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Kobayashi

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[54] **DIAZO TYPE DEVELOPING DEVICE USING A POWDER DEVELOPING AGENT**

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[52] **U.S. Cl.** ..... **95/89 R**, 355/15

[51] **Int. Cl.** **G03d 13/00**

[58] **Field of Search** ..... 95/89 R, 89 G, 94 R, 95/94 G; 355/3, 15, 16

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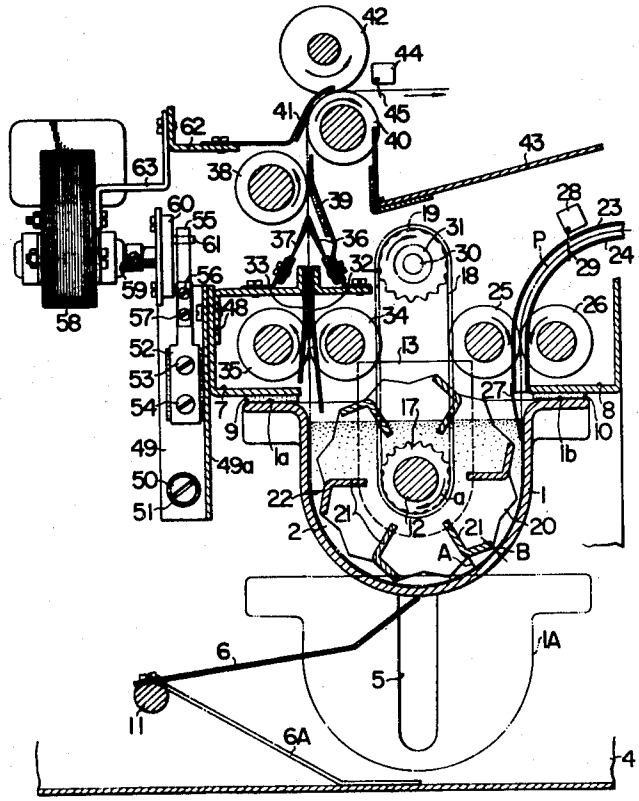
[57] **ABSTRACT**

A developing device using a powder developing agent comprising fine powder and alkaline developing liquid adsorbed on the powder surface. The developing device comprises a trough-shaped developing tray which is semicircular in cross-section and contains a quantity of the developing agent. The leading edge of an exposed diazo type photosensitive sheet is introduced along the curved inner wall of the tray such that the diazo material of the sheet faces the powder in the tray. The powder developing agent in the tray is agitated by uniquely shaped vanes which simultaneously serve to (1) agitate the powder developing agent in the tray, (2) move the sheet introduced in the tray along the inner tray wall, and (3) press powder developing agent against the side of the sheet which has the diazo type photosensitive material thereon to develop the latent image on the sheet. A control mechanism is provided to turn on the vanes when the leading edge of a sheet is introduced into the tray and to turn off the vanes when the trailing edge of the same sheet is extracted from the tray. Wiper elements also provided for brushing off powder developing agent remaining on extracted sheets, and for replacing or adding to the developing agent in the tray.

