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Huber et al.

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[45] **Jan. 14, 1975**

[54] **APPARATUS FOR THE FLUID TREATMENT OF PHOTOGRAPHIC SHEET MATERIAL WHEREIN THE LATTER IS PASSED ALONG AN ARRAY OF ROLLERS**

[75] Inventors: **Norbert Huber,** Oberaichen; **Siegfried Nissler,** Echterdingen; **Hans Schneider,** Leinfelden, all of Germany

[73] Assignee: **Firma Autopan Heimerdinger & Stabler OHG,** Oberaichen/Wurtt., Germany

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July 21, 1972	Germany	357604
Sept. 8, 1972	Germany	440717

[52] **U.S. Cl.** **354/324,** 118/423, 118/429

[51] **Int. Cl.** **G03d 3/02**

[58] **Field of Search** ..... 95/94 R, 94 G, 89 R, 89 A, 95/93; 118/423, 426, 429

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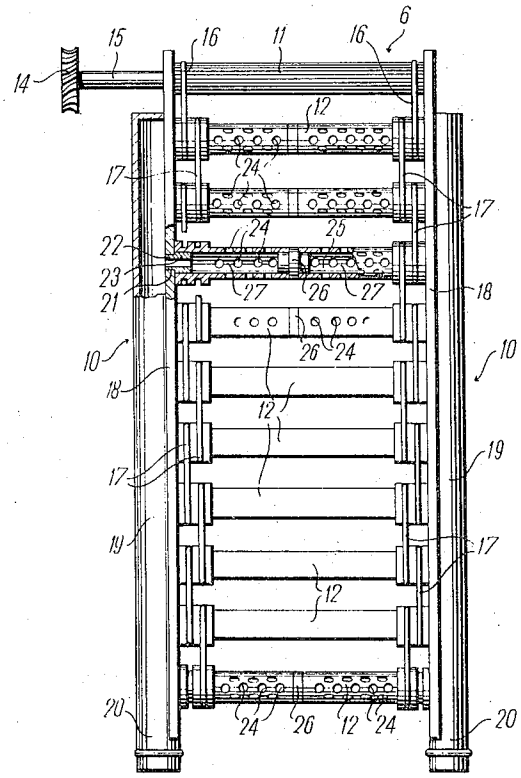
Primary Examiner—Richard L. Moses

Attorney, Agent, or Firm—Karl F. Ross; Herbert Dubno

[57] **ABSTRACT**

An apparatus for the treatment of sheet material, especially photographic sheets, comprises a multiplicity of surfaces or a single surface movable in a transport direction and defining a transport path through a vessel into which the treating fluid (e.g. developer, fixer or washing liquid, mist or gas) is admitted. The surface is provided with openings which are under suction so that a pressure differential is applied across a sheet carried along the surface to retain the sheet thereon without pressure members overlying the emulsion or sensitive side of the sheets. A drying chamber downstream of the fluid-treatment vessels circulates air into contact with the photographic paper or film, the air being dehumidified by a cooler in the circulating path. A counter responsive to the width and length of the photographic material measures the area treated.

23 Claims, 16 Drawing Figures



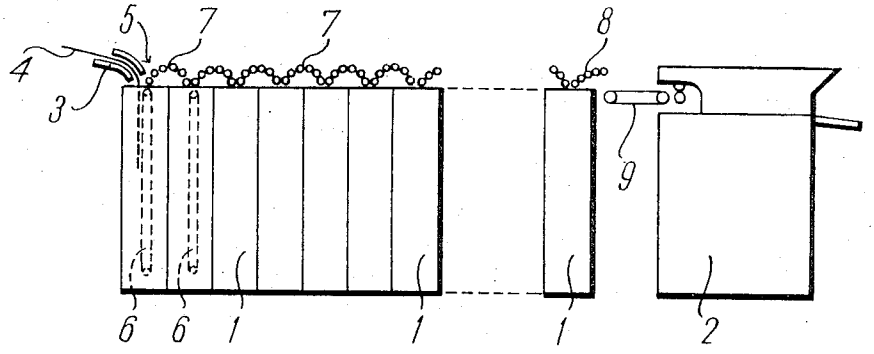

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Fig.1

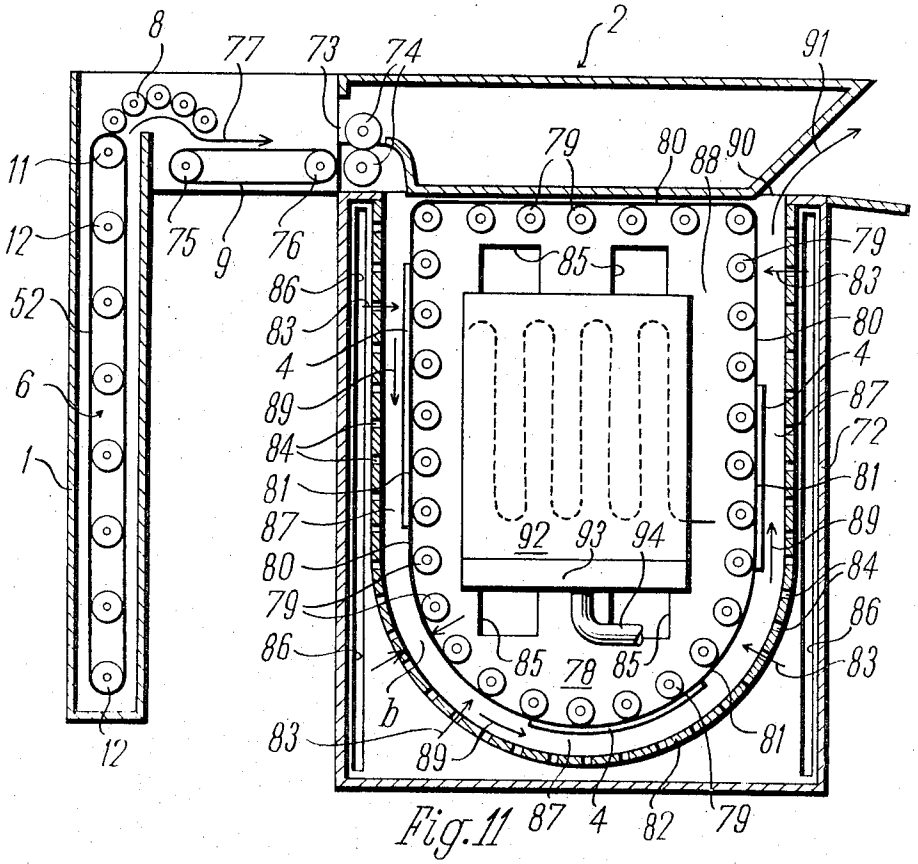
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Fig.11

