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APPARATUS FOR TRANSPORTING FILM STRIPS ON A FLUID CUSHION

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2 Sheets-Sheet 2

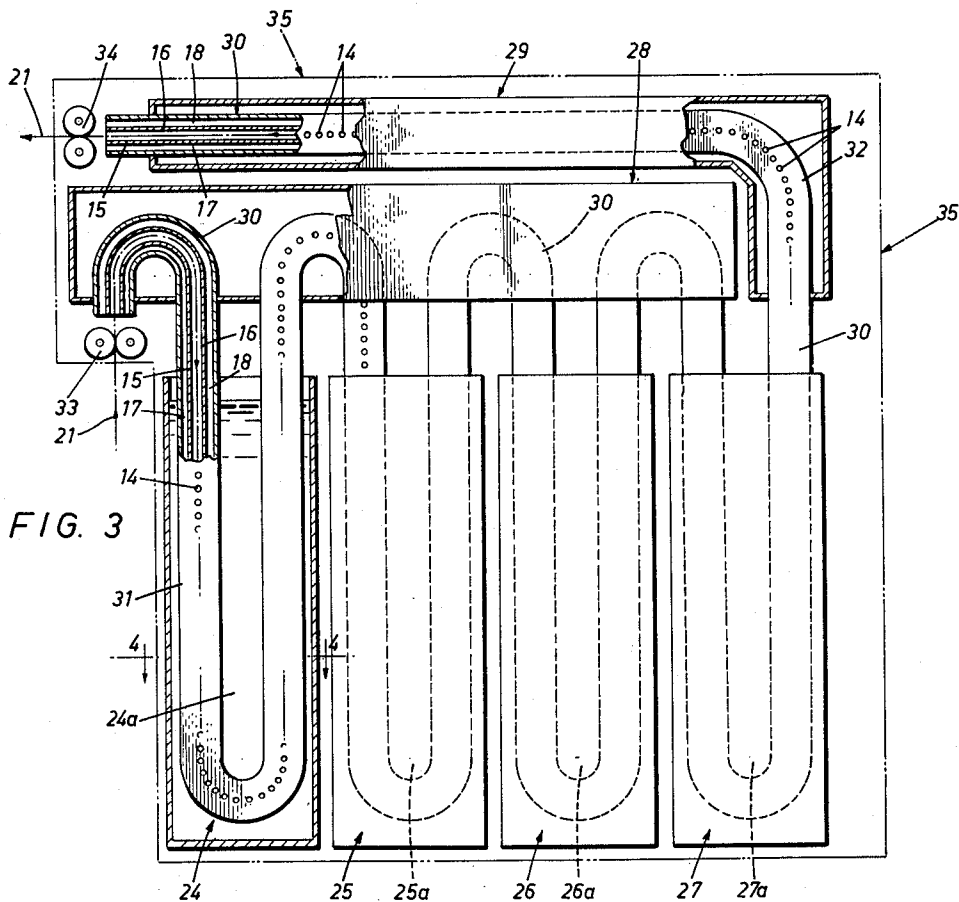


FIG. 3

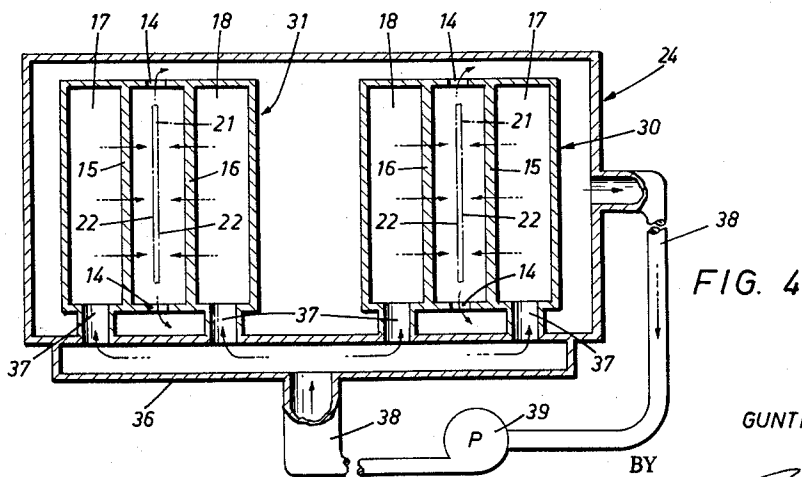


FIG. 4

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APPARATUS FOR TRANSPORTING FILM STRIPS ON A FLUID CUSHION

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This invention relates to apparatus for transporting strip material having two side edges and two major surfaces. More particularly, this invention relates to apparatus especially suited for transporting film strip during processing of the film strip to develop and dry the same. Even more particularly, this invention relates to apparatus useful for transporting film strip or the like during developing and drying of the same which are such that the film strip does not contact any solid object during processing of the film strip while it is wet.

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 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 apparatus for transporting film strip which, during the whole processing of the film strip, precludes any engagement between the major surfaces of the film strip and any solid object while the film strip is wet.

It is another object of my invention to provide apparatus for transporting film strip which does away with the use of rotating or rotatable rollers and which precludes any marring or scratching of the major surfaces of the film strip.

It is another object of my invention to provide apparatus for transporting film strip between two cushions of fluid, one cushion being formed adjacent each major surface of the film strip.

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

Accordingly, it is another object of my invention to provide apparatus for transporting film strip which prevents image distortion due to excess tensioning of the film strip.

Prior art types of film processing apparatus require that a leader be attached to the film strip and threaded through the apparatus. This is objectionable because of the time involved in the threading operation, to say nothing of the time involved in rethreading if the leader should break. Accordingly it is yet another object of my invention to provide apparatus for transporting film

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strip during processing of the same which does not require the employment of leaders.

It is yet another object of my invention to provide film processing apparatus which is self-threading.

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

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