12 Claims, 3 Drawing Figures



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SHEET 1 OF 2

FIG. 1

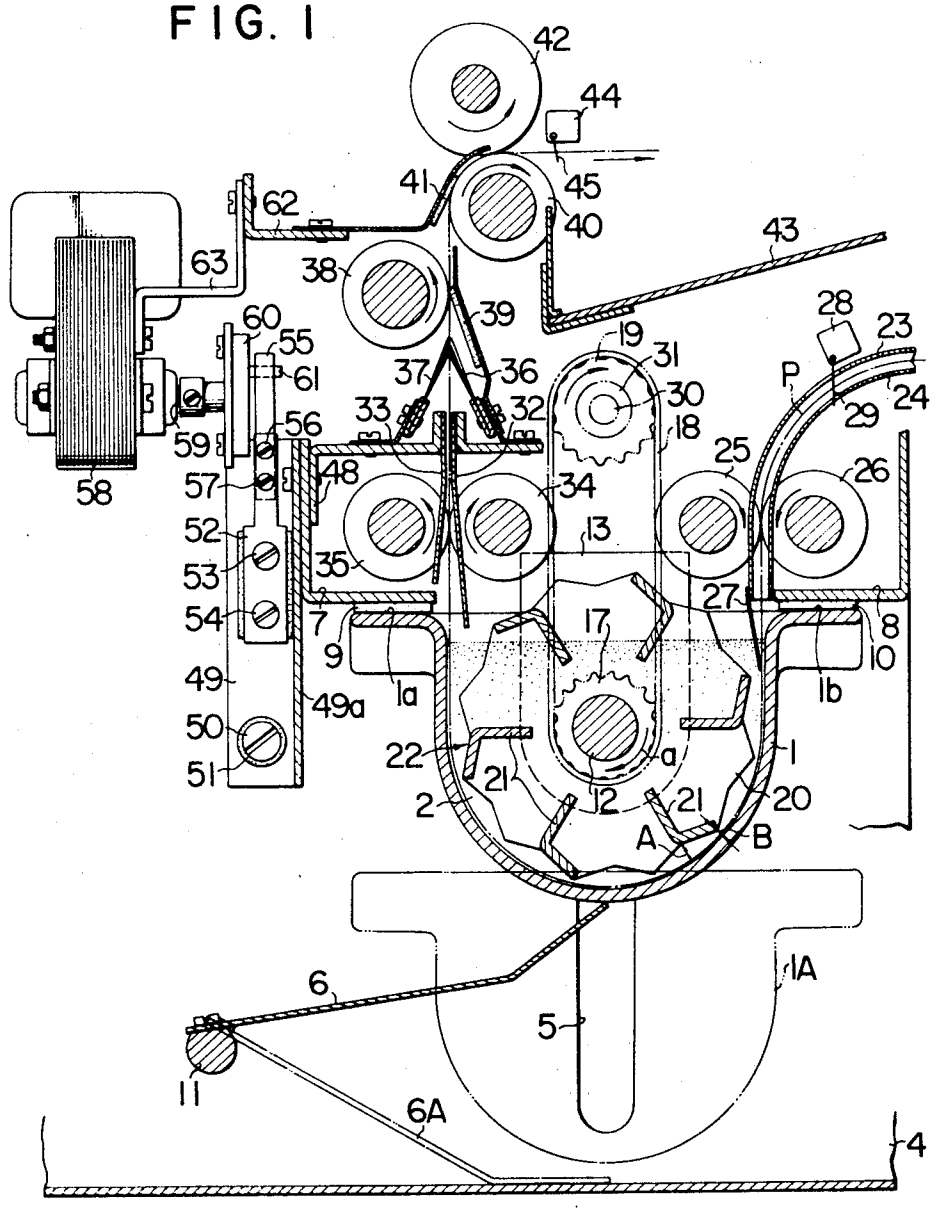


FIG. 2

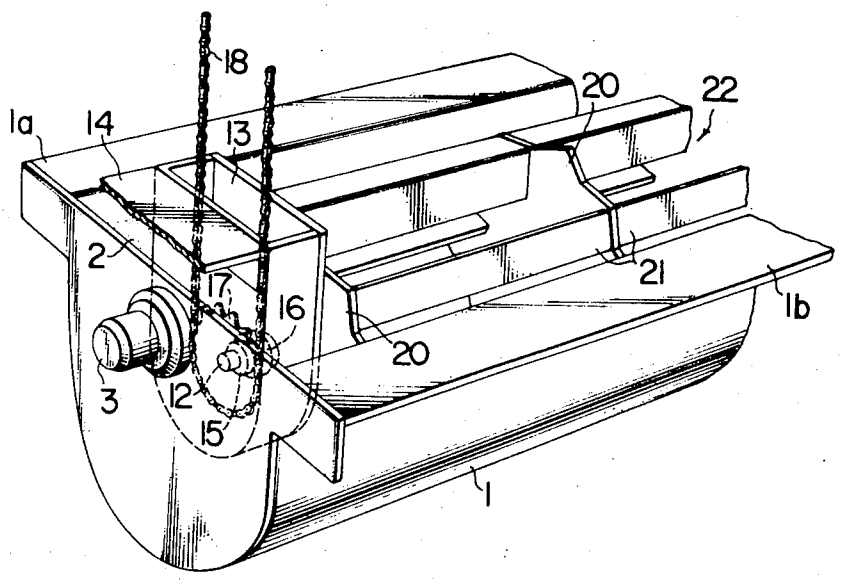
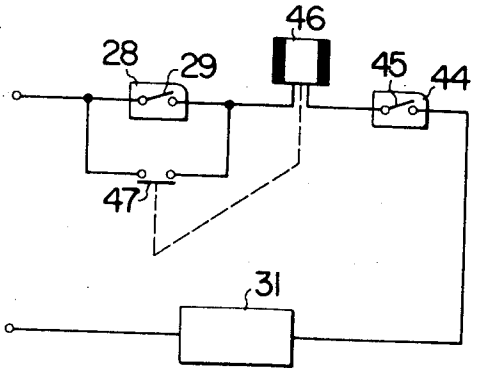


FIG. 3



DIAZO TYPE DEVELOPING DEVICE USING A POWDER DEVELOPING AGENT

BACKGROUND OF THE INVENTION

The invention relates to diazo type developing devices using powder developing agents.

It has been suggested to use powder developing agent comprising fine powder (about 10 to 20 microns in diameter) such as silica or polystyrene, with alkaline liquid, such as an amine, adsorbed on the surface of the powder particles. The powder should be insoluble in, and should not react with the particular alkaline liquid which is used. Exposed photosensitive sheets of the binary type comprising a mixture of a diazo compound and its coupler may be developed by contact with such powder developing agent.

The quality of the image on a duplicate made by using powder developing agent is comparable to the image quality of duplicates made by the ammonia process. However, the use of powder developing agents has significant advantages such as freedom from ammonia odor and dryness of the duplicate as it emerges from the copying machine. When ammonia developing processes are used, the odor of ammonia often stays with the copy emerging from the machine. Additionally, the copies made by the ammonia process are often wet to the touch when they emerge from the machine. These disadvantages are obviated by the use of powder developing agents.

SUMMARY OF THE INVENTION

The invention is in the field of diazo type copying machines and methods and particularly relates to diazo type copying machines and methods using powder developing agents. An object of the invention is to provide convenient and reliable developing of exposed diazo type photosenstive sheets by use of powder developing agents.

