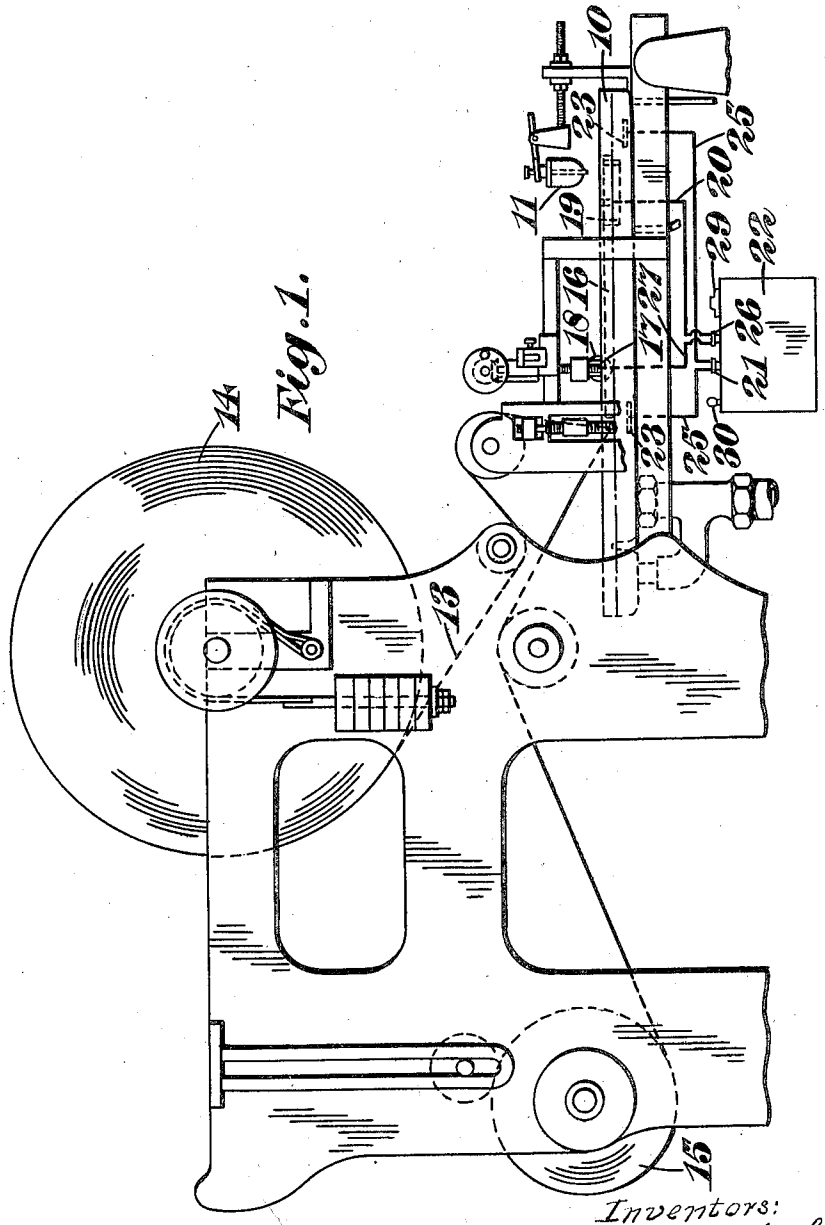
Sept. 8, 1936. W. B. PIRIE ET AL 2,053,494

PROCESS AND APPARATUS FOR SURFACING SHEET MATERIAL WITH PIGMENTS, VARNISHES, LACQUERS, WATERPROOFING SOLUTIONS OR THE LIKE

Filed Feb. 5, 1935 3 Sheets-Sheet 1

Fig. 1.



