June 23, 1970 R. E. MEYER 3,516,345

STRIP PROCESSING SYSTEM

Filed Sept. 19, 1967 2 Sheets-Sheet 1

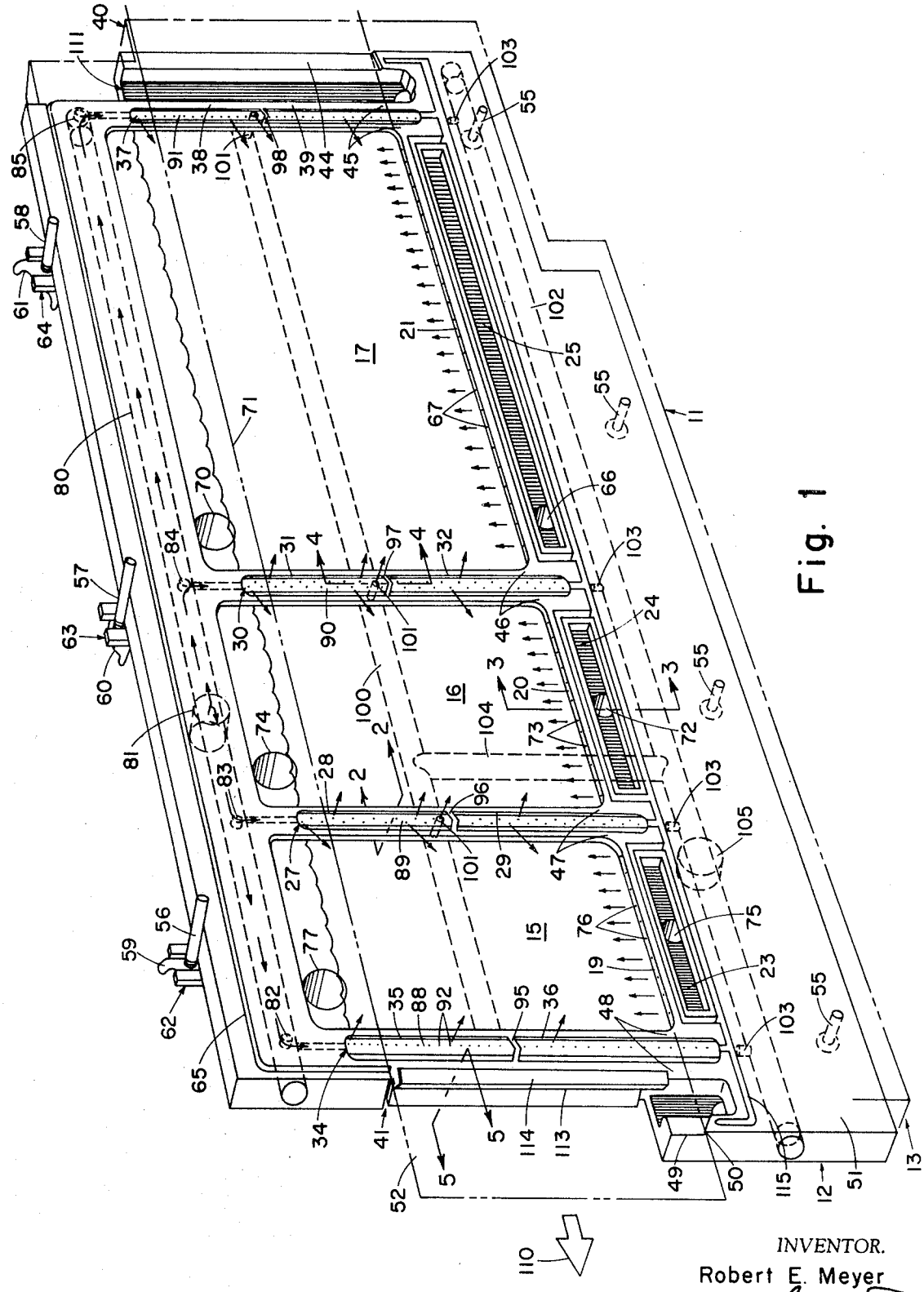


Fig. 1

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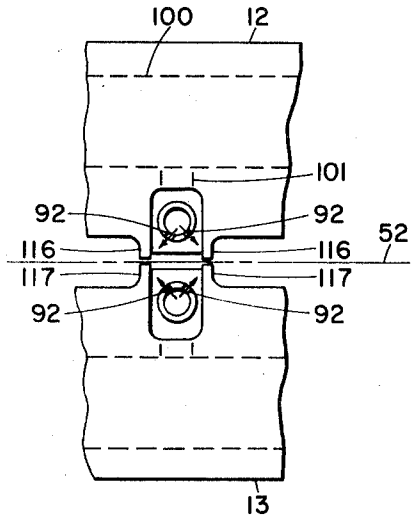


