June 1, 1965 G. SCHMIDT 3,186,326

FLUID BEARINGS FOR STRIP MATERIAL

Filed March 28, 1962 2 Sheets-Sheet 1

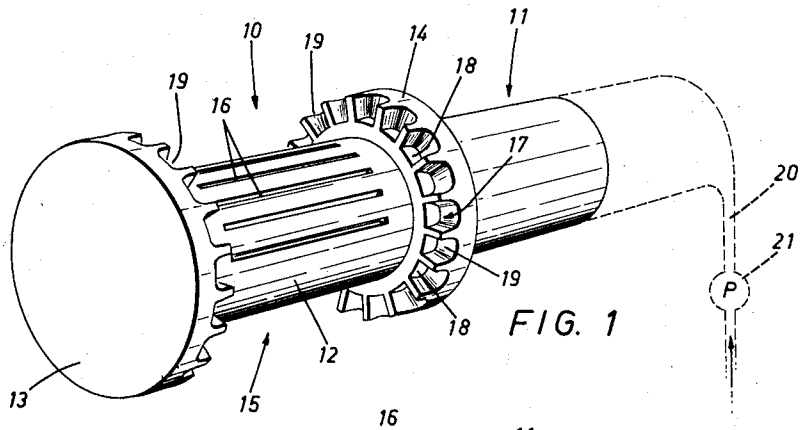


FIG. 1

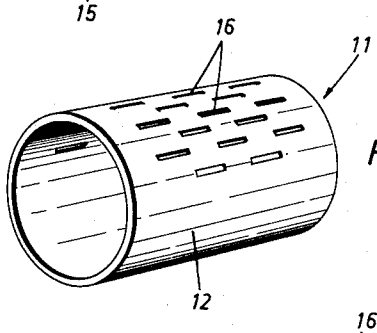


FIG. 2

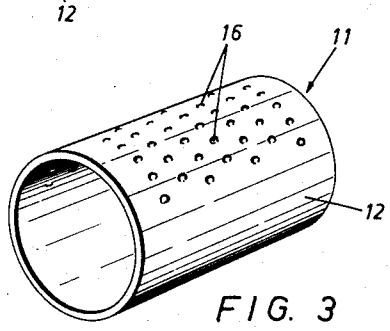


FIG. 3

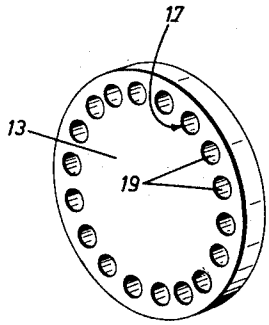


FIG. 4

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FLUID BEARINGS FOR STRIP MATERIAL

