Sept. 12, 1939. R. J. H. ALINK ET AL 2,172,783

METHOD AND DEVICE FOR DEVELOPING

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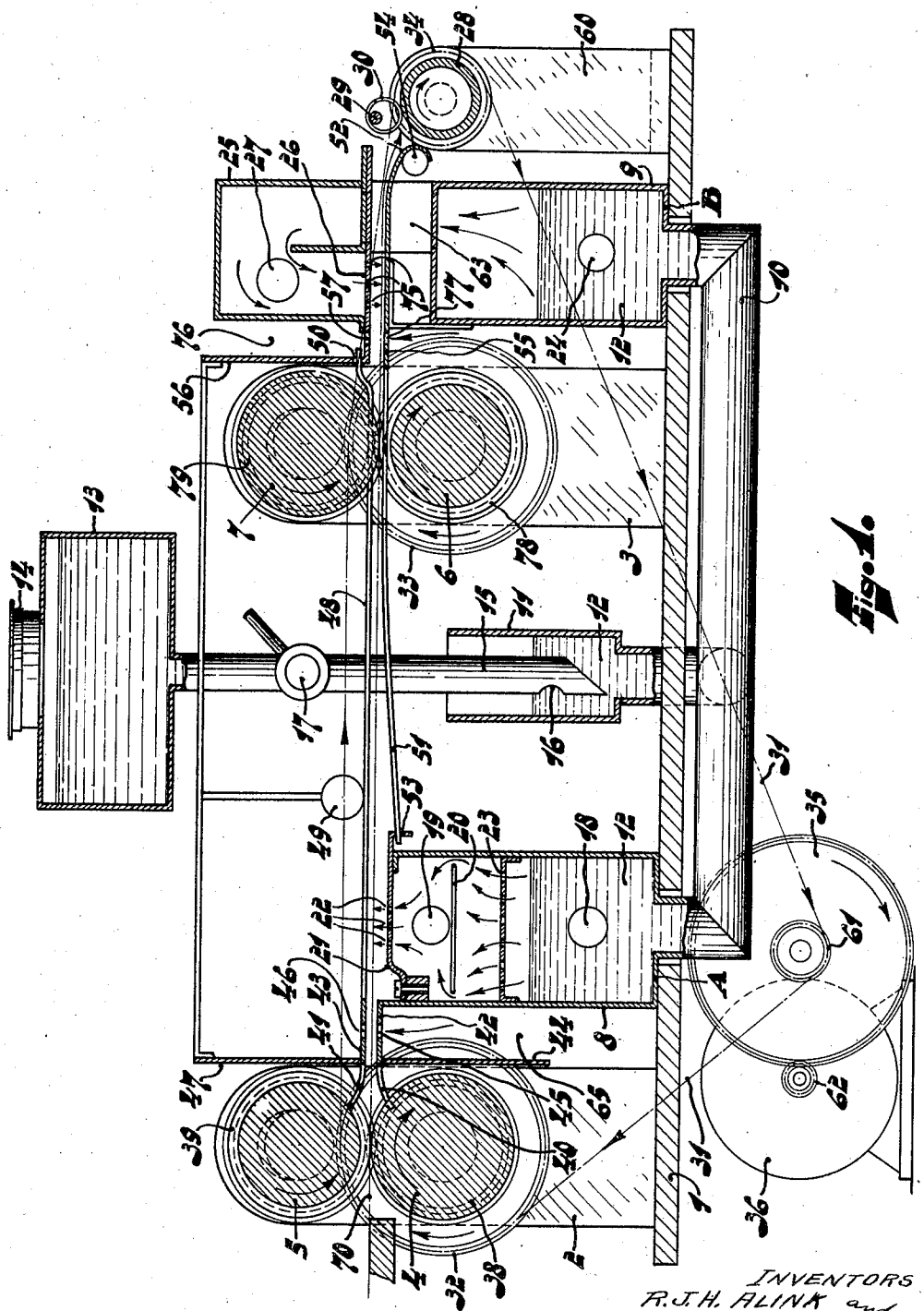

Fig. 1.

INVENTORS
R. J. H. ALINK and
J. ANINGA.

BY E. F. Wendroth
ATTY.

