

July 12, 1949.

H. H. SULLIVAN ET AL  
GAS DEVELOPING MACHINE FOR PHOTOSENSITIVE  
SHEETS HAVING AUTOMATIC GAS DELIVERY

2,475,809

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4 Sheets-Sheet 1

Fig. 1

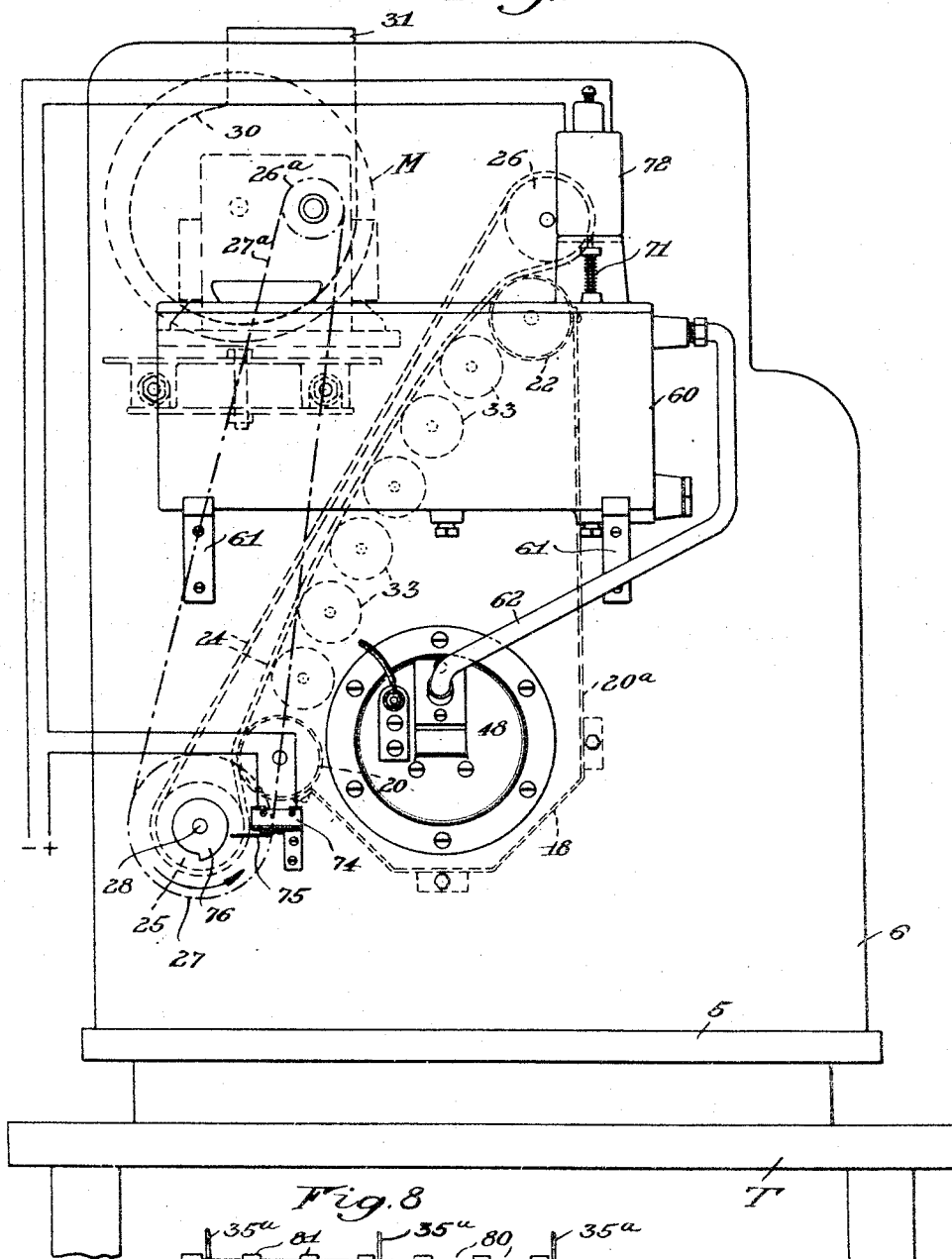
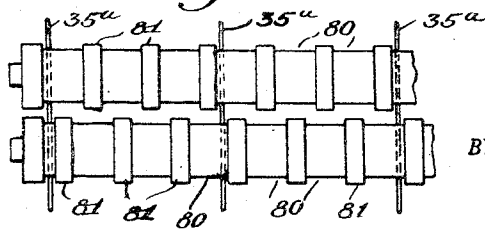


