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(54) **Segmented coronode scorotron.**

(57) A segmented coronode scorotron charging device (90) comprising a coronode wire (92) that is zig zagged with respect to the direction of travel of a charge receptor in order to reduce the effective distance between "hot spots" in the wire and thereby insure uniform charging of the receptor, and to reduce the length of coronode wire between support points, thereby eliminating sagging, singing, and tensioning problems and providing a scorotron of unlimited length.

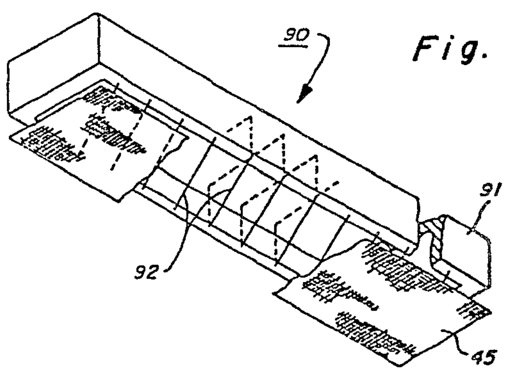

Fig. 3

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SEGMENTED CORONODE SCOROTRON

This invention relates to a compact corona device for charging a surface uniformly with either positive or negative ions.

Corona charging xerographic photoconductors has been disclosed in U.S. Patent 2,588,699. It has always been a problem that current levels for practical charging require coronode potentials of many thousands of volts, while photoconductors typically cannot support more than 1000 volts surface potential without dielectric breakdown.

One attempt at controlling the uniformity and magnitude of corona charging is disclosed in U.S. Patent 2,777,957 which makes use of an open screen as a control electrode, to establish a reference potential, so that when the receiver surface reaches the screen voltage the fields no longer drive ions to the receiver, but rather to the screen. Unfortunately, a low porosity screen intercepts most of the ions, allowing a very small percentage to reach the intended receiver. A more open screen will deliver charge to the receiver more efficiently, but compromises the control function of the device.

Further, problems with negative charging systems have been troublesome historically in charging a receptor uniformly. Some such systems involves the use of wires spaces at large distances from the receptor and thereby requiring high voltages. Charging units and power supplies therefore, are relatively large and consume considerable space in copying machines.

Other methods exist for trying to obtain uniform charging from negative charging systems such as dicorotron charging devices as shown in U.S. Patent 4,086,650 that include glass coated wires and large specialized AC power supplies. A simpler system includes a screened corotron which is usually referred to as a scorotron. However, these methods are well know for being inefficient, but uniform charging units requiring slower charging speeds.

Accordingly, in answer to the above-mentioned problems and in one aspect of the present invention there is provided a compact scorotron charging device for uniformly charging a photoconductive surface (16), comprising:

a partially enclosed non-conductive shield (41 or 91);

corona emitting means (42 or 92) positioned within said shield, and screen means (45) interposed between said corona emitting means and said photoconductive surface characterized by said corona emitting means having a uniform zig zag configuration in order to reduce the effective distance between hot spots and sagging of said corona emitting means; photoconductive surface. With this configuration the effective distance between hot spots in the wire is reduced thereby insuring uniform charging.

This invention enables more uniform charging of photoconductors at high speeds and with greater stability, lower manufacturing costs and service and less sensitivity to wire sagging, vibration and arcing. This also provides greater latitude in tensioning the coronode wire and provides a means of making scorotrons of indefinite length.

The scorotron may employ a helically wound coronode wire that is supported by an insulating support to provide free standing segments.

Embodiments of the instant invention will be described with reference to the accompanying drawings in which:

Figure 1 is a schematic elevational view of an electrophotographic printing machine incorporting the features of the present invention.

Figure 2 is a partial enlarged plan view of a corona wire that is angled with respect to the direction of travel in accordance with one aspect of the present invention.

Figure 3 is a schematic side view of an alternative embodiment of the scorotron of the present invention depicting a corona wire helically wound around an insulating support.