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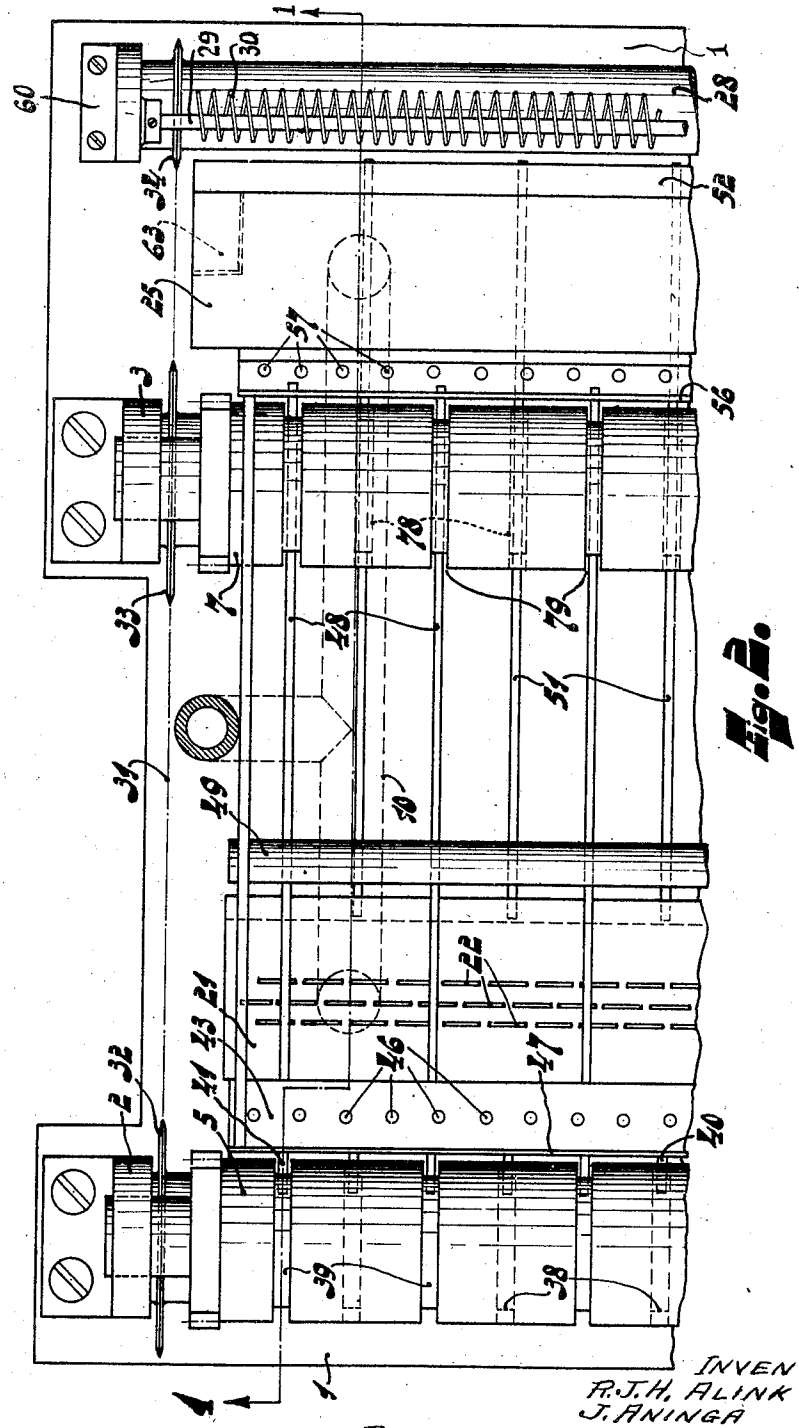

Fig. 2.

INVENTORS
R. J. H. ALINK and
J. ANINGA

BY

E. F. Underoth

ATTY.

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METHOD AND DEVICE FOR DEVELOPING

Roelof Jan Hendrik Alink and Johannes Aninga, Eindhoven, Netherlands, assignors to N. V. Philips' Gloeilampenfabriken, Eindhoven, Netherlands

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6 Claims. (Cl. 95—88)

Our invention relates to a method and device for developing photo-sensitive material, more particularly photo-sensitive material which is developed with steam.