Fig. 8



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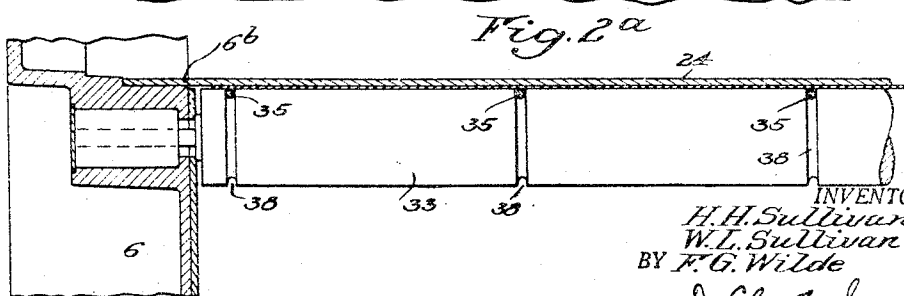
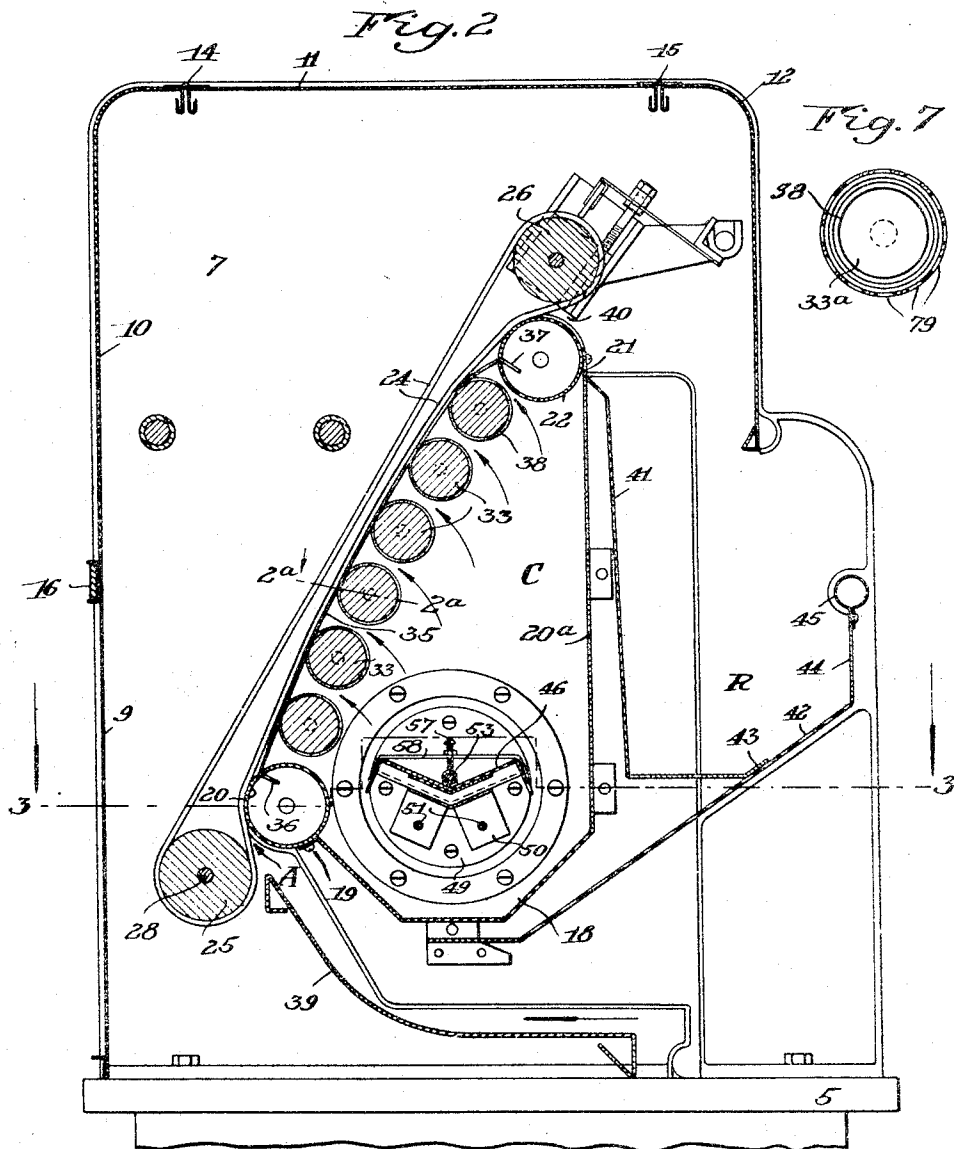
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4 Sheets-Sheet 2