Fig. 2

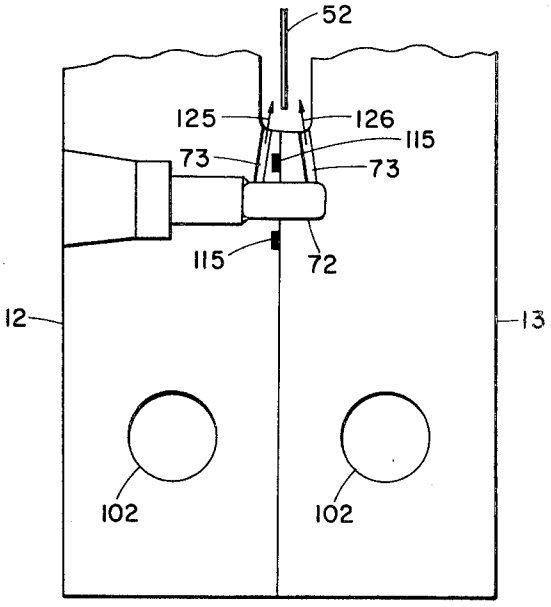


Fig. 3

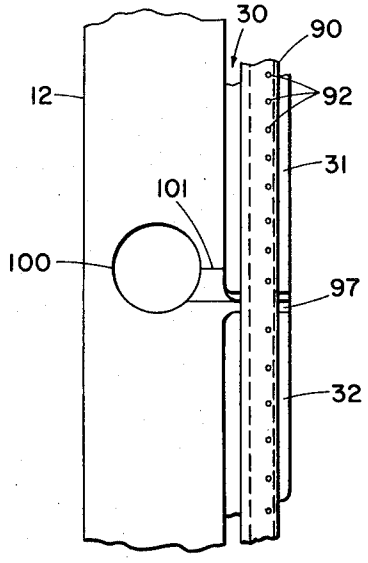


Fig. 4

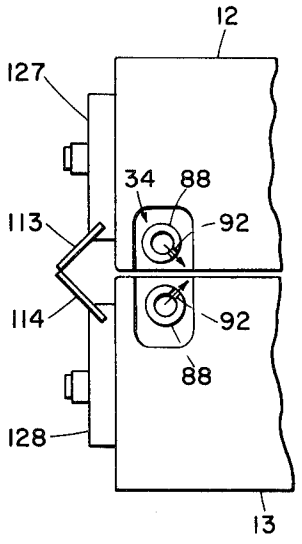


Fig. 5

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STRIP PROCESSING SYSTEM

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U.S. Cl. 95—89 2 Claims

ABSTRACT OF THE DISCLOSURE

A compact processing head used for developing, fixing and rinsing photographic films successively in adjacent chambers of a structure. The film or other strip material is continuously moved through the structure and traverses successively each of three chambers each containing processing fluid. Each chamber receives fluid through orifices along the bottom surface thereof and is sealed along the narrow vertical sides by barriers formed of high pressure air directed against opposing surfaces of the film. Movement of processing fluid thus is transverse to the direction of film movement and this, together with barrier air movement, provides desirable turbulence of the fluids.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a device for rapidly processing strip material through a plurality of adjacent processing baths, and more particularly to a rapid photographic processing head for use in a high resolution recording device.

In many processing and developing systems, processing time must be as short as is compatible with the required processing quality. Such rapidity obviates the use of individual processing baths where the film passes through a developer bath and then is transported to separate fixing and rinsing baths usually enough removed from one another to require a distinct interruption in action when moving from one bath to the next. Where relatively long lengths of film or other strip materials are used, the proper rapid processing thereof without cutting the material into pieces of convenient size is not obtainable through conventional processing methods.

In the rapid processing desired, the film must move continually through a processing system with substantially no friction. This frictionless movement is required not only because the film might be scratched by contact with the processing device but also because friction would cause tension fluctuations and corresponding transport velocity fluctuation. The latter fluctuation would cause striations to be recorded on the film.

Some devices for rapid film processing have been developed in recent years, however, these do not accommodate the film in substantially frictionless contact with the processing head and further do not combine several baths in one head or provide for continuously processing the film. The use of stationary fluid baths or spray fluid in prior devices seriously impedes rapid and yet quality processing.

