United States Patent [19]

Suzuki et al.

[11] **3,898,085**

[45] **Aug. 5, 1975**

[54] **SCREEN DRUM WITH SCREEN TENSION ADJUSTABLE AXIALLY AND CIRCUMFERENTIALLY**

[75] Inventors: **Shigeru Suzuki; Yasumori Nagahara**, both of Yokohama; **Yoshiharu Kagari**, Tokyo, all of Japan

[73] Assignee: **Electroprint, Inc.**, Cupertino, Calif.

[22] Filed: **Dec. 17, 1973**

[21] Appl. No.: **425,014**

Related U.S. Application Data

[63] Continuation of Ser. No. 168,180, Aug. 3, 1971, abandoned.

[52] **U.S. Cl.** ..... **96/1.5**; 355/3 R

[51] **Int. Cl.** **G03g 5/00**

[58] **Field of Search** ..... 96/1.5; 355/3; 160/385; 29/148.4 D, 119, 123

[56] **References Cited**

UNITED STATES PATENTS

1,744,267	1/1930	Hamel	160/385
3,004,592	10/1961	Norton	160/385
3,220,833	11/1965	McFarlane	96/1 R
3,327,369	6/1967	Catlin	29/119
3,453,712	7/1969	MacKendrick	29/148.4 D
3,625,604	11/1971	Pressman	355/3
3,645,614	2/1972	McFarlane	355/3
3,680,954	8/1972	Frank	355/3

Primary Examiner—Norman G. Torchin
Assistant Examiner—Judson R. Hightower
Attorney, Agent, or Firm—Townsend and Townsend

[57] **ABSTRACT**

A screen drum apparatus and method of constructing it wherein a pair of attaching strips are secured to the opposite long side marginal portions of a rectangular screen formed with a multitude of very small openings therein, and the screen is mounted on a drum framework comprising a pair of main structural frame members and at least one ring-shaped adjusting frame member. The attaching strips are respectively fastened to the periphery of the adjusting frame member and one of the main frame members so that the screen is circumferentially attached to the drum framework to produce a screen drum in which the attaching strips are interposed between the screen and the drum framework. When the screen is mounted on the drum framework in this way, the screen is spread taut circumferentially of the screen drum, and the spread of the screen across the width of the screen drum can be adjusted by moving the adjusting frame member toward or away from the main structural frame members.

5 Claims, 21 Drawing Figures

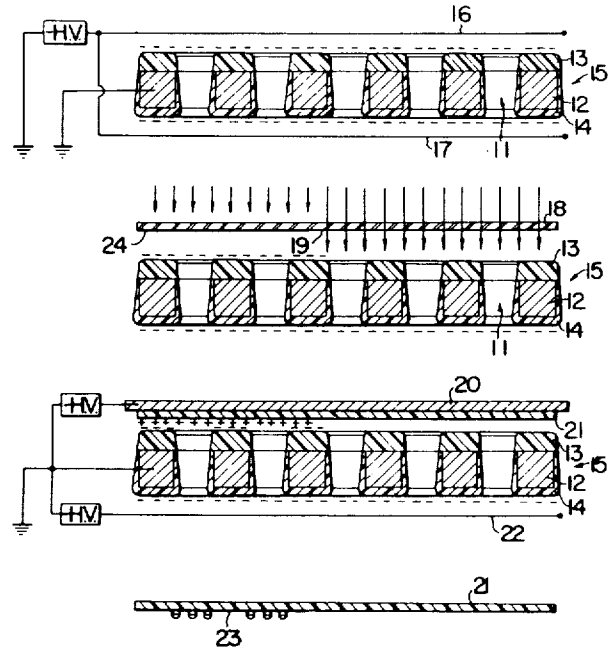


FIG. 1a

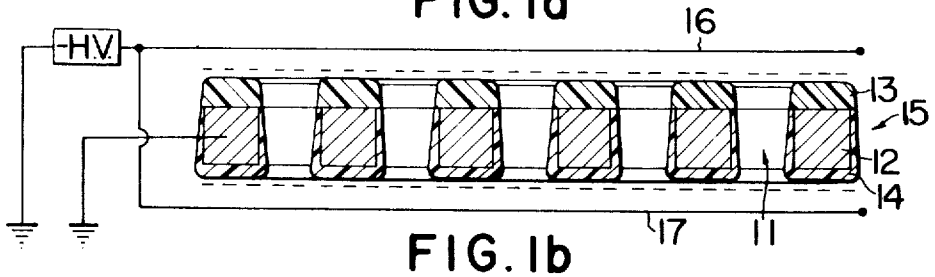


FIG. 1b

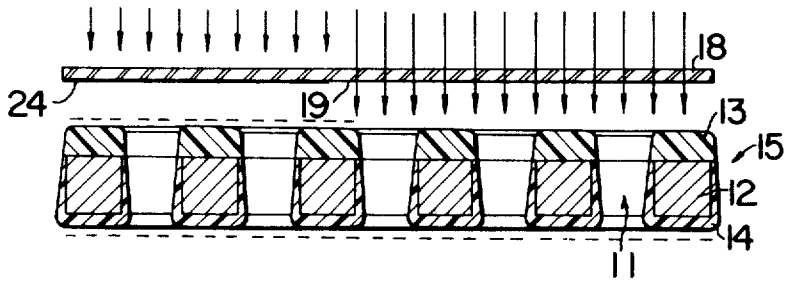


FIG. 1c

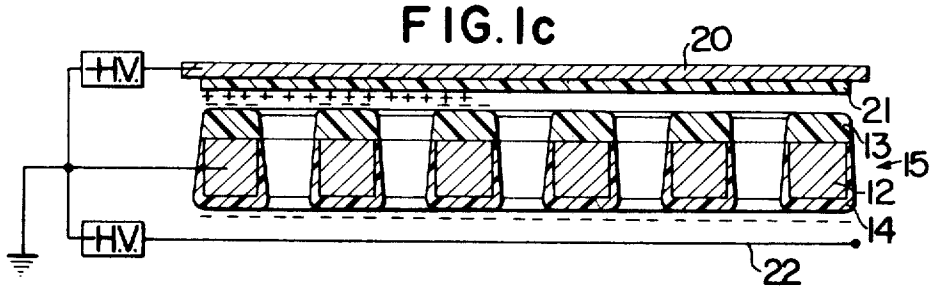
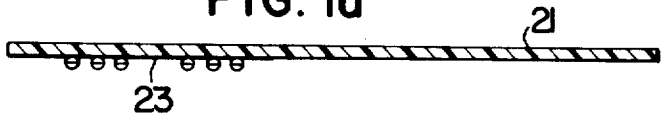