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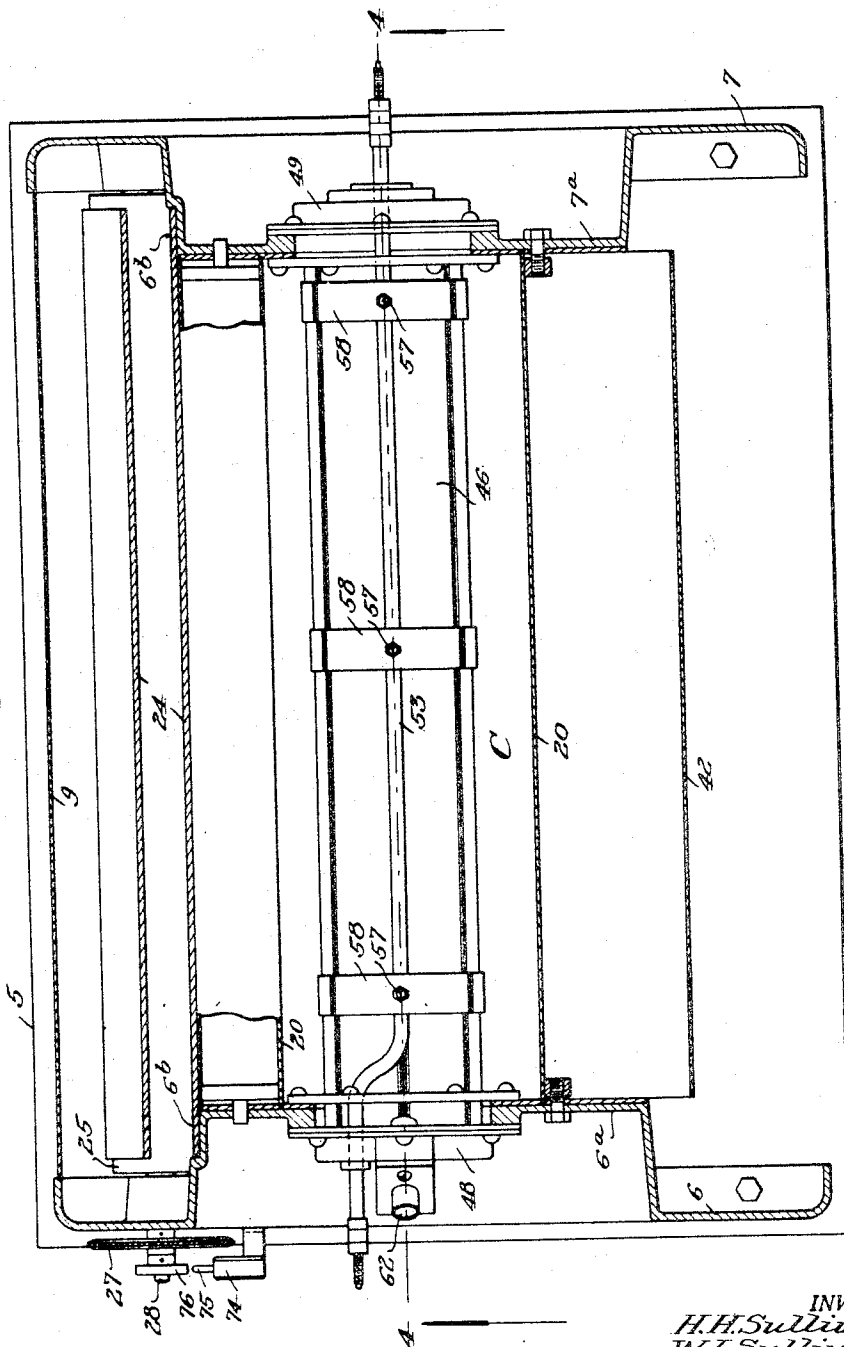
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Fig. 3