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Filed Feb. 5, 1935 3 Sheets-Sheet 2

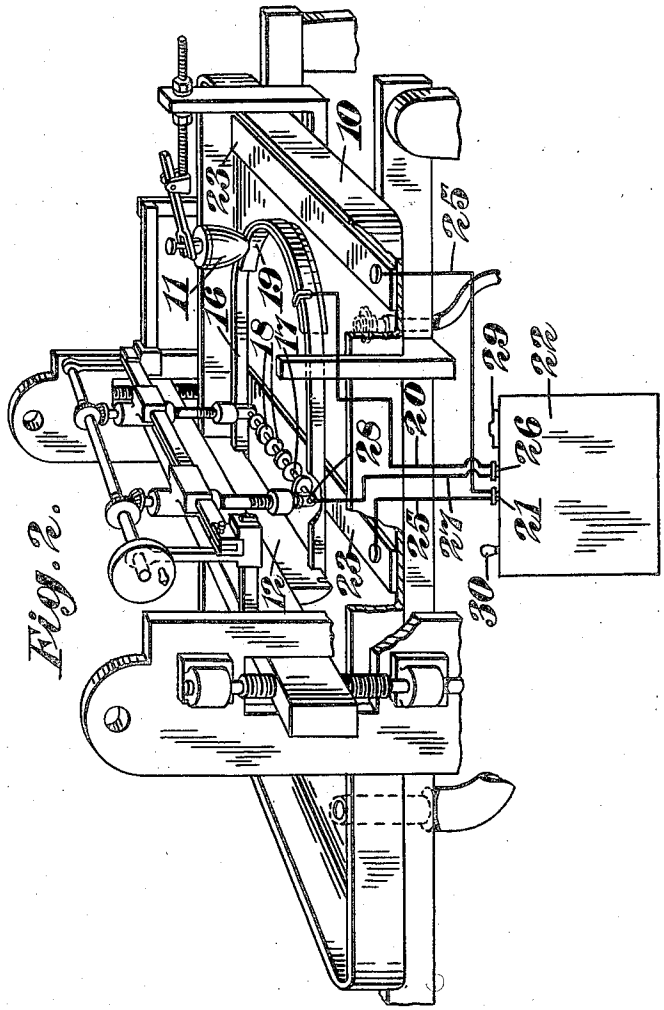

Fig. 2.

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Filed Feb. 5, 1935 3 Sheets-Sheet 3

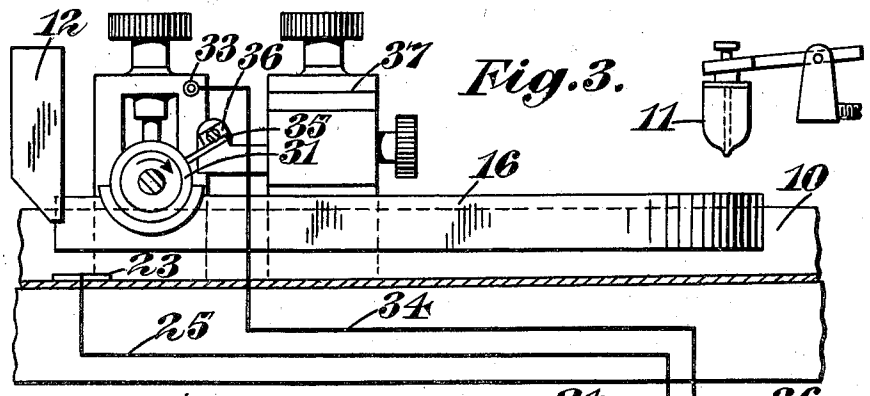


Fig. 3.

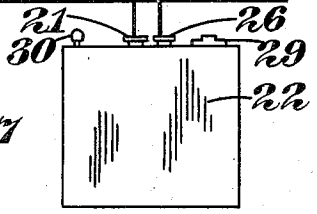
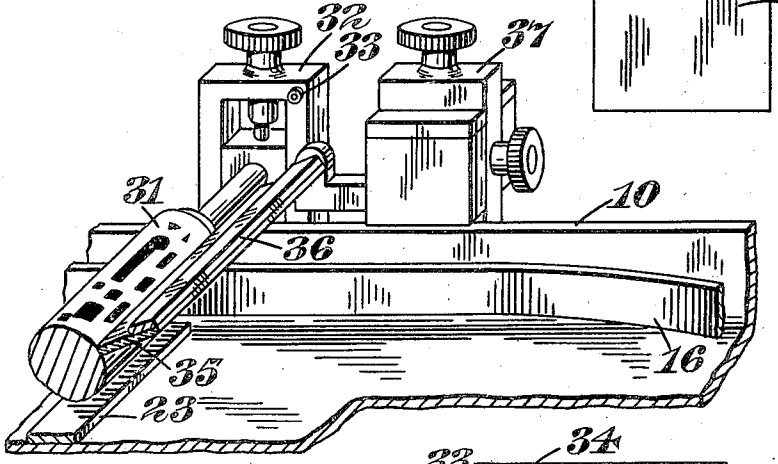


Fig. 4.



