April 12, 1966 A. J. SABLE 3,245,335

PHOTOGRAPHIC PROCESSING APPARATUS AND METHOD

Original Filed Sept. 19, 1962 2 Sheets-Sheet 1

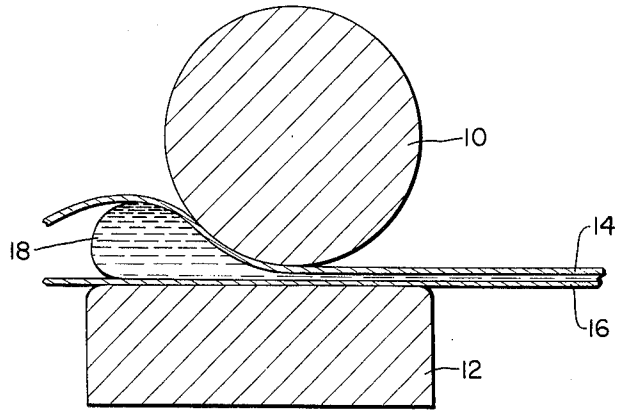


FIG. 1

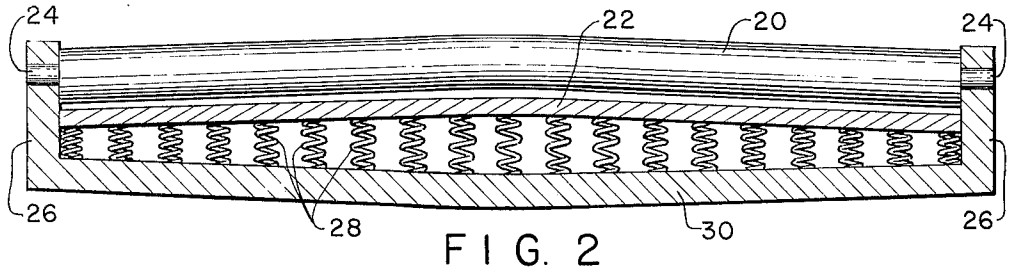


FIG. 2

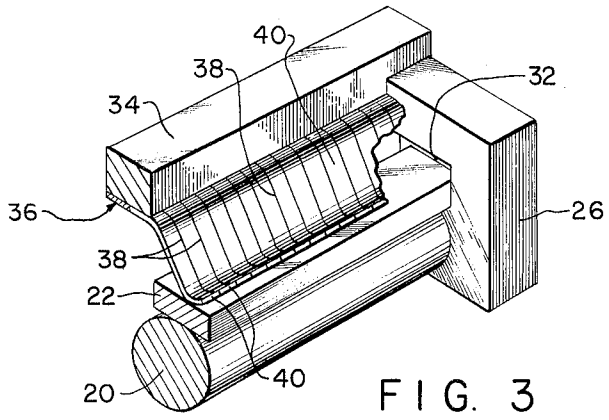


FIG. 3

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PHOTOGRAPHIC PROCESSING APPARATUS AND METHOD

Original Filed Sept. 19, 1962 2 Sheets-Sheet 2

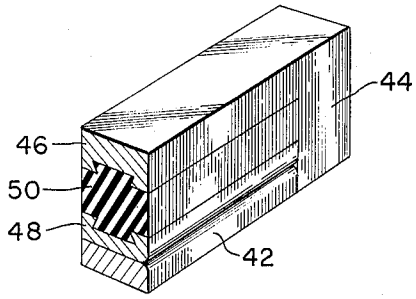


FIG. 4

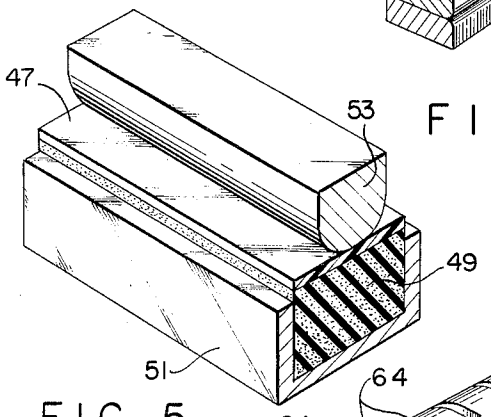


FIG. 5

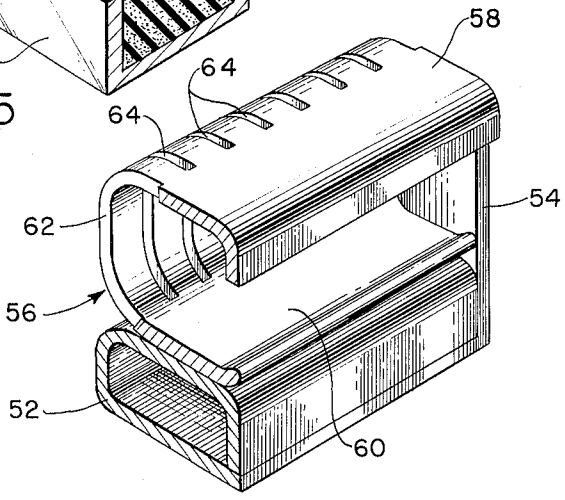


FIG. 6

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3,245,335

PHOTOGRAPHIC PROCESSING APPARATUS AND METHOD

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Continuation of application Ser. No. 224,644, Sept. 19, 1962. This application Mar. 18, 1965, Ser. No. 444,914
14 Claims. (Cl. 95—89)

This application is a continuation of my application Serial No. 224,644, filed September 19, 1962, now abandoned.

This invention relates to photographic processing apparatus for distributing a liquid in contact with a photographic sheet and methods performed thereby; and particularly to apparatus including a pair of juxtaposed pressure-applying members for and methods of distributing a liquid between a pair of superposed photographic sheets.

In U.S. Patent No. 2,647,056, issued July 28, 1953, in the name of Edwin H. Land, there is shown and described a method of producing a photographic transfer image involving the movement of a pair of sheets in superposition between a pair of juxtaposed members for distributing a viscous processing liquid between and in contact with the sheets. The pressure-applying members, while shown as rolls in the above patent, may take a number of different forms, but generally comprise a pair of members having adjacent surfaces defining a convergent passage or gap between them through which the sheets are moved relative to the members for advancing or spreading a quantity of a processing liquid, usually quite viscous, relative to, between and in contact with the sheets in a direction opposite the direction of movement of the sheets relative to the members. The pressure-applying members may be movable with respect to one another and biased, e.g., by springs toward one another; and/or the two members may be fixed against movement more than a predetermined distance apart so that the maximum width of the gap between the members is fixedly predetermined.

