Sept. 20, 1966 W. LIMBERGER 3,273,485

PHOTOGRAPHIC DEVELOPING APPARATUS

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Fig. 1

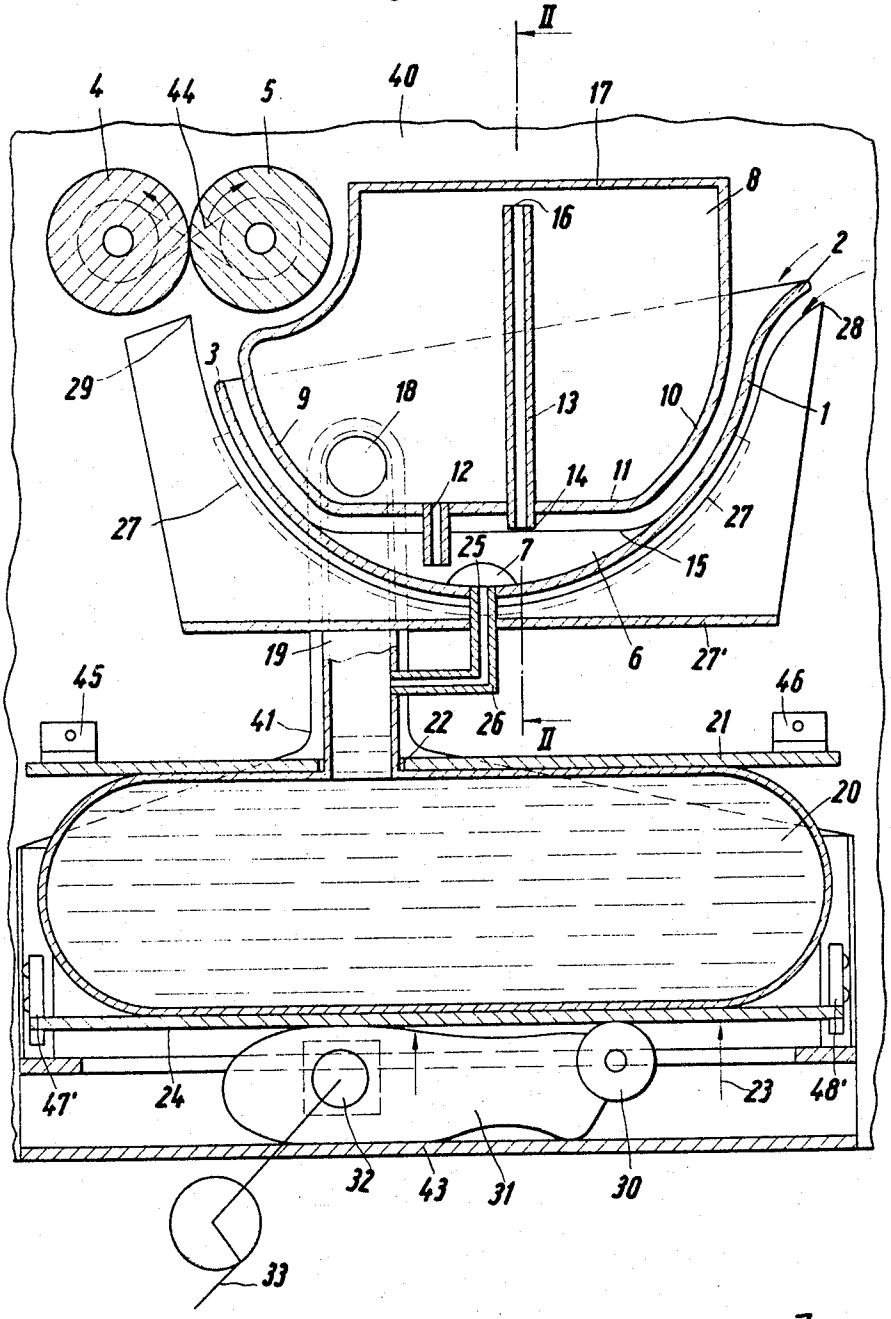