15 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 this misalignment is that the thin base film strip tends to track to one edge of each misaligned roller and bunch up.

20 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.

25 In brief, apparatus for transporting strip material embodying my invention comprises two spaced apart side walls which define a strip material receiving space therebetween. The side walls each have a plurality of openings extending therethrough along the length thereof. The strip material is positioned in the space with both major surfaces of the strip material extending across the space and with both edges of the strip material adjacent the side walls. Means are provided for introducing a fluid into the space and for directing the fluid against 30 both major surfaces of the strip material with sufficient force to maintain the strip material suspended in the space with the edges adjacent the side walls, the fluid being expelled from the space through the openings.

My invention will become more apparent from the following detailed description taken in conjunction with the drawings in which:

FIGURE 1 shows in perspective apparatus embodying my invention;

FIGURE 2 is a perspective view of an alternative embodiment of my invention;

FIGURE 3 is a schematic side elevation of film processing apparatus embodying my invention; and

FIGURE 4 shows in detail part of the apparatus shown in FIGURE 3.

50 Turning now to FIGURE 1, I have shown a part of one embodiment of strip material transporting apparatus constructed in accordance with my invention. This apparatus includes a generally rectangular side-enclosed housing 10 which defines a compartment 11, housing 10 having two sets of oppositely disposed spaced apart side walls 12 and 13, these side walls defining compartment 11. Housing 10 has a plurality of openings 14 extending through both of side walls 13 along the length of the housing and positioned midway between side walls 12. 55 Two plates 15 and 16 are positioned in compartment 11 with plate 15 being on one side of openings 14 and plate 16 being on the other side of openings 14. Plates 15 and 16 extend along the length of housing 10 and divide compartment 11 into two header compartments 17 and 18 and a film strip receiving compartment 19 positioned between header compartments 17 and 18. Plates 15 and 16 each have apertures 20 extending therethrough and spaced evenly apart along the length thereof. Apertures 20 connect header compartments 17 and 18 in fluid flow relationship with film strip receiving compartment 19. On the 60 other hand, openings 14 establish a fluid flow relationship

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between film strip receiving compartment 19 and the exterior of housing 10.