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## UNITED STATES PATENT OFFICE

2,475,809

## GAS DEVELOPING MACHINE FOR PHOTO-SENSITIVE SHEETS HAVING AUTOMATIC GAS DELIVERY

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8 Claims. (Cl. 95—89)

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This invention relates to a machine for developing photosensitive sheets by means of ammonia gas and the like.

In conventional developing machines of this type, ammonia gas is generated in a chamber, one of the walls of which has a perforated area. The photosensitive sheet to be processed is drawn across the perforated area, by means of an impervious belt which also serves as a closure for the perforations to prevent the escape of gas therethrough. The perforated area of the chamber wall, while it does permit passage of the gas to the photosensitive sheet, greatly increases the developing time over that required where the sheet is exposed to the gas directly without the interposition of the perforated wall.

In former devices of this type, it has been difficult to regulate closely the feeding of the liquid ammonia to the evaporator and the rate at which evaporation is effected therein.

In accordance with the present invention, there is provided a developing machine wherein guide rollers replace the perforated wall of the chamber with the result that developing speed of the machine is materially increased. Also, in accordance with this invention, the feeding of the liquid ammonia to the evaporator and the rate of evaporation effected therein, are easily regulated in a novel and accurate manner.

The various features and advantages of the invention will appear from the detailed description and claims when taken with the drawings, in which:

Fig. 1 is a side elevation of the developing machine of the present invention;

Fig. 2 is a vertical section through the machine on a plane substantially parallel to the view of Fig. 1; Fig. 2a is a detail view;

Fig. 3 is a horizontal section taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is a section taken on the line 5—5 of Fig. 4;

Fig. 6 is a vertical section showing a fragment of the ammonia container and the electrically operated pump for pumping ammonia from this tank;

Fig. 7 is a cross section of a modified roller for use in the machine; and

Fig. 8 is a front elevation of a modified roller construction as well as the arrangement of a pair of such rollers for use in the developing machine of the present invention.

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Referring to the drawings, the present developing machine is provided with a base 5 to be supported on a table T. On this base, there are mounted end frames 6 and 7 suitably held in spaced relation to form part of a cabinet. The rear part of the cabinet as well as the top and the upper portion thereof are closed by a cover which also serves as a hood to collect waste fumes. This cover includes a sheet metal rear section 9 retained on the end frames. The remainder of the cover comprises the sections 10, 11 and 12 which are suitably joined together, as by hinges 14 and 15. The section 10 at its lower margin has a strip 16 secured thereto which strip overlaps the upper margin of the rear section 9 to cover the joint between it and the section 10. It will be understood that the sections 10, 11 and 12, since they are hinged together, can be opened up to provide access to the interior of the developing cabinet or they can be completely removed, as occasion demands. The present developing machine includes a developing chamber C (Fig. 2) in which there is supplied ammonia gas or other developing gas for processing a photosensitive sheet (not shown). This developing chamber comprises a sheet metal structure 18 which is substantially trough shaped in cross-section (Fig. 2) with its left-hand edge 19 attached to a cylindrical guide 20. The opposing side 20a of the trough extends vertically and its margin 21 is attached to a second cylindrical guide 22 similar in construction to the first. The chamber, with its marginal cylindrical guides, is preferably coextensive with the width of the machine, the edges thereof being sealed to the end frames 6 and 7 respectively. Preferably, the end frames have depressed portions 6a and 7a, as shown in Fig. 3, to which the ends of the developing chamber are attached.

