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METHOD AND APPARATUS FOR PROCESSING LIGHT-SENSITIVE ELEMENTS

Filed June 23, 1966

FIG 3

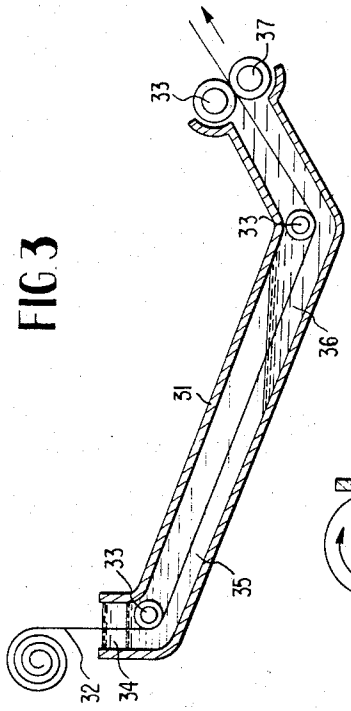


FIG 4

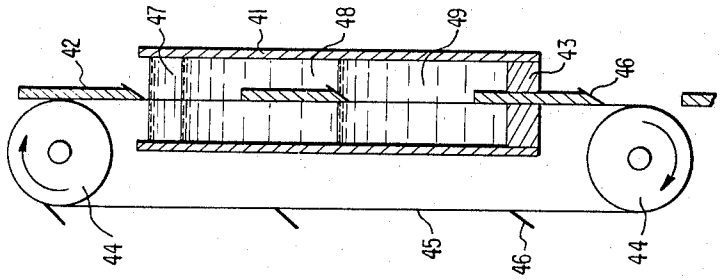


FIG 2

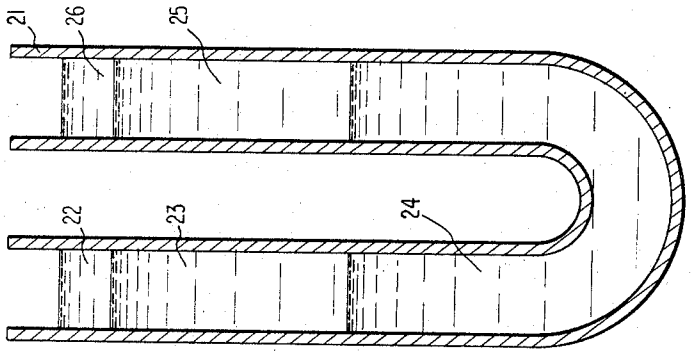
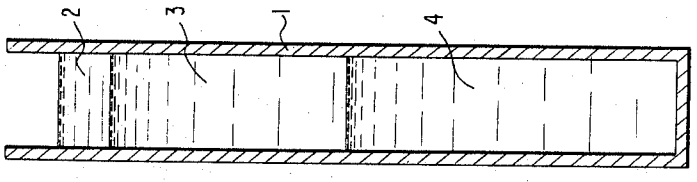


FIG 1



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METHOD AND APPARATUS FOR PROCESSING LIGHT-SENSITIVE ELEMENTS

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10 Claims. (Cl. 95—89)

The present invention relates generally to a method for processing light-sensitive elements and more particularly to a method for processing in one tank light-sensitive elements which usually are required to be subjected to two or more processings.

Hitherto, in subjecting light-sensitive elements to two or more processings, a method has been employed wherein a light-sensitive element is dipped successively in two or more processing baths, each containing a different processing solution therein. Or, the processing solution in a tank wherein a light-sensitive element is placed is successively replaced with other different processing solutions. In an automatic developing system having a mechanism of the former type, in which a light-sensitive element is passed continuously through a plurality of tanks each containing a different processing solution, the processing period of time is controlled by varying the travelling speed of the light-sensitive element. Therefore, the change of the processing period in one processing tank is accompanied inevitably with the change of the processing period in other tanks, and this may lead to undesirable influences on the processing period in other tanks. Consequently, it is impossible to increase, for example, the period for development and at the same time to reduce the period for fixing, or to increase the period for fixing and at the same time to decrease the period for development. Moreover, it is generally difficult to process a rigid or non-flexible light-sensitive element, such as a glass plate, in a flow system using a plurality of processing tanks.

An object of this invention is to provide an improved method for processing light-sensitive elements of the above-mentioned type unaccompanied by the aforementioned troubles.

Another object of the present invention is to provide a method for continuously processing light-sensitive elements of the above-mentioned type using only one tank.

These and other objects of the present invention will become clear from the following description and by reference to the accompanying drawings, in which:

FIG. 1 and FIG. 2 are schematic cross-sectional views showing the principle of the present invention, and

FIG. 3 and FIG. 4 are schematic cross-sectional views of the embodiments shown in Example 1 and Example 2, respectively, in which light-sensitive elements can be continuously processed.

In accordance with this inventon, desired processing solutions having different specific gravities are placed in a tank such that these solutions are kept in layers or phases. That is, as shown in FIG. 1, the solutions are kept in a tank **1** as processing solution layers **2**, **3** and **4**. A light-sensitive element to be processed is, after exposure, passed through all of the solution layers in the tank, whereby it is subjected to the necessary processing in each solution.

