United States Patent [19]

Harpavat

[11] **3,906,899**

[45] **Sept. 23, 1975**

[54] **DEVELOPER SEAL**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

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[52] **U.S. Cl.** **118/637;** 117/17.5

[51] **Int. Cl.²** **G03G 15/08**

[58] **Field of Search** 118/637; 117/17.5

[56] **References Cited**

UNITED STATES PATENTS

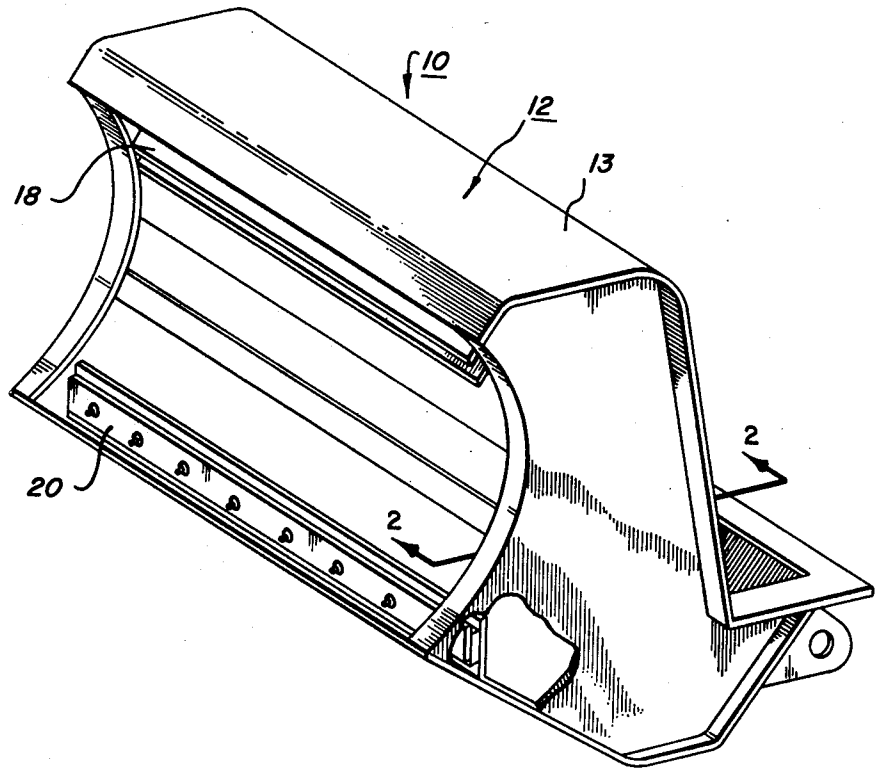
3,015,305	1/1962	Hall et al.	117/17.5
3,133,834	5/1964	Sowiak	118/637
3,332,328	7/1967	Roth, Jr.	118/637
3,635,196	1/1972	Tsilibes	118/637
3,809,012	5/1974	Delvecchio	118/636
3,814,515	6/1974	Takahashi et al.	118/637
3,840,879	10/1974	Catabrette et al.	117/17.5

Primary Examiner—Mervin Stein
Assistant Examiner—Douglas Salser

[57] **ABSTRACT**

A developer housing seal for electrophotographic apparatus in which an image developer material comprising magnetic particles is applied to a photoreceptor surface inside a developer housing held adjacent the photoreceptor. A magnetic seal is provided for retaining the developer in the developer housing, utilizing the magnetic particles, which are magnetically attracted by the magnetic fields of the seal. The seal is U-shaped, having a channel with two parallel spaced thin magnetic pole edge seal areas and a much wider recess therebetween to contain captured magnetic material. A seal is formed which reduces the likelihood of photoreceptor damage. A thin non-magnetic overlying protective shield slides off for cleaning of the seal.