Our invention is particularly adapted for developing layers comprising a diazonium compound whose light-decomposition product is oxidized by a diazonium compound to form coloring material as described in the U. S. Patent No. 2,034,508 to De Boer et al., or layers comprising a diazonium compound, an azo-coupling compound and an alkaline reacting powder, as described in the copending U. S. patent application Ser. No. 758,334 to Alink et al., filed December 19, 1934. Our invention is also suitable for developing layers comprising a diazonium compound in which image formation is effected by a reaction between the light-decomposition product of the diazonium compound and a mercurous salt as described in the copending U. S. patent application Ser. No. 1,436 to Alink et al., filed January 11, 1935, now Patent No. 2,067,690, issued January 12, 1937.

To satisfactorily develop such materials it is essential to have a sufficient difference between the temperature of the material and the temperature of the steam, and also to prevent formation of undesired spots upon the material by condensation of steam forming water on parts of the device with which the material comes in contact. Furthermore, the developed material should assume an uncoiled or flat condition, and should preferably be moved through the device without the use of belts or ropes.

The object of our invention is to provide a method and device for developing which meets the above conditions.

In accordance with the invention, we first subject one side of the exposed material, preferably the exposed side, to the action of steam, subsequently cool the so-treated material by passing same through air, and then treat the other side with steam; thereby insuring a sufficient temperature difference between the material and the steam, when applying the steam.

The method according to the invention is carried out in a simple manner in an open device by mechanically continuously moving the material, preferably by means of rollers and without the use of bands or ropes, so as to successively pass it by means for applying steam to one side of the material, through an intermediate space in which the material is cooled, and by means for applying steam to the opposite side.

By an "open" device is meant herein a device which is open to the atmosphere, in contradistinction to closed devices such as are used for developing prints with a substance which must be confined, such as ammonia gas.

To avoid spotting of the material, we provide hot-air circulating means which prevent the steam from reaching the rollers in the periods of absence of the material to be developed, and we also heat those parts of the device with which the material might contact; thus preventing undesired condensation of water on parts of the device. Furthermore, to prevent the material from becoming too wet, we provide heating means to superheat the steam.

Further features of our invention will appear as the description progresses.

In order that our invention may be clearly understood and readily carried into effect, we shall describe same more fully with reference to the accompanying drawings, in which:

Figure 1 is a side view of a developer according to the invention taken on the section I—I of Fig. 2;

Figure 2 is a partly sectionized plan view of Fig. 1 with several parts omitted for clarity.

The developer shown in the drawings comprises a common base 1 upon which are mounted three sets of brackets 2, 3, and 60 (only one bracket of each set being shown in the figures). Rotatably mounted on the brackets 2 are two cooperating rollers 4 and 5 each provided with a plurality of peripheral grooves 38 and 39, which are staggered with respect to each other and serve a purpose later to be described. Similarly, brackets 3 carry cooperating rollers 6 and 7, similar in construction to rollers 4 and 5 respectively and provided with staggered grooves 78 and 79 respectively. The surfaces of rollers 4, 5, 6 and 7 are of metal, whereas rollers 5 and 7 are mounted so as to be movable in a vertical direction to allow for the passage of the material to be developed while at the same time pressing the material against the rollers 4 and 6.

Rotatably mounted on brackets 60 is a roller 28 having a smooth surface preferably of rubber. Furthermore, a rod 29 carrying a helical spring 30, which contacts with the surface of roller 28 is secured thereon.

The rollers 4, 6 and 28 are driven in a clockwise direction, as indicated by the arrows, by a motor 36 and for this purpose are provided with sprockets 32, 33, and 34 respectively driven by chain 31 from a sprocket 61 secured to a reduction gear 35 directly driven by a gear 62 on the shaft of motor 36. Rollers 5 and 7 bear upon rollers 4

and 6 respectively either directly or through the material being developed and are driven in a counterclockwise direction, as indicated by the arrows. The material to be developed passes through the device in the direction indicated, by line 70.