The present invention provides for three-step processing of considerable lengths of photographic film in a minimum time in a compact, efficient processing head. Three fluids are used in the present processing head although it will be realized that a much greater number of fluids could be accommodated within the concept of the invention. Each fluid is forced upward through separate chambers milled out of a pair of complementary blocks which when assembled provide spaced vertically disposed processing chambers. Ante-chambers placed at each end of the processing chambers have headers inserted therein with orifices through which any suitable gas such as air is pressurized and directed toward the strip material and the vertical wall of each adjacent chamber to form fluid barriers at these areas. With air thus introduced and the lead portion of a strip or roll of film positioned between assembled head sections, fluids are forced into their respective chambers through manifolds thereunder thereby providing continually changing fluid baths. The fluid enters in jet form thereby creating a desired turbulence. The pressurized air which may enter the chambers after they have been filled with fluid enhances the turbulence of the fluid therein. Each fluid overflows to its respective reservoir, while a portion of the pressurized air is vented through passages which also permit draining off of any fluid seeping into the ante-chambers through the air barrier seals. The ante-chambers are divided into two substantially equal compartments by a horizontal baffle in order that greater air pressure may occur in the lower compartments where greater fluid pressure is encountered.

Accordingly, it is an object of this invention to provide a system capable of rapidly processing strip material by continuous movement through a plurality of processing baths.

Another object of this invention is to provide a rapid photograph processing head capable of providing high quality processing at a film velocity of from one-tenth to at least three-tenths inch per second.

A further object of this invention is to provide a device for rapidly processing strip material through a plurality of fluid baths wherein there is substantially no contact between the film and the device while substantially constant tension is maintained in the film.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description thereof when considered in conjunction with the accompanying drawings in which like numerals represent like parts throughout and wherein:

FIG. 1 is an isometric view of one half of the device showing the various chambers, passages and overflows;

FIG. 2 is a section taken along a line substantially corresponding to line 2—2 of FIG. 1;

FIG. 3 is a section taken along a line substantially corresponding to line 3—3 of FIG. 1;

FIG. 4 is a section taken along a line substantially corresponding to line 4—4 of FIG. 1; and

FIG. 5 is a section taken along a line substantially corresponding to line 5—5 of FIG. 1

Referring to FIG. 1, the processing head 11 is shown as comprising two opposed complementary head sections 12 and 13 the details in section 13 being omitted to more clearly show the interior of section 12. Sections 12 and 13 are provided with chambers 15, 16 and 17 preferably milled out thereof, the chambers having respective bottom surfaces 19, 20 and 21 containing a plurality of orifices which connect through the underlying material to respective manifolds 23, 24 and 25. Intermediate end chamber 15 and chamber 16 are separated by ante-chamber 27 which is divided into an upper cavity 28 and a lower cavity 29. Disposed between end section 17 and section 16 is a second ante-chamber 30 comprising an upper cavity 31 and a lower cavity 32. At either end of the processing head are disposed ante-chambers 34, having an upper cavity 35 and a lower cavity 36, and 37, having an upper cavity 38 and a lower cavity 39. The complementary sections 12 and 13 are further milled or otherwise shaped to provide recessed areas at the film entrance area 40 and the film exit area 41 of head 11 and at each of the ante-chambers 27, 30, 34 and 37. These recessed areas, designated 44, 45, 46, 47, 48 and 49, are indented a short distance as indicated at 50 from the

interior face **51** of each section so as to provide a narrow space between a film **52** and the respective interior faces of these sections.

The complementary sections of the processing head **12** and **13**, are secured together along the lower portion thereof preferably by bolts as indicated at **55** and are clamped along the upper portion preferably by swivel bars **56**, **57** and **58** on which wing nuts **59**, **60** and **61** permit tightening against attached posts **62**, **63** and **64** after the film **52** has been inserted in the recesses between the sections. Gasketing, not shown, is provided in the system where necessary to prevent leakage of fluids. Flexible seals **65** and **115** are inserted between sections **12** and **13** to promote sealing of the various chambers above and below the areas recessed to receive film **52**.

Chamber **17** in this embodiment is the developer bay and is supplied with developing fluid from a supply source, not shown, through tubing, not shown, to inlet **66** in manifold **25**. A pump, not shown, produces a selected pressure in the developing fluid such that the fluid will be forced from manifold **25** upward through orifices **67** into chamber **17**. A second row of orifices is contained in the complementary section **13** which is not shown, both rows of orifices being supplied from the single manifold **25**. The level of developer maintained is determined by the position of an overflow **70** which is disposed sufficiently above the upper edge **71** of film **52** to assure effective developing of the entire film and is connected to a reservoir, not shown.

