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ELECTROSTATIC DEVELOPING APPARATUS

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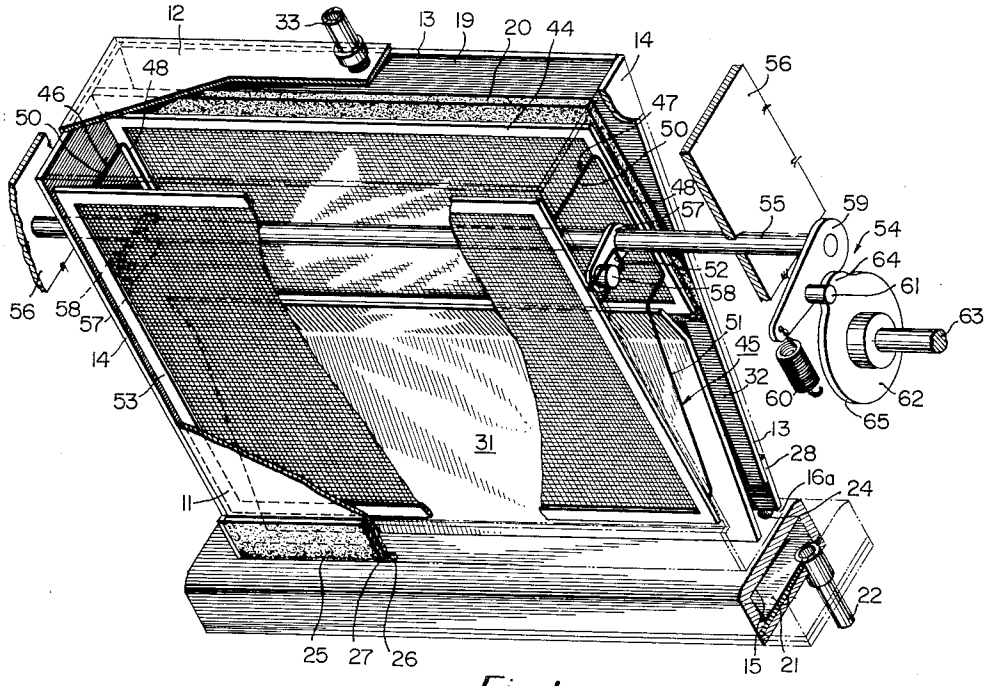


Fig. 1

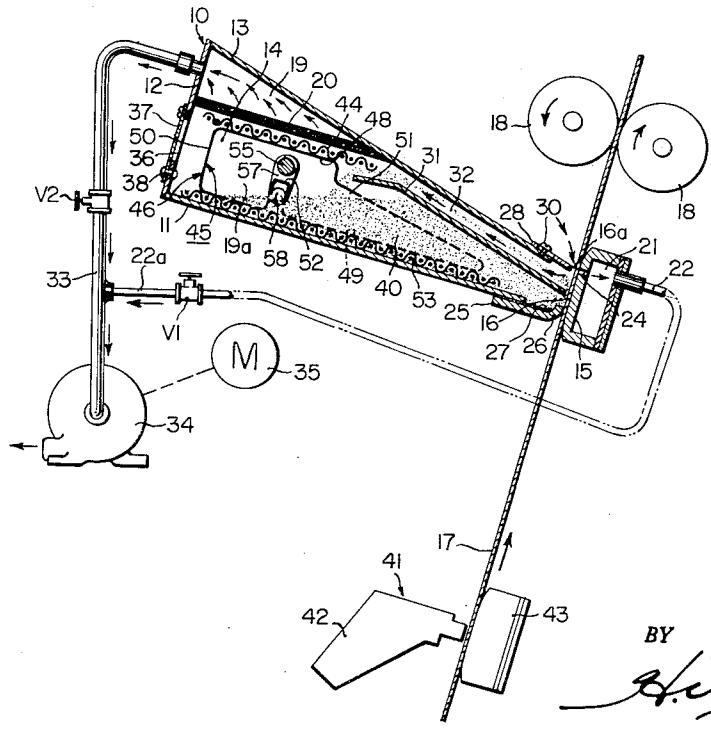


Fig. 2

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ELECTROSTATIC DEVELOPING APPARATUS

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The invention hereinafter described and claimed has to do with electrostatic apparatus and more particularly to apparatus for visibly developing information electrostatically recorded on a recording medium.