During distribution of the processing liquid in this manner, hydraulic pressure is generated within the mass of the liquid being advanced relative to and between the sheets; and this pressure tends to force the sheets and the pressure-applying members apart from one another. Heretofore it has been the practice to mount the pressure-applying members in the vicinity of their ends, i.e., near the lateral edges of the sheets, particularly in the case of rolls; and to apply any bias to the members at or in the region in the means mounting the members with this type of mounting of the pressure-applying members, even though the hydraulic pressure within the liquid may be uniform from side to side of the sheets, the resultant force or bending moment acts upon the medial portions of the two members, causing the two members to bow apart and this results in a gap between the members which is not uniform, being wider at its mid-portion, i.e., the mid-portions of the sheets, than at its ends, i.e., the lateral edges of the sheets. This, of course, may result in such an uneven distribution of the liquid as to adversely affect or even prevent processing in some areas of the sheets.

The magnitude of this problem varies with a number of factors, particularly the width of the sheets to be treated with the liquid; while variations in the thickness of the layer of the liquid which remains between the sheets becomes more critical as such layers become thinner. The answer to this problem has been to employ pressure-applying members which are stronger and are more rigid, and is achieved by providing larger and bulkier members and/or employing stronger and more expensive materials for the members. Both of these answers have proved less

than completely satisfactory from the point of view of performance as well as for reasons of size, weight and economy.

An object of the present invention is to provide novel and improved pressure-applying apparatus for and methods of distributing a processing liquid in contact with a photographic sheet.