A developing device illustrating one embodiment of the invention comprises a developing tray for holding a quantity of the powder developing agent, means for introducing exposed photosensitive sheets into the tray, means for simultaneously agitating the powder developing agent in the tray and for moving the sheets which have been introduced into the tray to develop the latent image thereof into a visible image, and means to extract the sheets from the tray. In a particular embodiment, the tray is semicircular in transverse section, and exposed photosensitive sheets are introduced down along the inner side of the tray wall, with the photosensitive surface of the sheet and with the back of the sheet sliding against the tray inner wall facing the powder developing agent in the tray. A shaft which is concentric with the semicircular transverse section of the tray carries a plurality of radially disposed vanes which rotate in the same direction as the direction in which the sheet is introduced into the tray and serve the functions of (1) agitating the powder developing agent in the tray, (2) moving the sheet from the side of the tray at which it was introduced to the opposite side of the tray where it is to be extracted from the tray, and (3) pressing powder developing agent againt the photosensitive surface of the sheet as the sheet is moved along the tray. The sheet which has travelled from one side of the tray to the other is then extracted, and powder developing agent which has adhered thereto is brushed off by vibrated brushes. Control means is provided for turning on the vanes when the leading edge of a photosensitive sheet is about to be introduced into the tray and for turning off the vanes after the sheet introduced into the tray has been extracted therefrom.