The electrographic recording process consists broadly of three steps. The first step comprises establishing, or printing, electrically charged areas on selected portions of a recording medium, which are representative of information. The second step consists of developing such charged areas on the recording medium by means of an inking powder thus to make them visible. The third step, which is optional, consists in fixing, or rendering such developed areas substantially permanent. In the electrographic recording process, these three steps take place sequentially and at physically separate locations.

The recording medium is preferably made of a backing layer, or web of paper, on one side of which is bonded a thin layer of high resistivity, or dielectric material. The web of paper is moved through the printing apparatus where the electrostatically charged areas are established and from this station it passes to the inking and fixing stations sequentially.

During the developing or inking of the latent electrostatic image, developing powder or ink will adhere to the electrostatically charged areas, thus to make them visible. Unfortunately under some conditions inking powder will also adhere to the background or uncharged portions of the recording material. This is an undesirable condition as it tends to obscure the desired information, therefore, it is an important object of the present invention to provide novel apparatus for developing or inking electrostatically recorded information or images in a manner overcoming this disadvantage.

More specifically, it is an object of the present invention to provide a novel inking device for images electrostatically recorded on a record medium whereby ink adhering to the uncharged or background areas of the recording medium is removed.

Another object of the invention is to provide such apparatus which will recover the ink removed from the non-charged or background areas of the recording medium.

In accordance with the above objects and first briefly described, the invention comprises apparatus through which an electrostatically charged web of recording material may be passed for developing the charged areas with inking powder which is maintained in contact with the charged side of the web. The inking powder is housed in a chamber maintained at slightly below atmospheric pressures whereby ambient air is drawn into the housing at high velocity across the inked surface of the web of recording material as it leaves the housing, thereby removing the ink particles adhering to the non-recorded or background area of the web. Means is provided in the housing for recovering the ink so removed from the web.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered with the accompanying drawings, wherein;

FIG. 1 is a perspective view looking upwardly from the bottom and with parts broken away to better show the interior of the apparatus; and

FIG. 2 is a diagrammatic transverse sectional view of the apparatus of the invention and showing associated apparatus.

Referring now to the drawings illustrating the preferred form of the invention and first to FIG. 2, it will be seen that the apparatus comprises a housing **10**, somewhat triangular in cross-section, and formed by a bottom wall **11**, a back wall **12**, a top wall **13**, side walls **14**, and a front wall **15**. The forward or right hand ends of walls **11** and **13** terminate short of front wall **15** thus to provide an inlet opening or slot **16** and an outlet opening or slot **16*a*** respectively, both of which extend from one side wall **14** to the other and together provide a passageway through which the record medium is threaded. While other types of record medium may be used, in the presently described embodiment of the invention it is a web of paper **17** of the type described above. It will be understood that the web of paper may be fed through the housing continuously, as by rollers **18**, or incrementally step-by-step, by means not shown. Even in the latter case the speed may be such that it can be described as being substantially constant.

The housing is divided into upper and lower compartments **19** and **19*a*** respectively, by a filter element **20** suitably fixed to the interior walls of the housing. While other types of filters may be used, it is preferred to use one commonly known as an "Oilite" filter of the type manufactured by the Chrysler Corporation.

Front wall **15** comprises a part of an elongated chamber **21** maintained at below atmospheric pressure, by suitable means hereinafter described, and connected thereto by a pipe **22**. The front wall **15** is provided with a plurality of apertures **24**, only one of which is shown, aligned across its face opposite the end of housing wall **13**. The pressure differential across these apertures maintains the web tightly against front wall **15** when being fed through the housing, thus to keep the paper from fluttering at that point during operation of the apparatus, as explained more fully hereinafter.

A strip of flexible material **25**, such as felt, is secured by suitable means, along the front edge of bottom wall **11**. The forward edge **26** of the felt member is turned upwardly and maintained flexed against the web **17**—or wall **15**, if no web is present—by means of a spring leaf **27** also suitably secured to the front edge of bottom wall **11** and terminating adjacent the front edge of the felt member **25**. Inlet opening **16** thus is sealed in a manner preventing ink from spilling out of the housing yet permitting a limited amount of air to enter, for the purpose to be explained later.