Other objects of the invention are: to provide apparatus and methods of the type described wherein a pair of juxtaposed pressure-applying members are biased toward one another so as to insure uniformity of distribution of the processing liquid; to provide an apparatus and method wherein the pressure-applying members are biased toward one another by a force which is uniformly distributed throughout the length of one of the members; and to provide pressure-applying means as described in which the member which is biased toward the other member is sufficiently flexible to permit it to conform to deflections in the other member.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts, and the process involving the several steps and the relation and order of one or more of such steps with respect to each of the others which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a somewhat schematic, sectional view of a pair of pressure-applying members illustrating the distribution of a liquid between a pair of superposed sheets;

FIG. 2 is a sectional view illustrating, somewhat schematically, apparatus embodying the invention and for performing the method thereof; and

FIGS. 3 through 6 are fragmentary perspective views of other embodiments of the apparatus.

Reference is made to FIGURE 1 of the drawings in which there is illustrated a pair of juxtaposed pressure-applying members in the form of a cylindrical roll **10** and a bar **12** having a plane surface disposed parallel with a plane tangent to the surface of roll **10** and cooperating with the surface of roll **10** to define a converging passage or gap between the roll and bar. The operation of any two pressure-applying members embodying the invention is substantially the same regardless of the particular construction of the members, that is, whether they be rolls which may rotate or remain stationary, a bar and roll as shown, two rolls, or two bars or similar members having non-circular cross sections and not designed to rotate. A pair of sheets, designated **14** and **16**, are moved into superposition through the convergent passage between roll **10** and bar **12** to effect the distribution of a processing liquid between the sheets. The liquid may be provided initially between the sheets in a number of different ways, for example, from a rupturable container mounted on one of the sheets, from a container which is moved relative to and across one of the sheets while its fluid contents are dispensed onto the sheet, or from a fixed device such as a nozzle which dispenses the liquid continuously. The liquid designated **18**, provided between the sheets, collects in a mass in the form of a meniscus at the convergent entrance portion of the passage between the pressure-applying members (as shown) during movement of the sheets relative to and between the pressure-applying members.

The sheets and processing liquid, in a preferred form, may comprise materials and reagents for producing posi-

tive photographic prints by a silver halide diffusion-transfer reversal process such as is described in detail in U.S. Patent 2,543,181, issued February 27, 1951, in the name of Edwin H. Land, in which case one of the sheets may comprise a gelatino silver halide emulsion carried on a flexible support, the other sheet comprises a layer for supporting a silver transfer image, and the processing liquid includes a silver halide developer and a silver halide solvent. The liquid, as indicated in the aforementioned patents, is preferably quite viscous, having a viscosity in excess of 1,000 centipoises of 24° C. It is this viscosity which facilitates the uniform distribution of the liquid and also contributes to the generation of hydraulic pressure within the liquid between the sheets as the liquid is being distributed.

By "distribution" of the liquid during and in response to movement of the sheets relative to and between the pressure-applying members, is meant that the mass of the liquid is moved relative to, between and in contact with those areas of the inner surfaces of the sheets to be treated, in a direction opposite the direction of movement of the sheets. The mass of the liquid may and usually does remain substantially stationary with respect to the pressure-applying members. In a photographic process particularly useful in document copying, distribution of the liquid is intended primarily to effect the wetting of the inner surfaces of one or both sheets which absorb reagents from the mass of viscous liquid as the latter is moved relative to and in contact with the sheets. However, even though the purpose of the liquid distribution process may not be to spread the liquid in a layer between the superposed sheets, the viscosity-providing agent in the liquid (e.g., sodium carboxymethyl cellulose) is a film-forming agent and as such tends to adhere to the sheets and form a layer which may be extremely thin. This layer, however thin, is formed between the sheets and performs the function of retaining the sheets in superposition during the period required for processing, i.e., formation of a transfer image.