The invention offers numerous advantages over the prior art. For example, the rotary agitating means efficiently agitate the powder developing agent and simultaneously press powder developing agent against the exposed photosensitive sheets in the tray to ensure even distribution of a sufficient quantity of developing fluid over the exposed sheets. Additionally, the rotary agitating means serve the function of moving the exposed sheets along the developing tray and thus obviate the usual need for conveyors or other means for moving exposed photosensitive sheets through the developing agent. Sheets of any length, and particularly very short sheets can be moved through the tray without jamming.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a diazo type developing device using powder developing agent and comprising one embodiment of the invention.

FIG. 2 is a perspective view showing rotary agitating means and a developing tray which are a part of the developing device shown in FIG. 1.

FIG. 3 is a circuit diagram of an electrical circuit for controlling the rotary agitating means shown in FIG. 1 and 2.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, a developing tray 1 has a trough-shaped smoothly curved bottom flanked by two longitudinally spaced vertical side walls (only one side wall is visible in FIG. 2). The developing tray 1 contains a relatively large quantity of developing agent 2 which comprises fine powder having an alkaline developing liquid adsorbed on the surface of the particles. A pair of support shafts 3 (only one shaft 3 is visible in FIG. 2) are affixed to the side walls of the developing tray 1 and extend longitudinally outwardly therefrom. The two support shafts 2 are loosely received in vertical slots 5 formed in side walls 4 which enclose the developing device (only one of these side walls 4 is visible in FIG. 1).

The bottom of the developing tray 1 is supported by a lifting member 6 which is affixed to a shaft 11 mounted for rotation on the side walls 4. The lifting member 6 has two positions, an up position in which it is shown in solid lines in FIG. 1 and in which it supports the developing tray 1 in its operative position shown in solid line in FIG. 1, and a down position in which the lifting member 6 is shown in broken lines in FIG. 1 and is labelled 6A, when the lifting member 6 is moved to its down position, it drops the developing tray 1 to the position shown in broken lines in FIG. 1 and labelled 1A. The tray 1 is guided in its vertical motion by the guide slots 5. When the developing tray 1 is in the lower position labelled 1A, the powder developing agent 2 contained therein may be replenished with additional developing agent, or it may be replaced with a new batch of powder developing agent. Suitable means (not shown) are provided for locking the shaft 11 and the lifting member 6 either in the up position shown in solid lines or in the down position shown in broken lines and labelled 6A.

When the developing tray 1 is in its operating position, as shown in solid lines in FIG. 1, a pair of transversely outwardly extending ledges 1*a* and 1*b* of the tray 1 press against hold-down plates 7 and 8 respectively through rubber cushions 9 and 10 respectively. The hold-down plates 7 and 8 are suitably secured to the side plates 4 of the copying machine of which the invented developing device is a part.

When the developing tray 1 is in the operating position shown in solid lines in FIG. 1, a shaft 12 is disposed concentrically with the curved portion of the tray 1 and is mounted for rotation between a pair of longitudinally spaced support boxes 13 (only one box 13 is visible in FIG. 2). The support boxes 13 are suitably affixed to a pair of support plates 14 (only one support plate 14 is visible in FIG. 2) which in turn are suitably affixed to the side walls 4. Each support box 13 contains a bearing 15 journalling one longitudinal end of the shaft 12. Each of the bearings 15 is provided with a seal ring 16 for the purpose of preventing the powder in the developing tray 1 from entering the support boxes 13.

Sprocket wheels 17 (only one sprocket wheel 17 is visible) are disposed within each of the support boxes 13 and are affixed to the rotary shaft 12. Chains 18 (only one chain 18 is visible) are trained about the sprocket wheels 17 and are also trained about drive sprocket wheels 19 (only one wheel 19 is visible) which are rotatably mounted above the sprocket wheels 17. The drive sprocket wheels 19 are rotated in the shown direction by motor means 19a to thereby rotate the shaft 12 in the shown direction.