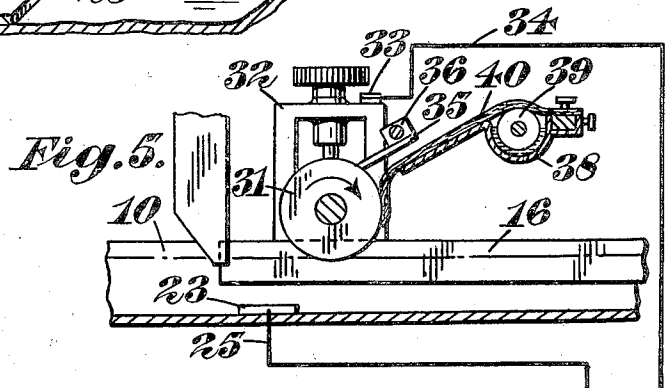


Fig. 5.

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UNITED STATES PATENT OFFICE

2,053,494

PROCESS AND APPARATUS FOR SURFACING SHEET MATERIAL WITH PIGMENTS, VARNISHES, LACQUERS, WATERPROOFING SOLUTIONS OR THE LIKE

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Application February 5, 1935, Serial No. 5,100
In Great Britain February 10, 1934

15 Claims. (Cl. 91—9)

This invention relates to processes and apparatus for carrying out mechanically and continuously the surfacing of sheet material, particularly paper, in continuous lengths, with pigments, varnishes, lacquers, waterproofing compositions and the like.

The invention deals with a flotation process of the type which consists in depositing the pigment or other coating composition in the form of a liquid film upon the surface of a liquid flotation medium and transferring the film as a coating on to a continuous web of paper or other sheet material.

In processes of the above type the film may be transferred from the surface of the flotation medium to the paper in various different ways. For example the pigment or like film-forming solution may be deposited continuously on to the surface of a liquid carrier medium in an annular trough which is bodily rotatable about a central vertical axis, and the film removed by traversing a continuous web of paper in contact with the under surface of a roller located at a fixed station and dipping into the flotation medium. Alternatively the annular trough may be fixed and the web-carrying roller movable bodily round the trough. With machines of the above kind the film is picked up by what is in effect a rolling motion of the paper surface in relation to that of the flotation medium. A similar effect can also be obtained by creating a current in the flotation medium so as to move the medium bodily with the film upon it up to a fixed station at which the film is taken off by the paper. In another process, described in U. S. Patent No. 1,912,885 the flotation medium is stationary and the web of paper is traversed past a fixed station in such manner that successive portions in the length of the web come into contact with the medium and remove the film by movement thereof in relation to the flotation medium in a direction along its surface—the process being based on the fact that films produced by the deposition on a flotation medium of suitable liquid compositions have sufficient tensile strength to enable them to be drawn along the surface of a stationary flotation medium without disruption.

The present invention is concerned with means for controlling the spreading and orientation of the film on the flotation medium, and the formation of patterns in the film, and is applicable in general to all processes of the type previously referred to, irrespective of the particular method employed for transferring the film to the paper or other web. The new method of control is, however, principally contemplated with reference to the flotation process described in U. S. Patent No. 1,912,885 and in certain cases to a form of that process in which the colour film passes over a transfer surface (e. g. a revolving cylinder or a moving endless band) at a point intermediate between the main colour supply station and the paper coating station. According to the present invention a flotation process of the type described is characterized by the application at selected locations (either directly or indirectly through some portion of the apparatus used for carrying out the process) of a regulated electric or magnetic potential, or a combination of both, to the flotation medium and/or to the film floating thereon and/or to a transfer surface. The purpose of such application is to control the spreading and orientation of the film or film-forming materials and the formation of patterns as will hereinafter be more fully described.