The processing liquid is initially provided between the sheets as a mass preferably uniformly distributed across the sheets. With a uniform distribution of the mass of fluid, the force exerted on the pressure-applying members due to the hydraulic pressure generated within the mass of the liquid is also uniformly distributed across the sheets and throughout the length of the pressure-applying members. The resulting bending moment on the pressure-applying members, however, is effectively located midway between the sides of the sheets or, more specifically, substantially midway between the ends of the mass of liquid, thereby causing the pressure-applying members to bow apart at their mid-portions. This bowing, of course, becomes increasingly pronounced as the width of the sheets is increased while the amount of bowing which can be tolerated becomes less as the thickness of the layer of liquid spread between the sheets is reduced.

Reference is now made to FIG. 2 of the drawings wherein there is illustrated fluid-distributing apparatus embodying the invention. This apparatus comprises an elongated roll **20** and a juxtaposed bar **22** both having cross sections which are substantially the same as the cross sections of roll **10** and bar **12** respectively. Roll **20** is provided with stub shafts **24** at its ends journaled in a pair of support members **26** and is rotatable about its axis. Bar **22** is mounted between support members **26** for movement toward and away from roll **20**, and the ends of bar **22** are preferably engaged with support members **26** in a manner which constrains the bar for movement only in a plane through the axis of roll **20**. Roll **20** and bar **22** are shown in FIG. 2 in the relative positions that they would assume during distribution of the processing liquid between a pair of sheets as the latter are moved between the roll and bar, although the sheets themselves have been omitted for purposes of clarity. No attempt is made to construct roll **20** so that it has sufficient strength and rigidity to resist bending due to hydraulic pressure within the liquid, and accordingly roll **20** bends in the manner shown (to an exaggerated extent) in FIG. 2. This deflection or bending of roll **20** is anticipated, and it is by virtue of the invention that the deflection of roll **20** can occur without adverse effect on the distribution of the processing liquid.

As previously indicated, the deflecting force exerted by the liquid on roll **20** and bar **22** is substantially uniformly distributed throughout the length of the roll and bar so that application of a uniformly distributed force to bar **22** urging the bar toward roll **20** will cause a deflection in bar **22** matching the deflection of roll **20** so that the gap between the bar and roll normally occupied by the sheets and any liquid therebetween will be of uniform thickness throughout its length. This uniform gap is illustrated in FIG. 2 which shows the pressure-applying members in an operating condition but without the sheets and liquid therebetween. As a means for applying a uniformly distributed biasing force to bar **22**, there is provided a multiplicity of compression springs **28** mounted between bar **22** and a backing member **30** secured at its ends to support members **26**. Springs **28** are distributed at regularly spaced intervals between bar **22** and backing member **30** throughout the length of bar **22**, and each of the springs has substantially the same rate as every other spring so that the force exerted thereby on the bar is uniformly distributed and the same throughout the length of the bar.

Bar **22** is sufficiently more flexible than roll **20** so that the bar can be deformed by the force of springs **28** so as to conform to the deflection of roll **20** and the adjacent surfaces of the bar and roll will remain substantially parallel as shown. On the other hand, bar **22** has sufficient rigidity to resist local deformations so that the bar deflects more or less uniformly in the same manner as roll **20**, and there are no local areas between the bar and roll where the width of the gap is more or less than in other areas. Backing member **30** may be sufficiently rigid to resist deflection, or it may be constructed in the form shown so that it too deflects, since deflection of the backing member affects only the difference in the extent of deflection of the springs. Backing member **30**, being mounted at its ends, deflects, in the same manner as but oppositely from roll **20**, since the loading on the backing member by springs **28** is uniform but the deflecting moment acts midway between the ends of the backing member. In the construction shown, springs **28** are deflected or compressed to different extents and are preferably of a relatively low rate so that the force exerted by each of springs **28** is the same as the force exerted by every other spring regardless of the deflections of the springs within the range of normal operation of the apparatus.