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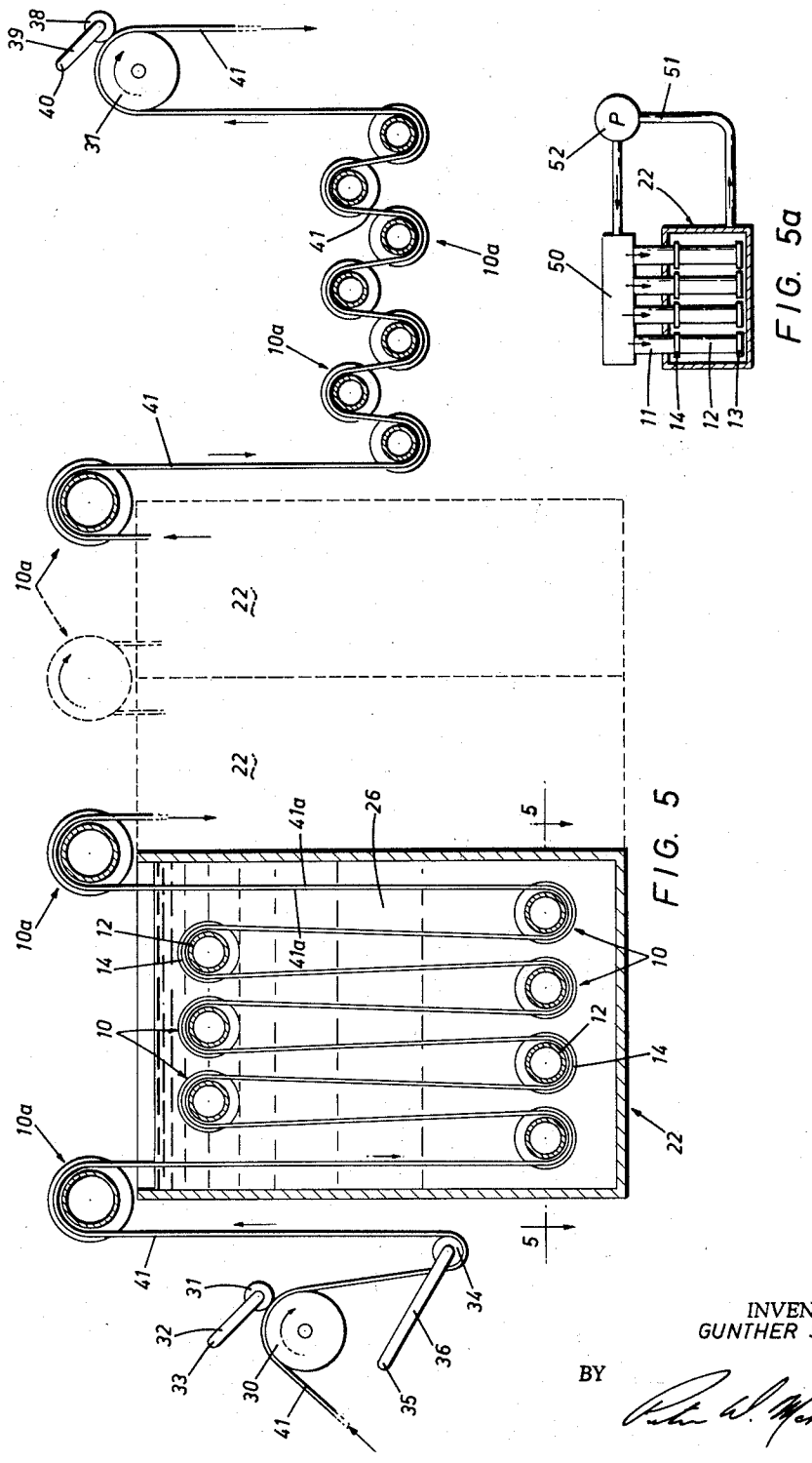


FIG. 5a

FIG. 5

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FLUID BEARINGS FOR STRIP MATERIAL

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This invention relates to fluid bearings for supporting strip material having two major surfaces and two side edges. More particularly, this invention relates to fluid bearings particularly suited for supporting film strip during the processing of the same. This invention also relates to film strip processing apparatus employing fluid bearings.

In the past it has been common practice in the developing of exposed film strip to provide a plurality of tanks each containing a different film processing liquid such as a developing liquid, a stopping liquid, a fixing liquid and a washing liquid. In each tank there have been provided rollers at the top and bottom thereof and immersed in the film processing liquid. Other rollers have been provided between the tanks. The film strip to be processed is guided over these rollers in a generally sinuous path and forms one or more loops in each tank. It has been common practice in the past to drive each of the rollers at the same speed to thereby drive the film strip through the tanks. Apparatus of the aforementioned type is shown in United States Patent No. 2,008,439 dated July 16, 1935, to H. N. Ensign et al., United States Patent No. 2,248,056 dated July 8, 1941, to J. M. Blaney and United States Patent No. 2,651,245 dated September 8, 1953 to A. W. Tondreau.

Such prior art apparatus has numerous disadvantages. One such disadvantage is that the rotating rollers tend to scratch and mar the surface of the wet film strip, this being especially true if all of the rollers are not driven at precisely the same speed, this being a very difficult criterion to meet.