8 Claims, 5 Drawing Figures



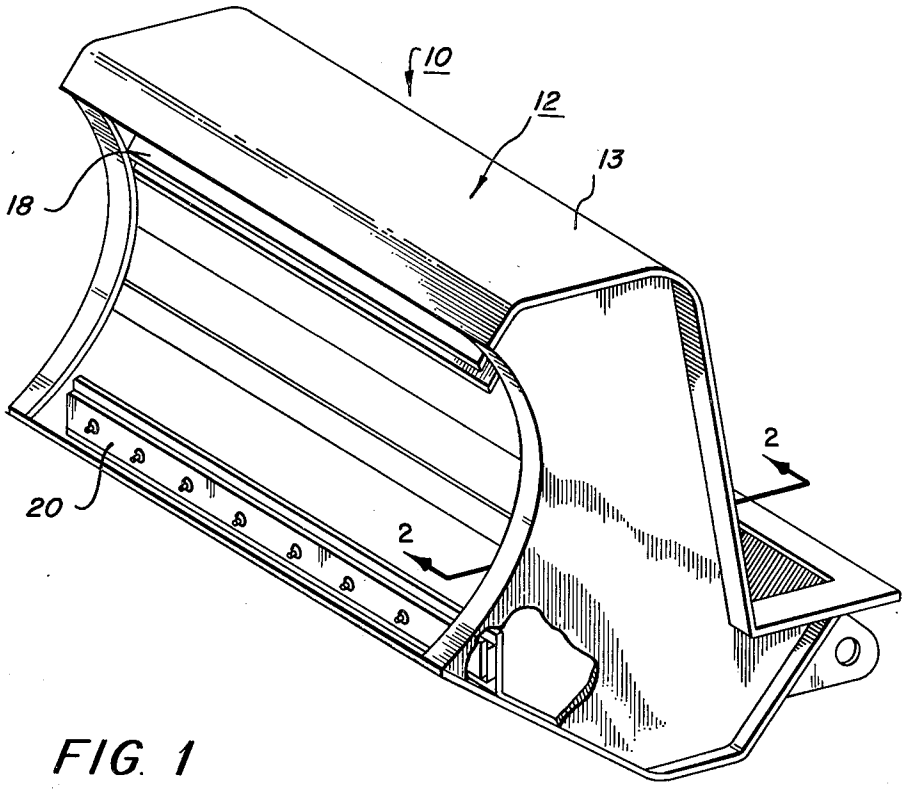


FIG. 1

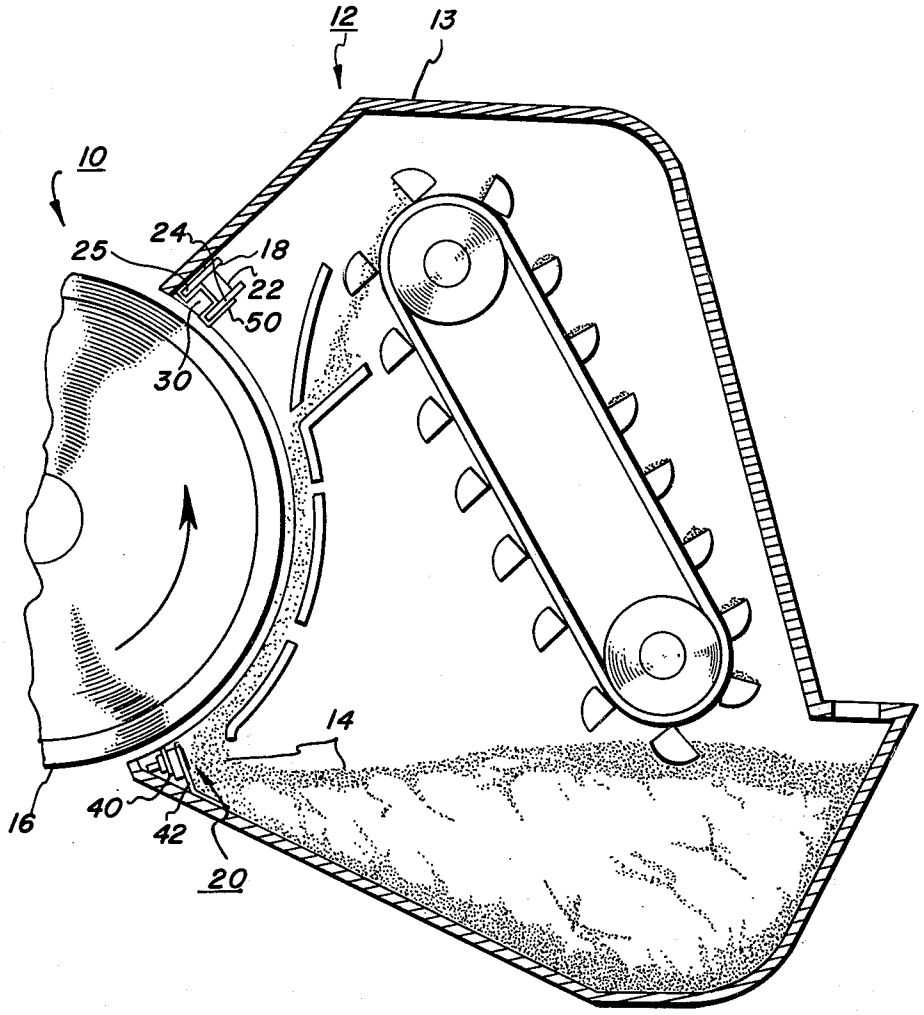


FIG. 2

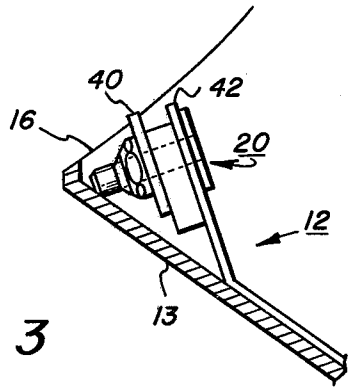


FIG. 3

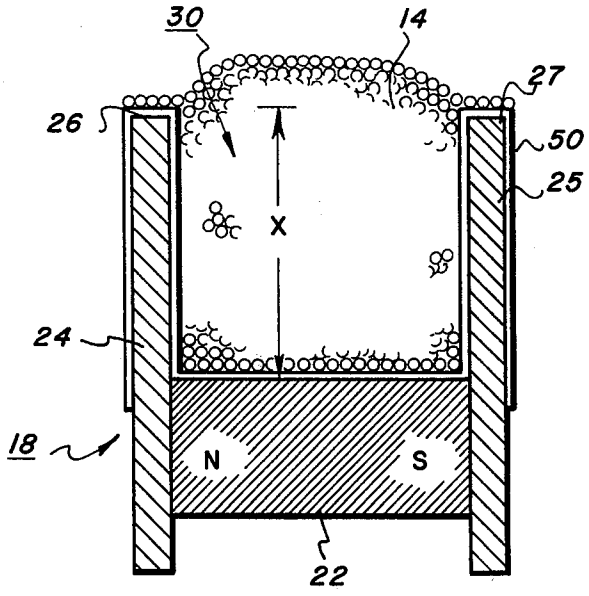


FIG. 4

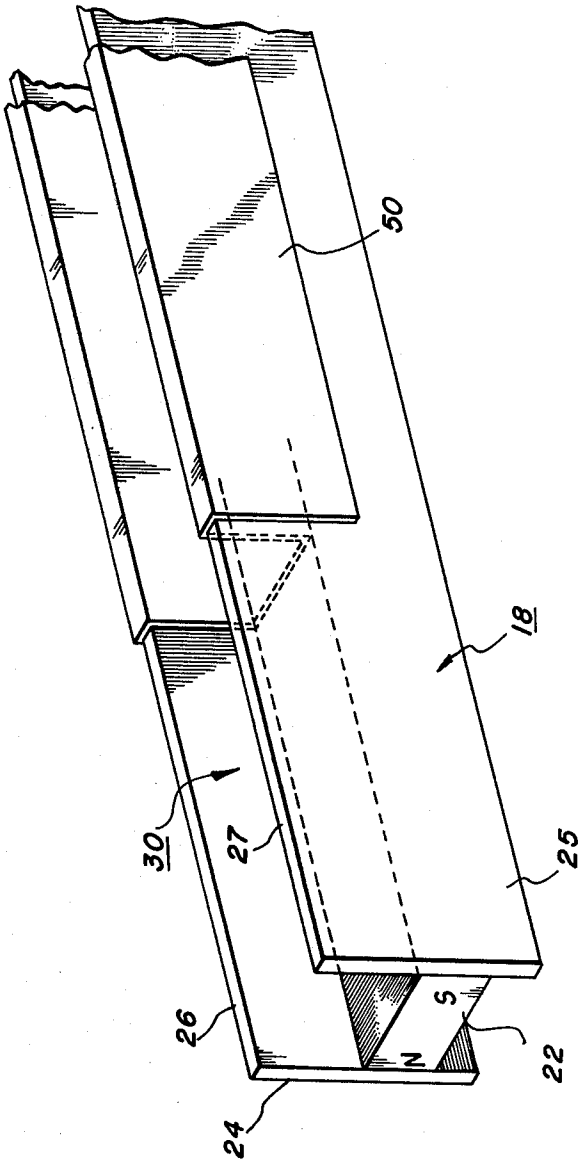


FIG. 5

DEVELOPER SEAL

The present invention relates to an improved seal for electrostatographic apparatus, and more specifically to a magnetic seal providing improved retention of xerographic image developer.

The problems of developer escape, and machine contamination thereby, are long-standing ones in the electrostatography art. Developer, which typically includes a mix of small carrier beads and very fine dry toner particles, is very difficult to confine. The material is electrostatically attractable and carries electrical charges. The developer is subject to considerable movement and agitation within the machine since it is normally cascaded, magnetically brushed, sprayed, or otherwise vigorously applied to an imaging surface to be developed.

The difficulty of confining or sealing the moving developer within a desired development area of the machine is even further aggravated in the classic xerographic machine configuration in which the