FIG. 1d



INVENTORS
SHIGERU SUZUKI
YASUMORI NAGAHARA
BY YOSHIHARU KAGARI
Henry G. Burke
ATTORNEY

FIG. 2

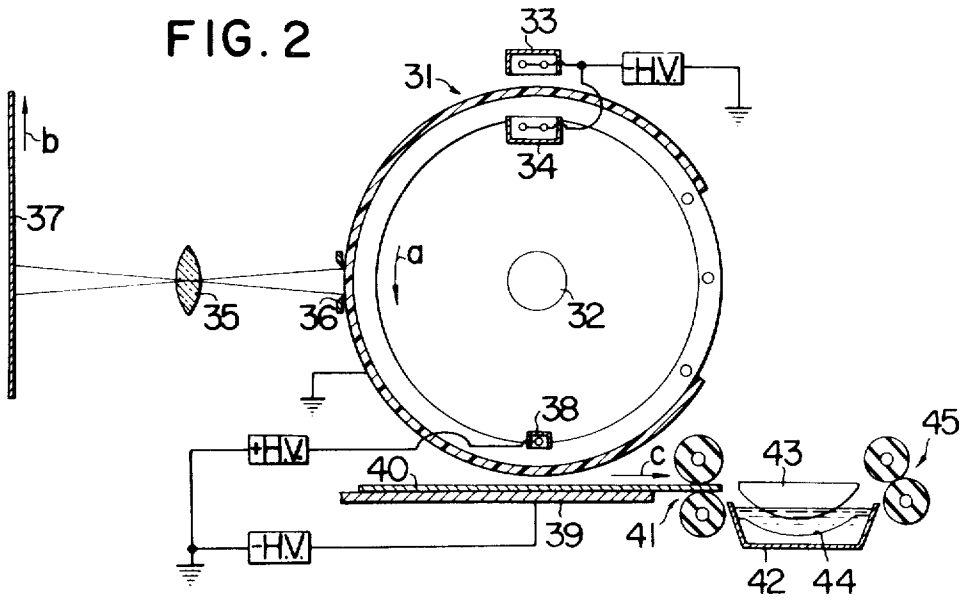


FIG. 3

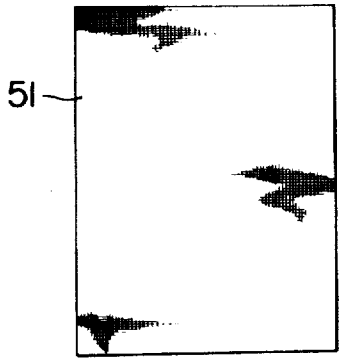


FIG. 4

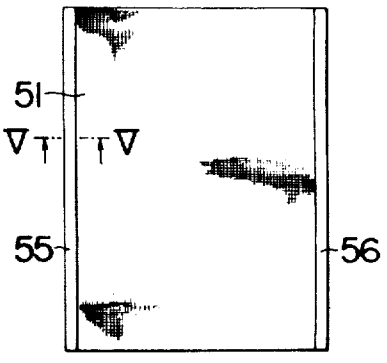


FIG. 5

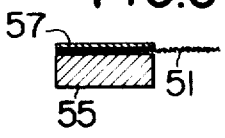


FIG. 6

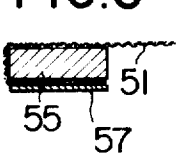
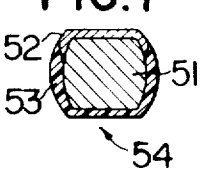