In one form of the invention the potential is applied to the wall of the flotation trough or of a frame within the trough which forms the boundary for the edges of the film, such application being made to control the spreading and orientation of the film with which the paper web is to be coated. With some pigment solutions there is a tendency for the colour to accumulate along the boundary wall of the film and thus to produce dark edges on the paper web. This disability may be remedied according to the present invention by applying a potential to a metal frame (or a metal plate attached to a non-metallic frame of celluloid or the like) which forms the boundary wall of the film. The effect of the applied potential is to repel the colour from the boundary wall and thereby prevent an accumulation of colour there.

In another form of the invention a potential difference is applied between the bulk of the flotation medium and mechanical agitating devices which dip into the medium and operate to form patterns in the film. The application of a potential in this case affects the pattern produced by the agitating devices.

In a further form of the invention in which a transfer surface is used between the main colour supply station and the coating station, a patterned orientation of the colour film is produced by applying a regulated potential to certain selected areas of the transfer surface. For example, the transfer surface may be of metal and selected portions thereof may be coated with

insulating material, so that when a potential is applied to it, a desired pattern can be produced in the film by the difference in effect of the applied potential acting through the insulated and uninsulated portions of the transfer surface respectively.

Some examples embodying the foregoing and other features of the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a side elevation showing the general arrangement of the machine,

Figure 2 is a perspective view, to a larger scale than Figure 1, showing more clearly certain details of the machine,

Figure 3 is a side elevation illustrating that example of the invention in which a potential is applied to selected areas of a transfer roller,

Figure 4 is a perspective view showing the transfer roller in more detail, and

Figure 5 is a side elevation showing an alternative method of feeding the film-forming material.

It is to be understood that for the sake of clearness the drawings have been made largely diagrammatic. In the several figures like parts are indicated by like reference numerals.

In the first example (see Figures 1 and 2) the potential control is applied to the frame used for forming a still pool in the coating of paper by the continuous flotation method described in U. S. Patent No. 1,912,885. The apparatus comprises in combination a trough **10** to contain the flotation medium (e. g. water), means such as one or more droppers **11** for maintaining a substantially continuous supply of the film-forming liquid to the surface of the flotation medium, a guide or doctor **12** arranged to dip into or just to touch the surface of the flotation medium or the film carried upon it at a station spaced apart from the region at which the film-forming liquid is supplied, means for traversing a continuous web **13** of paper from a supply reel **14** under the doctor **12** and from thence to a take-up spool **15**, and an open framework **16** spaced apart inwardly from the sides of the trough **10** and arranged to form a still pool within which the film-forming liquid is deposited by the dropper **11**. The film-forming liquid (in the present case a solution of printer's ink in petrol) spreads out naturally over the whole surface of the flotation medium bounded by the frame **16**, forming a thin cohesive film. Marbled patterns may be produced by means of a mechanical agitator operating within the still pool at a station between the doctor **12** and the dropper **11**, the agitator comprising a shaft **17** on which is mounted a series of inclined discs **18** so arranged that adjacent discs are at opposite inclinations to the axis of the shaft. By continuous rotation of the agitator shaft at a slow speed, the movement of the discs **18** produces a wave-form effect.

In the first example the invention is applied to the apparatus described above in the following way. At selected points on the inside of the still pool frame **16**, which is of celluloid, a potential is applied to metal plates **19** attached to the frame and dipping into the colour film and the flotation medium, for the purpose of repelling the colour from the frame. The plates **19** form an electrode which is connected by an insulated lead **20** to one pole **26** of a 3–4 volt battery **22**. Two metal plates **23** are placed on the bottom of the flotation trough **10** forming a second electrode which is connected by insulated leads **25** with the other pole **21** of the battery **22**. Conveniently the electrodes **23** are formed by strips of brass extending the full width of the trough. As already indicated, there is a tendency under some conditions for the colour to accumulate along the inner side of the frame **16** and to produce dark selvedges on the paper. The application of a potential in the manner just described remedies this disability. The electrode **19** may be a single plate clipped on to the frame **16** and extending any desired way round the frame, or alternatively several separate plates electrically connected together may be employed.