surface to be developed is a segment of a curved moving surface of a drum of selenium or other sensitive photoconductive materials. The developer must be confined within a large developer housing opening fitting against the outside edges of the desired segment of the photoreceptor surface without damaging or obstructing this surface. A complete seal is not desired at the downstream end, since the imaging surface must exit the development station with the developed toner image on it.

The peculiar characteristics of developer material and the requirements for protecting the photoreceptor surface preclude the use of many types of seals which would be suitable for different materials or different environments. Thus, in successful commercial practice xerographic developer seals have typically comprised frictional sealing side strips of suitable resilient materials, e.g., U.S. Pat. No. 3,809,012, issued May 7, 1974, to G. D. Delvecchio, and magnetic end seals. Magnetic seals are suitable with developer having magnetically attractable particles therein, such as steel shot carrier beads, ferrite particles, etc. For this invention the magnetic material in the developer may be the carrier, the toner, both, etc.

One example of a magnetic seal in xerography is disclosed in a reference of interest to this application, U.S. Pat. No. 3,133,834, issued May 19, 1964, to M. M. Sowiak. Further, magnetic top and bottom xerographic developer housing seals have been commercially utilized for several years in the Xerox Corporation "4000" copier, for example. They retain the steel carrier bead material within the developer housing. They function to prevent this magnetic material from escaping by its mechanical agitation, gravity, or at the top, by being carried away over the exiting imaging surface.

The build up of magnetic material at the magnetic seal can be utilized to form a seal with the material itself against further material escape, including non-magnetic material. Although conventionally used as end seals, transverse the direction of movement of the imaging surface, magnetic seals could also be used as side seals in certain applications.

The photoreceptor surface being developed is subjected to thousands of developer particles or beads being brushed, or rolled and bounced, over the photoreceptor surface at any given moment of time. Thus,

the agitated developer particles are continuously attempting to escape under the seals of the developer housing.