The rotary shaft 12 comprises a part of a rotary agitating means 22 which also include a plurality of agitating vanes support plates 20 (see FIG. 2) and a plurality of agitating vanes 21 (see FIG. 1) which are mounted on the support plate 20 such that the vanes 21 extend radially from the rotary shaft 12. Each of the vanes 21 is L-shaped in transverse cross-section and comprises a radical portion (i.e., the portion which extends radially of the rotary shaft 12) and a front end bent portion which is adjacent the developing tray 1 and is bent to extend in a direction substantially opposite to and forming an angle with the direction of rotation of the vane 21, so that a wedge-shaped space gradually diverging in the direction of rotating of the vane 21 is formed between the front end bent portion of the vane and the inner surface of the tray 1. Looking at FIG. 1, where A designates the distance between the location where the vane 21 is bent and B designates the distance between the free end of the bent portion of the vane 21, the distance A is greater than the distance B.

Exposed diazo type photosensitive sheets are introduced into the developing tray 1 through a pair of parallel guide plates 23 and 24 which define therebetween a passage P . An exposed photosensitive sheet is introduced into the open righthand side of the passage P between the guide plates 23 and 24. It proceeds then leftwardly and downwardly within the passage P and is gripped between a pair of conveyor rollers 25 and 26 which rotate in the shown directions and press against each other. A resilient guide plate 27 has an upper end secured to the guide plate 23 and a lower resiliently abutting the inner surface of the developing tray 1 near the ledge 1*b* thereof. An exposed photosensitive sheet is introduced between the guide plates 23 and 24 and enters the developing tray 1 between the resilient guide plate 27 and the inner curved wall of the developing tray 1. When the vanes 21 are rotated in the shown direction, i.e., clockwise, the vanes 21 agitate the developing agent 2 and simultaneously cause the photosensitive sheet which has been introduced into the developing tray to move along the inner wall of the developing tray 1 in the same direction as the direction of rotation of the vanes 21. Still simultaneously, because of the shape of the vanes 21, powder developing agent is pressed against the photosensitive sheet which is in the tray 1 such that the alkaline developing liquid adsorbed on the surface of the powder particles is transferred to the sheet to develop the latent image thereon into a visible image.

The agitating vanes 21 may perform the aforementioned functions of agitating the developing agent 2, moving the photosensitive sheet introduced into the tray and pressing developing agent thereagainst if they have shapes other than the shape shown in FIGS. 1 and 2. For example, the agitating vanes 21 may be planar, bent or curved in wave form to suit particular conditions. Additionally, the agitating vanes 21 may be mounted on the vane support plates 20 in different fashion from what is shown in FIGS. 1 and 2 and may face different directions. The vanes 21 may be mounted directly on the rotary shaft 12. Preferably, the inner surface of the developing tray 1 has a smooth finish for the purpose of facilitating the movement of exposed photosensitive sheets therealong.

The exposed photosensitive sheet which is developed while moving in the clockwise direction along the inner wall of the developing tray 1 emerges from the tray at the edge thereof adjacent the horizontal ledge 1*a*, i.e., the sheets which had been introduced at one transverse end of the developing tray 1 emerges at the opposite transverse end thereof. The photosensitive sheet emerging from the tray 1 enter extracting means which include a pair of facing guide plates 32 and 33 and a pair of delivery rollers 34 and 35 pressing against each other and adapted to grip therebetween the upwardly moving developed photosensitive sheet emerging from the developing tray 1. The rollers 34 and 35 rotate in the shown direction to feed upwardly the exposed and developed photosensitive sheet emerging from the developing tray 1.