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Fig. 2

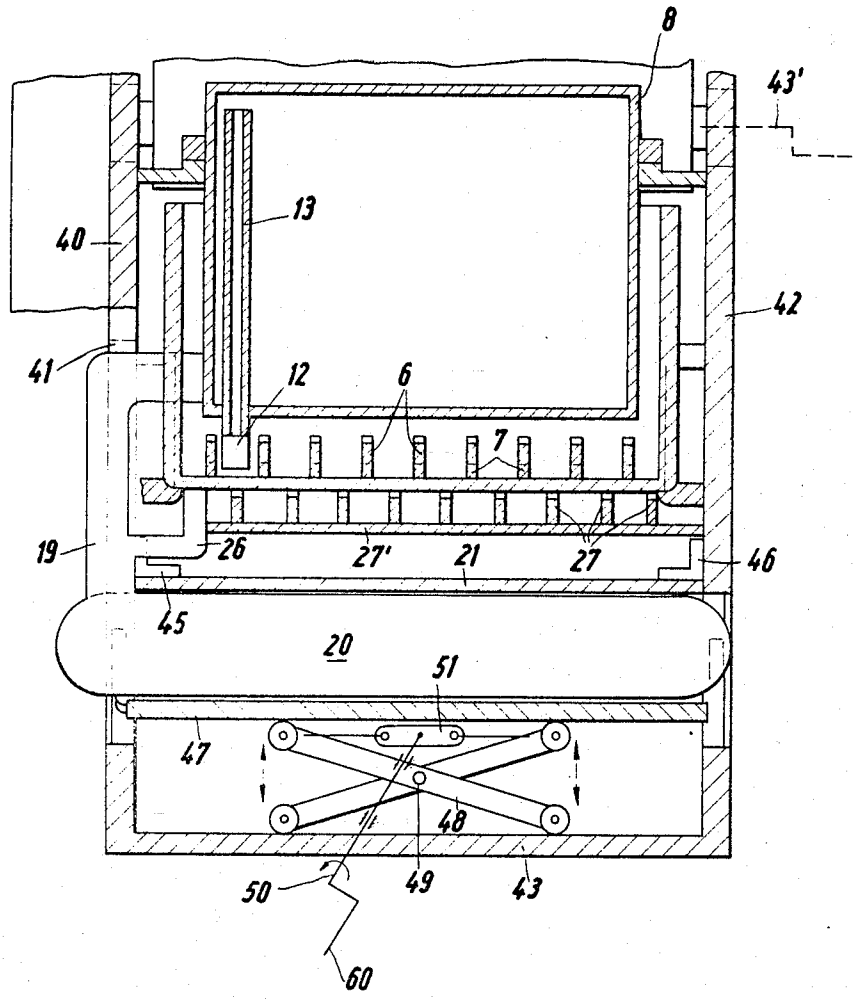

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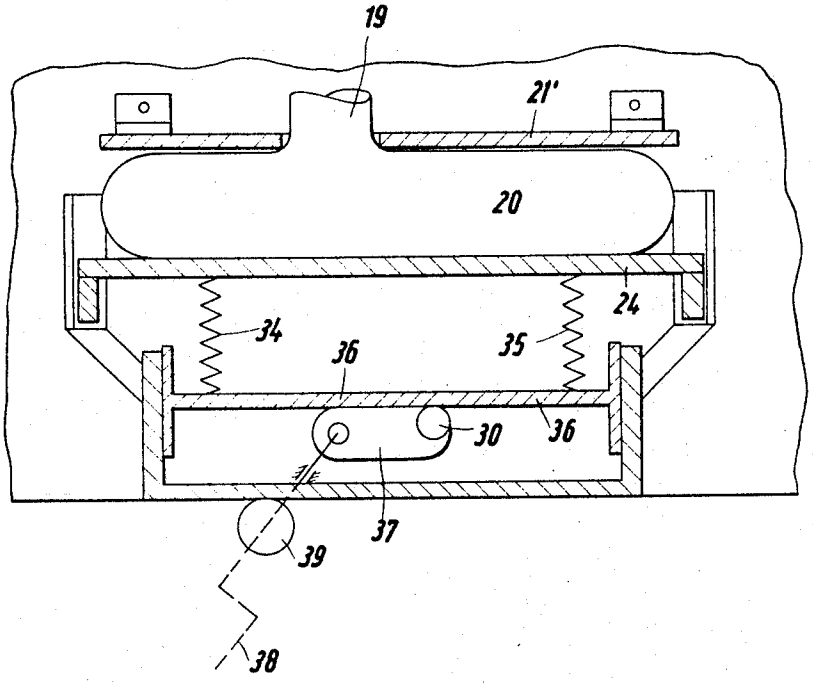
Fig. 3