FIG. 7



INVENTORS
SHIGERU SUZUKI
YASUMORI NAGAHARA
BY YOSHIHARU KAGARI
Henry J. O'Sorke
ATTORNEY

FIG. 8

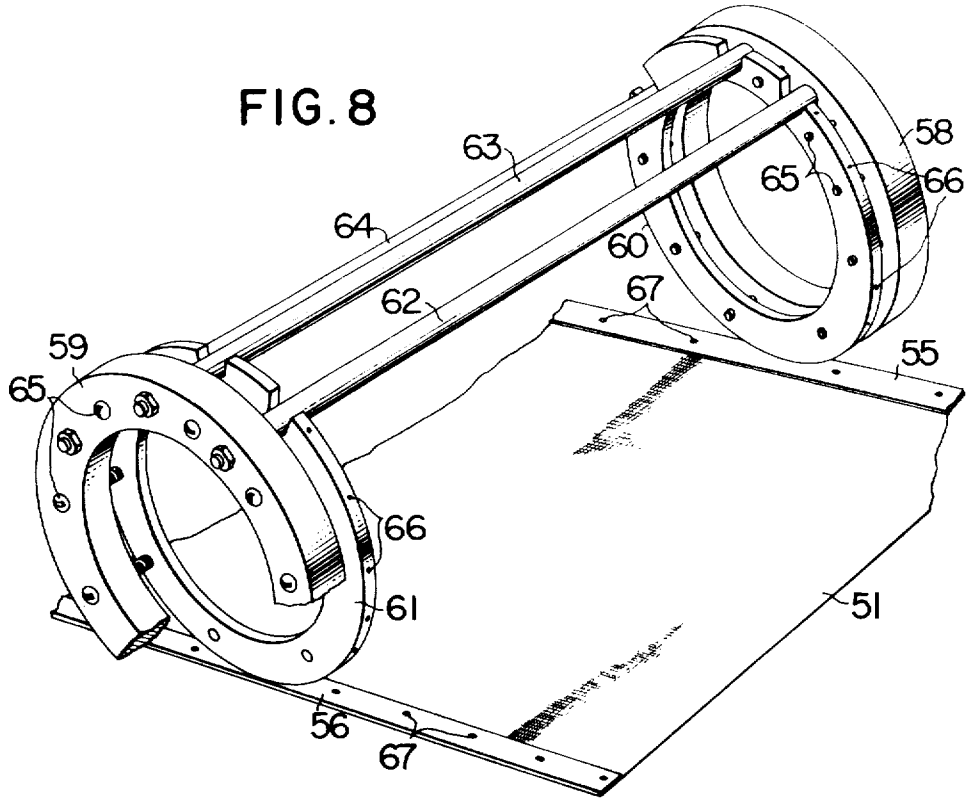


FIG. 9

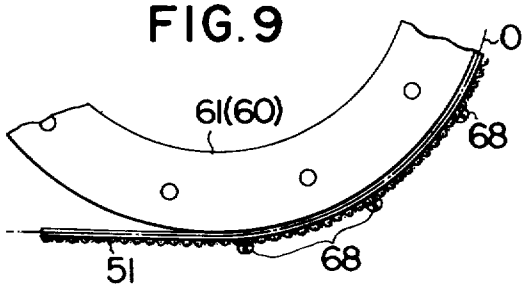


FIG. 10

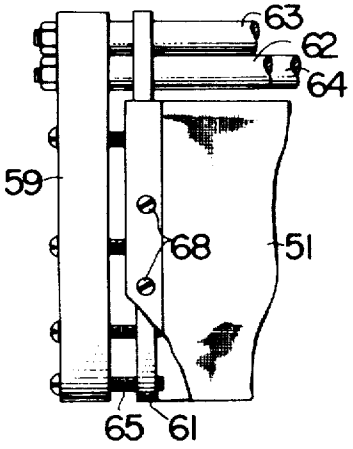
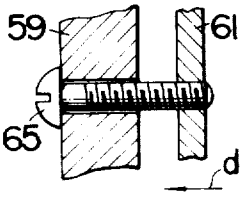


FIG. 11



INVENTORS
SHIGERU SUZUKI
YASUMORI NAGAHARI
BY YOSHIHARU KAGARI

Henry P. Burke
ATTORNEY

FIG. 12

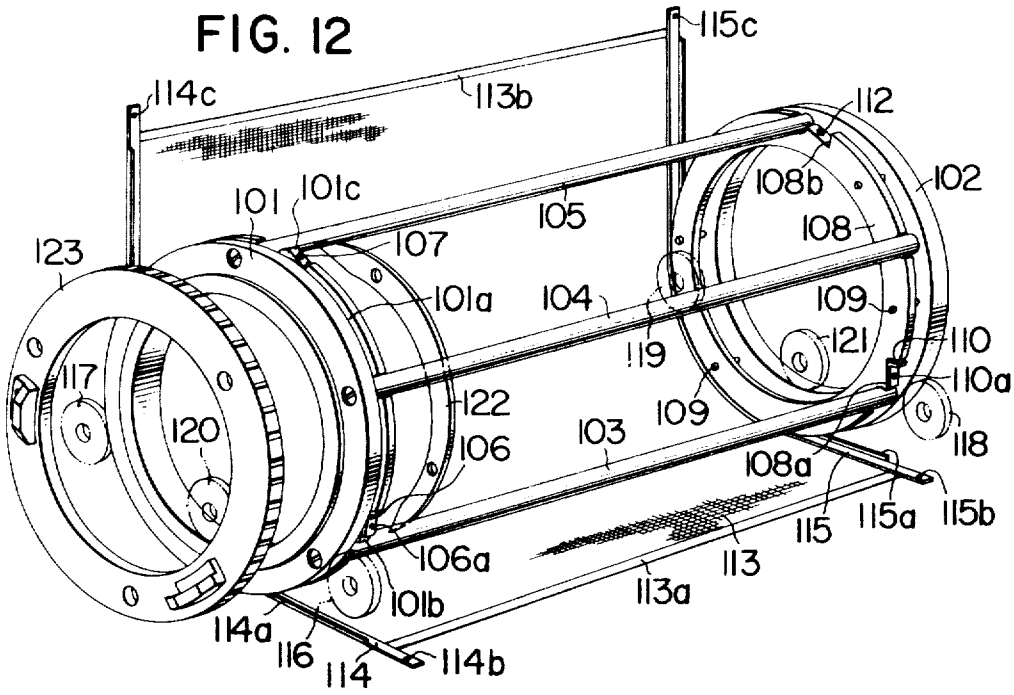


FIG. 13

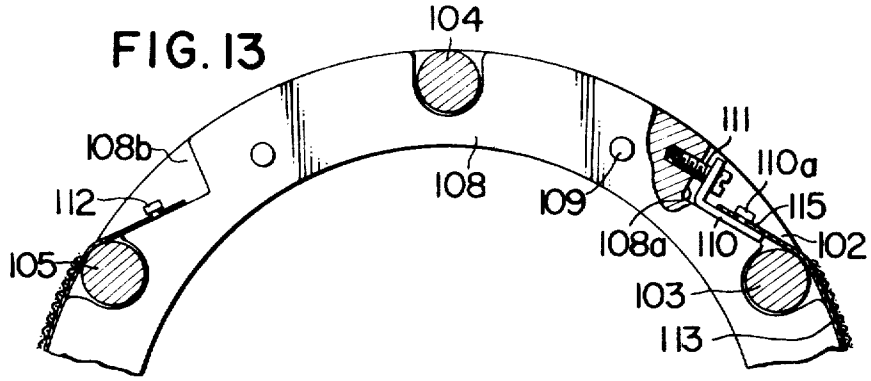
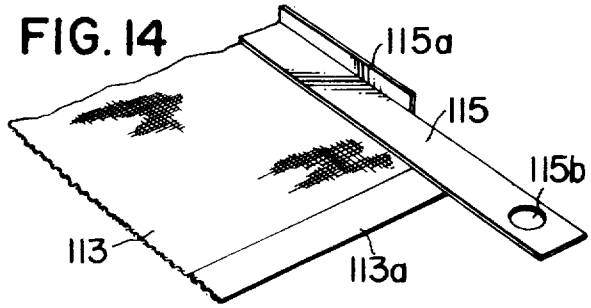