The photosensitive sheet emerging from the tray 1 may have powder particles adhering thereto. For the purpose of removing such powder particles which may have adhered to the sheet in the course of its motion through the developing tray 1, the sheet emerging upwardly between the guide plates 32 and 33 is fed between two converging hair brushes 36 and 37, then between a roller 38 rotating in the direction shown in FIG. 1 and a sponge brush 39 pressing against the roller 38, and then between another roller 40 rotating in the direction shown in FIG. 1 and another sponge brush 41 pressing against the roller 40. It is noted that the sponge brushes 39 and 41 clean the opposite side of the sheet emerging between the hair brushes 36 and 37. The sponge brushes 39 and 41 cooperate with the rollers 38 and 40 respectively to give a finished appearance to opposite surface of the developed photosensitive sheet. Another roller 42 disposed above the roller 40 is maintained in pressing engagement therewith to grip the finished photosensitive sheet and to eject it onto a receiving tray 43. The rollers 34, 35, 38, 40 and 42 are suitably journalled on the side walls 4.

For the purpose of insuring more efficient removal of powder particles which may have adhered to the photosensitive sheet conveyed through the developing tray **1**, the guide plates **32** and **33**, the hair brushes **36** and **37** and the sponge brushes **39** and **41** are vibrated by vibrating means which include an electric motor **58**. The electric motor **58**, which is suitably mounted to the side walls **4**, has a shaft **59** driving a disc **60**. The disc **60** has an eccentric pin **61** extending therefrom. The eccentric pin **61** reciprocates a vibration transmitting member **55** in a direction transverse to the plane of FIG. **1**. The vibration transmitting member **55** is connected by screws **56** and **57** to the top end of a resilient plate **52** which is in turn connected by means of screws **53** and **54** to a support plate **49** having a bent portion **49a** affixed to the hold down plate **7** and to a supported **48** for the guide plates **32** and **33** and for the hair brushes **36** and **37** and the sponge brush **39**. The support plate **49** is connected by a screw **50** to one of the side walls **4** through a rubber cushion **51**. A support plate **62** for the sponge brush **41** is connected by means of a connector **63** to the motor **58**.

When the motor **58** is suitably rotating its shaft **59**, the vibrations caused by the cooperation between eccentric pin **61** and the vibration transmitting member **55** vibrate the guide plates **32** and **33**, the hair brushes **36** and **37** and the sponge brushes **39** and **41** to facilitate removal of developing agent particles which may have adhered to a developed sheet. Additionally, the vibration has the effect of promoting the agitation of the powder developing agent **2** in the developing tray **1** since it is also transmitted to the developying tray **1**.

Since it is desirable to agitate the developing agent **2** in the developing tray **1** only when photosensitive sheets are being developed in the tray **1**, means are provided for turning on the rotary agitating means only when a photosensitive sheet is about to enter the developing tray and for turning off the rotary agitating means when the developed sheet has emerged from the tray **1**. In particular, a actuator **29** for a microswitch **28** is mounted between the guide plates **23** and **24** in the path of an exposed photosensitive sheet which is about to enter the developing tray **1**. Additionally, an actuator **45** of a microswitch is disposed in the path of an exposed and developed photosensitive sheet emerging from between rollers **40** and **42**. When a photosensitive sheet is introduced between the guide plates **23** and **24** its leading edge moves the actuator **29** of the microswitch **28** to trip the microswitch **28** just before the photosensitive sheet enters the developing tray **1**. After a sheet has been developed and cleaned of developing agent particles adhering thereto, it moves the actuator **45** to trip the microswitch **44**.

Referring to FIG. **3**, the microswitch **28** which is at the entry point for exposed sheets is normally open but is closed by a sheet entering the developing tray **1**. The microswitch **45** is normally closed; hence, when the microswitch **28** is closed, a relay **46** is energized to close a switch **47** bypassing the microswitch **28**. The motor **19a** is now turned on and it starts turning the drive sprocket **19** in the indicated direction through a clutch **31**. Once the relay **46** is energized by the closing of the microswitch **28**, the motor **19*a*** remains turned on even after the microswitch **28** is opened because the trailing edge of the photosensitive sheet introduced between the guide plates **23** and **24** is now below the actuator **29**. The motor **19a** remains operating as long as the microswitch **44** remains closed. After a photosensitive sheet has been developed and has been suitably cleaned off of adhering powder, its leading edge emerging between the rollers **40** and **42** and moves the actuator **45** to open the microswitch **44**. The power supplied to the motor **19*a*** is now cut off and the motor **19*a*** stops rotating the rotary agitating means. The relay **46** is also de-energized. It is appreciated that the motor **58** may be connected either in series or in parallel with the motor **19*a*** such that the motor **58** is also operating only while a photosensitive sheet is in its path between the microswitches **28** and **44**. It is also appreciated that the motors **19*a*** and **58** may be left on for continuous operation if so desired.