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PHOTOGRAPHIC DEVELOPING APPARATUS

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9 Claims. (Cl. 95—89)

The invention relates to a surface developing apparatus for exposed photographic emulsion carriers which are moistened on the emulsion side to effect development as they are led to a liquid meniscus which the emulsion side faces, in which associated guide members are provided for conveying the emulsion carriers to the meniscus and a constant level liquid reservoir is provided for adjusting the meniscus, the reservoir having an outlet extending below the level of the meniscus and terminating at the bottom of a supply container for the constant level liquid reservoir, and a short pipe which terminates outside the supply container and projects downwardly to the level desired for the meniscus.

In such surface developing devices there is sufficient liquid in the reservoir. This liquid is supplemented from the supply container only in proportion to quantitative consumption. In such liquid-developer devices, however, the consumption of the developing liquid is qualitative. By keeping available a supply of developing liquid for a considerable time, this qualitative consumption is allowed for by the developing liquid being mixed altogether. For this purpose, known pump installations have the disadvantage that during pumping all the liquid is subjected to eddying such that considerable air enrichment occurs and the free air intake leads to oxidation which reduced the efficiency of the liquid.

In order to overcome the disadvantage of oxidation of liquid which is stored in a tank over a long period, it is already known with standard treatment baths to allow the bath liquid to flow back into a reserve tank after one operation has been carried out and to reintroduce the liquid into the bath at the start of a new operation. This results in thorough intermixing of the liquid available, but adjustment of quantitative decreases in the amounts of fluid is out of the question. It is necessary to take into consideration, in this connection, that some of the developing liquid is removed with the copying material undergoing treatment so that the quantitative decrease in the amount of fluid is an important factor. This is particularly so when moistening the surface of a photographic emulsion carrier, since it is essential for the meniscus to be held at a constant height, which is not guaranteed by connecting a reserve tank with a bath.

The invention is based on the problem of providing a surface developing apparatus which provides the advantage of circulation of the developing liquid but avoids gradual oxidation.

A further object of the invention is to provide such an apparatus in which quantitative consumption of the developing liquid during developing is automatically compensated.

A further object of the invention is to provide an apparatus which overcomes the disadvantages of the known devices described above.

The problem upon which the invention is based is overcome in that the supply container of the constant level reservoir and the bath are connected with a known reserve tank for developing liquid which can be emptied or filled as desired, which is preferably compressible and from which both the bath and the supply container of the constant level reservoir are supplied. By connecting

both the supply container and the bath with the reserve tank, it is possible to fill or empty either one of them for controlling the meniscus without producing eddies in the flow.

According to the preferred embodiment, the reserve tank is connected with the supply container by a connecting pipe having a relatively large diameter, and a special connecting pipe with a greatly decreased cross-section is provided between the deepest part of the bath and the reserve tank. This dimensional relationship is important in order to ensure that the supply container is filled to the desired level before, or at least at the same time as, the bath is filled. This dimensional relationship is therefore surprising as in the normal way it would be assumed that filling of the bath was the first step.

According to a further particular embodiment of the invention, the volume of the reserve tank substantially corresponds with the volume of the supply container and the volume of the bath. As a result, when the reserve tank is fully compressed the meniscus in the bath is at the desired height, whilst the amount of liquid required for adjusting the meniscus is available in the supply container. For this, according to the invention, the diameter of the connecting pipe between the reserve tank and the supply container, relative to the diameter of the short pipe with the outlet and the end projecting upwardly inside the supply container and the diameter of the connection between the deepest part of the bath and the reserve tank is emptied on compression thereof when the meniscus in the bath is at the desired level.

According to a further embodiment of the invention, the reserve tank is supported between a rigid plate and a movable plate; the movable plate is moved by spring means whereby the power of the spring means is such that it is less than the power required to compress the reserve tank after the bath has been filled to the desired level. Control is thus obtained, independently of the various cross-sections, which fulfills the above-mentioned conditions.