Secured across the front or right hand edge of the top wall **13** of housing **10** is a plate **28** which is adjustable toward and away from web **17** to provide means for adjusting the size of slot **16*a*** in the area between the forward edge of plate **28** and web **17**. Adjustment of the plate toward and away from the web may be in any con-

venient and well known manner, such as by the slot and screw connection shown at **30**.

Still with reference to FIGURE 2, it will be seen that lower chamber **19***a* has a divider plate **31** which extends across the length of the chamber with its opposite ends secured to side walls **14**. The front portion of plate **31** extends across the narrow forward portion of chamber **10** with its front edges very close to web **17** as the latter passes through the inking station. Plate **31** also extends rearwardly toward rear wall **12** at the larger portion of chamber **19***a*, and in cooperation with top wall **13** forms an air duct **32** within the chamber the purpose of which is explained later. The left hand edge of plate **31** terminates beneath the right hand side of filter element **20** and is slightly bent in a downwardly direction toward bottom wall **11**.

Chamber **19** of the housing **10** is connected by a pipe **33** to a pump **34**, driven by a motor **35** for maintaining the interior of housing **10** at a below atmospheric pressure. Pump **34** may also be used for reducing the pressure in chamber **21** by connecting pipe **22** to pipe **33**, as indicated at **22***a*.

Pipes **22** and **33** are provided with adjustable valves **V1** and **V2**, respectively, to provide means for controlling the pressures within compartments **19**, **19***a* and **21** to suitable values for producing the desired results. For example, in this embodiment of the invention valve **V1** is regulated to maintain the pressure in chamber **21** at about 4″ of mercury, while valve **V2** is regulated to maintain compartment **19** at a pressure equalling 1″ of mercury. The pressure drop across filter element **20** produces a pressure in chamber **19***a* equal to 2″ of water. Thus it will be understood that close control of the pressure in compartments **19** and **19***a* will produce a substantially constant velocity of air into the housing through outlet opening **16***a*. The pressure of felt member **25** against web **17** is such that a small amount of air also enters compartment **19***a* between the felt member and the web thereby keeping the ink agitated at that point and thus providing a constant stream of ink over the paper as it passes through the housing.

Rear wall **12** is provided with an aperture **36** normally sealed by a closure member **37** pivotally mounted on wall **12** as at **38**. This aperture provides means whereby a supply of electrically conductive inking powder **40** may be poured into chamber **19***a* beneath wall **31**.

In the operation of the apparatus, motor **35** operates pump **34** to reduce the pressures in chambers **19**, **19***a*, and **21** to below atmospheric pressure, as described above, causing a high velocity constant flow of air into the housing through opening **16***a*. Web **17**, previously fed through slots **16** and **16***a* is drawn tightly against wall **15** to prevent fluttering of the paper across opening **16***a* which would interfere with the flow of air into the housing through the opening. Rollers **18** are then rotated, by means not shown, to move web **17** through the apparatus.

Information is electrostatically charged or printed on the web by the appratus shown at **41**, which includes at least one, but preferably a row of printing heads **42** and a back-up electrode **43**, which may be in accordance with the apparatus described in the copending application of Epstein et al. Serial No. 714,767, filed February 12, 1958, and assigned to the assignee of the present invention, or which may be in accordance with the apparatus described in U. S. Patent No. 2,919,171, also assigned to the assignee of the present invention. Incidentally, a suitable ink is also disclosed in this co-pending application.

As the charged paper moves through the lower portion of the housing between sealing member **25** and plate **31**, ink particles adhere to the latent image on the charged portions of web **17** thus visibly developing these images. Unfortunately, as mentioned above, some of the ink also may adhere to the background or uncharged areas of the web. However, in particular accordance with an important feature of the present invention, as the web of paper passes through the area between plates **31** and **28**, and through slot **16***a*, the high velocity of air flowing into the housing through slot **16***a*, as indicated by the arrows, sweeps across the paper and forcibly removes the unwanted ink adhering to the background area and carries it through duct **32** toward filter **20**. As the air reaches the large rear portion of chamber **19***a*, its velocity decreases and much of the ink entrained in the air will fall back into the ink supply in chamber **19***a*. The air will pass on through the filter into chamber **19** to be evacuated by pump **34**. Of course, some ink may adhere to the lower surface of filter **20** and apparatus is provided for removing excessive accumulations of this ink from the filter.