A film strip 21 having two major surfaces 22 and two edges 23 is positioned in film strip receiving compartment 19 with both major surfaces 22 extending across film strip receiving compartment 19 and both edges 23 adjacent side walls 13. Means which are not shown in FIGURE 1 are provided for introducing a fluid into header compartments 17 and 18. The pressure of the fluid introduced into header compartments 17 and 18 is sufficiently great that the fluid is directed through apertures 20 in plates 15 and 16 against both major surfaces 22 of film strip 23 with sufficient force to maintain major surfaces 22 in the position shown in FIGURE 1 where they are away from engagement with plates 15 and 16 and suspended on cushions of fluid. In this manner film strip 23 is suspended between plates 15 and 16 with edges 23 adjacent side walls 13. The fluid introduced into film strip receiving compartment 19 through apertures 20 in plates 15 and 16 is expelled from film strip receiving compartment 19 through openings 14 as shown by the arrows in FIGURE 1.

It will be noted that apertures 20 are at 90° with respect to major surfaces 22 of film strip 21. Consequently, if housing 10 were horizontal rather than vertical, unless there were some pull exerted on film strip 21 to move it through housing 10, film strip 21 would remain substantially stationary in compartment 19 where it would be supported on cushions of fluid formed adjacent each major surface 22. On the other hand, with the embodiment of my invention which is shown in FIGURE 2, and which differs from that shown in FIGURE 1 only in that slots 20 are inclined in the direction of travel of film strip 21, the fluid passing through inclined slots 20 has a component of motion in the direction of travel of film strip 21, and consequently the fluid serves not only the function mentioned in connection with FIGURE 1 of supporting the film strip 21 between plates 15 and 16, but also actually drives the film strip in its direction of travel, i.e. downwardly in FIGURE 2.

Turning now to FIGURE 3, I have shown four reservoir tanks 24, 25, 26 and 27. These tanks contain developing liquid 24a, stopping liquid 25a, fixing liquid 26a and washing liquid 27a respectively. Positioned above these tanks are two other tanks 28 and 29 which contain air and heated air respectively. A housing 10 of the type shown in FIGURES 1 or 2 extends through each of tanks 24-29 inclusive, housing 10 having portions 30 in tank 28, portions 31 in tanks 24-27 inclusive and a portion 32 in tank 29. Portions 30 and 31 of housing 10 are generally U-shaped, and portions 32 are oppositely disposed with respect to portions 30. These portions 30 and 31 form a generally sinuous housing 10 and film strip receiving compartment 19. As will become more apparent hereinafter, the function of portions 30 is to join adjacent ones of portions 31. As used herein the term "adjacent" does not necessarily mean physically adjacent, but rather means adjacent in terms of the steps of the process to be carried out in the apparatus. Positioned adjacent the entrance of the first portion 30 are two driven rollers 33, and positioned adjacent the outlet of portion 32 are two other driven rollers 34. All of the foregoing components are housed in a light-tight housing 35.

Referring now to FIGURE 4, I have shown in greater detail reservoir tank 24 and the portion 31 of housing 10 therein. Since the other reservoir tanks 25-27 are the same as tank 24, the detailed description of this latter tank will suffice as a description of all the tanks. It will be noted that tank 24 is provided with a header 36. Header 36 is connected through a plurality of pipes 37 extending through reservoir tank 24 to header compartments 17 and 18 of portion 31 of housing 10. Piping 38 is connected between reservoir tank 24 and header 36 with a pump 39 being connected in this piping.