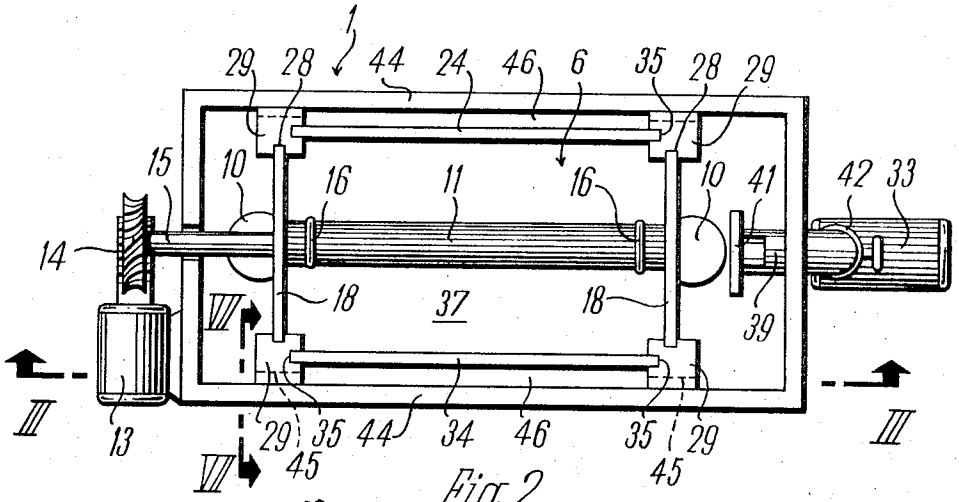

Fig. 2

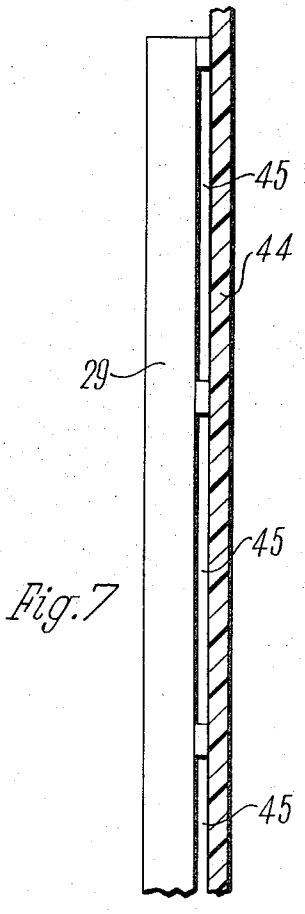

Fig. 7

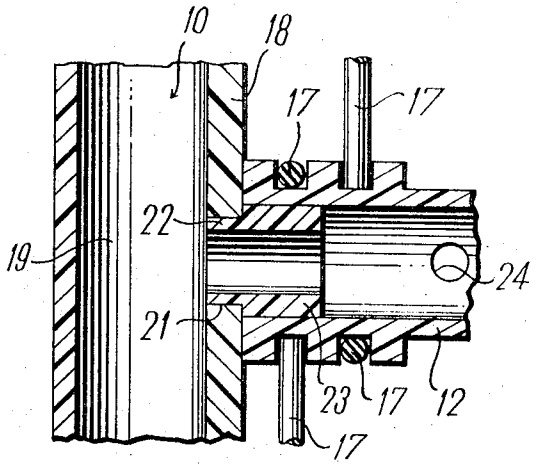

Fig. 5

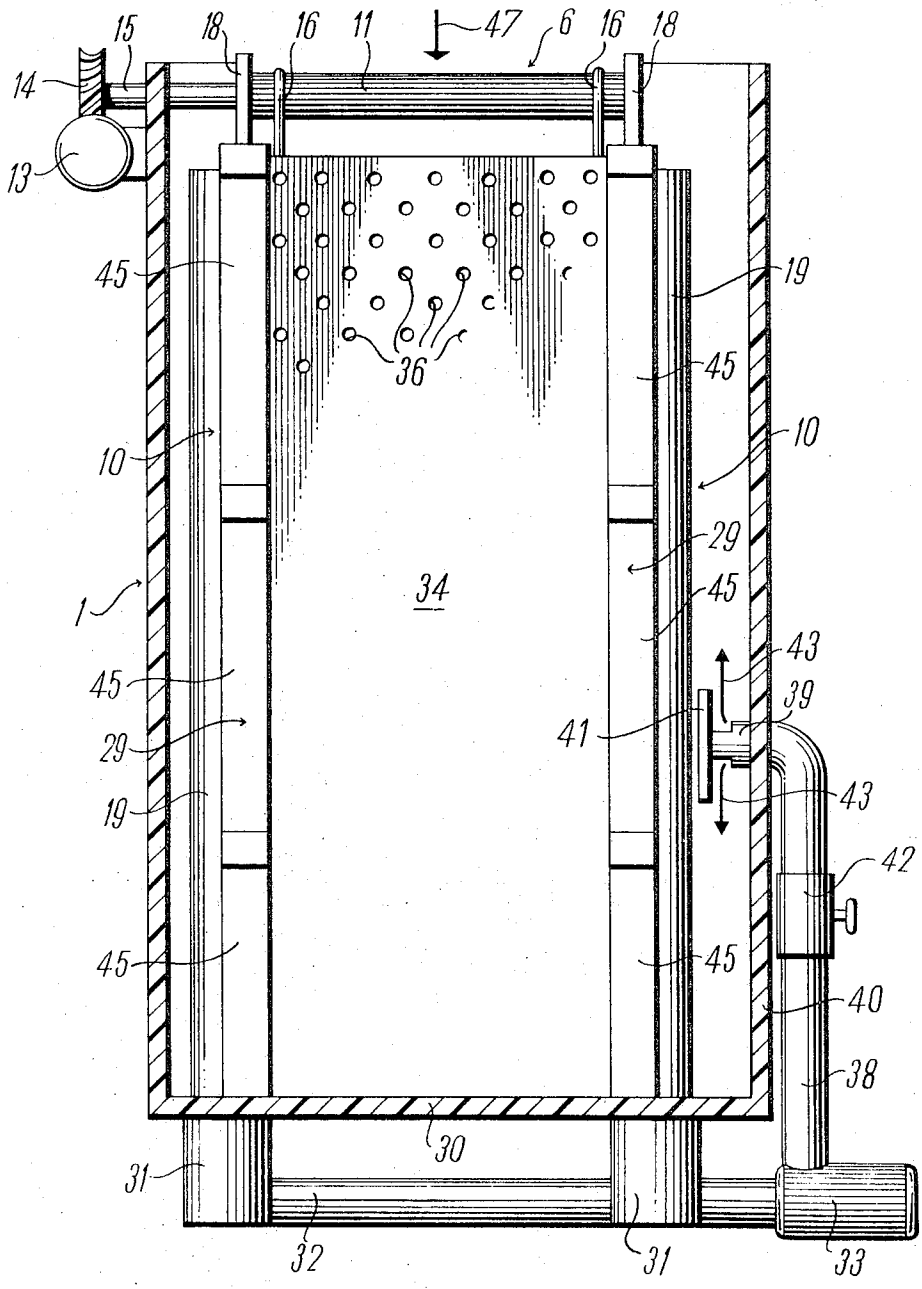
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Fig. 3

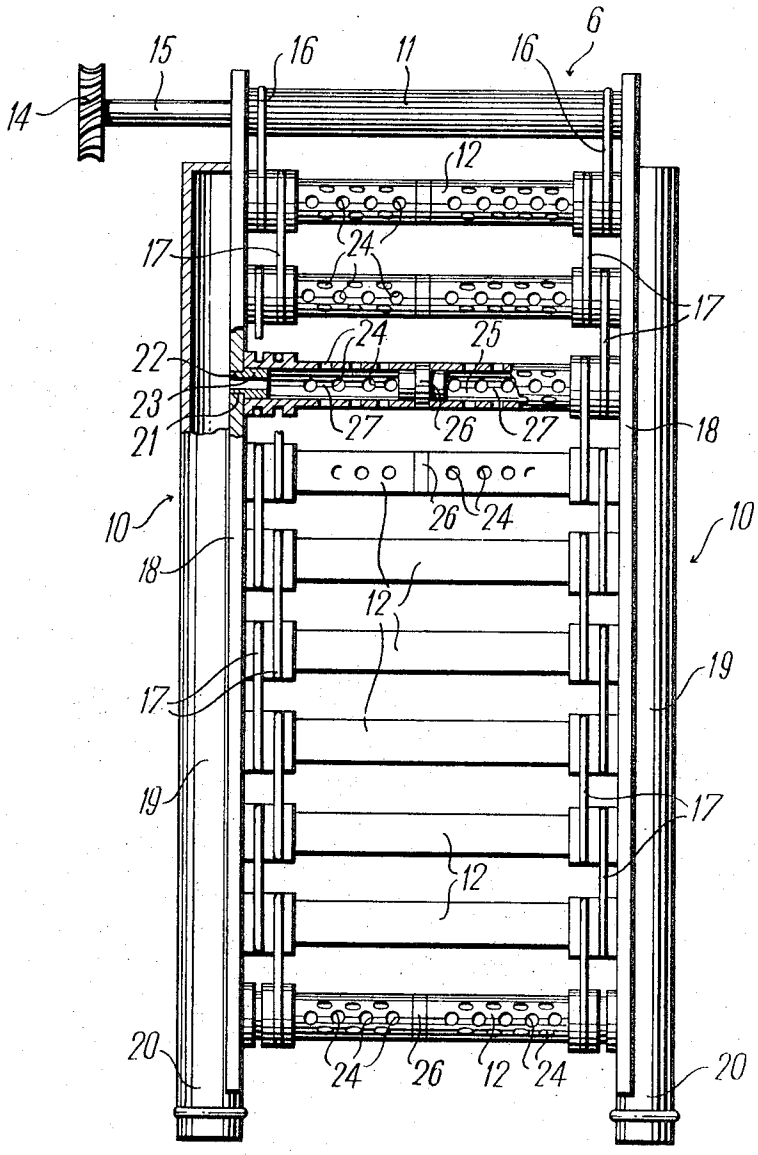
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Fig. 4

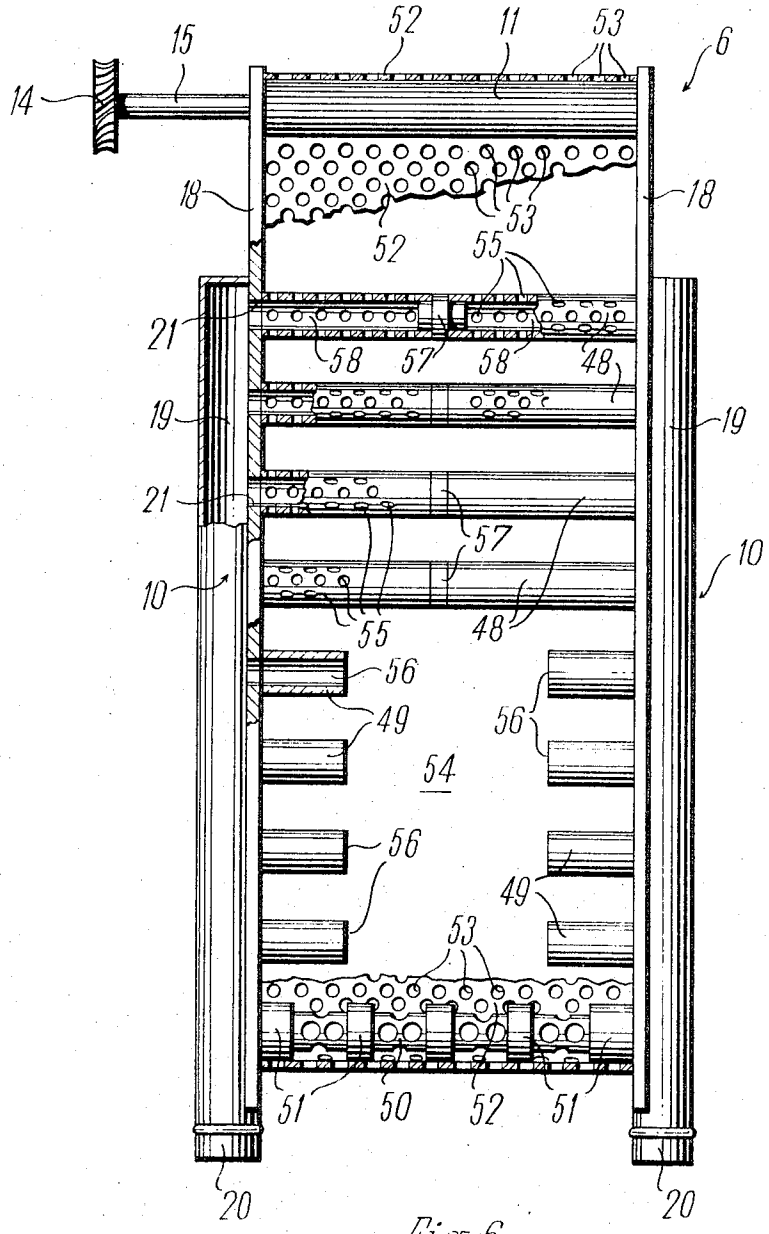
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Fig. 6