I claim:

1. A diazo type developing device using powder developing agent comprising fine powder with adsorbed developing liquid for developing exposed copy sheets having diazo type material on one side thereof, said developing device comprising a developing tray holding a quantity of said developing agent and having a trough-shaped smoothly curved bottom wall flanked by longitudinally spaced side walls, means adjacent one end of the tray, for introducing an exposed copy sheet into the tray, with the diazo material side of the sheet facing the powder developing agent in the tray and with the other side of the sheet facing and abutting the curved bottom wall of the tray, means for agitating the developing agent in the tray and for moving the sheet introduced into the tray along the direction in which the sheet is introduced, said agitating and moving means being out of direct contact with the moving sheet but acting thereon through the agitated developing agent, whereby the movement of the sheet through the agitated powder developing agent serves to develop the sheet, and means adjacent the other end of the tray for extracting the sheet from the tray.

2. A developing device as in claim **1** wherein said tray is semicircular in transverse cross-section.

3. A developing device as in claim **2** wherein said agitating and moving means comprise a plurality of vanes mounted for rotation about an axis parallel to the length of the tray in the direction of movement of the sheets introduced into the tray.

4. A developing device as in claim **3** wherein each of said vanes has a front end portion which is bent in a direction substantially opposite to and forming an angle with the direction of rotation of the vane, whereby a wedge-shaped space gradually diverging in the direction of rotation of the vane is formed between the front end portion of each vane and the inner curved wall surface of the developing tray.

5. A developing device as in claim **4** including means for causing rotation of the vanes in the direction of movement of the sheet introduced into the tray at the time a sheet is introduced into the tray and for stopping the rotation of the vanes when the sheet introduced into the tray is extracted by said extracting means.

6. A developing device as in claim **5** wherein said extracting means include vibrating brush means for removing, from the extracted sheet, powder developing agent that may have adhered thereto.

7. A developing device as in claim **6** wherein the vibrating brush means includes a pair of converging hair brushes flanking the path of a developed sheet extracted from the tray, a pair of roller-sponge brush

units, and means for vibrating the hair brushes and the sponge brushes.

8. A developing device as in claim **5** wherein the extracting means includes brushes for removing powder which may have adhered to the extracted sheet, and including means for vibrating the brushes and for transmitting vibrations to the tray for facilitating agitation of the developing agent therein.

9. A developing device using powder developing agent and comprising a developing tray holding a quantity of said developing agent and having a trough-shaped bottom wall which is smoothly curved in transverse section, means adjacent one end of said curved bottom wall for introducing a sheet into the tray, and means for agitating the powder developing agent in the tray and for moving the sheet from the end of the curved bottom wall at which it is introduced into the tray toward the other end of said bottom wall, said agitating and moving means being out of direct contact with the moving sheet but acting thereon through the agitated developing agent, said agitating and moving means comprising a plurality of vanes and means for mounting the vanes for rotation about an axis which is within the curvature of said curved bottom wall and in the direction of movement of the sheet introduced into the tray.

10. A developing device as in claim **9** wherein each of said vanes has a front end portion which is bent in a direction substantially opposite to and forming an angle of less than 180° with the direction of rotation of the vane, whereby a wedge-shaped space gradually diverging in the direction of rotation of the vane is formed between the front end portion of each vane and the curved wall surface of the developing tray.

11. A developing device as in claim **10** including means for causing said rotation of the vanes in response to the introduction of a sheet into the tray and for stopping said rotation of the vanes in response to a sheet leaving the developing tray.

12. A device as in claim **9** including means adjacent the other end of said curved bottom wall for extracting a sheet from the tray.

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