Once developer material escapes past the developer housing seals, it can scatter within the body of the copy machine. There it can interfere with or seriously damage various machine components. Escaped toner particles are readily attractable to other charged surfaces or charged elements within the machine.

Developer material tends to build up or accumulate at the developer housing seals. While, as noted, some build up may be desirable to form a part of the seal, excess build up and impaction interferes with or degenerates the seals. Excess developer build-up or entrapment adjacent to and directly under the seal can encourage developer escape in a conventional magnetic seal. This build up of material at the conventional magnetic seal can cause scratching or other photoreceptor damage if it becomes sufficiently impacted. The present invention provides a structure which can provide a much larger and softer seal area, yet not have a correspondingly large magnetic material build up and escape problem. It provideds a lower magnetic material build up density, (less impaction) for less danger of photoreceptor damage.

There is also taught herein a simple and effective seal cleaning arrangement using a non-magnetic removable shield. U.S. Pat. No. 3,015,305, issued Jan. 2, 1962, to R. H. Hall et al. is noted as a reference in this regard, although it teaches a different application.

An exemplary embodiment of the present invention is shown and described hereinbelow as incorporated in an otherwise conventional exemplary xerographic apparatus and process. Accordingly, said xerographic process and apparatus need not be described in detail herein, since various printed publications and patents and publicly used machines are available which teach details of various suitable exemplary electrophotographic structures, materials and functions to those skilled in the art. Some examples are disclosed in the books *Electrophotography* by R. M. Schaffert, and *Xerography and Related Processes* by John H. Dessauer and Harold E. Clark, both first published in 1965 by Focal Press Ltd., London, England; and the numerous patents and other references cited in these books. All references cited herein are hereby incorporated by reference in this specification, where appropriate.

Further objects, features and advantages of the present invention pertain to the particular apparatus and details whereby the above-mentioned aspects of the invention are attained. Accordingly, the invention will be better understood by reference to the following description and to the drawings forming a part thereof, which are substantially to scale, wherein:

FIG. 1 is a perspective view of an exemplary xerographic development station having two magnetic seal embodiments in accordance with the present invention;

FIG. 2 is a simplified schematic view of the development station of FIG. 1 operatively associated with a xerographic drum photoreceptor with the end of the developer housing cut away for clarity;

FIG. 3 is an enlarged detail view of the bottom magnetic seal of the embodiments of FIGS. 1 and 2;

FIG. 4 is an enlarged detail cross-sectional view of the top magnetic seal of FIGS. 1 and 2; and

FIG. 5 is a partial perspective view of the top magnetic seal of FIGS. 1 – 2 and 4, illustrating the removal of its non-magnetic shield for cleaning.

Referring now to the drawings, FIGS. 1–5, there are illustrated two different magnetic seal embodiments in accordance with the present invention illustrated in an otherwise conventional xerographic development system. Specifically, FIGS. 1 and 2 illustrate, as part of a conventional electrostatographic system 10, a conventional development station 12 having a developer housing 13 containing developer material 14, e.g., steel bead carrier plus toner. The developer material 14 is shown in FIG. 2 being conventionally utilized for cascade development of an imaging surface 16. The imaging surface 16 here is the upwardly moving surface of a xerographic photoreceptor drum. This is an "up hill cascade" xerographic development system, as utilized in the Xerox "4000" copier. Since all of the details of this development station 12 and electrostatographic system 10, other than the magnetic seals to be described herein, may be conventional, they will not be described herein and reference may be had to the previously cited references for appropriate details thereof.

As may be seen in FIGS. 1 and 2, a carrier bead carry-over magnetic seal 18 is positioned across the top edge of the developer housing 13. A pick-off baffle magnetic seal 20 is positioned across the lower edge or opening of the development housing 13. The carry-over seal 18 is further illustrated in FIGS. 4 and 5, and the pick-off baffle magnetic seal 20 is further illustrated in FIG. 3. The basic structure and function of both of the magnetic seals 18 and 20 is quite similar and the description of one will apply to the other herein unless otherwise noted specifically.