FIG. 14



INVENTORS
SHIGERU SUZUKI
YASUMORI NAGAHARA
BY YOSHIHARU KAGARI
Henry A. Sinker
ATTORNEY

FIG. 15

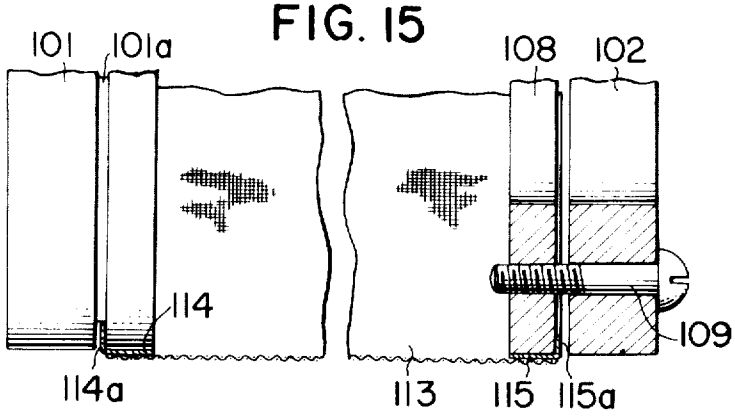


FIG. 16

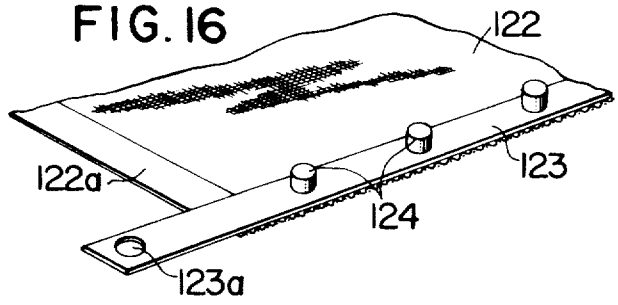


FIG. 17

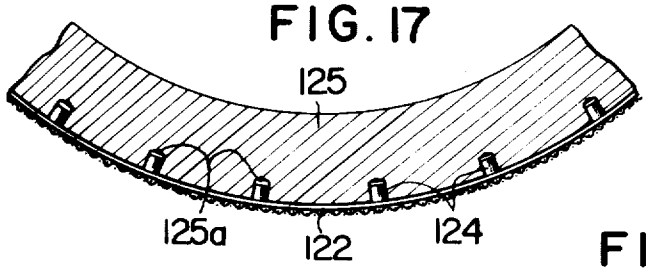
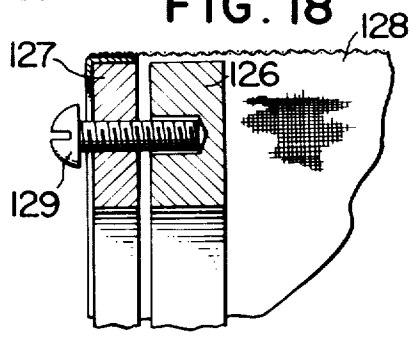


FIG. 18



INVENTORS
SHIGERU SUZUKI
YASUMORI NAGAHARA
BY YOSHIHARU KAGARI

Henry G. Barbee
ATTORNEY

SCREEN DRUM WITH SCREEN TENSION ADJUSTABLE AXIALLY AND CIRCUMFERENTIALLY

This is a continuation of application Ser. No. 168,180, filed Aug. 3, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to drums and more particularly to an apparatus and method for tautly mounting a screen on a drum support.

When a screen member having a multitude of very small openings therein is formed into a drum shape, such as for use as a cylindrical sieve or a photosensitive screen drum, it is required to use a framework for supporting the screen because the screen itself lacks a structure for supporting itself. Particularly, in the case of a cylindrical sieve or photosensitive screen drum in which high accuracy and precision is required of the dimensions of the openings or meshes therein, it is necessary to spread the screen taut on the support without distorting the correct shape and varying the size of the openings or meshes of the screen.

This invention has as its object the provision of a screen drum producing method and apparatus which permits a screen to be spread readily, smoothly and correctly on its supporting framework so that screen drums of high quality can be produced at reduced cost.

SUMMARY OF THE INVENTION

According to this invention, there is provided a screen drum wherein a screen is formed into a drum shape by attaching each of a pair of attaching strips to the opposite side marginal portions of the screen, and mounting it on a drum framework comprising a pair of main structural frame members and at least one ring-shaped adjusting frame member attached to a structural frame member by a plurality of screws by bringing the attaching strips into engagement with the drum framework and securing the same thereto so that the screen may be attached to the drum framework to produce a screen drum in which the attaching strips are interposed between the screen and the drum framework. The screen drum produced by the method according to this invention can have its screen spread taut both circumferentially and across the width of the screen drum, thereby permitting the production of a screen drum without distorting the shape and varying the size of the openings or meshes of the screen. The pair of main structural frame members and at least one ring-shaped adjusting frame member may be formed integrally to provide a drum framework in one piece.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1*a*–1*d* are views in explanation of an electrophotographic printing method using a photosensitive screen formed with a multitude of very small openings or meshes therein;