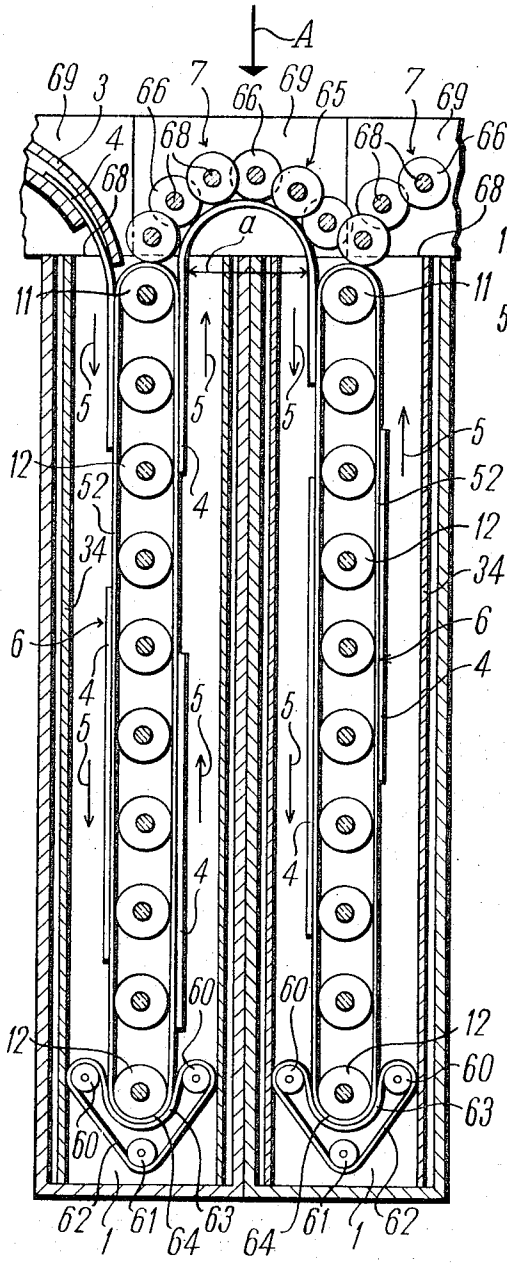

Fig. 8

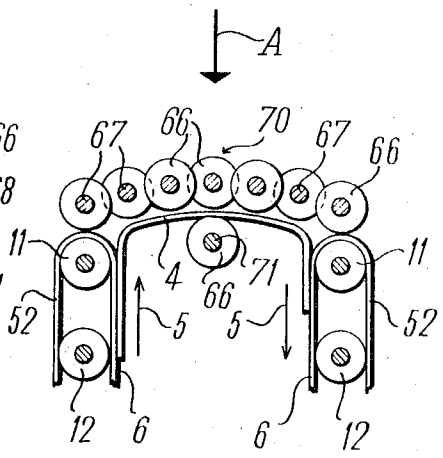

Fig. 9

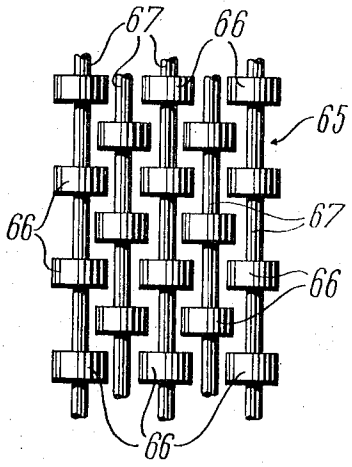

Fig. 10

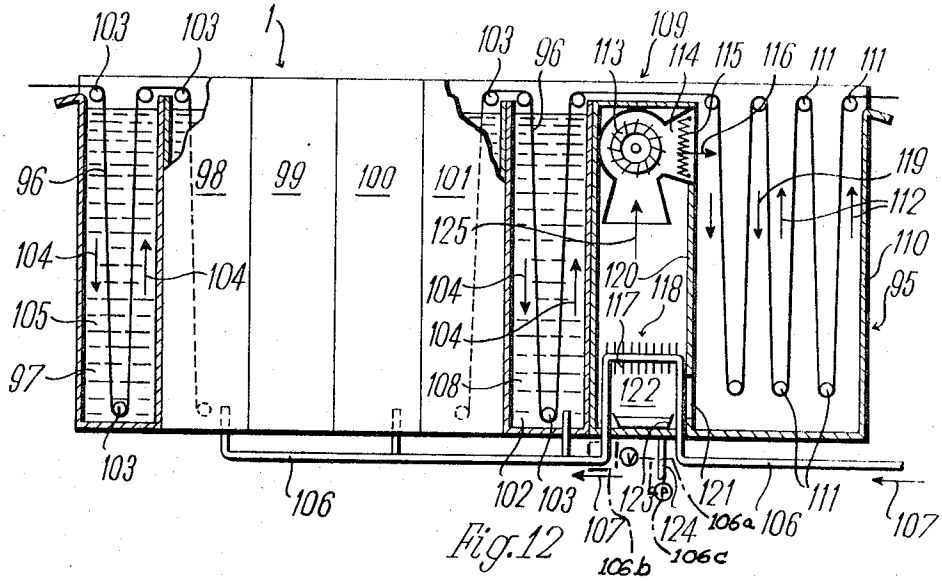
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Fig. 12

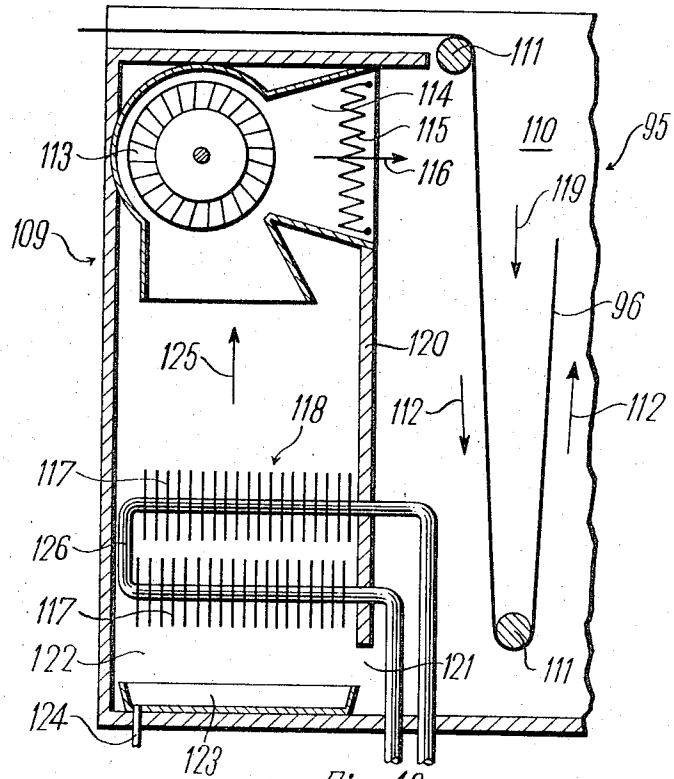
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Fig. 13