Accordingly, in the process of this invention, only one processing tank may be employed and the light-sensitive element is not exposed to the air during processing. Also, the processing period can be varied desirably by varying the proportion of each solution. The processing solutions used in the method of this invention may be a system of the combination of a developing solution layer and a fixing solution layer, or may be a system of the combination

of a developing solution layer and a stabilizing solution layer. Further, the system may be the combination of a first developing solution layer, a breaching solution layer and a second developing solution. Moreover, if necessary, other fixing solution layers, a water-rinsing promoter layer and the like may be added to the system.

The invention will be explained further in detail by referring to the following examples. A developer such as 1-4-phenyl-3- pyrazolidone or hydroquinone is dissolved in a solvent, such as ethyl cellosolve, butyl cellosolve, butyl alcohol, benzyl alcohol, acetone, ethyl acetate and the like, together with an alkaline substance, such as potassium hydroxide or sodium hydroxide to provide a developing solution. A fixing solution comprising a concentrated aqueous solution of sodium thiosulfate or ammonium thiosulfate is also prepared. When these two solutions are placed in one tank, they are kept in layers in the tank, with the developing solution being upper and the fixing solution lower. By passing an exposed light-sensitive element from above, through the tank, the development and fixing are finished in one step. Liquid paraffin may be added to the system and positioned above the upper developing solution layer. This prevents the oxidation of the developing solution caused by contact with the air and also prevents the evaporation of the upper solution.

Another preferred embodiment of the process of this invention is shown in FIG. 2 wherein in a U-shaped pipe there are placed in layers a first developing solution layer **23**, a bleaching solution layer **24** and a second developing solution layer **25**, and above the surfaces of the developing solution layers **23** and **25** are placed liquid paraffin layers **22** and **26**, respectively. By the above-mentioned system as shown in FIG. 2, a reversal developing procession can be conducted in one tank.

Furthermore, a foreign solution having an intermediate specific gravity may be positioned between the processing solutions for insuring the separation of the processing solution layers.

Our invention will be further illustrated by the following examples, but it is to be understood that the invention is not restricted thereto.

Example 1

An embodiment of this invention based on the principle shown in FIG. 2 is shown in FIG. 3 wherein guide rollers **33** are provided in suitable positions in a processing tank **31** for supporting a light-sensitive element **32** in the tank. A drive roller **37** made of an elastic material is positioned closely adjacent one of guide rollers **33** at the outlet of the tank **31** for advancing the light-sensitive element between said two rollers while preventing the leakage of the solution. In the above-mentioned processing tank were placed

(1) A fixing solution **35** having the following composition:

Sodium thiosulfate	g./liter	400

(2) A developing solution **36** having the following composition:

Ethyl Cellosolve	ml	200
Hydroqinone	g	100
1-phenyl-3-pyrazolidone	g	5
Aqueous potassium hydroxide solution (10%)	ml	75

These solutions are positioned in layers as shown by the numerals **35** and **36** and on the solution layer **35** was placed a liquid paraffin layer **34**. By passing through thus prepared processing tank a light-sensitive element **32** continuously, the element was subjected to development and fixing.

Example 2

Another embodiment of this invention, based on the principle shown in FIG. 1, is illustrated in FIG. 4, wherein a straight processing tank **41** is employed. An endless belt **45** for carrying light-sensitive elements **42** is circulated through the tank while supported by rollers **44**. The endless belt is equipped with slips **46** and fixing the light-sensitive elements at the proper portions thereof. The end of the tank **41** is closed by means of a member **43**.

In the above-mentioned tank were placed

(1) A developing solution 48 having the following composition:

Butyl alcohol	ml.	300
Hydroquinone	g.	40
1-phenyl-3-pyrazolidone	g.	2
Aqueous sodium hydroxide solution (10%)	ml.	50

(2) A fixing solution 49 having the composition:

Sodium thiosulfate	g./liter	400

Solutions **48** and **49** were arranged in layers as shown in FIG. 4 and over the developing solution **48** was placed a liquid paraffin layer **47**. By rotating the roller **44**, the endless belt was moved through the processing solution system and the bottom member **43** which was composed of two elastic sponges having a close gap between them, whereby the thus processed light-sensitive elements **42** could be continuously withdrawn from the bottom of the tank.

What is claimed is:

1. A method for processing light-sensitive elements which comprises placing in a tank at least two processing solutions in layers, said solution having different specific gravities, and passing a light-sensitive element successively through said solution layers.

2. The method according to claim **1** wherein said processing solutions are a developing solution and a fixing solution.

3. The method according to claim **1** wherein said processing solutions are a first developing solution, a fixing solution and a second fixing solution for reversal development.

4. The method according to claim **1** wherein said processing solutions are a developing solution and a stabilizing solution.

5. The method according to claim **1** wherein at least one of said solutions is covered by liquid paraffin.

6. The method according to claim **1** wherein said processing tank is a substantially straight tank having a bottom member through which a light-sensitive member can be withdrawn.

7. The method according to claim **1** wherein said processing tank is a U-shaped tank.

8. Apparatus for developing a film element comprising a tank,

a plurality of film treating solutions having different specific gravities arranged in layers in said tank, and means for advancing a film element successively through said layers of said solutions in said tank.

9. The apparatus of claim **8** further comprising a layer of a solution, substantially inert to said film, positioned above the uppermost layer of treating solution in said tank to protect said uppermost layer from the atmosphere.

10. The apparatus of claim **8** further comprising a layer of a solution which

(a) is substantially inert to said film,

(b) has a specific gravity intermediate the specific gravities of two of said treating solutions, and

(c) is positioned between layers of said two treating solutions to serve as a barrier against intermingling of said solutions.

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