FIG. 2 is a sectional view of one embodiment of the electrophotographic printing apparatus adapted to carry the electrophotographic printing method into practice by using the photosensitive screen of FIG. 1;

FIG. 3 is a plan view of a photosensitive screen used for producing a photosensitive screen drum;

FIG. 4 is a plan view showing the manner in which a pair of attaching strips are secured to the screen of FIG. 1;

FIG. 5 is a sectional view of a portion of FIG. 4 taken along the line V—V thereof;

FIG. 6 is a sectional view showing the manner in which one of the attaching strips forming the pair is drawn inwardly after being secured to the screen;

FIG. 7 is a sectional view of a wire of the photosensitive screen, a multitude of such wires being connected together to form the photosensitive screen;

FIG. 8 is a perspective view of a pair of ring-shaped frame members to which the screen is being attached;

FIG. 9 is a fragmentary side view of FIG. 8;

FIG. 10 is a side view showing the construction in part of a screen drum produced by the method according to this invention;

FIG. 11 is a fragmentary sectional view showing means for adjusting the spread of the screen across the width thereof;

FIG. 12 is a developed perspective view of another screen drum produced by a modification of the method according to this invention;

FIG. 13 is a fragmentary sectional view of the ring-shaped structural frame member;

FIG. 14 is a fragmentary perspective showing the screen and attaching strip;

FIG. 15 is a front view showing the construction in part of the screen drum of FIG. 12;

FIG. 16 is a fragmentary perspective view showing another form of attaching strip for the screen;

FIG. 17 is a fragmentary sectional view showing the ring-shaped structural support member using the attaching strip of FIG. 16; and

FIG. 18 is a fragmentary sectional view of another screen drum produced by another form of the method according to this invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

The screen drums produced by the method according to this invention may have wide application, for example, as cylindrical sieves used in the chemical industry as well as photosensitive screens used in photocopying. It is to be understood, therefore, that the apparatus and method according to this invention can be carried into practice for producing screen drums used for many other purposes than for that which will be described.

This invention and its modifications will be explained with particular reference to its use with photosensitive screen drums. Photosensitive screen drums have particular utility in electrophotographic printing apparatus for carrying into practice electrophotographic printing methods using the principles summarized below.

In FIG. 1(*a*), there is shown a photosensitive screen **15** which is produced by providing a photoconductive material layer **13** on one surface of an electrically conducting plate **12** formed with a multitude of very small openings **11** and an insulating material layer **14** on the other surface thereof. The electrically conducting plate **12** formed with the multitude of very small openings **11** may be prepared by connecting together fine wires of iron, steel, stainless steel, aluminum, zinc, copper, nickel or chrome into a screen of **100** to **300** mesh or by adhering a suitable metal on a plastic screen by vaporization in vacuum. The photoconductive material layer **13** may be provided by applying selenium, selenium sulfide, a dispersion of zinc oxide resin, a dispersion of cadmium sulfide, poly-N-vinyl carbazole or other organic photoconductive material, either as it stands or after increasing its photosensitivity, to one

surface of the electrically conducting plate **12** by means of a spray gun or vaporization in vacuum, so that the layer may have a thickness of 5 to 200 μ. A suitable electrically insulating resin, such as tetrafluoroethylene resin or Teflon (trade name), or a suitable insulating paint may be used as a material for providing the insulating material layer **14**.

The operation of producing a duplicate of an original by using the photosensitive screen **15** constructed as aforementioned in positive-to-positive or negative-to-negative printing will be explained step by step.

First Step (See FIG. 1(*a*)): Wire electrodes **16** and **17** on which a high voltage is impressed are arranged in face-to-face relationship with opposite surfaces of the photosensitive screen **15** for subjecting the latter to a corona discharge while the photoconductive material layer **13** is grounded. The photoconductive material layer **13** and insulating layer **14** are both uniformly charged in the same polarity.

Second Step (See FIG. 1(*b*)): An orignal **18** of transparent paper is arranged in face-to-face relationship with the photoconductive material layer **13** and exposed to light as indicated by a number of arrows. The light transmitted through a non-image region **19** of the original **18** reaches the photoconductive material layer **13** but the light impinging on an image region **34** thereof is blocked thereby and does not reach the photoconductive material layer **13**. Thus, the charge carried by a region of the photoconductive material layer **13** corresponding to the non-image region disappears but the charge on a region of photoconductive material layer **13** corresponding to the image region **24** of the original **18** remains unaffected, so that an electrostatic latent image of the original **18** is formed on the photoconductive material layer **13**. All the charge carried by the insulating material layer **14** remains unaffected.

Third Step (See FIG. 1(*c*)): An electrically insulating copy sheet **21**, such as electrostatic recording sheet, intimately adhered to the back side of an opposite electrode plate is arranged in face-to-face relationship with the surface of the photosensitive screen **15** on one surface of which an electrostatic latent image has been formed, and a wire electrode **22** is arranged in face-to-face relationship with the other surface of the photosensitive screen **15**. A voltage of opposite polarity to the voltage impressed on the electrodes **16** and **17** is impressed on the wire electrode **22**, and a high voltage of opposite polarity to the voltage impressed on the wire electrode **22** is impressed on the wire electrode **22** is impressed on the opposite electrode plate **20**, so as to subject the copy sheet **21** to a corona discharge while the electrically conducting plate **12** is grounded. Thus, an electrostatic latent image corresponding to the electrostatic latent image formed on the photosensitive screen **15** but oppositely charged thereto is formed on the copy sheet **21**. This is believed to be due to the fact that the movement of a corona discharge current produced by the electrode **22** is blocked by portions of the screen **15** which carry charges only on the insulating material layer but facilitated by portions of the screen **15** which carry charges on both the photoconductive material layer **13** and insulating layer **14** when such current is going to pass through the openings **11** in the screen **15**, since the portions of the screen **15** carrying charges on the two layers **13** and **14** behave as if they carried no charge, resulting in the copy sheet **21** being charged by a current of corona ions that have passed through the openings **11**.