The upper or carry-over seal 18 in this particular developer station 12 functions to prevent magnetizable carrier beads in the developer material 14 from being carried up on the imaging surface 16 past this seal, as by electrostatic attraction. The magnetic field of the seal 18, and the "brush" of magnetic material magnetically attracted to this seal 18, prevents this bead "carry-over." The seal 18 must function without smearing or otherwise disrupting the toner image which has been developed on the imaging surface electrostatically within the development station 12.

The lower or pick-off baffle seal 20 prevents the gravity induced or other leakage of developer material 14 down past this seal 20. This must be done without disturbing the electrical latent image on the imaging surface 16 as it enters the developer station 12.

In the prior art, magnetic seals of the Xerox "4000" copier, or the Sowiak U.S. Pat. No. 3,133,834, cited above, the structures differ in an important respect from those illustrated herein. In these prior art structures, the magnetic seal presents an effectively flat surface facing the imaging surface. This can cause a hard and excessively thick magnetic brush of the attracted developer material to form on the surface of the magnetic seal. In the prior "4000" copier seal, as the magnetic material continues to be picked off the imaging surface and deposited on the flat front of the magnetic seal, it forms an increasingly impacted brush which can begin scraping of the imaging surface after a sufficient operating time. In addition to potentially damaging the photoconductor, as the attracted brush becomes excessively thick some of the captured beads can rub off of the brush and escape. The disadvantages and problems caused thereby have been previously noted in the specification introduction. These prior seals also required frequent cleaning off of the magnetic material. This cleaning was difficult, requiring, for example, a strong air blast or vacuum cleaner to overcome the magnetic retraction. This or mechanical wiping required removal of the entire developer station from the xerographic apparatus to avoid its contamination by escaping material.

In contrast, in the present magnetic seal there is provided a large recessed channel opening between two separated magnetic seal areas. This channel recess provides a magnetic material retaining and soft brush formation area thereby providing greatly improved magnetic sealing characteristics, and eliminating the above-described disadvantages.

Referring to the carry-over magnetic seal 18, as shown in detail in FIGS. 4 and 5, this seal 18 comprises a field generating bar magnet 22 which also functions as a spacer substantially separating two pole pieces or keepers 24 and 25 of magnetic field conducting material, i.e., magnetizable iron or steel thin plates. The pole pieces 24 and 25 have, respectively, thin pole piece edges 26 and 27, both extending toward and spaced from the imaging surface 16. The pole pieces are oppositely magnetized by the bar magnets 22. The pole pieces 24 and 25 and their edges 26 and 27 extend parallel and evenly spaced apart across the imaging surface 16. The magnet 22 here provides this mounting and separation of the pole pieces 24 and 25. However, this could be provided by other spacing means. Also, other magnet arrangements could be utilized to provide the desired magnetizing of the edges 26 and 27 and a magnetic field between the pole pieces 24 and 25.

It may be seen that the substantially parallel spaced interior surfaces of the pole pieces 24 and 25 extend substantially downwardly in from their edges 26 and 27 to the bar magnet or other spacer 22, and that all three components thereby form a U-shaped channel recess 30 between the pole pieces which extends away in depth from the imaging surface 16 and the edges 26 and 27, with its opening towards all three. This channel recess 30 has a depth below the pole piece edges 26 and 27 (normal the imaging surface) illustrated by the distance "X" in FIG. 4. This arrangement of the magnet 22 and the pole pieces 24 and 25 provides a magnetic field which magnetically attracts the magnetically attractable developer material 14 toward the extending pole pieces 24 and 25 and also into the channel recess 30 therebetween. The channel recess 30 provides a retaining area of a width substantially greater than that of the edges 26 and 27 in the direction of movement of the imaging surface 16. The channel recess 30 also has a depth "X" preferably greater than the width of these edges 26 and 27. By way of 3xemplary appropriate dimensions the channel recess 30 may have a width between the pole pieces of 3/16 inch, pole pieces each of approximately 1/16 inch thickness (also here the width of the edges 26 and 27) and a depth X of ⅛ to 13/16 inches. However, no close tolerances are required for this arrangement.