To this end, a wire mesh screen **44** is positioned across the lower surface of the filter by a skeleton wire frame **45** including framing members **46** and **47** positioned at opposite ends of chamber **19***a* (FIG. 1). Each of the framing members is formed by a bent wire and includes upper and lower parallel portions **48** and **49** respectively, connected at their ends by upwardly extending portions **50** and **51**. The lower portions **49** of each framing member includes a re-entrant portion **52**, and also serves as the means for carrying a wire mesh ink agitator element **53** of screen-like construction positioned across the bottom wall **11** of housing **10**. Both screen elements **44** and **53** are adapted to be reciprocated across the surfaces upon which they bear, as by the means shown more clearly at **54** in FIG. 1 and now to be described.

With reference to FIG. 1 it will be seen that a shaft **55** extends through compartment **19***a* and is journalled in fixed structure **56** of associated apparatus. Arms **57** depending from shaft **55** at opposite ends of chamber **19***a* are provided at their lower ends with a lug **58** extending into reentrant portions **52** of framing members **46** and **47**. The right hand end of shaft **55** is provided with a link **59** normally urged in a counter-clockwise direction by a coil spring **60**, one end of which is secured to the lower end of link **59** and the other end to fixed structure, not shown. A pin **61** secured to and projecting from link **59** is urged against the periphery of a cam member **62** fixed to a shaft **63**. Rotation of shaft **63**, by suitable means not shown, moves the high point **64** of the cam against lug **61**, thus to urge link **59** in a clockwise direction during the travel of pin **61** up to the crest of the high point, after which spring **60** urges the link in a counter-clockwise direction as the pin moves to the low point **65** corresponding to the periphery of the cam. Continuous rotation of cam **62** is effective to reciprocate the screen elements across their respective surfaces. The reciprocatory movement of screen element **44** across the lower surface of filter **20** is effective to scrape off the excessive ink tending to adhere to the bottom surface of the filter, from which it falls back into the ink supply. Reciprocation of screen element **53** across the upper surface of bottom wall **11** is effective to agitate and keep the ink feeding across the bottom wall toward the narrow end of the housing, thus to keep a continuous supply of ink at that point and against the web **17** as it feeds through the housing. Preferably housing **10** is canted at a slight angle, as shown, to gravitationally facilitate the ink flow toward the front end of the compartment where the air entering between the felt sealing element **25** and the web of paper keeps the ink stirred up at that point thus to provide a constant stream of ink over the paper.

We claim:

1. Apparatus for visibly developing images electrostatically recorded on a record medium comprising, a housing for holding a supply of inking powder, said housing having inlet and outlet openings through which said record medium may be passed through said housing with the electrostatically charged record on said record medium in contact with said inking powder as the record

medium passes through said housing thus to develop the images recorded thereon, and means establishing a pressure drop across said outlet opening from the outside to the inside of said housing thereby to cause a stream of ambient air to flow into said housing through said outlet opening and across the inked surface of said record medium thereby to remove ink adhering to the uncharged areas of said record medium and return to said supply of inking powder within said housing.

2. Apparatus in accordance with claim 1 and including means at said outlet opening to prevent flutter of said record medium by the air entering said opening.

3. Apparatus according to claim 2 wherein said means to prevent flutter of said record medium comprises means for producing a pressure differential on opposite sides of said record medium.

4. Apparatus in accordance with claim 1 and further including means permitting a controlled amount of air to enter said chamber at said inlet opening.

5. Apparatus according to claim 4 wherein said last means comprises a flexible member resiliently urged against said recording medium.

6. Apparatus for visibly developing images electrostatically recorded on one side of a record medium comprising, a housing for holding a supply of inking powder, said housing having inlet and outlet openings through which said record medium may be passed through said housing, the electrostatically charged side of said record medium being in contact with said inking powder as the record medium passes through said housing thus to develop the images recorded thereon, and means for causing a stream of air to flow into said housing through said outlet opening and across the inked surface of said record medium thereby to remove ink adhering to the uncharged areas of said record medium, said last means comprising low pressure apparatus connected to the housing for maintaining a below atmospheric pressure within said housing.

7. Apparatus according to claim 6 and further including means for controlling the pressure within said housing thus to maintain said air flow into the housing through the outlet opening at a substantially constant velocity.