Another embodiment of the apparatus is shown in FIG. 3 of the drawings as comprising a roll **20** and bar **22** mounted between support members **26** in the manner described with reference to FIG. 2. The mounting of bar **22** for movement with respect to the rolls can be seen in FIG. 3 and comprises a recess **32** in each of support members **26** in which an end of bar **22** is engaged for sliding movement. The difference between this construction and that previously described resides in the means for applying a uniformly distributed force to bar **22**. In the form shown, these means include a backing member **34** mounted at its ends at support members **26** and a spring plate **36** including a section provided with a multiplicity of parallel, uniformly spaced slits **38** which define therebetween a multiplicity of spring fingers **40**. Plate **36** is mounted on bar **34**, and the spring fingers, which are all parallel to one another, are bent toward bar **22** and turned up at their ends to provide feet located in contact with the surface of bar **22** opposite roll **20**. Each of the spring fingers functions as a substantially independent, low-rate cantilever spring and in aggregate the spring

fingers provide a uniform, uniformly distributed spring force urging bar **22** toward roll **20**.

A further embodiment of the invention is illustrated in FIG. 4 as comprising a pressure-applying bar **42** mounted at its end on support members **44** in generally parallel relation and spaced from a backing member **46** also supported at its ends on members **44**. Bar **42** provides a pressure-applying surface facing backing member **46**, and the other pressure-applying member comprises a similar bar **48** mounted on a compressible member **50**, in turn mounted on backing member **48**. Compressible member **50**, preferably comprises an elastically deformable material such as rubber, is equal in length to bar **48**, is engaged with bar **48** and backing member **46** throughout its length and functions as an infinite number of compression springs for urging bar **48** toward bar **42**.

A somewhat simplified and less expensive form of fluid-distributing, pressure-applying device is illustrated in FIG. 5, and includes one pressure-applying member in the form of a relatively thin and flexible element **47** mounted on a resilient, elastically deformable member **49** supported in a backing member in the form of a channel **51** and juxtaposed with a relatively rigid pressure member **53**. Channel **51** may be formed of sheet metal and is substantially rigid while resilient member **49** is formed of an elastomeric material such as foam rubber which functions as a continuous spring, the compressive force of which is distributed and transmitted to the sheets by flexible element **47**. Member **49** comprises a generally parallelepiped-shaped homogeneous body of substantially uniform thickness and compressibility throughout the portion of its length supporting element **47**. The flexible element may be formed of a variety of materials in sheet form, many of the organic plastic such as the linear polyamides (e,g, nylon) being preferred, because of their inexpensiveness, flexibility and low coefficient of friction, and is adhered to resilient member **49** by a suitable cement or adhesive. Resilient member **49** performs the dual functions of movably mounting element **47** and biasing the latter toward pressure member **53**.

A form of pressure-applying device designed to be fabricated entirely from resilient sheet material and in which one of the pressure-applying members also comprises the multiplicity of springs is illustrated in FIG. 6 of the drawings. This device comprises a pressure-applying member formed by bending a sheet of resilient material, preferably metal, into a tube having a generally rectangular cross section with one side providing the pressure-applying surface of member **52**. Member **52** is supported at its ends by support members **54**, and the other pressure-applying member comprises another element formed from sheet material and having a generally C-shaped cross section. This element, generally designated **56**, includes a base side **58** at which the element is supported on support members **54**; a sheet engagement side **60** lying opposite base side **58** and providing the other pressure-applying surface of the device disposed in juxtaposition with the pressure-applying surface of member **52**; and a connecting side **62** extending between base side **58** and engagement side **60**. Connecting side **62** is formed with a plurality of uniformly spaced narrow slits or slots **64** so that the portions of connecting side **62** intermediate the slots and separated by the slots act as a plurality of individual, independent, low-rate springs mounted on base **58** for biasing sheet engagement side **60** toward pressure-applying member **52**. In this embodiment, deflection of both pressure-applying member **52** and base side **58** in opposite directions may be anticipated and does not interfere with the operation of the device.

Since certain changes may be made in the above apparatus and process without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Photographic apparatus for distributing a process-liquid between a pair of superposed sheets comprising, in combination:

a pair of pressure-applying members each having a sheet engagement surface extending lengthwise of said member;

support means for mounting said members in juxtaposition with said engagement surfaces in face-to-face relation, one of said members being mounted adjacent the ends of said engagement surface thereof; and

resilient means for applying, to the other of said members, a force substantially uniformly distributed throughout the length of said other member urging said other member toward said one member,

said resilient means comprising a member formed of an elastomer mounted on said support member and engaged between the latter and said other pressure-applying member.