For generating the steam used in the development two vaporizers or boilers A and B are provided; vaporizer A being used to supply developing steam to the lower side of the material, whereas vaporizer B serves to supply steam to the upper side. Vaporizer A comprises a rectangular cross-section container 8 extending the width of the rollers 4 and 5 and having an open top. Secured to the container 8 and extending over the right hand side thereof is plate 21 having a plurality of apertures 22 arranged in several rows and staggered relatively to one-another, as shown in Fig. 2. The container 8 is partly filled with water 12 which is heated by an immersion electric heater 18.

Vaporizer B comprises a container 9 which is closed except for connections 63, later to be referred to, and is partly filled with water 12 heated by an electric heater 24. For supplying water to the containers 8 and 9 they are connected together and to an open container 11 by means of tube 10. Above the container 11 and feeding same through a tube 15 containing a valve 17 is a reservoir 13 provided with a removable cap 14, which may be air-tightly closed. In placing the device in operation reservoir 13 is filled with water, the cap 14 is closed, and upon opening valve 17 the water in containers 8, 9 and 11 rises to a level determined by the position of an aperture 16 near the end of tube 15. As the water in containers 8 and 9 is vaporized during the operation of the device, the water is always maintained at the proper level. The valve 17 may be closed when the device is not in operation.

In the upper portion of container 8 is an electrical heating unit 19 which supplies heat for superheating the steam developed in the container to a temperature of about 105 to 110° C. so that the steam is dry and the material to be developed will not become too wet. To more readily transmit this heat to the steam, a plate 20 is secured to the unit 19. In addition unit 19 serves to heat the apertured plate 21 to thereby prevent condensation of the steam thereon, and also aids the passage of the steam through the apertures 22 by increasing the pressure of the steam within the container 8. A perforated baffle 23 is secured to the container 8 above the level of the water 12 and serves to prevent the water from splashing upon the plate 20 and cooling same.

The water in container 9 is vaporized into steam by the unit 24, which steam passes through the connections 63 into a container 25 disposed above container 9. An angle plate 26 is secured to the container 25 and is provided with a plurality of apertures 75 arranged in several rows. Within the container 25 is a heating unit 27 which serves to superheat and increase the pressure of the steam developed in container 9 which steam passes through apertures 75 to the upper side of the material to be developed.

The steam generated by vaporizer A and leaving the apertures 22 is prevented from reaching the rollers 4 and 5 and moistening the surface thereof, by a vertical rising current of hot air between the rollers 4 and 5 and the apertures 22. For this purpose an angle plate 42 having perforations 45, is secured to the container 8 and parallel thereto an angle plate 43 having perforations 46 is provided opposite the apertures 45. The portion 44 of plate 42 forms with the adjacent side of the container 8 a space 65 in which the air is heated by coming into contact with the side of container 8 and rises, when the material to be developed is not present, in the direction of the arrows through the apertures 45 and 46 on the right-hand side of portion 47 of plate 43.

Similarly means are provided to prevent the steam generated by vaporizer B and leaving apertures 75 from moistening the surface of the rollers 6 and 7. For this purpose the angle plate 26 is provided with perforations 57. Furthermore a plate 55 having apertures 77 opposite to the perforations 57 is secured to the container 9. The air coming in contact with the left-hand side of the container 9 is heated and rises, when the material to be developed is not present, in the direction of the arrows through apertures 77 and 57 into space 76, formed by the leg 56 of the angle plate 26 and the adjacent side of the container 25, where it is again heated by container 25.

For guiding the material during its passage through the device, upper and lower guides are provided. The upper guides comprise a plurality of strips 48, each strip having one end welded to the edge of plate 43 and its other end slidably supported in apertures 50 of angle plate 26 to allow for expansion. The strips 48 fit loosely into the grooves 79 of roller 7 and are secured to a heating element 49, whereby they are heated to prevent condensation thereon. Secured to the left-hand edge of plate 43 or forming part thereof is a plurality of upwardly-curved fingers 41 loosely fitting into the grooves 39 of roller 5.

The lower guides comprise a plurality of downwardly-curved fingers 40 secured to plate 42 or forming part thereof and loosely fitting into the grooves 38 of roller 4, and a plurality of strips 51. The strips 51 fit loosely into the grooves 78 of roller 6, and have their right-hand ends secured to plate 55 supported from container 9 whereas their left-hand ends are supported by apertures 53 in the bent end of plate 21 in a slidable manner to allow for expansion.