8. Apparatus according to claim 6 and further including a filter positioned within said housing between said low pressure apparatus and said outlet opening to remove ink entrained in the air flowing into said housing across the record medium thus to prevent ink from entering said low pressure apparatus.

9. Apparatus according to claim 8 and further including means to remove accumulations of ink on said filter and return the removed ink to said ink supply.

10. Apparatus according to claim 8 wherein said housing is canted upwardly away from said inlet opening thereby to cause said ink to flow toward said opening.

11. Apparatus according to claim 10 and further including means for agitating said ink supply.

12. Apparatus according to claim 8 and further including means to remove accumulations of ink from said filter and return the removed ink to said ink supply, and means for agitating said ink.

13. Apparatus according to claim 12 and further including means for actuating said last two means simultaneously.

14. Apparatus according to claim 13 wherein said ink removing means and said agitating means comprises screen elements, frame means interconnecting said screen elements, and means operable to reciprocate both screen elements simultaneously.

15. Apparatus according to claim 8 wherein said filter element divides said housing into two compartments, one of which is in direct communication with said low pressure means thus to maintain said one compartment at one pressure and the other compartment holding the supply of ink at a higher pressure due to the pressure drop across said filter, both pressures being below atmospheric, said other compartment being in open communication with the ambient atmosphere through said outlet opening.

16. Apparatus for inking information electrostatically recorded on a record medium, comprising, a housing defining a narrow front area and a larger rear area, filter means positioned across a portion of said larger area and dividing said housing into first and second compartments, the first of which is located in said larger area and the second of which comprises the remainder of said housing for holding a supply of inking powder, the walls of said second compartment having inlet and outlet slots defining a passage through the said narrow area of said housing and through which said record medium is threaded with the electrostatically charged surface thereof facing inwardly and in contact with said supply of inking powder within said second compartment, said outlet opening being of a size greater than the area thereof occupied by said record medium when passing through said opening, means defining an air duct within said second compartment, one end of said air duct being in communication with said outlet opening and the other end being in communication with the larger area of said housing adjacent said filter means, and means connected to said first compartment for maintaining both compartments below atmospheric pressure during operation of the apparatus whereby a substantially constant flow of ambient air is induced through said outlet opening and into the housing, said air sweeping across the inked face of said record medium to remove excess and unwanted ink adhering to said face, the inking powder entrained in said air flow passing through said duct and into said larger area where it is returned to said ink supply.

17. Apparatus for inking information electrostatically recorded on a record medium, comprising, a housing of substantially triangular cross section defining a narrow front area including a front wall and a larger rear area, filter means positioned across one corner of said larger rear area thus to divide said housing into first and second chambers, the second of which is adapted to hold a supply of inking powder, the walls of said second chamber having inlet and outlet slots defining a passageway across said front wall and through which said record medium is threaded through said chamber with the electrostatically charged areas thereof facing inwardly and in contact with said supply of inking powder within said second chamber, the area of said outlet slot being greater than the area occupied by the portion of said record medium when in said slot, means defining an air duct within the second of said chambers, one end of said air duct being in communication with said outlet slot and the other end being in open communication with the larger area of said housing adjacent said filter means, low pressure means connected to said first chamber for maintaining both chambers below atmospheric pressure during operation of the apparatus whereby a flow of ambient air is induced through said outlet slot and into said housing, sweeping across the charged face of said record medium to remove excess and unwanted ink adhering to said face, the inking powder entrained in said air flow passing through said duct and into said larger area where it is returned to said ink supply, and means drawing said record medium tightly against said front wall during operation of the apparatus.

18. Apparatus according to claim 17 wherein said last means comprises means cooperating with said front wall to define a chamber, and means connecting said last mentioned chamber to said low pressure apparatus, and wherein said front wall includes a row of apertures adjacent said outlet slot whereby the pressure drop through said apertures is effective to so draw said record medium against said front wall.

19. Apparatus in accordance with claim 18 and further including means for removing an accumulation of ink on said filter means, and means for agitating said ink.

20. Apparatus according to claim 19 wherein said ink removing means comprises a scraper element and said agitating means comprises an agitator element, and further including means interconnecting said scraper and agitator, and means for simultaneously actuating said last mentioned two elements.

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