By this construction, the portion of the chamber C adjacent the front of the machine is closed whereas the portion of the chamber directed toward the rear of the machine is open. The open portion of this chamber is closed by means of a belt 24 which passes around the driven roll 25 and the guide roll 26 at the upper part of the machine. This belt which is preferably made of rubber or other flexible material is impervious to ammonia or other developing gas. This belt, as it travels, wipes over the cylindrical guides 20 and 22 and its edges engage parts on the end frames 6 and 7, such as indicated at 6b (Fig. 2a) to provide an effective seal for the open side of the developing chamber. This arrangement substantially eliminates the leakage of gas from the developing chamber.

The roll 25 may be driven in any suitable manner but as illustrated in Fig. 1, a motor M operates a sprocket 26a which drives chain 27a and sprocket 27 secured on the shaft 28 of roll 25, to rotate the same. The motor M also operates a fan 30 to remove escaped fumes from the cabinet, through an exhaust pipe 31 leading to the atmosphere.

In accordance with the present invention, the photosensitive sheet to be processed, is supported against the under surface of the belt 24 by series of rollers 33 arranged in a steeply inclined upwardly directed row and freely rotatable on bearings in the end frames. These rollers are spaced apart to allow the processing gas to have access to the photosensitive sheet at the several areas indicated by the arrows (Fig. 2) but the spacing between adjacent rollers is preferably less than the diameters of said rollers so that the front end of the photographic sheet will tend to follow along with the belt 24. In order to insure that the photosensitive sheet will follow its intended path along the under surface of the belt 24 and not be diverted between the rollers 33 into the chamber, there may be provided a series of parallel guide rods 35. The guide rods have their respective ends mounted, as indicated, at points 36 and 37 in the cylindrical guides 20 and 22 (Fig. 2) and completely rest in channels 38 in the several rollers 33. Preferably the exposed surfaces of the guide rods 35 at the channels are substantially flush with the surfaces of the rollers 33.

The photosensitive sheet is introduced at A between the belt 24 and the cylindrical guide 20 at the lower part of the cabinet, being directed to this point by the guide plate 39. The photosensitive sheet is moved upward by the belt 24 over the rollers 33, being exposed at this time to the processing gas which enters through the spaces between these rollers. The processed sheet emerges from between the belt 24 and the upper cylindrical guide 22 at point 40 to drop into a receptacle R. This receptacle is formed from an L-shaped metal sheet 41, the ends of which generally extend to the end plates 6 and 7. The side edge of the sheet 41 extends downward from the cylindrical guide 22 to the sheet 42 to which it is secured at 43. The sheet 42, which is generally inclined downward from the front of the cabinet to the bottom of the trough, has a vertical portion 44 terminating in a rolled edge 45. It should be pointed out that the sheets 41 and 42, in addition to forming the receptacle R also define with the front wall of the chamber, an air pocket to reduce the loss of heat through this wall.

It has been mentioned that the chamber C is filled with gas, such as ammonia gas. This gas is generated by the evaporation of liquid ammonia in an evaporating unit located within the cabinet. The evaporator comprises a shallow V-shaped tray 46 which gently slopes from the left side (Fig. 4) of the cabinet toward an outlet 47 at the right side. The tray is removable through circular openings in the end frames 6 and 7, the openings being closed by the covers 48 and 49. The left end of the tray (Fig. 4) is conveniently screwed to the cover plate 48. However, the right end of the tray is not anchored so that it can freely expand and contract with changes in temperature within the chamber. Actually the right end of the tray is provided with a depending bracket 50 which is apertured

to receive a supporting pin 51 projecting inward from the cover 49.