Accordingly, it is one object of my invention to provide fluid bearings for supporting strip material such as film strip and which precludes any engagement between the major surfaces of the film strip and the fluid bearings.

It is another object of my invention to provide fluid bearings which are adapted to preclude any marring or scratching of the major surfaces of film strip.

Yet another object of my invention is to provide film strip processing apparatus employing fluid bearings, the apparatus being designed such that there is no contact between the major surfaces of the film strip and any solid object during processing of the film strip while it is wet.

A further disadvantage of prior art apparatus of the type hereinbefore described is that if there is any speed differential between the rotating rollers, the film strip tends to be unduly stressed in tension causing undesirable image distortion.

Accordingly it is another object of my invention to provide fluid bearings for transporting film strip which prevent image distortion due to excess tensioning of the film strip during processing thereof.

Still another disadvantage of many prior art types of film processing apparatus of the type hereinbefore mentioned is the lack of agitation of the film processing liquids.

Accordingly another object of my invention is to provide film processing apparatus employing fluid bearings and in which the film processing liquids are continuously agitated so that fresh recirculated liquid continuously is being brought into contact with the film strip.

Still another disadvantage of prior art film processing apparatus of the type hereinbefore described is that the rollers rather than the film strip determine the path that

the film strip is to take. This becomes extremely objectionable where thin base film strip is being employed, and the axis of one or more of the rollers is slightly off-line. The result of such misalignment will be that the thin base film strip will tend to track to one edge of each misaligned roller where it will bunch up.

Accordingly it is still another object of my invention to provide film processing apparatus in which the film strip determines its own path through the apparatus.

In brief, a fluid bearing embodying my invention is adapted to support strip material such as film strip having two major surfaces and two side edges. The bearing comprises a member having an outer surface and two spaced apart flange members. The flange members and the outer surface define a strip material receiving channel which is adapted to receive the strip material with both major surfaces thereof lying across the strip material receiving channel and both side edges thereof adjacent the flange members. The member having the outer surface has channels therein which are in fluid flow relationship with the strip material receiving channel. Fluid bleeding means are provided in the flange members for bleeding fluid from the strip material receiving channel. The fluid bleeding means terminate in inlets through which fluid from the strip material receiving channel passes into the fluid bleeding means. The inlets are positioned spaced from and above the outer surface of the bearing. The inlets and the fluid bleeding means thereby communicate in fluid flow relationship with the strip material receiving channel at points spaced from and above the outer surface of the bearing.

In the operation of such a fluid bearing, means are provided for supplying fluid under pressure to the channels in the member, this fluid passing through these channels into the strip material receiving channel and raising the film strip above the outer surface. At least a part of the fluid in the strip material receiving channel is exhausted therefrom through the fluid bleeding means.

Fluid bearings and film processing apparatus employing such fluid bearings all embodying my invention will become more apparent from the following detailed description taken in conjunction with the drawings in which:

FIGURE 1 shows in perspective one embodiment of a fluid bearing constructed in accordance with my invention;

FIGURES 2 and 3 depict alternative members which may be used in fluid bearings embodying my invention;

FIGURE 4 shows an alternative type of flange member;

FIGURE 5 is a section through film processing apparatus embodying my invention; and

FIGURE 5*a* is a section of part of the apparatus shown in FIGURE 5 taken along line 5—5.

Referring first to FIGURE 1, I have shown a fluid bearing **10** which includes a tube **11** having a curved surface **12** and a hollow interior. Secured to tube **11** are two spaced apart flange members **13** and **14**, flange member **13** being in the form of a cap which seals one end of tube **11**, and flange member **14** being in the form of an annulus. While flange members **13** and **14** are shown as extending completely around tube **11**, as will become more apparent hereinafter, it is only necessary that these flange members should each extend part-way around tube **11**. Flange members **13** and **14** together with outer surface **12** define a film strip receiving channel **15** which is adapted to receive a film strip therein with both major surfaces of the film strip lying across channel **15** and both side edges of the film strip being adjacent flange members **13** and **14**, as will be more readily apparent from a consideration of FIGURE 5. Ideally, the spacing between flange members **13** and **14** should be only slightly greater than the width of the film strip between the side edges thereof. Tube **11** has channels **16** therein which

connect film strip receiving channel 15 and the interior of tube 11 in fluid flow relationship. In the embodiment of my invention shown in FIGURE 1, channels 16 are in the form of slots which extend almost completely across film strip receiving channel 15, these slots being equally spaced from each other. It will be noted that channels 16 are provided only around a part of the circumference of tube 11.

