth monochrome positive picture. If, for example, the work be carried out on the three color principle, a light filter is chosen of three colored strips repeated over the surface (Fig. 6) and if the colors be properly chosen for the spraying process the final result is a colored picture of the original in natural colors.

On the cylinder A the needle point 1 on the lever 2 (Fig. 2) is pressed by means of a spring 16. The lever 2 is pivoted at O and carries at the other end a roller 3 which rolls on the rheostat 4 and serves for the purpose of altering the resistance inserted into the circuit of the battery 5. The rheostat 4 consists of several resistances which connect the thin insulated disks $b^1 \ldots b^n$ in series. In the same circuit there is inserted an electromagnet 13 (Fig. 8) arranged within a receptacle 13^1 (Figs. 2 and 8).

Since the radial movements of the needle depend on the irregularities of the copy in relief and these again correspond to the distribution of the shade in the original picture, it is obvious that by the movement of the roller 3 of the lever 2, the resistance inserted in circuit with the battery 5 is likewise altered in accordance with the distribution of the shade. The alteration of the strength of the current in the circuit effects a stronger or weaker attraction of the armature 15 of the before mentioned electromagnet 13 (Fig. 8) and thereby moves the needle valve 14 in relation to the opening of the nozzle line of the receptacle 13^1, which communicates by means of the pipe 12 through a pressure regulator 11 with a compressed air receptacle D (Fig. 1). In front of the opening of the nozzle 9 of the vessel 13^1, there is placed the outlet of the pipe 8 of the color receptacle 10. The air flowing through the nozzle 9 under a certain pressure sucks color from the receptacle 10 and atomizes it. The atomization depends on the strength of the current of air, which is regulated by the needle 14 in accordance with the variations in the strength of the current in the circuit of the battery 5, so that a definite dependence of the spraying process on the distribution of light and shade on the picture to be reproduced is attained.

Between the nozzle 9 and the cylinder B above it, and in close proximity thereto, there are arranged disks 17 (Figs. 7 and 8) in such a way that a space 18 (Fig. 7) is left between them exactly above the opening 9. The shape and size of this space are determined by the number of disks 17 and also by their shape and relative positions. The said disks 17 are preferably arranged in such a way that they can be moved in relation to each other for the purpose of altering the dimensions of the space 18 as required. The greater portion of the color spray is blown on to the said disks and only a relatively small portion thereof passes through the space 18 to the surface of the cylinder B, or to the backing for the picture (*e. g.* paper) surrounding it. The disks are rotated continuously, and carriers 19 for brushes or sponges are arranged under them for the purpose of removing the color from them, so that the space 18 always remains free and unrestricted. The color removed from the disks by means of the sponges or the like can be led back to the color receptacle 10.

The rheostat 4, the pivot O of the lever 2 and the spring 16 are mounted in a common frame which is slid uniformly, preferably by the main motor C, in the longitudinal direction of the rotating cylinder A. In consequence of these two movements, the needle 1 describes a helical line on the surface of the picture in relief, and thereby imparts oscillations to the lever 2 corresponding to the irregularities of the picture in relief.

The hereinbefore-described color spraying apparatus is caused, like the before-mentioned frame of the cylinder A, to slide in the longitudinal direction of the cylinder B, so that when working on this cylinder the color is applied in the form of a narrow strip wound like a screw thread. The width of this strip is determined by the width of the space 18 and must correspond to the width of the group of strips *a*, *b*, *c*, of the light-filter. If this width be equal to the pitch of the helical line, the entire surface of the cylinder B will be sprayed with color, but not uniformly over the entire surface, since the intensity of the spraying varies according to the strength of the current in the circuit of the battery 5, that is to say with the degree of clearness of the corresponding part of the picture to be reproduced.