Figure 4 is a graph that shows how the region of overlays of the helical wire in Figure 3 should be adjusted for uniform charge distribution.

Figures 5 and 6 show an embodiment of the present invention where half of each segment of a coronode wire is overlapped in order to provide redundancy.

While the invention will be described hereinafter in connection with preferred embodiments, it will be understood that it is not intended to limit the invention to these embodiments. On the contrary, it is intended to cover all alternatives, modification and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

For a general understanding of an electrophotographic printing machine in which the features of the present invention may be incorporated, reference is made to Figure 1 which depicts schematically the various components thereof. Hereinafter, like reference numerals will be employed throughout to designate identical elements. Although the apparatus of the present invention is disclosed as a means for charging a photosensitive member, it should be understood that the invention could be used in an electrophotographic environment as a pre-cleaning, transfer or detack device, or in any apparatus where uniform surface potential is desired or required.

Since the practice of electrophotographic printing is well known in the art, the various processing stations for producing a copy of an original document are represented in Figure 1 schematically. Each process station will be briefly described hereinafter.

As in all electrophotographic printing machines of the type illustrated, a drum 15 having a photoconductive surface 16 entrained about and secured to the exterior circumferential surface of a conductive substrate is rotated in the direction of arrow 12 through the various processing stations. By way of example, photoconductive surface 16 may be made from selenium of the type described in U.S. Patent 2,970,906. A suitable conductive substrate is made from aluminum.

Initially, drum 15 rotates a portion of photoconductive surface 16 through charging station A. Charging station A employs a corona generating device in accordance with the present invention, indicated generally by the reference numeral 40, to charge photoconductive surface 16 to a relatively high substantially uniform potential.

Thereafter drum 15 rotates the charged portion of photoconductive surface 16 to exposure station B. Exposure station B includes an exposure mechanism, indicated generally by the reference numeral 17, having a stationary, transparent platen, such as a glass plate or the like for supporting an original document thereon. Lamps illuminate the original document. Scanning of the original document is achieved by oscillating a mirror in a timed relationship with the movement of drum 15 or by translating the lamps and lens across the original document so as to create incremental light images which are projected through an apertured slit onto the charged portion of photoconductive surface 16. Irradiation of the charged portion of photoconductive surface 16 records an electrostatic latent image corresponding to the information areas contained within the original document.

Drum 15 rotates the electrostatic latent image recorded on photoconductive surface 16 to development station C. Development station C includes a developer unit, indicated generally by the reference numeral 19, having a housing with a supply of developer mix contained therein. The developer mix comprises carrier granules with toner particles adhering triboelectrically thereto. Preferably, the carrier granules are formed from a magnetic material with the toner particles being made from a heat fuseable plastic. Developer unit 19 is preferably a magnetic brush development system. A system of this type moves the developer mix through a directional flux field to form a brush thereof. The electrostatic latent image recorded on photoconductive surface 16 is developed by bringing the brush of developer mix into contact therewith. In this manner, the toner particles are attracted electrostatically from the carrier granules to the latent image forming a toner powder image on photoconductive surface 16.

With continued reference to Figure 1, a copy sheet is advanced by sheet feeding apparatus 32 to transfer station D. Sheet feed apparatus 32 advances successive copy sheets to forwarding registration rollers 35 and 36. Forwarding registration roller 35 is driven conventionally by a motor (not shown) in the direction of arrow 13 thereby also rotating idler roller 36 which is in contact therewith in the direction of arrow 14. In operation, feed device 32 operates to advance the uppermost substrate or sheet from stack 33 into registration rollers 35 and 36 and against registration fingers 38. Fingers 38 are actuated by conventional means in timed relation to an image on drum 15 such that the sheet resting against the fingers is forwarded toward the drum in synchronism with the image on the drum. A conventional registration finger control system is shown in U.S. Patent 3,902,715. After the sheet is released by fingers 38, it is advanced through a chute formed by guides 50 and 51 to transfer station D.