Provided in each of flange members 13 and 14 are fluid bleeding channels 17 which communicate in fluid flow relationship with film strip receiving channel 15 remote from curved surface 12 as at inlets 18 which are spaced from and positioned above surface 12. Channels 17 exhaust away from film strip receiving channel 15 through outlets 19.

A fluid under pressure is supplied to the interior of tube 11 through a pipe 20 and a pump 21 having its inlet connected to any suitable reservoir (not shown) of the fluid.

In the operation of fluid bearing 10, the film strip is positioned in film strip receiving channel 15 in the manner hereinbefore noted, and fluid supplied to the interior of tube 11 under pressure through pump 21 and pipe 20 is injected into film strip receiving channel 15 beneath the film strip through channels 16. The fluid so supplied to film strip receiving channel 15 raises the film strip above outer surface 12, and the film strip is thus supported above outer surface 12 on a cushion of fluid. As the film strip is so raised above outer surface 12 it will eventually become aligned with inlets 18 of fluid bleeding channels 17, at which point the fluid in channel 15 beneath the film strip will escape through fluid bleeding channels 17 and will be exhausted away from channel 15 through outlets 19. It will be appreciated, of course, that in order for the film strip not to be forced completely out of channel 15, it is necessary for a slight amount of tension to be exerted on the film strip on opposite sides of the bearing, this tension being just sufficient to retain the film strip in the channel 15.

An alternative form of tube 11 is shown in FIGURE 2. This tube is provided with channels 16 which, instead of being in the form of slots extending across outer surface 12 between flange members 13 and 14, are in the form of shorter slots 16. It will be noted that the slots 16 in any one row are positioned where gaps are located in each adjacent row of slots 16 so that fluid is injected into film strip receiving channel 15 over the whole of outer surface 12.

In the embodiment of my invention shown in FIGURE 3, tube 11 is provided with channels 16 which are in the form of circular openings. The position of circular openings 16 is, as in the case of slots 16 in FIGURE 2, such that the gaps between the openings in any one row are filled in another row.

An alternative type of flange member 13 is shown in FIGURE 4. In this flange member fluid bleeding channels 17 are in the form of circular channels which extend through flange 13 and which are remote from outer surface 12. Each channel has an outlet 19 and an inlet which is positioned opposite the outlet 19 on the inside of flange member 13.

Turning now to FIGURE 5, I have shown a plurality of tanks 22, only one of which is shown in detail. Generally there are four such tanks and these contain a developing liquid, a stopping liquid, a fixing liquid and a washing liquid respectively. Positioned in each tank, but only shown in the tank 22 shown in detail are a plurality of fluid bearings 10 of the type hereinbefore described in connection with FIGURE 1, some of the bearings 10 being positioned at the top of each tank 22 just below the level of the liquid 26 therein, while others of the bearings 10 are positioned in a row adjacent the bottom of each tank 22. Fluid bearings 10 in the tanks will hereinafter be referred to as liquid bearings. A gas bearing 10*a* of the type shown in FIGURE 1 is positioned outside each of tanks 22. A rotatable driven roller 30 driven by any suitable mechanism (not shown) is provided together with a rotatable pressure roller 31 mounted on an arm 32 pivoted at 33. Also provided is a film tension roller 34 pivotably mounted at 35 on an arm 36. Following tanks 22 are a plurality of gas bearings 10*a* of the type shown in FIGURE 1. Following these gas bearings 10*a* is a rotatable driven take-out roller 37, and a pressure roller 38 which is rotatably mounted on an arm 39 pivoted at 40. It will be appreciated, of course, that all of the equipment shown in FIGURE 5 is housed in a light-tight housing.