Fourth Step (see FIG. 1(*d*)): The electrostatic latent image formed on the copy sheet **21** as aforementioned is developed with a toner by a known process. In this way, a toner image **23** corresponding to an image **24** of the original is produced on the copy sheet **21**.

This duplicating method is suitable to positive-to-positive or negative-to-negative printing. When it is desired to obtain a duplication in positive-to-negative or negative-to-positive printing, one has only to repeat the aforementioned process by using a photosensitive screen which has no insulating layer provided thereon.

An electrophotographic copying apparatus will be described with reference to FIG. 2 which permits the continuous production of duplications of an original by using the photosensitive screen **15** arranged in drum shape to provide a photosensitive screen drum. In FIG. 2, there is shown a photosensitive screen drum **31** comprising a photosensitive screen (identical with the photosensitive screen **15** described above) which is produced by providing a photoconductive material layer and an insulating material layer on opposite surfaces of an electrically insulating plate formed therein with a multitude of very small openings, the photoconductive material layer being disposed on the outer side surface of the electrically conducting plate and the insulating layer on the inner side surface thereof. The photosensitive screen drum **31** is supported by a drive shaft **32** for rotation in the direction of the arrow *a*.

Electrically charging means **33** and **34** are disposed in the upper portion of FIG. 2 and arranged opposite each other with respect to the photosensitive screen of the photosensitive screen drum **31**. High voltages of the same polarity are impressed on the charging means **33** and **34** so as to subject the photosensitive screen drum **31** to a corona discharge to uniformly charge opposite surfaces of the photosensitive screen as the drum **31** rotates.

Upon completion of charging, the photosensitive screen of the photosensitive screen drum **31** is exposed, through a projection lens **35** and a slit member **36** disposed on the left side of FIG. 2 and in a slit system to an optical image of an original **37** moving in the direction of the arrow *b* in synchronism with the movement of the photosensitive screen drum **31**. Any other exposing means may be used.

The photosensitive screen on the photosensitive screen drum **31** on which an electrostatic latent image has been formed by the aforementioned process is then passed between charging means **38** disposed inwardly of the lower portion of the drum **31** and an opposite electrode plate **39** disposed outwardly thereof in FIG. 2.

An insulating copy sheet **40** is delivered to the opposite electrode plate **39** at a rate equal to the peripheral velocity of the drum **31** and in synchronism with the rotation of the drum **31**, and conveyed in the direction of the arrow *c* while being held intimately on the plate **39** by the negative pressure of the latter. During the movement of the copy sheet **40**, a high voltage of opposite polarity to the voltages impressed on the charging means **33** and **34** is impressed on the charging means **38** and a bias voltage of opposite polarity to the voltage impressed on the charging means **38** is impressed on the opposite electrode plate **39**, so that the copy sheet **40** being conveyed is subjected to a corona discharge.

Thus, an electrostatic latent image is formed on the copy sheet **40** which corresponds to the electrostatic latent image on the photosensitive screen of the drum **31** but which is oppositely charged thereto.

The copy sheet **40** on which an electrostatic latent image has been formed is delivered by a pair of conveyor rollers **41** to a developing solution tank **42** in which several rows of guide fins **43** and **44** are provided in the upper and lower portions. The copy sheet **40** is guided by these fins and discharged from the system to outside through a pair of squeeze rollers **45**. It is to be understood that the electrostatic latent image on the copy sheet **40** may be developed by any other known dry developing method than the wet developing method described above.

The photosensitive screen drum used in the aforementioned electrostatic copying apparatus is produced as described previously, by spreading a screen with a multitude of very small openings on a drum framework.

The present invention will be explained in detail with reference to FIGS. **3** to **11**. In FIG. **3**, there is shown a screen **51** which may be **30** to **60** μ thick, and produced by connecting fine wires of stainless steel together at a rate of **150** to **250** wires per inch in screen form and then pressing the product. This screen **51** may be made into a photosensitive screen **54** (see FIG. **7**), by applying a photoconductive material layer **52** and an insulating layer **53** as described previously on opposite surfaces of the screen **51**. The steps of the method according to this invention will be described with reference to embodiments using the screen **51**.

Firstly, attaching strips **55** ad **56** made of bronze or the like are each secured, as by soldering, to the opposite lateral marginal portions of the underside of the screen **51** lengthwise thereof. FIG. **5** shows in section the attaching strip **55** soldered to the screen **51** at **57**. The screen **51** with attaching strips **55** and **56** secured thereto is mounted in a manner presently to be described on a pair of ring-shaped adjusting frame members **60** and **61**, which are connected to a pair of main structural frame members **58** and **59** as shown in FIG. **8**. The structural frame members **58** and **59** which may also be ring-shaped, are firmly connected together by rigid support rods **62**, **63** and **64**, and may be made of a suitable metal of relatively low resilience having high resistance to forces exerted thereon circumferentially but of relatively low resistance to forces exerted on the end surfaces thereof. The adjusting frame members **60** and **61** are connected to the structural frame members **58** and **59** respectively by a number of screws **65** which are loosely connected to the frame members **58** and **59**. Three recesses may be formed in the peripheral edges of each of the frame members **60** and **61** for receiving the support rods **62**, **63** and **64** therein. Initially, the adjusting frame members **60** and **61** are not firmly secured but are movable axially of the support rods **62**, **63** and **64** by adjusting the screws **65**.

A plurality of threaded openings **66** are formed in the peripheral edge of each of the adjusting frame members **60** and **61**, and a plurality of threaded openings **67** corresponding in position to the threaded openings **66** are formed in each of the attaching strips **55** and **56** secured to the screen **51**. The screen **51** may be spread on a table or other surface with the attaching strips **55** and **56** facing upwardly and mounted on the adjusting frame members **60** and **61** by bringing the threaded openings **66** into index with the corresponding threaded openings **67** and threadably inserting screws **68** (see FIG. **9**) into the openings **66** and **67** to firmly attach the screen **51** to the frame members **60** and **61**. In this screen attaching operation, the support rods **62**, **63** and **64** are left uncovered with the screen **51**.