Continuing now with the various processing stations, transfer station D includes a conventional corona generating device 55 which applies a spray of ions to the back side of the copy sheet. This attracts the toner powder image from photoconductive surface 16 to the copy sheet.

After transfer of the toner powder image to the copy sheet, the sheet is advanced by endless belt conveyor 60, in the direction of arrow 11, to fusing station E.

Fusing station E includes a fuser assembly indicated generally by the reference numeral 70. Fuser assembly 70 includes a fuser roll 71 and a backup roll 72 defining a nip therebetween through which the copy sheet passes. After the fusing process is completed, the copy sheet is advanced by conventional rollers 75 and 76 to catch tray 78.

Invariably, after the copy sheet is separated from photoconductive surface 16, some residual toner particles remain adhering thereto. Those toner particles are removed from photoconductive surface 16 at cleaning station F. Cleaning station F includes a corona generating device (not shown) adapted to neutralize the remaining electrostatic charge on photoconductive surface 16 and that of the residual toner particles. The neutralized toner particles are then cleaned from photoconductive surface 16 by a rotatably mounted fibrous brush (not shown) in contact therewith. Subsequent to cleaning, a discharge lamp (not shown) floods photoconductive surface 16 with light to dissipate any residual electrostatic charge remaining thereon prior to the charging thereof for the next successive imaging cycle.

It is believed that the foregoing description is sufficient for purposes of the present application to illustrate the general operation of an electrophotographic printing machine. Referring now to the subject matter of the present invention, Figure 2 depicts the corona generating scorotron device 40 in greater detail.

Referring specifically to Figure 2, the detailed structure of the scorotron will be described. The segmented coronode scorotron unit, generally referred to as 40, is positioned above the photosensitive surface 16 and is arranged to deposit an electrical charge thereon as the surface 16 moves in a clockwise direction. The corona unit includes a shield member 41 as shown in Figure 1 that encloses a substantial portion of coronode wire

42. Wire 42 is adapted to have active regions that give off corona emissions and support regions that anchor the wire. The shield is preferably made from an electrically conductive material that is biased with respect to ground at 43 by conventional means. A slit or opening is formed in the bottom of the shield opposite the moving photoconductor or photoreceptor 15 and provides a path by which ions flow from coronode 42 through control screen 45 onto photoconductive surface 16. For further details regarding the structure of a conventional corona unit, reference is had to the disclosure in U.S. Patent 4,112,299.

The corona generating wire 42 is connected by suitable means such as an electrical connector to a high potential source or power supply 43. The corona wire utilized in this embodiment is connected directly to the negative terminal of the power source whereby negative ion discharge is placed on the photosensitive surface 16. However, it should be clear that an opposite polarity can be employed to obtain positive discharge. The wire is spaced about 3/32" to 1/8" away from screen 45. As corona units of more than ten inches are required for copying machines, these low tolerance dimensions become sensitive to wire sagging, vibration and arcing. Also, corona for negative charging tends to be spotty, i.e., emission points are seen at intervals of about 1 cm. To correct these problems corona wire 42 is angled at an angle Θ from the direction of travel to reduce the effective distance d between "hot spots" to d $\cos\Theta$. Also, with zig zagging, the coronode spans a very short distance at a time, therefore, sagging and "singing" are negligible.

An alternative corona generating scorotron 90 is shown in Figure 3 and comprises a wire 93 (1 to 4 mil diameter) that is helically wound on an insulating support so that charging regions of the wire overlap and give support to free standing segments. The insulating support includes two U-shaped channel members shown molded together in Figure 3 that are made of plexiglass, polycarbonate, or the like. A screen 45 encloses the wire to form a scorotron unit. The region of overlap of the helically wound wire must be carefully adjusted to insure a uniform charge distribution on the receiver. For example, with reference to Figure 4, with segment "A" charging as shown, segment "B" must be spaced so that the sum of "A" + "B" is constant. In this Figure, X is the length of the coronode wire and V_S

is the surface potential of photoconductive surface 16.