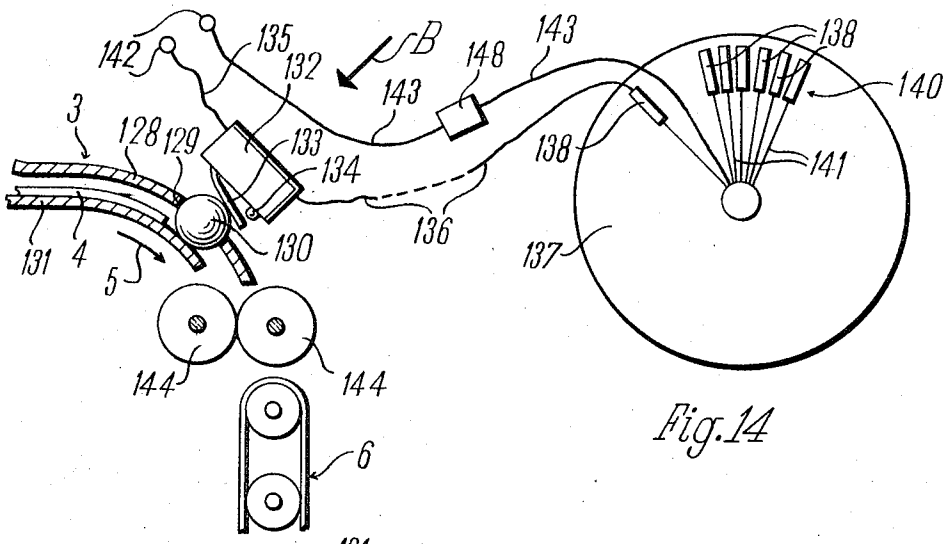

Fig.14

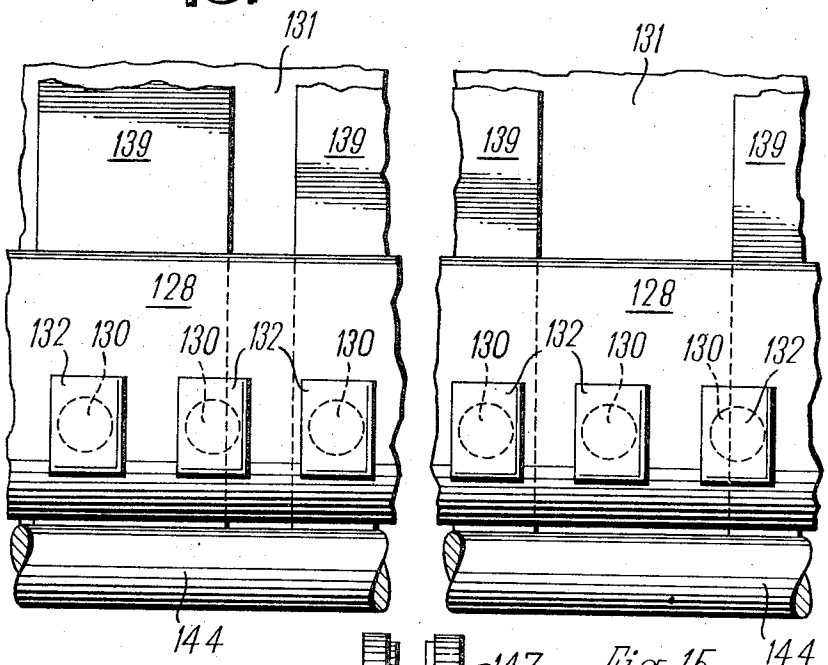

Fig.15

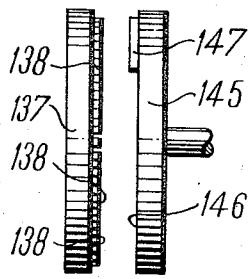

Fig.16

APPARATUS FOR THE FLUID TREATMENT OF PHOTOGRAPHIC SHEET MATERIAL WHEREIN THE LATTER IS PASSED ALONG AN ARRAY OF ROLLERS

FIELD OF THE INVENTION

The present invention relates to an apparatus for the treatment of sheet material, especially photographic sheets or continuous film, with a liquid and/or gaseous medium. The invention also relates to a method of treating sheet materials of a photographic nature.

BACKGROUND OF THE INVENTION

Large-scale development of photographic papers or film requires subjecting at least the sensitive or emulsion side of the photographic sheet material to various fluids which may be in a liquid state or in a gaseous state. The developing process may require treatment of the sheet material with one or more developer solutions or gases, one or more stop baths terminating the developing process, one or more fixing baths in which the photo-sensitive component of the emulsion, not affected by exposure or development, is removed to leave the image and various washing solutions between the chemical-treatment stages. The treatment may also include a washing step in which the photographic sheet material is treated with water until traces of the fixer are eliminated and for applying finishing chemicals to the sheet material. Thereupon the sheet material is subjected to a drying step in which the treatment fluid may be heated air. In each of the aforementioned states, the emulsion side of the photographic sheet material must be contacted with a fluid in the liquid and/or gaseous phase.

In modern photographic processes, it is required to handle sheet material at a high rate with a minimum of manipulation and a maximum of automatic control. To this end, it has been proposed to provide treatment vessels in which an endless-band conveyor forms a transport path against which the nonsensitive back or reverse face of the photographic sheet is held, e.g. by a pressure band engaging the emulsion-carrying surface of the sheet. The transport bands may convey the sheet material through the vessel or tanks in which the sheet material is treated with a liquid.

A significant disadvantage of this system is the covering of a portion of the emulsion by the pressure band which holds the sheet against the transport band. Since effective photographic development and treatment requires that all portions of the emulsion receive the same exposure to the treating fluid, this system is inherently defective.

It has been proposed to alleviate this problem by subdividing the pressure band into a multiplicity of spaced-apart strip-like belts which permit access of the fluid to the emulsion surface between the strips covered by the band. It has also been proposed to stagger the bands successively encountered by the sheet material to eliminate the striping effect which might otherwise occur.

In practice, none of these techniques has been found to be fully satisfactory or free from the difficulty mentioned, namely, the irregular, nonuniform or discontinuous nature of the treating process. It may be mentioned in passing that even the reduction of the width of the strip-like bands spaced across the emulsion face of the sheet does not solve the problem since the reduction in the surface area of the pressure band or bands retaining the photographic sheet against the transport band increases the tendency toward slippage and an unsatisfactory advance of the photographic sheets.

OBJECTS OF THE INVENTION

It is the principal object of the present invention to provide an improved apparatus, for the treatment of sheet material and especially photographic sheets, which has a high operating rate, is of relatively low cost and is free from the disadvantages enumerated earlier.

Another object of the invention is to provide an improved apparatus for the purposes described which permits uniform access of a treating fluid to a sensitive surface of the sheet materials without the difficulties encountered heretofore when pressing bands were employed.

Still another object of the invention is to provide an improved system for treating photographic sheet material whereby the aforementioned disadvantages are obviated.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are obtained, in accordance with the present invention, with an apparatus for the treatment of photographic sheet materials which comprises at least one displaceable transport surface defining a transport path through a treatment vessel and driven in the direction of travel of the photographic sheet material along this path, the surface being provided with openings which are connected to a suction source so that a pressure differential is applied across the sheet material overlying this surface favoring retention of the sensitive or back face of the sheet against the surface. The sensitive or emulsion face of the sheet is thereby exposed to the fluid and access of the fluid to the sensitive face is not obstructed at least over a major portion of this path.

The term "photographic sheet material" and terms of similar import are intended to refer to individual sheets of photographic paper which may be exposed in contact with a negative or by a light beam trained thereon through a negative, to photo-sensitive materials exposed to other forms of electronic energy and developable by treatment, to photographic films or negative sheets and the like, and to photo-sensitive papers used for reproduction of a master or an image and requiring development by contact with a fluid.

According to a feature of the invention, the transport surface is constituted by the peripheries of a plurality of tubular transport rollers which are journaled in a frame and are spaced apart along the transport path with axes parallel to one another and to the plane of the photographic sheet materials but orthogonal to the transport direction. Means is provided for rotating these rollers in the same sense. The cylindrical rollers are formed with radial bores which communicate with the cylindrical interior, the latter being connected via a pipe or conduit system or the like to the suction side of a pump (fluid-displacement means) adapted to displace the treating liquid or gas through the vessels. The pressure side of the pump may be connected to a feed duct of the vessel whereby the treating fluid is returned to the latter.

As the treating fluid (liquid or gas) is drawn by a pump or blower from the transport rollers (or, more

generally, from behind the apertured transport surface), a pressure differential is applied at the surface thereof at each of the radial bores and, since a large number of bores may be provided, the treating medium may circulate through the transport rollers without significant resistance. As the photographic sheet material is passed onto the surface of the rollers is covers the radial bores therein and the resulting pressure differential retains the photographic sheet material against the roller surface. Around the edges of the sheet, the treatment medium may continue to flow into the bores of the rollers.

When a treating liquid is used it is advantageous to increase the force with which the sheet is held against the transport surface by providing an increased fluid pressure against the sheet at its emulsion or sensitive side. The pressure differential, of course, increases as the level of treatment liquid in the duct system falls with increasing obstruction of the ports of the rollers as the sheet covers increasingly greater portions of the surface. Thus the sheet material is retained against the rollers without a pressing band or the like.

The transport rollers are driven by endless drive members, e.g. cables, belts or chains and, to achieve a uniform flow of the treating medium to the duct system, it has been found to be advantageous to subdivide the hollow interior of the transport rollers with partitions separating discs, studs or plugs into the chambers of equal sizes.

Instead of the rotating transport rollers, we can provide between the vertical columns a pair of vertically spaced horizontal deflection rollers about which passes a transport band covering substantially the entire length of each of these rollers and spanning the entire width of the chamber formed by the treatment vessel. The transport band is provided with openings under a pressure less than that in the chamber so that the uncoated or insensitive surface of the sheet is drawn by the pressure differential against the band and the treatment medium has free access to the emulsion or photosensitive surface. Here again no pressing band is required and the full emulsion face of the sheet is in contact with the treatment medium.