2. Photographic apparatus for distributing a processing liquid between a pair of superposed sheets comprising, in combination:

a pair of pressure-applying members each having a sheet engagement surface extending in a substantially straight line lengthwise of said member;

support means for mounting said members in superposition at the ends of said surfaces with said surfaces in face-to-face relation; and

resilient means for applying to one of said members a multiplicity of substantially independent and equal forces uniformly distributed throughout the length of said one member urging said one member toward said other member;

said resilient means comprising a resilient element mounted on said support means and including a portion formed with a plurality of uniformly spaced parallel slits extending inwardly from one edge to define a multiplicity of cantilever springs each located between two of said slits and disposed in engagement with said one pressure-applying member.

3. Photographic apparatus for distributing a processing liquid between a pair of superposed sheets comprising, in combination:

a pair of pressure-applying members each having a sheet engagement surface extending in a substantially straight line lengthwise of said member;

support means for mounting said members in superposition at the end of said surfaces with said surfaces in face-to-face relation; and

resilient means for applying to one of said members multiplicity of substantially independent and equal forces uniformly distributed throughout the length of said one member urging said one member toward said other member;

said other pressure-applying member comprising a roll having a substantially cylindrical pressure-applying, sheet-engagement surface mounted for rotation about the generatrix of said surface;

said sheet engagement surface of said one member including a portion lying in a straight line disposed in a plane through said generatrix.

4. Photographic apparatus for distributing a processing liquid between a pair of superposed sheets comprising, in combination:

a first pressure-applying member having a sheet engagement surface extending lengthwise of said member substantially in a straight line;

a second pressure-applying member having a sheet engagement surface extending lengthwise of said member;

an elongated resilient deformable member of substantially uniform resilience and compressibility throughout a length substantially equal to the length of said sheet engagement surface of said second pressure-applying member; and

a backing member mounting said deformable member for juxtaposition with said first pressure-applying member;

said second pressure-applying member being mounted on said deformable member with said sheet engagement surface of said second pressure-applying member juxtaposed with said sheet engagement surface of said first pressure-applying member.

5. The photographic apparatus of claim 4 in which said deformable member comprises a body of an elastromeric material having a support surface lying substantially in a straight line, and said second pressure-applying member is relatively thin and flexible and is mounted on said surface of said body.

6. The photographic apparatus of claim 5 in which said backing member is a channel having side walls, said body is secured within said channel between said side walls with a portion of said body including said surface thereof projecting from between said side walls.

7. The photographic apparatus of claim 5 in which said body comprises an elastomeric foam material.

8. A method of uniformly distributing a liquid between and in contact with a pair of flexible superposed sheets comprising:

superposing said sheets;

providing a quantity of said liquid between said sheets in a mass extending transversely of said sheets;

moving said sheets in superposition together with and mass of liquid relative to and between a pair of elongated pressure-applying members having juxtaposed sheet-engagement surfaces and at least one of said members mounted adjacent the ends of said surface thereof; and

applying a multiplicity of substantially equal and effectively independent forces to said other member substantially uniformly distributed from end-to-end of said other member to urge said other member toward said one member.

9. The method of claim 8 wherein said other member is urged toward said one member by resilient means and is mounted on said resilient means.

10. The method of claim 9 wherein said other member is substantially more flexible than said one member and said resilient means comprise a member formed of an elastomer.

11. The method of claim 9 wherein said surface of said other member is continuous and said other member is urged toward said one member by a plurality of springs each exerting substantially the same force against said other member.

12. The method of claim 9 wherein substantially all of said liquid is squeezed by said members from between said sheets during distribution of said liquid in contact with said sheets.

13. The method of claim 12 wherein said liquid comprises an aqueous alkaline solution and a thickening agent and said solution is impregnated into at least a layer of one of said sheets during distribution of said liquid between said sheets.

14. The method of claim 9 wherein said liquid contains a thickening agent and is distributed as a layer of substantially uniform predetermined thickness between said sheets.

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