In Figures 5 and 6 an embodiment of the present invention is shown where each segment of a coronode wire is overlapping half of the adjacent segment to provide redundancy to enchance the smoothing of "hot spots" in the coronode. This embodiment gives a great amount of redundancy because it adds the corona currents from two wires, i.e., a straight line drawn from a to a' will go through two wires (in this example wire segments B and C) for better averaging. It should be understood that the overlap of the coronode wire could be by 2/3 or another fraction if one desired. The coronode wire could either be helically wound on an insulating support as shown in Figure 3, or be supported by end blocks as shown in Figure 2.

In summary, a corotron/scorotron design is disclosed in which the coronode wire is supported in short segments which are angled to the conventional wire direction. The segments are positioned so that their output currents overlap to deliver uniform current along the length of the device. Since the wire segments span short distances, singing and sagging are reduced. The use of fine wires and close spacings are made readily viable with this design. The charging redundancy of overlapping segments serves to smooth out "hot spot" effects.

Claims:

1. A compact scorotron charging device (40 or 90) for uniformly charging a photoconductive surface (16), comprising:

a partially enclosed non-conductive shield (41 or 91);

corona emitting means (42 or 92) positioned within said shield, and screen means (45) interposed between said corona emitting means and said photoconductive surface characterized by said corona emitting means having a uniform zig zag configuration in order to reduce the effective distance between hot spots and sagging of said corona emitting means.

2. A compact scorotron charging device (40 or 90) for uniformly charging a photoconductive surface (16), comprising:

a partially open non-conductive housing (41 or 91);

corona generating means (42 or 92) mounted within said non-conductive housing in a zig-zag configuration such that a portion of said corona generting means is exposed through the open portion of said non-conductive housing;

means for applying a bias to said corona generating means; and

screen means (45) adapted to enclose said open portion of said non-conductive housing facing said photoconductive surface, said screen means having a bias applied thereto to provide control for voltage to be applied to the photoconductive surface.

3. The scorotron charging device of Claim 1 or Claim 2, wherein said corona emitting means is a wire.

4. The scorotron charging device of Claim 3, wherein said wire is helically wound within said non-conductive housing such that non-enclosed areas of said wire produces overlapping corona emissions on the surface of the photoconductive surface.

5. The scorotron charging device of Claim 3 or Claim 4, wherein said wire produces corona emissions that overlap by one half.

6. The scorotron charging device of Claim 3 or Claim 4, wherein said wire produces corona emissions that overlap by two thirds.

7. The scorotron charging device of any preceding claim, wherein said zig-zag configuration of said corona generating means includes both active and support regions with said active regions being angled with respect to the direction of relative motion of the photoconductive surface while said support regions are orthogonal to said direction of relative motion of the photoconductive surface.

8. The scorotron charging device of any preceding claim, wherein said photoconductive surface includes any insulating charge receiving surface.

9. The scorotron charging device of any preceding claim, wherein said screen is supported by said non-conductive shield.

10. A compact scorotron charging device for uniformly charging an insulating surface (16) comprising;

corona emitting means (42 or 92) positioned adjacent said insulating surface (16);

said corona emitting means having a uniform zig zag configuration in order to reduce the effective distance between hot spots and sagging of said corona emitting means; and

screen means (45) interposed between said corona emitting means and said insulating surface.