Film strip 41 to be developed is led from a suitable magazine (not shown), over driven roller 30 between roller 30 and pressure roller 31, over tension roller 34 and over the first gas bearing 10*a*. Film strip 41 extends sinuously part of the way around each liquid and gas bearing with its major surfaces 41*a* lying across channels 15 thereof as shown in FIGURE 5 and finally is passed over roller 37 between this roller and pressure roller 38. On delivery from take-out roller 37, the now processed film strip 41 is wound up on a suitable reel (not shown).

Film strip 41 passes sequentially through tanks 22 where the image thereon is developed in a well known manner. During passage of film strip 41 through each of tanks 22 the film processing liquid in the respective tank is passed into the interior of tubes 11 of the liquid bearings 10 in the tank and maintains film strip 41 out of contact with the curved surfaces 12 of liquid bearings 10. As best seen in FIGURE 5*a*, a header 50 is connected in fluid flow relationship with each liquid bearing 10 in a tank 22, and liquid from the tank is pumped through pipes 51 and a pump 52 into header 50, thereby establishing a continuous circulation system. One such system is provided for each tank 22. It will be noted that the liquid in question is continuously agitated, and that fresh recirculated liquid is continuously brought into contact with film strip 41. In addition, by a pump and header system air under pressure is passed into the hollow interiors of tubes 11 of gas bearings 10*a* and maintains film strip 41 out of contact with curved surfaces 12 thereof. During passage of film strip 41 through the plurality of gas bearings following tanks 22 heated air from any suitable source and under pressure is forced into the hollow interiors of tubes 11 of these air bearings, and not only serves to support the film strip 41 above the curved surfaces 12 of these air bearings, but also serves the purpose of drying film strip 41. Thus it will be noted that during the complete processing operation film strip 41 only contacts solid objects at the beginning and end of the processing operation, and this is not objectionable because the film strip is dry at these points. Thus there is no possibility of there being any scratching or marring of the surface of the film strip when it is wet, and in addition the problem of image distortion caused by rollers rotating at different speeds is obviated.

Tension roller 34 maintains a constant tension on film strip 41 and thus maintains the film strip in the film strip receiving channels 15. Pressure rollers 31 and 38 are provided to ensure good contact between the film strip and rollers 30 and 37 respectively. In the event that the loop around film tension roller 34 should become too short, automatic means (not shown) are provided to increase the speed of driven roller 30, thereby lengthening the loop, but take-out roller 37 is always driven at a constant speed.

While I have described certain preferred embodiments of my invention, it will be appreciated by those skilled in the art that various changes, alterations and modifications may be made thereto without departing from the spirit and scope of my invention.

What I claim as my invention is:

1. A fluid bearing for supporting strip material having two major surfaces and two side edges, said bearing comprising a member having an outer surface, two spaced

apart flange members, said flange members and said outer surface defining a strip material receiving channel adapted to receive said strip material with both major surfaces thereof lying across said strip material receiving channel and both side edges thereof adjacent said flange members, said member having first channels therein in fluid-flow relationship with said strip material receiving channel, and spaced apart fluid bleeding means provided in said flange members for bleeding fluid from said strip material receiving channel, said fluid bleeding means terminating in inlets through which fluid from said strip material receiving channel passes into said fluid bleeding means, said inlets being positioned spaced from and above said outer surface, said inlets and said fluid bleeding means thereby communicating in fluid-flow relationship with said strip material receiving channel at points spaced from and above said outer surface.

2. A fluid bearing according to claim **1** including means for supplying fluid under pressure to said first channels, said fluid passing through said first channels into said strip material receiving channel.

3. A fluid bearing according to claim **2** wherein said first channels are slots extending substantially across said strip material receiving channel.

4. A fluid bearing according to claim **2** wherein the spacing between said flange members is substantially equal to the width of said strip material between said side edges thereof.