When the screen **51** is attached to the frame members **60** and **61** as aforementioned, the upper surface of the screen **51** is disposed outwardly of the outer peripheral surface of the resultant drum-shaped member. The screen **51** arranged in drum-shape is disposed outwardly of the attaching strips **55** and **56**, so that the screen **51** is subjected to a tensile force which stretches the portion of the screen **51** which is disposed outwardly of the center line **0**. As a result, the screen **51** is suitably stretched circumferentially of the drum-shaped member.

In securing the attaching strips **55** and **56** to the adjusting frame members **60** and **61**, an error which might otherwise occur in attaching the screen **51** to these members **60** and **61** can be obviated or minimized if the center part of the screen **51** is first connected to the frame members **60** and **61** and then successive portions are secured till finally the opposite end portions are connected. If the screen **51** is attached to the adjusting frame members **60** and **61** in the manner described, then the drum-shaped member produced substantially assumes the form of a screen drum, though the screen **51** may be somewhat loose across the width thereof. If any position of the screen **51** of the drum-shaped member produced in this way is loose across the width of the screen, then the screw or screws **65** at such portion of the screen **51** are turned to move the adjusting frame member **60** toward the structural frame member **58**. Since the ring-shaped frame member **61** offers a relatively low resistance to a force exerted on an end surface thereof as described previously, the portion of the frame member **61** corresponding to the loose portion of the screen **51** moves in the direction of the arrow *d* as shown in FIG. **11**. It is thus possible to locally adjust the spread of the screen **51**.

If the screws **65** are adjusted in all the portions of the structural frame members **58** and **59** by taking the spread of the screen **51** on its entire surface, then it is possible to obtain an optimum spread of the screen **51** so that the screen **51** is mounted taut on the frame members without being tightened or slackened. When this condition is obtained, the screen **51** and ring-shaped frame members **60** and **61** pull each other in tension and are positively supported by the structural frame members **58** and **59**.

In the aforementioned step, if the attaching strips **55** and **56** are drawn inwardly as shown in FIG. **6** by rotation after being secured to the screen **51**, it is possible to prevent the soldered portion **57** from being exposed to view. Besides, the screen **51** can be supported by the adjusting frame members more positively if the screen **51** is secured to the ring-shaped frame members **60** and **61** with opposite side portions of the screen **51** being folded into contact with the undersides of the strips, in mounting the screen **51** on the frame members **60** and **61**.

Modifications of the photosensitive screen drum and the method of producing it according to this invention will be described with reference to FIGS. **12** to **18**. In FIG. **12**, a pair of sturdily built structural frame members **101** and **102** are disposed in face-to-face relationship and connected to each other by rigid connecting

rods **103**, **104** and **105** which are attached to arcuate portions of the structural frame members **101** and **102** which are slightly smaller than semi-circular portions thereof. This arrangement is sufficiently stable to securely support the photosensitive drum as a whole. The connecting rods **103**, **104** and **105** are lopsidedly connected to the frame members **101** and **102** as aforementioned in order that the screen **113** may have the greatest possible effective area.

The structural frame member **101** is formed on its outer peripheral surface with a circumferentially disposed groove **101***a* of a small width, and oppositely facing cutouts **101***b* and **101***c* are formed on a portion of the outer peripheral surface of the member **101** disposed inwardly of the groove **101***a* in positions which correspond to the positions in which the connecting rods **103** and **105** are secured to the member **101**. A stopper **106** having a pin **106***a* is adjustably mounted in the cutout **101***b* by a screw (not shown), and a pin **107** is attached to the other cutout **101***c*.

On the opposite side, a ring-shaped adjusting frame member **108** of relatively small width, formed with oppositely facing cutouts **108***a* and **108***b* in positions in its outer peripheral surface corresponding to the positions in which the connecting rods **103** and **105** are disposed, is arranged inwardly of the structural frame member **102**. The adjusting frame member **108** is adjustably connected to the structural frame member **102** by a plurality of equidistantly-spaced adjusting bolts **109**. Cutouts are formed in positions on the outer peripheral surface of the ring-shaped adjusting frame member **108**, corresponding to the positions in which the connecting rods **103** and **105** are disposed, for receiving the connecting rods therein. A stopper **110** having a pin **110***a* is adjustably mounted in the cutout **108***a* of the ring-shaped adjusting frame member **108** by a screw **111** (see FIG. **13**) in the same manner as the stopper **106** is mounted in the cutout **101***b*. Similarly, a pin **112** is attached to the cutout **108***b* in the manner of pin **107** in cutout **101***c*.

A screen **113** produced in the same manner as described previously is mounted on the frame members **101** and **108** in a process presently to be described in one modification of the apparatus and method according to this invention, so as to provide a screen drum. Opposite end marginal portions of the screen **113** spaced apart lengthwise of the screen from each other are folded twice or three times to form folded portions **113***a* and **113***b*, and attaching strips **114** and **115** of small width which may be made of metal are secured, as by soldering, to opposite side marginal portions of the screen **113** spaced apart across the width of the screen from each other. The attaching strips **114** and **115** which have a length slightly greater than the length of the screen **113** are slightly bent at their outer marginal portions to form engaging portions **114***a* and **115***a* (See FIG. **14**).

Openings **114***b* and **114***c* and **115***b* and **115***c* are formed on opposite end portions of the attaching strips **114** and **115**, respectively, for receiving the pins **106***a* and **107**, and **110***a* and **112**, respectively. The screen **113** is mounted on the structural frame member **101** and ring-shaped adjusting frame member **108** (see FIG. **13**) by first inserting the pins **107** and **112** in the openings **114***c* and **115***c* and then fitting the engaging portions **114***a* and **115***a* in the circumferential groove **101***a* in the structural frame member **101** and on the outer edge of the outer peripheral surface of the frame member **108** respectively.