A similar system to that shown in FIGURE 4 is provided

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for tank 28 to permit air to be forced into header compartments 17 and 18 of portions 30, but in this case there is no need to recirculate, and consequently tank 28 can be permitted to exhaust to the atmosphere. Similarly tank 29 is provided with a header (not shown) which is connected through pipes (not shown) to header compartments 17 and 18 of portion 32 of housing 10, this air supplied to the header being exhausted to the atmosphere from tank 29 and being supplied to the header of tank 29 by any suitable means acting as a source of heated air under pressure.

In utilizing the apparatus shown in FIGURES 3 and 4, one end of film strip 21 is passed between rotating rollers 33 which drive the film strip 21 into the first of portions 30. In the manner hereinbefore described in detail, film strip 21 is maintained in film strip receiving compartment 19 in the first portion 30 by means of the air under pressure which is directed from the header of tank 29 through pipes into header compartments 17 and 18, through apertures 20, against major surfaces 22 of film strip 21 and thence out openings 14 to tank 28 where the air is exhausted to the atmosphere. Subsequently film strip 21 enters portion 31 of housing 10 in tank 24 and passes therethrough with a cushion of developing liquid adjacent each major surface 22. The film strip threads itself completely through the portions 30 and 31 and then enters portion 32 where it is supported in the film strip receiving compartment 19 in portion 32 by heated air which effects drying of the film strip. After threading itself through portion 32, film strip 21 passes between driven rollers 34 and is wound up on a suitable reel (not shown). It should be noted that it is not objectionable for the film strip to engage rollers 33 and 34 because the film strip is dry during engagement with such rollers. After the film strip 21 becomes engaged with rollers 34, rollers 33 spring apart and release their grip on film strip 21. Rollers 34 then serve to meter the flow of film strip 21 and preclude the film strip from passing through the apparatus too quickly. It will be seen from the foregoing that in using film strip processing apparatus embodying my invention there is no necessity to employ a leader, and that the film strip threads itself through the apparatus. Furthermore, it will be noted that the film strip never comes into contact with any solid object such as a roller when it is wet. Therefore, there can be no image distortion or scratching or marring of the major surfaces of the film strip.

It will be appreciated, of course, that rather than supplying air under positive pressure to headers 17 and 18 of portions 30, my invention may be practised by connecting a vacuum pump to tank 28, and hence supplying air to these headers by reason of the negative pressure created at apertures 14 which will draw air into headers 17 and 18, through plates 15 and 16 and into compartment 19.

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. Apparatus for transporting strip material having two major surfaces and two side edges, said apparatus comprising two spaced apart side walls defining a strip material receiving space therebetween, said side walls each having a plurality of openings extending therethrough along the length thereof, said strip material being positioned in said space within the confines of said side walls with both major surfaces of said strip material extending across said space and both side edges of said strip material adjacent the openings in said side walls, and means for introducing a fluid into said space and directing said fluid against both of said major surfaces of said strip material with sufficient force to maintain said strip material suspended in said space with said edges adjacent the openings in said side walls, said fluid being expelled from said

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space within the confines of said side walls through said openings.

2. Apparatus for transporting strip material having two major surfaces and two side edges, said apparatus comprising a housing defining a compartment, said housing having a plurality of openings extending through two oppositely disposed spaced apart side walls of said housing along the length of said housing, two plates positioned one above and one below said openings, said plates being spaced from said openings and extending along the length of said housing and dividing said compartment into two header compartments and a strip material receiving compartment positioned between said header compartments, said plates each having apertures extending therethrough along the length thereof, said apertures connecting said header compartments and said strip material receiving compartment in fluid flow relationship, said openings establishing a fluid flow relationship between said strip material receiving compartment and the exterior of said housing, said strip material being positioned in said strip material receiving compartment within the confines of said side walls with both major surfaces of said strip material extending across said strip material receiving compartment and both edges of said strip material adjacent the openings in said side walls, and means for introducing a fluid into said header compartments, said fluid being directed through said apertures against both of said major surfaces of said strip material with sufficient force to maintain said major surfaces of said strip material away from engagement with said plates and said strip material suspended between said plates within the confines of said side walls and with said edges adjacent the openings in said side walls, said fluid being expelled from said strip material receiving compartment through said openings.