The copy in relief is fixed on the cylinder A in such a way that the strips corresponding to the colored strips of the light filter employed during the exposure form each a continuous helical line, that is to say, in such a way, that the ends of the strips register, which correspond to a certain color of the light filter. This may be attained by using a light filter having colored strips inclined in such wise that when a cylindrical hull is formed from the sheet bearing the

picture the ends of the corresponding strips of the copy in relief will register. Successive helical lines of "red," "green," "blue," etc., or strips forming the helical line are thus obtained. If the movement of the needle 1 is adjusted in such a way that it describes a helical line corresponding to the before-mentioned strips forming a helical line, it will remain on the cylinder, when the latter is rotated on one of the said helical lines, if it has been duly adjusted, that is to say it will be in contact only with those surfaces of the picture in relief that correspond to a certain color, *e. g.* the red. In this case the atomizing apparatus must work the red color and the disks 17 be adjusted in relation to each other in such a way that a complete monochrome picture is obtained on the cylinder B and not a striped one. During this operation the strips or surfaces corresponding to the other colors will be excluded from the picture in relief. These strips are utilized in the succeeding similar operations, the atomizing apparatus then working with the corresponding primary colors.

After the completion of the first monochrome picture, the color spraying apparatus 8, 9 and 10 is returned to the initial position, and the receptacle 10 is replaced by another (*e. g.* with the blue color) and the apparatus is set in operation after the needle has been adjusted on the corresponding helical line of the copy in relief. By this means a blue monochrome picture is transferred in register on the red-tinted surface of the cylinder B. The same operation is repeated with the other primary colors.

It is obvious that the diameter of the cylinders A and B and the velocities of the frame carrying the needle 1 and of the atomizing apparatus 8, 9 and 10 must be chosen in such a way that blurring or other distortion of the picture does not occur. If the colors for the successive monochrome reproductions are properly chosen, the final result is a picture in natural colors. The accuracy of the register of the several monochrome pictures is guaranteed by the fact that for the production of each successive monochrome picture only the needle 1 has to be suitably adjusted, which is simply and easily effected.

It is obvious that several cylinders B with atomizing apparatus 8, 9 and 10 can be employed simultaneously, and that therefore a large number of colored pictures can be produced simultaneously from a single picture in relief (Fig. 1).

The atomizing process can be regulated according to the variations in the strength of the current in the circuit of the battery 5 by employing on the cylinder A a picture in relief, of which the surface conducts the electric current. If this surface is then inserted into the circuit of the battery 5 (Fig. 3) by means of the needle 1, the resistance of this circuit will alter according to the resistance of the layer on the several parts, that is to say with its thickness. The current flows through the contact 20 and the electromagnet 13 of the atomizing apparatus back to the battery 5.

Instead of a single needle, a number of needles may be used in combination with a single cylinder A, and at the same time a corresponding number of atomizing devices may be arranged to slide underneath each cylinder B. By this means the entire surface of the picture can be divided into several portions which are reproduced simultaneously. By this modification of the apparatus the reproduction of the picture is therefore correspondingly accelerated.

The cylinders A and B may be replaced by a flat backing. In this case the needles of the atomizing apparatus are given a zig-zag movement in relation to the backings. This relative movement can be obtained by causing the flat backing to oscillate to and fro in a straight line, while the needles and the spraying apparatus are moved along the backings at right-angles to this movement and at a suitable slow speed. Figs. 4 and 5 show such an arrangement in plan and in section. A and B are the plates, on the lower surface of which the copy in relief or the backing for the colored positive picture is secured. These plates are moved to and fro on guides 20 and 21. On the screw 22, which is rotatably mounted underneath these plates, there are carried, by means of a nut, the carrier 13^{11} and for the spraying apparatus and the carrier for the rheostat 4 and the lever 2 with the needle 1. By rotating the screw 22, these carriers, with the apparatus thereon, are moved longitudinally thereof. If, at the same time, the backings are moved to and fro on the guides 20 and 21, the before-mentioned zig-zag relative movement is obtained.