In the second example, also illustrated in Figures 1 and 2, the potential is applied to the pattern-forming discs **18**. In this application of the invention one electrode is constituted by the discs **18** which are connected to the pole **26** of the battery by an insulated lead **27** which makes contact with the bearings **28** of the agitator shaft. The other electrode is as before formed by plates **23** placed in the bottom of the flotation trough and connected by insulated leads to the pole **21** of the battery. Under the conditions in which the present example was carried out, the application of positive and negative potentials to the discs **18** caused a difference in the pattern, arising from the attraction of the colour to or its repulsion from the discs. By such means the strength and clearness of the outline of the pattern and the depth and contrast in the shading were considerably altered. Other differences in pattern were also produced by altering the supply voltage.

A high-resistance variable potentiometer **29** may be included in the battery circuit so that the applied potential may be smoothly varied from zero to full voltage of the battery used. A switch **30** may also be fitted in order to enable the current to be reversed.

Instead of applying a steady potential, a fluctuating direct current voltage or an alternating current voltage may be applied to the flotation medium or to the film. A difference of potential may, if desired, be applied between two pattern-forming devices or between two sets of such devices, dipping into the flotation medium. These devices may be stationary or movable, and the film is attracted to or repelled from them according to the pole of the battery with which they are connected. It is also within the invention to apply a substantially high voltage to the film by employing a condenser whereof one plate is placed just beneath the surface of the flotation medium, and the other is located above it, the intervening film and air constituting the dielectric. Alternatively both may be placed above or both below the surface of the flotation medium.

The term "electric or magnetic potential" where used herein is intended to include the use of high voltage discharges for producing patterns by actual breaking down of the dielectric, and also magnetic and electro-magnetic effects on films containing colloidal or finely dispersed magnetic substances. It is also within the invention to generate the necessary potential difference without the aid of an external battery or other generator by employing two different metals as electrodes, the flotation medium itself forming the electrolyte.

A further application of the invention is to film-forming liquids which comprise mixtures of liquid reagents, for example a mixture of a pigment and a suitable dye (i. e. a dye soluble in petrol but not in water) in a petrol solution.

In certain cases where a potential is applied (directly or indirectly) to such mixtures it is found that one constituent of the mixture will be affected by the potential while the other will remain unaffected.

The results described above refer to the application of potentials to films formed by spreading one colour on the flotation medium, but it will be appreciated that it is within the scope of the invention to apply potentials to films formed with more than one colour (e. g. by means of the marbling device with moving droppers described in U. S. Patent No. 1,912,885 not only for controlling them as above described, but also for controlling the relation of different colours to each other and the proportion of space which each of them shall occupy in the total film.

In the third illustrated example (see Figures 3, 4, and 5) the application of a potential is used in conjunction with that form of the flotation process in which a transfer surface is employed between the main colour supply station and the coating station. The apparatus is arranged in substantially the same manner as before as to the trough 10, the dropper or droppers 11 for supplying the film-forming material to the top of the flotation medium, the still pool frame 16, and the doctor 12 under which the paper web is continuously traversed. In this example, however, a transfer roller 31 of metal (e. g. brass) is located in front of the doctor 12 with its axis parallel with the doctor, and is arranged to dip into the flotation medium. As will be seen, the transfer roller 31 extends the full width of the still pool frame. The roller is supported in bearings 32 and is rotated in a direction (clockwise as viewed in Figure 3) such that its surface remote from the doctor is moving downwardly into the flotation medium. The coating liquid supplied by the dropper 11 spreads out in a film over the surface of the flotation medium within the still pool frame, and it is carried by the transfer roller 31 under the surface of the flotation medium, and is fed to the exposed surface of that medium on the side of the roller adjacent to the doctor, where most of the coating liquid spreads in a film over that surface, while a small quantity (varying according to the colour used) adheres to the roller during the continuance of its revolution.

For the purpose of producing a patterned orientation of the film by the roller 31, a coating of insulating varnish is applied to its surface over selected portions to conform with the desired pattern. A potential is applied to the roller by connecting one pole 26 of a battery 22 to a terminal 33 on the bearings 32 of the roller by means of a lead wire 34, while the other pole 21 of the battery is connected by a lead 25 to a metal electrode 23 placed in the bottom of the flotation trough. The electrode 23 extends substantially the full width of the trough and is located near the doctor. In one series of experiments, the current was varied from 2 to 60 milliamperes according to the coating liquids used and the voltage employed. By these means the proportion of the coating liquid discharged by different portions of the roller on the surface of the flotation medium may be increased or diminished according to whether such portions are insulated or uninsulated, and also according to the sign of the potential applied to the particular coating liquid in use. In this way a patterned film is transferred to the surface of the flotation medium between the roller and the doctor, and a corresponding pattern is formed on the paper web. By altering the polarity and varying the voltage of the applied potential many variations may be made in the patterns produced; for example dark patterns on a pale background of the same colour or pale patterns on a dark background of the same colour may be obtained, the effects varying somewhat for different colours.