Chamber **16** is the fix bay and is supplied with fixing fluid through tubing or ducting, not shown, to inlet **72** of manifold **24**. The fixing fluid enters chamber **16** through a plurality of orifices **73** disposed in parallel rows in each of the sections, excess fluid being carried through overflows **74** to a reservoir, not shown. A similar supply and overflow system is provided for the rinse bay, chamber **15**. A pressurized supply source and connecting tubing, not shown, provides a supply of rinsing fluid to inlet **75** of manifold **23** from which manifold the fluid is forced into chamber **15** through orifices **76** in both sections of the processing head. Excess fluid is disposed of through overflow **77** to a reservoir, not shown.

A suitable gas such as air is used in the preferred embodiment to form part of the side walls of the bays in chambers **15**, **16** and **17**, this air being pressurized and supplied to an air pressure manifold **80** from a supply source, not shown. The air under pressure enters the manifold through inlet **81** and is distributed to the respective ante-chambers through outlets **82**, **83**, **84** and **85**. Air exiting through outlets **82–85** enters, respectively, headers **88**, **89**, **90** and **91** which are disposed in ante-chambers **34**, **27**, **30** and **37**. Each header is provided with a plurality of orifices **92** which direct fluids selectively toward areas at which an air barrier is to be maintained. Each ante-chamber is divided substantially at its midpoint by baffles **95**, **96**, **97** and **98** to form the upper and lower cavities previously described. These barriers serve to permit the air in the lower cavities to be maintained at a higher pressure than that in the upper cavities so as to compensate for the greater fluid pressure in the lower cavities. A cavity waste drain **100** is connected to each of the upper cavities of the ante-chambers by vents **101** while a second cavity waste drain **102** is connected to the lower cavities of the ante-chambers by vents **103** which are of smaller diameter than passages **101**. The two cavity waste drains are joined by tubing or pipe **104**, overall waste drainage system being connected to an external receiving tank, not shown, through air waste exit **105**.

Film **52** is fed through the system from right to left as indicated by arrow **110**. At the point of entrance, film traverses a chamber **111** which may be utilized to provide for wiping, dusting, etc. the film surfaces. At the exit end, the film passes between a pair of film wipers **113** and **114** which are shown in more detail in FIG. 5. A

cavity **115** may be provided for collecting fluid wiped off by the squeegee action of wipers **113** and **114**.

In FIGS. 2–5 the arrangement of the headers, orifices and ante-chambers is shown in greater detail. In FIG. 2, film **52** is shown passing between two pairs of inwardly extending flanges **116** and **117** of sections **12** and **13**, respectively, these flanges having a length such that when the film is disposed between them after the sections have been assembled for operation of the system a narrow space exists between the film and each of the respective flange ends. Orifices **92** in the headers are arranged to divert barrier forming air in the direction indicated by the adjacent arrows.

In FIG. 3, the arrangement of orifices **67**, **73** and **76** is shown in detail illustrating the angle at which the fluid jets direct fluid along the surfaces of film **52**. Arrows **125** and **126** indicate that fluid is diverted substantially equally to each side of film **52**.

FIG. 4 shows the arrangement at the upper cavity of ante-chambers **27**, **30**, **34** and **37**. Header **90** is shown disposed in ante-chamber **30** which is divided into upper cavity **31** and lower cavity **32** by baffle **97**. This baffle effectively separates the upper cavity from the lower cavity so that air may be maintained at a greater pressure in the lower cavity. The upper cavity **31** is connected to upper cavity waste drain **100** by passage **101**, serving to drain off fluid which may escape through the air barrier as well as air which is not forced into the chambers through the barrier wall. The film exit area is shown in detail in FIG. 5 wherein it may be seen that wipers **113** and **114**, held in position by members **127** and **128**, are disposed to exert a selected wiping pressure against the opposing surfaces of the film. At this end of the device, air at selected pressure is directed through orifices **92** only toward the approaching film as indicated by the adjacent arrows. A converse arrangement is provided at the entrance portion of the device where air is introduced only in the direction of film travel.