According to a further embodiment of the invention, the supply container is arranged at least partially within the bath and has wall members which run parallel to the wall members of the bath, at least in part, a guide member being provided beneath the bath for conveying a sheet directly under the bottom of the bath. In this way, when carrying out a copying process with a negative and a positive, the latter can be guided between a pair of gripping and transport rollers along a completely dry path until it meets the negative.

In order that the invention may be readily understood, preferred embodiments therefore are described in detail below, by way of example only, in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic side view in section;

FIG. 2 is a front view of an alternative embodiment, in which the upper part is a sectional view along the line II—II of FIG. 1 and only the lower part beneath the supply container is different;

FIG. 3 is a side view of an alternative embodiment of a part of the apparatus of FIG. 1.

In the drawings, only those parts essential for operation of the invention are illustrated.

FIG. 1 shows a bath **1** for receiving developing liquid. This vessel is provided with a curved bottom, which extends from an inlet end **2** to an outlet end **3** above which is arranged a pair of gripping and transport rollers **4**, **5**. In FIG. 1, a supporting frame **40** is shown in section. This supporting frame **40** corresponds to the supporting frame shown in FIG. 2. This supporting frame is provided with a slot **41** for the connecting pipes.

Another supporting frame **42** (FIG. 2) is provided op-

posite the frame **40** on the other side of the apparatus. A base **43** extends between the two supporting frames **40** and **42**. The rollers **4**, **5** are positioned in the supporting frames in known manner. Driving means **43** (FIG. 2) are arranged on the spindle of one of the rollers. A belt drive **44** is provided between the rollers and the driving means provided on one of the rollers thus drives the other roller. The bath **1** is supported on lateral support members **44**, **45** in the lateral walls forming the frames **40**, **42**. Web members **6** are arranged parallel to the line connecting the inlet and outlet ends in the base of the bath **1**, on which web members a copy sheet is guided so as to pass over the bottom of the bath **1**. These web members **6** can be apertured, as shown at **7**, at the deepest part of the curved base of the bath **1**, in order to allow adjustment of the developing liquid between the sectional bath chambers defined between the web members **6**, several of which are provided parallel to one another.

A supply container **8** is provided on the frame inside the bath, the parts **9** and **10** of the container walls running parallel to the adjacent sections of the base of the bath **1** and the base **11** running parallel to the top edges of the web members **6**; a space is provided for permitting passage of an emulsion carrier. The top of the supply container **8** is hermetically closed. Two apertures are provided in the base **11**. A short pipe **12** projects downwardly from one opening towards the bottom of the bath **1** and terminates below the upper edge of the web members **6**. The end **14** of a pipe **13** provided in the other opening terminates approximately at the height of the upper edge of the web members **6**, and preferably a little above these web members. The pipe **13** projects into the supply container **8** and terminates at **16** just below its upper wall **17**. In addition, the supply container **8** is provided with a lateral opening **18** which is connected with a reserve tank **20** for developer fluid by means of a connecting pipe **19** of relatively large cross-section. The reserve tank **20** is made of a flexible material. It is positioned between a fixed plate **21**, provided with an opening **22** through which the connecting pipe **19** passes, and a mounting plate **24** which is movable in the direction of the arrow **23**. It will be seen that the diameter of the connecting pipe **19** is considerably greater than that of the pipes **12** and **13**.

A connecting pipe **26** of relatively small cross-section is provided between the lowest part **25** of the bath **1** and the connecting pipe **19**. The cross-section of the pipe **26** can be substantially the same as the cross-section of the pipes **12**, **13**.

A guideway is constructed parallel to the base of the bath, but spaced therefrom, by providing at least one guide member **27**, which guideway serves for guiding a further sheet of material and extends from an entry point **28** beneath the inlet edge **2** to a guide member **29** beneath the nip between the pair of gripping and transport rollers **4**, **5**. It will be understood that the guideway can consist of a plane surface, a perforated surface, or web members, particularly web or wall members some of which are parallel to one another and the others perpendicular to one another. In the drawings, web members are indicated at **27** and the part of the wall supporting these web members at **27'**. The latter is advantageously arranged laterally on the side walls **40**, **41** in a removable manner. The plate **21** is also secured to these side walls by means of brackets **45**, **46** (FIG. 2). In addition, it can be seen that the pipes **12**, **13** are provided to one side of the bath **1**, outside the path of movement of a sheet of copy material (FIG. 2).

The gripping and transport rollers **4**, **5** are driven in the direction indicated by the arrow by a driving motor, not shown.