3. Apparatus according to claim 2 wherein at least some of said apertures are inclined in the direction of travel of said strip material.

4. Apparatus according to claim 2 wherein at least some of said apertures are at an angle of substantially 90° to said major surfaces of said strip material.

5. Apparatus for transporting strip material having two major surfaces and two side edges, said apparatus comprising a generally rectangular housing having two sets of oppositely disposed spaced apart side walls defining a compartment, said housing having a plurality of openings extending through both of one set of said side walls along the length of said housing and positioned substantially mid-way between the other set of said side walls, two plates spaced from said openings and positioned one on one side and the other on the other side of said openings and between said other set of side walls, said plates extending along the length of said housing and dividing said compartment into two header compartments and a strip material receiving compartment positioned between said header compartments, said plates each having apertures extending therethrough along the length thereof, said apertures connecting said header compartments and said strip material receiving compartment in fluid flow relationship, said openings establishing a fluid flow relationship between said strip material receiving compartment and the exterior of said housing, said strip material being positioned in said strip material receiving compartment within the confines of said one set of side walls with both major surfaces of said strip material extending across said strip material receiving compartment and both edges of said strip material adjacent the openings in said one set of side walls, and means for introducing a fluid into said header compartments, said fluid being directed through said apertures against both of said major surfaces of said strip material with sufficient force to maintain said major surfaces of said strip material away from engagement with said plates within the confines of said one set of side walls and said strip material suspended between

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said plates with said edges adjacent the openings in said one set of side walls, said fluid being expelled from said strip material receiving compartment through said openings.

6. Film strip processing apparatus comprising a housing defining a film strip receiving compartment and having first portions and second portions, said second portions joining adjacent ones of said first portions, said film strip receiving compartment being defined by and said housing comprising two spaced apart side walls each having a plurality of openings extending therethrough along the length thereof, said film strip being positioned in said compartment within the confines of said side walls with both major surfaces of said film strip extending across said compartment and both edges of said film strip adjacent the openings in said side walls, means for introducing film processing liquid into said first portions of said housing and directing said liquid against both of said major surfaces of said film strip with sufficient force to maintain said film strip suspended in said first portions of said housing within the confines of said one set of side walls and with said edges adjacent the openings in said side walls of said first portions of said housing, and means for introducing a gas into said second portions of said housing and directing said gas against both of said major surfaces of said film strip with sufficient force to maintain said film strip suspended in said second portions of said housing within the confines of said side walls and with said edges adjacent the openings in said side walls of said second portions of said housing, said liquid being expelled from said film strip receiving compartment of said first portions of said housing through said openings in said side walls of said first portions of said housing, said gas being expelled from said film strip receiving compartment of said second portions of said housing through said openings in said side walls of said second portions of said housing.

7. Apparatus according to claim 6 wherein said housing has a third portion following said first and said second portions for drying said film strip after processing in said first portions, and means for introducing a gas into said third portion of said housing and directing said gas against both of said major surfaces of said film strip with sufficient force to maintain said film strip suspended in said third portion of said housing within the confines of said housing and with said edges adjacent the openings in said side walls of said third portion of said housing, said last-mentioned gas being expelled from said film strip receiving compartments of said third portion of said housing through said openings in said side walls of said third portion of said housing.

8. Apparatus according to claim 7 wherein there are at least four of said first portions of said housing, said liquid is developing liquid, stopping liquid, fixing liquid and washing liquid respectively, one of said liquids being introduced into each of said first portions of said housing, and wherein said gas is air and said last-mentioned gas is heated air.

9. Apparatus according to claim 7 wherein said first and second portions of said housing are generally U-shaped, said first portions being oppositely disposed with respect to said second portions, said first and second portions defining a generally sinuous film strip receiving compartment, wherein there are at least four of said first portions of said housing, said liquid is developing liquid, stopping liquid, fixing liquid and washing liquid respectively, one of said liquids being introduced into each of said first portions of said housing, and wherein said gas is air and said last-mentioned gas is heated air.