Fig. 1

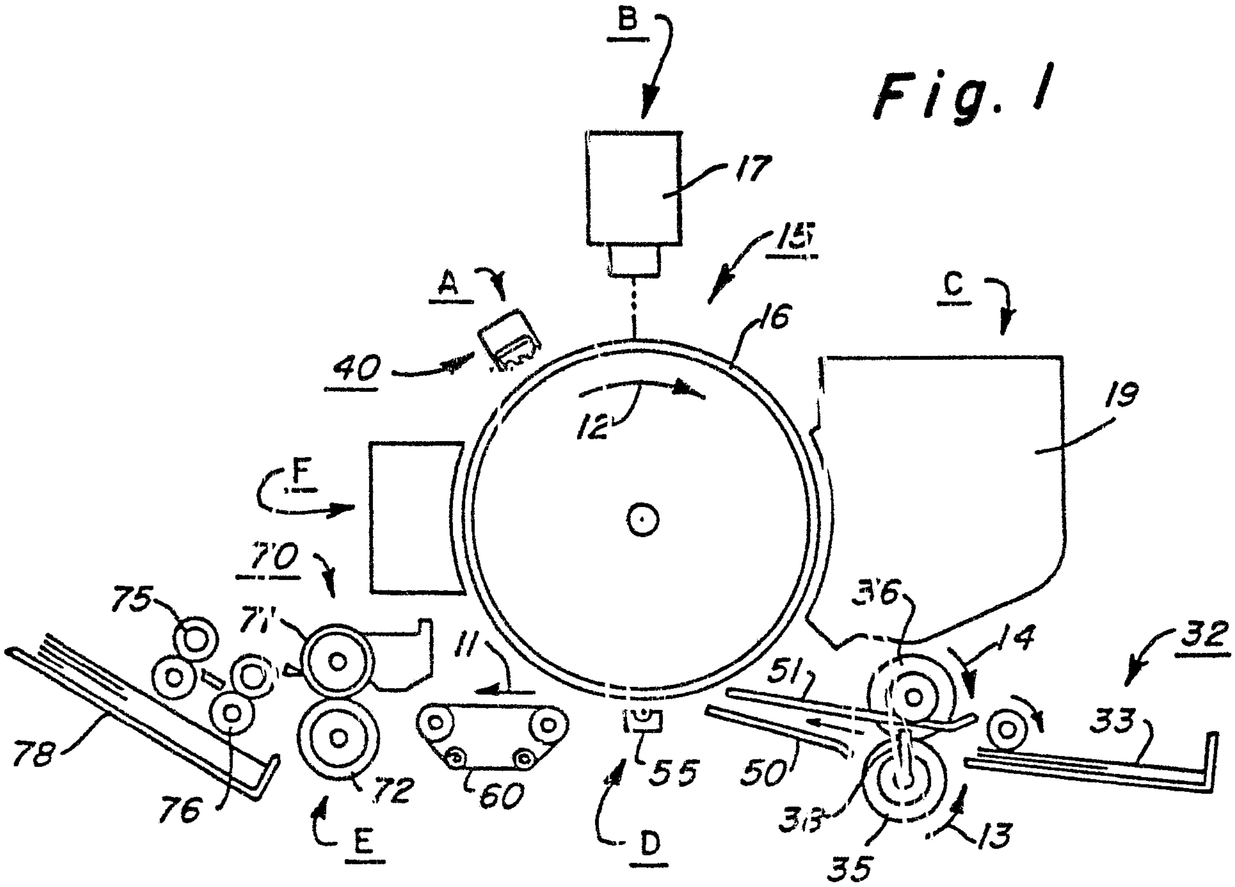
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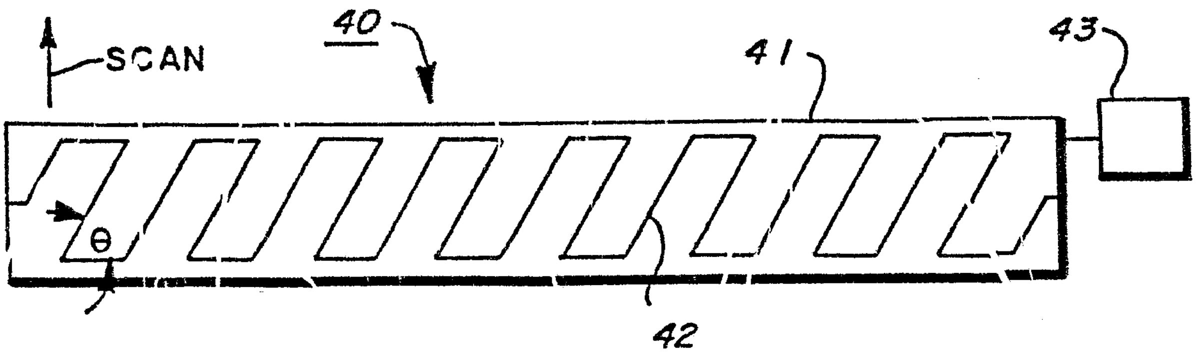