The movable plate **24** is moved parallel to the plate **21** and is supported on a roller **30** which is positioned on a rocking lever **31** which rotates about a shaft **32**. The shaft **32** is driven by a crank handle **33**; a driving motor can be used in place of the crank handle, if desired.

The movable plate **24** is provided at its corners with upwardly extending projections **47**, **48** which run in perpendicular guide members in order to prevent tilting.

Like the relationship between the cross-sections of the connecting pipes **19** and **26** and the pipes **12** and **13**, the volume of the tank **20** is so chosen that, on compression of the reserve tank **20**, developing liquid passes into the supply container **8** and a proportionately smaller amount simultaneously passes into the bath **1** through the pipe **26**. The supply container **8** is thus filled relatively quickly and the air displaced can escape through the short pipe **13**. It can be seen from FIG. 1 in particular that the opening **18** is arranged near the base **11**. During filling of the supply container **8**, liquid flows through the pipe **12** into the bath **1**, which is simultaneously filled from below through the connecting pipe **26**. If the meniscus, which rises in the bath **1** during the filling operation, reaches the opening **14** of the pipe **13**, then further flow of developing liquid from the supply container **8** is prevented since air can no longer escape therefrom. Because of the volume relationship, namely the fact that the contents of the reserve tank **20** corresponds to the capacity of the supply container **8** up to the height of the opening **16** and the capacity of the bath up to the meniscus, corresponding to the level **15**, this meniscus is reached exactly when the reserve tank **20** is empty. This is the starting position with a completely full supply container **8**. In this connection, the larger cross-section of the connecting pipe **19** with respect to the connecting pipe **26** is of importance. If developer liquid is used, this flows through the pipe **12** from the supply container **8** so that the meniscus required in the bath **1** is automatically adjusted in known manner.

If the movable plate is retracted so that expansion of the reserve tank **20** can occur, the liquid flows through the connecting pipe **19** from the supply container and simultaneously through the connecting pipe **26** from the bath so that all the liquid is once again stored in the reserve tank **20**. Advantageous mixing of all the liquid is thus achieved, without the formation of eddies.

FIG. 2 is a front view in which the same parts have the same references as in FIG. 1 and it will be seen that the pipes **13** and **12** are arranged laterally of the guideway. More detailed description of these parts is thus unnecessary.

According to FIG. 2, the reserve tank **20** is provided as a flexible container beneath the plate **21**, which corresponds to the plate in FIG. 1. The plate corresponding to the supporting plate **24** is indicated at **47** in FIG. 2. It is supported on a scissor-like member or "lazy-tongs" **48** having arms which are pivoted in the centre region, rollers being provided on the ends of the arms to reduce friction. The centre pivot pin **49** is movable upwardly but not laterally in spatial relationship to the base member **43**, in known manner, i.e. for example it is positioned in bearing blocks with vertical slots. In addition, a rotatable driving shaft with a handle **60** is provided in the housing. A rocking lever **51** is non-rotatably secured thereto and is connected with the upper ends of the arms by means of cables. Rotation through 90° in the direction indicated by the arrow results in contraction of the upper ends of the arms and thus the supporting plate **47** is raised.

FIG. 3 shows a further embodiment of the invention in which the volume of the reserve tank **20** is not exactly proportional to the capacity of the supply container **8** and the bath **1**. In this embodiment, the movable plate or wall **24** is supported on springs **34**, **35** whose support **36** is constructed as a plate which can be moved up and down, for example by means of one or two rocking levers **37**. The rocking lever **37** is movable by a crank handle **38** or by a motor **39** in the manner already described.

The force of the springs **34**, **35** is such that the springs first force the liquid from the reserve tank **20** but are then no longer effective when the desired meniscus level is obtained in the treatment bath **1**, i.e. closing of the

opening **14** by the meniscus in the treatment bath prevents further liquid from passing into the container **8** if the liquid pressure at this opening **14** or at the opening **25** of the connecting pipe **6** is not to be controlled.

By means of such springs **34**, **35**, fluid is forced from the reserve tank **20**, irrespective of the size of the latter, only in an amount required by the dimensions of the supply container **8** and necessary for obtaining the respective meniscus level in the treatment bath **1**.