The transport band can be formed by a plurality of parallel endless band portions or strip-like belts bridging a pair of common rollers or respective rollers having a common axis of rotation. These individual band members define the openings of the transport band between them.

To prevent the inwardly directed forces which are transmitted from the sheet materials to the belt or band from urging the oppositely moving passes thereof together, we can provide one or more supporting surfaces, e.g. rollers journaled in the support frame for the transport device or perforated or tubular supports through which the fluid medium is withdrawn. According to a preferred construction of the mechanism of the present invention, the transport device comprises a support frame or structure having a pair of uprights which may constitute the ducts communicating with the space behind the open-work surface against which the sheet material is pressed by the pressure differential. The tubular uprights may then be connected to the common suction or intake line (intake side) of a pump whose discharge or outlet line (discharge side) communicates with chambers or compartments outwardly of the photographic sheet material carrying the roller journal and extending the full height and width of the treatment cell or vessel, the walls or plates being provided with ports which communicate with the space behind the open-work surface. When the surface is composed in part by perforated rollers or by bands passing over such perforated rollers or stationary tubes, the interiors of the rollers may communicate via the aforementioned ports with the ducts formed by the uprights. The interior of each perforated roller, moreover, can be provided with plugs or other partition means subdividing the roller into two portions each of which communicates through the wall or plate with a respective duct. This ensures uniformity of suction across the length of the rollers. Of course, the suction force may be applied by stationary perforated surfaces underlying the band or across which the photographic sheet material is caused to move by rotated or otherwise displaced surfaces. The stationary surfaces may also be placed under suction at their sides turned away from the sheet material to draw the latter against the surfaces. One roller may be displaced relative to the other to tension the band.

An important embodiment of the invention comprises an array of mutually parallel but vertically spaced horizontal rollers, each of which is perforated (i.e. provided with radial bores), mounted upon respective tubular sleeves projecting inwardly from the partitions or plates. The sleeves may pass through the aforementioned openings in these plates to communicate with ducts on the opposite sides thereof. Each tubular roller thus is free to rotate upon a pair of sleeves forming the journal of the roll. Advantageously, the end portions of each roller are formed to accommodate a driving means coupling the rollers to a common drive source.

It has been found to be advantageous to provide above the array of rollers at each treatment vessel, a feed roller along which the sheet material is directed downwardly into the vessel and into engagement with successive displacement rollers, all rotating in the same sense. The feed roller may be provided with a worm wheel which, when the frame carrying the rollers is lowered into the upwardly open vessel or cell, rests upon and engages the worm of a motor disposed externally of the cell casing. A flexible force-transmission member, e.g. a cable, belt or chain, passes around the end formations of the roller to drive the latter in a single sense. Thus, on one side of the array of rollers, the surfaces move downwardly to entrain the photographic sheet material into the cell while, on the opposite side of the array, the surface move upwardly to carry the sheet material out of the cell and, if desired, into the next treatment vessel. The drive means preferably includes at least one endless member passing around each uppermost roller of the array and around the next lowermost roller so that the roller of the array are coupled together for joint rotation in a common sense. When a chain is used as an endless member, the end formations of the rollers may be sprocket wheels whereas the end formations may be grooved to accommodate a belt when the latter constitutes the torque-transmission means.

We have also found it to be advantageous to constitute the framework from a plurality of plates including the two plates mentioned earlier, which lie in vertical planes and flank all sides of the roller array over the full height of this array. These walls may be provided with

openings through which the treating fluid can be passed. The walls thus lie ahead of the mouth of the outlet duct from the pressure side of the pump communicating with the compartment of the vessel.

The suction effect of the pump and the rate at which the treating medium is fed to the vessel may be controlled by a valve in one of the lines connecting the pump to the vessel, preferably the fluid feed line.

It has been found to be advantageous to provide a number of such vessels in series for the treatment of the photographic sheet materials with different liquids. It has been pointed out earlier that these liquids may include one or more developers, one or more rinsing or washing liquids, stop bath and one or more foxer solutions, each liquid or treating fluid being applied to the sheet in a respective vessel so as to prevent intermixture. In this case, the serially arranged vessels are placed in a row with the upstream side or wall of each vessel contacting the downstream side of an adjoining vessel, a deviating device being provided between each pair of vessels to deflect the rinsing sheet of an upstream vessel downwardly into the next downstream vessel for passage therethrough by the transport means of this latter vessel. The deviating device preferably comprises an array of rollers constituting a roller conveyor. The axes of these rollers lie along an arc extending from a location directly above the uppermost roller of one vertical array to a location directly above the uppermost roller of the next array, the axes being spaced apart by a distance less than the diameter of the individual rollers but greater than the radius thereof. The latter rollers may, moreover, be axially spaced along the respective axes so that they interdigitate with the rollers on the upstream and downstream sides thereof (i.e. the rollers of successive axes along the sheet path are staggered with respect to one another). It has also been found to be advantageous to provide at the bottom of each array of tubular transport rollers or conveyor band system in accordance with the present invention, a deflecting means which may include a pressing band passing around a pair of rollers whose axes lie in a plane in or somewhat above the lowermost roller of the array. The return pass of this deflecting device defines with the first mentioned rollers a triangle. The rollers of the deflection device may have axes parallel to those of the transport array and serve to sandwich the sheet material between the transport surface (band or roller) and the deflection band so that the sheet wraps around the lowermost roller of the transport device as it rises along the opposite side of the rollers of the transport array.

Either the roller conveyor or the conveyor-belt deflector and preferably both may extend over an arc of substantially 180°.

According to another feature of this invention, the battery of treatment vessel terminates in a drying apparatus which is also provided with means for conducting the photographic sheet material through a treatment chamber in which it is subjected to a fluid, e.g. drying air, which may be at a higher temperature than ambient. The drying apparatus is provided with a plurality of transport rollers about which a transport band or belt passes in a closed path. The belt is provided with openings through which circulated air can pass into a space within the zone defined by the belt. In this embodiment as well, the zone enclosed by the belt is evacuated by an air-circulation device (e.g. a blower) whose suction or intake side is connected to this zone and whose outlet opens or discharge side into the zone surrounding the belt.

To remove moisture from the circulated air, we provide in the circulation path a cooling device which is maintained at a temperature below the dewpoint of circulated air so that moisture picked up by the air upon contact with the photographic material is condensed at the cooler. The latter may be a heat exchanger and the precipitated water may be collected and, in order to minimize the operating costs of the device, can be returned as a diluting fluid for the chemicals used to treat the photographic material in the battery of vessels previously described, or to a rinsing vessel. It has also been found to be advantageous to operate the heat exchanger with a sheet-treating liquid and thus the heat exchanger is provided in the line feeding water to any of the treating vessels. When control of the temperature of the water delivered to one of the treating vessels is required, we may provide a mixing chamber downstream of the heat exchanger in the water-supply line and a valve for controlling mixing of a portion of the condensed water with the cooled water delivered to the vessels. A mixing valve may also be provided for bypassing a part of the cold water past the heat exchanger and to the mixing chamber. The condensed water can be collected in a tray or trough and led away via a discharge line if desired.

It has also been found to be advantageous to provide counting means along the path of the sheet material, preferably in the form of switches actuated by the leading edge of each sheet. A register may indicate the count and alert the operator to the depletion of any of the chemicals used or the completion of processing of a predetermined sheet area.

The counting device preferably comprises an array of balls which are free to move in windows of a plate disposed above the path of the sheet material and displaced upwardly by the leading edge of the sheet. A sensitive switch is actuated by each ball and constitutes an input to a control device. Advantageously the switches are provided in circuit with respective magnetic switches which can be arranged in a crown configuration with a common return conductor in circuit with a counter. The magnetic switches are operated in succession by a disk carrying a magnet once during each revolution of this disk.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a vertical elevational view, partly in diagrammatic form, illustrating the apparatus according to the invention;

FIG. 2 is a plan view, drawn to an enlarged scale, of one cell or vessel of the apparatus of FIG. 1;

FIG. 3 is a cross-sectional view taken along the line III — III of FIG. 2;

FIG. 4 is a side-elevational view, partly broken away, of a transport system according to an embodiment of the invention;

FIG. 5 is a detail view, partly in axial section, showing a portion of the device of FIG. 4;

FIG. 6 is a vertical elevational view, partly broken away, of another embodiment of the transport means according to the invention;

FIG. 7 is a section taken along line VII — VII of FIG. 2;

FIG. 8 is a vertical section through an embodiment of the invention having upper and lower deflectors;

FIG. 9 is a fragmentary sectional view illustrating another upper deflector;

FIG. 10 is a view taken in the direction of arrow A (FIGS. 8 and 9);

FIG. 11 is a vertical section through a drying chamber according to the invention;

FIG. 12 is a vertical cross-sectional view through a treatment apparatus provided with another drying means according to the present invention;

FIG. 13 is a vertical section of the drying chamber of another embodiment of the apparatus;

FIG. 14 is a somewhat diagrammatic elevational view, partly broken away, of a sheet-detecting arrangement according to the invention;

FIG. 15 is a view taken generally in the direction of arrow B in FIG. 14; and

FIG. 16 is a side-elevational view of a disk arrangement with a magnetic switching according to the invention.