Fig. 2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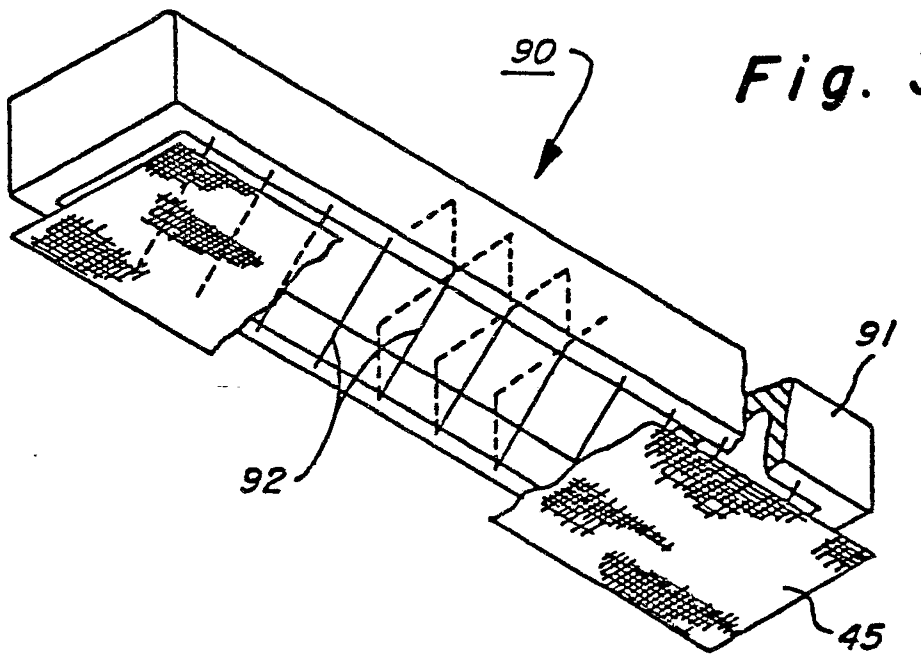
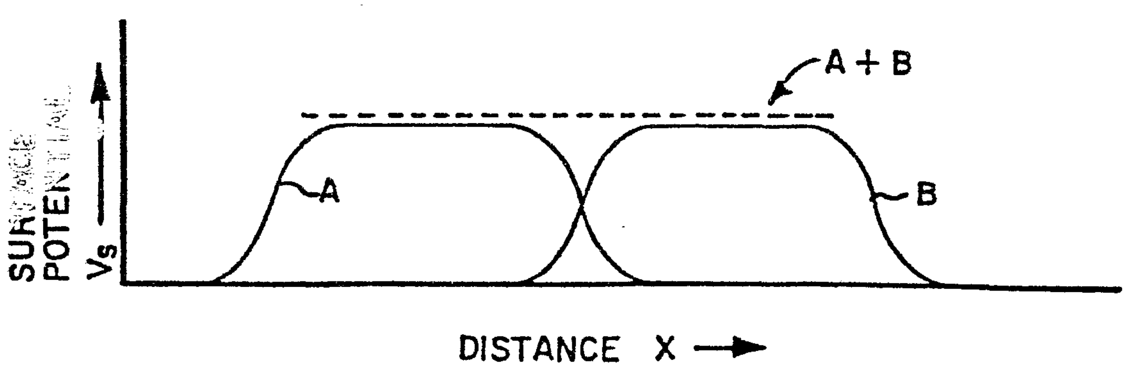