With reference to FIG. 1, it is apparent that the provision of the cross-sectional proportionality between the connecting pipe **19** on the one hand and the connecting pipe and the pipes **12**, **13** on the other hand is an essential feature of the invention, in order to produce uniform filling of the bath **1** from the top and from below with simultaneous filling of the supply container **8**.

An essential feature of the invention is the combination of a compressible reserve tank, which expands again when it is released, with a device for automatically correcting or re-setting a predetermined meniscus level in a treatment bath for wetting the surface of a copy material sheet; in a preferred embodiment of the invention, such device can be provided as a known constant level liquid reservoir.

I claim:

1. A surface-developing apparatus for exposed photographic emulsion carriers which are moistened on the emulsion side to effect development thereof by being guided past a liquid meniscus which the emulsion side faces, which apparatus comprises, in combination, a bath container for holding treatment liquid, guide members associated with said bath container for guiding emulsion carriers through such bath container so as to moisten the emulsion layer sides thereof, constant level liquid reservoir means for adjusting the meniscus level, a supply container for said constant level liquid reservoir means, said reservoir means being located above said bath container, first pipe means associated with said reservoir means and extending from the base of said supply container down to a position below the meniscus level in the filled bath container, second pipe means associated with said reservoir means and projecting upwardly inside the supply container and downwardly outside such container to a height which corresponds to the liquid meniscus level in the bath container, a compressible reserve tank for developer liquid, first connecting duct means between said reserve tank and the supply container, second connecting duct means between the reserve tank and a lower part of the bath container and means for compressing said reserve tank.

2. The developer apparatus of claim **1**, in which said first connecting duct means comprises a first connecting pipe having a larger diameter than that of a second connecting pipe constituting said second connecting duct means, said second connecting pipe being connected to the deepest part of the bath container.

3. The developer apparatus of claim **1**, in which said first and second connecting duct means comprises first and second connecting pipes, the first connecting pipe having a greater cross-section than said second connecting pipe and said first and second pipe means.

4. The developer apparatus of claim **1**, wherein the second pipe means is located upwardly in the vicinity of an upper closure wall of the supply container.

5. The developer apparatus of claim **1**, wherein the second connecting duct means communicates with said first connecting duct means at its end adjacent said reserve tank.

6. The developer apparatus of claim **1**, where the means for compressing said reserve tank comprise a frame, said bath container and said constant level liquid reservoir means being supported on said frame, a fixed plate secured in said frame, a movable plate adapted to be moved in a direction towards the fixed plate, the reserve tank being disposed between said fixed and movable plates, actuating means supported in said frame and adapted to move said movable plate, spring means disposed between said actuating means and said movable plate, the force of said spring means being less than the force required to compress the supply container after the bath container has been filled to the desired level.

7. The developer apparatus of claim **1**, wherein the supply container is positioned at least partly within the bath container and has wall members disposed at least partly parallel to wall members of the bath container, a guidance structure being provided beneath the bath container holding the treatment liquid and including guide members adapted to guide copy sheets directly under the bottom of the bath container.

8. A surface-developing apparatus for exposed photographic emulsion carriers which are moistened on the emulsion side to effect development thereof by being guided past a liquid meniscus which the emulsion side faces, which apparatus comprises, in combination, a bath container for holding treatment liquid, guide members associated with said bath container for guiding emulsion carriers through such bath container so as to moisten the emulsion layer sides thereof, constant level liquid reservoir means for adjusting the meniscus level, a supply container for said constant level liquid resrevoir means, said reservoir means being located above said bath container, first pipe means associated with said reservoir means and extending from the base of said supply container down to a position below the meniscus level in the filled bath container, second pipe means associated with said reservoir means and projecting upwardly inside the supply container and downwardly outside such container to a height which corresponds to the liquid meniscus level in the bath container, a compressible reserve tank for developer liquid, said reserve tank having an uncompressed volume which substantially corresponds to the sum of the volume of the supply container and of the volume of the bath container, first connecting means between said reserve tank and the supply container, second connecting duct means between the reserve tank and the lower part of the bath contanier and means for compressing said reserve tank.

9. The developer apparatus of claim **8**, wherein the diameter of the first connecting pipe relative to the diameters of the first and second pipe means and of the second connecting pipe are so dimensioned that the reserve tank is emptied on compression thereof when the meniscus is at the predetermined level in the bath.

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