SPECIFIC DESCRIPTION

FIG. 1 shows, somewhat diagrammatically, an apparatus for the development of photographic paper or film, hereinafter described simply as photographic sheet material or sheets. The apparatus comprises a plurality of upright cells or vessels **1**, each of which is upwardly open and receives a treating fluid, the cells or vessels **1** being arranged in a horizontal stack. At the end of the stack there is provided a drying device **2** which may be of the type described, for example, in FIG. **11**.

The first cell or vessel **1** (at the upstream end of the system) is provided with means for feeding the sheet into the apparatus, the means comprising a pair of downwardly curved guide plates together defined a feed slot **3** into which the leading edge of the sheet **4** may be introduced into the direction of arrow **5**. As the sheet is fed to the first cell, it is entrained downwardly through a treating liquid (developer) or in juxtaposition with nozzles admitting a treating gas by a transport device represented generally at **6** and constituted as set forth in connection with any of the subsequent Figures. As the sheet rises along the transport device **6**, it is diverted via a deflecting device **7** downwardly into the next vessel **1**. The process continues until the roller conveyor **8** deposits the sheet material onto a belt conveyor **9** which carries the sheet into the drying device. Deflecting device **7**, of course, is also a roller conveyor.

FIGS. **2** – **6** illustrated various transport systems whereby the sheet material is passed downwardly through the narrow vessels or cells and thence upwardly to emerge from the open top of the vessel for deflection to the next treating stage.

The transport means within each cell may comprise two vertical beams or uprights **10** carrying a frame **18** etc. at its upper end received centrally between the two opposite walls **44** of the cell.

A plurality of vertically spaced mutually parallel tube-like hollow rollers **12** are journaled on the uprights **10** below an inner feed roller **11**. Externally of the vessel **1**, there is provided a motor **13** whose worm engages a worm wheel of a step-down partition **14** connected to the uppermost roller **11** by a shaft **15** (FIG. **4**).

The rollers **12** are driven by belts **16** and **17** connecting the upper roller **11** to the topmost roller **12** and each roller **12** with the next lower roller. To this end, the rollers **12** are formed with cylindrical bosses at their opposite ends having circumferential grooves receiving the belts **16** and **17**. Of course, a chain drive may also be used in which case these bosses would be formed as sprocket wheels. All the rollers **11** and **12** are thus driven in common and in the same sense by the shaft **15**.

The supporting uprights **10** carry the frame structure **18** etc. which acts as a confinement (see especially FIGS. **2** and **4**). The structure comprises a pair of vertical plates **18** extending the full height of the vessel **1** and the uprights **10** may be constituted as ducts **19** which terminate in pipe fittings **20**. As can be seen especially from FIG. **5**, the spacing of the transport rollers **12** corresponds to the spacing of bores **21** in the plates **18** which receive the small-diameter portions of respective tubular sleeves **22** upon which the transport rollers **12** are rotatably mounted. The resulting journal is represented at **23**.

Each of the transport rollers **12** is provided with bores **24** communicating with the interior of the rollers, the latter being represented at **25** and being subdivided by a plug **26** into two compartments **27**. Each of the compartments **27** is connected to a respective sleeve **23** and the bore **21** of the wall **18** with the respective ducts **19**.

The entire assembly **6** is rigid and can be lifted upwardly out of and inserted downwardly into the upwardly open vessel **1** whereby the outer edges of each partition plate enter respective vertical grooves **28** of ledges **29** affixed to the inner walls **44** of the vessel **1**. At the same time the pipe fittings **20** at the bottom ends of the ducts **19** (FIG. **4**) pass through the floor **30** of the vessel **1** (see FIG. **3**) and connect to the mating pipe fittings **31**. The latter communicate with a pipe network **32** connected to a pump **33**. Just as the fittings **20** engage tightly into the fittings **31**, the worm wheel **14** of the roller comes to rest in meshing relationship with the worm.

As can be seen from FIGS. **2**, **3** and **7**, between the supports **29** and flanking the array of transport rollers **12**, there are provided a pair of partitions or walls **34** which slide downwardly in respective guide grooves **35** of the support **29**. The partitions or walls **34** are formed with holes **36** through which the treating fluid can be introduced into the space **37** enclosed by the four vertical plates **18** and **34**.

To permit the pump **33** to circulate the treating fluid back into the vessel **1**, a supply line **38** (FIG. **3**) is provided whose horizontally bent end **39** passes through the wall **40** of the vessel and is formed at its mouth with a deflection plate **41** to divert the flow of fluid upwardly and downwardly as represented by the arrows **43**. A valve **42** is provided in line **38** and thereby controls the discharge rate of pump **33** and, indirectly, the suction developed within the space enclosed by the perforated transport surfaces.

When photographic sheet material is fed into the first vessel **1** over the feed roller **11** and the pump **33** is energized, the treating fluid is drawn from the space **37**

enclosed by the vertical walls **18** and **34** via the transport rollers **12** and the ducts **19**, through the conduit **32** and to the pump **33**. The fluid is then returned via the feed duct **38** to the vessel **1** whereby the treating fluid is deflected upwardly and downwardly by the baffle **41** as represented by the arrows **43**. From the space around the enclosure **18, 34**, the liquid flows through the perforations **36** into the space **37** to enclose the circulation path.

The sheet material introduced into the space **37** in the direction of arrow **5** (FIG. 1) and arrow **47** (FIG. 3) is entrained downwardly by the suction at the uppermost transport roller **12**, a portion of the radial bores **24** of which are covered. The sheets thus lie flush against the surfaces of the rollers **12** and are held by the pressure differential applied thereacross between the radial bores **24** and the remainder of the chamber **37** with a force which is equal to the product of the total cross-sectional area of all the blocked bores and thus pressure differential. The rollers **12** at the side onto which the sheets initially pass move in the downward direction entraining the sheet material similarly (arro5 in FIG. 8). This force is such that the sheets are held only with enough pressure as to keep them from moving relative to the surface of the roller but not sufficient to cause the leading edge of the sheet to bend around the roller. Alternatively, the belts **17** may underlie the outer edges of the sheet material so that from roller to roller the sheet material passes without deflection in spite of rotation of the apertured surface. In other words the sheet material is merely entrained by the rollers by generally tangential contact and without a tendency of the sheet material to bend to conform with the roller surface.

The downward movement of the sheet material continues until the lowermost roller **12** is reached, whereupon the sheet material is deflected through 180° and rises in contact with the diametrically opposite sides of the rollers **12**. Since the movement of the sheet material along the rollers progressively blocks more and more radial bores **24**, the liquid must be drawn through fewer and fewer bores **24**. This has the effect of reducing the level of liquid in the duct system **19/32** with respect to the level of liquid in chamber **37**, thereby reinforcing the pressure differential applied to the sheet material and retaining it against the rollers.

Control of the flow rate of the liquid via valve **42** in the supply line **38** permits regulation of the contact pressure applied to the sheet material. This control is important since the degree to which the ports **24** are covered by the sheet material is a function of the size and nature thereof.

FIG. **6** shows a modification of the system according to the present invention in which, in place of the rotatable rollers **12**, stationary suction tubes **48** and nonperforated suction tubes **49** are provided, the latter extending only limitedly from the opposite walls **18** of the support structure. The lowest suction tube **50** is provided with freely rotatable rings **51** around which a perforated belt **52** passes, the belt **52** passing over the infeed roller **11**. The perforations **53** of the band **52** permit the flow of fluid through this band into the space **54** enclosed thereby, this space being connected to a suction source as described for the chamber **37**.

The operation of the pump includes a flow of treating liquid from the space **54** defined by the band **52** and the lateral walls **18** through the perforations **55** of the stationary suction tubes **48** and through the mouth **56** of the nonperforated suction tubes **49** into the ducts **19** forming the uprights **10**. The liquid is then carried by a duct system similar to that shown at **31** and **32** to the intake side of pump **33** and is returned via the feed duct **38** to a nozzle and baffle arrangement **41** communicating with the space around the enclosure **54**. In this embodiment, as in the embodiment of FIG. **4**, the suction tubes **48** and **50** are subdivided by plugs **57** into respective axial compartments communicating with the respective ducts **19**.

In general, the system of FIG. **6** operates similarly to that of FIGS. **2** and **3** in that a photographic sheet brought into contact with the perforated band **52** will be entrained in the direction of arrow **47** and will contact, with its uncoated side, the outer surface of the band **52**. A portion of the perforations **53** of the band **52** will be obstructed and, as a result, a pressure differential is developed which presses the uncoated surface of the sheet material against the band. The liquid to which the sheet material carried by the band is exposed, provides the necessary treatment free from any interference by a surface masking the emulsion face.