10. Apparatus according to claim 6 wherein there are at least four of said first portions of said housing, said liquid is developing liquid, stopping liquid, fixing liquid and washing liquid respectively, one of said liquids being introduced into each of said first portions of said housing,

11. Apparatus according to claim 6 wherein said gas is air.

12. Apparatus according to claim 6 wherein said first and second portions of said housing are generally U-shaped, said first portions being oppositely disposed with respect to said second portions, said first and second portions defining a generally sinuous film strip receiving compartment.

13. Apparatus according to claim 12 wherein there are at least four of said first portions of said housing, said liquid is developing liquid, stopping liquid, fixing liquid and washing liquid respectively, one of said liquids being introduced into each of said first portions of said housing, and wherein said gas is air.

14. Film strip processing apparatus comprising a housing defining a compartment and having first portions and second portions, said second portions joining adjacent ones of said first portions, said housing having two oppositely disposed spaced apart side walls each having a plurality of openings extending through said side walls along the length of said housing, two plates spaced from said openings and positioned one on one side and one on the other side of said openings along the length of said housing and dividing said compartment into two header compartments and a film strip receiving compartment positioned between said header compartments, said plates each having apertures extending therethrough along the length thereof, said apertures connecting said header compartments and said film strip receiving compartment in fluid flow relationship, said openings establishing a fluid flow relationship between said film strip receiving compartment and the exterior of said housing, said film strip being positioned in said film strip receiving compartment within the confines of said side walls with both major surfaces of said film strip extending across said film strip receiving compartment and both edges of said film strip adjacent the openings in said side walls, means for introducing film processing liquid into said header compartments in said first portions, said liquid being directed through said apertures against both of said major surfaces of said film strip in said first portions with sufficient force to maintain said major surfaces of said film strip away from engagement with said plates in said first portions and said film strip suspended between said plates in said first portions within the confines of said side walls and with said edges adjacent the openings in said side walls of said first portions, said liquid being expelled from said film strip receiving compartment of said first portions through said openings in said side walls of said first portions, means for introducing a gas into said header compartment in said second portions, said gas being directed through said apertures against both of said major surfaces of said film strip in said second portions with sufficient force to maintain said major surfaces of said film strip away from engagement with said plates in said second portions and said film strip suspended between

said plates in said second portions within the confines of said side walls and with said edges adjacent the openings in said side walls of said second portions, said film strip receiving compartment of said gas being expelled from said second portions through said openings in said side walls of said second portions.

15. Apparatus according to claim 14 wherein said housing has a third portion following said first and said second portions for drying said film strip after processing in said first portions, and means for introducing a gas into said header compartments in said third portion, said gas being directed through said apertures against both of said major surfaces of said film strip in said third portion with sufficient force to maintain said major surfaces of said film strip away from engagement with said plates in said second portions and said film strip suspended between said plates in said third portion within the confines of said side walls and with said edges adjacent the openings in said side walls of said film strip receiving compartment of said third portion, said last-mentioned gas being expelled from said third portion through said openings in said side walls of said third portion.

16. Apparatus according to claim 15 wherein there are at least four of said first portions of said housing, said liquid is developing liquid, stopping liquid, fixing liquid and washing liquid respectively, one of said liquids being introduced into each of said first portions of said compartment, and wherein said gas is air and said last-mentioned gas is heated air.

17. Apparatus according to claim 16 wherein said first and second portions of said housing are generally U-shaped, said first portions being oppositely disposed with respect to said second portions, said first and second portions forming a generally sinuous film strip receiving compartment.

18. Apparatus according to claim 15 wherein at least some of said apertures are inclined in the direction of travel of said film strip.

19. Apparatus according to claim 18 wherein at least some of said apertures are at an angle of substantially 90° to said major surfaces of said film strip.

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