Contrast in the patterns depends upon the roller being kept clean as well as upon the voltage of the applied potential. A scraper 35 in the form of a rubber strip supported by a bar 36 is therefore employed for maintaining a clean surface and preventing an accumulation on the transfer roller of colour which has not spread on to the surface of the flotation medium. The scraper 35 bears on the upper surface of the transfer roller on that side of it remote from the doctor, and the bar 36 by which it is carried is supported by brackets 37 at the sides of the machine which are provided with means for regulating the pressure of the scraper on the transfer surface, the angle at which the scraper is inclined to the surface and the height of the scraper at each end. By tilting the scraper slightly out of the horizontal position, the colour collected by it may be caused to flow down the V-shaped channel between the scraper and the transfer surface to the lower end of the scraper, where it may be collected in any suitable container. Alternatively the ends of the scraper may be so formed as to close the ends of the aforesaid V-shaped channel, and the colour collected may be pumped out of the channel into a suitable container.

In the arrangement shown in Figure 5, the device for feeding the coating liquid to the surface of the flotation medium comprises a reservoir 38 for the coating liquid in the form of a trough as long as or longer than the width of the paper being coated, mounted horizontally parallel to the doctor above the flotation medium and partially filled with the liquid, the level of which is constantly maintained by the addition of a regulated quantity of make-up liquid. A feed roller 39 is associated with the reservoir and is mounted so that its under surface is immersed, the roller being rotatable about a horizontal axis. A wick 40 of absorbent material, e. g. of cotton, woollen or silk fabric (or other suitable material which will allow a coating liquid to soak through it easily and regularly) and of approximately the same width as that of the paper web, is stretched above the reservoir and is attached thereto in such a way that it rests upon the upper surface of the reservoir roller and then hangs down therefrom and bears on the surface of the transfer roller 31 on that side of it remote from the doctor. As before the roller is rotated in the clockwise direction, as viewed in Figure 5, and the coating liquid fed by the wick is carried by the transfer roller under the surface of the flotation medium and fed on to the exposed surface of that medium in front of the doctor. As before a scraper 36 is employed.

While the process is especially suited for printing solid patterns, a design which is broken up into dots or lines of varying sizes and at varying distances from one another may be applied to the roller, or portions of a solid insulating coating may be scraped away correspondingly, and in this way shaded effects may be introduced. Shading may also be produced by varying the potential of the current applied to different portions of the roller surface, for example by varying the electrical resistance of the insulated coating at different places.

The desired pattern may be produced in insulating material on the transfer surface by hand drawing or brushing, by spraying, by stencilling or by various photographic methods. As examples of such photographic methods, the transfer surface has been coated with sensitized fish glue or similar films, the required design has been printed on the sensitized films from celluloid negatives in line, stipple, half-tone or the like and the printed design has then been made resistant to the electric current by surfacing it with appropriate insulating material and exposing it to appropriate stoving temperatures.

The pattern applied to the transfer roller may be reproduced exactly in the same size on the paper web, or it may be lengthened or shortened on the paper web (but without spoiling its outline) by altering the peripheral speed of the roller and the speed of the paper relatively to one another, and in this way one-way enlargements or reductions of patterns may readily be obtained. The latter effect is impossible by the use of mechanical methods of enlargement and reduction (e. g. by photography) in which an alteration of the length of a pattern involves a corresponding alteration in its width.

The use of a strong potential will in some cases cause the appearance of irregular spots in the film and distortion of the pattern, and if desired this effect may be purposely produced in order to form spotted, broken or distorted patterns.

It is within the invention to prepare a transfer surface by coating it with selenium or other substance, the conductivity of which varies according to the strength of light to which it is exposed. The selenium transfer surface, as it revolves, may be exposed to a strong light passed through a revolving negative or stencil of the desired pattern and some parts of the surface will thereby be made temporarily non-conductive, while other parts will remain conductive, according to the particular pattern.