FIGS. **8** and **9** show in section the transport device of a vessel **1** which is provided with means for deflecting the emerging sheet into the next vessel (FIG. **1**) and for facilitating a transition between the downward movement of the sheet material and upward displacement thereof at the bottom of the vessel. The deflection means **59** at the bottom of the vessel comprises three deflection rollers. The deflection rollers **60** flank the array of transport rollers **12** and the band **52** and have axes of rotating lying in a horizontal plane above the axis of the lowermost roller **12** so that a deflection band **62**, passing around the rollers **60**, is slung underneath the region at which the band **52** is deflected from its downward stretch into its upper stretch. A third deflection roller **61** defines a triangle with roller **60** and may have its axis lying in a common vertical plane with the axes of the rollers **12**. The roller **61** lies beneath the lowermost roller **12**. The deflection band **62** has a bight paralleling the band **52** through 180° and holds the sheet material thereagainst as it makes its transition from the downward movement to the upward movement. Thereafter, the band **62** is deflected away from the transport band **52** so that treatment of an uncovered sensitive surface of the photographic sheet may continue. It will be appreciated that, in FIGS. **8** and **9**, the band **62** has been shown to cooperate with a perforated band **52** which passes over perforated rollers **12**. It may also be used with perforated rollers alone and with a perforated band passing over rollers which are not perforated. The band may also pass over stationary suction tubes provided with suction apertures distributed over their lengths or having only an axial suction inlet at the mouth of the pipe. In general, therefore, we prefer to sling a deflector band under the perforated or open-work suction surfaces no matter how the latter are constituted.

To deflect the photographic sheet material from one vessel to the next (FIG. **1**), the roller-conveyor deflectors **7** are provided. Each of these conveyors comprise an arc-shaped array **65** of rollers having individual ball-bearing wheels **66** axially spaced apart upon shafts **67** (if the latter are not driven). This structure is best seen in FIGS. **8 – 10**. The arc (FIG. **8**) may extend from the topmost roller of the array of perforated rollers or from

the top of the conveyor band system of one vessel to the top of the array of rollers or conveyor band of the next vessel over an arc of about 180°. In FIG. **8** the roller shafts are represented at **68** and two successive sells are shown to have a pair of upright support walls **69** in which the shafts are mounted. When ball-bearing wheels are used, the sheet entrains them by friction and thus the arc of the roller conveyor must have a length which is less than the length of the sheet in the direction of movement thereof. Of course, the wheels may be driven with a peripheral speed equal to the conveyor or perforated-surface speed as required.

As will also be apparent from FIGS. **8** and **10**, each row of wheels carried by a common shaft **67** or **68** interdigitates with a pair of adjacent rows having a spacing which is less than the wheel diameter but greater than the wheel radius. The sheet **4** (FIG. **8**) is thus engaged by the wheel along its nonsensitive or backing surface and is deflected downwardly such that its backing surface is entrained by the perforated surface of the next array of rollers or conveyor band. The wheels lie tangent to a circle substantially of the diameter *a* which corresponds to the spacing of the successive bands from one another, less twice the thickness of the sheet which is processed.

In FIG. **9** we have shown another deflector system wherein, however, the roller conveyor does not lie along a circular arc through 180° between the perforated conveyor bands of adjoining cells, vessels or compartments. The roller conveyor **70** here forms a highly flattened arc which nevertheless deflects the sheet material although we prefer to provide a row of wheels **66** upon a shaft **71** engageable with the emulsion face of the sheet material to provide greater security insofar as advance of the sheet from one vessel to the other is concerned.

The apparatus according to the present invention is provided, at the end of the battery of cells or vessels **1**, with a drying installation represented generally at **2.** In this device, as in each cell, the sheet material is subjected to treatment with a fluid (circulating air in the case of the dryer) and is held against a transport surface by a fluid-pressure differential.

FIG. **12** shows this arrangement in somewhat greater detail, only a single cell **1** being illustrated ahead of the drying chamber although, under normal conditions, a row of such cells is provided.

The drying device comprises a chamber **72** having an inlet opening **73** at which a pair of feed rollers **74** is provided. Between the transport device **6** of the last vessel **1** and the inlet **73** to chamber **72,** there is provided an arcuate roller conveyor **8,** which may be identical in all respects to the roller conveyors described in connection with FIGS. **8** and **10.** The roller conveyor **8** deflects the sheet material as represented by the arrow **77** onto an endless conveyor **9** passing about horizontally spaced rollers **75, 76** which leads the sheet material into the nip between the transport rollers **74.** A deflection plate behind these latter rollers directs the sheet downwardly.

Between the vertical side walls **78** (all of the vertical walls being designated **78**) of the drying chamber **72,** there are provided transport rollers **79** which are spaced around a closed path and serve to support an endless transport belt **80,** the latter being perforated as described for the band **52.** At a distance *b* from the bight **81** or U-shaped stretch of this perforated band **80,** a U-shaped partition **82** is disposed. The partition **82** is formed with perforations **84** through which air can be admitted into the space surrounding the band **80** as represented by the arrow **83.**

At the rear wall **78,** within the zone surrounded by the rollers **79** and the band **80,** there are provided air outlet openings **85** which are connected by ducts and a blower to the air-inlet slits **86** in the walls **79** between the partition **82** and the outer wall **72.** The air emerging from these slots can thus return into contact with the sheet material through the openings **84.** It will be apparent, therefore, that the air displaced by a blower not illustrated in FIG. **11,** is drawn from the chamber **88** surrounded by the band **80,** thereby retaining the sheets **4** against this band, and is returned to the space **87** around the band and directed against the sheet material thereon to further support the sheet material on its transport surface. At the upper end of the path of the band **80** in the drying chamber it is deflected sharply to the left (FIG. **11**) and, because of the stiffness of the photographic sheet material, the leading edge thereof does not follow the band but instead issues from the device through a slot **90** as represented by the arrow **91.**

The air circulating past the sheet material **4** picks up moisture therefrom and suffers an increase in its relative humidity. To remove this moisture, we provide in a space **88** surrounded by the band **80,** a cooling device **92** having at its base a water-collection through **93** from which the collected water can be led by a duct **94** to one of the vessels **1** as replacement water. The cooler **92** lowers the temperature of the circulated air below its dewpoint and may be provided with a blower (not shown) for circulating air in the space **88** into heat-exchanging relationship with the surfaces of the cooler. The dehumidified air continues it circulation and may be passed through a heating device to warm it to its original temperature or a temperature above ambient. The heat-exchange fluid fed to the cooler **92** may be cold water which is heated during the drying process and can be led to one of the vessels **1** as previously described.

FIGS. **12** and **13** illustrate another embodiment of the invention in which the drying arrangement **95** serves to dry a continuous film **96** passing about rollers **111.** The apparatus which terminates in the drying device of FIG. **12** comprises six treating vessels **97 – 102** which are traversed in succession by a photographic film strip **96** passing over deflecting rollers **103** in the direction of the arrows **104.**

In tanks **97, 99** and **101** of the apparatus, the film is treated with developing liquids, stop bath and fixer, respectively, while the tanks **98, 100** and **102** are provided with rinsing water delivered by a line **106** and supplied in the direction of arrow **107.** Inother words, the film is washed, after each chemical treatment, by fresh water delivered to the tanks or vessels **98, 100** and **102** downstream from each of the treatment vessels.

Immediately downstream of the last treatment vessel **102,** there is provided a drying station which has been represented at **95** in FIGS. **12** and **13** and is provided with a drying unit **109** and a chamber **110** in which the film is treated with the drying air. The film **96** is passed in a zig-zag pattern about rollers **111** in the chamber **110** and moves generally in the direction of the arrow **112.**

The air-circulation unit **102** comprises a radial blower **113** having an electrical resistance heating element **115** spanning its outlet opening **114.** The air from this blower is trained in the direction of arrow **116** upon the film carried along the path defined by the rollers **111.**

Below the radial blower **113,** there is provided a cooling unit **118** which is formed with heat-exchange ribs or fins **117** and through which cold fresh water is fed via the fresh-water feed line **106.** Since the fresh water traverses the cooler **118** before it enters the washing tanks **98, 100, 102,** the water is somewhat warmed while the air passing over this heat exchanger and the fins is cooled, thereby condensing moisture which is collected in a trough **123** (FIGS. **12** and **13**).

The heating element **115** warms the air before it returns to the drying chamber **110.**

In operation, the intake side of blower **113** draws air upwardly in the direction of arrow **125** within the compartment **122** set off by a partition **120** from the chamber **110.** Air is induced to flow into the compartment **122** through an opening **121** at the bottom of this partition **120** and thus a downward flow of air **119** is provided within the chamber **110.**

As the moisture-lated air passed over the cooling coil **126** of FIG. **13** or the fins **117** of FIG. **12,** it encounters surfaces at a temperature below the dewpoint of the air and condenses moisture thereon, the water droplets being collected in the trough **123.** The cooled air, carrying a reduced proportion of moisture, is then drawn into the blower **113** and is forced through the outlet **114** over the resistance-heating elements **115** where it is rewarmed to increas its moisture-carrying capacity. The warmed air then flows over the film **96** to dry the latter and pick up additional moisture. Of course, the heat delivered by elements **115** to the air is transmitted in part to the fresh water fed to the chemical treatment tanks and no other means is required for heating this water. The condensed water from trough **123** is carried off by a line **124** and may be fed to the tanks as part of the water making up the chemical solutions or constituting the washing fluid.

In FIG. **13** a drying arrangement has been illustrated in which a cooling loop **126** is provided as the heat exchanger. Of course, the cooling loop may be charged with water to be fed to the treatment tanks or may simply be part of a refrigerator cycle using the refrigerant such as FREON. In the system of either FIG. **12** or FIG. **13,** a bypass may be provided across the heat exchanger as represented at **106***a* for mixing at a chamber **106***b* a quantity of cold water with the warm water from the heat exchanger. A pump **106***c* may be used to feed collected water into this mixing chamber as well (see FIG. **12**).