The liquid ammonia which is supplied to the tray in a manner to be described, is evaporated by an electric heating element 53. This heating element is tubular in form and its ends project through the covers 48 and 49. The rate of evaporation of the liquid ammonia is preferably controlled accurately and to this end, the space relation between the heating element and the liquid in the tray, is closely adjusted. This adjustment is effected by groups of set-screws spaced along the tray. As illustrated (Fig. 3), there are three groups respectively located adjacent the ends and the intermediate portion of the tray. Each group comprises three set-screws 55, 56 and 57 (Fig. 5), the two screws 55 and 56 projecting upward through the bottom of the tray to engage the bottom of the heating element. The third screw 57 of each group is used to force the heating element against the related screws 55 and 56. Each screw 57 is preferably threaded through a transverse strip 58 secured to the edges of the tray across the top thereof. By adjusting the several groups of screws 55, 56 and 57, any desired spacing between the heating element and the bottom of the tray can be established and maintained. A lock nut on each set-screw assures that a given adjustment will be maintained. Preferably the screws 55, 56 and 57 are adjusted so that the heating element can freely expand and contract lengthwise with changes in temperature.

The liquid ammonia or other liquid to be evaporated in the chamber is contained in a closed reservoir 60 supported by brackets 61 secured on the outside of the end frame 6. The reservoir is located above the tray 46, so that liquid ammonia pumped from the reservoir can flow by gravity through the delivery tube 62 to the tray. It is preferred to pump the liquid into the delivery tube in order to insure that accurate amounts of liquid are discharged into the tray. A suitable pump, best illustrated in Fig. 6, includes a cylinder 63 having an inlet 64 and an outlet 65. The outlet communicates through a check valve 68 to a passage 67 opening into the delivery pipe 62. A piston 69 mounted on the lower end of the piston rod 70 reciprocates in the cylinder. The piston rod is forced downward against the action of a return spring 71 by a solenoid 72, the core 73 of which is attached to the upper end of the piston rod. The solenoid is periodically energized to force the piston downward, being energized in a circuit completed at switch 74 (Fig. 1). This switch is closed by an arm 75 which is actuated by a cam 76. The cam is secured to the shaft 28 which it will be recalled, drives the roll 25 and with it the belt 24. Thus, with each rotation of belt 24 a predetermined amount of liquid ammonia is delivered to the evaporating tray.

Briefly, the device operates in the following manner. After the motor M has been turned on and after heating current has been applied to heating element 53 to evaporate the liquid ammonia into gas, a photosensitive sheet to be processed is pushed along the guide plate 39 to enter at point A between the belt 24 and the cylindrical guide 20. The belt advances the sheet over the rollers 33 and guide rods 35, the ammonia gas being applied to the sheet along the paths between the rollers as indicated by the arrows in Fig. 2. On emerging from the belt, the processed sheet falls into the receptacle R. With each rotation of shaft 25 and its cam 76, the

switch 74 is closed to operate the solenoid of the pump. The pump delivers a predetermined amount of liquid ammonia to the evaporating tray 45 where heat from the heating element evaporates the liquid filling the developing chamber with ammonia gas.

The rollers 33, referred to above, have been shown to be solid. However, in accordance with one modification of the invention, the rollers are made of perforated sheet metal such as stainless steel. A cross-section of one such roller designated 33a and provided with perforations 79 is indicated in Fig. 7.

In accordance with another modification of the invention the rollers (Fig. 8) are provided with channels 80 defining lands 81 at the surface of the rollers. The channels are preferably much wider than the lands to permit currents of ammonia gas to pass between the photosensitive sheet and the rollers. Preferably the lands of adjacent rollers are staggered to insure that the sheet will be held flat against the belt. Guide rods 35a lying in certain of the channels may be used to hold the sheet in its proper path.