5. A fluid bearing according to claim **2** wherein said fluid bleeding means comprise second channels in said flange members, the sides of said second channels adjacent said strip material receiving channel being open to said strip material receiving channel.

6. A fluid bearing according to claim **2** wherein said outer surface is curved.

7. A fluid bearing according to claim **2** wherein said member is a tube, said first channels communicate in fluid-flow relationship with the interior of said tube, and said fluid is supplied to said first channels through the interior of said tube.

8. A fluid bearing according to claim **7** wherein the spacing between said flange members is substantially equal to the width of said strip material between said side edges thereof, and said fluid bleeding means comprise second channels in said flange members, said second channels exhausting away from said strip material receiving channel, the sides of said second channels adjacent said strip material receiving channel being open to said strip material receiving channel.

9. A fluid bearing according to claim **1** wherein said member is a tube and said first channels communicate in fluid-flow relationship with the interior of said tube.

10. A fluid bearing according to claim **9** wherein said fluid bleeding means comprise second channels in said flange members, the sides of said second channels adjacent said strip material receiving channel being open to said strip material receiving channel.

11. A fluid bearing according to claim **10** wherein the spacing between said flange members is substantially equal to the width of said strip material between said side edges thereof.

12. A fluid bearing according to claim **11** wherein said first channels are slots extending substantially across said strip material receiving channel.

13. A fluid bearing for supporting film strip and the like having two major surfaces and two side edges, said bearing comprising a tube having a curved outer surface, two spaced apart flange members secured to said tube and each extending at least part way around said tube, said flange members and said outer surface defining a film strip receiving channel adapted to receive said film strip with both major surfaces thereof lying across said film strip receiving channel and both side edges thereof adjacent said flange members, the spacing between said flange members being substantially equal to the width of said film strip between said side edges thereof, said tube having first channels therein connecting said film strip receiving channel and the interior of said tube in fluid flow relationship, and fluid bleeding means comprising spaced apart second channels in said flange members for bleeding fluid from said film strip receiving channel, said second channels terminating in inlets through which fluid from said film strip receiving channel passes into said second channels, said inlets being positioned spaced from and above said outer surface, said inlets and said second channels thereby communicating in fluid-flow relationship with said film strip receiving channel at points spaced from and above said outer surface, said second channels exhausting away from said film strip receiving channel, the sides of said second channels adjacent said film strip receiving channel being open to said film strip receiving channel.

14. A fluid bearing according to claim **13** including means for supplying fluid under pressure to said interior of said tube, said fluid passing through said first channels into said film strip receiving channel.

15. Film strip processing apparatus comprising a tank containing a film strip processing liquid, at least one liquid bearing positioned in said liquid, said bearing comprising a member having an outer surface in contact with said liquid, two spaced apart flange members, said flange members and said outer surface defining a film strip receiving channel, said member having first channels therein communicating in fluid-flow relationship with said film strip receiving channel, and spaced apart liquid bleeding means provided in said flange members for bleeding liquid from said film strip receiving channel, said liquid bleeding means terminating in inlets through which liquid from said film strip receiving channel passes into said liquid bleeding means, said inlets being positioned spaced from and above said outer surface, said inlets and said liquid bleeding means thereby communicating in fluid-flow relationship with said film strip receiving channel at points spaced from and above said outer surface, a film strip having two major surfaces and two side edges, said film strip being positioned in said film strip receiving channel over said first channels with both said major surfaces lying across said film strip receiving channel and both said side edges adjacent said flange members, and means for supplying said liquid under pressure to said first channels, said liquid under pressure passing through said first channels into said film strip receiving channel and raising said film strip above said outer surface, at least a part of said liquid in said film strip receiving channel passing into said tank through said liquid bleeding means.