Referring now to the lower or pick-off baffle magnet 20 illustrated in enlarged detail in FIG. 3, it is basically the same structure and function as magnetic seal 18. However, it may be seen that it is tilted relative to the imaging surface 16 so that one pole piece edge 40 is positioned substantially closer to the imaging surface 16

than the other pole piece edge **42.** With this arrangement the pole piece edge **42** (which is at the inboard side of the development station **12** and, therefore, the first to contact any magnetic developer material **14** attempting to escape therefrom) is further away from the imaging surface **16.** Thus, this pole piece **42** has a greater clearance available for the formation of a larger and softer magnetic brush of developer material. Any material not captured by the pole piece **42** and the channel recess between it and the other pole piece edge **40** will be captured by the closer pole piece edge **40.** Being closer to the imaging surface **16,** the pole piece edge **40** provides a stronger and more attractive magnetic field in the smaller gap between it and the imaging surface **16.**

For both of the illustrated magnetic seals **18** and **20** herein, the theory of their improved sealing will be discussed. The depth of the channel recess **30** (shown by the distance X in FIG. **4**) may be large compared to other dimensions of the seal. However, since the pole pieces or keepers **24** and **25** are of a high magnetic permeability material the magnetic field at the edges **26** and **27** is virtually independent of the depth X. Thus the increase in the depth X can be utilized as a storage space for the magnetic particulate material accumulated by the seal without substantially changing the magnetic field force needed for an efficient seal with the imaging surface **16.** The large space provided by the channel recess **30** between the pole pieces **24** and **25** for this bead storage allows the magnetic brush formed by the captured beads (or other magnetic particles) to be much softer and less abrasive to the photoreceptor. The magnetic field concentration at the tips of the keepers (the pole piece edges **26** and **27**) is reduced by the presence of the magnetic material in the gap between the pole pieces. The rate of the magnetic brush build-up out away from the edges **26** and **27** can be controlled by adjusting the distance X, so that imaging surface **16** scraping is eliminated and also so that magnetic material leakage due to an excessively thick brush is avoided. This is in contrast to the situation in the cited Sowiak patent structure for example, where, since there is no storage space for the magnetic material other than in the plane of the pole piece edges the magnetic field would be strongly concentrated at those points which would undoubtedly cause a relatively harder magnetic brush to form there, in addition to mechanical compaction problems, especially if that structure were attempted to be used as a downstream rather than upstream seal.

Referring particularly to FIGS. **4** and **5,** it may be seen that there is provided herein as an additional feature a magnetic seal shield **50** of a thin non-magnetizable material. It may be seen that the shield **50** closely overlies all of the magnetic seal **18** facing toward the imaging surface **16.** It is genrally M-shaped with the two outer portions thereof closely overlying the pole piece edges **26** and **27** and with the central portion thereof conforming to the U-shape of the channel recess **30** so as to provide a complete material containing lining for the channel recess. The shield **50** slidably mounts to the seal **18,** and is slidably removable from the seal transversely of the imaging surface **16.** It allows the developer material to be easily removed from the magnetic seal, and thereby provide an improved cleaning arrangement for the magnetic seal.

Since the shield covers all of the portions of the seal which magnetically attract developer material **14,** this material is confined against the shield **50.** It is confined only by the magnetic field of the magnetic seal acting through the shield **50.** Accordingly, upon the removal of the shield from the magnetic seal, as illustrated in FIG. **5,** the magnetic field is removed from the material thereon, and this material is then freely removable from the shield. In fact, as the seal slides out of the macahine, the material thereon will demagnitize and fall off immediately as each segment thereof slides past the end of the magnetic seal. Since almost all of the material will be retained until it reaches the edge of the magnetic seal, the magnetic seal **18** can be easily cleaned in this manner without removing the development station **12** from the electrostatographic apparatus. The material can be captured by a container held at this one point as only the shield is pulled out of the electrostatographic apparatus.