In FIGS. **14 – 16** we show an apparatus, according to the invention, which includes a counter disposed at the inlet **3** to the system and responsive to the presence of the photographic sheet for indicating the treated area thereof. The system operates with a row of sensors across the path of the sheets, the number of sensors operated by the sheet being a function of the width thereof. All of the operative sensors are "scanned" periodically to a counter or register so that the pulse count or registered indication represents the area of the sheet which has been treated. For example, with each periodic scan, each sensor operated across the width of the sheet will trigger the register only for a duration representing the length of the sheet and only those sensors across the width of the sheet will be operated.

As can be seen from FIG. **14,** there is provided in the region of the feed slot **3** a curved plate **128** which extends transversely to the feed direction **5** and is provided with a row of circular openings each receiving a ball **130** which rests by its weight against the lower plate **131** defining the inlet slot **3.** Each ball **130** is provided with a sensitive sheet **132** whose spring finger **133** likely biases the ball downwardly but is deflectible by slight movement of the ball to operate the switch actuator **134.** As the photographic sheet passes beneath the row of balls, only those balls across the width of the sheet are lifted to operate their sensitive switches **132.** Each sensitive switch **132** is connected in series with a current source **142** and a communicating arrangement represented generally at **140.** From the communicating arrangement, all of the switches are returned via a counter **148** to the other terminal of the source. The commutating arrangement comprises a disk **137** upon which a crown of magnetically actuatable (reed) switches are provided, each in series with a respective microswitch **132** and the line **141** connected via a conductor **143** to the counter **148.** From FIG. **16,** it will be apparent that the disk **137** is confronted by a rotating disk **145** whose face **146** confronting the magnetic reed switch crown **140** is formed with a magnet **147** which operates each magnetic switch **138** once per revolution of the disk **145.** It will be noted further from FIG. **15** that a number of photographic sheets **139** can be passed in parallel through the apparatus and that it is not necessary to align the leading edges of these sheets since the counter will respond to the product of the width and length as noted. When the balls are spaced apart by 1 cm and the array of magnetic switches is scanned once for every cm of advance of the sheets, the number registered by the counter will be the total area in cm^2.

As the magnet **147** sweeps past each reed switch **138** it closes the contacts and, in the event the associated microswitch **132** is in a closed state, causes a signal to register at the counter **148.** If three microswtiches along the array are closed by a single photographic sheet, the actuation of the corresponding number of reed switches will provide a respective number of counts. Of course, when the sheet has passed the row of balls, the microswitches previously actuated are released and no further counts register until the balls are again lifted. As a consequence, the counter records the total area of the photographic sheets processed.

I claim:

1. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of pho-

tographic material disposed thereon, said means forming said surface being the surface of said roller means, said roller means comprising a plurality of tubular rollers spaced apart along said path and provided with radial bores opening at the surfaces of said rollers, said intake side of said fluid-displacement means communicating with the interiors of said rollers; and

a support frame receivable in said housing and having a pair of uprights carrying said rollers, at least one of said uprights being hollow and forming a duct connecting the interiors of said rollers with said intake side of said fluid-displacement means.

2. The apparatus defined in claim **1**, further comprising drive means including at least one flexible endless element passing about two of said rollers for rotating same.

3. The apparatus defined in claim **1**, further comprising a pair of upright lateral walls flanking said rollers and received in said housing, said walls being formed with bores and with cylindrical sleeves receivable in said bores, said rollers being rotatably mounted on the exteriors of said sleeves and communicating therethrough with said intake side of said fluid-displacement means.

4. The apparatus defined in claim **1** wherein said uprights are formed with downwardly projecting tubular fittings receivable in upwardly open sockets formed at the bottom of said housing and communicating with said intake side of said fluid-displacement means.

5. The apparatus defined in claim **1** wherein said rollers are each subdivided into two portions, each communicating with the interior of a respective hollow upright and connected thereby to said intake side of said fluid-displacement means.

6. The apparatus defined in claim **1** wherein said means for treating said sensitive face with said fluid includes a partition extending substantially parallel to said path and defining a compartment within said housing along a side of said partition opposite that juxtaposed with said path, said partition being perforated, and means connecting said discharge side of said fluid-displacement means with said compartment.

7. The apparatus defined in claim **6** wherein said discharge side is provided with an outlet opening into said compartment, said outlet being formed with a baffle for deflecting fluid parallel to said partition.

8. The apparatus defined in claim **1** wherein said photographic material is to be treated with a number of fluids, said apparatus comprising a plurality of vessels each having such a housing, roller means and surface, said apparatus further comprising deflector means for diverting the photographic material from one housing into the other housing, said deflector means including a roller conveyor disposed above the path of said one housing and leading to the path of said other housing.

9. The apparatus defined in claim **8** wherein said roller conveyor comprises a plurality of shafts lying along an arc between said housing, and a plurality of axially spaced rollers mounted on each shaft with the rollers of adjacent shafts in interdigitating relation.

10. An apparatus for the treatment of photographic material, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon, said roller means including a pair of spaced-apart rollers and said surface being defined by at least one conveyor band extending around said rollers; and

means for displacing one of said rollers relative to the other to tension said band.

11. The apparatus defined in claim **10** wherein said band is preforated.

12. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engagable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon, said roller means including at least one pair of spaced-apart rollers and said surface being formed by an endless perforated conveyor band extending around said rollers; and

stationary support members spaced apart along said path and engaged by said band, said support members opening into the space enclosed by said band, said intake side of said fluid-displacement means communicating with said space through said members.

13. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon, said roller means including at least one pair of spaced-apart rollers and said surface being formed by an endless perforated conveyor band extending around said rollers; said rollers being spaced apart vertically in

said housing, the lowermost roller being tubular; and

openings in said lowermost roller communicating with said intake side of said fluid-displacement means, said lowermost rollers being provided with axially spaced rings freely rotatable thereon and engaging said band.

14. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating wtih said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon;

a conduit connecting said discharge side of said fluid-displacement means with the interior of said housing: and

a valve in said conduit for controlling the fluid-pressure differential across photographic material on said surface.

15. The apparatus defined in claim **14** wherein said roller means includes a pair of rollers spaced apart along said path and said means forming said surface is at least one conveyor belt passing endlessly around said rollers, said apparatus further comprising a pair of vertical lateral walls flanking said belt and defining therewith a first chamber surrounding by said belt and a second chamber between said belt and walls of said housing, at least one of said lateral walls being formed with an opening communicating with said first chamber and connected to said intake side of said fluid-displacement device, one of said lateral walls being formed with a slot extending parallel to said belt and opening into said second chamber while communicating with said discharge side of said fluid-displacement device.

16. The apparatus defined in claim **14** wherein said path has a downwardly extending stretch and an upwardly extending stretch in said housing, said apparatus further comprising deflector means at the bottom of said path diverting the photographic material from said downward stretch into said upward stretch, said deflector means comprising a pair of rollers flanking said path and a third roller disposed therebelow, and an endless deflector band passing around said rollers of said deflecting means for retaining said photographic material against said surface during the transition from said downward stretch to said upward stretch.

17. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon, said housing defining a drying chamber downstream of a system for the chemical treatment of photographic material, said drying chamber having a blower for directing air against said photographic material on said surface and for drawing air from said housing beyond said surface;

cooling means in the path of air circulated by said blower from condensing water therefrom; and

means for collecting the condensed water.

18. The apparatus defined in claim **17** wherein said path is generally U-shaped and said surface is a perforated band extending endlessly around said path, said cooling means being disposed within the space surrounded by said band.

19. The apparatus defined in claim **18,** further comprising a perforated partition extending parallel to said path and closely spaced therefrom, said blower communicating with said housing between said partition and an outer housing wall, the total area of the perforations of said partitions being greater than the area of the perforations of said band.

20. The apparatus defined in claim **17** wherein said drying chamber is provided downstream of a chamber for the liquid treatment of said photographic material with an aqueous solution, said apparatus further comprising means for passing water through said cooling means and thereupon into said treatment chamber.

21. The apparatus defined in claim **16** wherein said drying chamber is provided downstream of a treatment chamber for contacting said photographic material with a liquid, further comprising means for delivering condensed water from said cooling means to said treatment chamber.

22. An apparatus for the treatment of photographic materials, comprising:

a housing;

roller means defining a transport path for a photographic material having a sensitive face and a reverse face;

means forming at least one open-work surface engageable with said reverse face of the photographic material and displaceable to entrain said photographic material along said path;

means for treating said sensitive face with a fluid and including fluid-displacement means having an intake side communicating with said housing on the side of said path opposite said sensitive face and a discharge side communicating with the interior of said surface outwardly of the sensitive face of photographic material disposed thereon;

means downstream of said housing for contacting said photographic material with a stream of drying air subsequent to its treatment with said fluid, the last-mentioned means including:

a blower for the circulation of air,

heating means at a discharge side of said blower for heating the circulated air, and

a cooler at the intake side of said blower for condensing moisture from the circulated air; and

a trough for collecting the condensed moisture.

23. The apparatus defined in claim **22,** further comprising means for passing said fluid through said cooling means prior to admitting same to said housing.

* * * * *