The processing head preferably is constructed of Plexiglas or Lexan, the chambers for processing fluids and the ante-chambers for air seals preferably being milled out of the plastic blocks. Head **11** is adapted for mounting in conventional environments by means which are not shown. The fluids (developer, fixer and wash) are pumped under pressure from external tanks, not shown, through the series of orifices along the bottoms of the respective chambers. The fluids emerge at a sufficient velocity to cause agitation in the chambers thus promoting even processing. The fluids fill the chambers to a level above the top edge of the film and leave the chambers through the overflow vents which are connected by tubing to the respective tanks.

Air is supplied to the ante-chambers through orificed headers **88–91** which extend vertically from top to bottom. Baffles **95–98** preferably are positioned horizontally in the ante-chambers, separating the ante-chambers into the two cavities. Orificed vents **101** and **103** selectively restrict the air flow exiting from each cavity of each ante-chamber thereby permitting control of the back pressure. The vents for the upper cavities preferably are located just above the baffle; the vent for the lower cavities are located at the bottom thereof. In addition to allowing a controlled escape of the air from the ante-chambers, the vents permit a drain-off of any fluid seeping into the ante-chamber through the air barriers.

The size of the air vents **101** and **103** is carefully calculated so that the pressure in the ante-chambers is closely related, in two steps in the present embodiment, to the pressure of the adjacent processing fluid. The air pressure and its distribution in the ante-chambers must be carefully controlled since an excessively low pressure would permit excessive leakage of processing fluids into the ante-chambers and an excessively high pressure would permit excessive bubbling of air from the ante-chambers into processing chambers **15**, **16** and **17** and

might impair processing. The squeegee formed by wipers **113** and **114** at the output end of the processing head lightly wipes water droplets from the film to promote quicker drying. A dryer, not shown, may be positioned at end **41** of the processing head.

In operation, the two sections **12** and **13** of processing head **11** are bolted together at the bottom and clamped with the removable clamps at the top after the film has been inserted into the head from the top. Air under pressure is admitted into inlet port **81** and is distributed to the perforated headers in each air ante-chamber adjacent the fluid bays by manifold **80**. Air exits the orifices in the headers in jets which impinge into the corner formed by the film and the section flanges presenting an air barrier in the manner shown in FIG. 2. Exhaust air plus any waste seepage past the air barriers enters cavity waste drains **100** and **101** and is discarded. Air entering the liquid bays returns to the reservoirs through the respective overflows. Processing fluid is pumped from respective tanks to the appropriate manifolds and is jetted, as shown in FIG. 3, against the film thereby breaking up boundary conditions. Fluid is returned to the tanks through the respective overflows.

The processing system of the present invention is a compact efficient means for continuously processing a variety of strip materials requiring a plurality of processing steps. Although rapid photographic processing is described herein, it will be appreciated that other processings not requiring the preciseness of photographic processing may be accommodated in the present system with much greater rapidity than the one-tenth to three-tenths inch per second referred to. Also, with the arrival of more rapidly acting fluids photographic processing may be accomplished more rapidly than described.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A compact composite film processing device particularly adapted for use in high resolution recording means comprising:

a processing head formed of a pair of opposed complementary head sections;

said head having individual chambers formed therein for individual processing steps;

jet means for providing a flow of a selected processing fluid through each of said chambers;

said processing head sections having slits formed there-

in at the ends of each chamber to permit substantially nonfrictional movement of film means therethrough and through said chambers;

chamber fluid retaining means disposed intermediate corresponding slits;

said retaining means forming jet barriers between said film and the adjacent end of said slits;

said processing head disposed in a vertical attitude during normal processing operations;

said means for providing a flow of processing fluid including jet orifice inlet means along the lower extremities of said chambers and overflow outlet means along the upper extremities thereof;

film and film transport means for continually moving the film through said processing head;

jet means for forcing processing fluids into said chambers so as to promote uniform processing of said film;

said jet means directing processing fluid substantially equally along opposing faces of said film;

said retaining means being headers perforated so as to direct pressurized gas at a selected pressure and volume toward the opening between the film and the open end extremities of said chambers;

said headers disposed in gas chambers;

said gas chambers divided vertically into individual chambers containing perforations of different size so as to provide for pressure differentials corresponding to varying depths of the processing fluids; and

drains interconnecting gas chambers of equal pressure, whereby substantially frictionless processing of film may be accomplished.

2. The device as defined in claim **1** wherein said jet orifice inlet means include at least one manifold for each of said chambers; and

a plurality of orifices interconnecting respective manifolds and chambers so as to form said jet means and provide turbulence in the processing fluids.

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U.S. Cl. X.R.

95—94; 118—405