The plate 55 extends to the right into a downwardly-curved portion 52, and a heating unit 54 secured to the portion 52 serves to heat guides 51 and plate 52 to prevent condensation thereon.

From the above it is seen that heating units 49 and 54 heat all parts of the apparatus used for guiding the material to be developed, whereby these parts are maintained in a dry condition and there will be no formation of spots on the material due to condensation on these parts.

The heating units 18, 19, 24, 27, 49, and 54 are connected in parallel to a suitable source (not shown) during the operation of the device. By connecting these units in series when the device is temporarily placed out of operation the water can be maintained at a temperature below the boiling point, but at a sufficiently high temperature to allow the device to be placed in service without delay.

In operating the device the material to be developed, for instance paper provided with a photo-sensitive layer adapted to be developed by coming into contact with steam, is inserted with its exposed side down between rollers 4 and 5, which move same between fingers 40 and 41. As the paper is passed along it first comes into contact with the steam leaving apertures 22, which steam develops the image and also causes the paper to curl upwardly whereby undesired contact with

heated plate 21 is avoided and the paper is placed in contact only with the guides 48. This displacement of the material is essential as the steam-absorbing capacity of the material would be greatly reduced if it were allowed to come into contact with the heated plate 21.

The paper then passes between strips 48 and 51 into the cool region between the vaporizers and is thus cooled by coming into contact with the air in this region. The paper at this point having been treated with steam on one side and then cooled, is strongly curved upwardly; however after passing between rollers 6 and 7 it is subjected on its upper side to the steam leaving apertures 75, whereby the curling is removed and it assumes the desired flat condition. The paper then passes over plate 52 and leaves the device between the roller 28 and the helical spring 30 in a substantially dry and flat condition.

Instead of treating the exposed side of the paper first, as above described, the operation may be effected in reverse order; i. e., the nonexposed side may be treated first, the material then cooled by passing it through the air in the central region of the device, and finally the exposed side treated with steam.

It should be noted that the entire apparatus with the exception of the vaporizers is open to the atmosphere, and that the escaping steam is so directed and the various parts sufficiently heated, that condensation of the steam will have no deleterious effect on the proper development of the material.

While we have described our invention in connection with specific examples and applications, we do not wish to be limited thereto, but desire the appended claims to be construed as broadly as permissible in view of the prior art.

What we claim is:

1. A method of developing images on a diazo layer developable with steam, comprising the steps, continuously moving the layer to be developed, applying steam to only one side of the layer in a space open to the atmosphere, moving the so-treated layer through a space open to the atmosphere to cool same, and applying steam to only the opposite side of the layer in a space open to the atmosphere.

2. A method of developing images on a diazo layer developable with steam, comprising the steps, continuously moving the layer to be developed through a space open to the atmosphere, applying steam to only the exposed side of the layer, moving the layer through a portion of the space substantially free from steam to cool same, and applying steam to only the non-exposed side of the layer.

3. A method of developing images on a diazo layer developable with steam, comprising the steps, continuously moving the layer to be developed through a space open to the atmosphere, applying superheated steam to only the exposed side to develop the image, passing the so-treated layer through a portion of the space substantially free from steam to cool same, and applying steam to the other side of the layer.

4. A method of developing images on a diazo layer developable with steam, comprising the steps, continuously moving the layer to be developed through a space open to the atmosphere, applying steam at a pressure above atmospheric pressure to only one side of the layer, passing the so-treated layer through a portion of the space substantially free from steam to cool same, and applying steam to only the other side of the layer.

5. A method of developing images on a diazo layer developable with steam, comprising the steps of continuously moving the layer through the atmosphere, directing steam upon only one side of the layer, moving the layer through a space in the atmosphere substantially free from steam to cool the layer, and directing steam upon only the opposite side of the layer.

6. An open device for developing images on a diazo layer developable by steam, comprising means for guiding the layer including a guide member, means for continuously moving the layer past said member, means for producing steam and for applying the same to only the surface of the layer opposite the guide member, said latter means comprising a container having an apertured member disposed at a point adjacent the guide member, means for producing steam and for applying the same to only the surface of the layer opposite the apertured member and at a point spaced from said member, and means to cool the layer between said two points.

ROELOF JAN HENDRIK ALINK.
JOHANNES ANINGA.