Various structural alterations may be made in the apparatus for carrying out the invention. For example, instead of employing a roller, the transfer surface may be provided by an endless band having a patterned surface of insulating material and arranged to be traversed past a station at which the coating liquid is applied, and from thence under the surface of the flotation medium in order to deposit the patterned film thereon. Two or more colours may be applied by the transfer surface, such colours being fed by a wick supply, a dropper supply or any other convenient method. Again two or more transfer surfaces may be arranged to operate in the same flotation trough and receive separate colour supplies, or a series of transfer surfaces may operate in separate troughs. The formation of patterns by means of a transfer surface may be used in combination with the methods of forming patterns described in U. S. Patent No. 1,912,885.

In general two kinds of pattern may (in the case of most colours) be produced by means of a transfer surface as described herein with minus and plus potentials respectively. In the case of both potentials the insulated portions discharge most of their colour on to the surface of the flotation medium, what is left on the roller being removed by the scraper. The uninsulated portions retain the colour on the roller with the potential of one sign (which is negative in the case of most colours) until it is removed by the scraper; with a potential of the opposite sign they feed practically all their colour to the surface of the water. It is believed that the attractive force of the potential acts only on the pigment part of the solution, keeping the particles of pigment (combined with a small amount of varnish) on the uninsulated portions of the roller, but allowing the transfer from the roller to the flotation medium of a film of varnish-petrol solution from which the pigment has been withdrawn. On the other hand, it is believed that with a potential which exerts a repelling action, the uninsulated portions of the roller disharge not only the pigment, but the varnish and petrol as well.

We claim:—

1. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, means for controlling the spreading and orientation of the film on the flotation medium by the application of a regulated potential to a device immersed in said medium, and means for traversing a continuous web of sheet material in contact with the film so as to apply it as a coating to the web.

2. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, a film controlling member which dips into the flotation medium, means for applying a potential difference between said member and the bulk of the flotation medium, and means for traversing a continuous web of sheet material in contact with the film so as to remove it as a coating on the web.

3. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, a film controlling member which dips into the flotation medium, means for applying to said member an electric potential of such sign as to repel the coating composition from the surface of the member in contact with the film, and means for traversing a continuous web of sheet material in contact with the film to remove the latter as a coating on the web.

4. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, an electric control circuit including a source of potential difference and two associated electrodes one constituted by a member which dips into the flotation medium at the surface thereof and the other being at the base of the container, a potentiometer for regulating the difference of potential applied between the two electrodes, and means for traversing a continuous web of sheet material in contact with the film to remove the latter as a coating on the web.

5. Apparatus for carrying out a flotation process of the kind described comprising a trough to contain a liquid flotation medium, means at one station over the trough for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, means at a station spaced apart from the supply station for traversing a continuous web of sheet material in contact with the film to remove the

latter as a coating on the web, a mechanical agitating device operable on the film between the two stations aforesaid, and means for controlling the patterning effect of the agitating device by the application to it of a regulated electric or magnetic potential or a combination of both.

6. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, an open framework immersed in the flotation medium and spaced apart inwardly from the sides of the container aforesaid in such manner as to form within the frame a still pool, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium within the still pool, means for applying a potential difference between the still pool frame and the bulk of the flotation medium, and means for traversing a continuous web of sheet material in contact with the film within the still pool so as to remove the film as a coating on the web.

7. Apparatus for carrying out a flotation process of the kind described comprising a trough for a liquid flotation medium, means located at one station over the trough for depositing a coating composition in the form of a liquid film on the surface of the flotation medium, means operable at a station spaced apart from the supply station for the coating composition to traverse a continuous web of sheet material in contact with the film to remove the latter as a coating on the web, a transfer surface partially immersed in the flotation medium at a position between the two stations aforesaid, and means for producing a patterned orientation of the film by applying a regulated potential to selected areas of the transfer surface.