16. Film strip processing apparatus comprising a plurality of tanks each containing a different film strip processing liquid, at least one liquid bearing positioned in each of said tanks in the liquids therein, at least one gas bearing positioned outside each of said tanks, said liquid bearings each comprising a first member having a first outer surface in contact with said liquid in said tank, two spaced apart first flange members, said first flange members and said first outer surface defining a first film strip receiving channel, said first member having first channels therein in fluid-flow relationship with said first film strip receiving channel, and spaced apart liquid bleeding means provided in said first flange members for bleeding liquid from said first film strip receiving channel, said liquid bleeding means terminating in first inlets through which liquid from said first film strip receiving channel passes into said liquid bleeding means, said first inlets being positioned spaced from and above said first outer surface, said first inlets and said liquid bleeding means thereby communicating in fluid-flow relationship with said first film strip receiving channel at points spaced from and above said first outer surface, each said gas bearing comprising a second member having a second outer surface, two spaced apart second flange members, said second

flange members and said second outer surface defining a second film strip receiving channel, said second member having second channels therein communicating in fluid-flow relationship with said second film strip receiving channel, and spaced apart gas bleeding means provided in said second flange members for bleeding gas from said second film strip receiving channel, said gas bleeding means terminating in second inlets through which gas from said second film strip receiving channel passes into said gas bleeding means, said second inlets being positioned spaced from and above said second outer surface, said second inlets and said gas bleeding means thereby communicating in fluid-flow relationship with said second film strip receiving channel at points spaced from and above said second outer surface, a film strip having two major surfaces and two side edges, said film strip sinuously extending part of the way around said liquid and gas bearings and between said liquid and gas bearings, said film strip being adapted to travel sequentially through said tanks and passing over at least one of said gas bearings between each of said tanks, said film strip being positioned in said film strip receiving channels over said first and second channels with both said major surfaces of said film strip lying across said said film strip receiving channels and both said side edges of said film strip adjacent said flange members, means for supplying the respective liquid in each tank under pressure to said first channels of said liquid bearing in the respective tank, said liquid under pressure passing through said first channels into said first film strip receiving channel and raising said film strip above said first outer surface, at least a part of said liquid in said first film strip receiving channel being exhausted from said first film strip receiving channel through said liquid bleeding means, and means for supplying a gas under pressure to said second channels, said gas under pressure passing through said second channels into said second film strip receiving channel and raising said film strip above said second outer surface, at least a part of said gas in said second film strip receiving channel being exhausted through said gas bleeding means.

17. Apparatus according to claim 16 wherein there are at least four of said tanks, said tanks containing developing liquid, stopping liquid, fixing liquid and washing liquid respectively and said gas is air.

18. Apparatus according to claim 16 wherein the spacing between said flange members is substantially equal to the width of said film strip between said side edges thereof, said liquid bleeding means comprise third channels in said first flange members, the sides of said third channels adjacent said first film strip receiving channel being open to said first film strip receiving channel, said third channels exhausting away from said first film strip receiving channel, and said gas bleeding means comprise fourth channels in said second flange members, the sides of said fourth channels adjacent said second film strip receiving channel being open to said second film strip receiving channel, said fourth channels exhausting away from said second film strip receiving channel.

19. Apparatus according to claim 16 wherein said first member is a first tube, said first channels communicate in fluid flow relationship with the interior of said first tube and said liquid under pressure is supplied to said first channels through the interior of said first tube, and wherein said second member is a second tube, said second channels communicate in fluid-flow relationship with the interior of said second tube and said gas under pressure is supplied to said second channels through the interior of said second tube.

20. Apparatus according to claim 19 wherein there are at least four of said tanks, said tanks containing developing liquid, stopping liquid, fixing liquid and washing liquid respectively and said gas is air, and wherein the spacng between said flange members is substantially equal to the width of said film strip between said side edges thereof, said liquid bleeding means comprise third channels in said first flange members, the sides of said third channels adjacent said first film strip receiving channel being open to said first film strip receiving channel, said third channels exhausting away from said first film strip receiving channel, and said gas bleeding means comprise fourth channels in said second flange members, the sides of said fourth channels adjacent said second film strip receiving channel being open to said second film strip receiving channel, said fourth channels exhausting away from said second film strip receiving channel.

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