It will be understood that the use of the rollers facilitates the application of the gas to the photosensitive sheet. By the use of the perforated rollers or by the use of the widely channeled rollers, the application of the gas is further aided by the fact that the gas can rise as currents along the exposed surface of the sheet, thereby greatly increasing the speed of the present developing machine over that of known machines.

What we claim is:

1. In a developing machine, a chamber adapted to contain gas, said chamber having an exposure area therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said area to close and seal the same, means for advancing said belt across said area, and a series of parallel rollers mounted close together in a steeply inclined upwardly directed row to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said area whereby said belt and said rollers cooperate to advance said photosensitive sheet past said area.

2. In a developing machine, a chamber adapted to contain gas, said chamber having an exposure area therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said area to close and seal the same, means for advancing said belt across said area, and a series of hollow perforated rollers mounted to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said area whereby said belt and said rollers cooperate to advance said photosensitive sheet past said area.

3. In a developing machine, a chamber adapted to contain gas, said chamber having an opening therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said opening to close and seal the same, means for advancing said belt across said opening, and a series of rollers mounted close together in a steeply inclined upwardly directed row to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is

presented to said opening whereby said belt and said rollers cooperate to advance said photosensitive sheet past said opening, said rollers having therein a plurality of peripheral channels defining lands on which said sheet rests, the lands of adjacent rollers being staggered with respect to one another.

4. In a developing machine, a chamber adapted to contain gas, said chamber having an opening therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said opening to close and seal the same, means for advancing said belt across said opening, and a series of rollers mounted close together in a steeply inclined upwardly directed row to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said opening whereby said belt and said rollers cooperate to advance said photosensitive sheet past said opening, said rollers having therein a plurality of peripheral channels defining lands on which said sheet rests, said channels being substantially wider than said lands.

5. In a developing machine, a chamber adapted to contain gas, said chamber having an opening therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said opening to close and seal the same, means for advancing said belt across said opening, and a series of rollers mounted close together in a steeply inclined upwardly directed row to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said opening whereby said belt and said rollers cooperate to advance said photosensitive sheet past said opening, said rollers having therein a plurality of peripheral channels defining lands on which said sheet rests, the lands of adjacent rollers being staggered with respect to one another and guide rods substantially spanning said opening and lying in said channels.

6. In a developing machine, a chamber adapted to contain gas, said chamber having an opening therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said opening to close and seal the same, means for advancing said belt across said opening, and a series of rollers mounted to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said opening whereby said belt and said rollers cooperate to advance said photosensitive sheet past said opening, said rollers having therein a plurality of peripheral channels defining lands on which said sheet rests, the lands of adjacent rollers being staggered with respect to one another.

7. In a developing machine, a chamber adapted to contain gas, said chamber having an opening therein through which a photosensitive sheet can be exposed to said gas, an impervious belt rotatable across said opening in contact with the edges of the chamber thereat to seal the same, means for rotating said belt, a series of rollers mounted to have their axes extend at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said opening whereby said belt and said rollers cooperate to advance said

photosensitive sheet past said opening, an evaporating unit including a tray within the chamber extending transversely of said belt, and means actuated in synchronism with the rate of the rotation of said belt for discharging periodically a predetermined amount of liquid into said tray to be evaporated into developing gas.

8. In a developing machine, a chamber adapted to contain gas, said chamber having an exposure area therein through which a photosensitive sheet can be exposed to said gas, an impervious belt movable in contact with the edges of the chamber at said area to close and seal the same, means for advancing said belt across said area, and a series of hollow perforated rollers mounted in a steeply inclined upwardly directed row to have their axes extending at right angles to the direction of movement of said belt and to have their surfaces contact that surface of the belt which is presented to said area whereby said belt and said rollers cooperate to advance said photosensitive sheet past said area, the spacing between adjacent rollers being less than the diameters of said rollers.

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