The spraying apparatus and particularly the device for regulating the intensity of the deposit of color (Fig. 8) on the surface of the cylinder, may be constructed in various ways. Fig. 9 shows a further example of this apparatus. The receptacle 13^1 has, in addition to the nozzle 9, a second nozzle 23, which is inclined in such a way that the current of air flowing therefrom cuts the stream of atomized color at an angle. The mouth of the jet 9 is not controlled in this case, whereas the area of the opening of the jet 23, for example, is controlled in a similar manner to the apparatus hereinbefore described and shown in Fig. 8. The stronger or weaker current of air from the jet 23 caused by the inequalities of the picture in relief diverts the stream of color more or less from its vertical direction. Now, since the

distribution of the particles of color in the upwardly directed spray obviously becomes gradually less toward the outer edge, the less concentrated color spray from the opening 18 will reach the cylinder when the spray is diverted from its normal direction by the effect of the inclined current of air. By this means the necessary color tones are obtained.

The apparatus can also be modified according to Fig. 10. A stronger attraction of the armature 16 of the electro-magnet 13 oscillates a double-arm-lever about the axis 24 in such a way that the needle valve 25 opens the mouth of the nozzle 23, while the needle valve 26 closes the mouth of the nozzle 9 correspondingly. In this arrangement, the suction and atomizing effects of the current of air from the nozzle 9 is varied on the one hand, and on the other hand an additional regulation is obtained through the inclined current of air from the nozzle 23 (as in Fig. 9).

Fig. 11 shows a further form of construction of the spraying apparatus, in which a uniform current of air flows through the nozzle 9 and produces a uniform color spray. For the purpose of diverting this color spray more or less from its normal direction, a fine, and it may be partly flattened tube 27 is arranged at the side, and is connected to a compressed air reservoir by means of a pipe 28, a baffle or diverting plate 29 being placed in front of the mouth of the nozzle 27. A metal plate 30 attached to the tube 27 forms the armature of the electro-magnet 13, which is inserted into the circuit of the before-mentioned battery 5 and is excited in accordance with the irregularities of the copy in relief. When the armature 27 is more strongly attracted by the electro-magnet, the mouth of the tube 27 comes behind the plate 29. By this means the fine current of air which diverts the color spray is thereby weakened or diverted from its normal direction in such a way that its effect on the color spray is reduced. Experiments have shown that this apparatus is very sensitive and therefore enables very fine regulation of the spraying process to be obtained.

The apparatus 27—30—13 may be arranged also in such a way that the diverting current of air enters the horizontal opening between the superimposed disks 17 and thereby diverts a correspondingly greater portion of the color spray on these disks. Fig. 11 shows in dotted lines the position of the small tube 27 in the above-described arrangement, the mouth of the tube in this case being preferably in the form of a horizontal slit.

What I claim is:

1. An apparatus for the production of pictures in natural colors comprising a cylinder having a copy in relief attached thereto, a lever adjacent said cylinder, a needle attached to one arm of said lever, an electric circuit including a battery and a rheostat, said arm carrying a roller engaging said rheostat for regulating the resistance in the circuit of the battery; a compressed air receptacle having a valved nozzle for spraying the pictures, an electro-magnet inserted in the circuit of the battery, the armature of said electro-magnet being adapted to control the outlet opening of the nozzle according to the irregularities of the copy in relief, means for causing the valve of the spraying devices to be moved in a relatively coördinated movement along the said cylinder, and means arranged between the sprayed portion of the spraying apparatus for the purpose of adjusting the width of the spraying portion, said last mentioned means taking part in the movement of the spraying apparatus.

2. An apparatus for the production of pictures in natural colors comprising a cylinder having a copy in relief attached thereto, a lever adjacent said cylinder, a needle attached to one arm of said lever, an electric circuit including a battery and a rheostat, said arm carrying a roller engaging said rheostat for regulating the resistance in the circuit of the battery; a spraying apparatus comprising a compressed air receptacle having a valved nozzle for spraying the pictures, a series of spaced rotating disks arranged between said cylinder and said spraying apparatus, certain of said disks being capable of movement in a horizontal direction for the purpose of enabling the width of space between said disks being adjusted, an electro-magnet inserted in the circuit of the battery, the armature of said electro-magnet being adapted to control the outlet opening of the nozzle according to the irregularities of the copy in relief, and means for causing the valve of the spraying devices to be moved in a relatively coördinated movement along the said cylinder.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

BORIS BOUBNOFF.

Witnesses:

WILLIAM HEININGER,

M. BREITFUSS.