In the orientation illustrated in FIGS. **1** and **2** of the seal **18** the magnetically attractable material is not retained in the channel recess **30** seal **50** portion by gravity. However, in an upwardly opening seal location the material can be retained in the channel recess in the shield by gravity as it is removed.

The material of the non-magnetic shield **50** can be, for example, 4 mill thick brass shimstock, plastic, or the like. The presence of a shield **50** overlay of this thinness does not significantly affect the magnetic field at the tips of the pole pieces, i.e., the edges **26** and **27,** and the dimensional tolerances are not critical. The non-magnetic shield **50** material can be much softer than that of the magnetic material from which the pole pieces themselves are constructed. It can also be somewhat resilient. Thus, the shield **50** can protect against inadvertant damage of the imaging surface **16** by direct contact.

The shield **50** can protect the imaging surface **16** by appreciably reducing the frictional forces between the attracted magnetic material and the magnetic seal. It has been observed that with the shield **50** that the magnetic brush formed within the channel recess **30** tends to build up from the bottom of the channel recess.

It is believed that the presence of the shield **50** allows the tangential component of the magnetic force tending to pull the magnetic material down into the channel recess **30** to be greater than the frictional force holding the magnetic material against the inside walls of the pole pieces **24** and **25,** since these walls are overlaid by the intervening shield **50.** This further tends to reduce the hardness of the magnetic brush formed by the seal. In contrast, it has been observed that without the shield **50,** the magnetic brush of developer material **14** begins building up at the edges **26** and **27** and need to be pushed inside the channel recess **30.** With the shield **50,** the magnetic brush starts building right from the bottom of the gap and the maximum brush thickness projecting out of the seal face (i.e., above the plane of the edges **26** and **27**) is independent of the distance X and much softer.

The magnetic seals disclosed herein are presently considered to be preferred; however, it is contemplated that future variations and modifications within the purview of those skilled in the art can be made herein. The following claims are intended to cover all such variations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In electrostatographic copying apparatus wherein an image on an imaging surface is developed with imaging development material comprising magnetically attractable material in a developing station, and wherein a magnetic seal is provided adjacent said imaging surface to at least partially confine said developer material, the improvement in said magnetic seal wherein said magnetic seal comprises:

a pair of elongated magnetizable pole pieces extending across said imaging surface,

said pole pieces having thin edges extending toward, but spaced from, said imaging surface,

said pole piece edges being substantially spaced apart; and

spacing means between said pole pieces forming between said pole pieces edges an open channel recess extending away from said imaging surface and said pole piece edges,

said channel recess being open to receive said magnetically attractable material between said pole pieces,

said magnetic seal having a magnetic field magnetically attracting said magnetically attractable material to said pole pieces and into said channel recess.

2. The apparatus of claim 1, wherein said magnetic seal has a U-shaped configuration opening toward said imaging surface.

3. The apparatus of claim 1, wherein one said pole piece edge is positioned substantially closer to said imaging surface than the other.

4. The apparatus of claim 1, wherein said pole piece edges and said channel are overlaid with a non-magnetizable shield.

5. The apparatus of claim 4, wherein said shield is removable to remove said developer material from said magnetic seal.

6. The apparatus of claim 5, wherein said shield covers said channel recess and said pole piece edges and said magnetically attractable material is confined against said shield only by said magnetic field of said magnetic seal acting through said shield whereby upon the removal of said shield from said magnetic seal said magnetic material is removed with said shield and is freely removable from said shield.

7. The apparatus of claim 6, wherein said shield is slidably mounted to said magnetic seal and slidably removable therefrom transversely of said imaging surface.

8. The apparatus of claim 4, wherein said magnetic seal has a U-shaped configuration opening toward said imaging surface, and said shield is M-shaped with the outer portions thereof closely overlying said pole piece edges and with the central portion thereof conforming to the U-shape of said channel recess.

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