8. Apparatus for carrying out a flotation process of the kind described comprising a trough for a liquid flotation medium, means located at one station over the trough for depositing a coating composition in the form of a liquid film on the surface of the flotation medium, means operable at a station spaced apart from the supply station for the coating composition to traverse a continuous web of sheet material in contact with the film to remove the latter as a coating on the web, a metal transfer surface which dips into the flotation medium intermediate between the two stations aforesaid and which has selected portions coated with insulating material, and means to apply a potential to the transfer surface, whereby a pattern is produced in the film by the difference in effect of the applied voltage acting through the insulated and uninsulated portions of the transfer surface respectively.

9. Apparatus for carrying out a flotation process of the kind described comprising a trough for a liquid flotation medium, means located at one station over the trough for depositing a coating composition in the form of a liquid film on the surface of the flotation medium, means operable at a station spaced apart from the supply station for the coating composition to traverse a continuous web of sheet material in contact with the film to remove the latter as a coating on the web, a transfer roller mounted for rotation about a horizontal axis and arranged to dip into the flotation medium between the two stations aforesaid, a design represented on the surface of the transfer roller by electrically insulated and uninsulated areas, and means for applying an electric potential to the roller.

10. Apparatus for carrying out a flotation process of the kind described comprising a trough for a liquid flotation medium, means located at one station over the trough for depositing a coating composition in the form of a liquid film on the surface of the flotation medium, means operable at a station spaced apart from the supply station for the coating composition to traverse a continuous web of sheet material in contact with the film to remove the latter as a coating on the web, a transfer roller mounted for rotation about a horizontal axis and arranged to dip into the flotation medium between the two stations aforesaid, a design represented on the surface of the transfer roller by electrically insulated and uninsulated areas, means for applying an electric potential to the roller, and means for altering the peripheral speed of the roller and the speed of the continuous web relatively to one another to produce one-way enlargements or reductions of pattern.

11. Apparatus for surfacing sheet material with pigments and the like, comprising in combination a stationary trough to contain a liquid flotation medium, supply means for film-forming liquid located near one end of the trough, a guide arranged to extend into the trough at a station near the opposite end thereof, means for traversing a continuous web of sheet material past the guide aforesaid in contact with its lower edge, a metal roller located between the supply station for the film-forming liquid and the guide aforesaid with its axis parallel to the guide and arranged to dip into the flotation medium, means for rotating the roller in a direction such that its surface remote from the guide is moving downwardly into the flotation medium, a coating of insulating material applied to the surface of the roller over selected portions conforming with a pattern, and means to apply a regulated potential difference between the roller and the bulk of the flotation medium.

12. Apparatus for surfacing sheet material with pigments and the like, comprising in combination a stationary trough to contain a liquid flotation medium, a guide arranged to extend into the trough, means for traversing a continuous web of sheet material past the guide aforesaid in contact with its lower edge, a rotatable patterning roller having selected areas of its surface electrically conducting and other areas electrically insulated, said roller being located in front of the guide aforesaid with its axis parallel thereto and arranged to dip into the flotation medium, means for feeding film-forming liquid to the surface of the patterning roller, and means for applying a potential difference between the patterning roller and the bulk of the flotation medium.

13. A flotation process of the kind described which comprises maintaining a substantially continuous supply of film-forming liquid to the surface of a body of flotation liquid, applying a regulated potential difference between an electrode in contact with the flotation medium and an electrode in contact with the floating film, selecting the respective polarity of the two electrodes to determine the control imposed thereby on the spreading and orientation of the film on the flotation medium, and traversing a continuous web of sheet material in contact with the film so as to apply it as a coating to the web.

14. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, two co-operating electrodes, one immersed in the flotation medium and in contact with the

film-forming liquid, and the other associated with the base of the container, means for applying a potential difference between the two electrodes, means for controlling the polarity of the electrodes, and means for traversing a continuous web of sheet material in contact with the floating film so as to apply it as a coating to the web.

15. Apparatus for carrying out a flotation process of the kind described comprising a container for a liquid flotation medium, means for maintaining a substantially continuous supply of film-forming liquid to the surface of the flotation medium, two co-operating electrodes, one dipping into the flotation medium and in contact with the film, and the other associated with a wall of the container, means for applying a potential difference between the two electrodes with their respective polarities so selected as to repel the coating composition from the surface of the electrode which dips into the medium, and means for traversing a continuous web of sheet material in contact with the film to remove the latter as a coating on the web.

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