After the screen **113** is mounted on the structural frame member **101** and ring-shaped adjusting frame member **108**, the pins **106***a* and **110***a* are inserted in the openings **114***b* and **115***b* respectively and the positions of the stoppers **106** and **110** are adjusted as by threading the screw **111** into the cutout **108***a*, so as to spread the screen taut lengthwise thereof. The screen is thus spread taut lengthwise thereof on the frame members **101** and **108** by the difference in tensile force exerted on its outer peripheral surface and inner peripheral surface.

On the other hand, the screen **113** can be spread taut across the width thereof by moving the adjusting bolts **109** so as to adjust the position of the ring-shaped adjusting frame member **108** with respect to the frame member **101** thereby spreading the screen **113** across its width (see FIG. **15**).

The screen drum produced in the manner described above is rotatably supported, when the screen drum is a photosensitive screen drum, by rollers **116**, **117**, **118**, 119, 120 and **121** shown in the dash-and-dot or broken lines in FIG. **12**. The rollers **116** and **117** are maintained in pressing engagement with the outer peripheral surface of the structural frame member **101** and the roller **120** is maintained in pressing engagment with the inner peripheral surface thereon so as to hold the frame member **101** therebetween. Similarly, the rollers **118** and **119** are maintained in pressing engagement with the outer peripheral surface of the frame member **108** and the roller **121** is maintained in pressing engagement with the inner peripheral surface thereof so as to hold the member **108** therebetween. The screen drum can be held against movement axially thereof by rollers (not shown) maintained in the engagement with end surfaces of the structural frame members **101** and **102**. A relief cam **122** of crescent shape is shown provided on the inner end surface of the structural frame member **101**, and a gear **123** is shown mounted on the outer end surface thereof to satisfy other requirements of designing.

In the modification of the apparatus and method according to this invention described above, the structural frame members **101** and **102** are shown and described as ring-shaped or annular in shape. The invention is not limited to this specific form of the frame members **101** and **102**, and members of any form may be used as desired. The structural frame member **101** is shown as being integrally formed with a ring-shaped adjusting frame member. However, the frame member **101** and the adjusting frame member may be formed separately in two pieces and connected together in combination as are the other structural frame member **102** and the adjusting support member **108**.

The bent outer marginal portions of the attaching strips serving as engaging portions have a height which is greater than the thickness of the attaching strips. However, since the ring-shaped frame member has a large diameter, the screen can be readily mounted on the frame members.

FIG. **16** shows an alternate form of engaging portion wherein a number of pins **124** attached to an attaching strip **123** secured to a screen **122** serve as engaging portions. The pins **124** are adapted to be received in corresponding openings **125***a* formed in a ring-shaped adjusting frame member **125** (see FIG. **17**) when the

screen **122** is mounted on the frame members. The engaging portions of this form are effective to readily produce a screen drum by mounting a screen on the frame members. An opening **123***a* formed at an end portion of the attaching strip **123** serves the same purpose as the openings **114***b*, 114*c*, 115*b* and **115***c* formed in the attaching strips **114** and **115**. An end portion of the screen **122** is folded like the screen **113** to provide a folded portion **122**.

FIG. **18** shows another modification of the apparatus and method according to this invention for producing a screen drum. In FIG. **18**, a ring-shaped adjusting frame member **127** is provided outwardly of a main structural frame member **126** so that a screen **128** is mounted on the ring-shaped adjusting frame member **127**. In this modification, screws **129** for moving the frame member **127** toward or away from the main frame member **126** threadably extend through the frame member **127** into engagement at their front end portion in openings formed in the frame member **126**. When it is desired to spread the screen **128** taut across the width thereof, the screws **129** are turned to move the adjusting frame member **127** outwardly away from the main frame member **126**. It is to be understood that according to this invention any other means than the screws **129**, such as means using springs and pins, for example, may be used for moving the adjusting frame member **127** toward or away from the main frame member **126**.

The apparatus and method according to this invention and the modifications thereof which are shown and described herein may be used for producing a screen drum comprising a screen made of a synthetic resinous material as well as stainless steel of aforementioned. The screen drum produced by this invention and the modifications thereof can be used not only in electrophotographic copying but also in any other fields in which a screen drum formed with a multitude of very small openings in its outer periphery is needed. In case no adjustments of the spread of the screen across the width thereof are required, the structural frame members and ring-shaped frame members may be formed integrally in one piece as a drum framework. The drum framework may be a cylindrical member formed with openings therein.

What is claimed is:

1. A photosensitive screen drum for use in noncontact electrostatic printing comprising:

a. two main frame members;

b. spacing means rigidly connecting said main frame members in spaced face-to-face relationship to form a drum framework;

c. a screen member having a photoconductive material layer on one side thereof;

d. attaching strips secured to each of two opposite marginal portions of said screen member and having a plurality of engaging means thereon;

e. at least one circular adjusting frame member;

f. means spaced on the outer peripheries of said adjusting frame member and one of said two main frame members and cooperating with said engaging means for fastening said attaching strips respectively to said adjusting frame member and to one of said two main frame members whereby said screen may be tensioned circumferentially; and

g. means for adjustably connecting said adjusting frame member to the other of said two main frame members for axial movement with respect to the drum framework whereby said screen member may be adjustably tensioned across the width of the screen drum.

2. A screen drum as in claim **1** in which said screen is provided on the other surface thereof with an insulating material layer.

3. A screen drum as in claim **1** wherein said engaging means comprises screw means and said cooperating means comprises receptacles for said screw means, so that in circumferential tension of said screen member may be adjusted.

4. A screen drum as in claim **3** wherein said screw means are positioned adjacent the opposite ends of said attaching strips.

5. A screen drum as in claim **1** further comprising bent portions on the outer edges of said attaching strips for engaging the outer end surfaces of said frame members.

* * * * *