Fig. 3

Fig. 4



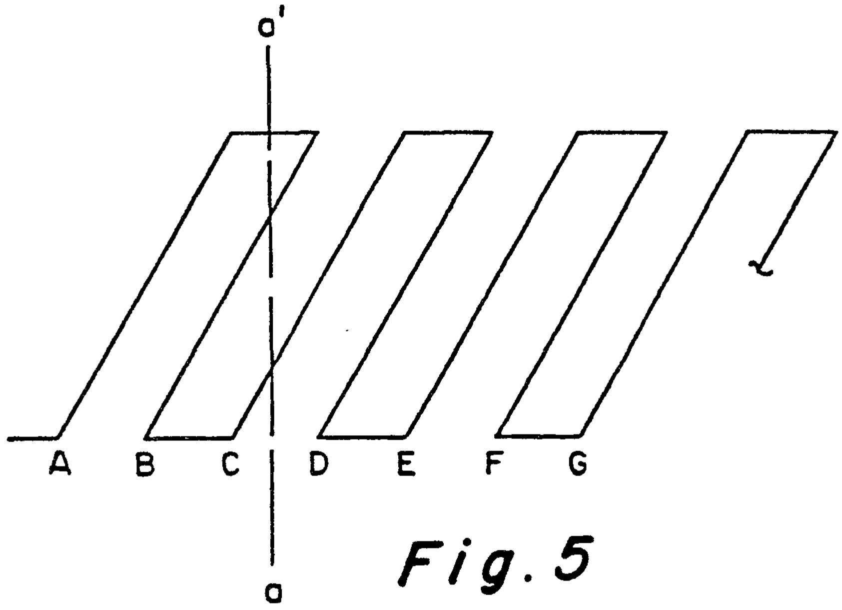


Fig. 5

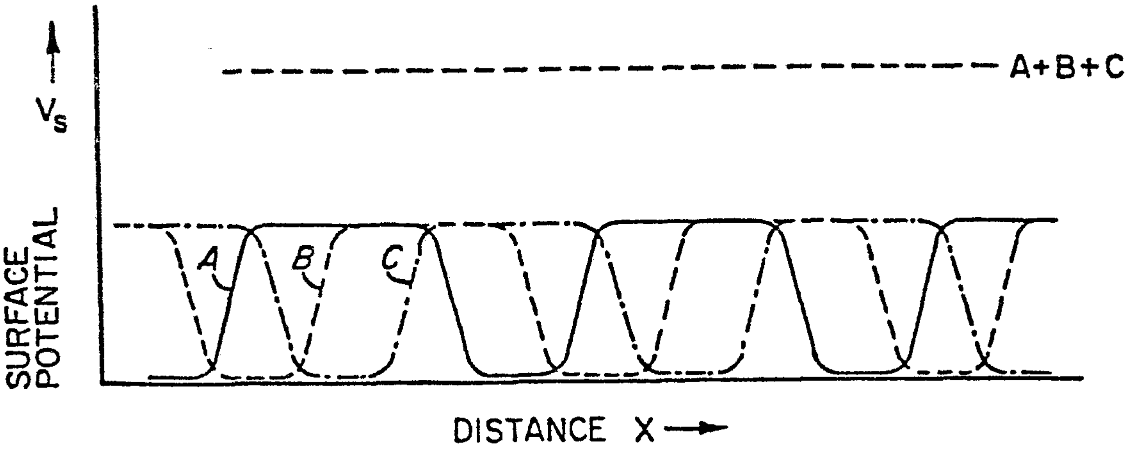


Fig. 6